# Describing Habitat Utilization and Life History Characteristics of Deep-Water Snappers Targeted by the Deep-Water Snapper Fishery in Puerto Rico

**EFP Final Report**

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## Introduction

The National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries lab in Panama City, FL was awarded funding to conduct a project titled, "A comprehensive US Caribbean Fishery-Independent Survey utilizing stereo video and hook and line methods to assess the deep water snapper-grouper complex in Puerto Rico" through the Cooperative Research Program. This project's goal was to complete a year of research utilizing a working relationship with commercial fishermen to develop and use low cost methods to gain information regarding the deep-water habitats and the deep-water fishery in Puerto Rico. A scientific and technical consulting service, HJR Reefscaping, provided a commercial fishing vessel and accompanying fishery observers to conduct the fieldwork in Puerto Rico, which operated from March-August, 2021.

This project built upon the results and recommendations of two prior fishery-independent surveys conducted over the course of five years by the National Marine Fisheries Service and the University of Miami Rosenstiel School of Marine and Atmospheric Science in Puerto Rico. These joint projects utilized GoPro video and hook and line fishing to characterize the deep-water snapper-grouper complex from 50-450 m depths. Previous video sampling methods did not encompass the full depth range of the targeted deep-water snapper species due to limits on sampling gear. This project's intent was to extend the sampling range from 100-650 m, to explore possible maximum depth ranges of species within the snapper-grouper complex and reduce sampling bias. This was done by implementing an optimized fishery-independent survey design, including advanced technologies, which improved our ability to track changes in fish size and abundance through time and assess the status and trends of deep-water fishery species. The project developed and trialed a stereo-baited remote underwater video (S-BRUV) array, which utilized the addition of optical imagery in the form of custom-built, paired, deep-water stereo-video cameras, which allowed for the collection of non-destructive size composition data, to 650 m depths (Figure 1). The S-BRUV array frame was constructed out of stainless steel, in a tripod formation. The cameras were mounted to the top of the tripod, via a stainless steel platform. The platform allowed the cameras to be permanently mounted in place, to not to compromise the stereo calibrations completed prior to the start of field sampling. An aluminum rod was secured through the middle of the tripod, and served as a mounting point for the lights, stereo-video battery housing, temperature depth sensor (TDR), and float (Figure 1). Wavelength modified LED lights were developed and include on the S-BRUV to reduce bias of deep-water fishes not approaching the array.

Stereo imagery, coupled with biological sampling from hook and line fishing, provided us with data for age, growth, and reproductive studies on data poor, deep-water species in the US Caribbean such as silk snapper (*Lutjanus vivanus*), queen snapper (*Etelis oculatus*), blackfin snapper (*Lutjanus buccanella*), and black snapper (*Apsilius dentatus*), and catch per unit effort indices for both target and other species in the snapper-grouper complex. These data will be of great benefit to upcoming stock assessments in Puerto Rico. The creation of a deep-water stereo camera system provides size and abundance data for data-poor species, diversity indices, as well as providing groundtruthing for multibeam mapping data. Deep-water stereo-video systems have never been implemented in the US Caribbean, and as such, the design of the system alone is providing us with technology that is directly transferable to other organizations and regions, where it can be reproduced at low cost to gather data on distribution, abundance, and length composition for species of interest.

## Objectives

The primary objectives of this survey were as follows:

1. Develop fishery-independent sampling methods utilizing stereo-video imagery and wavelength modified LED lights that reduce bias and provide non-destructive data.
2. Deploy S-BRUV array and hook and line fishing gear at a maximum of 100 survey stations.
3. Generate non-destructive length estimates utilizing stereo-video for exploited reef fishes.
4. Provide groundtruthing for multibeam mapping efforts via habitat classification from video.
5. Develop species richness and a diversity index for both recorded video and catch data.
6. Estimate abundance indices (e.g., catch-per-unit effort and video minimum counts)

7. Generate length composition of principal exploited snapper species, including queen snapper (*Etelis oculatus*), silk snapper (*Lutjanus vivanus*), blackfin snapper (*Lutjanus buccanella*), vermilion snapper (*Rhomboplites aurorubens*), black snapper (*Apsilus dentatus),* wenchman snapper (*Pristipomoides aquilonaris*), and cardinal snapper (*Pristipomoides macrophthalmus*).
8. Provide biological samples (paired otoliths, gonads, and eye lenses) from queen, silk, blackfin, and black snapper to fill data gaps in ongoing growth predictions, age validation, and reproductive studies in order to give the Caribbean Fishery Management Council (CFMC) more insight into management for these species.

**Methods**

Sampling was conducted following a stratified random statistical survey design. The randomly selected sites from each region were center points of 500 x 500 m boxes in a grid system. Two hundred sampling sites were selected at random for the W/NW coast of Puerto Rico, stratified by depth and rugosity scores as defined by University of Miami Rosenstiel Marine and Atmospheric Science (RSMAS) and National Centers for Coastal Ocean Science (NCCOS) multibeam backscatter and bathymetry data. One hundred of two hundred sites were randomly selected to complete based on factors such as weather and sea state. The sampling procedure within a selected grid cell, termed the Standard Fishing Sample, is summarized in Table 1.

