NOAA Technical Memorandum NMFS-AFSC-501

Deep Sea Coral Research and Technology Program: Alaska Coral and Sponge Initiative 2020-2024 Final Report

C. Conrath, P. Malecha, J. Hoff, P. Goddard, L. Sadorus, C. Rooper, R. Waller, S. Rooney, M. Everett, W. Larson, and J. Olson

August 2025

U.S. DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Alaska Fisheries Science Center

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This document should be cited as follows:

Conrath, C., Malecha, P., Hoff, J., Goddard, P., Sadorus, L., Rooper, C., Waller, R., Rooney, S., Everett, M., Larson, W., and Olson, J. 2025. Deep Sea Coral Research and Technology Program: Alaska Coral and Sponge Initiative 2020-2024 Final Report. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-AFSC-501, 79 p.

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U.S. DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration
National Marine Fisheries Service
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August 2025

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Executive Summary

Each large marine ecosystem in Alaska has unique coral and sponge ecosystems that provide habitat for commercially important groundfish species. Numerous areas with high densities of sponges and corals have been identified throughout the Aleutian Islands and this area supports the most abundant cold-water coral resources known in high latitudes (Stone and Rooper 2017). In the Gulf of Alaska, expansive areas of red tree coral thickets have been identified as well as other areas of dense coral and sponge habitats in high relief and rocky habitats. Although deep-sea corals and sponges (DSCS) are scarcer in the Bering Sea due to a lack of hard substrate, there are high-density areas found within slope and outer shelf regions, as well as around canyons. A complete understanding of DSCS resources within Alaska is hampered by the large size of the U.S. Exclusive Economic Zone (EEZ) in Alaska and the logistical challenges of sampling in deep-sea waters. The National Oceanic and Atmospheric Administration (NOAA) Deep Sea Coral Research and Technology Program (DSCRTP) sponsored a second research initiative in the Alaska region from 2020 to 2024, referred hereafter as the Alaska Coral and Sponge Initiative (AKCSI, a previous initiative took place from 2012 to 2015, https://deepseacoraldata.noaa.gov index.php/regions/Alaska). The science plan executed for this program was guided by six priorities derived from ongoing data needs and objectives identified during the pre-initiative workshop described in the introduction (Hoff et al. 2021).

This report presents the results of 10 projects conducted using DSCRTP funds from 2020 to 2024 and other continuing efforts to promote the preservation and knowledge sharing about DSCS within the Alaska region. Four of the projects conducted as part of the Alaska Initiative included dedicated at-sea cruises (Section 2). These projects included the 1) Gulf of Alaska species distribution model validation study, 2) the *Primnoa* recruitment and reproduction study, 3) the Joint Canada-USA international seamount survey, and 4) the Aleutian closure area study. In all, these four projects included seven separate research cruises with a total of 82 at-sea days. The other six projects (Section 3) were supported by samples collected during these field projects or other Alaska Fisheries Science Center (AFSC) supported surveys.

Given the vast size of the U.S. EEZ in Alaska, using direct visual observations to understand the distribution of DSCS within this region is an unreachable goal. Building the modeling tools and collecting the information needed to accurately estimate coral and sponge distribution is a continuing objective of the previous and current Alaska initiatives. During the previous initiative, maps of the predicted occurrence of corals and sponges were produced on a 1 ha scale for each of the Gulf of Alaska, eastern Bering Sea, and Aleutian Island ecosystems based on data from annual or biennial trawl surveys that are conducted by the AFSC. The performance of these models was analyzed for the eastern Bering Sea and the Aleutian Islands using targeted visual surveys. During the current initiative, a research cruise was completed in 2022 in the Gulf of Alaska to collect *in situ* stereo images for validating the previously completed species distribution models of coral and sponge distribution. In general, these models indicate that coral and sponge habitat occur at predictable locations, throughout Alaska, where hard bottom substrate is present. These studies, comparing visual observations with trawl survey data, highlight the strengths and weaknesses in assessing distribution and abundance from trawl survey data and enable scientists to explore the most effective ways to add to our knowledge of

the distribution of these important deep-sea habitats. In addition, the Aleutian closure area study and the joint Canada-USA international seamount cruise added many new visual observations of coral and sponge habitat over a variety of depths in the Aleutian Islands and offshore waters of the Gulf of Alaska. These visual observations provide valuable data that will aid in refining our understanding of how the abundance and distribution of these species are influenced by a suite of oceanographic conditions. In addition, eDNA samples were collected during these three field expeditions during most visual transects. These samples will expand our knowledge of DSCS distribution and may enhance our ability to accurately predict the distribution of coral and sponge species throughout Alaska's waters.

The Alaska Coral and Sponge Initiative also continued to build on our knowledge of the biology and taxonomy of DSCS species and communities in Alaska waters. Three research expeditions took place over three years (2022-2024) to examine the recruitment and reproduction of the red tree coral, *Primnoa pacifica,* in partnership with the Alaska Department of Fish and Game. The placement and retrieval of Autonomous Reef Monitoring Structures (ARMS) continues to build our understanding of the recruitment dynamics of this species, which has a patchy distribution and is locally abundant in several areas in southeast Alaska. In addition, during this study, live coral were collected and transported in flowing seawater tanks to the Auke Bay Laboratories in Juneau, Alaska. This allowed researchers to observe live mature sperm in spermatocysts and assess the stages of maturity. Asexual reproduction was also observed through polyp bailout in stressed specimens. This project is an important and exciting first step in the development of methods to transport and observe live coral in a laboratory setting located in Alaska. Results from this study will substantially increase our knowledge of how this and potentially other coral species reproduce. Additionally, sponge samples were collected throughout the initiative from AFSC bottom trawl surveys conducted in the Gulf of Alaska, the Aleutian Islands, the eastern Bering Sea, as well as the west coast of the United States. This study has resulted in the identification of nine new sponge species from Alaska, multiple species range extensions, and has provided additional information to understand the taxonomy of sponge species.

The development of national and international collaborations was an important accomplishment of this initiative. An ongoing international collaboration with scientists from the Department of Fisheries and Oceans in Canada resulted in a field guide for corals and sponges and two research cruises conducted at the Cobb Seamount Chain in offshore waters of the Gulf of Alaska. The logistical challenges of this cooperative research were steep but the collaboration enabled the sharing of resources, equipment, and knowledge that was invaluable in developing a sampling program in this remote location. Two research cruises for this project took place in 2022 and 2024 with the objective of studying DSCS communities on seamounts in international waters that are adjacent to the U.S. EEZ. These data are being used to develop presence-absence and abundance models for DSCS distributions in this region. These data will be made available to the North Pacific Fisheries Commission, which is the Regional Fisheries Management Organization (RFMO) for international waters of the North Pacific Ocean. National collaborations included participating in activities and planning of Seascape Alaska and collaborating with NOAA Ocean Exploration to assist in efforts to map and explore areas within the Gulf of Alaska and the Aleutian Islands with the NOAA Ship *Okeanos Explorer*.

Another important objective of the initiative was to better understand both how sponge and coral habitats are impacted by commercial fishing activities as well as the recovery rates of DSCS that have been impacted by these and other anthropogenic activities. During this initiative, code was developed in collaboration with scientists at Alaska Pacific University to integrate DSCS distribution models into the existing fishing effects model to better understand how these habitats overlap with and are impacted by fishing activities. In addition, work was initiated to obtain more accurate estimates of bottom footprints of longline and pot gears and to observe the susceptibility of DSCS to those gear types. These data can be used to refine the outputs from the fisheries effects model. Additionally, a field expedition in the Aleutian Islands in 2023 was conducted to examine if DSCS habitat protections are ensuring the maintenance of healthy communities and how DSCS are recovering in areas that have been previously fished that are now protected. These ongoing studies will help scientists understand the impacts of fishing and recovery of DSCS habitats.

The 2020-2024 Alaska Coral and Sponge Initiative is providing new information to support the long-term management of DSCS ecosystems through studies aimed at improving spatial distribution models, increasing our knowledge of DSCS biology and taxonomy, expanding our understanding of how these habitats are impacted by fishing activities, and developing national and international collaborations to continue to foster our knowledge of these important habitats. This initiative built on the results and progress of the 2012-2015 initiative by providing new data and continuing to develop new questions needed to appropriately understand and manage these important resources in Alaska waters.

Acknowledgments

The Alaska Coral and Sponge Initiative members are Christina Conrath (AFSC-RACE Division), Pat Malecha (AFSC-ABL Division), Jerry Hoff (AFSC-Center Directors Office), Pamela Goddard (AFSC-Lynker), and Lauri Sadorus (AFSC-Lynker). Previous members include Rachel Wilborn (AFSC-Lynker), Vanessa Lowe (AFSC-Lynker) and Kim Rand (AFSC-Lynker). Additional principal investigators for this program include: Chris Rooper (DFO Canada), Rhian Waller (University of Gothenburg), Sean Rooney (AFSC), John Olson (US-ACE), Meredith Everett (NWFSC), and Wes Larson (AFSC). Additional collaborators include: Lara Maleen Beckman (University of Gothenburg), Scott Smeltz (Alaska Pacific University), and Helmut Lehnert (GeoBio-Center LMU München). We would like to thank our current and past steering committee members including Alexis Weinnig (DSCRTP), Tom Hourigan (DSCRTP), Heather Coleman (DSCRTP), Bryan Costa (NCCOS), Chris Rooper (DFO Canada), Seanbob Kelly (AKRO), Sam Candio (OER), Cal Mordy (PMEL), Carol Ladd (PMEL), Amanda Netburn (OER), Jennifer Le (OER), Caitlin Adams (OER) and Linda Shaw (AKRO). We would also like to thank Robert McGuinn, Arvind Shantharam, and Jessica Clyburn from the DSCRTP for their support with data reporting and additional logistical support.

A number of individuals and groups within the Alaska Fisheries Science Center were instrumental to the success of this initiative. We would like to thank Kresimir Williams and Rick Towler who developed and outfitted the stereo cameras used in most projects, the ARMS deployment system, as well as maintaining and updating the software used to analyze the stereo camera images. We would also like to thank the many individuals who supported the deployment and care of the equipment used in the surveys including Dennis Benjamin, Gary McMurrin, Joanna Magner, Matias Gradilla, Michael Craig, Steve Smith, Geoff Lebon, and the AFSC RSST survey team. We thank Brad Reynolds for constructing the ARMS recruitment devices and Fletcher Sewell for wet laboratory support at Auke Bay Laboratories. We would like to thank the AFSC Gulf of Alaska and Aleutian Island survey teams for their valuable assistance collecting specimens and data. We would like to thank Jodi Stebbins, Kate Strang, Dona Cocking, Michelle Ledbetter, Cindy Swietzer, Mark Piotrowski, Rebekah Jones, Christie Lang, Cathy Lin and the rest of the AFSC Administrative team for their assistance with budget administration, travel, security, and their continued support of the operations of this initiative. We would like to thank Maggie Mooney-Seus, Paul Hillman, Lisa Hiruki-Raring, Stori Oates, Christine Baier, Rebecca White and the AFSC Communications team for their invaluable assistance in sharing our research with the public and other interested collaborators and partners.

A large number of people supported our survey operations. We thank the captain and the crew of the RV *Woldstad*, Meredith Pochardt and Elaina Jorgensen. We thank the captain and crew of the RV *Solstice*, Mike Byerly and David Anderson. We thank the captain and crew of the CCGS *John P. Tully* and the CCGS *Sir John Franklin*, Paul Hillman, Janelle Curtis, Devon Warawa, Cynthia Wright, Stephen Romaine, Janelle Curtis, and Steven Schut.

We would also like to thank the NOAA Ocean Exploration team including: Sam Candio, Kasey Cantwell, Shannon Hoy, and the crew and captain of the NOAA Ship *Okeanos Explorer.*

We would also like to thank the following individuals for valuable assistance with initiative activities: Mike Sigler, Jim Thorson, Nate Raring, and Michael Martin.

We would also like to thank Darin Jones and Cynthia Yeung for comprehensive and thoughtful reviews of this report.

Additional funding for this project was provided by the Alaska Fisheries Science Center, Department of Fisheries Oceans Canada, and the North Pacific Research Board (*F2111-00)*.

Introduction

Overview of the Alaska Region

Alaska has 32 ecologically distinct regions within five large marine ecosystems including the Gulf of Alaska, Eastern Bering Sea, Aleutian Islands, Beaufort Sea, and Chukchi Sea. The Eastern Bering Sea is frequently considered two or more regions with the northern portion (northern Bering Sea) being defined as a separate region. In addition, the expansive Gulf of Alaska is frequently separated into additional regions (Fig. 1). The current and previous Alaska Coral and Sponge Initiatives have focused on the southern regions including the Eastern Bering Sea, Aleutian Islands, and Gulf of Alaska (Rooper et al. 2017a, Hoff et al. 2021).

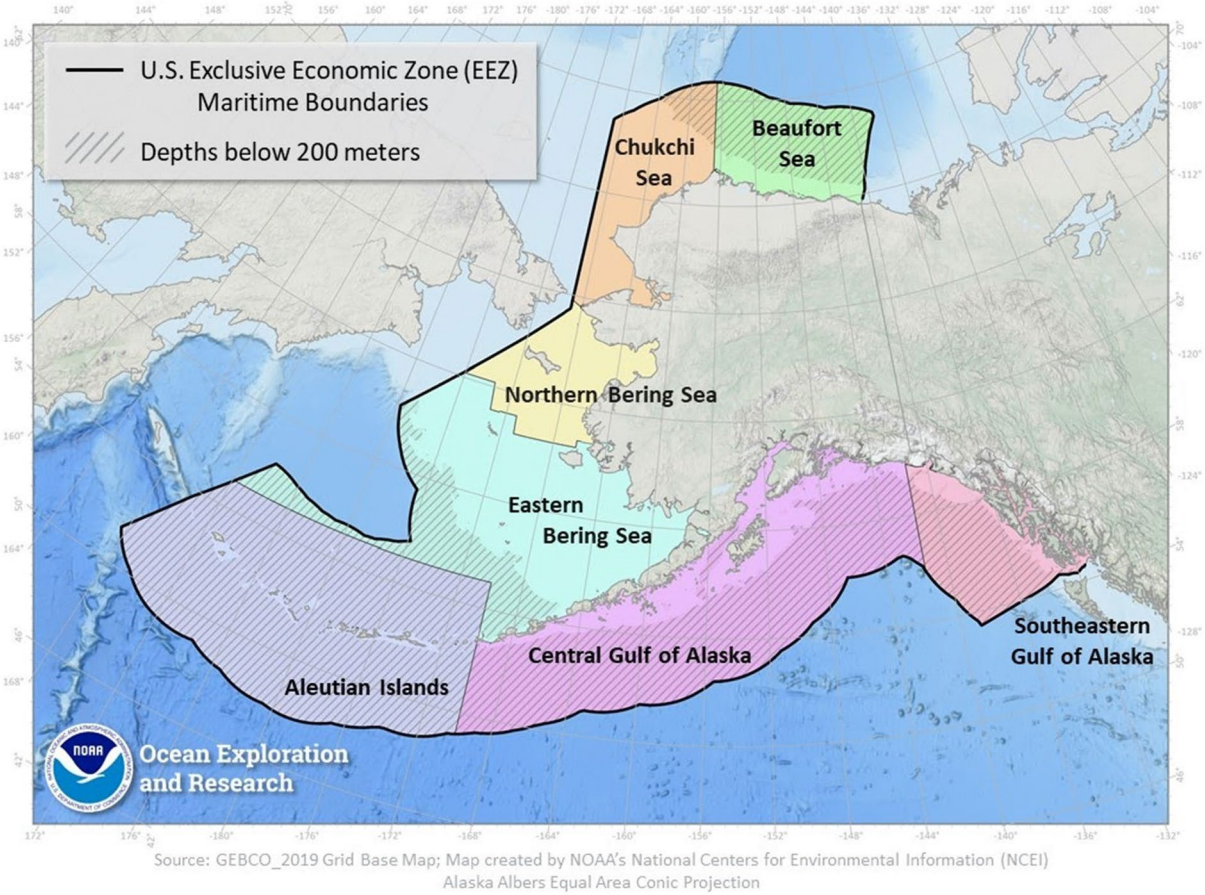

Figure 1. -- The large marine ecosystems found within Alaska's Exclusive Economic Zone. Source: Shin and Roberts (2020).

EASTERN BERING SEA

The Bering Sea is a large water mass that spans greater than 1,200 km from the Bering Strait to the Alaska Peninsula and 500 km from the Alaska coast to the continental shelf break. The delineation between this region and the northern Bering Sea is generally defined by the 60°N latitude based on physical and biological changes (Baker 2023). This region is relatively flat but

is cut by a number of large canyons including Bering, Pribilof, Navarin, Pervenets, and Zhemchug canyons (Stabeno et al. 2016). Three of these canyons (Zhemchug, Bering, and Navarin) are the largest submarine canyons in the world based on drainage area and cross-sectional area (Normark and Carlson 2003). The habitat within this region is dominated by low relief sandy and muddy bottom. In addition, there are limited areas with rocky ledges and boulders along the continental slope and steep canyon faces.

The North Pacific Fishery Management Council (NPFMC) has established habitat protections within this region that are primarily focused on red king crab (*Paralithodes camtschaticus*), blue king crab (*Paralithodes platypus*), and walruses (*Odobenus rosmarus*; Fig. 2). In 1995, the Red King Crab Savings Area (13,720 km^2) was established and closed to all non-pelagic trawling to protect red king crab and their habitat. The Nearshore Bristol Bay Trawl Closure established an area of 65,107 km^2 that was closed to fishing with all types of trawl gear to protect juvenile red king crab. These protections include an area of an extremely high density of a single sponge species, *Suberites montalbidus,* on the eastern Bering Sea shelf (Stone et al. 2019). The Pribilof Islands Habitat Conservation Area (24,010 km^2) was created by Bering Sea/Aleutian Islands (BSAI) Groundfish FMP Amendment 21a, and the area was permanently closed to all trawling and dredging year-round to protect habitat for juvenile blue king crab and forage fish for marine mammals and seabirds, and to maintain a stable ecosystem in the surrounding habitats. In 2008, precautionary measures to 'freeze the footprint' by limiting trawl effort to areas currently being fished were enacted. Measures were also enacted to establish habitat conservation areas in the deep slope and basin area of the eastern Bering Sea, around St. Matthew Island, St. Lawrence Island, and an area encompassing Nunivak Island-Etolin Strait-Kuskokwim Bay. In 1990 and 1992, habitat in the eastern Bering Sea totaling 3,087 km^2 was set aside as a walrus haul-out area, protecting not only walruses but also the invertebrates that form the benthic habitat of that area. In addition, a variety of locations received some habitat protections from fishing within this region to protect Steller sea lion (*Eumetopias jubatus)* habitat and prey resources in 2002 (NPFMC 2023).

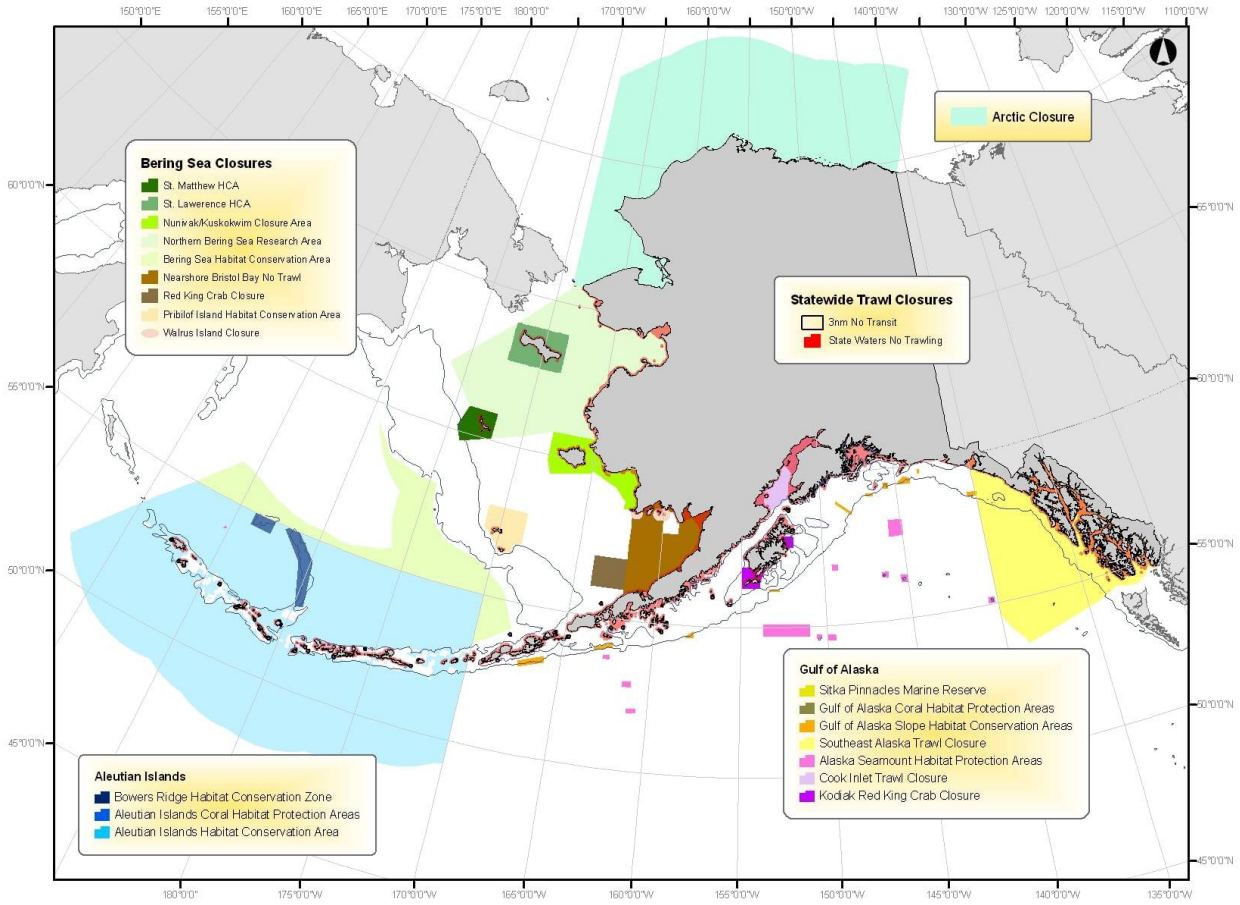

Figure 2. -- All Alaska habitat protection closures (North Pacific Fishery Management Council, 2024).

Deep-sea coral abundance within the Bering Sea is relatively low due to the lack of hard substrate and most corals are concentrated in the slope and outer shelf regions. One exception is the abundance of sea pens (Pennatulaceans), a type of octocoral that anchors in soft sediments (sand and mud), which occur in higher densities within this region (Rooper et al. 2016). Deep-sea sponges have been found to commonly occur on the Bering Sea shelf and slope with higher concentrations occurring on the upper continental slope and in the submarine canyons. (Stone et al. 2019). The physical characteristics that have been identified as important in structuring coral and sponge communities are depth, latitude, and sediment (Sigler et al. 2015). Prior research from the first Alaska Coral and Sponge Initiative focused on providing data to inform possible management measures for deep-sea corals in Pribilof and Zhemchug canyons.

ALEUTIAN ISLANDS

The Aleutian Islands Archipelago is a narrow chain of volcanic islands extending 1,900 km from the Alaska Peninsula to the Commander Islands (Fig. 1). This island chain separates the Bering Sea from the North Pacific Ocean with passes between the islands that vary from narrow and shallow to wide and deep. Three current systems supply water to this region, the Alaska Coastal

Current, the Alaska Stream, and the North Slope Current. Waterflow through the passes is dominated by tidal currents, which mix the full water column in shallow passes (Hunt and Stabeno 2005). The Aleutian Ridge is formed of these islands and is a volcanic arc that includes more than 20 active volcanoes and frequent earthquake activity. The width of the continental shelf varies throughout this region, narrowing from east to west with the largest shelf occurring east of Samalga Pass (Stabeno et al. 2005). The benthic substrate and habitat types are diverse and include areas of high relief (pinnacles, bedrock, large boulders, and cobble; Hoff et al. 2021).

