South Pacific Regional Environment Programme

SPREP Training Course on: Coral Reef Survey and Monitoring Techniques

Held on
6-17 November 1995
in **Saipan**
Commonwealth of the Northern Mariana Islands

SPREP Library Cataloguing-in-Publication Data

SPREP Training Course on Coral Reef Survey and Monitoring Techniques
(1995 : Saipan, Commonwealth of the Northern
Mariana Islands)

SPREP Training Course on Coral Reef Survey and
Monitoring Techniques held on 6-17 November 1995 in Saipan, Commonwealth
of the Northern Mariana Islands. - Apia, Western Samoa
: SPREP, 1996.

iii, 17 p. ; 29 cm.

"Conducted by Debbie Bass and Ian Miller of the
Australian Institute of Marine Science"

ISBN: 982-04-0160-7

1. Coral reefs and islands - Oceania. 2. Coral reef
conservation - Oceania. I. Bass, Debbie. II. Miller, Ian.
III. South Pacific Regional Environment Programme.
IV. Title.

574.5263667

Published in October 1996 by:
South Pacific Regional Environment Programme
P.O. Box 240
Apia, Western Samoa

Printed by:
Commercial Printers Ltd
Apia, Western Samoa

Original Text: English

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Foreword

A regional training course in coral reef monitoring techniques was held in Saipan, Commonwealth of the Northern Marina Islands (CNMI). The course was a 'Train the Trainer' style course designed to provide participants with basic skills in the design and implementation of monitoring programmes for coral reefs. The aim of the course was to train participants to a level such that they could conduct national training programmes in their home countries.

Funding for the course was provided by the Australian Agency for International Development (AusAID), the US Department of State and the Canadian International Development Agency (CIDA). The course was designed and conducted by staff from the Australian Institute of Marine Science (AIMS), particularly Ian Miller and Debbie Bass of the AIMS Long Term Monitoring Program. The Coastal Resources Management Office (CRMO) and Northern Mariana College, both of CNMI, assisted with the organisation and provided in kind assistance, facilities and support. The course was administered by the South Pacific Regional Environment Programme (SPREP).

As a result of this course, twelve participants from five Pacific nations were trained in both the 'Manta Tow' and 'Line Intercept' techniques. These techniques, developed during the Association of South East Asian Nations (ASEAN) - Australia Living Coastal Resources Project, are internationally recognised and form the basis for global assessment and monitoring of coral reefs.

The success of the workshop was largely due to the experience of the participants in working in the marine environment and their dedication to acquiring new skills. Such training will enhance the capacity for island nations to monitor and manage their own coral reef resources. This report summarises the training and offer recommendations for future courses.

Don Stewart
Acting Director
South Pacific Regional Environment Programme

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SPREP Training Course on: Coral Reef Survey and Monitoring Techniques

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1 Introduction

Coral reefs are one of the most productive and biologically diverse of all marine ecosystems. They are a valuable resource for tropical coastal communities providing social and cultural benefits as well as substantial commercial benefits through industries such as fisheries, tourism and recreation. The importance of coral reefs is recognised by IUCN in their World Conservation Strategy (1980) in which reefs are identified as one of the essential ecological processes and life support systems necessary for human survival and sustainable development.

It is globally recognised that coral reefs are becoming increasingly stressed, for instance, as much as 10 percent of the earth's coral reefs are significantly degraded and an even greater percentage is threatened (Wilkinson 1993). The major causes of coral reef degradation are typically linked to stresses induced by human activities. These stresses vary from direct impacts such as extraction of resources, siltation, over harvesting, tourism, nutrient enrichment and pollution, to indirect impacts such as land use practices and human induced climate change. As human populations grow, the increase in pollution and usage of this important resource may accelerate the current decline in coral reef ecosystems. Thus there is an urgent global need for coastal communities collectively, to acquire and maintain the knowledge and capacity to conserve the sustainable use of coral reefs and related ecosystems.

Recognition of this problem and the need for action at the global level led to a decision by the Fifteenth Session of the International Oceanographic Commission (IOC) Assembly in 1989 to develop the Global Ocean Observing System (GOOS). GOOS was subsequently co-sponsored by the World Meteorological Organization (WMO), and the United Nations Environment Programme (UNEP) with the aim of allowing a coordinated approach to the monitoring of physical, biological and chemical parameters of the ocean.

