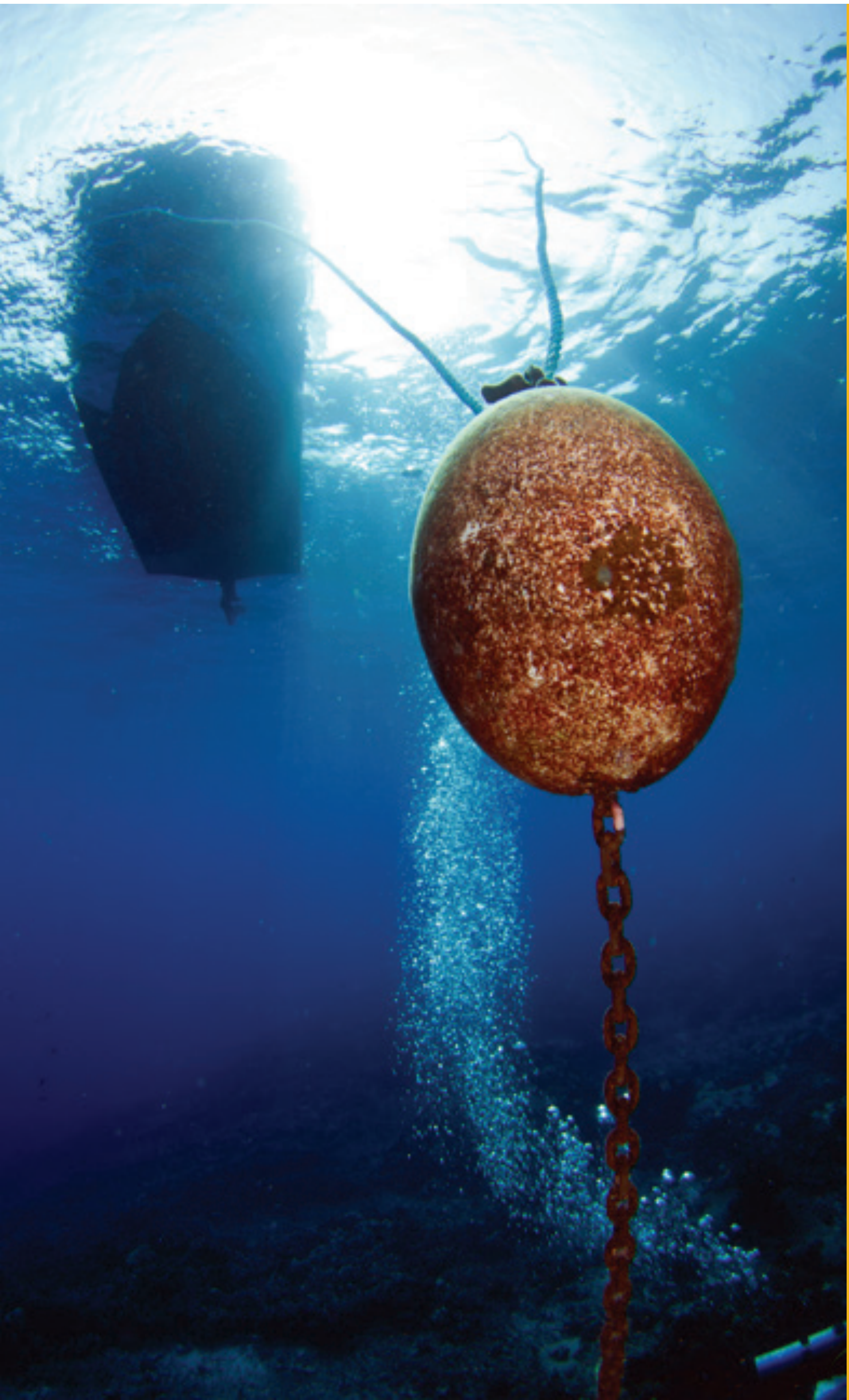
Natural Resource Assessment Near Day Moorings: Hawaii Island

September 2016



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*** See the Supplementary Kona DMB Assessment Report for detailed buoy information and photos*

Abstract

The University of Hawaii, Social Science Research Institute's Hawaii Coral Reef Initiative was contracted to conduct an assessment of the day moorings along the Kona coast of Hawaii Island. This assessment adds to the growing information about the current status of day moorings in Hawaii. This report includes a table of 86 Hawaii island buoys, their updated GPS location, summaries of the ecological conditions around the buoys, and maps of the DMB locations as well as a link to the ArcGIS Online DMB map.

