

FORMAT for Annual Progress Report

A. Grant Number:

B. Amount of Grant:

\$56,010

C. Project Title:

STRENGTHENING CORAL REEF MONITORING OF MAIN HAWAIIAN ISLANDS

D. Grantee: Hawaii Coral Reef Initiative – Research Program

E. Award Period: From: 01/01/2006 To: 12/31/2006

F. Period Covered by this Report: From 01/01/2006 To 06/30/2006

G. Summary of Progress and Expenditures to Date:

I. Work Accomplishments: (as related to project objectives and schedule for completion)

a. Provide a brief summary of progress, including results obtained to date, and their relationship to the general goals of the grant; and

(Objective 1) Further increase capacity within DAR by extending GIS-approach from West Hawaii to other MHI.

Work planned under this component falls under two broad categories: (1) using GIS system to generate site maps and extract basic survey parameters, such as distance covered by timed surveys (based on lat/long of start and end points); and (2) using DAR's GIS system to extract information on habitat including benthic community (e.g. 'sand', 'colonized hard bottom'), large-scale rugosity, depth, etc..

To date, GIS work on this project has been in the first area – the GIS/monitoring technician hired under this project has produced Maui survey site maps, which have been used in interim monitoring documents and presentations on DAR's monitoring program. The tech has also done considerable GIS work to support the adult yellow tang surveys in West Hawaii, in identifying potential survey sites, measuring distance covered during individual surveys, and generating site maps for use by the DAR survey team.

Other GIS work done this year has been to generate estimates of reef area for West Hawaii in each of the NOAA benthic habitat categories within a series of depth ranges. Those estimates now give us much greater capacity to extrapolate from data from surveys within specific habitats and depths to estimate population sizes for the whole of West Hawaii. The specific project those area estimates were generated for is a project by Birkeland and Dierking on Roi population size and prey consumption. Dierking is now generating estimates of total prey consumption by Roi over the whole of West Hawaii in order to compare predation by Roi with other sources of mortality, such as fishing for key prey items.

(Objective 2) Use integrated-monitoring sites throughout MHI as units of analysis for assessment of influence of range of possible anthropogenic and natural factors.

A core element of the proposed work was to generate indices of fishing pressure at DAR's coral reef monitoring sites using the recreational fishing data gathered by the Hawaii Marine Recreational Fisheries Survey (HMRFS). The only progress to date in this area has been to develop an MS-Access database of intercept data for use by DAR's HMRFS coordinator, Jeff Muir. The database includes functionality to integrate new intercept data from spreadsheets and some quality control functionality. Previously all data was maintained in separate Excel files- one for each month of data, meaning that standard queries of the whole data set were impossible, and that it was very difficult to check for errors in that data.

(Objective 3) Continue to develop and support DAR reef monitoring database

Ongoing work has added substantial additional querying and reporting functionality to DAR's survey database. The DAR survey database is now being routinely used by DAR survey staff on the Big Island and Maui, and is available to DAR staff in Oahu for use when, later this year, Oahu coral reef monitoring begins. In addition, stripped-down stand-alone versions of the DAR survey database have been developed for use by partner groups involved in coral reef monitoring in Hawaii – specifically, De Leon Hallacher of UH Hilo, who is co-ordinating monitoring of WaiOpae MLCF in East Hawaii, and Reef Watcher of Hawaii, who co-ordinate volunteer surveys of reefs in Hawaii and Maui. Use of a common database, as in this case, will facilitate future integration and common analysis of that data.

(Objective 4) Facilitate dissemination of findings of MHI coral reef surveys to the scientific community, relevant management agencies, and the public through comprehensive reports and summarized information accessible via DAR's website.

The only work to date has been to hold a meeting of DAR's reef monitoring group in March 2006 to discuss framework of proposed DAR monitoring report. That framework is now in place, and production of DAR's first public monitoring report will begin in 4th quarter of 2006 as originally planned.

