Chapter 1:

Keynote Address: Establishing Coral Reef Monitoring in the Hawaiian Islands: GCRMN Philosophies and Strategies for Community-Based Monitoring

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Abstract

The most effective way of managing coral reef resources in developing countries is through the direct involvement of user communities. This can only occur if these communities are aware of damage to reefs and probable causes, as well as being provided with assistance to implement management. The Global Coral Reef Monitoring Network seeks to raise that awareness by involving all users in gathering data on the status and trends in coral reefs using basic methods. Three levels of monitoring are identified: community, government and research, with the intensity of monitoring increasing with each level. Community level monitoring will use Reef Check methodology and approaches, with government level monitoring using a more detailed form of this monitoring. Methods for research level monitoring should be selected by the scientist in response to specific questions and habitats. A call is made on the Hawaiian government and science community to establish wide-scale monitoring in the region, assist communities with monitoring and assist other countries in the Pacific to establish monitoring Networks.

Keywords

local community, volunteers, global database, awareness, Great Barrier Reef

Introduction

Surveying and monitoring are essential to understand the extent of the problem facing coral reefs; what is current reef status and the trends; what are the possible causes for changes; and what remedial action should be indicated to management to implement sustainability in reef exploitation. There are arguments that sustainable exploitation is an oxymoron – that one cannot exploit a natural ecosystem and hope to retain ecosystem composition and processes. This is not an argument for this paper, as exploitation is current on most reefs and will continue, and reefs will continue to be degraded (Brown 1987; Kinsey 1988; Grigg and Dollar 1990; Salvat 1992; Wilkinson 1993; Bryant et al. 1998; Wilkinson 1998). Anthropogenic stresses pose the greatest immediate threat to coral reefs, with global climate change posing a longer term threat (Smith and Buddemeier 1992; Wilkinson and Buddemeier 1994). Therefore, our collective efforts are required to ensure that large tracts of coral reefs remain as functional units into the future, with the need for more reef monitoring considered as a first step in these efforts (Ginsburg 1993).

Monitoring and surveying are defined as a spectrum of activities; surveying is one time; performed repeatedly, it becomes monitoring. Within this spectrum, the level of statistical reliability of different procedures can be quite variable. The Global Coral Reef Monitoring Network adopts a flexible definition for 'monitoring' (the title of the Network was provided by a committee), and will encourage and accept any action that involves looking more closely at a reef and recording status and trend parameters.

The GCRMN is the research and monitoring arm of the International Coral Reef Initiative (ICRI), which aims at more efficient management and long-term conservation of reefs. There are two interlinked strategies: determine the current status and long-term trends in reefs and how they are used; and increase the awareness amongst user communities, governments and funding agencies of the problems facing reefs, their causes, and mechanisms to alleviate those problems.

The GCRMN is co-sponsored by IOC (Intergovernmental Oceanographic Commission of UNESCO), UNEP, IUCN and the World Bank and based at AIMS and ICLARM (International Center for Living Aquatic Resources Management, Manila). It has a broadly based Scientific and Technical Advisory Committee to provide science and management advice. The GCRMN functions as a network of independent Regional Nodes that coordinate training, monitoring and databases within participating countries and institutes in regions based within the UNEP Regional Seas Programme: Middle East; Western Indian Ocean Eastern Africa; South Asia; East Asian Seas; Pacific; and Caribbean and Tropical Americas. Each of these regions can contain several GCRMN Nodes e.g., there are 6 provisional Nodes in the Pacific, with the greater Hawaiian region being one.

The GCRMN concentrates on basic monitoring of reefs along line transects, assessing "lifeform" categories to provide percent cover data and counts of fish populations, with an emphasis on "target" fish. As people gain more experience, more monitoring will be performed at species level etc. There will be parallel socio-economic monitoring of local communities to determine resource use patterns and how management may be improved.

Role of Science in Informed Management

Biological science assessment constitutes about 20% (plus or minus), of the process of managing coral reefs for sustainability (depending on the system and the nature of the problems). The remainder consists of input from other disciplines e.g., legal and economic expertise; social and community workers; management and policy people.

