

Final Report To The University Of Hawai‘i At Hilo Marine Option Program

REEF.org Based Survey Project

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Abstract

Monitoring fish in coral reef habitats is important for assessing the long-term sustainability of reef fish populations. Large scale monitoring can be done through the help of community volunteers and is known as citizen science. Citizen science allows for extensive data collection using large numbers of volunteers. REEF, the Reef Environmental Education Foundation, is a non-profit organization with a Volunteer Fish Survey Project that aims to monitor reef fish populations through citizen science worldwide. REEF monitors the coral reefs around the Hawaiian Islands through the process of reef surveying. Reef surveys are conducted throughout the Hawaiian Islands, however here on Hawai'i Island there is a lack of surveyors and there is an opportunity to increase the amount of reef fish monitoring on Hawai'i Island through increased training using the REEF surveying techniques and protocol. The University of Hawai'i at Hilo's Marine Option Program (MOP) provides students interested in studying marine science the opportunity to gain hands-on experience with volunteer work, research opportunities, and projects. For this project, a volunteer-based fish survey team was formed to train UH Hilo MOP students in REEF monitoring techniques so that they can gain experience in surveying techniques and provide REEF with data about the reef fish populations on the east side of Hawai'i Island. Training sessions with the REEF curriculum are held at the beginning of each semester followed by a field trip and the logging of reef surveys to the REEF survey database. This project increases the number of REEF surveyors and the amount of reef fish population data on Hawai'i Island and provide the opportunity for students in the UH Hilo MOP Program to learn surveying techniques and gain experience in collecting reef fish population data.

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Introduction

Coral reefs are productive ecosystems that are valuable because they provide many ecological and economic services. Coral reef ecosystems provide breeding and feeding grounds for local species, creating a rich and productive environment (Bishop et al. 2011, Brander et al. 2006, Cesar 2000, Moberg & Folke 1999). Spanning over 600,000 square kilometers, these ecosystems make up only 0.1% of the Earth's surface (Bishop et al. 2011). These ecosystems surround many island nations and provide protection against storms by dissipating wave energy (Brander et al. 2007, Cesar 2000, Cesar & Beukering 2004, Moberg & Folke 1999). Waves and currents carry sediments, made of decomposed corals and eroded rocks, that create sand beaches that line the coastlines (Bishop et al. 2011, Cesar & Beukering 2004, Moberg & Folke 1999). In addition to coastal protection, coral reefs provide food and tourism opportunities. Reef ecosystems are exploited for the use of recreational activities, including diving and snorkeling. The Hawaiian Islands are home to approximately 85% of United States reefs (Cesar & Beukering 2004). The estimated annual income from reef recreation for the United States is \$35.8 billion (Spalding et al. 2017). Approximately 11 million people visit Hawai'i annually, providing \$360 million to the Hawaiian economy (Bishop et al. 2011, Cesar & Beukering 2004). In the United States, about 50% of Food and Drug Association (FDA) managed fisheries depend on coral reefs for fishing purposes, and about 10% of the fish consumed by humans comes from the reefs directly (Bishop et al. 2004, Moberg & Folke 1999). The harvesting of reef fish for food is estimated at a total of 9 million fish per year, which is one eighth of the total catch worldwide (Spurgeon 1992). Coral reefs are productive environments that provide various ecological benefits for humans as well as provide important habitats for reef dwelling fish.

Coral reefs are important for fish because they provide habitat and shelter. The structure, complexity and configuration of reefs impact the number and size of reef fish (Darling et al. 2017, Friedlander et al. 2003, Komyakova et al. 2013). Many of the fish assemblages found on reefs are affected by the decline in corals (Komyakova et al. 2013). In Hawaiian waters, reefs with low diversity of corals exhibit low abundance of fish assemblages (Friedlander et al. 2003). Approximately 75% of reef fish rely on coral reefs for habitat, shelter, and food (Darling et al. 2017, Friedlander et al. 2003, and Komyakova et al. 2013, Pratchett et al. 2011). Some

reef fish rely on one coral species for food and habitat, while other fishes rely on a variety of live corals for food and habitat (Pratchett et al. 2011). Pratchett et al. (2011) found that when the loss in live coral cover was decreased by 16-36%, the decline in reef fish diversity was 1.8 to 2.3 times the coral loss. Coral reefs located in Marine Protected Areas have anywhere from two to ten times higher biomass of reef fish assemblages compared to the reefs that have been overfished (Williams et al. 2008).

Reef fish are an important source of food for the human population, but are exploited by fishing and the aquarium trade (Kittenger et al. 2012, Martin et al. 2017, Warren-Rhodes et al. 2003). Fisheries on coral reefs tend to focus on the larger more desirable fish species and then as the stock becomes overexploited, the fisheries move on toward the smaller fish species (Friedlander and DeMartini 2002). Fishing industries collect reef fish for aquariums (Cesar 2000, Spurgeon 1992). The aquarium trade collects approximately 350 million fish annually with about 10% to 15% of the fish caught from reef habitats (Tissot & Hallacher 2003). In the Pacific aquarium trade, 52%, 103 species, of fish caught originated from the Hawaiian reefs (Tissot & Hallacher 2003). The exploitation of reef fish through fishing and collection are causing a loss in biodiversity in reef ecosystems (Friedlander and DeMartini 2002, Martin et al. 2017, Stevenson et al. 2007).