Habitat protections within the Aleutian Islands region have been focused on Steller sea lions, *Eumetopias jubatus,* as well as on coral and sponge communities (Fig. 2). In 1993, National Marine Fisheries Service (NMFS) designated critical habitat for endangered Steller sea lions (SSL) based on their rookeries and foraging habitats in the Aleutian Islands. Critical habitat designation created no-entry buffer zones to protect SSL from disturbances such as fishing (Witherell and Woodby 2005). An unintended potential benefit of identifying these critical habitats is that coral and sponge communities in these areas also evaded disturbance. Submersible observations have found areas with complex coral and sponge communities within the areas encompassed by the SSL critical habitat (Witherell and Woodby 2005). In 2006, the NPFMC enacted habitat protections that effectively 'froze the footprint' of the bottom trawling within this region. The Aleutian Islands Habitat Conservation Area (946,341 km^2) was established prohibiting bottom trawling within this region except in established open areas (NPFMC 2023). In addition, the Aleutian Islands Coral Habitat Protection Areas (381 km^2) and Bowers Ridge Habitat Conservation Zone (18,124 km^2) were established. The Coral Habitat Protection Areas were designed to protect areas with high densities of corals and sponges known as "coral gardens" and are closed to fishing with all bottom contact gear types. A garden is an area of high-density coral or sponge habitat with nearly complete coverage of emergent epifauna (Stone 2014). The Bowers Ridge Habitat Conservation Zone was established because the area is largely unexplored. In addition, Bowers Seamount is protected as part of the Alaska Seamount Habitat Protection Area (described in next section).

The Aleutian Islands management area supports the most abundant deep-sea coral resources known in high latitudes (Stone and Rooper 2017). Many coral species extend into shallower waters here compared to other parts of their ranges (Hoff et al. 2021). Numerous areas with high densities of sponges, corals, and other structure forming invertebrates have been identified throughout the Aleutian Islands. Six coral garden areas have been designated as Habitat Areas of Particular Concern (HAPC) and comprise the Aleutian Islands Coral Habitat Protection Area. In addition, 51 coral and sponge gardens were identified thereafter using the criteria of having a density of coral or sponge > 1.0 organisms/m^2 (Stone 2014, Goddard et al. 2017). Prior research from the first Alaska Coral and Sponge Initiative was focused on modeling the distribution of DSCS using data from bottom trawl and towed/drift camera surveys, collecting long-term physical and geological data from this region, and improving taxonomy of these species.

GULF OF ALASKA

The Gulf of Alaska is a semi-enclosed basin that is bounded by the coast of Alaska to the north, west, and east and is open to the south. Circulation within this region is dominated by the Alaska Coastal Current and the subarctic gyre (Alaska Current and the Alaska Stream). The bathymetry

of this region is complex and many deep canyons intrude into the continental shelf (Stabeno et al. 2004). Seamounts are common throughout this region and the seamount province within the Northeast Pacific Ocean ranges from the Explorer Juan de Fuca Ridge to the Aleutian Islands with over 100 seamounts. There are two major seamount chains, the Kodiak-Bowie seamount chain and the Cobb-Eickelberg seamount chain (Chaytor et al. 2007). The bottom topography and habitats within this region are variable and include both areas of high relief and flat sandy/muddy areas.

Several habitat protections have been enacted throughout the Gulf of Alaska (NPFMC 2023). Since 1987, several regions of the Gulf of Alaska seafloor habitat have had some level of protection from fishing impacts (Fig. 2). For example, in 1998, a Marine Protected Area (MPA) was designated under GOA Groundfish FMP Amendment 41, which prohibited trawling in southeast Alaska east of 140°E longitude. The 180,418-km^2 MPA not only met the objective of conserving habitat for rockfishes but also had the additional benefit of protecting vulnerable coral and sponge ecosystems (Witherell and Woodby 2005). Sitka Pinnacles, a 4.6 km^2 benthic feature, was designated a Marine Reserve and the only no-take area in Alaska in 2000 as part of the GOA Groundfish FMP Amendment 59 (Witherell and Woodby 2005). The Gulf of Alaska Slope Habitat Conservation Areas were established in 2005. In these 10 designated areas on the continental shelf bottom trawling is prohibited. In 2006, 16 seamounts, labeled the Alaska Seamount Habitat Conservation Zone, became Habitat Areas of Particular Concern (HAPC). This includes 15 seamounts in the Gulf of Alaska and one seamount in the Aleutian Islands. Also in 2006, a Gulf of Alaska Coral Habitat Protection Area (230 km^2) was established west of Cape Ommaney and Fairweather Grounds to protect expansive thickets of red tree coral (*Primnoa pacifica*) (Witherell and Woodby 2005). This region also has some habitat protections related to preserving SSL habitat with variable protections (NPFMC 2023).

Areas with high densities of DSCS have been identified within the Gulf of Alaska. Expansive thickets of red tree corals have been identified in southeast Alaska as well as glass sponge gardens. Seamounts within this region have been found to have coral and sponge communities (Hoff and Stevens 2005) as have other areas with high relief or rocky substrate in the central and western Gulf of Alaska (Conrath et al. 2019, Rooper et al. 2017b). Prior research from the first Alaska Coral and Sponge Initiative was focused on understanding the distribution, ecological function, and recovery rates for the red tree coral, examining the productivity of commercial fishery species within these habitats, modeling the distribution of DSCS, collecting long-term physical and geological data from this region, and improving taxonomy of these species.

Deep-Sea Corals and Sponges in the Region

Deep-sea coral and sponge taxonomy is undergoing many changes, new species are being discovered, and range extensions are being found for many species within Alaska waters. All Alaska waters are underexplored but this is particularly true of areas north of the Bering Sea. Therefore, this description of coral and sponge distribution is limited to the eastern Bering Sea, Gulf of Alaska, and Aleutian Islands ecosystems. Each of these three large marine ecosystems is unique and broad generalizations that apply to all of Alaska are limited.

Deep-sea corals are defined as any colonial azooxanthellate coral that generally occurs at depths below 50 m (NOAA, Coral Reef Conservation Program, 2010). Stone et al. (2023) provided an updated description of coral taxa found within Alaska waters through 2023. At that time, there were 161 unique coral taxa. Within the class Anthozoa, the subclass Octocorallia is the most speciose within this region with 25 Malacalcyonacean species, and 81 Scleracyonacean species, of which 20 are Pennatuloidean species. The subclass Hexacorallia is represented by 18 species in the order Antipatharia, 10 species in the order Scleractinia, and 4 species in the order Zoantharia. Within the class Hydrozoa, there are 23 species from the order Anthoathecata (family Stylasteridae). The Aleutian Islands region has the most taxa with 104 species, followed by the Gulf of Alaska seamount province with 57 species, the eastern Gulf of Alaska with 44 species, the western Gulf of Alaska with 31 species, and the Bering Sea with 21 species.

Deep-sea sponges are also broadly defined as any sponge that generally occurs at depths below 50 m (NOAA, Coral Reef Conservation Program, 2010). Stone et al. (2011) reported 196 sponge species are known in Alaska with the majority of these being in the classes Demospongiae or Hexactinellida, and only a small number of species within the Calcarea or Homoscleromorpha classes. Since that time period, an additional 31 species have been identified resulting in a total of 227 species of sponges in Alaska waters (Lehnert et al. 2012; Lehnert and Stone 2013; Lehnert et al. 2013; Lehnert and Stone 2014, 2015a, 2016b, 2017a, 2017b, 2020a, 2020b). All sponge classes within Alaska waters have a broad depth range with most classes found from the intertidal to thousands of meters deep. Stone et al. (2011) focused on the Aleutian Islands and confirmed the presence of 125 species of deep-sea sponge including 95 species of demosponges, 20 species hexactinellid sponges, and 10 species of calcareous sponges. Within the Bering Sea, at least 42 unique demosponge taxa have been identified. Sponges within this region are widespread and while found throughout the continental shelf and slope, they are concentrated in deepwater areas with available hard substrate (Stone et al. 2019). A sponge inventory assembled by Lehnert and Stone (2016a) found 52 confirmed taxa and 38 suspected taxa within the Gulf of Alaska. Of the confirmed taxa, 37 species were demosponges, 12 were hexactinellids, 2 were calcareous sponges, and 1 was a homoscleromorph. Additional species of sponges have been identified since these inventories were published (Lehnert and Stone 2020a, Lehnert and Stone 2020b) and also during the current initiative.

The Alaska Coral and Sponge Initiative

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 and to protect the Nation's deep-sea coral and sponge ecosystems (NOAA 2010). To facilitate this mission, the DSCRTP works with partners to support multi-year regional fieldwork initiatives and targeted projects centered on conducting new research, assimilating historic data, and making results public in support of DSCS ecosystem management. Functionally, the DSCRTP supports a rotating initiative program across each U.S. National Marine Fisheries Service (NOAA Fisheries) region on an approximate 6-year cycle. The DSCRTP has funded research initiatives in the U.S. South Atlantic (2009-2011), West Coast (2010-2012, 2018-2021), Alaska (2012-2014, 2020-2024), Northeast (2013-2015, 2023- 2026), Pacific Islands (2015-2017, 2025-2028), and greater Southeast (U.S. South

Atlantic, Gulf of Mexico and U.S. Caribbean; 2016-2019) regions. The regionally led initiatives have included mapping and surveys to understand the spatial distribution of DSCS habitats, research to understand DSCS life histories and their contributions to biodiversity, habitat suitability modeling, and assessments of the impact of human activities on DSCS. A national-level data management infrastructure underlies the regional initiatives, assuring DSCRTP-supported data are accessible to the public.

2012-2015 INITIATIVE ACCOMPLISHMENTS

The first Alaska Coral and Sponge Initiative took place from 2012 to 2015. The research and accomplishments of this first initiative formed the foundations for the development of the science plan for the second initiative, which began in 2020. A brief summary of the achievements of this initiative is presented here; a more complete description can be found in Rooper et al. (2017). This initiative supported 15 research projects, three multiple-year field expeditions, and nine separate research cruises. A series of interrelated projects examined the habitat and associated species of the red tree coral, *Primnoa pacifica.* This multidimensional project examined distribution, fishing effects and recovery, recruitment, reproductive biology, feeding ecology, and genetic connectivity of this species (Waller et al. 2019, Choy et al. 2020). Another important achievement of this initiative was the production of species distribution models of corals and sponges for the Bering Sea, Gulf of Alaska, and Aleutian Island regions (Rooper et al. 2014, Sigler et al. 2015, Rooper et al 2017b). These models were validated for the Bering Sea and Aleutian Island regions (Rooper et al. 2016, Rooper et al. 2018). Stereo camera data associated with these projects resulted in numerous coral and sponge records added to DSCRTP's Deep-Sea Coral Data Portal and resulted in site characterizations for each of 506 camera drop sites in the Gulf of Alaska, Aleutian Islands, and Bering Sea (Goddard et al. 2016, Goddard et al. 2017, Wilborn et al. 2017). This initiative also provided support to establish long-term monitoring of oceanographic conditions within these regions. During this initiative, 23 new species of demosponges were described and geographic range extensions for many species were published.

2020-2024 INITIATIVE SCIENCE PLAN AND OBJECTIVES

This report presents the results to-date of the second Alaska Coral and Sponge Initiative. From 2020 to 2024, the NOAA Deep Sea Coral Research and Technology Program (DSCRTP) sponsored a field research program in the Alaska region. The priorities for this initiative were derived from ongoing data needs and objectives identified during the pre-initiative workshop convened by the Principal Investigators from the Alaska Fisheries Science Center (AFSC) and members of the DSCRTP. A total of 59 scientists and managers, with relevant expertise from across Alaska and throughout the United States and Canada, participated in the workshop. Participants represented numerous NOAA offices, other federal agencies, non-government organizations, the commercial fishing industry, the Aleut Community of St. Paul Island, Fisheries and Oceans Canada, and academic institutions, totaling 29 entities. Six research priorities guided the science plan for this initiative:

- Model validation of Gulf of Alaska coral and sponge distribution models using visual surveys that collect environmental and spatially-explicit biological data.

- Mapping of untrawlable habitats in the Gulf of Alaska and Aleutian Islands.
- Collection of life history information on corals and sponges to support population modeling.
- Use of eDNA for species distribution modeling and biodiversity studies, and other genetic techniques for taxonomy and connectivity modeling.
- Development of risk assessment models for corals and sponges in the Gulf of Alaska, Aleutian Islands, and eastern Bering Sea regions that take into account anthropogenic and climate effects.
- Investigation of recovery and susceptibility rates of corals and sponges to anthropogenic activities.

The research was carried out by AFSC scientists from the Auke Bay Laboratories and the Resource Assessment and Conservation Engineering Division, the Alaska Regional Office, as well as partners at the Northwest Fisheries Science Center, U.S. Army Corps of Engineers, Alaska Department of Fish & Game, Fisheries and Oceans Canada, and University of Gothenburg. Supplemental funding was provided by the AFSC, Fisheries and Oceans Canada, and the North Pacific Research Board.

Major Field Research Projects

Four of the projects executed during the second Alaska Coral and Sponge Initiative included dedicated research cruises that occurred between 2022 and 2024. These projects were 1) the Gulf of Alaska model validation study, 2) the *Primnoa* recruitment and reproduction study, 3) the Joint Canada-U.S. international seamount study, and 4) the Aleutian closure area study. In all, there were seven separate research cruises carried out with a total of 82 at-sea days (Fig. 3; Table 1).

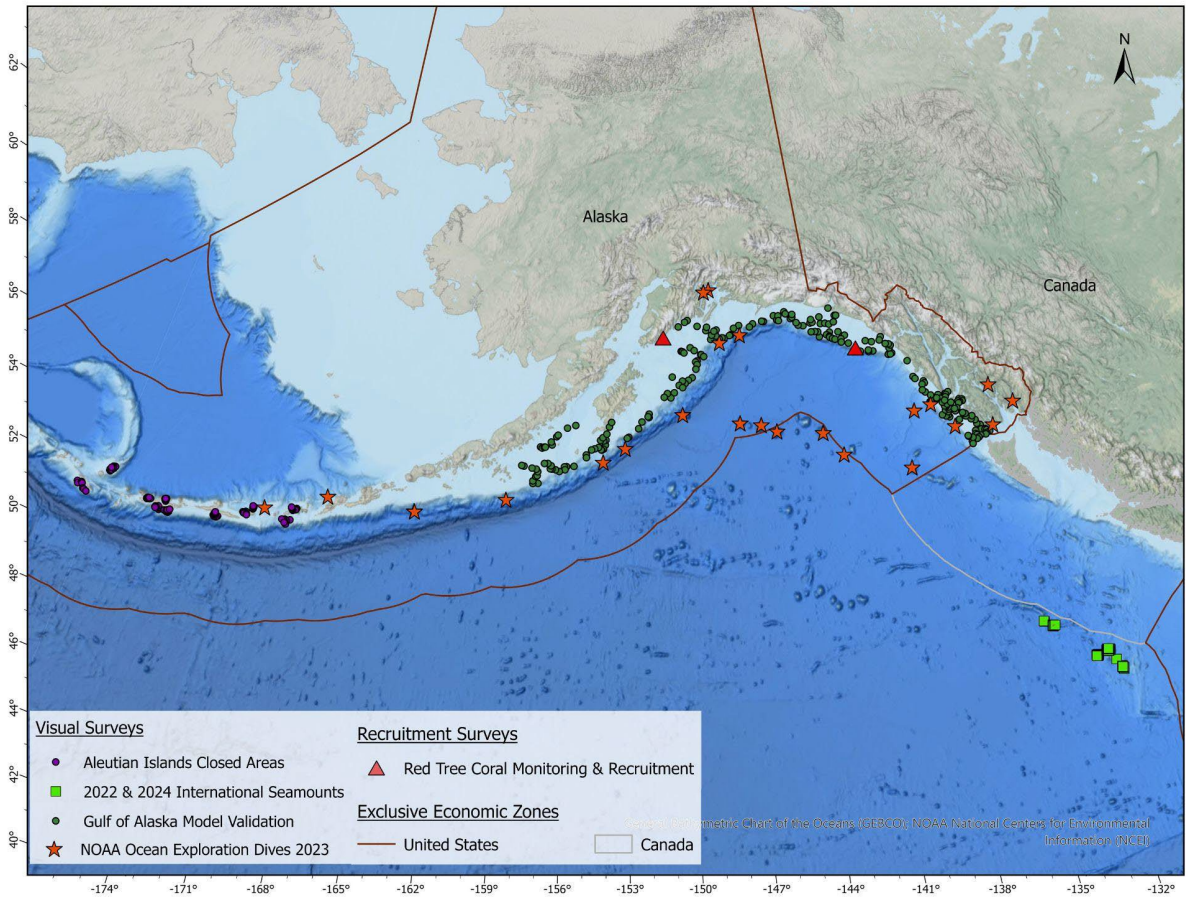

Figure 3. -- Locations of the research cruises partially or fully funded in FY2022-2024 by the Deep Sea Coral Research and Technology Program. In addition, this map includes the locations of the 2023 ROV dives that occurred as part of the NOAA Exploration Seascape Alaska Expeditions.

Table 1. -- List of cruises by project for the Alaska Coral and Sponge Initiative (FY20-24).

Project	Study Sites	Cruise Dates	Vessel	Purpose
Gulf of Alaska species distribution model validation study	Throughout the Gulf of Alaska	June 14 – July 15, 2022	RV *Woldstad*	Occupy random stratified survey transects
Primnoa recruitment and reproduction study[1]	Southeast Gulf of Alaska	June 11-15, 2022	RV *Solstice*	Deploy settlement plates
	Southeast Gulf of Alaska	August 20 – 23, 2023	RV *Solstice*	Deploy settlement plates
	Central Gulf of Alaska	August 3-5, 2024	RV *Solstice*	Deploy settlement plates, collect live coral specimens
Joint Canada-USA international seamount survey[2]	Cobb Seamount Chain	September 6 – 20, 2022	CCGS *John P. Tully*	Occupy random stratified survey transects
	Cobb Seamount Chain	September 3 – 13, 2024	CCGS *Sir John Franklin*	Occupy random stratified survey transects
Aleutian closure area study	Aleutian Island	July 2 – 16, 2023	RV *Woldstad*	Occupy random stratified survey transects

Gulf of Alaska Species Distribution Model Validation

Background and Objectives: Effective management of DSCS ecosystems in Alaska requires knowledge of where these organisms occur and where they are absent, as well as knowledge about areas of high diversity and high abundance. The immensity of Alaska's marine waters necessitates the development of predictive models to best determine where sponges and corals are likely located since not every site can be explored given available time and resources. Therefore, a systematic and analytical approach to determining where coral and sponge ecosystems are likely present is needed. The ultimate goal of the approach is to accurately predict the presence or absence of DSCS, the diversity of the communities, and the abundance of the organisms.

Maps of predicted occurrence of corals and sponges, based on trawl survey catch data and environmental variables, were previously published for each of the three major regions of

[1] Partially funded by the North Pacific Research Board.

[2] Partially funded by Department of Fisheries and Oceans, Canada.

Alaska, on a 1 ha scale (Rooper et al. 2014, Sigler et al. 2015, Rooper et al. 2017b). The maps and models created for the Bering Sea (Rooper et al. 2016) and Aleutian Islands (Rooper et al. 2018) were subsequently validated with visual observations in the field that confirmed that DSCS ecosystems occurred at predictable locations where hard bottom substrate is present. The maps and models created for the Gulf of Alaska were not previously validated with visual surveys. As part of the Alaska Coral and Sponge Initiative, a research cruise was completed in 2022 in the Gulf of Alaska to collect *in situ* stereo images for validating the previously completed species distribution models of DSCS (Rooper et al. 2017b). The fieldwork was completed on the RV *Woldstad* and took place from 14 June to 15 July, beginning and ending in Homer, AK.

The primary objectives of the survey:

- Collect stereo imagery of the seafloor at predetermined locations throughout the central and eastern Gulf of Alaska.
- Collect and filter benthic water samples for environmental DNA (eDNA) analyses.

The primary objectives of the research:

- Validate existing species distribution models of DSCS presence and absence with *in situ* seafloor observations.
- Document DSCS species compositions and estimate densities.
- Document species associations of DSCS with fish using visual and eDNA observations.
- Compare visual and eDNA observations of DSCS to evaluate detection consistency and limitations of each observation type.

Approach: Before the cruise commenced, a sampling plan was devised that utilized a random-stratified design that took into account depth, trawlability, and coral model density predictions. Previously completed seafloor visual observations in the Gulf of Alaska (n ~ 431) provided an existing dataset that reduced the number of new sampling locations needed to validate the models. A modified optimal sampling allocation plan used the locations and depths of the existing dataset to prioritize locations for new samples. At each station, a stereo camera system was deployed and ~15 minutes of on-bottom imagery was collected while drifting with the prevailing current or underway, depending on the sea conditions. Images were analyzed by identifying and measuring (using stereoscopy) benthic invertebrates and fish for determining 1) the presence or absence of sponges and corals, 2) species identifications of fish, sponges and corals, 3) density and size distribution of fish, sponges, and corals, 4) associations between fish and invertebrates, and 5) seafloor substrate type.

Significant Results to Date: Sampling in 2022 occurred primarily in the eastern and central Gulf of Alaska at 228 transect locations (Fig. 4). Observations were made in depths from 18 to 879 m. Image pre-processing, image annotation, data preparation, and preliminary data analysis took place between 2022 and 2024. Image analysis from 2022 transects indicate pennatulaceans (sea whips and sea pens) were the most prevalent habitat-forming

invertebrate observed and occurred on 40% of transects (Fig. 5), followed by demosponges (34%), hexactinellids (20%), octocorals (19%), and hydrocorals (15%). Coral and sponge presence, absence and density data from the 2022 survey were combined with data from previous camera surveys to validate species distribution models for coral, sponge, and sea whips that were developed using trawl survey data (Rooper et al. in review). Results show that models based on bottom trawl survey data performed fairly well at predicting presence or absence of fan-type corals, Primnoid corals, and demosponges (average area under the receiver operator curve (AUC) values above 0.70) (Fig. 6). However, average AUC values for pennatulaceans (0.56), hexactinellids (0.59) and porifera (0.66), in general, were lower indicating that the bottom trawl survey models were not as good at predicting presence or absence of those taxa. Generally, bottom trawl survey models were better at predicting absences than presences, which is likely a result of the low catchability of DSCS in bottom trawls. Camera-observed DSCS densities were significantly correlated to predicted densities from the bottom trawl models. However, the models were poor at explaining density variations, typically predicting less than 25% of observed density variability. The results of this work complete validation efforts of species distribution models for all three large marine ecosystems in Alaska (Bering Sea, Aleutian Islands, and Gulf of Alaska). Overall, the results of the Gulf of Alaska model validations were consistent with previous findings in the Bering Sea and Aleutian Islands and highlight the usefulness and limitations of using bottom trawl survey data to describe DSCS distributions. Continued efforts to improve models, through an iterative approach, that incorporates multiple data sources should be pursued for managing benthic habitats.

Separate analyses of eDNA samples collected during the camera survey are ongoing. Invertebrate and fish taxa will be identified from the eDNA and will be compared to visual observations to assess the detection abilities of each observation type. eDNA data may also be used as another means to validate and improve the bottom trawl species distribution models and to investigate species associations. A NOAA Technical Memorandum site characterization report is forthcoming that will detail camera survey observations, including the taxa observed, the size and density of invertebrates and fish, and seafloor characteristics for each transect.

Funding: DSCRTP funds ($450,000) were used in FY2021 to fund a 30-day vessel charter in the Gulf of Alaska that occurred in 2022. DSCRTP funds ($24,821) were used in FY2022 for cruise supplies, travel and overtime. Leveraged salary and benefits for science team members were contributed by the AFSC.

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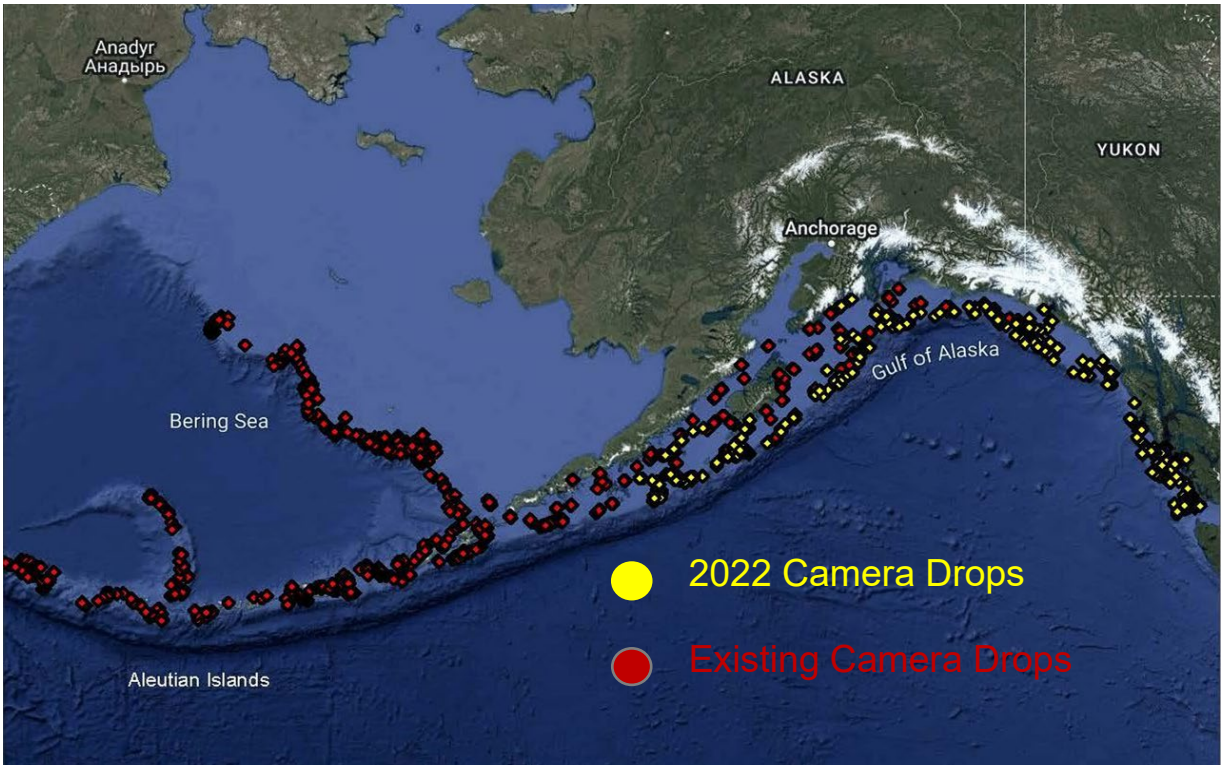

Figure 4. -- Locations of previously existing and 2022 underwater camera survey observations.

