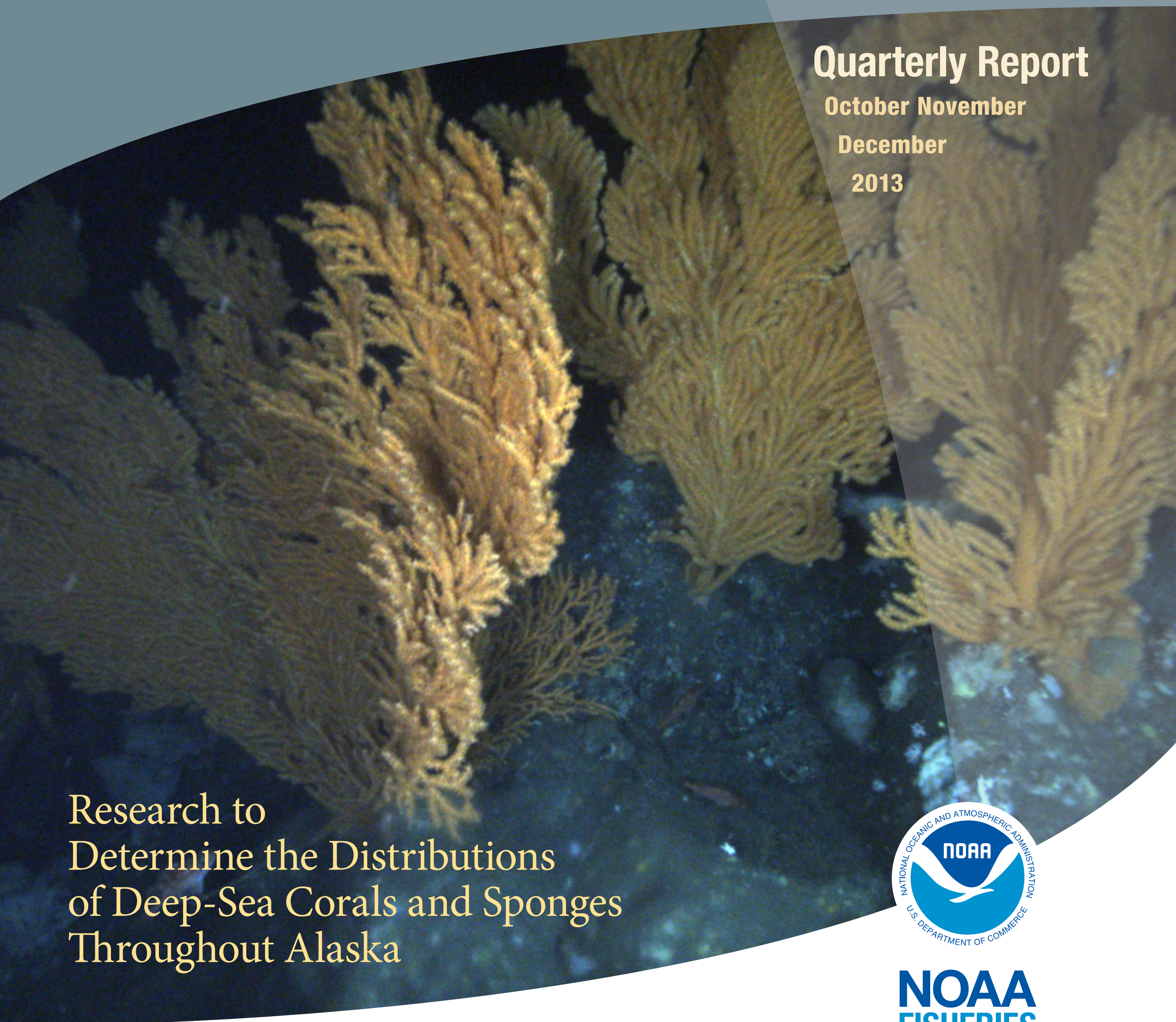
Alaska FISHERIES SCIENCE CENTER



Quarterly Report

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Research to Determine the Distributions of Deep-Sea Corals and Sponges Throughout Alaska

NOAA FISHERIES

Research to Determine the Distributions of Deep-Sea Corals and Sponges Throughout Alaska

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The U.S. Exclusive Economic Zone off Alaska covers 3.3 million km^2 and contains more than 70% of the U.S. continental shelf. These marine waters support a diverse and abundant collection of fish and invertebrate species, many of which are harvested by the commercial fishing industry. The harvest of these resources consistently puts Alaska at the nation's top in terms of volume and value of commercial landings, with 5.3 billion pounds and $1.7 billion in 2012. Alaska's continental shelf also contains significant deposits of oil and precious minerals which support resource extraction activities contributing to the national and state economies. Accordingly Alaska's marine resources and their associated activities require scientific research to support well-informed management practices in response to the impact of human activities and the effects of global warming.

