

## Progress Report – Integrated Monitoring of MHI Williams & Walsh

A. Grant Number: ??

B. Amount of Grant: **\$103,385**

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

D. Grantee: **Hawaii Coral Reef Initiative – Research Program**

E. Award Period: From: **01/01/05** To: **12/31/05**

F. Period Covered by this Report: From **05/16/05** To **09/30/05**

G. Summary of Progress and Expenditures to Date:

1. 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

### **(1A). Development of Integrated Monitoring Scheme**

The primary objectives of the 'integrated-monitoring' projects, all of which will contribute to the development of a MHI monitoring strategy for DAR, are to: (1) develop a toolkit of survey methods' (2) conduct extended field trials of those methods in West Hawaii; and (3) develop a data environment including an Access database and ArcInfo GIS system.

Work early in the project period (and described in previous report) focused on the development of methods for surveying the large and mobile fishery-target species which are not well surveyed by small transect-based methods; and for 'large-scale benthic characterization'. Field trials of large-scale benthic characterization are scheduled for later in the project period, but considerable field testing has now been done of the fishery-target species method. Specifically, 100 survey dives (each dive involving a pair of divers) over 14 sites in West Hawaii and 78 survey dives over 8 sites in Maui.

Compared to the small-scale fixed transect approach which has been principally used in Hawaii to count the small and generally site-attached species which constitute the majority of the species targeted by the aquarium trade, timed swims cover much more ground and take considerably less time (Table 1). The larger and more mobile groups which are not well surveyed by the small scale fixed transects were substantially more frequently encountered in timed swims and recorded in much higher numbers (# counted varying from 1.8 to 30.5 times higher depending on the group, Table 1). Differences between methods were even more dramatic for larger individuals of those groups: the mean # >30cm fish counted was 6.1 to 71.6 higher in timed swims than in fixed-transect surveys (Table 1). The timed swim approach is, therefore, greatly more effective than the fixed transect surveys at capturing abundance data on those larger and more mobile species. The timed swim approach is especially complementary to the fixed-transect method, as the total time to conduct both surveys at a site (approx 45 minutes) is within what can comfortably be done by divers on one scuba tank. We have therefore adopted a survey protocol which involves both methods being done in each fish survey dive at our integrated monitoring sites.

**Table 1. Comparison of fixed transects and timed-swims West Hawaii. Comparative data from 2005 surveys where both methods applied in same survey dive by same dive pair. Total of 11 sites, at which two surveys were done per round, 3 complete 'rounds' in 2005 included here.**

Method	7-min Timed Swim	2*25m*4m fixed transects	Difference in # fishes counted per method
Time (2 divers)	14 min.	30 min.	
Area covered	approx. 1,500 m <sup>2</sup> .	200 m <sup>2</sup> .	
<b>Mean ± SD # target fish counted per survey dive (fishes &gt;15cm TL)</b>			
Small schooling acanthurids	2.2 ± 5.2	0.4 ± 1.6	<b>6.0</b>
Large acanthurids	16.6 ± 33.8	0.5 ± 0.9	<b>30.5</b>
Large labrids	0.9 ± 1.1	0.5 ± 0.7	<b>1.8</b>
<i>Monotaxis grandoculis</i>	5.4 ± 14.7	0.2 ± 0.6	<b>27.3</b>
Scarids	11.3 ± 6.5	4.3 ± 3.8	<b>2.6</b>
<i>Cephalopholis argus</i>	5.9 ± 2.4	1.9 ± 1.5	<b>3.1</b>
Carangids	0.2 ± 0.7	0.0 ± 0.2	<b>7.0</b>
<b>Mean ± SD # target fish counted per survey (fishes &gt; 30cm TL)</b>			
Scarids	5.6 ± 4.3	0.9 ± 1.2	<b>6.1</b>
Large acanthurids	14.1 ± 33.5	0.2 ± 0.5	<b>71.6</b>
Naso spp.	9.1 ± 20.3	0.6 ± 0.7	<b>15.0</b>
All fishes	43.0 ± 50.7	3.3 ± 2.1	<b>13.0</b>

