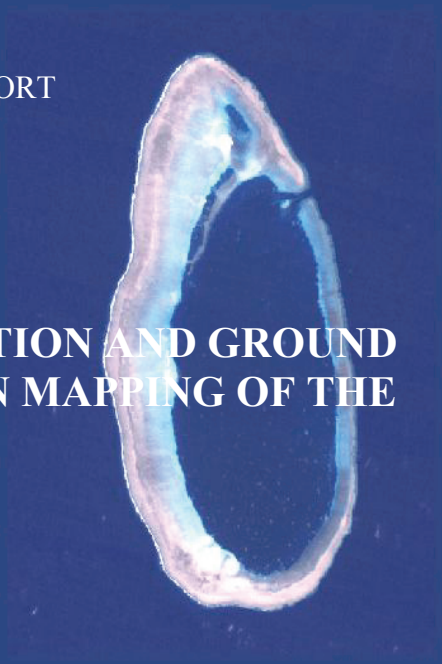
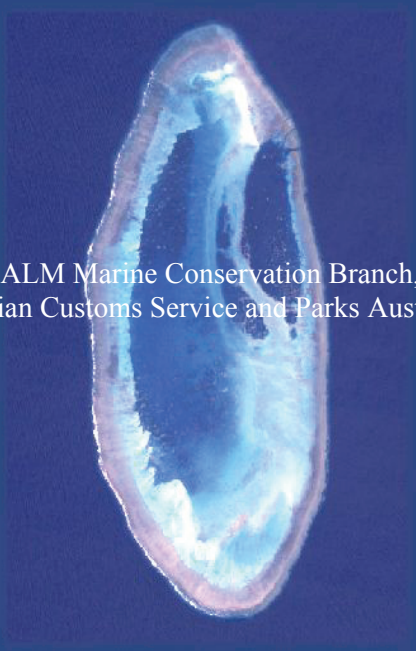
MARINE MANAGEMENT SUPPORT
ROWLEY SHOALS



GATHERING OF SPATIAL RECTIFICATION AND GROUND TRUTH DATA FOR HIGH RESOLUTION MAPPING OF THE ROWLEY SHOALS 9-20 OCTOBER 1997

Data Report: MMS/OSS/RSH-06/1997



A collaborative project between CALM Marine Conservation Branch, Calm West Kimberly District Office, Australian Customs Service and Parks Australia North

Prepared by
Ray Lawrie and Mike Lapwood

June 1998

Marine Conservation Branch
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ACKNOWLEDGEMENTS

Direction

- Dr Chris Simpson - Manager, Marine Conservation Branch (MCB) Nature Conservation Branch.
- Allen Grosse - Manager, West Kimberley District.

CALM collaboration

- Ray Lawrie - Project leader, MCB.
- Mike Lapwood - Field Team Leader, MCB.
- Warwick Roe - District Wildlife Officer, Broome.
- Elena Anière - Parks, Policy and Tourism Branch.

External collaboration

- Australian Customs Service, Broome.
- Skipper and crew of the ACV Andrew Fisher.
- Des Pike - Parks Australia, North.

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Copies of this report may be obtained from:

Marine Conservation Branch
Department of Conservation and Land Management
47 Henry St
Fremantle, Western Australia, 6160

Ph: 61-9-3360100
Fx: 61-9-3360408

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SUMMARY

This report presents results of a spatial rectification and marine habitat ground truth survey carried out 9-20 October 1997 over the Rowley Shoals, three shelf edge atolls approximately 260km west of Broome. The objective of this survey was to gather accurate spatial position data over pre-selected points. These points will provide spatial control for rectification of aerial photography and satellite imagery to facilitate future spatially accurate mapping of the Rowley Shoals. Habitat ground truth data, depth and time were also recorded to aid marine habitat mapping and determination of bathymetry. This level of spatial accuracy will aid effective zoning and management of the Rowley Shoals Marine Park and the Mermaid Reef Marine National Nature Reserve.

A preliminary analysis of the spatial control data indicates that it will be sufficient for 2 dimensional rectification of digital image data immediately and with further work on sea level data available from the Australian Institute of Marine Science (AIMS) accurate 3 dimensional models could be developed.

