PROPOSAL TO THE UNIVERSITY OF HAWAIʻI AT HILO MARINE OPTION PROGRAM

The use of an ROV to conduct coral reef surveys: A comparison between human and technological survey methods.

Sebastian Baca

Marine Science Department
University of Hawaiʻi at Hilo

MOP ADVISOR

John Coney, UH Hilo MOP Coordinator

Division of Natural Sciences
University of Hawaiʻi at Hilo

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Abstract

Recent plans have been proposed to construct an addition to the Hilo Harbor. Dredging of the construction areas must occur and as a result, mitigation of the damages incurred to the environment is a required action by federal legislature. Coral reef surveys are to be conducted as a part of the mitigation process. This provides an opportunity for a comparison of survey methods. The use of ROVs in coral surveys is a relatively novel but a more recently popular approach. The use of an ROV has significant advantages over human divers but little is known about the proficiency of ROVs capabilities to perform coral surveys. This proposed study aims to compare coral reef survey methods between using human divers and a video-capable ROV. The main objectives of this study are to compare data between ROV and human methods, compare time and cost efficiency, and to demonstrate if ROVs are suitable alternatives to using human divers in regards to coral reef surveys.

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1. Introduction

Reef degradation as a result of human development has become common in tropical areas with extensive economies. The responsibility of minimizing the effect of the damage to the ecology of an area is now being considered and the mitigation of such detrimental activities is now commonly becoming an obligation to the developer. This is enforced through the Coral Reef Conservation Act of 2000 (U.S. Code Title 16 Ch. 83 Sec. 6401),which requires the development of mitigation measures for coral reef ecosystem degradation due to direct destruction caused by activities associated with commercial vessel traffic. Recently, in Hilo Bay plans have been proposed to expand the harbor. In response, mitigation of the damaged area is required and areas of reef inside the bay have been proposed as possible sites where modular artificial reef substrates will be developed. As a result, coral surveys need to be conducted of these sites and this provides an opportunity for a comparison of reef survey methodologies.

Surveys of coral reefs have been conducted numerous ways. A review and comparison of several different methods for assessing coral reef community structure has been the focus of a recent study (Leujak & Ormond 2007). There are several methodologies that are commonly used but one major difference between studies is the type of sample collection used. Recently, with the advancement of media technology, cameras and video recorders have become popular tools in marine surveys; this in contrast with using human surveyors using compressed air and *in-situ* observational data. A comparison between survey methods has demonstrated that video is not only an accurate method but also a cost and time efficient method when compared to using human divers (Leujak & Ormond 2007). Furthermore, it has been shown there is no significant difference between using video or human surveyors to conduct reef surveys (Leujak & Ormond 2007, Lam *et al.* 2006).

With the advancement of underwater technology, ocean exploration and monitoring through the use of Automated Underwater Vehicles (AUVs) and Remotely Operated Vehicles (ROVs) is becoming more popular and practical. These unmanned submersibles allow researchers a variety of advantages when applied to the sampling and studying of an environment as difficult as the open ocean. As an advantage, unmanned vehicles do not require human risk and can be functionally designed for a variety of tasks. It is with increasing popularity that scientists are including unmanned vehicles in short-term underwater surveys and long-term ocean monitoring studies (Norcross and Mueter 1999; Hudson *et al*. 2003; Teixidó *et al.* 2006; Raskoff *et al.* 2009). The use of ROVs and AUVs in the ocean for research and commercial purposes is a significant advance in marine technology and will most likely continue to be a highly utilized industry in the foreseeable future.

In the proposed study, a ROV will be used to collect coral reef survey data and compare data taken from surveys completed by human divers. The experimental design for the ROV will be coincident with the human surveyors; therefore the only differentiating factor will be the use of an ROV or human diver to conduct the survey. The method for this study is based on

previous studies done on survey method comparisons (Leujak & Ormond 2007, Lam *et al.* 2006). There are main objectives that this study would like to accomplish.

