

COP Format for Project Final Report

I. Report Title, Author, Organization, Grant Number, Date

Title: Integrated Monitoring of coral reefs of West Hawai'i: Developing a whole-reef & ecosystem approach for the Main Hawaiian Islands

Grant Number: ????????????????????

Author, Organization & Date:

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II. Abstract

Effective management of coral reef ecosystems depends on adequate data on the status and trends of key ecosystem components. In spite of which, previous coral reef monitoring programs in the Main Hawaiian Islands (MHI) have been fragmentary and uncoordinated, with little or no overlap among programs in terms of survey site location or habitat. The primary goal of this project was to develop and optimize an integrated reef-scale and ecosystem-scale monitoring approach for use by the state of Hawaii's aquatic resource management agency, the Division of Aquatic Resources (DAR), within the MHI. A combination of methods already applied by DAR with new ones developed and trialed by this project now form the basis of a standard 'methods toolkit' for use by DAR monitoring staff. The key output of this project, an integrated statewide coral reef monitoring scheme, has been adopted by DAR, who have committed to implementing it, beginning in 2006.

III. Executive Summary

- Two new monitoring approaches: (i) 'Resource-Fish' surveys (targeting the large and mobile fishes which are primary targets of recreational and commercial food fisheries); and (ii) 'benthic characterization' (intended to be a medium-large scale survey approach capable of relatively easily generating benthic information suitable for improved understanding of fish distribution and community structure, and for detecting gross change in benthos) were developed and field trialed at sites in West Hawaii.
- Extended field trials of an 'integrated monitoring' approach, comprising both existing small-scale and the newly developed medium-large scale approaches were conducted at 14 sites in West Hawaii (each site surveyed 4 times for fish, once for 'benthic characterization'). Additionally, 'resource-fish' surveys using the newly developed methodology were conducted at 39 sites in Maui, and data from those surveys compared with an alternative approach focusing on the same fish groups which had been previously utilized at Maui sites (but not elsewhere in the state). 'Benthic characterization' surveys were conducted at 14 sites in West

Hawaii.

- Following extensive discussion and coordination with DAR reef monitoring staff, a common statewide monitoring approach based around that field trialed in West Hawaii was adopted by DAR. That plan formed the basis of the monitoring funding proposal submitted by DAR in late 2005 to cover monitoring programs through 2008.

IV. Purpose

- A. Detailed description of any problems or impediments of research project that were addressed

The chief problem addressed by this project was the lack of a common ecosystem-integrated approach to monitoring among different islands within the MHI. Therefore, although certain individual components of DAR's previous monitoring regime were effective stand-alone programs, the resulting data provided only limited opportunity to make meaningful comparisons among sites, or, at most locations, to explore potentially important interactions among ecosystem biological and physical components, such as between herbivores and algal communities, or between reef structural characteristics and fish communities

- B. Objectives of the project.

The principal objective of the program was to develop a comprehensive and integrated coral reef monitoring program for the MHI, based on a common toolkit of robust and efficient methods. Specific components of the project included:

- development of new survey methodologies to supplement and complement existing monitoring approaches used by DAR;
- production of explicit written methods protocols – i.e. monitoring standard operating procedures, (SOPs);
- extended field trial of the new methods and overall integrated approach at sites in West Hawaii;
- to use data generated during extended field trials as the basis of analysis of impacts of marine protection and fishing at surveyed sites; and
- most crucially, development of an integrated coral reef monitoring plan for DARs use in the MHI

V. Approach

- A. Detailed description of the work that was performed.
B. Project management: List individuals and/or organizations actually performing the work and how it was done.

- Development of New Survey Methods

(a) 'Resources-fishes' surveys ('resource-fish' being the relatively large and mobile species which are the principle targets of commercial and recreational food fisheries, but which are not well covered by existing small-scale fixed transect approaches used in West Hawaii and elsewhere by DAR). Design considerations for a method focusing on

those 'resource' taxa were that the method should: (1) be sufficiently labor and time efficient for the overall monitoring burden of an integrated monitoring approach (fixed transects plus resource surveys) to be feasible for DAR to implement statewide; (2) record sufficient numbers of target fishes for useable estimates of abundance and particularly abundance trends to be achievable in a manageable number of surveys; and (3) the area covered should be large enough that counts were representative of a 'reef' area, rather than simply being driven by local habitat features.