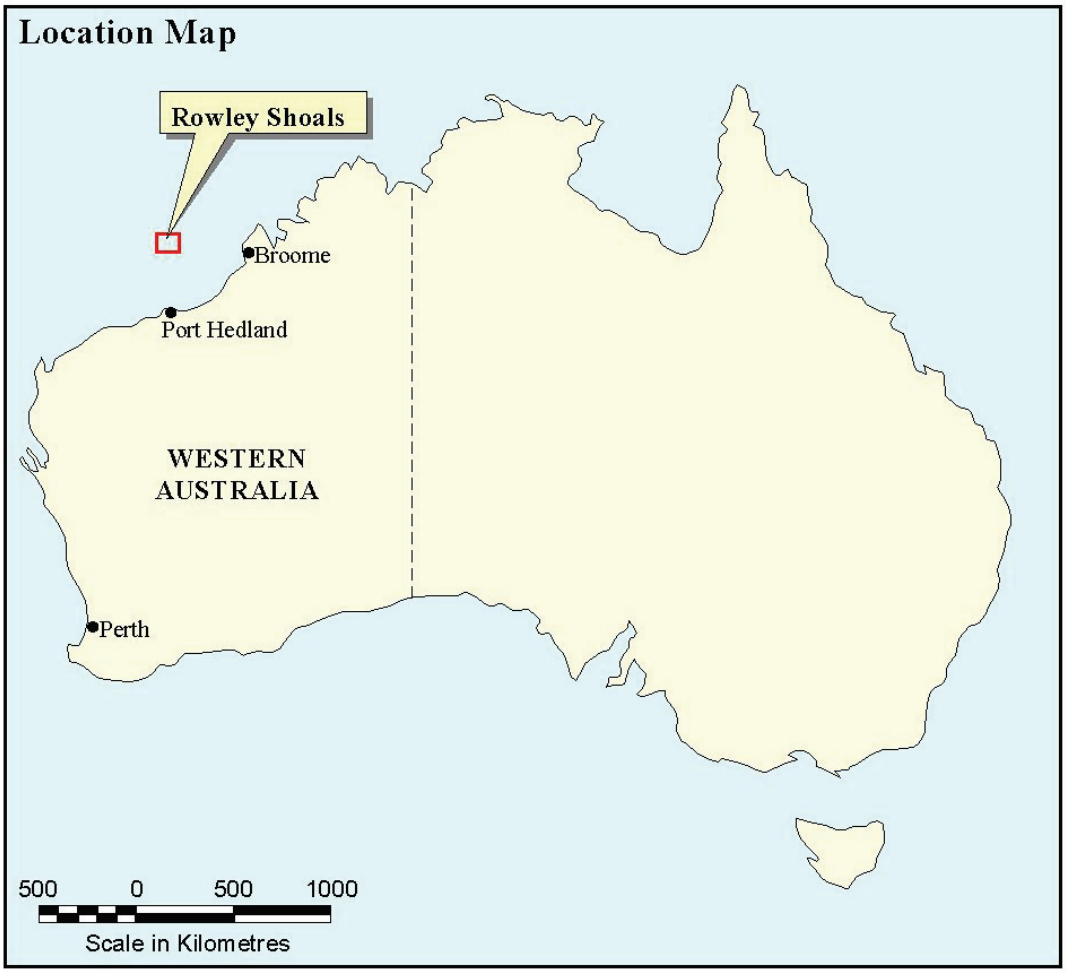


Figure 1: Location map of the Rowley Shoals

1. INTRODUCTION

1.1. General background

The CALM Act (1984) allows for the establishment of multiple-use marine conservation reserves for the purposes of conservation of marine flora and fauna and public recreation. Commercial activities, such as fishing, aquaculture and petroleum exploration and production, are also acceptable within specific zones of multiple-use marine conservation reserves. The CALM Act specifies the statutory process for the reservation of marine conservation reserves, including a public planning process for the development of management zoning schemes that allow for the spatial separation of incompatible activities in a marine park. In anticipation of this process the major marine resources and current uses of areas recommended for reservation in the Wilson Report, are being identified and mapped in a Geographical Information System (GIS) by CALM's Marine Conservation Branch (MCB).

Whilst is it is acknowledged that this is an existing marine reserve, successful zoning and management strategies requiring stakeholder and public input are necessary.

The success of this process is reliant on accurate presentation of marine resources and current usage patterns in a spatially accurate GIS.

This survey was part of the Department of Conservation and Land Management's (CALM) Marine Management Support Programme and was co-ordinated by CALM's Marine Conservation Branch (MCB). It was conducted in collaboration with CALM's Kimberley Region and West Kimberley District offices, the Australian Customs Service and Parks Australia.

1.2. Objectives

1.2.1. *Primary objectives*

To obtain detailed spatial rectification data (approximately 20 sites per atoll) that will enable accurate mapping of each atoll from aerial photography and satellite data.

To obtain further biological data on benthic habitats at each of the above sites to facilitate the generation of biologically accurate habitat maps.

1.2.2. *Secondary objectives*

To video benthic habitat transects across each atoll, in each major biological zone.

To assess the need for dedicated moorings at each of the commercial dive sites (i.e. is there a coral rubble/sand zone in 3 - 10 metre depth that will allow anchoring without damage to coral communities).

To opportunistically collect video and still photography of representative marine communities at the Rowley Shoals for educational purposes.

To physically check reports of fuel drums discarded in the lagoon at Clerke Reef Anchorage remove if possible and attempt to trace the origin.

1.3. Survey Area

The Rowley Shoals are located approximately 260 km west of Broome lying between 17º 07'S, 119º 36'E and 17º 35S, 118º 56'E on the edge of one of the widest continental shelves in the world. The shoals (Clerke, Imperieuse and Mermaid Reefs) are 30-40 km apart and are elliptical in shape, measuring 14-18 km long and 7.5-9.5 km wide (Done, *et al.*, 1994). They are situated in water ranging from 230-500 metres deep. These coral reefs have grown directly onto the shelf, and have been described as the most perfect morphological shelf atolls in Australian waters.

The Rowley Shoals Marine Park comprises Clerke and Imperieuse Reefs and was gazetted on 25 May 1990. It is managed as marine conservation reserve by CALM on behalf of the Marine Parks and Reserves Authority. As Mermaid Reef does not contain any land above high water mark it is under Commonwealth jurisdiction. It was gazetted as a Marine National Nature Reserve in March 1991 and is jointly managed by Environment Australia (Parks Australia North), CALM and the Western Australian Fisheries Department under a Memorandum of Understanding.