It is essential to be able to monitor reef populations to ensure long term sustainability of the resource. Monitoring reef ecosystems is resource intensive in both cost and the expertise required (Pattengill-Semmens & Semmens 2003, Roelfsema et al. 2016). Local managers and government agencies are underfunded for large scale data collection (Branchini et al. 2014, Pattengill-Semmens & Semmens 2003, Roelfsema et al. 2016). The result of the underfunding and intensive expertise required is that large areas of shallow, accessible reef ecosystems are going unmonitored, which results in gaps in data (Roelfsema et al. 2016). Volunteer participation provides a significant way to overcome the economic restrictions on mass data collection (Branchini et al. 2014, Roelfsema et al. 2016). Non-specialized volunteers collect reliable data, spread environmental awareness, and increase public education through citizen science (Branchini et al. 2014, Pattengill-Semmens & Semmens 2003, Roelfsema et al. 2016). Citizen science significantly reduces the costs and required resources for monitoring reef ecosystems, while increasing the capacity to monitor.

Underwater visual surveys are a simple but time-consuming approach to monitoring fish abundance (Roelfsema et al. 2016, Williams et al. 2006). Surveying can be done through walking or snorkeling, or by SCUBA (Roelfsema et al. 2016). In Hawai‘i, the Department of Aquatic Resources (DAR) uses underwater visual surveys, using SCUBA, to collect data on species abundance, but is challenged by limited underwater time, observer mobility, and visibility (Williams et al. 2006). Extensive benthic surveys were conducted in West Hawai‘i through underwater visual surveys in 1999, 2003, 2007, and 2011 (Walsh et al. 2013).

Scientists within government agencies increasingly draw upon volunteers to survey reef ecosystems. Citizen science can be an effective way for scientists to expand data collection by drawing on the public. The sampling effort and geographic coverage expands when involving citizen science. Citizen science incorporates scientific projects and programs that include the public to collect and analyze scientific data over a period of time (Cigliano et al. 2015, Foster-Smith and Evans 2003, Roelfsema et al. 2016, Wolfe & Pattengill-Semmens 2013). Citizen science originated before science became a paid profession, approximately two centuries ago (Silvertown 2009). The earliest project involving citizen science is the Christmas Bird Count, which began in the 1900s (Silvertown 2009). Since the start of this project there have been over 63 million birds recorded and over tens of thousands citizen scientists involved (Silvertown 2009). Conservation agencies and managers have consulted volunteer-based projects because of the lack of government funding for long-term projects (Pattengill-Semmens & Semmens 2003, Wolfe & Pattengill-Semmens 2013). The growth of citizen science is driven by growing software availability, free labor, and skill sets provided by the volunteers (Silvertown 2009). Citizen science creates an opportunity for people that are interested in the project or program to contribute to its understanding and gain knowledge for themselves (Pattengill-Semmens & Semmens 2003). Citizen science can be an effective and efficient way of monitoring reef habitats.

Reef surveying is a method used in monitoring designed to collect data on reef ecosystems and is easily adaptable for citizen science projects. Volunteer surveying has been used successfully in the Caribbean and the Florida Keys in monitoring the decline of the reefs (Schmitt et al. 1999). Volunteer surveying techniques have also been implemented in California, specifically Monterey Bay, to monitor fish assemblages and strengthen conservation and

management efforts (Wolfe & Pattengill-Semmens 2013). Citizen science programs using reef surveying have been implemented in Australia to help monitor biodiversity (Roelfsema et al. 2016). Programs such as Reef Check and Coral Watch engage the community in their projects to survey and collect data on benthic and fish communities (Roelfsema et al. 2016). In 1998, Hawai'i implemented the Hawaii Coral Reef Assessment and Monitoring Program, a program involving reef surveying through citizen science volunteers, developed to survey the reefs of Hawai'i (Brown et al. 2004, Gulko et al. 2000). Reef surveying as a citizen science project is used by many organizations, including REEF.org.