Initial trials of 'resource-fish' survey approaches were conducted at Kona and involved teams of divers repeatedly applying variations on two basic approaches: serial transects (multiple linear transect conducted per dive); and timed-swims. Analysis of resulting data revealed marginal differences in data quality generated from the two approaches, therefore, because of the much lower effort involved in implementing them, timed-swims were adopted as the standard for extended trials by incorporating them into routine monitoring (see section below on extended field trials).

(b) Medium-large scale 'Benthic Characterization'. Detailed monitoring of benthic change will continue to be done by DAR on short (25m-long) permanently-located transects, but a robust 'benthic characterization' approach is intended to be a medium-large scale survey approach capable of relatively easily generating information suitable for improved understanding of fish distribution and community structure (coming, for example, from resource fish surveys), and adequate to identify gross change in reef condition, such as might be associated with mass bleaching events or overgrowth by invasive algae. Method development was a two-stage process: first the potential of visual survey and for range of 'large-footprint' digital photographic survey approaches were trialed in West Hawaii, by comparing data quality and effort involved in surveying benthos visually and from digital photographs taken at 2m and 4m above substrate. Results from those surveys were compared with data taken from photographs of same reef-areas from 1m above substratum (where we assumed image quality was sufficient for benthic analysis to be reliable). Based on those trials, and on consideration of the repeatability and applicability of a benthic characterization approach in sometimes sub-optimal conditions elsewhere in the MHI, a standard of digital stills taken 1.5m above substratum with a wide-angle lens was adopted. The second component of developing a methodology was to find an efficient means of surveying medium-scale survey areas using that kind of photo-survey approach. We balanced the contradictory requirements of (i) spreading images as widely as possible throughout the survey area; and (ii) conducting a time efficient method, i.e. limiting time spent moving between photo locations while still selecting survey points in an unbiased way, by developing an approach which involves laying multiple short transects throughout the target survey areas and taking a small number of photographs at fixed points on those short transect. In total, 100 photo images are taken on 20 10m 'rib' transects, laid at 10m intervals on a 200m 'spine' transect placed through the middle of the area to be surveyed. Using this approach, 3 divers working efficiently can survey one site in 2 dives.

Methods development and initial field trials were principally conducted by project PIs: Ivor Williams, Bill Walsh (Hawaii DAR) and the GIS/monitoring technician, Kosta Stamoulis, hired for this project, but supported by other Hawaii DAR biologists and technicians: Steve Cotton, Brent Carman (both DAR Kona), Skippy Hau, Russell Sparks, and John Mitchell (all DAR Maui).

- development of explicit methods protocols – i.e. monitoring standard operating procedures, (SOPs);

Draft monitoring protocols were prepared by Williams and Walsh with the assistance of Stamoulis and other DAR monitoring technicians, and circulated to the DAR monitoring group (PIs plus DAR staff involved in reef monitoring) for comments. Following comments, SOPs were revised and issued to all DAR monitoring personnel.

- extended field trial of the new methods and overall integrated approach at sites in West Hawaii;

Integrated-monitoring surveys of 14 West Hawaii sites, encompassing the ‘resource-fish’ and ‘benthic characterization’ surveys funded by this project, as well as DAR’s previous and ongoing fixed-transect monitoring, funded from other sources) were carried out by project PIs: Ivor Williams, Bill Walsh (Hawaii DAR) and the GIS/monitoring technician, Kosta Stamoulis, hired for this project, but supported by other Hawaii DAR biologists and DAR Kona technicians: Steve Cotton, Brent Carman. Additionally, a number of casual hire students from UH Hilo were also used. Surveys were conducted at 14 already-established long-term monitoring sites in West Hawaii – where small-scale monitoring has been conducted since 1999. Over the course of 2005, 4 resource-fish surveys and benthic characterization survey were done at each of those 14 stations. Additionally, 39 ‘timed-fish’ surveys were conducted at Maui sites by DAR Maui staff, assisted by Williams and Stamoulis, and results from those surveys were compared with a previous round of surveys at the same sites, using a variation on the serial transect approach, which had been trialed during the methods development phase.