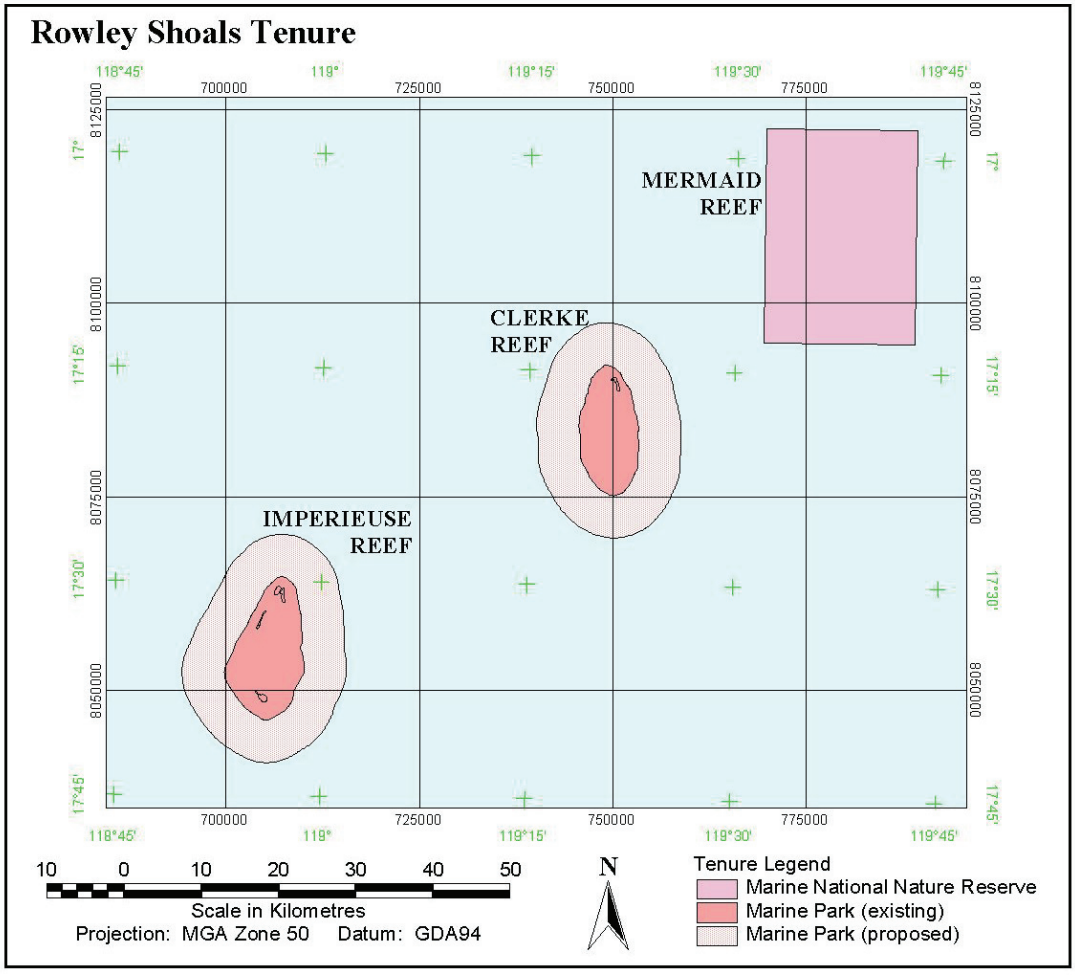


Figure 2: Tenure map of the Rowley Shoals.

2. METHODS

2.1. Site Selection

Points were selected primarily for their suitability for spatial control and were most often isolated coral bommies or channel intersections on the outer reef edge. Other considerations in site selection were ease of access and ease of field identification.

Water penetration (yellow filter) aerial photography of the Rowley Shoals has been flown in colour at a scale of I:10000, resulting in 30- 40 frames per atoll for full stereo coverage. In addition one run per atoll (5 frames each) at 1:44000 in plain unfiltered colour were flown to support mapping (Project No.960525, Film No.3759 & 3763, date 03.07.96). Sufficient Ground Control Points (GCPs) to allow orthophoto generation were selected in the overlap areas of adjoining 1:44k photos. Due to the high quality of photography features as small as 1 square metre could be selected from the 1:10k photographs and re-located on the 1:44k coverage.

Points were transferred to previously rectified Landsat TM image and an approximate latitude and longitude for each point calculated and loaded to the GPS unit as a waypoint. This approach allowed some guidance in locating the approximate area of the target point. Navigation to the actual site was then carried out by feature recognition using the 1:10k photos. Even though on processing the early position data it became apparent that current satellite imagery was in error some 1-2 km east, this approach was still useful once recognised, as the latitudes were still reasonably accurate.

The set of 1:10k water penetration aerial photographs loaned to us by CALM Broome proved invaluable in the field and these were used almost exclusively to identify sites. The extreme tidal range and the effect of sun angle on sub surface visibility meant that scheduling visits to sites was most important in order to maximise time on the reef.

It was initially thought that the survey teams could work on the outside perimeters of the atolls but this proved impractical due to the swell on the western side and some deeper sites on the eastern sides being impossible to identify. Thus the survey area comprised in the main the lagoon systems of all three atolls where features were more identifiable and sea conditions were more sheltered.

In addition, a detailed examination of Clerke Reef anchorage area was undertaken with six ‘fixes’ taken of prominent bommies within the proposed anchorage area.

Three sites were also identified and recorded on Bedwell Island one on the Cunningham Lighthouse and a further three sites on the western side of Mermaid Atoll marking the wreck of the ‘Lively’ (1810).

2.2. Sampling methodology.

2.2.1. Spatial Control Points

Once the identification of the site was confirmed by a thorough check of surrounding features against the photo, the point on the feature for sampling was selected. (centre of feature, corner, between features etc.) and the position marked with a pin point through the site on the aerial photograph. In addition the point was circled and labelled on the photo with chinagraph pencil. Taking into account tide and wind drift the boat was anchored so that the GPS receiving aerial was above the selected point. After allowing time for the signal to stabilise (5-10minutes) *DGPS position, time and depth were then recorded manually. All positions were recorded in geographical co-ordinates in the format DDº MM' SS.S". I.e. 0.1 seconds of latitude or longitude an accuracy of +/- 1.5 metres. The datum used was WGS 84.

* The MCB/FUGRO DGPS demodulation unit, coupled to a Scoutmaster GPS was used extensively during this field trip. FUGRO supplied real time correction signal from their Perth base station and estimated the error in horizontal position to be not worse than 4 metres from true position.

2.2.2. Habitat Ground Truth

After recording spatial position data and notes describing the control point and impressions of habitat, the site was marked with a buoy for an underwater video team who were maintaining visual contact site to site. The site and surrounds were videoed and logged then the buoy removed before moving on to the next site

In addition a west to east transect of the lagoon system of Imperieuse atoll was undertaken to ground truth habitat types with a DGPS 'fix' was taken at the boundaries of each habitat type. This will further enhance the spatial habitat data and allow for more accurate biological mapping of the major habitat types.

3. RESULTS

3.1. Spatial Rectification Ground Control Points

Sufficient GCPS at a spatial accuracy of no worse than 4 metres horizontally were established at all three atolls, 24 at Imperieuse, 28 Clerke and 20 at Mermaid. Bad weather and time constraints forced us to move on to Clerke before completing Imperieuse however we managed to return on the final day and complete our survey.

3.2. Video and photographic capture

Video camera malfunction during the Clerke survey left only four sites with video data and no video of Mermaid.

4. MAPPING

4.1. Spatial Rectification Ground Control Points

In order to check the GCPs against available Landsat imagery, which was, rectified to AGD 84 datum; the GCPs were converted from WGS 84 to AGD 84 using conversion figures supplied by the Department of Transport WA Marine Division. The points were moved South by 0.083 minutes and West by 0.078 minutes to accommodate this datum shift. Using ESRI Arcview 3.1 software, GIS files of GCPs in AGD 84 datum were generated and plotted on Landsat Tm image acquired prior to the survey, highlighting an error in the original image rectification. Re-rectification of Landsat TM image used has been carried out (see ROW_SHO.BIL on CD 38 in MCB CD library) and GCP points overlaid (see Figures 3,5,7).

GCPS have been forwarded to Don Daams at CALM's Information Management Branch for use in generating Digital Orthophoto Mosaics from the available 1:44000 colour photography.

4.2. Habitat

Data lodged in MCB Marine information system for use in future habitat mapping. (See Data Management section)

5. DATA MANAGEMENT

5.1. Report

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

1. Marine Conservation Branch, Department of Conservation and Land Management, 47 Henry Street, Fremantle Western Australia, 6160. Ph: (08) 9336 0100 Fax: (08) 9430 5408.

