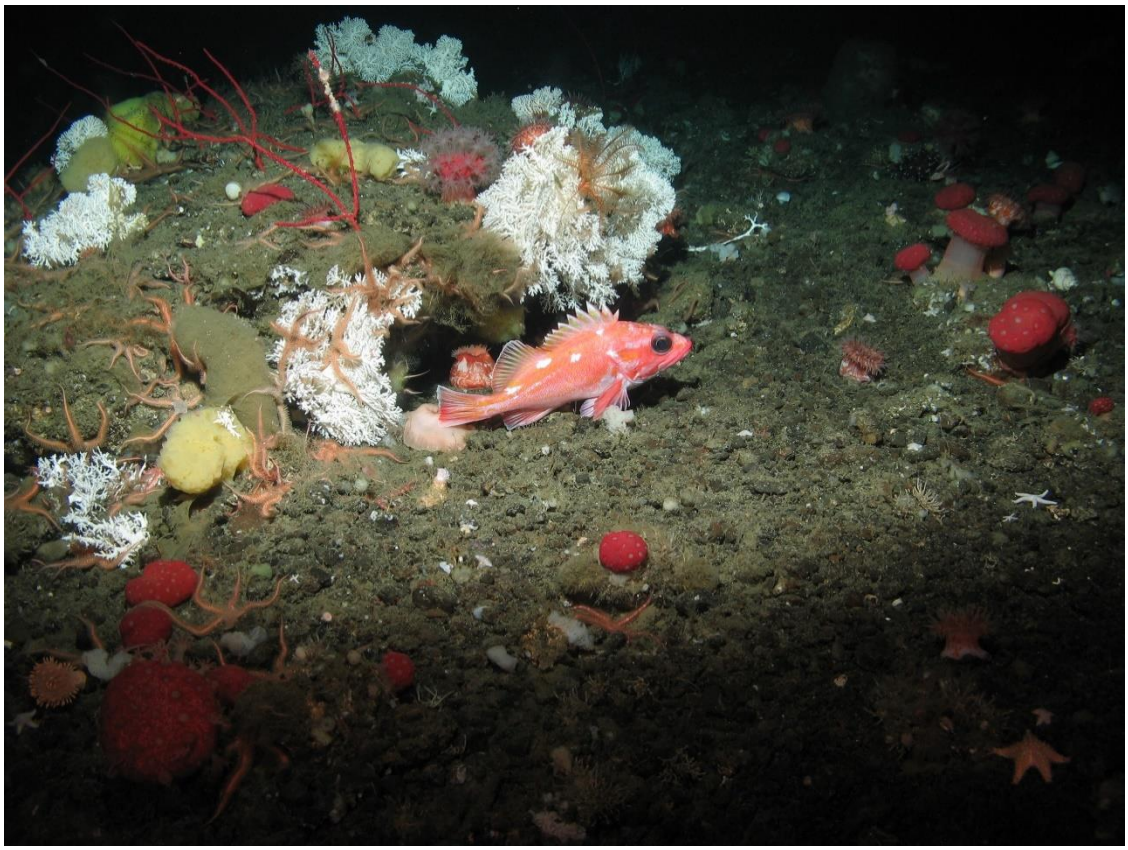
Deep-sea Coral Research and Technology Program
Research Priorities Workshop Report for the DSCRTP West Coast Research Initiative
2018-2021

Workshop Dates: 16-17 April 2018
CINMS Office
Santa Barbara, California



DSCRTP

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Executive Summary

The National Oceanic and Atmospheric Administration (NOAA) Deep Sea Coral Research and Technology Program's (DSCRTP) convened a 2-day science priorities workshop on April 16-17, 2018 at the University of California, Santa Barbara. The purpose of the workshop was to build partnerships and set research priorities for the Program's 4-year West Coast Deep-Sea Coral Initiative (WCDSCI; 2018-2021). A total of 41 scientists and managers with relevant expertise from across the West Coast participated in the workshop representing seven NOAA offices, other federal agencies, non-government organizations, several coastal Washington treaty tribes, Fisheries and Oceans Canada, and academic institutions. The workshop started with a welcome and introduction to both the DSCRTP and WCDSCI. Once the purpose, structure, and goals of the initiative were summarized, other agencies active in deep-sea research provided overview presentations outlining their mission-specific goals and objectives, their previous and ongoing deep-sea coral and sponge (DSCS) research efforts, as well as the tools and technology available for potential WCDSCI-aligned activities. After the DSCS research landscape was established for the region, the majority of the remaining discussions took place during interactive breakout sessions.

Working in small groups, participants identified and discussed West Coast DSCS science and management priorities in five topic areas: 1) mapping; 2) visual surveys and research questions; 3) modeling; 4) species identification, genetics, and connectivity; and 5) human impacts. Participants highlighted the following priorities.

- *Mapping*: Develop high-resolution habitat information in areas where Essential Fish Habitat Conservation Area status is changing, national marine sanctuaries, offshore banks and ridges, and areas with historically high accounts of DSCS bycatch.
- *Visual surveys and research questions*: Gather simultaneous images, video, and environmental data to characterize DSCS communities within areas such as those with historically high bycatch records, where Essential Fish Habitat Conservation Area status is changing, offshore banks, and potential wind energy locations. Participants also highlighted science needs such as using visual surveys to characterize fish and DSCS associations, DSCS abundance, distribution, and genetic connectivity, as well as standardizing visual survey protocols and using new technologies for data collection and analysis.
- *Modeling*: Advance modeling approaches, building on current DSCS habitat suitability modeling efforts. Priorities include adding certain predictor variables, improving methodology to include absences, densities, or multiple species, as well as designing possible protocols for model validation.
- *Species identification, genetics, and connectivity*: Sample understudied DSCS groups (especially sponges) and sample across a greater range of depths, investigate genetic connectivity across the region, facilitate opportunities for collaboration via a species target list, and incorporate genetic information into DSCS models.
- *Human impacts*: Investigate potential long-term impacts of bottom fishing on DSCS communities by taking advantage of Essential Fish Habitat Conservation Area designation changes, monitor DSCS ecosystems to detect change in response to threats such as climate change and ocean acidification, and identify relatively pristine DSCS communities such as those in national marine sanctuaries.

Cover: A rosethorn rockfish (Sebastes helvomaculatus) rests among gorgonian and stylasterid corals.

A final breakout session focused on developing product ideas for WCDSCI research, education, and outreach. Participants recognized that outreach was an important complement to the science and management priorities. Suggested products include a West Coast coral and sponge species identification guide, innovative uses of new technologies such as photomosaics, story maps and infographics, as well as enhancing the national marine sanctuaries online deep-sea curriculum, and taking advantage of telepresence and social and traditional media opportunities to share engaging WCDSCI content.

Overall, three research priorities emerged as the most pervasive across topics during the science priorities scoping workshop. The following overarching themes will, in part, guide WCDSCI activity selection: (1) the need to characterize areas proposed for Essential Fish Habitat Conservation Area modification by Amendment 28 to the Pacific Groundfish Fishery Management Plan, (2) the need to refine and better understand DSCS bycatch “hot spots” and potential associated fishing impacts, and (3) the need to continue exploration and identification of places of special significance to DSCS, such as national marine sanctuaries. The next steps will be to develop the WCDSCI Science Plan in light of the results of this workshop to guide research activities in 2019 and 2020, and data analysis in 2021.

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Introduction

Deep-sea corals and sponges (DSCS) create important biogenic habitats and support remarkably complex communities in deep waters around the globe, including off the U.S. West Coast (Clarke et al. 2017). The National Oceanic and Atmospheric Administration (NOAA) established the Deep Sea Coral Research and Technology Program (DSCRTP) under the authority of the Magnuson-Stevens Fishery Conservation and Management Act (MSA), as reauthorized in 2007. The goal of the DSCRTP is to provide scientific information needed to manage, conserve, and protect deep-sea coral and sponge ecosystems throughout the United States. The DSCRTP is guided by the NOAA Strategic Plan for Deep-Sea Coral and Sponge Ecosystems (NOAA 2010) and aims to (1) support NOAA's role in managing fishing impacts by addressing threats to deep-sea coral ecosystems, (2) aid conservation of deep-sea ecosystems in national marine sanctuaries, and (3) integrate expertise and resources across NOAA. In collaboration with regional fishery management councils, national marine sanctuaries (NMS), other federal agencies, academic partners, industries, and non-government organizations (NGO), the DSCRTP supports studies that collect and analyze information on topics including deep-sea coral biology and ecology and potential anthropogenic impacts on corals.

To facilitate this work, the DSCRTP works with partners to support multi-year regional fieldwork initiatives centered on conducting new research, assimilating historic data, and making results public in support of DSCS ecosystem management and conservation. The DSCRTP began operations in 2009, and has funded targeted fieldwork initiatives in the U.S. South Atlantic (2009-2011), West Coast (2010-2012), Alaska (2012-2014), Northeast (2013- 2015), Pacific Islands (2015-2017), and greater Southeast (2016-2020) regions. The regionally-led initiatives have included mapping and conducting surveys to understand the distribution of DSCS habitats, research to understand their life-history and contribution to biodiversity, habitat-suitability modeling, and assessing impacts of human activities, among other topics. A national-level data management infrastructure underlies the regional initiatives, allowing DSCRTP supported data to be accessible by the public.

West Coast Deep-Sea Coral Research Initiative Science Priorities Workshop

In 2018, DSCRTP began a four-year research initiative in the West Coast Region (Figure 1) in the area under jurisdiction of the Pacific Fishery Management Council (PFMC). The objective of the West Coast Deep-Sea Coral Initiative (WCDSCI) is to obtain scientific information that will further the management, conservation, and protection of deep-water coral and sponge ecosystems throughout the region. Specifically, the initiative will strive to collect information that is most urgently needed by the agencies that manage deep-sea coral ecosystems, particularly the PFMC and five California and Washington national marine sanctuaries. Projects to be supported should (1) be relevant to management of DSCS ecosystems in the region, (2) address priority research questions identified during this workshop, and (3) be achievable within the budget and 2018-2021 timeframe. Similar to previous deep-sea coral research initiatives, supported activities will consist of research expeditions to survey, sample, and map DSCS ecosystems, and

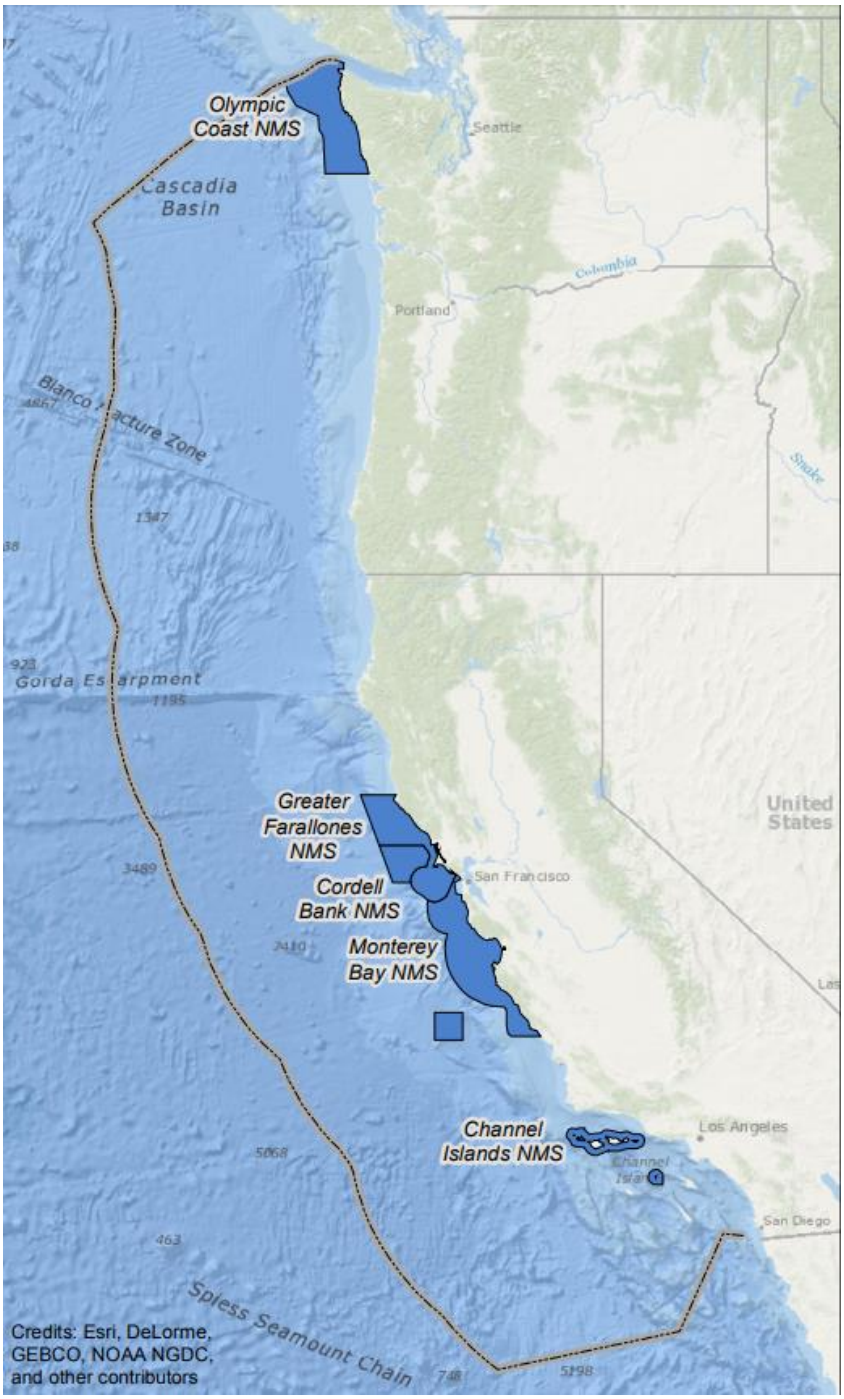

Figure 1. Map of the West Coast Region exclusive economic zone, highlighting the five national marine sanctuaries (NMS) located in the northeast Pacific.

data or sample analyses in line with WCDSCI goals. Priority will be placed on activities that partner with others and leverage additional resources. As a ramp-up year, in 2018 research objectives were scoped, prioritized, and planned for the following field-intensive years, 2019 and 2020, with the final year 2021 set to conclude outstanding data analyses, database submissions, publications, etc.

