NOAA FISHERIES

Deep Sea Coral Research and Technology Program
2020 Report to Congress

Appendices

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Appendix 1: NOAA's Deep Sea Coral Research and Technology Program's Summary of Outreach and Education Efforts

Corals and sponges form the most important living habitats in the deep sea. Despite their ecological and economic importance, most people are not aware of these valuable resources that occur off every coast of the United States. In fiscal years 2018-2019, the NOAA Deep Sea Coral Research and Technology Program ("Program") supported a variety of research and management publications (see figure) and created a variety of materials to share this knowledge:

- **Southeast Deep Sea Coral Digital Atlas:** This atlas displays seafloor maps, coral and sponge observations, habitat model outputs, submersible dive sites, managed area boundaries, and other data to inform decision-making. (Created by NOAA's National Centers for Coastal Ocean Science (NCCOS)).
- **Coral Image Identification Guides:** The Alcyonacean octocorals of the Pinnacle Trend, and Photographic catalog of deep-sea corals collected from the U.S. West Atlantic margin image guides can aid researchers and others seeking to identify deep-sea coral species in the U.S. Southeast region. (Created by NCCOS).
- **Explore NOAA's Deep-Sea Coral Database:** This Learn ArcGIS Lesson allows students to build mapping software skills while better understanding deep-sea coral habitats of the Pacific Islands. It was used by more than 2,000 students within only six months of its release. (Created by the Program and the ESRI Learn ArcGIS team).
- **Exploring Ocean Frontiers Educator Resources:** These innovative lessons and accompanying video series teaches ocean planning and stewardship, collaborative science, marine biodiversity, ocean data use, and stakeholder engagement with examples from NOAA's deep-sea coral research in the U.S. Northeast region. (Created by Green Fire Productions).
- **Deep Coral Communities Curriculum:** This curriculum allows students to collaboratively design spatial solutions to real-world planning problems using coral records and associated data. (Created by NOAA's Office of National Marine Sanctuaries).
- **Deep-Sea Corals and Sponges of Alaska:** This story map describes Program-supported research in Alaska, highlighting the Aleutian Islands as one of the most abundant and diverse deep-sea communities in the world. (Created by NOAA's Alaska Fishery Science Center and Office of Habitat Conservation).
- **Deep-Sea Coral Protection in U.S. Waters:** This story map illustrates the history and mechanisms of deep seafloor protections around the country. (Created by Program-supported Hollings Scholars).
- **The Scary Truth About Party Balloons:** This blog post features an analysis of marine debris co-occurring with deep-sea corals and sponges, noting that >60% of analyzed remotely operated vehicle (ROV) dives documented debris and about half of that debris was observed interacting with deep-sea corals or sponges. (Created by a Program-supported Hollings Scholar).

- **Analysis of Deep-sea Coral Distribution:** Masters students conducted an analysis of how seafloor features may be influencing deep-sea coral distribution, and developed a technique to assess the extent of past ROV survey footprints.
- **3D Printing of Coral Specimens:** Program-supported researchers at NOAA's Channel Islands National Marine Sanctuary, in partnership with the University of California, Santa Barbara, are using three-dimensional printing to make re-creations of deep-sea coral specimens accessible to researchers and the public.

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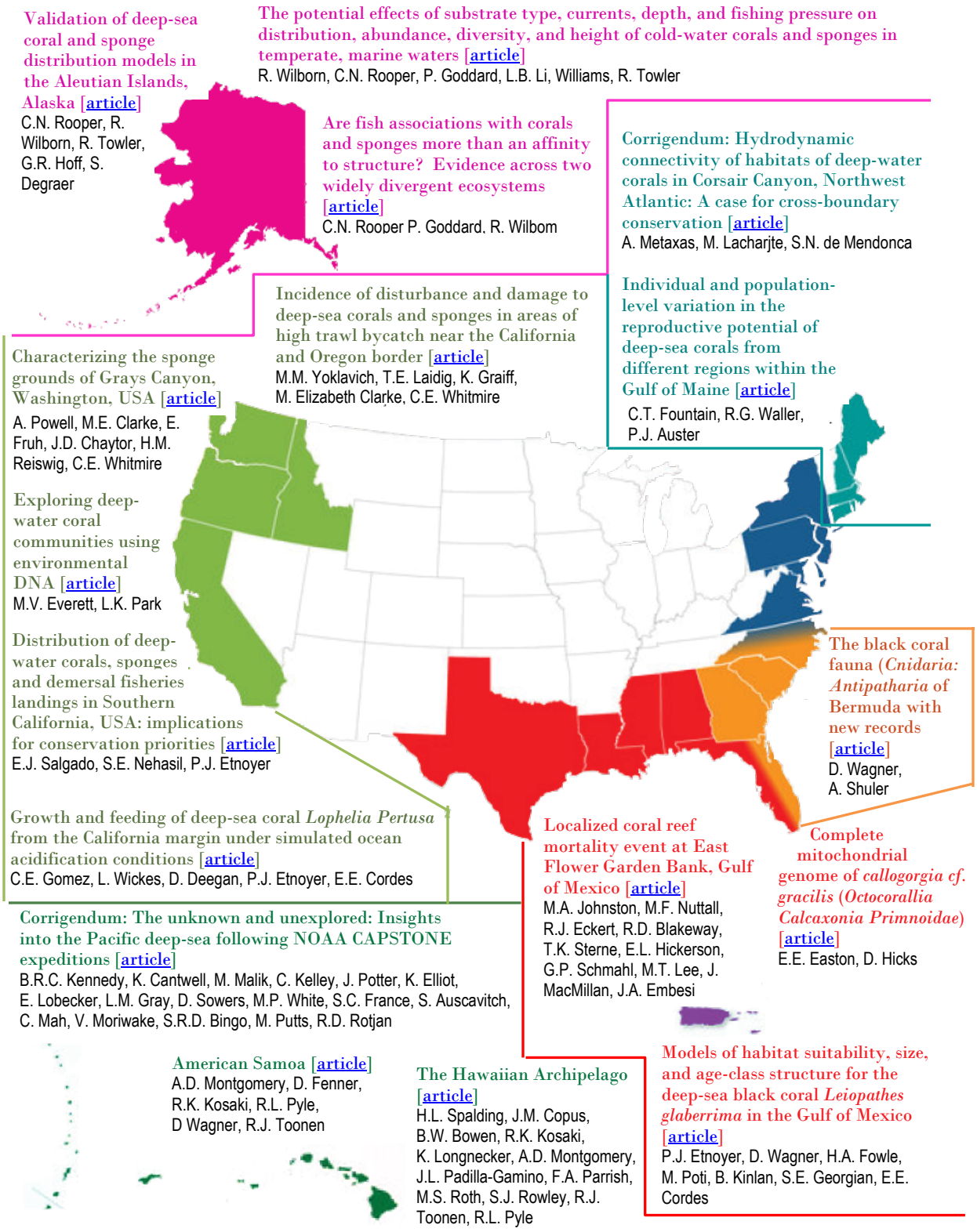
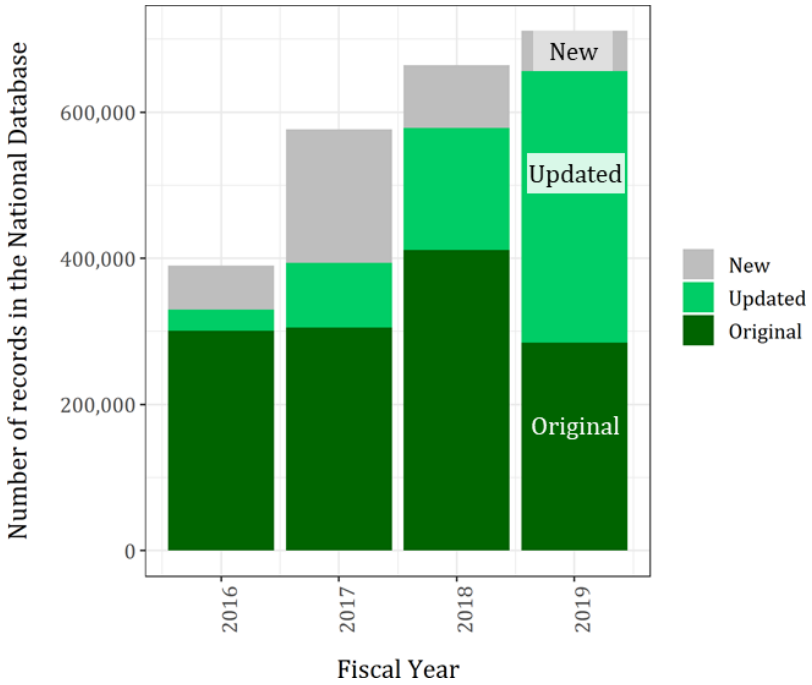


Titles and authors of studies published in 2018-2019 that were partially or fully supported by NOAA's Deep Sea Coral Research and Technology Program.