A UNEP-IOC-WMO Meeting of Experts on the Long-Term Global Monitoring System of Coastal and Near Shore Phenomena Related to Global Climate Change (1990), recommended that the monitoring and assessment of coral reef ecosystems be a pilot activity of GOOS. Following an action plan provided by the UNEP-IOC-WMO-IUCN Global Task Team on the Implications of Global Climate Change on Coral Reefs, standard procedures for monitoring coral reefs were defined. These methods are as described in UNEP (1993) and in the Survey Manual for Tropical Marine Resources (English et al. 1994). The task team emphasised that the development and instigation of a long-term monitoring programme for coral reef ecosystems will require the training of personnel from regional areas to standardise techniques used for monitoring coral reefs. This standardisation will allow reefs to be compared on a global scale.

Increasing recognition of the particular problems facing the sustainable development of coral reefs has led to the establishment of the International Coral Reef Initiative (ICRI). Announced at the Convention on Biological Diversity in December 1994, ICRI is aimed at maintaining the biological diversity, condition, resources and values of coral reefs and related ecosystems. The ICRI 'Framework For Action' research and monitoring component recognises the need for standardisation and promotes the development of a Global Coral Reef Monitoring network under the Coastal Zone Module of GOOS. The ICRI Pacific Regional Strategy was developed at a workshop in Suva, Fiji in late 1995 and published by SPREP in July 1996. The strategy builds on the ICRI 'Call to Action' and 'Framework for Action'. One of the issues arising from the workshop was "the lack of appropriate methods and standard techniques for surveys and monitoring". An action that evolved from this issue was to develop the capacity to conduct training within the region on resource assessment and monitoring; data management; analysis and interpretation; and reporting. In response, AIMS developed a training programme which directly addresses this issue and the action arising from the ICRI Pacific meeting.

As part of the pilot phase, coral reef monitoring activity of the GOOS module on Monitoring of Coastal Zone Environments and its Changes, a training course was held in Rarotonga, Cook Islands from 23 February to 13 March 1994, and conducted by staff from AIMS and the National University of Singapore (UNEP 1993). Co-sponsored by IOC-UNEP-SPREP, the course

trained participants from the Cook Islands, Fiji, Papua New Guinea and the Solomon Islands on the standard techniques required for monitoring coral reefs (UNEP 1993). The course was aimed at expanding each participating nation's data collection programme to include data in a standard format allowing global comparison of their coral reefs.

Recognising the ongoing need for regional capacity-building in coral reef survey methods and acting on a request from the Coastal Resources Management Office (CRMO), SPREP sought and received funding for a further workshop at Saipan, Commonwealth of the Northern Mariana Islands (CNMI), and as a result of the successful Cook Islands workshop, SPREP again requested AIMS to conduct the training.

Participants were instructed by trainers on the standard methods for coral reef resource assessment, compatible with the Global Coral Reef Monitoring Network (GCRMN) as defined by GOOS and recommended by ICRI. The course included participants from Saipan, Fiji, Papua New Guinea, Palau and Pohnpei. This report summarises the training course and includes recommendations for future training.

2 Objectives

The objectives of the SPREP-sponsored Coral Reef Monitoring course using a 'train the trainer' approach were:

(i) to train participants from Pacific island nations on standard methods adopted by UNEP-IOC-WMO-IUCN for assessing coral reef benthic communities;

(ii) to provide participants with a data base that conforms to the UNEP-IOC-WMO-IUCN standard and to emphasise the correct methods for data handling, storage and basic analysis;

(iii) to give participants a general background on other methods for monitoring coral reefs (i.e. reef fish populations and water quality parameters) and the relevance of monitoring techniques in the management of ecologically sustainable development of coral reefs; and

(iv) to refine training procedures for the global programme of monitoring coral reefs and to assess the effectiveness of training.

3 The Training Course

Training focused on the methods developed jointly within the ASEAN-Australia Living Coastal Resources Project and AIMS (English et al. 1994). Trainers Ian Miller and Debbie Bass, were selected from the AIMS Long Term Monitoring Program (Annex V includes a list of the trainers), Ian Miller had previous training experience from the Cook Islands training course.

The course structure involved an introduction to sampling and sampling design for coral reef ecosystems, the relevance of monitoring for management and general talks on the different types and reasons for monitoring. The course focused on the Line Intercept and Manta Tow techniques (English et al. 1994) for assessing benthic communities and on the use and design of data bases. These topics were emphasised in the classroom and reinforced through fieldwork and tutorials.

All lectures and tutorials were held at the Northern Mariana College which also provided a computing laboratory for data entry and analysis tutorials. The course benefited greatly from the cooperation of the College and particularly the staff of the Marine Technology Department who provided the classroom and organised the diving logistics. Diving equipment, tanks and the assistance of three dive masters were provided by this Department.

