

ADOPT-A-REEF PROGRAM ANALYSIS

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FINAL REPORT

Prepared for



by

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Contributions by

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scientific Paper

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INTRODUCTION

Scientists estimate that 75 - 80% of Hawaii's coral reef fish populations have been depleted over the past 100 years, and that the decline has increased exponentially in the past 50 years due to more efficient fishing gear and vessels and the importation of destructive fishing methods.

The continued decline of reef fish populations in heavily populated areas worldwide has been documented repeatedly, with severe human impact cited as the cause. Peter Young, chairperson of Hawaii's Department of Land and Natural Resources (DLNR), suggests that marine protected areas are one way to protect Hawaii's resources for the future (*Honolulu Advertiser*, March 9, 2005).

In 2000, the principal investigators on this project, Donna Brown and Robin Newbold, worked as a committee of the Maui Coral Reef Network to involve the community in preservation of our reefs by introducing a community based coral reef monitoring program to Hawaii. They felt that efforts to increase awareness and a sense of stewardship in residents and visitors might help protect our reefs while providing an abundant supply of data to managers. To meet this goal, they chose the roving diver technique developed by the Reef Environmental Education Foundation (REEF).

This report provides background information about REEF and the "Adopt-a-REEF" program. The program's success is documented, with comments from participants. A comparative study carried out by the principal investigators and expert-level REEF surveyors of 12 popular dive sites in Maui County is reviewed, the data are presented, and conclusions drawn. Anecdotal reports taken during the study are summarized.

Fish lists documenting species abundance were also prepared for each site. Sighting frequency was multiplied by the abundance score for the 60 most abundant fish at each site to yield an abundance score. Species were listed by that abundance score. This information will be made available to National Fish and Wildlife Foundation (NFWF), Hawaii's Department of Land and Natural Resources, the Division of Aquatic Resources (DAR), DLNR, and other management agencies on request.

In a companion report, REEF Scientific Coordinator Dr. Christy Pattengill-Semmens reviews REEF data collected from 311 sites adopted by volunteers throughout Hawaii from 2001 to 2004. She analyzed a sub-set of 32 sites where at least 20 surveys had been done by volunteers using the REEF method. Her data analysis examines regional patterns of fish assemblage similarity, current status of 12 species of interest to local managers, and the effect of marine protected areas on the relative abundance of particular species. Dr. Pattengill-Semmens' paper will be provided to National Fish and Wildlife Foundation, Hawaii's Department of Land and Natural Resources, the Division of Aquatic Resources (DAR), and will be made available to management and legislative agencies.

REEF ENVIRONMENTAL EDUCATION FOUNDATION [REEF]

Background

REEF was founded in Florida in 1990, out of growing concern about the health of the marine environment, and the desire to provide the dive community a way to contribute to the understanding and protection of marine populations. REEF achieves this goal primarily through the REEF Fish Survey Project, a volunteer fish monitoring program. Project participants learn about the environment they are diving in, and produce valuable information at the same time.

The REEF program was designed in conjunction with marine scientists from NOAA, the University of Miami, and The Nature Conservancy. For over two years, a team of marine ecologists and fisheries managers monitored and carefully evaluated REEF field methods and reporting procedures. Their study, published in the *Bulletin of Marine Science* in 1996, confirmed that the collected data are of extreme value to the scientific community. Fish surveys conducted using the REEF roving diver method were found to meet several objectives:

- Collect large quantities of presence/absence and relative abundance data
- Indicate species distribution throughout a geographical area based on sighting frequency and abundance
- Allow for the breakdown of specific species presence/absence and abundance lists for any given region, sub-region, zone, or site
- Allow the computation of similarity in species composition between any combination of geographical areas

For the past 10 years, REEF has been compiling what has become the largest fish sightings database in the world. Thanks to a growing, loyal membership of 28,000, more than 81,000 individual surveys have been tallied. The database, which tracks diversity and relative abundance of marine species, has proven to be an increasingly powerful and valuable data set frequently utilized by natural resource managers, policy makers, and researchers to make informed decisions about fish populations throughout much of the Western Hemisphere.

The Key Largo-based nonprofit has developed survey materials for several geographic areas, including Tropical Western Atlantic/Northeast US & Canada, the U.S. and Canadian West Coast, Tropical Eastern Pacific, and most recently, the Hawaiian Islands. Materials for Samoa and the Indo-Pacific region are currently being developed.

Mission

Because Earth is a water planet, its well-being depends on the health of the oceans. Regrettably, marine habitats around the world – places of great aesthetic, environmental and commercial value – are in decline, many threatened with extinction because of ever increasing human impacts.

Mission Statement: REEF's mission is to educate, enlist and enable divers and non-divers alike to become active stewards in the conservation of coral reefs and other marine habitats.

Armed with knowledge, training and the opportunity to become involved, these concerned citizens can make significant and ongoing contributions to effective marine life conservation.



Goals

- Educate and enlist a growing corps of volunteer divers and snorkelers to conduct marine life surveys. To provide the marine science, resource management and conservation communities with a reliable, geographically broad and continuing source of marine biodiversity data for practical application in habitat conservation and resource management.
- Encourage the implementation of, and support for, effective marine conservation strategies – including marine protected areas
- Educate divers, snorkelers and the general public about threats confronting the marine environment and to encourage them to become active stewards in ocean conservation.
- Promote the diving community as an active partner in the long-term conservation of coral reefs and other marine habitats.
- Work cooperatively with other like-minded individuals and organizations to effectively and efficiently achieve these goals.

History in Hawaii

In 1999, Donna Brown (Maui Community College Marine Option Program) and Robin Newbold (Maui Coral Reef Network) collaborated with Skippy Hau (Dept. of Land and Natural Resources, Division of Aquatic Resources [DAR]), Dr. Christy Pattengill-Semmens (REEF), and Laddie Akins (REEF) to develop the Hawaii-based REEF survey materials. The goal was to involve the community in the process of collecting data about Hawaii's fish populations in order to increase public awareness and concern for the reefs and to increase the amount of data available to resource managers. The development of Hawaii-based REEF materials was supported by grants from Hawaii Coastal Zone Management and the PADI Project AWARE Foundation from 2000-2001. The Hawaii REEF program debuted in February 2001.

In 2003 - 2004, Adopt-a-REEF received additional funding from Hawaii Coastal Zone Management and the National Fish and Wildlife Foundation to greatly expand efforts to involve the community in coral reef monitoring. Funding supported an "Adopt-a-REEF" program to enlist and train community members to actively participate in the REEF fish survey method, and a comparative study of reef fish populations at marine protected and non-protected areas.





ADOPT-A-REEF PROGRAM

Project Goals

- Establish new and build on existing partnerships with educational institutions, dive shops, tour operators, community groups, businesses, and individuals
- Facilitate participation and community involvement in REEF activities
- Significantly increase the amount of coastline and the number of reef areas being surveyed
- Significantly increase the amount of data available to managers and research scientists over a long period of time
- Significantly reduce the cost of collecting large amounts of data from many locations for long periods of time
- Significantly increase public involvement, awareness, and sense of stewardship about our coral reefs
- Reduce the impacts of tourism and overharvesting by involving residents and visitor in the data collection process
- Promote the responsible and sustainable use of the coral reef resource; identify community stakeholders and provide target groups with an alternative to the exploitation of the reef resource
- Create an abundant, inexpensive, and sustainable flow of data that may easily be accessed and used by state, federal, and local agencies, managers, and legislators for assessment, conservation, and management of coral reefs
- Use the data collected at adopted reefs to compare protected sites to non-protected sites, and make that information available to management and legislative agencies
- Facilitate the expansion of Maui's Adopt-a-Reef program to other islands of Hawaii
- Assist with efforts to develop, diversify, and establish new Marine Protected Areas and Reserve Systems in Hawaii