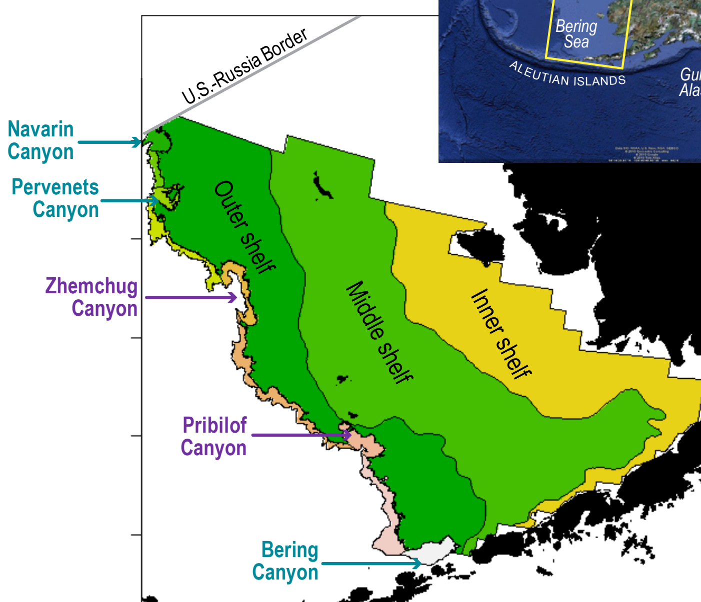

Figure 1. Eastern Bering Sea shelf and slope showing the location of canyons along the outer shelf.

Deep-sea coral and sponge ecosystems are widespread throughout most of Alaska's marine waters. Some areas, such as the western Aleutian Islands, may contain the most abundant and diverse cold-water coral and sponge species assemblages in the world. Many different fish and invertebrate species in Alaska are associated with deep-sea coral and sponge communities. For example, the consistent association of juvenile Pacific ocean perch (*Sebastes alutus*) with sponges and corals may imply better growth or survival for this species in these habitats.

Challenges facing management of deep coral and sponge ecosystems in Alaska begin with the lack of specific knowledge of where these organisms occur in high abundance and diversity. Because of the size and scope of Alaska's continental shelf and slope, the vast majority of the area has not been surveyed for the presence of coral and sponge communities. It is difficult to predict the locations and types of human activities that may be threats to the deep-sea coral and sponge ecosystems, because the spatial distribution of these communities in Alaska waters is largely unknown.

The North Pacific Fisheries Management Council (NPFMC) recently requested that the Alaska Fisheries Science Center (AFSC) conduct an analysis of the distribution of sponge and coral ecosystems in eastern Bering Sea slope habitats. In part, this request was due to ongoing interest in the two largest underwater canyons on the eastern Bering Sea slope, Pribilof and Zhemchug Canyons (Fig. 1). The slope area including the canyons supports important commercial fisheries for sablefish, Greenland turbot, golden king crab, and