- Compare cost and time efficiency between ROV and human survey methods.
- Determine if ROV data is significantly different than those taken by human divers.
- Demonstrate if an ROV is capable of performing reef surveys as proficient as human divers.

2. Methods

2.1 Study site

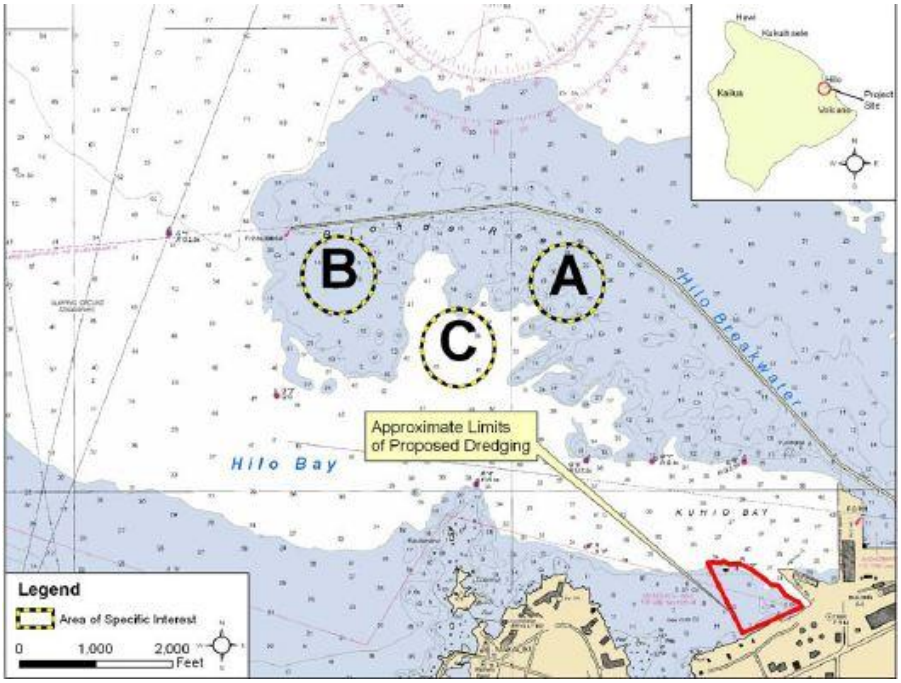

Figure 1. Map of Hilo Bay. Sites A, B, C are the proposed possible placements of the artificial reefs. (Image from the report, Dredging Phase for Construction of Interisland Cargo Terminal Facility at Hilo Harbor Final Submittal prepared by Oceanit.)

The study site is located inside Hilo Bay. Located at 19°44'11"N and 155° 3'55"W, the surveys will be conducted on Blonde Reef. Hilo Bay is fed by two rivers, the Wailoa and the Wailuku. Therefore, inside the bay estuarine conditions are present. Hilo Bay is the location of the largest port on the Big Island of Hawaii; an artificial breakwater was constructed to protect the port from high wave energy. Locations of line transect surveys will be selected based on areas that are of priority to be monitored for the mitigation process.

2.2 Line Transects

Line Transect surveys will be conducted inside Hilo Bay, along Blonde Reef. Using 50m transects and 1m quadrats, estimations of coral species and associated coverage inside the quadrat will be determined by SCUBA divers. The study will include three or more randomly selected line transects along nearby areas of the reef. 1m quadrats will be randomly placed along 15 points to determine coral coverage and composition. Using slates to record, divers will visually estimate percent coral cover and species.

Figure 2. VideoRay ROV used to conduct the benthic composition survey.