As a first step towards launching this research initiative in 2018, the Northwest Fisheries Science Center (NWFSC) and Office of National Marine Sanctuaries (ONMS) led a science priorities scoping workshop in April at the University of California, Santa Barbara. This workshop brought together 41 experts from NOAA (NWFSC, Southwest Fisheries Science Center (SWFSC), Alaska Fisheries Science Center (AFSC), West Coast Regional Office, ONMS, National Centers for Coastal Ocean Science (NCCOS), and Ocean Exploration and Research (OER)), the PFMC, Bureau of Ocean and Energy Management (BOEM), U.S. Geological Survey (USGS), Fisheries and Oceans Canada (DFO), Ocean Exploration Trust (OET), members of the Quileute Tribe and Makah Tribe and a representative from the Northwest Indian Fisheries Commission, academic institutions, and NGOs to prioritize potential research activities on DSCS ecosystems in the West Coast Region (a list of participants, both in person and remote, is provided in Appendix A). Discussions at the workshop centered around priority management issues, geographic areas, and research questions relating to deep-sea coral ecosystems along the U.S. Pacific coast. Follow-up outreach was also conducted to gather further input from those participating remotely or unable to attend.

Workshop Results and Presentation Summaries

In preparation for the workshop, participants were provided with background materials including the NOAA Deep-Sea Coral and Sponge Ecosystem Strategic Plan (NOAA 2010), the 'State of Deep-Sea Coral and Sponge Ecosystems of the United States' report (Hourigan et al. 2017), a presentation given by Elizabeth Clarke summarizing accomplishments and challenges from the previous regional initiative, and the Southeast Deep-sea Coral Initiative priorities workshop report (Schull et al. 2016). The first day of the WCDSCI priorities workshop began with a welcome and introduction to the DSCRTP followed by a series of overview presentations from various entities that conduct deep-sea ecosystem research on the West Coast. Presentations covered each institution's general mission, previous, current, and future work related to DSCS, research tools and technology, potential opportunities for collaboration, and goals for the outcome of the workshop or for WCDSCI overall. This informative session primed small breakout discussions that focused on identifying and prioritizing research needs as well as brainstorming potential WCDSCI outreach products. The structure of this report follows the general flow of the workshop and a complete agenda is provided in Appendix B. The last piece of the presentation summary section was contributed after the workshop, following further consultation with the coastal Washington Treaty Tribes. Specifically, material was provided by the Makah, the Quileute Tribes, the Quinault Indian Nation, and the Indian Fisheries Commission; content was not edited by the WCDSCI steering committee.

2010 Deep-Sea Coral West Coast Initiative Overview

Elizabeth Clarke (NWFSC) presented an overview of priorities, projects, and accomplishments from the first research initiative on the West Coast to focus on DSCS, which she led in 2010.

To scope initial DSCS research priorities, a workshop was convened Jan 20-21, 2010 in Portland, Oregon with 38 participants from tribes, states, sanctuaries, academia, the Pacific Fishery Management Council, NGOs, and the fishing industry. At this workshop, the following priorities for the initiative were established.

- Identify deep-sea coral species distribution, abundance, densities, and diversity throughout the California Current Large Marine Ecosystem.
- Determine the ecological roles of DSCS (nature of associations between DSCS and other species such as invertebrates and fishes).
- Understand the basic biology of deep-sea corals, including taxonomy, age structure, growth, gender, population connectivity, and life histories.
- Inventorying and analyzing existing data was a critical need and in many instances a requirement to adequately address the critical information needs.

A steering committee for the 2010 initiative was established with members from National Ocean Service (NOS), Oceanic and Atmospheric Research (OAR), and National Marine Fisheries Service (NOAA Fisheries), and on an annual basis this steering committee developed a research and budget plan that identified and funded specific projects focused on the above priorities. Over the course of three years, 15 projects or cruises were funded. These projects resulted in the following.

- Over 200,000 square meters of remotely operated vehicle (ROV), submersible, autonomous underwater vehicle (AUV), and towed camera system surveys
- Multibeam bathymetry and sub-bottom surveys
- Proposal process with National Undersea Research Program
- Twelve Site Characterizations from new data
- Two Site Characterizations from previously collected data
- Three NOAA Technical Memos
- Ten peer-reviewed publications
- One dissertation

Over 100 dives annotated for corals, sponges, and habitat type were conducted on a variety of vessels along the West Coast. These data have been used for the essential fish habitat (EFH) decision-making by the PFMC and for sanctuary boundary expansion analyses and sanctuary condition assessments. Thousands of records from these data have been submitted to the national deep-sea coral data portal and are being used to model habitat suitability for DSCS by BOEM and NOAA. These data have also enabled new analyses related to understanding anthropogenic and environmental disturbances on coral and sponge assemblages (Yoklavich et al. 2018) and on octocoral reproduction (Feehan and Waller 2015). In addition, many specimens of DSCS and associated organisms were collected to confirm taxonomic identifications and for genetic, reproductive, and stable isotope analyses. Collections resulted in several new species descriptions and new records added to the national database. Genetic analysis of a variety of species is ongoing.

National Marine Fisheries Service (NMFS) Overview

Tom Laidig (SWFSC) presented on the previous, ongoing, and future research goals of NOAA Fisheries as they relate to DSCS.

When the MSA was reauthorized in 2007, it established a deep-sea coral research program at NOAA and further authorized regional fishery management councils to protect DSCS from damage from fishing gear. In the 2010 West Coast Initiative, priorities for DSCS studies were to determine distribution and abundance of DSCS along the West Coast, collect and identify

unknown species of DSCS, and examine the relationship between fish and DSCS to better understand whether DSCS act as essential fish habitat.

Following the first DSCS initiative on the West Coast, researchers continued to investigate distribution, abundance, identification, and fish associations of DSCS. Seafloor mapping and species modeling have allowed researchers to better target specific species for visual surveys. Advances in genetics have helped identify species. Environmental DNA (eDNA) has been used to determine the presence of octocoral species when they were not observed by visual transect, thus increasing opportunity for detection (Everett and Park 2017).

This year, NOAA Fisheries produced "Priorities and Annual Guidance for 2018" to describe three strategic goals and numerous priorities for the year. Two priorities pertain to DSCS. The first is "leveraging existing resources, identify and implement high-priority, near-term actions from the Ecosystem-Based Fisheries Management (EBFM) Roadmap and National Bycatch Strategy." Anticipated results are to advance and implement EBFM, and to reduce DSCS bycatch through new management measures. The second priority is to "focus habitat conservation efforts on essential fish habitat and deep-sea coral protection in support of regional fishery management councils." Anticipated results are to maximize habitat conservation and to deliver high-quality EFH and DSCS data to councils. Guidance was given to improve our understanding of climate change effects on species and habitats through focused research.

Combining the priorities and guidance over the past 8 years, current WCDSCI-related priorities include the following.

1) Determine distribution and abundance of DSCS.
2) Increase knowledge on identification of DSCS through collections.
3) Gain a better understanding of associations of fishes and DSCS.
4) Reduce the bycatch of DSCS.
5) Understand the role that climate change will have on current and future biology and distribution of DSCS.

Office of National Marine Sanctuaries (ONMS) Overview

Jenny Waddell (Olympic Coast NMS) presented the overlapping goals between DSCRTP and ONMS, as well as the overarching research and resource protection needs from the West Coast sanctuaries.

The five national marine sanctuaries of the West Coast Region together encompass over 15,300 square miles of coastal and oceanic habitats from the Southern California Bight to the Canadian border, including significant areas known to contain DSCS habitats. The National Marine Sanctuaries Act gives NOAA the legislative authority to establish sanctuaries and to create management plans that are intended to protect these special places and the living marine resources and habitats found therein.

Many of the goals and objectives found within the strategic plan of the Office of National Marine Sanctuaries directly complement those found in the DSCRTP's strategic plan, and in places the two documents reference each other. For example, sanctuary research on DSCS habitats seeks to characterize DSCS abundance and distribution, and better understand the biodiversity of important seafloor communities, two objectives that are virtually identical to elements of the DSCRTP's Strategic Plan. Another shared objective of West Coast sanctuaries and DSCRTP involves gathering critical new baseline data and information about current and proposed spatial management areas identified by the PFMC, including EFH and Rockfish Conservation Areas

(RCA), prior to changes recently approved in Amendment 28. Where these fishery management designations overlap sanctuary boundaries, staff are focused on investigating changes in closed areas proposed to be opened to fishing in the near future, as well as assessing habitat recovery in areas proposed to be closed.

Additional sanctuary objectives focus on developing a better understanding of a broad suite of human impacts to DSCS habitats, characterizing the seafloor in unexplored areas of each sanctuary to identify potential DSCS habitat, providing new information about DSCS for ONMS' public outreach and educational applications, and evaluating the efficacy of management actions in protecting sensitive sanctuary habitats.

Pacific Fishery Management Council (PFMC) Overview

Essential Fish Habitat (EFH) Process and Research Priorities Plan, Revisions to EFH Conservation Areas (EFHCA) and Trawl Rockfish Conservation Area (RCA)

John Stadler (NOAA Fisheries West Coast Regional Office) and Kerry Griffin (PFMC) provided an overview of PFMC's research priorities with an emphasis on previous and upcoming changes to the status of EFHCA and RCA on the West Coast.

The MSA requires all regional fishery management councils to, among other things, minimize to the extent practicable the adverse effects on EFH from the fisheries they manage. The PFMC first identified and described EFH for groundfish in 1998 but did not adopt fishery management measures until 2005, with Amendment 19 to the Pacific Groundfish Fishery Management Plan. Amendment 19 established a number of EFH Conservation Areas (EFHCAs) that prohibit the use of bottom trawl gear and, in some cases, the use of all bottom-contact gear, to protect benthic habitats. Within the area shoreward of 700 fathoms, where the groundfish fishery operates, the EFHCAs closed a total of 5,773 square miles to bottom trawling.

Amendment 28 to the groundfish plan will close additional areas to bottom trawling while reopening some of the Amendment 19 EFHCAs. It will also reopen most of the trawl RCA that was closed to groundfish bottom trawling in 2002 to protect overfished species, and will close waters deeper than 3,500 meters to all bottom-contact gear. These changes, expected to be implemented in 2019, will result in a net increase of approximately 10,000 square miles in bottom trawl closures shoreward of 700 fathoms, while restoring access by bottom trawlers to approximately 3,000 square miles of valuable, historic fishing grounds. It will also close 123,000 square miles in waters deeper than 3,500 meters. The closures in both amendments were based, in part, on protection of DSCS. These new closures and reopenings present an opportunity to evaluate the effects of bottom trawling on habitat-forming invertebrates and the rate at which they recover from bottom trawling.

The PFMC's Habitat Committee identified a number of research priorities for DSCS that are directly related to Amendment 28. The priorities include improving our understanding of the relationships between managed groundfishes and habitat-forming invertebrates, comparing fish densities where habitat-forming invertebrates occur and do not occur, determining baseline conditions before the changes are implemented, and examining the response of habitat-forming invertebrates to bottom trawl closures and reopenings.

NOAA Office of Ocean Exploration and Research (OER) and Ocean Exploration Trust (OET) Overview

Amanda Netburn (Office of Ocean Exploration and Research) and Nicole Raineault (Ocean Exploration Trust) presented their individual and collaborative deep-sea exploration goals.

NOAA Office of Ocean Exploration and Research

OER conducts and sponsors goal-specific, multidisciplinary exploration of the ocean with emphasis on the U.S. exclusive economic zone and areas of interest to the U.S. Extended Continental Shelf program. OER engages in a broad diversity of collaborations and partnerships to identify priority areas for exploration; jointly supporting efforts to develop and use exploration tools and methodologies; and encouraging and supporting the next generation of ocean explorers, scientists, and engineers. Data and information collected during OER expeditions provide NOAA, other federal ocean-related program managers, the academic community, and private sector organizations information needed to identify, understand, and manage ocean environmental issues as well as living and non-living ocean resources for current and future generations.

Closely associated with the NOAA Office of Marine and Aviation Operations (OMAO) and other partners, OER operates NOAA Ship *Okeanos Explorer* to investigate unexplored regions of the ocean using multibeam bathymetry, water column acoustics, a dual-bodied ROV, conductivity-temperature-depth (CTD), and telepresence technologies. Recent campaigns, the 2015-2017 Campaign to Address the Pacific monument Science, Technology, and Ocean Needs (CAPSTONE) and the ongoing Atlantic Seafloor Partnership for Integrated Research and Exploration (ASPIRE) campaign, have been coordinated with the DSCRTP region of focus. The *Okeanos Explorer* will, however, remain in the Atlantic Ocean for the next few years, and OER's primary investment in ocean exploration off the U.S. West Coast during this time is through partnership with the Ocean Exploration Trust and possible participating in the evolving BOEM-USGS-NOAA Expanding Pacific Research & Exploration of Submerged Systems (EXPRESS) campaign. Other potential opportunities for partnership are through OER's annual federal funding opportunity and participation in an emerging technology demonstration cruise on the *Okeanos Explorer*.