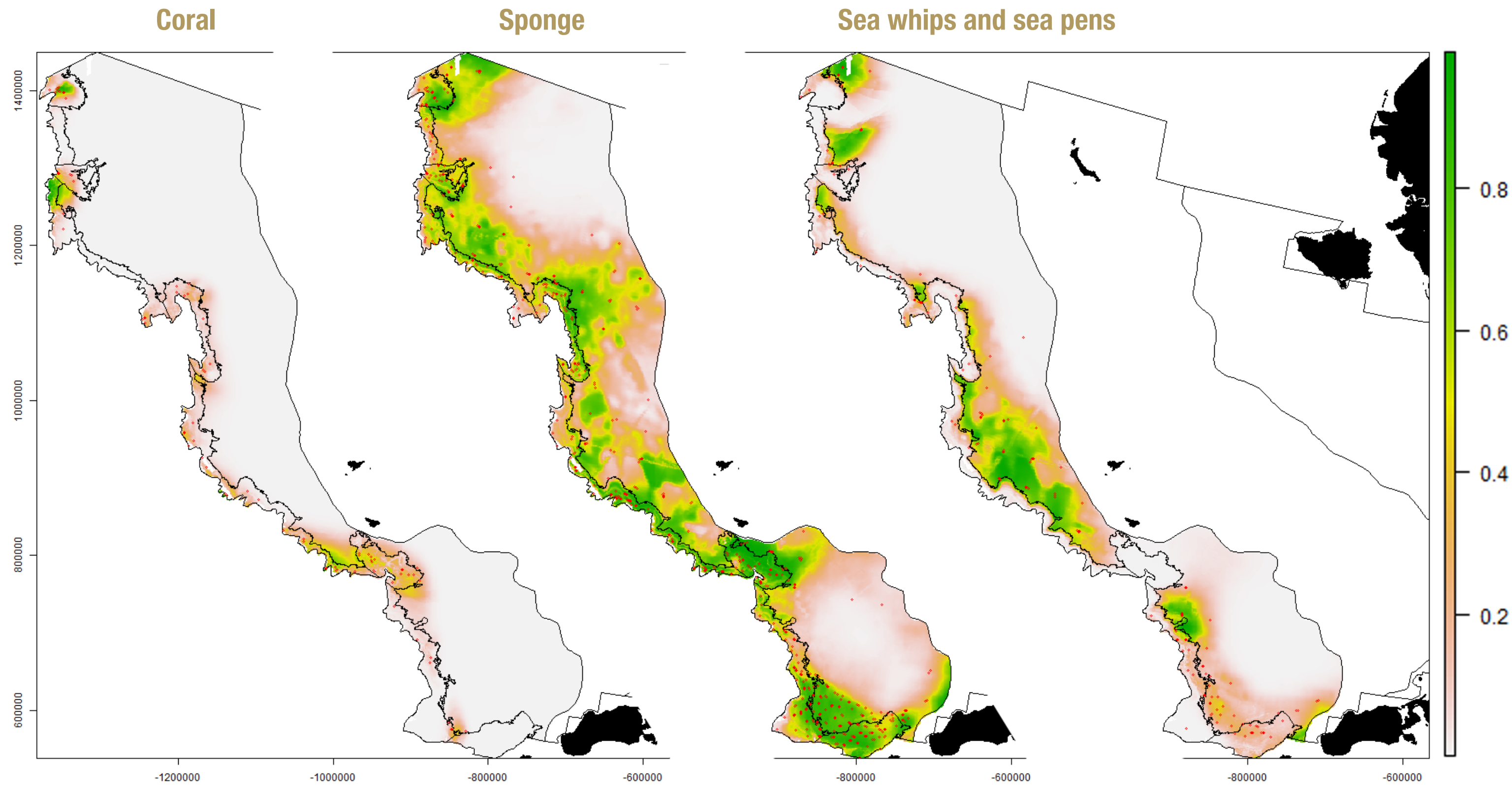

Figure 2. Predicted probability of presence of coral, sponges and sea whips and sea pens on the eastern Bering Sea outer shelf and slope from a generalized additive model (Sigler et al. 2013).

walleye pollock (among other species). Some coral and sponge habitat has been reported previously in these two canyons. The question posed by the NPFMC is: Do these canyons constitute unique habitats that should be considered for additional protection from fisheries and other human impacts?

Historical AFSC bottom trawl surveys have collected data on the presence and abundance of corals and sponges in all areas of Alaska. In response to the NPFMC request, data from 1996-2012 AFSC biennial bottom trawl surveys of the eastern Bering Sea slope and outer shelf were used to examine the distribution and abundance of coral and sponge ecosystems. Generalized additive models, a statistical tool, were used to predict the probability for the presence of sponges, corals, and sea whips based on location (latitude and longitude), depth, slope, sediment grain size, ocean current, bottom temperature, and ocean color (Fig. 2). The best fitting models of sponges, corals and sea whips explained 31%-39% of deviance in presence-absence data. The significant explanatory variables were current (coral, sea whip, sponge); depth (sea whip, sponge); sediment grain size (sponge); seafloor gradient (coral, sea whip, sponge); ocean color (sea whip, sponge); and location (coral, sea whip, sponge). Using threshold probabilities of 0.30 and 0.28, the models accurately predicted coral and sea whip presence-absence 94% and 91% (respectively) of the time. Using a threshold probability of 0.53, sponge presence-absence was correctly predicted 76% of the time. The model predicted that coral, sponge, and sea whips and sea pens would occur both inside and outside canyons. Predicted coral distributions were limited to sections of the slope, both within and between canyons. In contrast, the model predicted that sea whips would occur shallower and be found in sections of the outer shelf. Predicted sponge distribution occurred for sections of the slope, both within and between canyons, as well as outer shelf. Within Pribilof Canyon, there was some tendency for prediction of more coral presence inside or adjacent to the lateral wings of these two canyons. Sea whips were predicted to occur adjacent to Zhemchug, but not Pribilof Canyon.