Others

General function to be performed as part of this grant included development of appropriate new survey methods as needed by DAR. Work in this area has been on 2 survey approaches new to DAR, to: (1) survey populations of adult yellow tangs on shallow water reefs in West Hawaii; and (2) survey fish, invertebrates, and algal cover using simple low-tech in-situ methods (i.e. not photographic or video based) which can be broadly applied in studies which involve potentially inter-related changes in populations of fish, invertebrates, and algal cover, such as are done for DAR's invasive species programs, and are planned for assessment of upcoming laynet regulation.

(1) Adult yellow tang surveys.

The prime habitat for adult yellow tangs is the boundary between the shallow pavement zone and the upper end of the *Porites lobata* zone in about 10-20 ft of water. The habitat is inherently patchy, and yellow tang being schooling fishes have a clumped distribution, both of which make it difficult generate reliable density estimates using traditional underwater survey methods. We attempt to minimize the impact of those problems by using 'jet-boots' (underwater propulsion units, which allow users to have both hands-free) to cover large distances (generally 600m to 1000m linear distance covered). Survey divers follow the boundary between the two habitats, counting all yellow tangs within 5m wide belts during 18-minute runs. Distance covered per survey is calculated from start and end positions using DAR's GIS system, and adult yellow tang counts can therefore be converted to densities per unit area. Preliminary results of West Hawaii adult yellow tang surveys are shown below (Figure 1).

(2) Low-tech fish-Benthos-Inverts

One component of DAR's plans to assess the effectiveness or otherwise of the forthcoming laynet regulation on Maui and portions of Oahu will be to use simple methods to look for changes in herbivore density and consequently (we assume) algal community composition – the base assumption being that it is possible that recovery of herbivorous fish stocks following laynet regulation will lead to reductions in cover of invasive algae. This additional work load on DAR's survey group means that methods need to be very time efficient and ideally capable of being applied by small teams. We are therefore in the process of developing low-tech methods which will be sufficiently powerful to detect moderate to large changes in conditions following laynet regulation – i.e. methods will not generate the level of precision that can be achieved by the detailed surveys of full teams in DAR's core monitoring program, but should be capable of detecting the scale of change which would be considered a meaningful positive outcome of laynet regulation. In order to reduce total survey load, priorities were that surveys should be doable by 2 persons and that all data should be generated onsite, i.e. survey teams do not need to subsequently analyze photo or video images in the lab. Our final methods are likely to be based around visual benthic quadrat surveys and simple transect or timed fish surveys.

There are a number of other potentially inter-related survey efforts which are about to begin or have just begun, including those by DAR Oahu invasive species staff, TNC community-based monitoring, and UH 'super-sucker' teams in Kaneohe Bay, and therefore it made sense to try to develop a suite of common methods which can be applied across all those projects. Williams (PI on this project), Eric Co of TNC, Tony Montgomery of DAR Oahu, and Eric Conklin of UH Manoa have coordinated on this. Current status is that the methods are being applied on a *Gracilaria salicornia* removal experiment being run in Manalua Bay, Oahu, by DAR's invasive species group. Based on the effectiveness of those methods, we plan to meet again later in the summer, to consider extending and possibly modifying those approaches for use in Kaneohe Bay and Maui.

- b. Provide a brief summary of work to be performed during the next year of support, if changed from the original proposal; and indication of any current problems or favorable or unusual developments; and any other significant information pertinent to the type of project support by COP, or as specified by the terms and conditions of the grant.

(Objective 1) Further increase capacity within DAR by extending GIS-approach from West Hawaii to other MHI.

To date, the enhanced GIS capacity within DAR's reef survey unit has been extremely useful in terms of our ability to identify potential survey sites, generate maps and measure survey areas, and that work will continue on an as-needed basis. The primary additional project we plan to use the GIS for is in production of site maps for the planned public reef monitoring report.

A listed objective in the proposal was to combine DAR's Arc-Info GIS system and MS-Access survey database into a single 'geodatabase'. Greater experience of how we actually use the GIS system has shown us that total integration of the data would add very little to our ability to maintain and analyze our data. Given the drawbacks in terms of size and the need to have both ArcInfo and MS Access on computers of users who would plan to use the integrated geodatabase, we now believe that the benefits of integrating the two systems are outweighed by the drawbacks.

(Objective 2) Use integrated-monitoring sites throughout MHI as units of analysis for assessment of influence of range of possible anthropogenic and natural factors.

