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Quantifying the Impacts to Coral and Sponge Habitats in the Eastern Gulf of Mexico during Southeast Area Monitoring and Assessment Program Fishery-Independent Bottom Trawl Surveys

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Cover Image: Low relief flat hardbottom with epibiotic habitat.
Image Credit: Florida Wildlife Research Institute Fisheries Independent Monitoring Program

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Introduction

The Southeast Area Monitoring and Assessment Program (SEAMAP) annually conducts two fishery-independent bottom trawl surveys that have the potential to encounter coral, sponge and other live bottom habitats in the eastern Gulf of Mexico (GOM). The summer and fall trawl surveys were established respectively in 1982 and 1987 to assess the seasonal, spatial and inter-annual variation in abundance of benthic fauna, determine population size/age structures of collected fauna and quantify associated environmental data. Under the auspices of SEAMAP, the surveys are completed through a cooperative effort by the National Marine Fisheries Service (NMFS), Southeast Fisheries Science Center (SEFSC) and the states of Texas (TX), Louisiana (LA), Mississippi (MS), Alabama (AL) and Florida (FL). Data collected during these surveys provide critical fishery-independent indices of relative abundance, estimates of bycatch and life history information for many species identified under Federal Fishery Management Plans (FMP, Table 1).

Spatial coverage of the surveys initially ranged from Brownsville, TX to Mobile Bay, AL (NMFS Statistical Zones 10 to 21,) in waters from 9 to 110 m (5 to 60 fm) with sampling conducted by NMFS, LA, MS and AL (Figure 1). In 2008, SEAMAP received supplemental funding that allowed FL to begin experimental bottom trawl surveys over the West Florida Shelf (Figure 1). Based on the success of the FL trawl program, SEAMAP surveys were expanded GOM-wide in 2010 to include the area from Mobile Bay, AL to Key West, FL (NMFS Statistical Zones 2 to 9). The decision to expand the fishery-independent trawl sampling into the eastern GOM was based on recommendations by the Southeast Data Assessment and Review (SEDAR) red snapper (*Lutjanus campechanus*) Update Assessment Workshop Committee[1]. The recommendation was derived from the need to obtain much needed information concerning age 0 and age 1 red snapper, as well as other managed species occurring in the eastern GOM such as red grouper (*Epinephelus morio*) and gray snapper (*Lutjanus griseus*) among others.

The eastern GOM supports diverse live bottom habitats composed primarily of epibiotic algae, sponge and coral communities associated with rock or firm substrate throughout the West Florida Shelf and in limited areas over the MS/AL shelf. These live bottom areas are generally of low relief and small in size. Unlike many of the moderate to higher relief live bottom habitats on the mid to outer MS-AL and FL outer shelves these smaller habitat areas are not well mapped. These unknown expanses of live bottom present significant challenges for SEAMAP trawl surveys in regards to effectively targeting demersal fish populations, minimizing disturbance to these habitats and preventing loss and damage of trawl gear.

In this report we provide initial estimates of gear/loss damage and impacts to coral and sponge live bottom habitats in the eastern GOM. We review past and current efforts to mitigate impact to these habitats during SEAMAP trawl operations. Lastly, we provide recommendations on future steps needed

[1] SEDAR7 Update, 2009. Stock Assessment of Red Snapper in the Gulf of Mexico: SEDAR Update Assessment. Miami, FL. Available online at http://sedarweb.org/2009-update-sedar-07-gulf-mexico-red-snapper

to better quantify and minimize impact to coral and sponge habitats, and address potential implications to data utilized from these surveys for fisheries management.

Quantification of Lost or Damaged Gear and Coral and Sponge Catch

SEAMAP trawl operations conducted in the eastern GOM (east of 89.25°W) serve as a baseline for quantifying gear loss/damage and impacts to coral and sponge habitat. The operations encompass experimental trawling by the state of FL during 2008-2009 and annual survey data collected between 2010 and 2015. Trawl operation, effort and catch information were extracted from the Gulf States Marine Fisheries Commission (GSMFC) SEAMAP Database (public_SEAMAP.zip Version 07-17-2016) obtained from their online SEAMAP access portal (Gulf States Marine Fisheries SEAMAP Online Access).

SEAMAP standard and experimental trawl operations utilized a 12.8 m (42 ft) semi-balloon trawl with 2.4 m x 1 m (8 ft x 3.33 ft) chain doors towed at 2.5 kt for 30 min. Research permit exemptions do not require trawls to be equipped with either turtle excluder devices (TEDs) or bycatch reduction devices (BRDs). Trawl operation codes are assigned to tows that are aborted or experience irregularities during operations. Quantifiable tows (no operation code) are processed in total or subsampled depending on total weight and/or taxonomic diversity. Catch is then sorted into component taxa, enumerated and weighed.

Gear loss/damage due to interaction with bottom habitat was examined using a two part process to classify whether a trawl was hanged. First, any trawl with an operation code indicating torn webbing (T), lost whole rig (L) or hang up (Z) were identified as a hanged tow. Station and/or trawl comments were then examined for tows without operation codes. Tows with comment(s) indicating a hang were then re-classified as a hanged tow regardless of their original operation code.

The identification of coral and sponge in SEAMAP trawl catches is problematic. Coral identifications are primarily done in situ and most specimens are not retained for subsequent laboratory examination. Identifications are hampered by limited taxonomic expertise, available keys and damaged specimens. Identification of sponges is difficult and often requires microscopic examination of spicules. Efforts to identify sponge to the lowest possible taxonomic level are not undertaken at sea, nor are specimens retained for subsequent laboratory examination. Instead, sponges are classified into broad morphological categories of barrel, ball, vase/tube, finger/branching and encrusting/other.

Catches of coral and sponge were examined at a generic level in order to address concerns with the taxonomic resolution of coral and sponge. Individual taxa identified as belonging to the phylum Porifera were categorized as sponge and all catch occurrences and weights collapsed by individual trawl. Taxa identified from the phylum Cnidaria were further filtered to include only taxa identified as belonging to the class Anthozoa. Taxa within the subclass Octocorallia and order Alcyonacea (soft corals), the subclass Hexacorallia and the orders Antipatharia (thorny and black corals) and Scleractinia (hard corals) were categorized as coral and all individual occurrences and weights collapsed by individual trawl.