REEF.org is a nonprofit organization that involves citizens in reef surveying. REEF stands for Reef Environmental Education Foundation that focuses on training local divers and snorkelers in survey techniques used in reef surveying (REEF.org 2018). The organization was founded in the 1990s in Florida (REEF.org 2018, Pattengill-Semmens & Semmens 2003). REEF is supported by the Nature Conservancy and Southeast Fisheries Science Center of the National Marine Fisheries Service (REEF.org 2018). The Volunteer Fish Survey Project is aimed at allowing the public to conduct their own reef surveys. Volunteers involved in the program learn common endemic fish species and how to survey abundance (REEF.org 2018). The program collects data primarily on species abundance, but volunteers have the option to collect data on species presence as well (REEF.org 2018). Surveyors use the Roving Diver Technique, surveyors roam freely over the reef habitat collecting species abundance data (REEF.org 2018). Data from the surveys are pooled together and then used by research scientists (REEF.org 2018). The REEF.org database has accumulated over 250,000 surveys and engaged over 16,000 recreational SCUBA divers/snorkelers from all over North and South America, Hawai'i, and the South Pacific (Wolfe & Pattengill-Semmens 2013, Wolfe & Pattengill-Semmens 2013).

REEF.org monitors areas around the Hawaiian Islands but lacks consistency. REEF surveyors in the islands have accumulated 19,996 surveys in Hawai'i, which is a small number compared to the number of surveys that have been collected in other regions and is not enough to accurately monitor the extensive reefs in Hawai'i (REEF.org 2018). To collect more surveys for the region, there is a need for more surveyors. The University of Hawai'i at Hilo has a strong Marine Science Department as well as a Marine Option Program (MOP). MOP is a program that allows students to gain hands-on experience through volunteer work, research opportunities and

projects. The mission of MOP is to improve the quality of life for the students and the surrounding community by increasing ocean awareness through marine-related education. The objective of this project was to create a Volunteer Fish Survey team at the University of Hawai'i at Hilo. This program includes training sessions in the REEF curriculum and organizing field trips for the students in the MOP program.

Methods

Surveying Site

Richardson's Ocean Park (Fig. 1) is a beach park located in Hilo, Hawai'i, approximately 16 minutes from The University of Hawai'i at Hilo. The reef is protected and exhibits a large amount of biodiversity. The reef is easily accessible for snorkelers of all experience levels.



Figure 1: Satellite image of Richardson's Ocean Park (Google Maps, 2020).

Fish Survey Training Sessions

Training sessions in the REEF curriculum were held over Zoom each semester for 3 semesters, for UH MOP students. The Zoom meetings were held over a two-week period where the students attended one of the two nights offered each week. Curriculum for the trainings was the same curriculum REEF uses to train their volunteers. The first training covered an introduction to REEF and the

basics of how to survey using REEF protocols. The student volunteers were taught how to navigate the website and enter data, and how to snorkel using the Roving Diver method (REEF 2018). The second training covered identification of the most common fish species found in Hawai'i, by both scientific and common names.

Fish Survey Field Trips

Once the training sessions were finished, a field trip was planned for the student volunteers that participated for them to practice what they had learned in the training. With the COVID-19 pandemic, the use of the university vans for transportation was unavailable so the students that participated in the field trip had to find their own transportation to and from the field site. Students that participated were broken up into groups of ten students and arrived at the site fifteen minutes to thirty minutes apart to allow for social distancing since there were only ten students allowed on the beach at a time due to County COVID regulations. As the students arrived at the survey site, they were briefed on the survey site and given a quick review of the Roving Diver surveying method. The students were handed dive slates and REEF survey paper and surveyed the reef at the survey site for an hour. After the surveying, the students were instructed to go back home and input the data they collected into the REEF.org database.

Results and Discussion

After the three training sessions held Fall 2020, Spring 2021, and Fall 2021 there were a total of 73 volunteer surveyors trained in the REEF curriculum. In September 2020, there were a total of 38 volunteers trained, in February 2021 there were 8 volunteers trained, and in September 2021 there were 27 volunteers trained. The field trips were designed to allow the volunteers to practice what they learned by conducting a survey themselves. Out of the 38 volunteers trained in September 2020, 25 of them participated in the field trip in October 2020, all 8 trained volunteers and 2 volunteers from the previous training participated in the field trip in February 2021, and 19 out of the 27 volunteers participated in the field trip in October 2021.

Since the start of the program, there has been an increase in surveys in Hawai'i in the REEF database. Jana Nicholas, head of the Volunteer Fish Survey Team at REEF, reached out after seeing the increase in surveys from the surveyors that have gone through the program asking to test the new Hawaii curriculum. The new REEF curriculum was used for the Spring 2021 and Fall 2021 semesters. At the beginning, the goal of the project was to get at least 10 people involved and the overall outcome of the program exceeded my expectations. Since the field trips, the volunteers can go out and conduct surveys and report them back to REEF. The team is active during the semesters and the past volunteers are allowed to join in on the field trips to keep adding to their survey log. To keep the program going, the next person that leads the team will be someone who has gone through the training, including the field trip, and comfortable with the fish species identification and interested in teaching surveying to others. The next step for the program includes continuing the opportunity for new students to become involved by continuing the training, but also to expand the program to other UH schools to offer the same opportunities for other students and to have a team of surveyors on every island. Another chance for expansion for this program is to introduce REEF and its curriculum in the introductory marine science labs during their fish surveying unit to train even more surveyors.

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