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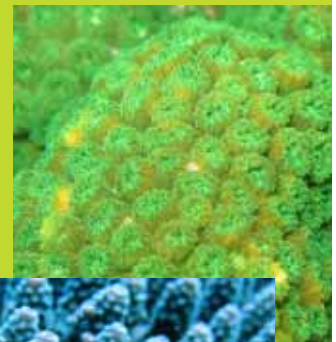


Keppel Islands reefs: Baseline study 2008-2010

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Dr Ray Berkelmans



A report prepared for the Fitzroy Basin Association



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FOR
OUR
COUNTRY



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Keppel Reef Scuba Adventures
on Great Keppel Island
www.keppeldive.com.au



Aims

The aim of this project was to conduct a detailed assessment of coral biodiversity and abundance in the Keppel region of the southern Great Barrier Reef. The information in this report provides a baseline for future changes and can be used to investigate patterns, linkages and implications for conservation. This study is one of the most comprehensive bio-physical assessments of this region ever conducted.

Geographical description of the study region

The Keppels is a group of 15 continental islands situated along the inner shelf of the Great Barrier Reef near Rockhampton (23.1°S, 150.9°E). The islands are surrounded by a patchwork of fringing reefs with relatively high coral cover (~67%) compared to the rest of the Great Barrier Reef (~35%, AIMS LTMP 2004). Radio carbon dating of similar reefs to the north (Percy Islands) suggests that reefs in the Keppel group are relatively young, having developed in the late Holocene (~1500 years ago) following landward migration of the terrigenous sediment wedge and sea level fall (Hopley 1982; Belperio 1983). Keppel Bay is essentially an ancient flood plain, in-filled with accumulated coastal sediment from the Fitzroy River following sea level rise in the early Holocene (~9000 years ago). Sediment continues to accumulate in the river mouth and in inner Keppel bay north along the coast during episodic fluvial events which usually have high discharge and are of short duration (Ryan, Bostock *et al.* 2005; Ryan, Brooke *et al.* 2005). However, around the islands and in the outer part of the bay there is relatively low sediment accumulation. The strong long-shore wind-driven current and east-west littoral drive drift inner bay sediment accumulation to the north-west; promoting sediment resuspension and episodic high turbidity (Larcombe and Woolfe 1999).

The lack of sediment accumulation and resuspension around the outer islands permits strong fringing reef development in bays and along rocky shores on leeward and windward sides of the outlying islands. In general, leeward bays are dominated by shallow reef flats (where the geomorphology allow adequate flushing of fluvial and accumulated sediments) while eastern shores and rocky headlands comprise deeper reef slopes. In spite of the prevailing turbidity in Keppel Bay, fringing reefs are remarkably robust, actively growing and resilient to environmental disturbance: making them one of the Great Barrier Reef's highest conservation value reef systems.

The reefs of the Keppels were initially described by van Woesik in 1989 and 1997 (van Woesik 1989) as 'distinct ecological entities' comprising mainly of fast growing *Acropora* species with relatively low coral diversity. Van Woesik's study described the coral assemblages at 8 sites. In a later study which included a much larger set of similar fringing reefs in the Whitsundays, Cumberland and Northumberland regions (van Woesik and Done 1997), there were major differences identified in the extent of Holocene reef development and coastal geomorphology between the regions (Larcombe and Woolfe 1999; Perry and Smithers 2010). These geomorphic differences, combined with the small subset of sites and low taxonomic resolution upon which the initial study was based may not have allowed adequate assessment of the coral biodiversity in the region.

The project surveyed 35 sites, on 19 dive sites in the inshore fringing reefs of the Keppels region of the southern Great Barrier Reef between 2008 and 2010 (Figure 1). This report is supplementary to a more detailed coral species assemblage description and analysis. More detailed data sets are available on request.

Study location

Figure 1: Map of surveyed reefs with inset maps showing the location of the Keppels on the Central Queensland coast in Australia.



Methods

Surveys took place in the Keppels between March 2008 and April 2009 . A total of 19 sites were surveyed between March 2008 and April 2009 (Table 1). Reefs were selected using a combination of aerial photographs and local knowledge of key biodiversity hotspots within reefs based on their representation of the surrounding reef community. The Overall Assessments Section (Page 8) shows the results of species counts and benthic assessments as bar charts and an excel spreadsheet. Results are reported for individual reefs following the Overall Assessment Section. Each detailed reef description includes:

- a GIS map of the survey transects,
- Number of species found at the reef,
- The average taxonomic distinctness at each site
- A bar chart showing the breakdown of the benthic community composition
- Typical substrate photos for flats and slopes

Location	Abbreviation	Latitude (decimal degrees)	Longitude (decimal degrees)	Reef area (Ha)
Bald Rocks	Bald	23.17108	150.9938	10.0
Barren Island	Barren	23.15674	151.0253	31.0
Clam Bay	Clam	23.187	150.9782	45.0
Egg Rock	Egg	23.20004	151.0993	4.5
Halftide Rocks	Halftide	23.15352	150.9385	8.0
Halfway Island	Halfway	23.2011	150.9729	45.0
Humpy Island	Humpy	23.21639	150.9744	68.0
Leekes Point	Leekes	23.16712	150.9519	0.5
Man & Wife Rocks	Man and Wife	23.11836	150.9916	4.0
Miall Island	Miall	23.1539	150.9038	27.0
Middle Island	Middle	23.16235	150.9205	28.0
Monkey & Shelving	Monkey	23.19491	150.9362	10.5
Nth Keppel Island	Nth Keppel	23.08477	150.8987	44.0
Outer Rock	Outer	23.06545	150.9521	10.0
Parkers Bommie	Parkers	23.15407	150.9768	8.0
Passage Rocks	Passage	23.16865	150.9287	4.5
Pelican Island	Pelican	23.24123	150.8769	41.0
Pumpkin Island	Pumpkin	23.09211	150.9028	11.0
Wreck Bay	Wreck	23.1601	150.9768	4.5

† Coral cover assessments were not conducted for Clam Bay or Leekes's Point in 2008. Species diversity assessment are reported for these sites in a separate document.