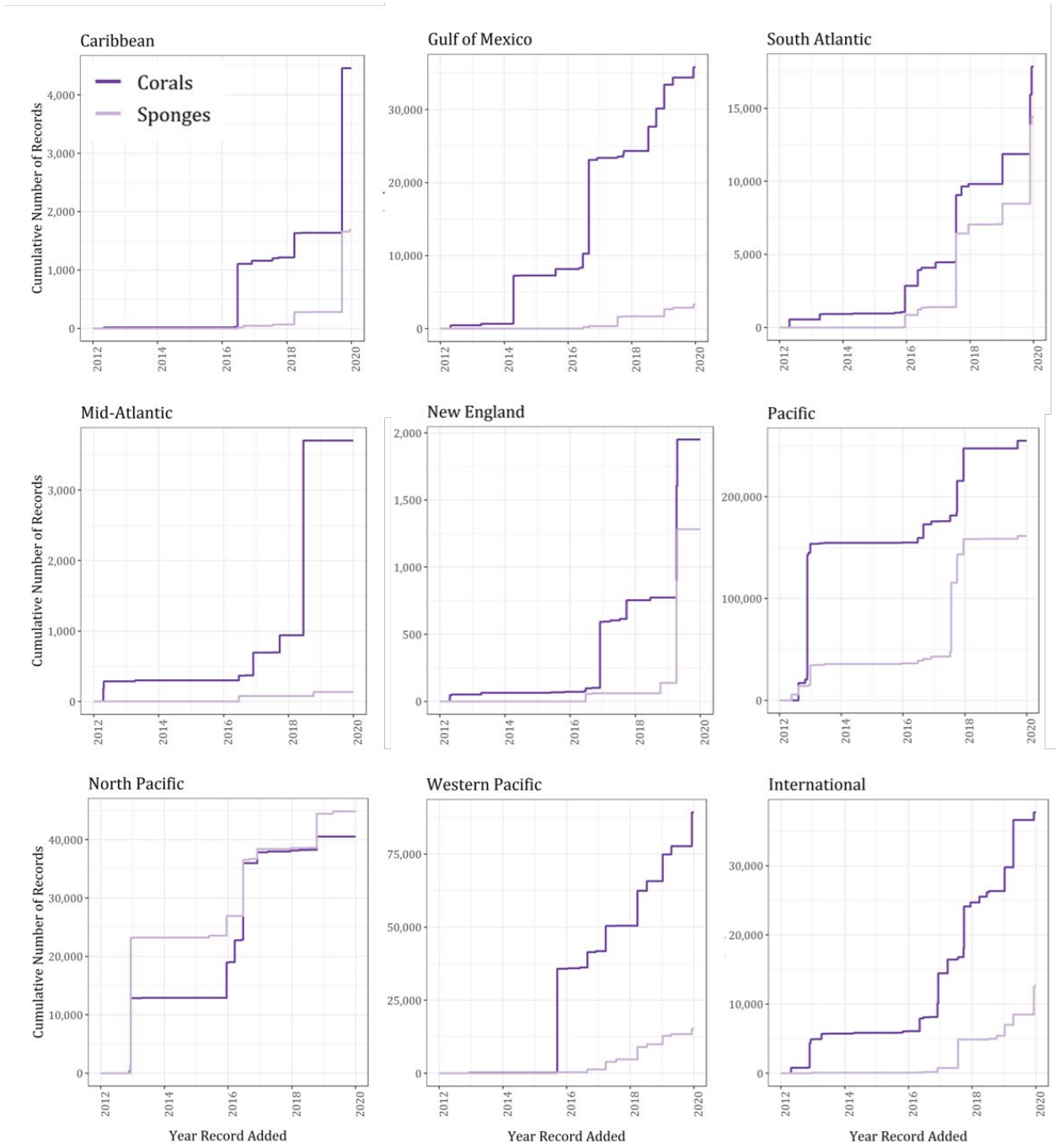
Appendix 2: Growth in the National Database for Deep-Sea Corals and Sponges

The Program and NOAA's National Centers for Environmental Information serve resource managers by maintaining and consistently adding to the National Database for Deep-Sea Corals and Sponges. The Database displays known deep-sea coral and sponge locations submitted by researchers located across the country and internationally. In 2018-2019, 31 research teams contributed information, increasing the number of coral and sponge records in the database by 10 percent overall and up to 370 percent regionally. Almost every region of the United States has used Program data to inform management of deep-sea coral resources (please see the main report text for 2018-2019 examples).

The database's interactive map displays known deep-sea coral and sponge locations along with taxonomic identification, depth, oceanographic conditions, and accompanying photographs where available. The map also displays outputs of habitat suitability models for many regions to show where corals and sponges are predicted to occur in unsurveyed areas. NOAA and partner research expeditions maximize the chance of discovering habitats and enhancing knowledge of poorly understood ecosystems with this information.



Cumulative number of coral and sponge records contained in the National Database for Deep-Sea Corals and Sponges since its creation in 2015. Number of original data records at the end of each fiscal year (dark green bars, labeled "original"), number of new records added each year (gray bars, labeled "new") and number of records corrected or otherwise updated to improve accuracy (light green bars, labeled "updated"). Some submitted records are withheld by the Program because they do not meet our quality standards. When additional information is available those records can be published.

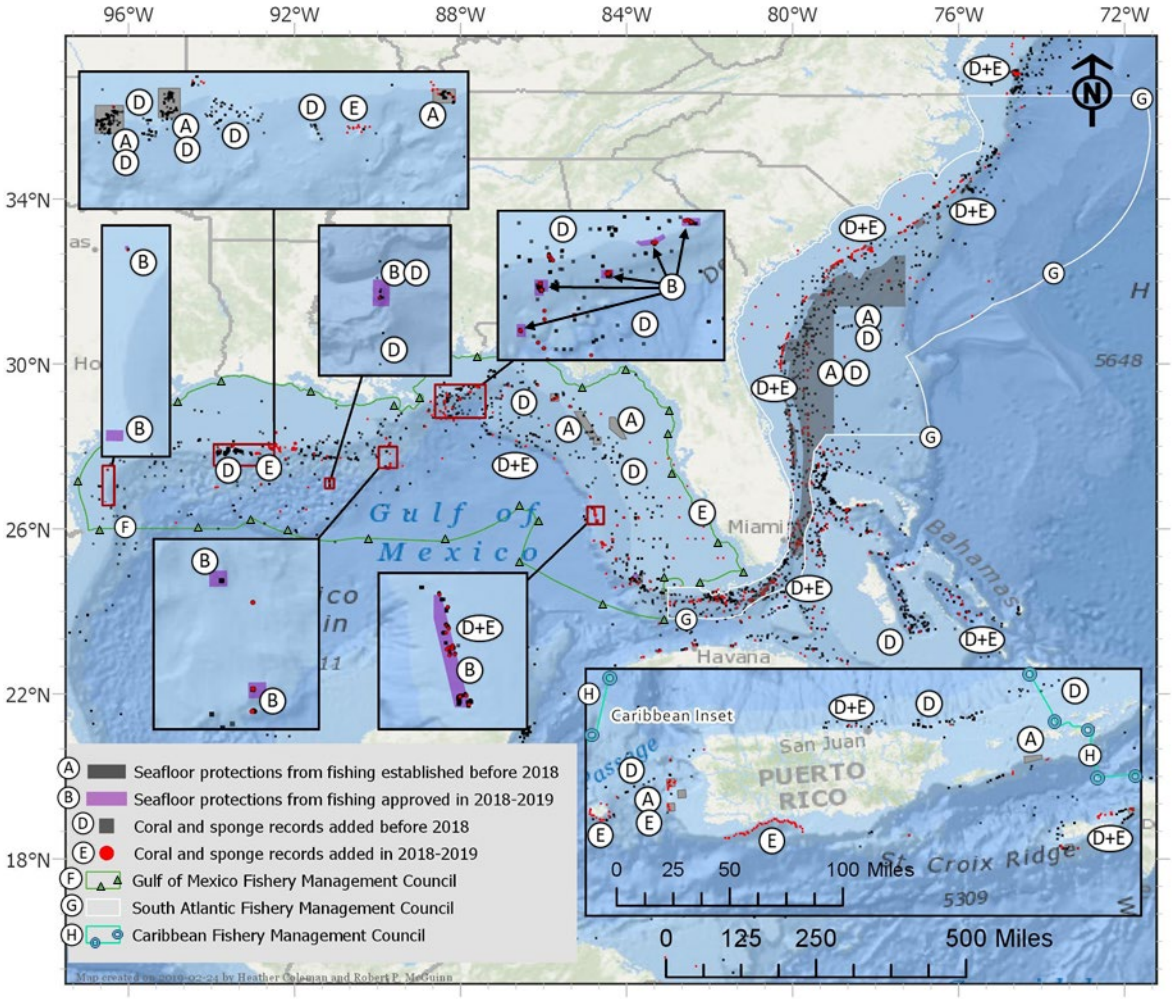


Cumulative number of coral and sponge records maintained by the Program over time in each fishery management council region and internationally. Coral records are shown in dark purple lines and sponge records are in light purple.

