NOAA Deep-Sea Coral and Sponge Ecosystems Exploration and Research Priorities Workshop for Alaska
Anchorage, Alaska
September 14-15, 2010

Background

NOAA's Deep Sea Coral Research and Technology Program (DSCRTP) was established under Section 408 of the 2006 Magnuson-Stevens Reauthorization Act (Public Law 109-479). In 2009 NOAA received $1.5 million to begin implementing field research efforts as part of the program. Initial efforts focused on a single region (South Atlantic) with the intent that funding would be for three years and rotate to other regions (e.g. West Coast 2010 and Alaska 2012) as funding levels allowed. To maximize the opportunity to meet the requirements of the DSCRTP, NOAA is conducting regional exploration and research priorities workshops to inform investment strategies for the regional three-year field research efforts.

On September 14-15, 2010, scientists and resource managers met in Anchorage, Alaska 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 in the waters off Alaska. The goal of the workshop was to develop a three-year exploration and research priorities plan. Workshop participants represented a broad range of stakeholders including the Federal government, the North Pacific Fishery Management Council (NPFMC), academia, private industry, and non-governmental organizations (see Appendix A for a list of participants).

Accomplishments

Workshop results included: (1) identifying a core list of critical information needs related to locating, mapping and modeling deep-sea corals; understanding deep-sea coral biology and ecology; and understanding and managing the impacts of human activities on deep-sea coral ecosystems; (2) identifying that key data sets exist and need to be analyzed to help refine the location of research targets prior to commencing field activities in 2012; and (3) identifying initial research activities and geographical targets for meeting scientific and management needs in Alaska. The information collected at the workshop will be used as a guiding framework to improve our knowledge, conservation and management of deep-sea coral and sponge ecosystems in Alaska waters.

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

Overview

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 cooperative 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.

Section II lays out objectives and approaches that NOAA will undertake to enhance protection of deep-sea coral and sponge ecosystems in collaboration 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 objectives to enhance international conservation of deep-sea coral and sponge ecosystems. Those objectives are to 1) promote international partnerships to conserve deep-sea coral and sponge ecosystems through the management of deep-sea fisheries activities impacting those resources; 2) ensure that international trade of deep-sea coral and sponge species, and their parts and products, is sustainable; and 3) increase international exploration and research of 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 the 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 primarily on Section I (Exploration and Research Strategy) of the Strategic Plan to identify critical information needs for waters under U.S. jurisdiction off the coast of Alaska.

About the Workshop

The goal of the workshop was to identify exploration and research priorities for three years, commencing in Fiscal Year (FY) 2012, that address management needs for deep-sea coral and sponge ecosystems in the waters off the Alaska coast. The workshop was scheduled in FY 2010 to maximize planning and execution of exploration and research activities in FY 2012 – a benefit not previously afforded to the South Atlantic and West Coast Regions. The workshop was organized by NOAA's CRCP and the Alaska Fisheries Science Center (AFSC). A Steering Committee (Appendix A) consisting of representatives from NOAA (OAR and NMFS) and the NPFMC presided over the development of the workshop's goals, objectives, schedule, logistics, and final summary.

The workshop consisted of presentations highlighting national and regional plans, presentations to provide background information on the current state of Alaska deep-sea coral and sponge ecosystems and management activities, breakout groups to identify and refine critical information needs, and plenary discussions (Appendix B).

Presentations

To set the context for identifying critical information needs, several presentations were given to provide an overview of national and regional plans, as well as background information on the current state of Alaska deep-sea coral and sponge ecosystems and management actions.

The presentations of national and regional plans 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 2007 State of the Deep Coral Ecosystems of the United States Report;
- Research priorities identified in the AFSC FY 2011 Essential Fish Habitat (EFH) request for proposals;
- NPFMC's five-year research priorities (2010-2014);
- Research priorities identified in the North Pacific Research Board's FY 2005 Science Plan and FY 2010 request for proposals; and,
- Conservation actions pertaining to deep-sea coral habitats identified in the Alaska Department of Fish and Game (ADF&G) publication "Our Wealth Maintained: A Strategy for Conserving Alaska's Diverse Wildlife and Fish Resources".

The presentations on current knowledge of deep-sea coral and sponge ecosystems and management actions included:

- An overview of the current knowledge of deep-sea coral and sponge biology and ecology in Alaska;
- Studies on the effects of ocean acidification on deep-sea corals in the North Pacific Ocean;
- An overview of deep-sea coral research on the Gulf of Alaska seamounts;
- An overview on the ecology of North Pacific Ocean hexactinellid sponge reefs;
- A synthesis of Alaska seafloor mapping activities;
- An overview of modeling efforts to understand the spatial distribution of deep-sea corals in the North Pacific Ocean; and,
- An overview of relevant habitat management activities in Alaska.