Deployment of the S-BRUV system and separate fishing line by commercial Captain and observer occurred at the provided coordinates on the site selection sheet. Deployment(s) at a site consisted of one exploratory line deployed with a weight to test the current speed and direction at depth, one S-BRUV deployment and retrieval, and one vertical hook and line deployment and retrieval (the latter in two, ten-minute intervals). The exploratory line with a weight was deployed first to test direction and speed of current at the bottom. This ensured that currents at the seafloor were conducive to a stable deployment and successful recovery of the S-BRUV. Upon retrieval of the exploratory line, the S-BRUV was baited with a combination of *Loligo* and tuna, and deployed at the selected coordinates for a bottom time of 30 minutes, once the system reached the seafloor. Upon retrieval of the S-BRUV, the baited (combination of *Loligo* and tuna) vertical hook and line was deployed at the same coordinates, with the Captain repositioning the vessel as necessary. The deployment of the fishing line was followed by a 20 minute 'Fishing Time', which began once the hook and line set reached the seafloor. The 'Fishing Time' was defined as the total elapsed bottom time for the gear, not including the time for deployment to the bottom, or retrieval. The Captain and observer were allowed to retrieve the hook and line, rebait, remove caught fish, and re-deploy once, at ten minutes of bottom time. After a total 'Fishing Time' of 20 minutes elapsed, the hook and line was retrieved. All fish caught on hook and line were identified and measured (total length, fork length). Fish were either: 1) tagged and kept in the cooler for further biological sampling on land (target snapper species), 2) retained by Captain if not a target species and within season, or 3) vented (if needed) and released. The exact latitude and longitude in decimal degrees was recorded at the exact time the S-BRUV was deployed from the boat, at the beginning of S-BRUV retrieval from the seafloor, the hook and lines(s) deployment from boat, and the retrieval of the hook and line(s) from seafloor.

Videos and field datasheets were downloaded at the end of a field day and uploaded to a shared Google Drive for review by principal investigator K. Overly. Uploaded videos are currently undergoing review. Videos are read for a total of 20 minutes and fish species are identified to the lowest taxonomic level possible on a high-resolution video monitor. Minimum counts (maximum number of fish observed in a single frame) will be recorded for each species. Habitat will be classified according to Coastal and Marine Ecological Classification Standards (CMECS), which was created with the intention of unifying classification efforts for integration and comparisons of data among organizations and surveys. Teleosts, elasmobranchs, and invertebrates will be measured at their respective minimum count to the nearest millimeter using stereo-video measurement software (SeaGIS).

**Preliminary Results**

Sampling methods were successfully trialed and the S-BRUV array continues to undergo minor changes to improve stability in the deep-water reef environments. A total of 83 videos were recorded and uploaded over the course of 29 sampling day (Figure 2). All videos are accounted for and have been prepped for fish and invertebrate identification, minimum counts, and habitat classification. Preliminary SeaGIS measurements have been computed, confirming that the calibrations for the stereo-video cameras are accurate and function in the deepwater environment (Figure 3). All field sampling data has been transcribed into the excel database.

The target snapper species caught each field-sampling day were processed by the fishery observer and delivered to Wilson Santiago (contracted by the DNER Fisheries Research Lab) where they were recorded and shipped to University of South Carolina Aiken, and the NOAA Fisheries Labratory in Panama City, FL for further processing in ongoing age, growth and reproductive studies. Of the target snapper species, a total of 32 queen snapper, 15 silk snapper, 3 blackfin snapper, and 1 black snapper were caught and processed. Otolith samples will be sectioned, and undergo age estimation. The eye lens cores will be extracted from the eyes for use in bomb radiocarbon chronometer age validation. Gonad samples will be processed and staged, and sex will be confirmed microscopically.

Pictures were taken of incidental catch for preliminary identification at sea, and a tissue sample was collected for processing if the species was unknown. Tissue samples taken from incidental catch will be utilized to ensure correct species identifications, provide new information regarding the biodiversity and taxonomic richness of deep-water habitats around Puerto Rico, and to identify unknown specimens. To date, tissue samples have been taken from several deep-water shark species, eels, and various other incidental catch. Incidental catch species outside of the deep-water snapper-grouper complex that have been identified include: tilefishes (*Caulolatilus spp.*) beardfish (*Polymixia nobilis*), flagfin (*Aulopus filamentosus*), lizardfish (*Synodus spp.*), lanternbelly (*Synagrops spp., Verilus sordidus*), squirrelfish (*Ostichthys trachypoma*), tattler (*Serranus notospilus*), eels (*Gymnothorax spp.*, *Ophichthus rex, O. spp.*), and several shark species (*Carcharhinus spp.*, *Centrophorus spp.*, *Mustelus spp., Scyliorhinus spp., Squalus clarkae, S. spp.*).