2. Woodvale Library, Science and Information Division, Ocean Reef Road, Woodvale, Western Australia, 6026. Ph: (08) 9405 5100 Fax: (08) 9306 1641.

3. Archives, Woodvale Library, Science and Information Division, Ocean Reef Road, Woodvale, Western Australia, 6026. Ph: (08) 9405 5100 Fax: (08) 9306 1641.

4. West Kimberley District, Department of Conservation and Land Management 154 Herbert Street, Broome, Western Australia, 6537. Ph: (08) 9192 1036 Fax: (08) 9193 5027.

Digital copies of this report will be held at the following:

1. The Marine Conservation Branch server:
   Shareddata on 'Calm-frem-1'
   [T:\144-Marine Conservation Branch\Shared Data\Current_MCB_reports\MMS\mms_1198]

2. The Marine Conservation Branch server full backup DAT tape:
   Shareddata on 'Calm-frem-1'
   [T:\144-Marine Conservation Branch\Shared Data\Current_MCB_reports\MMS\mms_1198]

3. CD ROM held at Marine Conservation Branch and Archives (Woodvale Library, Science and Information Division):
   CD-ROM [mms_1198]

5.2. Spatial Rectification Data

Original data collected on the survey will be stored digitally at four locations:

1. MCB server (x2,mirrored): @ MIS\Data\Development\Contextual\Geodetic\calm
2. MCB Sever Full backup DAT tape: MIS\Data\Development\Contextual\Geodetic\calm
3. CD & Floppy disk in Marine Information Management Section.

GIS data developed from the survey will be stored digitally at three locations:

4. MCB server (x2,mirrored): @ MIS\Data\Production\Contextual\Geodetic\calm
MCB Sever Full backup DAT tape: MIS\Data\production\Contextual\Geodetic\calm.

5.3. Habitat Ground Truth Data

Note: Some of the habitat data sheets only exist in hardcopy format in this report due to corrupt files supplied on floppy disks

5. MCB server (x2,mirrored: @ MIS\Data\Development\ Development\Ecosystem\3_local\calm

6. MCB Sever Full backup DAT tape: MIS\Data\Development\Ecosystem\3_local\calm
7. CD & Floppy disk in Marine Information Management Section.
8. All original survey data sheets, including underwater recording sheets and transcribed copies, have been archived in the MCB library.
9. Original photos and field books lodged in MCB library and held in MCB Marine Information Section.
10. The Hi8 videotapes have been catalogued and all footage has been duplicated on to VHS tapes. Both sets of tapes are archived in the MCB's video library, and one set is stored separately off the premises. Duplicates of all 35-mm transparencies have been catalogued and are archived in the MCB's slide library.

Table 1: Ground Control Point (GCP) locations as collected in WGS 84 datum.

ROWLEY SHOALS SPATIAL RECTIFICATION SURVEY. 9-20 OCTOBER 1997					
STIE NO	**LATITUDE**	**LONGITUDE**	**DATE**	**TIME**	**WATER DEPTH**
	IMPERIEUSE REEF				
I 1	-17 30' 17.6"	118 57' 48.7"	11.10.97	1519	2.4m (reef);4.5m (sand)
I 2	-17 30' 26.3"	118 57' 52.3"	11.10.97	1540	4.2m (reef);6.2m (sand)
I 3	-17 32' 08.1"	118 58' 06.7"	12.10.97	713	1.8m (reef);1.3m (top of shelf)
I 4	-17 33' 44.1"	118 57' 57.7"	12.10.97	1330	1.0m (ctr bommie);2.4m (sand)
I 5	-17 35' 08.5"	118 58' 12.2"	12.10.97	902	0.8m
I 6	-17 36' 21.5"	118 58' 13.3"	12.10.97	922	1.1m
I 30	-17 37' 08.3"	118 57' 34.0"	12.10.97	943	1.75m
I 31	-17 31' 08.3"	118 58' 04.6"	12.10.97	1430	1.0m
I 32	-17 30' 45.1"	118 57' 57.8"	12.10.97	1507	2.8m
I 33	-17 32' 50.1"	118 57' 01.1"	12.10.97	1640	1.8m (top of bommie);3.0m (sand)
I 7	-17 38' 13.8"	118 57' 12.8"	14.10.97	726	1.6m (top of bommie) fix to ctr.
I 8	-17 38' 55.7"	118 56' 02.1"	14.10.97	751	1.4m (centre of bommie)
I 9	-17 38' 46.7"	118 55' 46.5"	14.10.97	810	2.0m (sand ctr of bommie)
I 34	-17 37' 17.4"	118 55' 03.6"	14.10.97	833	3.2m (sand)
I 10	-17 36' 13.3"	118 54' 01.4"	14.10.97	903	2.3m (reef);5.5m (sand)
I 11	-17 35' 13.1"	118 54' 09.5"	14.10.97	938	1.5m (ctr of acropora plate)
I 12	-17 34' 36.5"	118 54' 24.3"	19.10.97	1035	2.2m (sand)
I 13	-17 33' 46.4"	118 55' 19.7"	19.10.97	1045	1.5m (ctr of bommie)
I 14	-17 33' 02.7"	118 55' 49.5"	19.10.97	1054	2.0m (NE side in sand)
I 15a	-17 32' 23.7"	118 56' 05.8"	19.10.97	1105	3.5m (sand)
I 15b	-17 32' 24.6"	118 56' 06.6"	19.10.97	1107	1.7m
I 18	-17 30' 36.9"	118 57' 16.8"	19.10.97	1134	1.0m
I 19	-17 31' 00.0"	118 56' 22.6"	19.10.97	1123	
I16	-17 31' 18.8"	118 57' 11.4"	19.10.97	1150	4.0m aboveSL(lighthse)
	CLERKE REEF				
C 1	-17 16' 47.5"	119 22' 18.4"	15.10.97	1035	3.6m (sand)
C 2	-17 17' 58.9"	119 22' 28.7"	15.10.97	1052	3.5m (sand)
C 3	-17 19' 33.3"	119 22' 23.7"	15.10.97	1125	1.5m (brommie);3.0m (sand)
C 4	-17 21' 03.8"	119 23' 01.8"	15.10.97	1148	2.1m (reef);5.5m (deep hole)
C 5	-17 22' 06.2"	119 22' 52.5"	15.10.97	1207	4.5m (deep hole)
C 6	-17 22' 32.2"	119 22' 38.4"	15.10.97	1220	1.2m (reef);2.8m (hole)
C 7	-17 23' 17.9"	119 22' 14.4"	15.10.97	1232	1.7m (reef)
C 9	-17 21' 49.1"	119 20' 03.8"	15.10.97	1315	0.5m
C 10	-17 20' 42.5"	119 19' 42.4"	15.10.97	1338	0.35m
C 11	-17 19' 45.1"	119 19' 33.9"	15.10.97	1358	0.65m (top of bommie)
C 12	-17 18' 35.4"	119 19' 35.1"	15.10.97	1451	1.9m (sand)
C 13	-17 17' 19.5"	119 19' 54.0"	15.10.97	1502	1.2m (edge of reef)
C 14	-17 16' 30.3"	119 20' 19.2"	15.10.97	1523	0.4m (reef);1.3m (sand)
C 15	-17 15' 47.2"	119 20' 11.3"	15.10.97	1540	0.6m (bommie);1.4m (sand)
C 17	-17 14' 50.4"	119 21' 13.7"	15.10.97	1702	4.9m (sand)
C 18	-17 15' 06.9"	119 21' 28.4"	15.10.97	1713	1.0m (reef); 3.0m (sand)
C 8	-17 22' 49.5"	119 20' 29.8"	16.10.97	1057	2.7m (sand)
C 22	-17 23' 04.1"	119 21' 05.3"	16.10.97	1118	2.2m (top of bommie);3.4m (sand)
	BEDWELL Is.				
C 23	-17 16' 29.2"	119 21' 40.6"	16.10.97	1430	plus 2.0m
C 19	-17 16' 05.1"	119 21' 36.7"	16.10.97	1504	0 (waterline)
C 21	-17 15' 57.8"	119 21' 27.9"	16.10.97	1519	nw rock
	CLERKE ANCHORAGE				
C 24	-17 16' 46.6"	119 21' 53.4"	16.10.97	1652	bommie nearest mooring
C 26	-17 16' 53.7"	119 22' 06.7"	16.10.97	1659	flag point
C 25	-17 16' 31.9"	119 22' 01.7"	16.10.97	1719	dinghy channel entrance
C 27	-17 16' 38.1"	119 21' 55.7"	16.10.97	1724	0
C 28	-17 16' 42.8"	119 21' 50.9"	17.10.97	806	HOWSON MOORING
C 29	-17 16' 43.8"	119 21' 56.9"	17.10.97	810	OLD ORANGE MOORING
	MERMAID ATOLL				
ANC'GE	-17 04' 26.5"	119 38' 14.4"	17.10.97	1250	plus 4.0m
M 16	-17 02' 25.9"	119 37' 25.0"	17.10.97	1308	3.8m (sand)
M 15	-17 02' 46.5"	119 37' 44.9"	17.10.97	1334	1.7m (reef)
M 14	-17 03' 23.3"	119 37' 24.2"	17.10.97	1341	1.6m (top bommie)
M 13	-17 03' 59.7"	119 37' 17.9"	17.10.97	1350	3.8m (centre lump)
M 12	-17 04' 48.2"	119 36' 44.2"	17.10.97	1400	3.9m (to lump)
M 11	-17 06' 10.3"	119 36' 30.5"	17.10.97	1413	3.2m (sand)
M 10	-17 07' 14.6"	119 36' 31.4"	17.10.97	1430	2.0m (sand)
M 9	-17 08' 02.0"	119 36' 44.0"	17.10.97	1438	0.9m (top bommie)