A total of 2,546 SEAMAP trawl operations from 2008-2015 were summarized to quantify hanged tows and catches of coral and sponge. Florida, NMFS, MS and AL each accounted for 68%, 17%, 10% and 5% of sampling effort, respectively. Together these trawls represent approximately 100 km^2 of sea floor swept with an average tow area of 0.038 km^2. Total biomass collected during trawling operations massed 141,289 kg. Hanged tows occurred during 133 (5.2%) trawl operations (Table 3, Figure 2). Incidents of hangs increased east and south of statistical zone 11, peaked in statistical zone 7 and then declined moving southwards towards statistical zone 1 (Figure 2).

Twenty individual coral taxa representing 57 catch records were identified from SEAMAP trawls (Table 2). The majority of taxa were identified to genus or higher taxonomic levels. Soft corals in the order Alcyonacea (70.0 %) and hard corals in the order Scleractinia (29.7 %) accounted for nearly all coral biomass. Coral catch was not recorded from MS and AL trawl operations. A single instance of coral in the order Pennatulacea (sea pens) was reported by FL and two instances of coral in the order Antipatharia (black corals) were reported by NMFS. Differences in the occurrence of corals identified in the orders Alcyonacea (soft corals) and Scleractinia (hard corals) were apparent between NMFS and FL. Trawl operations conducted by NMFS accounted for 74 % of all identified soft corals and 100 % of hard corals. Overall, NMFS trawl operations accounted for 79 % of all identified coral, but only accounted for 17 % of the sampling effort. Collectively, corals were encountered in 49 (1.9%) tows and accounted for less than 0.2 % of total biomass. (Table 3, Figure 3). Trawl operations more often encountered coral in the northeast GOM (statistical zones 10 to 6) than in areas to the south.

Catches of sponge were examined collectively and for instances when they exceeded 50 kg in a single trawl. Sponges were encountered in 1037 (40.7 %) tows and accounted for 31.5 % of total biomass (Table 3, Figure 4). Catches of sponge exceeding 50 kg occurred in 209 (8.2 %) tows and accounted for 83.0 % of the total biomass of sponge (Table 3, Figure 4). The occurrence rate of sponge increased eastward from statistical zone 11 to 8, and then greatly increased in statistical zones 7 through 1. Encounter rates of sponge in these latter statistical zones exceeded 50% and sponge percentage of total biomass was typically greater than 30%.

Efforts to Avoid and Minimize Catch from Sensitive Habitats

Efforts to avoid and/or minimize gear loss/damage and encounters with coral, sponge and other live bottom habitats during SEAMAP trawl operations in the eastern GOM has been an evolving process. Efforts between 2010 and the summer of 2016 focused primarily on preemptively eliminating areas of known obstructions and/or sensitive habitats during the survey site selection process or the re-positioning of individual stations at sea based on localized navigational chart information. The site selection process used from 2010 through 2014 preemptively removed sites falling within the MS and AL Reef Permit Areas, a series of large fish havens located between the AL/FL border and Cape San Blas, FL, the Madison and Swanson Sites and Steamboat Lumps seasonal closure areas to protect reef fish and the Florida Keys National Marine Sanctuary. The Florida Middle Grounds, Pulley Ridge and Tortugas marine reserve habitat areas of particular concern (HAPC) and the Tortugas Shrimp Sanctuary were added to the list of areas preemptively being excluded during the site selection process in 2015. Station

locations at which trawl operations have experienced hanged tows were also provided to ships personnel to assist in the on-site determination as to whether a trawl needed to be relocated prior to sampling.

The majority of SEAMAP trawl operations over the West Florida Shelf are conducted by FL via the Fish and Wildlife Research Institute (FWRI). Beginning in 2013, FL began efforts intended to reduce gear loss/damage and minimize the disruption to sensitive bottom habitat during their surveys by identifying pre-selected survey sites that were in close proximity to documented live and hard bottom areas and/or potentially hazardous locations. Spatial point and area data were compiled using various sources including FL public artificial reef and wreck locations, FWRI Baitfish Survey hangs, FWRI Reef Fish Survey side scan sonar mapped benthic habitats (geoform) data, NMFS Panama City Laboratory Reef Fish Survey identified hard bottom locations, West Florida Shelf sensitive HAPCs, marine protected areas (MPAs) and sea grass beds and University of South Florida (USF) hydrophone array locations, as well as a comprehensive list of previous SEAMAP survey locations conducted by FL where major gear damage previously occurred or sponge collection weights exceeded 50 kg. A multi-step GIS process was then utilized to assess the potential risk of towing in or near sensitive habitats and obstructions based on the positions of pre-selected SEAMAP Survey sites in relation to the compiled spatial data.

The initial step involves identifying any pre-selected sites that fall within 2.0 nm of any previous FWRI sampled SEAMAP location experiencing a hang (major gear damage) or that caught greater than 50 kg of sponge. These sites are then dropped from the list of proposed locations in order to avoid towing through these hazardous and/or live bottom areas. Next, the remaining sites are examined to determine if they intersect with a 1.5 nm buffer of any FWRI benthic habitat geoforms not identified as "Flat Hard Bottom". For these sites towing direction(s) necessary to avoid trawling over or into these areas are provided to the ship. Geoforms classified as "Flat Hard Bottom", defined as flat or nearly flat areas (<0.1 m of relief) of hard bottom habitat that are typically covered by sediments and often colonized by benthic biota are currently considered trawlable habitat and no effort is made to avoid these areas (Figure 5). Next, a check is done to ensure that no sites fall within the boundaries of the Madison, Swanson, Steamboat Lumps, Pulley Ridge, Florida Middle Grounds, Florida Keys Marine Sanctuary and Dry Tortugas National Park MPAs or HAPCs. Sites falling within these boundaries are relocated to the closest border and towing directions necessary to avoid any sensitive habitats and obstructions as determined by the spatial data provided. Next, sites falling within 0.25 nm of any sea grass bed, artificial reef, wreck, FWRI Baitfish Survey hangs or NMFS Panama City Reef Fish Survey hard bottom sites are identified. Sites within 0.25 nm of obstructions are then recommended to be relocated no more than 1.0 nm from the original site while trying to stay in the same depth zone and statistical zone per SEAMAP protocols. Towing directions necessary to avoid additional sensitive habitats and obstructions as determined by the spatial data are also provided. Finally, in cases where a site falls within an area where sensitive habitats and obstructions are unavoidable it is marked as non-trawlable and dropped from the master list. The compiled information on all pre-selected sites is then shared among SEAMAP partners when allocating annual survey stations.