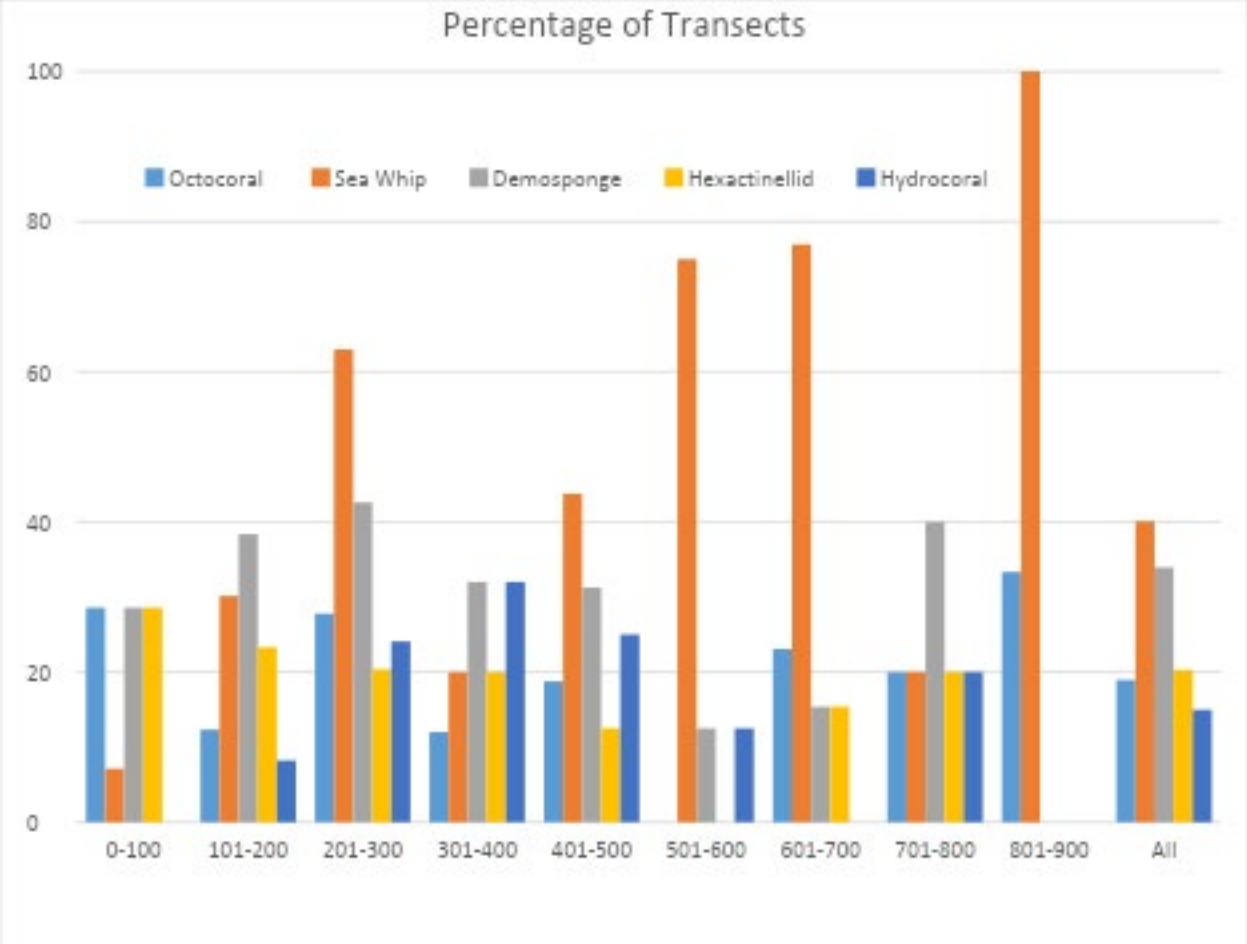

Figure 5. -- Percent of transects by depth where habitat-forming invertebrates were observed in 2022 Gulf of Alaska underwater camera survey.

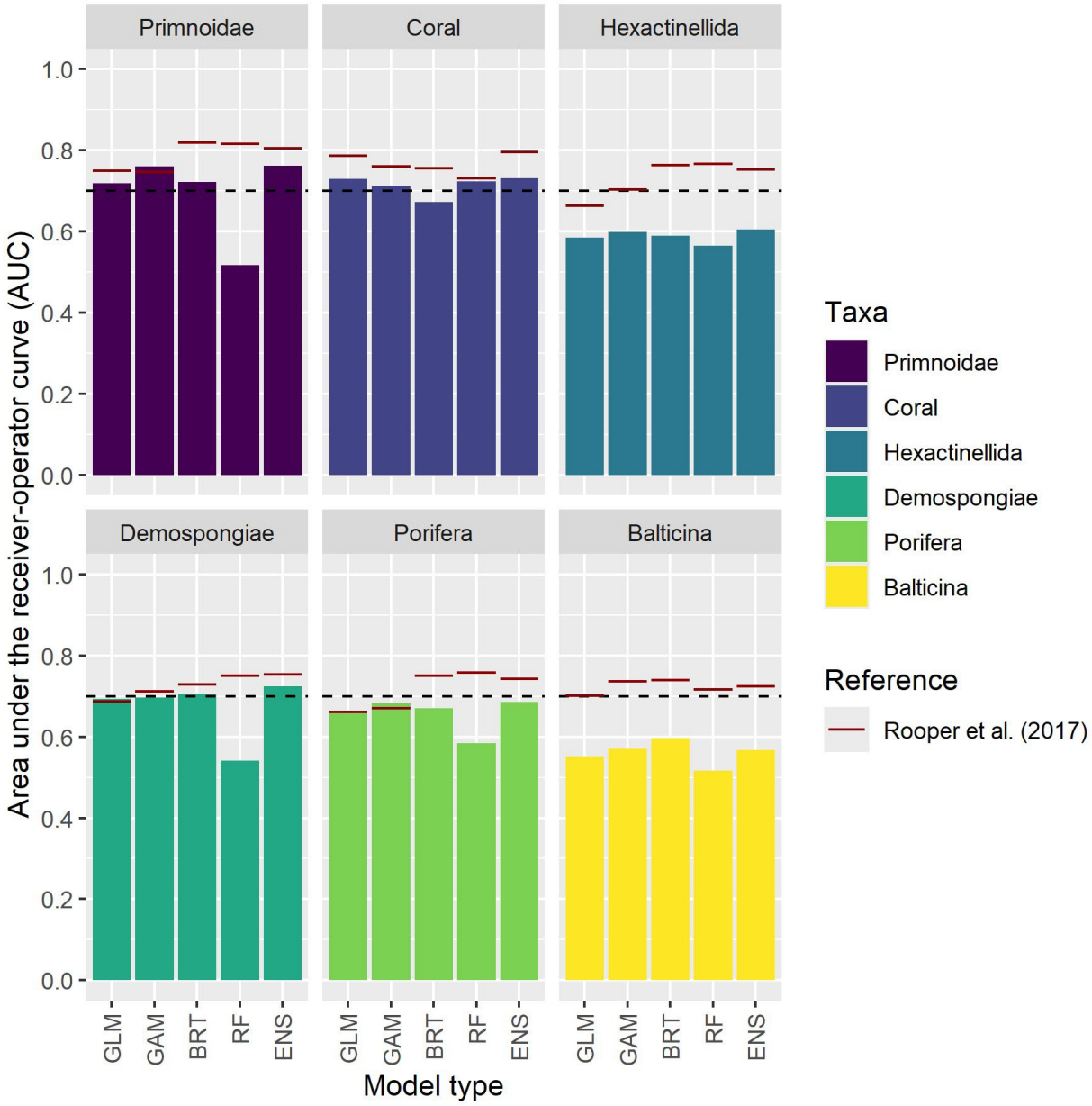

Figure 6. -- Area under the receiver operator curve (AUC) between bottom trawl survey model presence/absence predictions and underwater camera survey observations in the Gulf of Alaska (n = 712). Solid brown reference lines in each column indicate the AUC between model predictions and bottom trawl survey data held back for testing the original models in Rooper et al. (2017). Model types are as follows: general linear models (GLM), generalized additive models (GAM), boosted regression trees (BRT), random forest models (RF) and ensemble models (ENS) created by averaging predictions across the four model types. Horizontal lines at values of 0.70 indicates a useful model according to Hosmer et al. (2013). Coral refers to fan-type coral taxa (including Order Antipatharia, Families Stylasteridae, Acanthogorgiidae, Isididae, Keratoisididae).

Figure 7. -- Sponge aggregation on Learmonth Bank in the eastern Gulf of Alaska.

Primnoa Recruitment and Reproduction

Background and Objectives: The Alaska region has some of the highest biodiversity and widespread distributions of DSCS in the Pacific region, yet despite their importance to benthic ecosystems, ecological knowledge is poor for the majority of species. The general life history characteristics of DSCS (slow growth, late maturity, infrequent reproduction and recruitment) make them particularly susceptible to damage from anthropogenic impacts. Difficult collection conditions (deep water, restricted to summer sampling due to weather, etc.) combined with their prevalence on hard bottom areas which are difficult to sample without specialized equipment, cause sample sizes often to be small and restricted to small-scale, highly visited areas. This lack of ecological information on species of DSCS is particularly true for reproductive ecology, yet this information is essential for understanding recruitment, population viability, and recovery from damage.

This project was funded by the North Pacific Research Board and the Alaska Coral and Sponge Initiative. The overarching goal of this project was to investigate recruitment processes in the dominant deep-sea coral species in the Gulf of Alaska, the Pacific red tree coral, *Primnoa pacifica*, utilizing settlement plates that were dropped in two locations in 2013 and 2015, and to

replace those settlement plates with Artificial Reef Monitoring Structures (ARMS) to allow standardized analysis. Secondarily, we aimed to collect live *P. pacifica* corals to culture live and attempt to collect gametes for fertilization and larval ecology studies.

Approach: There were three research expeditions over the course of three years with the Alaska Department of Fish and Game (ADF&G) using the RV *Solstice* and their ROV system *Buttercup* (Fig. 8). During the first research cruise that was conducted at Fairweather Banks in 2022 one original settlement plate deployed in 2013 (Rooper et al. 2017a), herein called the Stone plate, was retrieved (Fig. 8). This plate had a Star Oddi DST centi-T sensor (Star-Oddi n.d.) attached that data was subsequently retrieved from. Six ARMS plates (Fig. 8) were placed in pairs with temperature loggers attached within a coral patch, on the edge and away from a large *P. pacifica* population (surveyed via ROV). During the second research cruise (2023), 3 ARMS plates were retrieved and replaced with three fresh plates – one from each of the patches. Unfortunately, the ROV arm malfunctioned so live corals were not possible during that expedition. In 2024, the study site had to be moved to a site around the Pye Islands (59.40°N, 150.45° E) because of redeployment of the ADF&G vessel to the northern end of the Gulf of Alaska. There, coral communities were surveyed, 3 ARMS plates with HOBO temperature loggers were deployed (for later retrieval), and 15 snips from distinct colonies of *P. pacifica* were collected. These were brought back to AFSC's Auke Bay Laboratories in Juneau, Alaska and kept alive in flowing seawater tanks. Gametes were dissected over the course of 14 days post-collection for experimentation and preservation.

Significant Results to Date: Moving the sample locations severely impacted the collection of meaningful data on recruitment from the ARMS panels – there is one year of data from three panels at Fairweather Grounds, as well as temperature logger data. No recruits were actively seen, though samples were preserved for metabarcoding which will be occurring in approximately the next 6-12 months by Ph.D. student Lara Beckmann using a separate Swedish grant, Kungliga Vetenskaps- och Vitterhets-Samhället (KVVS). It is uncertain if there will be an opportunity to retrieve either the Fairweather Banks ARMS panels or the Pye Island ARMS panels to gain additional data.

For the live coral work, only one year of sampling was conducted. Live mature sperm exiting and moving around spermatocysts were observed (Fig. 9). While many pairings of gametes were made, no fertilization was achieved. This is presumably due to only immature oocytes being collected (only a small number of colonies were female, so fewer chances for mature oocytes, as colonies are asynchronous). Further laboratory investigation of preserved sperm is planned to assess the stage of maturity (as in some species sperm can swim before fully mature enough to fertilize). Gametes were preserved for electron microscopy to be undertaken systematically in the next 6-12 months (by Ph.D. student Lara Beckmann). Initial “quick” TEM slices show distinct sperm tails and sperm heads though none were confirmed as fully mature as yet (Fig. 9).

One unexpected finding from the live coral work was of polyp bail out in *P. pacifica*, something that had not been previously observed (Beckman and Waller 2025). Live polyps kept in aquariums were observed to split and drop from the main parent colonies. The negatively buoyant dropped polyps were placed in jars close to the parent colonies to reduce disturbance while photographs were taken. After 14 days, the polyps attached themselves to the substrate.

This mode of asexual reproduction has not been widely described from any species of Octocorallia and represents a mode of "last ditch" reproductive effort, usually induced by stress. While this would preserve the genetics of the original coral colony, it has the potential to skew and reduce genetic diversity within a population. The 2 weeks observed between separating and settling in laboratory conditions (this could be significantly different *in situ*) suggests their transport between populations by benthic currents is possible. However, as they are negatively buoyant, long-distance transport is unlikely.

The Star Oddi temperature logger attached to the Stone plate recovered in 2023 recorded daily temperature readings at four intervals each day. This probe began reading bottom temperature on 17 August 2013 and took its last reading on the bottom on 24 August 2023. Figure 10 shows the temperature data with annual maximum and minimum highlighted. The lowest temperatures of 5.19° C were recorded on 30 May 2021, 21 March 2023, and 9 April 2023. The highest temperatures of 10.35° C were recorded November 2018. There was considerable variation in the temperature readings each year, with some years having variations of only around 2° C (2022) and others varying over double of that at nearly 5° C (2018).

These temperature fluctuations have the potential to affect reproductive processes in these corals, similar to impacts seen in shallow water populations (Waller et al. 2019), where fully mature gametes are unable to be produced. The absence of recruitment seen on either the retrieved Stone plate or the three retrieved ARMS panels, could potentially be the effect of such temperature fluctuations currently occurring in the region. Retrieving the ARMS panels from Fairweather Grounds would add another 3 years to the temperature and recruitment data thereby increasing our understanding of the effects of environmental variables on coral recruitment processes in this region. This activity should therefore be highly prioritized in the coming years.

Funding: This project was supported by the DSCRTP as well as a grant from the North Pacific Research Board (NPRB Grant Number 2111) and generous in kind support from the Alaska Fisheries Science Center. The DSCRTP and NPRB provided $69K in support of the ADFG RV *Solstice* to conduct fieldwork. Contracted labor for project organization, tracking and fieldwork supported by the DSCRTP was $29.5K. In addition, $21.0K was provided by both DSCRTP and NPRB to support supplies and shipping.

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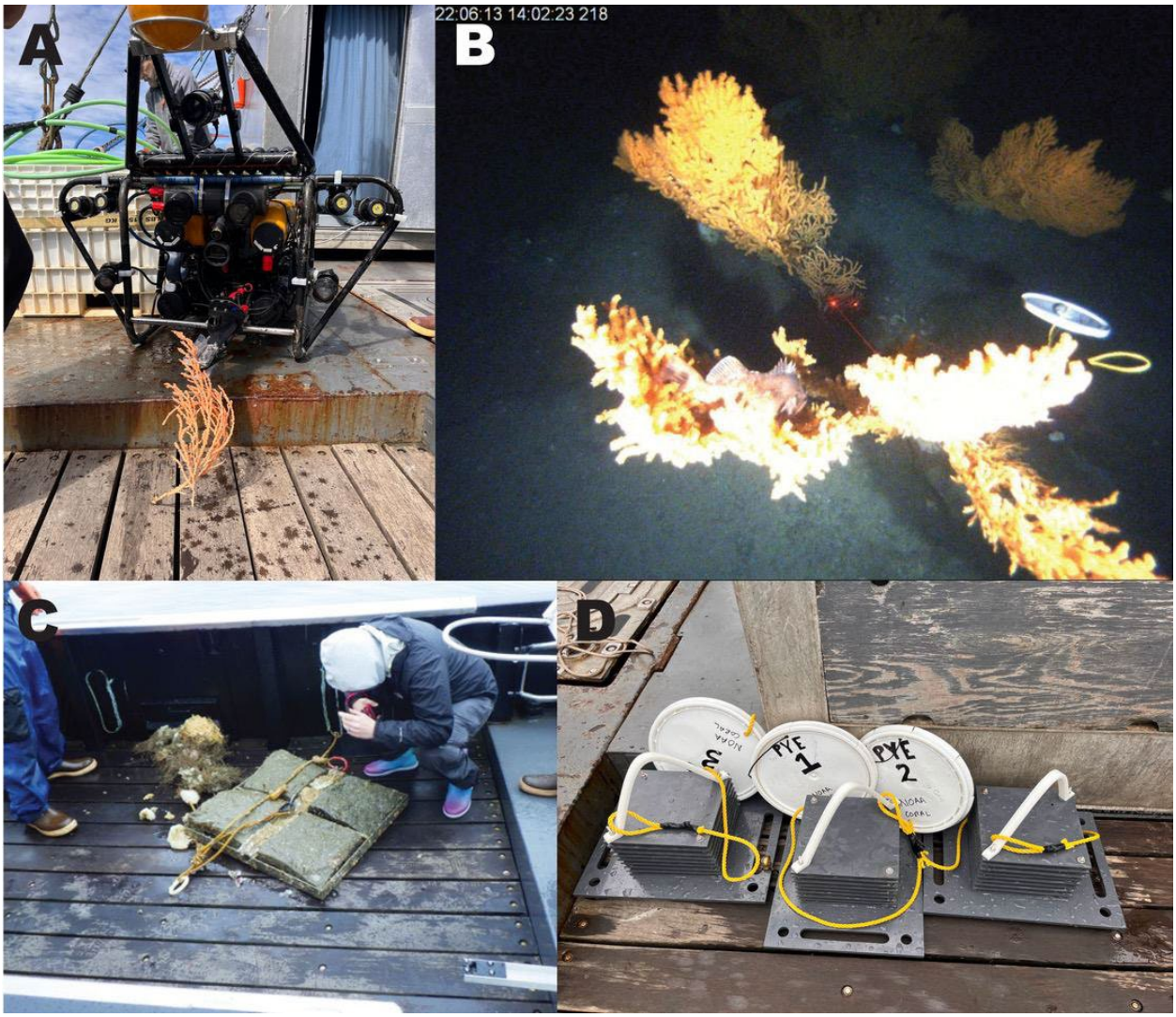

Figure 8. -- Images showing the field activities, a) ROV Buttercup in 2024 with a collected *Primnoa pacifica* sprig; b) ARMS panel marker on the seafloor at Fairweather Banks; c) Stone plate collected and scraped on deck during 2022 expedition; d) ARMS plates on deck ready for deployment at the Pye Islands.

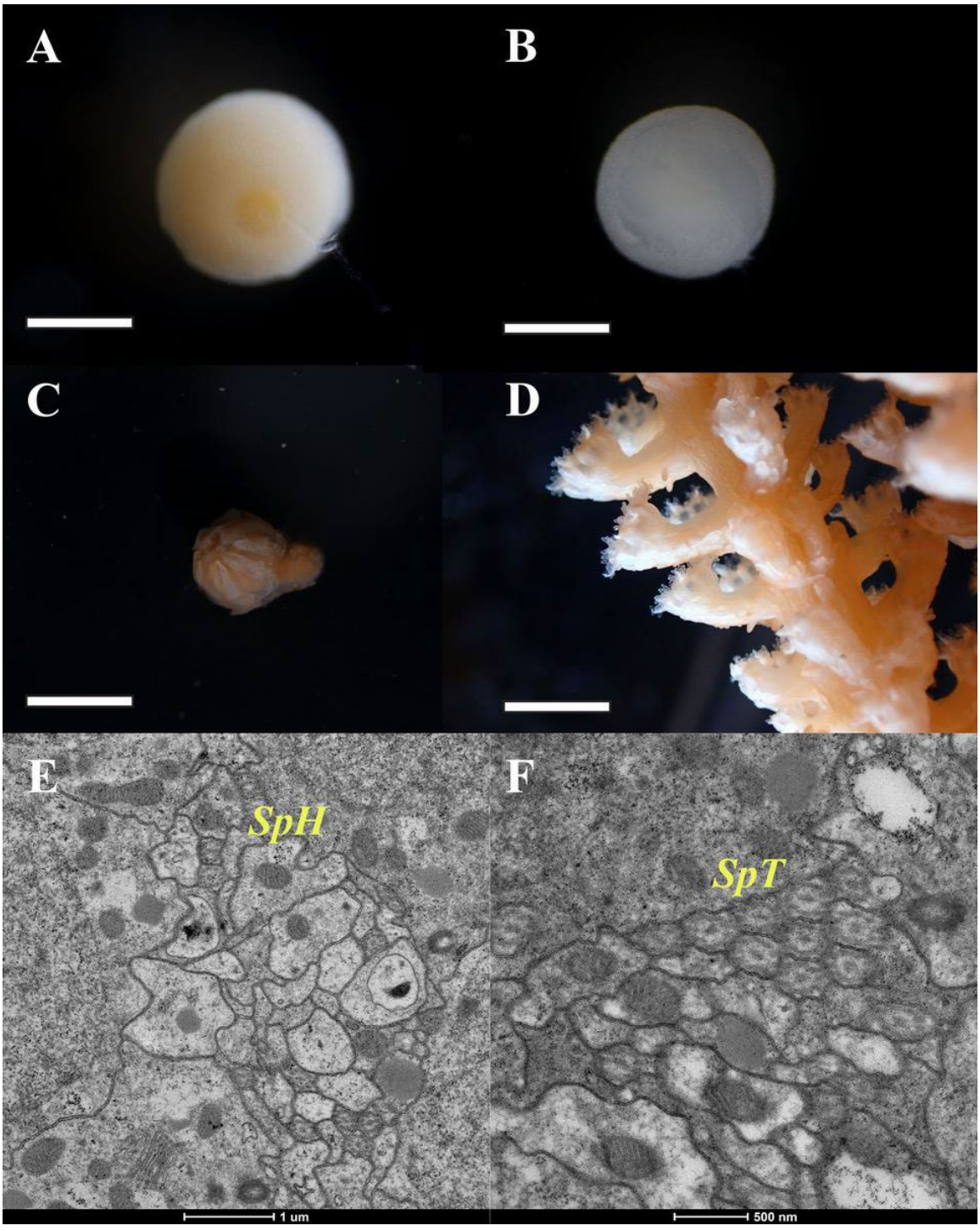

Figure 9. -- a) Dissected oocyte, scale = 50 microns; b) Dissected spermatocyst, scale = 50 microns; c) Dropped polyp during the aquaria experiments; d) Live *P. pacifica* colony in the aquaria with polyps open and tentacles out; e) TEM micrograph showing sperm heads (below SpH); f) TEM micrograph showing cluster of sperm tails (SpT).

