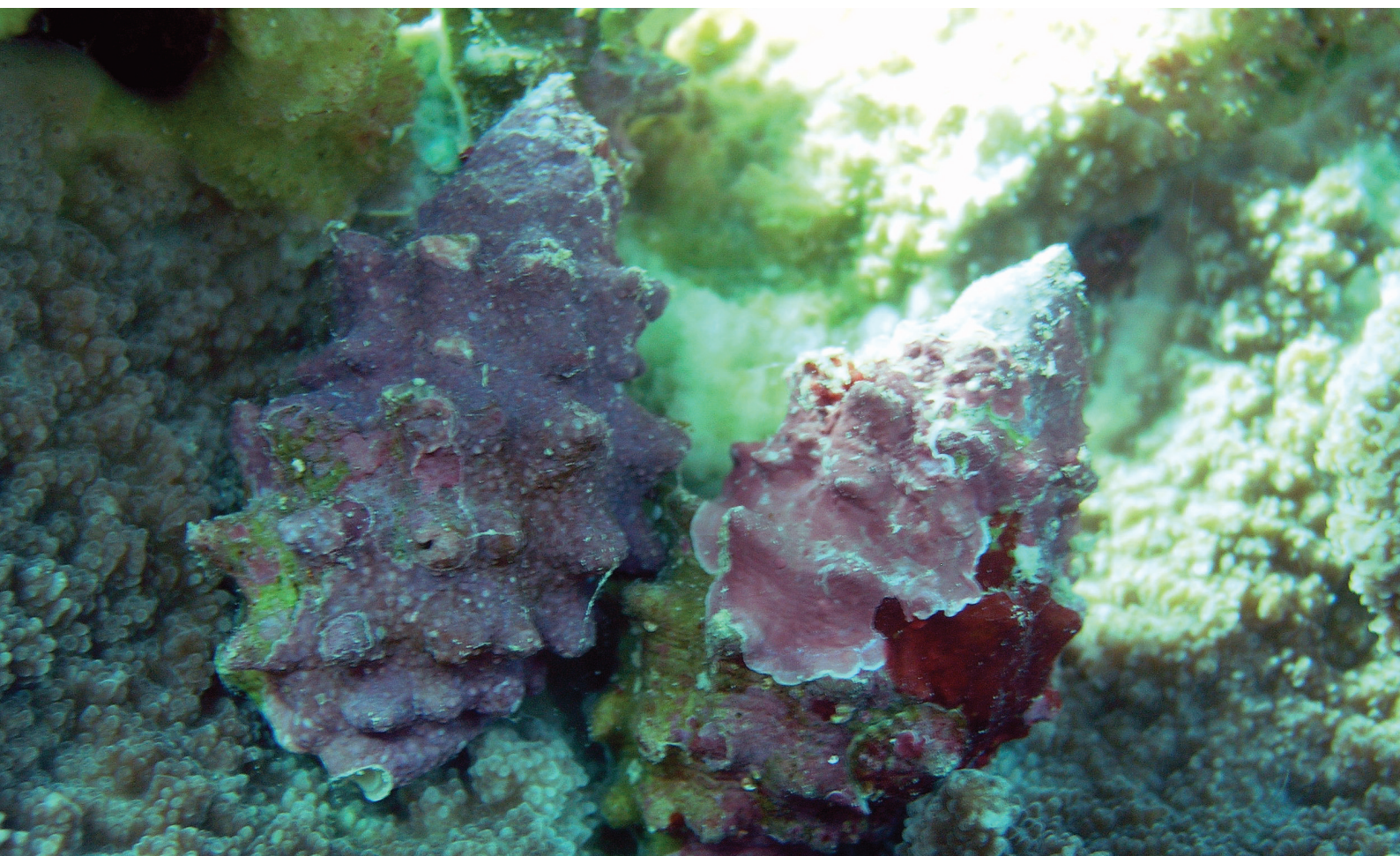
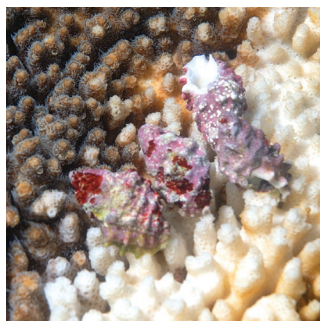


Ningaloo Marine Park *Drupella* long-term monitoring program: 2008 survey

Marine Science Program Data Report

MSPDR5 January 2009

Shannon J Armstrong
Marine Science Program, Science Division



Ningaloo Marine Park *Drupella* long-term monitoring program: Data collected during the 2008 survey

Marine Science Program Data Report Series
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Science Division
Department of Environment and Conservation



Department of
Environment and Conservation

Our environment, our future



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Cover images: (small images, left to right) Example of *Drupella* feeding scars on an *Acropora* plate coral; Diver recording the cover of coral communities using underwater video transect techniques at Ningaloo Marine Park in 2008; *Drupella* collected for size frequency analysis in 2005; The survey team about to deploy a site marker from a DEC vessel in 2008; and (large image) Close up of, the often cryptic, *Drupella cornus* snails. Photos - Department of Environment and Conservation/Marine Science Program.

SUMMARY

Between the mid 1980s and early 1990s, the feeding activity of unusually high densities of the corallivorous gastropod *Drupella cornus* resulted in massive coral damage along at least 100 km of Ningaloo Reef, with coral mortality approaching 100% in some areas. For this reason the Department of Environment and Conservation (DEC) monitors changes to the density of *Drupella* sp. and the corallivorous *Acanthaster planci* (crown of thorns starfish) at Ningaloo Marine Park and the Muiron Islands Marine Management Area. DEC also monitors coral cover and composition as an associated indicator of coral health. 17 long-term monitoring locations have been established and a major survey is undertaken by DEC every three years. In 2008, 10 monitoring locations covering the full extent of the marine protected areas were re-surveyed. Predator density was estimated by visual search and coral cover was recorded using underwater video transect techniques.

This report provides a record of the data collected during this survey and a detailed description of the methods used and position of survey sites. An accompanying Marine Science Program Technical Report will provide the results of any statistical analyses undertaken on the data and discussion on the results in the context of conservation management.

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1 INTRODUCTION

Between the mid 1980s and early 1990s, the feeding activity of unusually high densities of the corallivorous gastropod *Drupella cornus* resulted in massive coral damage along at least 100 km of Ningaloo Marine Park (NMP), with coral mortality approaching 100% in some areas. The density of *D. cornus*, the area and severity of associated coral damage, and longevity of the outbreak itself that occurred at NMP during this event was on a greater scale than recorded on other reefs elsewhere in the world to date.

As the health of coral communities is a key performance indicator of management of NMP and the Muiron Islands Marine Management Area (MIMMA) the Department of Environment and Conservation (DEC) needs to monitor spatial and temporal changes to *D. cornus* densities and cover of associated corals in these conservation reserves (Department of Conservation and Land Management, 2005). Adhering to this management need, the aim of the NMP *Drupella* Long-term Monitoring Program (NMPDMP) is to monitor long-term changes in the density of *D. cornus* and cover of associated coral communities at the NMP and the MIMMA. Monitoring of *D. cornus* at NMP has produced a long-term data set with information describing the status of *D. cornus* populations and coral communities dating back to 1987.

