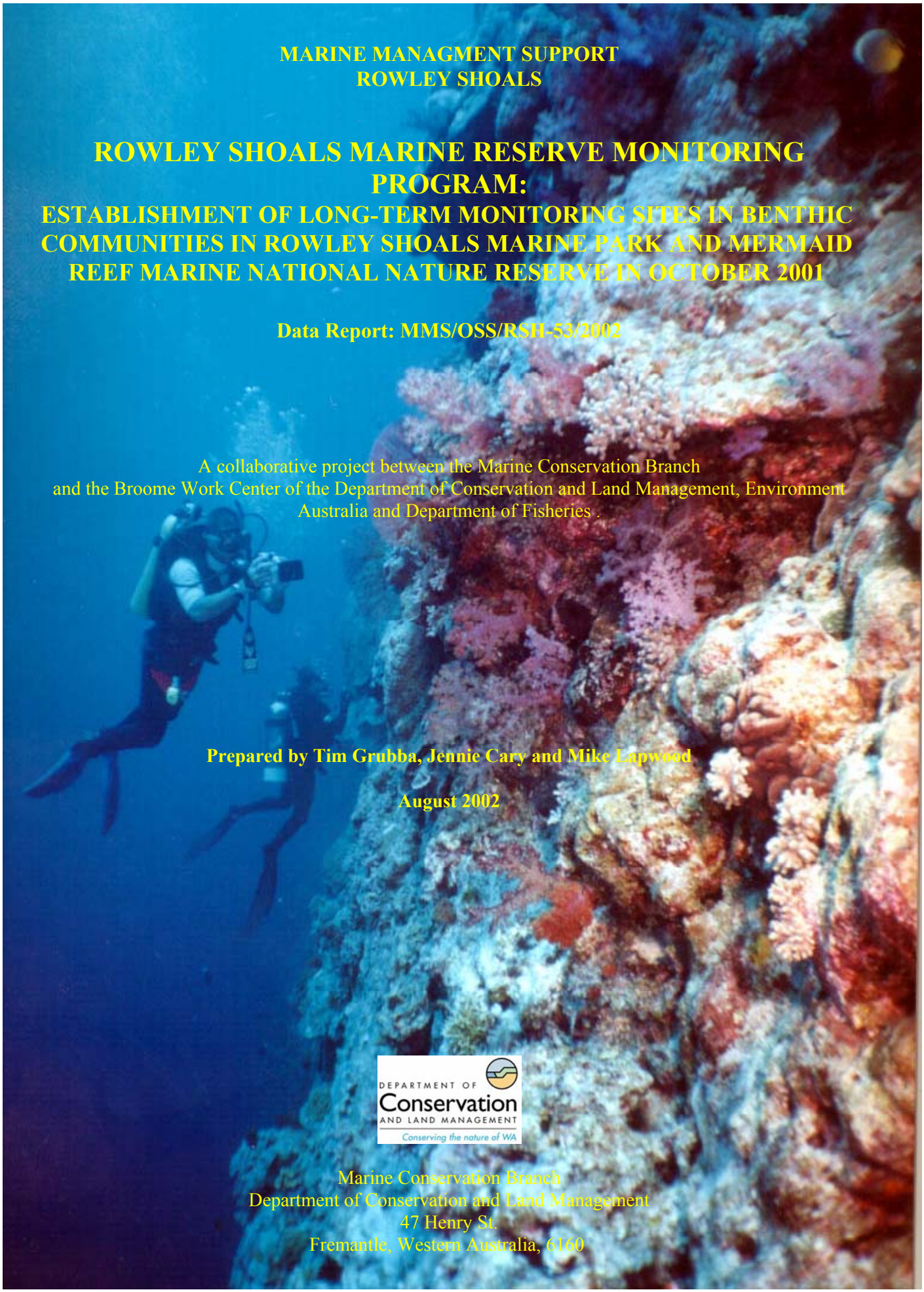

MARINE MANAGMENT SUPPORT
ROWLEY SHOALS

ROWLEY SHOALS MARINE RESERVE MONITORING PROGRAM:
ESTABLISHMENT OF LONG-TERM MONITORING SITES IN BENTHIC COMMUNITIES IN ROWLEY SHOALS MARINE PARK AND MERMAID REEF MARINE NATIONAL NATURE RESERVE IN OCTOBER 2001

Data Report: MMS/OSS/RSH-53/2002

A collaborative project between the Marine Conservation Branch
and the Broome Work Center of the Department of Conservation and Land Management, Environment Australia and Department of Fisheries .

Prepared by Tim Grubba, Jennie Cary and Mike Lapwood

August 2002

DEPARTMENT OF Conservation AND LAND MANAGEMENT
Conserving the nature of WA

Marine Conservation Branch
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State and Federal Government collaboration

Department of Fisheries
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SUMMARY

The Department in collaboration with Environment Australia and Department of Fisheries are establishing a monitoring network in RSMP and MRMNNR. This monitoring program is entitled the *Rowley Shoals Marine Reserves Monitoring Program (RSMRMP)*. The main aim of the *RSMRMP* is to establish a network of long-term re-locatable monitoring sites to gather quantitative baseline data on the 'health' of benthic communities (e.g. corals). The DCLM and the Marine Parks and Reserves Authority (MPRA) use the data from RSMP sites to assess (audit) the status of the key ecological and social values of the RSMP against pre-determined management targets. If targets are exceeded or adverse data trends identified this triggers the Department and the MPRA to adapt RSMP management strategies to ensure that human activities are ecologically sustainable. EA use the data from MRMNNR sites to assess its management of the MRMNNR.

This data report presents data collected during a field survey in October 2001 conducted as part of the *RSMRMP*. A total of 59 monitoring sites (Mermaid Reef - 20 sites, Clerke Reef - 23 sites and Imperieuse Reef - 16 sites) in benthic communities were established at the Rowley Shoals. At Mermaid Reef, 18 sites were established in areas of low human usage and two sites in areas of high human usage. Sites were established in the following zones: reef front (seven sites), back reef (seven sites), lagoon (five sites) and channel habitats (one site). At Clerke Reef, 17 sites were established in areas of low human usage and six in areas of high human usage. Sites were established in the following zones: reef front (seven sites), back reef (seven sites), lagoon (six sites) and channel (three sites). At Imperieuse Reef, 14 sites were established in areas of low human usage and two sites in areas of high human usage. Sites were established in the following zones: reef front (six sites), back reef (four sites), lagoon (five sites) and channel (one sites). For each site the habitat type, dominant species and visible impacts were described. Associated high quality video imagery that was acquired at the sites has been archived.

The October 2001 field survey was coordinated by the Marine Conservation Branch (MCB) of DCLM (Project Supervisors: Jennie Cary and Tim Grubba) in collaboration with the Broome Work Center, West Kimberley Region of DCLM (Contact: Jennie Cary). In addition EA and DoF provided significant levels of financial support, equipment and staff.

CONTENTS

LIST OF TABLES

LIST OF FIGURES

APPENDICES

1 INTRODUCTION

1.1 GENERAL

The Rowley Shoals are located approximately 260 km west of Broome on the edge of one of the widest continental shelves in the world (Figure 1). The Rowley Shoals include three reefs Clerke, Imperieuse and Mermaid, which are located 30-40 km apart (Figure 1). Each reef is elliptical in shape and is 14-18 km long and 7.5-9.5 km wide and surrounded by clear oceanic waters 230-500 meters deep. The Rowley Shoals have been described as the most perfect morphological shelf atolls in Australian waters (Fairbridge, 1950) (Done, *et al.*, 1994) (Berry and Marsh 1986). Reef structure is typical and includes a front reef, a wide reef flat (500-800m wide), back reef and large lagoons. Imperieuse and Clerke reefs have developed islands while Mermaid reef has an intertidal sand shoal located in the northern lagoons. Each reef has distinctive channels located in the northeast of reef that provide a link between the ocean and the lagoons.

The Rowley Shoals are considered to be in a pristine condition largely as a result of the relatively low level of recreational and commercial activity due to its isolated location. The Rowley Shoals are renowned for it's unspoilt coral gardens, giant clams and other spectacular shellfish, and abundant large reef fish with many species not found on the adjacent northwest Australian coast. These attributes, combined with the sheer isolation of the area, are responsible for attracting an increasing number of visitors to the area from both Australia and overseas.

The majority of visitors visit the Rowley Shoals aboard vessels operated by licensed marine nature-based tourism operators. In 2000, Environment Australia (EA) issued seven licences for MRMNNR and the Department of Conservation and Land Management (DCLM) issued eight licences for RSMP for commercial operators. A limited number of visitors reach the Rowley Shoals in private recreational vessels. The most frequently visited reefs are Clerke and Mermaid with their accessible lagoons and protected anchorage. Imperieuse is the least frequently visited due to its relatively inaccessible lagoon and less protected anchorage. The most common visitor activities at the Rowley Shoals include SCUBA diving, snorkelling and recreational fishing (demersal and pelagic fish).

The Rowley Shoals Marine Park (RSMP) was gazetted on 25 May 1990 under the State's *Conservation and Land Management Act 1984* and includes Clerk and Imperieuse reefs. The RSMP is managed as a marine conservation reserve by the DCLM on behalf of the Marine Parks and Reserves Authority. The *Rowley Shoals Marine Park Draft Management Plan and Indicative Management Plan for Extensions to the Existing Marine Park* expected to be released for public comment in 2002. The Mermaid Reef Marine National Nature Reserve was gazetted in March 1991 under the Commonwealth's *National Parks and Wildlife Conservation Act 1975*. The *Mermaid Reef Marine National Nature Reserve Plan of Management* was released in 2000 (Commonwealth of Australia, 2000). The RSMP and MRMNNR are jointly managed by EA, DCLM and the Department of Fisheries (DoF) under a Memorandum of Understanding (MOU).

The Department in collaboration with EA and DoF are establishing a monitoring network in RSMP and MRMNNR (Figure 1). This monitoring program is entitled the *Rowley Shoals Marine Reserves Monitoring Program (RSMRMP)*. The main aim of the *RSMRMP* is to establish a network of long-term re-locatable monitoring sites to gather quantitative baseline data on the 'health' of benthic communities (e.g. corals). The DCLM and the Marine Parks and Reserves Authority (MPRA) use the data from RSMP sites to assess (audit) the status of the key ecological and social values of the RSMP against pre-determined management targets. If targets are exceeded or adverse data trends identified this triggers the Department and the MPRA to adapt RSMP management strategies to ensure that human activities are ecologically sustainable. EA use the data from MRMNNR sites to assess its management of the MRMNNR.

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channel habitats (one site). At Clerke Reef, 17 sites were established in areas of low human usage and six in areas of high human usage. Sites were established in the following zones: reef front (seven sites), back reef (seven sites), lagoon (six sites) and channel (three sites). At Imperieuse Reef, 14 sites were established in areas of low human usage and two sites in areas of high human usage. Sites were established in the following zones: reef front (six sites), back reef (four sites), lagoon (five sites) and channel (one sites). For each site the habitat type, dominant species and visible impacts were described. Associated high quality video imagery that was acquired at the sites has been archived.

The October 2001 field survey was coordinated by the Marine Conservation Branch (MCB) of DCLM (Project Supervisors: Jennie Cary and Tim Grubba) in collaboration with the Broome Work Center, West Kimberley Region of DCLM (Contact: Jennie Cary). In addition EA and DoF provided significant levels of financial support, equipment and staff.

1.2 BACKGROUND

The management of WA's marine conservation reserves is now based on an outcome-based "best practice" model of performance reporting in natural resource management (ANZECC, 1997). The "best practice" model facilitates the assessment (auditing) of management performance allowing for a more adaptive and effective management style. To facilitate the conversion to this new model, the Department is developing marine work plans (MWP) for each marine park as an interim bridging mechanism. The MWP for each marine park identifies all the ecological and social values, listing for each value:

- existing and potential uses and/or pressures,
- management objectives,
- strategies,
- performance measures/s,
- desired trends, and
- targets.

In addition, the MWP prioritises values and management strategies using a value/threat framework (Simpson *et. al,* 2002). Values identified as having the highest priority and being the most threatened by human impacts are classified as Key Performance Indicators (KPI). For each KPI there are established short-term and long-term targets, which can be audited. Lower priority values are classified using the scale: high, medium and low. Priority is given to monitoring programs that provide the quantitative baseline data necessary to identify trends and assess whether established management targets of KPIs are being met (i.e. auditing).