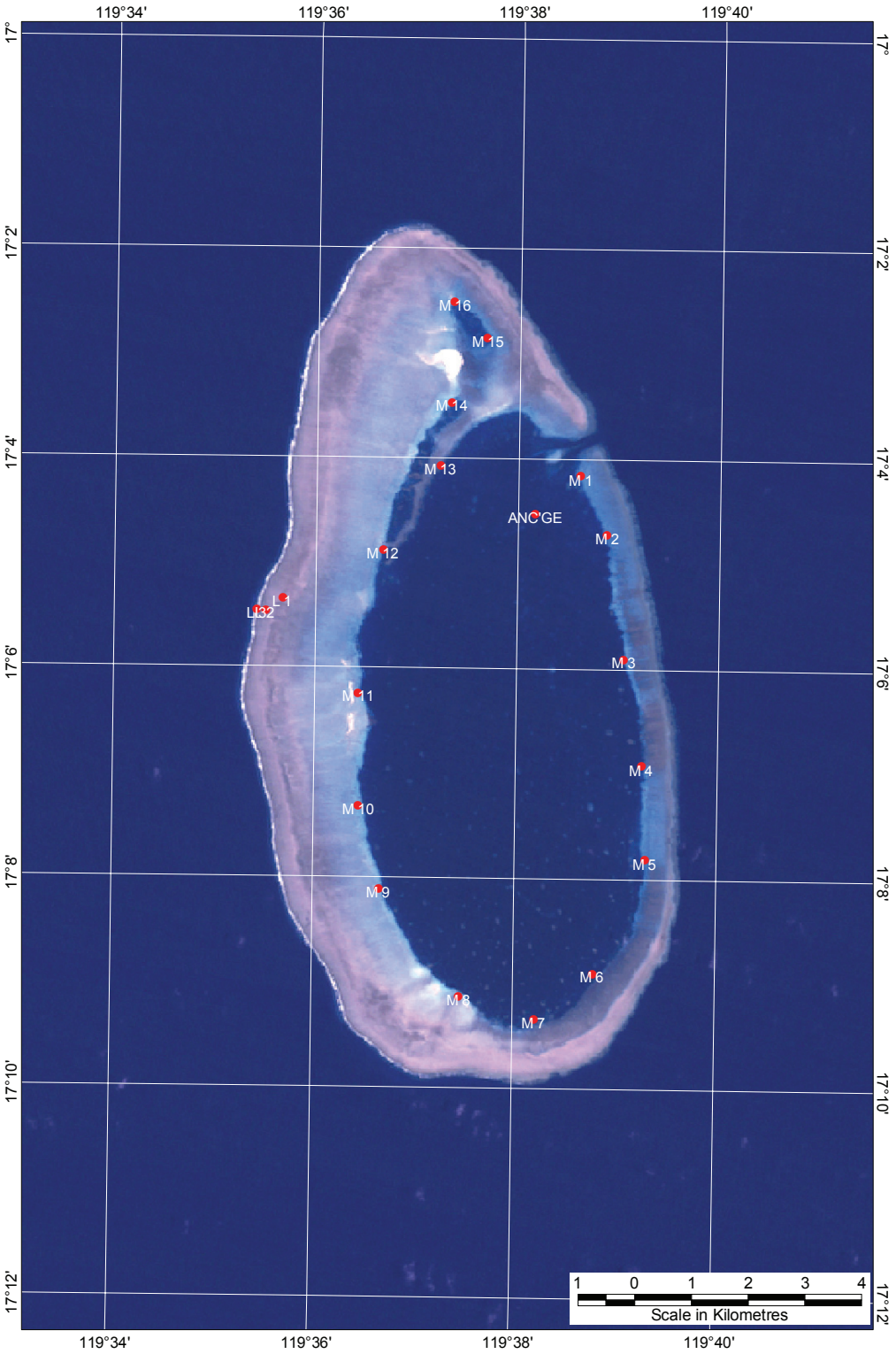


Figure 3. Mermaid atoll showing position of ground truth sites.