Ocean Exploration Trust

OET has three mission priorities that are broadly defined as: exploration of the deep-sea, development and enhancement of technologies to explore the ocean and connect the ship with scientists and the public live, and outreach and education to inspire and train the next generation of science, technology, engineering and mathematics educated persons and increase the public's awareness of the importance of the ocean. OET is largely funded through government grants, primarily NOAA-OER, but also ONMS and others.

OET's *E/V Nautilus* has been located in the eastern Pacific Ocean since late 2015 collecting seafloor mapping data and conducting ROV dives to characterize the seafloor. The *E/V Nautilus* has conducted 18 cruises since 2015 off the West Coast of the U.S. The location and basic information from the cruises can be found at https://www.ncddc.noaa.gov/website/google_maps/OE/mapsOE.htm. Dive reports and logs, sample logs, observation logs, captured images from the ROVs, mapping data and products, and CTD and O_2 data are all part of the archived dataset.

OET plans to continue to operate cruises along the U.S.West Coast for the foreseeable future. During even-numbered years *Nautilus* will operate as far west as Hawaii and Papahanaumokuakea Marine National Monument, and in odd years the range will span from Canada to as far south as the Galapagos Islands. We will continue to include Scientists Ashore in the planning of all non-chartered cruises. Scientists and researchers are encouraged to sign up each year to receive cruise information and to participate in planning. Routine sampling programs have emerged to collect water samples for eDNA analysis of coral and fish at coral-rich areas thanks to ongoing work with Meredith Everett at the Northwest Fisheries Science Center (Everett and Park 2017). In the future, as early as 2019, OET will also have a second ROV system that can be used on platforms of opportunity. Initially this will be an imaging-only 6000 meter-rated ROV.

Bureau of Ocean Energy Management (BOEM) Overview

Lisa Gilbane (BOEM) provided an overview of BOEM's mission, research priorities, and on-going collaborative work with NOAA and NGO partners.

The mission of BOEM is to manage development of U.S. Outer Continental Shelf energy and mineral resources in an environmentally and economically responsible way. BOEM has a regulatory authority to lease and develop U.S. federal waters for oil and gas, renewable energy, and mineral extraction. BOEM also is actively involved and funds projects to fulfill our obligation for responsible stewardship of the environment and for making science-informed decisions. BOEM is interested in understanding where high density DSCS communities occur along the U.S. West Coast in order to avoid impacts to these areas from leasing and development projects.

BOEM has partnered with NOAA Fisheries and NCCOS to improve coral and sponge predictive maps using DSCRTP's coral and sponge database. BOEM will use these maps to inform decisions about lease areas for floating wind and to require additional surveys prior to development. Additionally, the WCDSCI steering committee will have an opportunity to review draft products and reports over the next year to ensure the model utility for additional management purposes and to guide initiative surveys. A second intersection for BOEM and this initiative is a project with USGS and NOAA's Office of Coast Survey (OCS) to collect shallow subsurface and multibeam sonar from Point Conception to the southern part of the Monterey Bay NMS (400 to 1100 meters). A high priority area for BOEM in this region was mapped in 2017 aboard NOAA Ship *Rainier*, thanks to OCS, OMAO, and the Channel Islands NMS, and updated high resolution maps will help inform future deep-sea exploration. The Monterey Bay Aquarium Research Institute (MBARI) is also an important partner in the region, who recently completed several high-resolution sonar dives. USGS and BOEM are planning an ROV cruise for this area in the first half of 2019. Lastly, BOEM is also leading a multi-agency (BOEM, USGS, NOAA) campaign, known as EXPRESS, with the goal to enhance interagency collaboration related to undersea research on the West Coast. Individual EXPRESS expeditions collect a diverse suite of data and information, but the core focus is relevant to WCDSCI in that it aims to collect spatially explicit deepwater habitat information, with a specific objective, among others, to locate and characterize DSCS and chemosynthetic communities including associated fish assemblages.

United States Geological Survey (USGS) Overview

Nancy Prouty (USGS) provided an overview of USGS's overall goals, skill sets and tools as they relate to DSCS research, and their future research priorities for the West Coast.

Scientists from the USGS Diversity, Systematics, and Connectivity of Vulnerable Reef Ecosystems (DISCOVRE) project have developed a multidisciplinary research program, grounded in geologic studies (e.g., seafloor mapping, geological processes, seafloor stability), to understand complex deep-sea communities and to provide ecosystem-based scientific studies in areas considered for oil and gas leasing and/or renewable energy. This information allows for an adaptive, ecosystem-based approach to the Department of the Interior's stewardship responsibilities while proceeding with development of offshore energy resources.

Overarching USGS goals for deep-sea research include: protecting sensitive biological communities based on best available science; understanding the distribution, relative abundance, and population structures of deep-sea organisms; conducting interdisciplinary baseline characterizations using advanced undersea technologies; and working with other agencies (e.g., NOAA-OER) to explore and discover new deep-sea habitats, communities, and species and to innovatively engage and educate the community.

USGS strategic science for deep-sea environments includes: identifying coral and seep-associated species and understanding how they are ecologically and genetically connected to other deep-sea habitats in the region; describing the oceanographic, geological, and biogeochemical conditions associated with each environment; modeling the distribution of habitats and fauna with respect to environmental conditions; determining deep-sea coral growth rates and life-spans, and evaluating their vulnerability to natural and anthropogenic disturbances and time scales of their recovery; and defining sensitive benthic habitats that need to be included in conservation areas within and outside the U.S. exclusive economic zone.

Specific USGS skill sets and capabilities include expertise in population genetics, microbial ecology, deep-sea community ecology and associated food webs (including seeps, canyons, and corals), paleo-oceanography, mapping/bathymetry/sub-bottom profiling, submarine geohazard assessments, including identifying seafloor vulnerabilities and tsunami risk potential, and environmental monitoring of deep-sea habitats, including corals, seeps, and canyons

USGS hopes to expand research on the West Coast to include testing for biogeographic breaks among provinces in deep-sea coral species distribution; placing Pacific scleractinian species into a phylogenetic context with Atlantic species; estimating connectivity between Channel Islands NMS corals and other populations outside of the sanctuary; developing coral genomic stress-response assays and microbiology data for Pacific *Lophelia pertusa;* and deciphering food web connections and the role of surface production in deep-sea coral food webs for monitoring and tracking change.

Fisheries and Oceans Canada (DFO) Overview

Fisheries and Oceans Canada manages Canada's fisheries and safeguards its waters. Tammy Norgard (DFO) presented on the Marine Spatial Ecology and Analysis Group's goals related to seafloor exploration using various tools and future work planned in DSCS research.

In May 2017, DFO announced an area of interest for consideration as a marine protected area under Canada's Oceans Act. The 140,000 square kilometer area covers half of Canada's Pacific offshore region and includes 93% of Canadian Seamounts and 100% of known Canadian hydrothermal vents. In October 2017, Canada closed 60% of the area to all bottom contact fisheries. DFO has led multiple research surveys to collect information on Canadian Pacific seamounts, in an effort to provide science advice for management and monitoring. The agency is developing an online species inventory to share species identifications and findings globally.

Multiple research programs on the Pacific Coast of Canada are collecting visual survey data on sponge and coral locations as well as samples for identification. Future research as part of this program will hopefully include work on the basic biology/physiology of the deep-sea coral population, dynamics modeling, fine scale collection of environmental variables and bathymetry, and continued work towards making data and video publically available.

Coastal Washington Treaty Tribes Overview

The Makah and Quileute Tribes and the Quinault Indian Nation provided an overview of their goals and priorities for deep-sea coral systems.

The Coastal Treaty Tribes (Hoh, Makah, Quileute tribes and the Quinault Indian Nation) have place-based treaty rights that require them to manage marine resources responsibly and in perpetuity so that future generations will be able to continue to rely on the ocean for their sustenance, economic, spiritual, and cultural well-being. The Coastal Treaty Tribes are co-managers of marine resources that inhabit over 6,000 square miles of marine waters adjacent to the Olympic Peninsula.

The Coastal Treaty Tribes' overarching goal is to progress towards being able to effectively employ ecosystem-based management approaches to their marine resources. The tribes are currently working to advance their Habitat Framework Project, which aims to comprehensively map out the marine habitats within their Usual and Accustomed areas (U&As) and to provide for the examination of species-habitat and species-species interactions and develop strategies in how this information can be used by resource managers. Completion of the Habitat Framework is also a key step for the tribes before they move forward with any type of special designations such as Essential Fish Habitats within their U&As. The Coastal Treaty Tribes note that while their focus on the surface appears to be on fishery management, there are also other holistic priorities, including basic research and discovery.

Overall, the Coastal Treaty Tribes' priority for the DSCRTP WCDSCI is to ensure that its priorities and deliverables are well aligned to achieve both the national program's broader goals while still supporting more local West Coast resources managers in effective decision making.

Technically, there remains a need for standardized and quantitative methodologies to be used when surveying DSCS that move the data generated beyond presence/absence type observations and into percent cover and species interactions at all life stages. In addition, changing ocean chemistry may be one of the biggest threats to coral and sponge resources thus emphasizing the need to collect this information as well. With the upcoming changes in EFH closures it will be important to monitor the effectiveness of these management changes by surveying both inside and adjacent to them, and this work will also need to be balanced with the need to explore and quantify the role of deep-sea corals in new areas. Additionally, the sizeable backlog of data related to DSCS must be analyzed, and if possible, reported in a standard format (e.g., the Coastal and Marine Ecological Classification Standard (CMECS) for habitat classification) so that it is transferable and usable by resource managers. Given the logistical and financial challenges of working in the deep ocean, development of high-resolution models of DSCS cover and species interactions are also a priority. Furthermore, in the DSCS community there is often a bias against trawl fisheries, and there is a need to more effectively evaluate the impacts of both these fisheries and the efficacy of current management strategies to minimize impacts to habitat functionality. Lastly, the Coastal Treaty Tribes should be engaged early and often in DSCS research, and other related activities, occurring off of the Olympic Coast.

Breakout Session Summaries

Mapping

Seafloor habitat information is critical for informing models of deep-sea coral distribution, planning ROV dives, and guiding conservation management decisions for a number of deepwater resources. Despite the relevance of these data to a variety of management concerns and research goals, much of the seafloor lacks high quality bathymetry and habitat information. These data gaps are especially prevalent for the West Coast and worse in deep water habitats as state-led efforts have focused on nearshore waters.

This need has spurred a number of agencies to take action and form the Southern California Seafloor Mapping Initiative, which focuses effort in the Southern California Bight; the Washington State Seafloor Mapping Spatial Prioritization effort, which includes state and federal waters on Washington's Pacific coast; and the newly formed EXPRESS campaign, which has a coastwide focus and includes mapping as one central objective. WCDSCI has the opportunity to benefit from these efforts and leverage them to collect new data in priority deepwater habitats.

During the workshop, participants were asked to consider which areas are important to the organizations they represent, and what data types or products would be most useful from those areas. The discussion was focused mostly on areas for new data acquisitions. Participants were provided a large map of the West Coast and allowed to highlight areas important to their respective organizations while notes were taken on data types required in each prioritized area. Participants then voted for three priorities. Votes (Figure 2) typically fell under three major goals:

1. Identify rocky habitats.
2. Collect better resolution backscatter data in areas previously mapped in 2005. Participants wanted a more quantitative approach to habitat classification instead of qualitative expert judgments.
3. Map areas currently under, or considered for, protection.

As many deep-sea corals and sponges are closely associated with hard bottom habitat, goals 1 & 2 are heavily focused on refining our understanding of the distribution of this habitat. Goal 3 focuses on management application and acquiring data to help agencies understand management efficacy. The priority with the largest number of votes was EFHCAs, as these zones will change under Amendment 28 to the Pacific Groundfish Fishery Management Plan. Participants felt that new closures, currently designated areas, and areas set to re-open require up to date seafloor data to properly understand importance to the region and to properly manage these areas. Participants agreed focus should be on EFHCAs that have limited to no seafloor data instead of areas with existing data of moderate quality. Because there are numerous EFHCAs along the West Coast, these areas were not drawn on the map in Figure 3.

The second highest spatial priority was Santa Lucia Bank just south of the Monterey Bay NMS border. Santa Lucia Bank is identified as high potential for offshore wind energy development, but is also believed to have extensive rocky habitats that could potentially support DSCS. The bank is within the proposed Chumash NMS and, in addition, various parts of Lucia Bank are being considered as EFH and a Sanctuary Ecologically Sensitive Area. High resolution maps of the area are lacking, but would be needed for wind energy development with minimal disturbance to sensitive habitats. Acquiring high quality mapping data would also be of interest to geologists due to its potential for geohazards.