All sampled survey sites and their associated general habitat classification are listed in Appendix A, alongside their corresponding region, depth and coordinates. One station was sampled in federal waters in the exempted fishing area of Bajo de Sico during the month of May; however, no fish were caught at this station (Figure 2). No fish were caught during seasonal closures, which was a direct result of delayed sampling due to the COVID-19 pandemic. No protected species were encountered during the duration of this EFP.

Total catch, range of lengths (mm), and average length (mm) for all species caught on hook and line gear is summarized in Table 2. Within the snapper-grouper complex, species caught starting with the highest frequency included: queen snapper (n=32), silk snapper (n=15), wenchman snapper (n=15), vermilion snapper (n=9), cardinal snapper (n=7), blackfin snapper (n=3), black snapper (n=1), snowy grouper (n=1), misty grouper (n=1), and red hind (n=1). Fewer target species were caught under this permit when compared to the previous EFP held from 2018-2020, which is likely due to an increase in maximum sampling depth (from 450 m to 650 m) where species in the snapper-grouper complex do not commonly reside. Catch per month of each species is summarized in Table 3. Deposition of all species caught on hook and line fishing is recorded in Table 4.

One S-BRUV array was lost during deployment due to the vessel's prop cutting the line. Following the equipment loss, preventative measures were discussed and implemented with the Captain and onboard observer. The Captain moved the electronic fishing reel that was used in deployment towards the bow of the vessel to assist with keeping the line clear of the prop as the S-BRUV array descends. Additionally, as the observer wrote down deployment data, they served as an extra set of eyes on the line if the Captain needed to reposition the vessel as the S-BRUV was deployed. The Captain began to announce aloud when he was repositioning the vessel, so both the deckhand and observer could monitor the line. Lastly, if there was any risk of the S-BRUV line coming near the prop, the

Captain turned the engines off immediately at the notice of the deckhand and observer.

Data collected in this study is providing critical information on data-poor, deep-water snapper life history and habitat associations to improve management and conservation of this deep-water fisheries resource. Analyzing habitat utilization and the distribution will not only add to our limited knowledge regarding habitat preference, but results could also be incorporated into spatial planning under ecosystem-based fisheries management (EBFM).

Two publications in preparation that include samples collected in Puerto Rico:

Overly, K.E. and V. Lecours. 2021 (in prep). Mapping Queen Snapper (Etelis oculatus) Suitable Habitat in Puerto Rico Using Ensemble Species Distribution Modeling

Overly, K.E., W.F. Patterson III, and V.R. Shervette. 2021 (in prep). Caribbean deep-water snappers: novel application of the radiocarbon chronometer in understanding aspects of ecology and life history

Table 1. Standardized fishing method followed by commercial fishermen in the western region of Puerto Rico for the duration of this project.

| Category | Item | Specification |
|---|---|---|
| **Gear Specifications** | Type | Vertical Hook-Line, Electric Reel |
| | Number of Lines Fished Per Site (Hook and Line set) | 1 (split into two, 10 minute bottom times) |
| | Number of Hooks (Hook and Line set) | 12 |
| | Hook Type, Size (Hook and Line set) | Circle, #9 |
| | Length of Leader Line Attaching Hooks to Main Line (Hook and Line set) | 6" |
| | Spacing between Leaders/Hooks Along Main Line (Hook and Line set) | 18" |
| | Weights on end of Main Line (Hook and Line set) | 5-10 lbs (specify amount on datasheet; left to Captain's judgement) |
| | Bait (S-BRUV and Hook and Line Set) | S-BRUV bait arm: California Squid (*Loligo*) AND tuna (*Thunnus*) combined in S-BRUV bait box; Four *Loligo* and four 2"x2"x2" chunks of Tuna.<br><br>Hook and Line: bait with *Loligo* and tuna, with a differing bait everyone other hook. |
| **Fishing Sample** | Site Coordinates (Provided by NOAA) | Decimal degrees |
| | Bottom Time for Equipment At Each Site | 30 min bottom time for S-BRUV; 20 min total bottom time for hook and line |
| **Daily Trip** | Trip Duration (Dock to Dock Time) | 10-12 hrs |
| | Maximum Distance from Port | 12 nautical miles |
| | Estimated Average Sites per Trip Day | 3-5 |

Table 2. Quantity, range of lengths in millimeters, and average length in millimeters of all species obtained from hook and line sampling.

