



# How Depth and Year Affect Reef Fish Species in Islamorada

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## Background

- Environmental and anthropogenic factors, such as hurricanes, ocean acidification, global warming, fishing, and nutrient/fertilizer runoff, are known to affect fish species on coral reefs and can affect businesses that rely on coral reefs (Hughes and Connell 1999, Mora 2008).
- Diving and snorkeling are a big business in the Florida Keys, estimating around \$3 billion annually (Safiq et al. 2018).
- Due to this massive industry, knowing the trends of fish species on coral reefs is very important. With few or no fish on the reefs, this industry will go out of business.
- The Reef Environmental Education Foundation (REEF) is a non-profit organization that has developed a fish survey project in order to monitor fish populations globally. Their data can help researchers and managers determine the best course of action based on the trends of reef fish in many areas around the world.
- Determining the fish species present at specific sites can be complicated because their abundances can vary greatly over time and from place to place within or between study areas (Starck et al. 2017).
- Nevertheless, an estimate of fish species abundances will be beneficial to both managers of and businesses that rely on reef fish and their habitats.
- This study focuses on analyzing the trends in fish species abundances at deep and shallow dive sites in Islamorada since the beginning of the REEF Volunteer Fish Survey Project in 1993.
- I hypothesized that there would be more species at shallow dive sites and that more species will be seen in recent times.

## Abstract

Fish species abundances can change over time and those changes can affect the coral reefs in which they live. As ocean temperatures change and the ocean becomes more acidic, fish will move to find more suitable habitat. Some species will move along a latitudinal gradient while others will move to deeper waters. This study aimed to see how reef fish species abundances changed over time in Islamorada, Florida and if depth played a role as well. Fish surveys were conducted as described in REEF's (Reef Environmental Education Foundation) Volunteer Fish Surveys. The sighting frequency (%SF) was used as a measure of fish abundance. Depths for each dive site were recorded as an average based on all previous dives I have done at those locations and each site was categorized as deep (>45ft) or shallow (<45ft). Three time frames were used: 1993-1999 (Past), 2000-2009 (Middle), and 2010-2019 (Recent). Overall, fish species abundance decreased over time although there were increases at some dive sites. More species changed in abundance at shallow dive sites than at deep dive sites between both time frames (Past-Middle and Middle-Recent). Changes in fish abundances could be due to a variety of environmental and anthropogenic factors. Regardless of the reasons, fish abundances are changing in Islamorada. Monitoring these changes is important for managers and scientists as it enables them to determine if rules and regulations need to be changed in order to continue maintaining the coral reefs and their inhabitants of Islamorada.

## Results and Discussion

- At each dive site, most fish species changed in some way (Appeared, Disappeared, Increased, or Decreased) between all three time frames.
- Only six dive sites had fish species that did not change in abundance, but there were no more than 16 that did not change in abundance (Tables 1 & 2).
- Although these species did not change in abundance, it is possible that they did change in density.
- Majority of the time the abundance of a single fish species changed at only one or two sites.
- More species changed in abundance between the Middle and Recent time frames than between the Past and Middle time frames (Fig. 2).
- An increase in changes in recent times could be due to an increased number of surveys, fish species adapting or not adapting to changing environmental conditions, and anthropogenic affects (Hughes and Connell 1999, Mora 2008, Starck et al. 2017).
- The average number of fish species at each dive site (shallow and deep) decreased over time (Tables 3 & 4). The increase in fish species seen at some dive sites could be due to a variety of factors such as a lower human presence, less fishing, or designation as a marine protected area.
- While there were more changes in fish species abundances at shallow sites (Fig. 2), there does not appear to be a difference in the overall number of species between shallow and deep dive sites (Tables 3 & 4), which does not support my hypothesis.
- More changes at shallow dive sites could be due to a greater number of surveys conducted or the fact that they are closer to the surface and therefore more affected by environmental and anthropogenic changes.
- Overall it appears that fish species abundances are decreasing, albeit at a low rate across dive sites in Islamorada.

Shallow Dive Sites with No Change in Species Abundance			
Past-Middle	# Species	Middle-Recent	# Species
Pocket	2	Pocket	11
		Captain Grumpy	14
		Bigfoot	16

Table 1: Number of fish species at each shallow dive site that did not change in abundance.

Deep Dive Sites with No Change in Species Abundance			
Past-Middle	# Species	Middle-Recent	# Species
The Eagle	13	The Runway	3
Victory	2		

Table 2: Number of fish species at each deep dive site that did not change in abundance.