Monitoring programs generally comprise of one or more of the following components: (i) local scale impact or *compliance monitoring* that examines the effects of human activities in a localised area; (ii) temporally-constrained, broadscale *surveillance monitoring* to assess the response of key biological parameters to episodic regional physical and biological processes (eg the effect of storms and predators) and (iii) spatially-constrained, long-term monitoring of key biological parameters to determine the extent and cause of *natural variation* (eg seasonal and inter-annual variability) of key ecosystem attributes.

The *RSMRMP* established a network of 59 monitoring sites in 2001 along the front reef, back reef and lagoon zones of each reef in areas of low and high human usage to collect baseline data on the benthic communities. The monitoring networks established are compatible with the research and monitoring program established by the Australian Institute of Marine Science (AIMS) in 1995. AIMS have established monitoring sites to collect data on natural variability on the front reef of the north-east section of Imperieuse, Clerke and Mermaid reefs. The Department will establish additional monitoring sites as required, to fill gaps identified in the networks. The *RSMRMP* will also expand with the development and implementation of monitoring programs to collect baseline data on the other KPIs (Table 1).

Table 1. Key Performance Indicators (KPIs) for the Rowley Shoals Marine Park

Key Performance Indicator
• Water Quality
• Coral reef communities
• Invertebrate communities (excluding corals)
• Wilderness

1.3 AIMS OF THE *RSMRMP*

The main aim of the *RSMRMP* is to establish a network of re-locatable long-term monitoring sites to monitor the status of key ecological and social values in the RSMP and MRMNNR.

- To establish a network of sites in representative undisturbed areas of the Rowley Shoals to assess the effects of natural processes on KPIs.
- To establish a network of sites in areas of human activity/pressure in Rowley Shoals to assess the impacts of human activities on KPIs.
- To determine the presence/absence and relative abundance (if appropriate) of key species at each monitoring site.
- To take still images and video footage of benthic communities at representative sites on an opportunistic basis to assist with future education programs.

1.4 OBJECTIVES OF THE OCTOBER 2001 SURVEY

The objectives of the October 2001 field survey were:

- To establish monitoring sites, in benthic communities in areas of low human usage in Imperieuse, Clerke and Mermaid reefs in order to collect quantitative data on natural impacts and coral community 'health'.
- To establish monitoring sites, in benthic communities in area of high human usage in Imperieuse, Clerke and Mermaid reefs in order to collect qualitative data on human impacts and coral community 'health'.

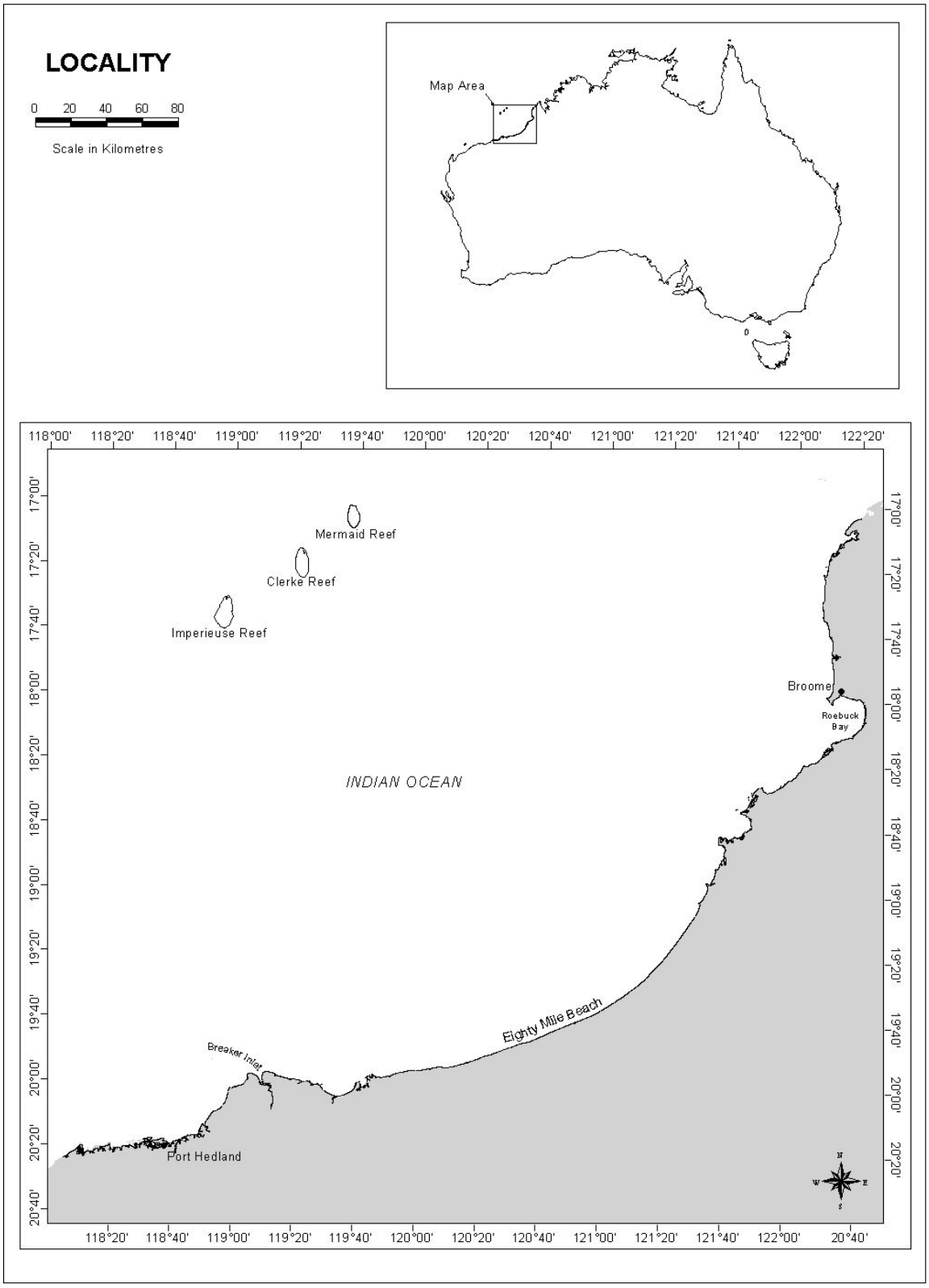


Figure 1. Locality

Figure 1: Location map of the Rowley Shoals (Imperieuse, Clerke and Mermaid reefs).

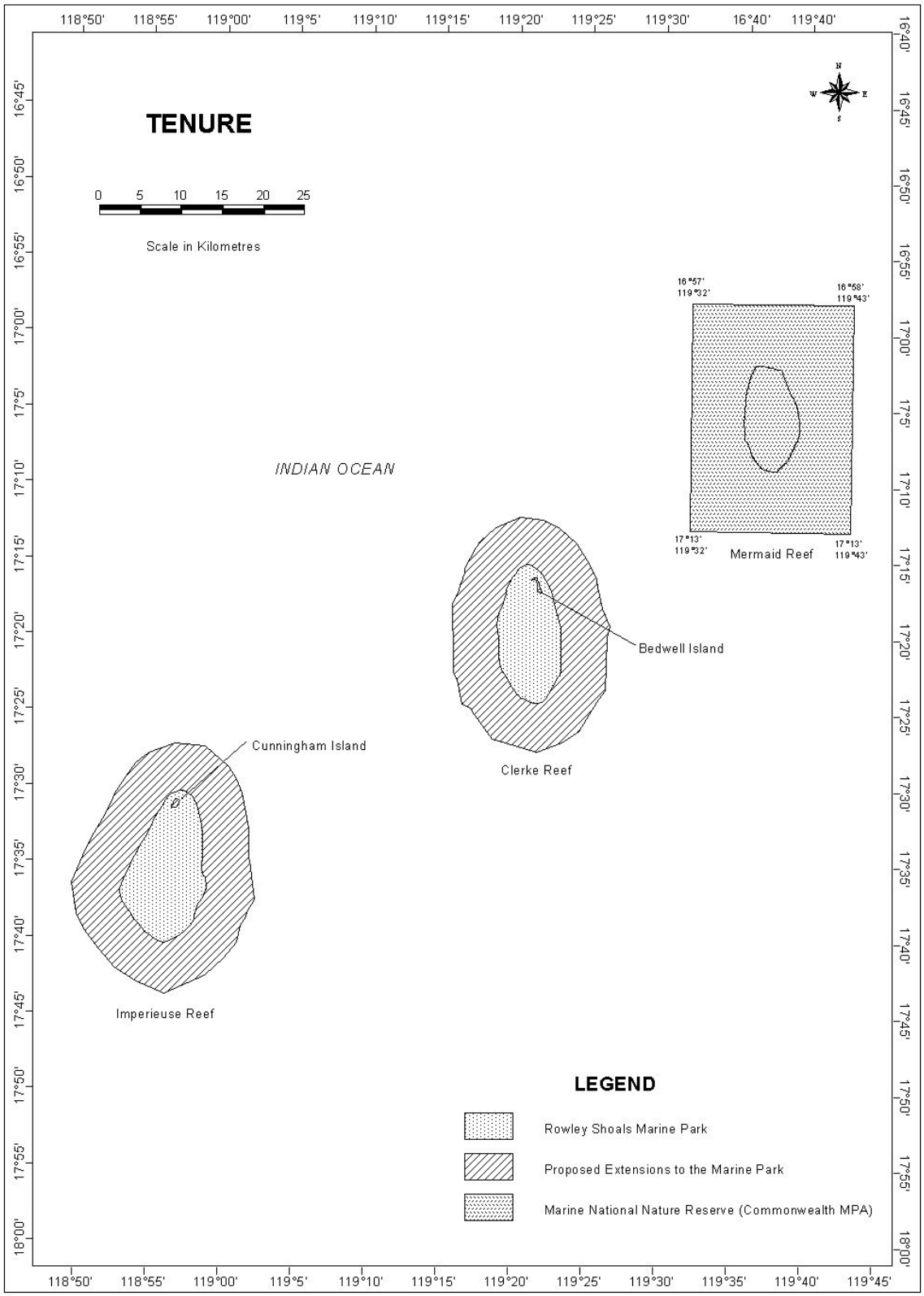


Figure 2. Boundaries of Mermaid Reef Marine Natural Nature Reserve and Rowley Shoals Marine Park and proposed extensions to the marine park.

2 METHODS

2.1 SITE SELECTION

Monitoring sites were selected to represent the ecological attributes of reef front, back reef and lagoon coral communities in area of high and low human usage at the three reefs (Imperieuse, Clerke and Mermaid). High human usage sites (e.g. designated anchorage and dive/snorkel sites) were identified in the data report '*Human Usage in the Rowley Shoals Marine Park and Mermaid Reef Marine National Nature Reserve*' (Lapwood and Grubba, 2001). It was assumed that areas not mentioned in the report are low human usage. The selection of sites took into account the natural variability monitoring sites established by AIMS on the north-east reef front of each reef.

Sites were initially selected using distinctive benthic features on aerial photographs. The position of each site was digitized to determine site coordinates. During the survey, sites were located using a Global Positioning System (GPS) unit pre-loaded with the site coordinates in conjunction with the marked aerial photographs. All sites were located easily due to the distinctive features being clearly visible from the survey vessels. Once located the site position was refined if required by re-locating the site so that the start of transect 1 started on a distinctive benthic feature. Not all selected sites could be established due to unsuitable distinctive features, adverse sea conditions and low tides. Where possible sites were re-positioned, however in a number of cases sites were abandoned.

Once the site position was confirmed, four marker buoys were deployed to mark the start of each transect and end of transect 3. The position of each marker buoy was recorded using a Differential GPS (DGPS) set to the datum WGS84). See Appendix 2 for plots of the monitoring sites overlaid on amarked on GIS maps.

2.2 SITES ESTABLISHED IN AREAS OF LOW HUMAN USAGE

A total of 49 'transect' monitoring sites in benthic communities were established in areas of low human usage in reef. At Mermaid Reef 18 sites were established of which seven are located in the front reef, seven in the back reef and four in the lagoon communities (Figure 3 and Table 2). At Clerke Reef, 17 sites were established of which six are located in the front reef, six in the back reef and six in the lagoon communities (Figure 4 and Table 2). At Imperieuse Reef, 14 sites were established of which five are located in the front reef, four in the back reef and five in the lagoon communities (Figure 5 and Table 2).

At each site three 50m transects were established in a line following the depth contour of the site (i.e. 50+50+50 = 170m). Unlike other monitoring programs (e.g. Ningaloo Marine Park Monitoring Program) the RSMRMP does not use star pickets to permanently mark the start of each transect and the end of transect 3. Instead the RSMRMP relies on positioning the start of transect 1 on a distinctive permanent re-locatable benthic feature (e.g. large coral bommie). Where possible the start of transect 2 and 3 and the end of transect 3 were positioned near distinctive features. The location of the start of each transect and the end of transect 3 was recorded using a DGPS set to the datum WGS84 that has an accuracy of 3-4m. In addition a detailed site map was produced clearly detailing the start and end of each transect in relation to distinctive benthic features.