| Species | Count | Range TL (mm) | Average TL (mm) | Range FL (mm) | Average FL (mm) |
|---|---|---|---|---|---|
| *Apsilus dentatus* | 1 | 545 | 545 | 501 | 501 |
| *Aulopus filamentosus* | 1 | 293 | 293 | 259 | 259 |
| *Carcharhinus spp.* | 2 | 850-900 | 875 | 730-760 | 745 |
| *Cauloltaus spp* | 1 | 340 | 340 | 325 | 325 |
| *Centrophorus spp* | 1 | 1020 | 1020 | 900 | 900 |
| *Epinephelus guttatus* | 1 | 213 | 213 | 205 | 205 |
| *Etelis oculatus* | 32 | 272-877 | 421 | 215-725 | 343 |
| *Gymnothorax spp* | 3 | 530-705 | 602 | | |
| *Hyporthodus mystacinus* | 1 | 465 | 465 | | |
| *Hyporthodus niveatus* | 1 | 280 | 280 | | 280 |
| *Lutjanus buccanella* | 3 | 245-375 | 300 | 227-340 | 275 |
| *Lutjanus vivanus* | 15 | 235-430 | 314 | 250-395 | 287 |
| *Mustelus spp* | 6 | 480-800 | 574 | 430-680 | 502 |
| *Ophichthus rex* | 4 | 750-960 | 885 | | |
| *Ophichtus spp* | 1 | 620 | 620 | | |
| *Ostichthys trachypoma* | 1 | 20 | 200 | 180 | 180 |
| *Polymixia nobilus* | 2 | 210-240 | 225 | 180-200 | 190 |
| *Pristipomoides aquilonaris* | 15 | 200-265 | 239 | 141-221 | 198 |
| *Pristipomoides maculatus* | 7 | 303-423 | 334 | 262-360 | 288 |
| *Rhomboplites aurorubens* | 9 | 239-350 | 293 | 215-310 | 263 |
| *Scyliorhinus spp* | 1 | 500 | 500 | | |
| *Serranus notospilus* | 1 | 222 | 222 | 207 | 207 |
| *Squalus clarkae* | 12 | 240-570 | 447 | 245-500 | 393 |
| *Squalus spp* | 25 | 410-705 | 527 | 345-620 | 452 |
| *Synagrops spp* | 1 | 242 | 242 | 215 | 215 |
| *Synodus spp* | 2 | 375-455 | 415 | 332-407 | 370 |
| *Verilus sordidus* | 4 | 332-375 | 359 | 297-340 | 323 |

Table 3. Quantity of fish caught per month obtained from hook and line sampling.

| | Month | | | | | | |
|---|---|---|---|---|---|---|---|
| **Species** | **March** | **April** | **May** | **June** | **July** | **August** | **Total** |
| *Apsilus dentatus* | | | 1 | | | | 1 |
| *Aulopus filamentosus* | | | | | 1 | | 1 |
| *Carcharhinus spp.* | 1 | | 1 | | | | 2 |
| *Cauloltaus spp* | | 1 | | | | | 1 |
| *Centrophorus spp* | | 1 | | | | | 1 |
| *Epinephelus guttatus* | 1 | | | | | | 1 |
| *Etelis oculatus* | 3 | | 7 | 2 | 14 | 6 | 32 |
| *Gymnothorax spp* | | | | | 3 | | 3 |
| *Hyporthodus mystacinus* | | | | | 1 | | 1 |
| *Hyporthodus niveatus* | | | 1 | | | | 1 |
| *Lutjanus buccanella* | 2 | | 1 | | | | 3 |
| *Lutjanus vivanus* | 1 | 3 | 2 | 5 | 4 | | 15 |
| *Mustelus spp* | | 4 | 1 | | 1 | | 6 |
| *Ophichthus rex* | 4 | | | | | | 4 |
| *Ophichtus spp* | | | 1 | | | | 1 |
| *Ostichthys trachypoma* | 1 | | | | | | 1 |
| *Polymixia nobilus* | | | | 2 | | | 2 |
| *Pristipomoides aquilonaris* | 2 | 1 | 1 | 2 | 8 | 1 | 15 |
| *Pristipomoides maculatus* | 1 | 1 | | | 3 | 2 | 7 |
| *Rhomboplites aurorubens* | | 1 | | | 6 | 2 | 9 |
| *Scyliorhinus spp* | | 1 | | | | | 1 |
| *Serranus notospilus* | | | | | 1 | | 1 |
| *Squalus clarkae* | 3 | 5 | 3 | | 1 | | 12 |
| *Squalus spp* | | 15 | | 5 | 5 | | 25 |
| *Synagrops spp* | | | | | | 1 | 1 |
| *Synodus spp* | | | | | 2 | | 2 |
| *Verilus sordidus* | | | | | 4 | | 4 |
| **Total Per Month** | 19 | 33 | 19 | 16 | 54 | 12 | 153 |

Table 4. Final deposition of each species caught using hook and line fishing methods.