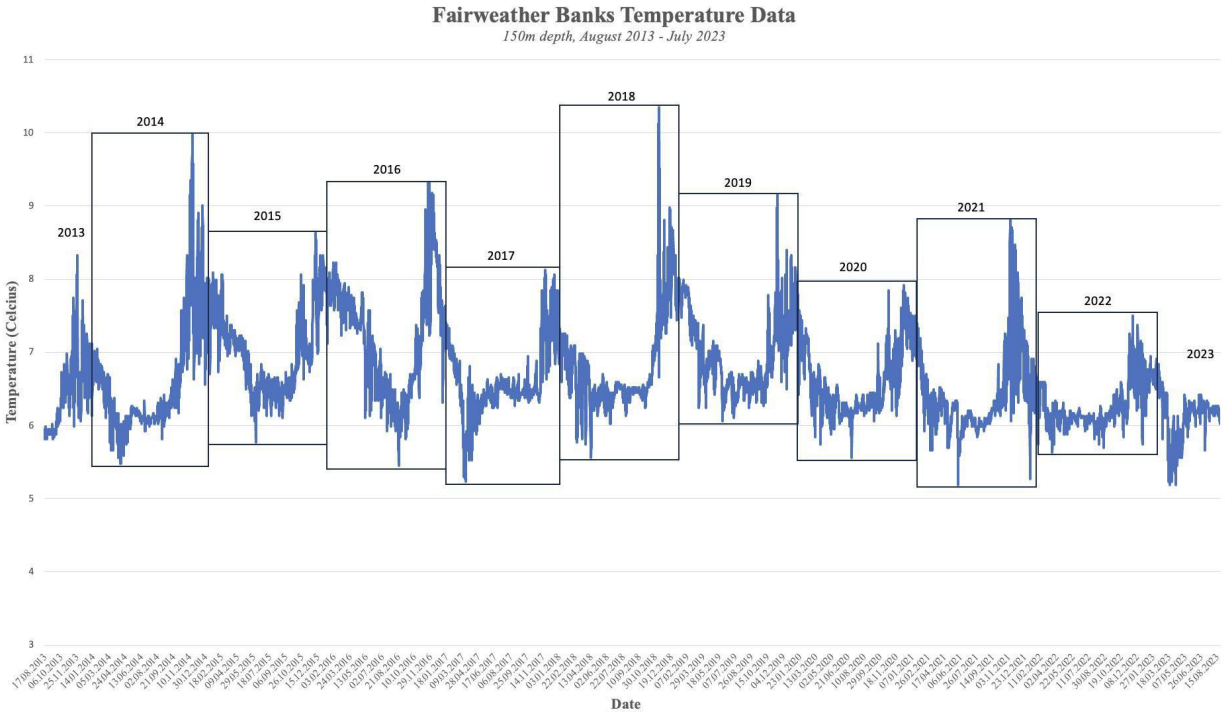

Figure 10. -- Star Oddi temperature data from collected Stone recruitment plate, 2013 – 2023. Boxes denote each year's range with top and bottom bars of the box delimiting the maximum and minimum temperature, respectively.

Joint Canada-USA International Seamount Survey

Background and Objectives: The Joint Canada-USA International Seamount Survey was designed to study the relatively underexplored DSCS communities on seamounts in international waters outside U.S. and Canadian EEZs. Historically (1970s – 1990s) many of these offshore seamounts were fished by both domestic (Canada and USA) and foreign (Russia, Korea, and Japan) fishing fleets. Currently there is limited fishing at the seamounts in international waters. The only fishing currently occurring is by the Canadian Sablefish longline trap fleet. The intersection between DSCS distribution and fisheries is an ongoing concern of the North Pacific Fisheries Commission (NPFC), the Regional Fisheries Management Organization (RFMO) for international waters of the North Pacific Ocean (www.npfc.int). The NPFC manages fisheries and Vulnerable Marine Ecosystems (VMEs) to monitor potential significant and adverse impacts on DSCS communities. Thus, there is interest in these offshore seamount chains, both in terms of their biological characteristics and for management issues related to international fisheries. In addition, the Alaska Coral and Sponge Initiative workshop identified priorities including 1) the distribution of DSCS on the Gulf of Alaska and wider North Pacific Ocean seamounts, and 2) DSCS hotspots as a priority for conducting visual surveys (Hoff et al. 2021).

Approach: The primary objective of the surveys was to collect image data along transects to map the distribution of DSCS at five seamounts in the Cobb Seamount Chain during two cruises in 2022 and 2024 (Fig. 11). A number of secondary objectives were also addressed during the fieldwork, including the following:

- Collecting eDNA samples from each stereo-camera transect for laboratory analysis.
- Collecting observations of marine mammals and birds along the vessel track line.
- Collecting oceanographic data (temperature, salinity, oxygen, etc.) and zooplankton samples at stations during nighttime hours.
- Collecting acoustic data continuously along the vessel track line at seamounts to improve bathymetric mapping.

The survey used a stratified-random sampling design using depth strata on the five seamounts (0-200 m, 201 – 400 m, 401 – 600 m, 601 – 800 m, and 801 – 1,100 m). The main tool used in this work was an underwater stereo-camera system. The stereo-camera survey followed a standard protocol outlined in Rooper et al. (2016), with a target of 15 minutes of on-bottom time for each transect. Images were processed to determine substrate type, density and size of structure forming invertebrates, and density and size of fish species using Sebastes software (Williams et al. 2016).

Significant Results to Date: In total, 77 camera transects were completed on five seamounts in 2022 and 58 additional transects at two seamounts of the Cobb Seamount Chain in 2024. A high proportion of transects had glass sponges and corals, particularly transects below 600 m (Fig. 12). Species distribution models were developed predicting both presence and abundance of DSCS taxa (Fig. 13). Preliminary analysis shows densities of sponges and corals were relatively low (~ 0.004 to 0.04 individuals/m^2) and appeared to be related to the oceanographic and geological conditions at the sites (e.g., there was an increase in density with depth similar to the observations of increased probability of presence). The sizes of sponges and corals were generally large indicating mature communities (Fig. 14). The fish fauna was dominated by rockfishes and pleuronectids that are found in the adjacent shelf and slope ecosystems. The coral and sponge communities observed were diverse (Fig. 15) and appeared to be largely organized by depth. Evidence of both historical and current fishing activity was observed on most of the seamounts with discarded or lost longline gear observed at ~50% of the transects on Cobb Seamount below 200 m. There were less frequent observations of discarded gear on the other seamounts (< 10%). The data collected during this survey will be useful for the RFMO responsible for assessing the risks and sustainability of the Canadian sablefish fishery conducted at these seamounts.

Funding: This project was jointly funded by Fisheries and Oceans Canada (DFO), NOAA's Alaska Fisheries Science Center (AFSC) and NOAA's DSCRTP. DFO provided funds for operational days for the Canadian Coast Guard Fisheries Research Vessel *J.P. Tully* (~$420,000), the AFSC provided in-kind funding through the provision of the stereo-camera system and winch (and backup systems), the DSCRTP provided ($184,000) for analysis of oceanographic samples, image analysis and to support data analysis (primarily species distribution modeling). Travel, salary and benefits for science team members (three from each collaborator) were contributed by the AFSC and Fisheries and Oceans Canada, respectively.

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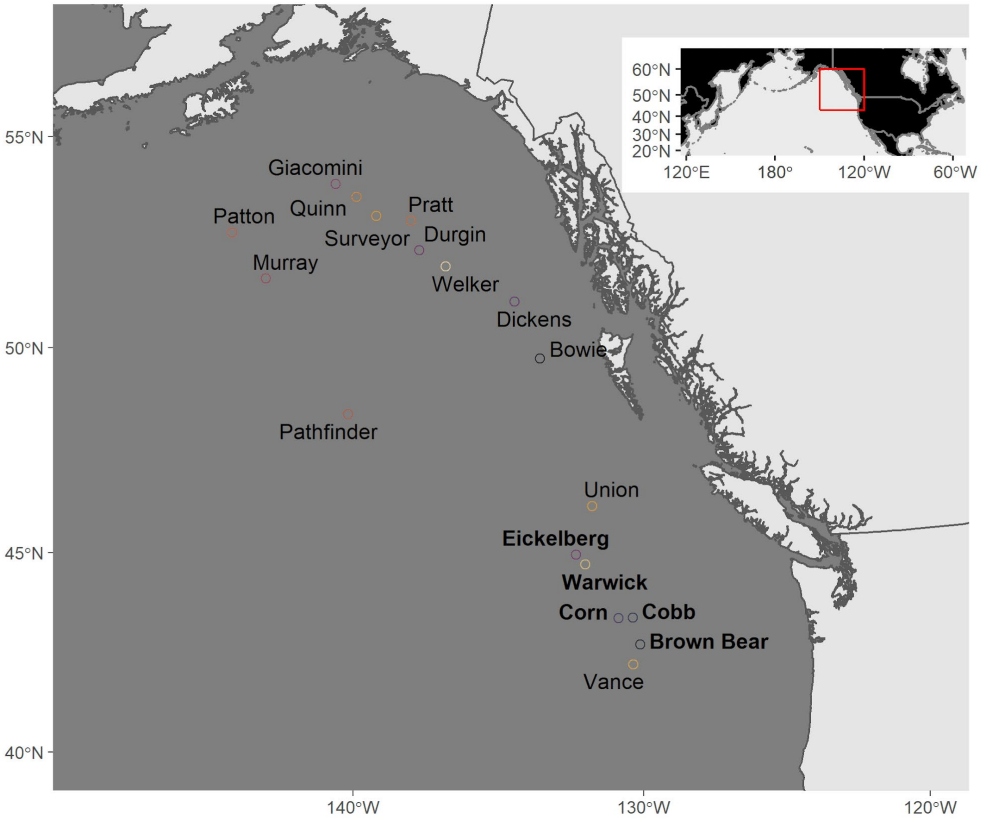

Figure 11. -- Map of eastern North Pacific Ocean seamounts showing the five seamount complexes surveyed aboard the *J.P. Tully* on the 2022 joint Canada-USA International Seamount Cruise in bold text (Eickelberg, Warwick, Corn, Cobb and Brown Bear).

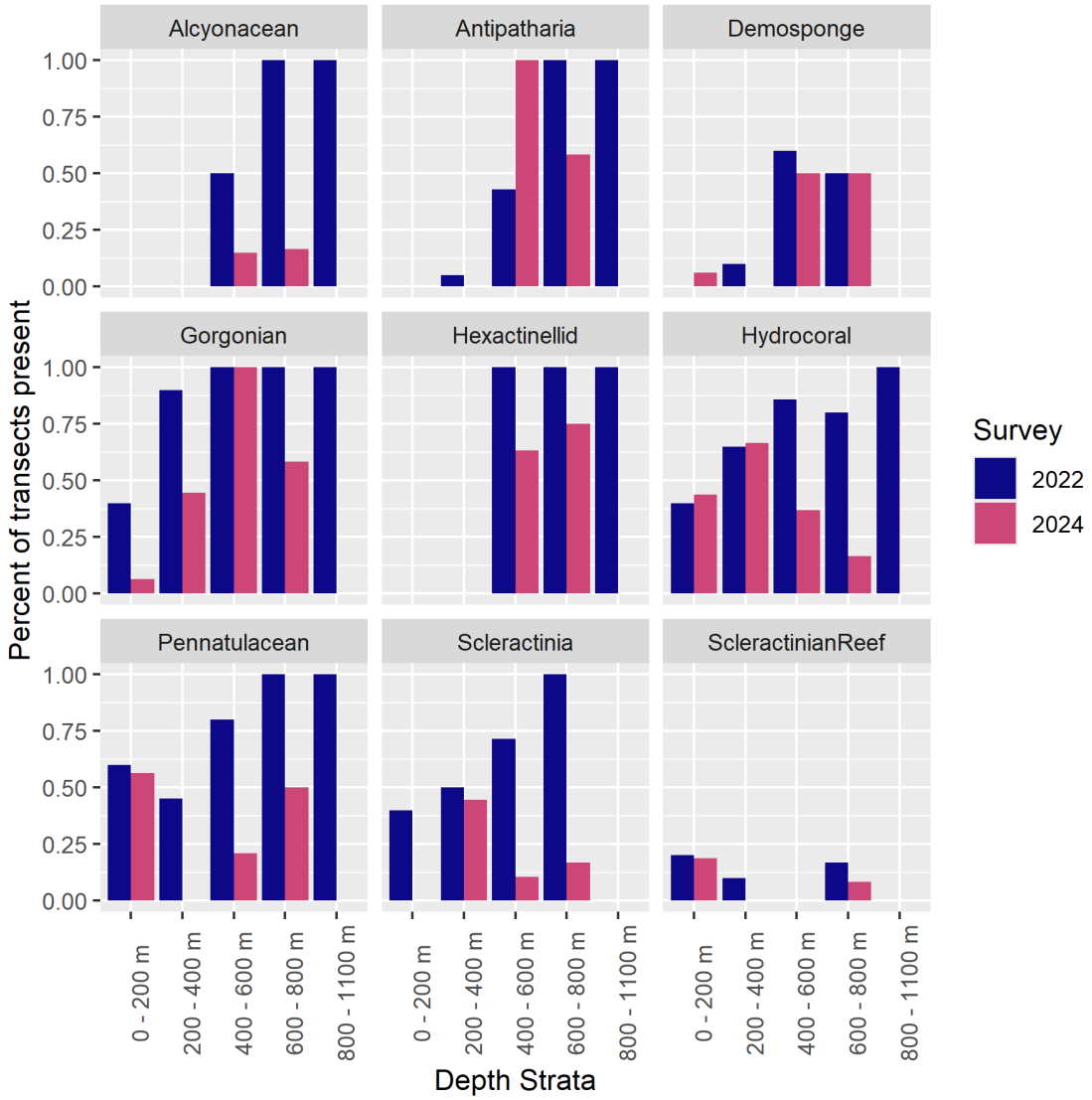

Figure 12. -- Percentages present for the most common structure forming invertebrates at the five seamounts surveyed during the Joint Canada-USA International Seamounts cruise in 2022 and 2024.

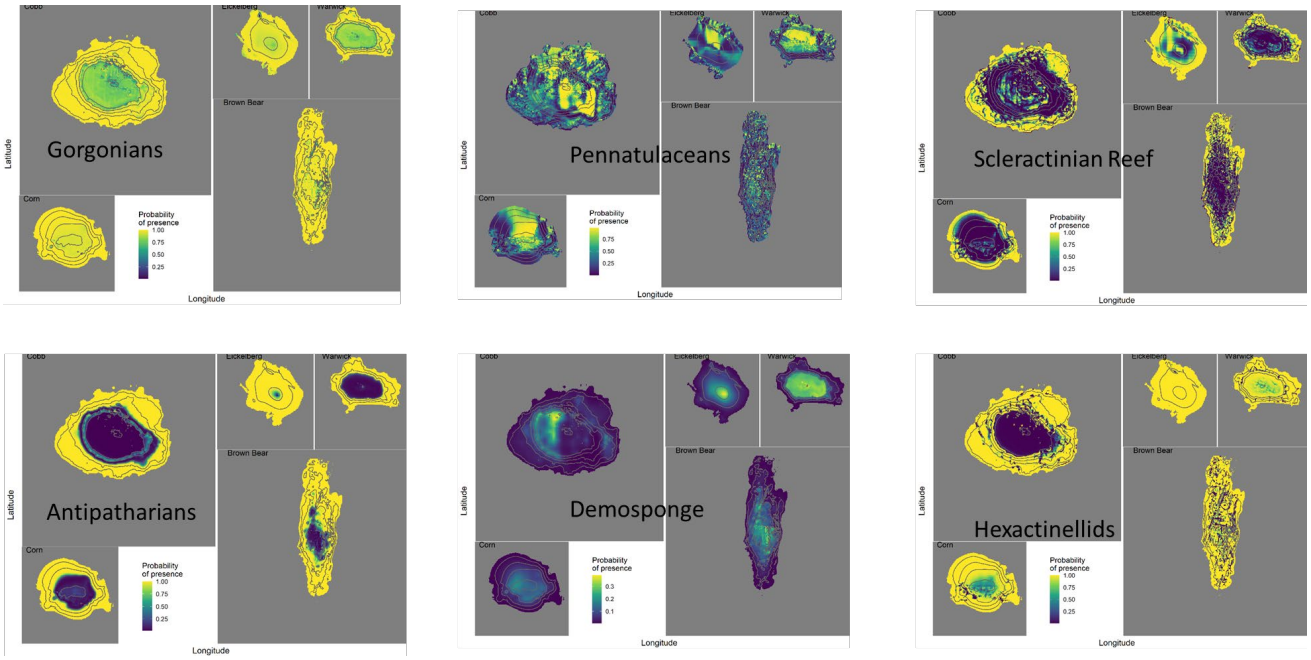

Figure 13. -- Species distribution models based on presence-absence data on sponges and corals collected during the 2022 Joint Canada-USA International Seamount Survey. The models were tested against 2024 survey data.

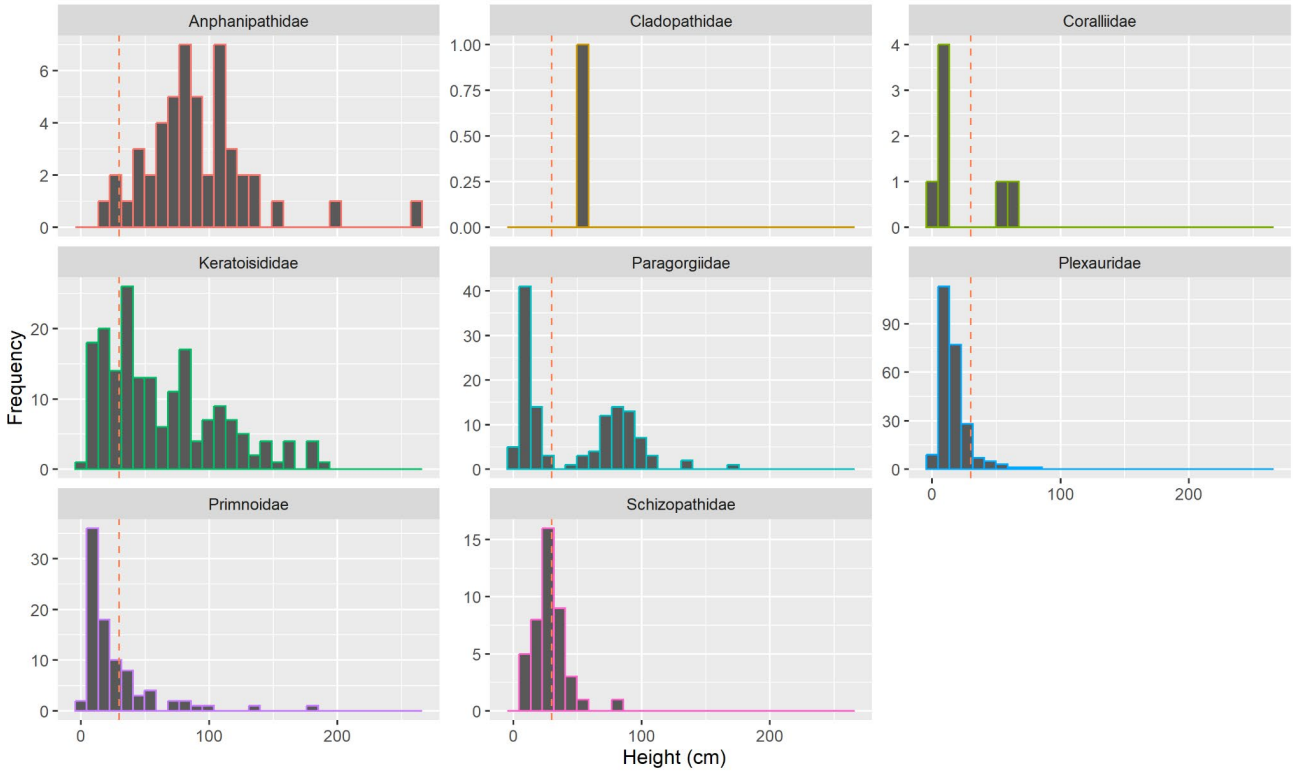

Figure 14. -- Size frequency histograms from preliminary image analysis of coral taxa collected during the 2022 and 2024 Joint Canada-USA International Seamount Survey.

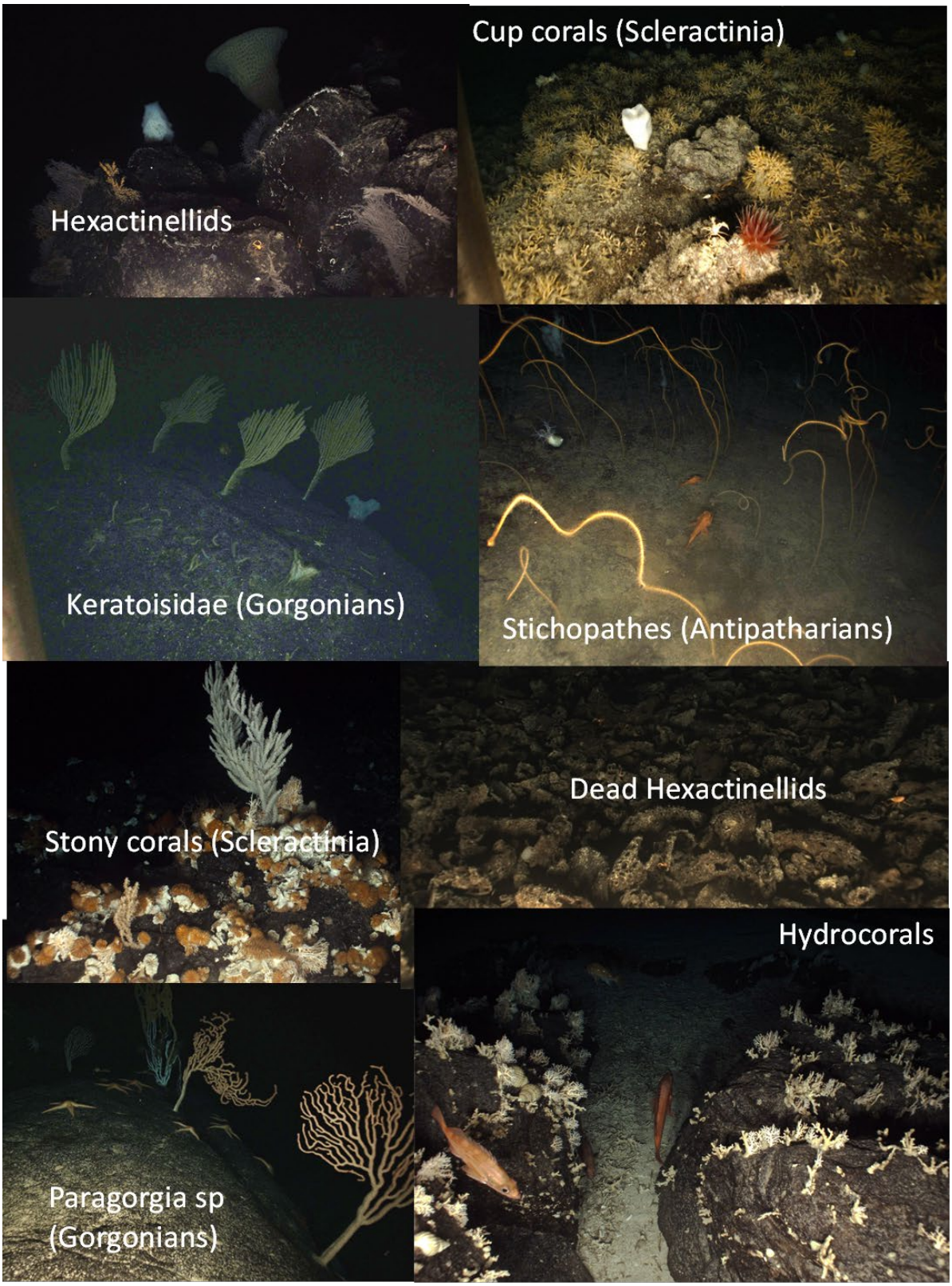

Figure 15. -- Example images from seamounts surveyed during the 2022 and 2024 Joint Canada-USA International Seamount Survey.

Aleutian Islands Closure Areas

Background and Objectives: Alaska is home to some of the world's most diverse and abundant deep-sea corals and sponges (Stone and Shotwell 2007). The Aleutian Islands in particular are home to over 95 coral species representing 22 families and over 135 species of sponge in four classes (Stone et al. 2011, Lehnert and Stone 2016a). Many commercially important fishes, including Pacific ocean perch and Atka mackerel, are associated with DSCS communities in the Aleutian Islands and throughout Alaska (Heifetz 2002, Malecha et al. 2005, Rooper and Boldt 2005, Rooper et al. 2007, Laman et al. 2015). DSCS communities are vulnerable to damage and removal by fishing gear and to changing oceanographic conditions (van Dolah et al. 1987, Auster et al. 1996, NRC 2002, Heifetz et al. 2009, Tittensor et al. 2010, Yara et al. 2012, Hennige et al. 2015). Since corals are long-lived and slow-growing (Andrews et al. 2002, Andrews et al. 2009), the recovery of damaged or removed communities may take decades or longer (Rooper et al. 2011).