The protocols developed by FL were adopted for all SEAMAP trawl operations conducted over the West Florida Shelf in the fall of 2016. However, the core information on hanged tows, catches of sponge greater than 50 kg and coral occurrence used to define areas to avoid was updated to include an additional 486 observations. The expanded list includes any of these instances from all SEAMAP and

NMFS Pelagic Acoustic Trawl operations and not just those encountered during FL surveys. Moving forward, SEAMAP will be combining the initial site selection process, the integration of annually updated habitat mapping and the application of the FL protocols post site selection into a single process.

Budget constraints did not allow FL to participate in the 2016 fall survey, and all trawl operations over the West Florida Shelf were conducted by NOAA Ship *Oregon II*. *Oregon II* is equipped with a Simrad© EK60 scientific echo sounder and Olex© sea floor mapping software. The EK60 provides information on bathymetry, bottom hardness and acoustic backscatter. The Olex mapping software in conjunction with the EK60 is capable of generating bathymetric and/or bottom hardness maps as real time displays. Both systems archive raw data that can be used for further analysis.

The availability of data from the EK60 and Olex systems allowed additional protocols to be put in place to help minimize gear loss/damage and encounters with coral and sponge. Potential trawl sites were surveyed by conducting 1.5 nm transects within a 5 nm diameter of selected trawl locations with the goal of finding 1.25 nm of trawlable bottom. Data from the EK60 and Olex systems were monitored in real time and data archived for each transect. Based on the bottom profile and hardness data, a determination was then made by scientific personnel as to whether a site was considered trawlable. Trawl sites were dropped if trawlable bottom was not identified after conducting at least three transects.

Based on the available sea days, 250 trawl stations were selected for the 2016 fall survey with 127 allocated in the western and 123 in the eastern GOM. Filtering stations based on the modified FL protocols preemptively eliminated 10 stations in the eastern GOM. Due to a miscommunication, two of these eliminated stations were trawled by MS with both resulting in successful trawl operations. Sampling of the remaining 115 selected stations was split between MS (10) and NMFS (105). All stations sampled by MS resulted in successful trawl operations. The 105 stations conducted by NMFS implemented the additional bottom profiling protocols. Twenty three sites were profiled and determined to be non-trawlable. Trawl operations were conducted at 82 sites resulting in 63 good tows, three hanged tows, and 16 tows with catches of excessive sponge that were not processed. Altogether, 73 successful trawl operations were completed in the eastern GOM. Coral was taken in six (8.2%) tows for a total weight of 13.9 kg, and sponge was taken in 42 (57.5%) tows for a total weight of 578.9 kg. There were 18 trawl operations that were not processed due gear damage or excessive sponge catch. These catches were estimated to contain at least an additional 910 kg of sponge.

Discussion

The field identification and quantification of coral collected during SEAMAP trawl operations have been inconsistent over the time series and across state/federal partners. Nearly all coral and sponge collected during trawl operations were taken by FL and NMFS trawl operations. Differences in the occurrence rate of coral and the types identified were apparent between FL and NMFS. Coral occurrence was four times higher during NMFS trawl operations although they accounted for only 17% of the sampling effort, and no hard corals were reported in FWRI catches. Independent discussions held with FL and NMFS to determine possible explanations were revealing. Florida indicated that corals were rarely seen, but when encountered typically consisted of broken fragments. These individual fragments were not identified as biological catch, nor recorded in the catch database. NMFS also indicated that this

practice was followed but with less consistency during their operations, and also indicated that in some instances bryozoans and hydroids may have been mistakenly identified as coral. These revelations help explain the over/under reporting of the occurrence of corals between the FWRI and NMFS sampling programs. It is also clear that there is a need to develop protocols to consistently quantify and record coral catch among sampling programs.

The consistent categorization and quantification of sponge from trawl operations has also been problematic. FL initiated the categorization of sponge into five morphological categories in the fall of 2008, but the practice was not implemented by the other SEAMAP partners until 2011. Interviews with NMFS personnel also indicated the morphological categorization of sponge may have been inconsistently applied at times since 2011. More problematic is the quantification of sponge. FWRI, with few exceptions, quantifies the biomass of all sponge collected during trawl operations. NMFS protocols have allowed watch leaders and/or field party chiefs to make a determination of whether a trawl contained excessive sponge, and designating it as a "non-representative" tow. These trawls were not processed and given an operation code to reflect their status. In most cases these catches were discarded without being brought aboard. The weight of sponge for these catches may have been estimated and recorded in comments, but this practice was not consistent. In the fall of 2016, NMFS trawl protocols were modified to require estimated weights to be taken for all trawls with excessive sponge. Examination of estimated sponge catch from the fall 2016 discarded tows and comments from earlier surveys indicated that sponge catch from unprocessed NMFS trawls can greatly exceed that of successful tows. Trawl protocols implemented for 2017 now require sponge to be quantified from all tows regardless of whether the tow was considered successful or not.

There is a recognized need to develop taxonomic expertise to consistently and accurately identify coral, sponge and other epibiotic organisms to lower taxonomic levels. However, the effort required must be balanced against the primary survey objectives to monitor demersal fish and motile invertebrate populations. Sponge comprises over 30% of total biomass and would require a significant effort to train personnel, process, store and transport specimens for laboratory identification. Due to the volume of sponge collected this is impractical given current resources. Increasing the taxonomic resolution of coral identifications may be more practical due to the rarity of occurrence. Initial efforts can be directed at developing resources to identify species listed under the ESA and to accurately separate corals to at least order or suborder to allow for separation into major categories. Additional taxonomic expertise can be built over time and would benefit from cooperative work with regional experts and existing NOAA programs.