Species richness

Coral species abundance (ranked % abundance) for each of the sites was assessed during a random swim over ~60 minutes. Species lists were limited to scleractinian corals. Most coral species could be adequately identified in the field with the exception of species in the Poritidae (massive growth form) and Fungiidae families which were counted as one if present. Digital still photographs of the identifying features of each species were taken to check and verify identity. Each species was ranked in terms of abundance compared to the total live hard coral cover using a scale of 0-5 (0 = none present, 1 = 1-10%, 2 = 11-30%, 3 = 31-50%, 4 = 51-75%) as per de Vantier *et al.* (1998) however, only species richness (presence of absence of species) is reported here.

Benthic composition

The cover of benthic communities was assessed at 17 of the sites along two random 50m transects on the reef flat (0 - 6.0m at chart datum, 2.4 - 8.4m at mean sea level) and reef slope (6.0 - 12.0m at chart datum, 8.4 - 14.4m at mean sea level). Transects were photographed every 2m at a height of 1m above the substratum using a digital still camera (4Mp) fitted with a 16mm wide angle lens. A GPS track was recorded for each transect using a towed GPS (Garmin Map76CS) for later geo-location of the transects. Digital still images were analysed using 20 random points per image with the program CPCeTM v3.1 (www.nova.edu/ocean/cpce). Cover was assessed as the percentage of the total biotic and abiotic benthos.

Average versus Expected Taxonomic Distinctness

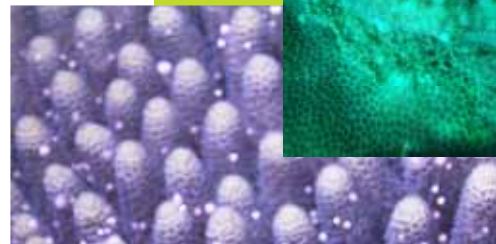
The species list from each site was compared with the full species inventory for the study to determine whether the subset of species from each site was representative (Warwick and Clarke 1998). This analysis tests the null hypothesis that each site contains species randomly selected from the full species list. Histograms were constructed of the expected range of average taxonomic distinctness (Δ^+) following random drawings of 's' species and the true values for each site were compared to these expected values. Values outside the 95% confidence limits were considered to have departed significantly from expectation.

Funnel plots of the average taxonomic distinctness for each of the 19 sites versus the expected average taxonomic distinctness for a range of theoretical sublist sizes (m) allowed simultaneous comparison to be made of distinctness values with each site within the 95% confidence limits. Simulated 95% probability limits are based on 999 random selections from each of m = 10, 20, 30 ..., 150 species from the total inventory of 167 species.



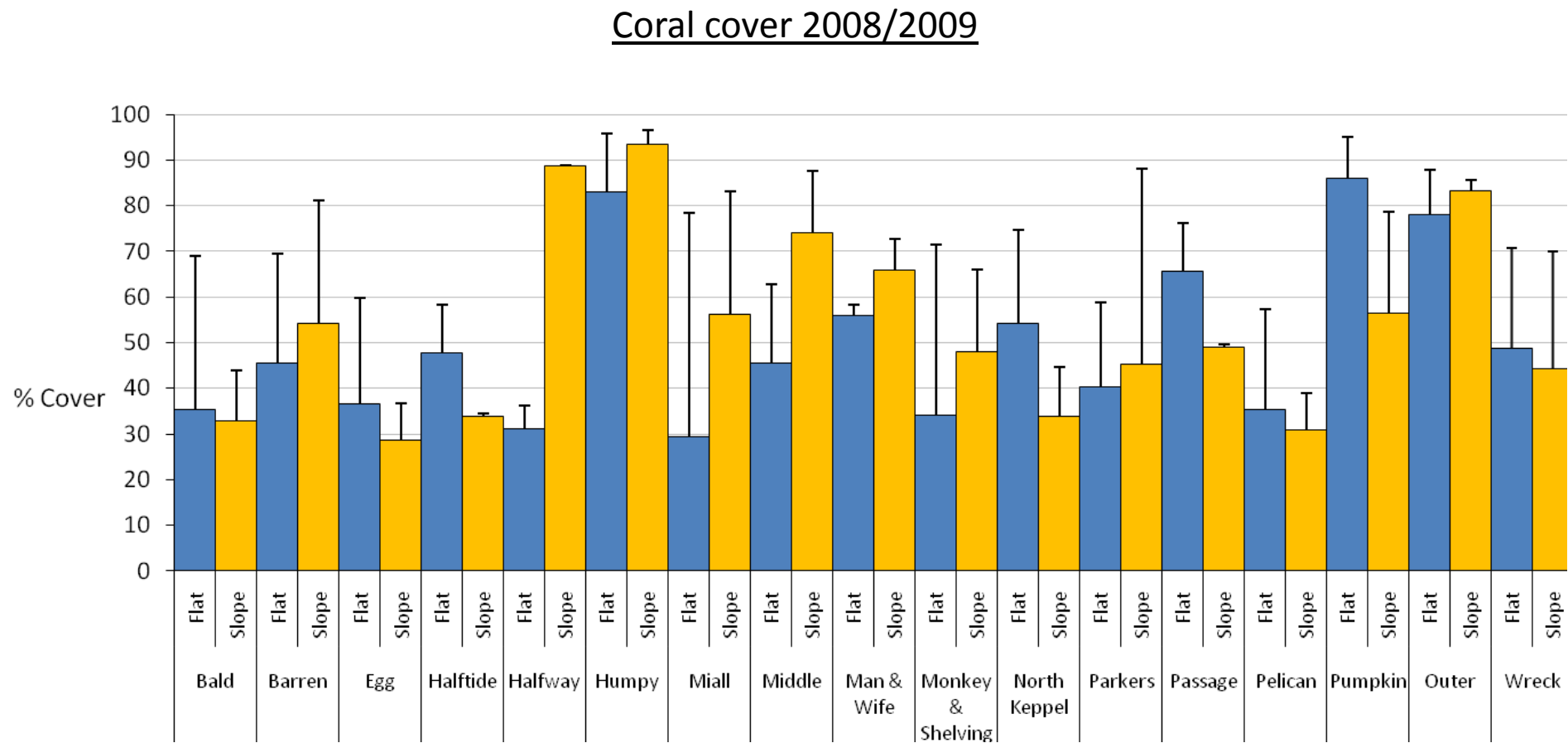
Overall Assessments:

Coral cover, benthic composition and taxonomic composition



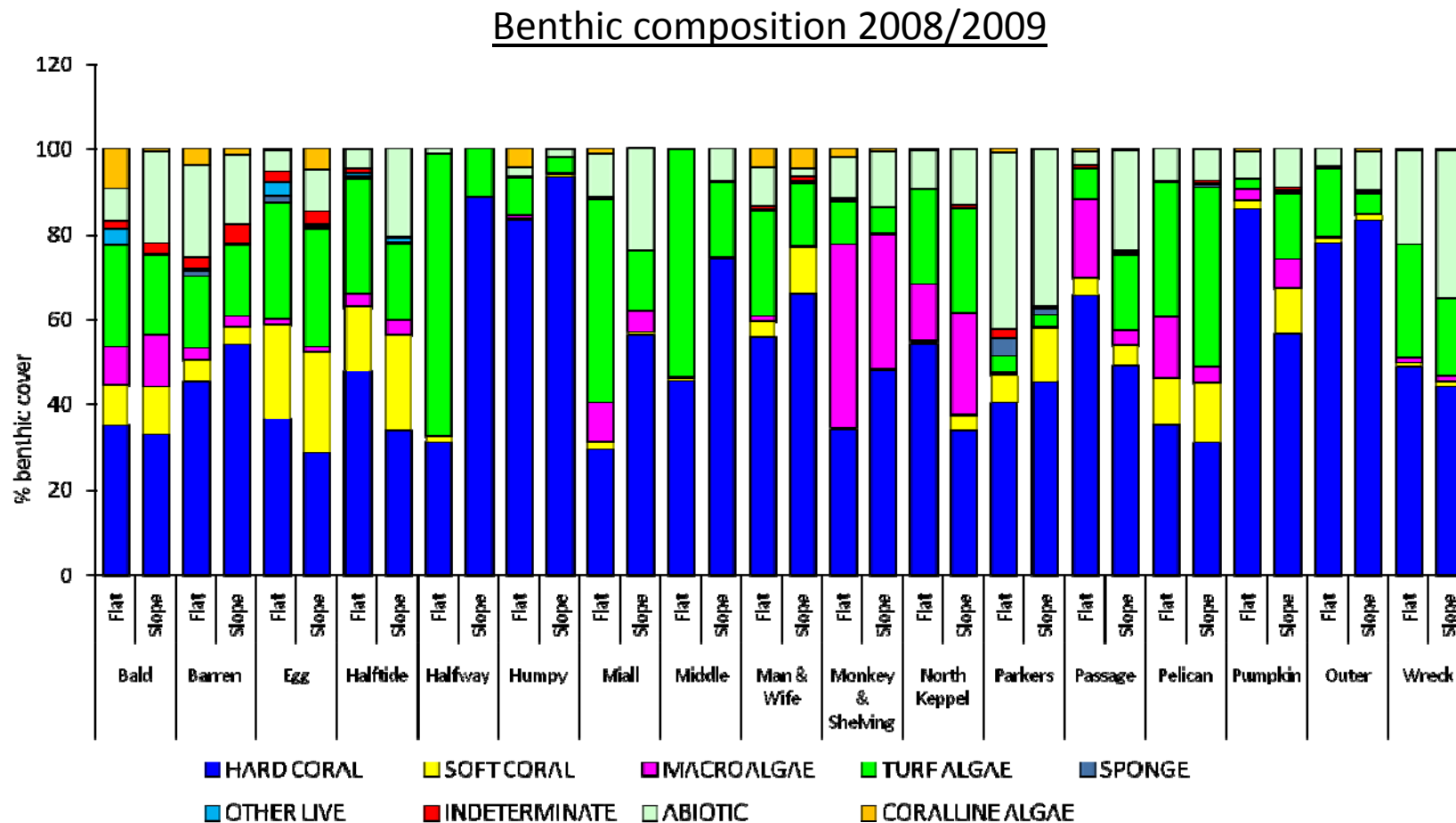
CORAL COVER

Figure 2. The following chart illustrates the percentage hard coral cover on reef flats and slopes on 17 of the study sites. Bars represent the average (2-3 50m transects) percentage coral cover on reef flats and slopes. Standard deviations are shown as error bars above the mean.