A 50 m scaled (every 10cm) and weighted transect line that follows the contour of the seabed is laid out starting at the distinctive feature that marks the start of transect 1. The benthic habitat within a meter wide strip along transects was recorded using high quality digital video imagery. The video imagery is archived and will be latter analysed using the Line Intercept Transect (LIT) method. In addition the following observations are recorded onto the long term monitoring site and habitat data sheets (Appendix 1):

- habitat description, including dominant species and those vulnerable to impacts by humans eg gorgonian and branching corals;
- type and extent of impacts from human activities on benthic communities;
- type of litter and number of items;
- the relative abundance of non-cryptic indicator species within a two meter belt (one meter on either side of the transect line).

- Fish
  - Potato Cod (*Epinephelus tukula*)
  - Humphead wrasse (*Cheilinus undulatus*)
  - Coral trout (*Plectropomus leopardus*)
- Molluscs
  - Giant clam (*Tridacna gigas*)
  - Trochus (*Trochus maculatus*)
  - Tiger cowrie (*Cypraea tigris*)
- Other invertebrate
  - Sea cucumbers (all species)
- Presence/absence and relative abundance of coral predators
  - Crown of thorns starfish; and
  - *Drupella sp*

2.3 SITES ESTABLISHED IN AREAS OF HIGH HUMAN USAGE

A total of ten 'non-transect' sites in benthic communities were established in areas of high human usage including the designated anchorage areas of each reef and at popular SCUBA dive and snorkel sites. At Mermaid Reef, two sites were established including the designated anchorage in the lagoon and the channel (Figure 3 and Table 2). At Clerke Reef, six sites were established including two dives, the designated anchorage in the lagoon and three channels (Figure 4 and Table 2). At Imperieuse Reef, two sites were established including the designated anchorage on the front reef and the channel (Figure 5 and Table 2).

Sites were surveyed (generally) to determine the spatial extent of human activities and impacts. A sample of this area was temporarily marked out using weighted marker buoys on each corner (rectangular area). At 'wall'-type dive sites only marker buoy was used. Differential GPS (DGPS) coordinates of each marker buoy were recorded along with a site map on the long-term monitoring site data sheet (Appendix 1).

At each site digital video footage will be taken of any damage to benthic communities from assumed human activities (eg anchor or diver damage) and any observed litter. In addition the following observations were recorded onto the long term monitoring site and habitat data sheets (Appendix 1):

- habitat description, including dominant species and those vulnerable to impacts by humans e.g. gorgonian and branching corals;
- type and extent of impacts from human activities on benthic communities;
- type of litter and number of items;
- the relevant abundance of non-cryptic indicator species.
  - Fish
    - Potato Cod (*Epinephelus tukula*)
    - Humphead wrasse (*Cheilinus undulatus*)
    - Coral trout (*Plectropomus leopardus*)
  - Invertebrates
    - Giant clam (*Tridacna gigas*)
    - Trochus (*Trochus maculatus*)
    - Tiger cowrie (*Cypraea tigris*)
    - Sea cucumbers (all species)
- Presence/absence and relative abundance of coral predators
  - Crown of thorns starfish; and
  - *Drupella sp.*

Table 2. Summary of the monitoring sites established in benthic communities in Mermaid Reef Marine Natural Nature Reserve and Rowley Shoals Marine Park in October 2001.

Site No.	Site Name	Date	Method	Zone	Habitat	Depth	Latitude (dec deg)	Longitude (dec deg)
M1	Mermaid	16/10/01	Transect	Front reef	Sub tidal coral reef	12	-17.0286	119.6181
M2	Mermaid	16/10/01	Transect	Back reef	Intertidal coral reef	2	-17.0352	119.621
M3	Mermaid	16/10/01	Transect	Back reef	Intertidal coral reef	2.5	-17.0836	119.5996
M4	Mermaid	16/10/01	Transect	Front reef	Sub tidal coral reef	8	-17.0762	119.5965
M5	Mermaid	15/10/01	Transect	Front reef	Sub tidal coral reef	8	-17.1272	119.5943
M6	Mermaid	16/10/01	Transect	Back reef	Intertidal coral reef	10	-17.1266	119.6019
M7	Mermaid	16/10/01	Transect	Front reef	Sub tidal coral reef	8	-17.1641	119.6279
M8	Mermaid	17/10/01	Transect	Back reef	Sub tidal coral reef	3	-17.1534	119.6284
M9	Mermaid	16/10/01	Transect	Front reef	Sub tidal coral reef	11	-17.1309	119.6614
M10	Mermaid	17/10/01	Transect	Back reef	Sub tidal coral reef	3	-17.1297	119.6569
M11	Mermaid	17/10/01	Transect	Lagoon	Sub tidal coral reef	0.0	-17.1333	119.6334
M12	Mermaid	18/10/01	Transect	Lagoon	Sub tidal coral reef	0.0	-17.1143	119.6348
M13	Mermaid	17/10/01	Transect	Lagoon	Sub tidal coral reef	0.0	-17.0891	119.6358
M14	Mermaid	17/10/01	Transect	Back reef	Intertidal coral reef	4.9	-17.0803	119.6509
M15	Mermaid	17/10/01	Transect	Front reef	Sub tidal coral reef	8	-17.0789	119.655
M16	Mermaid	18/10/01	Transect	Lagoon	Sub tidal coral reef	0.0	-17.0413	119.6255
M18	Mermaid	16/10/01	Non-transect	Channel	Sub tidal coral reef	6	-17.0615	119.648
M19	Mermaid	18/10/01	Non-transect	Lagoon	Sub tidal coral reef	10	-17.0751	119.6425
M21	Mermaid	18/10/01	Transect	Back reef	Sub tidal coral reef	3	-17.0906	119.6536
M22	Mermaid	18/10/01	Transect	Front reef	Sub tidal coral reef	22	-17.0333	119.634
C1	Clerke	21/10/01	Transect	Front reef	Sub tidal coral reef	6	-17.2477	119.3447
C2	Clerke	21/10/01	Transect	Back reef	Intertidal coral reef	3	-17.2488	119.3452
C3	Clerke	21/10/01	Transect	Front reef	Sub tidal coral reef	9	-17.2798	119.3213
C4	Clerke	20/10/01	Transect	Back reef	Intertidal coral reef	2	-17.2818	119.3275
C5	Clerke	21/10/01	Transect	Front reef	Sub tidal coral reef	7	-17.3492	119.3153
C6	Clerke	19/10/01	Transect	Back reef	Intertidal coral reef	2	-17.3499	119.3228
C7	Clerke	21/10/01	Transect	Front reef	Sub tidal voral reef	9	-17.3962	119.3569
C8	Clerke	19/10/01	Transect	Back reef	Intertidal coral reef	2	-17.3884	119.3546
C9	Clerke	19/10/01	Transect	Front reef	Sub tidal coral reef	6	-17.3562	119.3834
C10	Clerke	19/10/01	Transect	Back reef	Intertidal coral reef	2	-17.355	119.3793
C11	Clerke	19/10/01	Transect	Lagoon	Sub tidal coral reef	5	-17.3448	119.3511
C12	Clerke	20/10/01	Transect	Lagoon	Sub tidal coral reef	8	-17.3033	119.3359
C13	Clerke	20/10/01	Transect	Lagoon	Sub tidal coral reef	7	-17.311	119.3679
C14	Clerke	20/10/01	Transect	Back reef	Intertidal coral reef	2.5	-17.283	119.373
C15	Clerke	19/10/01	Transect	Front reef	Intertidal coral reef	7	-17.2895	119.377
C16	Clerke	22/10/01	Non-transect	Back reef	Sub tidal coral reef	18	-17.2585	119.35
C17	Clerke	21/10/01	Non-transect	Front reef	Sub tidal coral reef	22	-17.3382	119.3843
C18	Clerke	21/10/01	Non-transect	Lagoon	Sub tidal coral reef	7	-17.2795	119.3641
C19	Clerke	21/10/01	Non-transect	Channel	Sub tidal coral reef	3	-17.2694	119.372
C20	Clerke	20/10/01	Transect	Lagoon	Sub tidal coral reef	5	-17.3074	119.3714
C21	Clerke	20/10/01	Transect	Lagoon	Sub tidal coral reef	5	-17.3197	119.3608
C22	Clerke	21/10/01	Non-transect	Channel	Sub tidal coral reef	4	-17.2727	119.3737
C23	Clerke	21/10/01	Non-transect	Channel	Sub tidal coral reef	4	-17.2788	119.3719
I1	Imperieus	13/10/01	Transect	Front reef	Sub tidal coral reef	3	-17.4988	118.9535
I3	Imperieus	14/10/01	Transect	Front reef	Sub tidal coral reef	10	-17.535	118.9194
I4	Imperieus	14/10/01	Transect	Back reef	Intertidal coral reef	1.5	-17.539	118.9262

I6	Imperieus	14/10/01	Transect	Back reef	Sub tidal coral reef	5	-17.5959	118.8967
I7	Imperieus	14/10/01	Transect	Front reef	Sub tidal coral reef	7.7	-17.6601	118.9314
I9	Imperieus	14/10/01	Transect	Front reef	Sub tidal coral reef	6	-17.6102	118.9747
I10	Imperieus	15/10/01	Transect	Back reef	Intertidal coral reef	1.5	-17.6101	118.97
I11	Imperieus	14/10/01	Transect	Lagoon	Sub tidal coral reef	6	-17.6122	118.9335
I12	Imperieus	15/10/01	Transect	Lagoon	Sub tidal coral reef	16	-17.5889	118.9634
I13	Imperieus	15/10/01	Transect	Lagoon	Sub tidal coral reef	4.7	-17.5601	118.9419
I14	Imperieus	13/10/01	Transect	Lagoon	Sub tidal coral reef	7	-17.549	118.9666
I15	Imperieus	13/10/01	Transect	Front reef	Sub tidal coral reef	8.7	-17.5522	118.973
I17	Imperieus	13/10/01	Non-transect	Front reef	Sub tidal coral reef	20	17.5075	118.9658
I19	Imperieus	15/10/01	Transect	Lagoon	Sub tidal coral reef	2.7	-17.5804	118.9369
I20	Imperieus	15/10/01	Non-transect	Channel	Sub tidal coral reef	3	-17.5361	118.9664
I21	Imperieus	15/10/01	Transect	Back reef	Intertidal coral reef	1	-17.5531	118.9687

Figure 3. Location of the monitoring sites in benthic communities established in Mermaid Reef Marine National Nature Reserve in October 2001 as part of the Rowley Shoals Marine Reserve Monitoring Program.