Project Objectives

- Establish four sites in Maui County to serve as Protected-Area Adoptive Sites
- Establish at least 12 sites in Maui County to serve as Heavy-Use, Non-Protected Adoptive Sites
- Produce REEF Advanced course materials consisting of species lists, curriculum, higher level quizzes, 35MM slideshow, and PowerPoint presentation created with digital images and video gathered during REEF surveys
- Collect data from protected sites every other month, and heavily used, non-protected sites quarterly using the REEF method
- Document adoptive sites using digital photography and video; make images and footage available to adoptive agencies and scientific institutions
- Publicize Adopt-a-REEF program through direct contact with at least 20 local partners
- Publicize Adopt-a-REEF program in the local press through at least three concentrated efforts of promotional activity
- Enlist at least 12 agencies to commit to Adopt-a-REEF terms of contract, and to survey their adoptive site at least four times a year
- Provide at least 12 in-house REEF training seminars (Novice and / or Advanced, as requested) to adoptive agencies or conduct training in other public venues
- Through Adopt-a-REEF program, enlist at least 150 divers and snorkelers to conduct and return REEF surveys to REEF headquarters (from within adoptive agencies and visitors to Hawaii)
- Provide internship and service-learning opportunities to at least five local students
- Using statistical analysis, provide data to managers so they may draw conclusions regarding various management issues related to reef fish species diversity and relative abundance (among other things), at protected vs. non-protected sites
- Prepare and submit results of data analysis to local, state, and federal management agencies
- Disseminate results through local media; provide conclusions to management and legislative agencies

Target Audience:

- Commercially operated recreational dive / snorkel tour companies
- Dive shops
- Independent SCUBA instructors
- Nonprofit organizations
- Educational institutions
- Commercial businesses
- Hotels
- Community organizations (e.g. Rotary Club)
- Hawaii visitors
- Local fishermen
- Youth groups
- K-12 classrooms, public and private schools
- High school and college students (internships and service-learning projects may be arranged)
- Individuals

An overall goal of this project is to promote an understanding of and respect for the coral reef and its inhabitants, which will ultimately lead to positive attitudes toward and sustainable practices regarding this resource and reduce various negative impacts upon Hawaii's coral reefs. Only through education and active involvement can others be influenced to modify or change their means of working toward this goal on both a short- and long-term scale.

The REEF fish survey method emphasizes community involvement and stewardship, and provides powerful and useful scientific data in the process. All community stakeholders, locals and visitors, young and old, must be shown the importance of recognizing and preserving Hawaii's marine resources, and in particular, the coral reef and its inhabitants. Efforts target businesses, institutions, and community groups, as well as individual ocean users.

Project Outcome

Over 50 individuals officially joined the Adopt-a-REEF program by attending a REEF workshop or field survey and signing the Adoptive Agreement. Overall, 43 different sites were adopted, including two on Kauai, totaling 114 adoptions. Many people agreed to adopt more than one reef, and several reefs were adopted by multiple individuals (Table 1). About a third of the participants adopted more than one reef, and the highest number of adoptions per person was eight. The majority of adoptions occurred on Maui. Eighteen of the participants were represented by a high school group on Kauai.

Table 1 demonstrates that most sites that were adopted were in fact surveyed. Only a small number of participants did not complete the four surveys necessary to represent an "adoption." However, during the course of the project many individuals became active surveyors and conducted four or more surveys at adoptive and other sites throughout Hawaii. They did not necessarily sign the official "Adopt-a-REEF Agreement." We were unable to specifically track such occurrences, but at adoptive sites 174 different individuals conducted surveys during the grant period. This demonstrates the appeal and effectiveness of the REEF program, and the benefit of offering workshops and field surveys.

Table 2 presents a complete list of participants and the agencies many of them represent. Fifteen different agencies participated in this program. Adoptive Agencies included both individuals and representatives of local businesses, schools, and non-profit organizations. These included: 'Ao'ao O Na Loko l'a O Maui (Association of the Fishponds of Maui), Mike Severns Diving, Octopus Reef, Maui Community College Marine Option Program, Snorkel Maui, Hawaii Wildlife Fund, Trilogy Excursions, Maui Thrill Tours, Pacific Whale Foundation, Maui Ocean Center, Maui Dreams Dive Company, Wailea Community Association, Save Our Seas, Myron B. Thompson Academy, and Kauai Economic Opportunity.



Local community volunteers as well as Hawaii visitors devoted many hours participating in REEF workshops and field surveys. These events were conducted by principal investigators Donna Brown and Robin Newbold.

During the project period (June 2003-December 2004), 37 training workshops (including both novice and advanced) were offered by the three principal investigators. Volunteers participated in 66 of the field surveys. Over 1,600 surveys were conducted. Of those, 65% were in Maui County, 25% on the Big Island, 5% on Kauai, and 4% on Oahu.

The training workshops and surveys drew nearly 900 attendees, who volunteered over 3,200 hours. A significant number of attendees participated in multiple events throughout the course of the project, and many continue to do surveys on their own. All told, the project engaged hundreds of individuals of all ages, represented by families, school groups, teachers, businesses, institutions, and nonprofit organizations.

In general, the REEF program in Hawaii has been particularly successful during its initial years. According to REEF Scientific Coordinator Dr. Christy Pattengill-Semmens, "survey effort in Hawaii has increased 50% over the last few years and we anticipate that this exponential increase will continue." To date, over 2,800 surveys have been conducted in Hawaii, by over 400 individuals at 325 sites statewide (including the Northwest Hawaiian Islands). Of those surveys, approximately 20% have been conducted by expert-level surveyors.

Surveyors represent 27 states and four countries (USA, Canada, American Samoa, and Puerto Rico). The majority of people who conducted a REEF survey in Hawaii were residents of Hawaii. Of the top 25 REEF surveyors, half were Hawaii residents. The remainder consisted of part-time residents, frequent visitors to Hawaii, REEF staff members, and "Advanced Assessment Team" members from other states. Comments from a few of the participants follow.

Volunteer Comment

Pauline Fiene, Owner, Mike Severns Diving: *"As a dive boat operator, I get to participate in reef education and various monitoring projects regularly. But if I were a recreational diver with such interests, what could I do? The REEF program provides the perfect framework for divers who have that extra spark of interest and the desire to contribute. Divers can participate at different levels depending on their abilities, they can work toward achieving higher levels of competency, and they can contribute their talents to a larger project. It is thrilling to go to REEF activities and see all different kinds of people finding a forum where their enthusiasm and concern for Hawaii's reefs can blossom and be appreciated. These will be some of the people responsible for drawing attention to the essential need for Hawaii's reefs to be returned to a healthy state."*

Joylynn Oliveira, Vice President, `Ao`ao O Na Loko I`a O Maui (Association of the Fishponds of Maui): *`Ao`ao O Na Loko I`a O Maui (Association of the Fishponds of Maui) is excited to be a part of the Adopt a REEF program. We have been looking at ways to monitor the life of Ko`ie`ie Fishpond in Kihei but have not had a dependable method until now. REEF has given our organization an opportunity to systematically survey the success of an ancient Hawaiian fishpond in the heart of Kihei. In the past, native Hawaiians would gather as a community to build, maintain and produce a bountiful supply of fish within fishponds. Today, we are excited to bring the modern community together to survey, evaluate and maintain the reef habitat so that Ko`ie`ie Fishpond may flourish once more. We invite snorkelers and divers to be a part of this wonderful program and help us get a better picture of the life within one of Kihei's last remaining native Hawaiian fishponds.*

John Gorman, Curatorial Manager, Maui Ocean Center: *"I really feel quite strongly about the adopt a reef initiative. Here in Maui there is runaway development taking place and before our eyes access to beaches is being restricted. For those of us who love the ocean and frequently visit our reefs there is a depreciation of the quality of life on these reefs that is taking place over an alarmingly short*



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timeframe. The resources of state agencies are strained, particularly in manpower. This program gets many pairs of eyes out there looking. For us at MOC it is a natural fit as a great deal of our focus is on Coral Reef displays and education about coral reefs.”

Skippy Hau, Aquatic Biologist, DLNR-DAR: “I would like to emphasize that we need to know the status of our natural resources. The REEF methodology is a way of gathering information on fish populations and turtles. As we enjoy the marine environment, it is a great way for people to learn fishes through their common, scientific and Hawaiian names. Hopefully, through their introduction of fish, I hope they will better understand natural ecosystems which I continue to learn and study as a career. Observations and scientific studies have helped to increase everyone’s knowledge about natural and human impacts on the environment.”

Terry Hunt, President, American Reef Coalition: “I think the Adopt A Reef program is a great way for individual members of the community as well as business interests to get involved and actually participate in coral reef conservation. Hawaii has approx. 80% of all the naturally occurring coral reef in the United States. They’re the “rainforests of the sea”, the second most biodiverse ecosystem on our planet!”

