REGIONAL SEAS

UNITED NATIONS ENVIRONMENT PROGRAMME

APRIL 1993

In association with:

AUSTRALIAN INSTITUTE OF MARINE SCIENCE

Monitoring coral reefs for global change

Reference Methods For Marine Pollution Studies No. 61

Prepared in cooperation with:

LCR ASEAN AIDAB IOC IAEA

UNEP 1993

NOTE: This document was prepared as a consequence of the UNEP-IOC-WMO-IUCN Meeting of Experts on a Long-Term Global Monitoring System of Coastal and Near-Shore Phenomena Related to Climate Change, Pilot Projects on Mangroves and Coral Reefs, Monaco, 9-13 December 1991 (UNEP-IOC-WMO-IUCN/GCNSMS-II/3). The meeting agreed to adopt the methods and protocols of the ASEAN-Australia Marine Science Project: Living Coastal Resources (LCR) which were developed under funding from the Australian International Development Assistance Bureau (AIDAB).

This compilation has been prepared in cooperation between the ASEAN-Australia Living Coastal Resources project (LCR), the International Atomic Energy Agency (IAEA), the Intergovernmental Oceanographic Commission (IOC) of Unesco and the United Nations Environment Programme (UNEP) under project FP/5102-88-03.

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PREFACE

The Regional Seas Programme was initiated by UNEP in 1974. Since then the Governing Council of UNEP has repeatedly endorsed a regional approach to the control of marine pollution and the management of marine and coastal resources and has requested the development of regional action plans. The Regional Seas Programme at present includes ten regions and has over 120 coastal States participating in it (1),(2).

One of the basic components of the action plans sponsored by UNEP in the framework of the Regional Seas Programme is the assessment of the state of the marine environment and of its resources, and of the sources and trends of the pollution, and the impact of pollution on human health, marine ecosystems and amenities. In order to assist those participating in this activity and to ensure that the data obtained through this assessment can be compared on a world-wide basis and thus contribute to the Global Environment Monitoring System (GEMS) of UNEP, a set of Reference Methods and Guidelines for marine pollution studies is being developed as part of a programme of comprehensive technical support which includes the provision of expert advice, reference methods and materials, training and data quality assurance (3). The Methods are recommended to be adopted by Governments participating in the Regional Seas Programme.

The methods and guidelines are prepared in co-operation with the relevant specialized bodies of the United Nations system as well as other organizations and are tested by a number of experts competent in the field relevant to the methods described.

In the description of the methods and guidelines the style used by the International Organization for Standardization (ISO) is followed as closely as possible.

The methods and guidelines, as published in UNEP's series of Reference Methods for Marine Pollution Studies, are not considered as final. They are planned to be periodically revised taking into account the development of our understanding of the problems, of analytical instrumentation and the actual need of the users. In order to facilitate these revisions the users are invited to convey their comments and suggestions to:

Marine Environmental Studies Laboratory
IAEA Marine Environment Laboratory
BP. No. 800
MC 98012, MONACO

which is responsible for the technical co-ordination of the development, testing and intercalibration of Reference Methods.

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(1) UNEP: Achievements and planned development of the UNEP's Regional Seas Programme and comparable programmes sponsored by other bodies. UNEP Regional Seas Reports and Studies No. 1 UNEP, 1982.

(2) P. HULM: A Strategy for the Seas. The Regional Seas Programme: Past and Future, UNEP 1983.

(3) UNEP/IAEA/IOC: Reference Methods and Materials: A Programme of comprehensive support for regional and global marine pollution assessments. UNEP 1990.

The present manual was designed as a practical output of recent international meetings organised by UNEP as a response to the potential threats of climate change to coastal resources. A detailed report on the potential effects of climate change on the South Pacific was prepared by UNEP in 1990 (4). This reported the work of a task team of experts formed by OCA/PAC and the Association of South Pacific Environmental Institutions (ASPEI). Subsequently, UNEP, the Intergovernmental Oceanographic Commission (IOC) of Unesco, the World Meteorological Organisation (WMO) and the International Union for the Conservation of Nature and Natural Resources (IUCN) strongly recommended that a global programme for monitoring of coral reefs be established without delay. In December 1991, a meeting of experts (UNEP-IOC-WMO-IUCN/GCNSMS-II/3) selected the methods and protocols developed by the ASEAN-Australia Marine Science Project: Living Coastal Resources, for use in a global monitoring programme on coral reefs (5). A pilot phase programme to monitor the effects of climate change on coral reefs has been included as an integral part of the Global Ocean Observation System (GOOS, IOC Resolution XVI-10) - an initiative jointly sponsored by IOC, UNEP and WMO. The methods included in the present manual will form the basis tools for the implementation of this programme.

This document was compiled and edited by Susan English of the Australian Institute of Marine Science as part of a revised edition of survey methods used by the ASEAN-Australia Marine Science Project: Living Coastal Resources. Illustrations were prepared by Bevon Peddell.

ACKNOWLEDGEMENTS

The following people contributed significantly to the development of these methods: Members of the LCR management committee, particularly - Suraphol Sudara, Chairman (Thailand); Edgardo Gomez and Angel Alcala (Philippines); R. Soekarno (Indonesia); Chou Loke Ming and Khoo Hong Woo (Singapore); Ridzwan Abdul Rahman and Mohd. Ibrahim B. Hj. Mohamed (Malaysia). Staff at the Australian Institute of Marine Science (past and present), particularly - Kevin Boto, Roger Bradbury, Russel Reichelt, Craig Mundy, Peter Moran, Scott Bainbridge, Christine Cansfield-Smith, Martin Jones, Alan Dartnall and Don Kinsey. The participants in the project have tested and fine-tuned the methods used by the LCR project and a special acknowledgement is reserved for their tireless efforts.

The publishers (UNEP) wish to express their thanks to Clive Wilkinson of AIMS for coordinating this work on behalf of the international organisations.

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(4) UNEP: Implications of expected climate changes in the South Pacific region: an overview (Pernetta, J.C. and Hughes, P.J., Eds.) - UNEP Regional Seas Reports and Studies No. 128. UNEP, 1990.

(5) DARTNALL, A.J. and JONES, M. (Eds.). A Manual of Survey Methods for Living Resources in Coastal Areas.. Australian Institute of Marine Science, 1986.

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1. GENERAL INTRODUCTION

Coral reefs are economically vital to many developing countries in the tropics, providing an essential source of protein for the growing populations, and income through the tourism industry. Predictions that 70% of the world's coral reefs will collapse in the next 10 to 40 years, with the remainder threatened by global climatic change (Wilkinson, C.R. 1993. Proceedings 7th International Coral Reef Symposium, University of Guam, Mangilao, in press), threaten the viability of coral reefs as economic components of these countries, and the quality of life of the peoples supported by these resources.

The development and growth of coral reefs are closely controlled by environmental factors impacting on the atmosphere, the oceans and the adjacent land masses, and any localised or global changes in these factors will affect coral reefs. Therefore, it is essential that possible changes in coral reefs be monitored as soon as possible for the effects of climate change.

While climate-induced changes to coral reefs are likely to be gradual and imperceptible in the short term, their effects may be irreversible and catastrophic in the longer term. In order to detect changes in ecosystems which have a high degree of natural variability, long-term monitoring programs must be established over broad geographical (global) scales. With a better understanding of the natural fluctuations in the system, it will be possible to discriminate between the effects of global climate change and anthropogenic stresses, such as pollution, over-exploitation and sedimentation. A global monitoring system must have the ability to detect change and to identify questions which require closer examination. All the baseline data must be collected in the same way from all monitoring sites to ensure that comparisons are possible.

The methods in this handbook are recommended for gathering baseline data to monitor coral reefs for the effects of global climate change and other impacts. They have been specifically selected to be easily repeatable, and they use inexpensive, accessible equipment. While these methods are the minimum requirement for data collection, it is both possible and desirable to expand the methods to provide a more detailed analysis of the resources.

The methods were developed through a collaborative project between scientists from five ASEAN countries (Indonesia, Malaysia, the Philippines, Singapore and Thailand) and from the Australian Institute of Marine Science. This collaboration was begun in order to assess the extent and degradation of the living coastal resources of these countries. The ASEAN-Australia Marine Science Project: Living Coastal Resources has continued to monitor and research the coastal resources of the region since 1984, and has developed a large regional database.

Before choosing reefs for routine monitoring for the effects of global climate change and anthropogenic disturbance, the following set of criteria should be considered:

Selecting reefs

- Reefs chosen should be as isolated from other influences as possible. Select a reef site that is remote from land-based pollution and not heavily exploited, particularly by destructive methods.

- Countries participating in the monitoring should, where possible, compare reefs at several remote sites as well as some reefs that are affected by other influences (such as pollution, land runoff).
- Reef sites can either be close to land, to detect adjacent land influences as a result of climate change effects and/or the reef sites can be oceanic in nature to detect ocean influences only.
- Where possible, several sites should be chosen to encompass a range of latitudes. That is, select sites at the northern and southern extremities of the countries.
- It would be a distinct advantage if data are available from current meters and weather stations.

Selecting sites

- Once a reef is chosen, it is essential to select sites for the study that are representative of the reefs in the region.
- Study sites should be chosen after an extensive survey of large areas of the reef to select sites that are representative of the reef communities. The Manta Tow technique is useful for site selection.
- Study sites should be marked on maps or aerial photographs so that relocation of the site is possible. This is easier if the sites are near prominent land or reef features.
- The sites should be marked by stakes or subsurface buoys. Surface markers rarely survive for more than a few months because of removal by visitors or storm action.
- The surveys should be completed on the fore-reef slope, however, useful inter-reefal comparisons may be made if other habitats are also chosen e.g. reef flat locations or back-reef sites.
- Where possible the reef slope should gradually drop away to more than 10 metres depth so that transects can be completed at both 3 meters and 10 metres.
- It is an advantage if study sites are close to research facilities or marine laboratories, when temporal data collection is being conducted so that repeated visits are facilitated. The collaboration of tourist or dive operators may assist in observing unusual events at the study site e.g. bleaching.
- Training in the application of methods is an important prerequisite of data collection and should be repeated regularly to ensure standardisation of the methodology throughout the monitoring period. Trial runs with all components of the study including data entry and analysis are essential before full implementation of the monitoring scheme.
- Countries should hold workshops on the methods to extend the group of people who are able to monitor reefs.
- It is important that all components of the monitoring programme be standardised around the world to ensure that cross-comparisons are valid. Participants should use the standard data entry format and transmit data immediately to regional and global databases.

Clive Wilkinson,
(Chief Technical Adviser, ASEAN-Australia Living Coastal Resources project)

2. MEASUREMENT OF AMBIENT ENVIRONMENTAL PARAMETERS

Introduction

All surveys of living resources of coral reefs should include environmental parameters which characterise the conditions at the site when the data were collected. The parameters to be included with the survey methods described in this handbook have been selected because they are important to the 'health' of the reef and they do not require expensive, sophisticated equipment. The environmental parameters that should be measured are: temperature, salinity, light penetration, cloud cover and wind. These parameters, together with data on the benthos and fishes, characterize a particular reef site/zone. The recommended equipment is easily obtained and will provide standardised measures in all countries.

Logistics

Equipment

- Mercury thermometer enclosed in a protective casing - used to measure temperature with an accuracy of 0.5 degrees Celsius.
- Refractometer - used to determine salinity (Fig. 1).

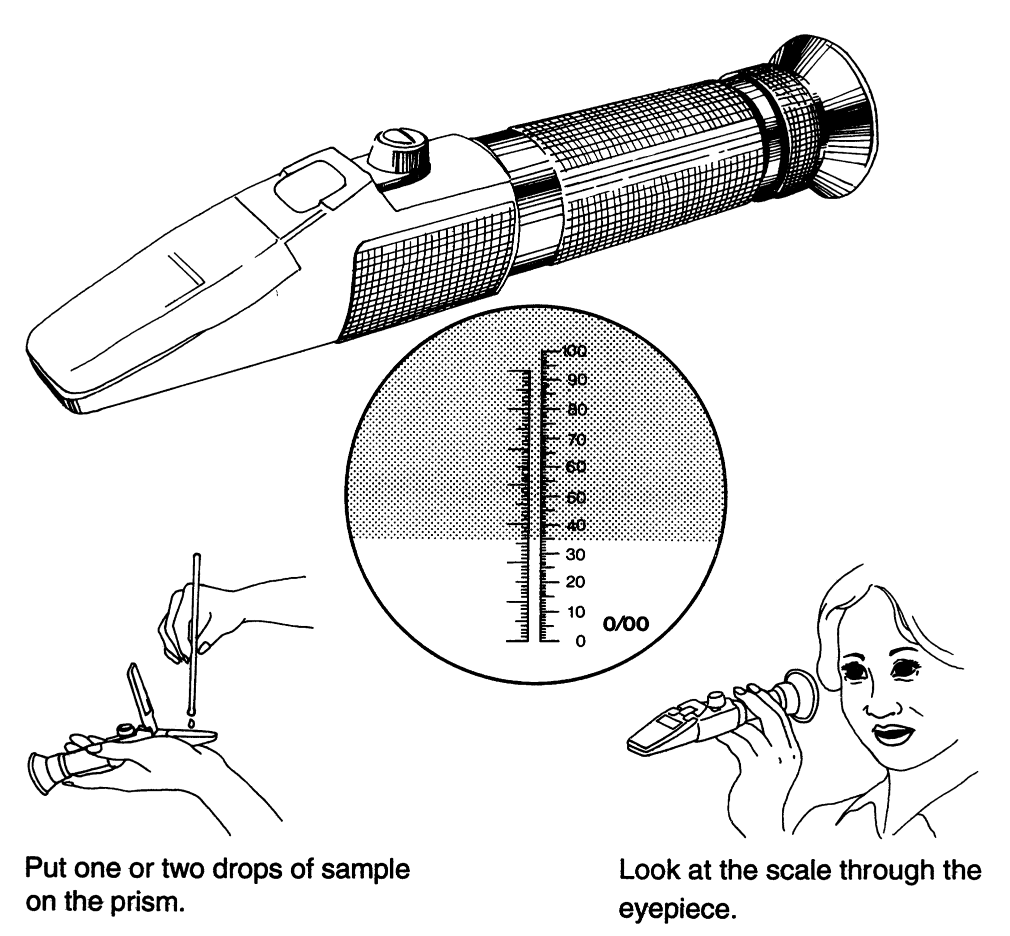

Figure 1. A diagram of a refractometer showing its use for measuring salinity.

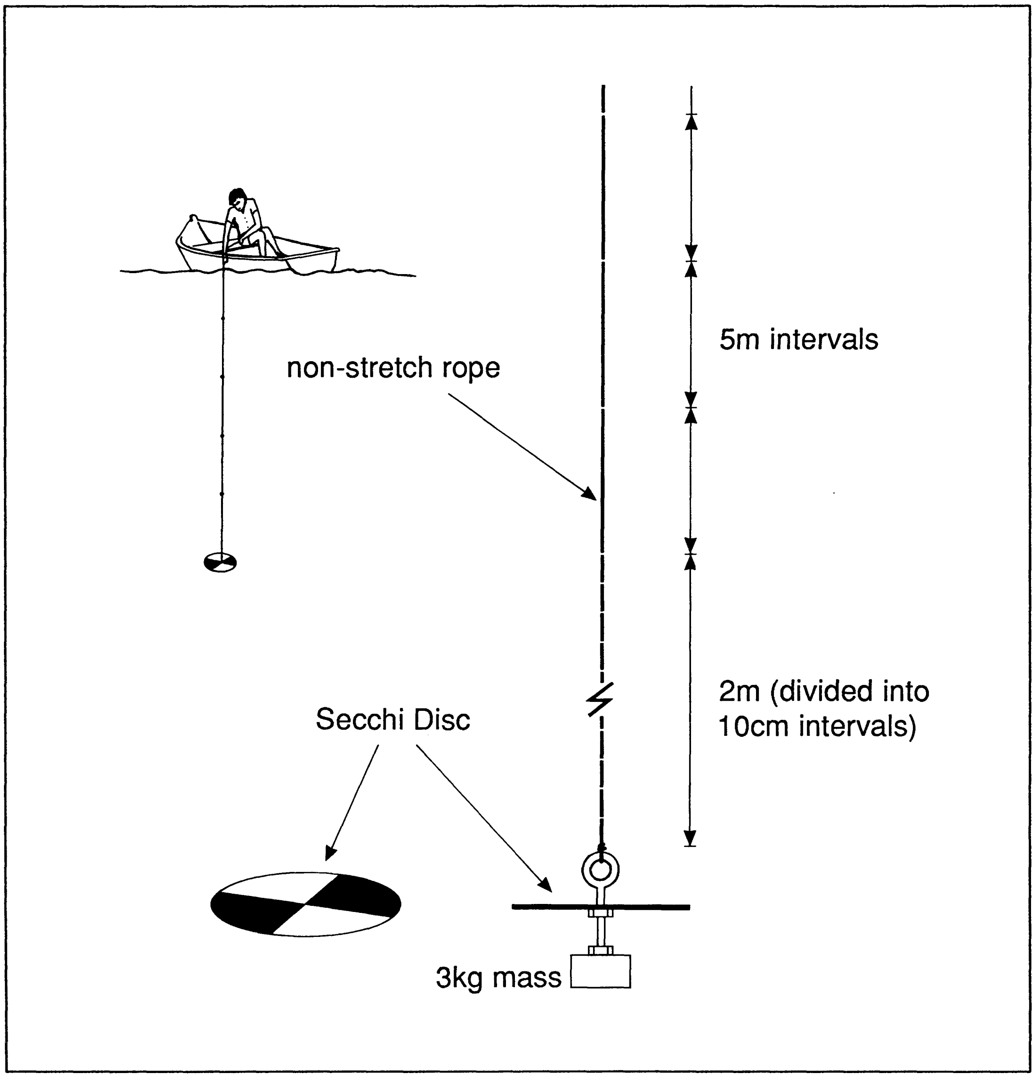

Figure 2. Diagram of secchi disk showing its use.

- 10 millilitres plastic vials/bottles (tight-sealing) - used to collect water samples for salinity measurements.
- Secchi disc - this is 30 centimetres in diameter and divided into 4 quarters alternating black and white in colour (Fig. 2).
- A portable light meter - used to determine the turbidity and light penetration of water in the study area (Fig. 3). A model widely used for surveys conducted as part of the ASEAN-Australia project is the LI-COR® 1000 quantum meter with an underwater quantum sensor.

Maintenance

- Rinse all equipment with freshwater after use.
- Pay special attention to the photocell of the light meter to ensure that saltwater does not splash onto the main console. Care should also be taken to avoid scratching the surface of the cell.
- The glass cell and cover of the refractometer should be rinsed carefully after use (with distilled water if possible) and then wiped dry with tissue paper.
- Store the refractometer in its protective box/bag when not in use.

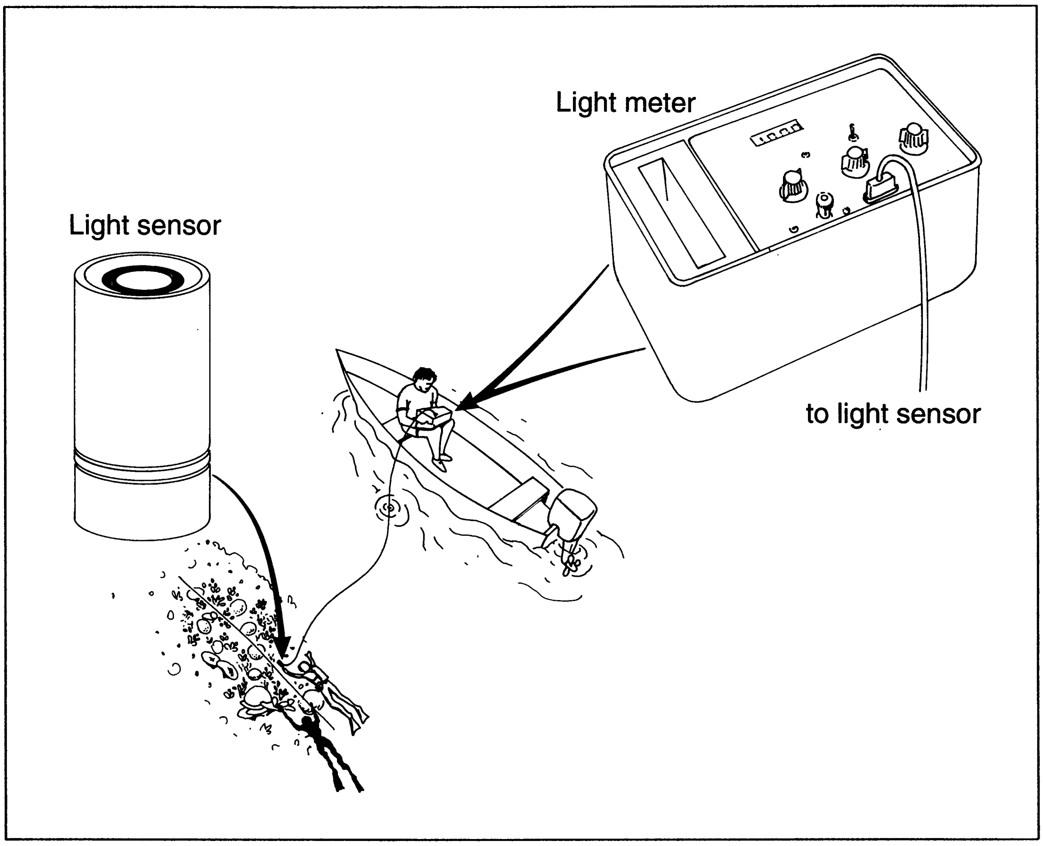

Figure 3. The sensor is held at the required depth while the light level measurements are recorded from the meter on the boat.

General procedure

Temperature

- Take the readings before commencing transects.
- Read the thermometer in the water just below the surface (30 centimetres) and at the depth of the transects ('transect depth').
- When thermoclines are encountered take a series of measurements, recording the depth and the temperature.

Salinity

- Obtain water samples at the surface and at 'transect depth' using small plastic vials. These samples are taken back to the shore for measurement using a refractometer. Put a small sample of water under the cover. Hold the cover down and looking through the eyepiece, face the instrument to the light so that the salinity can be read (Fig. 1).
- A series of salinity measurements should be made at sites near freshwater discharge to determine the extent of any gradient in salinity caused by the freshwater input.

Visibility

- Use the Secchi disc to measure vertical visibility in deeper water. The disc is attached to a weighted rope which is marked at intervals along its length. Lower the disc until you can no longer see it, then pull it slowly back toward the surface until it is just visible. Record the distance to the disc from the marks on the rope (Fig. 2).

- Make the measurements with the Secchi disc on a clear day, within 2 hours before or after noon. If cloud cover does not allow measurement, then the cloud should be recorded in oktas (See the Manta Tow Survey, Fig. 12).
- A light meter should be used to determine the amount of light penetration (at the depth of the transect) in situations when the Secchi disc is not appropriate, i.e. the water is shallow water or very clear. An underwater sensor is taken to the desired depth and the light level is read from the meter, which is in the boat (Fig. 3).

Data recording

- Ambient environmental parameters are measured for each set of manta tows and for each set of transects. The environmental parameters measured in conjunction with each of these survey methods may differ.

Data processing

- At the end of each day the data should be entered into the database using the structure described in Appendix I.
- The sample table (XXCRSAMP.DBF) contains a description of the data collected in each sample and indicates the type of data collected in that sample. Ambient data is denoted by a DATA_TYPE of "A".
- Every sample taken has a unique sample identifier (SAMPLE_ID).
- The ambient data are entered into the data table (XXCRADAT.DBF) using the sample identification allocated in the sample table.

Note: While the ambient environmental parameters are collected in conjunction with survey methodologies such as manta tow, the ambient table is not linked to that data in the relational design. Ambient data has its own sample_id and is connected to the survey data (e.g. manta tow) by common records such as the location, reef name, date, latitude and longitude.