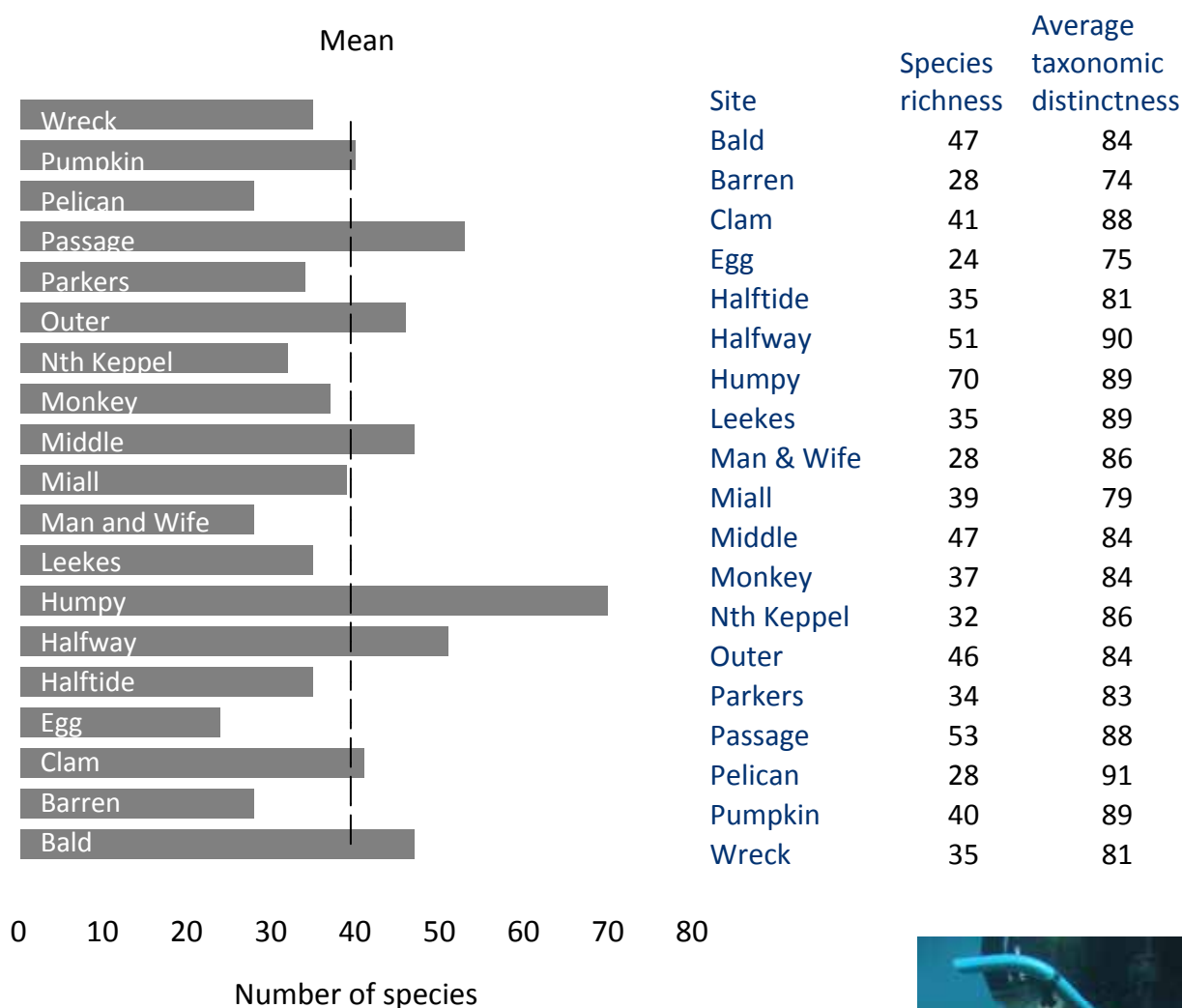
BENTHIC COMPOSITION

Figure 3. The following bar chart illustrates the percentage benthic community composition (coralline algae, turf algae, macro algae, sponge, and hard coral, soft coral, abiotic, other live and indeterminate) on reef flats and slopes on 17 of the study sites. Bars represent the percentage of each type of benthic cover on reef flats and slopes.



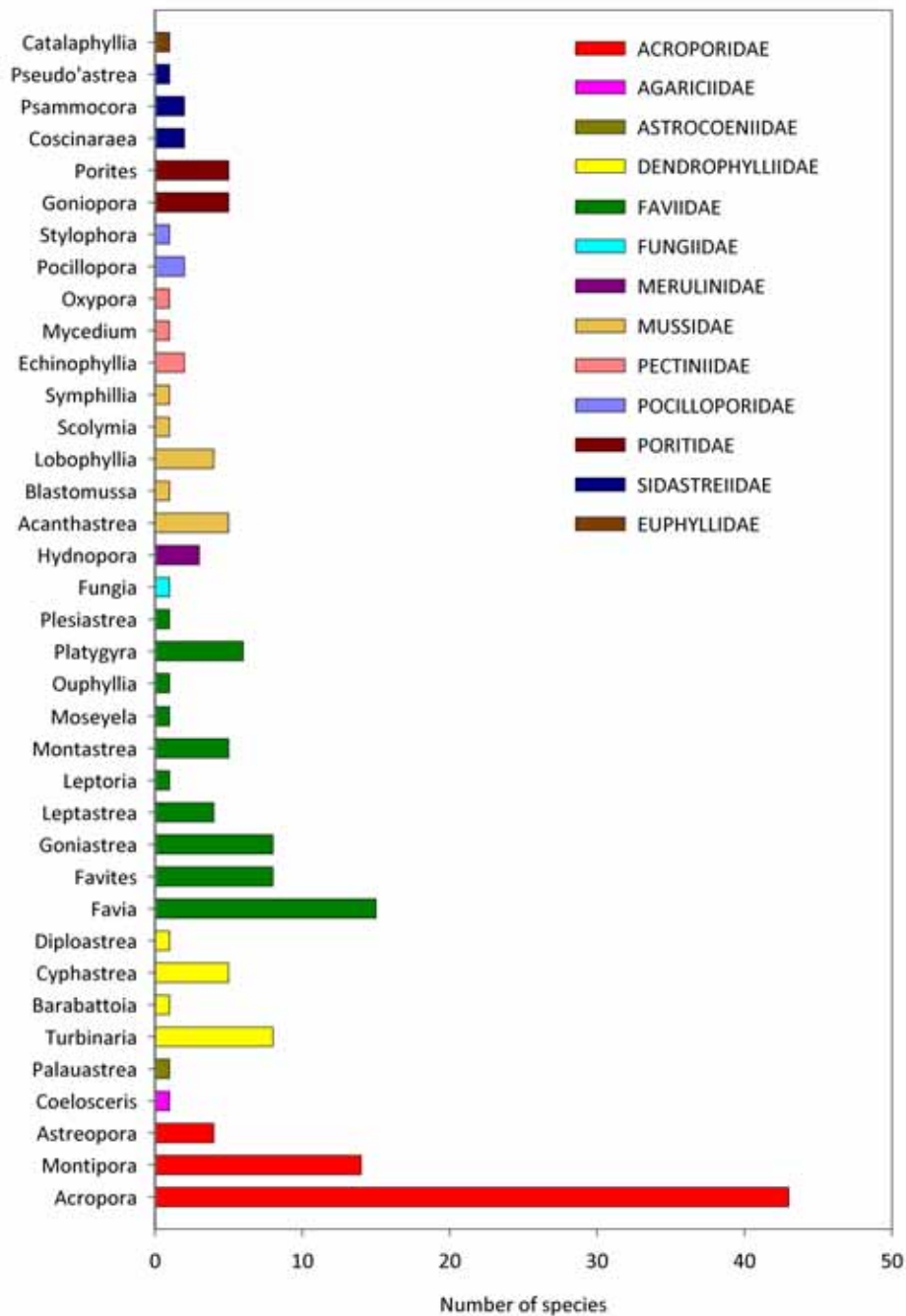
SPECIES DIVERSITY

Figure 4. Chart showing the number of scleractinian coral species (species richness, S) for each site. Species lists were compiled in the same general area of the coral cover transects. The mean species richness for the 19 sites in the Keppels is 40. Humpy had the highest number of species followed by Passage Rocks and Halfway Island. Bars represent the total species identified during ~1hr on scuba at varying depths.