A core component of this objective was to use the state of Hawaii's Marine Recreational Fisheries Survey to develop metrics of fishing pressure on the coral reef areas surveyed for DAR's statewide coral reef monitoring program. The ultimate objective being to place sites on a gradient of fishing intensity, so that we could assess the relative importance of fishing as compared to other natural and anthropogenic factors on condition of reef communities at those sites. However, greater familiarity with the HMRFS dataset has shown us the severe limitations of the HMRFS as a measure of shoreline fishing, the element of recreational fishing which likely most impacts reef fish communities. The great bulk of all intercepts conducted for this program are of fishers returning to harbors after boat trips. HMRFS data therefore does not generate data which could be used for meaningful assessment of shoreline fishing at the spatial scale we are interested in (i.e. corresponding with DAR's monitoring sites). A second problem is that HMRFS includes two components – the intercept data (i.e. records of actual observations of fishing activity and interviews with fishers) and a telephone survey. As we now understand it, intercept data is principally used to generate CPUE numbers, and telephone survey data to generate effort estimates. Reliable integration of those two data sources depends on the application of algorithms which have been developed by NOAA. Until recently, DAR's only means of generating fishing or catch estimates was to send queries to the NOAA data center in Seattle. Despite repeated attempts on our part, and the support of the HMRFS coordinator, Jeff Muir, we were never able to get any cooperation from NOAA on this. DAR is now making considerable efforts to revise both the HMRFS program and DAR's relationship with its NOAA partners, both of which should greatly improve the value of this program. The problems we have had in this areas, and the wider awareness of the limitations of the HMRFS programs as a result of those, have probably therefore been beneficial for DAR. At this point, we do not believe further work on fishing metrics would be productive and we therefore intend to greatly downplay this objective. To the extent possible, we will still use HMRFS data to compare statewide recreational catch with commercial catch for main coral reef fishes, and explore the extent to which recreational fishing can be quantified at smaller spatial scales. We will also continue to work with the HMRFS coordinator to further enhance the HMRFS intercept database, and provide MS Access training to him.

To replace this objective we plan to add two additional research/analytical components, both of which are based around questions central to DAR's mission – (1) can marine reserves be effective fishery management tools?; and (2) what do long-term (decadal-scale) changes in reef communities in Hawaii indicate about the principal factors driving that change? Detail on these areas are given below.

(Objective 3) Continue to develop and support DAR reef monitoring database

The DAR survey database has made an enormous difference to DAR's ability to maintain and analyze our data and in preventing transcription errors from reducing the data quality. We will continue to make improvements to querying and data-entry functionality as necessary. However, we do not propose to carry out one of the original objectives of this project, namely to hire an external contractor to convert the current desktop/standalone version to a web-based version which could be accessed by staff in any DAR office. Further work on this has shown us that that would be a vastly more complex job than we had budgeted for (\$3,000). We now understand that modifying our existing MS Access database into a web version, would have led to very severe performance issues, and converting the database to a real network system would cost more than an order of magnitude more.

(Objective 4) Facilitate dissemination of findings of MHI coral reef surveys to the scientific community, relevant management agencies, and the public through comprehensive reports and summarized information accessible via DAR's website.

No proposed changes in this objective.

(Proposed new objective 1 – Replenishment effects of West Hawaii FRAs?)

Yellow-tangs make up 80% of the catch and 70% of the value of the aquarium fishery in Hawaii, and are therefore the most commercial important species taken for the aquarium trade. Since a network of aquarium-catch closed areas (FRA's) were established in 2000, yellow-tang numbers have increased by 57% coastwide (approx 30% in open areas and long-term closed areas, 117% in the 30% of the coast which was closed to fishing in 2000), and reported catches are up by 99%. Those increases in catch and population size have been driven by sustained high levels of recruitment beginning in the 3rd year of protection. The crucial question in terms of expected future performance of the fishery is whether increased recruitment is (i) a coincidental good recruitment patch; or (ii) a genuine 'replenishment effect' of the FRA network – i.e. a consequence of a build up of spawning stocks as a result of protection within the reserve network.