The northern Channel Islands and Southern California offshore banks were tied as the next highest priorities (eight votes each). The northern Channel Islands are within an existing NOAA

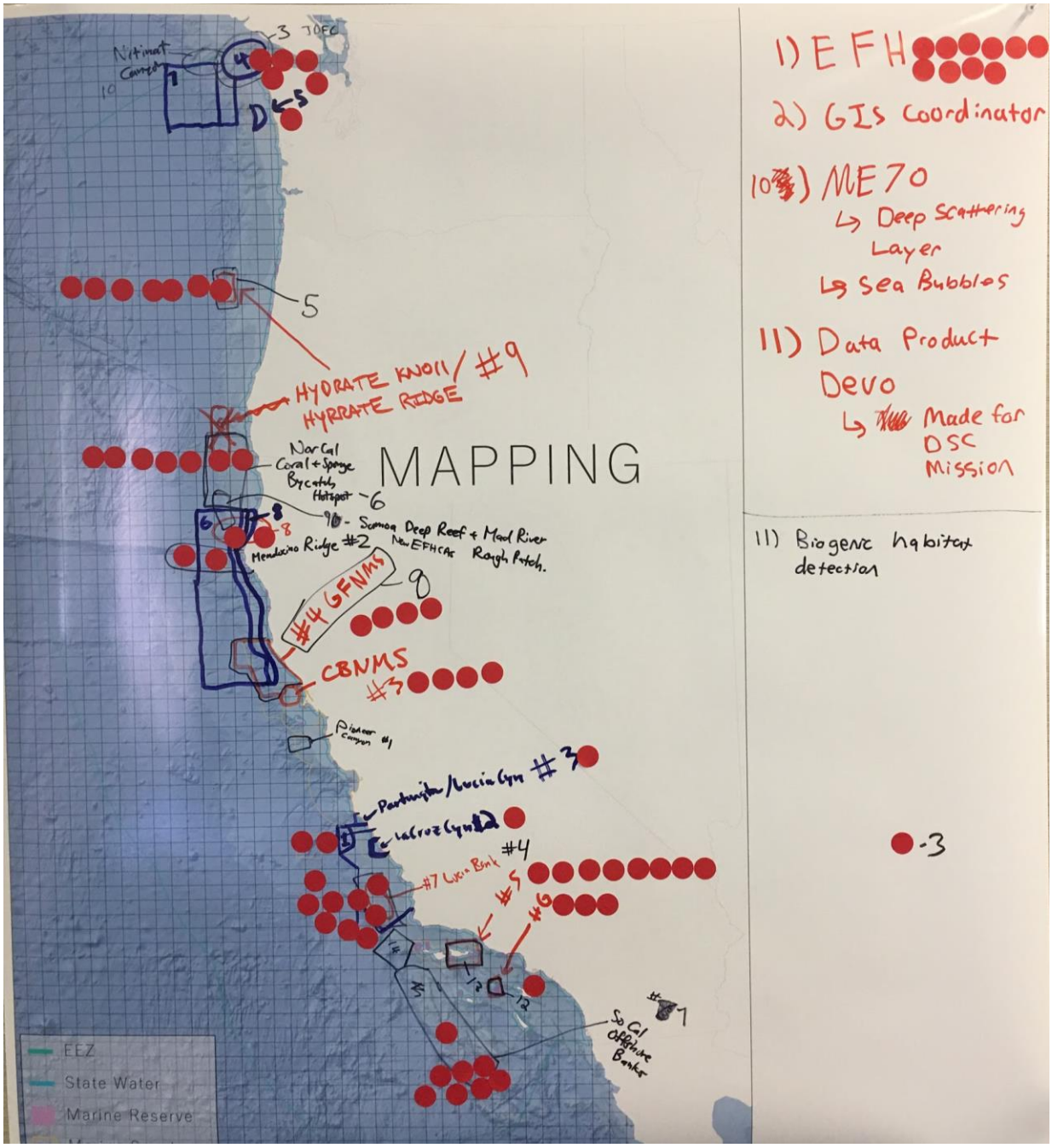

Figure 2. Results of voting for mapping priority sites. Red circles indicate individual votes by participants.

NMS while the offshore banks contain areas under consideration for additional protections. These areas support a variety of fisheries and a highly biodiverse ecosystem yet lack foundational bathymetry and habitat data layers to guide management decisions. Santa Barbara Island, one of the five islands within the Channel Islands NMS received an additional four votes not included in the tally for the northern Channel Islands. A more thorough overview of the specific needs of

stakeholders in Southern California were outlined previously in the Southern California Seafloor Mapping Workshop report (Freedman et al. 2016).
With seven votes each, Hydrate Ridge and the Northern California/Southern Oregon Coral Bycatch zone were the next highest spatial priorities. Hydrate Ridge is an area with mineral mining potential, but could also contain DSCS. The Northern California/Southern Oregon Bycatch Zone is where the majority of gorgonian and other coral bycatch on the West Coast is reported; however, seafloor data and ROV dive effort are limited within the area despite the concern of chronic human impacts.

Also of note, the northern outer Washington coast had a number of priority areas in close spatial proximity that gathered six votes. The area is home to Olympic Coast NMS, EFH and biogenic area closures, and a high abundance of deep-sea coral and sponge resources, while also encompassing the 'usual and accustomed' fishing areas of Washington State's four Coastal Treaty Tribes. More in-depth information spatially depicting the mapping requirements of local stakeholders is discussed in Battista et al. (2017). A summary image of mapping priorities listed above is available in Appendix D.

Visual Surveys and Research Questions

Deep-sea coral and sponge visual surveys along the West Coast have been conducted using ROVs, AUVs, submersibles, and drop and towed cameras. In the past, these surveys have mainly focused on the abundance and distribution of DSCS along the coast from California to Washington, with most of the work centered in southern California or Washington. This breakout group was tasked with ranking the importance of DSCS research goals and suggesting site locations that need either new or further survey efforts. The main questions to be considered in this breakout group were:

- Are there areas along the coast that need to be explored for the first time?
- Are certain depths zones underrepresented in DSCS surveys and need more sampling?
- Is there physical and biological information that needs to be collected that would better describe DSCS distributions?
- Are there specimens that need to be collected for further studies (positive identifications, ageing studies, ocean acidification studies, genetic work, etc.)?
- How can we create partnerships to leverage NOAA funding and maximize the DSCS research opportunities?

Discussions in these sessions were split into two categories: geographic priorities - i.e., physical locations to conduct DSCS surveys (Figure 3), and DSCS research priorities.

Geographic Survey Priorities:

The top four sites prioritized by workshop participants follow.

- Juan de Fuca Canyon (13 votes) is close to port and potentially has a high abundance of DSCS. It was suggested that it be mapped and then sampled.
- Areas of high DSCS bycatch in trawl fisheries (southern Oregon/northern California; 12 votes) need more surveys to determine the extent of the DSCS distributions and detect potential impacts from fishing gear.
- A proposed wind energy lease area north of Pt Conception (10 votes) would provide baseline data on DSCS abundance and distribution before construction.
- Sverdrup Bank (9 votes) is a relatively untouched area far offshore along the western edge of the Southern California Bight that has not been adequately surveyed for DSCS.

In addition to these discrete areas, the collective sites of newly closing and opening EFHCAs received the most votes, 16 total. Discrete sites included in this group include western Heceta Bank (8 votes), an area just south of Heceta Bank (1 vote), areas around the Gulf of the Farallones (6 votes), and Monterey Bay area reopenings (1 vote).

Research Priorities

Discussions on research ideas and priorities ranged from general to very specific. The nine subjects below were discussed most often.

- *Essential Fish Habitat Conservation Areas*: One topic that came up at each group was the opening and closing of areas as determined by Pacific Fishery Management Plan Amendment 28. Many participants were interested in the opportunity to gather baseline information on DSCS in areas that have been closed to bottom contact gear for years and will soon be open to fishing. This unforeseen event may give researchers an opportunity to study the direct effects of bottom contact fishing. Conversely, surveys of new areas to be closed to fishing may provide baseline information on recovery of damaged DSCS habitat.
- *Function of DSCS habitat*: The importance of understanding fish and invertebrate associations with DSCS habitat was discussed in each group. A question arose on how to differentiate fish and invertebrate associations from co-occurrence. A suggestion was raised to have direct experiments but no consensus was reached on how to conduct such experiments.
- *Environmental determinants of DSCS distributions*: Each session also focused on understanding the environmental factors related to DSCS distributions. How do the distributions of DSCS relate to the oxygen minimum zone? Are there buoys or other projects that routinely collect this environmental information? What are the physical limitations of different species? A comparison of vertical zonation of DSCS with aragonite and calcite saturation levels was also suggested.
- *West Coast DSCS data clearinghouse*: Participants brought up the need for a clearinghouse of DSCS data containing all DSCS cruise data along the West Coast. Data stored here would include locations and types of surveys, species observed, species collected, dates of surveys, researchers involved, disposition of data/samples, etc. Options included an Excel sheet shared on a Google drive, a government entity housing a web page, and using the DSCS portal and expanding or adding a section for projects.
- *Automated image processing*: Two sessions discussed the value of automated image processing. Annotation of survey images and video is often a major bottleneck in data analysis. Automated processing can speed data annotation, but results would still need to be checked by researchers. Discussion centered on species identifications, and it was decided to send more images to interested parties to train the programs. These programs would be used for both video and still imagery.
- *Increasing survey comparability*: Two sessions also discussed the need to establish comparable survey designs for conducting ROV and AUV transects. This progress would simplify data comparison and aid consistency in data collection. The survey methods could be used during an entire research cruise or just a portion.

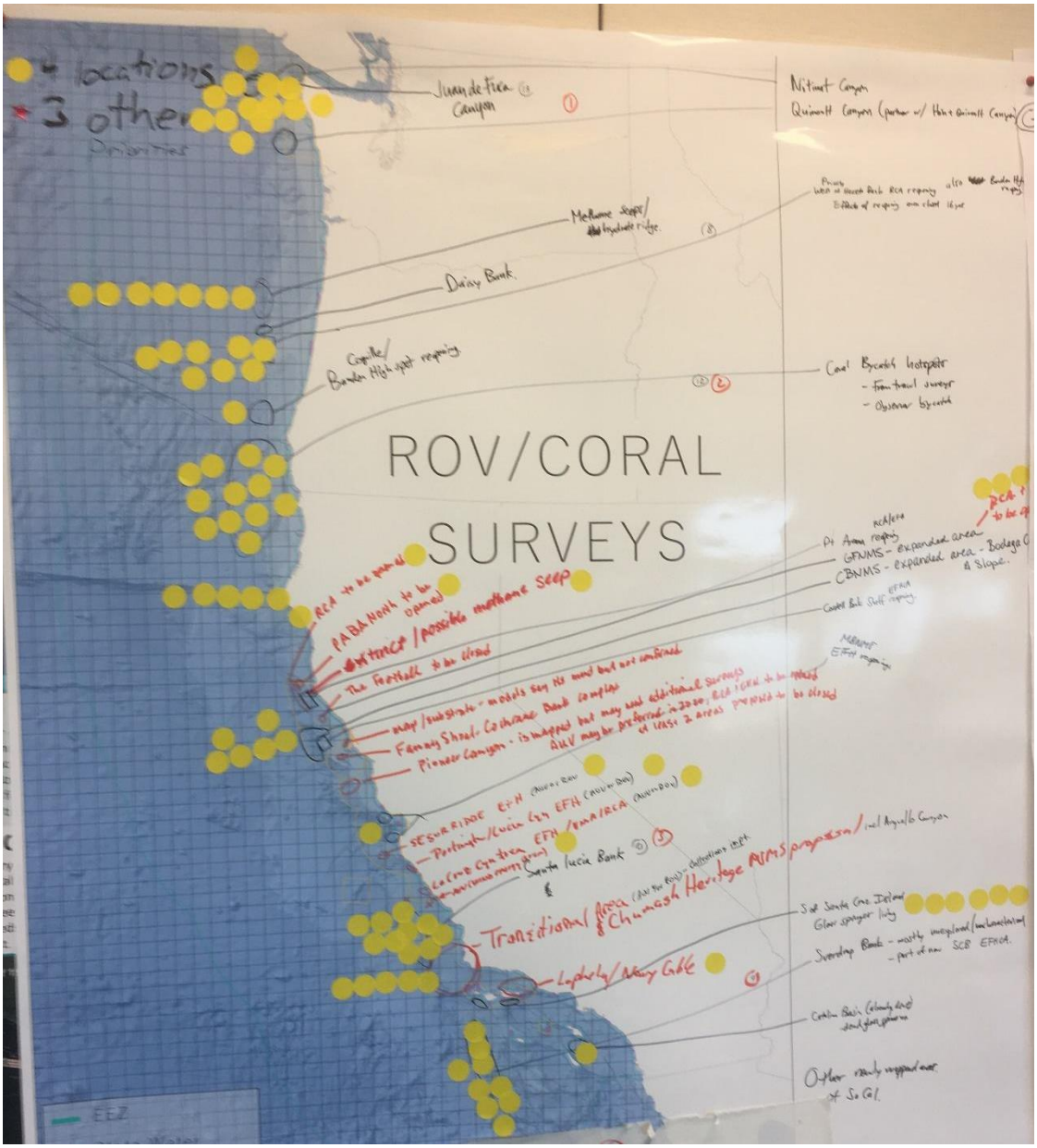

Figure 3. The results of the voting for top priority sites to survey DSCS. Yellow circles indicate individual votes by participants.

- *Identifying synergies among project priorities*: Due to the high cost of deep-sea field research, every effort should be made to ensure that field surveys meet multiple objectives if practical. Examples include surveying areas to groundtruth maps or verify models. As a part of this initiative, there is high interest in obtaining good multibeam data and creating habitat maps of the seafloor (see Mapping discussion). Groundtruthing these areas would increase map usefulness. Similarly, groundtruthing areas of predicted coral habitat would help validate modeling efforts. Building partnerships and ensuring communication before, during and after field expeditions will be crucial for such efforts.
- *Targeted sample collections:* Each session identified that many research questions can only be addressed through the collection of samples of specific species of interest. Such

collections are often essential to determining coral and sponge species identifications, and understanding reproduction, age and growth. Samples can also be used to study genetic diversity along the coast (e.g., the *Swiftia* spp. coral complex has many members that are short, red, and look identical) and across oceans (e.g., where *Lophelia pertusa* occurs in the Pacific and Atlantic oceans), as well as for species identifications and better species descriptions.