Commercial fishing using bottom trawls, pelagic trawls, longlines, and pots target species such as Pacific cod, Atka mackerel, and rockfish species in the Aleutian Islands. In 2006, partly in response to concerns about the vulnerability of coral communities to commercial fishing, area closures to mobile bottom contact gear were implemented throughout the Aleutian Islands. The closures effectively froze the footprint of the existing commercial fisheries. Additional areas identified as coral gardens (Stone 2006) were also designated as Habitat Areas of Particular Concern (HAPC) and closed to all bottom contact fishing gear. These fishing closures were implemented specifically to protect coral habitat. In addition to the coral habitat closures, other fishing closures to protect critical habitat for Steller sea lions have also been in place since 2003. These closures have been placed around rookery and important haul-out sites. Although they were not designed to protect coral habitat, they have effectively been refugia for benthic communities. Recent changes in regulations implemented in 2015 have resulted in changes for some boundaries of these Steller sea lion closures. These changes have allowed bottom trawling to occur within previously closed areas.

Two fundamental questions regarding coral habitat in the Aleutian Islands are 1) is protection by mobile fishing gear closures sufficient to maintain healthy DSCC communities and 2) do DSCS communities within closures implemented in 2005 remain in an impacted state due to previous fishing activity? The effectiveness of fishing closures implemented in 2005 has been identified as an "Important (Near term)" research priority for the North Pacific Management Council (Research Priority #184 - Evaluate efficacy of habitat closure areas and habitat recovery). The objectives of this project are to evaluate fisheries closures to protect benthic habitat that occurred in 2005 at their effectiveness at protecting DSCS resources in the Aleutian Islands and western Gulf of Alaska.

Specific objectives include the following:

- Compare densities of DSCS in areas that were closed to mobile bottom contact gear to adjacent open areas where mobile contact fishing has occurred since 2003.
- Compare size structure of DSCS in closed and open areas.

- Compare rates of damaged DSCS observed in closed and open areas and examine evidence of fishing in these areas.
- Examine patterns in fishing effort from the vessel monitoring system (VMS) data and compare these to terrain metrics such as slope, depth, and ruggedness to determine common habitat features among fished areas.

Approach: Study locations were identified as having high densities of DSCS at multiple transects during prior drop camera surveys in 2012 and 2014 (Goddard et al. 2017). The study locations are also in areas that have adjacent bottom trawl tows targeting Pacific cod, Atka mackerel, or Pacific ocean perch. The locations of bottom trawl tows were identified using VMS data (S. Lewis, AKRO). Within each chosen area, 100 m × 100 m grid cells were designated as having one of five treatments: no historical trawling and closed to trawling in 2005, no historical trawling and currently open to trawling, historical trawling and closed in 2005, historical trawling and closed to trawling in 2011, and historical and current trawling. Grid cells to sample were selected using a stratified random sampling design. The sampling protocol resulted in 276 stations chosen within the study locations, which were then prioritized according to their treatment. High priority areas included those in closed areas, areas open with fishing currently ongoing, or closed areas with fishing prior to 2005 or 2011. Medium-priority stations included those in open areas with no fishing since 2005 or 2011. Low-priority stations included those in open areas with no fishing. Some stations in closed areas were reprioritized as medium priority if they were closer than 500 m from another station.

Sampling was completed on the chartered research vessel RV *Woldstad* from 2 July to 16 July 2023. Sampling occurred at depths from 16 m to 650 m. At each station, an underwater stereo camera system was deployed and 15 minutes of on-bottom imagery was collected. The camera primarily drifted with prevailing currents with some vessel power or maneuvering depending on the prevailing currents. Images will be processed to determine substrate type, density and size of structure forming invertebrates, and density and size of fish species using Sebastes software (Williams et al. 2016). Water samples were also collected with adjoining images that can contribute to ongoing eDNA studies and taxonomic studies. Depth data, vessel track line, and position data were also collected. During each transect, a water sample was collected with a Niskin bottle, 2-5 m above the seafloor. Replicate 1-liter water samples were immediately vacuum-filtered through 0.45 μm nitrocellulose membranes. Membranes were folded inward with sterilized forceps, placed in tubes with Longmire's lysis buffer, which stabilizes DNA at room temperature, and stored until further processing.

In the laboratory, DNA will be extracted from the membranes and stored in buffer solution. DNA concentration will be determined and next generation sequencing analyses will identify individual taxa. The presence, absence, and signal strength of eDNA will be compared with the visual survey analyses to reconcile species composition, diversity, and density of fish, coral, and sponge between the two types of observations. Data from eDNA analyses will also be available for incorporation into or validation of species distribution models for fish, coral, and sponge.

Significant Results to Date: A total of 102 stations were completed in depths ranging from 16 to 650 m (Fig. 16) at 11 sampling areas. A total of 77 high priority, 20 medium priority, and 5 low priority stations were sampled. Image analysis, using the Sebastes program, has been

initiated with anticipation of completion in the winter of 2025. In addition to the camera observations, paired water samples for eDNA analysis were collected on 96 transects. DNA extractions were completed at the NWFSC. Aliquots of the samples were split and separate labs will process the DNA to identify invertebrates (M. Everett, NWFSC) and fish (W. Larson). A preliminary view of the images from the sites sampled have revealed that coral and sponge were present at the majority of sites (95 and 88 sites, respectively). In addition, many other invertebrate and fish species were documented throughout all the sampling areas (Fig. 17). Some evidence of fishing activity was also documented, most notably derelict longline gear.

Funding: To date, AKCSI has funded this research project with DSCRTP funds. The bulk of the support was used to charter the vessel for 15 days ($303,135 in FY 22, including charter fees, moorage, transit of the vessel from Homer to Dutch Harbor, AK, and fuel). Funds in FY23 were used to provide supplies for the cruise, to repair and upgrade camera and winch systems, and to ship cameras, winches, and related equipment to Dutch Harbor ($16 K). Salary for J. Olson, overtime funds for P. Goddard and C. Conrath, and travel funds for all scientific personnel were supported in FY23 (35K). The share of funds necessary to support initiative coordinators and image analysts as related to this project is estimated at approximately $50,000.

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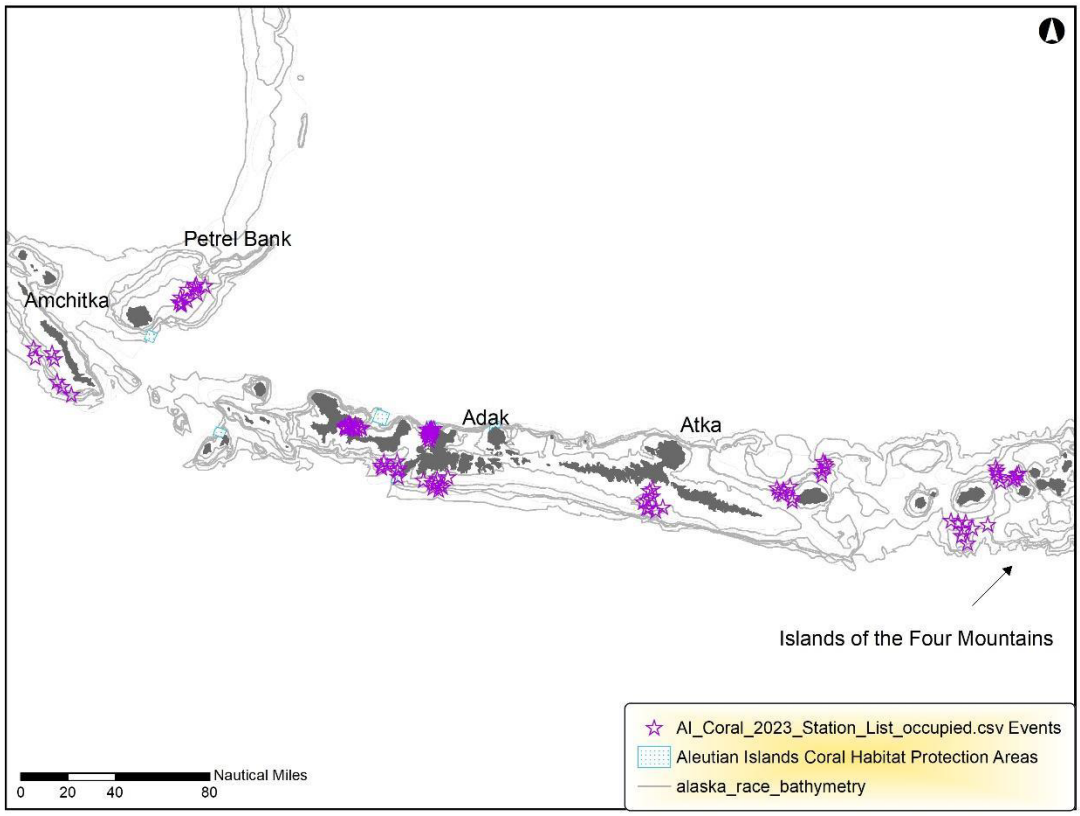

Figure 16. -- Map of the sites sampled within our 11 sampling areas in the Aleutian Islands.

Figure 17. -- Example images of coral and sponge communities observed on the 2023 Aleutian Islands habitat recovery cruise.

Associated Field Projects

Six additional projects were implemented during the Alaska Coral and Sponge Initiative. These wide-ranging projects acquired data through field or laboratory work, or modeling of data from current and past research. The field components of these projects were either carried out during the large expeditions mentioned above or other existing AFSC cruises.

The Influence of Deep-Sea Coral and Sponge Ecosystems on the Life History of Fishery Management Plan Species in Alaska

Background and Objectives: This project addresses priorities related to the importance of DSCS ecosystems to Fishery Management Plan species in Alaska. Rockfish species are frequently associated with coral and sponge habitat in both the Gulf of Alaska and the Aleutian Islands (Rooper et al. 2007, Rooper and Martin 2011, Conrath et al. 2019). It is often assumed structure-forming invertebrates provide valuable habitat that results in higher productivity of these species. A previous study in the Gulf of Alaska examining rockfish abundance and community structure in different habitats found that rockfish densities were highest in complex habitat, but additional value of habitat containing structure-forming invertebrates was not demonstrated (Conrath et al. 2019). Similarly, Rooper et al. (2019) found that rockfish in the eastern Bering Sea and the Aleutian Islands had an affinity for coral and sponge habitats, but that any structure is important for rockfishes and both abiotic and biotic structure was associated with increased rockfish densities. Spatial differences in fish condition have been related to both water temperature and depth (Lloret and Ratz 2000, Chouinard and Swain 2002), but differences due to the presence of different substrate types are not as well documented. A more comprehensive examination of fish condition and reproductive success across large spatial scales within the Gulf of Alaska and the Aleutian Islands would provide valuable information about the value of coral and sponge habitats within these large marine ecosystems.

The primary objectives of this research project:

- Examine the feasibility of developing an accurate fish condition index that is easy to incorporate into standard survey operations during AFSC annual bottom trawl surveys in the Gulf of Alaska and Aleutian Islands.
- Assess the predictive value of fish condition on reproductive success.
- Examine how fish condition and reproductive success are related to DSCS habitats.

Approach: The approach was to collect samples over broad spatial scales during AFSC bottom trawl surveys in the Gulf of Alaska in 2021 and the Aleutian Islands in 2022. Sampling efforts in 2021 were focused on assessing a variety of condition indices for rockfish species that could be used to evaluate the value of specific habitat types. During 2021,
50 samples of Pacific ocean perch, *Sebastes alutus,* and northern rockfish, *S. polyspinis,* were sampled and then frozen for bioenergetic analyses (Fig. 18). Sampling included taking standard length and weight measurements, obtaining fish condition measurements using two types of fat meters, and measuring liver weights. These samples were transported to the Auke Bay Laboratories and bioenergetic processing was completed by scientists at the Recruitment, Energetics, and Coastal Assessment program. These data will be used to calibrate data from the

Distell Fatmeter and the Yamato Fish Analyzer (Fig. 19). In addition, these data will be used to assess a variety of fish condition indices including indices based on length-weight relationships, liver weight relationships, and data from the two fat meters.

Sampling in 2022 was focused on a broader collection of condition and reproductive information for both species in both coral and sponge habitat and habitat that does not contain structure-forming invertebrates. In 2022, appropriate habitat areas in the Aleutian Islands were identified using known coral areas identified during the 2012 – 2014 sampling period (Rooper et al. 2018). During 2022, 391 Pacific ocean perch and 163 northern rockfish were sampled. Sampling was the same as in 2021 but in addition, otolith and ovary samples were collected. Parameters examined at the laboratory will include maturity status, fecundity, reproductive failure, age, and condition. Juvenile and adult Pacific ocean perch were collected from six trawl tows in the eastern Aleutian Islands (Fig. 18) and ranged in size from 19 to 51 cm fork length. Juvenile and adult northern rockfish were collected from four trawl tows in this region and ranged in size from 19 to 44 cm fork length. The relationship of fish condition and reproductive success will be compared by habitat type for the locations utilized in the study. These data will inform fish condition collections on future annual AFSC bottom trawl surveys enabling larger spatial scale assessment of the relationship of condition and habitat.

Significant Results to Date: This project is behind schedule due to a significant delay in completing the energetic analyses. Multiple cancellations of travel plans during 2021 as a result of restrictions on facility use due to COVID-19 precautions delayed the completion of bioenergetic analyses. During 2024, frozen fish samples from 2021 were analyzed for moisture, lipid content, and energy density. Moisture was measured in a TGA drying oven, lipid was measured via the SPV extraction method, energy density was measured using bomb calorimetry (Pinger et al. 2024). Currently calibrations are being developed for measurements collected with the Distell Fatmeter and the Yamato Fish Analyzer. Initial preliminary analyses comparing energy density to condition indices are not promising for development into an accurate and precise metric of fish condition for these two rockfish species, but these analyses will be revisited when the calibrations of the fat meters are complete.

Funding: DSCRTP funds ($8,525) were used in FY 2021 to purchase a Distell Fish Fatmeter. DSCRTP funds were utilized in FY2022 to purchase two days of sampling time on the Aleutian Islands Bottom Trawl Survey ($30,000). In addition, funds were utilized to pay for bioenergetics processing ($13,500), to pay for overtime hours ($2,400), and project supplies ($2,307). This work occurred during the Alaska Fisheries Science Center bottom trawl surveys and would not have been possible without the use of this large sampling platform that is supported by the AFSC.

Point of Contact: Christina Conrath, AFSC RACE Division (Christina.Conrath@noaa.gov)

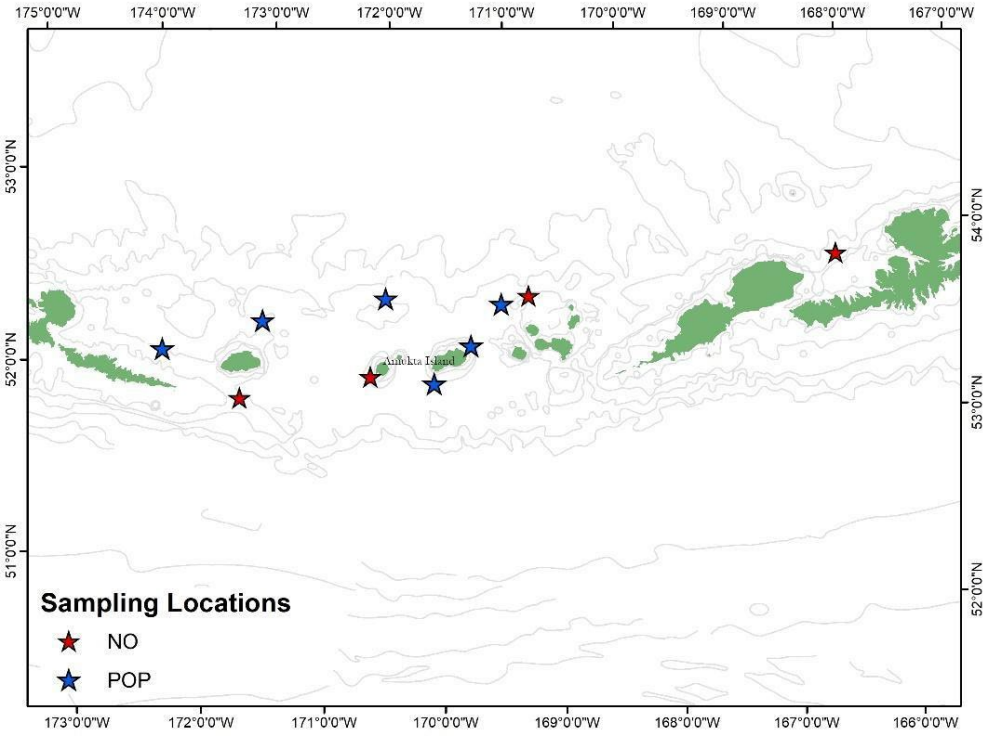

Figure 18. -- Map of sampling locations in 2022 in the eastern Aleutian Islands denoting stations where northern rockfish (NO) and Pacific ocean perch (POP) were sampled.

Figure 19. -- The Yamato Fish Analyzer (left) and the Distell Fatmeter (right). Both meters are easily hand-held and are placed on the fish musculature to read the index of lipid content.

Figure 20. -- AFSC scientists collecting rockfish measurements and samples during the 2022 Aleutian Islands Bottom Trawl Survey.

Figure 21. -- Fish and structure forming invertebrates captured during the 2022 Aleutian Islands Bottom Trawl survey.

Sponge Identification and Genetics in the Gulf of Alaska and Aleutian Islands

Background and Objectives: Sponges comprise an important part of the Alaska benthic fauna and ecosystem. However, our knowledge of Alaska sponge fauna is limited and largely based on opportunistic collections and inferences made from neighboring regions. Alaska contains a rich fauna of sponges with 125 confirmed species (or subspecies) in the Aleutian Islands and 52 taxa confirmed in the Gulf of Alaska (Lehnert and Stone 2016a). Nevertheless, it is assumed that several hundred sponge species are yet to be inventoried or described from the region. Objectives of this fieldwork were to obtain definitive identifications, to collect voucher specimens and accompanying genetic sequences to better understand sponge diversity, and to support future eDNA work proposed in the region. Identification of the sponge species supports sustainable management of deep-sea sponge ecosystems and facilitates the creation of sponge species distribution models and maps.

Approach: The study utilized specimens collected during the Alaska Fisheries Science Center (AFSC) Resource Assessment and Conservation Engineering Division's Groundfish Assessment Program's bottom trawl surveys in the Gulf of Alaska, Aleutian Islands, eastern Bering Sea and West Coast.

The Gulf of Alaska bottom trawl survey covers approximately 2,800 km, from the Islands of Four Mountains (170°W) to Dixon Entrance (133°25'W). Collections were made aboard the FV *Ocean Explorer* (6/3-7/30/2021) and FV *Alaska Provider* (6/21-7/30/2021). The vessels were equipped with RACE Division Poly Nor'Eastern high-opening bottom trawl nets with rubber bobbin roller gear. The vessels sampled a total of 562 stations at depths ranging from 30 to 700 m.

The Aleutian Islands bottom trawl survey coverage extends over 1,670 km from the Islands of Four Mountains (170°W) in the east to Stalemate Bank (170°E) in the west, including the northern side of the archipelago between Unimak Pass (165°W) and the Islands of Four Mountains. Collections were made aboard the FV *Alaska Provider* (6/11-8/17/2022). The vessel utilized RACE Division Poly Nor'Eastern bottom trawls to sample at 200 stations at depths ranging from 15 to 500 m.

Samples were also obtained from historic vouchers from RACE bottom trawl surveys conducted in the Gulf of Alaska, Aleutian Islands, eastern Bering Sea, and West Coast. The eastern Bering Sea survey covers the continental shelf from the Alaska mainland to the U.S.-Russia Maritime Boundary between the Alaska Peninsula and the Bering Strait. Vessels in the eastern Bering Sea utilized 83-112 eastern otter trawls to make collections at stations ranging from 20 to 200 m depth. West Coast surveys covered the U.S.-Canada border to 43˚ 00'N latitude. Vessels on the West Coast survey utilized standard RACE Division Poly Nor'Eastern bottom trawls at stations ranging from 180 to1,280 m depth.

We also examined nine previously unidentified samples from NOAA's West Coast Deep-Sea Coral Initiative EXpanding Pacific Research and Exploration of Submerged Systems (EXPRESS) campaign (4 Oct. – 7 Nov. 2019). The campaign covered an area from Washington (46° 33.16'N, 124° 35.80'W) to California (33° 11.33' N, 118° 28.09' W). Samples were

collected aboard the NOAA Ship *Reuben Lasker* using the Global Foundation for Ocean Exploration (GFOE) ROVs at depths ranging from 190 to 1,245 m.

Samples were preserved at sea in 95% ethanol for later analysis. An initial screening of ~400 samples was conducted in the lab and a subset of 138 samples was selected for further analyses. Specimens were identified using morphological methods in consultation with Helmut Lehnert, an expert morphological taxonomist at GeoBio-Center LMU München. Spicules were obtained by boiling small sections of sponge in concentrated nitric acid and were then embedded in Canada Balsam for examination via light microscopy. Spicules were also examined using a scanning electron microscopy (SEM) which included mounting spicules on a stub that was sputtered with gold. The World Porifera Database was used as the taxonomic authority for our analysis (de Voogd et al. 2025). Type materials and reference samples are being deposited at the Smithsonian Institution National Museum of Natural History, Washington, D.C.

DNA was extracted from the sponge tissues using a DNEasy Blood and Tissue kit following manufacturer's protocols. PCR amplification of the 28s locus was carried out using standard Sanger sequencing methods with NL4F/R primers at NOAA-Northwest Fisheries Science Center. The resulting genetic sequences were submitted to GenBank. To ensure molecular identification corresponded with the morphological analysis and previous molecular studies, sequences were compared to a reference database of existing demosponge sequences.

Significant Results: To date, our morphological analysis has resulted in the identification of 97 different species of demosponges (Fig. 22), 12 of which are newly described species. Nine of the new species were from Alaska waters (Fig. 23), with two from the Gulf of Alaska, and seven from the Aleutian Islands. Three new species from the West Coast off California (Fig. 24) were identified. Nine additional first-time observations were also recorded from Alaska, as well as numerous range extensions. The new species from Alaska waters (Fig. 25) represent six different orders of Demosponges, including Tetractinellida, Poecilosclerida, Suberitida, Haplosclerida, and Axinellida.

Other highlights included the following. During our examination of the *Polycapus rubrum* sample, a unique combination of acanthoxeas and chelae spicules was noted that has resulted in our recommendation for the creation of a new genus within the Family Hymedesmiidae. Another discovery occurred while examining the *Stelletta plana* sample, on which was found an additional encrusting species *Desmacella alaskensis*, resulting in the description of two new species from a single sample. One final new discovery, from a zoogeographic point of view, was the discovery of *Julavis borealis.* This genus is known from only three records at disparate locations, one from the tropical Pacific (Funafuti), another from the Caribbean (Jamaica), and our observation from the Aleutian Islands. This research is contributing to clarification of species identification, which is necessary to establish species distributions models and support sustainable management of deep-sea sponge ecosystems.

DNA was successfully extracted from each of the nine newly described species from Alaska. The 28s loci were only successfully amplified for three of the novel species (*Stelletta* n.sp, *Forcepia atka* sp.n, and *Julavis* n. sp.). Samples from the remaining individuals either failed to amplify after repeated attempts or examination of the chromatograms indicated cross-

amplification of a secondary sequence. This cross-contamination was likely a secondary organism living within the sponge tissue, or cross-contamination (e.g., fish slime) from the trawl. Future sequencing with additional tissue resources from the region should help resolve this issue.

The phylogenetic trees obtained from this study have been useful in comparing how the molecular identification results for the new species corresponded. For example, the result of our phylogenetic analysis confirmed the expected placements of the two samples of *Stelletta plana* n.sp. within the subclass Heteroscleromorpha (Fig. 26). In addition, these phylogenetic trees have been useful in identifying relationships between species and finding common ancestors among sponges collected in the wider Northeast Pacific region.

Funding: DSCRTP funds ($44,405) were used in FY2021 to support a contract for taxonomic services as well as other project costs. DSCRTP funds ($44,963) were used in FY2022 to support a contract for taxonomic services as well as other project costs. Samples were collected during AFSC annual bottom trawl surveys and this project would not have been possible without the support of the AFSC and science team members. Leveraged salary and benefits for science team members were contributed by the AFSC.

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Additional Collaborators:
Meredith Everett, NWFSC-Molecular-genetics division
Helmut Lehnert, GeoBio-Center LMU München

Figure 22. -- Examples representing a diverse variety of sponge morphotypes examined in this study to showcase the rich sponge fauna found in Alaska and adjacent regions.