Erik Stein, Owner, Extended Horizons: “I support the Great Annual Fish Count and recognize it as a fun and valuable way to acquaint ourselves with the diversity and health of our local reefs. Counting fish and watching reefs also hones us to be better observers of our natural world. This activity is not only fun, but establishes a deeper understanding and appreciation of how reef health and fish species are interrelated.
Go REEF!”

Captain Paul Clark, President, Save Our Seas: “Save Our Seas and some community partners on Kaua’i have conducted REEF fish count for the past two years. During this time we have received many types of support from Robin Newbold and Donna Brown, from phone calls to visits to Kaua’i to assisting with community training programs. Having Liz and Donna available to come to Kaua’i was of great benefit to the community members of Kaua’i and we hope to have them return ASAP for similar training session and participation in other community environmental awareness events.”

Nanette Harter, Expert-Level REEF Volunteer: “After 16 years of diving, I am still fascinated by the underwater world. I now dive just for fun after being a professional instructor for over 5 years. I loved introducing people to the Hawaiian marine environment, but over the years I have seen the decline of coral, fish and invertebrate species, and general abundance. I was introduced to the REEF fish counting techniques by Robin Newbold in 2003. It seemed a way to quantify and record data that before I could only say was my impression by observation. I have filled out over 100 REEF scanforms recording fish counts all around Maui, Molokini, and Lanai. It is my hope that the recorded data may be used for education purposes to encourage individuals, organizations, corporations, and especially developers to work to preserve the precious life in the nearshore marine environment, rather than the current view of many that it as indestructible and eternal.”

Tom & Renee Culbert, REEF & Kanaka Malama Kai Volunteers: “Our names are Renee and Tom Culbert. We received a phone call from Florida thanking us for doing REEF surveys. We do 4 locations here on Maui and we send our findings to Florida. We have sighted many rare fish, plus a nose to nose encounter with the largest manta ray that we have ever seen. We are having wonderful, exciting experiences while at the same time helping the environment.”

Linda Castro, REEF Volunteer: “Ryan and I are having the time of our lives. It has been a great pleasure to meet you, Donna, and Robin. We had a blast and now Ryan is planning to save his money so we can go to Lanai again and have fun in our lovely Pacific Ocean. I’m so happy that Ryan and I could share this experience with you all. We both have great interest in Marine Science and we are in one of the best parts of the world to study and learn. I wish every one could learn to appreciate our Ocean as much as we see it and see how we could all benefit from it. I’ve been born and raised in the Kapalua area, and since I was 5 yrs old I loved our Ocean. I have seen a great change from the Seaweed, Opihi’s, Shells, Crabs, and most of all the fishes. Everyone needs to take care of our environment and also to learn how to conserve for the next generation to come. In other words “conserve for our future generation”. Ryan and I are happy, glad, excited, etc..all the above to have been able to help. Whenever you need help you can count on us.”



Jim Petruzzi, REEF Volunteer & Maui Dreams Dive Company Employee: “My experience with REEF has been a rewarding one, on both a personal and professional level. As a diver and nature enthusiast, participating in REEF Fish ID classes and fish surveys has broadened my appreciation for the unique underwater environment in the Hawaiian islands, while at the same time allowing me to contribute positively to the preservation and study of that environment. As a working divemaster, I find that REEF activities provide an ideal focus to teach about preserving our ecosystem, and are a terrific means to encourage ecological awareness and participation for new divers. In addition, REEF fish surveys afford the opportunity to meet like-minded divers, expanding and enriching our dive community.”

Karen Levy, REEF Volunteer: “Upon moving to Maui full time in 1999, I swam in the ocean near my home 4 to 5 times a week. About a half mile of great rocks and reef, full of eels, turtles, and a wide array of fish. I bought books to help me identify the fish. I was so glad to see your newspaper article several years ago on how to learn to identify the fish I was swimming with almost daily. Since the SEA-Link and REEF program’s lecture, it has become a great hobby of mine to collect what data I can to help know the rise and fall of reef fish in my area over years to come. When one becomes a “senior citizen,” it is very important to stay active with something one truly loves. And an ocean and fish lover I am. Mahalo for your assistance whenever I get stuck with a fish I’ve gotten to see regularly but still can’t identify. And then, it is exciting when the Marine Scientist emails questions concerning a specific sighting, and then to ultimately find out it’s the first REEF Identifier’s sighting. Wow!”

Fred Litt, REEF Volunteer: “The survey really makes you learn; on my first surveys I knew about forty species of Hawaiian fish; the database now has me down for about 170. I doubt that I would now know more than eighty or so if I had not been surveying. Generally, I survey the sites I would dive anyway. Most of the time, that means diving with Mike Severns Diving, and that means that a large fraction of the dives are Molokini back wall and Reef’s End, and other popular sites. I add snorkel sites, like the Kamaole sites and several beaches on Kauai, where I’ve taken the only surveys in the database. I’m always looking for sites that have not yet been surveyed for REEF. I have about 260 dives and more than half are in Hawaii in the last ten years. All my survey dives are in Hawaii.”

Danene Warnock, REEF & Kanaka Malama Kai Volunteer: “The REEF program provides an essential venue for those who want to protect Hawaii’s reefs. My frequent snorkel and occasional dive experiences have been profoundly changed by involvement with REEF. After moving to Maui, I started learning everything I could about the local reef biota, which fulfilled a personal desire for knowledge but was of no use to the environment. Then I discovered the REEF Hawaii program, and learned that my interest and knowledge of reef fish could be put to meaningful use. Involvement in REEF has been very satisfying, particularly the collection of special data at sites like Ko’ie’ie Fishpond and La Perouse Bay. Involvement with REEF transformed my fish-watching from a personal hobby to a main focus and passion in my life — a profound influence, indeed. Through my involvement in REEF, I’ve met other people who are as fascinated and concerned about sea life as I am. REEF is more than doing surveys. There is a synergy which stems from the positive encouragement provided by all who are promoting, teaching, and using REEF protocol here, sharing knowledge and experiences with the goal of doing something positive for our environment.”

Fernando Lopez Arbarello, Underwater Photographer and REEF Volunteer: “I met Robin Newbold in 2003, while trying to meet people to dive with. I attended one of her REEF presentations and found it so rich and interesting that I immediately wanted to get involved. I joined Reef Check and only a couple of days later I was part of a group surveying the species in our traditional dive sites. Robin encouraged me to develop my passion and skills for conservancy and underwater photography. My underwater camera and my Reef Check slate have become an integral part of my SCUBA gear. Now I willingly volunteer my free time, photographs, and ideas in order to educate the general public on how to take care of our reefs and how to develop proper diving techniques to minimize our impact. To me, the Adopt-a-REEF program goes far beyond reef surveys. It encourages the explorer, scientist, and leader in us all to spread the message. It makes us curious to understand the reefs we dive and the fish we see.”



Table 1 - Adoptive sites, number of adoptions, and total surveys per site during grant period (June 2003-December 2004).

Site Name	No. of Adoptions	Total Surveys at Site
Ahihi Cove/Kanahena Bay	3	64
Airport Beach/Kahekili Beach	2	101
Anini Beach (Kauai)	19	20
Aquarium	1	3
Bill's Reef/Near Tunnel at Pali	1	3
Black Rock	2	6
Cliff House	2	0
Embassy Suites Reef	1	15
First Cathedral	1	31
Fish Bowl	1	16
Five Graves	1	22
Goodyear Reef	1	0
Hauwea Point	5	0
Honokeana Cove	1	1
Honolua Bay	2	48
Hulopoe Bay	1	39
Kalepolepo (Ko'ie'ie Fishpond area)	19	12
Kam I & Kam II (Dee's Reef)	5	20
Kapa'a Beach (Otsuka's) (Kauai)	3	4
Kapalua Bay	1	30
Keawakapu beach	1	11
Keoneoio	1	0
La Perouse	1	6
Launiopoko	1	0
Maalaea Harbor	2	0
Mai Poina Oe Lau Beach	2	18
Makena Landing	1	39
Mala Wharf	1	7
Maliko Gulch	1	9
Manele Bay	2	44
McGregor Point	1	4
Molokini	2	105
Nan's Reef	1	14
Neil's Reef	1	26
Olowalu	5	31
Palaua Beach/Haloo Pt	3	30
Pu'u Olai	1	16
Second Cathedral	1	28
Shark Fin	1	25
Shark Pit	2	1
Summerhouse	1	0
The St. Anthony	2	17
Turtle Arches	1	0
Ulua Beach	1	108
Wailea Point	4	5
Maluaka Beach	1	4



Table 2 – Individuals and agencies participating in the Adopt-a-REEF program.