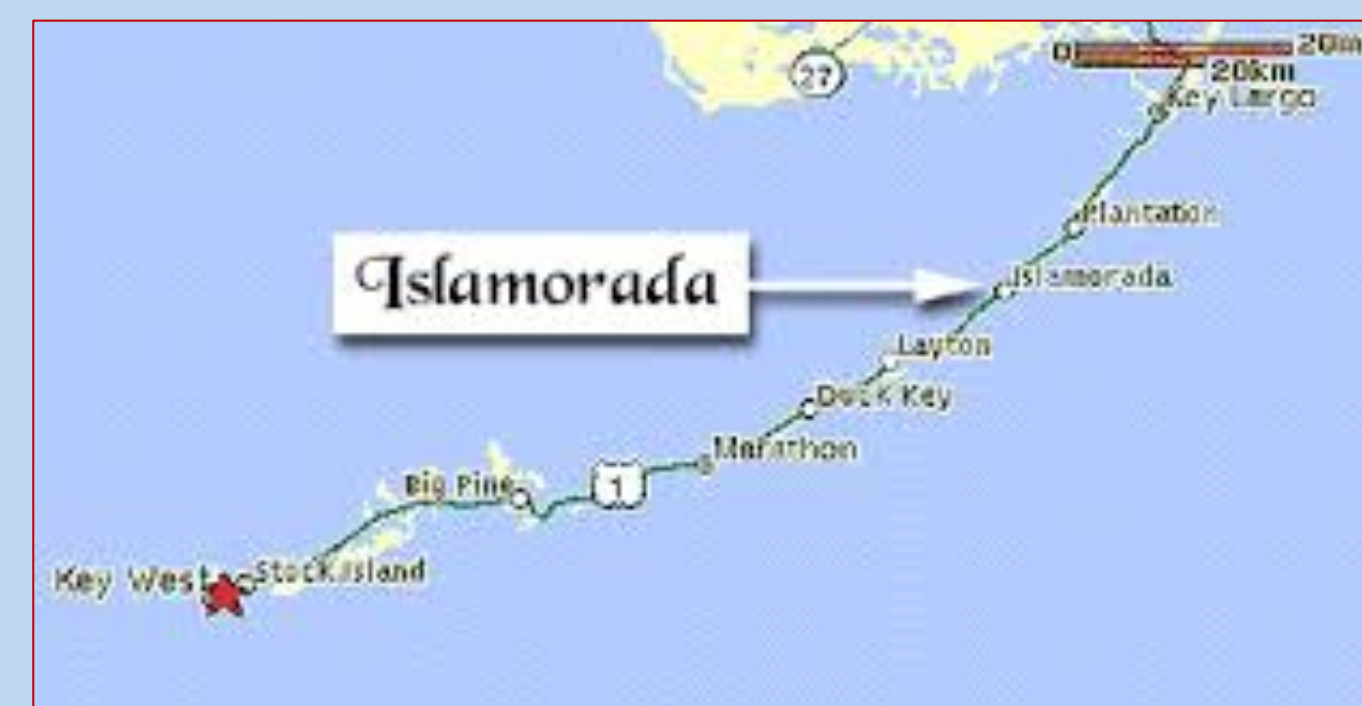


Figure 1: Map of Florida Keys pointing out the study area, Islamorada.



Figure 2: The number of fish species that Appeared, Disappeared, Increased, or Decreased in abundance across time periods. Left – Fish species abundance trends between the Past and Middle time periods. Right – Fish species abundance trends between the Middle and Recent time periods.

Number of Fish Species Per Shallow Dive Site				Number of Fish Species Per Deep Dive Site			
	1993	2000	2010		1993	2000	2010
Alligator Reef	177	177	277	Victory	96	140	148
Hens & Chickens	177	181	121	Crocker's Wall	163	139	104
Davis Reef	196	199	191	The Eagle	102	143	155
Rocky Top	46	146	185	Runway		60	81
Pocket	113	85	40	Crocker's Point			34
Bigfoot		63	41	The Bluff			125
Davie Crocker		106	123	Chutes			106
Captain Grumpy		81	95	Hammerhead			62
Morada			102	Kaily's Corner			107
Ball 1			55	The Fingers			184
The Maze			91	Angela			73
				Jumpin Mac			126
<b>Average</b>	<b>141.8</b>	<b>129.8</b>	<b>120.1</b>	<b>Average</b>	<b>120.3</b>	<b>120.5</b>	<b>108.8</b>

Table 3: Number of fish species at each shallow dive site per time period and the average number of species per time period.

Table 4: Number of fish species at each deep dive site per time period and the average number of species per time period.