Published locations varied wildly among the buoys. Some buoys had six or more different associated GPS points spread over a distance of miles, while other published buoys were unable to be located and may not have been installed. Updated and verified points for every assessed buoy are included in this report.

The benthic conditions around each of the buoys was consistent with providing recreational divers access to reefs. The most common benthic types found near the buoys in descending order were live coral, limestone cement, rubble, sand, crustose coralline algae, and macroalgae. The most common species of coral encountered at the sites were *Porites lobata, Montipora capitata,* and *Porites compressa*.

The installation hardware often serves as an artificial settling substrate for newly recruiting sessile organisms, including coral. The only two coral genera that were found growing on mooring components were *Pocillopora* spp. and *Porites* spp.

Introduction

Day-use mooring buoys (DMBs) have been implemented at popular dive sites around the world as an alternative to anchoring, which has been shown to cause damage to coral reefs (Forrester & Flynn, 2014; Dinsdale & Harriott, 2004; Saphier & Hoffmann, 2005; Jameson et al, 2007), seagrass beds (Milazzo et al, 2004; Lloret et al, 2008), and other benthic communities such as bivalves (Hendriks et al, 2013). To ensure the safety and efficiency of the DMB system, it is important to regularly monitor and maintain buoys as well as document any impacts to the area associated with the mooring**.** The goal of this study was to verify day mooring locations and provide an ecological assessment of the area surrounding day moorings along the Kona coast.

Ecological assessments of mooring sites can help determine the effectiveness of moorings at protecting sensitive resources by detecting changes to the ecosystem over time. While moorings are considered an effective management tool for protecting coral reefs from the widespread damage of anchoring (Hocevar, 1993), localized damage to the mooring site can still occur. Loose mooring components can drag on the benthos, abrading or breaking corals, and SCUBA activities associated with most mooring sites can also lead to habitat damage (Saphier & Hoffmann, 2005; Harriott et al, 1997; Di Franco et al, 2009; Hasler & Ott, 2008; Barker & Roberts, 2004; Meyer & Holland, 2008), particularly in close proximity to the mooring itself (Tratalos & Austin, 2011; Hawkins et al, 1999; Hawkins et al, 2005) as divers usually congregate to make buoyancy and gear adjustments upon descent. If left unmanaged, these sources of damage can result in a shift from a healthy reef to an algae dominated state (Shloder et al, 2013; Jameson et al, 2007), or lead to further coral decline, as injury may increase a coral's susceptibility to disease (Aeby & Santavy, 2006). Such changes to benthic habitat composition can lead to further ecosystem shifts, such as decline in reef fish populations or diversity (Pratchett et al, 2014; Jones et al, 2004; Coker et al, 2013). Ecological assessments can identify such community changes, and guide management actions such as mooring maintenance or sustainable limits for dive numbers to further protect resources from impacts.

This study provides an updated and verified record of mooring locations and baseline ecological data for each site that can be used to inform managers and support future monitoring and maintenance efforts for DMBs on the Kona coast.

Methodology

The *in situ* survey methodology used in this study was based on past methodology used by the Division of Aquatic Resources to describe sites proposed for DMB installation and assess Oahu DMBs in 2014. In-water surveys were conducted by a two diver team, while surface support crew conducted a survey of user traffic in the area.

The dive team navigated to the waypoint for each site using a Garmin GPS Map 78 handheld unit, visually looking for the submerged buoy until the vessel drifted over and well past the site. If no buoy was found, a swimmer was deployed to look for abandoned ground tackle or buoys hidden by poor surface visibility. If the buoy was still not found, secondary points were sourced from local ocean users and historical documents to be revisited later. If the buoy was found more than 30 feet away from the recorded waypoint, a new, more accurate waypoint was taken. Any unpermitted day moorings were marked on the GPS and described in thsclere database.

Before conducting diving operations, personnel recorded metadata for each site, including island, dive site, date, GPS position, survey divers, and time. Divers carried with them a dive slate and a camera for recording survey data and photographing mooring components and the surrounding benthos. Two cameras were used in this study including a Canon T1i in Ikelite housing with a Tokina 10-17mm lens and a Canon Powershot 300HS in a Canon housing.