Name	Agency Represented	No. Sites Adopted
Alden Dobbins	Kauai School Group	1
Alex Latif	Kauai School Group	1
Alexandra Pond	Kauai School Group	1
Angie Hofmann	Individual / MCC Marine Option Program	1
Ann Fielding	Snorkel Maui	2
Anna Nonoselova	Kauai School Group	1
Ariel Carlson	Kauai School Group	2
Bud Pikrone	Wailea Community Association	2
Carrie Culbert	Individual	1
Charlie Balderas	Individual	1
Danene Warnock	Individual	1
Donna Brown	Individual	1
Fernando Lopez Albarello	Individual	4
Judy Edwards	Hawaii Wildlife Fund	1
Jim Coon	Trilogy Excursions	6
Joan Keith	Individual	2
Joan Morris	Individual	1
John Gorman	Maui Ocean Center	2
John Mitchell	Individual / MCC Marine Option Program	1
Jonathan Hultquist	Pacific Whale Foundation	6
Josh Fahey	Kauai School Group	1
Joylynn Oliveira	'Ao'ao O Na Loko I'a O Maui	2
Kai Lani Mathur	Kauai School Group	1
Karen Levy	Individual	1
Leena Robertson	Kauai School Group	1
Linda Castro	Individual	3
Lucas Frailey	Kauai School Group	1
Maria Larsen	Individual	1
Martin Knutzen	Kauai School Group	1
Michael Mijares	Kauai School Group	1
MiQe Kleme	Maui Thrill Tours	5
Moana Ferry	Kauai School Group	2
Nanette Harter	Individual	8
Neil Rhoads	Individual	3
Nora Robertson	Kauai School Group	1
Paul Clark	Save Our Seas, Kauai	2
Pauline Fiene	Mike Severns Diving	1
Penny Wakida	Individual	1
Povi Gonsales	Pacific Whale Foundation	1
Rene Umberger	Octopus Reef	5
Renee Culbert	Individual	1
Ryan McKeon	Individual	1
Ryan Nakagawa	Individual	3
Sean Ogawa	Kauai School Group	1
Sharon McKeon	Individual	1
Smith Kibo	Kauai School Group	1
Steven Lentile	Kauai School Group	1
Teri Stewart	Maui Dreams Dive Company	1
Terry Hunt	American Reef Coalition	1
Tom	Culbert Individual	1
Tyler Clark	Kauai School Group	2
Victoria Martocci	Octopus Reef	5
Wailana Waite	Kauai School Group	1



A COMPARISON OF FISH SPECIES DIVERSITY AT PROTECTED AND NON-PROTECTED SITES IN MAUI COUNTY

JULY 2003 - DECEMBER 2004

Introduction

A preponderance of evidence confirms that stocks of reef fish in Hawaii's Main Hawaiian Islands are 75% - 80% lower than they were 100 years ago (Shomura 1987; Clark and Gulko 1999; Friedlander and DeMartini 2002). Overfishing is considered the main cause of this decline (Shomura 1987; Harman and Katekaru 1988). Not only abundance, but size, diversity and average trophic levels have decreased as a result of overfishing (Birkeland and Friedlander 2002).

Over the years, protected marine areas have been set aside worldwide in an attempt to stop the staggering losses caused by overfishing. Follow-up studies confirm that marine life will begin to flourish once human impact is curtailed. One such study in the Philippines (Alcala and Ross 1990) found that protection of fish populations *inside* a reserve increased abundance of both targeted and non-targeted species *outside* the reserve, as well. Similar studies worldwide report similar results.

Overharvesting by aquarium collectors has also been shown to negatively impact reef fish populations (Birkeland and Friedlander 2002; Tissot, Walsh, and Hallacher 2003). To protect ornamental species on the Big Island of Hawaii, 30% of its west coast was established as Fish Replenishment Areas (FRAs) effective January 1, 2000. Baseline surveys conducted earlier documented declines of ornamental species. A subsequent study by Tissot, Walsh, and Hallacher in 2003 compared the pre- and post-FRA fish populations and concluded that the establishment of FRAs "can effectively promote recovery of fish stocks depleted by fishing pressures in Hawaii."

This study examines the effectiveness of Maui County's four Marine Protected Areas (MPAs). MPAs are similar to FRAs in that they both attempt to protect fish populations. With the exception of pole fishing at Hulopoe Bay, fishing and aquarium collecting are prohibited at these four MPAs.

In order to gauge the effectiveness of Maui's MPAs, eight non-protected areas were surveyed along with the four protected areas by the principal investigators. At each site, data were collected on fish species diversity and relative abundance.

Species diversity is a measure of the number of species in a particular area and their distribution within the community under normal conditions (Thorne-Miller and Catena 1991). This report examines one aspect of species diversity, species richness, defined as the number of species in a particular area. The following accounts and data represent the findings of the principal investigators.



Survey Method

Scheduled SCUBA surveys were conducted every other month at four protected sites: Honolua Bay and Ahihi Cove (Maui), Hulopoe Bay (Lanai), and Molokini. In this analysis, only data from the inside area of Molokini is included. Quarterly surveys were conducted at the eight non-protected sites chosen for this study: Embassy, Kahekili, Olowalu, Palauea, Ulua and Makena (Maui), Cathedrals and Shark Fin (Lanai). Additional surveys were performed as time and weather permitted. The data analyzed herein come from 63 survey dives in which two to five expert-level surveyors participated.

Shark Fin and Cathedrals differ from the other non-protected sites in that they are not heavily used shore-based sites. They are deeper sites with dramatic walls, arches, and caves and are situated away from population and visitor centers on Maui. Their benthic characteristics are markedly different in terms of rugosity and coral cover.

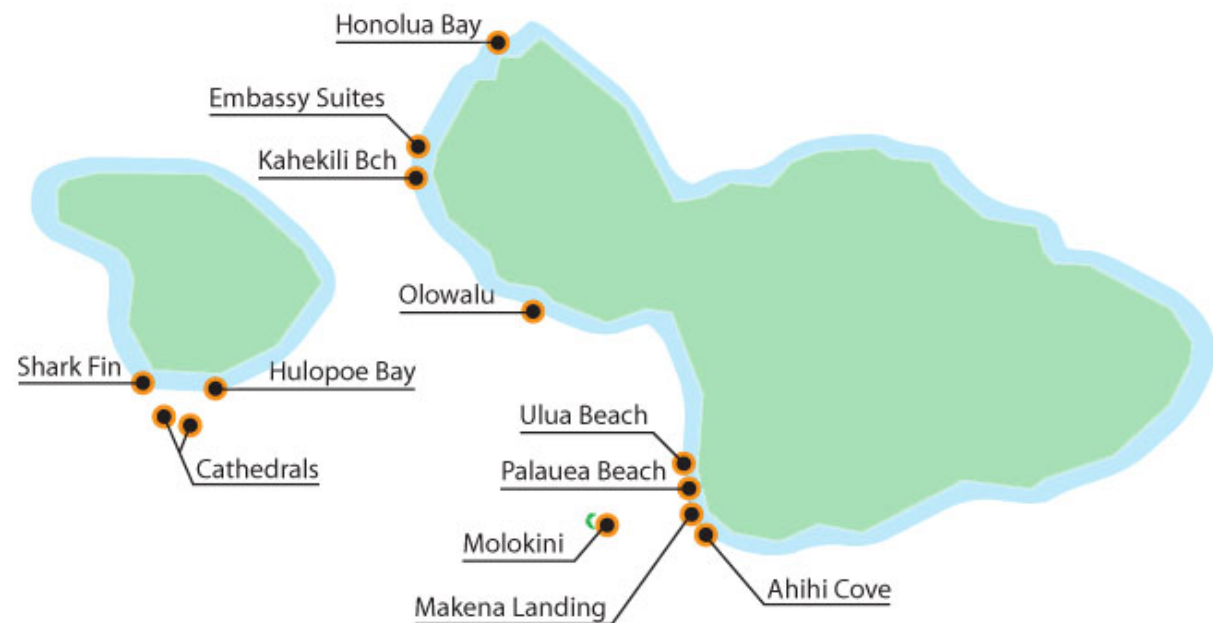


Illustration 1 – The 12 dive sites on Maui, Lanai, and Molokini.