Suggested reading

UNEP/IAEA/IOC 1991. Standard chemical methods for marine environmental monitoring. Reference Methods for Marine Pollution Studies No. 50. UNEP, Nairobi.

3. MANTA TOW SURVEY

Introduction

The manta tow technique is used to assess broad changes in the benthic communities of coral reefs where the unit of interest is often an entire reef, or large portion thereof. It enables visual assessment of large areas of reef within a short time and is highly recommended for determining the effects of large-scale disturbances such as those caused by cyclonic storms, coral bleaching and crown-of-thorns starfish (COTS). The technique is also useful for selecting sites that are representative of large areas of reef.

The technique involves towing an observer, using a rope and manta board, behind a small boat powered by an outboard motor. Tows are carried out at a constant speed around the perimeter of a reef and are broken into units of 2 minutes duration. During each 2-minute tow, observations are made on several variables (e.g. percent cover of live coral, dead coral and soft coral). These are recorded onto data sheets as categories or integer values. Additional information may be collected, dependent on the survey objectives, e.g. percent cover of sand and rubble, and numbers of Tridacnid clams, *Diadema* or COTS. However, Fernandes (1989), cautions against recording data on too many variables, and the technique is not recommended for fish counts.

The method described in this manual is not only useful for assessing the distribution and abundance of corals, but is also widely used for the study of COTS. Details of the COTS assessment have been included because of the extensive destruction to many reefs in the Indo-Pacific which has been caused by these starfish. The technique may also be used to assess other organisms of particular interest to a survey region, however, it should be noted that estimates of the accuracy and precision of the technique have only been made in relation to coral cover and COTS (Kenchington and Morton 1976; Fernandes 1989, 1990; Fernandes 1990, in press; Moran and De'ath 1992).

Background

In general, the manta tow technique has been used to investigate issues at a broad level (Kenchington 1978). Since Chesher's study (1969) to assess the effects of COTS on coral reefs in Micronesia, similar surveys have been conducted on reefs within the Red Sea (Roads and Ormond 1971) and the Great Barrier Reef (GBR) (Endean and Stablum 1973; Moran *et al.* 1988). The technique has also been used for more general, broadscale surveys of coral reef systems (Done *et al.* 1982; Kenchington 1984).

While manta tow techniques have been used extensively since the early 1970's, the details of the method have varied between the different studies (Kenchington 1975; Kenchington and Morton 1976; Done *et al.* 1982; Nash and Zell 1982; Kenchington 1984). Work by Moran *et al.* (1988, 1989) to assess the broadscale distribution and abundance of COTS and their effect on the GBR has greatly refined the technique.

More recently, studies have focussed on the precision of the manta tow technique for estimating coral cover and COTS abundance (Fernandes 1989, 1990; Fernandes *et al.* 1990, 1992; Moran and De'ath 1992). These studies have shown the technique to be particularly useful for assessing broad changes in the distribution and abundance of coral cover (especially live coral) and COTS. The studies also show that, despite under-estimating the number of COTS, manta tow counts could be calibrated to predict estimates that would be obtained from SCUBA swim surveys. Over the same sized area the latter are more accurate, however the manta tow technique surveys a far greater area than that possible by SCUBA swims. Hence, the combined information from a relatively large number of tows can give more accurate estimates of abundance when the spatial distribution of the target organism is highly variable (e.g. COTS), and the unit of interest is the whole reef. A typical manta tow survey (of approximately 50-60 tows) is capable of detecting a 20% change in the abundance of an outbreaking population of COTS (Moran and De'ath 1992).

Logistics

Personnel

- Manta tow surveys are conducted by teams of 1 or more pairs of trained personnel. The duties of the team are divided between the boat driver and the observer. See notes in the "Standardisation" section for details of training.
- Each series of manta tows is coordinated by a leader who is responsible for ensuring that the technique is conducted in a standardised way, for determining when conditions are appropriate for surveying, and for the safety of personnel.

Equipment

- A small boat with an outboard motor is used for towing observers. The boat should be fitted with a towing bridle.
- A 17 metre tow rope connects the manta board to the boat (Fig. 4). The rope should be braided and approximately 10 mm in diameter (polyethylene ski-rope is recommended). Two buoys are placed on the rope, one at 6 metres from the manta board, and the other at 12 metres. These buoys allow the observer to estimate visibility in a standard manner.
- The dimensions of the manta board (Fig. 5) are 600 x 400 x 20 mm (length x breadth x thickness). It is recommended that the board be made from marine ply and painted white. Two indented handle grips are positioned towards each corner of the front of the board. A single handhold is located centrally at the back of the board.

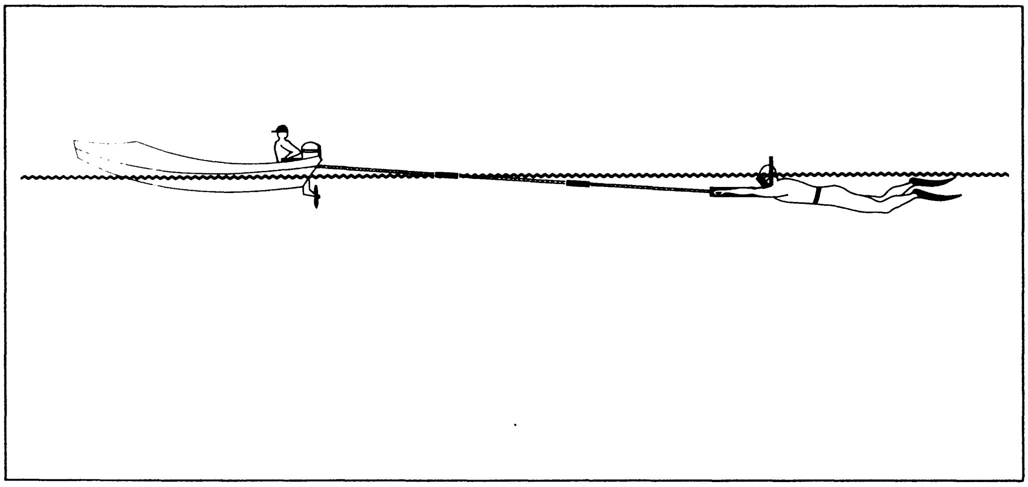

Figure 4. The manta tow technique showing the observer being towed along the surface of the water behind a small boat.

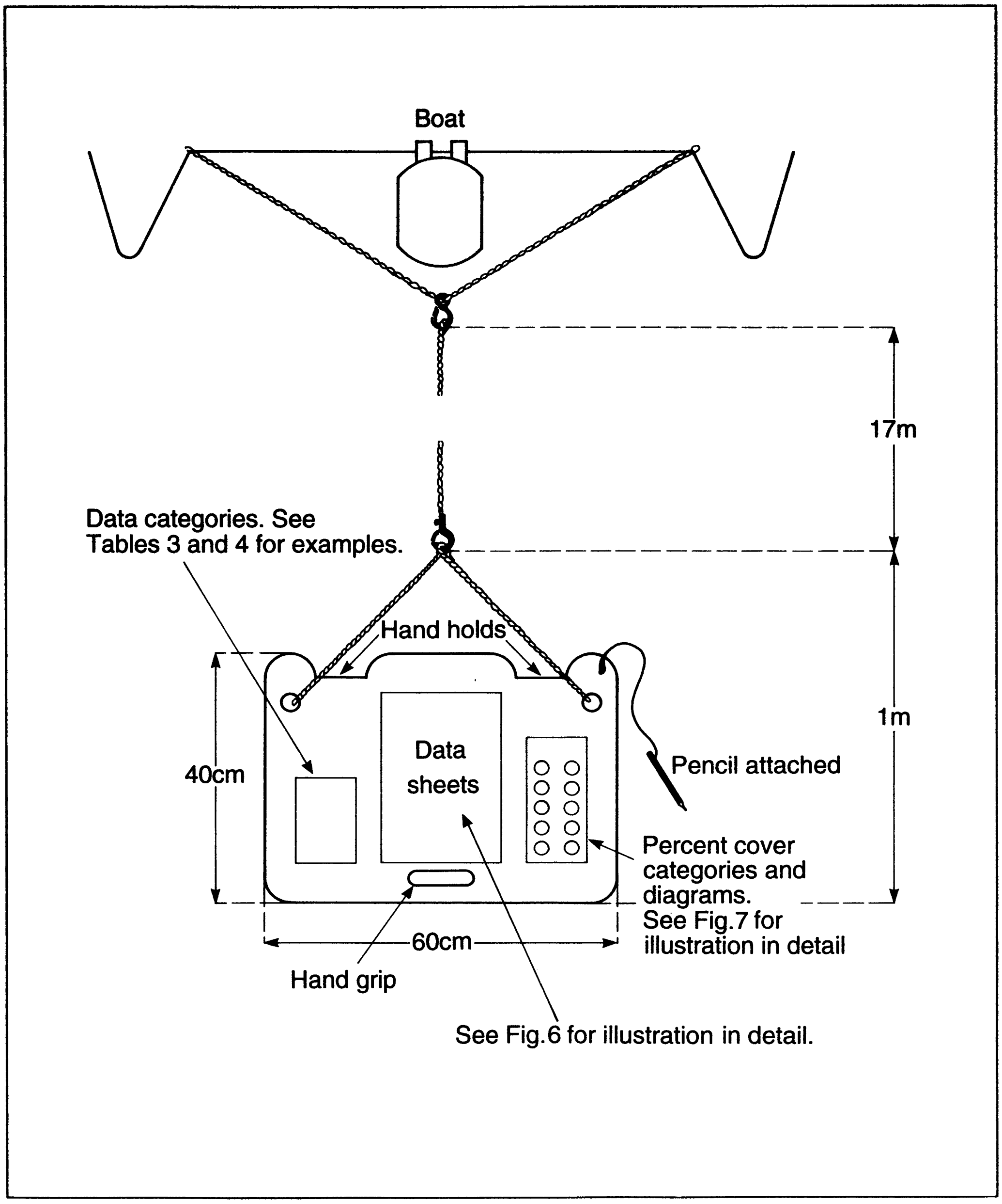

Figure 5. Detail of the manta board, and associated equipment. Summaries of the categories are attached to the board for easy reference by the observer.

- A data sheet (A4 underwater paper is recommended) is held in position within a recess on the centre of the board. The data sheets should be pre-printed to assist the observer record a set of biological variables and other significant observations (Fig. 6).
- Diagrammatic representations of coral cover categories (Fig. 7) are attached to the board for observer reference. Any other list which may assist the observer may also be attached, e.g. if survey will include COTS then categories used to record feeding scars and COTS size (Tables 3 and 4) should be provided.
- A pencil(s) is attached with light twine to the board.
- The observer wears snorkelling equipment (mask, snorkel and fins) and preferably a full-length dive suit or nylon ("stinger") suit.

Reef name:................................ Sample ID:..

Time:........... Date:........... Wind:........... Cloud:........... Collector:...............

Tow	Coral Cover			Vis.	C O T				Remarks
No.	Live	Dead	Soft		No.	Size	Scars		
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
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16									
17									
18									
19									
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22									
23									
24									
25									
26									
27									

Figure 6. Example of a printed sheet used by observers to record data. The column headed "Remarks" is used for general comments (to record items of interest, e.g. a large concentration of *Porites* colonies). The columns headed "COT" are only required when crown-of-thorns starfish (*Acanthaster*) are to be surveyed. The blank column can be used for additional variables.

- The driver should be protected from the sun, and should have the following equipment in the boat:
  - Waterproof watch for timing the duration of tows;
  - An image of the reef sealed in plastic and attached with rubber bands to a plastic board. An aerial photograph of the reef is recommended (Fig. 8), however a map or photocopy can be substituted if this is not available;
  - A waterproof pen for marking the position of the tows.

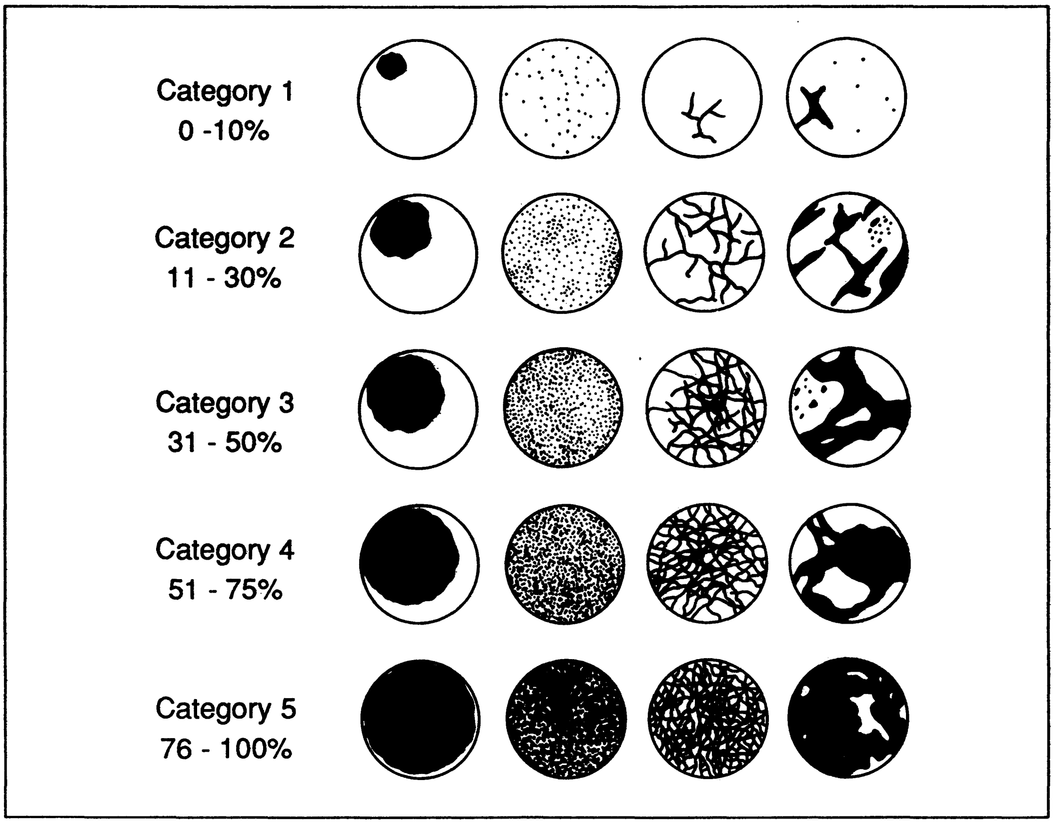


Figure 7. Schematic representations of percent cover used for the estimation of live and dead coral, soft coral and sand/rubble (after Dahl 1978).

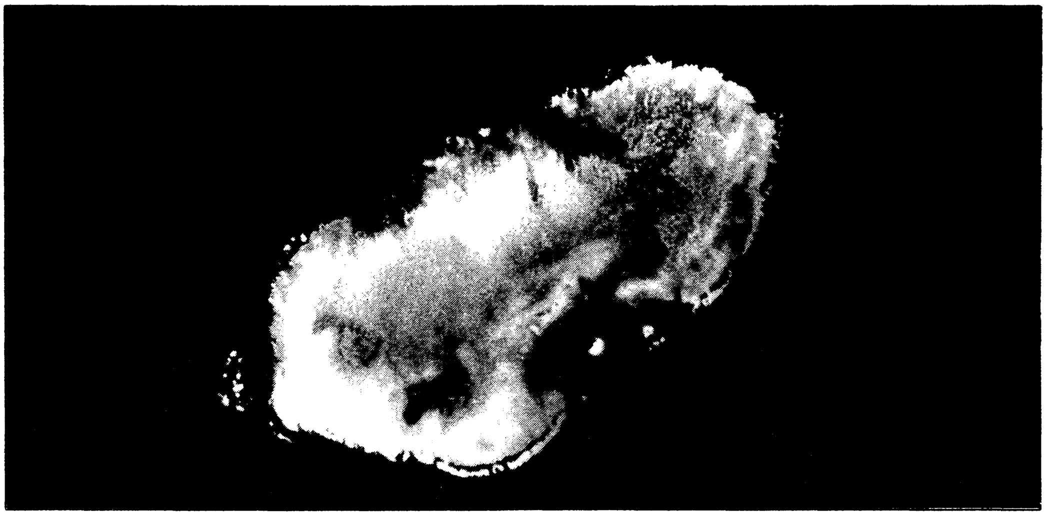


Figure 8. An aerial photograph of the reef is used by the driver to record the location of the manta tows.

Site selection

- Whole (unbroken) reef perimeters are surveyed where possible. Shoals and ill-defined areas of reef, separated by deeper water, are not usually surveyed.
- Tows are begun from an easily identifiable point on the reef. This is particularly important when resurvey of the reef is intended. A GPS (Global Positioning System) can be very useful for relocating sites if available.
- For long sections of coastline with fringing reefs allocate a section of the length as a reef, e.g. headland to headland.

- If there are 2 teams conducting the survey, the teams should start from the same point and then proceed in opposite directions. Tows are continued until the boats meet again. In situations where the reef is not circular, teams should start at opposite ends of the reef and proceed toward one another, repeating the tows until the boats meet. Hence each reef will consist of a set of consecutive tows which will vary in number according to the size of the reef to be surveyed.
- If it is not possible to complete a survey in a single set of consecutive tows, marker buoys are left to denote where the next set of tows will begin.

General procedure

- The observer is towed parallel to the reef crest so that the entire slope can be seen, i.e. the tow path should be close to the crest. The tow speed should be constant. During calm weather the speed should be between 3 to 5 km per hour (1 to 1.5 knots, or the equivalent to a slow walk). Factors such as currents and sea conditions may vary the tow speed.
- The survey of the reef is broken into manta tows of 2 minutes duration. At the end of each 2 minute tow, the boat is stopped to allow the observer to record the data on the printed sheet attached to the manta board. At this time, the driver marks the tow number and position of the boat on the aerial photograph. When the observer is ready to continue, he/she signals the driver to start another 2 minute tow. This procedure is repeated until the entire perimeter, or length, of the reef has been surveyed.
- Since the boat driver may not be able to position the boat on an ideal tow path, the observer may have to vary the search relative to their position on the reef slope (Fig. 9). The width of search is variable, but a scan of a 10 to 12 metre strip of the reef is recommended. The search path and width will also vary according to visibility, reef gradient, distance from the substratum, and the distribution and density of the organisms being counted.
- The direction for surveying the reef is determined by factors such as wind, currents and angle of sun. When weather conditions allow, it is advised to standardise the direction in which tows are conducted (e.g. clockwise on a circular reef; north to south, or east to west, along a length of fringing reef) so that comparison of resurveyed reefs requires less correction.
- Observations should be discontinued where visibility is less than 6 metres. This distance is determined using the buoys located along the tow rope (Fig. 10). If the back of the boat can be seen, the visibility is judged to be greater than 18 metres.
- Standard hand signals should be used between the observer and the driver to allow effective communication (Fig. 11). For instance, observers should signal the driver to move closer to the reef when being towed over deep water.
- The maximum number of consecutive tows conducted by an observer is normally 15. Once a series of 15 tows have been completed, the observer and the driver (or a fresh observer) exchange roles. During this change-over a debriefing should occur. This includes discussion about general conditions, state of the reef, number of COTS, and anything else of note seen by the observer during the tows.

- **Observations are generally made from the surface. Manta towing below the surface may be necessary when the substratum is not clearly visible or closer inspection is required. Prolonged diving should be avoided.**

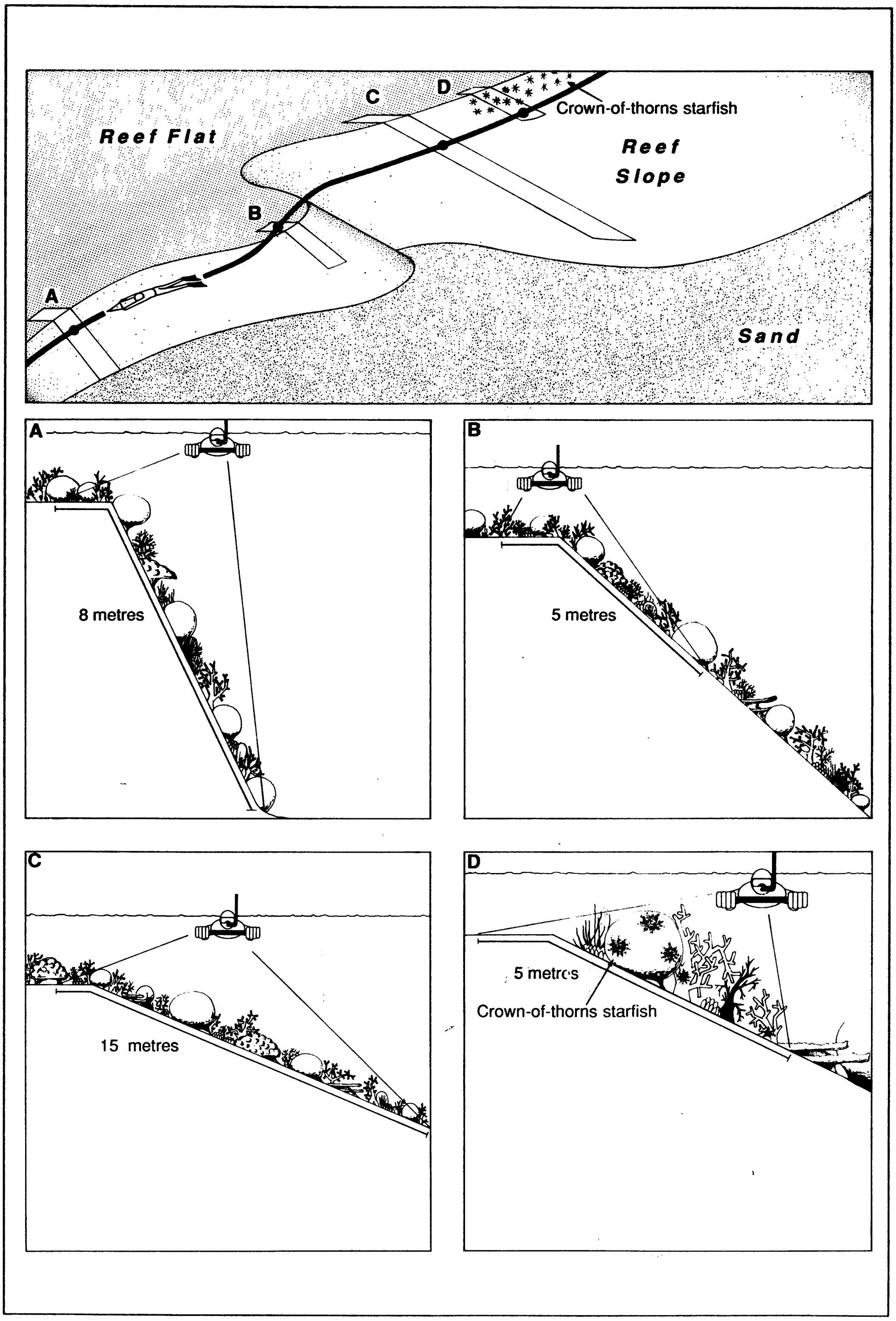


Figure 9. Diagram showing how both the search path and width vary according to the angle of the slope, the position of the observer relative to the perimeter and the presence of starfish (taken from Moran and De'ath 1992). The solid line indicates the tow path and the rectangular boxes the search path and width.