It is naive to assume that the provision of sound scientific data showing that the status of a reef system has degraded because of anthropogenic activities, will automatically result in decisions being taken to change human behavior and access. This has rarely happened elsewhere and is unlikely to happen with coral reefs.

Marine scientists and lawyers share a similar characteristic. It is acknowledged that you can always find a lawyer to support any opinion or debate any issue, no matter how apparently hopeless. Likewise it appears that one can usually find a marine scientist who will contest the hypotheses, assumptions, methods, data and conclusions of another scientist.

There are many models that demonstrate how the provision of scientific information, even though clear, has failed to change decision-making. This is particularly clear when there are strong commercial or traditional interests that compete for access to the same resource. This has been patently clear in the debate over sustainable fisheries; decision makers who were reluctant to deny access to fisheries by entrenched commercial lobby groups would seek out a scientist to question the validity of models of "minimum" or "maximum" sustainable yields. Probably more effort has gone into predicting and modeling the fate of marine fisheries than in any other area of marine science. And yet the consistent pattern is one of over-exploitation of fisheries and apparent or real collapses in parent stocks and system degradation (Pauly et al. 1998).

Likewise, predictions of the impacts of excessive population growth, increasing levels of greenhouse gases inducing global climate change, the abuse of antibiotics that result in dangerous levels of drug resistance, have all been clear, but resulted in few remedial actions. There are a few examples where the provision of scientific information has had an immediate impact, the most notable being the destruction of the ozone layer through the release of CFCs and other compounds. Here the solution was relatively simple (compared to reducing fishing access) and the net economic equation was essentially neutral.

The GCRMN has 2 distinct strategies to address this problem of getting decisions made – gather the necessary data and raise the awareness of all stakeholders. The objective is to do both at the same time, but if this is not possible, then the primary objective should be awareness raising, because there are already considerable scientific data demonstrating anthropogenic impacts on coral reefs.

Value of Scientific Monitoring Data

Science is well equipped to pose questions and then provide answers to some. Thus a well-designed scientific monitoring program can provide decision-makers with an unambiguous statement on changes and trends in a coral reef over time. Such a program may also indicate why changes have occurred, and this is particularly pertinent for management, when changes are due to human activities. The role of science often stops there, leaving remedial action to decision makers in resource management. If a scientist considers that action is either inadequate or slow, then the scientist may become involved in advocacy, a role few scientists are trained for, or feel comfortable with.

Scientific "monitoring" can either be purpose driven or undertaken for "scientific curiosity". The best cited example is from Discovery Bay, Jamaica. The primary objective of long-term monitoring of these reefs by 3 researchers, Terry Hughes (1994), David Liddell and Sharon Ohlhorst (1993), was scientific curiosity – "what happens to coral reefs over time?" The anecdotal past history from Tom Goreau (Snr) was that the coral communities were essentially stable and that fish were not important to the maintenance of a healthy coral reef. Monitoring for 4 years detected minor changes, until the reefs effectively collapsed from apparently natural events; but the ultimate cause was anthropogenic. These studies,

designed to detect minor changes, are well-cited examples of good monitoring benefiting reef management. Almost any monitoring program would have detected these changes; however, poorly designed studies may not detect gradual anthropogenic changes until the damage is severe.

Another example is the long term monitoring of the Great Barrier Reef. One primary objective back in 1982 was to detect populations and effects of Acanthaster planci on over 250 reefs, but the monitoring since has shown that reefs can go through large amplification swings in coral and algal abundance. Most changes on the GBR are natural (cyclones and A. planci plagues), but these monitoring data on 50 reefs over the last years are now invaluable to management to detect incipient anthropogenic changes (Done 1997; Sweatman et al. 1998).