- *Survey new areas*: Participants thought that surveying and sampling new areas is important, including any areas that have not been sampled at all or have been sampled very little. The DSCS data from these new areas would help in modeling and increase our understanding of the distribution and abundance of DSCS.
- *Other topics*: Some topics were brought up in a single session, including the following.
    - Monitoring health or status of DSCS over time.
    - Sampling pennatulaceans on soft bottom for possible associated larval rockfish (e.g., Baillon et al. 2012).
    - The value of stratified coastwide surveys to inform managers and aid in the placement of protected areas.
    - The value of surveys and sampling in different habitat types, including seamounts, canyons, banks, continental slope and shelf, and different substrata including hard, mixed, and soft seafloors.
    - The need to inventory survey vehicles and equipment that are available to researchers.
    - The value of considering artificial structures as habitat and using these areas as a location to conduct experiments (e.g., removal experiments).

After three sessions of breakout groups were held, all the conversations were pooled into a list of nine research topics. Voting results are summarized in Table 1 and a summary map of the visual survey priorities is available in Appendix C.

Table 1. Summary of votes from the surveys breakout group.

Research topics	Votes
Conduct DSCS surveys in EFH determined areas that will be newly opened or closed due to Amendment 28	15
Understand fish and coral/sponge associations more clearly to determine the importance of corals and sponges as EFH	11
Collect physical oceanographic data and pair it with coral/sponge distributions	11
Determine programs for automated image processing	9
Find a central repository for DSCS survey data. A clearinghouse of DSCS information on the West Coast and projects	9
Determine a common survey design for conducting transects	7

Determine priority surveys or sampling that would help other projects (e.g., sampling to validate models)	7
Sample specific coral/sponges of interest (e.g., *Lophelia*, *Swiftia*, etc)	5
Conduct DSCS surveys in new areas	3

Modeling

The DSCRTP's 2017 'State of Deep-Sea Coral and Sponge Ecosystems of the United States' report has a chapter by Guinotte et al. (2017) reviewing predictive habitat modeling (hereafter simply referred to as modeling) for deep-sea corals in U.S. waters. As discussed in that chapter, modeling of deep-sea corals is an active area of research, providing a cost-effective means of identifying potential deep-sea coral habitat over large areas that can help target research and inform management. Several past and current studies have conducted modeling of deep-sea corals in waters off Washington, Oregon, and/or California (e.g., Guinotte and Davies 2014, Huff et al. 2013). A major interagency cross-shelf habitat suitability modeling project, funded by BOEM and led by NOAA (NCCOS), is currently underway to model DSCS habitat suitability along the whole west coast, and any future work will build on this effort. The objective of this breakout session was to discuss research priorities for modeling-related work as part of WCDSCI. The main questions considered in this breakout session include the following.

- What modeling has been conducted or is being conducted for the U.S. West Coast?
- What are the spatial and depth domains of those studies and are there gaps?
- What types of data have been modelled (e.g., presence only) and are there opportunities to model new types of data (e.g., presence-absence, abundance)?
- What are the spatial and taxonomic resolutions of existing models and are there opportunities for improved resolution?
- What environmental predictor variables have been used and are there opportunities for new or improved predictors?
- What statistical frameworks have been used and are there other frameworks that could be useful?
- Where are there opportunities for field validation of model predictions and how best can validation data be collected?
- Are there areas of predicted suitable habitat that should be prioritized for exploration?
- How can model results be used to inform management?

Most of the breakout discussion fell within three categories: environmental predictor variables, modeling methodology, and model validation. Cutting across these categories was discussion regarding geographic locations for modeling work, and use of models by management. The modeling breakout session did not conduct voting on priorities.

Discussion regarding environmental predictor variables for modeling mainly focused on identifying variables that could potentially be used to predict the distributions of deep-sea corals. The presence of specific bottom habitats and features were identified as potentially useful predictors including hard bottom, seeps and bubble plumes, carbonate and hydrate formations, canyons, fault scarps, and knolls. The amount of total organic carbon in substrate and the aragonite and calcite saturation state were also identified as potentially useful environmental predictor variables. It was discussed whether the presence of other species or taxa (e.g., other deep-sea

corals or fish) could be useful predictors of the presence of individual deep-sea coral species, and it was suggested that multi-species models may be the most appropriate way to model dependencies among the distributions of multiple species. It was recognized that a challenge with predictor variables is that complete data for the entire domain of a predictive model are required. As a result, all possible sources of habitat data should be considered (e.g., deep-sea surveys whose focus is not necessarily corals). One specific area that was identified as currently lacking mapping data was between Monterey Bay, CA and Point Conception, CA (including St. Lucia Bank), although there is a planned USGS survey there in 2018 as part of the EXPRESS campaign. Other recognized challenges included difficulties with the use of discrete predictor variables and variable quality of predictor data. Regarding the latter, a current NOAA SWFSC effort to develop a comprehensive substrate map for the West Coast including a categorical measure of data quality was discussed. In addition to types of predictor variables, the formulation of predictor variables was discussed as an important modeling consideration, including types of climatologies (e.g., mean values or frequency of exceeding threshold values) and the definition of seasons (e.g., correspondence with reproductive phenology).

Discussion regarding modeling methodology mainly focused on directions for future modeling to improve upon past and current modeling efforts. Past and current coast-wide modeling efforts, for example the current BOEM-funded NOAA (NCCOS)-led Cross-shelf Habitat Suitability Modeling project, have used presence-only models, capitalizing on the large number of occurrence data that are available. However, it was noted that survey effort has not been uniform and the lack of comprehensive absence/effort data is a challenge for presence-only models. Presence-absence and density modeling were identified as important future directions, although it was noted that such models have already been developed for smaller areas and other regions. Integrated modeling of presence-only, presence-absence, and abundance data simultaneously is also theoretically possible and should be considered when multiple data types are available from multiple surveys (e.g., visual and trawl surveys). Joint species distribution modeling was another technique identified for future consideration. Multi-species models can leverage information across species and capture dependencies in distributions among species. Multi-species models also allow for straightforward prediction of multi-species metrics (e.g., species richness). Dynamic models were also discussed as a technique for future consideration. Dynamic models could be used retrospectively to assess distributions prior to human impacts or prospectively to forecast the effects of climate change. Important aspects relevant to all of these modeling techniques were discussed, including spatial autocorrelation and spatial scale. It was further suggested that demographic/life history modeling could potentially be combined with spatial modeling. It was noted that the suggested future directions for modeling entail increased data requirements. For example, presence-absence modeling requires complete absence/effort data, which is not always available. In some cases it may be possible to conduct ‘data rescue’ for past surveys to obtain enhanced data (e.g., absence/effort data) through retrospective video analysis. Data rescue would require dedicated time and resources, but would be far less expensive than new field surveys. In the future, centralized databases should allow for the entry of effort data to facilitate the collection and analysis of such data. Dynamic models require repeated data from the same locations over time. Such data may exist for some areas on the West Coast (e.g., southern California). Given the data requirements of these future directions for modeling, it was suggested that focusing on a smaller area with the prerequisite data could be useful. Southern California and the National Marine Sanctuaries along the West Coast were identified as possibilities. A workshop on best

practices for modeling was identified as a priority and starting point for future modeling work as a result of the discussion.

Discussion regarding model validation focused mainly on how future surveys and data sampling could best be designed to validate model predictions. It was recognized that new independent data would provide the best test of model predictions, and it was noted that presence and absence data are required. Ideally, future surveys to validate model predictions would be comprehensive and designed according to statistical theory, however it was acknowledged that practical and logistical considerations influence survey effort and design. Simulation testing and scenario analysis were posed as potential techniques for evaluating how informative different amounts of survey effort and survey designs would be with respect to validating model predictions. It was noted that the results of the current Cross-shelf Habitat Suitability Modeling project could potentially be used to inform the design of future data sampling aimed at validating those model predictions if the model predictions are available in time for survey planning. Areas recently closed or reopened to fisheries by the PFMC were suggested as candidate focal areas for model validation.

A final topic of discussion was the use of model predictions by management, for example the PFMC. Some participants expressed a desire to have models considered by the PFMC in their management decisions, noting that there was a precedent for this in other regions (e.g., Mid-Atlantic Fishery Management Council). There was some uncertainty regarding the best way to introduce models to the PFMC process, and suggested approaches included providing informational documents (e.g., reports or white papers), presenting to the PFMC Scientific and Statistical Committee, and requesting a formal methodology review. It was noted that the process of engaging with the PFMC could take some time, especially a formal methodology review. It was also noted that the PFMC has previously considered spatial predictive models in the context of fish and fisheries.

Species Identification, Genetics, and Connectivity

Genetic studies play an important role in the understanding of deep-sea corals on the United States West Coast. Genetic and genomic methods are being used to confirm species identifications and improve taxonomy, an important component for monitoring species distributions and for habitat suitability monitoring. In addition, its value for identification, understanding genetics and connectivity within species is also important for conservation and management. Identifying patterns of connectivity can inform selection of regions needing protection as well as in planning recovery efforts. To date on the West Coast, much of the research has focused on genetic identification of species, either with direct sampling via ROV surveys or from fisheries bycatch, or through eDNA survey efforts. In this region there has also been a single connectivity study in *Swiftia simplex* (Everett et al. 2016).

Genetics and connectivity was one of the breakout group themes selected for the West Coast Initiative planning workshop. The purpose of the breakout group was to discuss what ongoing or new genetic research is needed on the West Coast, and how genetic tools and resources can best be used to inform management decisions. The following questions were used as a discussion starter for three breakout sessions, where conference participants identified priorities for genetics and connectivity research, and how that research could support other areas.

- What further work is needed in terms of taxonomy and species?
- Are there taxa where more genetic study is needed to help clarify taxonomy?

- How should research proceed where morphological taxonomy and genetic identification fail to match?
- Are there specific "taxa of concern" where connectivity studies are most needed?
- Which taxa should be prioritized for connectivity studies?
- How can genetic connectivity data be best presented to managers for use in planning?
- Are there additional sources of genetic material (e.g., museum collections) that could be further included to enhance genetic studies?
- How can we best used genetic information to inform about resilience and recovery in DSCS?
- Novel research in sponges is providing a wealth of new biomolecules for industries and medicine, is there further work to be done in sponges and corals that is of use in these fields?
- How can we best use new tools like eDNA analysis to inform researchers and managers about the importance of corals and sponges as fisheries habitat and track species?
- How can genetic tools inform research into other biological processes such as reproduction, basic life-cycle biology and community health?

Ideas that were suggested during the three breakout sessions could generally be categorized into several broad, related themes: sampling issues, connectivity, the need for more collaboration, modeling, and taxonomy. Related subjects were discussed in more detail within the context of each of these themes. These themes often overlapped, for instance, the need for more samples overall is partially driven by the need for better taxonomic sampling in some taxa. Sampling and connectivity were also related, as specific species will need additional sampling for connectivity studies. Finally, there was discussion of how genetic data could feed into various types of modeling efforts. Out of these discussions, a list of potential research needs was developed.

Several items were related to sampling. One was the need for all types of sponge samples as not much sampling or genetic work has been done in this group, leading to a desire prioritize future genetic work with sponges. Another item was the desire for more samples overall, with the caveat to prioritize particular species and to share resources and samples (existing and newly collected) with multiple research groups. The break out groups noted that there is a need for additional samples that cover a broader depth range, particularly deeper areas, as well as a need to sample in ways that profile community biodiversity and across diverse habitats, which could allow research into patterns of local adaptation.

The ongoing need for improved taxonomy, and sampling targeted to clarify species identifications was a common theme. Specific coral taxa lacking clear taxonomic identification on the West Coast were discussed, including black corals, coralliids, and plexaurids. Also discussed was the need to train more people in both morphological and genetic taxonomic identification, and the need to develop further genetic markers that may better distinguish taxa of interest. While taxonomic work is ongoing, the need for a common nomenclature, for instance, deciding to designate specific haplotypes or clades, or specific morphotypes (operational taxonomic units), even if there isn't yet a clear species name, in a common way was also discussed. As new methods and markers for doing species identification are being developed, the need for a workshop to cover common methods, particularly for eDNA, molecular markers, and common species nomenclature was suggested.

The need for additional connectivity studies was discussed in all three sessions. One of the highlighted research priorities was the need for targeted sampling for connectivity studies. To

facilitate connectivity studies, there is a need to select a list of target species. Several possibilities for such a list were discussed, including a focus on habitat-forming species, i.e., species that might be important for future management. The most popular idea was simply to select a number of species that cover diverse life history traits and habitats, to help get a better understanding of deep-sea coral biology overall. Another proposal was to focus sampling in a way to identify biogeographic breaks. As connectivity studies proceed, there was a desire to plan them in a way that would facilitate the identification of source populations.

To support the need for additional sampling, one recurrent idea was to generate a list of target taxa for collection (Appendix F), which could be shared across the research community. This could help facilitate obtaining the samples discussed as ongoing research occurs. Such samples could be used for taxonomy and genetics, as well as for other studies (e.g., life history, etc.). Additionally, if specific species needs are identified, existing collections can be subsampled, allowing more efficient use of existing resources among researchers. Related to this discussion, multiple sessions mentioned the desire for collaboration with both Canadian and Mexican researchers, and that maintaining and sharing such a target list might help facilitate this process.

Finally, there was also a desire to find ways to incorporate these data into modeling efforts. One idea that came up a number of times was to work with a species that is relatively shallow, making them accessible to the Sanctuaries research vessels, as a pilot study for local connectivity. In the case of the Channel Islands, this could potentially allow research into local scale connectivity, and possible use or incorporate the local ROMS model funded by BOEM.

After the end of the three breakout sessions, the overall themes, and sub-discussions were summarized into a list of potential priorities. All workshop participants had the opportunity to vote on the priorities, and the votes were tallied. The priorities and vote tallies can be found in Table 2.

Table 2. Priorities identified by the genetics and connectivity breakout group.