In order to attempt to assess the increase in spawning stocks as a result of the FRA network, we have recently initiated surveys of adult yellow tangs in and out of FRAs. Preliminary results indicate that adult densities are 44% higher in FRAs than in open areas, and are consistent with the reserve network boosting adult stocks within closed areas and on areas adjacent to the closed areas (Figure 1), and therefore strongly corroborate the idea that recent high levels of recruitment are a positive consequence of West Hawaii's FRAs network.

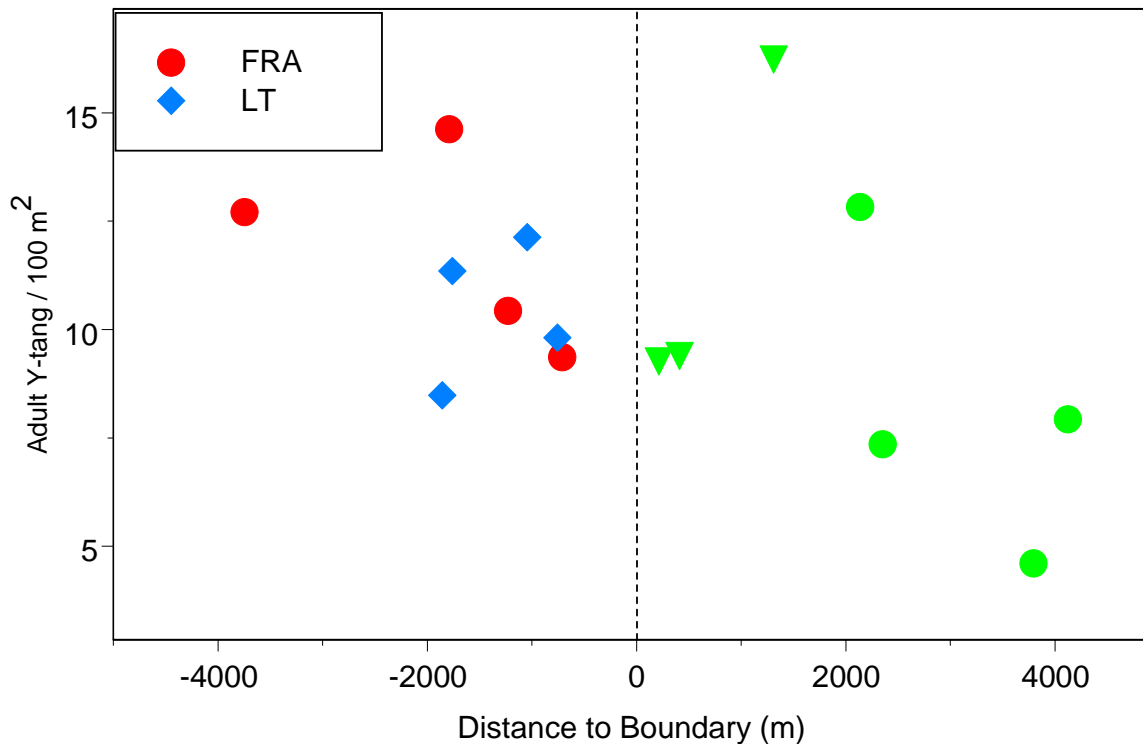


Figure 1. Adult y-tang densities in open and protected areas in West Hawaii in relation to distance from protected areas boundaries. Sites to the left of the boundary are protected area (circles represent FRAs, Diamonds are long-term protected areas, i.e. MLCs and FMAs), and sites to the right of the boundary are open areas.

We would like to continue this work by doing more repeat surveys at these sites to firm up these preliminary patterns, and adding additional work in related habitats as necessary. Analytical and reporting work would then involve tying together the various strands of evidence on effects of marine reserves on this species – i.e. underwater visual surveys of adults, juveniles and of recruits, together with catch records. Results to date are very promising and appear to be the best evidence we are aware of from any reserve network in the world of this so called 'replenishment effect' – i.e. closure of network of reserves leading to net benefit for remaining open areas and to fishery as a whole.