A strategy in the revised NMP Management Plan 2005-2015 requires that *D. cornus* abundance and the health of coral communities be surveyed at least every three years. The last major survey was completed in 2008. This report documents the data collected and methods used during the 2008 survey, and provides information as to where the data is stored.

The objective of the NMPDMP is:

- To monitor changes in *Drupella* sp. and *Acanthaster planci* density and the cover and composition of hard coral at selected sites in NMP and MIMMA over time.

2 METHODS

2.1 Study location

The Ningaloo Reef is located approximately 1000 km north of Perth in Western Australia, and runs parallel to the coastline as a discontinuous barrier for over 280 km (Fig 1). It is the largest fringing coral reef system in the world and the only extensive coral reef fringing the west coast of a continent (Taylor & Pearce, 1999). Temperate and tropical currents converge in the Ningaloo region, resulting in a diversity of marine life including more than 500 species of fish, 250 known species of corals and approximately 600 species of molluscs (Department of Conservation and Land Management, 2005). The area has very high ecological and social conservation significance and was gazetted as a marine park in 1987. In 2005, the park boundary was amended to include the southern section of the Ningaloo Reef and the MIMMA was also gazetted.

2.2 Survey locations

There are 17 *Drupella* long-term monitoring locations distributed approximately every 20 km along the NMP (Fig 1). See Armstrong (2007) for a description of when the locations were established and how their position was determined. A selection of the 17 locations is surveyed on a tri-annual basis (comprising two locations from the north, north-central, south-central and south regions of NMP as well as Bundegi within Exmouth Gulf and North Muiron at the MIMMA). In 2008, the following 10 locations were surveyed (see Figures 2 to 11 for an aerial photograph of each site):

NMP North: Tantabiddi, Turquoise Bay
NMP North-central: Winderabandi, Cloates
NMP South-central: Pelican Point, Coral Bay Backreef
NMP South: Cape Farquhar, Gnarraloo Bay
Exmouth Gulf: Bundegi
MIMMA: North Muiron Island

The locations were selected on the following basis:

1. To provide *D. cornus* density data that is representative of the north, north-central, south-central, south and gulf sections of NMP and the MIMMA.
2. Locations that have had consistently high or low densities of *D. cornus* relative to other locations over time.
3. Locations where high numbers of *D. cornus* recruits have been recorded in the past as these areas may provide an early warning of future outbreaks (i.e. Cloates).

In addition, the South Muiron and Turtles locations were revisited in 2008 to revise the appropriateness of their position in regard to habitat and safety of divers from high waves and strong currents.

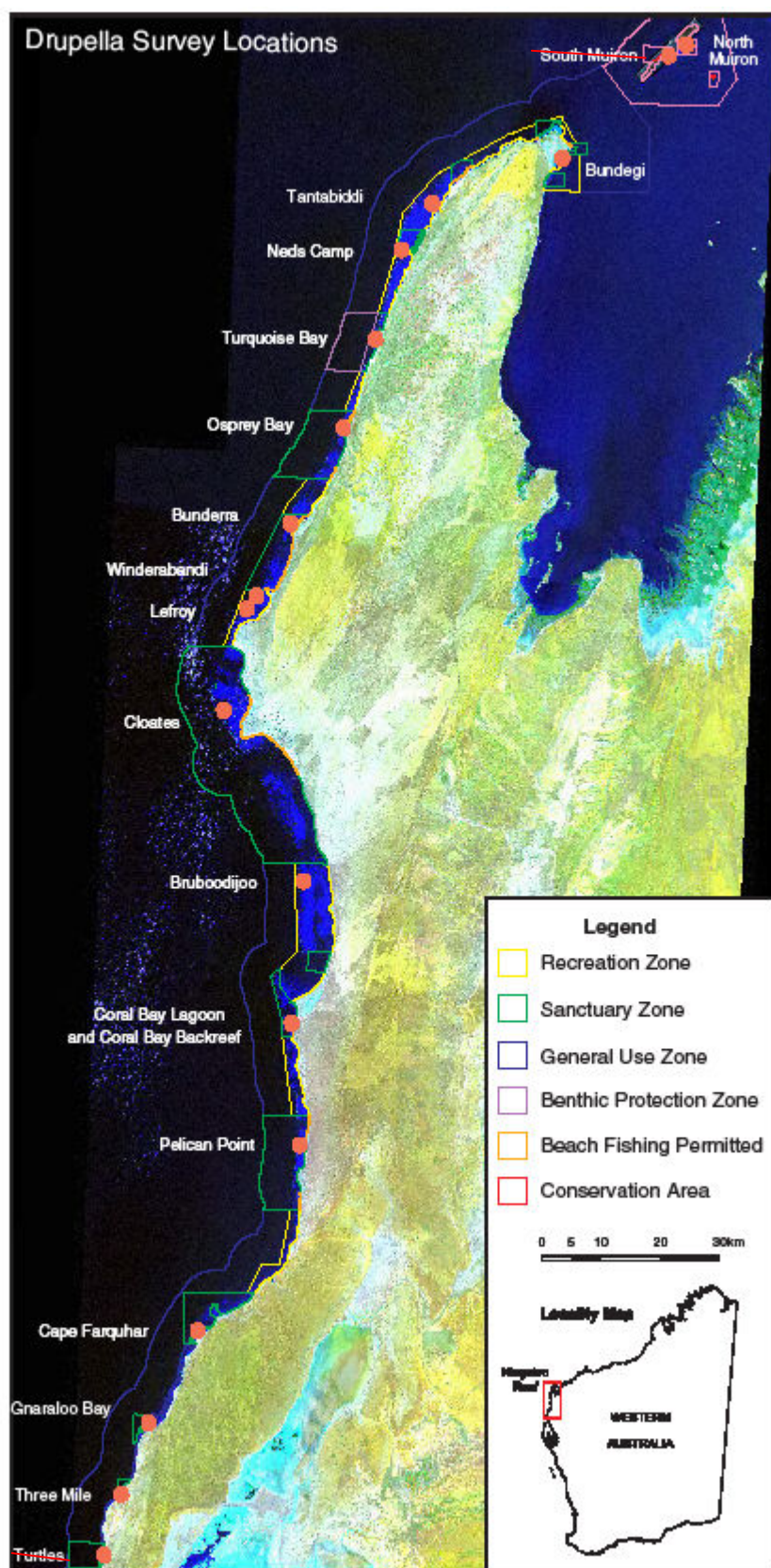


Figure 1. Overview of the *Drupella* long-term monitoring locations within Ningaloo Marine Park showing management zone boundaries. Note that Turtles and South Muiroon Island locations were revised in 2008 and considered unsuitable locations for *Drupella* monitoring because of unsuitable habitat and diver safety concerns respectively. These two locations will not be surveyed in the future.