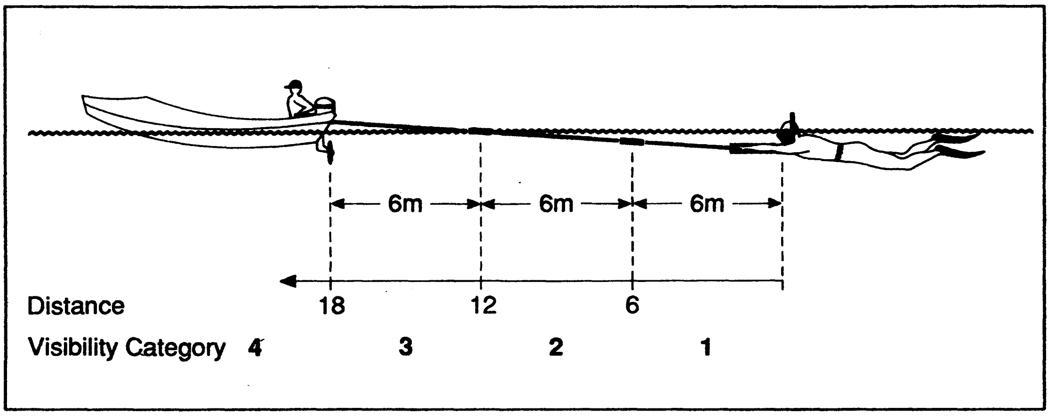


Figure 10. Method for estimating visibility during manta tow survey. Categories for recording data are indicated.

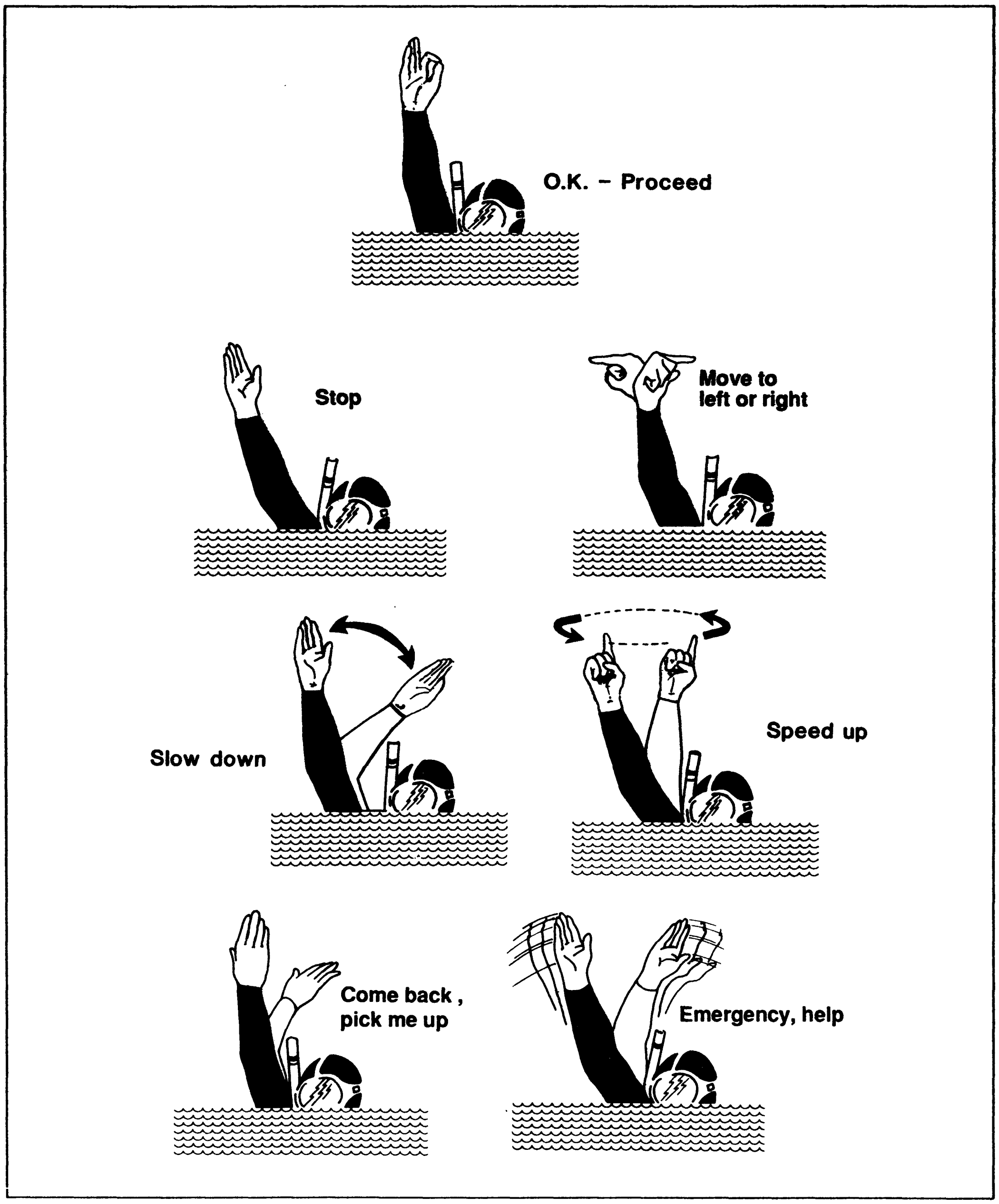


Figure 11. Hand signals used between observers and drivers.

Data recording

- Before the observer enters the water physical variables should be recorded at the top of the data sheet (Fig. 6). Weather conditions are described by cloud cover and wind strength, the latter including sea state:
  - The amount of cloud is estimated according to the number of eighths of sky (celestial dome) that is covered by cloud (Fig. 12). The unit of measure is the okta. Observation should be made from a position where the entire sky can be seen. Commence by subdividing the sky into quadrants (1 quadrant = 2 oktas), and estimate the amount of cloud in each quadrant. Finally, combine these quadrant estimates to give the total amount. If the sky is completely free of cloud it is recorded as '0'. If there is only a small amount of cloud which is recorded as '1'. See Table 1 for cloud categories.

Table 1. Categories of cloud cover.

Category	Amount of Cloud
0	cloudless
1	1 okta or less, but ≠ 0
2	2 oktas
3	3 oktas
4	4 oktas
5	5 oktas
6	6 oktas
7	7 oktas
8	8 oktas

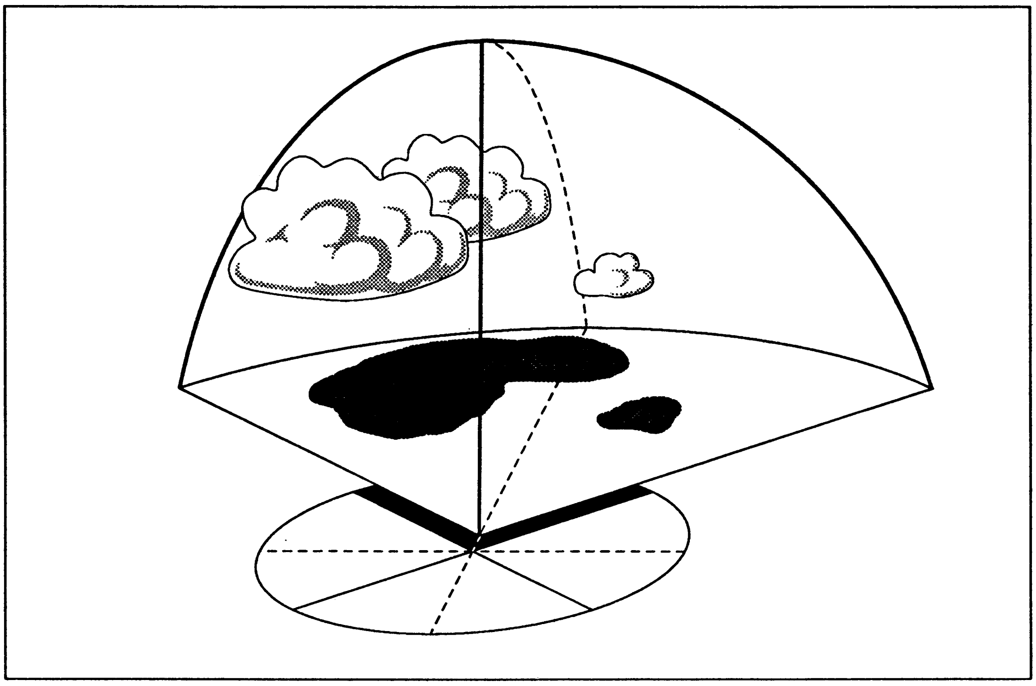


Figure 12. Estimation of cloud cover using oktas.

Table 2. Wind scale and sea state criteria (modified from the Beaufort scale).

Wind Force	Wind (knots)	Sea State	Wind	Sea Criteria
1	0 - 5	calm	light air	mirror-like, to small ripples
2	6 - 10	smooth	gentle breeze	large wavelets, crests begin to break
3	11 - 15	slight	moderate breeze	small waves becoming longer
4	16 - 20	moderate	fresh breeze	many white caps forming
5	21 - 25	rough	strong breeze	large waves, extensive white caps

- Wind and sea state are described in the Beaufort Wind Scale and Sea Disturbance Table. A modified extract, using 5 categories, is presented in Table 2.
- At the beginning a series of tows, the boat driver should mark the starting point (denoted as **zero**) on an aerial photograph and record the direction of the tows. The starting position should be near a prominent feature.
- At the end of each 2 minute tow:
    - the observer records the percent cover of live and dead coral, and soft corals (Fig. 7). Other features such as, recent storm damage, COTS, clams etc. can be included in the remarks column.
    - the boat driver marks the boat position at the end of each tow on the aerial photograph, taking note of any prominent features. The starting position is marked as zero. The end of the first tow is then marked by 1, the end of the second tow marked by 2, and so on, until the survey is complete (Fig. 13).
- Visibility should be recorded every 15 tows, or whenever a change is observed (Fernandes 1989). It is estimated using marks along the tow rope and is recorded as one of 4 categories (Fig. 10).

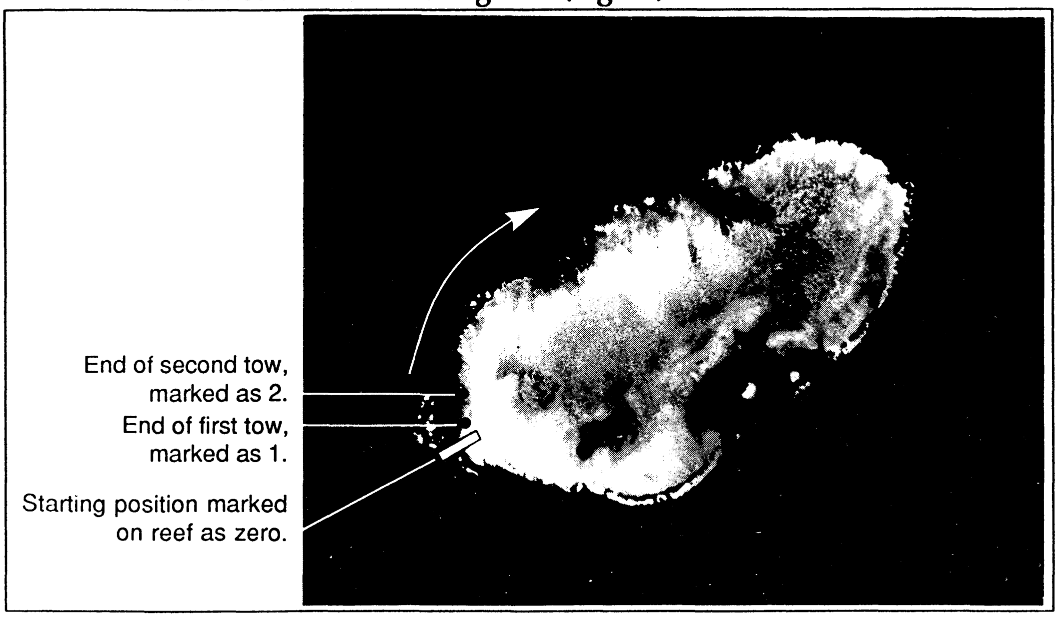


Figure 13. The boat driver marks, on the aerial photograph, the direction of tows, the starting position and the position at the end of each tow.

- It must be emphasised that the percent cover of live and dead coral are the minimum requirements for the manta tow survey data. Where distribution and abundance information is required for COTS, the data categories used for the GBR studies should be followed.
- Other variables may be included which are specific to the survey aims (e.g. *Diadema*), but accuracy and precision of the counts should be verified.

Note: Where surveys are to include estimates of COTS abundance, the observer should follow the categories used in studies of these starfish on the GBR. This will allow comparison of the COTS throughout their distribution. The categories include:

1. ***The number of feeding scars** (Table 3);*
2. ***The number of COTS** - observations are given as integer values, or where values are greater than this as 100;*
3. ***The average size of the COTS** (Table 4).*

Table 3. Categories for feeding scars.

Category	Number of Scars
Absent	0
Present	1 - 10
Common	> 10

Table 4. Size categories for crown-of-thorns starfish

Category	Average Size
Small	1 - 15 cm
Large	> 15 cm

Standardisation

- All personnel should be trained in the manta tow method. This is done by repeatedly towing observers over the same area of a reef until all team members have developed consistency in all aspects of the methodology (e.g. tow speed, observer recording). Re-training in the field should be conducted regularly (twice a year) and may be supplemented by laboratory-based training using video footage and colour transparencies. A useful piece of equipment for training is a manta board that can accommodate more than one observer.
- The variability in recording between observers should be checked at the beginning of each survey trip by towing each observer over the same section of reef and comparing the data collected. Surveys of this section of reef should be repeated until comparable data are recorded by all observers. It is particularly important to test inexperienced observers against experienced team members.

Data processing

- The starting point for each survey should be checked and tow numbering corrected so that each consecutive tow follows the previous one in a **clockwise** direction around the reef perimeter. For fringing reefs, the team must set their sampling protocol (e.g. east to west), and then follow that protocol for all data collected for that reef. The standardisation of starting point and tow direction is essential for temporal comparison of data collected during the manta tows. Correction of data ensures that the same sections of reef can be identified from resurvey datasets. Examples of the types of corrections that may be required are given in the worked example at the end of this section.
- At the end of each day the data should be corrected and then entered into the database using the structure described in Appendix I.
- Information about the sample is entered into the sample table (XXCRSAMP.DBF) and a unique sample identifier (SAMPLE_ID) is allocated. The type of data collected in the sample is described by the DATA_TYPE field, which for manta tow data, is denoted by "M".
- The manta tow data are entered into the data table (XXCRMDAT.DBF) using the sample identification allocated in the sample table. The manta table has one row, or record, for each 2 minute tow (TOWNBR). Hence, the set of tows which make up the reef perimeter have the same SAMPLE_ID.
- An entry is made into the sample table (XXCRSAMP.DBF) to describe the ambient data collected in conjunction with the manta tow survey, i.e. DATA_TYPE is "A". The ambient data are entered into the ambient table (XXCRADAT.DBF) using the sample identification allocated in the sample table.

Note: The manta tow data and ambient data will have different sample identification numbers but are connected through common fields in the sample table e.g. location, reef name, date, latitude and longitude.

- A diagram of the survey area with the starting point of the survey, and the position of the end of each tow clearly marked should be stored with the raw data for future reference.
- The distance covered by a 2 minute tow will vary with tow speed and currents. Therefore, comparisons between surveys are only approximate. Such comparisons over groups of tows are possible if accurate records are kept on the location of tows against prominent features on the reef.

Analysis

- The database file allows the retrieval of information about general conditions of the reef slope in relation to percent cover of live coral, dead coral and soft coral. Information on the conditions of the reef slope in relation to different locations of the reef is readily obtained when cross-referenced with the map showing the position of individual tows (e.g. Bass *et al.* 1988, 1989).
- Median values of biological variables give an indication of the state of the whole reef (see summary sheet in the worked example). These values are readily calculated using statistical software packages.
- If estimates of abundance are required for organisms other than those included in this handbook (e.g. *Tridacna*), then detailed analysis of data will be required to measure the precision of the technique for that organism.

Advantages

- Large areas of a reef can be surveyed in a relatively short time. This reduces the possibility of overlooking population changes or disturbances which can be variable in space and time (e.g. dynamite fishing, COTS, bleaching, storm damage).
- It is relatively simple to perform after some training.
- It does not require the use of expensive or specialised equipment which require the observer to have special qualifications (e.g. SCUBA apparatus).
- It can be performed in remote locations with minimal support.
- The observer can cover great distances with little fatigue.

Disadvantages

- The survey may be conducted over inappropriate sections of the reef (e.g. large areas of sand or deep water) because the tow path is controlled by the driver who views the reef from above the water.
- If the animals are not obvious they may be overlooked.
- The observer may have too much information to remember, particularly if many variables are being recorded.
- The method is not suitable for areas with poor visibility (less than 6 metres).

Worked example

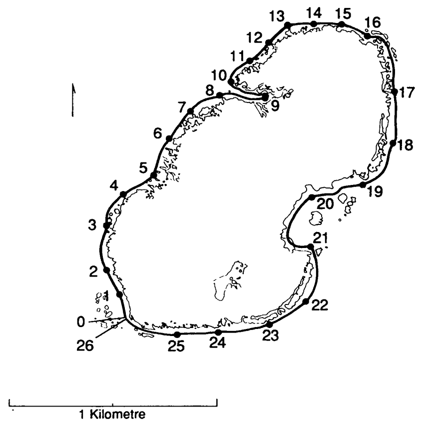
Resurvey of reefs is an essential part of any monitoring programme. It is therefore important that data entry of manta tow information follows a strict protocol. Any deviation from the protocol must be corrected before entry of data into the database. All tow data should be entered from a fixed starting point, following a set direction (clockwise), along the reef. An outline of the reef should be stored with the data marking the starting point, tow direction and tow numbers for each set of data. This will allow the identification of sections of reef for comparison through time.

If circumstances arise which prevent the collection of data in the preferred format (e.g. weather conditions, availability of more than one team) the data must be corrected before entry into the database. Examples are given using data collected as part of the crown-of-thorns starfish surveys on the GBR (Bass *et al.* 1989). A variety of sampling situations are presented:

- Tows conducted clockwise around the reef - no adjustment to data necessary (Fig. 14).
- Tows conducted anti-clockwise around the reef - adjust data (Fig. 15).
- Two boats surveying the same reef (Fig. 16).
- Different starting point from a previous survey - adjust data (Fig. 17).

Data from a reef may be summarised as median values (see below). Such summaries allow quick comparison of data collected from reefs (Fig. 18).

Reef	Date	SAMPLE_ID	No. tows	Median live coral	Median dead coral	Median soft coral	No. COTS
Trout	10/11/87	AURMA0098	26	3	1	1	0
.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.

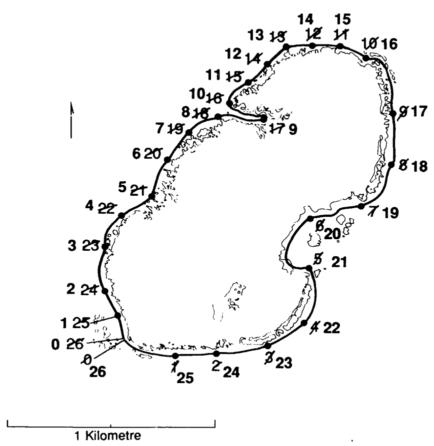


Reef name: TROUT Sample ID: AURMA 0098

Time: 0930 Date: 10/11/87 Sea: SLIGHT Wind: 4 Cloud: 1/8 Collector: DB/CC

Tow No.	Coral Cover Live	Coral Cover Dead	Coral Cover Soft	Vis.	C.O.T. No.	C.O.T. Size	C.O.T. Scars		Remarks
1	2	1	3	3	0		A		DB TABULATES
2	2	1	1	3	0		A		DB TABULATES
3	3	1	1	3	0		A		DB
4	3	1	2	3	0		A		DB
5	2	1	1	3	0		A		DB
6	2	1	1	3	0		A		DB
7	2	1	1	3	0		A		DB
8	2	1	1	3	0		A		DB
9	3	1	2	2	0		A		DB
10	2	1	1	2	0		A		DB POSSIBLE STORM DAMAGE
11	2	1	1	2	0		A		DB
12	3	1	1	3	0		A		DB
13	3	1	1	2	0		A		DB
14	4	0	1	2	0		A		DB
15	4	0	3	2	0		A		DB
16	3	0	2	2	0		A		CC
17	3	1	2	3	0		A		CC
18	3	1	2	3	0		A		CC
19	2	1	1	3	0		A		CC
20	3	1	1	3	0		A		CC
21	1	1	1	3	0		A		CC
22	3	1	2	3	0		A		CC STEEP SLOPE
23	3	1	1	3	0		A		CC STEEP SLOPE
24	3	1	1	3	0		A		CC
25	4	1	1	3	0		A		CC
26	4	1	1	3	0		A		CC
27									

Figure 14. Tows conducted in a clockwise direction around the reef. A prominent starting point should be selected which is then the reference point for all resurvey data. Outline of the reef locates the relative position of the tows.

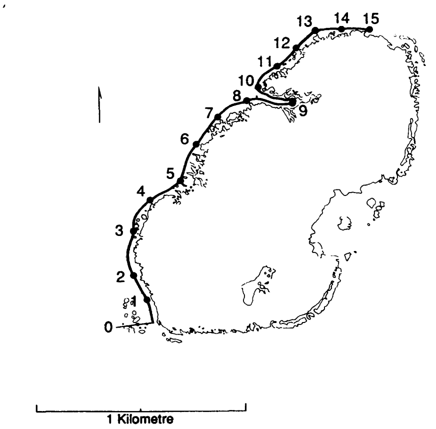


Reef name: TROUT Sample ID: AURMA 0098

Time: 0830 Date: 10/11/87 Sea: SLIGHT Wind: 4 Cloud: 1/8 Collector: DB/CC

	Tow No.	Coral Cover Live	Coral Cover Dead	Coral Cover Soft	Vis.	C.O.T. No.	C.O.T. Size	C.O.T. Scars		Remarks
26	~~1~~	4	1	1	3	0		A		DB
25	~~2~~	4	1	1	3	0		A		DB
24	~~3~~	3	1	1	3	0		A		DB
23	~~4~~	3	1	1	3	0		A		DB STEEP SLOPE
22	~~5~~	3	1	2	3	0		A		DB STEEP SLOPE
21	~~6~~	1	1	1	3	0		A		DB
20	~~7~~	3	1	1	3	0		A		DB
19	~~8~~	2	1	1	3	0		A		DB
18	~~9~~	3	1	2	3	0		A		DB
17	~~10~~	3	1	2	3	0		A		DB
16	~~11~~	3	0	2	3	0		A		DB
15	~~12~~	4	0	3	2	0		A		DB
14	~~13~~	4	0	1	2	0		A		DB
13	~~14~~	3	1	1	2	0		A		DB
12	~~15~~	3	1	1	2	0		A		DB
11	~~16~~	2	1	1	3	0		A		CC
10	~~17~~	2	1	1	2	0		A		CC POSSIBLE STORM DAMAGE
9	~~18~~	3	1	2	2	0		A		CC
8	~~19~~	2	1	1	2	0		A		CC
7	~~20~~	2	1	1	3	0		A		CC
6	~~21~~	2	1	1	3	0		A		CC
5	~~22~~	2	1	1	3	0		A		CC
4	~~23~~	3	1	2	3	0		A		CC
3	~~24~~	3	1	1	3	0		A		CC
2	~~25~~	2	1	1	3	0		A		CC TABULATES
1	~~26~~	2	1	3	3	0		A		CC TABULATES
	27									

Figure 15. Tows were conducted in an anti-clockwise direction. Data are then corrected so that the tows are entered into the database in a clockwise direction.