Coral reef monitoring by the state of Hawaii's Division of Aquatic Resources has been piecemeal in the past – different standards and techniques having been applied at different islands throughout the state. As our aim has been to develop a suite of standard methods which can be applied throughout the Main Hawaiian Islands, we instigated field trials of the timed swim method at sites in Maui which have previously been surveyed by means of 3 linear 25\*4m transects per diver, with two divers swimming in parallel. The target groups of both survey methods are the same (the larger and more mobile fishes which are the principle targets of food- and recreational-fishers). Compared to the linear transects, timed swims cover more area in considerably less time. Target groups were approximately equally or slight more frequently encountered during timed swims than in linear transects and similarly, equally many or more larger fishes (>30cm TL) were generally counted during timed swims than during linear transects. However, among all fishes counted (only fishes >15cm TL were recorded by either method) the number counted per survey tended to be higher for linear transects than for timed swims (Table 2). It is not obvious why that should be given the greater areal coverage and lower disturbance of the timed swim method compared to linear transects. Possible explanations for higher counts of smaller fishes during linear transects include the possibility that some such fishes were actively attracted by the transect lines being laid out, that divers swimming closely in parallel tended to double count passing fishes (i.e. both observers counted them), or that divers swimming fixed transects focused more carefully in and around the benthos than divers attempting to cover large distances in timed swims. Overall, both methods have advantages and disadvantages, but the lower effort per survey required by timed swims means that considerably increased replication would be possible with that method.

Given our strong desire to adopt consistent methods statewide and the clear evidence that timed swims are an effective complement to the fixed transects use in West Hawaii, we intend to press for adoption of the timed swim method statewide.

**Table 2. Comparison of linear transects and timed-swims at monitoring sites in Maui. Transect surveys come from two survey rounds in 2004 and 1 survey round in 2005 surveys (all Maui monitoring stations surveyed once per round). Timed swim data come from one survey round in 2005 at the same sites.**

	Mean # Fish / Survey			Encounter Rate		
	Linear Transects	Timed Swim	Diff	Linear Transects	Timed Swim	Diff
Time (per pair of divers)	~25 min.	~10 min.				
Area covered	600 m <sup>2</sup>	1,200 m <sup>2</sup>				
<b>MID-DEPTH REEFS (10m) Fishes &gt; 15cm TL</b>						
Mullids	17.5	10.8	0.62	90%	88%	0.98
<i>C. argus</i>	2.4	2.0	0.84	71%	66%	0.93
Large Acanthurids	10.7	11.4	1.06	70%	88%	1.25
<i>M. grandoculis</i>	1.5	0.6	0.42	38%	34%	0.92
Naso spp.	16.8	10.1	0.60	88%	94%	1.07
Scarids	22.9	13.8	0.60	86%	94%	1.08
Small schooling Acanthurids	6.8	9.3	1.38	38%	44%	1.17
ALL FISH	88.7	63.0	0.71	96%	100%	1.04
<b>Fishes &gt;30cm TL</b>						
<i>C. argus</i>	1.3	1.5	1.12	56%	66%	1.17
Large Acanthurids	4.8	6.6	1.36	43%	53%	1.24
Naso spp.	2.7	3.8	1.42	64%	56%	0.89
Scarids	0.0	3.0	<b>TS only</b>	0%	66%	<b>TS only</b>
ALL FISH	19.5	19.5	1.00	89%	94%	1.06
<b>SHALLOW REEFS (3m) Fishes &gt; 15cm TL</b>						
Mullids	24.2	9.5	0.39	88%	93%	1.07
<i>C. argus</i>	1.7	1.2	0.69	46%	52%	1.13
Carangids	0.8	1.3	1.53	29%	46%	1.58
Large Acanthurids	11.2	14.6	1.30	66%	91%	1.38
Naso spp.	19.5	16.0	0.82	86%	93%	1.09
Scarids	20.0	15.2	0.76	84%	96%	1.14
Small schooling Acanthurids	40.9	29.5	0.72	64%	65%	1.01
ALL FISH	121.6	91.1	0.75	89%	100%	1.12
<b>Fishes &gt;30cm TL</b>						
Carangids	0.6	0.8	1.44	22%	35%	1.60
Large Acanthurids	4.3	5.6	1.32	53%	67%	1.27
Naso spp.	6.7	5.5	0.82	73%	74%	1.01
Scarids	4.4	4.0	0.92	68%	85%	1.24
ALL FISH	22.2	21.4	0.96	86%	100%	1.17

### (1B) DAR reef monitoring 'Data Environment'

The recently developed DAR reef monitoring database is currently being used by DAR offices in Kona and Maui, and by UHH partners responsible for monitoring East Hawaii sites. By next year, we expect it to be adopted by DAR Oahu monitoring staff. We are continuing to transfer more of DAR's historical monitoring data into the database. Monitoring data from Kelekekua Bay MLC (West Hawaii) from 1952 onwards, and from Puako FMA (West Hawaii) from 1986 on, which were previously on paper records only have been added to the database within this reporting period.