2.2.1 Maps of the NMPDMP locations surveyed in 2008

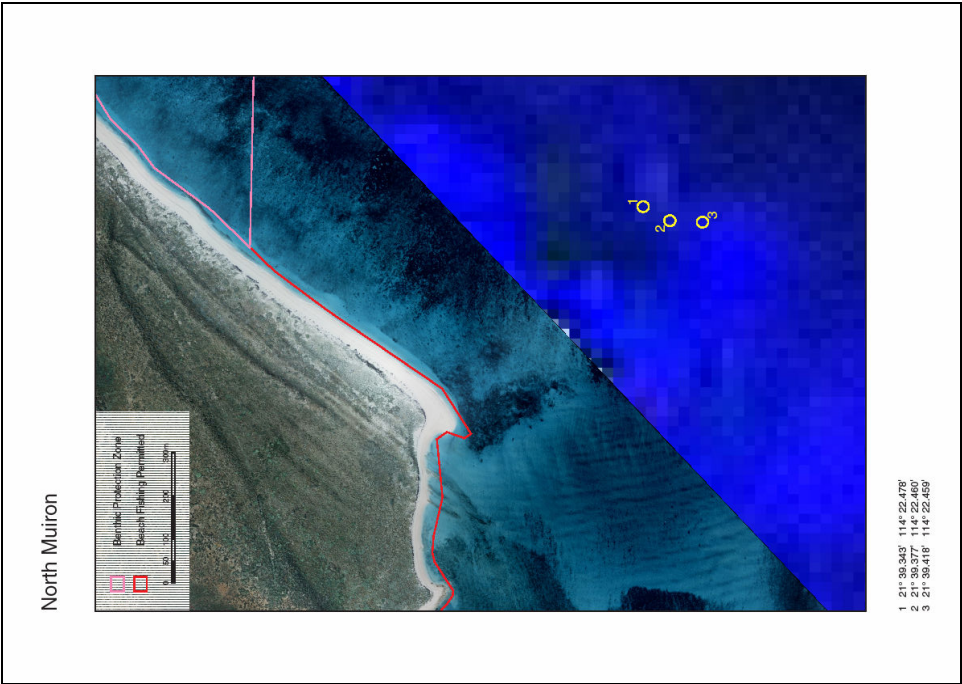


Figure 2. North Muiron Island monitoring location.

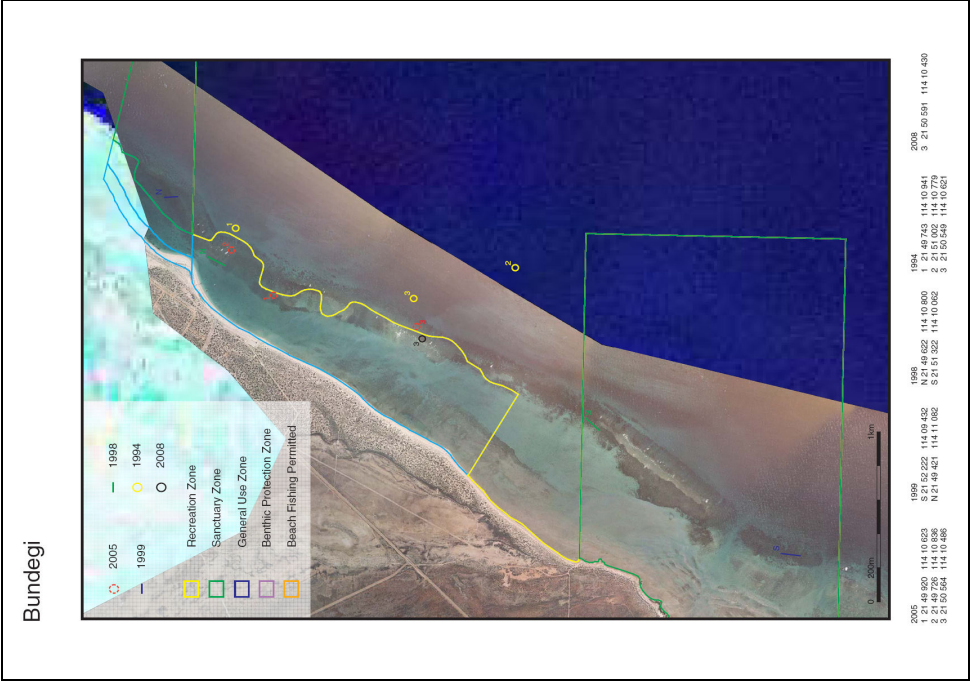


Figure 3. Bundegi monitoring location.

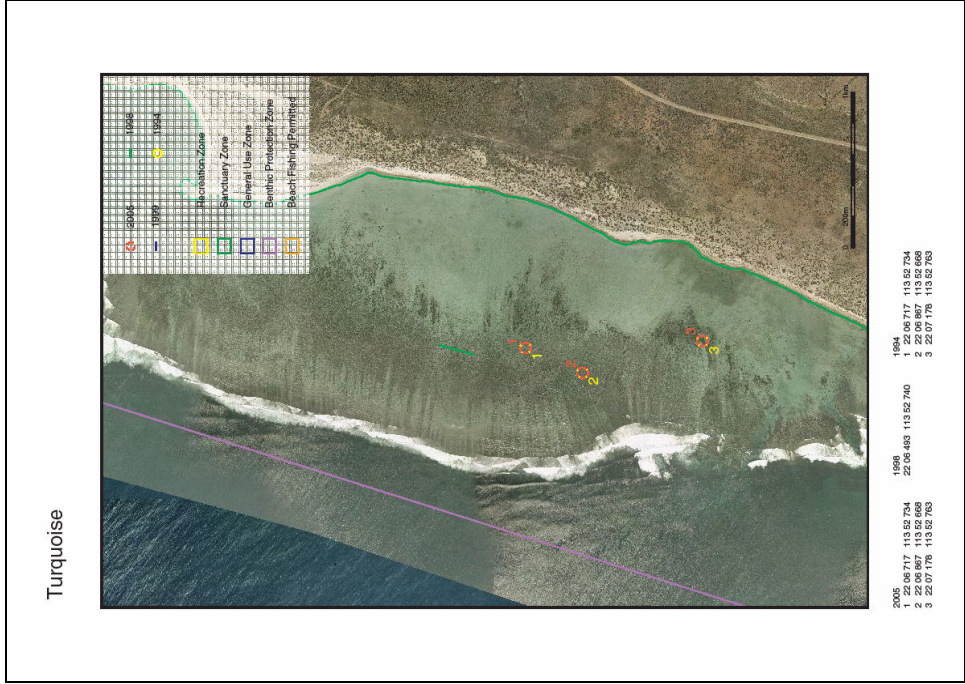


Figure 5. Turquoise Bay monitoring location.