Reef name: TROUT   Sample ID: AURMA 0098

Time: 0830 Date: 10/11/87 Sea: SLIGHT Wind: 4 Cloud: 1/8 Collector: DB

Tow No.	Coral Cover Live	Coral Cover Dead	Coral Cover Soft	Vis.	C.O.T. No.	C.O.T. Size	C.O.T. Scars		Remarks
1	2	1	3	3	0		A		DB TABULATES
2	2	1	1	3	0		A		DB TABULATES
3	3	1	1	3	0		A		DB
4	3	1	2	3	0		A		DB
5	2	1	1	3	0		A		DB
6	2	1	1	3	0		A		DB
7	2	1	1	3	0		A		DB
8	2	1	1	2	0		A		DB
9	3	1	2	2	0		A		DB
10	2	1	1	2	0		A		DB POSSIBLE STORM DAMAGE.
11	2	1	1	3	0		A		DB
12	3	1	1	2	0		A		DB
13	3	1	1	2	0		A		DB
14	4	0	1	2	0		A		DB
15	4	0	3	2	0		A		DB.
16									
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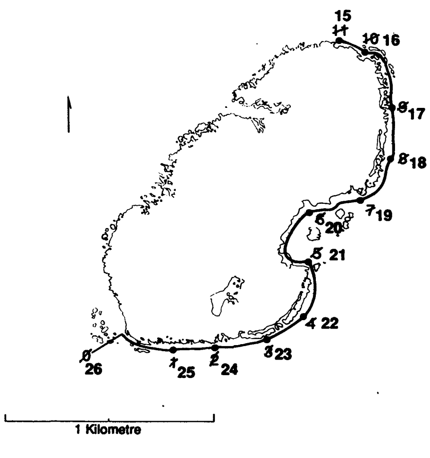

Reef name: TROUT   Sample ID: AURMA0098

Time: 0830 Date: 10/11/87 Sea: SLIGHT Wind: 4 Cloud: 1/8 Collector: CC

	Tow No.	Coral Cover Live	Coral Cover Dead	Coral Cover Soft	Vis.	C.O.T. No.	C.O.T. Size	C.O.T. Scars		Remarks
26	~~1~~	4	1	1	3	0		A		CC
25	~~2~~	4	1	1	3	0		A		CC
24	~~3~~	3	1	1	3	0		A		CC
23	~~4~~	3	1	1	3	0		A		CC STEEP SLOPE.
22	~~5~~	3	1	2	3	0		A		CC STEEP SLOPE
21	~~6~~	1	1	1	3	0		A		CC
20	~~7~~	3	1	1	3	0		A		CC
19	~~8~~	2	1	1	3	0		A		CC
18	~~9~~	3	1	2	3	0		A		CC
17	~~10~~	3	1	2	3	0		A		CC
16	~~11~~	3	0	2	3	0		A		CC
	12									
	13									
	14									
	15									
	16									
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	22									
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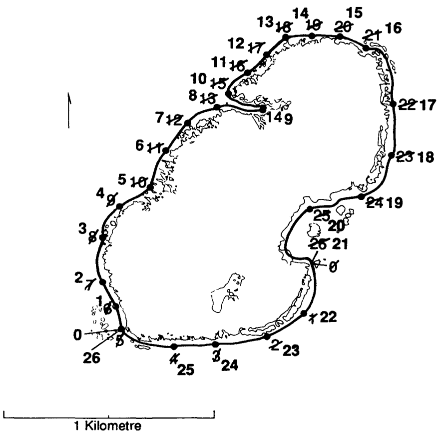
	26									
	27									

Figure 16. Survey of the reef was conducted by 2 teams (A and B). Data are combined to reflect the agreed starting point and the clockwise direction of tows.

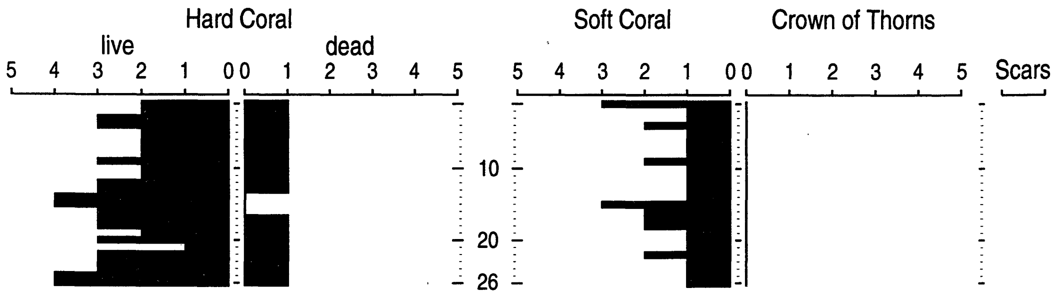


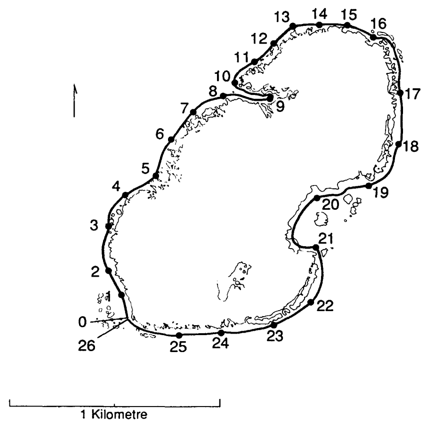
Reef name: TROUT Sample ID: AURMA 0098

Time: 0830 Date: 10/11/87 Sea: SLIGHT Wind: 4 Cloud: 1/8 Collector: DB/CC

	Tow No.	Coral Cover Live	Coral Cover Dead	Coral Cover Soft	Vis.	C.O.T. No.	C.O.T. Size	C.O.T. Scars		Remarks
22	~~1~~	3	1	2	3	0		A		DB STEEP SLOPES
23	~~2~~	3	1	1	3	0		A		DB STEEP SLOPE
24	~~3~~	3	1	1	3	0		A		DB
25	~~4~~	4	1	1	3	0		A		DB
26	~~5~~	4	1	1	3	0		A		DB
1	~~6~~	2	1	3	3	0		A		DB TABULATES
2	~~7~~	2	1	1	3	0		A		DB TABULATES
3	~~8~~	3	1	1	3	0		A		DB
4	~~9~~	3	1	2	3	0		A		DB
5	~~10~~	2	1	1	3	0		A		DB
6	~~11~~	2	1	1	3	0		A		DB
7	~~12~~	2	1	1	3	0		A		DB
8	~~13~~	2	1	1	2	0		A		DB
9	~~14~~	3	1	2	2	0		A		DB
10	~~15~~	2	1	1	2	0		A		DB POSSIBLE STORM DAMAGE
11	~~16~~	2	1	1	3	0		A		CC
12	~~17~~	3	1	1	2	0		A		CC
13	~~18~~	3	1	1	2	0		A		CC
14	~~19~~	4	0	1	2	0		A		CC
15	~~20~~	4	0	3	2	0		A		CC
16	~~21~~	3	0	2	3	0		A		CC
17	~~22~~	3	1	2	3	0		A		CC
18	~~23~~	3	1	2	3	0		A		CC
19	~~24~~	2	1	1	3	0		A		CC
20	~~25~~	3	1	1	3	0		A		CC
21	~~26~~	1	1	1	3	0		A		CC
	27									

Figure 17. Tows were begun from a different starting point to previous survey(s). Data are adjusted so that tow numbers begin from the same position.





Reef	Date	SAMPLE_ID	No. tows	Median live coral	Median dead coral	Median soft coral	No. COTS
Trout	10/11/87	AURMA0098	26	3	1	1	0
.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.

Figure 18. Example of a summary data sheet showing percent cover data collected using manta tow survey of Trout Reef, Great Barrier Reef (Bass *et al.* 1989).

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4. LINE INTERCEPT TRANSECT

Introduction

Line intercept transects are used to assess the sessile benthic community of coral reefs. The community is characterized using lifeform categories which provide a morphological description of the reef community. These categories are recorded on data sheets by divers who swim along lines which are placed roughly parallel to the reef crest at depths of 3 metres and 10 metres at each site. For future monitoring, the location of each site is recorded and marked on the reef. If the expertise of the observer allows the identification of coral species, this methodology may be expanded to include taxonomic data in addition to the lifeform categories. Monitoring should be repeated each year where possible, and at least every 2 years.

Background

The Line Intercept Transect (LIT) technique was developed in terrestrial plant ecology, and subsequently was adopted by coral reef ecologists (Loya 1978; Marsh *et al.* 1984). The procedure focuses on all types of substrata rather than a single taxonomic group. The LIT is used to estimate the cover of an object or group of objects within a specified area (Gates 1979) by calculating the fraction of the length of the line that is intercepted by the object. This measure of cover, usually expressed as a percentage, is considered to be an unbiased estimate of the proportion of the total area covered by that object if the following assumptions apply: that the size of the object is small relative to the length of the line; and that the length of the line is small relative to the area of interest. For a discussion of the technique see McIntyre (1953), Lucas and Seber (1977), and Mundy (1991).

The LIT has been used for objectives ranging from large-scale spatial problems (Benayahu and Loya 1977; 1981), to morphological comparisons of coral communities (Bradbury *et al.* 1986; Reichelt *et al.* 1986), and studies assessing the impact of natural and anthropogenic disturbances (Moran *et al.* 1986; Mapstone *et al.* 1989). Most studies using this method have used similar techniques (a plastic fibre tape, placed on the substratum parallel with the reef crest) with the following variations: Bouchon (1981) used tape tensioned between two pegs; Rylaarsdam (1983) used 3.75 metre metal chains with 2 cm links; Hughes and Jackson (1985) used 10 metre chains (the size of the links was not stated).

Logistics

Personnel

- All observers should be familiar with the definitions of each lifeform (Fig. 19 a,b,c; Table 7). Branching forms are defined as those with at least secondary branching (see inset, Fig. 19a). Training should be carried out in the field, but may include the use of slides and/or photographs in the laboratory.
- Standardisation between observers, and continuity of observers throughout the project is very important, as observer variability may obscure or complicate any real spatial patterns.
- Observers should spend 30 - 45 minutes in the water at the beginning of each field trip, comparing and standardising their interpretations of the various lifeforms. Particular attention should be given to the following lifeforms: CE, CS, CM, ACB, ACS, ACD, and the algae (see Table 7 for abbreviations).

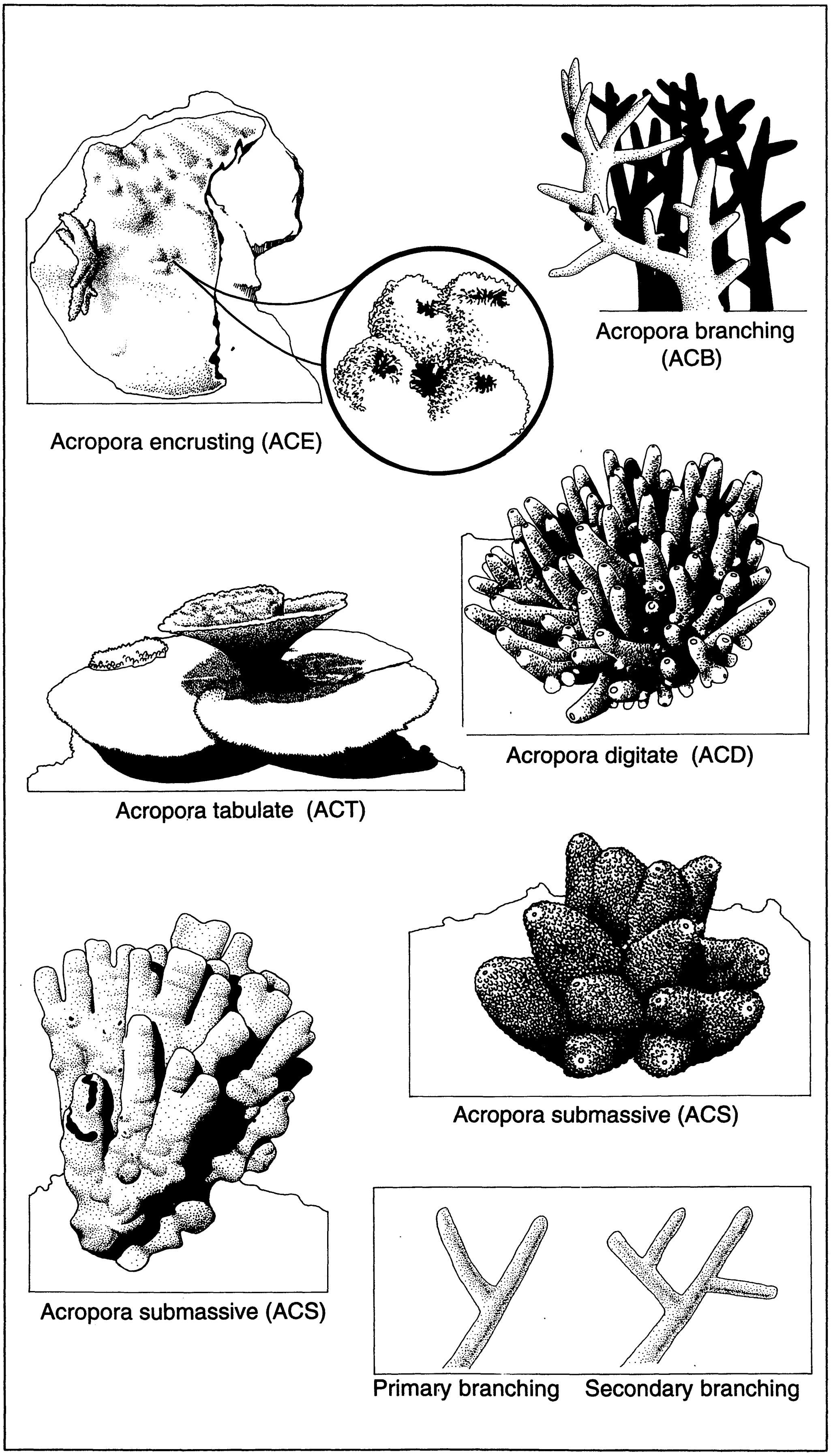


Figure 19 a. Examples of lifeform categories which group benthic communities through the use of morphological characteristics. Inset shows primary and secondary branching.

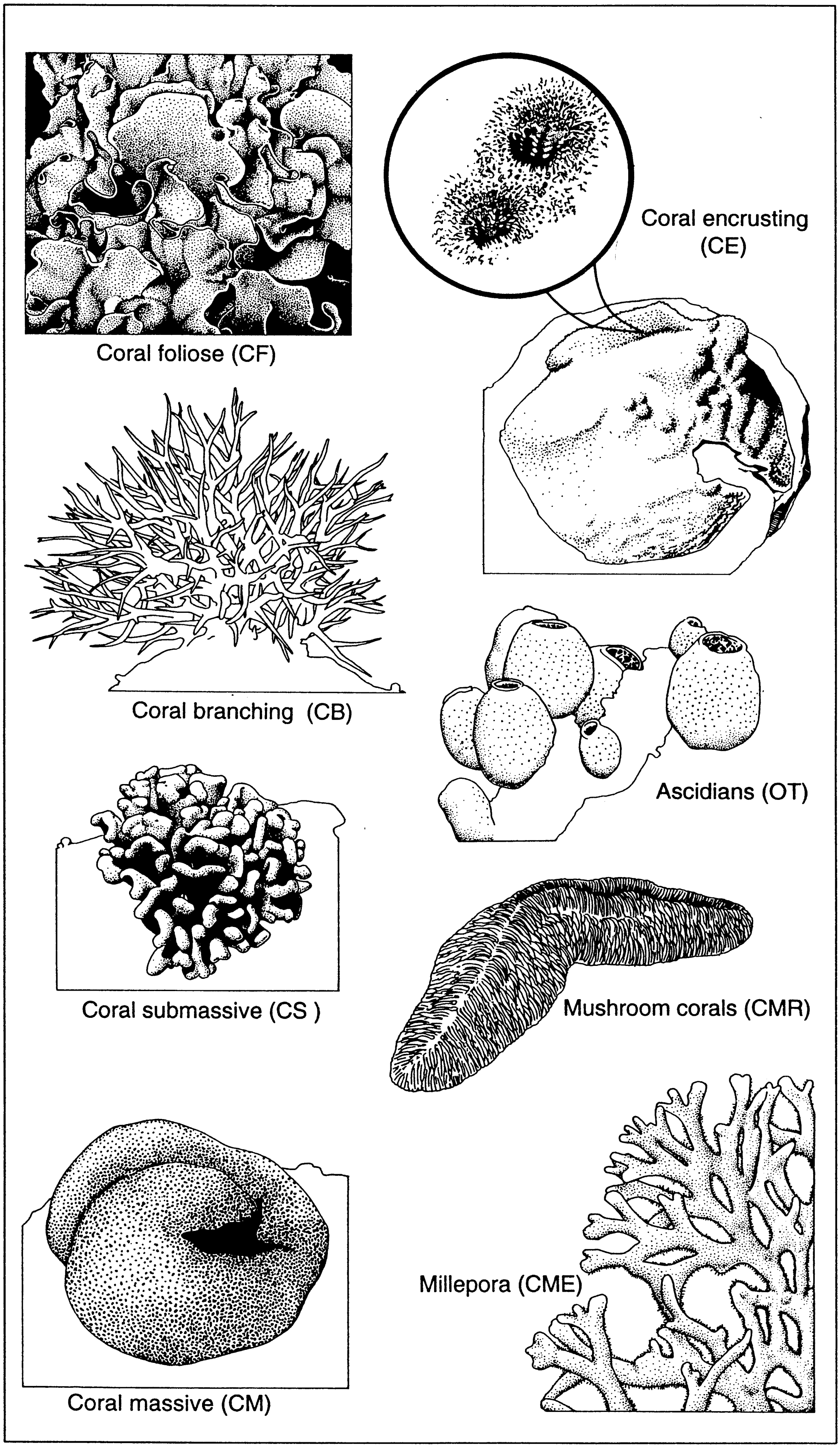


Figure 19 b. Examples of lifeform categories which group benthic communities through the use of morphological characteristics.

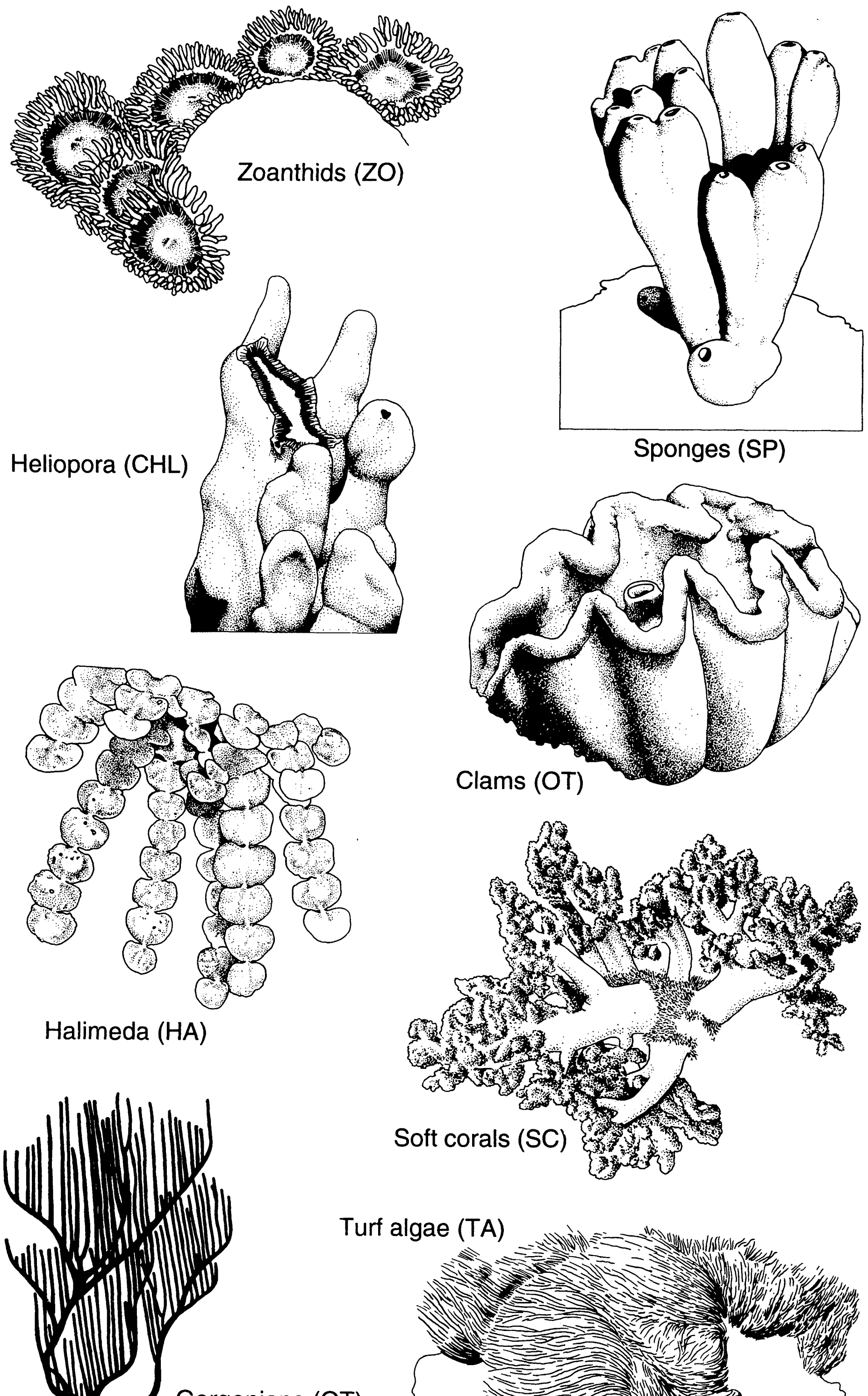


Figure 19 c. Examples of lifeform categories which group benthic communities through the use of morphological characteristics.

Table 7. Lifeform categories and codes. See Figure 19 a, b, c for examples.

CATEGORIES		CODE	NOTES / REMARKS
Hard Coral:			
Dead Coral		DC	recently dead, white to dirty white
Dead Coral with Algae		DCA	this coral is standing, but no longer white
Acropora	Branching	ACB	at least 2° branching, e.g. *Acropora palmata, A. formosa.*
	Encrusting	ACE	usually the base-plate of immature *Acropora* forms, e.g. *A. palifera* and *A. cuneata*
	Submassive	ACS	robust with knob or wedge-like form e.g. *A. palifera*
	Digitate	ACD	no 2° branching, typically includes *A. humulus, A. digitifera and A. gemmifera*
	Tabulate	ACT	horizontal flattened plates e.g. *A. hyacinthus*
Non-*Acropora*	Branching	CB	at least 2° branching e.g. *Seriatopora hystrix*
	Encrusting	CE	major portion attached to substratum as a laminar plate e.g. *Porites vaughani, Montipora undata.*
	Foliose	CF	coral attached at one or more points, leaf-like appearance e.g. *Merulina ampliata, Montipora aequituberculata.*
	Massive	CM	solid boulder or mound e.g. *Platygyra daedalea.*
	Submassive	CS	tends to form small columns, knobs, or wedges e.g. *Porites lichen, Psammocora digitata*
	Mushroom	CMR	solitary, free-living corals of the *Fungia*
	Millepora	CME	fire coral
	Heliopora	CHL	blue coral
Other Fauna:			
Soft Coral		SC	soft bodied corals
Sponges		SP	
Zoanthids		ZO	examples are *Platythoa, Protopalythoa*
Others		OT	Ascidians, anenomes, gorgonians, giant clams etc.
Algae	Algal Assemblage	AA	consists of more than one species
	Coralline Algae	CA	
	Halimeda	HA	
	Macroalgae	MA	weedy/fleshy browns, reds, etc.
	Turf Algae	TA	lush filamentous algae, often found inside damselfish territories
Abiotic	Sand	S	
	Rubble	R	unconsolidated coral fragments
	Silt	SI	
	Water	WA	fissures deeper than 50 cm
	Rock	RCK	reef pavement including limestone boulders, granite and volcanic rocks

Equipment

- Small boat/s, with outboard motors and safety equipment
- SCUBA equipment
- 4 fibreglass measuring tapes - 50 metres in length with hooks attached to the end of the tape and to the casing (Fig. 20). This tape length is recommended when visual fish censuses are conducted in conjunction with the LIT, otherwise a shorter transect length could be used.