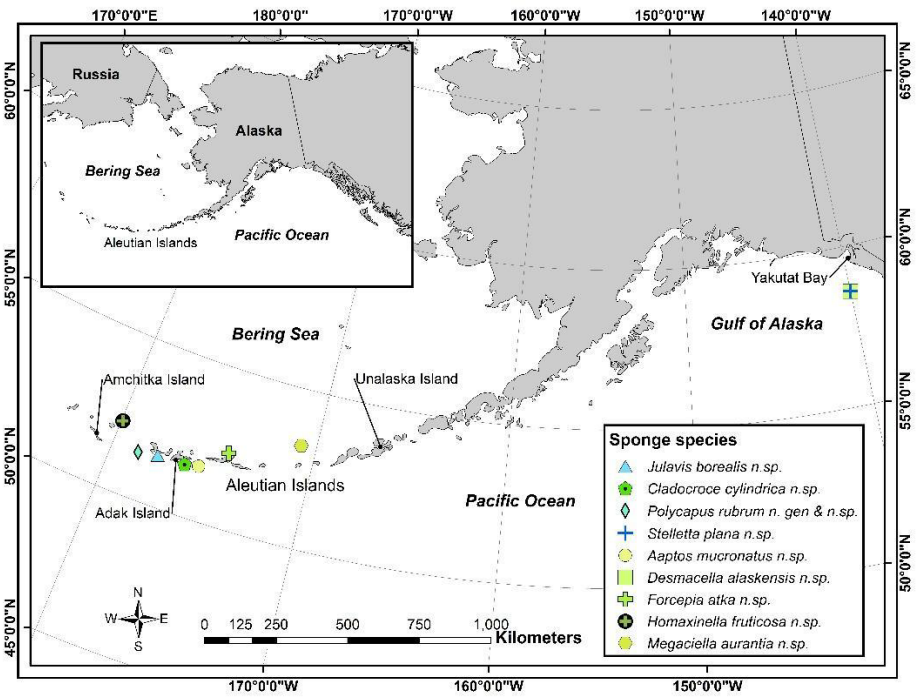

Figure 23. -- Map of the localities in Alaska where newly identified sponges were collected.

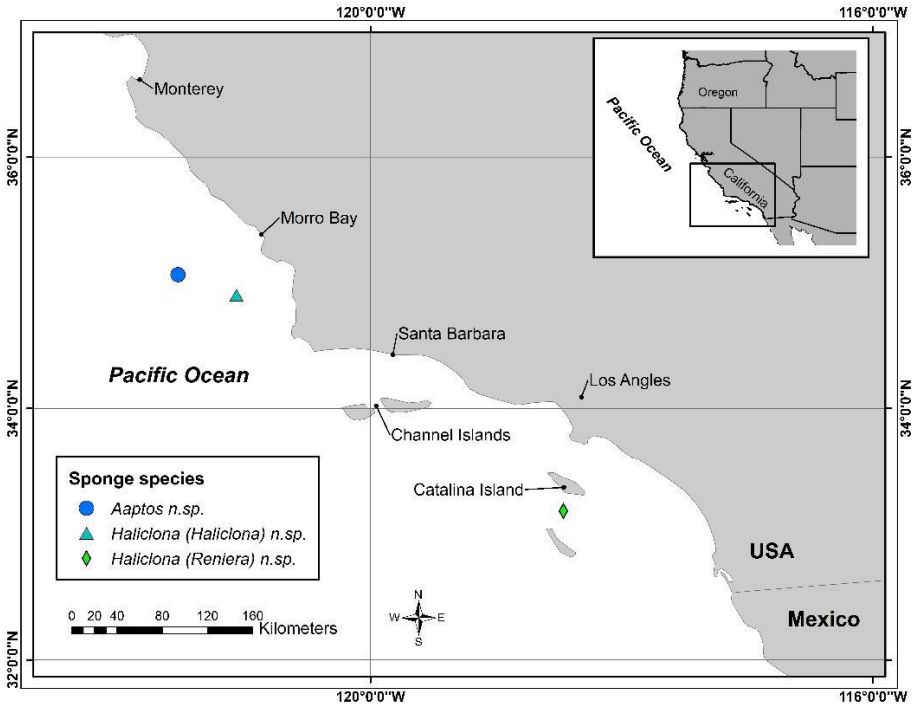

Figure 24. -- Map of the localities on the West Coast where newly identified sponges were collected.

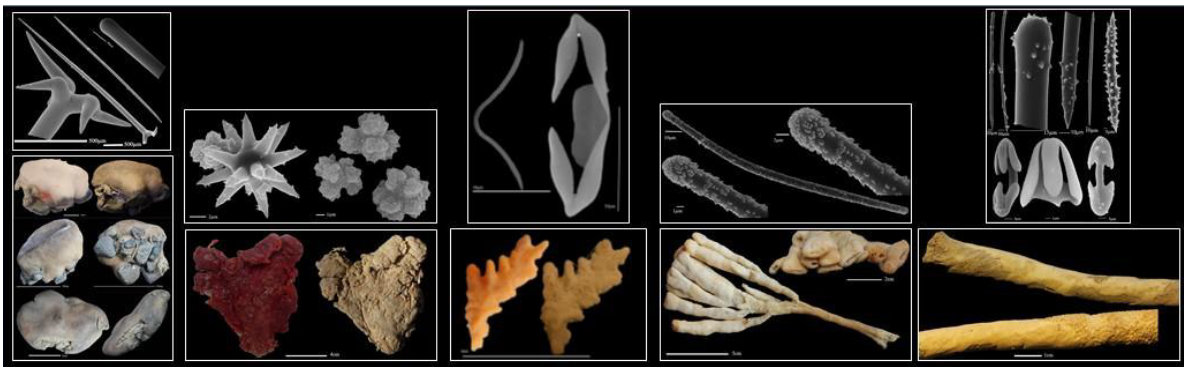

Figure 25. -- Examples of sponge images described during this study. Photos of the holotypes (lower images, from left to right): *Stelletta plana* (far left), *Polycapus rubrum* (left of center), *Megaciella aurantia* (center), *Julavis borealis* (right of center), and Cladocroce cylindrical (right). Accompanying SEM photos (upper images, above corresponding holotype photo) illustrating some of the diversity of spicules examined as part of the morphological analysis.

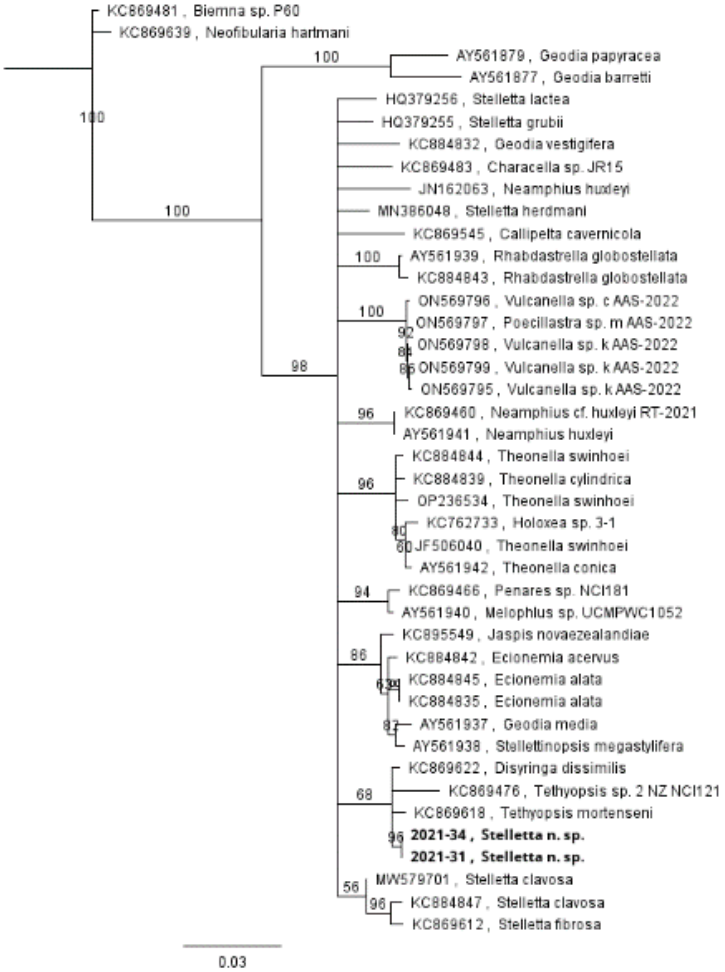

Figure 26. -- Example phylogenetic analysis of the Astrophorina species included in the current study. Members of the Biemnida were included as an outgroup. The two *Stelletta* n. sp. were grouped within the Ancorinidae.

Refine Estimates of Longline and Pot Gear Footprints and Interactions with Corals and Sponges

Background and Objectives: A Fishing Effects (FE) model was developed by the Alaska Regional Office of NMFS and Alaska Pacific University to analyze the effects of fishing on habitat during the 2015 Essential Fish Habitat review. The FE model utilizes a spatially explicit Catch-In-Areas (CIA) database to identify locations of fishing activity. The CIA database provides information on the locations of individual tows or other bottom contact fishing activities. Gear- and target-specific descriptions provide an estimate of the fishing footprint. The FE model identifies 27 unique habitat features and incorporates impact and recovery rates based on a global, gear-specific literature review (Grabowski et al. 2014) to predict habitat reduction and recovery over time. Habitat reductions are estimated at monthly time steps by calculating the impacts to habitat from fishing activities and simultaneously accounting for habitat recovery from past impacts.

The FE model includes gear descriptions for sablefish, Pacific cod, rockfish, turbot, and halibut longline fisheries as well as Pacific cod and sablefish pots. The current FE model uses estimates of the nominal and maximum width of the bottom contact of specific fishing gear types, which are 6 m wide for longline gears and 5.6 m^2 for sablefish and Pacific cod pots. These parameters were derived from the static footprint of the gear on the bottom. However, since the initial development of the FE model, empirical studies have demonstrated that longline and pot gears are not static on the seafloor and can interact with a much larger footprint than previously assumed. Welsford et al. (2014) calculated the maximum footprint of a toothfish longline in the Australian Southern Ocean to be 30 m, while Doherty et al. (2018) found that the footprint of a sablefish pot in British Columbia was 53 m^2 or 36 times the static footprint of the pot. Many studies have examined the footprint and impacts of trawls on benthic habitats. In contrast, few studies have looked at the footprint or effects of longlines and pots although these gears are used extensively in Alaska and elsewhere. Furthermore, the predominant gear used by the Alaska sablefish fishery has recently changed from longlines with baited hooks to longlines with lightweight slinky pots, for which there is little information about how they interact with the seafloor. The objectives of this project were to obtain more accurate estimates of bottom footprints of longline and pot gears, as well as to examine the susceptibility of corals and sponges to these gears. Once determined, these values can be used to refine and improve the outputs from the FE model.

Approach: In the previous Alaska Coral and Sponge Initiative, a project was funded to look at the impacts of longline gear on corals and sponges; however, success was limited due to the available camera technology. During the current initiative, the plan was to have a new camera system developed and produced based on the design of the Benthic Impacts Camera System (BICS), which is a proven system that can be attached to non-rigid fishing gears such as longlines, allowing direct observations of the gear as it interacts with benthic habitats. Images were to be used to determine the footprint of the gear, as well as document interactions of the gear with benthic habitats, such as corals and sponges.

Once the camera was completed, the plan was to initially deploy it in the Gulf of Alaska on hook-and-line and slinky pot sets on the AFSC longline survey. Utilizing the survey would provide a low-cost opportunity to test the technology and enhance our understanding of

fishery impacts on DSCS. Image review was to be conducted using the Sebastes software package. Additional deployments on other vessels would follow successful deployment on the AFSC Longline Survey.

Significant Results to Date: A contract was awarded through the CICOES cooperative institute mechanism at Oregon State University (OSU). The contract included funds for the purchase of supplies and engineering to design and build a BICS-type camera system. Initial administrative issues at OSU prevented funds dispersal and delayed the start of the work for several months. Once funds were released, the contractor worked with the OSU Innovation Lab to design and craft deep-water camera, battery, and light housings (Fig. 27) that were then built into a protective deployment frame (Fig. 28). Testing of the system identified issues with both the electronics and control programming. Several subsequent redesigns and modifications have been completed over multiple seasons, as well as multiple tests of the system. The most recent in-water test of the system occurred in September 2024 but was again not successful, as the camera failed to record as programmed. The contractor is troubleshooting the issue and will deliver an updated system in the spring of 2025. Presuming a successful test deployment is achieved in the coming months, plans to deploy the system on the AFSC Longline Survey and collect seafloor imagery will be resumed in the summer of 2025.

Although this project has suffered many setbacks and is considerably behind schedule, there is optimism that a functional camera system will eventually be delivered. If so, collected images would allow observations of fishing interactions with benthic habitats and estimates of longline and pot footprints could be developed and incorporated into fishery effects models.

Funding: DSCRTP funds ($40,000) were used in FY2021 to buy supplies and pay an engineer contractor to design and build a BICS-type camera system. Leveraged salary and benefits for science team members were contributed by the AFSC.

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Figure 27. -- Deepwater camera and lighting housings produced at Oregon State University's Innovation Lab. Depth ratings for the housings exceed 1,000 m.

Figure 28. -- Deepwater BICS-type camera system attached to groundline and ready for test deployment. The system is designed to be attached inline on longline gear and will record imagery of the gear actively fishing and interacting with seafloor biota.

eDNA to Support Species Identification, Distribution, and Habitat Characterization in Deep-Sea Corals

Background and Objectives: Deep-sea corals are an important biogenic essential fish habitat. However, there is little knowledge of their taxonomy, life history, and basic biology. The clear identification of deep-sea coral species and understanding of their biology and connectivity is a key part of their management (Hourigan et al. 2017). Traditional survey methods for characterizing deep-sea coral habitat include visual surveys with equipment including ROVs, AUVs, and camera sleds, paired with sampling (either via remote vehicle or through fisheries processes such as trawls). However, when samples are unavailable due to ongoing taxonomic uncertainty combined with morphological diversity, many species of octocorals cannot be identified through visual analysis alone, and the lack of clear species identification can have downstream effects on additional research and management (Everett and Park 2018).

eDNA surveys are increasingly used as a tool for cataloging and monitoring biodiversity and species distribution, and can be especially useful in hard to access habitats. When paired with traditional visual surveys, eDNA can enhance the identification of octocorals, and also have the

capability to detect the presence of species that are present but unobserved via traditional sampling methods, providing a valuable data stream for habitat and community characterization and management. The goal of this work was to pair eDNA surveys for octocorals and rockfish with the visual camera sled surveys carried out during the Alaska Coral and Sponge Initiative. These surveys will enhance the species identification of the observed octocorals, characterize individuals that may have been missed by the camera, and help characterize the relationships between deep-sea corals and commercially important rockfish species within the Alaska region.

Approach:

FIELD COLLECTIONS

Water for eDNA analysis of deep-sea coral presence was collected during the AFSC Coral and Sponge Initiative during the Gulf of Alaska species distribution model validation study, the Joint Canada-USA international seamount survey, and the Aleutian closure area study. A Niskin bottle was attached to the wire on the towed camera, and triggered by messenger after the camera reached the bottom. Upon retrieval, replicate 2-liter samples were collected from the Niskin bottle in sterile Whirl-Paks®. The samples were immediately filtered through a 0.45 uM mixed cellulose ester sterile filter, and the filter was preserved in Longmire's Lysis Buffer. Daily field blanks of 2 liters of commercially available distilled water were processed and preserved in the same manner as the eDNA samples.

LABORATORY PROCESSING

For the 2022 Gulf of Alaska species distribution model cruise samples, eDNA extraction from each sample was carried out at the AFSC Genetics Lab using a modified Qiagen DNEasy protocol (Baetscher et al. 2024). The extracted DNA was divided, and half of each sample was sent to NWFSC for deep-sea coral analysis, while the remaining sample was retained at the AFSC's Genetics lab to characterize the associated *Sebastes* community structure.

For the 2022 Joint AFSC/DFO Seamounts cruise and 2023 AFSC Aleutian Islands surveys, eDNA extraction is being carried out at the NWFSC via established phenol-chloroform extraction methods (Shelton et al. 2022), with the following modification: rather than extracting the entire 3 ml sample, 2 ml of each digested sample is transferred to a 5 ml Eppendorf tube, with the filter and remaining one ml of sample retained for archive. The final eDNA extraction is eluted in 50 ul of 10 mm Tris-HCl, pH 8.5. Each sample from the Aleutians survey will be divided as above between the NWFSC and AFSC as described above for analysis of both octocoral and *Sebastes* communities.

To ensure the reference libraries contain Alaska octocoral sequences, individual octocorals collected during the RACE trawl surveys from the Gulf of Alaska, Bering Sea, and Aleutians regions were extracted with Qiagen DNEasy reagents following the manufacture's protocol.

OCTOCORAL EDNA AND BARCODE SEQUENCING

eDNA samples from all years are undergoing metabarcoding for the octocoral specific mitochondria *MutS* locus to characterize octocoral community structure across the Alaska region. Metabarcoding methods follow those in Everett and Park (2018), with the addition of an additional primer targeting the Coraliidae to address primer bias encountered in the original study. eDNA samples are PCR amplified in triplicate 15 µl, imaged on an agarose gel, and gel purified with Qiagen MinElute kit following manufactures instructions. The resulting clean PCR products are prepared for Illumina Sequencing via MiSeq v3-600 chemistry following Illumina's 16 s metabarcoding protocol (available from Illumina at https://support.illumina.com/downloads/16s_metagenomic_sequencing_library_preparation.html).

DNA from octocoral samples from the AFSC RACE surveys were amplified with *MutS* primers (McFadden et al. 2011) and sanger sequenced using standard methods.

DATA ANALYSIS

Data analysis is being carried out using Qiime2 and RAxML (see Everett and Park 2018 for a description of the RAxML methods) using a custom octocoral reference database to carry out species assignments. The custom database includes the full collection of MutS sequences available from public sources (NCBI) as well as new octocoral MutS sequences generated at NWFSC from Alaska specimens collected during the RACE trawl surveys, leveraging funding from the DSCRTP genetics projects. Using these pipelines, amplicon sequences from each eDNA sample are assigned to the lowest possible taxonomic level (species whenever possible, with assignments to genus or family for sequences not represented in our database). The resulting species assignments will be used to characterize octocoral biodiversity within the region, using standard statistical ecological methods (alpha and beta diversity indices, etc.) carried out in R statistical software, and compared to rockfish distributions within the region (eDNA work being carried out at AFSC by Larson and Baetscher).

Significant Results to Date: Laboratory processing of all eDNA samples is ongoing; the 2022 Gulf of Alaska collections have all been extracted, amplified and sequenced for octocorals. DNA extraction for the 2023 Aleutians and 2022 Seamounts has begun and is ongoing. Data analysis of resulting octocoral metabarcoding sequences has begun on the 2022 samples and is ongoing. A first version of the reference database has been completed, and testing has begun with initial samples from 2022, in order to compare results with observations from the camera tows. The completion of sample extraction in Q2 FY2025 is anticipated, with ongoing sequencing efforts through that quarter and into Q3.

Funding: DSCRTP funds ($75,000) were used during FY2021, FY 2022, and FY 2023 to support the processing of environmental DNA samples including metabarcoding of coral and sponge eDNA from survey vessels and research cruises.

Point of Contact:
Meredith Everett, NWFSC-Molecular-genetics division (meredith.everett@noaa.gov)

Environmental DNA (eDNA) Collections for Identifying Fish Associations with Coral and Sponge

Background and Objectives: The Alaska Fisheries Science Center (AFSC) is responsible for groundfish and crab stock assessments in the Gulf of Alaska, Bering Sea, and the Aleutian Islands. Historically, the primary information used to assess these resources are catches from bottom trawl surveys. However, bottom trawl survey catches may not provide complete information for assessing and understanding fish and crab populations in Alaska. Many managed species are difficult to sample using bottom trawls because they reside in untrawlable habitats. Additionally, some juvenile fish, such as rockfish, are rarely caught using traditional sampling methods so the habitat utilization of the juvenile life stages is poorly understood. Within untrawlable habitats, there are often areas with high densities of structure-forming invertebrates (SFI) such as coral and sponge. Alternative sampling tools are desirable to fully understand the distributions of managed species, coral and sponge, and their associations.

Environmental DNA (eDNA) is a relatively new but rapidly growing field of research. eDNA can be used as a surveillance tool to monitor for the genetic presence of aquatic species and determine biodiversity. The advantage of eDNA is that the presence or absence of an organism can be determined at various locations even if the organisms are not visible or able to be sampled. For cryptic and rare species this makes eDNA highly advantageous and for deep-sea environments that are difficult and expensive to observe eDNA provides a relatively inexpensive and simple sampling mechanism. In addition to presence/absence information and measures of diversity, eDNA may provide insight into species associations between SFI, such as coral and sponge, which are poorly understood in deep-sea Alaska habitats. Furthermore, this technique may eventually be used to roughly quantify fish and SFI population densities based on the strength of the eDNA signal.

The primary objectives of this eDNA study:

- Collect and filter benthic water samples for eDNA analyses of fish communities.
- Document species associations of coral and sponge with fish using visual and eDNA observations.
- Compare visual and eDNA observations of coral and sponge to evaluate detection consistency and limitations of each observation type.

Approach: Water samples were collected with sterilized Niskin bottles in association with visual surveys of benthic habitats, during the Gulf of Alaska model validation survey, the Joint Canada-U.S. seamount survey, and the Aleutian closure areas survey. At each sampling location, water was collected 2-5 m above the seafloor. Upon retrieval, replicate 1-liter water samples were immediately vacuum-filtered through 0.45 μm nitrocellulose membranes. Membranes were folded inward with sterilized forceps, placed in tubes with stabilizing solution and stored until further processing. In the laboratory, DNA was extracted from the membranes and stored in buffer solution. DNA concentration will be determined within the water samples and next generation sequencing analyses will identify individual taxa.

eDNA presence, absence, and signal strength will be compared with the visual survey analyses to reconcile species composition and diversity of fish, coral, and sponge between the two types of

observations. eDNA data will also be available for incorporation into or validation of species distribution models for fish, coral and sponge. These results will aid in identifying Essential Fish Habitat (EFH) and determining areas for protection such as Habitat Areas of Particular Concern (HAPC).

Significant Results to Date: A total of 228 camera transects were completed on the Gulf of Alaska species distribution model validation survey in depths from 18 to 879 m. Most high priority sites were sampled, as well as many other lower priority sites. Paired water samples were collected on 223 of the 228 transects. Water samples were filtered onboard the vessel and DNA extractions were completed in the Larson lab post-cruise. Aliquots of the samples were split and separate labs will process the DNA extractions to identify invertebrates (Everett) and fish (Larson).

One major obstacle for this project was developing a sequencing primer that can accurately differentiate rockfish species throughout Alaska. Our lab has made excellent progress on this and a primer has been developed and is currently being tested. Once this primer is optimized, it will be screened along with a more universal fish primer on the samples. Once fish eDNA data are available, we will integrate them with other data from the survey.

Funding: Funds ($40,000 in FY21 and FY22 and $15,000 in FY2023) were used to buy supplies and supported a technician (Pochardt) who participated on the Gulf of Alaska model validation cruise and processed samples in the laboratory post-cruise.

Point of Contact:
Wes Larson, AFSC ABL Genetics Program Manager, wes.larson@noaa.gov

Additional Collaborators:
Pat Malecha AFSC-ABL Division
Kim Ledger, AFSC-ABL Division
Diana Baetscher AFSC-ABL Division

Incorporate validated coral and sponge covariates into Fishing Effects model

Background and Objectives: The Fishing Effects model was initially developed for the North Pacific Fishery Management Council (NPFMC) for their 2015 Essential Fish Habit (EFH) review to assess the effects of fishing on habitats in the North Pacific by estimating benthic habitat impacts from fishing activities over time and large spatial scales. As implemented for the NPFMC, the Fishing Effects model estimates habitat disturbance (i.e., "habitat reduction") on monthly time scales in 25 km^2 grid cells across the North Pacific (Smeltz et al. 2019). For the NPFMC EFH reviews, benthic habitats were categorized into six sediment-based categories (mud, sand, gravel, cobble, boulder, and deep/rocky). While these sediment-based habitats are useful categorizations for fish utilization of habitat, they are all comprised of a broad range of habitat features that have a variety of susceptibility and recovery (S/R) values. Habitat features (12 geological and 15 biological; Grabowski et al. 2014) are the geological formations or biogenic structures that create three-dimensional habitat on the seafloor and are associated with five sediment-based habitat categories, including corals.

This approach, while valuable for assessing broad-scale impacts to fish habitat, is not appropriate for assessing impacts to specific habitat features such as corals and sponges. During the 2015 EFH review, the NPFMC expressed interest in running the Fishing Effects model for individual habitat features rather than aggregating S/R values across sediments with the intent of assessing impacts to individual features. The objective of the work for this contract is to incorporate validated coral and sponge species distribution models developed by the Alaska Fisheries Science Center into the Fishing Effects workflow, which will allow more precise estimates of the effects of fishing on corals and sponges.

Approach: Code was developed to integrate the coral and sponge distribution model output into the existing Fishing Effects model, updated the corresponding S/R Fishing Effects data tables by reviewing the 2016-2021 literature of coral and sponge vulnerability studies (Table 2), acquired and processed the most recently available Vessel Monitoring System (VMS) fishing location data (2003-2021), and implemented the updated Fishing Effects model.