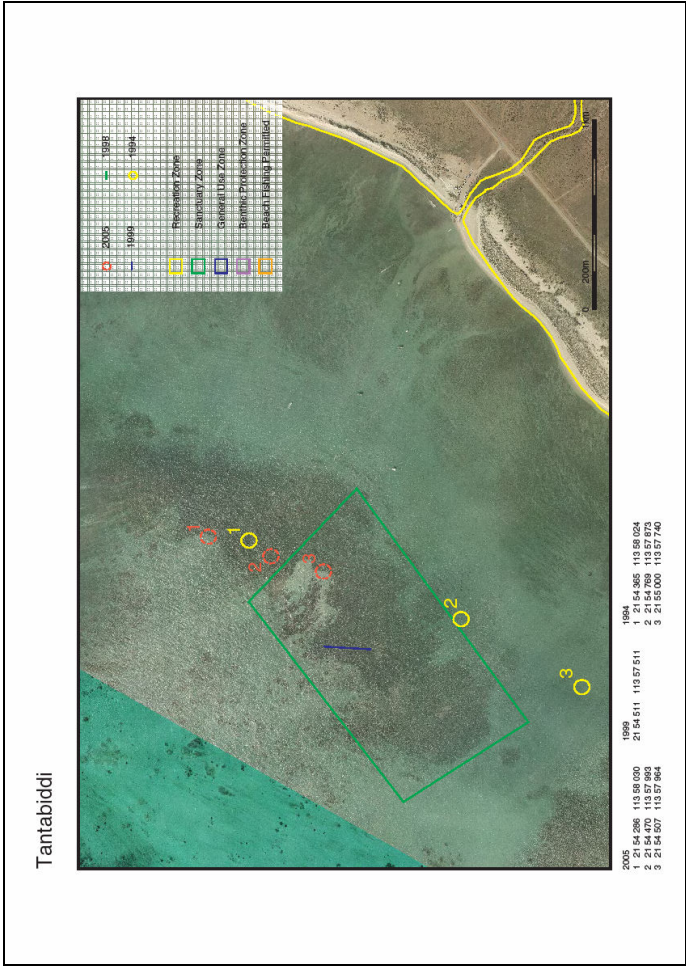


Figure 4. Tantabiddi monitoring location.

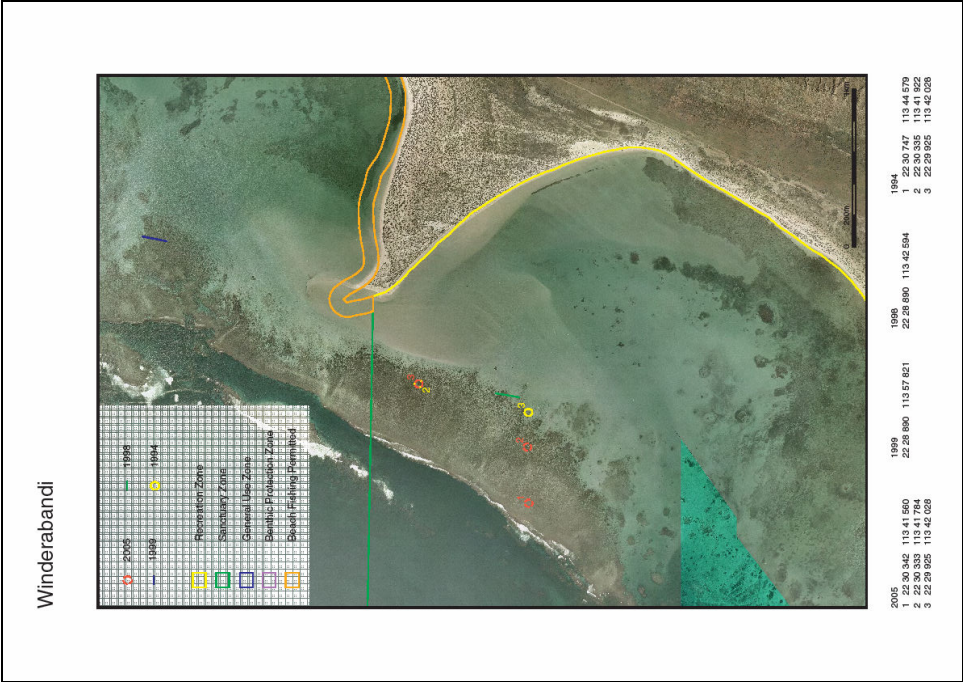


Figure 6. Winderabandi monitoring location.

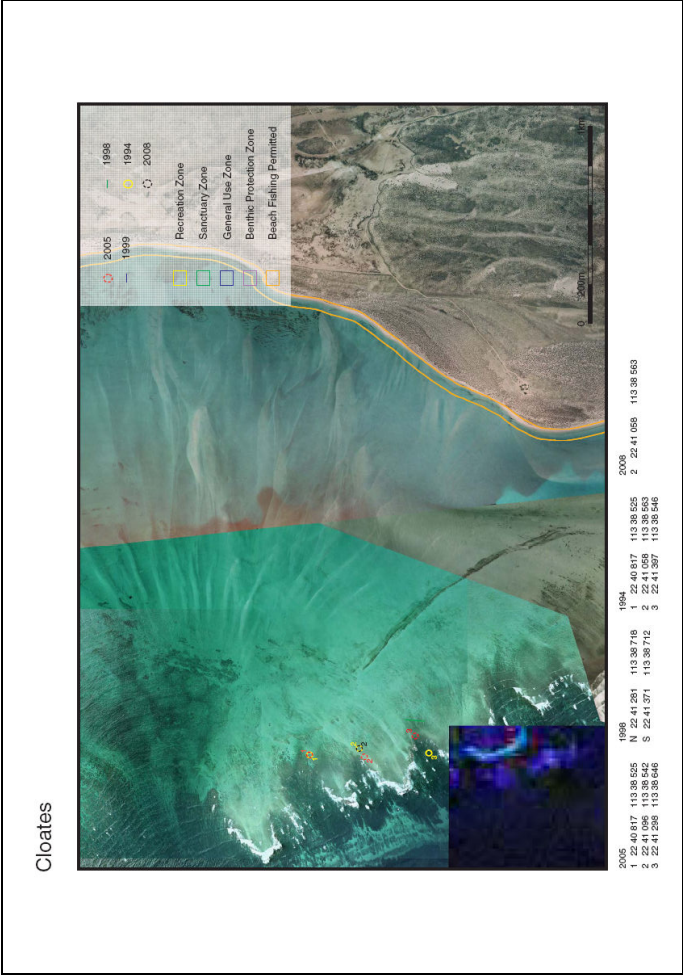


Figure 7. Cloates monitoring location.