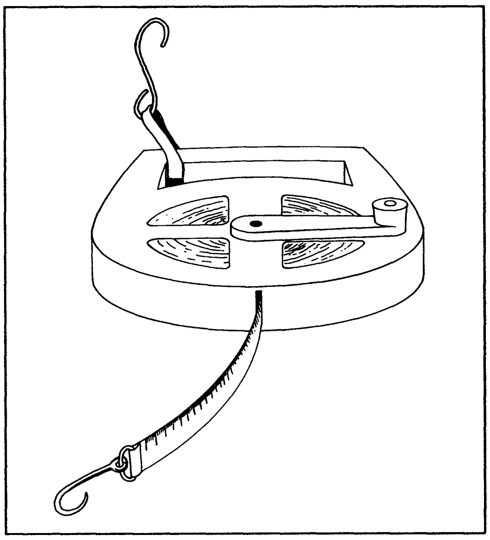


Figure 20. Hooks attached to the casing help secure the tape.

- Slates, data sheets (A4 underwater paper is recommended), and pencils. Printed data sheets will assist the observer record the intercept data (Fig. 21).
- Float or other material (e.g. plastic bottles) to mark site.

Maintenance

- Wash equipment, especially tapes, after use.
- Develop a routine of maintenance which is adhered to before and after each trip.

Site selection

- Conduct a general survey of the reef to select suitable sites on the reef slope which are representative of that reef. Manta towing is a useful technique for site selection.
- At least 2 sites should be selected. If distinct windward and leeward zones exist, sites should be selected in each zone.
- The precise location of sites should be recorded while at the site, noting landforms or unique reef features such as bays or indentations, points or channels, which may be useful for relocating the site. An aerial photo or chart of the area is extremely useful.
- Mark the transect site on the reef. Metal stakes, such as angle iron or star-pickets, should be hammered deep into the substratum to deter 'human predation'. Attachment of subsurface buoys may help reduce 'human predation' of site markers.

General procedure

- For each site, at least 5 transects of 20 metres length are located haphazardly at each of two depths, identifying shallow (3 metres) and deep (10 metres) coral communities.

Note: If permanent quadrats are monitored in the area, care should be taken to lay transects away from these quadrats in order to avoid damage.

- If a typical reef flat, crest, and slope is present, the shallow transects will be located on the reef slope, approximately 3 metres below the crest. The deeper transects will be located approximately 9-10 metres below the crest. If the site is on a reef without a well-defined crest, then transect depth should be approximated to depth below mean low water.

Reef/Island: .... Depth: .... Date: .... Time: ....

Reef zone: .... Site Nº: .... Temp. Top .... Bot. .... Salinity Top .... Bot. ....

Transect No.: .... Visibility: .... Collector: ....

Transition	Category	Taxon	Transition	Category	Taxon

Figure 21. Example of printed sheet used by observers to record line intercept data. The column headed "Taxon" is only used if the observer has expertise in coral taxonomy.

Note: If there is little or no coral at 10 metres then transects should be laid at 6-8 metres depth and the difference should be noted.

- The number of observers recording data should be kept to a minimum. These observers should collect data at all sites and, where possible, during repeat surveys.
- If personnel are available, it is more efficient if there are two observers recording data from the transects and a third diver rolling out, and rolling up the tapes.
- Each individual 20 metre transect should be completed by a single observer.
- The diver responsible for the tape should firmly attach the hook on the beginning of the tape (Fig. 20) to coral or other suitable 'anchor' and then roll the tape out parallel to the crest, following a constant depth contour (use depth gauge).
- The tape must remain close to the substratum (0-15 cm) at all times and should be securely attached to prevent excessive movement. This can be achieved by using the coral as a natural hook, e.g. by pushing the tape between branches. Do not wrap the tape around coral heads/branches or other lifeforms as this will affect intercept measurements. Care should be taken to minimise areas where the tape is suspended more than 50 cm above the substratum, i.e. the water category.

Note: When dive teams are limited and individuals must complete a number of transects on any one day, they must be aware of decompression safety. Divers must start with the deeper transects. When these are completed they can proceed to the transect at 3 metres depth.

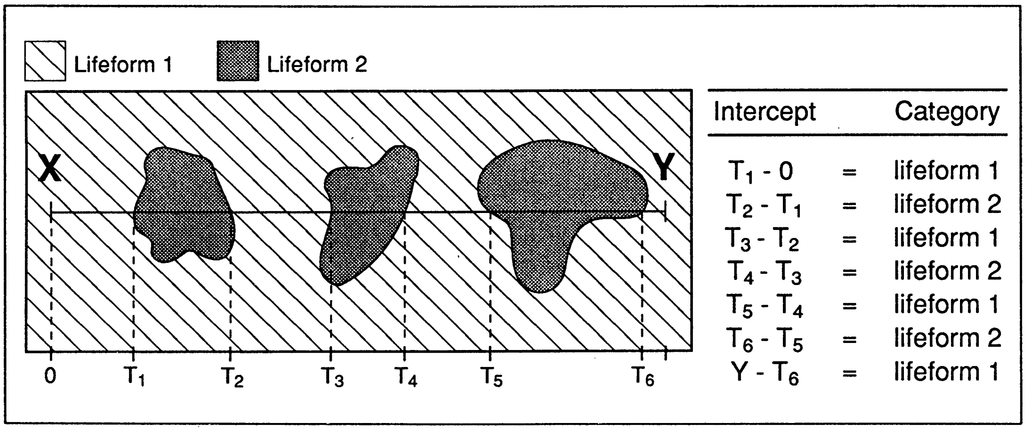
- After transects have been completed, divers should mark the study site by stakes or subsurface buoys. A GPS (Global Positioning System) can be very useful for relocating sites.

Data recording

- Before entering the water record the precise location of the site and any ambient parameters onto the datasheet. The precise location of the study area should be included.

Figure 22. Diver recording lifeform categories encountered under the transect tape.

- While the transect is being laid out the observer should record details of the site, depth etc. onto the datasheet. Detailed comments about the condition of the site at the time of survey should be included.
- Once the transect has been laid out, the observer moves slowly along the transect recording onto the data sheet the lifeforms encountered under the tape (Fig. 22). At each point where the benthic lifeform changes, the observer records the transition point in centimetres and the code of the lifeform. Hence, along the length of a transect (XY) a number of transition points (T) are recorded for each of the lifeforms (Fig. 23). The intercept of each lifeform encountered under the transect (I) is the difference between the transition points recorded for each lifeform.



Intercept		Category
$T_1 - 0$	I_1	Lifeform 1
$T_2 - T_1$	I_2	Lifeform 2
$T_3 - T_2$	I_3	Lifeform 1
$T_4 - T_3$	I_4	Lifeform 2
$T_5 - T_4$	I_5	Lifeform 1
$T_6 - T_5$	I_6	Lifeform 2
$Y - T_6$	I_7	Lifeform 1

Figure 23. Schematic diagram of a transect (XY) showing the transition points (T) for each lifeform crossed by the transect. The difference between consecutive transition points is the intercept of the lifeform.

- To facilitate accurate calculation of the number of occurrences of each lifeform, observers should note instances when the tape intercepts a single lifeform or colony more than once. For example, when a massive *Porites* colony includes both living tissue and dead patches with algal growth, each intercept with living tissue should be recorded as belonging to the same colony (Fig. 24). The (1) identifies the 2 intercepts of CM (Coral massive - *Porites*) as belonging to the same colony.
- Some colonies may be encountered which could be recorded as either of 2 lifeform categories, depending on where the colony is intercepted by the tape. Such colonies should be recorded by their dominant lifeform (i.e. the lifeform displayed by more than 50% of the colony). For example, large digitate *Acropora* species (*A. digitifera, A. humulis*) may have secondary and

tertiary branching at the ends of some of their branches. However, the proportion of the colony which displays these characteristics relative to the digitate form is small and hence the colony would be recorded as ACD.

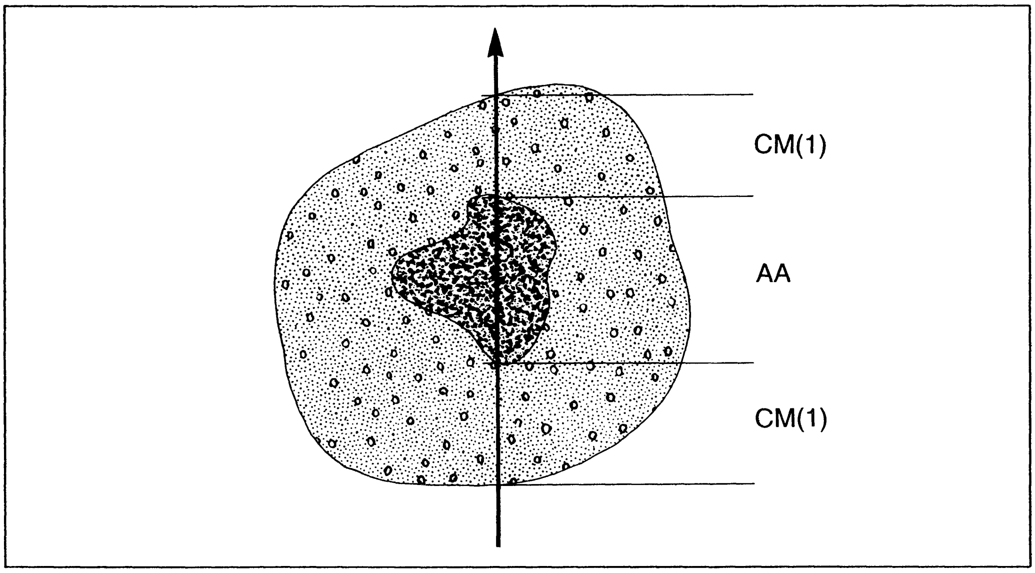


Figure 24. Diagram showing a transect crossing a single colony more than once. The data are recorded with the occurrence identified in brackets.

- More specific taxonomic identification may be included in addition to the lifeform category, dependent on the observer's knowledge. Veron (1986) is a recommended reference book for identification of scleractinian corals in the Indo-Pacific. Further references for regional coral identification are included in Suggested Reading.
- A list of coral species codes is included in Appendix II. This list should be updated if required, but ensure that codes are compatible with other survey teams to guarantee future compatibility of data collected.
- It must be emphasized that the lifeform categories specified are the **minimum** requirements for a regional database. If there is a need to add new categories for specific purposes, the category must allow retrieval of the minimum information (i.e. the new list of categories can readily be collapsed into the old one). For example, if the SC (soft corals) group is divided to note the growth form of the soft coral, provision must be made to allow the combination of the new categories back into SC for purposes of exchange.

Standardisation

- Observers must be as consistent as possible when recording the types of colonies. They should collect data at all sites and, where possible, during repeat surveys.
- Regular training and discussion of lifeforms should be undertaken in the field to ensure that interpretation of lifeform categories is the same for all observers, and that it does not change over time (i.e. data is comparable).
- The minimum requirements must always be met to ensure that data exchange is possible.

Data processing

- At the end of each day the data should be entered into the database using the structure described in Appendix I.
- Information about the sample is entered into the sample table (XXCRSAMP.DBF) and a unique sample identifier (SAMPLE_ID) is allocated. The type of data collected in the sample is described by the DATA_TYPE field, which for line intercept data, is denoted by "T".
- The line intercept data are entered into the data table (XXCRTDAT.DBF) using the sample identification allocated in the sample table. The data table has one row or record for each intercept recorded along the transect. Replicate transects have the same SAMPLE_ID but have a unique transect number.
- Each record in the data table should include a sample identifier (SAMPLE_ID), the transect number, the lifeform, the transition point (as read from the tape) and any other information such as the taxonomic code. Each transition along the one transect must have the same sample identifier and the same transect number. In this way all the records belonging to the same transect can be identified in the database and these in turn can be linked to the information in the sample table.
- An entry is made into the sample table (XXCRSAMP.DBF) to describe the ambient data collected in conjunction with the line intercept transect, i.e. DATA_TYPE is "A". The ambient data, e.g. temperature, salinity and visibility, are entered into the ambient table (XXCRADAT.DBF) using the sample identification allocated in the sample table.

Note: The LIT data and ambient data will have different sample identification numbers but are connected through common fields in the sample table e.g. location, reef name, date, latitude and longitude.

- Relatively large amounts of data will be collected, therefore adequate space for data storage and manipulation must be available.

Analysis

- Summary data showing percent cover and number of occurrences of each lifeform may be calculated using the line intercept data. After calculating the intercept from the transition points recorded along the transect (see Fig. 23), the percent cover of a lifeform category is calculated.

$$\text{Percent cover} = \frac{\text{Total length of category}}{\text{Length of transect}} \times 100$$

Hence, for Figure 23:

$$\text{Percent cover Lifeform 1} = \frac{I_1 + I_3 + I_5 + I_7}{Y} \times 100$$

$$\text{Percent cover Lifeform 2} = \frac{I_2 + I_4 + I_6}{Y} \times 100$$

- Preliminary calculations of percentage cover and number of occurrences can also be made from the data collected using the Lifeform program.

- These analyses will provide quantitative information on the community structure of the sample sites. Successive samples can also be compared when the sites have been sampled repeatedly over time.
- If reefs have been selected to represent both disturbed and pristine sites, then comparison of change detected in these sites may allow recognition of change due to disturbance from natural and man-induced pressures. This provides a predictive tool in reef management.
- Where rigorous statistical comparisons of reef community structures within and between sites are needed, greater replication of transects at each sampling site will be required. This should be identified in a pilot study, but will be at least 8-10 transects.

Advantages

- The lifeform categories allow the collection of useful information by persons with limited experience in the identification of coral reef benthic communities.
- LIT is a reliable and efficient sampling method for obtaining quantitative percent cover data.
- LIT requires little equipment and is relatively simple.

Disadvantages

- It is difficult to standardize some of the lifeform categories.
- Objectives are limited to questions concerning percent cover data or relative abundance.
- It is inappropriate for assessing demographic questions concerning growth, recruitment or mortality.
- While the LIT can provide detailed information on spatial pattern, it cannot provide precise information on temporal change. Therefore, if the objectives specifically address demographic questions, or detailed information regarding temporal change in the benthic community is required (i.e. impact studies), then belt transects and/or photo-quadrat techniques should be used in addition to LIT.

Comments

- Standardisation between observers and continuity of observers throughout the project is very important, as observer variability may obscure or complicate real spatial patterns.
- LIT should not be considered for obtaining quantitative assessments of percent cover or abundance of rare and small species.

Worked example

- Figure 25 shows a section of a line intercept transect and the data collected from that section of transect tape. The transition and category data would be recorded onto a data sheet similar to that shown in Figure 21. " Taxon" is only recorded if taxonomic expertise is available. It is then collected in addition to the lifeform data.
- Calculations of percent cover for Coral Foliose and Coral Massive lifeforms present in Figure 25 (CF and CM) are presented here.

$$\text{Percent cover} = \frac{\text{Total length of category}}{\text{Length of transect}} \times 100$$

Transition	Category	
57	CF	
60	AA	
80	ACD	
89	AA	
100	CM	
102	AA	
104	CM	
122	A	
136	ACB	
141	AA	
166	CM	
173	AA	
214	SC	
217	AA	
224	CM	
231	AA	
251	CF	
272	CS	

Figure 25. A section of a length of transect showing the lifeform categories and the intercept recorded from the transect tape. The taxon is only recorded if the observer has the appropriate expertise.

The length of the transect shown in Figure 25 is 272 centimetres. Therefore:

CF: Total length = 57 + 20 = 77

$$\% \text{ cover} = \frac{77}{272} \times 100 = 28.3\%$$

CM: Total length = 11 + 2 + 25 + 7 = 45

$$\% \text{ cover} = \frac{45}{272} \times 100 = 16.5\%$$

- The number of occurrences of CF and CM shown in Figure 25 are 2 and 4 respectively

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APPENDIX I. The Database

Background

The accumulation of information about coastal ecosystems is essential to an understanding of how these systems work. This information can then be used to set up effective management for sustainable development. To be truly useful however, potential users must be able to access the data easily. The use of database management systems such as dBASE® allows the storage and manipulation of vast amounts of information. Effective design of database structure can streamline data management tasks and vastly improve the efficiency of data storage and retrieval.

In the relational model of database design the data collected are broken down into related modules which are referred to as **tables** (Fig. 26). Each table is subdivided into records (rows), which contain a number of fields (columns). The tables are linked and cross-referenced by relating fields which are common to more than one table. In database terminology these fields are called **relational fields** or joining fields.

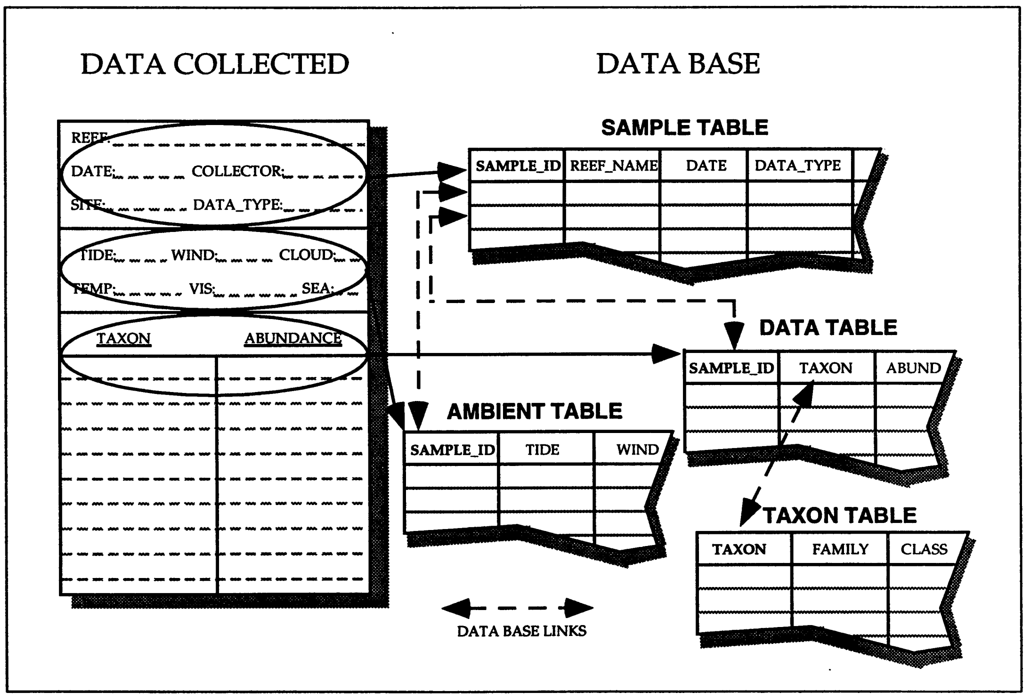

Figure 26. A relational database.

Data collected as part of the ASEAN-Australia project are relational in design. The methodologies detailed in this handbook are a subset of the database developed as part of this project. The overall database structure includes a sample or master table, data tables and reference tables.

After collection of the data using the methods described in this handbook data should be entered into dBASE™ (III+ or higher) using an IBM compatible computer. The structure of the Manta Tow data is shown in Figure 27. Information describing the sample is stored in the sample table and a unique sample identifier (SAMPLE_ID) is allocated. The data collected during manta tows are recorded in the Manta Tow table using the allocated SAMPLE_ID. Ambient data collected also have an entry in the sample table and are allocated a unique SAMPLE_ID. Ambient data are recorded in the Ambient table.

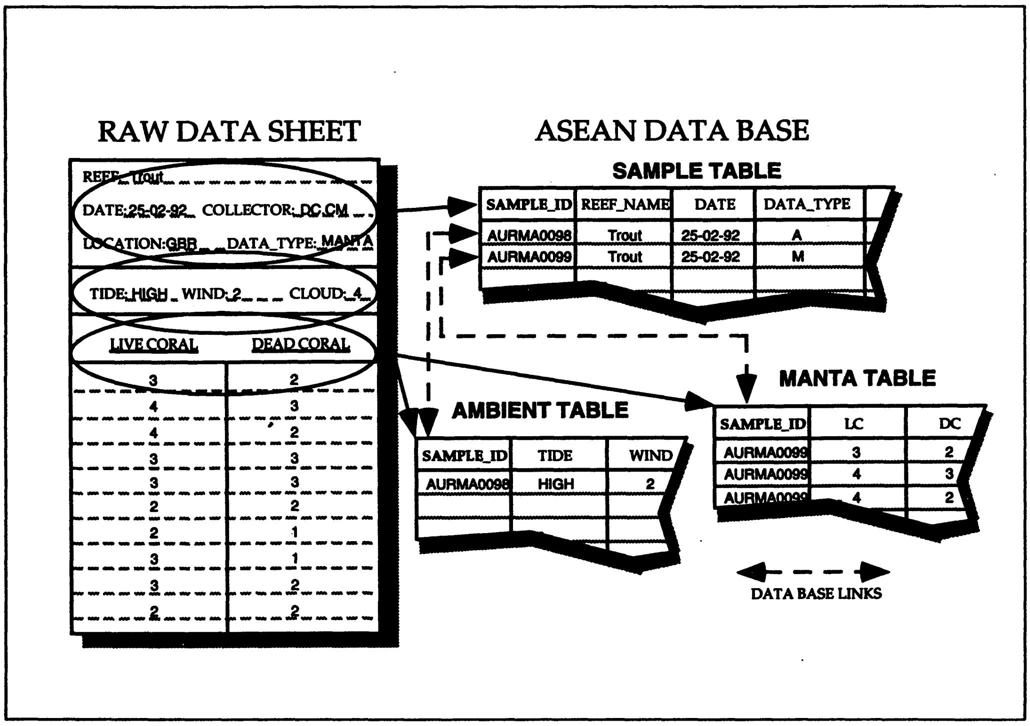

Figure 27. Manta Tow database structure.

Similarly, the LIT data structure (Fig. 28) is cross-referenced using the sample identifier as the linking field. Data collected at the time of sampling are entered into the Sample and LIT tables. The use of a reference table allows codes to be used in the data tables (e.g. species codes) which can be expanded for full referencing when data are retrieved. Ambient data collected also have an entry in the sample table where they are allocated a unique SAMPLE_ID. Ambient data are recorded in the Ambient table.

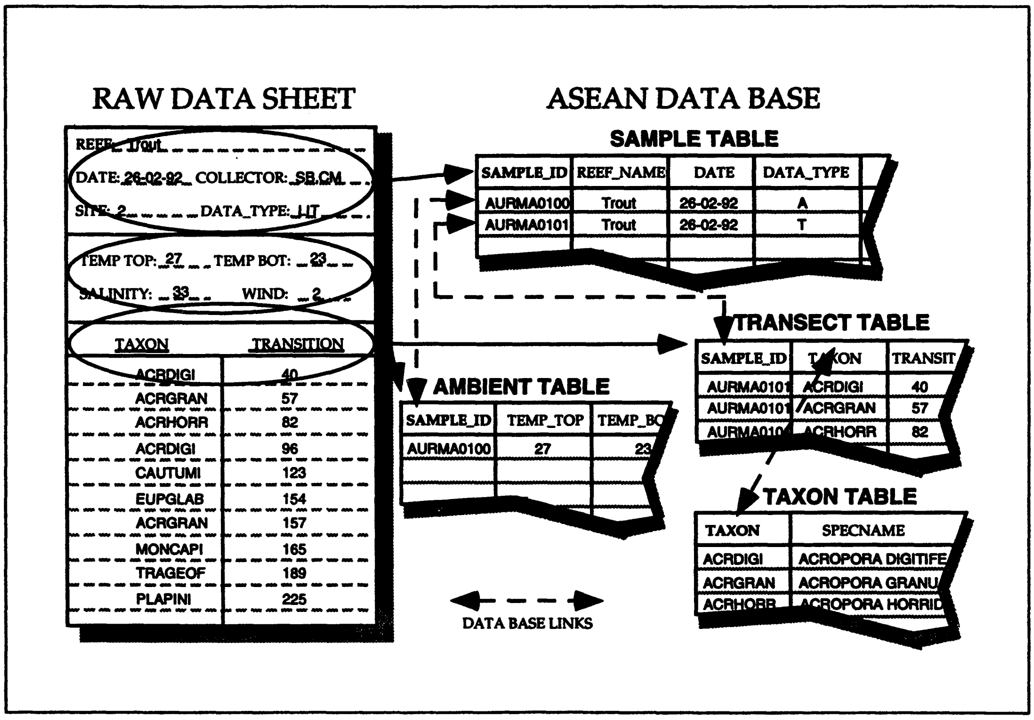

Figure 28. Line Intercept Transect database structure.