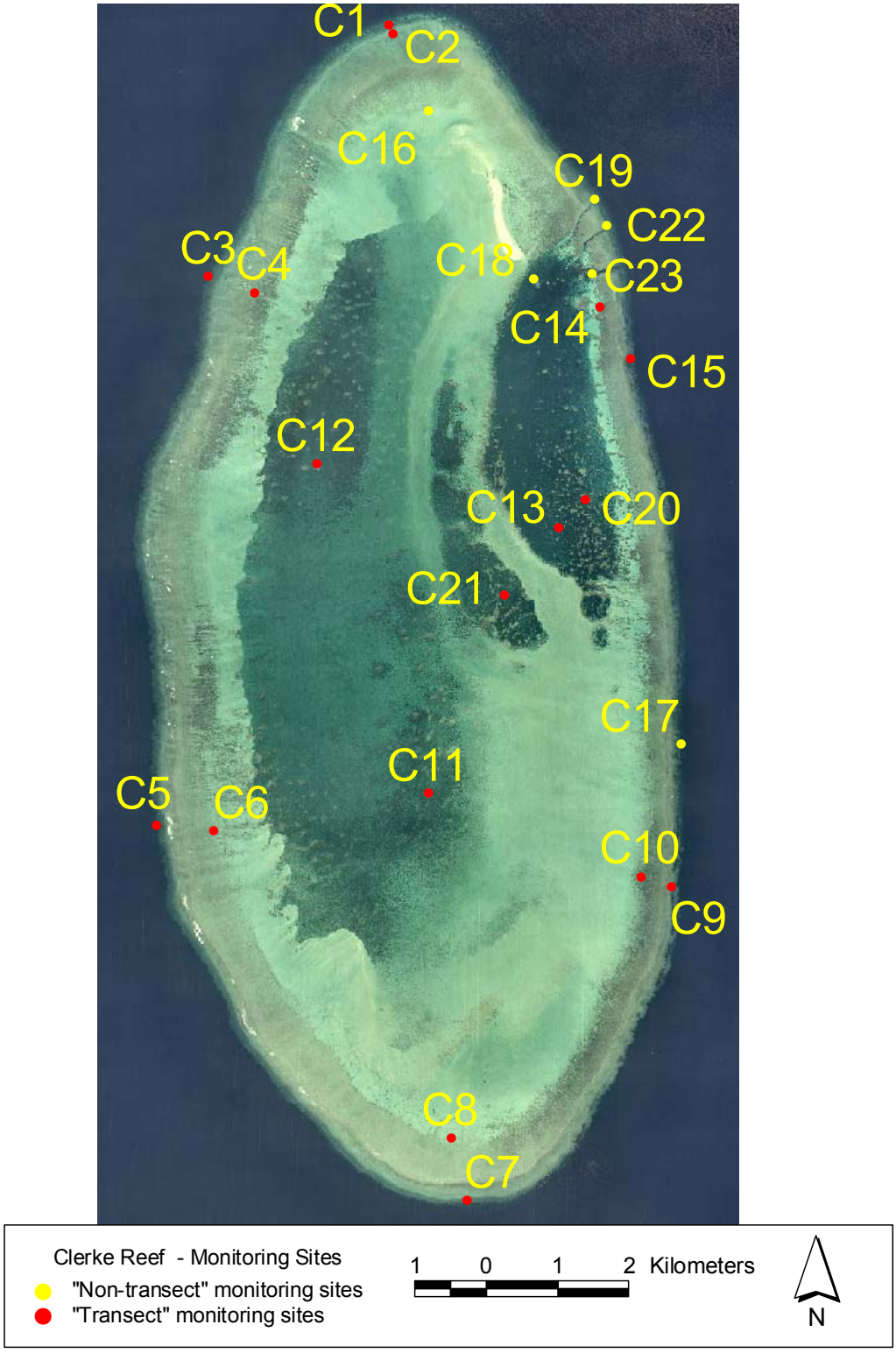


Figure 4. Location of the monitoring sites in benthic communities established in Clerke Reef, Rowley Shoals Marine Park in October 2001 as part of the Rowley Shoals Marine Reserve Monitoring Program.

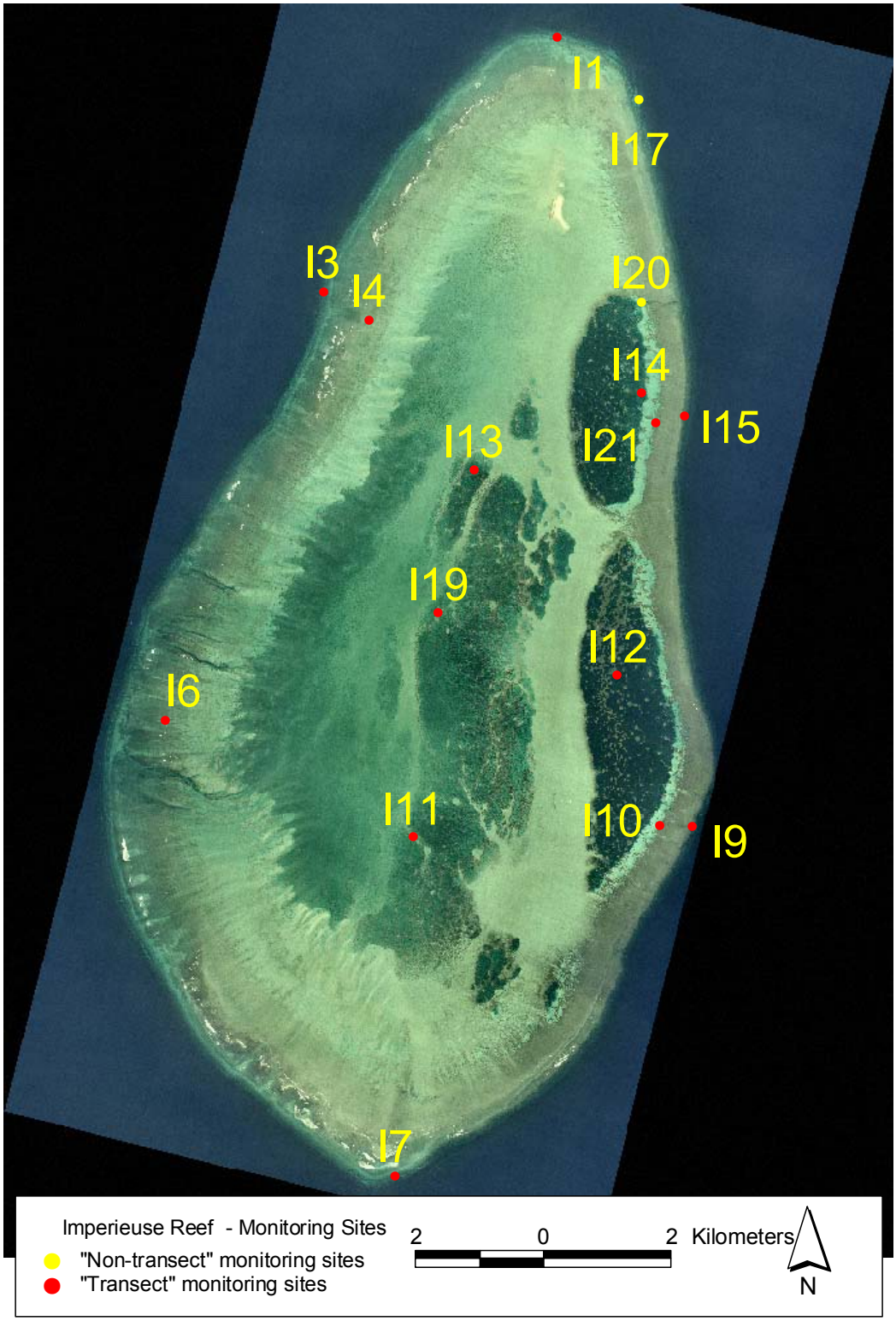


Figure 5. Location of the monitoring sites in benthic communities established in Imperieuse Reef, Rowley Shoals Marine Park in October 2001 as part of the Rowley Shoals Marine Reserve Monitoring Program.

3 RESULTS

3.1 SITES ESTABLISHED IN AREAS OF LOW HUMAN USAGE - DATA SHEETS

See Appendix 1 for the respective pairs of data sheets completed for each monitoring site. See Table 2 for a summary of the information recorded at each site.

3.2 SITES ESTABLISHED IN AREAS OF LOW HUMAN USAGE – DATA SHEETS

See Appendix 1 for the respective pairs of data sheets completed for each monitoring site. See Table 2 for a summary of the information recorded at each site.

4 DATA MANAGEMENT

4.1 REPORT

Hard copies of this report will be held at the following locations:

1. Marine Conservation Branch library, Department of Conservation and Land Management, 47 Henry St., Fremantle, Western Australia, 6010. Ph. (08) 9366 0100, Fax (08) 9430 5408.
2. Woodvale Library, Science and Information Division, Ocean Reef Rd., Woodvale, Western Australia, 6026. Ph (08) 9306 1641.
3. Archives, Woodvale Library, Science and Information Division, Ocean Reef Rd., Woodvale, Western Australia, 6026. Ph. (08) 9405 5100, Fax. (08) 9306 1641.
4. Broome Work Centre, West Kimberly District, Department of Conservation and Land Management, 111 Herbert St., Broome, Western Australia, 6725. Ph: (08) 9192 1036 Fax: (08) 9193 5027.
5. Kununurra Work Centre, Kimberley Region, Department of Conservation and Land Management, Messmate Way, Kununurra, Western Australia, 6743. Ph: (08) 9168 4200 Fax: (08) 9168 2179.

The Marine Conservation Branch will hold digital copies of this report at the following directory pathways:

1. The Marine Conservation Branch Server:
   Shareddata on 'DCLM-frem-1' [T:\144-Marine Conservation Branch\Shared Data\Current_MCB_reports\MMS\mms_5302]
2. MCB Server full backup DAT tape:
   [T:\144-Marine Conservation Branch\Shared Data\Current_MCB_reports\MMS\mms_5302]
3. CD_ROM [mms_5302]
4. MCB homepage on the Department of Conservation and Land Management Intranet CALMweb: http://CALMweb.CALM.wa.gov.au/drb/ncd/mcb/rep_pdf/mms_reps/mms_2002/mmsrep02.htm#mms_5302

4.2 VIDEO RECORDS

Original digital videotapes of the sites monitoring during the October 2002 survey (Appendix 3) will be held as follows:

- Mini digital video (MDV) masters have been archived in HOLD08 at the Information Management Branch, Department of Conservation and Land Management, 17 Dick Perry Avenue, Kensington, Western Australia. Ph: (08) 9334 0392 Fax: (08) 9334 0466.
- MDV copies have been stored at the Marine Conservation Branch, Department of Conservation and Land Management, 47 Henry St, Fremantle, Western Australia. Ph: (08) 9336 0100 Fax (08) 9430 5408.

5 REFERENCES

Berry , P F and Marsh L M (1986). Part 1 History of investigation and description of the physical environment . In Berry, P F (ed.) Faunal Surveys of the Rowley Shoals, Scott Reef, and Seringapatam Reef. Records of the Western Australian Museum, Supplement No. 25: 1-25.

Commonwealth of Australia (2000). Mermaid Reef Marine National Nature Reserve Plan of Management. Environment Australia, Canberra.

DCLM, (2001). Rowley Shoals Marine Park Draft Management Plan and Indicative Management Plan for Extensions to the Existing Marine Park. Department of Conservation and Land Management, Perth, Not yet released for public comment.

Done, T., Done, C. & Thomson, C. (1994). The Rowley Shoals. *Landscope*, Spring 1994: 28-34.
Environment Australia (1999). Mermaid Reef Marine National Nature Reserve (Plan of Management).

Fairbridge, R W (1950). Landslide Patterns on Oceanic Volcanoes and Atolls. Geographical Journal. CIV: 82-8.

CORAL PREDATORS

CORAL PREDATOR/COTS		CORAL PREDATOR/*DRUPELLA*	
Number of crown of thorns starfish (cots)		**Number of *drupella sp* feeding scars**	
Cots feeding scars (present/absent)		**Number of colonies checked**	
Average cots size (s/m/l)		**Number of colonies with *drupella***	
		Number of colonies without *drupella*	

HUMAN ACTIVITIES/IMPACTS

HUMAN ACTIVITIES	TYPE OF DAMAGE

LITTER	

NOTES

1x *Drupella* sp.

VIDEO DATA SHEET

SITE NO.	C11	**SITE NAME**	Clerke		
DATE	19/10/01	**TIME**	11:26 am		
RECORDER	Ryan	**TAPE ID**	RSMRMP/bvt/19.10.01/#16		
METHOD	Transect	**VIDEO FORMAT**	Digital	**DIGITAL COPY**	Yes
TIME CODING FOR SITE (START)	0:17:10	**TIME CODING FOR SITE (FINISH)**	0:35:03		
TAPE DESCRIPTION					

COMPLETE FOR EACH TRANSECT VIDEO

TRANSECT NUMBER	1		
START TIME CODE	0:17:10	**FINISH TIME CODE**	0:23:23
TOTAL TIME CODE	6:13		

TRANSECT NUMBER	2		
START TIME CODE:	0:23:23	**FINISH TIME CODE:**	0:29:10
TOTAL TIME CODE	5:47		

TRANSECT NUMBER	3		
START TIME CODE	0:29:10	**FINISH TIME CODE**	0:34:29
TOTAL TIME CODE	5:19		

COMPLETE FOR ALL OTHER FOOTAGE

DESCRIPTION	Moray eel		
START TIME CODE	0:34:30	**FINISH TIME CODE**	0:35:03

DESCRIPTION			
START TIME CODE		**FINISH TIME CODE**	

DESCRIPTION			
START TIME CODE		**FINISH TIME CODE**	

LONG-TERM MONITORING SITE DATA SHEET

SITE NO.	C12	**SITE NAME**	Clerke		
DATE ESTABLISHED	20/10/01	**TIME**	30/12/99	**RECORDER**	Davidson
SITE TYPE	Transect	**SITE ZONE**		Lagoon	
WATER DEPTH (MEAN)	8 m	**CORRECTED WATER DEPTH (MEAN)**			
GPS/DGPS	DGPS	**DATUM**		WGS84	
NOTES					