Field work was conducted at three sites, Lau Lau Reef, Ubyon Reef and Garapan Reef. The CRMO provided boats and drivers for the field work, organised transport to the dive sites, as well as organising the logistics for the course and providing office facilities for the trainers. The course outline is detailed in Annex II and a list of the training material is detailed in Annex III.

4 Outcome of Training

For monitoring to be successful, it is essential that trained observers are utilised in order to return the most precise information. This has been shown repeatedly through experiences gained in monitoring coral reefs in Southeast Asia and Australia. The levels of competence required to implement monitoring programmes successfully will vary with the methods used and the goals of the particular programmes. The methods selected

for this course (Manta Tow and Line Intercept Techniques) were chosen because a minimum level of competency can be achieved within a short time frame. Over the period of the course, some participants became more adept at applying the techniques than others, largely because of their prior experience in marine science. Therefore the levels of competence reported in this section are the levels achieved by the group as a whole.

4.1 Manta Tow Technique for the Broadscale Assessment of Coral Reefs

Lectures and field exercises were used to train participants in the Manta Tow Technique (see Annex II for more details). Four independent Manta Tow surveys of the same reef area using different trainee observers were used to compare observer performance. The comparisons showed similar estimates of coral cover (Table 1), the only exception was one pair of observers who initially overestimated dead coral cover with respect to the other groups. This problem was resolved by the trainer defining the difference between dead coral and substrate to the observers.

From Table 1, observers generally concurred on the levels of live coral, dead coral and soft coral. The ability of observers to detect crown-of-thorns starfish (COTS) remain unknown as none were seen on these reefs. All observers agreed that dead coral cover and soft coral cover were low. It is not known how precisely observers would assess communities with higher covers of these lifeforms.

Table 1. Results of four independent Manta Tow surveys of the same reef area using different trainee observers.

Reef	Median Live coral	Median Dead coral	Median Soft coral	No. of Crown-of-thorns	No. of Tows
Garapan	2	1	0	0	24
Garapan	3	3	1	0	20
Garapan	3	1	0	0	20
Garapan	3	1	1	0	24

Note: Coral cover is recorded under the following categories, 0=0%, 1= >0-10%, 2=11-30%, 3=31-50%, 4=51-75%, 5=76-100%

4.2 Line Intercept Technique for the Assessment of Benthic Communities

A total of four repeat surveys using paired observers randomly along different transects at each of two sites (Lau Lau and Garapan) were used to compare observer performance (see Annex II). At each site, 5 transects were laid down and the first 20 m of these transects surveyed. The site means are shown for each of the 4 surveys.

By the end of field training and lectures, all participants understood the mechanics of applying the Line Intercept Technique in the field. From Table 2, the second reef surveyed (Garapan Reef), showed less difference between the highest and lowest broad category percent covers (live coral, algae, abiotic, other). This indicated that the trainees have become more proficient with the technique. The percentage cover determined by the Line Intercept Technique at Garapan Reef also corresponds well to the estimates achieved by the Manta Tow observers (i.e. 30-50 per cent).

Table 2. Broad results for four independent surveys of two reefs using the Line Intercept Technique

Reef	Survey	% Hard coral cover ± se	% Algal cover ± se	% Abiotic ± se	% Other
Lau Lau	1	45.37 ± 5.14	46.69 ± 5.26	1.25 ± 0.96	6.70 ± 2.19
Lau Lau	2	36.21 ± 4.59	53.47 ± 5.17	2.16 ± 1.71	8.16 ± 2.77
Lau Lau	3*	57.19 ± 5.38	20.34 ± 1.28	1.11 ± 1.11	21.35 ± 6.01
Lau Lau	4	35.64 ± 3.54	55.24 ± 3.48	0.86 ± 0.46	08.27 ± 3.71
Garapan	1	34.41 ± 6.11	48.30 ±10.00	1.81 ± 1.32	15.50 ±10.58
Garapan	2	38.09 ± 4.19	53.78 ± 4.79	2.43 ± 0.75	5.69 ± 4.28
Garapan	3	40.23 ± 8.54	43.98 ± 5.97	1.96 ± 1.41	13.83 ± 9.95
Garapan	4	36.54 ± 4.89	55.45 ± 5.13	5.99 ± 2.84	2.03 ± 0.83

**Note: Results for the third survey at Lau Lau may not be representative of the other surveys at this reef as only three of the possible five transects were completed.*

Individual skill in the identification of benthic lifeforms was the limiting factor that dictated the taxonomic/structural level to which the technique was applied. All trainees applied the technique satisfactorily at the basic level presented here. However, from this training exercise, it is clear that most require more practise in order to be confident with the classification of benthic lifeforms.