Data collection at the 12 study sites occurred from July 1, 2003 to December 7, 2004. The data discussed herein was contributed by the three principal investigators; expert-level REEF surveyors Nan Harter, John Mitchell, and Neil Rhoads; and experienced photographer and fish surveyor Fernando Lopez Arbarello. Volunteers often joined these surveys; their species-only data were included when confirmed by an expert-level surveyor.

The visual surveys were conducted using REEF's Roving Diver Technique (RDT), described in detail on their Web site, www.reef.org. During the non-point visual survey, divers swim randomly through the survey site, compiling a comprehensive list of fish species and estimates of abundance of each species. After the dive, data are transferred to a scanform. For this study, maximum number of species (MNS) seen by all divers and anecdotal information was also recorded.



As much as possible, surveys at the 12 sites were made with similar effort, at similar depths and for similar duration. Differences are taken into account in data analysis. Data used in this analysis were taken between 8 AM and 2 PM.

Average depth for all surveys was 33 feet; average depth at all shore-based sites was 22 feet; average depth at the three off-shore sites of Molokini, Shark Fin, and Cathedrals was 45 feet.

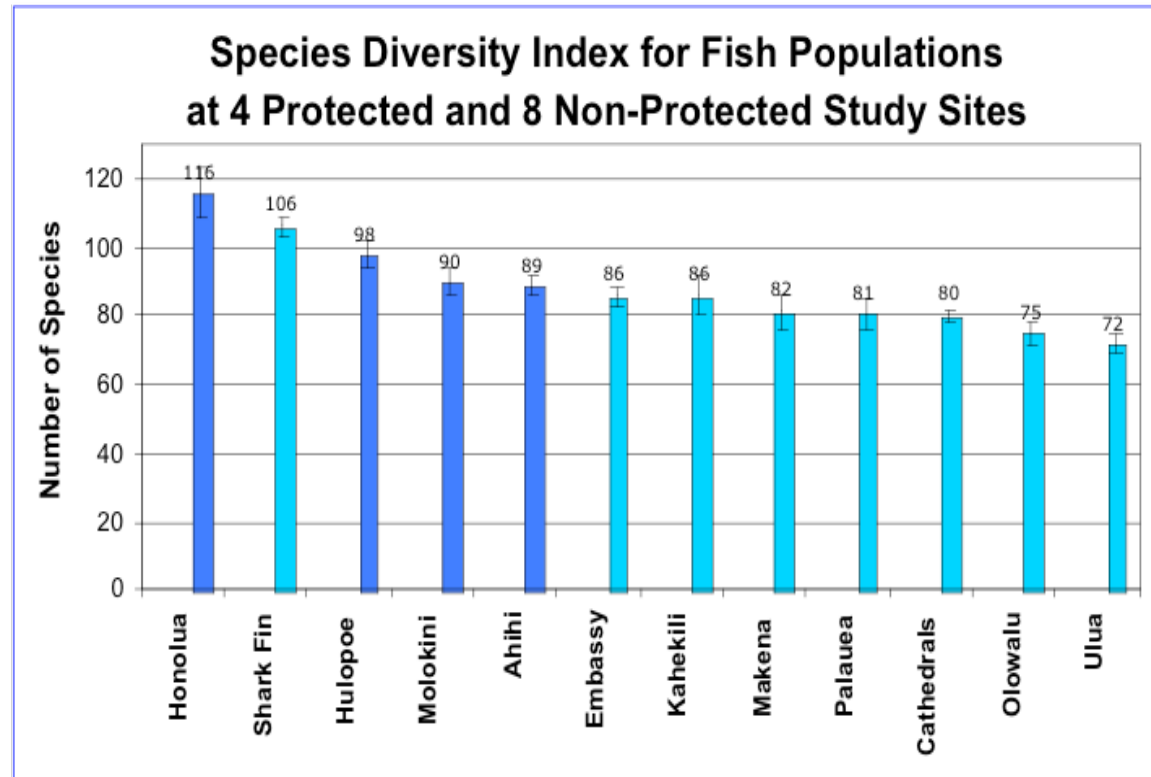
The average survey time was as follows: 75 minutes at the four MPAs; 77 minutes at the six non-protected sites on Maui; and 83 minutes at Maui's two protected sites, Ahihi and Honolua.

Average survey time was lower at Cathedrals (39 minutes), Molokini (56 minutes), and Shark Fin (68 minutes). Because less survey time could affect number of species sighted, comparisons are made both with and without those sites. However, species counts were second greatest and dive duration among the lowest at Shark Fin. Visibility at these three sites improves a diver's ability to spot fish.



Results

The maximum number of species (MNS) seen by all surveyors was recorded after each dive. That number usually exceeds the number of species recorded by any individual surveyor, as each diver often sees a few fish not observed by others. The average of those numbers from all surveys made at each site during the study period was graphed, standard deviation determined, and standard error plotted. Graph 1 shows average MNS recorded at each site for all surveys done during the study period.



Graph 1 -The four MPAs (dark blue) and Shark Fin have the highest average MNS seen on all dives.

This graph indicates that species richness is higher in areas that are protected, and possibly those that are more isolated from human impacts (Shark Fin). It should be remembered that average dive time at Shark Fin was shorter, so one might expect to record fewer fish. However, the site is remote; visibility is greater and benthic habitat and coral cover differ from that at the shore-based sites.

Analysis and Discussion

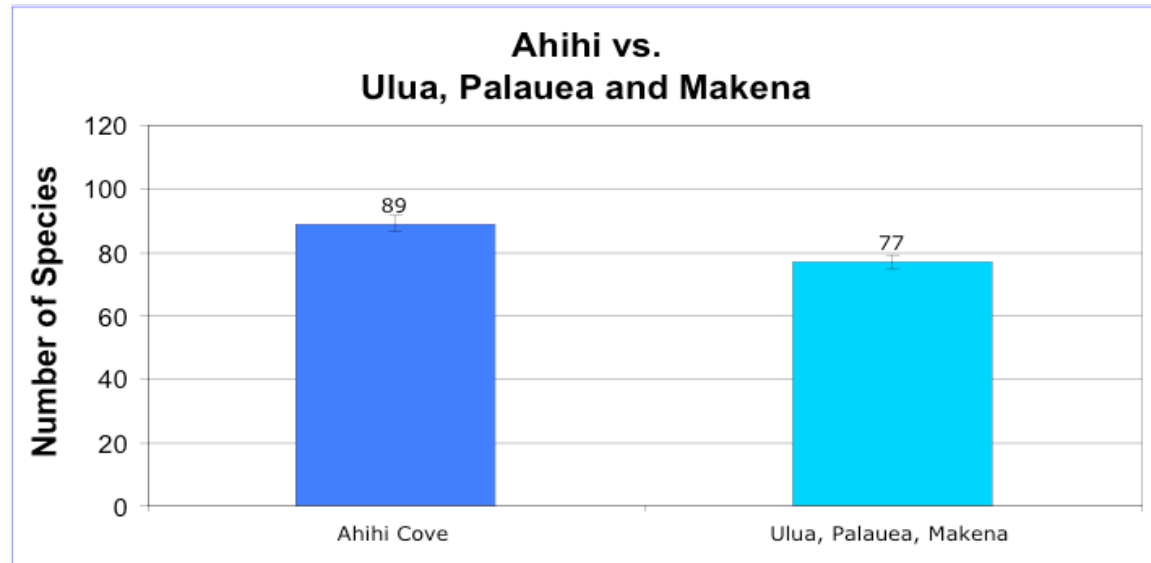
Data are “pooled” from certain sites and compared with that from other sites to examine the premise that protection is beneficial to reef fish populations. In this report, the four protected sites are compared three ways:

- 1) With nearby non-protected sites (proximity)
- 2) With non-protected sites of similar habitat and access (combinations)
- 3) With non-protected sites with similar fish assemblages (clusters)