| Species | Count | Total Kept | Total Disposed |
|---|---|---|---|
| *Apsilus dentatus* | 1 | 1 | 0 |
| *Aulopus filamentosus* | 1 | 1 | 0 |
| *Carcharhinus spp.* | 2 | 0 | 2 |
| *Cauloltaus spp* | 1 | 1 | 0 |
| *Centrophorus spp* | 1 | 0 | 1 |
| *Epinephelus guttatus* | 1 | 0 | 1 |
| *Etelis oculatus* | 32 | 32 | 0 |
| *Gymnothorax spp* | 3 | 0 | 3 |
| *Hyporthodus mystacinus* | 1 | 1 | 0 |
| *Hyporthodus niveatus* | 1 | 1 | 0 |
| *Lutjanus buccanella* | 3 | 3 | 0 |
| *Lutjanus vivanus* | 15 | 15 | 0 |
| *Mustelus spp* | 6 | 0 | 6 |
| *Ophichthus rex* | 4 | 1 | 3 |
| *Ophichtus spp* | 1 | 0 | 1 |
| *Ostichthys trachypoma* | 1 | 0 | 1 |
| *Polymixia nobilus* | 2 | 0 | 2 |
| *Pristipomoides aquilonaris* | 15 | 15 | 0 |
| *Pristipomoides maculatus* | 7 | 7 | 0 |
| *Rhomboplites aurorubens* | 9 | 9 | 0 |
| *Scyliorhinus spp* | 1 | 0 | 1 |
| *Serranus notospilus* | 1 | 1 | 0 |
| *Squalus clarkae* | 12 | 0 | 12 |
| *Squalus spp* | 25 | 0 | 25 |
| *Synagrops spp* | 1 | 1 | 0 |
| *Synodus spp* | 2 | 0 | 2 |
| *Verilus sordidus* | 4 | 0 | 4 |
| **Total** | 153 | 89 | 64 |

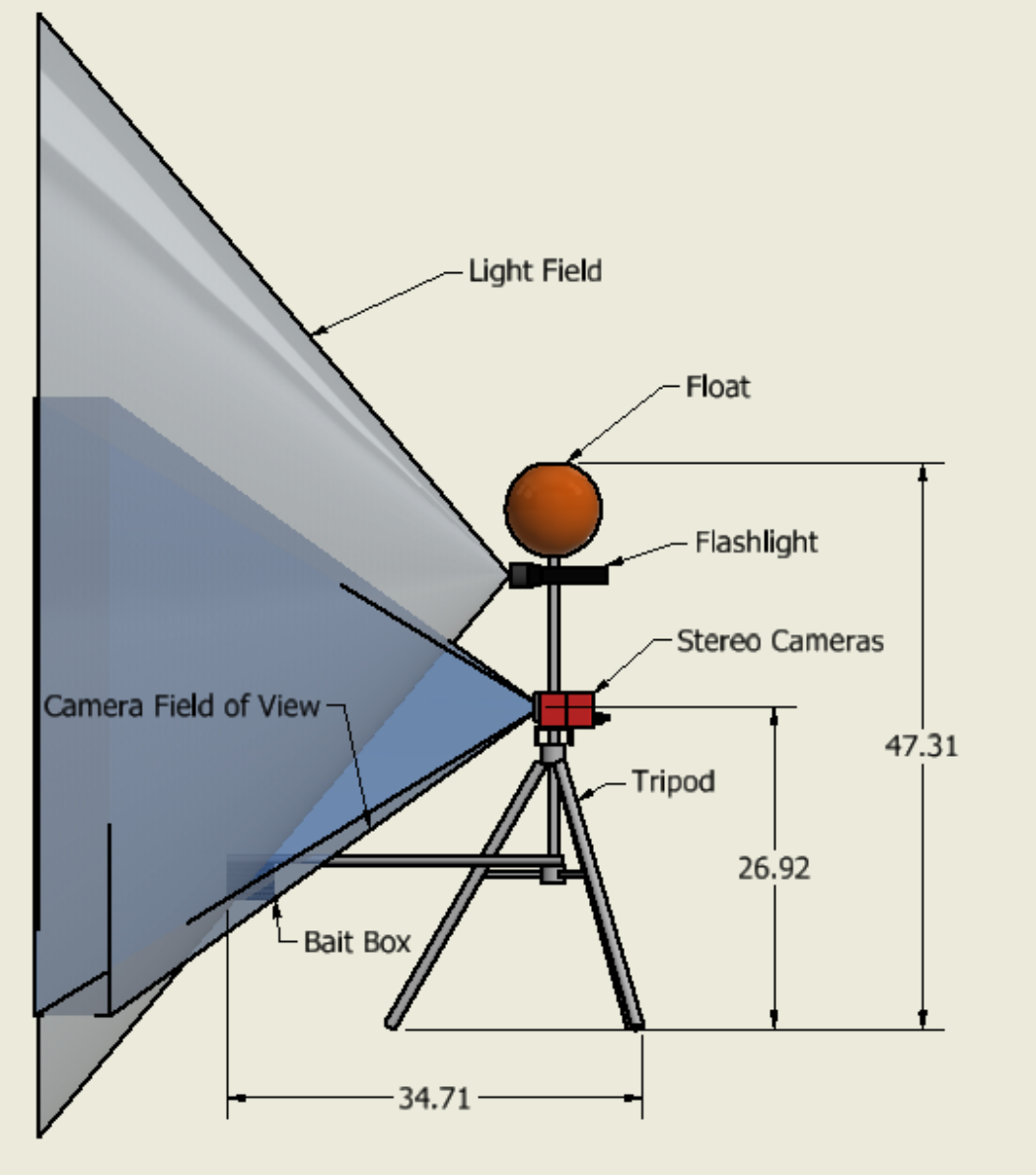


Figure 1. Schematic of S-BRUV array used in field sampling. All measurements are in inches.