Diver #1 was responsible for assessing the installation, epiphytic growth, and benthic damage (Appendix A: Data sheet #1: Installation condition). On initial descent, Diver #1 noted the buoy depth, then observed for growth and wear on the flotation, working down to the remaining components. D-rings, downline, shackles, chains, and ground pins were all assessed for corrosion, breakage, coral growth, and aquatic invasive species. Depth of the mooring anchor points was also recorded. Once the installation was observed and photographed, the surrounding area was surveyed for coral damage, abrasions, and breakage resulting from the mooring. Diver #1 also surveyed for coral bleaching and disease in the 10-meter radius around the mooring site, and counted broken coral colonies from actions other than waves. Determining the cause of a broken coral head is very difficult and highly subjective. In this case, only freshly broken, still white coral breaks were counted. Breaks were considered wave action if they occurred near rubble or loose material that might impact the coral head. The most obvious non-wave breaks occurred when the coral was attached to a solid substrate.

Diver #2 was responsible for conducting an ecological assessment of both the 10-meter radius around the mooring and the visible area outside the survey radius (Appendix B: Data sheet #2: Ecological condition). First, a DACOR (Dominant (>75%), Abundant (40-75%), Common (10-40%), Occasional (5-10%), and Rare (<5%)) assessment was conducted, applying a value to each of the following substrate types: Sand, Rubble, Cement, Coral, Macroalgae, and Crustose Coralline Algae (CCA). DACOR analysis was followed by a more specific benthic description that categorized CCA type and listed the species of coral and macroalgae present. Coral heads greater than 1 meter in diameter were noted by number and species both within the 10-meter survey radius and in the surrounding area.

The data were compiled to describe the conditions of the equipment and ecological state. The benthic habitat was tabulated to describe the immediate area around the buoys for each site and for the whole Kona coast. Epiphytic corals and invasive species were documented as a baseline to contribute to future determinations of rate of accumulation. Finally, nearby ocean users were documented to contribute to the social needs of the project.

Results

The goal of this study was to verify day mooring locations and provide an ecological assessment of the area surrounding day moorings along the Kona coast. Many records of mooring locations were found to be incomplete or inaccurate, and verified mooring site coordinates will make moorings easier to find and utilize as an anchoring alternative, and streamline maintenance and monitoring efforts in the future. The ecological data collected from these surveys will serve as a baseline for future assessments that can be used to track changes to the system over time and identify potential sources of damage.

Day Mooring Locations

Until this survey, the Division of Boating and Ocean Recreation did not have an accurate list of day moorings for the island of Hawaii. The initial list was derived from a variety of sources, including: 1994 Environmental Assessment, Division of Boating and Ocean Recreation's administrative rules, U.S. Army Corps of Engineers' 1995 general permit and 2009 and 2010 letters of permission, and Malama Kai Foundation's list. Not one source wholly concurred with any other. An updated site list with verified GPS locations is included in Appendix C: Updated DMB Coordinates.

Benthic Habitat Assessment

The ecological survey data for day use moorings along the Kona coast was captured in an Excel database and is provided in Appendix D: Ecological Survey Database. A summary of conditions for each buoy site and photos of the benthos are provided in *Supplementary DMB Assessment report.* This information can be use by DAR as a baseline to understand the effectiveness of DMBs as a tool to protect coral reefs. The information can also be used by DOBOR to determine the most efficient timing of their buoy repairs and the annual cost for maintenance and repair.

For the purposes of this report, each benthic type is described and summarized below.

Sand/Silt

Sand is defined as a loose, granular substrate that can be produced through erosion or the waste products of marine organisms. The DACOR assessment of the 10-meter survey radius around the buoys found sand/silt to be 4% dominant, 6% abundant, 45% common, 23% occasional, and 22% rare.

Rubble

Rubble consists of dead, broken coral fragments. It is much more rugose and provides more habitat than sand, cement, or base basalt, but it does not support the diverse community of a live coral reef. Heavy seasonal waves can roll rubble around and prevent successful recruitment of new coral colonies. The DACOR assessment of the 10-meter survey radius around the buoys found rubble to be 3% dominant, 16% abundant, 33% common, 20% occasional, and 28% rare.