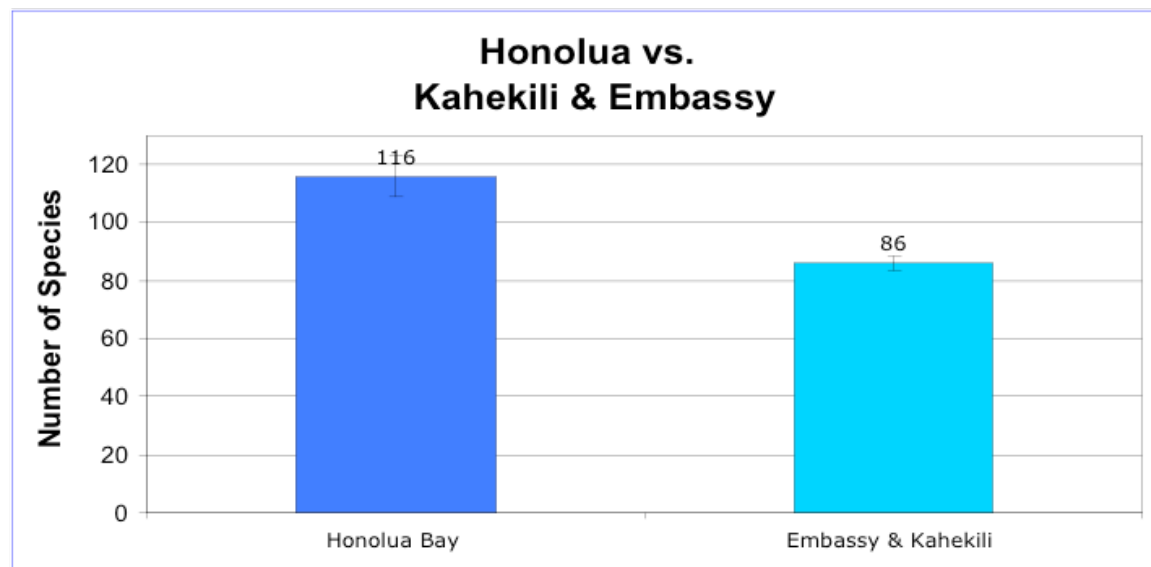


1. *Proximity*: Average MNS recorded at each of the four MPAs is compared with the pooled averages at nearby non-protected sites and the results shown below.

Graphs 2, 3, 4, and 5 illustrate that average MNS are 16% to 35% higher at all four MPAs than average pooled MNS at nearby non-protected sites. Surveys at these sites were done in areas of similar habitat, at similar depths and for similar duration.



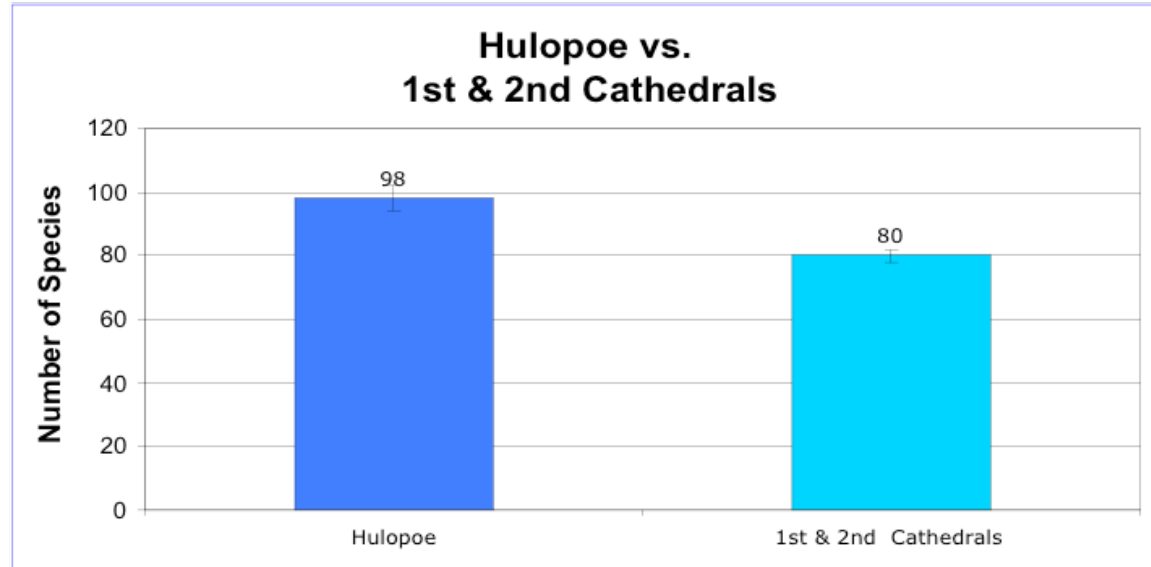
Graph 2 - Average MNS were 16% higher at Ahihi Cove than at 3 nearby sites of Ulua, Palauea and Makena.



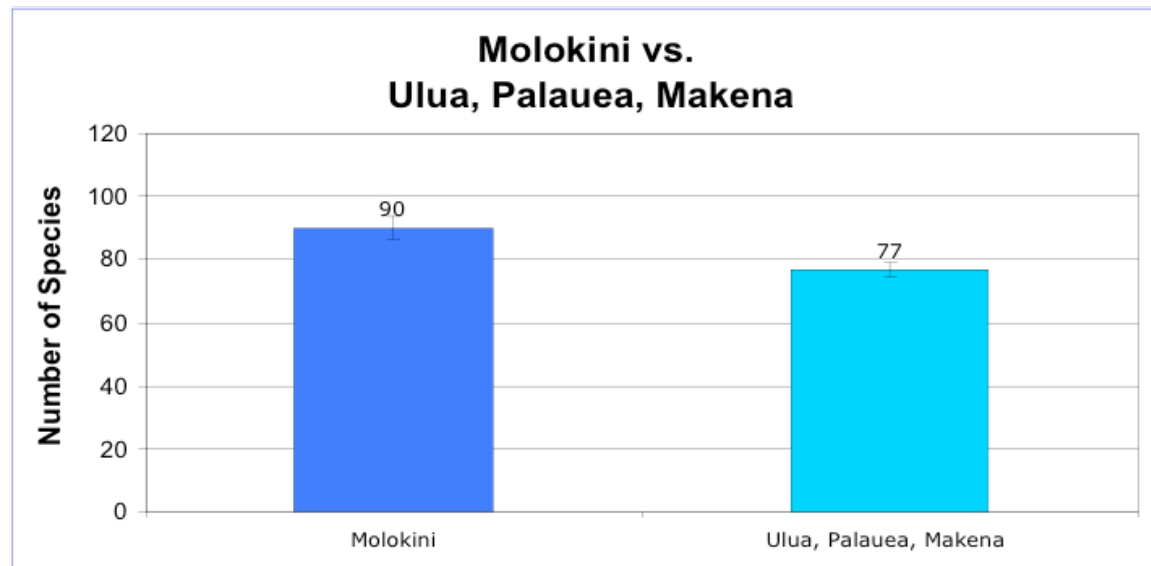
Graph 3 - Average MNS were 35% greater at Honolua Bay than at 2 nearby sites of Embassy and Kahekili.



Average MNS at the shore-based Hulopoe site on Lanai is 23% greater than at nearby 1st and 2nd Cathedrals. Cathedrals are located away from the population center on Maui and are only accessible by boat. They may receive “spill over” benefit from protection of nearby Hulopoe. Dive time at Cathedrals averaged 50% less than that at Hulopoe; depth and visibility at Cathedrals are greater.



Graph 4 - Average MNS were 23 % higher at Hulopoe compared to 1st and 2nd Cathedrals.