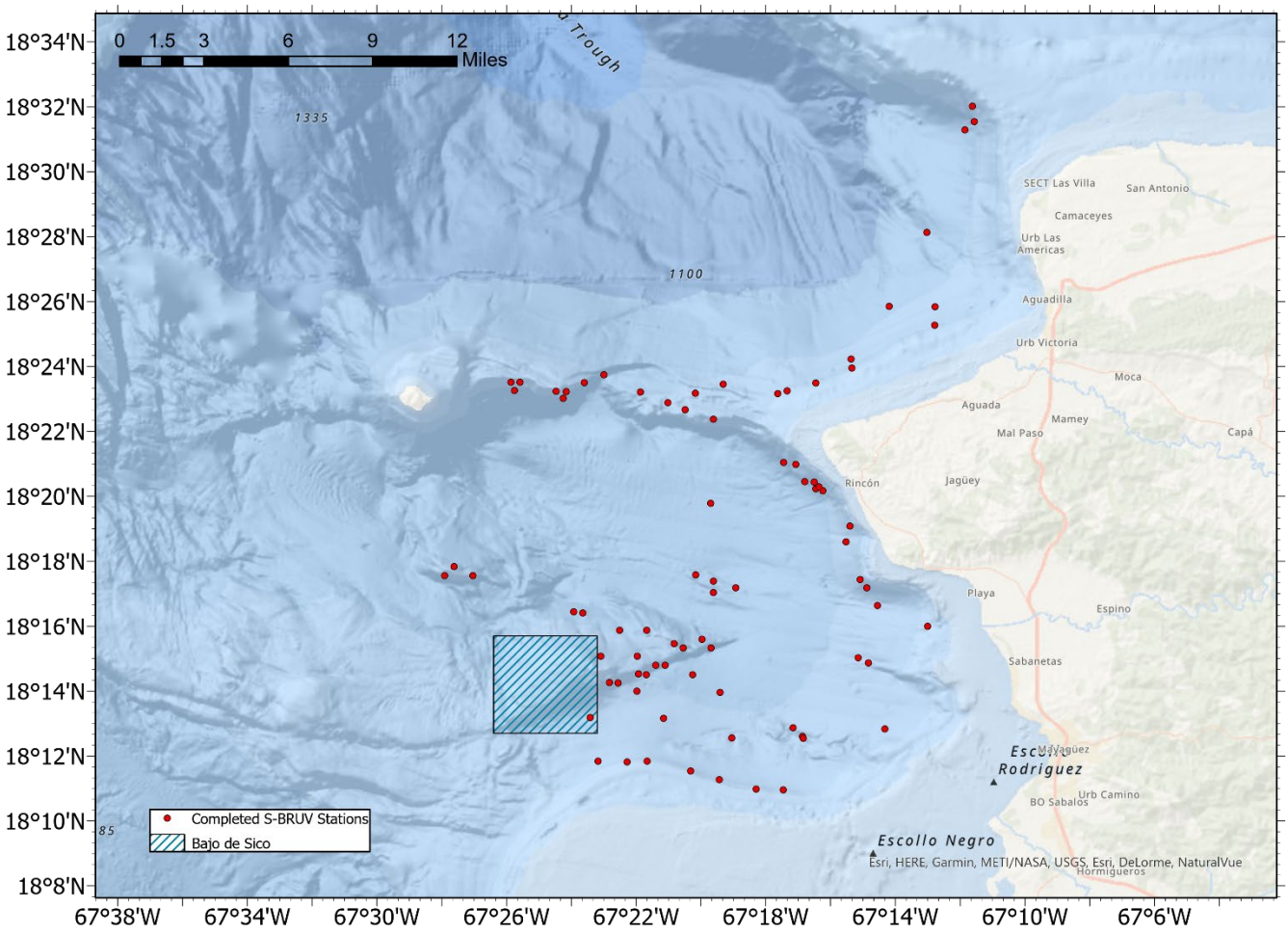


Figure 2. Map of sampling sites completed (red points) in 2021 with S-BRUV and hook and line fishing. The exempted fishing area of Bajo de Sico is depicted by the blue hatched square.

