Abundance and Distribution of Juvenile Mutton Snapper in Nearshore Seagrass Habitat in the Middle Florida Keys

Jessica Keller, Jack Olson, Ariel Tobin, Alejandro Acosta

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Abundance and Distribution of Juvenile Mutton Snapper in Nearshore Seagrass Habitat in the Middle Florida Keys

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Introduction:

Seagrass beds provide nursery habitat for many important snapper species in the Florida Keys, including mutton snapper. Understanding the recruitment of juvenile mutton snapper to seagrass beds could help with the management of these economically important snapper in the Keys. Therefore, the Florida Fish and Wildlife Research Institute's Finfish Research Program at the South Florida Regional Lab, in the Florida Keys has been conducting monthly seine surveys in the middle keys since 2006. These seine surveys aim to describe the distribution and abundance, species composition, size structure, and habitat usage of juvenile fishes in the middle Florida Keys. This seine dataset was used to look at the recruitment of mutton snapper and their habitat preferences.

Methods:

Sampling was conducted on the Atlantic side of the middle Keys in shallow (<1.3m deep) seagrass beds. Sites were selected by a habitat-based, stratified-random-sampling procedure based upon the "Benthic Habitats of the Florida Keys" Geographical Information System (GIS) (FDEP and NOAA, 1998). The middle Keys were divided into one-longitudinal- by one-latitudinal-minute [~1 nautical nm^2] sampling macrogrids (Fig 1). All grids touching land containing bottom habitat mapped as seagrass were included in the sampling universe. Each of these resultant grids was further subdivided into 100 microgrids (~0.01 nm^2) (Fig 1). Monthly sites were randomly selected from these microgrids.

One seine haul was conducted at each site during daylight hours using a 21.3m center-bag drag offshore seine net, constructed of knotless 3.2mm #35 Delta nylon-mesh and a 183cm x 183cm x 183cm bag. The net coverage area was approximately 140 m^2/haul. The net was set in open water away from the shoreline, oriented perpendicular or parallel to the tide, in water that was at least 0.3m deep. The seine was pulled by hand using PVC poles attached to the ends of the net. A 15.5m line was attached between the tops of the two end poles and kept taught in order to maintain a standardized distance between the end poles. Two small PVC tether poles with 9.1m of line attached were anchored in the substrate on both sides of the net adjacent to the starting point. In order to standardize the distance of the tow, the free end of these tether lines was attached to the seine end poles, and the net was pulled forward 9.1m until the tether lines became taught. At this point the tether lines were dropped and the seine ends were brought together encircling and trapping the fish. The ends of the net were then pulled together 90^o around a pivot pole in order to move the fish down into the bag. The bag was slowly inverted and the fish were removed from the net and placed in a five gallon bucket for processing.

All snappers collected were counted, measured to the nearest mm, and identified to the lowest possible taxon in the field, typically to species. Juvenile mutton Snapper were defined as fish that were < 100mm standard length (SL) and settlement-stage snapper were fish less than < 40mm SL. All other fish collected were counted, measured, and identified to the lowest possible taxon as well.

Hydrographic data, atmospheric and sea conditions, and observations relative to bottom type including water depth, substrate type, submerged aquatic vegetation (SAV) types, and percent bottom cover of SAV were recorded at each site. Water temperature (°C), salinity (‰), specific conductivity (µS/cm), dissolved oxygen (mg/L), and pH were measured using a YSI water-quality instrument. The primary vegetation at each site was considered the most abundant SAV (>50%). If multiple SAV species were present at a site, and no one species accounted for > 50% of seagrass bed composition, then the primary vegetation was considered to be "mixed".

Results and discussion:

From 2006 through 2022, 1744 seine surveys were conducted in the Middle Keys (Fig 2). Standardization of the sampling method occurred in June 2006, and experimental data before this time were removed. Due to Hurricane Irma, sites were not surveyed during September 2017. Only three months of seine surveys were conducted in 2020 before COVID-19 safety protocols suspended the monitoring program for the rest of the year and for the 2021 sampling year. 2020 data was removed from these analyses due to the limited survey numbers, but this only resulted in excluding one mutton snapper caught in those three months of surveys. Of the 1744 surveys included in these analyses, mutton snapper were present in 164 (9.06%) surveys (Fig 3). A total of 374 mutton snapper were caught and approximately 46% were settlement stage, less than 40mm (Fig 4). Only five fish were greater than 100mm.