## (2) Changes in reef community structure, Honaunau (Hawaii) between mid 1970s and late 1990s.

Between 1974 and 1978, reef fish communities in three habitats at Honaunau were surveyed 3-5 times per habitat per year by biologists working for the National Park Service (Ludwig, Taylor, Imase (1980). Summer census of the reef-fish community of waters adjacent to Puuhonua o Honaunau National Historical Park, summers 1975-1978. Cooperative National Park Resources Studies Unit, University of Hawaii. Technical Report 32) 23 years later (between 1998 and 2001), DAR biologists resurveyed the same habitats at the same time of year at the same location. One person, Dr Bill Walsh (DAR Kona, co-PI this project) was a member of the survey team at each of those time periods.

Comparisons of fish community structure and absolute abundance indicate that substantial and widespread changes have occurred to fish communities at Honaunau between the mid 70s and late 1990s. Over that time period, there was little overall change in community richness, but total fish abundance was much lower in later surveys (Table 4). Abundance of acanthurids, chaetodontids, and pomacanthids declined by half to two thirds between 1970s and late 1990s (Table 5). Each of those groups is dominated by species which are heavily targeted by the aquarium trade. In contrast, food- or recreational-target groups including scarids and holocentrids generally either increased or remained relatively constant over time (Table 4). The only fishery target group which appeared to have declined in abundance is the small schooling acanthurids (*A. leucopareius*, *A. guttatus*, *A. triostegus*, Table 4) which are targeted by shoreline net fishers.

**Table 3. Richness and total abundance of all fishes counted at Honaunau.**

	Mean (SD)	75-78	98-01	p-value
Richness (species/yr)		86.0 (9.7)	90.8 (3.0)	0.39
Abundance (fishes/transect/yr)		781.3 (237.7)	493.5 (47.5)	▼ 0.06

**Table 4. Abundance of fishery-rather groups at Honaunau.**

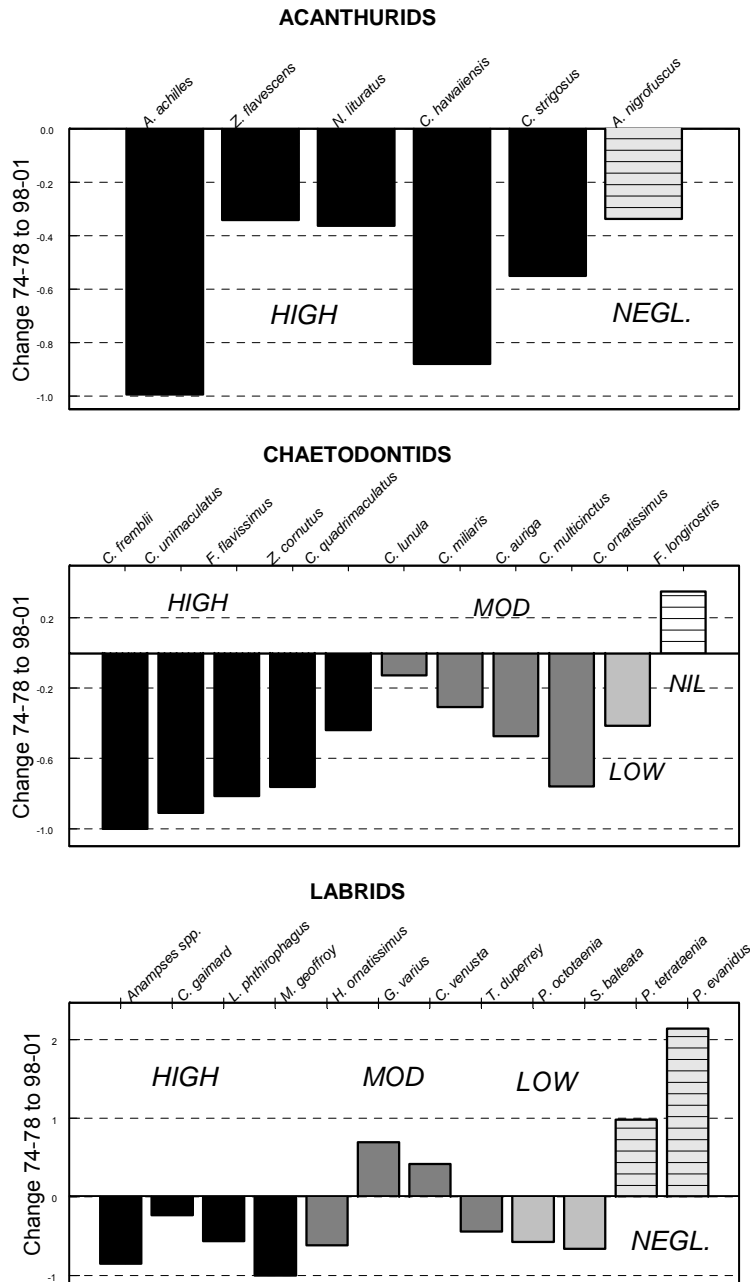
	Mean (SD)	75-78	98-01	p-value
Large acanthurids ( <i>A. blochii</i> , <i>A. dussumieri</i> , <i>A. xanthopterus</i> , <i>A. olivaceous</i> )		1.1 (0.9)	1.5 (1.5)	0.73
Naso spp.		6.8 (3.6)	4.0 (1.3)	0.20
Small schooling acanthurids		3.9 (1.8)	1.2 (0.6)	▼▼ 0.03*