Each presenter was asked to provide a list of key points and/or critical information needs related to their topic (Appendix C). Following the presentations, workshop participants were provided the opportunity to review and discuss, as a group, the key points/critical information needs identified during the presentations.

Breakout Group – Day 1

Workshop participants were divided into three breakout groups (Appendix D) and tasked with identifying and prioritizing a list of critical information needs. The breakout groups were instructed to use the NOAA Strategic Plan for Deep-Sea Coral and Sponge Ecosystems, the Reauthorized Magnuson-Stevens Fishery Conservation and Management Act that established the DSCRTP, and the background information provided in the presentations as guidance.

Plenary Discussion – Day 1

A rapporteur from each breakout group presented the list of critical information needs for their topic (Appendix E). Each workshop participant was then asked to identify up to three critical information needs per topic that they believed to be the highest priorities. The results of this group prioritization exercise are reviewed below.

Breakout Group – Day 2

On Day 2, the same breakout groups were tasked to develop a list of exploration and research activities for the next three years that would address the prioritized list of critical information needs. Breakout groups were asked to identify the location, methodology, time-frame, duration, and potential collaborators for projects addressing those activities. Prioritization of activities was based on whether they addressed a gap and/or management need; whether they were financially feasible;

and whether they had the potential to leverage funds and/or collaborate with other funded programs.

Plenary Discussion – Day 2

Participants reconvened in plenary session and each breakout group presented its prioritized list of exploration and research activities. During the final plenary discussion, participants focused on identifying potential opportunities and constraints that might affect the exploration and research activities. A summary of activities identified by participants is provided below under the NOAA Strategic Plan Objectives.

Critical Information Needs and Research Activities

The three overall highest priority needs identified by the participants (Table 1) were:

- Mine existing knowledge (video footage, etc.) to expand our current understanding of deep-sea coral and sponge distribution.
- Inventory and review the data resources that are available to understand deep-sea coral distribution, habitat, and species associations.
- Determine the key functions that deep-sea corals provide to managed species at different life stages.

Participants at the workshop recognized from the presentations and initial group discussions that there was a substantial amount of existing data (e.g. submersible video, multibeam bathymetry, and backscatter) that had been collected but never analyzed or otherwise processed for deep-sea coral and sponge information. The inventory and analysis of these data were highlighted by all participants as a critical information need and necessary first step to adequately address many of the program objectives. Modeling was also noted as a valuable first step (and especially important given the size of the Alaska Exclusive Economic Zone) to help identify targets for new field surveys of deep-sea coral and sponge habitats. However, the targets identified through modeling need to be ultimately ground-truthed with *in situ* methodology. Lastly, participants noted that those critical information needs that were rated as a low priority should not be eliminated from consideration, as they were indeed important but perhaps not the highest priority at this time.

The following section summarizes the critical information needs and specific research activities developed by the participants as they relate to the exploration and research objectives in NOAA's Strategic Plan for Deep-Sea Coral and Sponge Ecosystems.

Relevance to NOAA's Strategic Plan for Deep-Sea Coral and Sponge Ecosystems

Objective #1: Locate and Characterize Deep-sea Coral and Sponge Ecosystems

Alaska is the largest state in the U. S. and contains more than 66% of the nation's continental shelf habitat. The region has a highly varied submarine bathymetry owing to the numerous geological and physical processes at work. Deep-sea corals and sponges are widespread throughout Alaska, including the continental shelf and upper slope of the Gulf of Alaska, the Aleutian Islands, the eastern Bering Sea, and extending as far north as the Beaufort Sea. Deep-sea coral and sponge distribution, abundance and species assemblages differ among geographic regions. Dedicated submersible and other *in situ* surveys of deep-sea coral and sponges habitats have been completed in a few high-priority locations but most information on deep-sea coral and sponge distribution in Alaska is based on fisheries bycatch and stock assessment survey data. Consequently, our knowledge of deep-sea coral and sponge distribution is largely limited, and somewhat biased, to those geographic areas and depth zones where fisheries and stock assessment surveys have occurred.[1]

Critical Information Needs

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

- Mine existing knowledge to increase our understanding of deep-sea coral and sponge distribution.[2]
- Develop a taxonomically accurate geospatial database (including coral absences) for use in predictive models of deep-sea coral and sponge distribution.
- Construct predictive deep-sea coral habitat models and test and refine the list of model parameters.
    - Develop models for the western Aleutian Islands and Gulf of Alaska.
- Analyze the data resources available to understand deep-sea coral distribution, habitat, and species associations.
- Determine the location of areas of highest deep-sea coral and sponge bycatch and diversity.
- Determine the overall inventory of deep-sea coral and sponge resources.

Activities

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

[2]Mining of existing knowledge was highlighted by all participants as a critical information need necessary to adequately address all program objectives.