Combining all years of data, mean monthly catch per unit of effort (CPUE) began increasing in June and was highest in October (Fig 5), coinciding with peak mutton snapper spawning during the summer. Yearly CPUE was greatest in 2006, decreasing until 2010, then fluctuating with high and low years, which could coincide with high and low recruitment. However, the 2006 CPUE may be artificially inflated since standardized sampling began in June, with no surveys in the beginning of the year, when mutton snapper catches are low. Additionally, 2017 CPUE would likely have been slightly higher if sampling in September (a high CPUE month, Fig. 5) had not been canceled due to Hurricane Irma. Standard errors were generally high most years following 2010, suggesting that while mean CPUE has varied over the years, the trend has stayed fairly stable (Fig 6). However, 2010, 2012, and 2018 had low CPUE and smaller variance compared to other years. Years 2015 and 2022 were tied for the second highest mean CPUE of the dataset, with higher variance observed in 2022 (Table 1). These variations in mean CPUE may be due to high and low recruitment years.

Seine sites were conducted on four types of substrate, with the majority of sites having either mud or sand substrate (Table 2). Most juvenile mutton snapper (61%) were caught at habitats with sand substrate (Table 2). Seine samples were conducted at seagrass beds with eleven primary vegetation types (Table 3). Most sites (73%) were dominated by *Thallassia testudinum (*Turtle grass*)* and the majority of mutton snapper (56%) were caught at *Thallassia* dominated sites, followed by *Halodule wrightii* (Shoalgrass) dominated sites (31%; Table 3, Fig 7). Water temperatures at the seine sites ranged from 13.4 – 36.1°C (mean = 27.4°C; median = 28°C) and salinities ranged from 28.4 – 40.8 ppt (mean = 36.7 ppt; median = 36.7 ppt). Mutton snapper were found in waters between 21.4 and 36.1°C (mean = 28.6°C; median = 29°C) and salinities ranging between 31.8 ppt and 39.6 ppt (mean = 36.5 ppt; median = 36.9 ppt).

Table 1. Yearly mean catch per unit effort of juvenile mutton snapper in seine hauls, number of seine hauls each year, standard deviation, standard error, and coefficient of variance.

Year	Mean CPUE	n	SD	SE	CV
2006	0.54	89	1.36	0.14	251.66
2007	0.27	120	0.81	0.07	302.56
2008	0.13	110	0.49	0.05	385.35
2009	0.15	120	0.81	0.07	537.31
2010	0.02	116	0.13	0.01	758.26
2011	0.28	120	1.02	0.09	360.81
2012	0.05	120	0.29	0.03	571.01
2013	0.24	119	1.28	0.12	544.11
2014	0.18	120	0.96	0.09	524.34
2015	0.45	120	1.72	0.16	382.03
2016	0.09	120	0.39	0.04	424.18
2017	0.20	110	1.09	0.10	545.20
2018	0.04	120	0.24	0.02	573.36
2019	0.20	120	1.13	0.10	563.60
2022	0.45	120	2.00	0.18	445.23

Table 2. The type of substrate at each of the seine sampling sites, the number of sites sampled at each type of habitat, and the number of juvenile mutton snapper caught.

Substrate	Sites Sampled	Number
Detritus	2	0
Shell	7	0
Mud	782	144
Sand	953	230
Total	**1744**	**374**

Table 3. The primary vegetation at the sampling sites, the number of sites sampled at each type of habitat, and the number of juvenile mutton snapper caught.