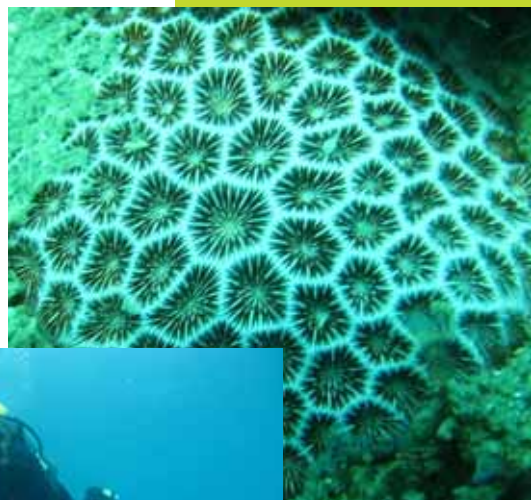


SPECIES LIST

Figure 5. Chart showing the number of species in each scleractinian coral Genus and Family in the Keppels. Families are shown in the legend. Bars represent the number of species in each Genus.

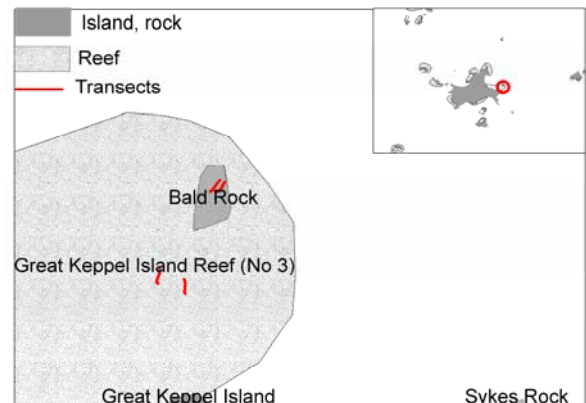


Site descriptions and survey results

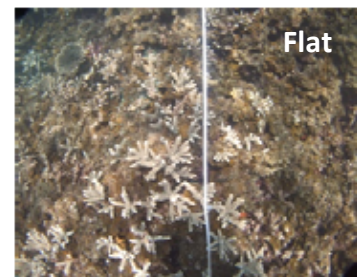


Photographs by James Than JCU/AIMS 2008

Bald Rocks reef (GBR-ID 23012C)



Bald Rocks is situated on the Eastern side of Great Keppel Island. The rocks are surrounded by moderately high (34%) coral cover to approximately 8m depth and there is a platform of shallow reef (~2-3m LAT) between Bald Rocks and Great Keppel Island. The reefs on the shallow platform are comprised mostly of branching *Acropora* corals and macro-algae. The site has relatively high light and cooler water temperatures.

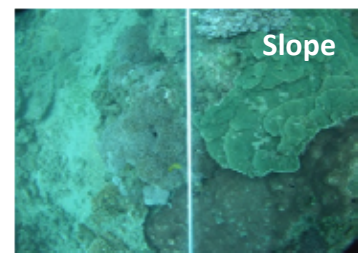


Species richness $S = 47/167$ (site richness vs total for all sites)

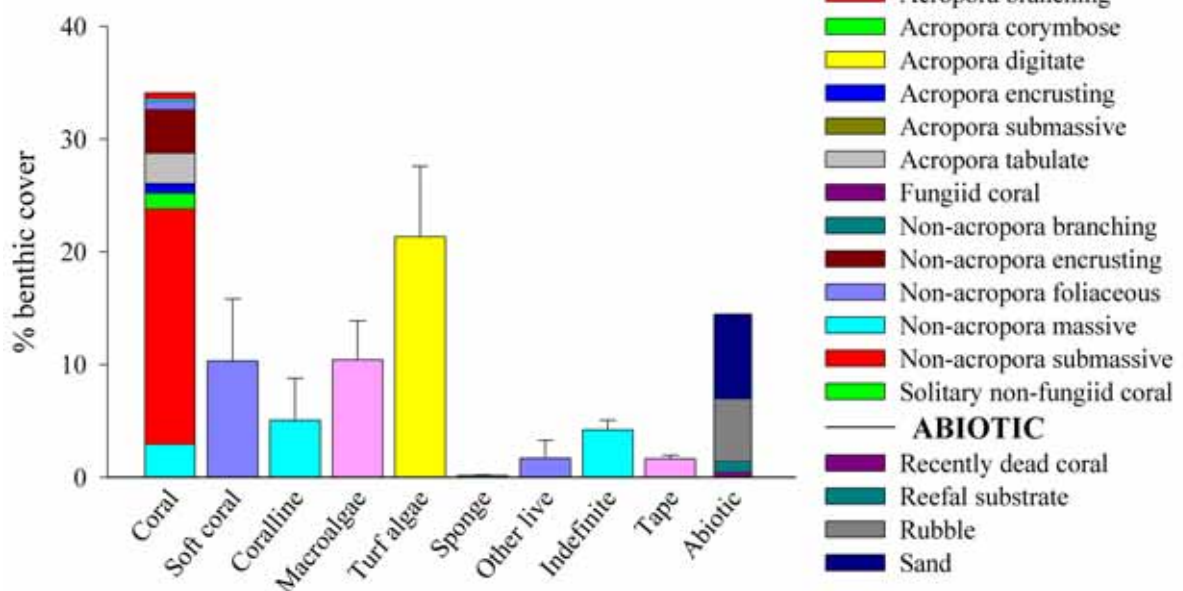
Average taxonomic distinctness $\Delta+ = 84/92$ (actual vs expected)