Workshop participants identified the following activities as they relate to this NOAA Strategic Plan objective. The emphasis was on assessment of existing information to determine which areas may contain valuable and potentially vulnerable deep-sea corals and sponge ecosystems, and to avoid duplication of previous efforts.

Inventory data sets

- Video inventory to include: 1) *Delta* dives collected by the Auke Bay Labs (ABL) and ADF&G; 2) *Jason II* dives collected by ABL and by other groups through the National Undersea Research Program (NURP); 3) *Alvin* dives collected by the Office of Ocean Exploration and NURP; 4) deep-water remotely operated vehicle dives collected by multiple agencies; and, 5) other footage (e.g. NOAA and ADF&G towed camera arrays).
- Records analysis to include: 1) archived specimen records from the National Museum of Natural History (Smithsonian), California Academy of Sciences, and ABL; 2) trawl survey bycatch data maintained by the Resource Assessment and Conservation Engineering (RACE) Division's Groundfish Assessment Program of the AFSC; 3) fisheries observer bycatch records maintained through the AFSC Fisheries Monitoring and Analysis Division; 4) bycatch records from the NMFS sablefish longline survey maintained by the ABL; and 5) possible bycatch records from ADF&G and International Pacific Halibut Commission fisheries surveys.
- Seafloor mapping data inventory to include: 1) multibeam bathymetry and backscatter, side-scan, and sub-bottom profiling collected by various agencies; 2) EK60 and ME70 echosounder data collected by RACE; and 3) Alaska Region sediment database compiled by United States Geological Survey.

Data analysis

- Obtain archived data sets with metadata. Conduct a quality assurance and quality control analysis (QA/QC).
- Prioritize new analysis of archived video and analyze selected archived data.
- Process unprocessed or poorly processed data of interest (e.g., unprocessed backscatter data from NOAA hydrographic surveys).
- Complete an inventory of ground-truthed substrate habitat maps.
    - Prioritize areas that need to be ground-truthed and areas for future substrate habitat mapping.

Construct region-specific model(s)

- Develop a 1-km resolution model to define large regions with coherent deep-sea coral and sponge species assemblages, distribution patterns, and habitat associations.
- Construct region-specific habitat suitability models for two contrasting regions (e.g. central Aleutian Islands and the Gulf of Alaska).

- Validate habitat suitability model(s) with existing data to determine what new data are needed (i.e. critical gaps) to strengthen the model(s).

Objective #2: Understand the Biology and Ecology of Deep-sea Corals and Sponges

Deep-sea coral communities in Alaskan waters are highly diverse and include six major taxonomic groups. One hundred and forty-one unique coral taxa have been documented from Alaskan waters and include 11 species of stony corals, 14 species of black corals, 15 species of true soft corals (including six species of stoloniferans), 63 species of gorgonians, 10 species of sea pens, and 28 species of stylasterids. Many deep-sea corals and sponges in Alaska provide important structural habitats, and the degree to which they provide structure depends on their maximum size, growth form, intraspecific fine-scale distribution, and interaction with other structure-forming invertebrates. The rich deep-sea coral and sponge resources of Alaska provide an opportunity to make great advances in our understanding of age and growth, feeding habits and patterns, reproductive, dispersal and recruitment dynamics, and taxonomy and systematics.[3]

Critical Information Needs

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

- Inventory data resources available to understand deep-sea coral distribution, habitat, and species associations.
- Determine the population characteristics (demographics) of deep-sea corals and sponges, including growth rates, life history and reproductive traits, trophic dynamics, environmental tolerances, and population connectivity.
- Determine the species composition and community structure of deep-sea coral and sponge ecosystems.

Activities

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

Mine existing knowledge

- Determine the status of video data analysis and survey records for deep-sea coral and sponges.
- Obtain archived data sets with metadata. Conduct QA/QC.

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

- Prioritize the analysis of archived video and analyze selected archived data.

Biological studies

- Conduct studies on population characteristics (e.g. density, size-class structure) by collecting quantitative data along video transects.
- Collect samples for a range of biological data needs including reproductive biology studies, genetic studies to determine population structure and connectivity, radio isotope analysis to determine growth, stable isotope analysis to determine trophic dynamics, and an inventory of dominant fauna from each major sub-region.
- Conduct studies to determine the status (i.e. condition) of deep-sea coral and sponge communities throughout Alaska.
    - Consider using habitat impacts modeling, GIS, fishing intensity and video data.