Appendix 3: Maps of Deep-Sea Coral and Sponge Locations by Region

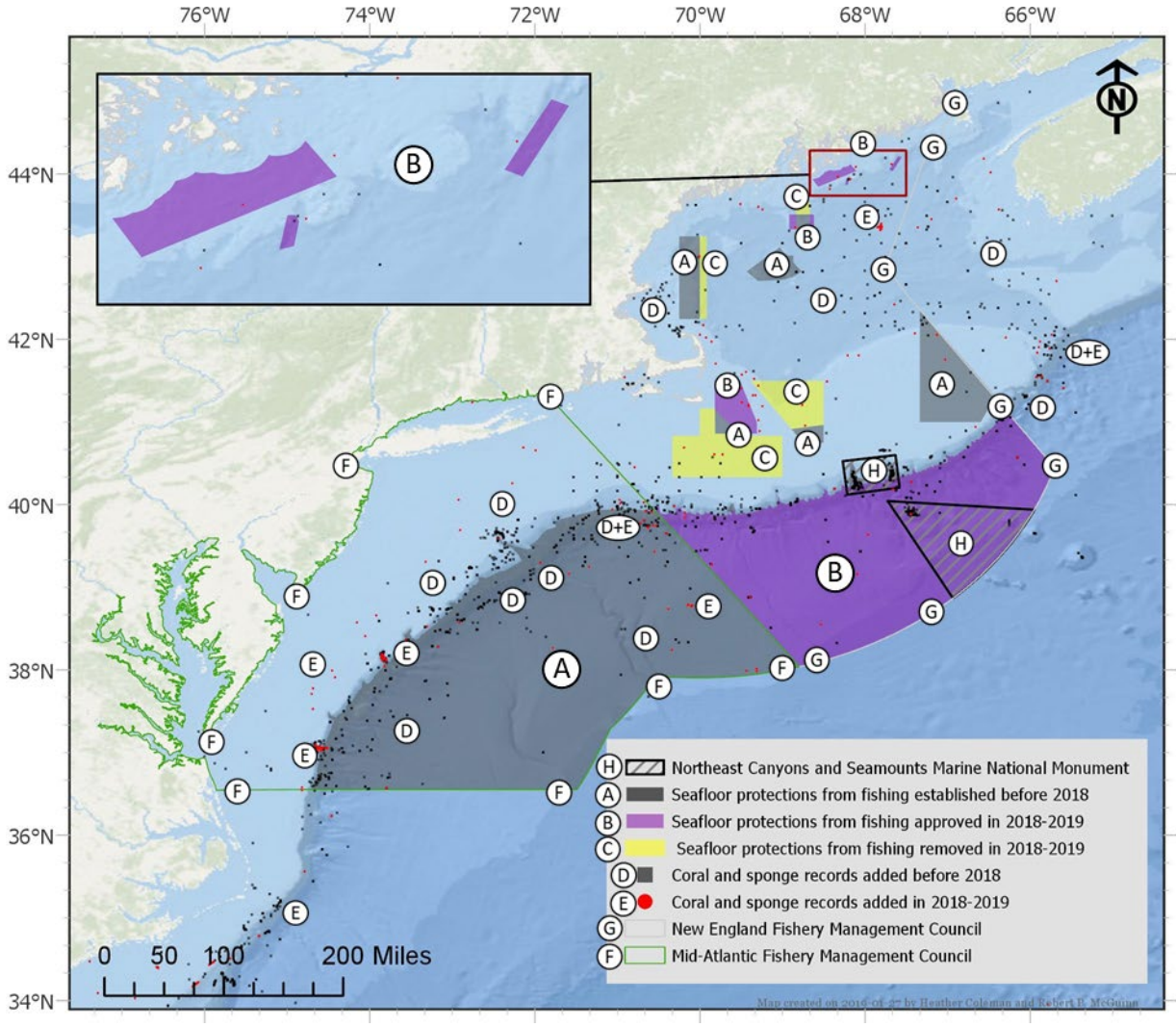
The following maps highlight deep-sea coral and sponge locations added to the National Database in 2018-2019, overlaid with earlier known locations and regional seafloor protections from fishing.

Gulf of Mexico, U.S. South Atlantic, and Caribbean
Regional Seafloor Protections from Fishing



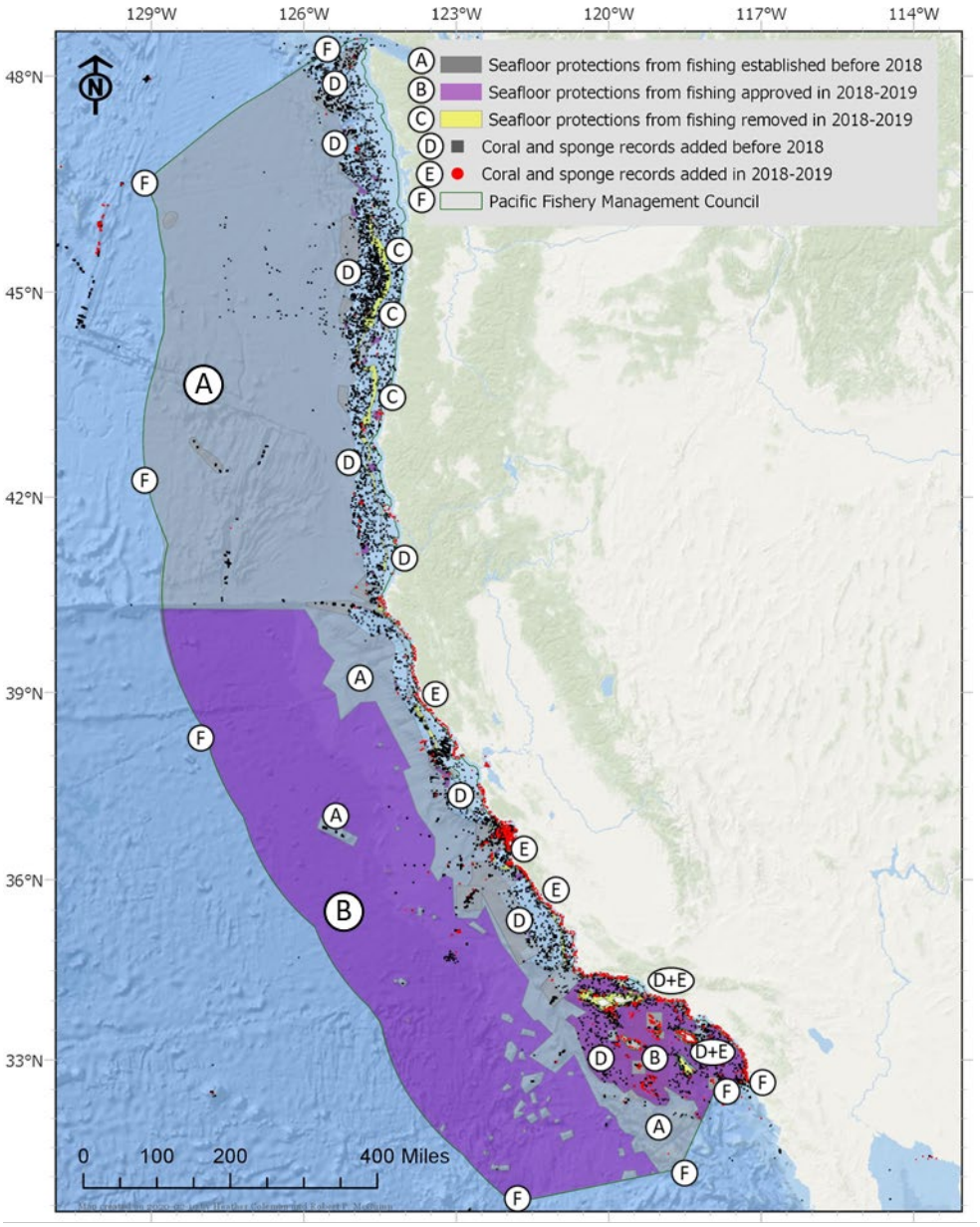
Gulf of Mexico, U.S. South Atlantic, and Caribbean regional protections from seafloor-contact trawling (gray shading (A), note some areas are also protected by more restrictive fishing gear regulations), and areas recommended for protection by the Gulf of Mexico Fishery Management Council in 2018 (purple shading (B)). Known deep-sea coral and sponge locations already in the National Database (black squares (D)) and records added to the database in 2018-2019 (red circles (E)). (Update note: In 2020, NOAA Fisheries implemented the Council's Amendment 9 to the Coral Fishery Management Plan that established 13 new Habitat Areas of Particular Concern in which the deployment of certain bottom-tending gear, including seafloor-contact trawling, is prohibited.)