Primary Vegetation	Sites	Number
Acetabularia spp.	2	0
Calcareous Algae Spp.	7	1
Filamentous Green Algae Spp.	1	0
Halodule wrightii	293	117
Laurencia Spp.	1	0
Mixed Vegetation	104	43
No Vegetation	18	0
Penicillus capitatus	1	0
Sargassum spp.	5	0
Syringodium filiforme	25	1
Thalassia testudinum	1287	212
Total	**1744**	**374**

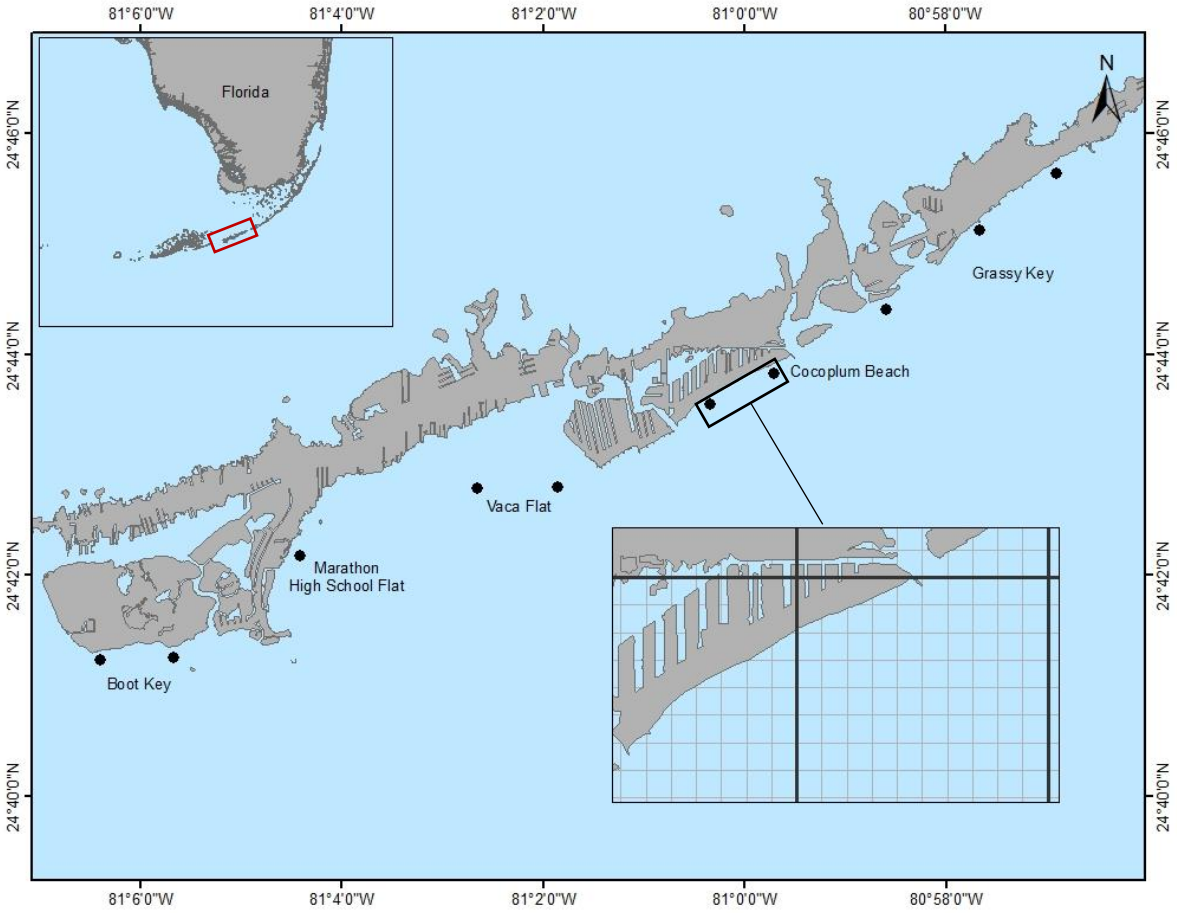

Figure 1: A map of the sampling area in the middle Florida Keys showing the location of the macrogrids (thick lines) and the microgrids (thin lines).

