Mapping and Analysis of Coral Reef Damage Related to Boating in Kane'ohe Bay

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Introduction

With coral reefs under increasing stress from global climate change and other anthropogenic factors, the need to protect them is more important than ever (Jameson et al. 2007). The reefs of Kane'ohe Bay are no different and serve as a microcosm of the state of coral reefs worldwide: devastated and damaged by increasing human population (Waddell 2008). Increased research and focused restoration efforts could lead to an improved ecosystem in the bay, but an analysis of collecting coral reef damage data using unmanned aerial vehicles (UAVs) of these reefs has yet to be completed.

Vessel Grounding and Anchoring Threat to Coral Reefs in Kane'ohe Bay

There is a relatively high volume of observed boat traffic in Kane'ohe Bay. Historically, the use of thrill craft, recreational boating, and reef/sandbar tour group activities have produced congestion on the Bay's waterways (Lowe 1995). Kane'ohe Bay is also home to the highest concentration of marinas, harbors, and piers in the State of Hawaii including Heeia Kea Small Boat Harbor, Marine Corps Base Hawaii, Kane'ohe Yacht Club, Makani Kai Marina, and the Hawaii Institute of Marine Biology (Figure 1). Inevitably, a proportion of boats will run aground on the poorly marked patch and fringing reefs that are spread throughout the bay whether due to human error, environmental conditions such as tides, winds, mechanical error, or a combination of these factors (Chauvin 1972). Boat groundings lead to broken and crushed corals as well as the creation of bare substrate for colonization by invasive species and elimination of topographic/habitat complexity (Precht 2001).

Ground vessel in Kaneohe Bay. Photo by: State of Hawaii, DLNR/DOBOR Staff

Kane'ohe Bay Research Techniques

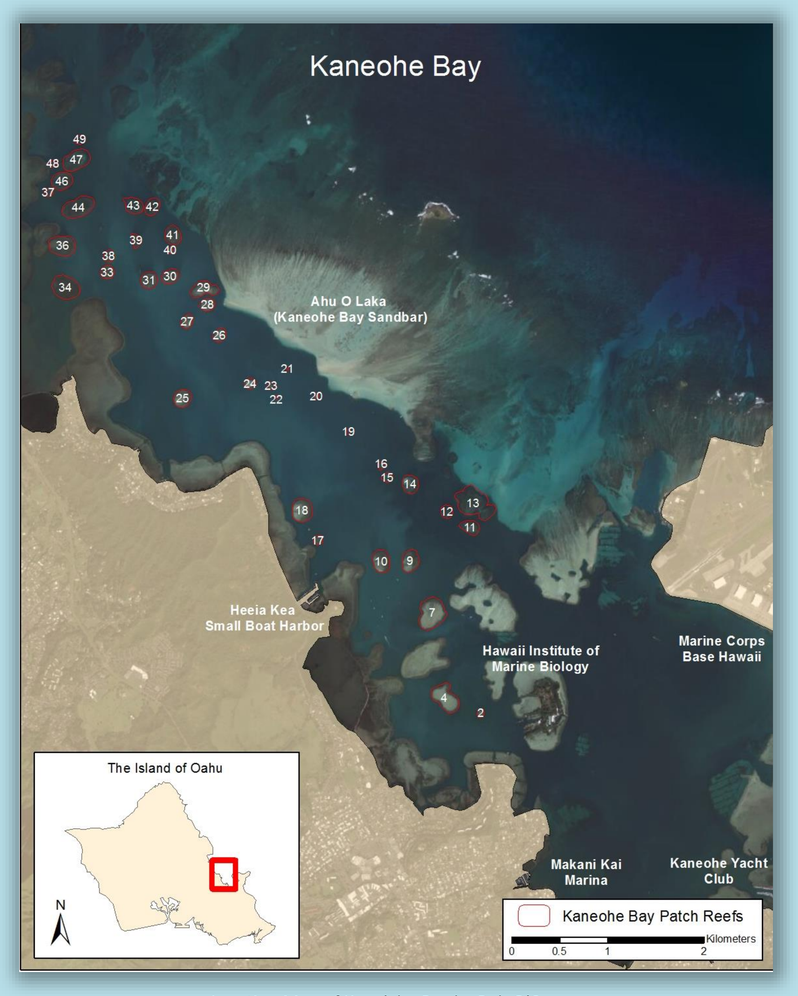
Benthic habitat maps allow for a better understanding of the seascape, ecosystem function and species habitat utilization patterns in coastal areas and are most useful when they are created at a scale that is relevant to management actions (Wedding 2006). Fisheries scientists have identified mapping of coral reefs and fish habitats as being highly important for maintaining sustainable fisheries (SFA 1996).

Unfortunately, techniques used in a terrestrial setting are not always easily transferred to an underwater setting. Diver limitations of depth and time underwater as well as oceanographic conditions provide unique challenges.

Existing Data for Kane'ohe Bay

Existing GIS data include satellite imagery, LIDAR, diver survey data, and boat based sonar data. Unfortunately, the cost and/or resolution of these data are not conducive to mapping vessel damage.

Project Area



Location Map of Kane'ohe Bay by Rob O'Conner

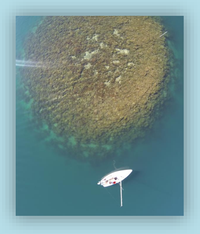
The solution: Unmanned Aerial Vehicles (UAVs)

UAVs can be an inexpensive alternative to tradional coral reef mapping techniques. In this case, a simple DJI Phantom UAV is used for data collection. This model is easy to fly out of the box, inexpensive at under $500, and it is customizable.

The camera: GoPro Hero 3 Specifications

- High Definition Stills
- 32 GB Memory
- 4 Hour battery life
- Auto shutter mode
- Bluetooth enabled
- Third party polarized filter
- Waterproof
- Inexpensive at $299
- Customizable (optional flat lens)

Methodology



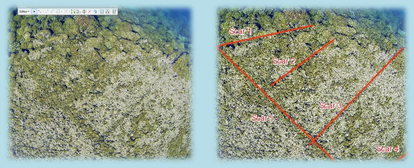
Step 1: The process begins by locating a study site, and collecting imagery with the UAV and camera. Images are collected at one second intervals.

Step 2: The imagery is processed in order to prepare the photos for the image mosaic software.

Step 3: Processed photos are then mosaiced in AgiSoft Photscan software

Step 4: The photo mosaics are then georeferenced within a geographic information system (GIS). Previously identified ground control points located in the photos will be used with the georeferrencing tool within the ESRI ArcGIS software.

Step 5: Once in the GIS, the imagery will be analyzed to identify possible damage targets such as individual damaged coral colonies, scarring from boats, and other anomalies.



Scar ID	Length	Orientation
1	1.3	85
2	1	45
3	1.8	40
4	0.7	42
5	2.6	320

Preliminary example of digitalized boat scars and associated attribute table.

Step 6: Field validated injury areas will be photographed in situ and linked to coordinates in the GIS.

Step 7: Vector data of injury features will be analyzed for spatial patterns including length, orientation relative to north/south, and density of injury section of reef area.

Conclusion

Coupling GIS with UAV technology can lead scientists to better understand impacts that recreational boaters have with the coral reefs of Kane'ohe Bay. The data and future associated publication should be the catalyst that drives NOAA and the State of Hawaii to install marker buoys and signage that prevent future damage.

Ahu O Laka (the Kane'ohe Sandbar), Kane'ohe Bay in July 2012. Photo by R. O'Conner.

References

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