Mid-Atlantic and New England Regional Seafloor Protections from Fishing



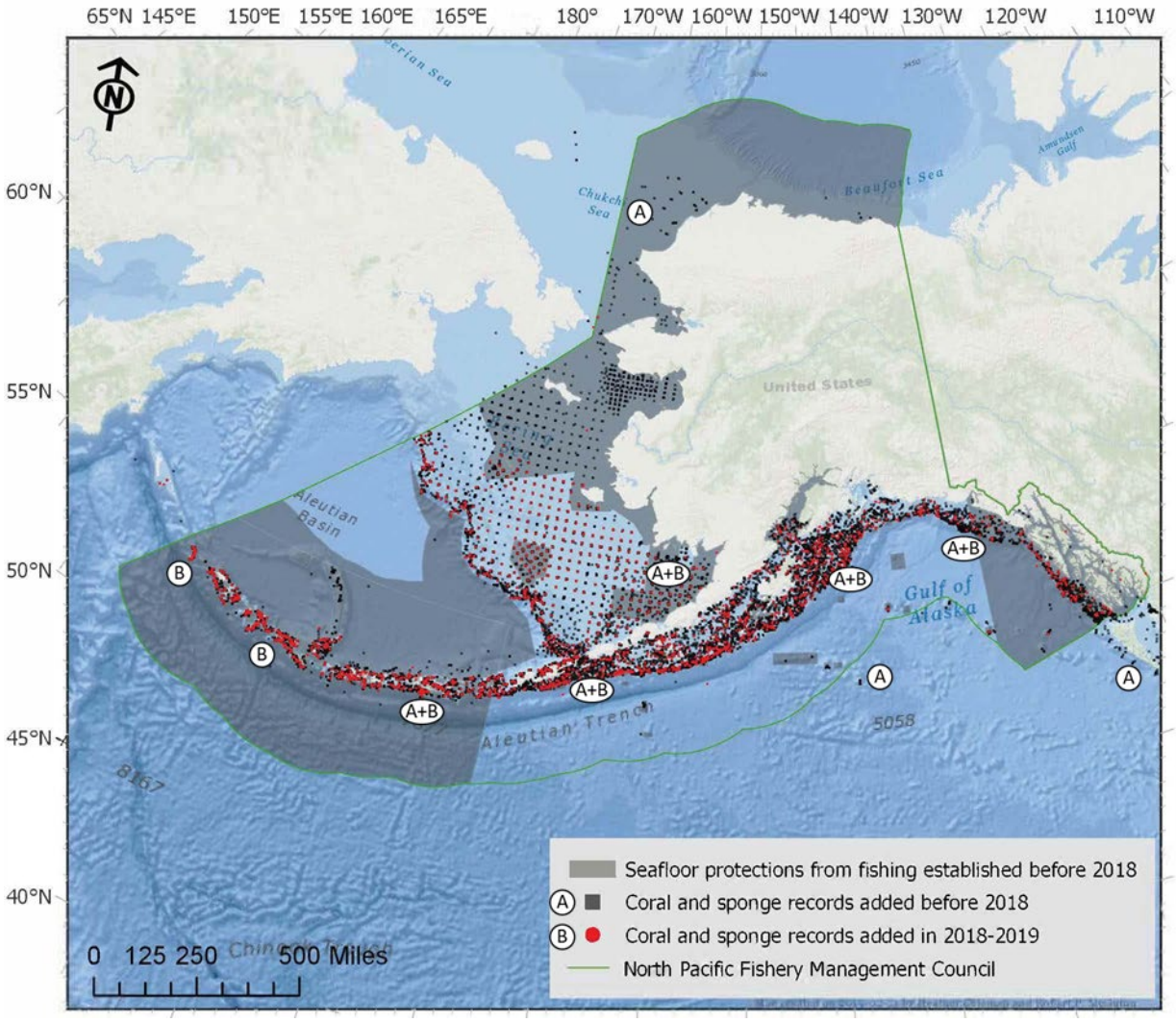
Mid-Atlantic and New England regional protections from seafloor-contact trawling (gray shading (A), note some areas are also protected by more restrictive fishing gear regulations); areas recommended by the New England Fishery Management Council in 2018 for protection under the Omnibus Deep-Sea Coral Amendment (purple shading (B)); and marine national monument boundaries (hatched lines). In 2018, NOAA Fisheries approved the Council's 2015 Omnibus Essential Fish Habitat Amendment containing several additional areas of closure (purple shading (B)) as well as reopening areas (yellow shading (C)). Known deep-sea coral and sponge locations already in the National Database (black squares (D)) and records added to the database in 2018-2019 (red circles (E)).

U.S. Pacific/West Coast Regional Seafloor Protections from Fishing



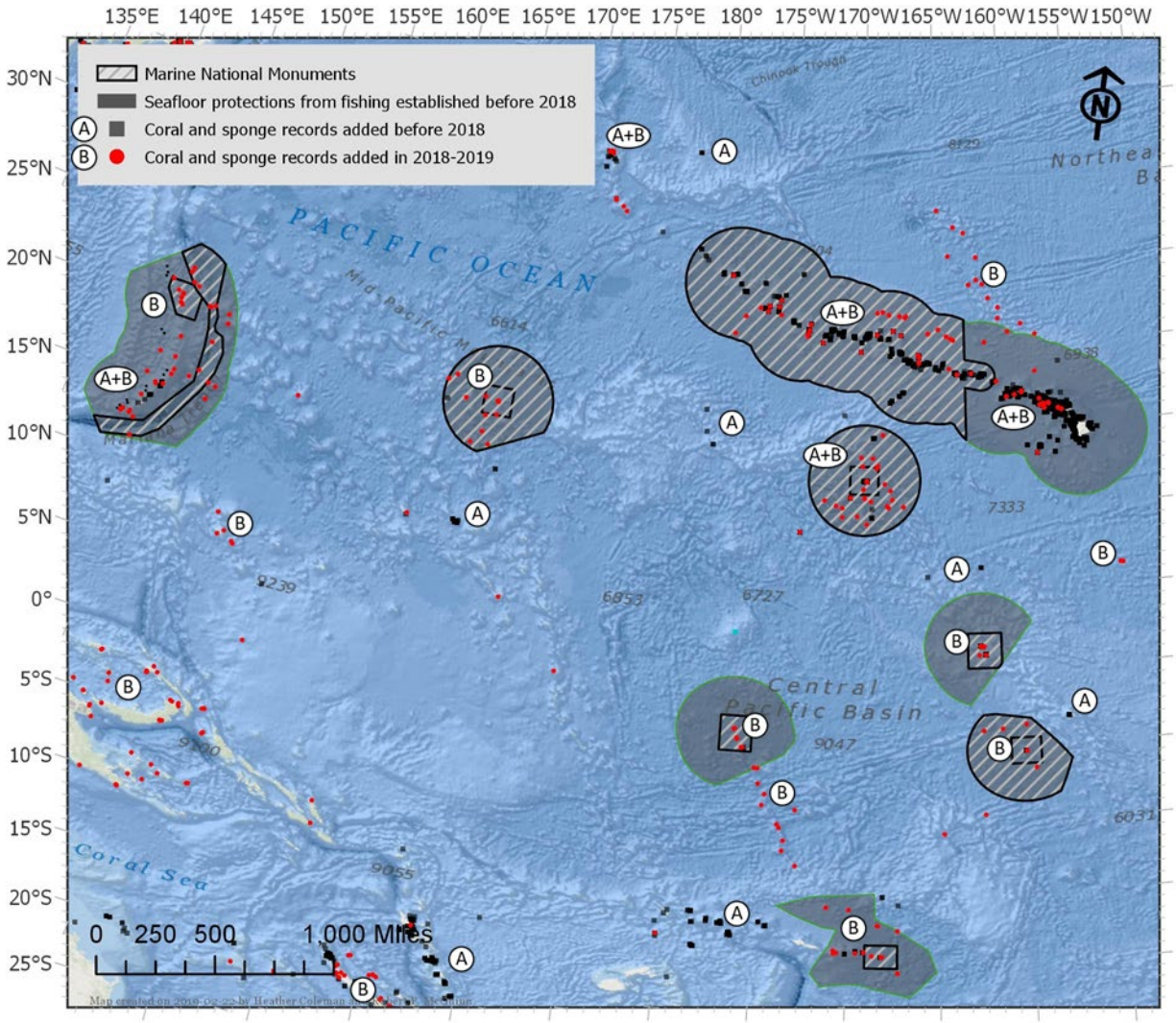
U.S. West Coast (Pacific Fishery Management Council (F)) regional protections from seafloor-contact trawling (gray shading (A), note some areas are also protected by more restrictive fishing gear regulations), and areas recommended by the Pacific Fishery Management Council in 2018 for protection (purple shading (B)) and reopening (yellow shading (C)). Known deep-sea coral and sponge locations already in the National Database (black squares (D)) and records added to the database in 2018-2019 (red circles (E)). (Update note: In 2020, NOAA Fisheries implemented the Council's 2018 proposed protections and reopenings contained in Amendment 28 of the Groundfish Fishery Management Plan.)