Sample Table

(Filename: XXCRSAMP.DBF)

Field Name	Type	Width	Dec	Description
SAMPLE_ID	Character	9		The standard sample identification. This links the sample table to the data files. Format CCGGXnnnn: CC = country code. See ISO codes in Appendix III. GG = study group code X = subgroup nnnn = running number
LOCATION	Character	30		Location name e.g. Seribu Islands
REEF_NAME	Character	25		Name of the reef surveyed (e.g. Malinjo, which is part of the Seribu Islands)
DATE	Date	8		Date when the data were gathered.
LATITUDE	Character	7		Latitude (AABBCCD) AA = latitude in degrees BB = latitude in minutes CC = latitude in seconds D = N (north) or S (south)
LONGITUDE	Character	8		Longitude (AAABBCCD) AAA = longitude in degrees BB = longitude in minutes CC = longitude in seconds D = E (east) or W (west)
REEF_ZONE	Character	8		The zone of the reef sampled: FLAT = reef flat; CREST = reef crest; SLOPE = reef slope; BASE = base of slope; LAGOON = lagoon. The above zone classifications may be prefixed by F=front, B=back, S=sheltered, E=exposed or P=pass or channel; e.g., EFLAT for exposed reef flat, BSLOPE for back reef slope.
DATA_TYPE	Character	1		A data code denoting the nature of the sample. Codes are listed listed in DATACODE.DBF.
DEPTH_M	Numeric	5	2	Depth (meters) of the sampling site
COLLECTORS	Character	40		Name(s) of the data collectors and their tasks.
REMARKS	Character	50		Additional observations regarding the site and the data.

Ambient parameters table [data table]

(Filename: XXCRADAT.DBF)

Field Name	Type	Length	Dec	Description
SAMPLE_ID	Character	9		The standard sample identification which links the data to the sample table. Format CCGGXnnnn: C C= country code. See ISO codes in Appendix III. GG = study group code X = subgroup nnnn = running number
TEMP_TOP	Numeric	5	2	Temperature reading at the top of the water column, °C
TEMP_BOT	Numeric	5	2	Temperature reading at the bottom of the water column, °C
SALN_TOP	Numeric	5	2	Salinity reading at the top of the water column measured in ppt
SALN_BOT	Numeric	5	2	Salinity reading at the bottom of the water column measured in ppt
SECCHI	Numeric	5	2	Visible depth of the standard secchi disc in centimetres
LICOR	Numeric	6	0	Light penetration of the water measures with a portable light-meter (LICOR) in μmoles/m^2/sec
CLOUDCOVER	Numeric	1		Cloud cover in oktas, see Table 1 for categories (0-8)
WIND	Numeric	1		Modified Beaufort scale for wind force and sea state as listed in DATACODE.DBF, see Table 2 for categories

Manta tow data table [data table]

(Filename: XXCRMDAT.DBF)

Field Name	Type	Length	Dec	Description
SAMPLE_ID	Character	9		The standard sample identification. This links to the sample table and is the same for all the tows which make up the survey of the reef perimeter. Format CCGGXnnnn: CC = country code. See ISO codes in Appendix III. GG = study group code X = subgroup nnnn = running number
TOWNBR	Numeric	3		Tow number, allocated sequentially for each 2-minute tow conducted at each reef
LC	Numeric	1		Live coral cover, score (0-5). See Table 3 for categories
SC	Numeric	1		Soft coral cover, score (0-5). See Table 3 for categories
DC	Numeric	1		Dead coral cover, score (0-5). See Table 3 for categories
VIS	Numeric	1		Visibility code (1-4). See Table 6 for categories
OTHERS	Character	40		General remarks on other reef-associated organisms or other observations (e.g. dominant lifeforms or taxa, dynamite fishing sites, fish abundance, etc.).

Line Intercept Transect data [data table]

Filename: XXCRTDAT.DBF

Field Name	Type	Length	Dec	Description
SAMPLE_ID	Character	9		The standard sample identification. This links to the sample table. All replicates transects will have the same sample_id. Format CCGGXnnnn: CC= country code. See ISO codes in Appendix III. GG = study group code X = subgroup nnnn = running number.
REPLICATE	Numeric	2		Number of the replicate transect
BENTHOS	Character	3		Code for benthic lifeform along the transect (Table 7).
TRANSITION	Numeric	5		The transition points along the transect in centimetres
OCCURRENCE	Numeric	1		Number of occurrences for a lifeform. If a single lifeform intercepts the transect more than once, an occurrence value of "1" is given for its first intercept, "2" for its second, "3" for the third and so on. Single occurrences are given the default value of "0"
LENGTH	Numeric	5		Length of the lifeform in centimetres (calculated by the lifeform program). This program is available from the Chairman of the Management Committee, Living Coastal Resources Project*
TAXON	Character	8		Taxonomic code name for the coral listed in the file TAXCODE.dbf (refer to Appendix II)

* Dr. Suraphol Sudara, Chairman, ASEAN-Australia Marine Science Project: Living Coastal Resources, Department of Marine Science, Chulalongkorn University, Bangkok 10500, Thailand.

Taxonomic codes for coral species data [reference table]

Filename: TAXCODE.DBF

Field Name	Type	Length	Dec	Description
TAXON	Character	7		Species code using format XXXYYYY, where: XXX = generic code YYYY = species code.
SPECNAME	Character	40		Scientific name i.e. latin binomial
AUTHORITY	Character	40		The authority for the taxonomy used. This provides information essential in areas of rapidly changing scientific nomenclature.
REF_CODE	Character	25		Reference code for the physical reference specimen. Must have the location and identification code (e.g. museum catalogue number).
FAMILY	Character	40		Higher order classifications to support analysis of groups where the taxonomy is not well understood.
CLASS	Character	40		see Family
PHYLA	Character	40		see Family
REMARKS	Character	20		

APPENDIX II. Coral Codes

Species Name	Code
Acanthastrea echinata	ACA ECHI
Acanthastrea hillae	ACA HILL
Acanthastrea lordhowensis	ACA LORD
Acanthastrea rotundoflora	ACA ROTF
Acrhelia horrescens	ACH HORC
Acropora aculeus	ACR ACUL
Acropora acuminata	ACR ACUM
Acropora anthocercis	ACR ANTH
Acropora aspera	ACR ASPE
Acropora austera	ACR AUST
Acropora brueggemanni	ACR BRUE
Acropora carduus	ACR CARD
Acropora caroliniana	ACR CARO
Acropora cerealis	ACR CERE
Acropora chesterfieldensis	ACR CHES
Acropora clathrata	ACR CLAT
Acropora copiosa	ACR COPI
Acropora cuneata	ACR CUNE
Acropora cytherea	ACR CYTH
Acropora danai	ACR DANA
Acropora dendrum	ACR DEND
Acropora digitifera	ACR DIGI
Acropora divaricata	ACR DIVA
Acropora donei	ACR DONE
Acropora echinata	ACR ECHI
Acropora elseyi	ACR ELSE
Acropora exquisita	ACR EXQU
Acropora florida	ACR FLOR
Acropora formosa	ACR FORM
Acropora gemmifera	ACR GEMF
Acropora grandis	ACR GRAD
Acropora granulosa	ACR GRAN
Acropora horrida	ACR HORR
Acropora humilis	ACR HUMI
Acropora hyacinthus	ACR HYAC

Species Name	Code
Acropora kirstyae	ACR KIRS
Acropora latistella	ACR LATI
Acropora listeri	ACR LIST
Acropora longicyathus	ACR LONG
Acropora loripes	ACR LORI
Acropora lovelli	ACR LOVE
Acropora lutkeni	ACR LUTK
Acropora magnifica	ACR MAGN
Acropora microclados	ACR MICL
Acropora microphthalma	ACR MICP
Acropora millepora	ACR MILL
Acropora monticulosa	ACR MONT
Acropora multiacuta	ACR MULA
Acropora nana	ACR NANA
Acropora nasuta	ACR NASU
Acropora nobilis	ACR NOBI
Acropora palifera	ACR PALI
Acropora paniculata	ACR PANI
Acropora parilis	ACR PARI
Acropora pruinosa	ACR PRUI
Acropora pulchra	ACR PULC
Acropora rambleri	ACR RAMB
Acropora robusta	ACR ROBU
Acropora samoensis	ACR SAMO
Acropora sarmentosa	ACR SARM
Acropora secale	ACR SECA
Acropora selago	ACR SELA
Acropora solitaryensis	ACR SOLT
Acropora spicifera	ACR SPIC
Acropora stoddarti	ACR STOD
Acropora subglabra	ACR SUBG
Acropora subulata	ACR SUBU
Acropora tenella	ACR TENE
Acropora tenuis	ACR TENI
Acropora teres	ACR TERE

Species Name	Code
Acropora valenciennesi	ACR VANE
Acropora valida	ACR VALI
Acropora vaughani	ACR VAUG
Acropora verweyi	ACR VERW
Acropora willisae	ACR WILL
Acropora yongei	ACR YONG
Alveopora allingi	ALV ALLI
Alveopora catalai	ALV CATA
Alveopora excelsa	ALV EXCE
Alveopora fenestrata	ALV FENE
Alveopora marionensis	ALV MARI
Alveopora spongiosa	ALV SPON
Alveopora tizardi	ALV TIZA
Alveopora verrilliana	ALV VERL
Anacropora forbesi	ANA FORB
Anacropora matthaii	ANA MATT
Anacropora puertogalerae	ANA PUER
Anacropora reticulata	ANA RETC
Anacropora spinosa	ANA SPIN
Astreopora cucullata	AST CUCU
Astreopora explanata	AST EXPL
Astreopora gracilis	AST GRAC
Astreopora listeri	AST LIST
Astreopora myriophthalma	AST MYRI
Astreopora ocellata	AST OCET
Astreopora suggesta	AST SUGG
Ausralogyra zelli	AUS ZELL
Australomussa rowleyensis	AUM ROWL
Barabattoia amicorum	BAR AMIC
Blastomussa merleti	BLA MERL
Blastomussa wellsi	BLA WELL
Cataphyllia jardinei	CAT JARD
Caulastrea curvata	CAU CURV
Caulastrea echinulata	CAU ECHU
Caulastrea furcata	CAU FURC
Caulastrea tumida	CAU TUMI
Coeloseris mayeri	COE MAYE
Coscinaraea columna	COS COLU

Species Name	Code
Coscinaraea crassa	COS CRAS
Coscinaraea exesa	COS EXES
Coscinaraea wellsi	COS WELL
Cycloseris costulata	CYC COST
Cycloseris cyclolites	CYC CYCL
Cycloseris erosa	CYC EROS
Cycloseris hexagonalis	CYC HEXA
Cycloseris marginata	CYC MARG
Cycloseris patelliformis	CYC PATE
Cycloseris sinensis	CYC SINE
Cycloseris somervillei	CYC SOME
Cycloseris vaughani	CYC VAUG
Cynarina lacrymalis	CYA LACR
Cyphastrea agassizi	CYP AGAS
Cyphastrea chalcidicum	CYP CHAL
Cyphastrea glomerata	CYP GLOM
Cyphastrea japonica	CYP JAPO
Cyphastrea microphthalma	CYP MICP
Cyphastrea ocellina	CYP OCEN
Cyphastrea serailia	CYP SERA
Cyphastrea tanabensis	CYP TANA
Diaseris distorta	DIA DIST
Diaseris fragilis	DIA FRAG
Diploastrea heliopora	DIP HELP
Echinophyllia aspera	ECL ASPE
Echinophyllia echinata	ECL ECHI
Echinophyllia echinoporoides	ECL ECHP
Echinophyllia orpheensis	ECL ORPH
Echinophyllia patula	ECL PATU
Echinopora gemmacea	ECH GEMC
Echinopora hirsutissima	ECH HIRM
Echinopora horrida	ECH HORR
Echinopora lamellosa	ECH LAMO
Echinopora mammiformis	ECH MAMM
Euphyllia ancora	EUP ANCO
Euphyllia cristata	EUP CRIS
Euphyllia divisa	EUP DIVI
Euphyllia glabrescens	EUP GLAB

Species Name	Code
Euphyllia yaeyamaensis	EUP YAEY
Favia danae	FAV DANE
Favia favus	FAV FAVU
Favia helianthoides	FAV HELI
Favia laxa	FAV LAXA
Favia lizardensis	FAV LIZA
Favia maritima	FAV MART
Favia matthaii	FAV MATI
Favia maxima	FAV MAXI
Favia pallida	FAV PALL
Favia rotumana	FAV ROTU
Favia rotundata	FAV ROTD
Favia speciosa	FAV SPEC
Favia stelligera	FAV STEG
Favia veroni	FAV VERO
Favites abdita	FVS ABDI
Favites chinensis	FVS CHIN
Favites complanata	FVS COMP
Favites flexuosa	FVS FLEX
Favites halicora	FVS HALI
Favites pentagona	FVS PENT
Favites russelli	FVS RUSS
Fungia concinna	FUN CONC
Fungia corona	FUN CORO
Fungia danai	FUN DANA
Fungia echinata	FUN ECHI
Fungia fralinea	FUN FRAL
Fungia fungites	FUN FUNG
Fungia granulosa	FUN GRAN
Fungia horrida	FUN HORR
Fungia klunzingeri	FUN KLUN
Fungia moluccensis	FUN MOLU
Fungia paumotensis	FUN PAUM
Fungia repanda	FUN REPA
Fungia scabra	FUN SCAB
Fungia scruposa	FUN SCRU
Fungia scutaria	FUN SCUT
Fungia simplex	FUN SIMP

Species Name	Code
Fungia spinifera	FUN SPIF
Galaxea astreata	GAL ASTR
Galaxea fascicularis	GAL FASC
Gardineroseris planulata	GAR PLAN
Goniastrea aspera	GOS ASPE
Goniastrea australensis	GOS AUSE
Goniastrea edwardsi	GOS EDWA
Goniastrea favulus	GOS FAVL
Goniastrea palauensis	GOS PALA
Goniastrea pectinata	GOS PECT
Goniastrea retiformis	GOS RETF
Goniopora burgosi	GON BURG
Goniopora columna	GON COLU
Goniopora djiboutiensis	GON DJIB
Goniopora fruticosa	GON FRUT
Goniopora lobata	GON LOBA
Goniopora minor	GON MINO
Goniopora norfolkensis	GON NORF
Goniopora palmensis	GON PALM
Goniopora pandoraensis	GON PAND
Goniopora pendulus	GON PEND
Goniopora somaliensis	GON SOMA
Goniopora stokesi	GON STOK
Goniopora stutchburyi	GON STUT
Goniopora tenuidens	GON TENU
Halomitra pileus	HON PILE
Heliofungia actiniformis	HEL ACTI
Heliopora coerulea	HEP COER
Herpolitha limax	HER LIMA
Herpolitha weberi	HER WEBE
Heteropsammia cochlea	HET COCH
Hydnophora exesa	HYD EXES
Hydnophora grandis	HYD GRAD
Hydnophora microconos	HYD MICR
Hydnophora pilosa	HYD PILO
Hydnophora rigida	HYD RIGI
Leptastrea inaequalis	LER INAE
Leptastrea pruinosa	LER PRUI

Species Name	Code
Leptastrea purpurea	LER PUR
Leptastrea transversa	LER TRAN
Leptoria phrygia	LEP PHRY
Leptoseris explanata	LES EXPL
Leptoseris foliosa	LES FOLI
Leptoseris gardineri	LES GARD
Leptoseris hawaiiensis	LES HAWA
Leptoseris incrustans	LES INCR
Leptoseris mycetoseroides	LES MYCE
Leptoseris papyracea	LES PAPY
Leptoseris scabra	LES SCAB
Leptoseris solida	LES SOLI
Leptoseris yabei	LES YABE
Lithophyllon edwardsi	LIT EDWA
Lithophyllon levistei	LIT LEVI
Lithophyllon lobata	LIT LOBA
Lithophyllon undulatum	LIT UNDU
Lobophyllia corymbosa	LOB CORY
Lobophyllia hataii	LOB HATA
Lobophyllia hemprichii	LOB HEMP
Lobophyllia pachysepta	LOB PACH
Madracis kirbyi	MAD KIRB
Merulina ampliata	MER AMPL
Merulina scabricula	MER SCAB
Millepora exaesa	MIL EXAE
Montastrea annuligera	MOR ANNU
Montastrea curta	MOR CURT
Montastrea magnistellata	MOR MAGL
Montastrea multipunctata	MOR MULP
Montastrea valenciennesi	MOR VANE
Montipora aequituberculata	MON AEQU
Montipora altasepta	MON ALTS
Montipora angulata	MON ANGU
Montipora cactus	MON CACT
Montipora caliculata	MON CALC
Montipora capitata	MON CAPI
Montipora capricornis	MON CAPR
Montipora cebuensis	MON CEBU
Montipora confusa	MON CONF
Montipora corbettensis	MON CORB
Montipora crassitiberculata	MON CRAT
Montipora danae	MON DANE
Montipora digitata	MON DIGI
Montipora efflorescens	MON EFFL
Montipora effusa	MON EFFU
Montipora foveolata	MON FAVE
Montipora florida	MON FLOR
Montipora foliosa	MON FOLI
Montipora friabilis	MON FRIA
Montipora gaimardi	MON GAIM
Montipora grisea	MON GRIS
Montipora hirsuta	MON HIRS
Montipora hispida	MON HISP
Montipora hoffmeisteri	MON HOFF
Montipora informis	MON INFO
Montipora mactanensis	MON MACT
Montipora malampaya	MON MALA
Montipora millepora	MON MILL
Montipora mollis	MON MOLL
Montipora monasteriata	MON MONA
Montipora orientalis	MON ORIE
Montipora peltiformis	MON PELI
Montipora samarensis	MON SAMA
Montipora setosa	MON SETO
Montipora spongodes	MON SPOG
Montipora spumosa	MON SPUM
Montipora stellata	MON STEL
Montipora tuberculosa	MON TUBE
Montipora turgescens	MON TURG
Montipora undata	MON UNDA
Montipora venosa	MON VENO
Montipora verrucosa	MON VERR
Mycedium elephantotus	MYC ELEP
Mycedium robokaki	MYC ROBO
Oulastrea crispata	OUR CRIS
Oulophyllia bennettae	OUL BENN

Species Name	Code
Oulophyllia crispa	OUL CRIS
Oxypora crassispinosa	OXY CRAP
Oxypora glabra	OXY GLAB
Oxypora lacera	OXY LACE
Pachyseris gemmmae	PAC GEMM
Pachyseris rugosa	PAC RUGO
Pachyseris speciosa	PAC SPEC
Palauastrea ramosa	PAL RAMO
Pavona bipartita	PAV BIPA
Pavona cactus	PAV CACT
Pavona clavus	PAV CLAV
Pavona danai	PAV DANA
Pavona decussata	PAV DECU
Pavona explanulata	PAV EXPN
Pavona frondifera	PAV FROF
Pavona maldivensis	PAV MALD
Pavona minuta	PAV MINU
Pavona varians	PAV VARI
Pavona venosa	PAV VENO
Pectinia alcicornis	PEC ALCI
Pectinia lactuca	PEC LACT
Pectinia paeonia	PEC PAEO
Pectinia teres	PEC TERE
Physogyra lichtensteini	PHY LICT
Physophyllia ayleni	PHI AYLE
Platygyra daedalea	PLA DAED
Platygyra lamellina	PLA LAME
Platygyra pini	PLA PINI
Platygyra ryukyuensis	PLA RYUK
Platygyra sinensis	PLA SINE
Platygyra verweyi	PLA VERW
Plerogyra eurysepta	PLE EURY
Plerogyra exerta	PLE EXER
Plerogyra simplex	PLE SIMP
Plerogyra sinuosa	PLE SINU
Plerogyra turbida	PLE TURB
Plesiastrea versipora	PLS VERS
Pocillopora damicornis	POC DAMI

Species Name	Code
Pocillopora eydouxi	POC EYDO
Pocillopora meandrina	POC MEAN
Pocillopora verrucosa	POC VERR
Pocillopora woodjonesi	POC WOOD
Podabacia crustacea	POD CRUS
Polyphyllia talpina	POL TALP
Porites annae	POR ANNA
Porites aranetai	POR ARAN
Porites attenuata	POR ATTE
Porites australiensis	POR AUSA
Porites cf. evermanni	POR EVER
Porites cumulatus	POR CUMU
Porites cylindrica	POR CYLI
Porites deformis	POR DEFO
Porites eridani	POR ERID
Porites horizontalata	POR HORI
Porites latistellata	POR LATI
Porites lichen	POR LICH
Porites lobata	POR LOBA
Porites lutea	POR LUTE
Porites mayeri	POR MAYE
Porites murrayensis	POR MURR
Porites nigrescens	POR NIGR
Porites rus	POR RUS
Porites sillimaniana	POR SILL
Porites solida	POR SOLI
Porites stephensoni	POR STEP
Porites tenuis	POR TENI
Porites vaughani	POR VAUG
Psammocora contigua	PSA CONT
Psammocora digitata	PSA DIGI
Psammocora explanulata	PSA EXPN
Psammocora haimeana	PSA HAIM
Psammocora nierstraszi	PSA NIER
Psammocora profundacella	PSA PROF
Psammocora superficialis	PSA SUPE
Pseudosiderastrea tayami	PSE TAYA
Sandalolitha robusta	SAN ROBU

Species Name	Code
Scapophyllia cylindrica	SCA CYLI
Scolymia vitiensis	SCO VITI
Seriatopora caliendrum	SER CALE
Seriatopora hystrix	SER HYST
Siderastrea savignyana	SID SAVI
Stylocoeniella armata	STL ARMA
Stylocoeniella guentheri	STL GUEN
Stylophora pistillata	STY PIST
Symphyllia agaricia	SYM AGAR
Symphyllia radians	SYM RADI
Symphyllia recta	SYM RECT
Symphyllia valenciennesii	SYM VANI
Trachyphyllia geoffroyi	TRA GEOF
Tubastraea aurea	TUB AURE
Turbinaria frondens	TUR FRON
Turbinaria heronensis	TUR HERO
Turbinaria irregularis	TUR IRRE
Turbinaria mesenterina	TUR MESE
Turbinaria peltata	TUR PELT
Turbinaria radicalis	TUR RADI
Turbinaria reniformis	TUR RENI
Turbinaria stellulata	TUR STUA
Zoopilus echinatus	ZOO ECHS

APPENDIX III. Country Codes (last updated November 1986)

Full Name	Short Name	Codes	
		CMC	ISO
EUROPE	Europe	AY*	
EUROPEAN ECONOMIC COMMUNITY	E.E.C.	AZ*	
ALBANIA	Albania	BA	AL
ANDORRA	Andorra	BB	AD
AUSTRIA	Austria	BC	AT
BELGIUM	Belgium	BE	BE
BULGARIA	Bulgaria	BF	BG
CZECHOSLOVAKIA	Czechoslovakia	BI	CS
DENMARK	Denmark	BJ	DK
DENMARK - Faeroe Is	Faeroe Is	BK	FO
FINLAND	Finland	BL	FI
FRANCE	France	BM	FR
FRANCE - Corsica	Corsica	BH	FR
GERMAN DEMOCRATIC REPUBLIC	G.D.R.	BO	DD
GERMANY, FEDERAL REPUBLIC OF	F.R.G.	BN	DE
GREECE	Greece	BQ	GR
HUNGARY	Hungary	BR	HU
ICELAND	Iceland	BS	IS
IRELAND	Ireland	BT	IE
ITALY	Italy	BU *	IT
ITALY - Sardinia	Sardinia	CF	IT
ITALY - Sicily	Sicily	CE	IT
LIECHTENSTEIN	Liechtenstein	BV	LI
LUXEMBOURG	Luxembourg	BW	LU
MALTA	Malta	BX	MT
MONACO	Monaco	BY	MC
NETHERLANDS	Netherlands	BZ	NL
NORWAY	Norway	CA *	NO
NORWAY - Svalbard and Jan Meyen	Svalbard	CM	SJ
POLAND	Poland	CB	PL
PORTUGAL	Portugal	CC *	PT
ROMANIA	Romania	CD	RO
SAN MARINO	San Marino	CS	SM
SPAIN	Spain	CG *	ES
(Includes Alboran, not covered by Flora Europaea)			
SPAIN - Balearic Islands	Balearic Is.	BD	ES
SWEDEN	Sweden	CH	SE
SWITZERLAND	Switzerland	CI	CH