Genetics and connectivity priorities	Votes
More work on sponges (i.e. start producing genetic data)	18
Target sampling for connectivity studies (create a list of species that cover diverse life history to better understand basic biology; sample to support connectivity modeling, tie to modeling efforts already underway)	14
Need for additional samples to: cover additional depth, diverse habitats, capture community biodiversity, find ways to share existing resources	7
Common species “target list” - coastwide to facilitate sampling across projects and provide sampling protocols, support and contact information	6
Target biogeographic boundaries, like Point Conception	6
Collaboration with Canada and Mexico	3
Use the deep-sea coral database to facilitate genetic data sharing and voucher identifications (“common references”) among researchers	3
Workshop for common eDNA methods, molecular barcodes and nomenclature across the research community	2
More taxonomy support (i.e. development of new barcodes, genetic data sharing among organizations)	1

Common nomenclature for "unique" species, but inclusive of data even if there isn't a species name yet; shared haplotype or isolate naming	1
Selection of target communities to study dispersal limitation across taxa	-
Create a communications "script" for outreach about genetic work	-

Human Impacts

The 2017 'State of Deep-Sea Coral and Sponge Ecosystems of the United States' report highlights the major anthropogenic threats to deep-sea ecosystems and the communities that rely on them within the U.S. (Hourigan et al. 2017). For the West Coast, this list included bottom fishing (trawls, bottom set long lines, gillnets, traps, etc.), oil and gas development, ocean acidification, climate change (including ocean warming, changes to deep-sea current regimes and productivity), offshore renewable energy, deep-sea mining, and sediment plumes from seafloor disturbances. Participants were provided with this information at the outset of the discussion, but to avoid limiting the discussion, participants were also asked what impacts were missing. Participants were also tasked with identifying sites or geographic areas associated with specific human impacts along with any data gaps or research needs related to those threats. Additional materials made available to facilitate the conversation included: a hard copy of a table from the 2017 Report, which displayed a summary of perceived human threat levels to DSCS, access to several web-based maps that outlined the potential changes to RCA and EFHCAs and sponge and coral observations from the national DSCS database, and a large, poster-sized map of the West Coast on which participants could demarcate spatial priorities by hand. The group's discussion and suggestions were recorded on large pads of paper and displayed on a nearby wall so all participants, including those in the sessions that followed, could expand the discussion and identify gaps.

In each session, participants recommended research priorities spanning a wide range of subjects (see Table 3) with a range of specificity. Participants circled back to particular topics at their discretion and further highlighted knowledge gaps or data needs. There were six topics that accumulated 90% of the votes at the end of the prioritization process, spanning two broad themes: fishing impacts and needs related to monitoring human disturbances. Those topics are discussed in detail below.

Fishing

Breakout session participants identified bottom trawling as one of the best documented chronic threats to DSCS. However, in recent years, the PFMC has taken significant actions to reduce this threat. The discussion centered around more precisely defining "hot spots" or areas of high coral and sponge bycatch within trawl fisheries, and included the use of multiple information sources including Automatic Identification System (AIS) and Vessel Monitoring System (VMS) data, as well as fishing community knowledge. Issues associated with the transmission of data and information to managers were also mentioned, emphasizing the need to produce research products during this initiative that the PFMC will support and use to inform management decisions.

Similar to other subject breakout groups, participants in all three sessions spent a significant amount of time discussing data needs and research opportunities related to a recent decision made by the PFMC to open or close specific areas to groundfish fishing, outlined by Amendment 28 of the Pacific Groundfish Fishery Management Plan. The majority of attendees

expressed that DSCRTP should utilize this management decision as an opportunity to collect baseline data, both within and outside areas to be re-opened or closed, to allow for the assessment of impacts of fishing on, and recovery of, DSCS communities.

Participants also called attention to the importance of identifying rocky habitats that are relatively undisturbed by human activity. These refugia could be identified both through analysis of existing data collected from sites characterized by past missions, or by mapping and surveying previously unexplored areas to seek out and characterize new, undisturbed sites. Determining how to objectively define and identify pristine rocky habitats, perhaps on a relative scale, was also a priority related to coral and sponge refugia. Given the limited information on the recovery of these long-lived species, such research could lead to shifts in management decisions towards protecting specific areas yet to face fishing-related disturbances, as opposed to protecting rocky habitats post-disturbance.

Another important discussion topic centered around quantifying the frequency and intensity of interactions between other bottom fishing gear types and DSCS. For example, more research is needed to investigate fixed gear types, like pots and traps, that target hard-bottom which could be potential habitat for DSCS. Additionally, although mid-water trawls do not target benthic species, there is evidence that this gear type does occasionally come into contact with the seafloor, and may disturb biogenic habitat. This is a point of particular concern given mid-water trawls are permitted in EFHCA's, places assumed to be protected from fishing-related seafloor disturbances.

Monitoring

Participants in all three sessions suggested the need for consistent surveys through time to observe the frequency and severity of a variety of anthropogenic disturbances. While the current West Coast DSCRTP Initiative is time-limited (i.e., principally two years of field work), it can contribute to baselines for longer-term monitoring. Ideas ranged from maximizing the use of existing data for monitoring (e.g. reanalyzing images or video for fish associations, coral and sponge health or condition, etc.), to proposing a set of coastwide, standardized protocols for survey methods and specimen collections, to using surveys to monitor DSCS recovery from seafloor disturbances (e.g. shipping container spills, cable laying, mineral mining, etc.). Some participants recommended that specific oceanographic variables be consistently collected during ROV/AUV/submersible surveys (e.g. pH, eDNA, aragonite saturation, etc.), while others proposed using surveys to continually improve our understanding of the basic biology of DSCS, too (e.g. assessing age and size structures across species and communities to better understand recovery trajectories). Another recommendation was to use surveys to quantify the impacts of various types of marine debris (both macro and micro) to DSCS through space and time.

Additionally, monitoring DSCS responses to ocean acidification (OA) and hypoxic events was recommended as a research priority for this initiative. Alongside visual surveys, addressing this data gap would involve monitoring the relevant environmental variables associated with OA and hypoxia such as ocean pH, temperature, aragonite saturation, and dissolved oxygen to track how the environmental conditions change *in situ*, and how those variables affect DSCS health over space and time. Understanding the physiological responses and tipping points of various DSCS species in the lab was also suggested to address this knowledge gap. Results of such studies could inform species distribution or simulation models.

In addition to the priorities listed above, a few were identified, some spatially explicit, that could serve as potential approaches to reach other research objectives. For example, taking advantage of new, advanced technologies was mentioned in multiple sessions, such as cameras to

create photomosaics (highly detailed 3-dimensional images) which could be used to monitor select sites through time, or utilizing machine learning techniques which could standardize and streamline ROV/AUV image analysis. For a complete list of all the research priorities participants identified, see Table 3.

Spatially, sanctuaries were called out as priorities since each on the West Coast contain DSCS and are typically areas that contain a relatively high concentration of fine scale data (mapping and/or biological). Analyzing other data sources such as AIS and VMS were also listed as a potential priority, both inside and outside of sanctuaries, to maximize the use of existing data to address multiple research priorities. Such data streams in conjunction with other data sets, such as those available within Sanctuaries, can help define the extent of bottom fishing more precisely, as well as aid the quantification of human use and related pressures on valuable living resources and deepwater habitats.

Table 3. Recommended research priorities and their cumulative number of votes from the 'Human Impacts' breakout sessions.

Research Priority	Votes
Fishing	
Identify and study bottom trawling "hot spots" of coral and sponge bycatch	17
Baseline data within areas to be closed/reopened according to Amendment 28	16
Find/Identify coral and sponge refugia	10
Understand impacts to DSCS from other fishing gears	7
Opportunities for sanctuaries to work with Tribal communities	2
Monitoring	
Long-term monitoring	25
Better understanding ocean acidification, warming temperatures and hypoxic events, and how they affect corals over space and time	11
Contaminants and DSCS	1
Utilize advanced technology	-
Microbiomes: potential indicator for coral health assessment	-

Products Discussion

Workshop participants were divided into breakout groups once again to discuss opportunities, outlets, and tools to help develop and distribute data products and other informative material as a part of WCDSCI. Many data products related to DSCS research are inherently technical, such as observation records and site characterizations, and some products are well-suited

to disseminate that information such as the NOAA Deep-Sea Coral Data Portal, peer-reviewed publications, NMS Condition Reports, and project overviews on the Sanctuary Integrated Monitoring Network (SIMoN) project webpage. Given those outlets already exist, participants were encouraged to think creatively about how to make WCDSCI research results more accessible, engaging, and digestible to other scientists, managers, and the public. Workshop participants formed three groups to discuss and generate product ideas, many of which overlapped between groups. The list of products from the final breakout session is summarized in Table 4.

Generally, all groups recognized and stressed the importance of setting outreach and education goals related to WCDSCI to inform the public, educators, academics, stakeholders, and partners about its purpose, data collection, and potential outcomes such as management decisions. Below is a brief description of the suggested products.

Identification Guide and a Species Target List for the West Coast Region

Deep-sea habitats are inherently difficult to study and opportunities to identify or collect certain species can be limited for numerous reasons. In addition, a comprehensive taxonomic guide for DSCS species that is inclusive of deep-sea habitats stretching from Canada to Mexico is not available. In response to this need, workshop participants suggested creating a species identification guide that includes both sponges and corals across the West Coast. Ideally this guide would be: searchable online and available for download, include photos as well as detailed descriptions of depth, range, size, and uniqueness, describe morphological characteristics using standardized language, and include a list of similar species. Previous efforts on which to build off of include exemplary guides such as MBARI's online tool that focuses on species found off Monterey Bay, or the Davidson Seamount Taxonomic Guide (Burton and Lundsten, 2008).

As discussed earlier in the genetics and connectivity breakout session summary, participants suggested that an inventory for DSCS collection needs be available to scientists to view and reference in order to facilitate collaboration and opportunistic data collection. A West Coast species target list would be a living document listing the latest need for specimens, the contact information of who requires the sample, the type of sample needed, and the proper collection protocol along with photos or other helpful information. In addition to target species, this list would ideally include a list of specimens that already exist in collections, how they've been preserved, where they're located, and who to contact regarding questions or requests for samples. Both the species identification guide and collections inventory would minimize the potential of duplicative efforts among DSCS scientists across the West Coast, allowing seemingly disparate principle investigators to work together more cohesively. Further, it would also maximize the use of existing samples and reduce the impact of research collections on valuable biogenic habitat.

Regional Database and Archive

Workshop participants highlighted the utility of having the information accumulated during WCDSCI standardized and stored in one regional database. Although the NOAA Deep-Sea Coral Data Portal and national databases such as those at NCEI house relevant data at a nationwide level, a regional database would allow for quick access to information gathered over the next several years specific to the West Coast. In particular, a web accessible GIS database could hold the spatial information accumulated during WCDSCI such as high resolution map products, ROV

survey and ship transects, environmental data, and other relevant data layers such as ocean use, to streamline cruise prioritization, mission planning, and data entry across the coast. A local database would also facilitate the acquisition of summary information and achievements for reports. Another suggestion was to archive all the physical video footage in additional locations, like at Undersea Imagery Archive at California State University, Monterey Bay (CSUMB).

Best Practices

Another major point of discussion was the interest in creating 'best practice' documents such as a shared set of standardized survey or collection protocols, that identify and prescribe a set of methodologies to standardize, to an extent, DSCS research conducted along the West Coast. Implementing some degree of standardization was suggested in response to the inability of scientists to make comparisons across multiple sites. Different methods, definitions (what is a 'site'?), and levels of detail in the characterizations of sites and transects all limit the ability to compare sites to one another. It is important to note, though, that different research questions or management goals may ultimately require different protocols. However, a comparison could still be possible if a subset of the survey work was executed using similar protocols. Without sacrificing the original mission or preferred methods entirely, in this way a portion of site could be used for multi-site comparisons. Ultimately, the goal for creating a series of best practices would be for their eventual adoption by the majority of DSCS scientists participating in DSCS research in the West Coast Region.

Standardizing methodologies for at least a portion of most deep-sea missions could also facilitate the establishment of long term monitoring locations, another highly discussed science priority. Although not equipped to lead long-term monitoring efforts, WCDSCI could initiate or endorse best practices for selecting sites for regular monitoring (such as creating photomosaics). The PFMC and other science centers would ideally vet suggested best practices to ensure protocols are based on sound science and statistical rigor. In doing so, resulting data products could also be more suitable to directly inform future management decisions.

Public Outreach and Education

Each group emphasized the importance of educating the public about DSCS and the value of deep-sea ecosystems through education and outreach. Generally, the groups expressed interest in outreach ideas that were interactive, made use of advanced technology, and were creative. For example, all groups suggested the use of story maps to break down complicated concepts related to DSCS research such as connectivity, genetics, seeps, or management decisions. It was also suggested that cruise reports could be published as story maps. The advantage of doing so would be the ability to include highlight clips from transect videos, as well as other figures and maps in a more engaging format. Participants also wanted to see WCDSCI present on social media in addition to taking advantage of telepresence where possible, as well as engaging other media types such as newspapers, podcasts, and youtube. Tapping into these information outlets would bring WCDSCI content to a broader range of audiences. Other forms of advanced technology that WCDSCI could utilize for public outreach and education include developing 3-dimensional (3D) images of rocky habitats (photomosaics) or 3D fly-throughs of transect videos to encourage the audience to directly interact with the deep-sea habitat imagery. The goal would be to get the public to interact with complicated, highly detailed images to help them better understand what deep-sea

ecosystems look like, how researchers characterize them, and why they are important to conserve. In addition, highly detailed photomosaics could also be used to develop and print 3D models of corals and sponges for display or handling by school groups; in-hand objects like 3D printed models of DSCS, or even preserved specimens in jars, along with other interactive material would greatly enhance and contribute to existing NMS educational products related to DSCS habitats on the West Coast.