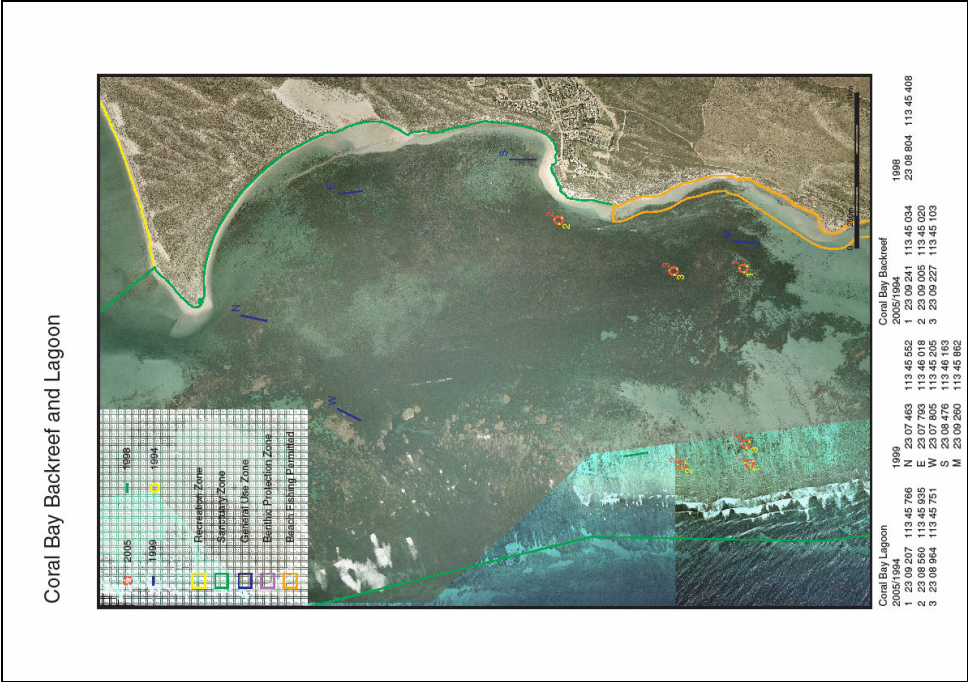


Figure 8. Coral Bay Backreef and Lagoon monitoring locations.



Figure 9. Pelican Point monitoring location.

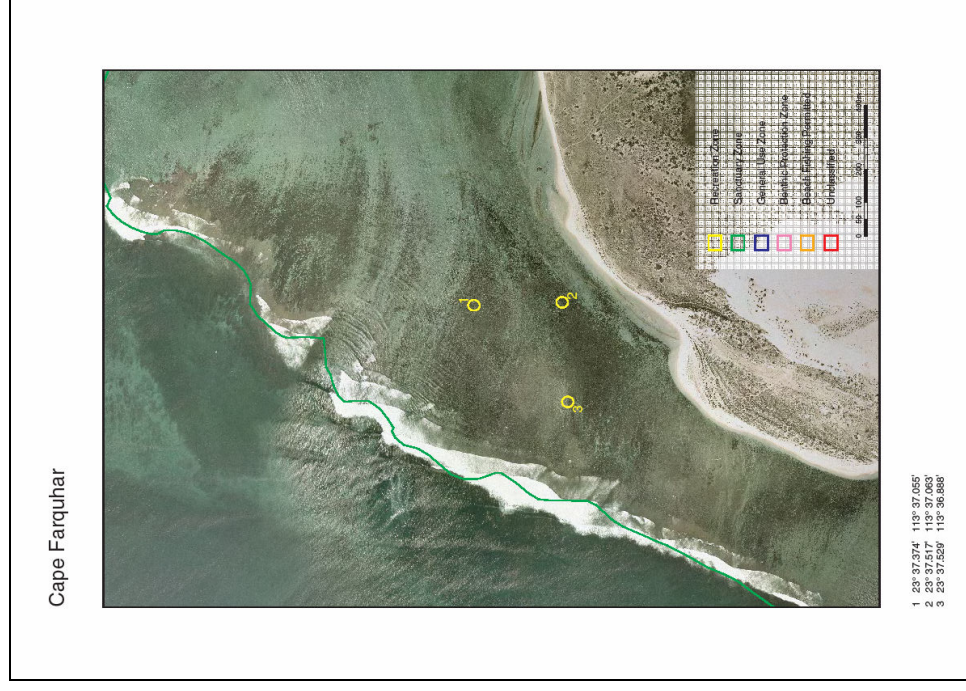


Figure 10. Cape Farquhar monitoring location.

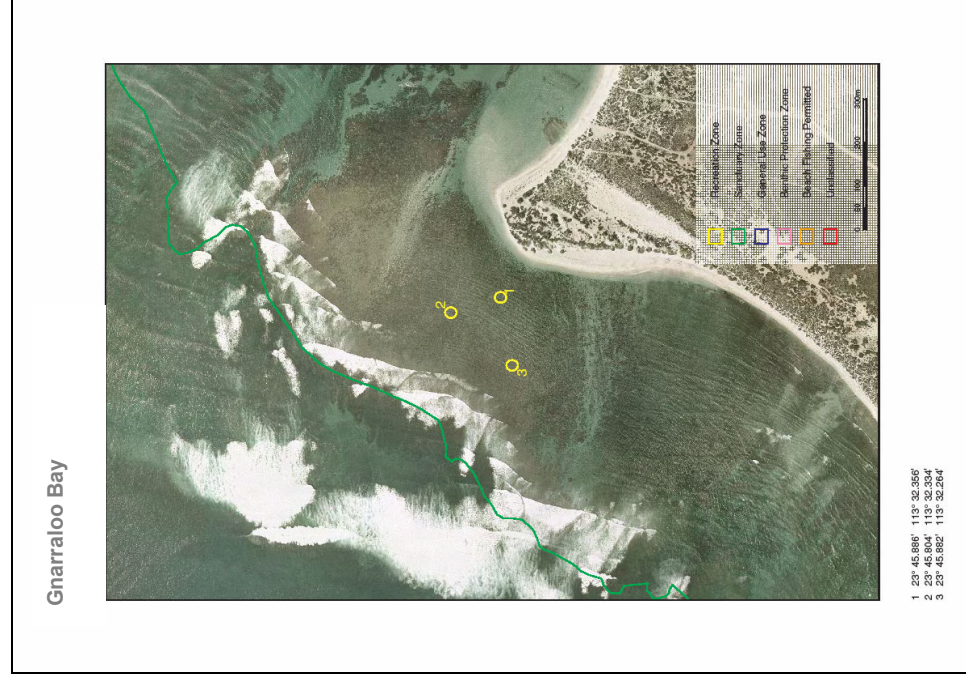


Figure 11. Gnarraloo Bay monitoring location.

Table 1. Information regarding the *Drupella* long-term monitoring locations. Showing GPS coordinates corrected after the 2008 survey.