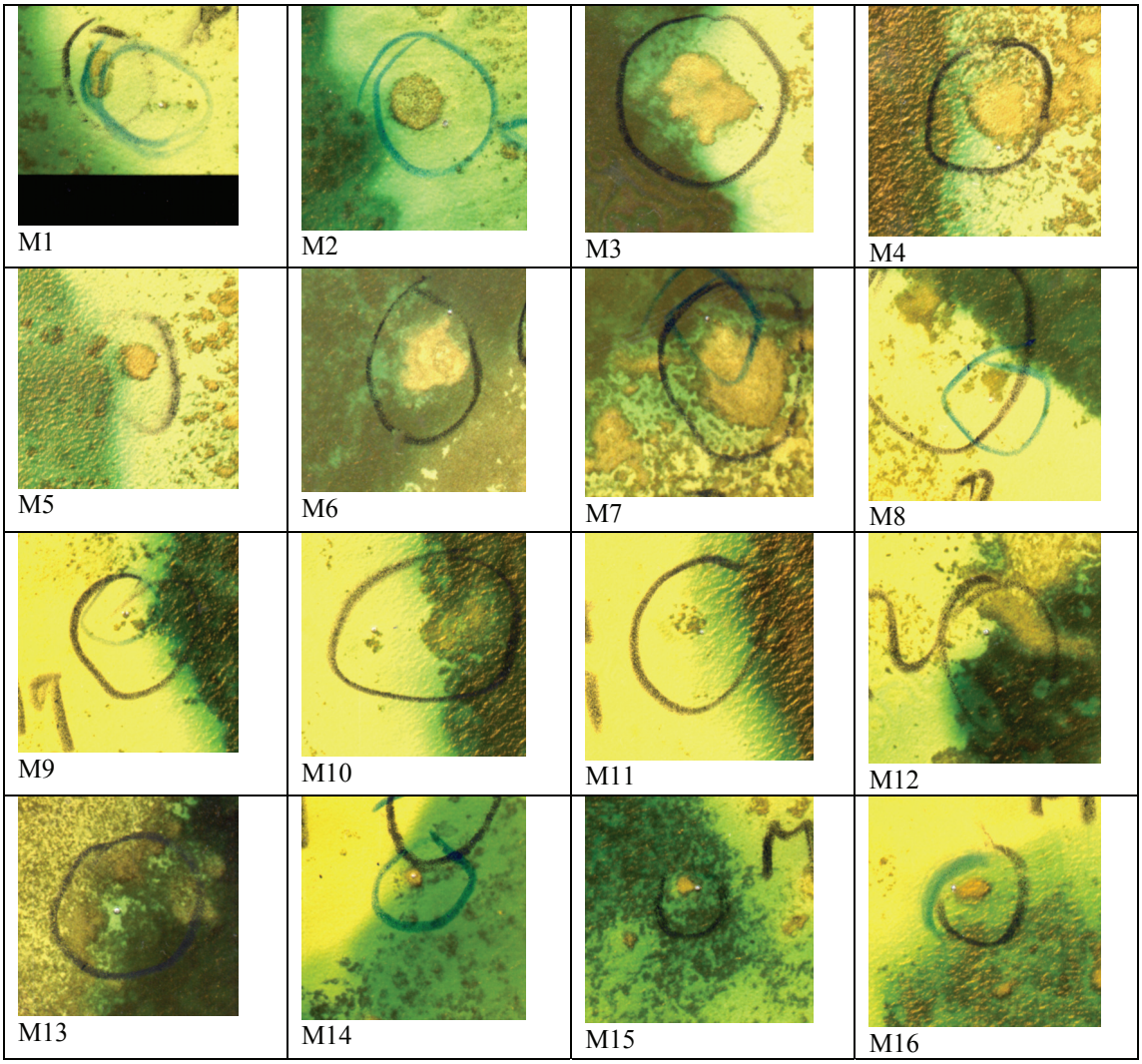


Figure 4. Detail of ground truth sites on Mermaid atoll.