**Table 5. Mean abundance per transect by Family, Honaunau 1975-78 and 1998-2001.**

Family	75-78	(SD)	98-01	(SD)	sig (p)	CHANGE
Acanthuridae	<b>349.4</b>	(85.0)	<b>189.5</b>	(22.2)	0.01	▼▼
Pomacentridae	<b>170.6</b>	(47.4)	<b>152.0</b>	(18.6)	0.49	-
Labridae	<b>92.3</b>	(38.3)	<b>53.0</b>	(14.0)	0.10	▼
Chaetodontidae	<b>82.9</b>	(39.4)	<b>25.4</b>	(2.8)	0.03	▼▼
Cirrhitidae	<b>24.8</b>	(8.1)	<b>15.1</b>	(5.2)	0.09	▼
Tetraodontidae	<b>8.2</b>	(4.6)	<b>16.5</b>	(6.5)	0.08	▲
Pomacanthidae	<b>16.4</b>	(10.0)	<b>3.9</b>	(1.2)	0.05	▼▼
Mullidae	<b>10.7</b>	(10. )6	<b>4.9</b>	(2.6)	0.33	
Scaridae	<b>1.2</b>	(0.6)	<b>10.1</b>	(4.3)	0.01	▲▲
Holocentridae	<b>0.9</b>	(0.5)	<b>7.8</b>	(4.4)	0.02	▲▲
Balistidae	<b>7.6</b>	(4.2)	<b>3.8</b>	(2.0)	0.15	
Monacanthidae	<b>6.2</b>	(3.1)	<b>0.5</b>	(0.4)	0.01	
Serranidae	<b>0.2</b>	(0.2)	<b>3.5</b>	(0.3)	<0.001	▲▲
Zanclidae	<b>1.5</b>	(1.1)	<b>0.4</b>	(0.4)	0.09	▼
Muraenidae	<b>0.1</b>	(0.1)	<b>0.6</b>	(0.2)	0.00	▲▲
Carangidae	<b>0.3</b>	(0.4)	<b>0.2</b>	(0.1)	0.41	
Lethrinidae	<b>0.3</b>	(0.5)	<b>0.0</b>	(0.0)	0.32	

As well as scarids and holocentrids, other groups to increase in abundance included morays (muraenids) and the introduced grouper *Cephalopholis argus* (Table 5).

A rough estimate of the intensity of fishing on aquarium species was calculated for West Hawaii by dividing the total number collected in West Hawaii between 1999 and 2004 by the mean abundance of those species in underwater visual surveys in West Hawaii over the same time period. Among small species of target groups - acanthurids, chaetodontids, and labrids - heavily targeted species all declined in abundance, mostly by 40% or more between mid 1970s and late 1990s (Figure 1). In contrast, lightly- or non-targeted, but similarly sized species, generally declined much less or actually increased in abundance over the same time period (Figure 1). As an example, the Long-nose Butterflyfish (*Forcipiger longirostris*) which is not taken by aquarium collectors increased in abundance by about 30% between mid 1970s and late 1990s. Over the same time period, the very similar Forceps Butterflyfish (*F. flavissimus*) which is taken for the aquarium trade, declined by over 60% in abundance (Figure 1).