It is often stated that a monitoring program MUST be designed around a sound scientific question, and monitoring without such an objective is false. The monitoring cases above demonstrate that just having a monitoring program was the most valuable feature, not the original objective. But even unambiguous data do not automatically lead to effective decision making; it is critical that these decision-makers are aware of the need for action and have the ability to implement effective action.

Effective Management of Coral Reefs

There are few examples of fully effective top-down management of human uses of coral reefs. Management of the Great Barrier Reef Marine Park is one possible example and that of the Florida Keys Marine Sanctuary may be another. These are both adjacent to wealthy populations, not dependent on reef resources for subsistence living, which predominantly believe in the importance of conserving the reef environments. In both cases, government has started with extensive public education programs and provided effective enforcement mechanisms.

In most instances, however, management of coastal resources by centralised government authority is ineffective or totally lacking. This is the case throughout most tropical countries with coral reefs. For example, in Southeast Asia, only 7 of over 92 gazetted MPAs are considered to be well managed (Kelleher et al. 1995a), and none are well managed amongst 37 MPAs in the Pacific islands (Kelleher et al. 1995b). Many of these MPAs are 'paper parks' with no management plans, and Governments have been unable to provide resources to enforce compliance with any regulations in those that do have management plans. The main reason that management of these parks is ineffective is that the local populations are either not informed of their presence, not given any role in that management, and not convinced that management will benefit them.

Effective management of human uses of these resources to ensure sustainability can only be achieved through community compliance, and preferably through community-initiated management. For a community to assume the role of resource managers will require that:

1. community members are aware of the problem facing the resources and informed of potential mechanisms to arrest system degradation;
2. communities have the authority and power to implement management, without being overruled by higher authorities; and
3. communities perceive there is a current or future benefit to them by implementing management that initially may require reducing their access to the resources.

A major strategy of the GCRMN is to act through point 1, achieving behavioral changes that will lead to better conservation of reefs.

Models of Awareness Influencing Behavior

There are several examples in sociological research of behavior changes that follow an awareness raising process. According to the "Health Belief Model" (Rosenstock et al. 1988), changes in behavior follow when people perceive that:

- they are susceptible to a particular health problem;
- they regard the problem as serious;
- they are then convinced that treatment or prevention will be effective; and
- they are able to afford the treatment.

But behavioral change still may not occur until there is a catalyst that initiates them to take health action. In most instances, these catalysts are people (like a medical practitioner) who will assist them to take corrective action, however, the catalyst may also be a close friend or relative falling ill. Stopping smoking is a good example of such a behavior model. This health belief model may be reworded as:

1. Threat - is perceived as present and serious;
2. Outcome expectations – both benefits and barriers to change are perceived;
3. Efficacy expectations – will it work?

Thus a model for implementing change in the use patterns of coral reef user communities can be constructed as the community:

1. being aware that degradation of their coral reef resources result from their actions;
2. having the authority and organisational capacity to implement management;
3. understanding that remedial action will be effective in arresting a decline in resources status;
4. perceiving that implementing management will ensure their access to a similar or greater level of resources in the future; and
5. receiving assistance and encouragement to start the process.

The primary objective of the GCRMN is point 1, 'raising awareness of the extent of the problem' with coral reef user communities about one reef, and raising the awareness in major donor organisations, agencies, governments and the public that local problems of coral reefs are also widespread. The success of the 1997 and 1998 Reef Check campaigns demonstrate the value of monitoring in raising awareness. While the data have not been fully published, widespread media releases carried one strong message – there were virtually no reefs that had not been impacted by roving bands of fishermen.

GCRMN Objectives, Strategies and Principles

The GCRMN has two parallel mechanisms to progress towards more effective conservation of coral reefs – the gathering of data on the status and trends in coral reefs and using monitoring to raise awareness amongst users communities. Thus, much emphasis will be on the involvement of local communities

in monitoring, with parallel collection of biophysical and socio-economic data. The GCRMN is based on existing organisations and networks, and aims to integrate existing monitoring programs. Flexibility must, however, be maintained to incorporate different methods of monitoring, other than the standard methodology. The Network must be responsive to reef users and provide information back in an understandable format.