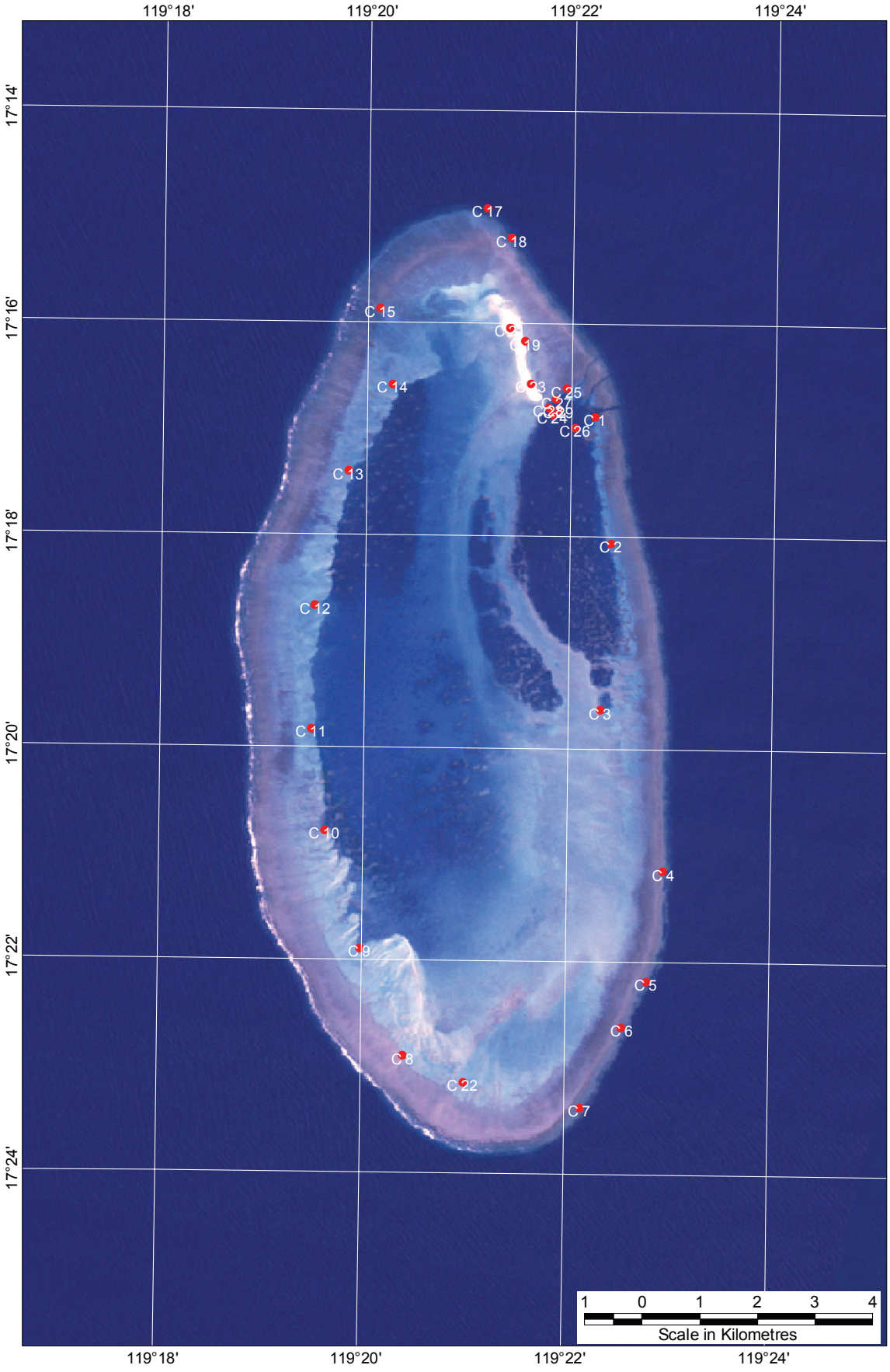


Figure 5. Clerke atoll showing position of ground truth sites

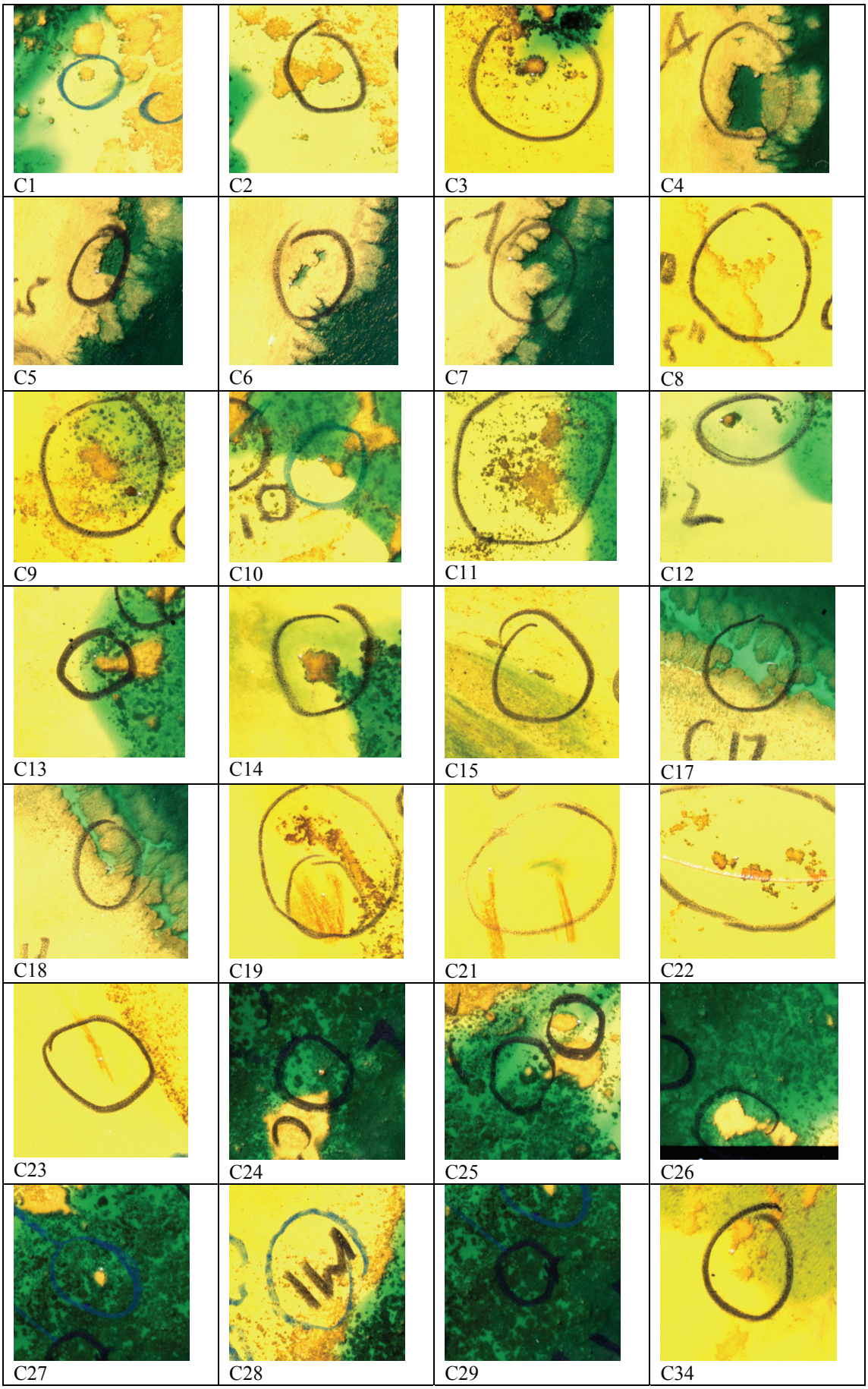


Figure 6. Detail of ground truth sites on Clerke atoll.