Due to the inconsistent identification and quantification of coral and sponge, the occurrence rates and biomass estimates presented here reflect minimum levels. These inconsistencies do not severely affect the monitoring of demersal fish and motile invertebrate populations. However they do limit the accurate quantification of coral and sponge bycatch, the ability to monitor the effects of mitigation measures on bycatch and the delineation of the spatial extent of these communities. The SEAMAP Trawl Working Group is actively addressing these issues and moving forward it will be possible to examine trends in coral and sponge catches to determine the effectiveness of mitigation measures.

The expansion of the SEAMAP summer and fall trawl surveys into the eastern GOM has resulted in increased rates of gear damage/loss and impacts to live bottom habitats as evidenced by the catch of

coral and sponge. Hanged tows resulting in gear loss or damage occur during 5.2 % of trawl operations. This rate is five times higher than for the same period in the western GOM. Impact to live bottom by trawl operations is occurring, but is minimal considering encounter rates of coral and sponge and the spatial coverage of the surveys. On average, 318 trawls sweep 13 km^2 of seafloor each year with 100 km^2 of seafloor swept from 2008 to 2015. This swept area represents less than 0.01 % of the eastern GOM survey area (152,532 km^2) annually, and less than 0.07 % on a cumulative basis. This view is supported by the SEFSC Draft Programmatic Environmental Assessment which currently recognizes minimal effects to ESA corals and sponge from SEFSC trawl surveys (SEFSC DRAFT Programmatic Environmental Assessment).

Avoiding and minimizing impact to live bottom habitats during fishery-independent trawl operations has been a priority of SEAMAP since the initial expansion of the survey into the eastern GOM. Station selection protocols were designed to eliminate major areas of known obstructions and live bottom habitats. The adoption of the FL protocols in 2013 and the utilization of an expanded set of hangs, coral and sponge occurrences beginning in 2016 have further reduced the potential impact. However, even with these mitigation measures in place, interaction with live bottom continues to occur during trawl operations.

Mitigation efforts based on eliminating known live bottom habitats and trawl sites encountering coral, sponge and hangs from the SEAMAP trawl sampling universe may not show results in the short term without the benefit of large scale efforts to map benthic habitats. Small scale mapping efforts in the eastern GOM are currently being conducted by the University of South Florida (USF), FWRI and NMFS utilizing various sonar technologies. The USF C-Scamp (Continental Shelf Characterization, Assessment, and Mapping Project's (C-SCAMP) Page) project has mapped approximately 4% of the West Florida Shelf since 2015, but the project ends in 2017. FWRI and the NMFS SEFSC Panama City, FL and Mississippi Laboratories conduct annual habitat mapping in conjunction with fishery-independent surveys to assess reef fishes. Combined the FWRI and NMFS surveys typically map up to 1750 km^2 each year. Habitat mapping on these scales will require decades to map the entire eastern GOM. Integrating data from these habitat mapping efforts will allow SEAMAP to further refine their trawl sampling universe. However, it is still remains unclear as to whether live bottom biota can be accurately identified through these mapping technologies, and if so, the minimal thresholds needed for detection.

The avoidance of obstructions and live bottom habitats prior to trawl deployment and habitat mapping during trawl operations is being explored. During trawl cruises aboard NOAA Ship *Oregon II*, bottom hardness, bathymetry and bio-acoustic data have been collected from potential trawl transects prior to and during gear deployment. The acoustic profiles allow for the avoidance of trawl deployment along transects in which obstructions and rough bottom indicate untrawlable bottom. They also allow the removal of any transect in which trawls are damaged and/or encounter live bottom from future site selection. Data archived from these profiles can also be examined to determine whether predictive models can be developed from bottom rugosity, bottom hardness and acoustic backscatter data to identify potential live or hazardous bottom. A major caveat to utilizing bottom transects to avoid habitat and obstructions is the narrow footprint of data obtained. The acoustic swath collected via the Simrad EK60 scientific echo sounder and Olex Bottom Mapping software is less than 14 m wide at the 110 m maximum sampling depth of the survey and narrows as depth decreases. The narrow swath makes it very difficult to reliably re-position a 14 m trawl along the exact path of a profiled transect. Bathymetry and

bottom hardness from acoustic return is easily interpreted from EK60 data. However, sponge which represents the majority of encountered live bottom has very little acoustic return and further work is needed to determine if it can be reliably detected using bio-acoustics.

Transect profiling and mapping utilizing side scan sonar may be a more viable option. These imaging systems can sample 5 to 10 times the swath area represented by the EK60, and may be able to better indicate areas of sponge habitat. Currently, side scan sonar technology is being deployed on an experimental basis during trawl surveys to evaluate its effectiveness at detecting low relief hard bottom habitats. These current protocols obtain sea floor side scan sonar images for all sites prior to trawl deployment, and deploy trawls regardless of the imaging results. Exception will be made if the images and/or the EK60 acoustics detect high relief or major bottom obstructions. The data will then be examined in conjunction with the EK60 and catch data to determine if side scan imaging can be an effective tool to avoid these areas.

The accurate quantification of sponge and mitigation measures based on transect profiling/mapping requires additional days at sea to maintain existing sampling effort. SEAMAP trawl surveys target 350 stations each year with 160 in the western and 190 in the eastern GOM. Typically, 7 to 8 trawl operations can be completed each day. Quantification of tows with excessive sponge require an additional half to full day in the eastern GOM, and transect profiling requires a significantly greater commitment. Bottom profiling of all eastern GOM stations would need 4 to 8 days to complete, and profiling only stations (120) located on the West Florida Shelf inside 50m where the greatest occurrence of sponge and coral are found would require 3 to 5 days. In addition to at sea data collection, effort will be required to process, archive and integrate mapping data into the site selection process for future surveys.