The GCRMN has three interlinked levels:

- **COMMUNITY** - communities, fishers, schools, colleges, tourist operators and tourists monitoring broad areas with less detail, to provide information on causes of damage to reefs;
- **GOVERNMENT** - moderate coverage at higher resolution and detail by tertiary trained personnel in government environment or fisheries departments and universities; and
- **RESEARCH** - high-resolution assessment over small scales by scientists and institutes currently monitoring reefs for research.

A full range of reef types will be monitored, with particular emphasis on existing or planned Marine Protected Areas (MPAs) to provide data on the resources and effectiveness of management. This will be coordinated with the World Bank, IUCN/CNPPA, GBRMPA Global Representative System of Marine Protected Areas project for site selection and questions asked by MPA management (Kelleher et al. 1995b). The main activity is introducing or strengthening existing capacity to examine reefs by providing a consistent monitoring program, that will identify trends in coral reefs and discriminate between natural, anthropogenic, and climatic changes.

The overall objectives of the GCRMN, listed in the IOC/UNEP/IUCN Strategic Plan (1997) are to:

(i) improve the conservation, management and sustainable uses of coral reefs and related ecosystems for peoples of the tropics and the world through assessing the trends in biophysical status and social, cultural and economic values of these ecosystems;

(ii) provide individuals, organisations and governments with the capacity to assess their coral reef resources and collaborate within a global network to document and disseminate data on reef status and trends.

The Strategic Objectives are to:

(i) develop and implement a mechanism to link governments, agencies, institutions and individuals for long-term monitoring of biophysical and socioeconomic (social, cultural and economic) aspects of coral reefs throughout the world within 5 years;

(ii) initiate, foster and facilitate the functioning of the GCRMN through interacting regional networks within 3 years, that coordinate activities in participating countries and organise training and database operations;

(iii) strengthen, or when necessary, build the capacity of governments, agencies, institutions and individuals to monitor and research coral reefs through provision of training, documentation and equipment within 3 years;

(iv) develop a consistent monitoring program within 5 years, incorporating biological, physical, social, cultural and economic studies, that will identify trends in coral reefs and discriminate between natural, anthropogenic, climatic and other aspects of global change to improve conservation and management of coral reefs;

(v) assemble, synthesize and disseminate to GCRMN participants, managers and international fora the results of coral reef monitoring at local, regional, and global scales as annual reports on coral reef status and trends;

(vi) collaborate with global observing systems, particularly GOOS (Global Ocean Observing System) and GTOS (Global Terrestrial Observing System), to provide high-quality annual data on the health and trends in coral reefs for the preparation of predictive global change models;

(vii) provide and disseminate continuously the results of GCRMN assessment and monitoring through cooperative interactions with environmental management agencies to facilitate more effective sustainable use and conservation of reef resources.

The GCRMN will be based, wherever possible and feasible, on the following basic principles. The Network will:

(i) emphasize the involvement of local communities of reef users in the monitoring and assessment of coral reefs;

(ii) place equal emphasis on gathering biophysical and social, cultural and economic data on coral reefs and associated ecosystems and their uses;

(iii) function through existing inter-governmental or coordinating organizations and networks as much as possible, thereby avoiding the need to create new bodies and enhancing sustainability;

(iv) integrate all monitoring programs wanting to join the GCRMN, and maintain flexibility to incorporate different methods, levels of monitoring and forms of data;

(v) offer a standard methodology to participants commencing monitoring, and ensure that this methodology is adaptable to regional and local variations in cultures, capacities and environments;

(vi) incorporate novel ways and means of assessing and monitoring these ecosystems, and be responsive and flexible to the attitudes and wishes of participants;

(vii) focus monitoring activities, where appropriate, on current or planned Marine Protected Areas and adjacent unprotected areas to provide data for the Global Representative System of Marine Protected Areas;

(viii) ensure that data and information gathered are relevant to economic and environmental policy development and are accessible to all participants in a comprehensible format.