COMPLETE FOR TRANSECT SITES

TRANSECT NUMBER	1	**DIRECTION OF TRANSECT (BEARING °)**	180°		
START: LATITUDE (DECIMAL DEGREES)	-17.3033 S	**START: LONGITUDE (DECIMAL DEGREES)**	119.3359 E		
TRANSECT MARKER (START)	No	**TRANSECT MARKER (END)**	No	**WATER DEPTH**	m
NOTES					

TRANSECT NUMBER	2	**DIRECTION OF TRANSECT (BEARING °)**	°		
START: LATITUDE (DECIMAL DEGREES)	-17.3037 S	**START: LONGITUDE (DECIMAL DEGREES)**	119.3356 E		
TRANSECT MARKER (START)	No	**TRANSECT MARKER (END)**	No	**WATER DEPTH**	
NOTES					

TRANSECT NUMBER	3	**DIRECTION OF TRANSECT (BEARING °)**	°		
START: LATITUDE (DECIMAL DEGREES)	-17.3042 S	**START: LONGITUDE (DECIMAL DEGREES)**	119.3356 E		
FINISH: LATITUDE (DECIMAL DEGREES)	-17.3046 S	**FINISH: LONGITUDE (DECIMAL DEGREES)**	119.3356 E		
TRANSECT MARKER (START)	No	**TRANSECT MARKER (END)**	No	**WATER DEPTH**	m
NOTES					

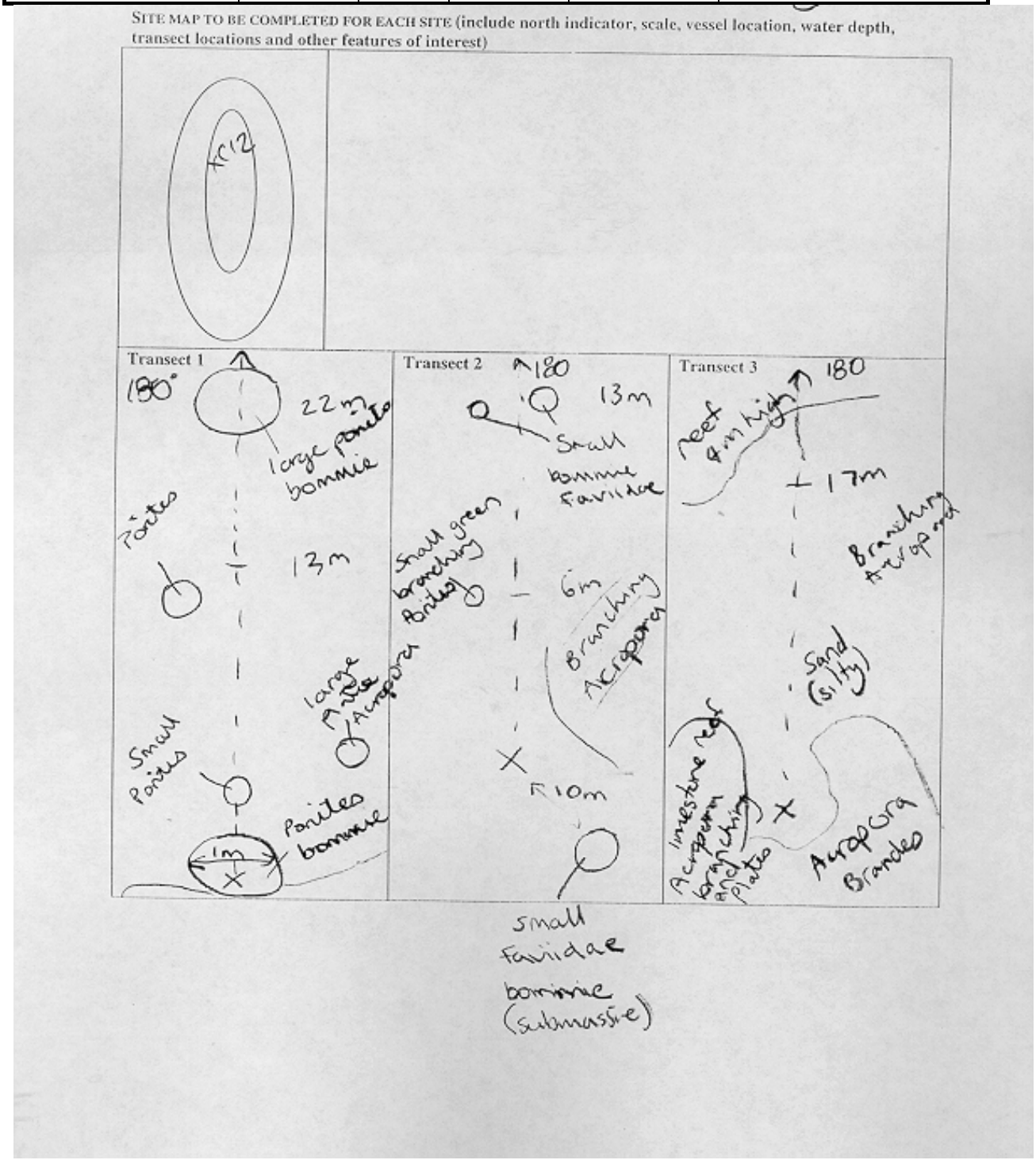
COMPLETE FOR NON-TRANSECT SITES
BOUNDARIES

1. LATITUDE (decimal degrees)	-17.3033 S	**1. LONGITUDE (decimal degrees)**	119.3359 E
2. LATITUDE (decimal degrees)	-17.3037 S	**2. LONGITUDE (decimal degrees)**	119.3356 E
3. LATITUDE (decimal degrees)	-17.3042 S	**3. LONGITUDE (decimal degrees)**	119.3356 E
4. SE LATITUDE (decimal degrees)	-17.3046 S	**4. LONGITUDE (decimal degrees)**	119.3356 E
WATER DEPTH 8 m		**NOTES**	

LONG-TERM MONITORING SITE DATA SHEET

SITE NO.	C12	SITE NAME	Clerke		
DATE ESTABLISHED	20/10/01	TIME	30/12/99	RECORDER	Davidson

SITE MAP TO BE COMPLETED FOR EACH SITE (include north indicator, scale, vessel location, water depth, transect locations and other features of interest)



HABITAT SHEET

SITE NO	C12	**SITE NAME**	Clerke		
DATE	20/10/01	**TIME**	10:45 am	**RECORDER**	Davidson
WEATHER/SEA CONDITIONS	Choppy	**WATER DEPTH (MEAN)**	8.0 m	**CORRECTED WATER DEPTH (MEAN)**	
SITE TYPE	Transect	**SITE ZONE**	Lagoon		
HABITAT TYPE	Sub tidal coral reef	**SUBSTRATE**	Sand		

DOMINANT SPECIES

DOMINANT CORAL (Family/form)	**DOMINANT VULNERABLE CORALS (family/form)**
PORM	ACRB
ACRT	
ACRB	
FAVE	
PERCENTAGE COVER OF LIVE CORAL (<10%, 11-30%,>30%)	<10

DOMINANT MACRO-ALGAE	**DOMINANT SEAGRASS**

INDICATOR SPECIES

FISH	**RELATIVE ABUNDANCE**	**INVERTEBRATES**	**RELATIVE ABUNDANCE**
Potato cod (*epinephelus tukula*)		**Giant clam (*tridacna gigas*)**	
Humphead wrasse (*cheilinus undulatus*)		**Trochus (*trochus maculatus*)**	
Coral trout (*plectropomus leopardus*)	1	**Tiger cowrie (*cypraea tigris*)**	
		Sea cucumbers (all species)	

CORAL PREDATORS

CORAL PREDATOR/COTS		**CORAL PREDATOR/*DRUPELLA***	
Number of crown of thorns starfish (cots)		**Number of *drupella sp* feeding scars**	
Cots feeding scars (present/absent)		**Number of colonies checked**	
Average cots size (s/m/l)		**Number of colonies with *drupella***	
		Number of colonies without *drupella*	

HUMAN ACTIVITIES/IMPACTS

HUMAN ACTIVITIES	**TYPE OF DAMAGE**

LITTER	

NOTES

LOTS OF RUBBLE

VIDEO DATA SHEET

SITE NO.	C12	**SITE NAME**	Clerke		
DATE	20/10/01	**TIME**	10:45 am		
RECORDER	Ryan	**TAPE ID**	RSMRMP/bvt/20.10.01/#19		
METHOD	Transect	**VIDEO FORMAT**	Digital	**DIGITAL COPY**	Yes
TIME CODING FOR SITE (START)	0:20:44	**TIME CODING FOR SITE (FINISH)**	0:38:35		
TAPE DESCRIPTION					

COMPLETE FOR EACH TRANSECT VIDEO

TRANSECT NUMBER	1		
START TIME CODE	0:20:44	**FINISH TIME CODE**	0:26:18
TOTAL TIME CODE	5:34		

TRANSECT NUMBER	2		
START TIME CODE:	0:27:54	**FINISH TIME CODE:**	0:32:06
TOTAL TIME CODE	4:12		

TRANSECT NUMBER	3		
START TIME CODE	0:32:06	**FINISH TIME CODE**	0:37:37
TOTAL TIME CODE	5:31		

COMPLETE FOR ALL OTHER FOOTAGE

DESCRIPTION	Cushion star		
START TIME CODE	0:27:49	**FINISH TIME CODE**	0:27:54

DESCRIPTION	Soft coral		
START TIME CODE	0:37:52	**FINISH TIME CODE**	0:37:53

DESCRIPTION	Porites nigrescens		
START TIME CODE	0:37:53	**FINISH TIME CODE**	0:37:55

LONG-TERM MONITORING SITE DATA SHEET

SITE NO.	C13	**SITE NAME**	Clerke		
DATE ESTABLISHED	20/10/01	**TIME**	30/12/99	**RECORDER**	Davidson
SITE TYPE	Transect	**SITE ZONE**		Lagoon	
WATER DEPTH (MEAN)	7 m	**CORRECTED WATER DEPTH (MEAN)**			
GPS/DGPS	DGPS	**DATUM**		WGS84	
NOTES					

COMPLETE FOR TRANSECT SITES

TRANSECT NUMBER	1	**DIRECTION OF TRANSECT (BEARING °)**	180°		
START: LATITUDE (DECIMAL DEGREES)	-17.311 S	**START: LONGITUDE (DECIMAL DEGREES)**	119.3679 E		
TRANSECT MARKER (START)	No	**TRANSECT MARKER (END)**	No	**WATER DEPTH**	m
NOTES					

TRANSECT NUMBER	2	**DIRECTION OF TRANSECT (BEARING °)**	°		
START: LATITUDE (DECIMAL DEGREES)	-17.3113 S	**START: LONGITUDE (DECIMAL DEGREES)**	119.3679 E		
TRANSECT MARKER (START)	No	**TRANSECT MARKER (END)**	No	**WATER DEPTH**	
NOTES					

TRANSECT NUMBER	3	**DIRECTION OF TRANSECT (BEARING °)**	°		
START: LATITUDE (DECIMAL DEGREES)	-17.3119 S	**START: LONGITUDE (DECIMAL DEGREES)**	119.3678 E		
FINISH: LATITUDE (DECIMAL DEGREES)	-17.3124 S	**FINISH: LONGITUDE (DECIMAL DEGREES)**	119.3678 E		
TRANSECT MARKER (START)	No	**TRANSECT MARKER (END)**	No	**WATER DEPTH**	m
NOTES					