SEAMAP has made significant progress in addressing issues regarding the quantification of coral and sponge and developing measures to minimize the impact to live bottom habitats during trawl operations. Identification/categorization and quantification protocols have been reviewed and are now consistent across federal and state surveys. Taxonomic resolution of coral and sponge identifications are still problematic, but consistent identification and quantification into broad categories still allows for the assessment of ongoing mitigation measures. Mitigation measures to avoid obstructions and live bottom habitats have focused on either the removal of a limited set of known locations from the trawl survey sampling universe prior to the site selection process, or post selection utilizing protocols developed by FWRI in 2013. The protocols primarily rely on the annual addition of sites at which trawls have been hanged or caught coral or sponge in excess of 50 kg, and use additional external GIS habitat and obstruction datasets to inform the positioning of trawl operations. SEAMAP will be combining the site selection process, the FWRI protocols and the integration of all available benthic habitat data into a single process in the near future. The goal is to continually adjust the trawl sampling universe using the best available benthic habitat data to pre-emptively avoid obstructions and live bottom habitats. Unfortunately, minimizing gear damage/loss and impact to live bottom habitats based on regular updates to the trawl sampling universe will be a long-term cumulative effort without the benefit of large scale benthic habitat mapping efforts. Experimental efforts to identify obstructions and live bottom habitats utilizing scientific echo sounders and side scan sonar imaging are ongoing. The success of these efforts would allow for the active avoidance of obstructions and live bottom habitats prior to trawl operations, as well as contribute to overall benthic habitat mapping effort in the eastern GOM. However, the successful

avoidance of live bottom areas is not without tradeoffs. Preliminary analysis indicates that many of the reef fishes taken in SEAMAP trawls show a corresponding increase with catch of sponge and other epibiotic fauna. Avoidance of these areas will undoubtedly affect indices of abundance for species that show preference for these habitats. Accordingly, careful consideration is required as to whether efforts to reduce survey impacts to live-bottom habitats are in fact warranted given the value and uniqueness of the data provided for assessment and management of fisheries resources.

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The statements, findings, views, conclusions, and recommendations contained in this document are those of the authors, and do not necessarily reflect the views of the U.S. Departments of the Interior or Commerce, and should not be interpreted as representing the opinions or policies of the U.S. government. Mention of trade names or commercial products does not constitute their endorsement by the U.S. government.

Table 1. Species for which SEAMAP fishery-independent trawl data has been used to provide indices of relative abundance, estimates of bycatch and/or life history information for stock assessments.

Category	Common Name	Species
Fishes		
	Cobia	*Rachycentron canadum*
	Gag	*Mycteroperca microlepis*
	Gray Snapper	*Lutjanus griseus*
	Gray Triggerfish	*Balistes capriscus*
	Greater Amberjack	*Seriola dumerili*
	Gulf Menhaden	*Brevoortia patronus*
	King Mackerel	*Scomberomorus cavalla*
	Lane Snapper	*Lutjanus synagris*
	Red Grouper	*Epinephelus morio*
	Red Snapper	*Lutjanus campechanus*
	Spanish Mackerel	*Scomberomorus maculatus*
	Vermilion Snapper	*Rhomboplites aurorubens*
	Wenchman	*Pristipomoides aquilonaris*
	Yellowedge Grouper	*Hyporthodus flavolimbatus*
Sharks		
	Atlantic Sharpnose Shark	*Rhizoprionodon terraenovae*
	Blacknose Shark	*Carcharhinus acronotus*
	Bonnethead Shark	*Sphyrna tiburo*
	Smoothhound sharks	*Mustelus spp.*
Shrimps		
	Brown Shrimp	*Farfantepenaeus aztecus*
	Pink Shrimp	*Farfantepenaeus duorarum*
	White Shrimp	*Litopenaeus setiferus*

Table 2: Sampling effort, number of hanged tows, percentage of hanged tows, number of tows with coral, percentage of tows with coral, coral biomass, coral percentage of total biomass, number of tows with sponge, percentage of tows with sponge, sponge biomass, sponge percentage of total biomass, number of tows with sponge in excess of 50 kg, percentage of tows with sponge >50 kg, total biomass of sponge >50 kg, sponge > 50 kg percent of total biomass and sponge > 50 kg percent of total sponge biomass by NMFS statistical zone and in total from SEAMAP Trawl surveys conducted in the eastern Gulf of Mexico from 2008 to 2015.

NMFS Statistical Zone	Total Tows	Hanged Tows	Hanged (%)	Coral Tows	Coral Tows (%)	Coral Biomass (kg)	Coral % of Total Biomass	Sponge Tows	Sponge Tows (%)	Sponge Biomass (kg)	Sponge % of Total Biomass	Sponge >50kg Tows	Sponge >50kg Tows (%)	Sponge >50kg Biomass (kg)	Sponge >50kg % of Sponge Biomass
11	396	3	0.76	0	0	0	0	4	1.01	1.4	0.01				
10	175	11	6.29	3	1.71	0.07	0.00	13	7.43	45.2	0.99				
9	176	11	6.25	4	2.27	1.48	0.03	27	15.34	255.4	4.41	2	1.14	140.2	54.88
8	220	9	4.09	7	3.18	48.49	0.52	35	15.91	427.3	4.62	2	0.91	116.3	27.22
7	228	34	14.91	9	3.95	88.79	0.73	125	54.82	6161.1	50.62	32	14.04	5230.9	84.90
6	370	34	9.19	19	5.14	78.64	0.35	222	60.00	12479.1	56.12	53	14.32	10930.4	87.59
5	320	18	5.63	2	0.63	5.44	0.04	169	52.81	3348.0	22.00	16	5.00	2430.9	72.61
4	306	6	1.96	3	0.98	0.43	0.00	194	63.40	7153.6	34.44	39	12.75	5724.8	80.03
3	274	6	2.19	2	0.73	0.22	0.00	207	75.55	13760.4	54.04	61	22.26	11865.9	86.23
2	78	1	1.28	0	0.00	0.00	0.00	39	50.00	795.8	30.35	4	5.13	481.2	60.47
1	3	0	0.00	0	0.00	0.00	0.00	2	66.67	35.5	24.01				
All	2546	133	5.22	49	1.92	223.56	0.16	1037	40.73	44462.8	31.47	209	8.21	36920.6	83.04

Table 3. Number of occurrences and weights of individual coral taxa. Asterisk (*) denotes no weight taken.