When the predicted presence of each taxon was compiled by area, about 61% of coral habitat was predicted to occur in slope areas (39% was predicted to occur on the outer shelf of the eastern Bering Sea). Of the slope areas, the highest amount of coral habitat was predicted to occur in Pribilof Canyon (33% of the predicted coral habitat occurs here). Only 1% of coral habitat was predicted for Zhemchug Canyon, and the rest occurred primarily in the Pribilof-Zhemchug inter-canyon area, the Zhemchug-Pervenets inter-canyon area, and Navarin Canyon. This implies that about one-third of the coral habitat predicted for the eastern Bering Sea occurs in Pribilof Canyon, an area that comprises only about 10% of the total slope area. In contrast, about two-thirds of sponge (64%) and most sea whip (91%) habitat was predicted to occur on the outer shelf, an area that comprises about 82% of the total area of the slope and shelf examined.

These findings based on bottom trawl survey data led to further interest in how to best test the model predictions. In summer 2014, the AFSC plans to conduct a random-stratified survey using a stereo drop camera system to perform ground-truthing transects. These transects will be located along the eastern Bering Sea outer shelf and slope at depths from approximately 150 m to greater than 800 m. The survey will not only allow us to compare the predicted presence of coral, sponge, and sea whips to the drop-camera observations, but it also will allow estimation of abundance for each taxonomic grouping. The stereo-imaging capabilities will provide size information for each of the invertebrate groups, with the hope that this size information will allow further insights into the vulnerability of invertebrate taxa to disturbance and damage by fishing gear. In addition, interviews with fishing industry participants are being conducted to determine where hard substrate areas (habitat for deep-sea corals and sponges) occur on the eastern Bering Sea shelf and slope. Other data sources from the eastern Bering Sea, such as observer data, longline survey data, multibeam bathymetry and backscatter, and remotely operated vehicles and manned submersibles also are being incorporated into the testing effort.

A similar modeling approach has been conducted in the Aleutian Islands. In 2006, large portions of the Aleutian Islands were closed to mobile fishing gear (trawls) by the NPFMC.nets) Distribution and abundance models are helping to evaluate the effectiveness of these closures. A generalized additive model similar to the one described above for the eastern Bering Sea was constructed for the Aleutian Islands at depths to 500 m (the lower limit of AFSC bottom trawl survey data). In these models, both presence and absence as well as abundance and coral diversity (number of families) were modeled. In this case 3,506 AFSC bottom trawl hauls from 1991 to 2012 were used to construct and test the model. The most important factors in determining coral presence or absence and abundance were location, maximum tidal current, and slope. For sponges, the most important factors determining presence or absence and abundance were location, maximum tidal current, and depth. Coral and sponge were predicted to occur in relatively high abundance throughout the Aleutian Islands, but particularly in the areas around Seguam Pass, Petral Bank, and the area just to the east of Kiska Island (Fig. 3).