## Materials and Methods

- Surveys were conducted in Islamorada, FL and followed REEF's Volunteer Fish Survey Guidelines (Fig. 1).
- Both regular (v6, 2018) and long (v3L, 2018) REEF datasheets for the Tropical Western Atlantic (TWA) area were used (Fig. 3).
- GPS coordinates were obtained from the boat captain for each dive site and matched to those on REEF's online database to ensure proper identification. All data collected for the purpose of this study was also uploaded to REEF's online database.
- Data was recorded as prompted by the datasheets including: date, start and end time, water temperature, visibility, maximum and average depth, strength of the current, habitat type, and species presence and density.
- Fish survey data was split into three time frames: 1993-1999 (Past), 2000-2009 (Middle), and 2010 – 2019 (Recent).
- For each dive site during each time period, the list of species and the sighting frequency (%SF) and density index for each was downloaded from REEF's online database.
- To determine how fish species changed over time at a given site, the sighting frequency (%SF) was used as a measure of abundance.
- Dive sites were also categorized as deep (>45ft) or shallow (<45ft) based on my previous dive experiences at those sites.
- For each fish species, the change in abundance between time frames was categorized into five types: Appeared (not present in the previous time frame), Disappeared (present in the previous time frame), Increased (higher %SF than previous time frame), Decreased (lower %SF than previous time frame), and Constant (no change).