Taxonomic Hierarchy	Taxa	Occurrences	Weight (kg)
Phylum	Cnidaria		
Class	Anthozoa		
Subclass	Octocorallia	1	*
Order	Alcyonacea (soft corals)		
Suborder	Holaxonia	2	0.828
Family	Gorgoniidae	5	47.502
Genus	*Gorgonia*	6	1.922
Genus	*Leptogorgia*	1	0.628
Genus	*Lophogorgia*	2	1.000
Genus	*Pseudopterogorgia*	1	*
Family	Plexauridae	1	0.046
Genus	*Eunicea*	1	0.001
Genus	*Muricea*	2	0.118
Genus	*Plexaura*	1	0.169
Genus	*Pseudoplexaura*	3	0.389
Family	Paramuriceidae		
Genus	*Echinomuricea*	1	0.076
Suborder	Scleraxonia		
Family	Coralliidae	13	103.793
Genus	Titanideum		
Species	*Titanideum frauenfeldii*	1	0.004
Family	Anthothelidae		
Order	Pennatulacea (sea pens)		
Suborder	Subselliflorae		
Family	Virgulariidae		
Genus	*Stylatula*		
Species	*Stylatula antillarum*	1	0.010
Subclass	Hexacorallia		
Order	Antipatharia (black corals)		
Family	Antipathidae	2	0.674
Subclass	Scleractinia (stony corals)	9	66.083
Order	Faviina		
Family	Oculinidae		
Genus	*Oculina*		
Species	*Oculina diffusa*	2	0.054
Suborder	Caryophylliina		
Family	Caryophylliidae		
Genus	Cladocora	2	0.258
	All Corals		223.555

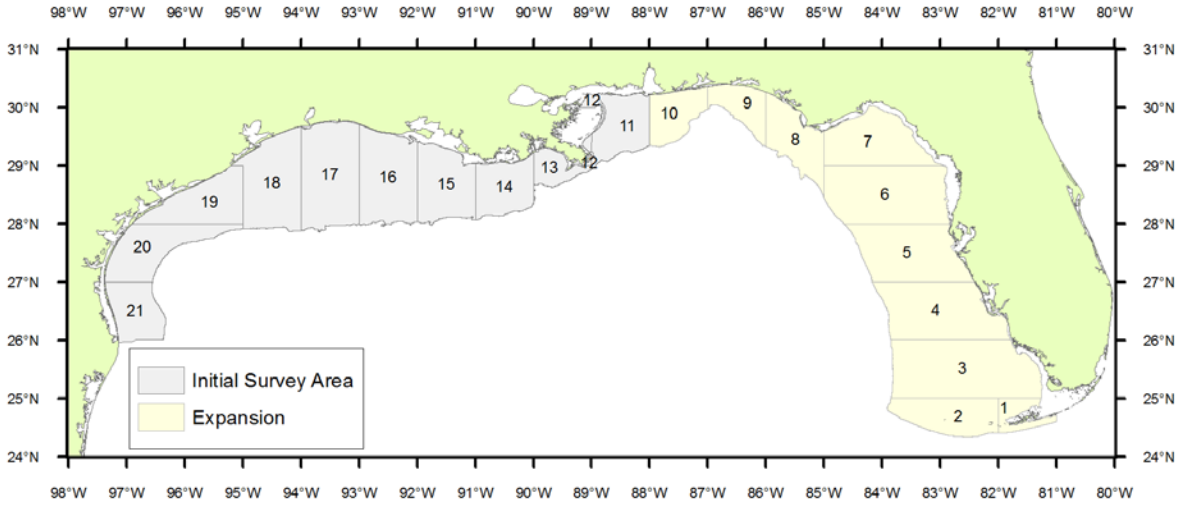

Figure 1. Spatial coverage of SEAMAP Summer and Fall Trawl Surveys in the northern Gulf of Mexico.

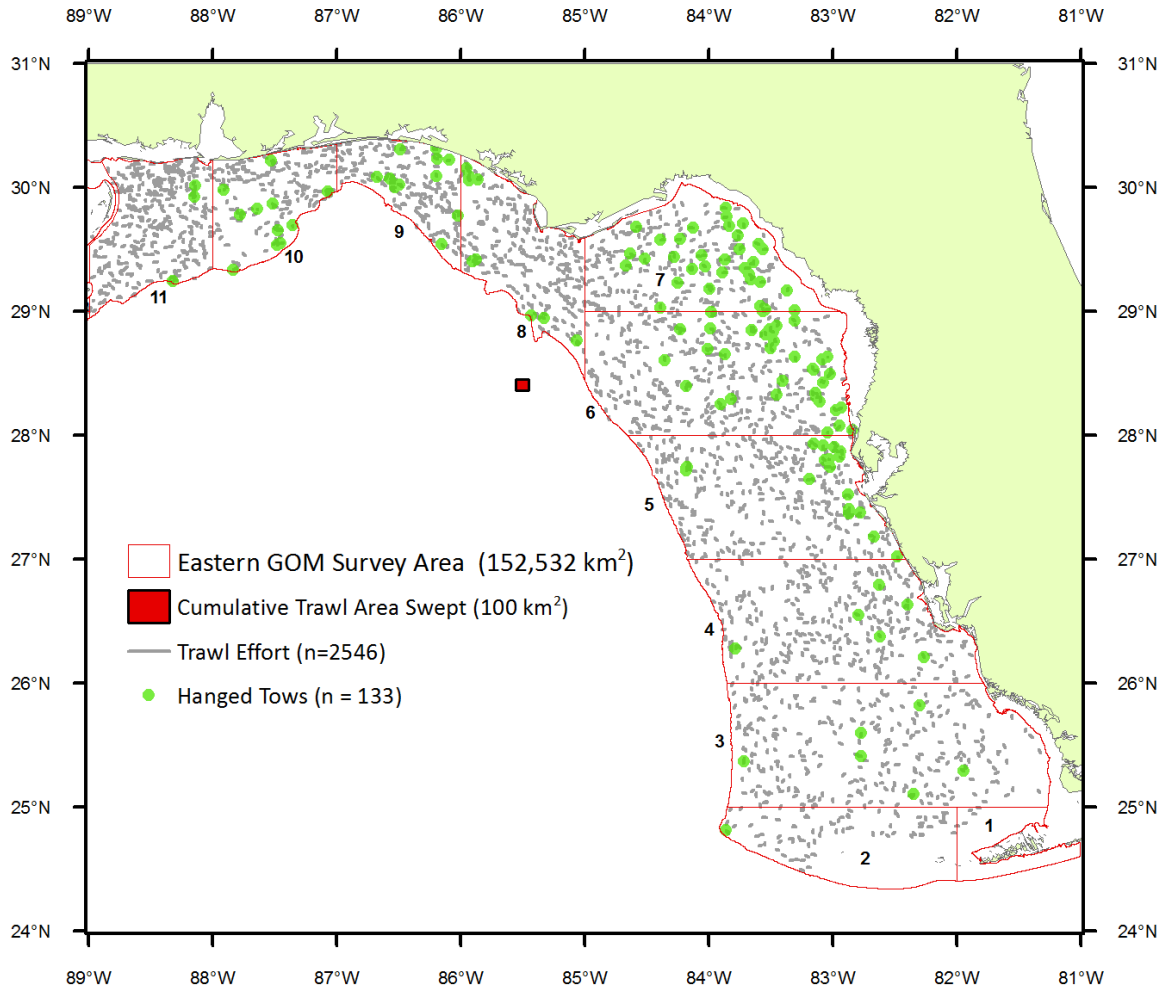

Figure 2. The occurrence of hanged tows from SEAMAP Trawl surveys conducted in the eastern Gulf of Mexico from 2008 to 2015.