Cement

Limestone cement is a hard-packed, two-dimensional substrate. While coral cement habitat does not provide much cover to support reef organisms, it can serve as a solid foundation for new coral settlement in favorable conditions. The DACOR assessment of the 10-meter survey radius around the buoys found cement to be 4% dominant, 16% abundant, 45% common, 21% occasional, and 14% rare.

Coral reef

Live coral habitat is the preferred benthic habitat type for SCUBA divers in Hawaii. Live coral was by far the most common substrate type encountered during the surveys. The three most common species were lobe coral (*Porites lobata*), rice coral (*Montipora capitata*), and finger coral (*Porites compressa*), occurring at 99%, 89%, and 84% of the sites, respectively. The least common species observed were false brain coral (*Porites duerdeni*) (5%), mushroom coral (*Fungia scutaria*) (2%), and pork chop coral (*Pavona duerdeni*) (1%). The DACOR assessment of the 10-meter survey radius around the buoys found coral to be 8% dominant, 27% abundant, 52% common, 13% occasional, and 0% rare.

Algae

Further up the Hawaiian archipelago, macroalgae and crustose coralline algae (CCA) are major substrata and contribute significantly to reef building, especially in the cooler waters of the Northwestern Hawaiian Islands. However, in Kona, these are relatively minor substrate types except in the event of a phase shift or sudden influx of nutrients.

The only site where CCA was Abundant was at the North mooring at Garden Eel Cove. CCA was Common at 8 of the other sites, Occasional at 7 of the sites, and Rare at the remaining 64 sites surveyed. Of these, 32% (26 total sites) were branching varieties of CCA while 86% (69 total sites) were encrusting. The DACOR assessment of the 10-meter survey radius around the buoys found CCA to be 0% dominant, 0% abundant, 5% common, 9% occasional, and 86% rare.

Macroalgae was similarly sparse among the Kona DMBs. The most common species were *Neomeris annulata* (9 sites), *Asparagopsis taxiformis* (3 sites), *Turbinaria ornata* (3 sites), *Glomerata* sp. (2 sites), *Gibsmithia hawaiiensis* (2 sites), *Pterocladia* sp. (1 site), and *Caulerpa racemosa* (1 site). The reef at one of the unpermitted sites (Auau Canyon) was inundated with a bloom of cyanobacteria at the time of the surveys. The DACOR assessment of the 10-meter survey radius around the buoys found macroalgae to be 0% dominant, 1% abundant, 10% common, 10% occasional, and 79% rare.

In summary, DACOR analysis provided information on the dominant habitat within a 10-meter radius of each buoy. The most common benthic habitat along the west coast of Hawaii was coral at 52%. Other common benthic habitats were sand/silt (45%) and cement (45%). Rubble was only dominant at 3% of sites, indicating mooring effectiveness in helping preserve coral reefs from anchoring impacts.

Coral bleaching was observed at 81% of mooring sites, and often coincided with instances of algal overgrowth. Bleaching was observed in multiple coral species, including *P. lobata, P. compressa, P. meandrina, P. eydouxi,* and *Montipora capitata.*

Impact to Corals Around DMBs

Broken coral was found at the majority of mooring sites within the 10-meter survey radius. Out of the 91 day moorings surveyed, 20% had no broken coral, while 53% had a single broken coral and 19% of sites had two to five broken corals. Only one mooring site had more than 10 broken corals within the survey radius. The dive team found that non-wave coral damage rarely occurred to mature colonies, and even then only small breaks at the tips. It is assumed that the cause of most breaks close to a mooring is scuba divers contacting the bottom. Dive operators try to find sandy landing points for beginning scuba divers and take measures to teach good buoyancy early in training, but unintended contact can still occur. While there were some chips and abrasions on coral around 92% of the buoys, these DMBs are preventing the uprooting and destruction of whole coral beds.

While day moorings concentrate impacts over a single area of reef in order to protect the area as a whole, intensely used sites like the Keauhou manta site, situated over a formerly pristine reef, have severe coral damage throughout the reef. Many large coral heads, some larger than 2 meters across, have been upended and broken. Damage of this scale is unlikely to be caused by a diver, indicating anchor use despite the presence of moorings. During surveys, an anchor was found under a chipped coral head, further implicating anchors as the cause of most of the damage, and supporting the use of DMBs as an anchoring alternative.

Coral Growth on DMBs

The buoys and tackle serve as settlement substrate for turf algae, barnacles, bivalves, tube-worms, and various other benthic organisms that can weigh the buoys down. The focus of this observational study was the presence of reef building, scleractinian corals.