Coral cover = $34 \pm 21\%$

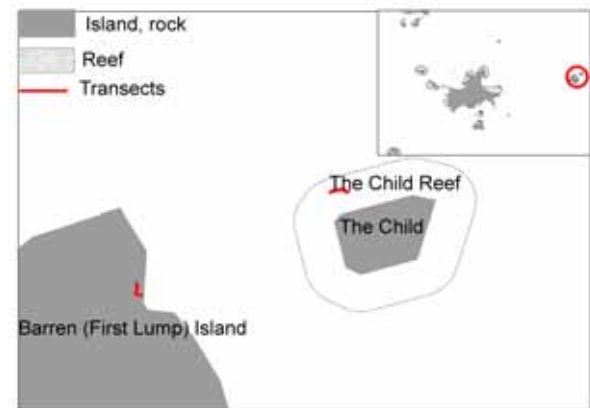
Macro-algal cover = $10 \pm 7\%$



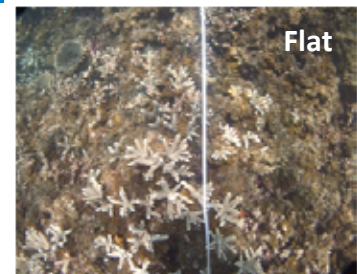
Coral cover Bald 2008



Barren and Child Island reefs (GBR-ID 23015)



Barren and Child Islands are situated on the South Eastern side of Great Keppel Island. Coral cover is high (50%) and macro-algal cover low (<3%) but species diversity and taxonomic distinctness are relatively low. The site has relatively high light and cooler water temperatures.

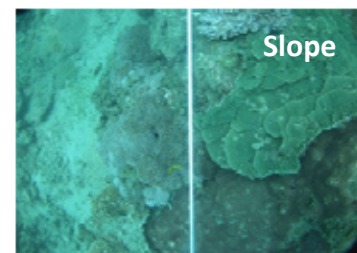


Species richness $S = 28/167$ (site richness vs total for all sites)

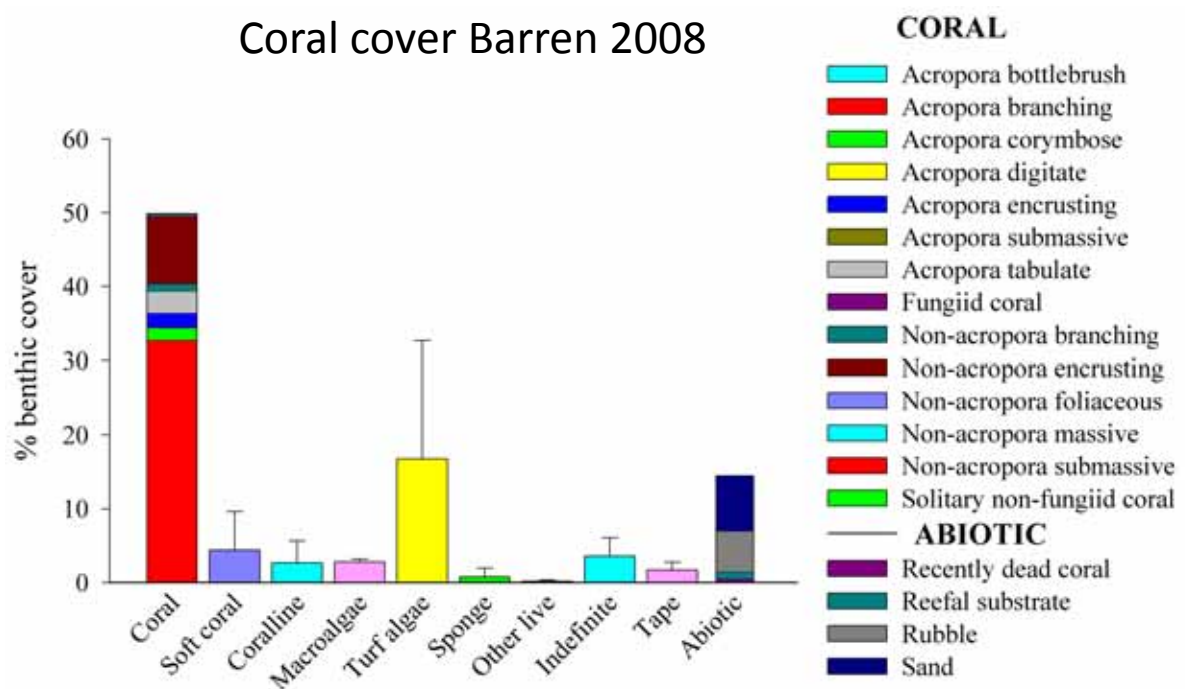
Average taxonomic distinctness $\Delta+ = 53/92$ (actual vs expected)

Coral cover = $50 \pm 21\%$

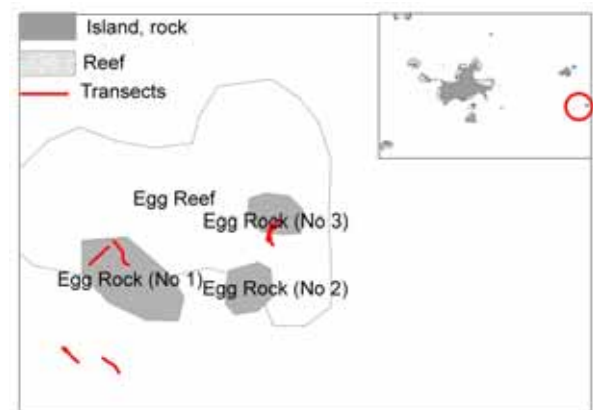
Macro-algal cover = $3 \pm <1\%$



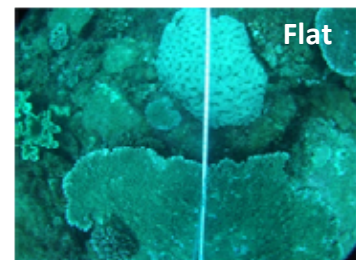
Coral cover Barren 2008



Egg Rock reefs (GBR-ID 23033)