2.3 ROV method

Using a VideoRay Remotely Operated Vehicle (ROV) launched from a small vessel, surveys will be done using the on-board video camera. The ROV surveys will be concurrent with the SCUBA divers. Using the same transects, a similar methodology will be conducted as per Leujak & Ormond (2007) with the use of video. The ROV will follow after the SCUBA divers have completed there surveys along the same transect. The method will be slightly different due to the use of video and the nature of the ROV. Similar to Leujak & Ormond 2007, the ROV will maneuver along the transect at about 7 m per min. Video will be taken in intervals of 2-3 seconds resulting in numerous frames that can be analyzed. The ROV should be positioned about 30-35 cm above the substrate with the video camera at a near vertical angle which should result in a 45 cm * 50m sample area.

2.4 Comparison of data

Comparisons of data between the ROV and human divers will be done by using the end result of both methods. A 2-sample t-test or ANOVA statistical analysis will be done to determine if the data is significantly different.

2.5 Comparison of time and efficiency

During the study, I will be keeping track of all expenses between both methods. Also the time it takes it to complete different aspects of the study will be recorded including field and lab time, and compared between methods. Keeping records of time and efficiency will allow me to compare the two methods and determine if one is more time and cost efficient.

3. Deliverables

As a result of this study, I plan to accomplish certain deliverables. These deliverables will be in the form of a written report, PowerPoint presentation, and representing UHH at the MOP Symposium. The report will be written according to MOP guidelines and will be submitted to the MOP's collection holdings. I will produce a PowerPoint presentation directed at a large audience in preparation of the MOP symposium. Lastly, I will present my findings at the MOP symposium at UH Leeward Community College on April 16th, 2011.

The report is tentatively planned to be submitted April 16, 2011, the date of the symposium. Although, pushing back the submission may be considered. I will have a completed PowerPoint presentation by the date of the MOP symposium. My aim is to present my findings at the symposium.

Part from the previous contributions, this study aims to initiate a long-term based study on Hilo Bay's coral mitigation plan. Also this study will demonstrate if ROVs are suitable alternatives to using SCUBA to conduct reef surveys as well as raising awareness about the utility of underwater vehicles.

4. References

Lam, K *et al.* (2006)A comparison of video and point intercept transect methods for monitoring subtropical coral communities. Journal of Experimental Biology and Ecology.Is 333. pp 115-128.

W. Leujak, R.F.G. Ormond, Comparative accuracy and efficiency of six coral community survey methods, Journal of Experimental Marine Biology and Ecology, Volume 351, Issues 1-2, 23 November 2007, Pages 168-187, ISSN 0022-0981, DOI: 10.1016/j.jembe.2007.06.028

Oceanit (2010). Mitigation Plan: Dredging Phase for Construction of Interisland Cargo Terminal Facility at Hilo Harbor Final Submittal. State of Hawaii Dept. of Transportation Harbors Division.

Hudson *et al*. 2003. The feeding behaviour of a deep-sea holothurian, Stichopus tremulus (Gunnerus) based on in situ observations and experiments using a Remotely Operated Vehicle. Journal of Experimental Marine Biology and Ecology. Vol 301. pp 75-91.

Norcross, B and Mueter, F 1999. The use of an ROV in the study of juvenile flatfish. Fisheries Research.Vol 39. Pp 241-251.

Raskoff, R.R *et al.* 2009, Jellies under ice: ROV observations from the Arctic 2005 hidden ocean expedition. Deep Sea Research Part II: Topical Studies in Oceanography. Vol 5. Issues 1-2. Pp 111-126.

Teixidó *et al.* 2006. Observations of asexual reproductive strategies in Antarctic hexactinellid sponges from ROV video records. Deep Sea Research part II: Tropical Studies in Oceanography. Vol 53. Issue 8-10. pp 972-984

5.Budget

Item	Quantity	Cost (dollars)
VideoRay ROV	1	Inkind from MOP
Time on Small research vessel(hrs)	4	250
Transects	2	Inkind from MOP
Quadrats	2	Inkind from MOP
Photo Analysis software	1	35
DVD	2	1
Travel Fare(roundtrip)	1	200
Total		486