North Pacific/Alaska Regional Seafloor Protections from Fishing



Alaska (North Pacific Fishery Management Council) regional protections from seafloor-contact trawling (gray shading, note some areas are also protected by more restrictive fishing gear regulations). Known deep-sea coral and sponge locations already in the National Database (black squares (A)) and records added to the database in 2018-2019 (red circles (B)).

Western Pacific/U.S. Pacific Islands Regional Seafloor Protections from Fishing



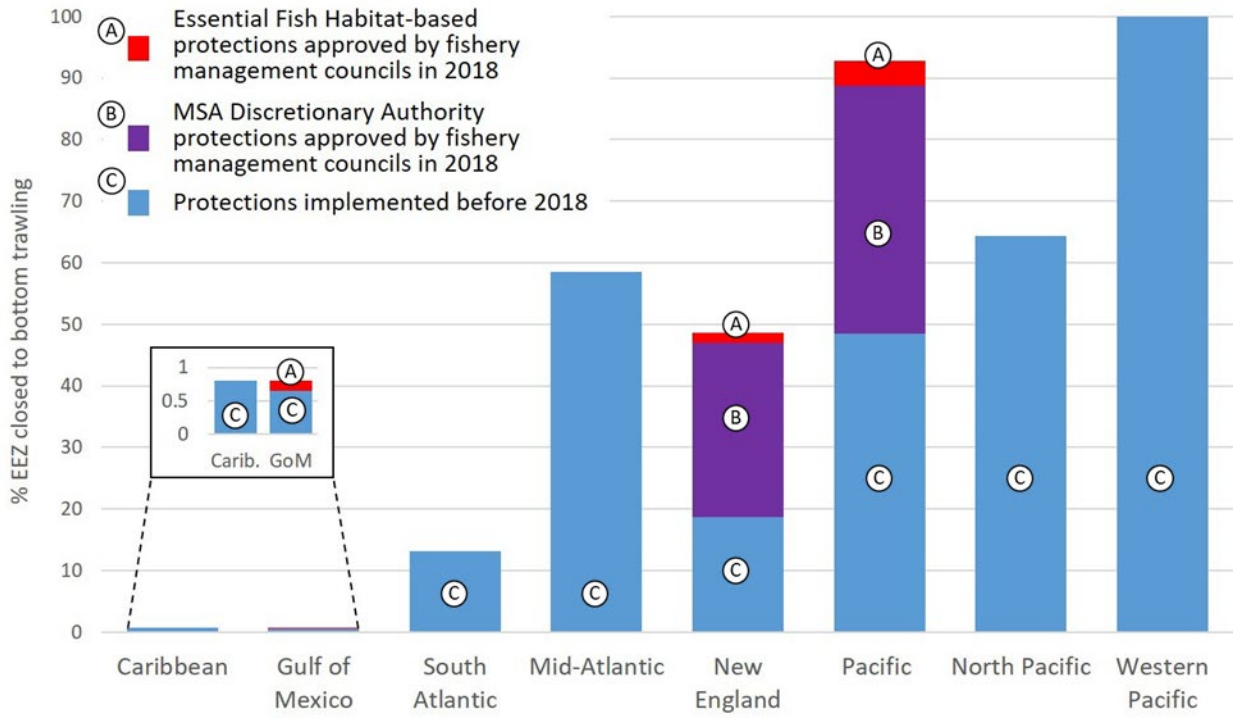
U.S. Pacific Islands (Western Pacific Fishery Management Council) regional protections from seafloor-contact trawling, longlines, and gill-nets (gray shading), and marine national monuments (hatched lines). Known deep-sea coral and sponge locations already in the National Database (black squares (A)) and records added to the database in 2018-2019 (red circles (B)).

Appendix 4: Maps of Deep-Sea Coral and Sponge Protections and Areas Remaining with High Potential for Fishing Gear Interactions

Most deep-sea corals grow extremely slowly, and can easily be damaged by activities that disturb the seafloor such as fishing, energy exploration and development, cable deployment, and more. Of the human activities that threaten deep-sea coral habitat, seafloor trawling is widely considered to have the greatest potential for damage.

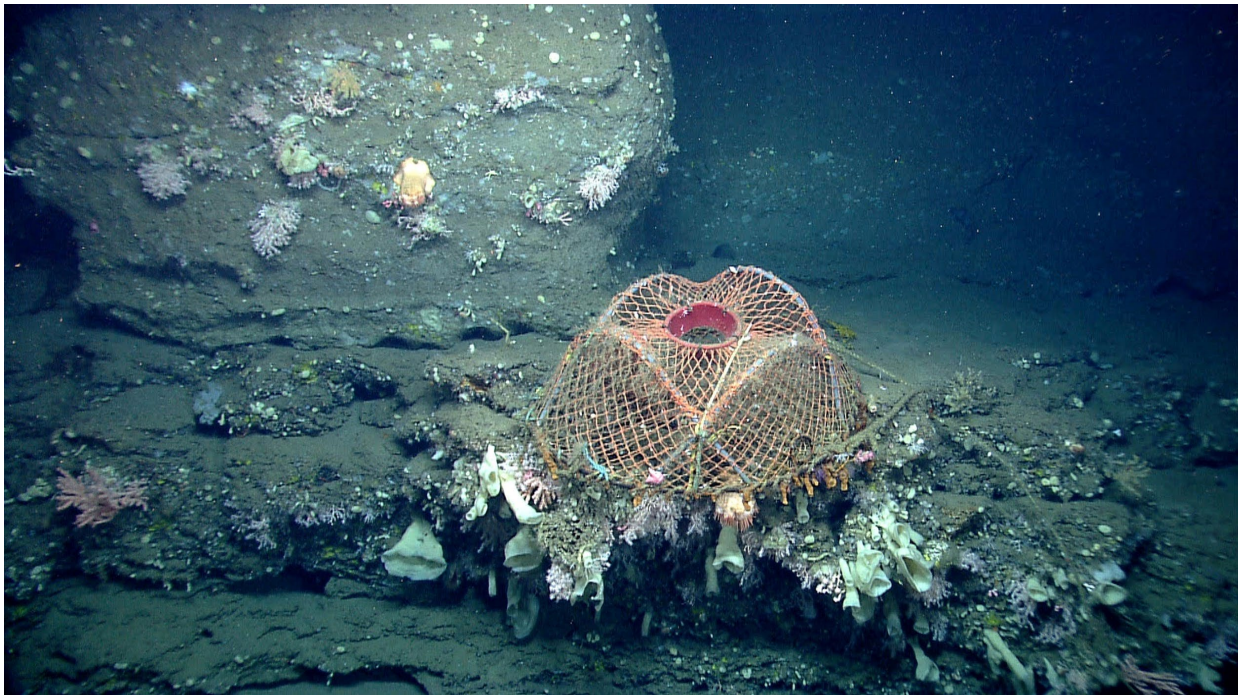
Fishery management councils have protected between 0.8 percent to 100 percent of their regions from seafloor trawling, and currently this activity is restricted in 76 percent of the overall U.S. exclusive economic zone. Some regions added substantial protections for their deep seafloor in 2018-2019, and the decisions behind these protections relied, in part, on Program information.

Percentage of Each Region's Seafloor within U.S. Waters that is Closed to Seafloor Trawling



New closures in areas containing deep-sea corals were approved by the Gulf of Mexico, New England, and Pacific Fishery Management Councils in 2018 through Essential Fish Habitat mechanisms (red bars (A)), and the Magnuson-Stevens Fishery Conservation and Management Act (MSA) Discretionary Authority (purple bars (B)). The percentage of each region's area closed to seafloor trawling before 2018 is shown in blue bars (C). This chart summarizes federal fishing restrictions; it does not include state restrictions. Note: Seafloor trawling is not known to occur in U.S. Caribbean waters.

This appendix highlights locations in U.S. waters that are open to seafloor trawling and have a documented presence of deep-sea coral and sponge communities. Directed by the Magnuson-Stevens Fishery Conservation and Management Act to reduce interactions between fishing gear and corals, the Program is committed to supporting studies that aid resource managers in developing and evaluating management options for vulnerable locations such as these.