GCRMN in the Pacific

The operational model for the GCRMN is to form Nodes, with several countries or states grouped around a regional center that has the expertise and ability to assist by training personnel, advising on site selection, assisting in the entry, storage and analysis of data and providing a problem-solving resource. There will probably be 6 GCRMN Nodes in the Pacific, because of the large area and difficulty in having easy airline connections.

The Hawaiian Islands and other US territories in the Northeast Pacific have already been identified as one Node. There is excellent capacity to monitor reefs in the region, with several large institutions (e.g. University of Hawai'i, East-West Center, Bishop Museum and the State of Hawai'i Division of Aquatic Resources) containing many scientists already conducting coral reef monitoring programs. In addition,

there is a strong awareness amongst government and the public of the need for conservation, and there are many NGOs operating in the community and volunteer SCUBA divers (e.g., Save Our Seas).

Adjacent nodes could be: the Polynesian islands, with the French station of Moorea likely to take a lead role; the high islands around Fiji, based on the expertise at the University of the South Pacific (USP); and the large atolls, with the USP campus on Kiribati providing coordination and support.

The South Pacific Regional Environment Programme (SPREP) will coordinate the participation of regional governments from their headquarters in Apia, Samoa. An example of such coordination would be ensuring widespread participation in training courses in monitoring methodologies. Hopefully all Nodes will select similar methods to ensure reproducibility and comparability of data. The Nodes will, however, be effectively independent, able to determine their own monitoring methods and programs and responsible for reporting of reef status to users, governments and the international network. It is requested that they combine their data and information to produce annual reports on the status of Pacific reefs, with the assistance of SPREP, which will also provide advice and assistance in the search for operational funding.

Selection of Monitoring Methods for the Pacific

The GCRMN recommends methods for **community** and **government** level monitoring. Decisions on **research** level monitoring are best left to scientists to select methods in response to particular questions and environments.

The UNEP-IOC-IUCN Global Task Team on the Implications of Climate Change on Coral Reefs selected the basic methods developed during the ASEAN-Australia Living Coastal Resources project (English et al. (1997) in 1992 as the basis for **government** level monitoring. These include:

1. manta tow (or an equivalent survey method e.g., 5 minute timed swims) to obtain a broad perspective. Participants undertake repetitive 2 minute tows covering the circumference of a small reef or equivalent length of a long fringing or barrier reef to gain an overall perspective and to select representative sites for subsequent transects. Participants assess percent cover of live and dead corals, and record incidents, like crown-of-thorns starfish and sea urchin populations, bomb damage, bleaching, giant clams etc. (illustrated in English et al. 1997). These methods include:
2. line intercept transect (LIT) with initial identification at 'lifeform' level (English et al. 1997; or equivalent transect method). Assessments are conducted along 5 by 20 m transects laid parallel to the reef crest at a depth between 3 and 6m (normally the zone of maximal coral coverage) and intercepts of about 20 lifeforms are recorded. If participants are proficient, they can record species or if less experienced, lumping several coral types together can use fewer lifeform categories. If groups have time, a second set of transects at about 10 m depth is requested; and
3. fish censuses, with emphasis on fisher target species and indicator fish, like butterfly fishes (chaetodontids; English et al. 1997). This uses 3 by 50 m transects and estimates fish numbers, and if possible estimations of size, in a corridor 5 m wide and 5 m high. Usually performed along the same transects as for the LIT, but done beforehand so that fish are not disturbed. Initial monitoring is for a limited number of fish species, but as experience increases, this number is increased to assess the whole population. Narrower transects can be performed to detect juvenile fishes.

Additional methods can be employed such as establishing permanent quadrats to observe coral recruitment and growth, interactions between species, and the fate of individual corals after bleaching or disease. Terracotta tiles can be placed to measure the rate of settlement of juvenile corals.

A manual to assess a parallel set of socioeconomic parameters is being assembled to determine community resource uses and values, and resource requirements. This should be used in parallel with biophysical monitoring and should involve active participation of the communities in the assessment.