- to use data generated during extended field trials as the basis of analysis of impacts of marine protection and fishing at surveyed sites;

This work was conducted by Williams and Walsh. Results reported to DAR resource managers (summarized in ‘findings’ section below)

- most crucially, development of an integrated coral reef monitoring plan for DARs use in the MHI

As well as numerous informal contacts with DAR staff, 3 formal meetings were held at DAR Hawaii premises involving Williams and Walsh together with all DAR biologists or managers actively involved in coral reef monitoring of MHI. A draft monitoring scheme was circulated by Williams and subsequently modified following responses from that group (PIs plus DAR staff). A final DAR MHI coral reef monitoring scheme was agreed in November 2005 and now forms the basis of ongoing MHI coral reef monitoring program by DAR.

VI. Findings

A. Actual accomplishments and findings.

The key goals of the project were accomplished, i.e.:

- Development of DAR MHI Monitoring Plan, which has been adopted by DAR and is being implemented statewide, beginning 2006.
- Agreement on a standard methods toolkit for DAR coral reef monitoring, including complementary methods to monitor fish, invertebrates, and benthos at small and medium-large scale. The core outputs of which are 2 standard operating procedures (SOP 1 – Benthos; SOP 2 – Fish and Mobile Invertebrates) for use by DAR.

Work done to achieve those goals included analytical comparison of fish and benthic survey data coming out of short-term and extended field trials, which were presented to DAR monitoring staff at a number of meetings throughout 2005.

- Another objective was to use data from extended field trials in West Hawaii as the basis of analysis of impacts of marine protection and fishing at surveyed sites

Biomass of resource fishes at the 14 sites surveyed is shown in Figure 1. Data represents results from only 1 year of surveys (4 surveys per site, and therefore approximately 30 minutes of total survey time at each site) and should therefore be treated with caution but it is nevertheless interesting to consider what these early results might indicate about the impacts of fishing and protection on the surveyed resource fishes.

Of the 14 sites surveyed, 4 had some form of protection, but only one – Kealekekua Bay - was fully protected from all forms of fishing. Protection relevant to specific sub groups of fishes (prohibitions on spearing and netting for large acanthurids, on spearing for scarids, and on netting only for mullids) are indicated in Figure 1A. In general, protection appeared to confer some benefits to resident fishes in that biomass of fishes in protected sites tended to be high in comparison to the average (see median line in graphs of all food fishes). High biomass of mullids was almost exclusively seen at sites where those fishes were protected, but for other groups, including scarids, acanthurids, and lethrinids, local habitat features were likely very important relative to possible protection effects (Figure 1A). In terms of all resource fish combined, sites with high biomass were either protected (Kealekekua Bay, Old Kona Airport, Puako), had significant structural features apparently driving fish density (Anaeho'omalu, Makalawena) or were relatively inaccessible (Una Aloha Pt). Sites close to harbours, where fishing intensity might be expected to be high (Honokohau, Waiakalio), had lowest resource fish biomass. However, without better information on the effectiveness of enforcement of fishing prohibitions and on the intensity of fishing at particular sites it is difficult to draw firm conclusions about the scale of fishing impacts or about the scope for recovery in protected areas.