Objective #3: Understand the Biodiversity and Ecology of Deep-sea Coral and Sponge Ecosystems

In Alaska, commercial species are managed with six Fishery Management Plans (FMPs)—Bering Sea and Aleutian Island (BSAI) Groundfish, Gulf of Alaska Groundfish, BSAI King and Tanner Crabs, Salmon, Scallops, and Arctic Fish Resources. The commercial harvest of approximately 35 species (or species groups) is specifically managed with the FMPs. Most of these species (approximately 85%) are found during some phase of their life cycle in deep-water habitats including those inhabited by deep-sea corals, so the potential for associations between commercial fish species and deep-sea corals is high.

In Alaska, many commercial and non-commercial fisheries species are associated with deep-sea corals and sponges at fine scales. Most associations are believed to be facultative rather than obligatory. Fish and crabs, particularly juveniles, use deep-sea coral habitat as refuge and as focal sites of high prey abundance. Some shelter-seeking fishes such as rockfish may use deep-sea coral habitat as spawning and breeding sites. The microbial communities supported by deep-sea corals and sponges may provide other ecosystem functions such as cycling carbon, fixing nitrogen, chelating iron, and other beneficial activities yet to be described. Future *in situ* surveys of deep-sea coral and sponge habitats should incorporate investigations of all ecosystem components and the functions that they provide.[4]

Critical Information Needs

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

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

- Determine the key functions that deep-sea corals and sponges provide to managed species at various life stages.
- Determine if the degree and function of associations vary by deep-sea coral and sponge taxa and abiotic structures (e.g. exposed bedrock devoid of emergent epifauna).
- Examine methods to standardize fish and invertebrate associations with deep-sea corals and sponges.
- Characterize deep-sea coral and sponge density to understand habitat functions.
- Determine the intrinsic value (i.e. value other than as fish habitat) of deep-sea corals and sponges.

Activities

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

Ecosystem and habitat functions

- Mine existing data to examine physiological differences between invertebrates and fishes associated with deep-sea corals and those that are not.
- Conduct studies on the community structure of representative sub-region habitats (e.g. deep-sea coral gardens and hexactinellid sponge reefs).
    - Consider conducting manipulative field studies and establishing long-term monitoring sites.
- Conduct laboratory-based controlled experiments and field research to understand how deep-sea corals function as habitat.

Objective #4: Understand the Extent and Degree of Impact to Deep-sea Coral and Sponge Ecosystems Caused by Fishing and Other Human Activities

All known threats to deep-sea coral and sponge communities in Alaska are directly or indirectly (i.e. climate change and ocean acidification) the result of human activities. While activities such as coastal development, point-source pollution, and mineral mining have the potential to affect nearshore habitats, the effects of these activities are geographically limited and occur or are likely to occur in areas with minimal coral habitat. Fishing activities, on the other hand, occur over vast areas of the seafloor and often in areas containing sensitive deep-sea coral and sponge habitat, and are presently the greatest threat to these habitats in Alaska.

Diverse benthic communities on the continental shelf and upper slope of the Gulf of Alaska, Bering Sea, and Aleutian Islands support some of the largest and most important groundfish and crab fisheries in the world. Four types of bottom-contact gear are currently used that potentially affect deep-sea coral habitat – otter trawls, longlines, pots, and scallop dredges. The degree to which a

particular gear affects deep-sea coral habitat depends on its configuration (i.e. physical area of contact), operation (i.e. physical forces on the seafloor), spatial and temporal intensity of operation, seafloor bathymetry and substratum type, and the resilience of components of benthic communities. NOAA estimates that approximately 81.5 metric tons of deep-sea coral were removed from the seafloor each year between 1997 and 1999 as commercial fisheries by-catch in Alaska. Approximately 91% of this by-catch occurred in the Aleutian Islands and Bering Sea and bottom trawls caught more than 87% of the total. Studies in the central Aleutian Islands have indicated that disturbance to the seafloor from bottom-contact fishing gear is widespread and that 8.5% of the deep-sea corals observed, mostly stylasterids and gorgonians, have been damaged or otherwise disturbed.

Since 1987, more than 1.3 million km^2 of seafloor habitat has been afforded some protection from fishing activities in Alaskan waters. Most area closures are for specific gear types only, others are seasonal, and recently some have been implemented specifically to protect sensitive seafloor habitats including deep-sea corals.[5]

Critical Information Needs

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

- Determine the recovery rates of disturbed deep-sea coral and sponge ecosystems.
- Determine whether areas that have been closed to protect deep-sea coral and sponge ecosystems are adequate and appropriate.
- Improve gear types to reduce impacts on deep-sea coral and sponge habitats.
- Establish cooperative research with fishermen to help identify deep-sea coral locations, inform survey design and ground-truth deep-sea coral locations.
- Examine whether bycatch information is useful for the management of deep-sea coral habitat.
- Examine the performance of current observer sampling protocols to improve accuracy in samples collected and determine the uses and limitations of that information.