Location site	Depth	NMP Management Zone	Reef Structural Zone	GPS coordinate, decimal minutes, WGS84 datum	
North Muiron					
1	4.7m	Conservation Area	Bommie field	21°39.343'	114°22.478'
2	5.4m	Conservation Area	Bommie field	21°39.377'	114°22.460'
3	5.3m	Conservation Area	Bommie field	21°39.418'	114°22.459'
South Muiron					
1	0.5-0.7m	Unclassified	Backreef	21°40.397'	114°20.780'
2	0.7-1m	Unclassified	Backreef	21°40.346'	114°20.807'
3	0.7-1m	Unclassified	Backreef	21°40.486'	114°20.712'
Bundegi					
1	2-3m	Recreation	Gulf- Lagoon	21°49.920'	114°10.623'
2	3.5m	Recreation	Gulf- Lagoon	21°49.726'	114°10.836'
3	3-4m	Recreation	Gulf- Lagoon	21°50.591'	114°10.430'
Tantabiddi					
1	4-5m	Recreation	Lagoon	21°54.286'	113°58.030'
2	3-4m	Sanctuary	Lagoon	21°54.470'	113°57.993'
3	3-4m	Sanctuary	Lagoon	21°54.507'	113°57.964'
Ned's Camp					
1	1.5-2m	Recreation	Backreef	21°58.557'	113°55.088'
2	1-1.5m	Sanctuary	Backreef	21°58.167'	113°55.161'
3	1-1.5m	Recreation	Backreef	21°58.337'	113°55.062'
Turquoise Bay					
1	0.5-1m	Sanctuary	Backreef	22°06.717'	113°52.734'
2	0.5-1.5m	Sanctuary	Backreef	22°06.867'	113°52.668'
3	0.5-1.5m	Sanctuary	Backreef	22°07.178'	113°52.763'
Osprey Bay					
1	0.5-1m	Sanctuary	Backreef	22°14.884'	113°49.731'
2	0.5-1m	Sanctuary	Backreef	22°15.336'	113°49.481'
3	0.7m	Sanctuary	Backreef	22°14.644'	113°49.718'
Bunderra					
1	0.5-1m	Sanctuary	Backreef	22°23.685'	113°44.716'
2	1-2m	Sanctuary	Backreef	22°23.273'	113°44.946'
3	0-2m	Sanctuary	Backreef	22°22.966'	113°44.958'
Winderabandi					
1	1-1.5m	Recreation	Backreef	22°30 342'	113°41.560'
2	1m	Recreation	Backreef	22°30 333'	113°41.784'
3	1m	Recreation	Backreef	22°29 925'	113°42.028'
Lefroy Bay					
1	1-3.5m	Recreation	Bommie field	22°31.534'	113°40.607'
2	1-3.5m	Recreation	Bommie field	22°31.525'	113°40.530'
3	1-3m	Recreation	Bommie field	22°31.434'	113°40.603'
Cloates					
1	0.5-2m	Sanctuary	Backreef	22°40.817'	113°38.525'
2	0.5-1m	Sanctuary	Backreef	22°41.096'	113°38.542'
3	1m	Sanctuary	Backreef	22°41.298'	113°38.646'
Bruboodijoo					
1	1.5m	Recreation	Backreef	22°56.242'	113°46.683'
2	2m	Recreation	Backreef	22°56.416'	113°46.708'
3	1-1.5m	Recreation	Backreef	22°56.708'	113°46.664'
Coral Bay Backreef					
1	1-1.5m	Sanctuary	Backreef	23°09.241'	113°45.030'
2	1-1.5m	Sanctuary	Backreef	23°09.005'	113°45.020'
3	0.5m	Sanctuary	Backreef	23°09.227'	113°45.103'
Coral Bay Lagoon					
1	3.5m	Sanctuary	Lagoon	23°09.207'	113°45.766'
2	<5m	Sanctuary	Lagoon	23°08.560'	113°45.935'
3	2.9m	Sanctuary	Lagoon	23°08.964'	113°45.751'
Pelican Point					
1	1-1.5m	Sanctuary	Backreef	23°20.153'	113°46.760'
2	1-1.5m	Sanctuary	Backreef	23°19.825'	113°46.790'
3	1-1.5m	Sanctuary	Backreef	23°19.641'	113°46.721'

Location site	Depth	NMP Management Zone	Reef Structural Zone	GPS coordinate, decimal minutes, WGS84 datum	
Cape Farquhar					
1	1m	Sanctuary	Backreef	23°37.374'	113°37.055'
2	0.5-2m	Sanctuary	Backreef	23°37.517'	113°37.063'
3	1m	Sanctuary	Backreef	23°37.529'	113°36.888'
Gnarraloo Bay					
1	1-1.5m	Sanctuary	Backreef	23°45.886'	113°32.356'
2	1m	Sanctuary	Backreef	23°45.804'	113°32.334'
3	0.5m	Sanctuary	Backreef	23°45.882'	113°32.264'
Three Mile					
1	0.5-2m	Sanctuary	Lagoon	23°52.396'	113°29.780'
2	0.5-2m	Sanctuary	Lagoon	23°52.366'	113°29.786'
3	0.5-3m	Sanctuary	Lagoon	23°52.327'	113°29.794'

2.3 Survey design

The NMPDMP uses a nested survey design of three replicate sites per location and three replicate 0.5 x 20 m belt transects per site (Fig 12).

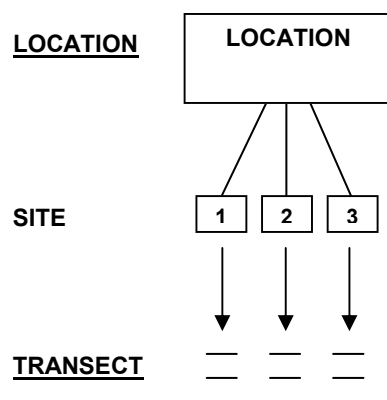


Figure 12. Tree diagram of the NMPDMP nested survey design.

2.4 Survey methods

The position of each survey site was located using a handheld GPS (Datum WGS84) and marked with a weighted buoy. The three 20 m transects are positioned along random compass bearings from the GPS point for the site. Since sites are intended to represent *Drupella* sp. habitat (i.e. live hard coral) bearings that had large areas of no live hard coral habitat, e.g. sand, were avoided.

Along each transect the density of *Drupella* sp. was estimated by visual search and recorded on a data sheet (see Appendix 1) and the cover of benthic reef communities was recorded using underwater video transect techniques. Once the first transect was established using a fiberglass measuring tape, the benthic community along each transect was recorded using a Sony HDR-HC1/E digital video camera in an Amphibico underwater housing. The diver held the camera at a height above the substratum so the field of view was approximately 30 cm when the camera was on full wide angle zoom. The diver filmed the entire 20 m transect, at a pace of approximately 10 m per minute (two minutes to complete a 20 m transect).

Once the filming commenced, the *Drupella* sp. counter began estimating density by visual search within 50 cm on the right-hand-side of each transect line and recorded the information on an underwater data sheet. It is very important that only the snails within 50 cm of the right-hand-side of the tape are included in these counts. Therefore the *Drupella* sp. counter carried a 50 cm long measuring rod to determine if snails are inside the 50 cm boundary.

The size class of each *D. cornus* snail as defined by Forde (1994) (see below), was also recorded.

- Recruits: <20 mm shell length
- Sub-adults: 20 mm – 30 mm shell length
- Adults: ≥30 mm shell length

A ruler was used to aid estimating the shell length of each snail. The number of *A. planci* within 2.5 m either side of the transect line was also recorded. Once the first transect was filmed and surveyed for *Drupella* sp. the process was repeated for the remaining two transects for that site.

Several photographs and a panoramic underwater video clip were also taken at each site to provide a record of the habitat type and rugosity of the substrate for future reference.

In addition, each NMPDMP location has a long-term monitoring data sheet associated with it. This data sheet contains information that will aid re-location of the sites and helpful logistical information including: photograph of the vessel launch area used to access the survey location, distance of location from the vessel launch site, position of location in relation to obvious land and sea markers, availability of mobile reception at the site, availability of radio communications at the site, mud map of the location and details of the vehicle and vessel route used to access the location. See Armstrong (2005) and Armstrong (2006) to view the long-term monitoring data sheets.