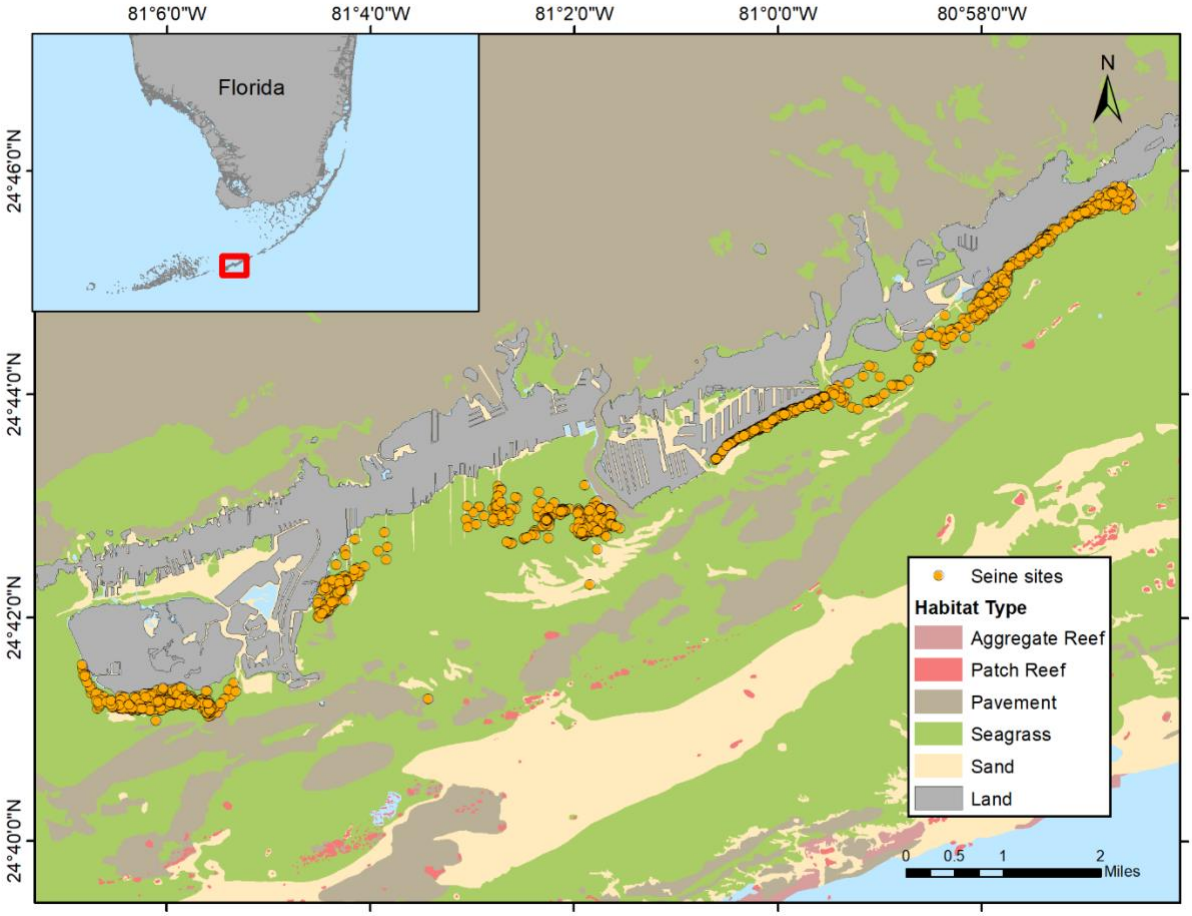

Figure 2. A map of all seining sites and benthic habitat (FWRI 2015) from 2006 through 2022.