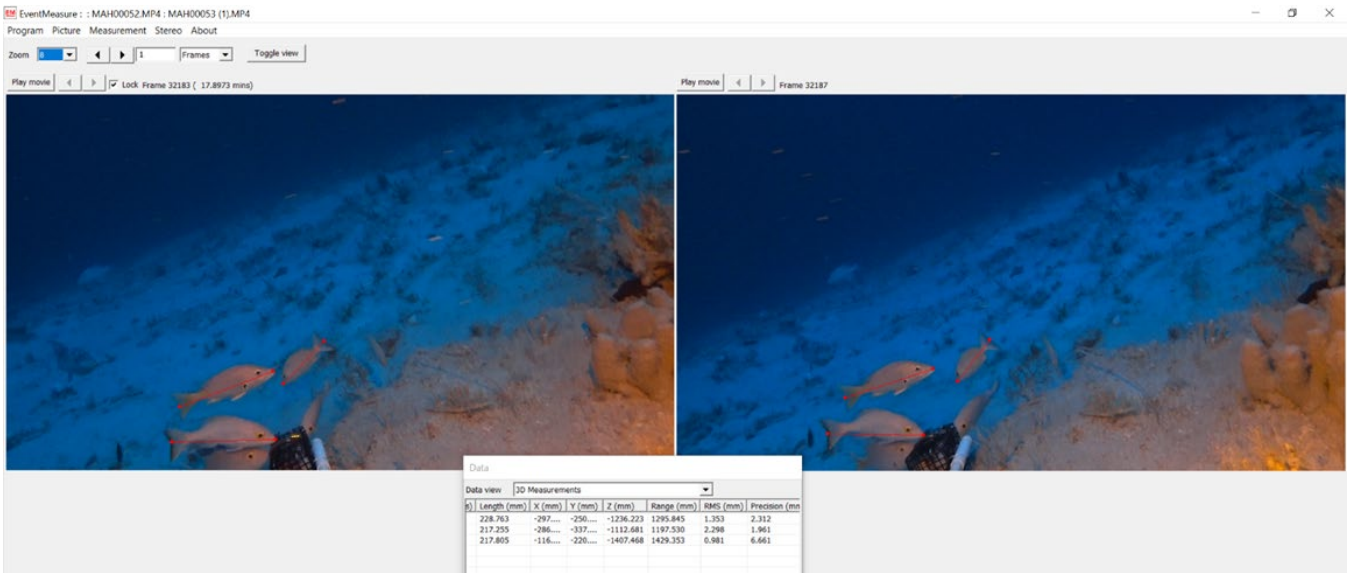


Figure 3. Length measurements of one blackfin snapper and two silk snapper using SeaGIS measurement software.

## Appendix A

All survey sites (n=83) sampled across the west coast of Puerto Rico. Listed in each row is the site name, the associated region, sampling year, latitude and longitude in decimal degrees, recorded depth in meters, and the general habitat classification from S-BRUV video. General habitat classifications are listed in the order of most coverage to least when multiple classifications existed.

| Site | Region | Year | Latitude | Longitude | Depth | General Habitat |
|---|---|---|---|---|---|---|
| 4584 | West | 2021 | 18.21 | -67.29 | 346 | NA |
| 4694 | West | 2021 | 18.21 | -67.28 | 346 | NA |
| 3625 | West | 2021 | 18.25 | -67.25 | 331 | Sand |
| 2944 | West | 2021 | 18.28 | -67.24 | 307 | Sand |
| 43 | West | 2021 | 18.35 | -67.29 | 408 | Sand |
| 1788 | West | 2021 | 18.39 | -67.27 | 110 | Rock, Sand, Epifauna |
| 2189 | West | 2021 | 18.35 | -67.28 | 260 | Sand |
| 1855 | West | 2021 | 18.39 | -67.29 | 165 | Epifauna, Sand |
| 3249 | West | 2021 | 18.26 | -67.36 | 397 | Sand |
| 3606 | West | 2021 | 18.25 | -67.37 | 307 | Epifauna, Sand |
| 1692 | West | 2021 | 18.40 | -67.38 | 476 | NA |
| 1846 | West | 2021 | 18.39 | -67.34 | 337 | Rock, Epifauna |
| 1967 | West | 2021 | 18.38 | -67.34 | 223 | Rock, Epifauna |
| 41 | West | 2021 | 18.29 | -67.32 | 594 | Sand |
| 40 | West | 2021 | 18.28 | -67.33 | 616 | Rock, Epifauna, Sand |
| 3369 | West | 2021 | 18.26 | -67.33 | 465 | Rock, Epifauna |
| 1838 | West | 2021 | 18.39 | -67.40 | 329 | NA |
| 44 | West | 2021 | 18.38 | -67.40 | 446 | NA |
| 2021 | West | 2021 | 18.37 | -67.33 | 187 | NA |
| 3602 | West | 2021 | 18.25 | -67.38 | 194 | Rock, Epifauna |
| 4106 | West | 2021 | 18.23 | -67.32 | 424 | Sand |
| 3731 | West | 2021 | 18.33 | -67.33 | 481 | Sand |
| 31 | West | 2021 | 18.47 | -67.22 | 604 | Rock, Epifauna |
| 1233 | West | 2021 | 18.43 | -67.21 | 294 | Sand |
| 1312 | West | 2021 | 18.42 | -67.21 | 181 | Sand, Epifauna |
| 3246 | West | 2021 | 18.26 | -67.38 | 415 | Sand |
| 3472 | West | 2021 | 18.25 | -67.00 | 221 | Sand, Epifauna |
| 3847 | West | 2021 | 18.24 | 42.00 | 296 | Rock, Epifauna |
| 4451[a] | West | 2021 | 18.22 | -67.39 | 296 | Sand, Epifauna |
| 4459 | West | 2021 | 18.22 | -67.35 | 340 | Sand |
| 1906 | West | 2021 | 18.38 | -67.35 | 358 | Rock, Epifauna |
| 886 | West | 2021 | 18.52 | -67.20 | 357 | Sand, Epifauna |
| 918 | West | 2021 | 18.53 | -67.19 | 366 | Sand |
| 847 | West | 2021 | 18.53 | -67.19 | 225 | Sand, Epifauna |
| 1228 | West | 2021 | 18.43 | -67.24 | 448 | Sand |
| 1548 | West | 2021 | 18.40 | -67.26 | 269 | Sand |
| 1629 | West | 2021 | 18.40 | -67.26 | 170 | Sand, Epifauna, Rock |
| 1856 | West | 2021 | 18.39 | -67.29 | 113 | Rock, Epifauna |
| 1837 | West | 2021 | 18.39 | -67.41 | 139 | Rock, Epifauna |