Budget Justification

The VideoRay ROV is an essential part of this study. It will be the primary means to collect data in which to compare to human diver data. This is provided inkind from the Marine Option Program (MOP). Time on a small research vessel is also required because the study sites may not be accessible by shore and the ROV has a limited tether length. Depending on conditions, the total time spent on the research vessel deploying the ROV should between 4 to 6 hours. We will need 2 transects to conduct line transect surveys. Also because we will be doing coral composition and coverage 2 quadrats are also required. Both the quadrats and transects will be provided inkind from MOP. In order to analyze the videographic data photo analysis software will be utilized to determine percent coral cover inside each frame of video. A DVD will be required to record the video data for later analysis. Lastly, Travel fare to the MOP symposium held in Oahu at UH Leeward Community College on April 16, 2011.

Curriculum Vitae
Sebastian Baca
81 Hokulani St, Hilo, HI 96720
Phone: 7202071325
slbaca@hawaii.edu

Objective:

To Earn a 4-year degree from UH Hilo in Marine Science and a MOP certificate.

Education:

University of Hawaii at Hilo 2007-Present
Concentrations:Marine Science, Biology, ROVs
Current Thesis project: The effect of water density on the performance and efficiency of small propellers.

Aurora Community Colleg 2004-2007
Concentrations: Biology, General Education

Experience:

MARE 350 Coastal Methods and Analyses
University of Hawaii at Hilo
Thesis: Mobile Macroinvertebrate Diversity and Abundance Between non-MLCD and MLCD Areas at Wai'opae

MARE 470 Senior Thesis
University of Hawaii at Hilo
Thesis: The effect of water density on the performance and efficiency of small propellers.

MARE 250 Statistical Applications in Marine Science
University of Hawaii at Hilo
Project: Comparing shell sizes of *Cypraea caputsurpentis* between two geographically different locations.

ENG 225 Writing for Science and Technology
University of Hawaii at Hilo
Thesis: Reevaluating the Notion that Increasing Freshwater Influx in to the North Atlantic Thermohaline Circulation May Lead to Sudden Global Climate Change

MARE 201L Oceanography Lab
University of Hawaii at Hilo
Methods: Deployment of sampling tools, location mapping, oceanographic sampling methods.

Research Skills:

I am very proficient in experimental research concepts. I have experience developing experimental designs, statistical analysis, and thesis writing development. I have written several research papers in my college career and have consistently received high grades.

I am proficient in benthic and coastal survey methods. I have done multiples studies using 50m line transects and 1m quadrats. I have experience taking nutrient and water quality samples. I also have experience seine netting, and point-count fish surveys.

I have strong statistical analysis skills. I have been the primary lead for statistical analysis in many of my research groups. I have used Minitab and Excel programs to develop graphs, report statistical findings, and conduct statistical analysis. I have experience with 2-sample t-tests, ANOVA, non-parametric testing, and regression analysis.

Pertinent to this study, I am heading up the UHH ROV team and have gained experience in the literature of use of ROVs for doing marine research. Also the use of ROVs to conduct research is a future career plan for me and I have been looking into the ROV field for about a year.

Presentations:

Baca, S, Trulsen, N, Murch, J , Suda, A (2009). Mobile Macroinvertebrate Diversity and Abundance Between non-MLCD and MLCD Areas at Wai'opae. Presentation to the MARE 350 class.

Baca, S (2010). Proposal for: The effect of water density on the performance and efficiency of small propellers. Presented to MARE 470 and Marine Science Department Faculty.

Baca, S (2008). Reevaluating the Notion that Increasing Freshwater Influx in to the North Atlantic Thermohaline Circulation May Lead to Sudden Global Climate Change. Presented to ENG 225 class.

Skills and Qualifications:

- Software: Microsft Office, Excel, Minitab, Web browsing, and PowerPoint
- Statistical analysis, experimental design, thesis writing, and literature review
- Leadership, communication, presentation, and project development
- Benthic survey methods and water quality analysis
- University of Hawaii at Hilo ROV team captain

References:

Excellent references available upon request.