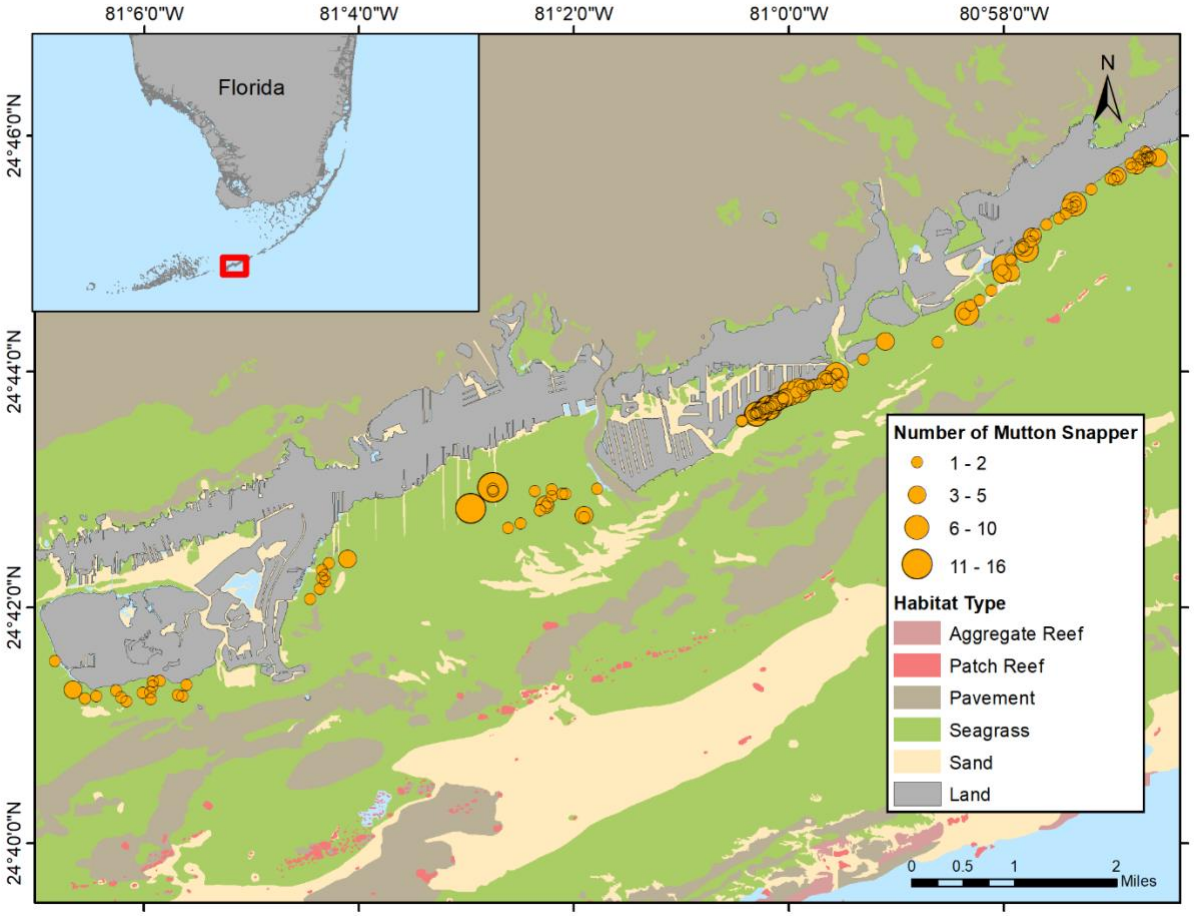

Figure 3. A map of seining sites and benthic habitat (FWRI, 2015) where juvenile mutton snapper were caught, showing the number caught at each site.