A. Pooled By Site

B. Pooled By Transect

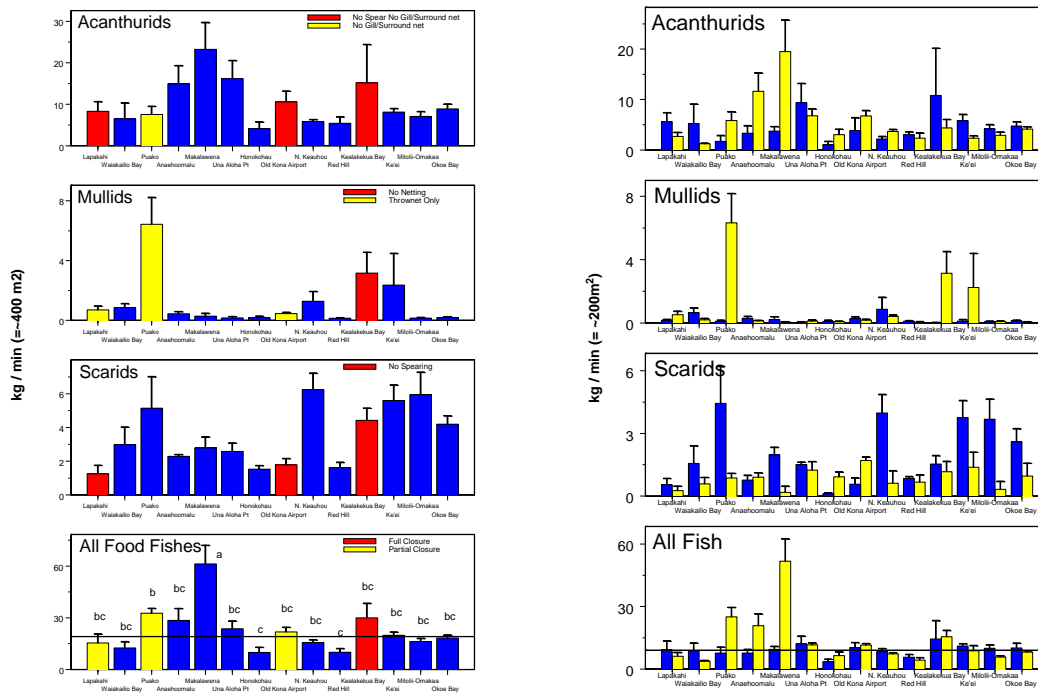


Figure 1. Biomass of ‘resource fishes’ at 14 West Hawaii sites. Data represent mean biomass in kg per minute of survey, error bars are SE (n=4). Dive pairs swam outward from a common central starting point following a depth contour, therefore each survey consisted of 2 ‘transects’ running in opposite directions.. Horizontal lines in bottom graphs represent median values. Letters a-c in bottom graph of figure A represent sites which are statistically indistinguishable (Tukey’s pairwise comparison, alpha=0.10).

B. If significant problems developed which resulted in less than satisfactory or negative results, they should be discussed.

One objective, namely to generate metrics of local fishing pressure based on data from the Hawai’i Marine Recreational Fisheries Survey (HMRFS) was not met, as we were unable to obtain the detailed site specific data which might have enabled us to generate those approximated metrics. However, over the course of this project, it became apparent to us that this objective may be unrealistic as surveys of recreational fishers were not designed to generate the reasonably robust fine-grain data we would need to generate usable local fishing metrics. Nevertheless, the HMRFS data set is potentially a useful one that is currently underutilized, at least within Hawaii DAR. In the coming year (not covered by this project), we intend to return to this subject to attempt to quantify the relative impact of recreational as opposed to commercial fishing and to assess the importance of different gear types on different sub-groups of fishes.

C. Description of need, if any, for additional work.

NONE

VII. Evaluation

A. Describe the extent to which the project goals and objectives were attained. This description should address the following:

1. Were the goals and objectives attained? How? If not, why?

The core goals, namely development of a monitoring toolkit including explicit written standard operating procedures, and a consistent and integrated statewide coral reef monitoring plan were all achieved. DAR has committed to implementing the monitoring plan beginning in 2006, and has already used it as the basis of the recently submitted proposal for monitoring funds to cover 2006 through 2008.

Extended field trials in West Hawaii demonstrated the effectiveness and practicality of the new integrated approach, and extended the range of information which is gathered by the DAR monitoring program. There is now widespread support among DAR's reef monitoring staff for the monitoring plan.

2. Were modifications made to the goals and objectives? If so, explain.

NO

B. Dissemination of Project results:
Explain, in detail, how the projects results have been, and will be, disseminated.

- Results of methods comparisons were disseminated to DAR reef monitoring staff at meetings in Oahu (March 2005) and Maui (November 2005).
- Detailed finalized Monitoring Plan & Methods SOPs circulated to DAR monitoring staff in January 2006.
- Presentations on plans and on progress given at 3 HCRI-RP quarterly meeting: January 2005; May 2005; and September 2005. Final plan presented at HCRI-RP meeting January 2006. All presentations given at Bishop Museum.
- Monitoring Plan for West Hawaii to be presented at HCRI-RP meeting in Kona, Hawaii, February 2006
- Work being done in the coming year (2006, not on this project) will include development of a standard annual coral reef monitoring report (target date being December 2006), which will be made publicly available through DAR's website.

NOTICE

Subsequently, all NOAA COP recipients with approved grants will be asked to file a COP Project Final Report in the specified format upon expiration or termination of grant support. Consistency in reporting requirements for competitive research grant programs is desirable and this is behind COP's efforts in proposing a standardized format. The use of the Project Final Report format will provide the level of detail required to evaluate the effort invested by investigators and staff on project management; any actual accomplishments and research findings; and what goals and objectives were attained. The proposed final report format is compatible with the format in use by other agencies that participate in joint projects with COP, e.g. the National Science Foundation.

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