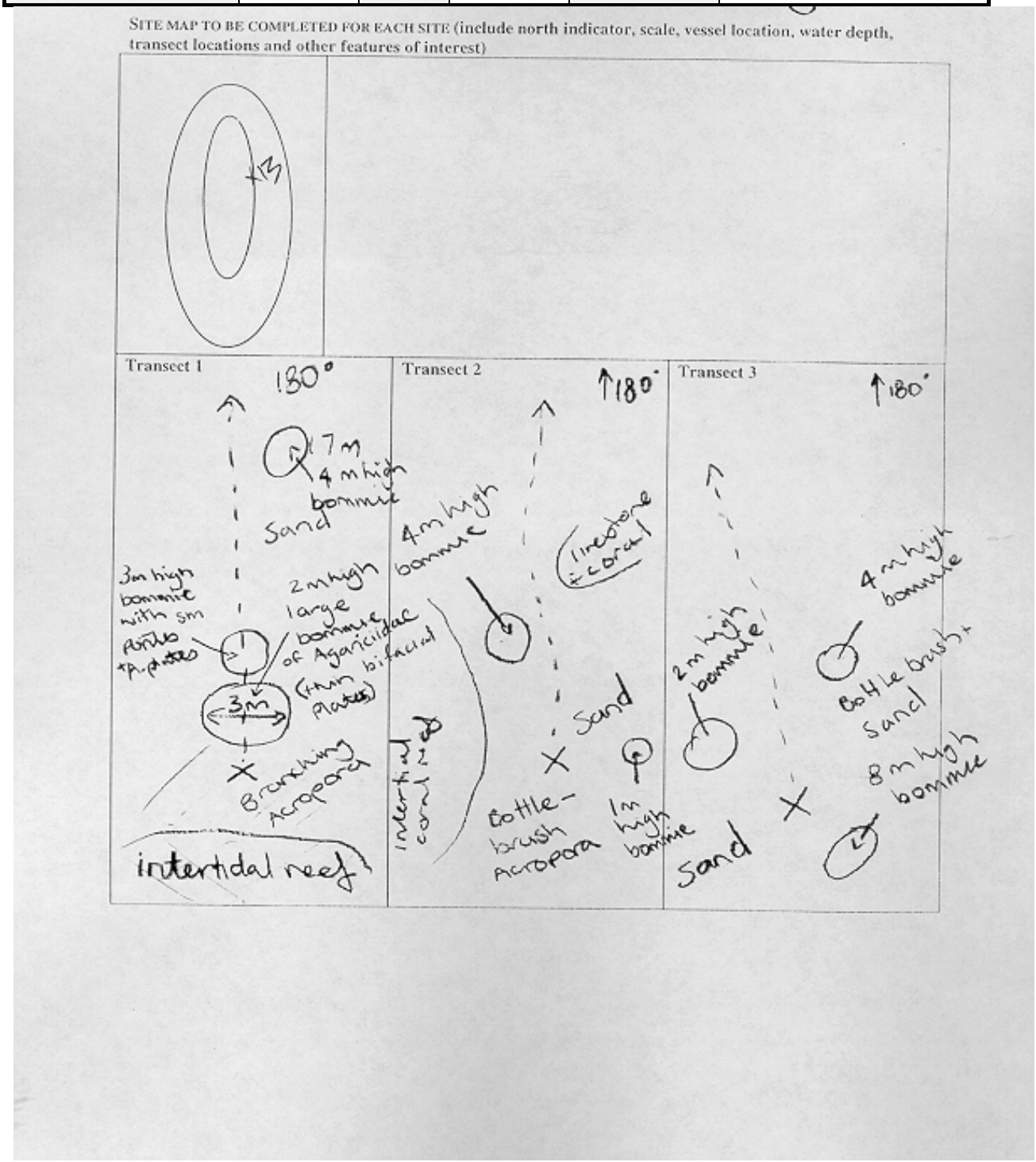
COMPLETE FOR NON-TRANSECT SITES
BOUNDARIES

1. LATITUDE (decimal degrees)		**1. LONGITUDE (decimal degrees)**	
2. LATITUDE (decimal degrees)		**2. LONGITUDE (decimal degrees)**	
3. LATITUDE (decimal degrees)		**3. LONGITUDE (decimal degrees)**	
4. SE LATITUDE (decimal degrees)		**4. LONGITUDE (decimal degrees)**	
WATER DEPTH		**NOTES**	

LONG-TERM MONITORING SITE DATA SHEET

SITE NO.	C13	SITE NAME	Clerke		
DATE ESTABLISHED	20/10/01	TIME	30/12/99	RECORDER	Davidson

SITE MAP TO BE COMPLETED FOR EACH SITE (include north indicator, scale, vessel location, water depth, transect locations and other features of interest)



HABITAT SHEET

SITE NO	C13	**SITE NAME**	Clerke		
DATE	20/10/01	**TIME**	10:00 am	**RECORDER**	Davidson
WEATHER/SEA CONDITIONS	Calm	**WATER DEPTH (MEAN)**	7.0 m	**CORRECTED WATER DEPTH (MEAN)**	
SITE TYPE	Transect	**SITE ZONE**	Lagoon		
HABITAT TYPE	Sub tidal coral reef	**SUBSTRATE**	Sand		

DOMINANT SPECIES

DOMINANT CORAL (family/form)	**DOMINANT VULNERABLE CORALS (family/form)**
ACRB	
ACRD	
FAVE	
PERCENTAGE COVER OF LIVE CORAL (<10%, 11-30%,>30%)	11-30

DOMINANT MACRO-ALGAE	**DOMINANT SEAGRASS**

INDICATOR SPECIES

FISH	**RELATIVE ABUNDANCE**	**INVERTEBRATES**	**RELATIVE ABUNDANCE**
Potato cod (*epinephelus tukula*)	1	**Giant clam (*tridacna gigas*)**	
Humphead wrasse (*cheilinus undulatus*)		**Trochus (*trochus maculatus*)**	
Coral trout (*plectropomus leopardus*)	4	**Tiger cowrie (*cypraea tigris*)**	
		Sea cucumbers (all species)	

CORAL PREDATORS

CORAL PREDATOR/COTS		**CORAL PREDATOR/*DRUPELLA***	
Number of crown of thorns starfish (cots)		**Number of *drupella sp* feeding scars**	
Cots feeding scars (present/absent)		**Number of colonies checked**	
Average cots size (s/m/l)		**Number of colonies with *drupella***	
		Number of colonies without *drupella*	

HUMAN ACTIVITIES/IMPACTS

HUMAN ACTIVITIES	**TYPE OF DAMAGE**

LITTER	

NOTES

VIDEO DATA SHEET

SITE NO.	C13	**SITE NAME**	Clerke		
DATE	20/10/01	**TIME**	10:00 am		
RECORDER	Ryan	**TAPE ID**	RSMRMP/bvt/20.10.01/#19		
METHOD	Transect	**VIDEO FORMAT**	Digital	**DIGITAL COPY**	Yes
TIME CODING FOR SITE (START)	0:00:00	**TIME CODING FOR SITE (FINISH)**	0:20:44		
TAPE DESCRIPTION					

COMPLETE FOR EACH TRANSECT VIDEO

TRANSECT NUMBER	1		
START TIME CODE	0:00:57	**FINISH TIME CODE**	0:08:04
TOTAL TIME CODE	7:07		

TRANSECT NUMBER	2		
START TIME CODE:	0:08:04	**FINISH TIME CODE:**	0:13:29
TOTAL TIME CODE	5:25		

TRANSECT NUMBER	3		
START TIME CODE	0:13:29	**FINISH TIME CODE**	0:18:47
TOTAL TIME CODE	5:18		

COMPLETE FOR ALL OTHER FOOTAGE

DESCRIPTION	Beautiful shots of exposed reef at low tide from boat		
START TIME CODE	0:00:00	**FINISH TIME CODE**	0:00:57

DESCRIPTION	Coral reef 1 m from the surface		
START TIME CODE	0:18:47	**FINISH TIME CODE**	0:20:12

DESCRIPTION	Fragile plate corals		
START TIME CODE	0:20:12	**FINISH TIME CODE**	0:20:34

LONG-TERM MONITORING SITE DATA SHEET

SITE NO.	C14	**SITE NAME**	Clerke		
DATE ESTABLISHED	20/10/01	**TIME**	30/12/99	**RECORDER**	Harasti
SITE TYPE	Transect	**SITE ZONE**		Back reef	
WATER DEPTH (MEAN)	2.5 m	**CORRECTED WATER DEPTH (MEAN)**			
GPS/DGPS	DGPS	**DATUM**		WGS84	
NOTES					

COMPLETE FOR TRANSECT SITES

TRANSECT NUMBER	1	**DIRECTION OF TRANSECT (BEARING °)**	0.0°		
START: LATITUDE (DECIMAL DEGREES)	-17.283 S	**START: LONGITUDE (DECIMAL DEGREES)**	119.373 E		
TRANSECT MARKER (START)	No	**TRANSECT MARKER (END)**	No	**WATER DEPTH**	m
NOTES					

TRANSECT NUMBER	2	**DIRECTION OF TRANSECT (BEARING °)**	°		
START: LATITUDE (DECIMAL DEGREES)	-17.2834 S	**START: LONGITUDE (DECIMAL DEGREES)**	119.3733 E		
TRANSECT MARKER (START)	No	**TRANSECT MARKER (END)**	No	**WATER DEPTH**	
NOTES					

TRANSECT NUMBER	3	**DIRECTION OF TRANSECT (BEARING °)**	°		
START: LATITUDE (DECIMAL DEGREES)	-17.2839 S	**START: LONGITUDE (DECIMAL DEGREES)**	119.3736 E		
FINISH: LATITUDE (DECIMAL DEGREES)	-17.2842 S	**FINISH: LONGITUDE (DECIMAL DEGREES)**	119.3739 E		
TRANSECT MARKER (START)	No	**TRANSECT MARKER (END)**	No	**WATER DEPTH**	m
NOTES					

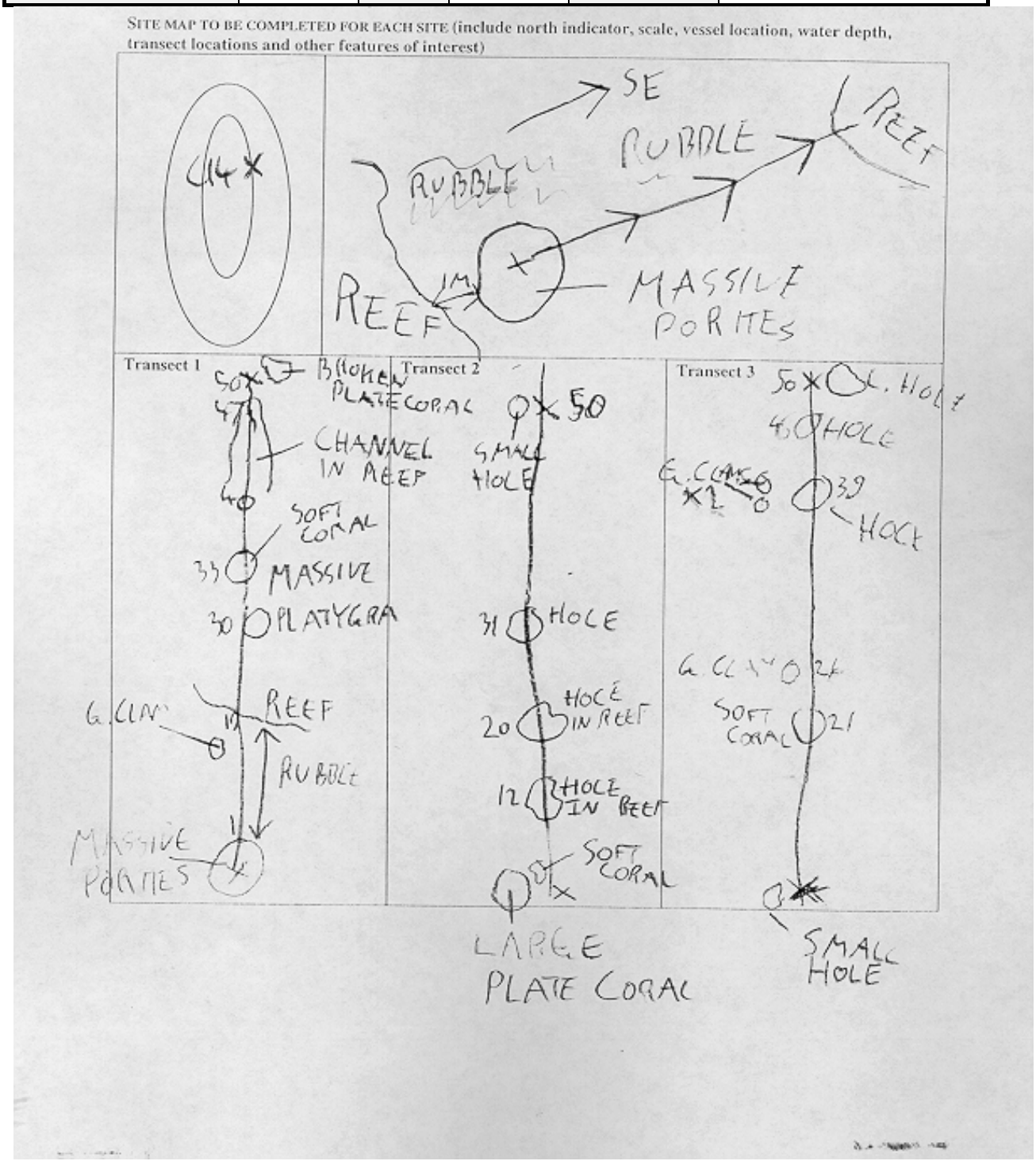
COMPLETE FOR NON-TRANSECT SITES
BOUNDARIES