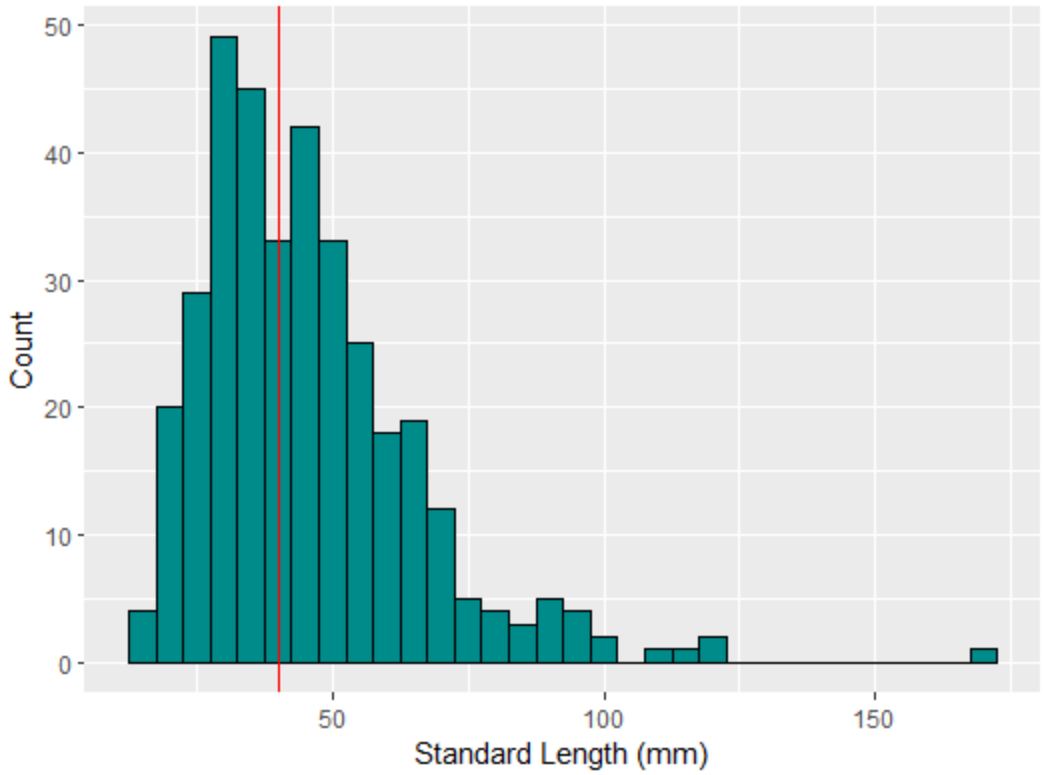

Figure 4. The length frequency of juvenile mutton snapper caught seining between 2006 and 2022. The red line represents settlement stage, 40 mm.