All trainees could identify live coral in the field and make the distinction between Acropora and non-Acropora corals. However, at the next level of identification (lifeform), it still presented some difficulties which could be reduced through more practise and refining of lifeform definitions.

Unlike the distinct coral life-forms, algal cover is more difficult to define. Trainees clearly had problems distinguishing between the different algae lifeforms. This occurred mainly in defining an algal assemblage and the separation of turf algae from coralline algae. This is also an area where the definitions could be tighter to reduce confusion (AIMS is currently looking at ways to refine category definitions of algal life-forms, to solve this problem area). All trainees could identify the other life form categories without difficulty. These included: dead coral, dead coral with algae, *Millepora spp*, soft coral, zooanthids, other life forms, rubble, sand, water, sponge, silt, and rock. *Heliopora* was not encountered over the course of the training exercise although all observers were made aware of its existence.

4.3 Data base

Participants were instructed on the correct design and use of data bases. A software package, the ARMDES was developed at AIMS for the training course to simplify data entry and analysis. The software is based on Microsoft Access© and conforms to the data base structure in English et al. (1994). Participants were instructed on correct data entry procedures, checking data, backing up and storing data and simple interpretation of data using the ARMDES software package. All participants found the software easy to use despite their level of computing experience. By the end of the course all participants were conversant with the ARMDES software and could input, check and export data successfully.

5 Conclusions

At the conclusion of the course, all participants were familiar with the practical applications of the Manta Tow and Line Intercept Techniques. They understood how to set up sites for monitoring and had gained basic knowledge of the sampling designs for monitoring. They also gained a basic understanding of other techniques relevant to monitoring coral reefs which are applicable to the transect methods described during the course. These skills, combined with the ability to input, check, store and perform basic analysis on the data should enable participants to develop relevant monitoring programmes that describe the reefs in their region at the broad levels of live and dead

coral, algae and others. With the appropriate support, such programmes can be easily extended in breadth and detail as the relevant skills of the trainees increase through further training.

The results obtained from independent surveys of the same site at Garapan Reef showed good correspondence between trainees. However, this result masks individual bias among course participants, because all participants surveyed the two sites but were randomised amongst the transects. Once participants began conducting and instructing observers in their own monitoring studies, individual bias between different observers will become evident. As observers build up their identification skills these differences will tend to become more pronounced. For this reason, if the integrity of the global monitoring data base is to be maintained and enhanced so that comparisons can be made between regions on a global scale, there is a strong need for in-country follow up training. This training should be developed in order to standardise monitoring programmes between countries with respect to the observers, and to enhance existing in-country monitoring by transferring more specialised knowledge and techniques (e.g. visual census of reef fish populations and water quality monitoring) to selected personnel. Until such programmes are implemented and quality control procedures for data integrity are established on a regional basis, monitoring programmes at a regional scale can only be compared on a broad level.

6 Recommendations

6.1 Course Content

6.1.1 Manta Tow Technique

The level of competence required to use the Manta Tow Technique to provide a general description of a reef and site selection can be achieved in one to two days. All course participants were able to use Manta Tow for these purposes in the allocated time during the course. However, to monitor changes of benthic organisms on a reef, data from different observers must be similar. This is achieved by practising the technique and making comparisons between observers, until the results are standardised between the trainees and trainers. Following this training course, the trainees should be able to teach the technique to people in their country and set quality control procedures to maintain this standard. Unfortunately there was not enough time (in a 2 week course) to make observer comparisons and to standardise estimates. There were also different levels of experience and knowledge of coral reefs within the class, therefore some participants were more confident in applying the technique than others. This is a limitation of intensive training courses where several techniques and principles are taught to students with a wide range of previous experience.

The problem that may arise is that some participants may have difficulty teaching the techniques in the different reef environment of their home country on their own. Ultimately the goal of this training course is to train participants to a level where they are able to teach the techniques themselves. For trainees to become confident in teaching these techniques, it is recommended that a trainer initially assist with the training in the trainee's home country, ensuring the trainee has fully understood the technique and estimating benthic cover correctly when teaching others.

6.1.2 Line Intercept Technique

The course structure allowed one day for theory and background information; two days learning the lifeforms; and two days practising the technique. To improve the skill levels achieved at this basic training course, requires more time in the field practising the technique. However, field work was constrained by the time and the ratio of trainers to trainees. The initial proposal and recommendation from AIMS specified that 8 was the ideal maximum number of students for two trainers. With a larger group, the class was split into two, and each trainer worked with a group practising different techniques.