Forty-three percent (43%) of the buoys (total=35) had some form of coral growth, and 9% harbored invasive hydroids. Coral colonies were often too small to determine species, and are described by genera instead. Out of the 35 buoys with coral growth, 60% had growths of *Pocillopora* spp., with the remaining growths being identified as *Porites* spp.

Forty-two percent (42%) of the downlines and ground tackle had coral growth and 16% had invasive hydroids. *Pocillopora* spp. was identified growing on 92% of the affected components, with *Porites* spp. identified on the remaining 12% of components exhibiting coral growth. *Pocillopora* spp. were found growing on components of 59% of all DMB installations.

If coral is allowed to continue growing on mooring components, it can potentially become big enough to weigh down the buoy over time. In addition, many of these colonies have settled on the anti-chaffing sleeve, dragging it down from the buoy. In the case of the Frog Rock and Crystal Cove buoys, this has allowed the wave action to noticeably chaff at and reduce the life of the rope.

Conclusion

Day moorings are designed to protect coral reefs and natural resources from the impacts of anchoring at popular recreation sites. However, DMBs can only be an effective management tool with routine maintenance and monitoring efforts to keep the mooring in usable condition and address ecological concerns associated with activity at mooring sites. The database of verified GPS coordinates and ecological conditions resulting from this study can serve as a baseline for mooring sites on the Kona coast, and can be used to identify ecological concerns and maintenance needs over time, supporting future management efforts to protect Hawaii's reef resources.

Appendix:

Appendix A: Data sheet #1: Installation condition

On-Site Addessment of Buoy/Chain/Emvironment For Permenant DMBs (10m radius)					
Island:		**Dive Site:**		**Date:**	
Lat:	**Long:**	**(use Datum WGS 84)**		**Depth(ft.):**	
Divers:					
Buoy Description	D-rings Intact:	Yes	No		
	Attachment to chain intact:	Yes	No		
	Buoy buoyancy and position:	Low	Medium	High	
	Coral browing on buoy:	Yes	No		
Use last column to identify any associated photos or notes.	AIS growing on buoy:	Yes	No		
	Coral on buoy (list #, spp., & form):				
	AIS on buoy (list #, spp. & form):				
Buoy Chain Description	Buoy in Good Condition:	Yes	No		
	Coral Growing:	Yes	No		
	Coral (list #, spp., & form)	Yes	No		
	AIS Growing on Y/N	Yes	No		
	AIS (list #, spp. & form)	Yes	No		
	Attachment to Ground Intact	Yes	No		
Impacted Resources at site	# of Broken Coral (not from wave action)	A = 1	B= 2-5	C=6-10	D = 11-20
	Diseased Coral (list #, spp., form, decribe type of disease and disease size)				
	JPEG BRC:				
	JPEG DC:				
	JPEG BLC:				
	JPEG T:				
	Trash (type, #):			Impaction Coral Y/N	
Prohibited Fishing Observed	Notes:				

Appendix B: Data sheet #2: Ecological condition

On-site Assessment of Buoy/Chain/Environment For Permanent DMB's (10m radius)							
Island:			Dive Site:			Date:	
Lat:	Long:		Depth(ft.):				
Divers:							
General Benthic Cover	DACOR Key		D>75%	A~40-75%	C~10-40%	O~5-10%	R<5%
	Sand/Silt						
	Coral						
	Gravel/Rubble						
	Hardbottom						
	Macroalgae						
	CCA encrusting						
Detailed Benthic Description	Hardbottom Type (basalt, limestone, etc.)						
	Coral (list spp. & form)						
	Macroalgae						
Circle if present:	CCA encrusting		CCA branching				
Sensitive Resources at Site	Coral colony > 1m diamter **within** 10m radius (#, spp., and form)						
	Coral colony >1m diameter **outside** 10m radius (#, spp., form)						
	Sessile E/T species (list spp.)						
	Unusual/sensitive resources (list spp.)						
	Steep rise of reef (height-ft)						
Protected species observed:		Turtle	Humpback	Monk Seal			
(Circle all that apply)		Dolphin	Other cetacean				
Notes:							