It is recommended that **community** level monitoring be conducted using the Reef Check methodology. This uses similar procedures to the LIT, but simplified (10 lifeform categories with only 1 coral type, 'live hard coral') so that volunteers are able to obtain valid data. This methodology was first trialed in 1997 and modified in 1998 for use simultaneously around the world within a 5-month time frame (April to September).

The core Reef Check methodology should be retained, but it may be advisable to include categories to monitor that are of particular interest to the community e.g. organisms that are special food or cultural targets. The window for monitoring could be widened to suit weather conditions or schedules in the community, but if outside the window chosen for Reef Check, the data would not be included in the global analysis. A critical feature of the Reef Check procedure is that teams should always have a qualified marine scientist as instructor and leader to ensure that data are collected reliably.

Request to Form a GCRMN Node in Hawai'i

The GCRMN invites Hawaiian government bodies, science institutes and scientists to assist in the formation of a node covering all the US West Pacific island states and territories. The goal of such a node should be to produce annual or biannual reports on the status of as many reefs as possible and include broad community participation in this monitoring.

Such a Node would automatically include the considerable amount of **research** level monitoring currently underway. Consideration should be given to expanding this to cover areas not being monitored or areas likely to come under significant anthropogenic pressures. Specific attention should be placed on monitoring areas that have been extensively damaged to detect the potential for recovery of coral reef communities.

It is requested that **Government** level monitoring be initiated to cover all areas within current or planned MPAs, with comparisons of adjacent unmanaged sites to assess the effectiveness of management procedures.

Community level monitoring should be encouraged anywhere there are communities willing to participate. The number may only be limited by the enthusiasm and available time of the people able to train and supervise the collection of data. Special attention should be placed on introducing Reef Check monitoring into schools and colleges, fisher cooperative groups, and tourist operators on all of the islands.

As there is a high level of coral reef monitoring expertise in the Hawaiian region, the GCRMN requests that governments, scientific institutes and scientists also assist in the development of nearby nodes. This would involve assistance in selection of methods, training, monitoring, database operations, problem resolution and assistance in the preparation of funding proposals. It will be important to assist in the annual analysis of data and writing of reports. The GCRMN will adopt the established technique of

having a special day, possibly coinciding with an existing ocean day, to present the results of monitoring during community focused festivities.

It is recommended that the State of Hawai'i form a local Coral Reef Initiative committee to link with similar groups on the mainland, and closely allied to the Presidential Task Force. Such a committee should be widely representative of all coral reef stakeholders and should be represented by each of the major islands. A monitoring coordinator should be appointed for each island with the specific task of developing monitoring in schools, volunteer groups (e.g., dive clubs, surfer groups) and coordinating reef education and awareness in the broader community.

Summary Recommendations

It is recommended that Hawaiian government bodies and academic institutions form a network under the ICRI umbrella to focus attention on coral reefs. This network should include all reef stakeholders e.g. schools, indigenous communities, commercial and recreational fishers, scuba divers, surfers, etc. One specific theme would be to conduct regular monitoring at three levels: by the community; by government staff; and by research scientists. The most appropriate methods would appear to be those adopted by the other Pacific GCRMN Nodes and others in Asia and the Indian Ocean: that of Reef Check for community use; and manta tow, line intercept transect and visual fish census as outlined in English et al. 1997 for government level monitoring. Scientific monitoring should be left to the individual to select methods for each task. These monitoring activities would automatically become part of the GCRMN.

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Section 1: Overview of Monitoring

Establishing a coral reef monitoring program will require thoughtful attention to a number of factors to insure that the methods are tailored to the specific needs of the State and address questions pertinent to the particular reef system of interest. There is no cookbook recipe for coral reef monitoring. Resource managers, scientists and local communities must work together to define objectives, select sampling methods and statistical design, identify data collectors, and interpret and communicate the results for effective management. Increasingly, volunteers and local community groups are participating in monitoring, leading to heightened awareness about the importance of preserving coral reef ecosystems.