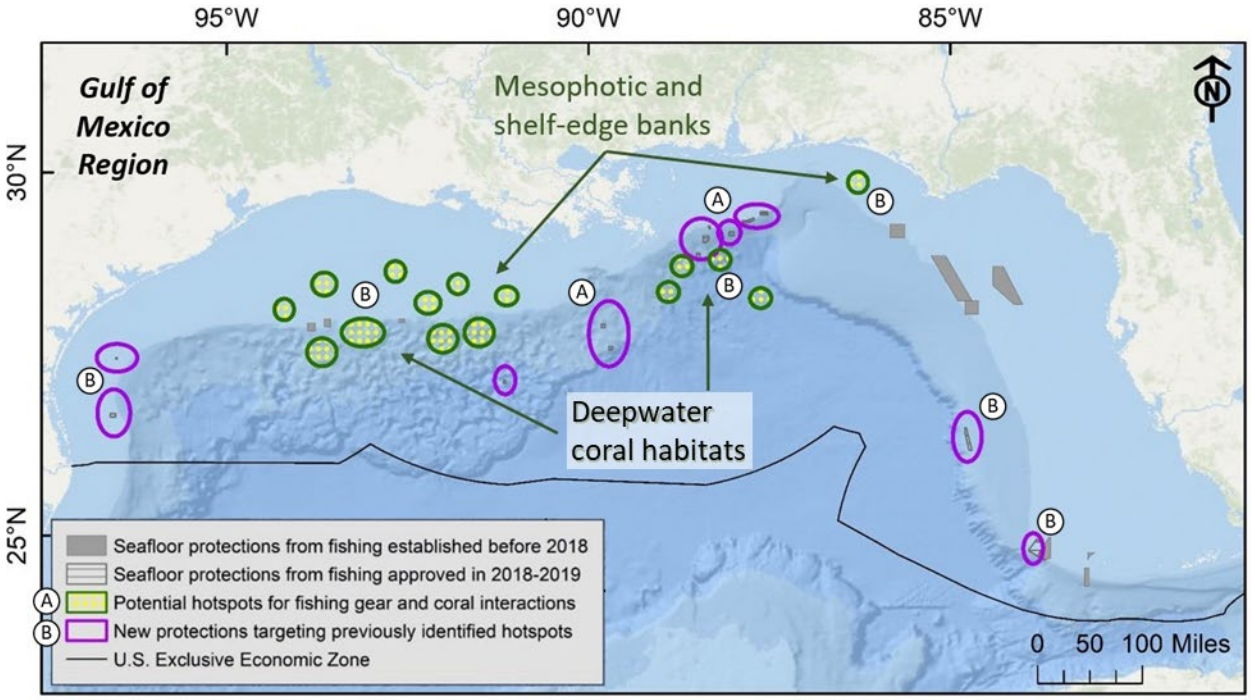


A lost red crab trap between Heezen and Nygren Canyons alongside corals and sponges in Northeast U.S. waters. Anthropogenic debris is commonly observed during NOAA's ROV surveys in the nation's deep water areas. Image courtesy of the NOAA Office of Ocean Exploration and Research, Northeast U.S. Canyons Expedition 2013.

Gulf of Mexico Region

Many areas approved for seafloor protections by the Gulf of Mexico Fishery Management Council in 2018 had been identified in past Reports to Congress as vulnerable deep-sea coral habitat (outlined in purple (B) on the map). In October 2020, NOAA Fisheries approved seafloor protections for 13 areas containing deep-sea corals. Areas that are still considered vulnerable to seafloor-contact fishing are outlined in yellow/green (A). These include deepwater coral habitats, as well as mesophotic ("twilight" reefs between shallow and deep depths) and shelf-edge banks.

Gulf of Mexico Regional Protections and Areas of High Potential for Seafloor-Contact Fishing Gear Interactions



Areas protected before 2018 (gray shading); areas approved for protection in 2018 (hatched pattern); areas that continue to have high potential for interaction with fishing gear (green/yellow (A)); formerly identified areas of high potential for seafloor-trawl fishing gear interactions that were approved for protection by the Gulf of Mexico Fishery Management Council in 2018 (hatched areas within purple outlines (B)).

U.S. South Atlantic and Caribbean Regions

NOAA Fisheries and the South Atlantic Fishery Management Council have closed a number of areas to seafloor-contact fishing to protect deep-sea coral habitats since the 1980s. The Council now has a substantial amount of new information from recent years available to inform upcoming decisions. The most vulnerable areas of coral aggregations are outlined in green/yellow (B) in the accompanying map.

Research on deep-sea habitats in the U.S. Caribbean to date is limited, and specific locations of deep-sea corals are not well-known. Mona Passage, off the west coast of Puerto Rico (outlined in green/yellow (B), has areas of important deep-sea coral habitat. Risks to these habitats from fishing are likely low, as fishermen do not use the most damaging seafloor-contact fishing gears.

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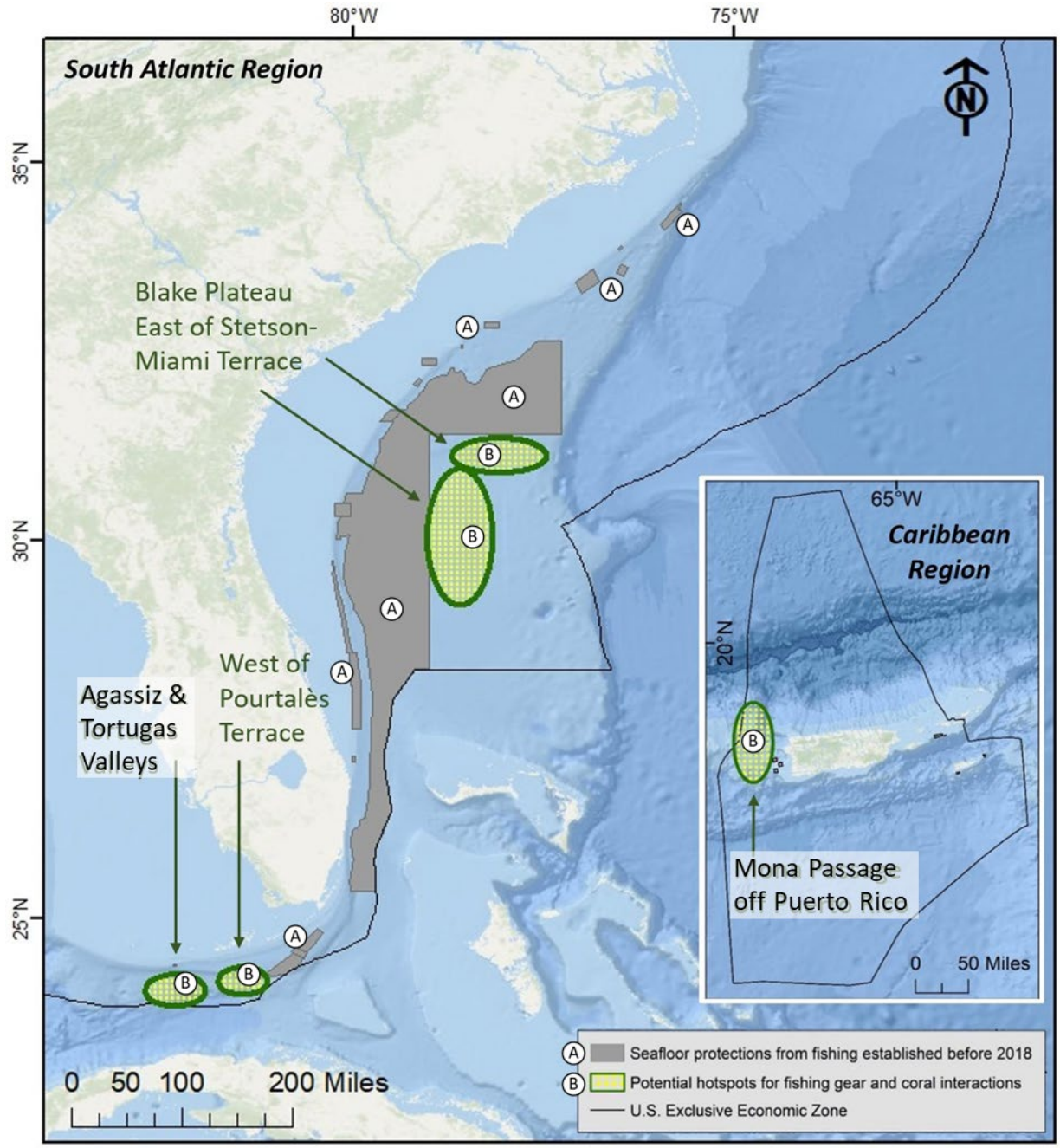
U.S. South Atlantic and Caribbean Regional Protections and Areas of High Potential for Seafloor-Contact Fishing Gear Interactions