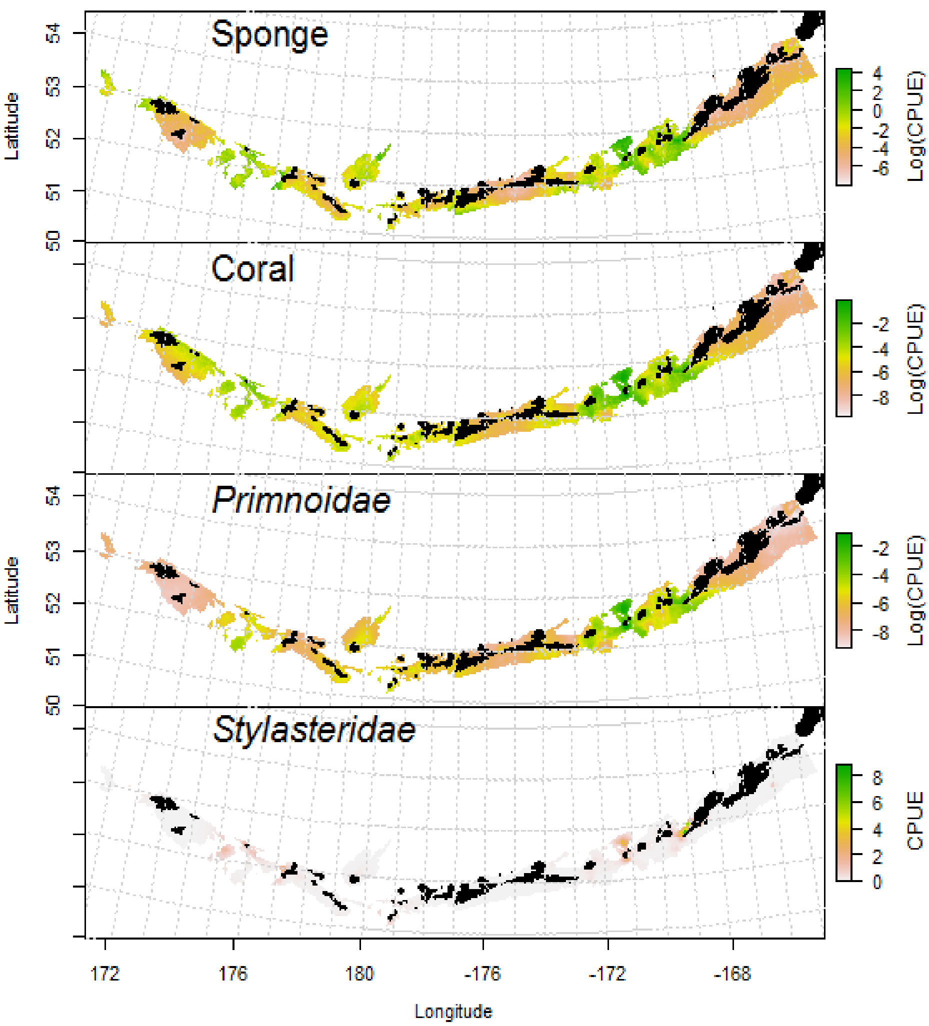

Figure 3. Predictions of the best-fitting generalized additive model for sponge, coral, Primnoidae, and Stylasteridae predicting the abundance (log-transformed catch-per-unit-of-effort (CPUE) or CPUE) in the Aleutian Islands bottom trawl surveys.

The results of these analyses demonstrate that current management regulations protect a relatively large fraction of deep-sea coral and sponge communities in the Aleutian Islands west of Samalga Pass (170° W) at depths less than 500 m. For example, in a recent petition to list 44 species of deep-sea coral in Alaska, petitioners stated that although more than 950,000 km*2* had been protected from mobile fishing gear in 2006, much of this area was "mudflats" and did not constitute coral habitat. Using the coral presence or absence model developed from AFSC trawl survey data, the total area where coral was predicted to be present (in less than 500-m water depth) is 27,732 km*2*. Of this total, 46.8% is protected by the 2006 bottom trawl closures. The amount of habitat where sponge is predicted to be present in the Aleutian Islands is 55,414 km*2*. Of this total, 47.7% falls within areas closed to bottom trawling. In areas where coral diversity is predicted to be greater than one family, 46.3% of the area is protected by the 2006 bottom trawl closure. In total, 46.5% of the Aleutian Islands region less than 500-m depth is protected in the 2006 closure. Further evaluation of these models would allow managers to consider trade-offs between protecting coral and sponge habitat and allowing commercial fishing by examining the effect of spatial closures on the amount of coral and sponge habitat that is protected.