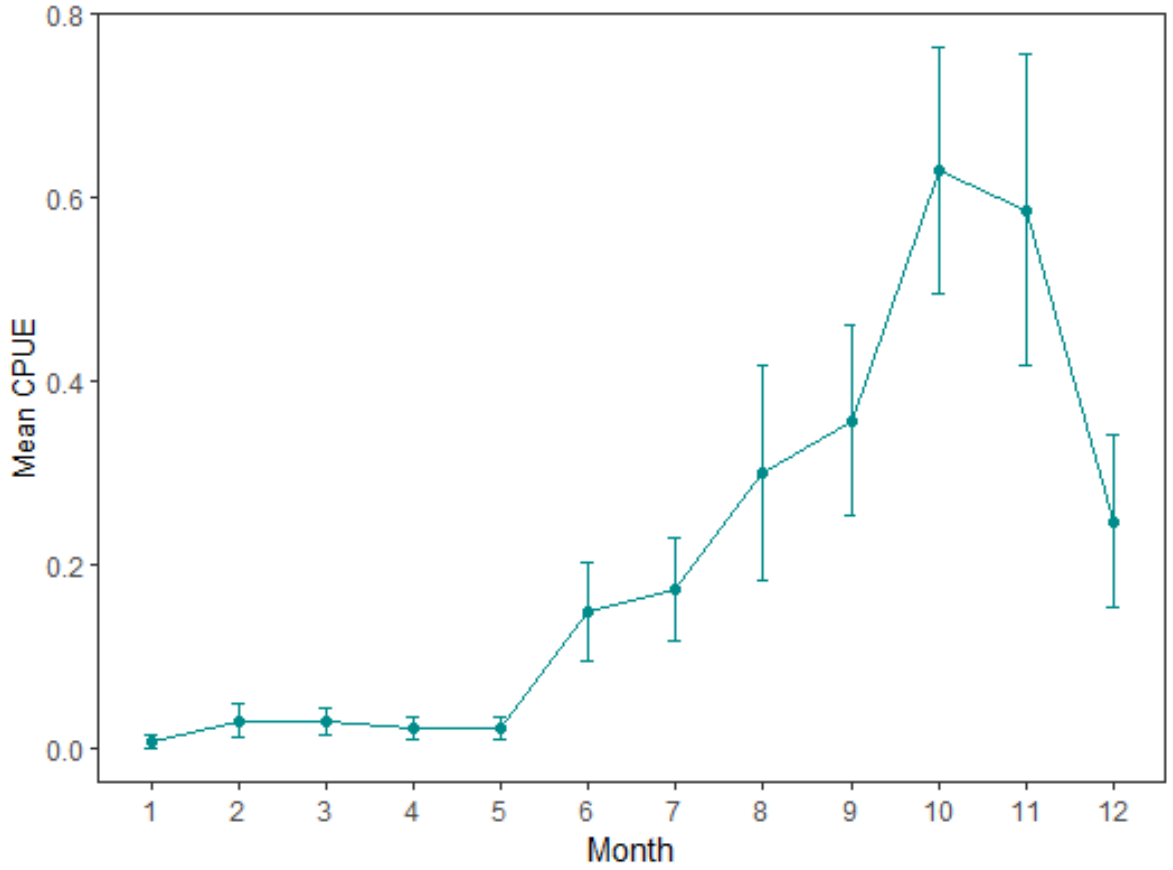

Figure 5. The mean monthly catch per unit effort (CPUE) for juvenile mutton snapper. Error bars represent the standard error.

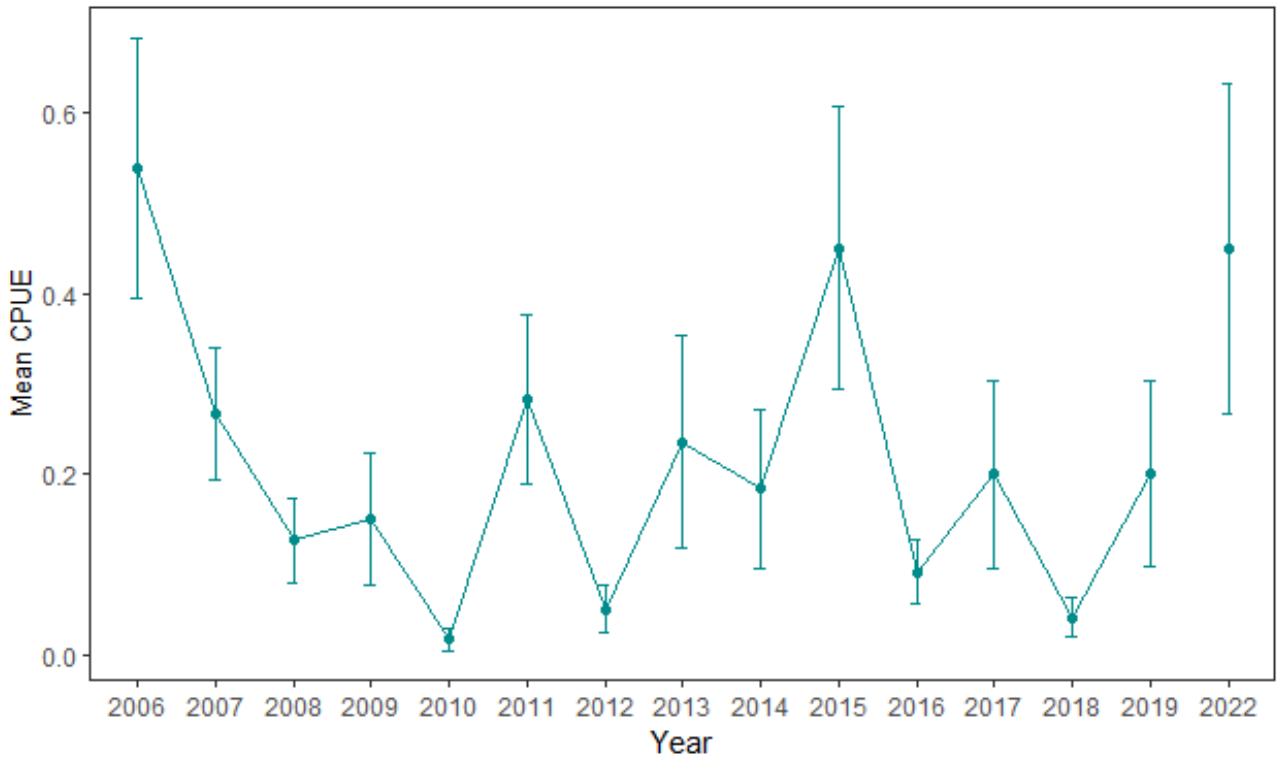

Figure 6. The mean yearly catch per unit effort (CPUE) for juvenile mutton snapper. Error bars represent the standard error.