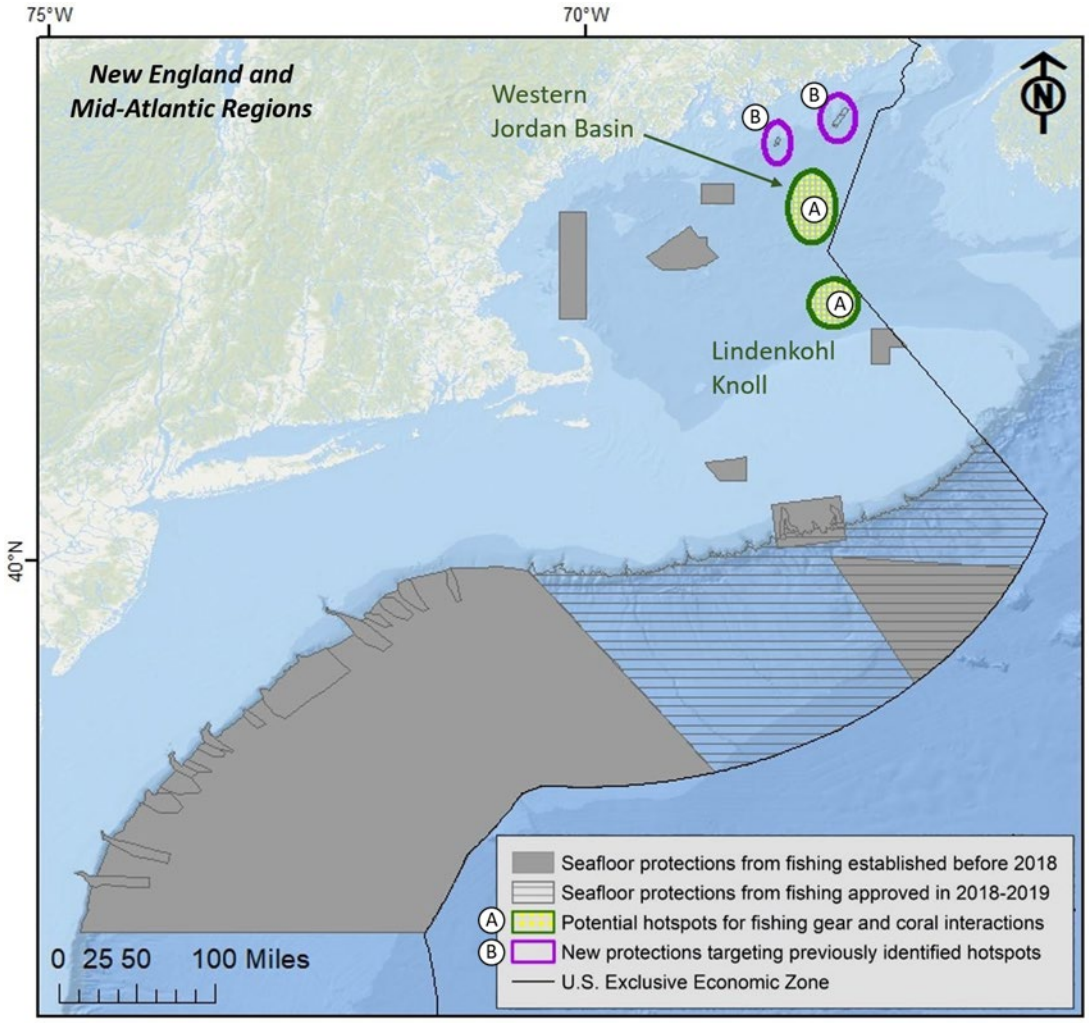


U.S. South Atlantic region and Caribbean region (inset). Areas protected before 2018 (gray shading (A)); areas that continue to have high potential for interaction with fishing gear (green/yellow (B)).

Mid-Atlantic and New England Regions

Since 2015, both the Mid-Atlantic and New England Fishery Management Councils have taken great strides to protect deep-sea coral habitat, particularly in canyons and on deep slopes. New England canyons and slopes deeper than 600 meters (2,000 feet) and several areas in the Gulf of Maine are hotspots that the Council has voted to protect from most seafloor-contact fishing gear. Documented areas of dense “coral gardens” still remain unprotected from seafloor-contact fishing, most notably in the Western Jordan Basin and Lindenkohl Knoll areas of the Gulf of Maine (outlined in green/yellow (A)).

Mid-Atlantic and New England Regional Protections and Areas of High Potential for Seafloor-Contact Fishing Gear Interactions



Areas protected before 2018 (gray shading); areas approved for protection in 2018 (hatched pattern); areas that continue to have high potential for interaction with fishing gear (green/yellow (A)); formerly identified areas of high potential for seafloor-trawl fishing gear interactions that were approved for protection by the New England Fishery Management Council in 2018 (hatched areas within purple (B) outlines).

Pacific Region/U.S. West Coast

The proportion of federal waters off Washington, Oregon, and California that is protected from seafloor trawling nearly doubled in January 2020. Expansions and new protections addressed seven of the ten former west coast sites identified for relatively high coral bycatch and documented presence of coral aggregations, as described in the Program's 2018 Report to Congress (sites outlined in purple in the accompanying map). Green/yellow (A) areas have commercial trawl fishery reports of standardized coral bycatch in the top 1 percent coast-wide, based on data from the West Coast Groundfish Observer Program.

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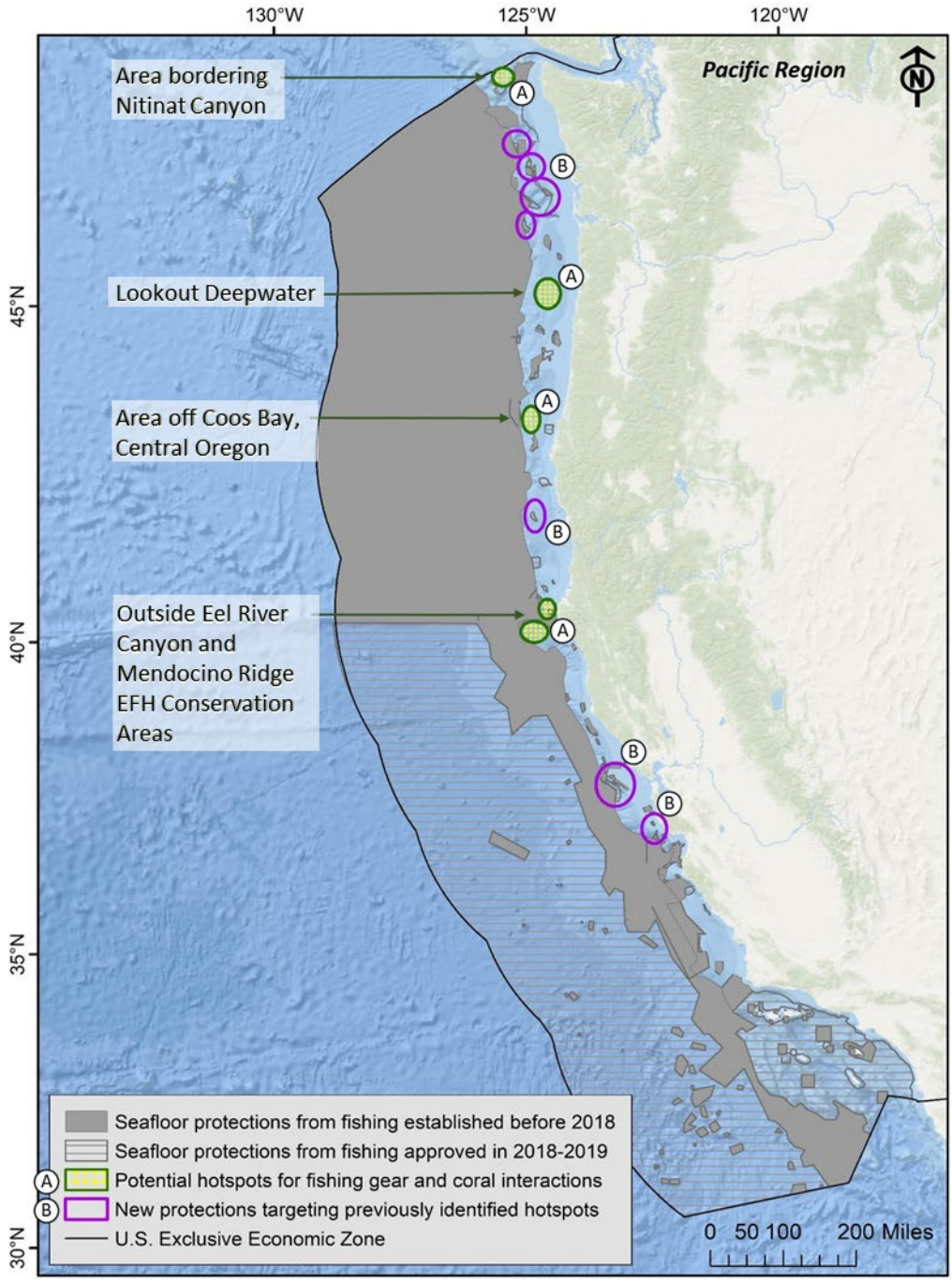
U.S. Pacific/West Coast Regional Seafloor Protections and Areas of High Potential for Seafloor-Contact Fishing Gear Interactions