Appendix C: Updated DMB Coordinates for Hawaii Island

DIVE SITE	LAT	LONG
GEC Deep Mooring	19.73705	156.05434
GEC Middle Inside	19.7365	156.05374
GEC North Ball	19.73725	156.05406
GEC Middle Outside	19.73664	156.05405
GEC South Inside	19.73598	156.05388
GEC South Outside	19.73601	156.05409
GEC Aggressor Chain	19.73729	156.05469
Keahou Aggressor North	19.55889	155.96797
Keahou Aggressor South	19.55885	155.968
Keahou North Inside	19.55938	155.96709
Keahou South Inside	19.55913	155.96744
Keahou North Outside	19.55941	155.96754
Keahou South Outside	19.55901	155.96773
A Bay - legal	19.91525	155.90001
A Bay - UnID # 1	19.90443	155.90359
A Bay - UnID # 2	19.91031	155.89972
Black Coral	19.8359	155.996483
Kua	19.812933	156.008117
TOG	19.7827	156.05265
Black Hole	19.715533	156.053967
Keahole Wash Rock	19.732233	156.059633
Phantom Ridge	19.704917	156.050267
Pipe Dreams	19.729117	156.06225
Rabbi's reef	19.705983	156.050933
Keahole Sand Chute	19.732583	19.732583
Eel Cove N	19.65503	156.03183
Eel Cove South	19.65415	156.03156
Pyramid Pinnacle Outer	19.692517	156.04625
Pyramid Pinnacle Shallow	19.692533	156.0457
Turtle Heaven	19.67108	156.02924
Turtle Pinnacle	19.67175	156.0305
Carpenter's Reef	19.70472	156.05016
Dotty's	19.70677	156.05002
Golden Arches North	19.70338	156.05011
Golden Arches South	19.70293	156.04985
Hoover's	19.74037	156.05556
Skunk Hollow Inner	19.69138	156.04303
Skunk Hollow Outer	19.6911	156.04314

Suck Em Up	19.69133	156.0423
Freeze Face	19.69042	156.03941
Honokohau Inner	19.66793	156.02882
Honokohau Middle	19.66786	156.02911
Honokohau Outside	19.66773	156.02946
Kaloko 2	19.68318	156.03653
Kaloko 1	19.68365	156.03587
Lone Tree	19.69113	156.04076
Terrapin	19.67216	156.03125
Turtle Pai	19.6717	156.02985
Windows	19.6859	156.03497
Air Tanks	19.64664	-156.01839
Casa Cave	19.61605	155.98682
Disneyland	19.64709	156.0197
Kaiwi Arches	19.64733	156.0229
Kaiwi Wash Rock	19.64689	156.02339
Kamanu	19.64761	156.0218
Outhouse	19.65021	156.03023
Kaiwi Sand Channel	19.64744	156.02238
Shark Fin Rock	19.64366	156.01566
Chimney	19.54125	155.06001
Coral Dome	19.52178	155.95937
Henry's Cave	19.50826	155.95486
Long Lava Tube	19.50398	155.95305
Mano Point	19.54595	155.96165
Kealakekua Bay MLCD	19.48194	155.93236
The Dome	19.49705	155.95003
Amphitheater	19.50308	155.95241
Driftwood	19.49881	155.95148
Ridges	19.49442	155.95016
Old Airport South	19.64356	156.01567
Black Point North	20.11295	155.88626
Black Point South	20.10338	155.88313
Black Point	20.10582	155.88477
Kei Kei North	20.0804	155.86763
Frog Rock	20.06492	155.85443
Ulua Cavern	20.07436	155.86435
Crystal Cove	20.05367	155.84583
Lava Dome Rock	20.0609	155.85097
Pentagon	19.9156	155.89911
Turtles	19.94928	155.87099

Haunted Cavern	19.94681	155.87231
Paniau South	19.95929	155.86009
Paniau North	19.95979	155.8597
Puako Reef 112	19.96753	155.85515
Puako Reef 69	19.97005	155.84872
Puffer Canyon	19.971	155.84547
Puako Reef 55	19.9701	155.84724
Puako Condos	19.97342	155.84358
Auau South/inner	19.2944	-155.8894
Auau North/Outer	19.29433	-155.88942
3 room cave	19.324333	-155.89033
Paradise Pinnacle	19.322333	-155.89127

Coordinates in red have been updated.