Just as story maps were suggested to break down complex ideas, creating educational infographics with WCDSCI content could also be useful, but more applicable to a wider variety of media. For example, once developed, infographics could be placed in outreach materials such as booklets or informational pamphlets, on websites, in story maps, or in any other material or signage; such material could be made particularly useful if WCDSCI scientists partnered with highly trafficked educational venues like Cal Academy, aquariums with deep-sea exhibits, or National Marine Sanctuary visitor centers, to display or distribute the information. Within this material, another suggestion was to include detailed timelines of management decision processes (e.g. the timeline from making a management decision to the enforcement of that decision, such as making changes to EFH or RCA closures).

Lastly, shirts, stickers, mugs, hats and a variety of other items could be made with the DSCRTP program identifier and be made specific to WCDSCI research. This kind of gear could be used to incentivise public participation and engagement by offering them as prizes or rewards for social media followers, and so on.

Student Involvement and Citizen Science

A research priority that was emphasized during the workshop was to proactively take advantage of emerging technology to advance WCDSCI research. However, utilizing machine learning algorithms to automate fish and coral identification for example, requires a large initial time investment to train the algorithm to accurately identify species. One proposed solution was to engage citizens scientists and students to increase the feasibility machine learning techniques. This would not only expedite the use of machine learning for WCDSCI, but it could also be used as a learning tool for students by partnering with the ONMS. The ONMS has an established deep-sea curriculum available online to teachers. This curriculum could be expanded to incorporate training modules where students learn about how deep-sea research is conducted and tag videos and images with the correct species identification. A regional WCDSCI geodatabase offers another opportunity to expand the ONMS deep-sea curriculum. For example, new lessons could be built around an educational portal through Sea Sketch where students can interact with and answer questions about various data layers such as DSCS observations, habitat suitability predictions, marine protected areas, etc.

Table 4. Consolidated list of the products participants suggested should be produced through WCDSCI during the final breakout session of the workshop.

Potential West Coast Initiative Products
Species identification guide for the West Coast Region
Species target list

West Coast Regional database(s)/archive
'Best Practices' for surveys, site characterizations, etc.
Seek opportunities to engage other social and tradition media, and telepresence
Citizen science and public outreach through the NMS online deep-sea curriculum
DSCRTP WCDSCI gear (hats, stickers, shirts, mugs, etc.)
Updated West Coast Sanctuary Condition Reports and SIMoN project web pages
Peer reviewed publications

Concluding Remarks

Contributions from this diverse group of experts resulted in this compilation of ideas, opportunities and paths forward to advance our understanding of deep-sea coral and sponges on the West Coast. Three themes that provide a spatial focus for the upcoming effort were pervasive throughout the discussions in each of the breakout groups include the following.

1) Timing of the new EFH/RCA changes proposed by Amendment 28 to the Pacific Groundfish Fishery Management Plan by the PFMC appropriately focused the community and discussion on the need for baseline surveys over closures newly proposed for opening as well as for long term monitoring of these sites.
2) Our understanding regarding areas of high coral and sponge bycatch has greatly improved over the last several years. A focus on these areas to better understand the impacts associated with bycatch and further refinement of bycatch maps is essential for management.
3) The west coast has many unique and special features including seamounts, submarine canyons and deep ocean basins. With limited time and budget, a priority should be given to NOAA trust resources such as National Marine Sanctuaries.

Core to the success of WCDSCI will be the development and improvement of map products and spatial models, as well as our understanding of taxonomy and human impacts. Focus areas should include the following.

1) High resolution multibeam bathymetry and associated backscatter are requisite products to identifying habitats for deep-sea coral and sponges.
2) Visual surveys via ROV, AUV, or towed camera systems will advance our understanding of DSCS across many research areas (biology, life history, resilience to human impacts, recovery trajectories, etc.) and will be required to: better characterize fish and coral/sponge associations, validate habitat suitability models, assess human impacts on DSCS related to fishing as well as long-term climatological effects, and the natural progression of DSCS communities over time.

3) Higher taxonomic and spatial resolution models of deep-sea coral and sponge distributions will help define priority areas for surveys, mapping and management. Developing improved predictor variables as well as developing and validating new models should be priorities.
4) Expanding the use of genetics as a way to identify corals and sponges and refine their taxonomy and also as a method to understand the connectivity of coral and sponge populations is important. Improvement of tools and protocols for collecting more and higher quality samples was identified as a prerequisite for expanded use of genetics.

Finally, the success of WCDSCI will depend upon making full use of partnerships, many of which were represented in the workshop. NOAA is committed to strengthening these partnerships as the Initiative moves forward.

Acknowledgements

We thank the WCDSCI steering committee for their input during the planning and execution of this workshop, making it a productive event. In addition to all the participants, both remote and in person, we also acknowledge and thank the people who played supportive roles: Jackie Buhl for facilitating and supporting workshop logistics, Mari Cajandig and Ryan Freedman for facilitating and creating informative materials for the for breakout session notes, Robert McGuinn for creating an interactive map displaying data from the DSCRTP national database, and Brandon Doheny who also helped facilitate and record notes. We also thank the presenters at the workshop for preparing material to share with the attendees about their respective agencies or institutions, as well as the coastal Washington treaty tribes for participating remotely and contributing to workshop the report. A special thanks to the NOAA DSCRTP for funding the workshop which allowed all of the thoughtful, cross-cutting discussions to take place to help prepare the steering committee for science plan development. And a special thanks goes to Tom Hourigan and Heather Coleman for their helpful guidance throughout the entire process.

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Appendix A - A list of workshop participants and their affiliations.

Name	Affiliation	Participation
Joe Bizzarro	NOAA National Marine Fisheries Service	
Erica Burton	NOAA Monterey Bay National Marine Sanctuary	
Shallin Busch	NOAA National Marine Fisheries Service	Remote
Chris Caldow	NOAA Channel Islands National Marine Sanctuary	Co-lead
Liz Clarke	NOAA National Marine Fisheries Service	Co-lead
Guy Cochrane	U.S. Geological Survey	
Heather Coleman	NOAA National Marine Fisheries Service	Steering Committee
Bryan Costa	NOAA National Centers for Coastal Ocean Science	
Lizzie Duncan	NOAA Channel Islands National Marine Sanctuary	Co-coordinator
Meredith Everett	NOAA National Marine Fisheries Service	Co-coordinator
Ryan Freedman	NOAA Channel Islands National Marine Sanctuary	
Lisa Gilbane	Bureau of Ocean Energy Management	
Kerry Griffin	Pacific Fishery Management Council	Remote
Jennifer Hagen	Quileute Nation	Remote
Beth Horvath	Westmont College	
Tom Hourigan	NOAA National Marine Fisheries Service	Steering Committee
Tom Laidig	NOAA National Marine Fisheries Service	Steering Committee
Danielle Lipski	NOAA Cordell Bank National Marine Sanctuary	
Milton Love	University of California, Santa Barbara - Marine Science Institute	
Bob Miller	University of California, Santa Barbara - Marine Science Institute	

Tommy Moore	Northwest Indian Fisheries Commission	Remote
Amanda Netburn	NOAA Office of Exploration and Research	Steering Committee
Tammy Norgard	Fisheries and Oceans Canada	Remote
Jacqueline Padilla-Gamino	University of Washington	Remote
Jeremy Potter	Bureau of Ocean Energy Management	
Nancy Prouty	U.S. Geological Survey	
Andrea Quattrini	Harvey Mudd College	
Nicole Raineault	Ocean Exploration Trust	Remote
Jan Roletto	NOAA Greater Farallones National Marine Sanctuary	
Tom Rudolph	Pew Charitable Trusts	
Geoff Shester	Oceana	
John Stadler	NOAA National Marine Fisheries Service	Steering Committee
James Thorson	NOAA National Marine Fisheries Service	
Brian Tissot	Humboldt State University	Remote
Jenny Waddell	NOAA Olympic Coast National Marine Sanctuary	Steering Committee
Curt Whitmire	NOAA National Marine Fisheries Service	
Gary Williams	California Academy of Sciences	
Arliss Winship	NOAA National Centers for Coastal Ocean Science	Steering Committee
Katie Wrubel	Makah Tribal Council Office	Remote
Mary Yoklavich	Moss Landing Marine Laboratories	

Appendix B - Workshop Agenda

Deep Sea Coral Research and Technology Program (DSCRTP)
West Coast Initiative: Science Priorities Workshop

Objectives:
(1) Identify and rank priority research questions by geographic region
(2) Discuss the tools, activities, and techniques by which these questions will be addressed
(3) Identify opportunities to leverage funding via partner collaborations
(4) Outline potential products to come out of the identified research objectives

DAY 1:
7:30 – 8:30 Check-In begins @ 8:00 am

8:30 – 9:00 Welcome, Intro to Steering Committee, Introductions to Attendees, Agenda Review, Goals and Attendee expectations (Chris Caldow and Liz Clarke)

9:00 – 9:30 DSCRTP Overview (Tom Hourigan)

9:30 - 10:00 Overview of DSCRTP West Coast Initiative in 2010 (Liz Clarke)

10:00 – 10:20 Overview Presentation: NMFS (Tom Laidig)

10:20 – 10:40 Overview Presentation: West Coast Sanctuaries (Jenny Waddell)

10:40 – 11:00 --BREAK--

11:00 – 11:20 Overview Presentation: Pacific Fisheries Management Council: EFH process and Research Priorities Plan, Revisions to EFH Conservation areas and trawl RCAs (John Stadler and Kerry Griffin)

11:20 – 11:40 Overview Presentation: OER/OET (Amanda Netburn and Nicole Raineault)

11:40 – 12:00 Overview Presentation: BOEM (Lisa Gilbane)

12:00 – 1:00 --LUNCH--

1:00 – 1:20 Overview Presentation: USGS (Nancy Prouty)

1:20 – 1:40 Overview Presentation: DFO (Tammy Norgard)

1:40 - 2:00 Wrap up: Open to the floor for additional research plans/priorities discussion

2:00 – 2:25 Review of visual aids/summary materials (Chris Caldow, Lizzie Duncan, Curt Whitmire, Arliss Winship)

- FRAM data warehouse and SoundGIS webpages: EFH and RCA proposed alternatives for Amendment 28

- Map of deep-sea coral and sponge observations and ROV pseudo-tracklines courtesy of Robert McGuinn and the DSCRTP national database
- Habitat suitability modeling products from BOEM-NCCOS collaboration available for viewing through Arliss

2:25 – 2:40 Introduce Breakout Sessions Structure/Objectives (Liz Clarke)
Modeling; Facilitator: Arliss Winship
Habitat Mapping; Facilitator: Ryan Freedman
Genetics/Connectivity; Facilitator: Meredith Everett
Sponge & Coral Surveys; Facilitator: Tom Laidig
Human Impacts; Facilitator: Lizzie Duncan

2:40 – 3:00 --BREAK--

3:00 – 3:45 **Breakout Session 1**: Simultaneous sessions on each of the 5 subject areas

3:45 – ADJOURN DAY 1

DAY 2:
8:45 – 9:00 Recap of Day 1, Preview of Day 2 (Chris Caldow and Liz Clarke)

9:00 – 10:00 **Breakout Session 2**: Simultaneous sessions on each of the 5 subject areas
Modeling; Facilitator: Arliss Winship
Habitat Mapping; Facilitator: Ryan Freedman
Genetics/Connectivity; Facilitator: Meredith Everett
Sponge & Coral Surveys; Facilitator: Tom Laidig
Human Impacts; Facilitator: Lizzie Duncan

10:00 – 11:00 **Breakout Session 3**: Simultaneous sessions on each of the 5 subject areas
Modeling; Facilitator: Arliss Winship
Habitat Mapping; Facilitator: Ryan Freedman
Genetics/Connectivity; Facilitator: Meredith Everett
Sponge & Coral Surveys; Facilitator: Tom Laidig
Human Impacts; Facilitator: Lizzie Duncan