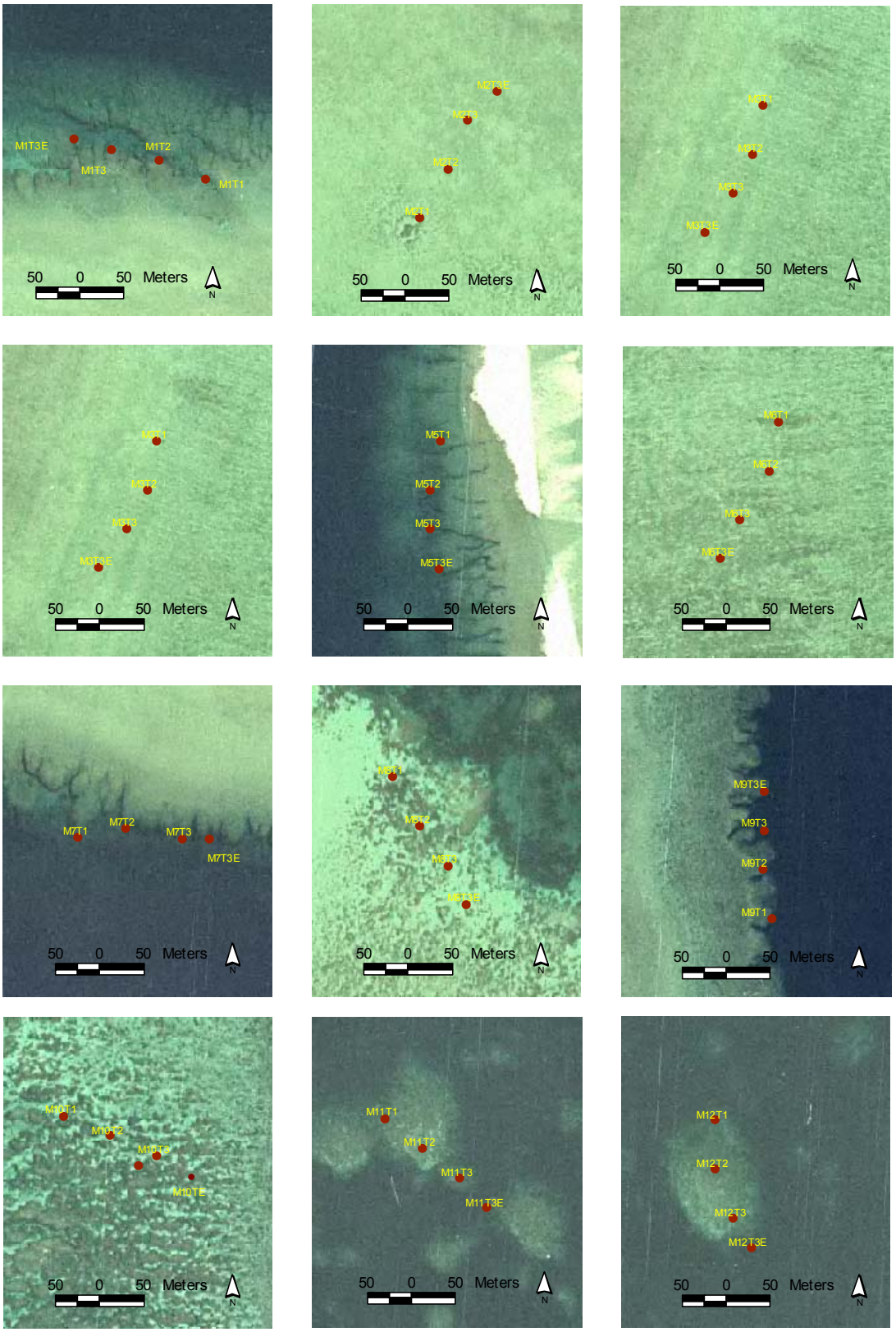
1. LATITUDE (decimal degrees)		**1. LONGITUDE (decimal degrees)**	
2. LATITUDE (decimal degrees)		**2. LONGITUDE (decimal degrees)**	
3. LATITUDE (decimal degrees)		**3. LONGITUDE (decimal degrees)**	
4. SE LATITUDE (decimal degrees)		**4. LONGITUDE (decimal degrees)**	
WATER DEPTH		**NOTES**	

LONG-TERM MONITORING SITE DATA SHEET

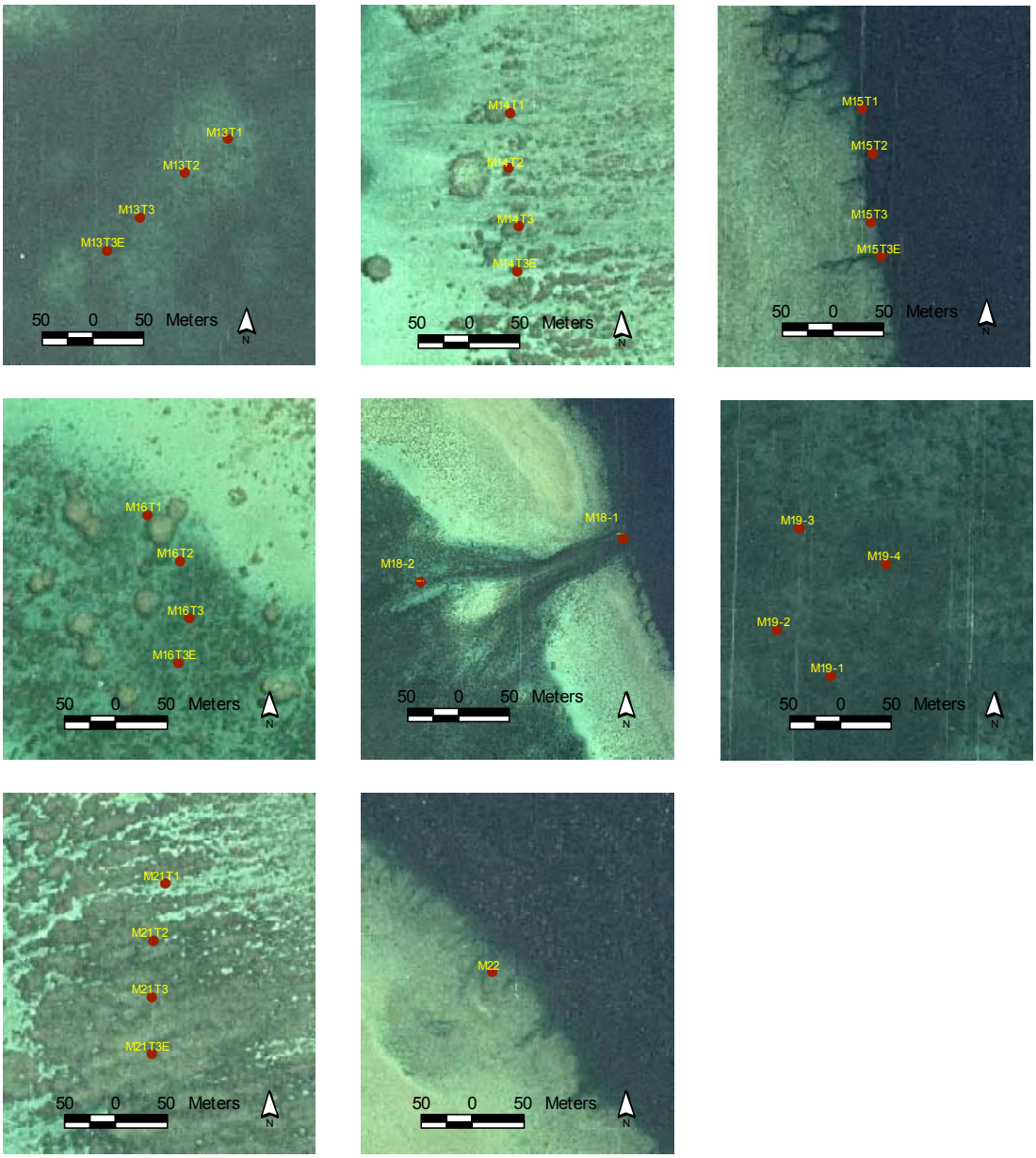
SITE NO.	C14	SITE NAME	Clerke		
DATE ESTABLISHED	20/10/01	TIME	30/12/99	RECORDER	Harasti

SITE MAP TO BE COMPLETED FOR EACH SITE (include north indicator, scale, vessel location, water depth, transect locations and other features of interest)