Appendix D: Ecological Survey Database (Sample page) (full database provided to DAR)

Site Information							DACOR substrate						Benthic Description																				Sensitive Resources						
DIVE SITE	DATE	Bottom DEPTH (ft)	LAT	LONG	DIVER	Time	sand/silt	gravel/rubble	hard bottom	coral	macroalgae	CCA	Hardbottom type	Coral spp list & form	Porites compressa	Porites lobata	Porites lichen	Porites duerdeni	Porites lutea / evermani	Pocillopora meandrina	Pocillopora eyudouxi	Palythoa caesia	Cyphastrea agassizi	Montipora capitata	Montipora patula	Pavona varians	Pavona duerdeni	Leptoseris incrustans	Fungia scutaria	Macroalgae	Encrusting CCA (Y/n)	Branching CCA (Y/N)	Coral >1m #, species, form INSIDE 10M RADIUS	Coral >1m #, species, form OUTSIDE 10M RADIUS	Sessile E/T species list spp.	Unusual sensitive resources list spp.	Steep rise of reef (ht in ft)	Protected species observed	Notes
GEC Deep Mooring	6/7/2016	79	19.73705	156.05434	KB	9:20	D	R	R	O	R	R	basalt			Y								Y						Pterocl	N	N	none	P. lobata x2	n/a				
GEC Middle Inside	6/7/2016	28	19.7365	156.05374	KB	11:34	C	C	O	A	R	C	basalt		Y	Y			Y					Y							N	N	none		n/a				
GEC North Ball	6/7/2016	27	19.73725	156.05406	KB	9:50	R	R	R	D	R	A	limestone, basalt		Y	Y			Y					Y	Y						N	N	none	P. lobata x 1	n/a				
GEC Middle Outside	6/7/2016	40	19.73664	156.05405	KB	10:03	C	O	O	A	R	C	limestone, basalt		Y	Y						Y	Y	Y	Y						N	N	none		n/a				
GEC South Inside	6/7/2016	24	19.73598	156.05388	KB	11:20	R	R	O	D	R	C	limestone, basalt		Y	Y			Y	Y				Y	Y	Y		Y			Y	N	none		n/a				corals stressed & cover in mucus
GEC South Outside	6/7/2016	36	19.73601	156.05409	KB	11:02	R	R	R	D	R	C			Y	Y			Y			Y		Y	Y	Y					Y	N	none		n/a				corals stressed JPG 6135 & 6136
GEC Aggressor Chain	6/7/2016	80	19.73729	156.05469	KB	9:35	C	A	R	A	C	C	limestone, basalt		Y	Y								Y						Pteroc	Y	N	none	none	n/a				
Keauhou Aggressor North	6/8/2016	43	19.55889	155.96797		9:17	O	A		A			basalt		Y	Y		Y	Y	Y	Y			Y	Y	Y	Y			Glome	Y		4 P. lobata m	3 P. lobata mounding			43 ft to 37 ft		
Keauhou Aggressor South	6/8/2016	42	19.55885	155.968			O	A		A			basalt	P. brighami	Y	Y		Y	Y	Y				Y	Y					Glome	Y		1 P. lobata M	3 P. lobata mounding					
Keauhou North Inside	6/8/2016	29	19.55938	155.96709	KB	10:54	R	O	R	A	R	O	balsalt and limestone		Y	Y								Y							Y		6 P. lobata (r	14					5 massive P lobata recovering from bleaching. Obs. Disease in 10 M radius
Keauhou South Inside	6/8/2016	31	19.55913	155.96744	KB	9:39	R	A		A			basalt	Porites evermani, P	Y	y						Y		Y	Y	Y	Y			Glome	Y		t P. lobata m	2 P. lobata mounding					6976, P. eydouxi
Keauhou North Outside	6/8/2016	36	19.55941	155.96754	KP									P. brighami	Y	Y			Y					Y							Y		1 P. lobata M	2 P. lobata					bleaching and disease observed
Keauhou South Outside	6/8/2016	34	19.55901	155.96773	KB	9:28	R	O		D			basalt	P. brighami, P. LICHE	Y	Y		Y	Y		Y			Y	Y	Y				Aspara	Y	N	P. lobata, mo	1 P. lobata mounding			33-20 ft		
A Bay - legal	6/13/2016		19.91525	155.90001	AP		R	O	R	C	R	C	basalt		Y	Y								Y						T. orna	Y	N	1 P. lobata	n/a	n/a				found dive weight. JPEG 1152-1163 (sm canon)

Appendix F: Literature Cited

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