Activities

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

Fishery closures and fishing gear effects

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

- Conduct studies on the recovery rates of deep-sea corals and sponges in representative habitats (e.g. settlement plates and establishment of long-term monitoring sites).
- Conduct comparative surveys of deep-sea coral and sponge habitat in closed and open areas.
- Ground-truth the presence of deep-sea corals via *in situ* surveys in areas that have been closed to fishing activities based on the premise that deep-sea corals "might be" located there.
- Collaborate with fishing industry participants to conduct video transect surveys in representative habitats before and after fishing survey activities or use nearby control sites as comparisons.
- Examine the effects of different gear types on deep-sea coral and sponge habitat and habitat function.

Bycatch and survey information

- Compare the catchability of deep-sea corals and sponges between commercial fishing and research survey gear.
- Create and maintain a database for all vessels in the fishing fleet to include types of gear used and specific information on gear components (e.g. foot-rope length and hook spacing).
- Determine if sub-sampling of trawl samples is representative of the entire haul, whether rare species are accounted for, and whether deep-sea corals caught in other components of the trawl gear are not being accounted for.
- Conduct studies to address the "false positive" bycatch issue using mark-and-recapture methodology.
- Develop comprehensive and easy-to-use deep-sea coral and sponge identification guides for fisheries observers and survey personnel.

Objective #5: Understand Past Oceanic Conditions and Predict the Impacts of Climate Change Using Deep-sea Corals

Climatic regime shifts and cyclic environmental fluctuations associated with Pacific Decadal Oscillations, El Nino/Southern Oscillation Climate and La Nina events have had documented effects on oceanographic and biological processes in the North Pacific Ocean. Long-term climatic change due to global warming could affect seawater temperature, salinity, density, sea level, and ambient light levels especially in shallow and nearshore waters. None of these changes is expected to cause direct mortality of deep-sea corals or significantly alter their geographic or depth distribution, but effects on growth rates and food supply (i.e. phytoplankton) are possible. Some deep-sea corals have annually-resolved skeletal organic bands making them proxies of environmental changes (e.g. temperature and nutrient levels) that can be used to reconstruct past oceanic conditions.

Increases in atmospheric carbon dioxide caused by manmade emissions have been linked to decreases in oceanic pH. Mounting evidence suggests that if carbon dioxide emissions continue as projected, undersaturated regions will develop in the sub-arctic and polar regions of Alaska by the end of the 21st century. The calcite and aragonite saturation horizons are moving to shallower depths over time, which could affect all corals in Alaska that use these minerals to build skeletal tissue. Decreases in oceanic pH and resulting decreases in calcium carbonate saturation state and calcification could have devastating effects on deep-sea corals that are dependent on the extraction of calcium carbonate from seawater for skeletal building. Deep-sea corals will be affected differently depending on their skeletal composition (aragonite versus calcite and magnesium content), geographical location, and depth. Studies were initiated in 2010 to examine the risk of Alaskan deep-sea corals to the effects of ocean acidification.[6]

Critical Information Needs

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

- Determine baseline conditions for environmental change and indices of deep-sea coral condition.

Activities

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

Past climate conditions

- Conduct studies to determine the status (i.e. baseline condition) of deep-sea coral and sponge communities throughout Alaska.
    - Establish long-term study sites to monitor environmental change and possible effects on biota.
    - Consider use of habitat impacts modeling, GIS, fishing intensity and video data.
- Collect deep-sea coral samples for paleoclimatological analysis (e.g. oceanographic conditions and nutrient levels) and forge collaborative work with experts.

Global climate change

- Conduct studies outlined in the AFSC's Ocean Acidification Research Plan for deep-sea corals.
- Construct predictive models for the western Aleutian Islands and Gulf of Alaska and refine the list of model parameters to address climate change and ocean acidification.

[6] Introductory material was taken, with some modifications, from the Alaska Region Chapter of the *State of Deep Coral Ecosystems of the United States: 2007*.

Conclusion

The Alaska Deep-Sea Coral and Sponge Ecosystems Exploration and Research Priorities Workshop brought together over 20 researchers and resource managers to identify and prioritize critical information needs to increase our understanding of deep-sea coral and sponge ecosystems in the Alaska region. Workshop participants discussed each critical information need focusing on applied research activities that would address current and future management needs. Participants realized value of coordinated approaches and activities to enhance our understanding of deep-sea corals and sponges ecosystems and advised that research efforts should be designed to provide information at regional scales rather than site-specific scales if possible.

Considerable progress was made during the two-day workshop to identify and prioritize exploration and research information needs. The information provided by the participants is an initial step that will help to inform future budget allocations, 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 in Alaska will be to provide a better understanding on the location, distribution, ecosystem role, and status of deep-sea coral and sponge habitats.