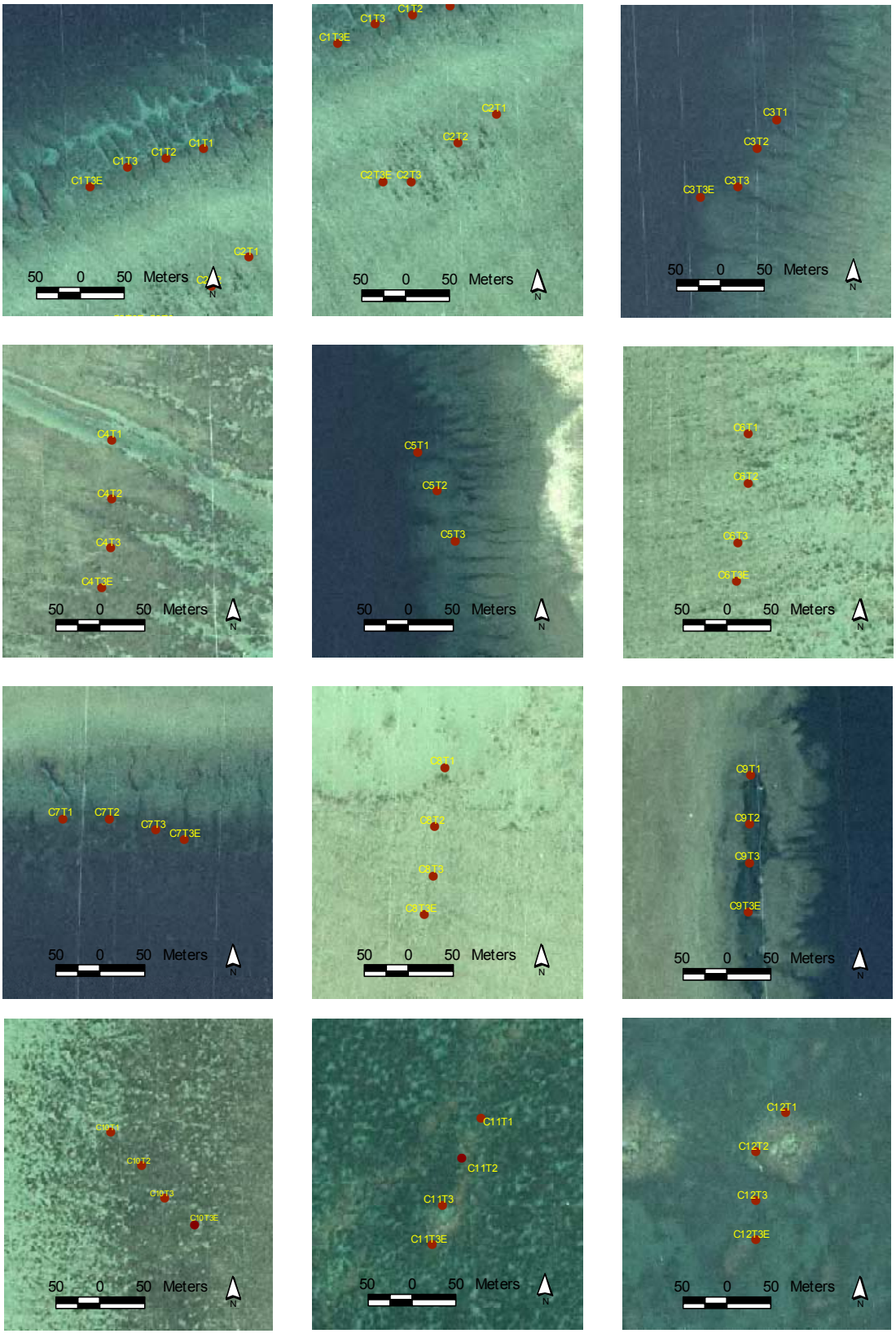




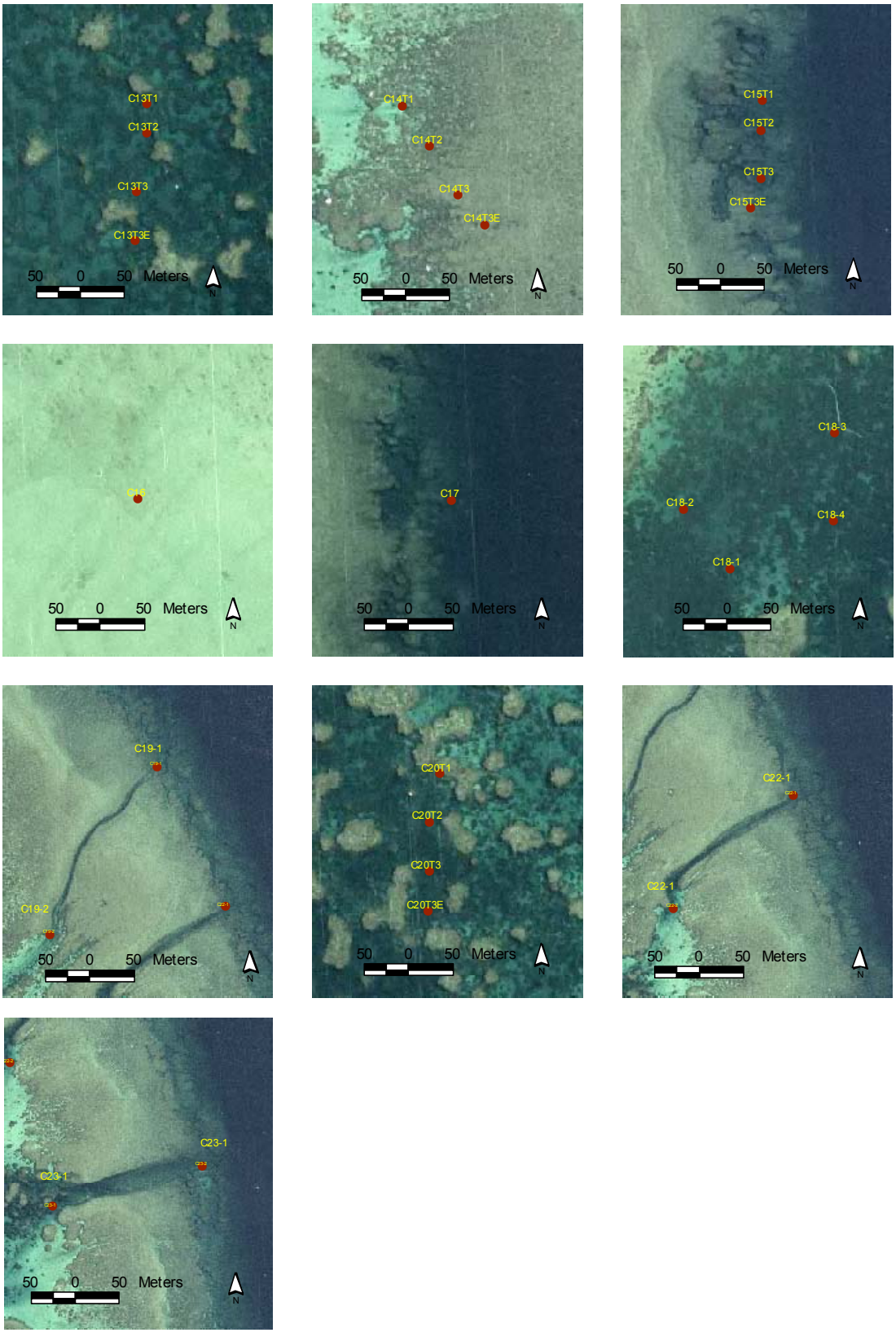
Monitoring sites established at Mermaid Reef Marine National Nature Reserve



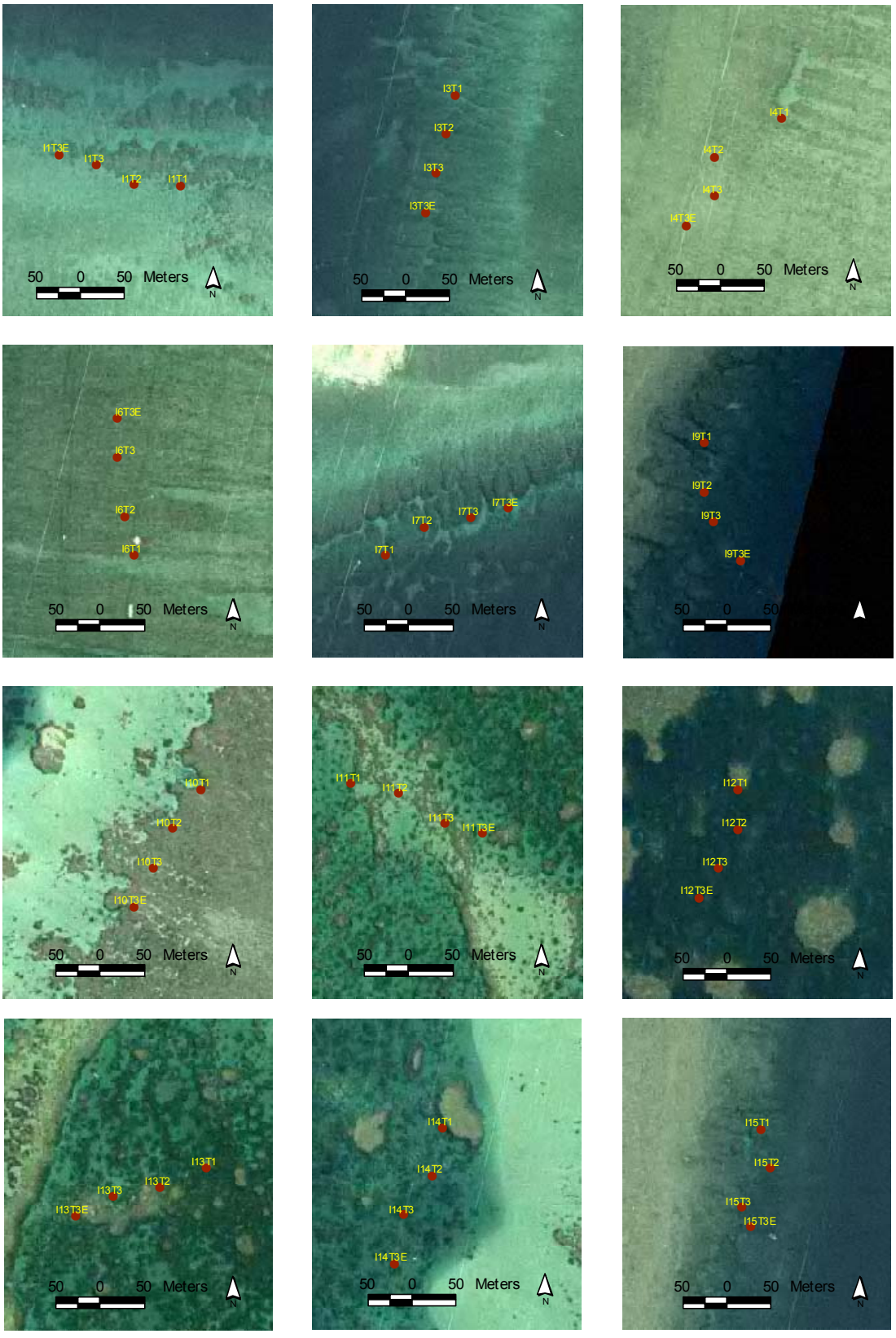
Monitoring sites established at Mermaid Reef Marine National Nature Reserve



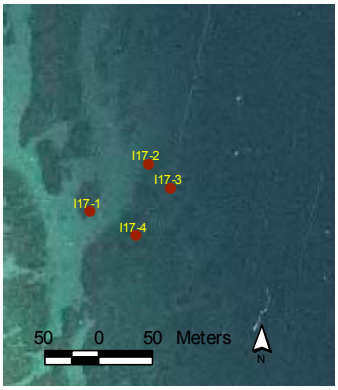
Monitoring sites established at Clerke Reef, Rowley Shoals Marine Park

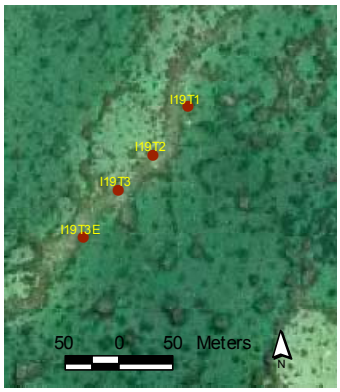


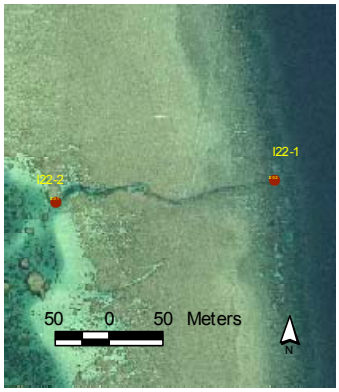
Monitoring sites established at Clerke Reef, Rowley Shoals Marine Park

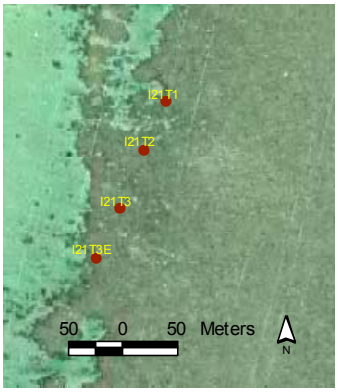


Monitoring sites established at Imperieuse Reef, Rowley Shoals Marine Park









Monitoring sites established at Imperieuse Reef, Rowley Shoals Marine Park

APPENDIX 3: MRMNNR 05/00 VIDEO TAPE

Tape No.	Program	Description	Digital original	VHS copy	Digital copy
RSMRMP/bvt/13.10.01/#1	RSMRMP	I1, I15	Yes	Yes	Yes
RSMRMP/bvt/13.10.01/#2	RSMRMP	I14, I17	Yes	Yes	Yes
RSMRMP/bvt/14.10.01/#3	RSMRMP	I6, I7, I11	Yes	Yes	Yes
RSMRMP/bvt/14.10.01/#4	RSMRMP	I3, I4, I9	Yes	Yes	Yes
RSMRMP/bvt/15.10.01/#5	RSMRMP	I13, I19	Yes	Yes	Yes
RSMRMP/bvt/15.10.01/#6	RSMRMP	I10, I12, I20, I21	Yes	Yes	Yes
RSMRMP/bvt/16.10.01/#7	RSMRMP	M1, M5, M6	Yes	Yes	Yes
RSMRMP/bvt/16.10.01/#8	RSMRMP	M2, M3, M4	Yes	Yes	Yes
RSMRMP/bvt/16.10.01/#9	RSMRMP	M7, M18	Yes	Yes	Yes
RSMRMP/bvt/16.10.01/#10	RSMRMP	M9, M18	Yes	Yes	Yes
RSMRMP/bvt/17.10.01/#11	RSMRMP	M13, M14, M15	Yes	Yes	Yes
RSMRMP/bvt/17.10.01/#12	RSMRMP	M8, M10, M11	Yes	Yes	Yes
RSMRMP/bvt/18.10.01#13	RSMRMP	M12, M16	Yes	Yes	Yes
RSMRMP/bvt/18.10.01/#14	RSMRMP	M19, M21	Yes	Yes	Yes
RSMRMP/bvt/18.10.01/#15	RSMRMP	M22	Yes	Yes	Yes
RSMRMP/bvt/19.10.01/#16	RSMRMP	C6, C8, C11	Yes	Yes	Yes
RSMRMP/bvt/19.10.01/#17	RSMRMP	C9, C10	Yes	Yes	Yes
RSMRMP/bvt/19.10.01/#18	RSMRMP	C15	Yes	Yes	Yes
RSMRMP/bvt/20.10.01/#19	RSMRMP	C4, C12, C13	Yes	Yes	Yes
RSMRMP/bvt/20.10.01/#20	RSMRMP	C18, C21	Yes	Yes	Yes
RSMRMP/bvt/20.10.01/#21	RSMRMP	C14, C20	Yes	Yes	Yes
RSMRMP/bvt/21.10.01/#22	RSMRMP	C22, C23	Yes	Yes	Yes
RSMRMP/bvt/21.10.01/#23	RSMRMP	C19	Yes	Yes	Yes
RSMRMP/bvt/21.10.01/#24	RSMRMP	C1, C2, C3	Yes	Yes	Yes
RSMRMP/bvt/22.10.01/#25	RSMRMP	C16	Yes	Yes	Yes
RSMRMP/bvt/21.10.01/#26	RSMRMP	C5, C7	Yes	Yes	Yes
RSMRMP/bvt/22.10.01/#27	RSMRMP	C17	Yes	Yes	Yes