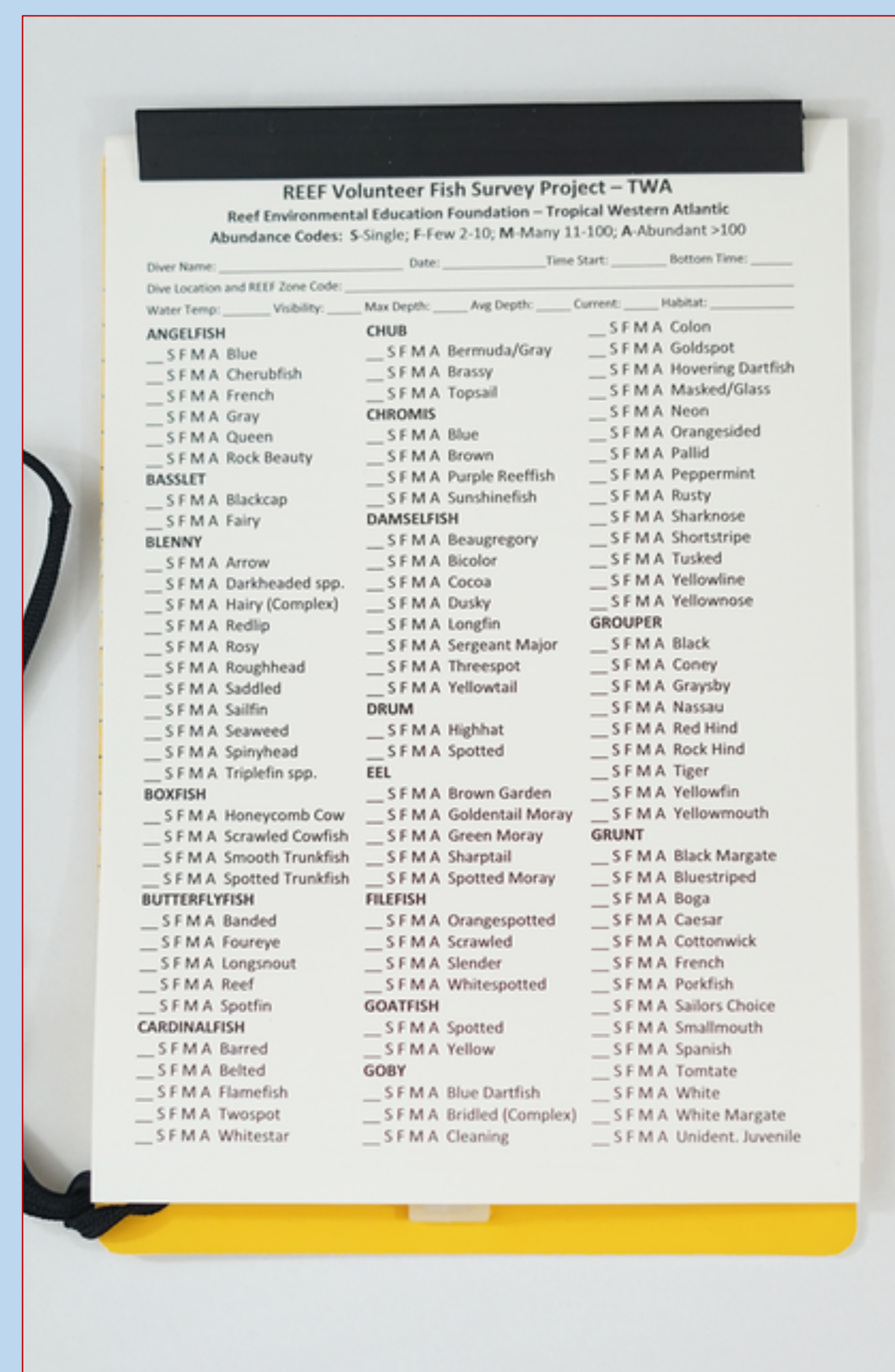
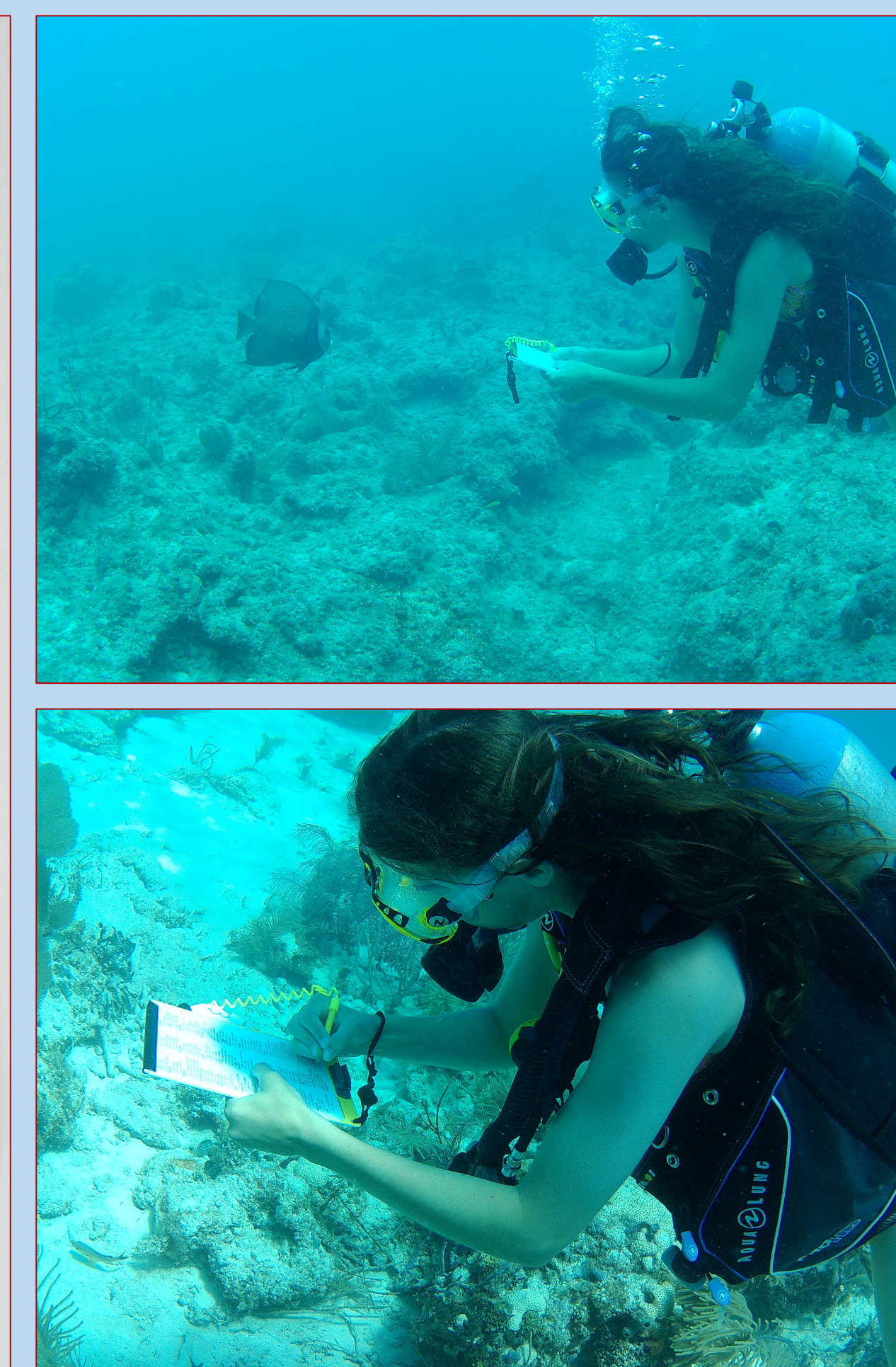


Figure 3: Diver surveys. Left – TWA long v3L data sheet. Top right – Surveyor looking at a gray angelfish. Bottom right – Surveyor recording fish species on data sheet.



## Acknowledgements

I would like to thank the Islamorada Dive Center and staff for aiding me in my surveys and accommodating my requests on their dive trips. Thank you to REEF for their information on how to conduct fish surveys and help with matching GPS coordinates to the dive sites in their directory. Their online database has been very helpful and I thank them for providing their information for free. My family has also been a huge help and I would like to thank my mom for being my dive buddy for the majority of my surveys.

## Literature Cited

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