The data collected by the trainees should be compared with the trainers throughout the course. Given a class of 14 students and 2 trainers this was not possible, therefore the trainers could only assist the students where needed. Four trainees are a manageable number for each trainer, in this way, each trainer could work with two buddy pairs on a transect (one pair starting at 0 m and the other at the 20 m mark).

Several trainees expressed the need to have a reference handbook for identifying lifeforms. It is recommended that for future training courses, each trainee receive a reference book such as the *Indo-Pacific Coral Reef Field Guide* (Allen and Steene, 1994) prior to the course. This would help trainee

identify examples of other lifeforms in the different reef environments found in their own country. Trainees may find coral reefs in their country to have different varieties of lifeforms, therefore having the assistance of a trainer in their own country following the course is an important consideration for sorting out problem areas. Ongoing training schemes and quality control procedures can be developed with the assistance of an external trainer as mentor.

6.2 Logistics

Field tuition was not ideal because of the number of trainees involved. Working with a large group underwater is difficult because of the varying levels of dive experience and understanding of techniques between the trainees. Ideally diving groups should not exceed a ratio of four trainees to one trainer as it can result in inadequate field supervision. The course was fortunate to have the help of two dive masters from the Marine Technology Department of Northern Mariana College that supervised diving procedures.

A full list of equipment and logistics for the course are detailed in Annex III. The only problem trainees identified was a need for more reference material and course notes, particularly for the lectures that are not covered by English et al. (1994).

6.3 Requirements of Participants

Prior to the training course the following set of prerequisites were circulated to the participants. All participants met these standards.

Trainees should:

(i) be available for long-term involvement in the actual gathering of data on the status of coral reefs;

(ii) be relatively fit and qualified to scuba dive;

(iii) be in the position to train others in their country;

(iv) have some understanding of computers particularly Microsoft Windows©; and

(v) be proficient in English.

The other prerequisite which may have helped some trainees understand the lifeforms would have been a basic knowledge of reef biota. This could have been alleviated if a reference book was sent to them prior to the course. Alternatively, if the group was not familiar with reef biota, perhaps some basic marine biology could be incorporated into the first few days of the course.

Trainers should:

(i) have an understanding of the need for monitoring programmes at a national level and how these correspond to the global coral reef monitoring initiative of GOOS and the goals of ICRI;

(ii) have comprehensive training and experience in the Manta Tow, Line Intercept Technique and some background to the measurement of ambient water quality parameters;

(iii) have a working knowledge of Microsoft Access©, data base design, data management and be conversant with the ARMDES software;

(iv) for more advanced courses, have a knowledge of data analysis and interpretation; and

(iv) have good verbal communication skills.

6.4 Development of a Central Data base

Course participants were supplied with the ARMDES software developed by AIMS. This fixed format data entry programme ensured data were input and stored correctly. The format conforms to the data base structure in English et al. (1994), and also provides some basic analytical routines, which enhances timely reporting of results. However data bases in isolation do not allow data from different regions to be collated. Similarly, the expertise may not exist on a sub-regional scale for in-depth reporting and analysis of monitoring data.

To maintain the momentum of the global monitoring network, it is essential that a central data base be established (ICRI Pacific Regional Strategy 1995). This would provide a focus for reporting and the dissemination of data. It would also enable participating nations to interact with

the global programme and to keep abreast of future developments (e.g. improved software).

Such a central data base should have set procedures for the lodgement and analysis of data. Information from participating countries should be summarised and networked. Such a data base should have the dual role of a depository for all monitoring data collected using the standard techniques, and providing participating nations with updated data reports.

6.5 Future Training Courses

In order to return more detailed monitoring information using Manta Tow and Line Intercept Techniques, there is a need for most participants to improve their identification and practical skills. Initially, it involved spending more time in the field familiarising themselves with the benthic lifeforms and conditions of their local environment. It would also be helpful if participants could familiarise themselves with the fish species in their local area to enable them to incorporate reef fish into their monitoring programmes (subject to training). Similarly, participants should consider the hydrodynamic environment of the reefs in their region with the aim of adding some basic water quality parameters to their monitoring programmes.

To transfer more specialised knowledge to participating nations, it is essential that follow-up training be supplied in-country. The scope of training and the level of skill achieved by the trainees is not adequate after one short training course. Trainers should assume a 'mentoring' role and be available for ongoing consultation and assistance in running refresher courses and additional training courses as the trainees' skills are developed. Refresher courses will ensure that methodology and techniques remain consistent and enable new staff to be trained. This will require longer term funds to allow for necessary strategic planning to provide consistent high quality training with ongoing follow-up support.