11:00 – 11:15 --BREAK--

10:45 – 11:30 Report out from breakout session facilitators

11:30 –12:00 Voting on priority research questions

12:00 – 1:00 --LUNCH--

12:45 – 1:15 Report out on top priorities by session **facilitators**

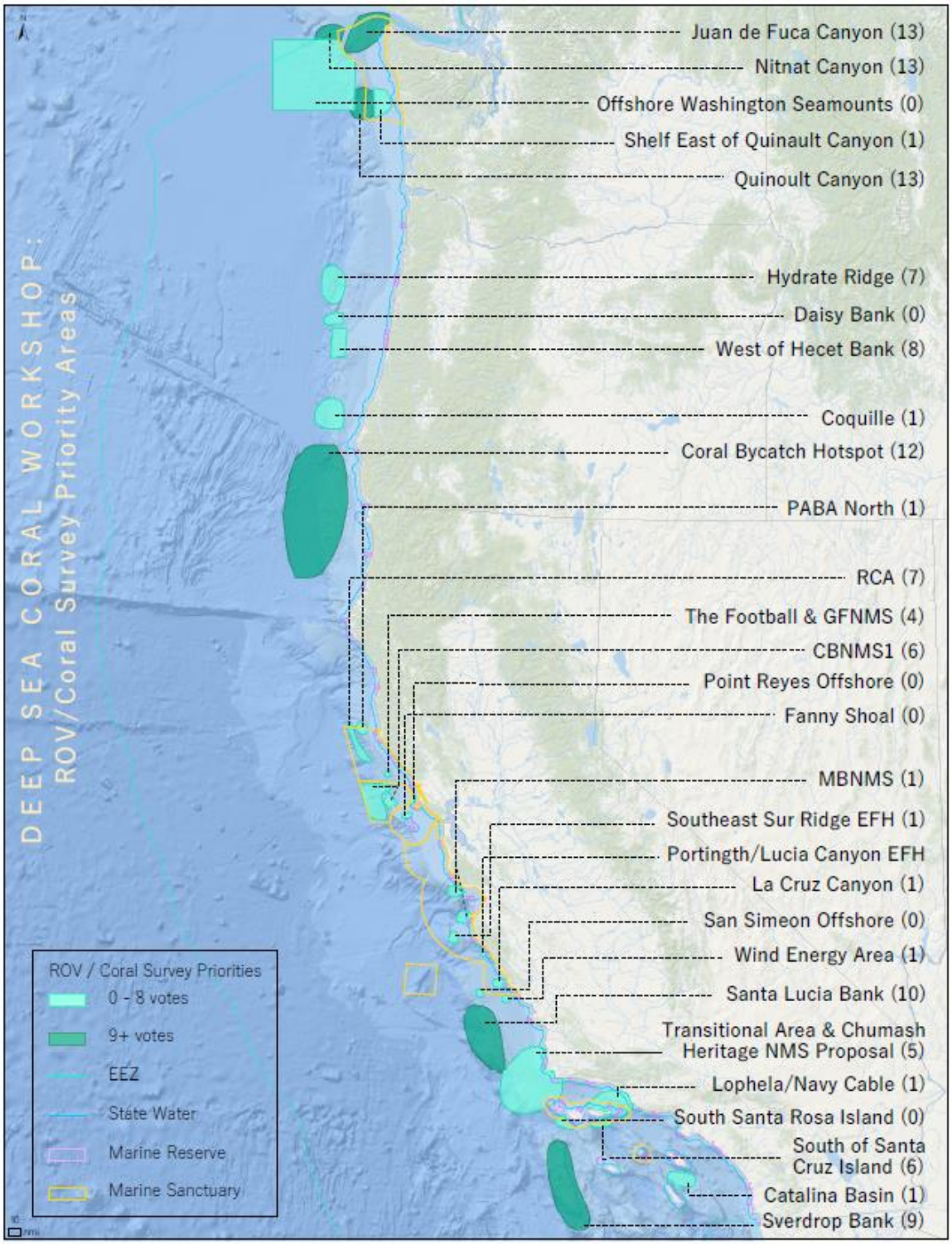
1:15 – 2:00 Discuss list of activities/projects that could answer priority questions (**Liz Clarke)**

2:00 – 2:45 Products breakout session (3 groups)

2:45 – 3:15 Report out on product breakout sessions

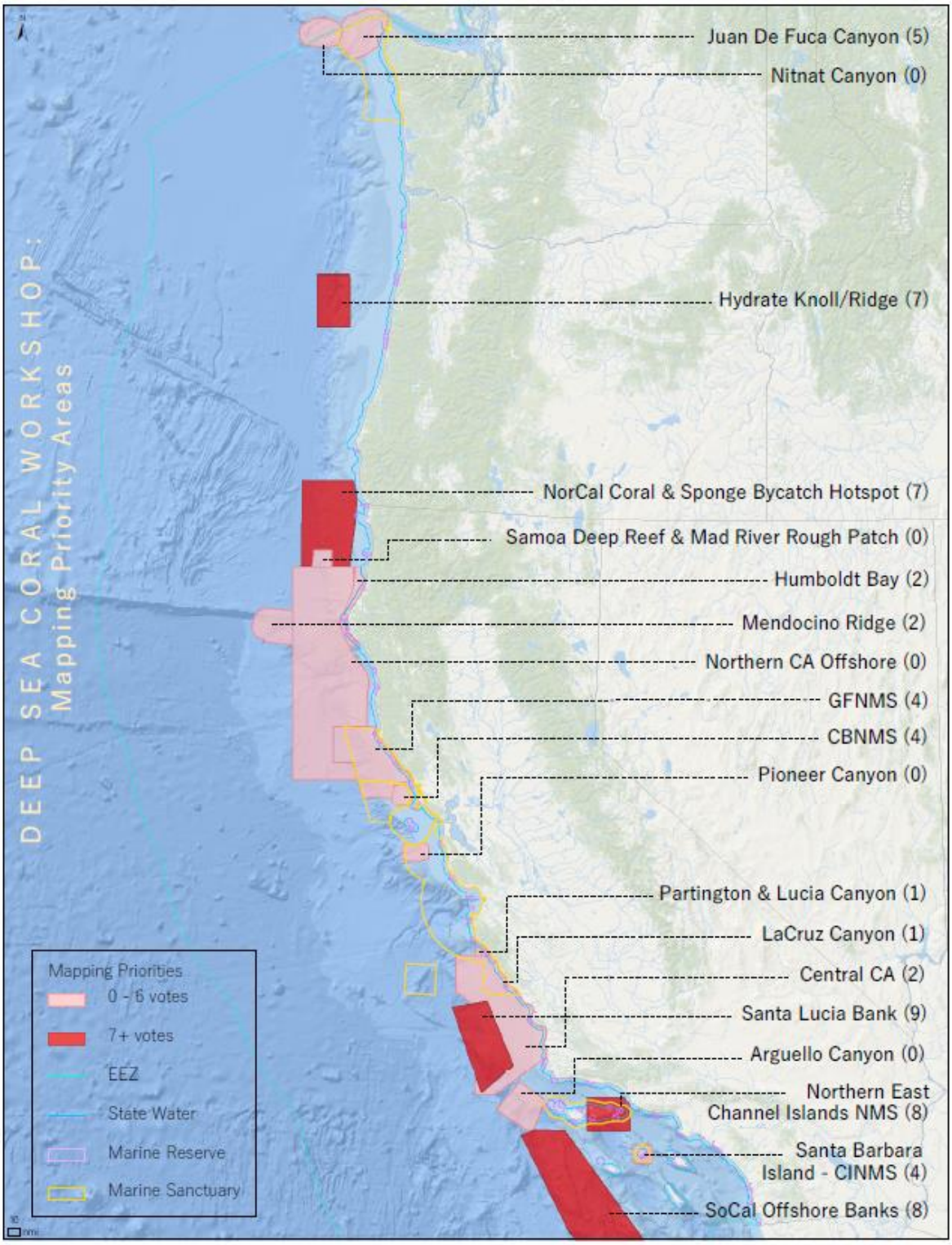
4:30 - ADJOURN

Appendix C - Map of Visual Survey Priority Areas



Map of the areas workshop participants prioritized for further exploration via visual survey on the West Coast. Numbers adjacent to polygon labels represent the number of votes that area received. Map courtesy of Mari Cajandig, NOAA CINMS.

Appendix D - Map of Mapping Priority Areas



Map of the areas workshop participants prioritized for mapping efforts on the West Coast. Numbers adjacent to polygon labels represent the number of votes that area received. Map courtesy of Mari Cajandig, NOAA CINMS.

Appendix E - Acronyms

Alaska Fisheries Science Center	AFSC
Automatic Identification System	AIS
Atlantic Seafloor Partnership for Integrated Research and Exploration	ASPIRE
Autonomous underwater vehicle	AUV
Bureau of Ocean Energy Management	BOEM
Campaign to Address the Pacific Monument Science, Technology, and Ocean Needs	CAPSTONE
Coastal and Marine Ecological Classification Standard	CMECS
California State University, Monterey Bay	CSUMB
Conductivity-Temperature-Depth	CTD
Fisheries and Oceans Canada	DFO
Diversity, Systematics, and Connectivity of Vulnerable Reef Ecosystems	DISCOVRE
Deep Sea Coral Research and Technology Program	DSCRTP
Deep-sea corals and sponges	DSCS
Exploration Vessel	*E/V*
Ecosystem-based fisheries management	EBFM
Environmental DNA	eDNA
Essential Fish Habitat	EFH
EFH Conservation Areas	EFHCA
Expanding Pacific Research & Exploration of Submerged Systems	EXPRESS
Monterey Bay Aquarium Research Institute	MBARI
Magnuson-Stevens Fishery Conservation and Management Act	MSA
National Centers for Coastal Ocean Science	NCCOS
Non-government organizations	NGO
National Marine Sanctuaries	NMS
National Marine Fisheries Service	NMFS
National Oceanic and Atmospheric Administration	NOAA
National Ocean Service	NOS
Northwest Fisheries Science Center	NWFSC
Ocean acidification	OA
Oceanic and Atmospheric Research	OAR
Office of Coast Survey	OCS
Ocean Exploration and Research	OER
Ocean Exploration Trust	OET
Office of Marine and Aviation Operations	OMAO
Office of National Marine Sanctuaries	ONMS
Pacific Fishery Management Council	PFMC
Rockfish Conservation Area	RCA
Remotely operated vehicle	ROV
Sanctuary Integrated Monitoring Network	SIMoN
Southwest Fisheries Science Center	SWFSC
United States Geological Survey	USGS
Vessel monitoring system	VMS
West Coast Deep-Sea Coral Initiative	WCDSCI

Appendix F - Current list of priority West Coast taxa for collection as of publication.

To suggest additions or modifications, or obtain the most recent version, please contact Meredith Everett (Meredith.Everett@noaa.gov).

Taxa	Requested By	Purpose/Interest	Area for collection
Anipatharia			
Lillipathes sp.	Meredith Everett	Taxonomy	Coastwide
Parantipathes sp.	Meredith Everett, Tom Hourigan	Taxonomy	Coastwide
Heteropathes sp.	Meredith Everett, Tom Hourigan	Taxonomy	Coastwide
Antipathes dendrochristos	Curt Whitmire	Biogeography	North of Pt. Conception, CA
Alcyonacea			
Acanthogorgia spp.	Meredith Everett, Tom Hourigan	Taxonomy, connectivity	Coastwide
Paragorgia spp.	Meredith Everett, Santiago Herrera, Peter Etnoyer	Connectivity	Coastwide
cf. Placogorgia sp.	Tom Hourigan, Beth Horvath	Taxonomy, connectivity	SoCal Bight
Keratoisis	Meredith Everett, Peter Etnoyer	Taxonomy, connectivity	Coastwide
Lepidisis	Meredith Everett	Taxonomy, connectivity	Coastwide
Acanella	Meredith Everett, Tom Hourigan	Taxonomy, connectivity	Coastwide
Chrysogorgidae	Meredith Everett, Tom Hourigan	Underrepresented group	Coastwide
Corrallium	Meredith Everett, Tom Hourigan	Underrepresented group	Coastwide
Iridogorgia spp.	Tom Hourigan		
Radicipes	Gary Williams	Taxonomy	Coastwide
Swiftia farallonesica	Gary Williams	Taxonomy	Coastwide
Any red, branched Swiftia species	Beth Horvath, Peter Etnoyer	Txonomy	Coastwide
Yellow, sparsely branching "Swiftia" Plexaurid gorgonian	Gary Williams, Odalisca Breedy	Taxonomy	Cordel Bank and South
Primnoa pacifica	Meredith Everett, Cheryl Morrison, Peter Etnoyer	Population genetics, range expansion	Coastwide

Pennatulacea			
Protoptilum spp.	Gary Williams	Taxonomy	Coastwide
Stachyptilum spp.	Gary Williams	Taxonomy	Coastwide
Halipteris spp. Deep and shallow	Everett, Williams	Taxonomy	Coastwide, 300m to 500m depth priority
Scleractinia			
Desmophyllum dianthus	Cheryl Morrison	Taxonomy, connectivity	Coastwide
Lophelia pertusa	Cheryl Morrison, Peter Etnoyer	Taxonomy, connectivity	
General requst for any primary taxa from large assemblages that we cannot readily identify.			
Sponges			
Acarnus sp.	Abi Powell	Taxonomy	Coastwide
Thenea muricata	Abi Powell	Taxonomy	Coastwide
Xestospongia sp.	Abi Powell	Taxonomy	Coastwide
Asbestopluma sp. (flat frond morphology)	Abi Powell	Taxonomy	Coastwide
Asbestopluma sp. (branching morphology)	Abi Powell	Taxonomy	Coastwide
Asbestopluma sp. (unbranched morphology)	Abi Powell	Taxonomy	Coastwide
Polymastia spp.	Abi Powell	Taxonomy	Coastwide
White spikey barrel sponge (see images)	Abi Powell	Taxonomy	Coastwide
White encrusting cushions (see images)	Abi Powell	Taxonomy	Coastwide
Latunculia spp. "Moon sponges"	Abi Powell	Taxonomy	Coastwide
Farrea sp. (stalked form)	Abi Powell	Taxonomy	Coastwide
Farrea sp. (foliose form)	Tom Laidig	Taxonomy	Southern Cal
Staurocalyptus sp. (yellow morph)	Abi Powell	Taxonomy	Coastwide
Staurocalyptus spp. (white)	Abi Powell	Taxonomy	Coastwide
Stylocordyla spp.	Abi Powell	Taxonomy	Coastwide
Tentorium spp.	Abi Powell	Taxonomy	Coastwide
Mycale spp.	Abi Powell	Taxonomy	Coastwide
Haliclona spp.	Abi Powell	Taxonomy	Coastwide
Heterochone calyx (#624 SWFSC)	Abi Powell	Taxonomy	Coastwide
Chonelasma spp.	Abi Powell	Taxonomy	Coastwide

White barrel/tube shaped glass sponges	Abi Powell	Taxonomy	Coastwide
Suberites sp.	Abi Powell	Taxonomy	Coastwide
White globular demosponge	Abi Powell	Taxonomy	Daisy Bank
Aphrocallistes vastus	Abi Powell	Taxonomy	Coastwide
Various encruising beige demosponges	Abi Powell	Taxonomy	Coastwide
Unidentified globular demosponge (#269 SWFSC)	Abi Powell	Taxonomy	Santa Lucia Bank
Unidentified plate sponges (# 603 SWFSC)	Abi Powell	Taxonomy	Santa Lucia Bank