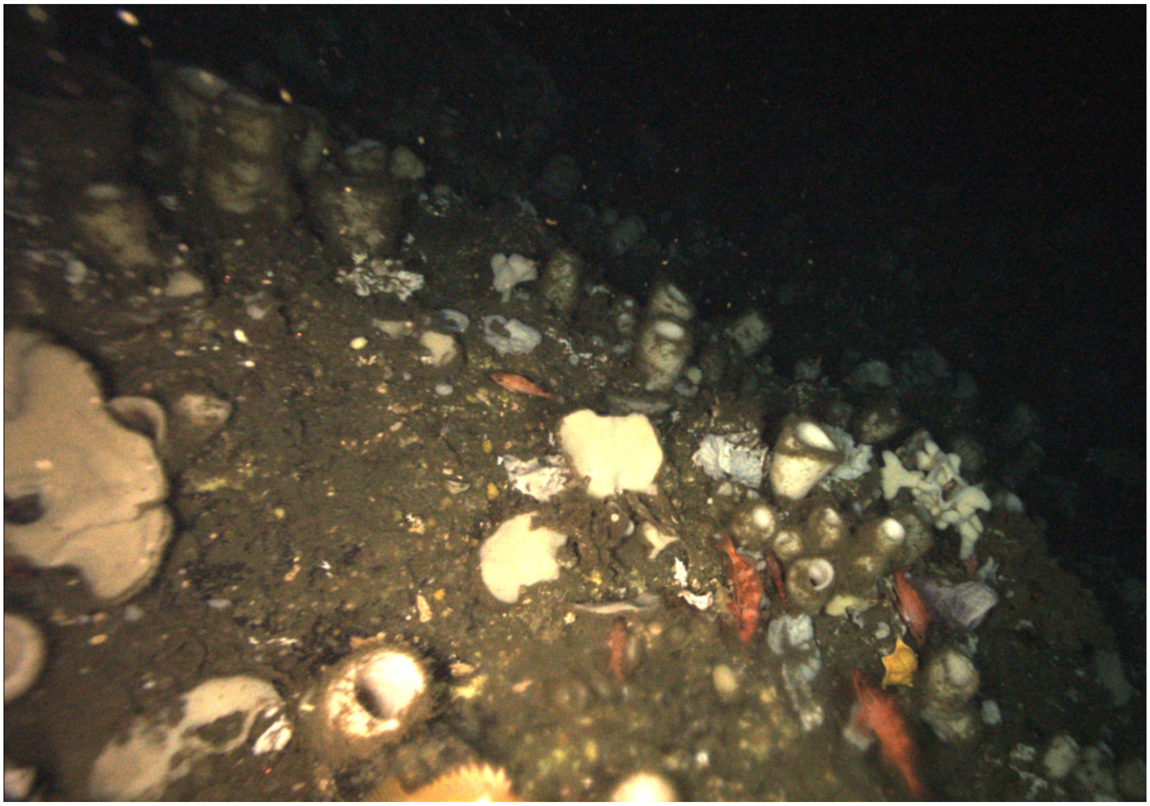

Figure 4. Vase sponges (Hexactinellids) and lobed sponges (demosponges) with rockfish species observed at an underwater bank, the Fairweather Ground, in Southeast Alaska.

Testing the Aleutian Island models also utilizes stereo drop-camera transects. In 2012, 106 stations in the eastern and central Aleutian Islands were studied, and in 2014 another 250-300 stations will be occupied in the central and western Aleutian Islands. These studies are funded by a larger 3-year study of deep-sea coral and sponge ecosystems sponsored by NOAA's Deep Sea Coral Research and Technology Program as part of a cycle of funding that will occur in all regions throughout the United States. Research to model the distribution of Alaska's deep-sea coral and sponge ecosystems has been completed for the eastern Bering Sea and Aleutian Islands. Modeling for the Gulf of Alaska is scheduled to be completed in 2014 as well as fieldwork to test model predictions. At the conclusion of that project, we expect to provide detailed descriptions of growth patterns for select deep-sea coral species in the Gulf of Alaska and descriptions of how deep-sea coral and sponge communities influence production of select fish and invertebrate species found in these habitats.

The AFSC's research efforts to study deep-sea corals and sponges throughout Alaska include a series of ten projects scheduled through 2014 which address key research goals: improving the taxonomy of corals and sponges; determining potential fishing impacts from unstudied gear types; and determining the role of corals and sponges in Alaska's fishery production (Fig. 4). Knowledge gained from this research is intended to enhance our understanding of deep-sea coral and sponge ecology in Alaska and the effects of human and climate impacts on those ecosystems, thereby improving management of these resources based on the best scientific information available.