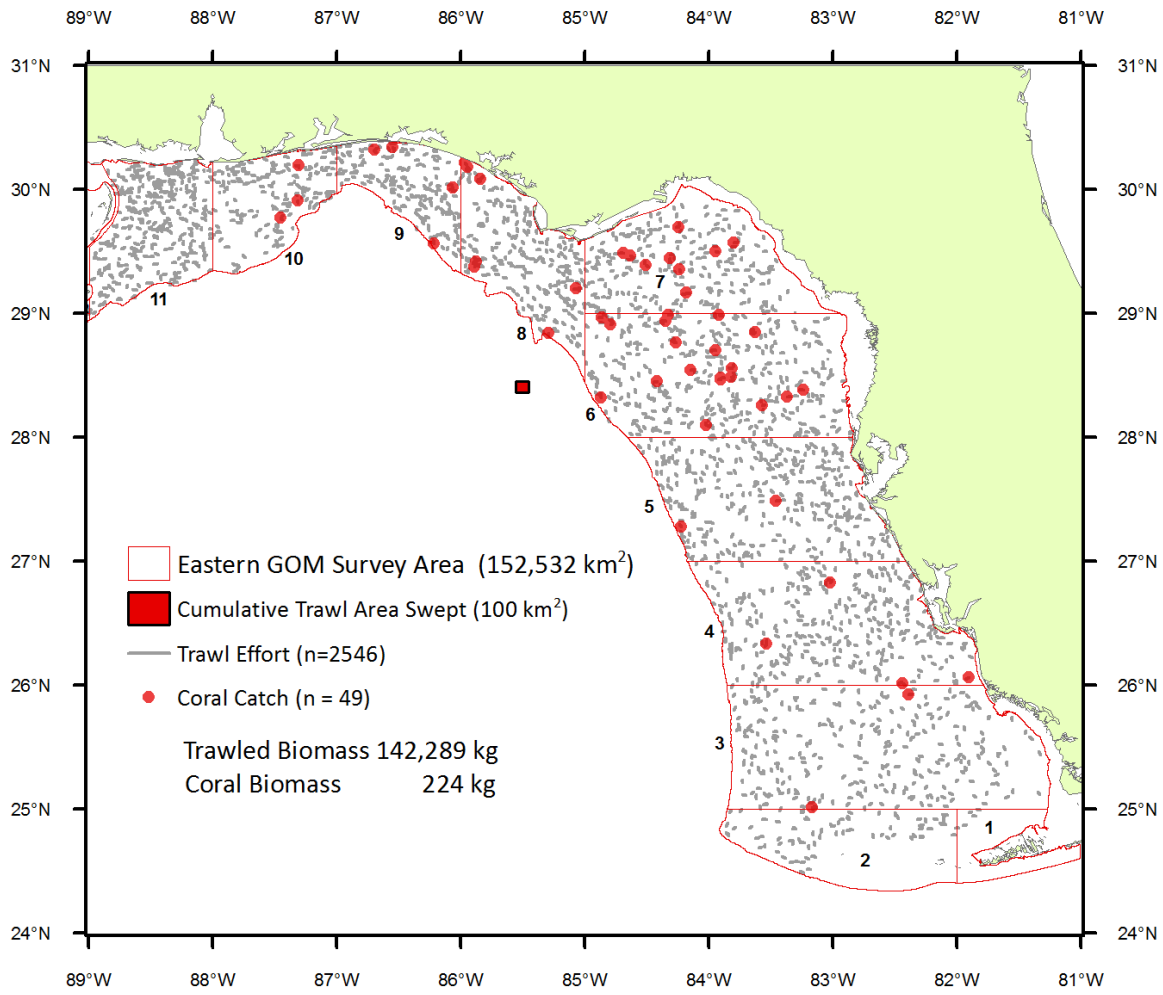

Figure 3. The occurrence of corals from SEAMAP Trawl surveys conducted in the eastern Gulf of Mexico from 2008 to 2015.