| | | | | | | |
|---|---|---|---|---|---|---|
| 1762 | West | 2021 | 18.39 | -67.43 | 247 | Rock, Epifauna |
| 1761 | West | 2021 | 18.39 | -67.43 | 256 | Rock, Epifauna |
| 5250 | West | 2021 | 18.18 | -67.29 | 165 | Sand |
| 5247 | West | 2021 | 18.18 | -67.30 | 104 | Rock, Epifauna, Sand |
| 3853 | West | 2021 | 18.24 | -67.34 | 439 | NA |
| 4594 | West | 2021 | 18.21 | -67.24 | 218 | Sand |
| 2858 | West | 2021 | 18.27 | -67.22 | 132 | Sand, Epifauna |
| 2778 | West | 2021 | 18.29 | -67.25 | 218 | Sand |
| 3488 | West | 2021 | 18.26 | -67.34 | 430 | Sand |
| 3726 | West | 2021 | 18.25 | -67.35 | 419 | Rock, Epifauna |
| 3725 | West | 2021 | 18.25 | -67.36 | 337 | Sand, Epifauna |
| 36 | West | 2021 | 18.29 | -67.34 | 640 | Sand Dunes |
| 35 | West | 2021 | 18.29 | -67.33 | 615 | Sand |
| 2709 | West | 2021 | 18.29 | -67.25 | 165 | Sand, Epifauna |
| 3491 | West | 2021 | 18.26 | -67.33 | 476 | Rock, Epifauna |
| 4097 | West | 2021 | 18.23 | -67.37 | 368 | Sand, Epifauna |
| 5157 | West | 2021 | 18.19 | -67.32 | 152 | Sand |
| 5069 | West | 2021 | 18.19 | -67.34 | 124 | Sand, Epifauna, Rock |
| 4973 | West | 2021 | 18.20 | -67.36 | 115 | Sand, Epifauna, Rock |
| 2641 | West | 2021 | 18.30 | -67.46 | 369 | Sand, Rock, Epifauna |
| 2698 | West | 2021 | 18.29 | -67.47 | 346 | Sand Dunes, Epifauna |
| 2701 | West | 2021 | 18.29 | -67.45 | 384 | Sand |
| 4968 | West | 2021 | 18.20 | -67.39 | 188 | Sand |
| 4971 | West | 2021 | 18.20 | -67.37 | 126 | Rock, Epifauna, Sand |
| 2406 | West | 2021 | 18.32 | -67.26 | 183 | Sand |
| 2241 | West | 2021 | 18.34 | -67.28 | 320 | Rock, Epifauna, Sand |
| 2021 | West | 2021 | 18.37 | -67.33 | 188 | Rock, Epifauna, Sand |
| 1778 | West | 2021 | 18.39 | -67.32 | 353 | Sand, Epifauna |
| 2266 | West | 2021 | 18.34 | -67.27 | 344 | Sand, Epifauna |
| 3969 | West | 2021 | 18.24 | -67.38 | 207 | Sand Dunes, Epifauna |
| 3970 | West | 2021 | 18.24 | -67.38 | 260 | Sand |
| 3848 | West | 2021 | 18.24 | -67.36 | 384 | Sand Dunes |
| 2267 | West | 2021 | 18.34 | -67.27 | 276 | Rock, Sand, Epifauna |
| 3028 | West | 2021 | 18.27 | -67.40 | 512 | Sand |
| 3029 | West | 2021 | 18.27 | -67.39 | 483 | Sand |
| 1840 | West | 2021 | 18.39 | -67.36 | 430 | NA |
| 1749 | West | 2021 | 18.39 | -67.39 | 329 | Rock, Epifauna |
| 45 | West | 2021 | 18.39 | -67.43 | 452 | NA |
| Site-01 | West | 2021 | 18.21 | -67.32 | 338 | Sand, Epifauna |
| Site-02 | West | 2021 | 18.21 | -67.28 | 320 | Rock, Epifauna, Sand |
| Site-03 | West | 2021 | 18.25 | -67.25 | 291 | Rock, Epifauna |
| Site-04 | West | 2021 | 18.34 | -67.27 | 267 | Sand |
| Site-05 | West | 2021 | 18.34 | -67.28 | 256 | Sand |
| Site-06 | West | 2021 | 18.31 | -67.26 | 293 | Sand |
| Site-07 | West | 2021 | 18.26 | -67.35 | 320 | Rock, Sand, Epifauna |

[a]Denotes the site sampled in Bajo de Sico.