(Proposed new objective 2 – Extent of and causes of decadal-scale changes in West Hawaii reef fish communities)

Within DAR, we have recently begun analysis of fish survey data from Honaunau on the West coast of Hawaii. This site was initially surveyed by staff of UH Manoa and Waikiki aquarium in the mid 1970s and then resurveyed using identical methods by staff of DAR Hawaii in the late 1990s and early 2000s. Analysis of changes in fish communities at that site, indicate very dramatic changes in community composition over that time period. Among the most dramatic changes have been substantial declines in abundance of species most heavily targeted by aquarium collectors (Figure 2), and including the virtual disappearance of several species of butterflyfish and angelfish. Several species, including the endemic bluestripe butterfly, *Chaetodon fremblii*, and bandit angle *Desmaholacanthus arcuatus*, which we now consider very rare in West Hawaii were fairly regularly encountered during surveys at Honaunau in the mid 70s.

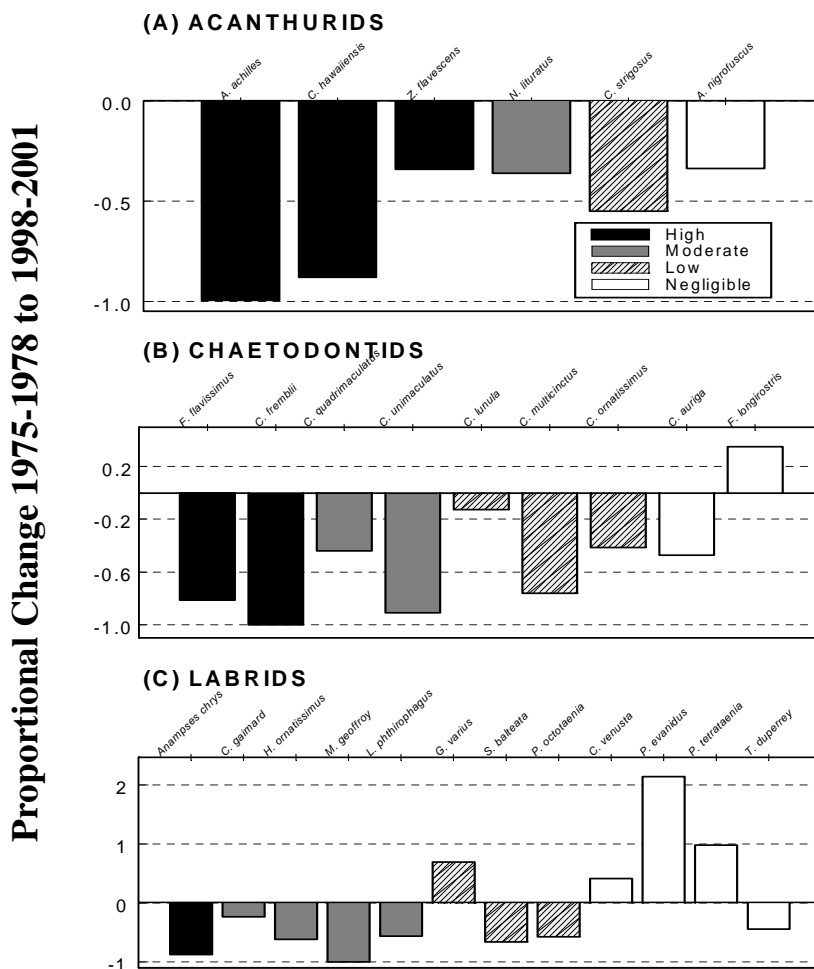


Figure 2. Proportional changes in abundance of small site-attached surgeonfish, Butterflyfish and wrasse. These being the main families targeted by aquarium collectors. Intensity of aquarium collecting on each species based on reported catch (DAR commercial records 1977 to 2000) relative to estimated population size of each species.

While dramatic, and extremely relevant to DAR's perception of what healthy MHI reef communities should look like, these results are limited by being from only one site (Honaunau). Patterns from multiple sites consistent with those at Honaunau would enable us to draw very much stronger conclusions about status and trends of West Hawaii reefs, and about the importance of fishing in those changes.