Full Name	Short Name	Codes CMC	ISO
UNITED KINGDOM	U.K.	CJ *	GB
UNITED KINGDOM - Channel Islands	Channel Is.	BG	GB
UNITED KINGDOM - Alderney C.I.	Alderney	CN	GB
UNITED KINGDOM - Guernsey C.I.	Guernsey	CO	GB
UNITED KINGDOM - Herm C.I.	Herm	CP	GB
UNITED KINGDOM - Jersey C.I.	Jersey	CQ	GB
UNITED KINGDOM - Sark C.I.	Sark	CR	GB
UNITED KINGDOM - Gibraltar	Gibraltar	BP	GI
VATICAN CITY	Vatican City	CL	VA
YUGOSLAVIA	Yugoslavia	CK	YU
NORTH AFRICA and MIDDLE EAST	N.Afr. & Mid.E.	CZ *	
ALGERIA	Algeria	DA	DZ
BAHRAIN	Bahrain	DC	BH
CYPRUS	Cyprus	DE	CY
EGYPT	Egypt	DF	EG
ISRAEL	Israel	DG	IL
JORDAN	Jordan	DH	JO
KUWAIT	Kuwait	DJ	KW
LEBANON	Lebanon	DK	LB
LIBYA	Libya	DL	LY
MOROCCO	Morocco	DN	MA
NEUTRAL ZONE (Saudi Arabia - Iraq)	Neutral Zone	DW	NT
(Included for conformity with ISO, however we believe that this area no longer exists following the settlement of the dispute between the two countries)			
OMAN	Oman	DP	OM
PORTUGAL - Azores	Azores	DB	PT
PORTUGAL - Madeira	Madeira	DM	PT
PORTUGAL - Salvage Islands	Salvage Islands	DR	PT
QATAR	Qatar	DQ	QA
SAUDI ARABIA	Saudi Arabia	DS	SA
SPAIN - Canary Islands	Canary Is	DD	ES
SYRIA	Syria	DT	SY
TUNISIA	Tunisia	DU	TN
TURKEY	Turkey	DV	TR
UNITED ARAB EMIRATES	U.A.E.	DX	AE
(Includes Abu Dhabi, Ajman, Dubai, Fujairah, Ras al Khaimah, Sharjah and Umm al Quaiwain)			
YEMEN	N. Yemen	DY	YE
YEMEN, DEMOCRATIC	S. Yemen	DZ*	YD
TROPICAL AFRICA	Tropical Africa	OZ *	

Full Name	Short Name	Codes CMC	ISO
ANGOLA	Angola	PA	AO
BURKINA FASO	Burkina Feso	QQ	BF
BURUNDI	Burundi	PC	BI
CAMEROON	Cameroon	PD	CM
CAPE VERDE ISLANDS	Cape Verde Is.	PE	CV
CENTRAL AFRICAN FREPUBLIC	C. African Rep.	PF	CF
CHAD	Chad	PG	TD
CONGO	Congo	PH	CG
COTE D'IVOIRE	Cote D'ivoire	PS	CI
DJIBOUTI	Djibouti	PJ	DJ
EQUATORIAL GUINEA	Eq. Guinea	PK *	GQ
(includes Rio Muni, Corisco, Elobey Chico and Elobey Grande)			
EQUATORIAL GUINEA - Bioko (Fernando Po)	Bioko	PI	GQ
EQUITORIAL GUINEA - Pagalu	Pagalu *	PO	GQ
ETHIOPIA	Ethiopia	PL	ET
GABON	Gabon	PM	GA
GAMBIA	Gambia	PN	GM
GHANA	Ghana	PP	GH
GUINEA	Guinea	PQ	GN
GUINEA-Bissau	Guinea - Bissau	PR	GW
KENYA	Kenya	PT	KE
LIBERIA	Liberia	PU	LR
MALAWI	Malawi	PV	MW
MALI	Mali	PW	ML
MAURITANIA	Mauritania	PX	MR
MOZAMBIQUE	Mozambique	PY	MZ
NIGER	Niger	PZ	NE
NIGERIA	Nigeria	QA	NG
RWANDA	Rwanda	QC	RW
SAO TOME	Sao Tome	QD *	ST
SAO TOME - Principe	Principe	QB	ST
SENEGAL	Senegal	QE	SN
SIERRA LEONE	Sierra Leone	QF	SL
SOMALIA	Somalia	QG	SO
SUDAN	Sudan	QJ	SD
TANZANIA	Tanzania	QK *	TZ
TANZANIA - Pemba Island	Pemba I.	QL	TZ
TANZANIA - Zanzibar	Zanzibar	QM	TZ
TOGO	Togo	QN	TG
UGANDA	Uganda	QP	UG
WESTERN SAHARA	Western Sahara	QH	EH

Full Name	Short Name	Codes CMC	ISO
ZAIRE	Zaire	QR	ZR
ZAMBIA	Zambia	QS	ZM
ZIMBABWE	Zimbabwe	QT	ZW
SOUTHERN AFRICA	Southern Africa	RM *	
BOTSWANA	Botswana	RB	BW
LESOTHO	Lesotho	RD	LS
NAMIBIA	Namibia	RE	NA
SOUTH AFRICA	South Africa	RL *	ZA
SOUTH AFRICA - Bophuthatswana	Bophuthatswana	RA	ZA
SOUTH AFRICA - Cape Province	Cape Province	RC	ZA
SOUTH AFRICA - Ciskei	Ciskei	RI	ZA
SOUTH AFRICA - Natal	Natal	RF	ZA
SOUTH AFRICA - Orange Free State	Orange Free State	RG	ZA
SOUTH AFRICA - Transkei	Transkei	RJ	ZA
SOUTH AFRICA - Transvaal	Transvaal	RK	ZA
SOUTH AFRICA - Venda	Venda	QZ	ZA
SWAZILAND	Swaziland	RH	SZ
U.S.S.R., CHINA and MONGOLIA	USSR, China etc	FJ *	
CHINA	China	EZ *	CN
CHINA - Anhui Province	Anhui	FA	CN
CHINA - Fujian Province	Fujian	FB	CN
CHINA - Gansu Province	Gansu	FC	CN
CHINA - Guangdong - Hainan Island	Hainan Island	EX	CN
CHINA - Guangdong Province	Guangdong	FD *	CN
CHINA - Guangxi Autonomous Region	Guangxi	FE	CN
CHINA - Guizhou Province	Guizhou	FF	CN
CHINA - Hebei Province	Hebei	FG	CN
CHINA - Heilongjiang Province	Heilongjiang	FH	CN
CHINA - Henan Province	Henan	FI	CN
CHINA - Hubei Province	Hubei	FK	CN
CHINA - Hunan Province	Hunan	FL	CN
CHINA - Jiangsu Province	Jiangsu	FM	CN
CHINA - Jiangxi Province	Jiangxi	FN	CN
CHINA - Jilin Province	Jilin	FO	CN
CHINA - Liaoning Province	Liaoning	FP	CN
CHINA - Nei Monggol Zizhiqu A.R.	Nei Monggol	FQ	CN
CHINA - Ningxia Autonomous Region	Ningxia	FR	CN
CHINA - Qinghai Province	Qinghai	FS	CN
CHINA - Shaanxi Province	Shaanxi	FT	CN
CHINA - Shandong Province	Shandong	FU	CN

Full Name	Short Name	Codes	
		CMC	ISO
CHINA - Shanxi Province	Shanxi	FV	CN
CHINA - Sichuan Province	Sichuan	FW	CN
CHINA - Xinjiang Uygur Zizhiqu A.R.	Xinjiang Uygur	FY	CN
CHINA - Xizang Zizhiqu Autonomous Region	Xizang Zizhiqu	FZ	CN
CHINA - Yunnan Province	Yunnan	FX	CN
CHINA - Zhejiang Province	Zhejiang	GA	CN
MONGOLIA	Mongolia	EY	MN
UNION OF SOVIET SOCIALIST REPUBLICS	U.S.S.R.	EA *	SU
ARCTIC U.S.S.R.	Arctic USSR	ET *	SU
ASIATIC U.S.S.R	Asiatic U.S.S.R.	EC *	SU
EUROPEAN U.S.S.R.	European U.S.S.R.	EB *	SU
U.S.S.R. - Armenia S.S.R.	Armenia	ED	SU
U.S.S.R. - Azerbaydzhan S.S.R.	Azerbaydzhan	EF	SU
U.S.S.R. - Byelorussian S.S.R.	Byelorussian	EG	BY
U.S.S.R. - Estonia S.S.R.	Estonia	EH	SU
U.S.S.R. - Georgia S.S.R.	Georgia (USSR)	EI	SU
U.S.S.R. - Kazakhstan S.S.R.	Kazakhstan	EJ	SU
U.S.S.R. - Kirghizia S.S.R.	Kirghizia	EK	SU
U.S.S.R. - Kurilskye Islands	Kurilskye Is.	EU	SU
U.S.S.R. - Latvia S.S.R.	Latvia	EL	SU
U.S.S.R. - Lithuania S.S.R.	Lithuania	EM	SU
U.S.S.R. - Moldavia S.S.R.	Moldavia	EN	SU
U.S.S.R. - R.S.F.S.R.	R.S.F.S.R.	EO	SU
U.S.S.R. - Sakhalin	Sakhalin	EV	SU
U.S.S.R. - Tadzhikistan S.S.R.	Tadzhikistan	EP	SU
U.S.S.R. - Turkmenistan S.S.R.	Turkmenistan	EQ	SU
U.S.S.R. - Ukranian S.S.R.	Ukraine	ER	UA
U.S.S.R. - Uzbekistan S.S.R.	Uzbekistan	ES	SU
MIDDLE ASIA to INDOCHINA and JAPAN	Middle Asia	GK *	
AFGHANISTAN	Afghanistan	GB	AF
BANGLADESH	Bangladesh	GC	BD
BHUTAN	Bhutan	GD	BT
BURMA - Myanmar	Burma	GE	BU
HONG KONG	Hong Kong	GF	HK
INDIA	India	GG	IN
INDIA - Andhra Pradesh State	Andhra Pradesh	IA	IN
INDIA - Arunachal Pradesh Union Terr	Arunachal Prad.	IB	IN
INDIA - Assam State	Assam	IC	IN
INDIA - Bihar State	Bihar	ID	IN
INDIA - Chandigarh Union Territory	Chandigarh	IZ	IN

Full Name	Short Name	Codes CMC	ISO
INDIA - Dadra & Nagar Haveli Union Terr.	Dadra & Nagar H	GH	IN
INDIA - Delhi Union Territory	Delhi	GI	IN
INDIA - Goa, Daman and Diu Union Terr	Goa, Daman, Diu	IE	IN
INDIA - Gajarat State	Gajarat	IF	IN
INDIA - Haryana State	Haryana	IG	IN
INDIA - Himachal Pradesh State	Himachal Prad.	IH	IN
INDIA - Jammu and Kashmir State	Jammu & Kashmir	II	IN
INDIA - Karnataka State	Karnataka	IJ	IN
INDIA - Kerala State	Kerala	IK	IN
INDIA - Madhaya Pradesh State	Madhaya Pradesh	IL	IN
INDIA - Maharashtra State	Maharashtra	IM	IN
INDIA - Manipur State	Manipur	IN	IN
INDIA - Meghalaya State	Meghalaya	IO	IN
INDIA - Mizoram Union Territory	Mizoram	IP	IN
INDIA - Nagaland State	Nagaland	IQ	IN
INDIA - Orissa State	Orissa	IR	IN
INDIA - Pondicherry Unin Territory	Pondicherry	GJ	IN
INDIA - Punjab State	Punjab	IS	IN
INDIA - Rajasthan State	Rajasthan	IT	IN
INDIA - Sikkim State	Sikkim	IU	SK
INDIA - Tamil Nadu State	Tamil Nadu	IV	IN
INDIA - Tripura State	Tripura	IW	IN
INDIA - Uttar Pradesh State	Uttar Pradesh	IX	IN
INDIA - West Bengal State	West Bengal	IY	IN
INDO-CHINA	Indo-China	EW	
(Comprises Kampuchea, Lao PDR, Thailand and Vietnam)			
IRAN (ISLAMIC REPUBLIC OF)	Iran	GL	IR
IRAQ	Iraq	GM	IQ
JAPAN	Japan	GN *	JP
JAPAN - Hokkaido	Hokkaido	OA	JP
JAPAN - Honshu	Honshu	OB	JP
JAPAN - Kyushu	Kyushu	OE	JP
JAPAN - Shikoku	Shikoku	OC	JP
JAPAN - Ryukyu Islands	Ryukyu Is.	GV	JP
(Includes Okinawa)			
KAMPUCHEA	Kampuchea	GO	KH
KOREA, DEMOCRATIC PEOPLES REPUBLIC OF	N. Korea	GQ	KP
KOREA, REPUBLIC OF	S. Korea	GR	KR
LAO PEOPLE'S DEMOCRATIC REPUBLIC	Laos	GS	LA
MACAO	Macao	GP	MO
NEPAL	Nepal	GT	NP

Full Name	Short Name	Codes CMC	ISO
PAKISTAN	Pakistan	GU	PK
TAIWAN	Taiwan	GX	TW
THAILAND	Thailand	GY	TH
VIETNAM	Vietnam	GZ	VN
INDIAN OCEAN ISLANDS	Indian Oean Is	LX *	
AUSTRALIA - Christmas Island	Christmas I.	ME	CX
AUSTRALIA - Cocos (Keeling) Islands	Cocos Is.	MF	CC
CHAGOS ARCHIPELAGO (Brit Indian Oc Terr)	Chagos Is	MD	IO
(Includes Diego Garcia I.)			
(BRITISH INDIAN OCEAN TERRITORY)			IO
COMORO ISLANDS	Comoro Islands	MX *	ZZ
(Comprises Mayotte and Comoros)			
COMOROS	Comoros	MG	KM
(Comprises Moheli, Grand Comore and Anjouan)			
FRANCE - Mayotte	Mayotte	MV	ZZ
FRANCE - Reunion	Reunion	MM *	RE
FRANCE - Reunion - Tromelin	Tromelin	MS	RE
INDIA - Andaman Islands	Andamans	MB	IN
INDIA - Lakshadweep Union Territory	Lakshadweep	MH	IN
(Includes Laccadive, Minicoy & Amindivi Islands)			
INDIA - Nicobar Islands	Nicobar	ML	IN
MADAGASCAR	Madagascar	MI *	MG
MADAGASCAR - Glorieuses Islands	Glorieuses Is.	MU	MG
MALDIVES	Maldives	MJ	MV
MAURITIUS	Mauritius	MK *	MU
MAURITIUS - Agalega Islands	Agalega Is.	MT	MU
MAURITIUS - Cargados Carajos	Cargados Carajo	MO	MU
MAURITIS - Rodrigues	Rodrigues	MN	MU
SEYCHELLES	Seychelles	MP *	SC
SEYCHELLES - Coralline Islands	Seychelles: Cor	MA	SC
(Includes Aldabra, Aldabra group, Amirante group, Alphonse group, Providence/Farquhar group, Ile Vache de Mer, Denis I., Coëtivy Is., Platte I.)			
SEYCHELLES - Granitic Islands	Seychesses: Gra	MW	SC
(Includes Mahe group, Praslin group, Silhouette group, Frigate group, Recif I., Mamelle I., The Brisans)			
SRI LANKA	Sri Lanka	MR	LK
YEMEN - SOCOTRA	Socotra	MQ	YD
(Includes Abd al Kuri)			
SOUTH EAST ASIA to PAPUA NEW GUINEA	S.E. Asia to PNG	HW *	
BORNEO	Borneo	HH *	ZZ

Full Name	Short Name	Codes CMC	ISO
BRUNEI DARUSSALAM	Brunei	HA	BN
EAST TIMOR	East Timor	HX	TP
(Included for conformity with ISO list, however we understand that it no longer exists as a country in its own right, but has been subsumed within Indonesia (ie INDONESIA - Lesser Sunda Islands)			
INDONESIA	Indonesia	HB *	ID
INDONESIA - Irian Jaya	Irian Jaya	HK	ID
INDONESIA - Java	Java	HL	ID
INDONESIA - Kalimantan	Kalimantan	HM	ID
INDONESIA - Lesser Sunda Islands	Lesser Sunda Is	HN	ID
INDONESIA - Moluccas	Moluccas	HP	ID
INDONESIA - Sulawesi	Sulawesi	HT	ID
INDONESIA - Sumatra	Sumatra	HU	ID
MALAYSIA	Malaysia	HC *	MY
MALAYSIA - Peninsular Malaysia	Pen Malaysia	HQ	MY
MALAYSIA - Sabah	Sabah	HR	MY
MALAYSIA - Sarawak	Sarawak	HS	MY
PAPUA NEW GUINEA	P.N.G.	HD *	PG
PAPUA NEW GUINEA - Bismarck Archipelago (Includes Admiralty Islands)	Bismarck Arch.	HG	PG
PAPUA NEW GUINEA - Bougainville	Bougainville	HI	PG
PAPUA NEW GUINEA - D'entrecasteaux Is.	D'entrecasteaux	HJ	PG
PAPUA NEW GUINEA - Louisiade Archipelago	Louisiade Arch	HO	PG
PAPUA NEW GUINEA - Trobriand Islands	Troubriand Is	HV	PG
PHILIPPINES	Philippines	HE *	PH
PHILIPPINES - Bohol	Bohol	RN	PH
PHILIPPINES - Cebu	Cebu	RO	PH
PHILIPPINES - Leyte	Leyte	RP	PH
PHILIPPINES - Luzon	Luzon	RQ	PH
PHILIPPINES - Masbate	Masbate	RR	PH
PHILIPPINES - Mindanao	Mindanao	RS	PH
PHILIPPINES - Mindoro	Mindoro	RT	PH
PHILIPPINES - Negros	Negros	RU	PH
PHILIPPINES - Palawan	Palawan	RV	PH
PHILIPPINES - Panay	Panay	RW	PH
PHILIPPINES - Samar	Samar	RX	PH
SINGAPORE	Singapore	HF	SG
AUSTRALIA and NEW ZEALAND	Australia, NZ	HZ *	
AUSTRALIA	Australia	JA *	AU
AUSTRALIA - Ashmore & Cartier Islands	Ashmore/Cartier	JO	AU
AUSTRALIA - Capital Territory	A.C.T.	JB	AU

Full Name	Short Name	Codes CMC	ISO
AUSTRALIA - Coral Sea Islands Territory	Coral Sea Is	JK	AU
AUSTRALIA - New South Wales	N.S.W.	JF *	AU
AUSTRALIA - NSW - Lord Howe Island	Lord Howe I	JE	AU
AUSTRALIA - Norfolk Island	Norfolk I	JH	NF
AUSTRALIA - Northern Territory	N Territory	JJ	AU
AUSTRALIA - Queensland	Queensland	JL	AU
AUSTRALIA - South Australia	S Australia	JM	AU
AUSTRALIA - Tasmania	Tasmania	JN *	AU
AUSTRALIA - Victoria	Victoria	JP	AU
AUSTRALIA - Western Australia	W. Australia	JQ	AU
NEW ZEALAND	New Zealand	JR *	NZ
(Includes offshore islands, e.g. Three Kings, Hen and Chicken Is., Great Barrier I., The Snares)			
NEW ZEALAND - North Island	N. Island (NZ)	JS	NZ
NEW ZEALAND - South Island	S. Island (NZ)	JT	NZ
NEW ZEALAND - Chatham Islands	Chatham Is	JU	NZ
NEW ZEALAND - Kermadec Islands	Kermadec Is	JV	NZ

PACIFIC ISLANDS	Pacific Is.	JZ *	

Island groups in the Pacific present a problem because geographical and political relationships overlap to a significant extent. Thus these areas are presented as two lists - political and geographical.

Pacific Islands - political list: In this list CMC areas in the Pacific are listed in terms of their political status. The list is in two parts - areas that are political units (including island groups comprising a discreet political unit), and areas that are geographical units only (ie island groups that cross political frontiers). ***Political units*** that are subdivided by other CMC areas, are in italics, with their subsets indented beneath.

Areas that are political units:

CHILE - Easter Island	Easter I.	KL	CL
CHILE - Islas Desventurados	Desventurados	KB	CL
CHILE - Juan Fernandez	Juan Fernandez	KE	CL
COLUMBIA - Isla Del Malpelo	I. Del Malpelo	KF	CO
COOK ISLANDS	Cook Is	KK	CK
(Includes Raratonga)			
COSTA RICA - Isla Del Coco	I. Del Coco	KA	CR
ECUADOR - Galapagos	Galapagos	KC	EC
FIJI	Fiji	LQ	FJ
(Includes Rotuma, Conway Reef)			
FRANCE - Clipperton Island	Clipperton Is	KJ	PF
FRANCE - French Polynesia	Fr Polynesia	KM *	PF
FRANCE - French Polynesia - Gambier Is	Gambier Is	KN	PF
FRANCE - French Polynesia - Marquesas Is	Marquesas	KR	PF
FRANCE - French Polynesia - Society Is	Society Is	KW	PF
FRANCE - French Polynesia - Tuamotu Is	Tuamotu Is	KZ *	PF

Full Name	Short Name	Codes CMC	ISO
FRANCE - French Polynesia - Tubuai Is	Tubuai Is	LA	PF
(Includes Austral Is)			
FRANCE - New Caledonia	New Caledonia	LS	NC
FRANCE - Wallis And Futuna	Wallis & Futuna	LD	WF
HUNTER, MATTHEW AND WALPOLE ISLANDS	Walpole Group	LR	NC
JAPAN - Kazan Retto	Volcano I	LO	ZZ
JAPAN - Minama Tori Shima	Marcus Is	LK	ZZ
JAPAN - Ogasawara Shoto	Ogasawara Shoto	LG	JP
KIRIBATI	Kiribati	KQ *	KI
KIRIBATI - Banaba Island	Banaba Is	LF	KI
(Ocean I)			
KIRIBATI - Gilbert Islands	Gilbert Islands	KI	KI
KIRIBATI - Line Islands	Kirib: Line Is	JX	KI
(Includes Fanning I, Washington I, Christmas I)			
KIRIBATI - Phoenix Islands	Phoenix Is	KU	KI
(Includes islands: Birnie, Gardner, Hull, McKean, Phoenix, Sydney,Canton and Enderbury)			
MEXICO - Guadelupe	Guadelupe	KD	MX
MEXICO - Revilla Gigedo	Revilla Gigedo	KG	MX
NAURU	Nauru	LM	NR
NEW ZEALAND - Tokelau	Tokelau	KX	TK
NIUE	Niue	KT	NU
PITCAIRN	Pitcairn	KV *	PN
PITCAIRN - Ducie Island	Ducie I.	AA	PN
PITCAIRN - Henderson Island	Henderson I	AB	PN
PITCAIRN - Oeno	Oeno	AC	PN
PITCAIRN - Pitcairn Island	Pitcairn I	AD	PN
SOLOMON ISLANDS	Solomon Is	LU	SB
(Includes Santo Cruz Is)			
TONGA	Tonga	KY	TO
TRUST TERRITORY OF THE PACIFIC ISLANDS	Pac Trust Ter	LN *	ZZ
(This is apparently no longer a political entity, so use of this code should be avoided)			
FEDERATED STATES OF MICRONESIA	Micronesia	LV	FM
(Includes Caroline Is [except Palau islands group], and includes Yap, Kosrae, Truk and Panape)			
MARSHALL ISLANDS	Marshall Is	LL	MH
NORTH MARIANA ISLANDS	North Marianas	LY	MP
(Includes Mariana Is except Guam)			
PALAU	Palau	LW	PW
TUVALU	Tuvalu	LB	TV
U.S. - American Samoa	American Samoa	KB	AS
U.S. - Guam	Guam	LI	GU
U.S. - Hawaii	Hawaiian Is	KO	US

Full Name	Short Name	Codes CMC	ISO
UNITED STATES MINOR OUTLYING ISLANDS	U.S. - Minor Is	JC	UM
U.S. - Howland Island and Baker Island	Howland & Baker	LC	UM
U.S. - Johnston Island	Johnston Is	KP	UM
U.S. - Line Islands	Us - Line Is	JY	UM
(Includes Kingman Reef, Jarvis Island, and Palmyra Atoll			
U.S. - Midway Islands	Midway Is	KS	UM
U.S. - Wake Island	Wake Island	LP	UM
VANUATU	Vanuatu	LT	BU
(Includes Banks Is and Torres Is)			
WESTERN SAMOA	Western Samoa	LE	WS

Areas that are not political units:

CAROLINE ISLANDS	Caroline Is	LH *	PC
HAWAIIAN ISLANDS	Hawaiian Is	LZ *	ZZ
LINE ISLANDS	Line Islands	JW *	ZZ
MARIANA ISLANDS	Mariana Is	LJ *	PC

Pacific Islands - geographical list: In this list CMC areas in the Pacific are listed in terms of their geographical rather than political relationships. It is a crude and arbitrary representation, as any list would have to be, but a map is available which has been annotated to show the CMC areas. Papua New Guinea has been included in the list for reference, because of the proximity of its eastern island groups to the Solomon Islands, although it is not part of the PACIFIC ISLANDS CMC area. However Australia, New Zealand, the Philippines and Japan are not included, although they could also be considered adjacent to some of these islands. Areas are listed in five bands running approximately N-S, following adjacent island chains. Island groups that are subdivided by other CMC areas are underlined, with their subsets indented beneath.