Appendix A: Participants List

NAME	AFFILIATION	EMAIL ADDRESS
Julie Bonney	Alaska Groundfish Data Bank	jbonney@gci.net
Sandra Brooke	Marine Conservation Institute	sandra.brooke@marine-conservation.org
Dave Carlile	Alaska Department of Fish and Game	dave.carlile@alaska.gov
Kim Conway	Geological Survey of Canada - Pacific	kconway@nrcan.gc.ca
Dan Dorfman	NOAA Ocean Service	dan.dorfman@noaa.gov
Peter Etnoyer	NOAA Ocean Service	peter.etnoyer@noaa.gov
Diana Evans	North Pacific Fishery Management Council	diana.evans@noaa.gov
John Gauvin	Alaska Seafood Cooperative	gauvin@seanet.com
John Guinotte	Marine Conservation Institute	john.guinotte@marine-conservation.org
Jon Heifetz	NOAA Marine Fisheries Service	jon.heifetz@noaa.gov
Tom Hourigan	NOAA Marine Fisheries Service	tom.hourigan@noaa.gov
Melissa Johnson	University of Alaska Fairbanks	majohnson16@alaska.edu
*John Olson	NOAA Marine Fisheries Service	john.v.olson@noaa.gov
Frank Parrish	NOAA Marine Fisheries Service	frank.parrish@noaa.gov
*Jennifer Reynolds	University of Alaska Fairbanks	jreynolds@guru.uaf.edu
Chris Rooper	NOAA Marine Fisheries Service	chris.rooper@noaa.gov
Mike Sigler	NOAA Marine Fisheries Service	mike.sigler@noaa.gov
Nathan Stewart	University of Alaska Fairbanks	n.stewart@sfos.uaf.edu
*Robert Stone	NOAA Marine Fisheries Service	bob.stone@noaa.gov
*John Tomczuk	NOAA Oceanic and Atmospheric Research	john.tomczuk@noaa.gov
Fan Tsao	NOAA Marine Fisheries Service	fan.tsao@noaa.gov
Jon Warrenchuk	Oceana	jwarrenchuk@oceana.org
*~Dave Witherell	North Pacific Fishery Management Council	david.witherell@noaa.gov

*Workshop Steering Committee Member
~Not in Attendance

Appendix B: Workshop Agenda

NOAA Alaska Region Deep-Sea Corals
Exploration and Research Priorities Workshop
September 14-15, 2010
Anchorage, Alaska
Agenda

GOAL:

- To develop a three-year exploration and research action plan for deep-sea corals and sponges in the Alaska Region that addresses resource management needs.

OBJECTIVES:

- Review existing knowledge on deep-sea coral and sponge biology and ecology and the state of current management of deep-sea coral and sponge habitats.
- Identify critical exploration and research information needs.
- Develop a concise description of priority activities that will address those needs.

Day 1 – Identifying Deep-Sea Coral and Sponge Critical Information Needs

8:00 Registration and Coffee

8:30 Welcome, Meeting Logistics, Review of Objectives and Agenda (Bob Stone)

8:45 Presentation on NOAA's Deep-Sea Coral Program and Overview of NOAA's Deep-Sea Coral and Sponge Strategic Plan (Tom Hourigan)

9:30 Review of Relevant Science Plans (Bob Stone)

9:45 Overview of Current Knowledge of Coral and Sponge Biology and Ecology (Bob Stone)

10:15 Overview of Current Knowledge of Ocean Acidification Effects on North Pacific Corals (John Guinotte)

10:25 Break

10:45 Overview of Gulf of Alaska Seamounts Research Activities (Peter Etnoyer)

11:00 Overview of Hexactinellid Sponge Ecology and Habitats (Kim Conway)

11:15 Overview of Seafloor Mapping Activities (Jon Heifetz)

11:30 Overview of Coral Habitat Modeling Efforts (John Guinotte)

11:45 Overview of Coral Habitat Management Activities (John Olson)

12:00 Lunch

1:15 Review of Critical Information Needs (Plenary)

1:45 Refinement of Critical Information Needs (Breakout Groups)

3:15 Break

3:35 Breakout Group Presentations of Critical Information Needs (Plenary)

4:20 Prioritization of List of Critical Information Needs (Plenary)

5:20 Review of Day 1 Accomplishments and Next Steps for Day Two (John Olson)

5:25 Adjourn

Day 2 – Planning Research Activities for Deep-Sea Corals and Sponges

8:30 Review Agenda for Day 2 and Briefly Review List of Critical Information Needs (John Olson)

8:45 Development of Exploration and Research List of Activities (Breakout Groups)

10:50 Break

11:10 Breakout Group Presentations of Lists of Exploration and Research Activities, and Begin Plenary Discussion (Plenary)

12:00 Lunch

1:15 Identify Opportunities and Constraints for Activities (Plenary)

- Refine Exploration and Research Activities

2:45 Accomplishments and Next Steps (Tom Hourigan)