This model run resulted in updated VMS and S/R data and coral/sponge covariates, describing "habitat reduction" as a percentage reduction from the unfished state, provided habitat feature-specific Fishing Effects model runs (both inclusive and by each of the 15 biological and 12 geological habitat types defined in the model), and provided an assessment of fishing impacts to corals and sponges.

Significant Results to Date: The direct assessment of impacts to individual habitat features requires information about the spatial distribution of each habitat feature. To assess impacts to corals and sponges, the Fishing Effects model runs for corals and sponges were juxtaposed with corresponding Species Distribution Models (SDMs). The SDMs represented the probability of occurrence in 1 ha (0.01 km^2) grid cells for the Aleutian Islands, Eastern Bering Sea, and Gulf of Alaska separately (Rooper et al. 2014, Rooper et al. 2017b). It should be noted that the provided feature-specific model outputs were conducted for the entirety of the North Pacific even if that habitat feature was not present throughout. Because the grid size of the SDMs was substantially smaller than those of the Fishing Effects model, the SDM grid cells were approximated as a point by overlaying the centroid of each SDM grid cell with the Fishing Effects model outputs. Aggregate impacts to corals and sponges were calculated as the mean impact across SDM points with low (5%-33%), medium (33%-66%), and high (> 66%) probabilities of occurrence as well as a total impact calculated as the mean impact weighted by the probability of occurrence (Tables 3 and 4).

Impacts to corals across the North Pacific domain (as a weighted total) ranged from 2.6 to 6.4% in the Aleutian Islands, from 6.8 to 18.9% in the Eastern Bering Sea, and from 1.1 to 4.2% in the Gulf of Alaska. Variability between areas of low, medium, and high occurrence of corals was noted. Impacts to sponges ranged from 2.5 to 6.5% in the Aleutian Islands and 8.9-25% in the Eastern Bering Sea, with similar variability between low, medium, and high occurrences. Sponge models were not available for the Gulf of Alaska.

Funding: DSCRTP funds ($15,000) were used in FY2021/2022 to support a contract with Alaska Pacific University.

Points of Contact:
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Scott Smeltz, Alaska Pacific University (tsmeltz@alaskapacific.edu)

Table 2. -- Recovery and susceptibility values for each benthic habitat feature included in the Fishing Effects model. Low and high impact estimates represent the lower and upper bounds for the recovery and susceptibility based on the ranges used in the 2022 North Pacific Fishery Management Council EFH review.

	Habitat feature	Low impact estimate parameters		High impact estimate parameters	
		Recovery (years)	Susceptibility (proportion)	Recovery (years)	Susceptibility (proportion)
Geological	Bedforms	0	0.25	1	0.5
	Biogenic burrows	0	0.25	1	0.5
	Biogenic depressions	0	0.25	1	0.5
	Boulder, piled	5	0.25	10	0.5
	Boulder, scattered, in sand	0	0	1	0.1
	Cobble, pavement	0	0.1	1	0.25
	Cobble, piled	5	0.5	10	1
	Cobble, scattered, in sand	0	0.1	1	0.25
	Granule-pebble, pavement	0	0.1	1	0.25
	Granule-pebble, scattered, in sand	2	0.1	5	0.25
	Sediments, surface/subsurface	0	0.25	1	0.5
	Shell deposits	2	0.1	5	0.25
Biological	Amphipods, tube dwelling	0	0.1	1	0.25
	Anemones, actinarian	2	0.25	5	0.5
	Anemones, cerianthid burrowing	2	0.25	5	0.5
	Ascidians	1	0.25	2	0.5
	Brachiopods	2	0.25	5	0.5
	Bryozoans	1	0.1	2	0.25
	Corals, sea pens	2	0.25	5	0.5
	Hydroids	1	0.1	2	0.25
	Macroalgae	1	0.1	2	0.25
	Mollusks, epifaunal bivalve, *Modiolus modiolus*	5	0.25	10	0.5
	Mollusks, epifaunal bivalve, *Placopecten magellanicus*	2	0.25	5	0.5
	Polychaetes, *Filograna implexa*	2	0.25	5	0.5
	Polychaetes, other tube dwelling	1	0.25	2	0.5

	Sponges	2	0.25	5	0.5
	Long-lived corals	10	0.5	50	1

Table 3. -- Impacts to corals in the Aleutian Islands, Eastern Bering Sea, and the Gulf of Alaska as of December 2021.

Aleutian Islands coral			
	Area (km^2)	Low impact estimate (%)	High impact estimate (%)
Low occurrence (0.05 – 0.33)	2,483.92	1.0	4.1
Medium occurrence (0.33 – 0.66)	4,670.43	3.2	7.8
High occurrence (0.66 – 1.00)	1,585.93	1.7	4.7
Weighted total		2.6	6.4
Eastern Bering Sea coral			
	Area (km^2)	Low impact estimate (%)	High impact estimate (%)
Low occurrence (0.05 – 0.33)	7,423.29	8.0	21.3
Medium occurrence (0.33 – 0.66)	1,965.63	6.8	19.2
High occurrence (0.66 – 1.00)	611.08	5.9	16.9
Weighted total		6.8	18.9
Gulf of Alaska coral			
	Area (km^2)	Low impact estimate (%)	High impact estimate (%)
Low occurrence (0.05 – 0.33)	8,568.30	1.5	5.6
Medium occurrence (0.33 – 0.66)	1,017.76	0.7	2.7
High occurrence (0.66 – 1.00)	158.93	<0.1	0.3
Weighted total		1.1	4.2

Table 4. -- Impacts to sponges in the Aleutian Islands and the Eastern Bering Sea as of December 2021.

Aleutian Islands sponges			
	Area (km^2)	Low impact estimate (%)	High impact estimate (%)
Low occurrence (0.05 – 0.33)	32.08	17.0	27.9
Medium occurrence (0.33 – 0.66)	3,409.67	2.1	5.3
High occurrence (0.66 – 1.00)	5,287.46	2.6	7.0
Weighted total		2.5	6.5
Eastern Bering Sea sponges			
	Area (km^2)	Low impact estimate	High impact estimate

		(%)	(%)
Low occurrence (0.05 – 0.33)	3,787.30	5.5	20.1
Medium occurrence (0.33 – 0.66)	3,875.36	7.9	24.2
High occurrence (0.66 – 1.00)	2,337.34	10.8	26.7
Weighted total		8.9	25.0

Contributions to the Deep-Sea Coral Data Portal

To meet the task of mapping and identifying deep-sea corals, the DSCRTP maintains a national geographic database. This database houses spatial records of DSCS obtained from research funded by DSCRTP, NOAA, voluntary contributions from other federal agencies and academic researchers, and international organizations. All data submitted are publicly available through the Deep-Sea Coral Data Portal (https://deepseacoraldata.noaa.gov/data). This database incorporates records of species from the U.S. Exclusive Economic Zone as well as other records where available. It is a valuable resource for scientists working in the region and fulfills NOAA's requirements to identify and map locations of deep-sea corals and to make this information available to regional fishery management councils (McGuinn et al. 2020, Hourigan et al. 2015). From 2021 through 2024, the AKCSI submitted a total of 101,917 coral, sponge, and fish drop camera records from the Aleutian Islands, Eastern Bering Sea, and Gulf of Alaska to the Deep-Sea Coral Data Portal (Table 5).

Table 5. -- Summary of Alaska Coral and Sponge Initiative drop camera records submitted to the Deep-Sea Coral Data Portal.

	Aleutian Islands	Eastern Bering Sea	Gulf of Alaska	Total
Corals				
Hexacorallia				
Antipatharia			22	22
Scleractinia			1	1
Octocorallia				
Malacalcyonacea				
Acanthogorgiidae	220		42	262
Alcyoniidea			5	5
Clavulariidae			2	2
Plexauridae	876		76	952
Malacalcyonacea insertae sedis	5,251		81	5,332
Scleralcyonacea				
Anthoptilidae			2	2
Balticinidae	1	674	15,947	16,662
Coralliidae	9		14	23
Keratoisididae			1	1
Pennatulidae	25,147		59	25,206
Primnoidae	1,702		4,943	6,645

Umbellulidae			1	1
Virgulariidae			1,292	1,292
Scleralcyonacea unid	46		1,815	1,861
Hydrozoa				
Stylasteridae	92	4	18,211	18,307
Sponges				
Calcarea			7	7
Demospongiae	6,321	21	4,098	10,440
Hexactinellida	2	4	9,694	9,700
Sponge unident			118	118
Fishes			4,747	4,747
Total	40,033	703	61,181	101,917

Model results for predicting coral and sponge distribution, abundance, and diversity in the Aleutian Islands (Rooper et al. 2014) and Gulf of Alaska (Rooper et al. 2017b) were also archived at NOAA's National Center for Environmental Information (NCEI). All models are presented in the GeoTIFF raster format. Environmental layers used in the modeling of the taxa are also part of this data package. They include the parameters GeoTIFF rasters of latitude, longitude, bathymetry, aspect relative to mean current, mean bottom temperature for the region, current speed and direction for the deepest depth bin at each sampling point, ocean color, seafloor rugosity, sediment type, seafloor slope, mean current speed (exclusive of tides), and max tidal current measured over a year.

Links to model results are here:
Deep-sea coral and sponge distribution, abundance, and diversity models of the Aleutian Islands (NCEI Accession 0289893)

Predictive models of the abundance and distribution of deep-sea corals and sponges in the Gulf of Alaska (NCEI Accession 0289894)

Data Recovery

Camera and video data have been collected in Alaska waters since 1988 or earlier to examine coral and sponge ecosystems and form a better understanding of the essential fish habitat requirements of commercial species. Much of this historical visual data were recorded in 8 mm or VHS formats and is vulnerable to degradation and loss. There is a recognized need shared across the regional coral and sponge initiatives of the DSCRTP to ensure these data are regularly backed up, archived, and made available to the public through the DSCRTP's Deep-Sea Coral Data Portal. These historical data are relevant to research being conducted by this initiative now and in the future. Some of these data were not previously analyzed for coral and sponge habitats. In addition to enhancing our understanding of coral and sponge abundance, distribution, and community structure, this visual data also provides historical points of comparison, which may aid researchers in understanding how fishing and changes in climate are impacting these habitats.

To date, 638 miniDV or Hi8 tapes from 232 Delta submersible dives and 38 field operations associated with Atka mackerel habitat studies have been digitized during both Alaska Coral and Sponge Initiatives. Efforts to digitize data have been focused on Delta sub dives that were part of studies done by AFSC scientists to analyze the benthic habitats of the Aleutian Islands and to better understand rockfish habitats within this region. These data were used to define the boundaries of the Aleutian Islands Coral Habitat Protection Areas, which created six areas of high coral and sponge density that are closed to all bottom contact fishing gear (Stone 2006, Stone et al. 2014). Additional data from Delta sub dives are available from the Aleutian Islands and from areas throughout the Gulf of Alaska. Many historical Delta dives are available from areas with high densities of red tree coral, *Primnoa pacifica*, from the southeast Gulf of Alaska. Beyond the Delta dive data set, additional data are available from the Aleutian Islands and other regions of Alaska. Another set of tapes is available from a study examining the habitat of Atka mackerel in the Aleutian Islands (Lauth et al. 2007). Additional data from the Gulf of Alaska are available from historical dives on seamounts within this region as well (Hoff and Stevens 2005). We are in the process of locating other data sources that can be recovered from this region and digitized.

Continuing to recover these data is a high priority of this initiative. Funding received from the DSCRTP small projects fund was utilized to digitize another 500 tapes from 136 dives. This effort was focused on completing the digitization of available Delta dives in the Aleutian Islands and beginning to digitize Delta dives in the Gulf of Alaska. Gulf of Alaska tapes were chosen with the goal of recovering data that will be utilized for a study examining changes in sponge abundance within this region. Efforts will continue in order to collaborate with other science centers and the DSCRTP to continue rescuing these data.

Exploration and Mapping Partnerships

Seascape Alaska

The Alaska Coral and Sponge Initiative is an active participant and collaborator in the Seascape Alaska mapping campaign. This regional campaign supports the objectives of the 2020 National Strategy for Mapping, Exploring, and Characterizing the U.S. Exclusive Economic Zone (NOMEC), a multi-decadal plan to advance ocean science and technology in the United States through ocean mapping, exploration, and characterization (NOMEC Implementation Plan 2020). Seascape Alaska is a collaboration among federal, tribal, state, and non-governmental partners with a wide range of interests. The vision of this group is, “Accessible, high-quality modern seabed data for Alaska waters to support U.S. research, resource management, sustainable economic growth, and the health and security of Americans.” The campaign values of this group include fostering access to high quality data and products, developing and following best practices, members working collaboratively, developing innovations, and sharing plans and projects broadly (Seascape Alaska 2021). Seascape Alaska includes efforts to not only gather bathymetric data, but also understand the habitat, seafloor, archaeological, biological, chemical, and other oceanic attributes. While increased knowledge of seafloor bathymetry is used as a metric to measure progress, accomplishments from this campaign are much broader with far-reaching benefits. The campaign meets monthly and several subteams have formed that meet

regularly including the Data Management Technical team, the Aleutian Islands and Exploration team, and the Offshore Energy team.

The Alaska Coral and Sponge Initiative continues to pursue research interests that directly align with the exploration and site characterization goals of this campaign. Ocean exploration is generally defined as the initial visualization or examination of an area's physical, chemical, or biological features. Ocean characterization is a more detailed examination of an area designed to address specific research questions related to resource management or other applied objectives (NOMEC Implementation Plan 2020). Field work for this project has included camera drop surveys into several areas that have not been visualized before and the addition of numerous records to the NCEI database. In addition, site characterization data has been or will be published for hundreds of transects in the Gulf of Alaska, Aleutian Islands, and Bering Sea ecosystems (Goddard et al. 2016, Goddard et al. 2017, Wilborn et al. 2017). The Interagency Working Group on Ocean Exploration and Characterization for the NOMEC council have identified the Aleutian Arc as a priority area for exploration and characterization. In particular, the Benthic Ecology Subgroup identified the Aleutian Islands and Slope as their highest priority due to the presence of deep-sea coral and sponge assemblages, the vulnerability of these habitats to fishing pressure, and the importance of these habitats in supporting invertebrate and fish communities (Interagency Working Group on Ocean Exploration and Characterization 2022). These priorities are being addressed by several research projects supported by AKCSI. Members of AKCSI regularly participate in Seascape meetings and work to collaborate with Seascape partners in exploration and site characterization research.

NOAA Ocean Exploration - Seascape Alaska Expedition Series

The Alaska Coral and Sponge Initiative provided support for the NOAA Ocean Exploration 2023 Seascape Alaska Expeditions. This was a series of research cruises on the NOAA Ship *Okeanos Explorer* that included four deep-water mapping expeditions and two combined ROV/mapping expeditions in the Aleutian Islands and the Gulf of Alaska. Telepresence technology on board the ship enabled live interactions with shoreside scientists and ROV dives were streamed in real time to the general public. During acoustic mapping operations over 285,000 km^2 of seafloor was mapped and numerous gas seeps were discovered. Highlights of ROV explorations included the collection of species new to science as well as identifying range extensions for coral, sponge, and sea star species, the observation of deep-sea octopus nurseries, the discovery of a large tube worm field off of Unimak Island, and collecting evidence of shoreline deposits on seamounts in the Kodiak-Bowie chain. All of the data collected during these expeditions will be publicly available on the NCEI NOAA Ocean Exploration Data Atlas and more information on these expeditions can be found at the NOAA Ocean Exploration website: https://oceanexplorer.noaa.gov/okeanos/explorations/seascape-alaska/welcome.html.

Communications

The Alaska Coral and Sponge Initiative used multiple media sources to communicate project goals and results with the scientific community, general public, and students (Tables 6 and 7). Starting in 2020 the team produced web stories on upcoming research projects, presented an initiative overview to the North Pacific Fishery Management Council, and participated in NOAA

Live! Alaska. During the 2022 field season, two blog series were authored describing research on the distribution of corals and sponges in the Gulf of Alaska and a joint Canada-U.S. expedition to the international seamounts. Principal investigators also presented results at international science conferences, NOAA seminars, and ecosystem management meetings. Below are brief descriptions of presentations, posters, and communication products. See Appendix for links and full citations for relevant content.

Field Guide to Corals of British Columbia, Canada, Alaska, USA, and the eastern North Pacific Ocean Anthozoa: Octocorallia and Hexacorallia Hydrozoa: Anthoathecata.

Fisheries and Oceans Canada, Alaska Coral and Sponge Initiative, and Thalassa produced an international field guide to corals of Canada, Alaska, and the Northeast Pacific. This extensive field guide is meant to assist survey personnel and image annotators with identification of deep-sea corals in the waters off Canada and Alaska. This guide includes corals distributed in Alaska, British Columbia, and international waters of the North Pacific Ocean. It includes pictures of specimens, information on spatial and depth distribution as well as morphological descriptions for five orders, 31 families and 153 coral species. This guide has been provided to fishery biologists at the AFSC for use during annual bottom trawl and other surveys and is digitally available to all other scientists working in this region upon request. Over 750 digital copies of the guide have been downloaded for free since publication.

Student Engagement

Engaging the next generation of scientists is an important objective of NOAA. The AKCSI participated in two NOAA programs to engage students in the coral and sponge initiative.

FIRST® LEGO® LEAGUE 2025

Alaska Coral and Sponge Initiative co-coordinators, Pam Goddard and Lauri Sadorus, met remotely with students, grades 4-8 who were a *FIRST*® LEGO® League team in Arkansas.

NOAA LIVE! ALASKA

NOAA Live! Alaska is a series of interactive webinars, aimed at Alaska students in grades 2-8 (but of interest to all ages!). Presentations feature NOAA scientists, educators, and partners to explore NOAA's work in Alaska. Members of the Alaska Coral and Sponge Initiative presented two webinars in 2021 and 2022 specifically targeted as education tools to students, which were viewed 380 times. The webinar recordings of the event are included online along with supplemental tools and resources.

HOLLINGS SCHOLARS

Three Hollings Scholars were mentored by Alaska Coral and Sponge Initiative scientists: Kaya Mondry, Harold Carlson, and Lindsay Weingart. The Hollings Scholarship program provides undergraduate students with financial assistance ($9,500/year) for 2 years and a 10-week internship at a NOAA facility during the summer. Undergraduate students gain hands-on experience with NOAA scientists around the country. Students present the results of their research at the annual Science & Education Symposium.

INTERNATIONAL PRESENTATIONS

Dr. Rhian Waller and Lara Beckmann, University of Gothenburg, Sweden presented results of their deep-sea coral research to three high schools, Sweden Chapter Explorers Club, and Gothenburg Science Festival. Dr. Waller presented at both Tjärnö High School Inspiration Day and Borås High School. Ms. Beckmann created six, 30-minute presentations for Forskfredag (Science Friday) held at Nösnäsgymnasiet (Nönäs High School). Dr. Waller also presented at Forskfredag (Science Friday).

Dr. Chris Rooper, Department of Fisheries and Oceans, Canada, presented results at the North Pacific Fisheries Commissions meetings in Japan and Canada, State of the Ocean Meeting Canada, and FAO Ecosystem Approach to Fisheries Management Symposium, Italy.

Blogs, Web Stories, and Story Maps

BLOGS

Two series of blog posts were created to highlight field expeditions occurring in 2022. The first set of blog posts described highlights of the Gulf of Alaska species distribution model validation cruise aboard the RV *Woldstad* in 2022. These posts included numerous photos of underwater and on-deck activities. The second set of blog posts described the experience of researchers aboard the Canadian Coast Guard Vessel *J. P. Tully* from 6 to 17 September 2022 while surveying the seamounts in international waters off the west coast of Canada and the United States. These include highlights of day-to-day activities, research goals, unexpected encounters and events, and numerous underwater and on-deck images.

WEB STORIES

Six web stories were created by the Alaska Coral and Sponge Initiative, the Alaska Fisheries Science Center's Communications Program, and Office of Habitat Conservation. Web stories provide an opportunity to share initiative goals and results with the general public. These web stories included several photos captured during underwater camera operations and were intended to highlight research findings. Findings were often put into context and included topics such as "Deep-Sea Coral and Sponge Biodiversity", describing the "Coral Life Cycle", and how all the data collected will ultimately validate coral and sponge distribution modeling efforts in the Gulf of Alaska.

STORY MAPS

Two story maps were created by Alaska Coral and Sponge Initiative, the Office of Habitat Conservation, Deep Sea Coral and Research Technology Program, and NOAA's National Centers for Environmental Information. Story maps provide a platform for in-depth presentation of data and images. Story maps are a useful tool to visualize the flow of information from a project through the use of text and graphics such as photos, and videos. The Alaska Coral and Sponge Initiative covered research in the Gulf of Alaska, Aleutian Islands, and the eastern Bering Sea slope.

Table 6. -- Summary of metrics for communications products produced by Alaska Coral and Sponge Initiative since the first initiative ended in 2017.

Product	Number of products	Intended audience	Number of users*	Number of sessions*
Seamounts Survey blogs	5	General Public	1,971	3,811
Gulf of Alaska Survey blogs	8	General Public	1,853	1,288
Web Stories	6	General Public	3,820	6,573
NOAA Live!	2	General Public/Educational	380	676
Story Maps	2	General Public	3,484	NA

* as of January 03, 2025; Users = unique visits. One user can have multiple sessions.

Scientific Presentations

Table 7. -- Principal investigators presented project results to students, fishery managers, marine scientists, and the international science community.

Organization	Presentations	Intended audience
North Pacific Fishery Management Council	1	Alaska Council and Fishing Community
Seascape Alaska	1	Scientific Community
Alaska Fisheries Science Center Seminar Series	1	Scientific Community
Auke Bay Laboratories Seminar Series	1	Scientific Community
Kodiak Area Marine Science Symposium	1	General Public and Scientific Community
8th International Symposium on Deep-Sea Corals - Talk or speed-talk and poster	5	International Scientific Community
North Pacific Fisheries Commission	2	International Scientific Community
State of the Ocean, Canada	1	International Scientific Community
FAO Ecosystem Approach to Fisheries Management Symposium (Italy)	1	International Scientific Community
University of Gothenburg, Tjärnö Marine Laboratory Seminar	1	International Scientific & Academic Community
Tjärnö Marine Laboratory: “Arctic in a changing climate” - Speed-talk and poster	1	International Scientific & Academic Community
Deep-Sea Biology Symposium	1	International Scientific Community
Smithsonian Museum of Natural History	1	Scientific Community

Deep Sea Coral Research and Technology Program	2	Scientific Community
Coral Research & Development Accelerator Program (CORDAP) Meeting, Oslo	1	International Scientific Community

Conclusions and Priorities for Future Research

Alaska Coral and Sponge Initiative Overview

The second Alaska Coral and Sponge Initiative built upon the successes of the first initiative by continuing to develop and expand prior research projects, expanding to new research directions, developing international and national collaborations, discovering new species, and adding data to the national deep-sea coral and sponge database. These projects occurred throughout the U.S. EEZ in Alaska and provided valuable new data on the distribution and biology of coral and sponges within the large marine ecosystems of Alaska.

The Gulf of Alaska model validation survey was completed in 2022 and provided the data needed to validate models of coral and sponge predicted occurrence based on trawl survey data produced in the first initiative (2012-2015). This completes the validation of models developed for three large marine ecosystems in Alaska, an important objective for both the first and second Alaska Coral and Sponge Initiatives. Results from the Gulf of Alaska model validation study were similar to results from model validation studies completed for other regions during the first initiative. In general, models based on trawl survey data tend to be better at estimating absence or presence of coral and sponges and perform less well when used to estimate abundance. The catchability of corals and sponges generally tends to be biased low in AFSC bottom trawl survey data. The results from these studies emphasize the usefulness and limitations of these models for understanding the distribution of coral and sponge species in Alaska and elsewhere. In addition, the results from these studies highlight the need to continue to collect additional types of data including visual, eDNA, and improved oceanographic data and use an iterative approach to improve models to assist in the management of these vulnerable marine communities.

The *Primnoa* recruitment and reproduction study was also a continuation from the first initiative focused on red tree coral and other coral species. The field work for this collaborative project occurred each summer from 2022 to 2024 and continues to grow our understanding of coral biology and recruitment. Research on recruitment continued throughout this period through the deployment and retrieval of Artificial Reef Monitoring Structures (ARMS) plates with attached temperature loggers. One Stone plate deployed during the first initiative in 2013 was retrieved and this plate had a temperature probe attached with several years of temperature data. While no recruits were actively seen on the recovered plates, samples from the plates were collected and will be analyzed in the future. In addition, nine plates remain deployed in three areas near and in red tree coral thickets for future collection. In addition, the successful collection and transfer of live coral allowed for the observation of live sperm within spermatocysts and the observation of a previously unobserved method of asexual reproduction. The development of these foundational

methods opens up many exciting possibilities for research aimed at understanding the reproductive biology of this and other coral species. In addition, the ability to transport and establish red tree coral in seawater facilities opens up possibilities for gaining understanding on many additional aspects of their biology.