PACIFIC ISLANDS	Pacific Is.	JZ *	

First band:

JAPAN - Ogasawara-Shoto	Ogasawara-Shoto	LG	JP
JAPAN - Kazan Retto	Volcano I	LO	ZZ
MARIANA ISLANDS	Mariana Is.	LJ *	ZZ
NORTH MARIANA ISLANDS	North Marianas	LY	MP
(Includes Mariana Is except Guam)			
U.S. - Guam	Guam	LI	GU
CAROLINE ISLANDS	Caroline Is	LH *	PC
FEDERATED STATES OF MICRONESIA	MICRONESIA	LV	FM
(Includes Caroline Is [except Palau Islands group], and includes Yap, Kosrae, Truk and Panape)			
PALAU	Palau	LW	PW
PAPUA NEW GUINEA	P.N.G.	HD *	PG
PAPUA NEW GUINEA - Bismarck Archipelago	Bismarck Arch.	HG	PG
(Includes Admiralty Islands)			
PAPUA NEW GUINEA - Bougainville	Bougainville	HI	PG
PAPUA NEW GUINEA - Trobriand Islands	Trobriand Is	HV	PG

Full Name	Short Name	Codes CMC	ISO
PAPUA NEW GUINEA - D'entrecasteaux Is	D'entrecasteaux	HJ	PG
PAPUA NEW GUINEA - Louisiade Archipelago	Louisiade Arch.	HO	PG
SOLOMON ISLANDS	Solomon Is	LU	SB
(Includes Santo Crux Is.)			
AUSTRALIA - Coral Sea Islands Territory	Coral Sea Is	JK	AU
FRANCE - New Caledonia	New Caledonia	LS	NC
VANUATU	Vanuatu	LT	VU
(Includes Banks Is and Torres Is)			
HUNTER, MATTHEW AND WALPOLE ISLANDS	Walpole Group	LR	NC
AUSTRALIA - NSW - Lord Howe Island	Lord Howe Is	JE	AU
AUSTRALIA - Norfolk Island	Norfolk I.	JH	NF
Second band:			
JAPAN - Minama Tori Shima	Marcus I.	LK	ZZ
U.S. - Wake Island	Wake Island	LP	UM
MARSHALL ISLANDS	Marshall Is	LL	MH
NAURU	Nauru	LM	NR
KIRIBATI - Banaba Island	Banaba I.	LF	KI
(Ocean I)			
KIRIBATI - Gilbert Islands	Gilbert Islands	KI	KI
TUVALU	Tuvalu	LB	TV
FRANCE - Wallis And Futuna	Wallis & Futuna	LD	WF
FIJI	Fiji	LQ	FJ
(Includes Rotuma, Conway Reef)			
TONGA	Tonga	KY	TO
NEW ZEALAND - Kermadec Islands	Kermadec Is	JV	NZ
Third band:			
U.S. - Howland Island And Baker Island	Howland & Baker	LC	UM
KIRIBATI - Phoenix Islands	Phoenix Is	KU	KI
(Includes Islands: Birnie, Gardner, Hill, McKean, Phoenix, Sydney, Canton and Enderbury)			
NEW ZEALAND - Tokelau	Tokelau	KX	TK
WESTERN SAMOA	Western Samoa	LE	WS
U.S. - American Samoa	American Samoa	KH	AS
NIUE	Niue	KT	NU
COOK ISLANDS	Cook Is	KK	CK
(Includes Rarotonga)			
Fourth Band:			
HAWAIIAN ISLANDS	Hawaiian Is	LZ *	ZZ
U.S. - Midway Islands	Midway Is	KS	UM

Full Name	Short Name	Codes CMC	ISO
U.S. - Hawaii	Hawaiian Is	KO	US
U.S. - Johnston Island	Johnston Is	KP	UM
LINE ISLANDS	Line Is	JW *	ZZ
U.S. - Line Islands	US - Line Is	JY	UM
(Includes Kingman Reef, Jarvis Island, and Palmyra Atoll)			
KIRIBATI - Line Islands	Kirib:Line Is	JX	KI
(Includes Fanning I, Washington I, Christmas I)			
FRANCE - FRENCH POLYNESIA	Fr. Polynesia	KM *	PF
FRANCE - French Polynesia - Marquesas Is	Marquesas	KR	PF
FRANCE - French Polynesia - Tuamotu Is	Tuamotu I	KZ *	PF
FRANCE - French Polynesia - Gambier Is	Gambier IS	KN	PF
FRANCE - French Polynesia - Society Is	Society Is	KW	PF
FRANCE - French Polynesia - Tubai Is	Tubai Is	LA	PF
(Includes Austral Is)			
PITCAIRN	Pitcairn	KV	PN
PITCAIRN - Ducie Island	Ducie I	AA	PN
PITCAIRN - Henderson Island	Henderson I	AB	PN
PITCAIRN - Oeno	Oeno	AC	PN
PITCAIRN - Pitcairn Island	Pitcairn I	AD	PN
CHILE - Easter Island	Easter I	KL	CL
CHILE - Islas Desventurados	Desventurados	KB	CL
CHILE - Juan Fernandez	Juan Fernandez	KE	CL
Fifth Band (American Coast):			
MEXICO - Guadelupe	Guadelupe	KD	MX
MEXICO - Revilla Gigedo	Revilla Gigedo	KG	MX
FRANCE - Clipperton Island	Clipperton I	KJ	PF
COSTA RICA - Isla Del Coco	I. Del Coco	KA	CR
COLOMBIA - Isla Del Malpelo	I. Del Malpelo	KF	CO
ECUADOR - Galapagos	Galapagos	KC	EC
These areas cross geographical groupings (see political list):			
KIRIBATI	Kiribati	KQ *	KI
TRUST TERRITORY OF THE PACIFIC ISLANDS	Pac Trust Ter	LN *	ZZ
(This is apparently no longer a political entity, so use of this code should be used with caution)			
UNITED STATES MINOR OUTLYING ISLANDS	U.S. - Minor Is	JC	UM
NORTH AMERICA	N. America	WT *	
CANADA	Canada	TA *	CA
CANADA - Alberta	Alberta	TB	CA
CANADA - British Columia	Brit. Columbia	TC	CA

Full Name	Short Name	Codes CMC	ISO
CANADA - Manitoba	Manitoba	TD	CA
CANADA - New Brunswick	New Brunswick	TE	CA
CANADA - Newfoundland	Newfoundland	TF	CA
CANADA - Northwest Territories	NW Territories	TG	CA
CANADA - Nova Scotia	Nova Scotia	TH	CA
CANADA - Ontario	Ontario	TJ	CA
CANADA - Prince Edward Island	P.E.I. (Canada)	TK	CA
CANADA - Quebec	Quebec	TL	CA
CANADA - Saskatchewan	Saskatchewan	TM	CA
CANADA - Yukon Territory	Yukon Territory	TN	CA
CANADIAN ARCTIC	Canadian Arctic	TO *	CA
DENMARK - Greenland	Greenland	TP	GL
FRANCE - St Pierre And Miquelton	St Pierre	TR	PM
UNITED STATES OF AMERICA	U.S.	TT *	US
U.S. - Alabama	Alabama	TU	US
U.S. - Alaska	Alaska	UA	US
U.S. - Arizona	Arizona	UB	US
U.S. - Arkansas	Arkansas	UC	US
U.S. - California	California	UD	US
U.S. - Colorado	Colorado	UE	US
U.S. - Connecticut	Connecticut	UF	US
U.S. - Delaware	Delaware	UG	US
U.S. - District Of Columbia	DC	UH	US
U.S. - Florida	Florida	UI	US
U.S. - Georgia	Georgia (US)	UJ	US
U.S. - Idaho	Idaho	UK	US
U.S. - Illinois	Illinois	UL	US
U.S. - Indiana	Indiana	UM	US
U.S. - Iowa	Iowa	UN	US
U.S. - Kansas	Kansas	UO	US
U.S. - Kentucky	Kentucky	UP	US
U.S. - Louisiana	Louisiana	UQ	US
U.S. - Maine	Maine	UR	US
U.S. - Maryland	Maryland	UT	US
U.S. - Massachusesetts	Massachusetts	UU	US
U.S. - Michigan	Michigan	UV	US
U.S. - Minnesota	Minnesota	UW	US
U.S. - Mississippi	Mississippi	UX	US
U.S. - Missouri	Missouri	UY	US
U.S. - Montana	Montana	UZ	US
U.S. - Nebraska	Nebraska	VA	US

Full Name	Short Name	Codes CMC	ISO
U.S. - Nevada	Nevada	VB	US
U.S. - New Hampshire	New Hampshire	VC	US
U.S. - New Jersey	New Jersey	VD	US
U.S. - New Mexico	New Mexico	VE	US
U.S. - New York	New York	VF	US
U.S. - North Carolina	N Carolina	VG	US
U.S. - North Dakota	N Dakota	VH	US
U.S. - Ohio	Ohio	VI	US
U.S. - Oklahoma	Oklahoma	VJ	US
U.S. - Oregon	Oregon	VK	US
U.S. - Pennsylvania	Pennsylvania	VL	US
U.S. - Rhode Island	Rhode Island	VM	US
U.S. - South Carolina	S Carolina	VN	US
U.S. - South Dakota	S Dakota	VO	US
U.S. - Tennessee	Tennessee	VP	US
U.S. - Texas	Texas	VQ	US
U.S. - Utah	Utah	VR	US
U.S. - Vermont	Vermont	VS	US
U.S. - Virginia	Virginia	VT	US
U.S. - Washington	Washington	VU	US
U.S. - West Virginia	W Virginia	VV	US
U.S. - Wisconsin	Wisconsin	VW	US
U.S. - Wyoming	Wyoming	VX	US
CENTRAL AMERICA	Central America	WA *	
BELIZE	Belize	WB	BZ
COSTA RICA	Costa Rica	WC *	CR
EL SALVADOR	El Salvador	WD	SV
GUATEMALA	Guatemala	WE	GT
HONDURAS	Honduras	WF	HN
MEXICO	Mexico	WG *	MX
MEXICO - Aguascalientes	Aguascalientes	YA	MX
MEXICO - Baja California (Norte)	Baja Calif. (N)	WQ	MX
MEXICO - Baja California Sur	Baja Calif. Sur	WR	MX
MEXICO - Baja California Peninsula (This is a region, not a state)	Baja California	YB *	MX
MEXICO - Campeche	Campeche	YC	MX
MEXICO - Chiapas	Chiapas	YD	MX
MEXICO - Chihuahua	Chihuahua	YE	MX
MEXICO - Coahuila	Coahuila	YF	MX
MEXICO - Colima	Colima	YI	MX

Full Name	Short Name	Codes CMC	ISO
MEXICO - Durango	Durango	YG	MX
MEXICO - Guanajuato	Guanajuato	YH	MX
MEXICO - Guerrero	Guerrero	YJ	MX
MEXICO - Hidalgo	Hidalgo	YK	MX
MEXICO - Jalisco	Jalisco	YL	MX
MEXICO - Mexico D.F.	Mexico D.F.	WS	MX
MEXICO - Mexico State	Mexico State	YM	MX
MEXICO - Michoacan	Michoacan	YN	MX
MEXICO - Morelos	Morelos	YO	MX
MEXICO - Nayarit	Nayarit	YP	MX
MEXICO - Nuevo Leon	Nuevo Leon	YQ	MX
MEXICO - Oaxaca	Oaxaca	YR	MX
MEXICO - Puebla	Puebla	YS	MX
MEXICO - Queretaro	Queretaro	YT	MX
MEXICO - Quintana Roo	Quintana Roo	YU	MX
MEXICO - San Luis Potosi	San Luis Potosi	YV	MX
MEXICO - Sinaloa	Sinaloa	YW	MX
MEXICO - Sonora	Sonora	YX	MX
MEXICO - Tabasco	Tabasco	YY	MX
MEXICO - Tamaulipas	Tamaulipas	YZ	MX
MEXICO - Tlaxcala	Tlaxcala	WM	MX
MEXICO - Veracruz	Veracruz	WN	MX
MEXICO - Yucatan	Yucatan	WO	MX
MEXICO - Zacatecas	Zacatecas	WP	MX
NICARAGUA	Nicaragua	WH	NI
PANAMA	Panama	WK	PA
ISLANDS OF THE CARIBBEAN	Caribbean Is.	RZ*	
ANGUILLA	Anguilla	SO	AI
ANTIGUA AND BARBUDA (Includes Redonda)	Antigua/Barbuda	SA	AG
ARUBA	Aruba	RY	AW
BAHAMAS (Grand Bahama, Gt Abaco, Eleuthera Is., New Providence, Andros Is., Gt Exuma,Cat Is., San Salvador, Rum Cay, Long Is., Crooked Is., Acklins Is., Mayaguana Is., Gt Inagua, Little Inagua)	Bahamas	SB	BS
BARBADOS	Barbados	SC	BB
BERMUDA	Bermuda	SD	BM
BRITISH VIRGIN ISLANDS	Brit Virgin Is	WX	VG
CAYMAN ISLANDS	Cayman Is	SE	KY
COLOMBIA - COLOMBIAN ISLANDS (Including I. de Providencia and I. de San Andres)	Colombian Is	SF	CO

Full Name	Short Name	Codes CMC	ISO
CUBA	Cuba	SG	CU
(Including Isla de Pinos)			
DOMINICA	Dominica	SH	DM
DOMINCAN REPUBLIC	Dominican Rep	SI	DO
FRANCE - Guadeloupe	Guadeloupe	SL	GP
(Including Marie Galante, GrandeTerre, Basse-Terres, Iles des Saintes, Iles de la Petite-Terre, La Desirade)			
FRANCE - Martinique	Martinique	SQ	MQ
GRENADA	Grenada	SJ	GD
HAITI	Haiti	SM	HT
HISPANIOLA	Hispaniola	SN *	ZZ
JAMAICA	Jamaica	SP	JM
(Including Morant Cays and Pedro Cays)			
MONTSERRAT	Montserrat	SR	MS
NAVASSA ISLAND	Navassa I	SS	ZZ
NETHERLANDS ANTILLES	Neth. Antilles	ST *	AN
(Aruba, Bonaire, Curacao)			
NETHERLANDS LEEWARD ISLANDS	Neth. Leeward I	SU	AN
(Saba And St Eustatius)			
PUERTO RICO	Puerto Rico	SV	PR
(Includes Isla Mona, Vieques, Culebra)			
ST CHRISTOPHER - Nevis	St Kitts - Nevis	SW	KN
ST LUCIA	St Lucia	SX	LC
ST MARTIN AND ST BARTHELEMY	St Mart & St Bt	SY	GP
ST VINCENT	St Vincent	SZ	VC
THE GRENADINES	Grenadines	SK	VC
(Bequia, Mustique, Canouan, Union, Carriacou, Ronde)			
TRINIDAD AND TOBAGO	Trinidad/Tobago	WV	TT
TURKS AND CAICOS ISLANDS	Turks & Caicos	WW	TC
(North-, South-, West- and East-Caicos, Middle Caicos, Providenciales, Ambergris Cays, Big Sand Cay, Grand Turk, Salt Cay, Seal Cays)			
VENEZUELA - Venezuelan Islands	Venezuelan Is.	WZ	VE
(Los Monjes, Las Ave, Los Roques, La Orchila, La Tortuga, La Blanquilla, Los Hermanes, La Sola, Los Frailes, Margarita, Coche, Cutagua, Los Testigos, Patos, Isla de Aves (by Dominica)			
VIRGIN ISLANDS OF THE UNITED STATES	Virgin Is (US)	WY	VI
(Includes St Croiz)			
SOUTH AMERICA	South America	XA *	
ARGENTINA	Argentina	XB	AR
BOLIVIA	Bolivia	XC	BO
BRAZIL	Brazil	XD *	BR
BRAZIL - Acre State	Acre	XQ	BR

Full Name	Short Name	Codes CMC	ISO
BRAZIL - Alagoas State	Alagoas State	XR	BR
BRAZIL - Amapa Federal Territory	Amapa	XS	BR
BRAZIL - Amazonas State	Amazonas	XT	BR
BRAZIL - Bahia State	Bahia	XU	BR
BRAZIL - Ceara State	Ceara	XV	BR
BRAZIL - Distrito Federal	Distrito Fed.	XW	BR
BRAZIL - Espirito Santo Staate	Espirito Santo	XX	BR
BRAZIL - Fernando De Noronha State	Fern. Noronha	XY	BR
BRAZIL - Goias State	Goias	XZ	BR
BRAZIL - Guanabara State	Guanabara	ZA	BR
BRAZIL - Maranhao State	Maranhao	ZB	BR
BRAZIL - Mato Grosso State	Mato Grosso	ZC	BR
BRAZIL - Mato Grosso do Sul State	Mato Grosso (S)	ZR	BR
BRAZIL - Minas Gerais State	Minas Gerais	ZD	BR
BRAZIL - Para State	Para	ZE	BR
BRAZIL - Paraiba State	Paraiba	ZF	BR
BRAZIL - Parana State	Parana	ZG	BR
BRAZIL - Pernambuco State	Pernambuco	ZH	BR
BRAZIL - Piaui State	Piaui	ZI	BR
BRAZIL - Rio Grande do Norte State	Rio Grande (N)	ZK	BR
BRAZIL - Rio Grande do Sul State	Rio Grande (S)	ZL	BR
BRAZIL - Rio de Janeiro State	Rio de Janeiro	ZJ	BR
BRAZIL - Rondonia Federal Territory	Rondonia	ZM	BR
BRAZIL - Roraima Federal Territory	Roriama	ZN	BR
BRAZIL - Santa Catarina State	Santa Catarina	ZO	BR
BRAZIL - Sao Paulo State	Sao Paulo	ZP	BR
BRAZIL - Sergipe State	Sergipe	ZQ	BR
CHILE	Chile	XE *	CL
COLOMBIA	Colombia	XF *	CO
ECUADOR	Ecuador	XG *	EC
FRANCE - French Guiana	French Guiana	XH	GF
GUYANA	Guyana	XJ	GY
PARAGUAY	Paraguay	XK	PY
PERU	Peru	XL	PE
SURINAME	Suriname	XM	SR
URUGUAY	Uruguay	XN	UY
VENEZUELA	Venezuela	XP *	VE

SOUTH ATLANTIC and SOUTHERN OCEAN IS	S Atlantic Is.	MY *	

This is divided into the Antarctic Treaty Territory, and areas which are sovereign states or parts thereof.

Full Name	Short Name	Codes CMC	ISO
ASCENSION ISLAND	Ascension I	NC	SH
AUSTRALIA - Heard And McDonald Islands	Heard Is	NJ	HM
AUSTRALIA - Tasmania - Macquarie Island	Macquarie Is	NL	AU
BRAZIL - I. da Trindade	Trindade	NU	BR
FALKLAND ISLANDS (Islas Malvinas)	Falkland Is	NI	FK
FRENCH SOUTHERN TERRITORIES	French S Terrs	NO *	TF
FR SOUTHERN TERRITORIES - Ile Amsterdam	Amsterdam I.	NA	TF
FRENCH SOUTHERN TERRITORIES - Iles Crozet (includes Iles des Apotres, Ile aux Cochons, Ile da la Possession, Ile de la L'Est)	Crozet Is	NH	TF
FR SOUTHERN TERRITORIES - Iles Kerguelen	Kerguelen Is.	NK	TF
FRENCH SOUTHERN TERRITORIES - Ile St Paul	St Paul I.	NP	TF
NEW ZEALAND - Antipodes Islands	Antipodes Is	NB	NZ
NEW ZEALAND - Auckland Islands	Auckland Is	ND	NZ
NEW ZEALAND - Bounty Islands	Bounty Is	NE	NZ
NEW ZEALAND - Campbell Island	Campbell I	NG	NZ
NORWAY - Bouvet Island	Bouvet I	NF	BV
SOUTH AFRICA - Price Edward Islands	P.E.Is (SA)	NM	ZA
SOUTH GEORGIA	South Georgia	NQ	FK
SOUTH SANDWICH ISLANDS	S Sandwich Is	NS	FK
ST HELENA	St Helena	NN	SH
TRISTAN DA CUNHA ISLANDS	Tristan d Cunha	NV	SH
ANTARCTIC TREATY TERRITORY	Antarctic T.T.	NX *	ZZ
comprises:			
ANTARCTICA	Antarctica	NW	AQ
ANTARCTIC ISLANDS	Antarctic Is	NY *	ZZ
the latter includes:			
SOUTH ORKNEY ISLANDS	S. Orkney Is.	NR	BQ
SOUTH SHETLAND ISLANDS	S. Shetland Is.	NT	BQ
OCEANS AND SEAS			
ARCTIC OCEAN	Arctic Ocean	OS *	
NORTH ATLANTIC OCEAN	N. Atlantic	OG *	
SOUTH ATLANTIC OCEAN	S. Atlantic	OO *	
CARIBBEAN SEA	Caribbean Sea	OK *	
MEDITERRANEAN SEA	Mediterranean Sea	OI *	
INDIAN OCEAN	Indian Ocean	OD *	
SOUTHERN OCEAN	Southern Ocean	OQ *	
NORTH PACIFIC OCEAN	N. Pacific	OU *	
SOUTH PACIFIC OCEAN	S. Pacific	OW *	

Full Name	Short Name	Codes	
		CMC	ISO
GENERAL CODES			
COUNTRY UNKNOWN	Country unknown	ZZ	ZZ
MANY COUNTRIES	Many countries	ZV *	
NEW WORLD	New World	ZW *	
OLD WORLD	Old World	ZX *	
PANTROPICAL	Pantropical	ZY *	

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or from:

Intergovernmental Oceanographic Commission,
UNESCO
7, Place de Fontenoy
75700 Paris, FRANCE