2.5 Data analysis

Raw video data was analysed using a random point sampling method with software named TransectMeasure. A total of 25 different categories were used to quantify the benthic community composition along each transect (Table 2). Approximately 135 points were sampled per transect, using one point per frame and approximately 135 frames per transect. Each point was positioned randomly on each frame. The benthic category underlying each point was recorded. In this way the mean percent cover of each benthic category was calculated per transect. The average of the nine transects provided a mean percent cover value for each benthic category per location. In 2005 and 2006, the same method was used to analyse the footage collected, however the TransectMeasure software was not used.

The *Drupella* sp. density data was summarised to provide a mean density (m^{-2}) value for each location.

Table 2. Benthic reef categories and codes for analysing the benthic video transect footage.

Living reef corals	Code
Acropora (plate)	AP
Acropora (branching)	AB
Acropora (corymbose)	AC
Montipora	MONT
Pocillopora	POC
Branching coral (non Acropora)	B
Faviids	FAV
Porites	POR
Other massive corals	MAS
Fungia	FUNG
Soft coral	SOFT
Mussidae	MUSS
Other live hard coral – unidentifiable	O
Algae	
Brown macro algae	MAC
Algal turf community	TURF
Encrusting coralline algae	ET
Sea grass	SG
Benthic Substratum	
Dead coral bare	DCB
Dead coral covered with turf	DCT
Bare coral rubble	BCR
Coral rubble covered with turf	CRT
Sand	S
Pavement	PAV
Invertebrates	
Clam	CLAM
Dead clam	DCLAM

3 DATA MANAGEMENT

3.1 Report archival

Hard copies of this report are held at the following locations:

1. Marine Science Program, Science Division, Department of Environment and Conservation, 17 Dick Perry Avenue, Western Australia, 6152. Ph: (08) 9334 0333.
2. Woodvale Library, Science Division, Department of Environment and Conservation, Ocean Reef Road, Woodvale, Western Australia, 6026. Ph: (08) 9405 5100 Fax: (08) 9306 1641.
3. Archives, Woodvale Library, Science Division, Department of Environment and Conservation, Ocean Reef Road, Woodvale, Western Australia, 6026. Ph: (08) 9405 5100 Fax: (08) 9306 1641 (CD also attached).
4. Department of Environment and Conservation: Exmouth, 20 Nimitz St, Exmouth, Western Australia, 6007. Ph: (08) 99478000 Fax: (08) 99478050.
5. Serials Section, State Library of Western Australia. Alexander Library Building, Perth Cultural Centre, Perth, Western Australia, 6000.
6. North West Research Association Field Station, Coral Bay, Western Australia. Ph: (08) 99485136.

Digital copies of this report are held at the following locations:

1. The Marine Science Program Server. Ph: (08) 93340 229.
2. The MSP Endnote Library.

3.2 Digital photographs

All digital still photographs taken during the survey are archived in the image library on the Marine Science Program server. Ph: (08) 93340 229.

3.3 Digital video

All mini digital video (MDV) footage collected during the survey is held at two locations:

1. MDV masters have been archived in the Ningaloo Marine Park *Drupella* Long-term Monitoring Program - Video Archive file (box) 2006/005668-1 held at the Information Management Branch, Department of Environment and Conservation, 17 Dick Perry Avenue, Kensington, Western Australia. Ph: (08) 9334 0333.
2. MDV copies have been stored at the Marine Science Program, Science Division, Department of Environment and Conservation, 17 Dick Perry Avenue, Kensington, Western Australia. Ph: (08) 9334 0333.

Video clips of each transect have been stored on portable hard drive in AVI format and are stored at the Marine Science Program, Science Division, Department of Environment and Conservation, 17 Dick Perry Avenue, Kensington, Western Australia. Ph: (08) 9334 0333.

3.4 Data sheets

Copies of the data sheets completed during the 2008 survey have been archived in the Ningaloo Marine Park *Drupella* Long-term Monitoring Program – corporate file no. 2008/002954 held at the Information Management Branch, Department of Environment and Conservation, 17 Dick Perry Avenue, Kensington, Western Australia. Ph: (08) 9334 0333.

3.5 Analysed benthic video transect and corallivore density and data

The *Drupella* sp. and *A. planici* density data collected during this survey are located in section 4.1 below. The analysed benthic video transect data, processed to the transect level, occupy too many pages to feasibly print therefore the data been stored on CD and archived in the Ningaloo Marine Park *Drupella* Long-term Monitoring Program - Video Archive file (box) 2006/005668-1 held at the Information Management Branch, Department of Environment and Conservation, 17 Dick Perry Avenue, Kensington, Western Australia. Ph: (08) 9334 0333.

4 RESULTS/DATA

4.1 *Drupella* sp. and *A. planici* density data

See Table 3 below for the corallivore density data collected in 2008. No *A. planici* were recorded within transects at any site in 2008. *A. planici* were observed near transects at the North Muiron Island location but were not observed at any other location in 2008. These observations are consistent with observations made during previous surveys at NMP and MIMMA.

Table 3. *Drupella* sp. density (m^{-2}) data. Note: No *Drupella rugosa* were recorded at any location in 2008 except at Bundegi where 1 *D. rugosa* was recorded at Site 1 Transect 2. No *Acanthaster planici* were recorded within transects in 2008.

Location	Site	Transect	<i>Drupella</i> sp. density m^{-2}
Pelican Point	1	1	6.2
Pelican Point	1	2	3.9
Pelican Point	1	3	2
Pelican Point	2	1	0.9
Pelican Point	2	2	0.8
Pelican Point	2	3	1.3
Pelican Point	3	1	1.5
Pelican Point	3	2	3.3
Pelican Point	3	3	1.5
Coral Bay Backreef	1	1	4.1
Coral Bay Backreef	1	2	3.5
Coral Bay Backreef	1	3	2
Coral Bay Backreef	2	1	3.6
Coral Bay Backreef	2	2	4.7
Coral Bay Backreef	2	3	2.6
Coral Bay Backreef	3	1	0.8
Coral Bay Backreef	3	2	1.8
Coral Bay Backreef	3	3	1.4
North Muiron	1	1	0.1
North Muiron	1	2	1.5
North Muiron	1	3	0
North Muiron	2	1	0.1
North Muiron	2	2	2.7
North Muiron	2	3	0
North Muiron	3	1	2.4
North Muiron	3	2	0.1
North Muiron	3	3	2
Cape Farquhar	1	1	1.5
Cape Farquhar	1	2	1.3
Cape Farquhar	1	3	1.1
Cape Farquhar	2	1	1
Cape Farquhar	2	2	0.8