To fine tune the global monitoring programme, trainees should have some basic training in the standard monitoring techniques (i.e. have attended a basic training course on standard monitoring techniques). These skills could then be applied to set up a preliminary monitoring programme in their own country. This could be achieved by firstly, setting up at least two permanent survey areas as a pilot scheme using standard techniques. A core group of staff (ideally four) should be selected to be responsible for monitoring. At this stage, experienced trainers could link up with this monitoring programme as technical advisers. They would help train the core personnel to a greater level of ability in survey design and technique, and offer advice on future research and monitoring.

By conducting further training in this way, many of the inevitable logistical problems will be addressed before the trainer arrives. This and the small number of people involved would allow for more intensive field based training. Through such a format, there is avenue for enhancing in-country monitoring through the addition of data on fish populations (using Visual Census Techniques) as well as relevant water quality parameters. Furthermore, experienced trainees will be confident to train additional personnel in their own country. Such a training format will enhance the capacity for island nations to monitor and manage their own coral reef resources.

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Annex 1: Course Outline

Day 1

0800-0900 Introduction to the course, presentation 1.
0900-1000 Sampling in the marine environment and the Point Quarter Method for determining coral cover (Prof. Charles Birkeland UOG), presentation 2.
1030-1130 Reef health assessment in Micronesia (Dr Bob Richmond UOG), presentation 3.
1300-1420 Sampling design for monitoring, presentation 4.
1440-1600 General discussion and video presentation on monitoring at AIMS.

Day 2

0900-1030 Introduction to the Manta Tow Technique, presentations 5, 6.
1100-1200 Introduction to the Line Intercept Technique, presentation 9.
1300-1430 Tutorial on life-form categories, presentation 10.
1500-1630 Discussion on site selection and sampling design.

Day 3

0800-0900 Organisation of field equipment and participants into two groups. Discussion of proposed dive plan.
0900-1200 Group 1: Field introduction to the Manta Tow Technique, presentation 7.
Group 2: Field tutorial on identification of benthic lifeforms, presentation 11.
1400-1700 Group 1: Field tutorial on identification of benthic lifeforms.
Group 2: Field introduction to the Manta Tow Technique.

Day 4

0800-0900 Review of major points from the previous days field activities. Discussion of proposed dive plan.
0900-1200 Group 1: Manta Tow field exercise, presentation 8.
Group 2: Field introduction to the Line Intercept Technique, presentation 12.
1400-1700 Group 1: Manta Tow field exercise.
Group 2: Field introduction to the Line Intercept Technique.

Day 5

Veterans Day. CNMI public holiday no classes held.

Day 6

0900-1000 General design for Data bases, presentation 14.
1000-1100 Revision of benthic lifeform identification.
1200-1400 Tutorial on installing and using the ARMDES software package.
1430-1530 Repeat of benthic lifeform identification, continued.
1600-1700 Data base entry and checking of data for the MTT.

Day 7

0800-0900 General discussion on the days activities and the proposed dive plan.
0900-1200 Groups 1 and 2 practical exercise on Line Intercept Technique, presentation 13.
1400-1500 Groups 1 and 2 practical exercise on Line Intercept Technique.

Day 8

0800-0900	General discussion on the days activities and the proposed dive plan.
0900-1200	Groups 1 and 2 practical exercise on Line Intercept Transect survey.
1400-1500	Groups 1 and 2 practical exercise on Line Intercept Transect survey.

Day 9

0900-1030	Monitoring, and management with regards to sustaining coral reef ecosystems presentation 15.
1030-1100	Collating data, brief discussion on filling in data sheets.
1200-1400	Data base entry and checking of data for the Line Intercept Technique.
1430-1530	General discussion on data management and quality assurance.
1600-1700	Data base entry and checking of data for the Line Intercept Technique.

Day 10

0900-1000	Water quality and monitoring coral reefs presentation 16.
1000-1100	Monitoring reef fish populations using the Visual Census Technique presentation 17.
1200-1400	Data analysis and presentation using the ARMDES software. General discussion of results.
1500-1600	Graduation ceremony.

Annex 2: Presentations

1. The AIMS Long Term Monitoring Program (Debbie Bass)

   The topics covered:

   (i) a general introduction and background on the Australian Institute of Marine Science (AIMS);
   (ii) the reasons behind the implementation of the AIMS Long Term Monitoring Program (LTMP);
   (iii) a background on the AIMS LTMP;
   (iv) the objectives of the AIMS LTMP;
   (v) the basic sampling design for the AIMS LTMP;
   (vi) what is monitored by the AIMS LTMP;
   (vii) methods employed by the AIMS LTMP;
   (viii) a brief discussion on some of the results obtained by the AIMS LTMP;
   (ix) the importance of data quality assurance;
   (x) examples of inter-observer comparisons made by the AIMS LTMP as a means for quality assurance;
   (xi) the international links between AIMS and other organisations;
   (xii) the importance of training to monitoring; and
   (xiii) future directions.