Egg Rocks (Egg, Bacon and Toast rocks) are situated south-east of Great Keppel Island in ~30m water. The coral cover and diversity are moderate at this site although light levels are high and water temperatures are relatively low. Species diversity is lower than Pelican Island reefs but Pelican has a more taxonomically diverse coral community. The lack of a variety of suitable habitat types and geographic isolation may contribute to the low species diversity at



Flat

Species richness $S = 24/167$ (site richness vs total for all sites)

Average taxonomic distinctness $\Delta+ = 75/92$ (actual vs expected)

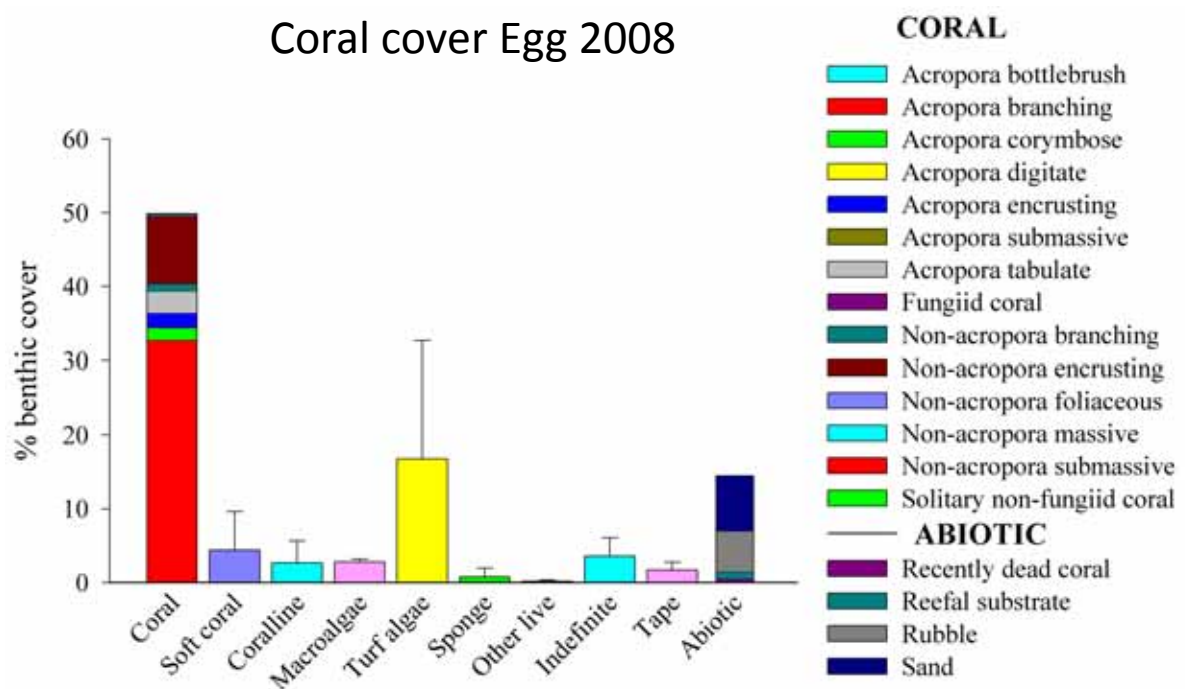
Coral cover = $32 \pm 16\%$

Macro-algal cover = 1%

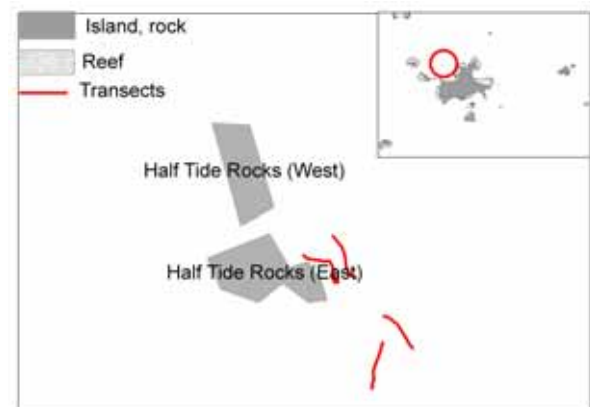


Slope

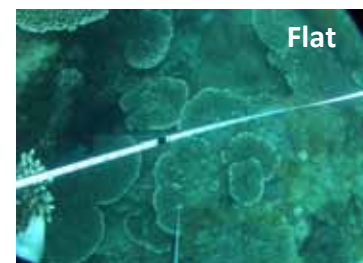
Coral cover Egg 2008



Halftide Rocks reef (GBR-ID 23802B)



Halftide Rocks is an isolated site to the North of Great Keppel Island. A shallow reef platform surrounds the sites. The fringing reef platform extends from a depth of ~3m to a maximum of ~12m. Shallow reefs are comprised mostly of branching and tabulate *Acropora* species and the deeper reef slopes comprise encrusting non-*Acropora* and *Faviidae* species.

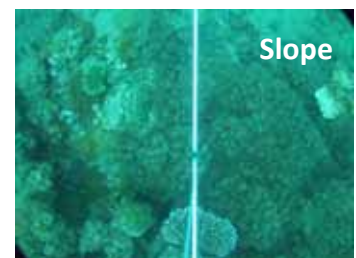


Species richness $S = 35/167$ (site richness vs total for all sites)