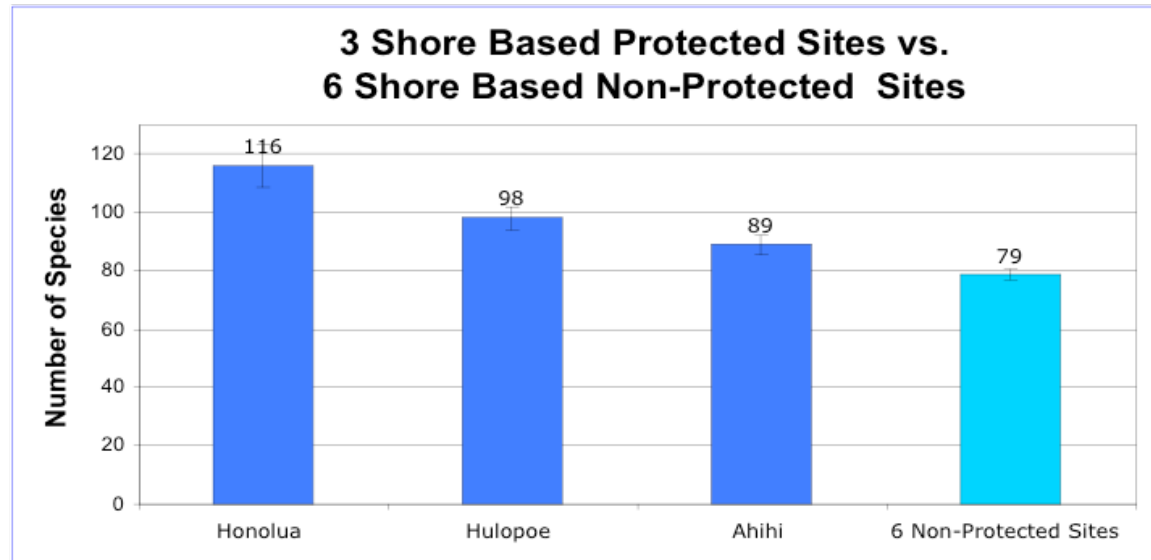
Graph 5 - Average MNS were 17% higher at Molokini compared to nearby Maui sites.

Average survey times were 46% less at Molokini; MNS is 17% greater. Molokini is accessible only by boat. It is a deeper site with significantly greater visibility and coral cover.

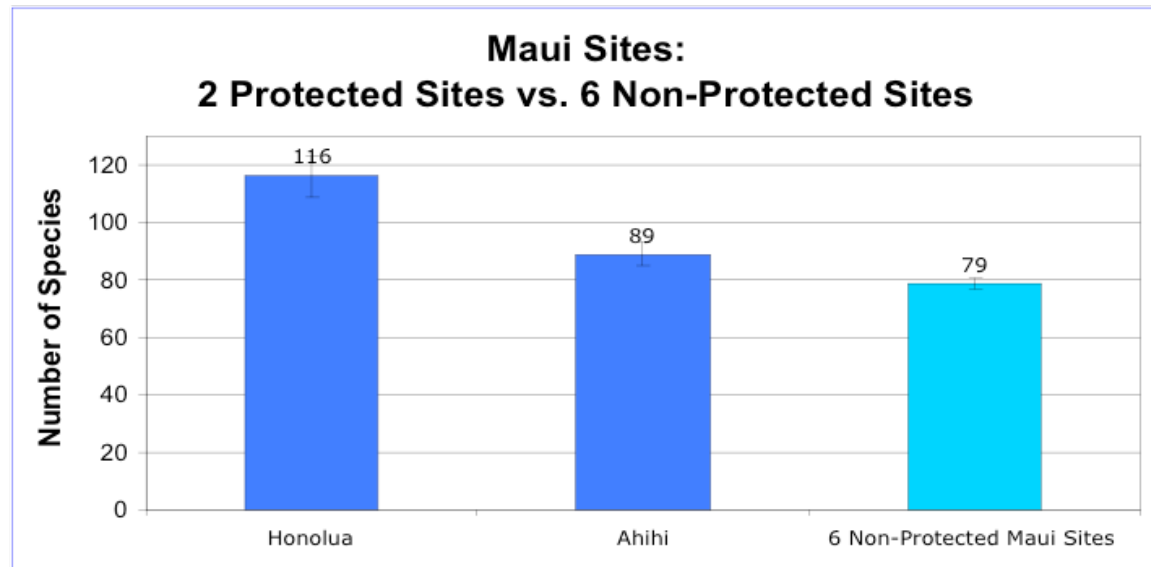


2. *Combinations of protected and non-protected sites:* Pooled data from the six shore-based non-protected sites are compared to data from the protected sites. Comparisons are as follows:

- a) Three protected shore-based sites with six non-protected shore-based sites
- b) Two protected sites on Maui compared to the six non-protected Maui sites



Graph 6 - Average MNS at each of the three protected shore-based sites is greater than average MNS at the six shore-based non-protected sites. Honolua (47%), Hulopoe (24%), Ahihi (13%).



Graph 7 - Average MNS at Honolua is 47% greater, and average MNS at Ahihi is 13% greater than that at the 6 non-protected sites on Maui.

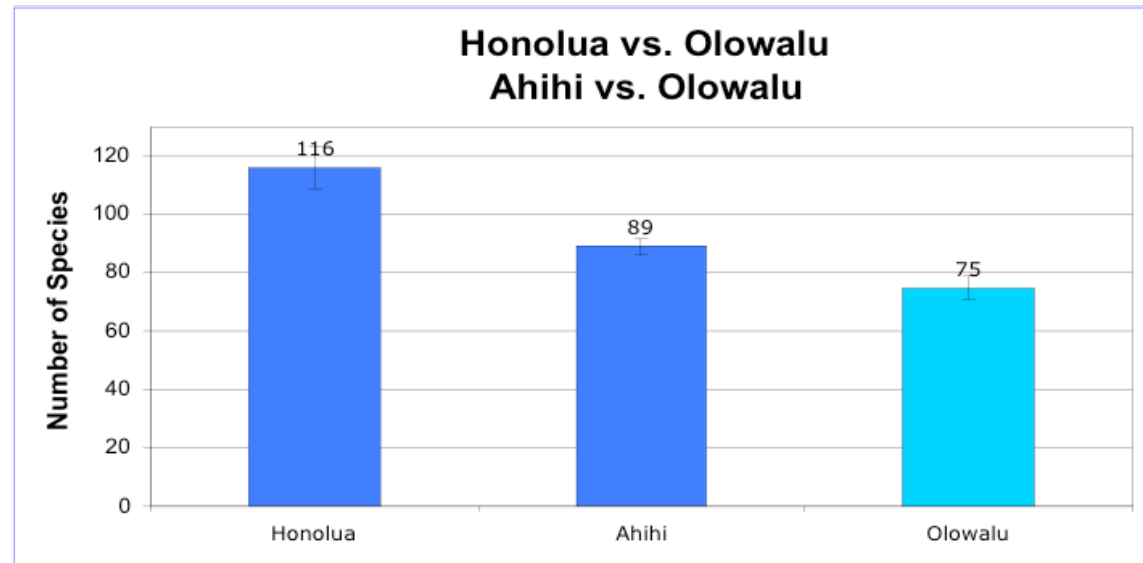


3. *Clusters*: Another way to compare fish populations at various sites is to first group, or *cluster*, sites based on natural occurrence of fish assemblages. It is commonly known that different groups of fish will be found in a shallow water surge zone, for example, than in deeper water, on steep walls or in caves. By comparing MNS at sites whose fish assemblages are similar, the effects of physical factors (e.g. wave action, distance from shore, bottom type and topography) may be minimized.

In her report, Dr. Pattengill-Semmens (2005) includes a cluster analysis of 32 REEF survey sites in Hawaii to determine similarity in fish assemblages. It illustrates that fish assemblages at the four protected sites surveyed for this study cluster most closely with non-protected sites in this study as follows:

- a) Ahihi and Honolua cluster with Olowalu
- b) Hulopoe clusters with Shark Fin
- c) Molokini clusters with Cathedrals

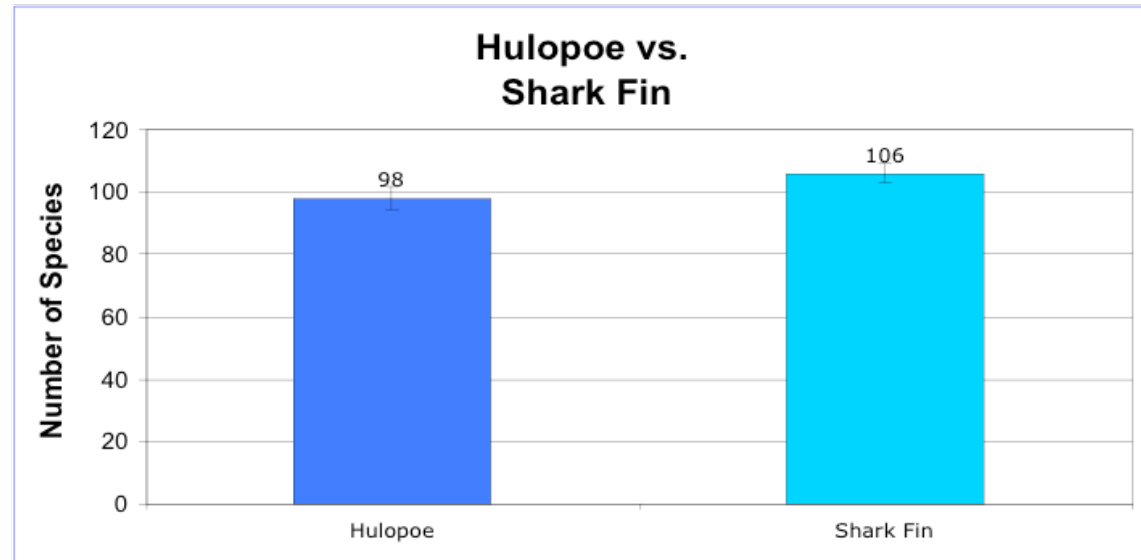
These clustered sites are compared in terms species richness in Graphs 8, 9, and 10 below. Physical characteristics of each dive site, and survey duration, are noted.