3:00 Adjourn

Appendix C: Critical Information Needs Identified by Presenters

Current Knowledge of Coral and Sponge Biology and Ecology

- Develop taxonomic expertise and partnerships for deep-sea corals especially for true soft corals (Order Alcyonacea) and sea pens (Order Pennatulacea).
- Explore and develop new growth rates techniques. Most deep-sea corals and sponges are relatively slow growers (on the order of 1-2 cm per year).
- Conduct size-dependent growth rates studies.
- Prioritize deep-sea corals and sponges for applied studies based on their abundance and importance as habitat (primnoid corals and demosponges are the most diverse and abundant fauna).
- Investigate reproduction, recruitment and dispersal of deep-sea corals and sponges.
- Conduct habitat impacts studies particularly in the Aleutian Islands on all gear types and include tests of gear modifications to reduce interactions with deep-sea corals and sponges.
- Conduct cooperative studies with fishing industry participants.
- Determine the function of species associations with deep-sea corals and sponges with carefully designed behavior studies.
- Develop updated deep-sea coral and sponge guides and make them available to fisheries and survey personnel.
- Conduct companion studies with collected specimens on marine natural products, paleoclimatological data, microbial ecology, molecular genetics, and micro-faunal associates.

Current Knowledge of Ocean Acidification Effects on North Pacific Deep-Sea Corals

- Develop a global network of ocean acidification monitoring buoys to determine the temporal and spatial variability of seawater chemistry. Data will provide higher resolution carbonate chemistry models for both oceanic and coastal regions.
- Develop saturation state (temperature, salinity and dissolved oxygen) algorithms at regional scales.
- Develop a global coral database with improved taxonomic and geospatial accuracy.
- Develop an opportunistic water sampling program in deep-sea coral areas to determine carbonate chemistry baselines.
- Determine calcium carbonate mineralogy for deep-sea corals.
- Conduct laboratory mesocosm experiments exposing deep-sea corals to high pCO_2 and increasing temperatures. High risk taxa should be the priority.

Overview of Gulf of Alaska Seamounts Research Activities

- Analyze existing seamount video data from past expeditions before collecting new data.
    - Complete species inventory and abundance estimates for deep-sea corals and sponges from 2002-2004 GOASEX (Gulf of Alaska Seamount Expedition) and other DSV *Alvin* and *Jason II* dives (1999 and 2004).
    - Inventory and archive all available dive and ship operations DSL/DSOG, CTD, and multi-beam bathymetry data from seamount research projects.

- Conduct deep-sea coral abundance and composition studies within and between seamount and shelf habitats to test the hypothesis that seamounts are sources of larvae to shelf habitats.
- Conduct deep-sea coral abundance and composition studies with temperature, dissolved oxygen, pH, and aragonite saturation on seamount and shelf habitats to test the hypothesis that controlling mechanisms are consistent and evident among and between seamount and shelf habitats.

Overview of Hexactinellid Sponge Reef Ecology

- Process and examine backscatter data collected simultaneously with multibeam data in inshore areas and on the Alaskan shelf.
- Examine existing seabed acoustic profile data to determine if sponge reef complexes occur on the Alaska shelf.
- Conduct surveys on ships of opportunity as they cross prospective sponge reef areas. This would entail collecting hull mounted profiler data or multibeam data. A single line could show presence or absence of reef complexes in prospective areas.
    - The following sites appear to be high priority targets for these surveys: 1) Yakutat Valley, 2) Alsek Valley, 3) Cross Sound Plateau, and 4) many sites in the inside waters of Southeast Alaska.
- Develop a habitat suitability model for the Gulf of Alaska Shelf focusing on substrate, water depth and other habitat indicators or proxies to indicate where sponge reefs would possibly occur.

Overview of Seafloor Mapping Activities

- Determine the significant features of the seafloor that might explain fish and deep-sea coral distribution and assess whether these features are measurable at the level of resolution traditionally obtained from detailed *in situ* surveys.
- Determine whether bottom hardness and depth is enough information to identify deep-sea coral habitats.
- Determine whether high resolution multi-beam imagery is necessary to identify deep-sea coral habitat.

Overview of Deep-Sea Coral Habitat Modeling Efforts

- Provide field validation of deep-sea coral distribution and abundance for predictive models.
- Overlay VMS trawl tracks bycatch, and effort data on models to identify potential areas of high impact.
- Expand model capabilities to include other structure forming emergent epifauna (e.g. hexactinellid sponges).

Overview of Deep-Sea Coral Habitat Management Activities

- Deep-sea coral protection in Alaska has been ancillary to other management issues, such as EFH, Habitat Areas of Particular Concern (HAPC), or other fisheries management actions.