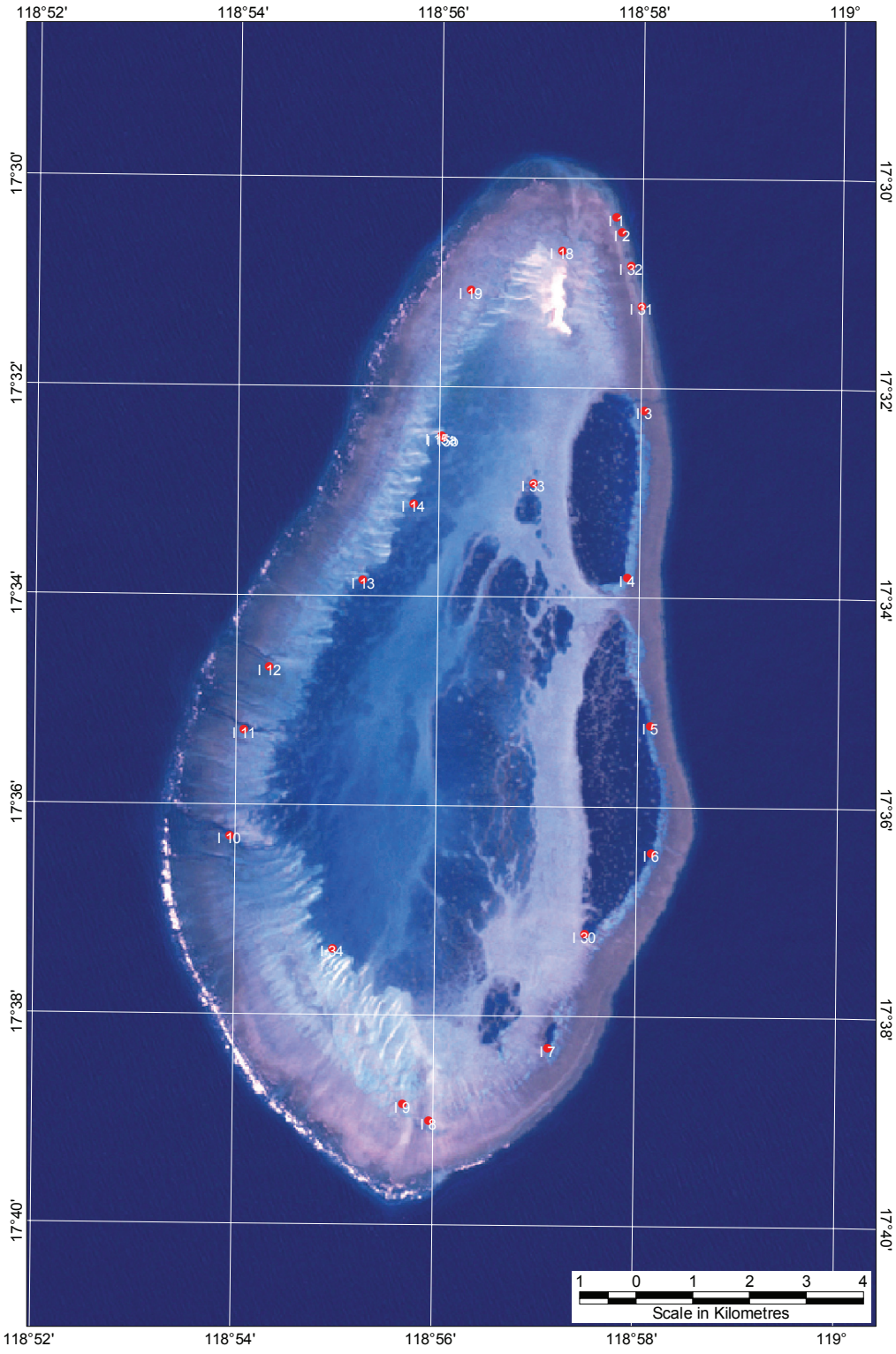
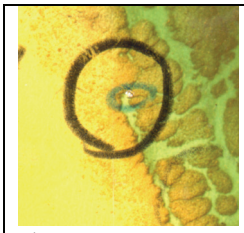


Figure 7. Imperieuse atoll showing position of ground truth sites.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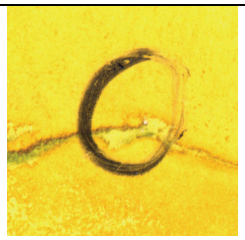
I2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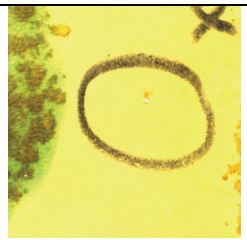
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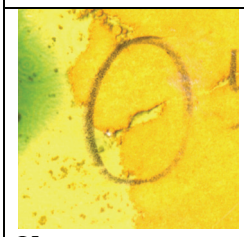
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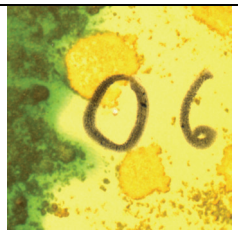
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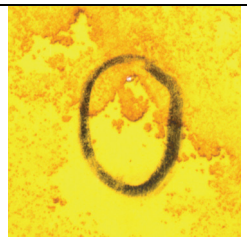
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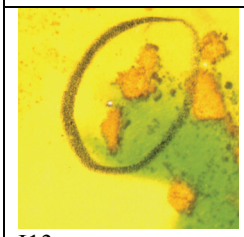
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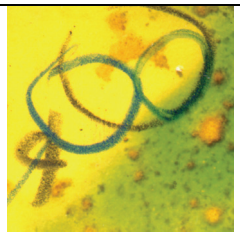
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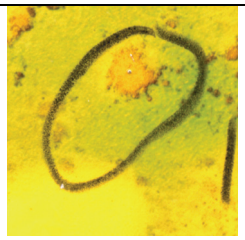
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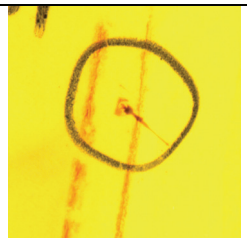
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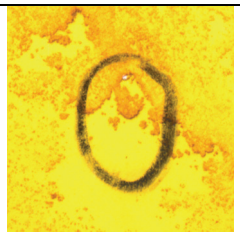
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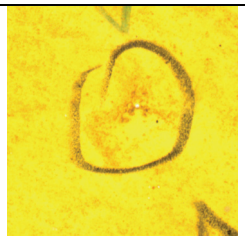
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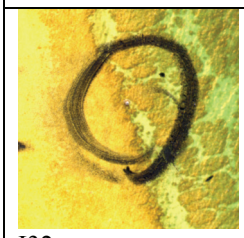
I32

8. Detail of ground truth sites on Imperieuse atoll.

APPENDIX I

Habitat data sheets from spatial rectification survey

APPENDIX II

Video data sheets from spatial rectification survey