**Figure 1. Relative changes in abundance of aquarium-target and associated acanthurids, chaetodontids and labrids. Species are grouped into 4 categories: highly; moderately, lightly, and negligibly (or not) collected species, depending on the ratio of number of fishes collected (taken from DAR catch records) divided by absolute abundance (from DAR long term underwater surveys in West Hawaii).**

The likely importance of aquarium collecting in declines of many species is also indicated by Figure 2 below, which shows a highly significant negative relationship between relative change in abundance and the aquarium fishing 'impact factor' of all commonly encountered species.

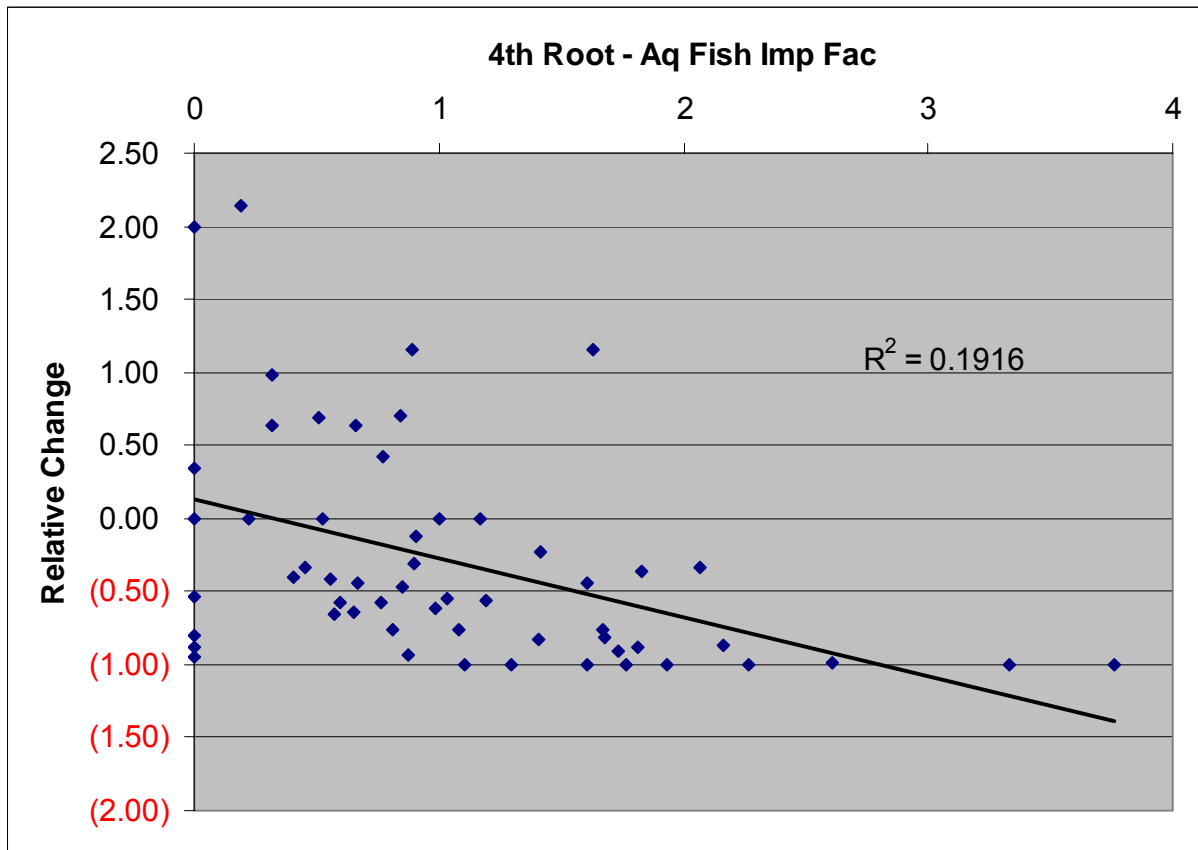


Figure 1. Relative changes in abundance of all commonly encountered species (All species with mean abundance > 1 per transect at either period) plotted against 4<sup>th</sup> root of aquarium-collecting impact factor (ratio of number of fishes collected FY1999 to FY2004 according to DAR catch records) divided by species' absolute abundance according to DAR long term underwater surveys of West Hawaii 1999 to 2004.