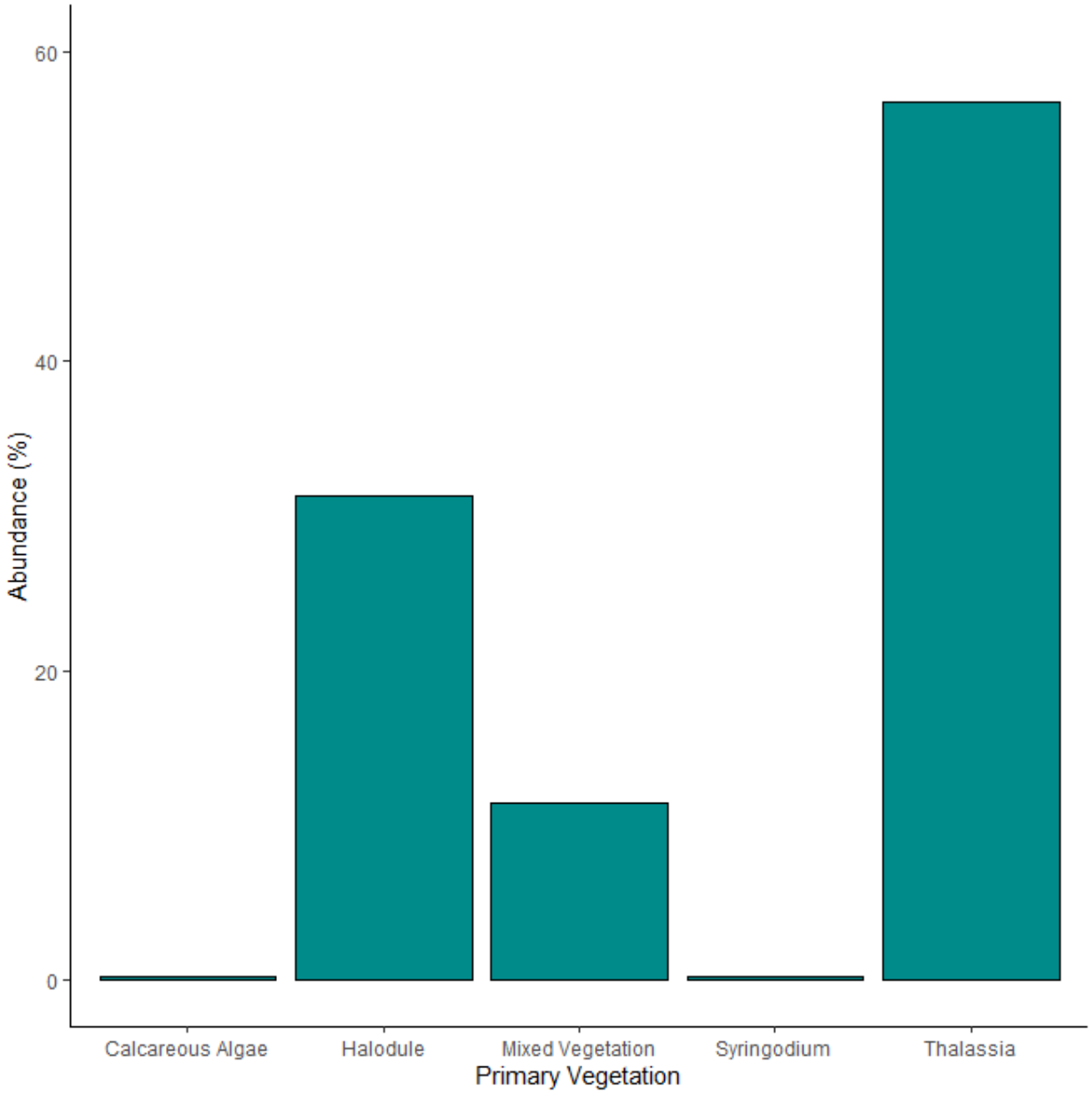

Figure 7. Percent of juvenile mutton snapper caught seining by type of primary vegetation at sites where mutton snapper were present.

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