- Several small discrete closures were enacted as a subset of EFH and HAPC, but the majority of areas closed to fishing in Alaska have been for other purposes.
- Carefully consider data sources when mapping bycatch data.
- Improve enforcement and regulation of area closures.
- Increase coordination with stakeholders to implement appropriate management efforts.

Appendix D: Breakout Group Participant List

Breakout Group 1: Mapping and Modeling	
Dave Carlile	Alaska Department of Fish and Game
Kim Conway	Geological Survey of Canada - Pacific
*Dan Dorfman	NOAA Ocean Service
John Guinotte	Marine Conservation Institute
John Heifetz	NOAA Marine Fisheries Service
Frank Parrish	NOAA Marine Fisheries Service
Jennifer Reynolds	University of Alaska Fairbanks

Breakout Group 2: Ecology and Biology	
Sandra Brooke	Marine Conservation Institute
Peter Etnoyer	NOAA Ocean Service
Chris Rooper	NOAA Marine Fisheries Service
Mike Sigler	NOAA Marine Fisheries Service
Robert Stone	NOAA Marine Fisheries Service
*John Tomczuk	NOAA Oceanic and Atmospheric Research

Breakout Group 3: Resource Management and Effects of Human Activities	
Julie Bonney	Alaska Groundfish Data Bank
Diana Evans	North Pacific Fishery Management Council
John Gauvin	Alaska Seafood Cooperative
Tom Hourigan	NOAA Marine Fisheries Service
John Olson	NOAA Marine Fisheries Service
*Fan Tsao	NOAA Marine Fisheries Service
John Warrenchuk	Oceana

*Breakout Group Leader

Appendix E: List of Critical Information Needs Identified by Participants

Critical Information Need	Participants Prioritization (# of votes)	NOAA Strategic Plan Objective Addressed
Breakout Group 1: Mapping and Modeling		
Mine existing knowledge (video footage etc.) to expand our understanding of deep-sea coral and sponge distribution.	20	All
Construct predictive models and refine the list of model parameters.	15	1, 5
Test and refine models.	14	1, 5
Develop models for the western Aleutian Islands.	2	1, 5
Breakout Group 2: Ecology and Biology		
Inventory data resources available to understand deep-sea coral distribution, habitat, and species associations.	12	1, 2
Determine the population characteristics (demographics) of deep-sea corals and sponges, including growth rates, life history and reproductive traits, trophic dynamics, environmental tolerances, and connectivity.	12	2, 3
Determine the species composition and community structure of deep-sea coral and sponge ecosystems.	9	2, 3
Determine the recovery rates of disturbed deep-sea coral and sponge ecosystems.	8	3, 4
Determine the regional status of deep-sea coral and sponge habitats and dependent managed species of fish and crabs.	7	3
Determine the location of areas of highest bycatch and biodiversity.	6	1
Design studies to provide information at regional scales rather than site-specific scales.	1	All
Breakout Group 3: Resource Management and Effects of Human Activities		
Determine the key functions that deep-sea corals provide to managed species at different life stages.	14	3
Examine whether bycatch information is useful for the management of deep-sea corals.	10	4
Determine whether the appropriate areas have been closed to protect deep-sea corals.	7	4
Incorporate the use of closures into study designs to understand the impacts of fishing.	5	4

Determine the use and limitations of current bycatch information (e.g. catchability by gear type).	3	4
Compare the function of deep-sea coral habitat to other structures.	2	3
Examine how gear types affect deep-sea coral habitat and habitat function.	2	4
Determine the recovery rates of deep-sea coral habitats and the functions they provide.	2	4
Determine baseline conditions from which to measure environmental changes.	2	5
Examine methods to standardize fish/invertebrate associations with deep-sea corals and sponges.	2	3
Determine the overall inventory of deep-sea coral and sponge resources.	1	1, 4, 5
Determine indices of deep-sea coral condition.	1	1, 4, 5
Utilize local knowledge (e.g. fishermen) to modify gear types to reduce effects on deep-sea coral and sponge habitats.	1	4
Characterize deep-sea coral and sponge density to understand habitat function.	1	3
Determine the intrinsic non-use value of deep-sea corals.	0	3
Conduct experiments to test and correct for false-positive problem with bycatch data (e.g. repeated catches and location misinterpretations).	0	4
Examine the performance of current observer sampling techniques on the utility of the bycatch data.	0	4
Conduct experiments to improve the accuracy and utility of deep-sea coral bycatch in samples taken by observers.	0	4
Simplify techniques and establish collection protocols for observers.	0	4
Utilize fishermen knowledge to identify deep-sea coral locations and inform survey design.	0	4
Ground-truth deep-sea coral locations identified by fishermen.	0	4
Examine how associations and functions vary by deep-sea coral taxa.	0	3
Determine what closure areas tell us about different gear types.	0	4