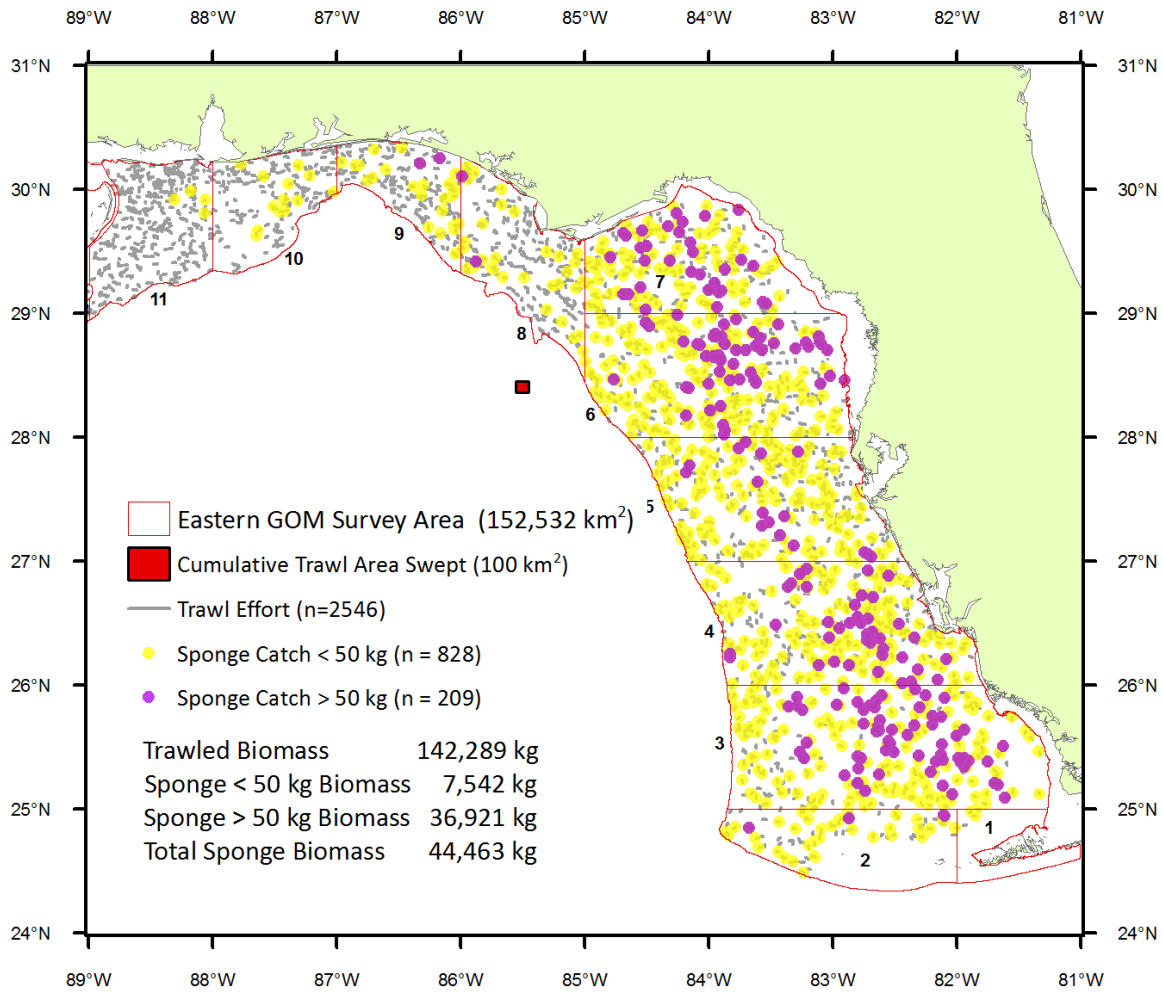

Figure 4. The occurrence of sponge from SEAMAP Trawl surveys conducted in the eastern Gulf of Mexico from 2008 to 2015.

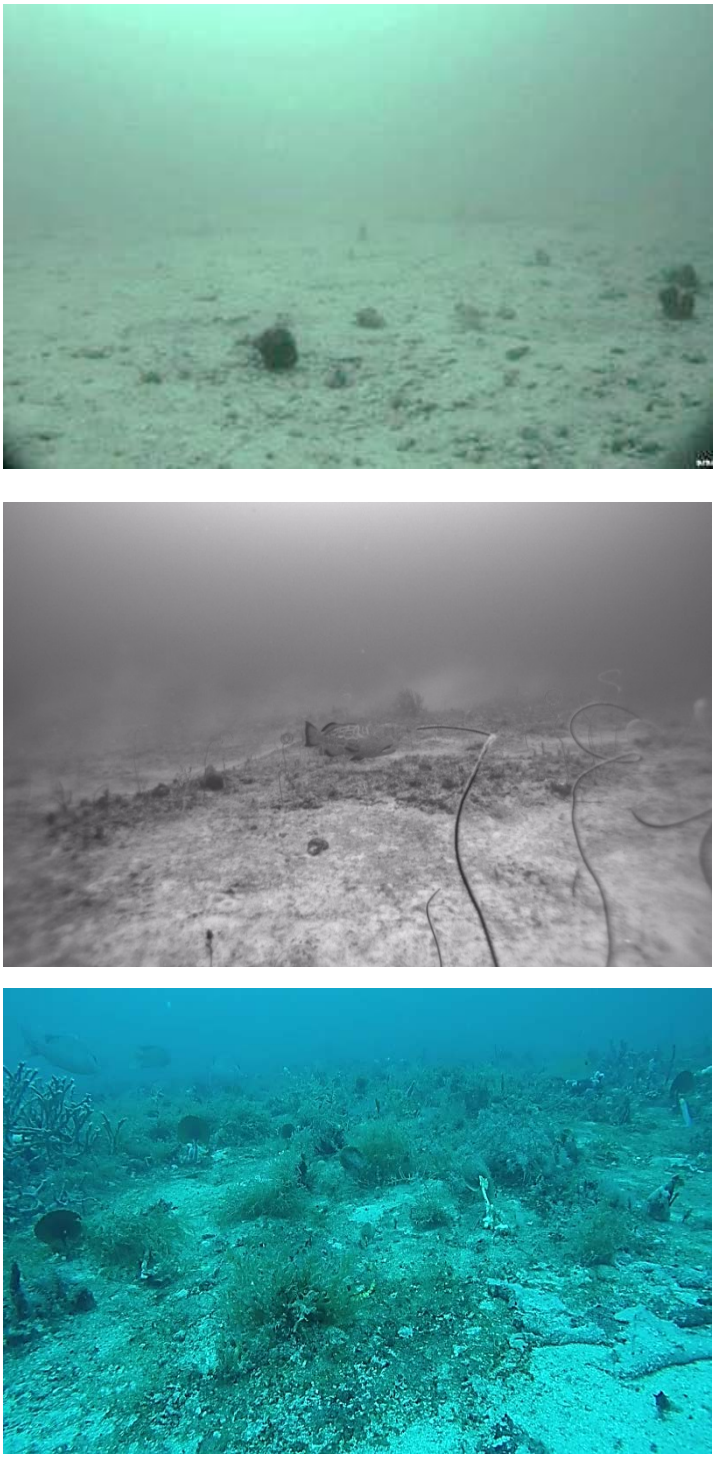

Figure 5. Areas identified as low relief flat hardbottom from sidescan sonar, representing the continuum of lower (top) to higher (bottom) quality epibiotic habitat. Images are courtesy of the Florida Wildlife Research Institute Fisheries Independent Monitoring Program (FWRI FIM).