2. Sampling in the Marine Environment (Professor Charles Birkeland)

   A general talk on sampling for marine field experiments. Particular reference was given to the fact that the type of sampling methodology used can strongly influence the results of an experiment. This factor must be considered when interpreting data. Time was also given to detailing the Point Quarter Technique as an alternative method for determining coral cover.

3. Reef Health Assessment and Monitoring in Micronesia (Dr Bob Richmond)

   A general look at the cultural, fiscal and ecological value of coral reefs in Micronesia. The main focus of the talk was on their ecological development in the face of human and natural impacts with special reference to the recruitment of corals.

4. Sampling Design for Monitoring (Ian Miller)

   Based on Oxley 1994.

   Topics covered:

   (i) reasons for monitoring programmes;
   (ii) the importance of sound planning before implementing a monitoring programme;
   (iii) defining objectives;
   (iv) determining which objectives can realistically be met;
   (v) considerations of scale and sampling;
   (vi) identifying important sources of variation;
   (vii) factors that can effect type and abundance of target organisms;
   (viii) determining which sources of variation can be incorporated into the sampling design;
   (ix) advantages of narrowing the questions being asked;

(x) importance of replication;
(xi) site selection;
(xii) importance of pilot studies;
(xiii) observer bias and the importance of training and standardising of observer estimates, traps for the unwary such as confounding and pseudo-replication; and
(xiv) data input, storage and analysis.

5. Introduction to the Manta Tow Technique (Ian Miller)

Based on Chapter 2.2 (English et al. 1994) and Bass and Miller 1995. Special emphasis was given to the following points:

(i) MTT is particularly useful for the large scale assessment of coral reefs as well as for site selection for more detailed studies using LIT and VCT;
(ii) advantages and disadvantages of the technique;
(iii) the importance of training and standardisation of observers;
(iv) correct equipment and procedure;
(v) safety considerations;
(vi) the need to read a chart so that the location of Manta Tow surveys can be reliably identified in order to compare data from repeat surveys; and
(vii) correct methods of data recording, entry and checking.

6. Manta Tow Variables (Ian Miller)

This was designed to familiarise trainees with the visual signals associated with Manta Tow surveys and emphasised:

(i) some general causes of coral mortality and the appearance of dead coral;
(ii) *Acanthaster planci* Crown-of-thorns starfish, feeding scars;
(iii) *Acanthaster planci* and a brief overview of its biology;
(iv) identifying live coral; and
(v) identifying soft coral.

7. Field introduction to the Manta Tow Technique

Two boats were available for Manta Tow training. Both training sessions took place at Garapan Reef. The first session involved all participants towing for five tows with an instructor on the two person manta board. At the end of each two minute tow, both trainee and instructor recorded their results independently before comparisons were made. A brief discussion occurred in situ on possible reasons for any discrepancies and general points about recording data using the Manta Tow Technique. Participants also practised the use of the single manta board from the second boat while the more formal training was in progress.

8. Manta Tow Field Exercise

The second session involved observer comparisons from independent Manta Tow surveys of the same area at Garapan Reef. Course participants were divided equally between the two boats. Under supervision, participants towed the reef section as would normally be the case during Manta Tow surveys. Results were then compared.

9. Introduction to the Line Intercept Technique (Debbie Bass)

Based on Chapter 2.3 (English et al. 1994) and Christie et al. 1996. This introductory lecture covered the following topics:

(i) background of the technique;
(ii) advantages and disadvantages of the technique;
(iii) examples of similar techniques for describing benthic communities;
(iv) sampling design considerations (size, number and permanent/random transects);
(v) observer differences;
(vi) description of the line intercept technique;
(vii) video transects; and
(viii) comparison of the video transect and LIT techniques.

10. Tutorial on Lifeform Categories (Ian Miller)

This presentation was designed to familiarise course participants with typical benthic lifeforms encountered when using the LIT. Special emphasis was given to:

(i) identification and definition of dead coral, possible cases of coral mortality and the phenomenon of coral bleaching;
(ii) identifying Acropora corals;
(iii) identifying non-Acropora corals and general hints for classifying often confused lifeforms; and
(iv) identifying types of algal cover.