We would therefore like to initiate new surveys and analyses to determine whether these patterns have also occurred at two additional sites in West Hawaii from which we have reliable mid data from the 1970s: Ke'ei and Puako. Five transects in Ke'ei were regularly surveyed by Bill Walsh in the mid 1970s, and again from the late 1990s to now. Most of that data exists only on paper, but if we can make this area a priority for the remainder of this grant, we can enter the data into DAR's database and conduct similar analysis as we have done on the Honaunau dataset. At the other site, we would like to revisit, Puako, 10 sub-sites were surveyed by staff of UH Manoa, including Jim Parrish, in the mid/late 1970s. That data, including the location of survey sites is available to us in their original report. Adequately resurveying those sites would be a considerable undertaking, but would be feasible if we can make this a priority in the current project.

2. Applications:

- a. Publications, presentations, workshops;
- b. Applications to management or research;
- c. Data and/or information products;
- d. Partnerships established with other federal, state, or local agencies, or other research institutions (other than those already described in the original proposal).

(a) Williams has given two presentations on project progress at HCRI quarterly meetings, and a presentation on project aims at a public meeting at NELHA in West Hawaii in January 2006. Williams has also given a presentation at the West Hawaii Fishery Council in June 2006 on effects of rotational closure at Waikiki FMA.

(b) none to date.

(c) As described above, work done as part of this project includes (i) routine maintenance of the DAR database, including keeping the database up to date with surveys done for DAR's reef monitoring program; (ii) increased querying functionality; and (iii) development of stand-alone versions of the DAR database for UH Hilo and for Reef Watchers, to enable future integration of data and, where appropriate, common analysis.

(d) Dr Ivor Williams has formed an informal group with Eric Co of TNC, Tony Montgomery of DAR Oahu, and Eric Conklin of UH Manoa to, as described above, develop common approaches to survey fishes and algae. Our aim is to use a common set of methods to survey fish, invertebrates and algae for DAR, UH and community-based survey programs focusing on potential impacts of (i) forthcoming lay-gillnet regulation; (ii) algal removal by 'super-sucker' in Kanehoe Bay; and (iii) invasive algal removal and herbivore manipulation projects.

As described above, additional partnerships include (i) agreements to use common database structure (based on DAR's survey database) between DAR and Dr Leon Hallacher of UH Hilo (for WaiOpae reef surveys), and with Sara Peck of Reef Watchers (for volunteer surveys); and (ii) collaboration with Birkeland and Dierking on continuing work on impacts of Roi on prey fishes in West Hawaii. Dierking is currently developing models of prey consumption, relying heavily on DAR fish survey data and on DAR-generated estimates of areas in different habitat and depth categories, together with their own data on Roi diet and consumption rates, to generate whole-coast estimates of Roi predation.

3. Expenditures:

- a. Describe expenditures scheduled for this period..
- b. Describe actual expenditures this period.
- c. Explain special problems, differences between scheduled and actual expenditures, etc.

Only departure from predicted expenditure is that, as described above, we do not now intend to convert DAR's survey database into a web-version. The original budget included \$3,000 for such database development – we plan to return that money to HCRI.

Prepared By: Dr Ivor D Williams
HCI-RP Data Analyst
June 30th 2006

Signature of Principal Investigator

Date

NOTICE

Subsequently, all NOAA COP recipients with approved grants will be asked to file a COP Annual Progress Report in the specified format. The first section of the proposed format is taken from the COP implementation plan and has some advantages in that previously-funded investigators will be familiar with the format. Consistency in reporting requirements for competitive research grant programs is desirable and this is behind COP's efforts in proposing a standardized format. This annual report format will enable COP program staff to monitor each project supported by an award.

Public reporting burden for this collection of information is estimated to average 300 minutes per response, including time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed and completing and reviewing the collection of information.

Send comments regarding this burden estimate or any other aspects of this collection of information, including suggestions for reducing this burden, to the National Ocean Service, CSCOR/COP Office, 1315 East-West Highway, Silver Spring, MD 20910. Grant files are subject to the Freedom of Information Act (FOIA). Confidentiality will not be maintained--the information will be made available to the public. However, unpublished research results shall not be published without prior permission from the recipient.

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