Location	Site	Transect	<i>Drupella</i> sp. density m ⁻²
Cape Farquhar	2	3	0.4
Cape Farquhar	3	1	0.5
Cape Farquhar	3	2	0.8
Cape Farquhar	3	3	1.4
Gnarraloo Bay	1	1	1.7
Gnarraloo Bay	1	2	2.5
Gnarraloo Bay	1	3	6.2
Gnarraloo Bay	2	1	2.2
Gnarraloo Bay	2	2	1.3
Gnarraloo Bay	2	3	1.9
Gnarraloo Bay	3	1	0.5
Gnarraloo Bay	3	2	0.9
Gnarraloo Bay	3	3	0.9
Turquoise Bay	1	1	1.6
Turquoise Bay	1	2	6.3
Turquoise Bay	1	3	2.8
Turquoise Bay	2	1	3
Turquoise Bay	2	2	3.1
Turquoise Bay	2	3	3.4
Turquoise Bay	3	1	0.7
Turquoise Bay	3	2	0.5
Turquoise Bay	3	3	0
Cloates	1	1	0.5
Cloates	1	2	0.8
Cloates	1	3	0
Cloates	2	1	4.2
Cloates	2	2	2.9
Cloates	2	3	2.4
Cloates	3	1	0.6
Cloates	3	2	0.7
Cloates	3	3	0.5
Tantabiddi	1	1	0.8
Tantabiddi	1	2	0.7
Tantabiddi	1	3	0.7
Tantabiddi	2	1	0.3
Tantabiddi	2	2	0.2
Tantabiddi	2	3	0.1
Tantabiddi	3	1	0.4
Tantabiddi	3	2	0.4
Tantabiddi	3	3	0.2
Winderabandi	1	1	2.4
Winderabandi	1	2	2.1
Winderabandi	1	3	1.7
Winderabandi	2	1	0.6
Winderabandi	2	2	1.6
Winderabandi	2	3	1.1
Winderabandi	3	1	1.1
Winderabandi	3	2	1.1
Winderabandi	3	3	0.7
Bundegi	1	1	0.8

Location	Site	Transect	<i>Drupella</i> sp. density m ⁻²
Bundegi	1	2	0.5
Bundegi	1	3	0.7
Bundegi	2	1	0
Bundegi	2	2	0.1
Bundegi	2	3	0
Bundegi	3	1	0
Bundegi	3	2	1.1
Bundegi	3	3	0

4.2 Record of significant observations or problems encountered in the field

Relocation of sites at South Muiron Island and Turtles

The reef at the South Muiron location is dominated by soft coral, which is not a prey species of *Drupella* and therefore makes it an inappropriate location for *Drupella* monitoring. During the 2008 survey, effort was made to find an area of reef along the eastern side of South Muiron Island that would be more suitable for a *Drupella* monitoring location. Small areas of reef dominated by live hard coral were identified but none were large enough in area for a monitoring location. An appropriate location was not found. This location will not be surveyed in the future.

Similarly, an alternative area for the Turtles location was investigated. The location at Turtles is often subject to high wave action and strong currents which presented a safety issue for divers undertaking sampling in 2006. Effort was made to find an area of reef that was not exposed to dangerous conditions for surveying and that was accessible by four-wheel-drive vehicle. An appropriate location was not found. This location will not be surveyed in the future.

Confusion with position of site 2 at Cloates

In 2005, site 2 was shifted approximately 50 m SW (of the 1994 site 2 coordinate) because the substrate at the 1994 coordinate was relatively bare with minimal live hard coral and was considered unsuitable for a *Drupella* monitoring location (Fig 9). Several other 1994 coordinates were similarly inaccurate, with a few sites actually positioned on land, possibly due to inaccuracies in GPS equipment or recording in 1994. Furthermore, the GPS coordinate for the new position of the site was incorrectly recorded on the transect data sheet in 2005. This led to confusion in the field in 2008 (when the mistake was discovered) and resulted in the original 1994 site 2 being surveyed (Fig 9). This will be taken into consideration when comparing data from 2008 to previous years for site 2 at Cloates. It is recommended to undertake monitoring at the 2005 site 2 coordinate during future surveys (see Appendix 1 for all site coordinates).

Confusion with position of site 3 at Bundegi

In 2008, due to confusion with incorrect GPS coordinates for site 3 at Bundegi surveying was undertaken approximately 125 m SW of the 2005 site (Fig 3). In 2005 it was discovered that the 1994 coordinate for site 3 at Bundegi was located in deep water (11 m) several hundred metres seaward of the main coral reef. The substrate at this site comprised of silt with filter feeding communities and was considered not suitable as a *Drupella* monitoring site. In 2005 the site was moved approximately 210 m west (Fig 3) so it was positioned along the main coral reef tract, but the new GPS coordinate was not recorded and the original GPS coordinate was left on the data sheet which caused problems in 2008. In 2008 the site was again shifted onto the main reef tract located to the west (approximately 125 m SW of where it was shifted in 2005). This will be taken into consideration when comparing data from 2008 to previous years for site 3 at Bundegi. It is recommended to continue monitoring at the 2008 GPS coordinate to avoid future problems.

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6 REFERENCES

Armstrong SJ (2005). The abundance and distribution of *Drupella* corallivorous gastropods at Ningaloo Reef, Western Australia: 2005 Data Report. Southern Cross University, Lismore NSW.

Armstrong SJ (2006). Ningaloo Marine Park *Drupella* Long Term Monitoring Program: Raw data sheets completed during the 2006 survey. Marine Science Program, Department of Environment and Conservation, Perth, Western Australia (unpublished report).

Armstrong SJ (2007). Ningaloo Marine Park *Drupella* Long Term Monitoring Program: Results of the 2006 survey. Technical Report: NIN/NMP-2007/03. Marine Science Program, Department of Environment and Conservation, Perth, Western Australia (unpublished report).

Department of Conservation and Land Management (2005) *Management plan for the Ningaloo Marine Park and the Muiron Islands Marine Management Area 2005-2015*. Prepared for Marine Parks and Reserves Authority by the Department of Environment and Conservation, Perth, Western Australia, Management Plan **52**.

Forde MJ (1994). Ecology of the Muricid gastropod *Drupella cornus* (Roding, 1798) and its significance as a corallivore on Ningaloo Reef, Western Australia. M.Sc. Thesis, University of Western Australia, Perth, Western Australia.

Taylor JG, Pearce AF (1999) Ningaloo Reef currents: Implications for coral spawn dispersal, zooplankton and whale shark abundance. *Journal of the Royal Society of Western Australia*. **85**, 57-65.

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- MSP 2007/04 Summary of the winter coral bleaching event at Ningaloo Marine Park, July 2006. Data Report. Armstrong S, Webster F, Kendrick A, Mau R, Onton K (2007).
- MSP 2007/05 Disturbance and recovery of coral communities in Bill's Bay, Ningaloo Marine Park: Field survey 16-23 October 2006. Technical and Data Report. Long S (2007).
- MSP 2007/06 Bibliography of marine scientific research relevant to Perth's metropolitan marine protected areas and adjacent waters. Data Report. Lierich D, Bancroft KP (2007).
- MSP 2007/07 Current and proposed marine research projects relevant to Perth's metropolitan marine protected areas and adjacent waters. Data Report. Lierich D, Bancroft KP (2007).
- MSP2007/08 Disturbance history of coral communities in Bill's Bay, Ningaloo Marine Park, 1975-2007. Data Report. van Schoubroeck P, Long S (2007).
- MSP 2008/01 Comparative marine biodiversity survey of the Rowley Shoals 1-17 December 2007. Metadata Report. Long S, Armstrong SJ, Fabricius K, Field I, Cook K, Colquhoun J, Huisman J (2008).