In summary, there is considerable evidence of substantial change in abundance and community structure across many common reef fish groups at Honaunau since the mid 1970s, and aquarium collecting is heavily implicated as a driving force in such changes.

Additionally, the evidence that two species, the Bluestrip butterfly (*Chaetodon frembli*) and the Bandit Angel (*D. arcuatus*), which are now considered extremely rare on shallow to mid-depth reefs in West Hawaii were commonly encountered in mid 1970 surveys led us to investigate trends in catch records of those and other currently rare species. Aquarium-catch records corroborate the findings of comparisons of fish UVC data from Honaunau in that several species currently considered rare, were regularly caught in West Hawaii in the 1970s and 1980s. This work is ongoing, but appears to provide an example of a 'sliding baseline', i.e. what is now considered 'normal/healthy' by relatively experienced observers with years to decades of experience actually reflects a community that has been seriously altered over time frames of decades or longer.

- 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.

'Physical structure' and 'mobile invertebrate' surveys, scheduled for 3<sup>rd</sup> quarter 2005 have been rescheduled for 4th quarter 2005. This change was necessitated by damage to camera housing necessary for broad-scale benthic surveys which will be conducted at the same time.

2. Applications:

- a. Publications, presentations, workshops;

**[Risa/Kristine: These publications have now been accepted. I'm not sure whether they are supposed to be accomplishments for the Dar portion or the HCRI portion of my salary..]**

Scientific Publications:

1. Effects of rotational closure on coral reef fishes in the Waikiki-Diamond Head Fishery Management Area, Oahu, Hawaii. ID Williams, Wj Walsh, A Miyasaka, AM Friedlander. **In press: Marine Ecology Progress Series**
2. Impact of observers' experience-level on counts of fishes in underwater visual surveys. ID Williams, Wj Walsh, BN Tissot, LE Hallacher. **In press: Marine Ecology Progress Series**

Presentations

(1) 'Effects of rotational closure on coral reef fishes in the Waikiki-Diamond Head Fishery Management Area, Oahu, Hawaii -Ivor Williams, HCRI-RP 3<sup>rd</sup> quarterly meeting, Honolulu Hawaii August 2005

- b. Applications to management or research;

The coral reef monitoring group has met twice in the period covered by this report, to review progress on the draft monitoring plan. To date, broad agreement on the methods and monitoring priorities have been agreed. The next meeting is scheduled for November 4<sup>th</sup>, at which time we aim to finalize details on sites and replication. We are therefore close to completing planning for a robust and cost and time-efficient integrated and reef-scale monitoring program for the Main Hawaiian Islands.

Greater departmental capacity to manage and analyze a range of long-term data sources including, among others, the long-term monitoring data and aquarium catch records has enhanced reef managers' ability to understand the nature and possible causes of changes in reef condition over time. As an example, analysis of changes in fish community and aquarium catches between mid 1970s and late 1990s at West Hawaii described above highlighted substantial changes in community structure as well as in absolute abundance and catch rates across many reef fish groups. This work will directly feed into activities of the West Hawaii Fisheries Council, who have begun to consider implementing fishery restriction of currently rare species.

Long-term analysis of effects of rotational closure at Waikiki FMA on Oahu has given biologists and managers within the division the capacity to make an informed assessment of the effectiveness or otherwise of the rotational closure strategy which has been adopted there since 1978. Active consideration is now being given to altering the management regime at Waikiki.

- c. Data and/or information products;

As described above, the recently developed DAR reef monitoring database is currently being used by DAR offices in Kona and Maui, and by UHH partners responsible for monitoring East Hawaii sites. By next year, we expect it to be adopted by DAR Oahu monitoring staff. Database contains data from current monitoring and, increasingly, historical monitoring data which we are transferring from paper records.

- d. Partnerships established with other federal, state, or local agencies, or other research institutions (other than those already described in the original proposal).

**None.**

3. Expenditures:

**[Risa/Kristine: I take it you will supply data for this section...]**

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

Prepared By:

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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