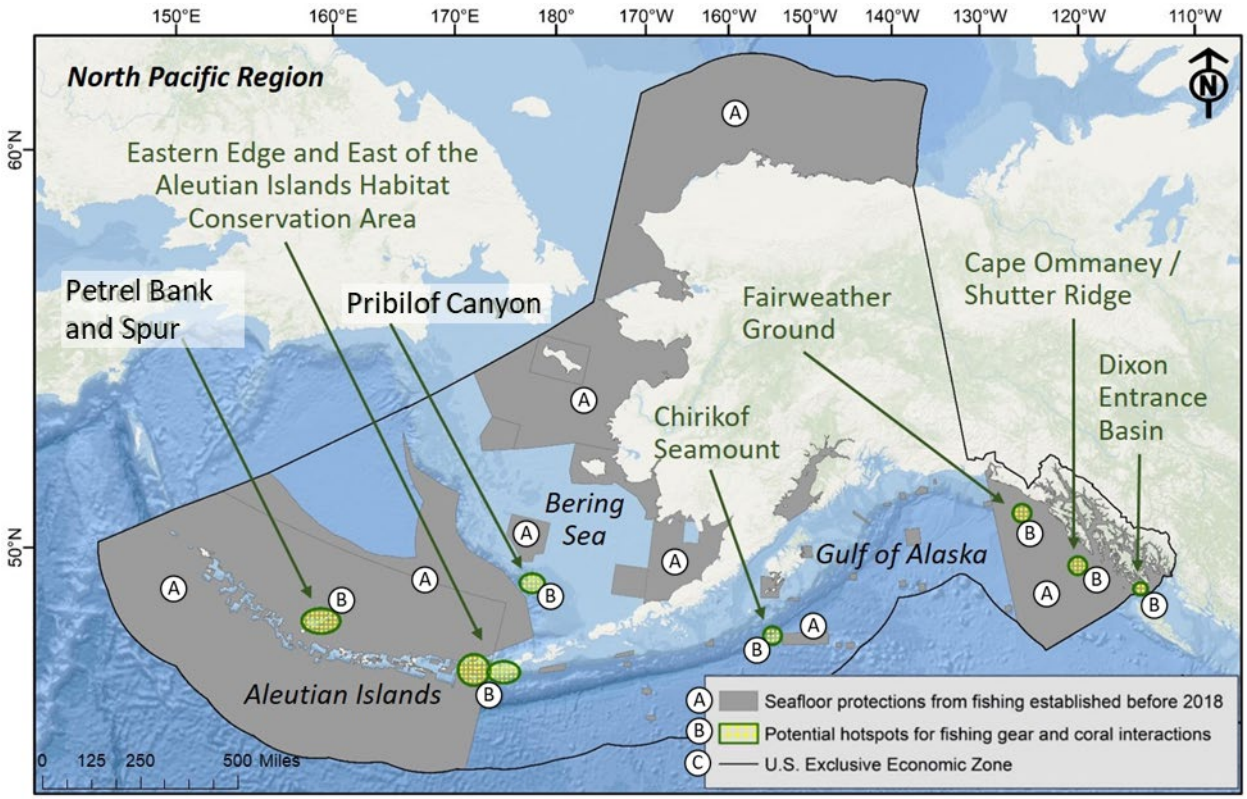


Areas protected before 2018 (gray shading); areas approved for protection in 2018 (hatched pattern); areas that continue to have high potential for interaction with fishing gear (green/yellow (A)); formerly identified areas of high potential for seafloor-trawl fishing gear interactions that were approved for protection by the Pacific Fishery Management Council in 2018 (hatched areas within purple (B) outlines).

North Pacific Region/Alaska

NOAA Fisheries and the North Pacific Fishery Management Council have established extensive conservation areas to protect essential fish habitat. The green/yellow (B) areas on the map are particular hot-spots of coral density or bycatch, but gear interactions with corals are not limited to these areas. In the Gulf of Alaska, substantial red tree coral habitats exist outside currently protected areas and in places closed to seafloor trawling but vulnerable to other gear types (e.g., bottom-tending longline and trap gears). The Aleutian Islands Habitat Conservation Area and Coral Habitat Protection Areas provide important protections. However, high-density "coral gardens" in these areas may still be vulnerable to other bottom-tending gear, and relatively high levels of coral bycatch are reported in surrounding areas from trawl and other fisheries.

North Pacific/Alaska Regional Seafloor Protections and Areas of High Potential for Seafloor-Contact Fishing Gear Interactions

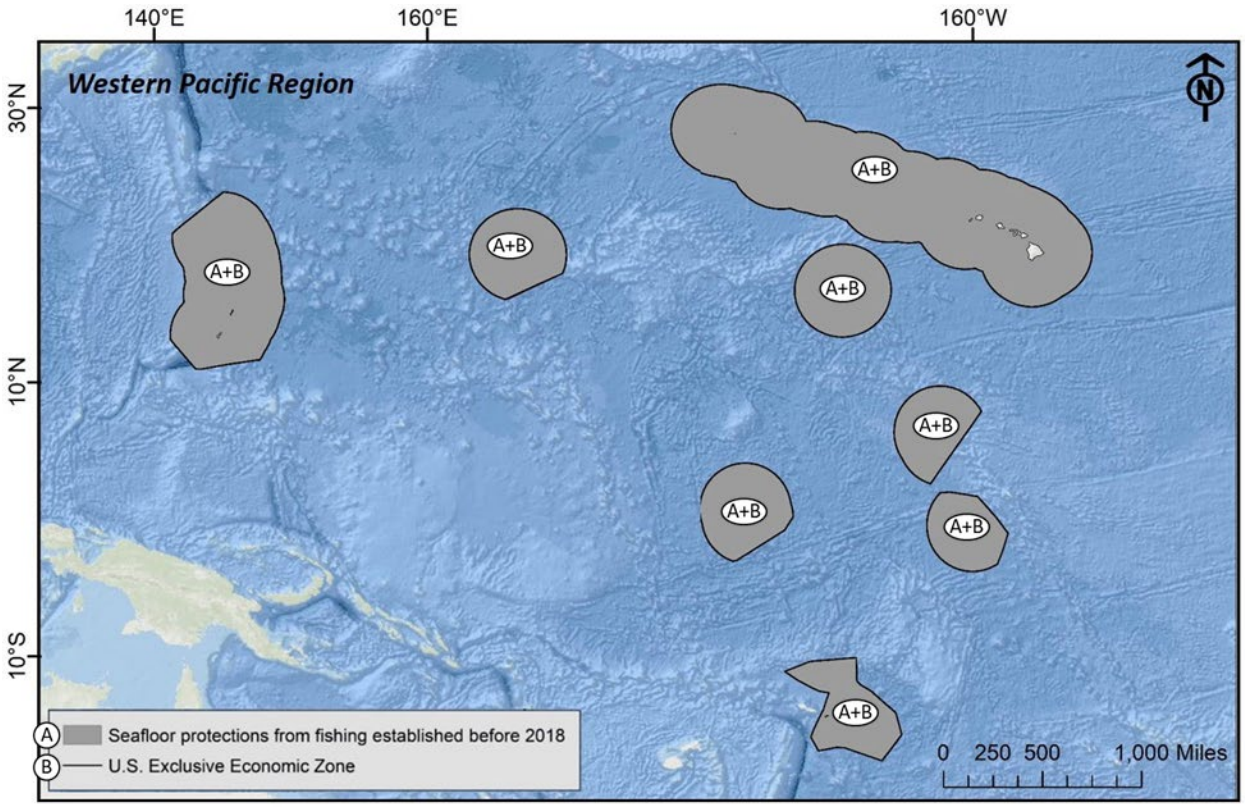


Areas protected before 2018 (gray shading (A)); areas that continue to have high potential for interaction with fishing gear (green/yellow (B)). The Fairweather Ground, Cape Ommaney/Shutter Ridge, and Dixon Entrance Basin, while protected from trawling in the Southeast Alaska Trawl Closure, represent particularly rich red-tree coral habitats that remain vulnerable to other bottom-contact gear.

Western Pacific Region/U.S. Pacific Island

NOAA Fisheries and the Western Pacific Fishery Management Council have prohibited seafloor-contact trawls, longlines, and gillnets throughout the U.S. Pacific Islands since 1983. Thus, there is little potential for these gears to damage deep-sea corals. Analyses of recent surveys continue to reveal important deep-sea coral communities, including in marine national monuments and sanctuaries in the region.

Western Pacific/U.S. Pacific Islands Regional Seafloor Protections and Areas of High Potential for Seafloor-Contact Fishing Gear Interactions



All areas were protected before 2018, as displayed in gray shading (A).