11. Field Tutorial on the Identification of Benthic Lifeforms

This exercise took place at Lau Lau Reef, where access was from the beach. All participants were provided with a slate and an underwater guide to benthic life forms taken from UNEP 1993. Trainees were asked to point out lifeforms they had difficulty with and the instructor would advise them on the proper classification. The instructor also pointed out benthos of interest and its proper classification to the trainees. In a one hour dive, all classes of benthic organism were recorded with the exception of Heliopora, Acropora submassive and non-Acropora branching coral.

12. Field Introduction to the Line Intercept Technique

The first group dived at Ubyon Reef, however for safety reasons, the afternoon session took place at Lau Lau Reef. At the site, the instructor laid down two parallel 20 m transects. Course participants surveyed each of these transects independently under supervision. Where participants encountered difficulty with identification of lifeforms they were aided by the instructor who also advised on correct methodology for recording data.

13. Practical Exercise on Line Intercept Technique

Two sessions were used to make inter-observer comparisons. The first session was at Lau Lau Reef and the second at Garapan Reef. In each case the instructors laid down five, 50 m transects. Two boats were used for diving at Garapan reef. Participants were paired off, with each pair responsible for surveying one, 20 metre section of the transect under supervision. The instructors observed participants performance and provided assistance with identification where necessary. Comparisons between observer observations and instructors were not made due to the high trainee to instructor ratio. Only four transects were surveyed at Garapan reef because of absenteeism.

14. General Design for Data bases (Debbie Bass)

Based on Bainbridge and Baker 1994.
This introductory lecture covered the following topics:

(i) why use a data base?;
(ii) guidelines for designing a Data base;
(iii) linking tables;
(iv) code tables;
(v) data base management; and
(vi) documentation of the data base.

15. Monitoring and Management with regards to Sustaining Coral Reef Ecosystems (Ian Miller)

An introduction to the role of management in the conservation of coral reef ecosystems and the importance of monitoring for informed management. Major points covered included:

(i) introduction and general background on the natural variability in the coral reef environment;
(ii) rationale behind the design and establishment of managed marine areas;
(iii) management processes and frameworks for action;
(iv) management in the context of coral reef ecosystems;
(v) typical inputs to reef systems;
(vi) the effect of uncertainty on management;
(vii) operational definitions of monitoring programmes for management;
(viii) the role of monitoring in managed marine areas;
(ix) the design of monitoring programmes in light of management considerations; and
(x) basic guidelines for monitoring programmes for management.

16. Water Quality and Monitoring Coral Reefs (Ian Miller)

Based on Devlin and Lourey 1996.

A background on how the biophysical characteristics of the water column strongly influence the growth and development of the coral reef ecosystem. Identifying typical water quality parameters, how they are measured and what they imply about the waters surrounding a reef. Major topics included:

(i) introduction and rationale;
(ii) sampling design for measuring water quality parameters;
(iii) problems associated with water quality monitoring;
(iv) sampling methods;
(v) sampling considerations;
(vi) typical water quality parameters measured in sampling schemes;
(vii) typical nutrients;
(viii) parameters measured by the AIMS LTMP; and
(ix) quality control and the importance of blanks and standards.

17. Coral Reef Fish Visual Census Technique (Debbie Bass)

Based on chapter 2.5 (English et al. 1994) and Halford and Thompson 1994.

(i) importance of reef fish;
(ii) techniques to estimate fish abundance;
(iii) advantages of visual census;
(iv) disadvantages of visual census;
(v) types of visual census;
(vi) general belt transect technique;
(vii) considerations whilst counting;
(viii) observer standardisation;
(ix) observer comparisons; and
(x) data entry and analysis.

Annex 3: Equipment and Logistics

Equipment and Logistics supplied by CRNMI

(i) Classroom, including slide projector and white board;
(ii) Computer room including six PCs capable of running the ARMDES software;
(iii) Dive store, including tanks, airfills and spare dive equipment;
(iv) Dive masters;
(v) Two boats and crew; and
(vi) Office facilities, including phone, fax, photocopier, P.C. and printer.

Equipment and Logistics supplied by AIMS

(i) Four manta boards and tow ropes;
(ii) Twelve copies of Survey Manual for Tropical Marine Resources (English et al. 1994);
(iii) Twelve underwater slates including pencils;
(iv) One hundred data sheets for MTT and LIT;
(v) Twelve copies of the ARMDES software and manuals;
(vi) Four Corals of Australia and the Indo-Pacific (Veron 1993);
(vii) Nine Indo-Pacific Coral Reef Field Guide (Allen and Steene 1994); and
(viii) Ten AIMS Standard Operational Procedures.

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