Graph 8 - Average MNS is 35% higher at protected Honolua than at Olowalu, and 19% higher at protected Ahihi than at Olowalu.

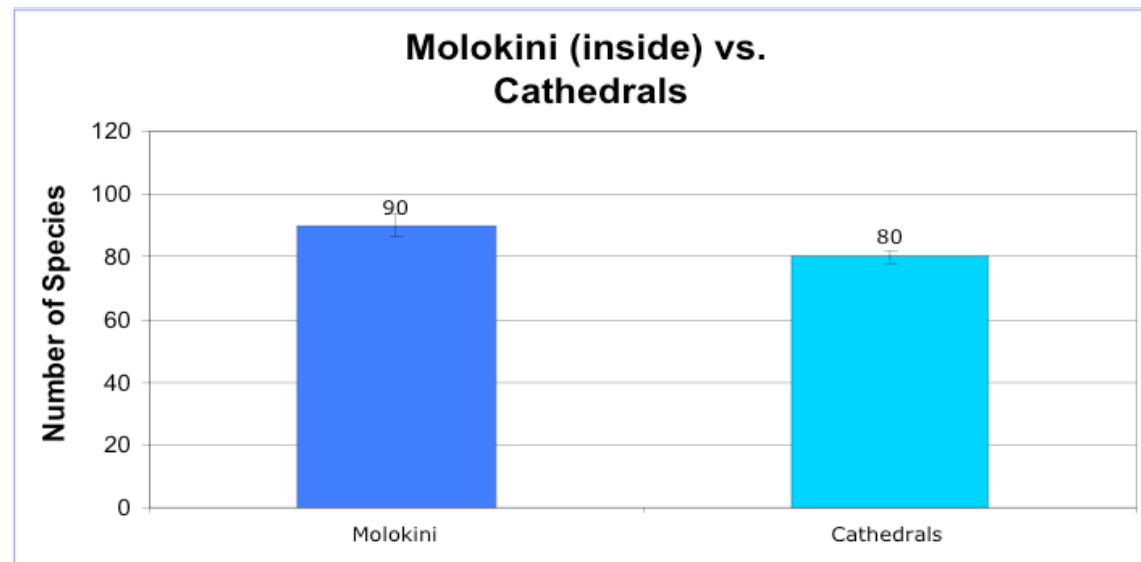
Honolua, Ahihi and Olowalu are all shore-based Maui sites. Average survey times at Honolua were 91 minutes compared to 76 minutes at both Ahihi and Olowalu, which could account for some of the increase.





Graph 9 - Average MNS at protected Hulopoe is 8% lower than Shark Fin.

Shark Fin is more remote and less accessible than Hulopoe. The visibility is often better, and the benthic characteristics quite different from those at shore-based Hulopoe. The average MNS at Shark Fin exceeds that at three of the four protected sites, although the average dive time was lower.



Graph 10 - Average MNS were 13% higher at Molokini than at 1st and 2nd Cathedrals

It is likely that Cathedrals benefits from a “spill-over” effect from protection within Hulopoe Bay. Both Molokini and Cathedrals are visited by dive boats, although little snorkeling activity occurs at Cathedrals. Molokini is protected from fishing and aquarium-collecting activities.



Conclusion

The data are preliminary, as the study period covers only 15 months, fish population dynamics change frequently in response to physical phenomenon (e.g. wave action) and this analysis covers only one aspect of data collected.

That being said, this community-based study supports the premise that protection increases species richness, as higher maximum number of species seen per dive was repeatedly documented in the four MPAs. High species richness recorded at non-protected Shark Fin raises the possibility that remoteness is beneficial for fish populations, as human activity is known to impact fisheries and reef fish populations worldwide (Lee and Safina 1995; Birkeland and Friedlander 2002).

Anecdotal records included at the end of this paper describe greater diversity and abundance of fish species at the four MPAs and Shark Fin. Greater size and presence of species not seen elsewhere is also reported at these protected sites. These first hand observations should not be ignored. Billy Causey, Superintendent of the Florida Keys National Marine Sanctuary, said, "One of the features I cherish the most about REEF data is that it is collected by people who are giving of their personal time and who have an interest in the health and well being of the coral community. The data is readily available and ... REEF participants are discussing their results immediately in the community and this creates a groundswell of interest and excitement along the waterfront."

In the four years since REEF was introduced to Hawaii, participation has grown dramatically, particularly from 2003 - 2004 when National Fish and Wildlife Foundation supported the Adopt-a-REEF program. Among the many benefits are increased community awareness and sense of stewardship, active and regular volunteer REEF survey efforts, and additional data available to managers. It is possible that protection of Hawaii's reefs will ultimately come from the residents themselves, inspired by REEF involvement and principles, and driven by deep personal concern for our natural resources.



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ANECDOTAL INFORMATION

In addition to data collected on fish diversity and relative abundance during the course of this study, anecdotal reports were made immediately following the dives to record surveyor perceptions of fish population abundance and size of targeted species. Of particular interest as indicator species was presence and size of parrotfish, certain goatfish, yellow tang and butterflyfish.

Anecdotal reports were regularly entered and tracked on spreadsheets. The following picture emerged: At Honolua, Ahihi, Molokini, Hulopoe, Shark Fin and Cathedrals – the four protected sites and two Lanai sites — many (20 - 50+) parrotfish over 8” and many terminals of most species were recorded. With the exception of Cathedrals, those sites also have many good size initial stage parrotfish. At the heavily used non-protected, shore sites on Maui only 0, 1 or 2 large parrotfish, 0, 1 or 2 terminal parrotfish, and a few small initial stage individuals were usually seen. At one location 12 - 15 large parrotfish, including terminal and initial stages were recorded. At another such site many small initial palenose and bullethead parrotfish were noted; a few terminals were recorded on one survey and four larger parrotfish on another.

It was clear to the survey team that diversity and abundance of fish appears to be greater at protected and remote areas than at non-protected areas.

Typical comments after survey dives at the four protected sites, Shark Fin and Cathedrals were:

- “There are so many parrotfish I lost count!”
- “There’s an abundance of yellow tangs!”
- “There are so many fish!”
- “Great diversity!”
- “There are fish here I’ve never seen!”

Comments recorded after dives at Maui’s non-protected sites are quite different:

- “no yellow tang”
- “only a few total butterflyfish”
- “about 12 small yellow tang”
- “no manini”
- “very few butterflys”
- “no terminal or large parrotfish”
- “just a few very small yellow tang”
- “no yellowstripe or yellowfin goatfish”
- “only one orangeband”
- “no blennies”
- “only 1 tiny yellow tang”
- “no sergeants”
- “where are the fish?”

These remarks are from divers who spend significant time surveying fish populations on Hawaii’s reefs, as well as volunteers who donate their time to help increase the amount of information available to managers. The comments indicate an immediate awareness of the significant difference in fish populations at the non-protected, heavily used and often over-fished reef areas along Maui’s south shore, versus those at protected and more isolated sites.





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- Kauai Children's Discovery Museum
- Koloa Library
- Lahaina Civic Center
- Maui Community College Marine Option Program
- Maui Bulletin
- Maui Marriott
- Maui Ocean Center
- Maui Weekly
- Mike Severns Diving
- Mokuapapa Discovery Center
- Octopus Reef
- Pacific Dive
- Pacific Whale Foundation
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- Janet Eyre (84)
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- Patricia Richardson (71)
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