In 2022, the first fieldwork of the Joint Canada-USA International Seamount Survey took place with a follow-up cruise occurring in 2024 in international waters at the Cobb Seamount Chain. The main focus of this survey was to generate the spatially explicit data needed to map and model the distribution of deep-sea corals and sponges on the seamounts. These data are being used to develop species distribution models for vulnerable marine ecosystem (VME) indicator taxa within this seamount chain. Preliminary models generally fit the data well and indicate high probabilities of finding VME indicator taxa on the seamounts, particularly at deeper depths. The collection of additional visual observations paired with oceanographic data will continue to iteratively improve these modeling efforts. These results will be provided to the North Pacific Fisheries Commission, the RFMO for international waters of the North Pacific Ocean to assist with the management and conservation of this seamount chain. We hope to continue this valuable international collaboration in future years.

The last large expedition of the initiative occurred in 2023 and was aimed at exploring the effectiveness of fishing closure areas in the Aleutian Islands. This region has high abundance and density of coral and sponge species found within both deep and shallow waters. Habitat protections in the Aleutian Islands established in 2006 protected expansive areas from the impacts of bottom contact fishing gear. These protections were placed in areas that were not previously fished with little impact to areas where fishing was already occurring in the region. While some coral and sponge garden areas are protected from commercial fishing, many occur in areas that continue to be fished. Additional habitat closures within this region provide the opportunity to examine the effectiveness of area closures and the recovery of coral and sponges previously impacted by fishing activities.

A variety of smaller projects occurred during these larger expeditions or in association with other large field efforts (e.g., AFSC bottom trawl or longline surveys). These projects had the goals of continuing to broaden our understanding of how deep-sea coral and sponge habitats support commercial fish species, how these habitats are affected by fishing activities, to grow our understanding of sponge taxonomy, and to use genomics to aid our understanding of sponge and coral distribution in Alaska. These projects were executed by a variety of researchers from the AFSC and other partners. While these projects are mentioned only briefly here, these projects provided valuable data in growing our understanding of coral and sponge habitats within Alaska waters. The identification of multiple new sponge species and range extensions for sponge species highlights the value and importance of these smaller projects. The development of collection protocols for sampling environmental DNA (eDNA) and the collection of these samples was an important new research direction for this initiative. eDNA sampling was incorporated into three of the four large expeditions and these samples will be used to inform and supplement visual data collected during these cruises.

The communication of our research, the contribution of data to national databases, and the development and interaction with partners were high priorities of this initiative. We worked with

the AFSC Communications team as well as the DSCRTP to develop web stories, seminars, and live events. A coral identification guide was produced for Alaska waters and efforts continue to develop additional guides as the taxonomy of corals and sponges are updated is a continuing need. The contribution of data records to the DSCRTP Deep-Sea Coral Data Portal will continue as visual data records are annotated and become available. The data collected during this initiative will be made available to other researchers and resource managers. The participation in and development of new national and international collaborations with groups like Seascape Alaska and Fisheries and Oceans Canada (DFO) will ensure that we continue to define and execute valuable science in the future.

Suggestions for Future Implementation/Administration

Alaska continues to be a challenging and costly region to conduct research on deep-sea coral and sponge ecosystems. The U.S. EEZ in Alaska is substantially larger than any other coastal U.S. region and the amount of resources and available partners for research tends to be much smaller. The increasing cost and decreasing availability of charter vessels will continue to be a limiting factor in future initiatives. The decline in the number of sea days between the first (109 sea days) and second initiative (82 sea days) is a reflection of this increased cost and a proportion of those sea days were supported by other funding resources. The difficulty and expense of securing charter vessels was further impacted by our inability to charter commercial fishing vessels to deploy camera equipment. This initiative has not received direct NOAA vessel support and the ability to take advantage of these resources would be invaluable to future initiatives. In addition to direct NOAA ship time, additional support from NOAA Exploration through dedicated time and expeditions on the NOAA Ship *Okeanos Explorer* would provide valuable assistance in the exploration of this region. NOAA Exploration's 2023 Seascape Alaska Expeditions expanded the mapped areas of Alaska and provided data on the understudied ecosystems of the deep-seas of Alaska. These expeditions provided a substantial increase in the mapping, exploration, and public education about Alaska coral and sponge within this region. Resources that are capable of exploring deep depths within this region are both expensive and logistically difficult to use in Alaska and continued support in this capacity would increase the data collection possibilities during the next initiative.

The next initiative would also benefit from a coordinated national effort to improve our ability to form and support international partnerships. International collaboration with Canadian partners was hampered by difficulties in transferring money between nations to pay for data analyses or other expenses. Additionally, transferring equipment across international borders proved to be extremely difficult. Future research collaboration with international partners would be enhanced by national support to handle basic logistics. Assistance with setting up international agreements and standardized processes for handling the movement of equipment across the border would enable researchers to collaborate more freely in the future.

Future Research Priorities

During this initiative, we expanded our knowledge of coral and sponge distribution in Alaska waters as well as continuing research to better understand the biology and recruitment of these species through a variety of research endeavors. Scientists from the AFSC will continue to study

the biology and distribution of coral and sponge habitat and have developed the following research priority list:

Declining Trends in the Abundance of Structure-Forming Invertebrates in the Gulf of Alaska and Aleutian Islands. -- There is evidence from bottom trawl surveys of a decline in abundance of coral and sponge throughout the Gulf of Alaska and the Aleutian Islands regions. Although, the unknown catchability and the grouping of many species into large taxonomic groups limits the amount of interpretation that is possible from these results, these surveys are standardized and the trends in these large taxa groups are an indication of a decline in the habitat available to rockfishes and other species. The decline in biomass indices for sponges and corals is concerning given the strong association between these habitat types and several species of rockfishes. Another factor that may be impacting these trends is that, since bottom trawl survey stations tend to be re-towed within the same known trawlable location and may have similar towpaths as previous years, the percentage of new ground surveyed compared to the total ground surveyed has generally continued to decline since the 1990s. This might mean the decline in abundance of these species within survey catches is not representative of non-surveyed areas. Visual surveys in the Gulf of Alaska in 2022 found areas with dead sponges that may have been silted over. While it is difficult to interpret all of these data, they do indicate the value of examining additional data sources to determine the magnitude of this decline in structure-forming invertebrates. We continue to rescue and digitize old data sources and additional historical Delta submersible dives predominately focused in the southeastern Gulf of Alaska between 1988 and 2009 were recently digitized and will provide data on the differences within these surveyed areas and areas visualized in 2022 as part of the Gulf of Alaska model validation study.

Impact of Oceanographic Changes. -- The impact of changing oceanographic conditions as well as warm water anomalies on these habitats remains difficult to predict. Due to their habitat requirements, many cold-water coral and sponge species have been shown to be successful in areas with hard substrate and moderate to strong currents (Wagner et al. 2012, Edinger et al. 2011). In addition, some of these species have carbonate skeletons that require the absorption of carbonate ions from the water and are likely to be negatively impacted by changing water chemistry. There is some evidence of changes to the strength and variability of the Alaska Stream in recent years, which could result in changes to the strength of currents and transport of biological material, such as the food available to filter feeding organisms, through the oceanic passes of the Aleutian Islands (Stabeno and Hristova 2014). The depths of the coral gardens within the Aleutian Islands range from shallow to deep water and the impact of carbon saturation will likely be related to depth. Therefore, changes in the oceanography and climate of this region have the potential to strongly impact the abundance, diversity, and community structure of coral and sponge habitats within this region. Historical oceanographic data are available in the Aleutian Islands from the Aleutian Islands Project (Hunt and Stabeno 2005) and historical visual survey data are also available throughout the Aleutian Islands as a part of several survey efforts. We will continue to seek funding to re-sample known garden areas as well as to fund oceanographic collaborators to place new moorings within the Aleutian Pass areas.

Distribution and Abundance: Essential Fish Habitat. -- During this initiative, we completed our analyses of the performance of models in predicting coral and sponge distribution using annual bottom trawl survey data from the Alaska Fisheries Science Center for the three large marine ecosystems. These analyses revealed the strengths and weaknesses of using these data to predict

coral and sponge abundance and distribution as well as provided additional visual data to strengthen our understanding of the distribution of these species. These data will be incorporated in models for Essential Fish Habitat of commercially important species within each of these three regions. In the future, the data that we have collected during this initiative will allow us to refine and update our understanding of where coral and sponge occur and how they overlap with commercial fishing resources. Future research into this region will be defined by these analyses.

Community Structure and Assemblages. The association of many commercially important groundfish species and high relief habitat containing structure-forming invertebrates like coral and sponge is documented. Structurally complex habitat provides a refuge from strong currents, protection from predators, and may increase prey resources (Carlson and Haight 1976, Carlson and Straty 1981). In Alaska, the three most commercially important rockfishes, Pacific ocean perch (*Sebastes alutus*), northern rockfish (*Sebastes polyspinis*), and dusky rockfish (*Sebastes variabilis*) have all been documented to have strong associations with this habitat type (Carlson and Straty 1981, Rooper et al. 2007, Rooper and Martin 2011, Conrath et al. 2019). Atka mackerel nesting sites have also been documented to occur in rocky substrata in the Aleutian Islands (Lauth et al. 2007). How these habitat areas support commercial rockfish species is not fully understood and additional research examining the community structure in areas with a strong association of structure-forming invertebrates and commercially important fish species would aid in our understanding of essential fish habitat.

Data Rescue and Standardization. Many of the previous research directions rely on the rescue of data that is currently only available in mini-DV or other vulnerable formats. This information needs to be digitized, annotated, stored, shared, and regularly backed up. As we continue to digitize tapes from the Delta submersible dives and other AFSC and related surveys, we will ensure these rescued data are archived on a NOAA server and available to interested parties. In addition, nationwide efforts are underway to standardize the analyses of video and photo data. We will continue efforts to rescue data sources found throughout Alaska waters and actively participate in efforts to standardize data analyses of visual data.

Biology and Taxonomy of Corals and Sponges. Research continues on the reproductive biology and recruitment of red tree coral, *Primnoa pacifica,* and other species in the eastern Gulf of Alaska. In addition, the identification of new coral and sponge species will continue along with contributions that aid in the taxonomic identification and status of these groups. We will continue to examine the associated species of coral and sponge and support efforts to understand their biology.

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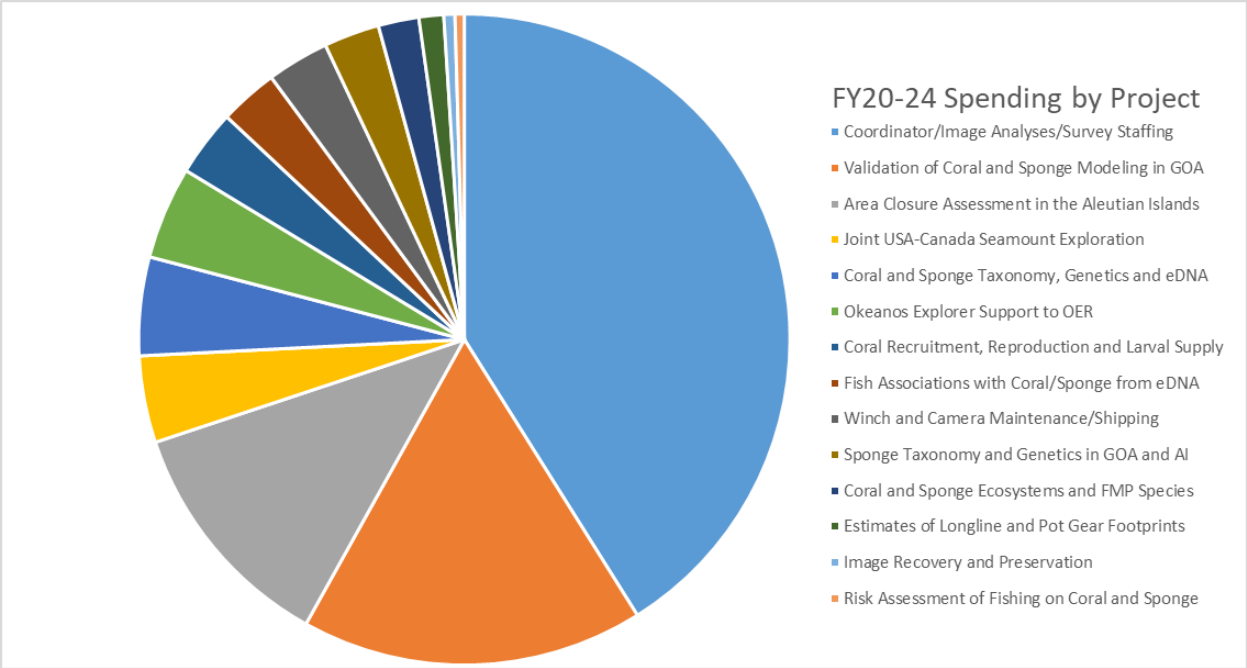
Appendices

Budget Expenditures

In total the Alaska Coral and Sponge Initiative received $3,263,524 from FY20 to FY24. The following amounts were allocated by fiscal year: FY20 $200,000, FY21 $996,240, FY22 $1,003,500, FY23 $786,000, and FY24 $280,000. The Gulf of Alaska model validation project required about 17% of the total funds over the life of the project (Appendix Fig. A1), the Aleutian Islands closure assessment work required 12% of total funds, and the joint USA-Canada Seamount work required 4% of total funds. It should be noted that these fieldwork efforts provided sample collections and data for the coral and sponge taxonomy, genetics, and eDNA projects, which were successfully piggybacked onto the larger at-sea projects. The other two major fieldwork projects required 5% (Support to OE for NOAA Ship *Okeanos Explorer* expeditions) and 3% (coral recruitment and reproduction) of the total funds. Winch and camera maintenance and shipping, which was required for the three major field projects plus the coral recruitment work, required 3% of total funds. Funds that supported contracts for initiative coordination, image analysis, and survey staffing amounted to 41% of total funds received; those services supported all projects.

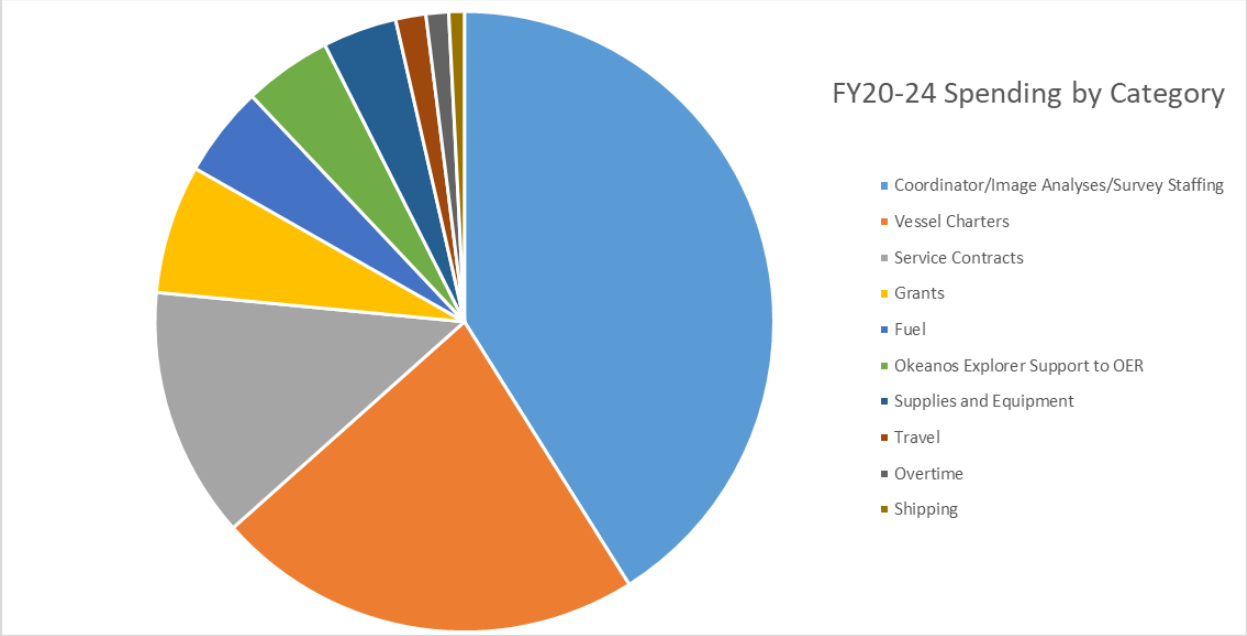


Appendix Figure A1. -- Cumulative Alaska Coral and Sponge Initiative spending by project for fiscal years 2020-2024.

Beside DSCRTP funds, some projects received external and/or collaborative support over the course of the initiative. In FY 22-24, a funded proposal to the North Pacific Research Board provided $39,800 to the AFSC to support the coral recruitment and reproduction project; those funds were applied to vessel charters, travel and supplies. The same proposal also provided $208,000 to support a graduate student at the University of Gothenburg. The Joint USA-Canada

Seamount project received a combined total of $562,030 from Fisheries and Oceans Canada in FY 22 and 23. Those funds helped pay for costs to charter a Canadian Coast Guard vessel. In kind support from the AFSC also included data collections on survey vessels and labor costs for at-sea staff.

The greatest percentage (41%) of AKCSI funding was spent on contracts that supported the initiative coordinators, image analyses, and survey staffing (Appendix Fig. A2). Vessel charters consumed the next highest percentage of funding (22%), followed by service contracts (13%) and grants (7%). Service contracts were for invertebrate and fish DNA analyses, sponge taxonomy, coral reproduction work, and image recovery and preservation. Grant funds were transmitted to Canada for model validation and oceanographic sample processing and analysis. Pass through support to OE for NOAA Ship *Okeanos Explorer* expeditions in Alaska received 5% of total funding. Supplies and equipment (4%), fuel for vessel charters (5%), travel (2%), overtime (1%), and shipping (1%) made up the balance of funding.



Appendix Figure A2. -- Cumulative Alaska Coral and Sponge Initiative spending by spending category for fiscal years 2020-2024.

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SCIENTIFIC PRESENTATIONS

2021

- North Pacific Fishery Management Council Presentation
  Jerry Hoff. "Deep Sea Coral Research and Technology Program (DSCRTP), Alaska Initiative (AKCSI) 2020-2023, 4-year plan" (26 January 2021)

2022

- Coursework for "Arctic in a changing climate"
  Lara Beckmann, Rhian G. Waller, Ricardo T. Pereyra-Ortega. Speed-talk and poster. "Life in a Changing Ocean: Cold-water Coral and Sponge Reproduction in Light of Environmental Change" (22 October 2022)

- North Pacific Fisheries Commission
  Chris Rooper, Christina Conrath: "Joint Canada-USA International Seamount Survey 2022" (December 2022)

- Seminar at Tjärnö Marine Laboratory, University of Gothenburg, Sweden
  Lara M. Beckmann, Rhian G. Waller, Ricardo T. Pereyra-Ortega. "Deepwater Coral & Sponge Gardens in Alaska: Reproduction and Recruitment in Keystone Species" (6 December 2022)

2023

- North Pacific Fisheries Commission
  Chris Rooper Goddard, Cynthia Wright, Christina Conrath, Kim Rand, Vanessa Lowe. "Joint Canada-USA International Seamount Survey Update for 2023" (December 2023)

- 8th International Symposium of Deep-Sea Corals: posters
  Christina Conrath: "The Influence of Deep-Sea Coral and Sponge Habitats on the Life History Parameters of Rockfish Species in Alaska" (May 2023)

  Tom Hourigan, Pamela Goddard, Rachel Wilborn, Chris Rooper, Christina Conrath, Robert McGuinn, Heather Coleman. "Coral and Sponge Communities of the Aleutian Archipelago: Diverse, Dense and Vulnerable" (May 2023)

  Jerry Hoff: "A Synopsis of the Alaska Coral and Sponge Initiative 2020-2023" (May 2023)

  Lara M. Beckmann, Rhian G. Waller, Johanne Vad, Sean Rooney. "Deepwater Coral and Sponge Gardens in Alaska, Ecology and Reproduction in Keystone Species" (May 2024)

2024

- Kodiak Area Marine Science Symposium
  Christina Conrath. “Seascape Alaska: Working Together to Understand the Depths of Alaska’s Vast Seascape” (2024)

- Alaska Fisheries Science Center Seminar Series
  Christina Conrath. “The Alaska Coral and Sponge Initiative: Past, Present, and Future” (9 April 2024)

  Auke Bay Lab Seminar Series
  Lara M. Beckman, Rhian G. Waller, Gerald R. Hoff, Fletcher Sewall. “Red Tree Coral Reproduction & Recruitment in Alaska” (19 August 2024)

2025

- Smithsonian Museum of Natural History, No Bones Seminar Series
  Lara M. Beckmann, Rhian G. Waller, Sean Rooney, Freya Goetz, Allen Collins, Andrea Quattrini. Presentation, preliminary title: “From Old Specimens to Reproductive Secrets: Insights into the Biology of Alaskan Deep-Sea Sponges and Corals through Museum Samples” (January 2025)

- Deep-Sea Biology Symposium, Hong Kong
  Lara M. Beckmann, Rhian G. Waller, Johanne Vad, Sean Rooney. “Alaska's Hidden Deep-Sea Sponge & Coral Communities - Exploring the Unknown with NOAA Okeanos Expeditions” (17 January 2025)

Links to Communications and Outreach Activities and Products

HOLLINGS SCHOLARS

Student Interns Take a Virtual Dive into the World of Deep-Sea Corals and Sponges
Cancer-Fighting Green Sponge Brings More Than Just Good Luck!

CORAL FIELD GUIDE

Field guide to corals of British Columbia, Canada, Alaska, USA, and the eastern North Pacific Ocean (Anthozoa: Octocoralia and Hexacorallia) (Hydrozoa: Anthoathecata) : a complete compilation of coral identification for the eastern North Pacific Ocean

NOAA LIVE! ALASKA

March 16, 2021 - Cold Dark Secrets: Discovering Alaska's Deep-Sea Corals and Sponges

May 17, 2022 - Soaking Up the Sea: Exploring Deep-Sea Coral and Sponge Habitat in Alaska

BLOGS, WEB STORIES, AND STORY MAPS

2022 Seamounts Blogs

Joint Canada-U.S. Deep-Sea Coral Seamount Survey Post #1

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Joint Canada-US Deep-Sea Coral Seamount Survey Post #3

Joint Canada-US Deep-Sea Coral Seamount Survey Post #4

Joint Canada-US Deep-Sea Coral Seamount Survey Post #5

2022 Gulf of Alaska Model Validation Blogs

Innovation to Learn More About Alaska's Deep-Sea Corals and the Species that Live There Post #1

Innovation to Learn More About Alaska's Deep-Sea Corals and the Species that Live There Post #2

Innovation to Learn More About Alaska's Deep-Sea Corals and the Species that Live There Post #3

Innovation to Learn More About Alaska's Deep-Sea Corals and the Species that Live There Post #4

Innovation to Learn More About Alaska's Deep-Sea Corals and the Species that Live There Post #5

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Innovation to Learn More About Alaska's Deep-Sea Corals and the Species that Live There Post #7

Innovation to Learn More About Alaska's Deep-Sea Corals and the Species that Live There Post #8

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Multi-Year Effort to Observe Seafloor Habitats and Learn More About Deep-Sea Corals and Sponges in Alaska (August 2021)

Discovering Deep-Sea Sponges in Alaska (September 2021)

Student Interns Take a Virtual Dive into the World of Deep-Sea Corals and Sponges (October 2021)

NOAA Launches New Season of Discovery in Alaska's Deep-Sea Coral and Sponge Ecosystems (June 2022)

Deep-Sea Coral Research to Gain New Understanding of Alaska Fish Habitat (December 2022)

Summer Expeditions will Explore Widespread Deep-Sea Coral and Sponge Communities in Alaska (July 2023)

Alaska Deep-Sea Coral and Sponge Research to Shed Light on Resilience of Living Fish Habitat (October 2023)

Story Maps

Characterizing U.S. Deep-Sea Corals and Sponges

Additional Electronic Resources

Site Characterization Reports from Alaska

- Aleutian Islands - https://repository.library.noaa.gov/view/noaa/14169
- Bering Sea - https://repository.library.noaa.gov/view/noaa/8689
- FMP species productivity sites - https://apps-afsc.fisheries.noaa.gov/Publications/ProcRpt/PR2017-06.pdf
- Central and Western Aleutian Island - https://repository.library.noaa.gov/view/noaa/19417

NCEI Deep-Sea Coral Data Portal

- https://deepseacoraldata.noaa.gov/data

2021 - Science Plan

- https://repository.library.noaa.gov/view/noaa/28910

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