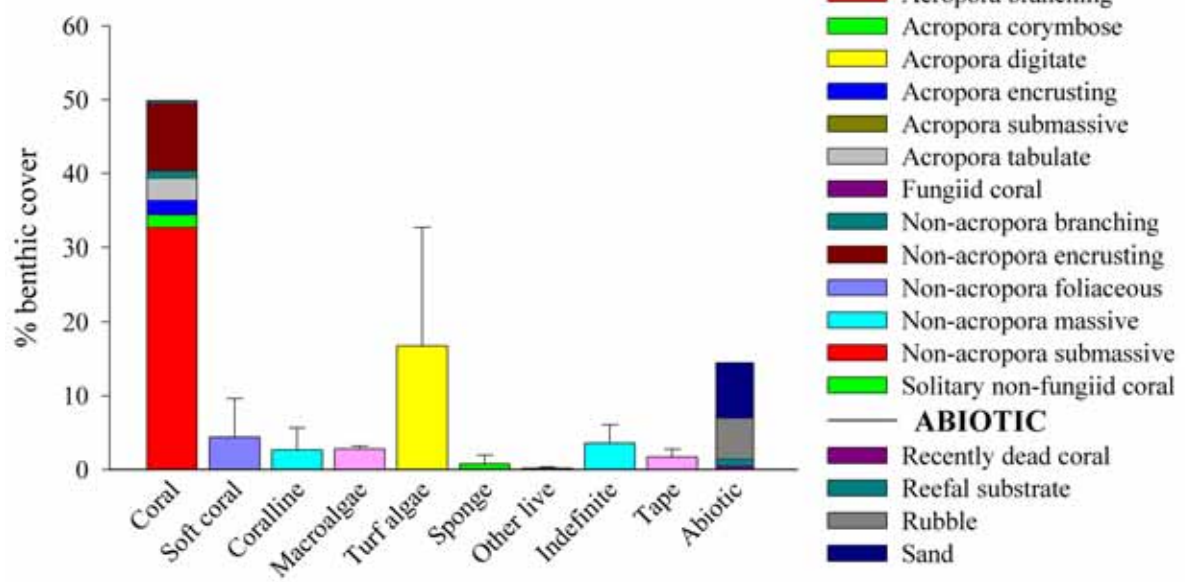
Average taxonomic distinctness $\Delta+ = 81/92$ (actual vs expected)

Coral cover = $41 \pm 10\%$

Macro-algal cover = $<3 \pm 2\%$



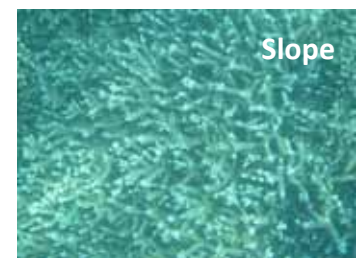
Coral cover Halftide 2008



Halfway Island reefs (GBR-ID 23014)



Halfway Island lies to the south of Great Keppel Island adjacent to Humpy Island. There is a large reef flat on the western side of the island and a steep slope on the eastern side. The western reef has three prominent crests which dry during spring tides. The reef flat is comprised of abundant small *A. millepora* colonies on a bed of other branching *Acropora* species and macro-algae. The reef flat is similar to those at Clam, Middle and Miall Islands. There is high species diversity on the steep slope to the east.



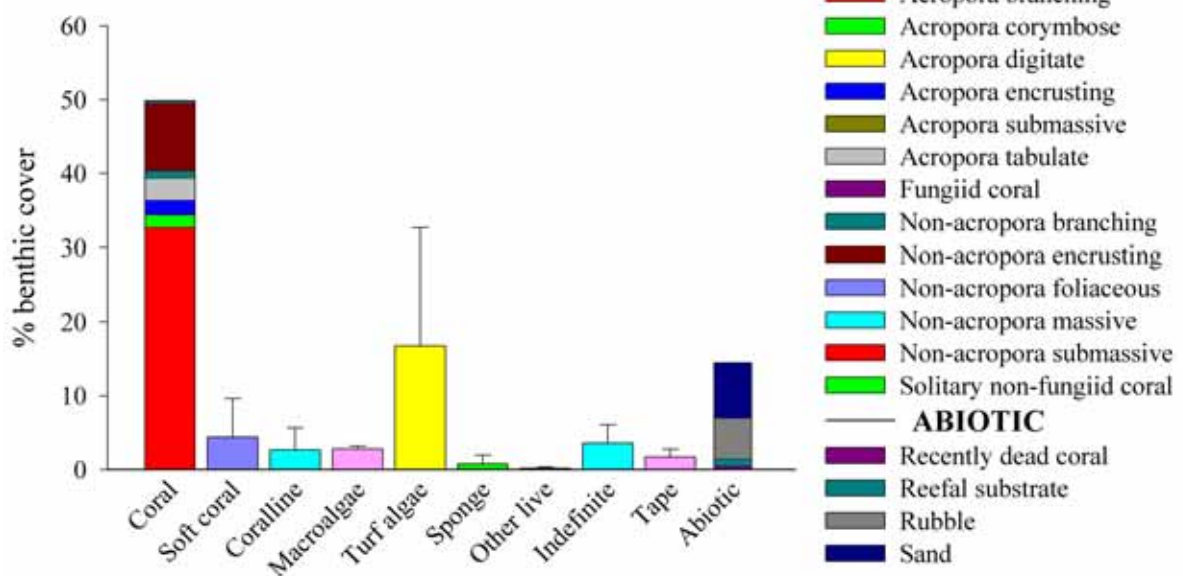
Species richness $S = 51/167$ (site richness vs total for all sites)

Average taxonomic distinctness $\Delta+ = 53/92$ (actual vs expected)

Coral cover = $60 \pm 33\%$

Macro-algal cover = NA

Coral cover Halfway 2008



Humpy Island reefs (GBR-ID 23016)



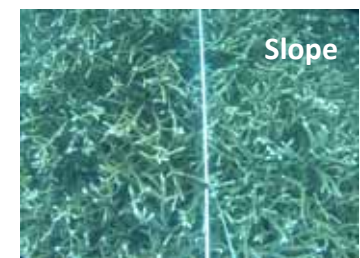
Humpy Island lies to the South west of Great Keppel Island. The survey sites at Humpy included the south western and southern bays. Humpy has very high light levels but also has high turbidity. The island is surrounded on all sides by extensive fringing reefs with very high coral cover and rich species diversity, particularly on the southern, eastern and western sides. A shallow reef platform extends from the beach on the northern side. Deeper reefs on the southern and western faces comprise the highest species diversity and coral cover in the Keppels.

Species richness $S = 70/167$ (site richness vs total for all sites)

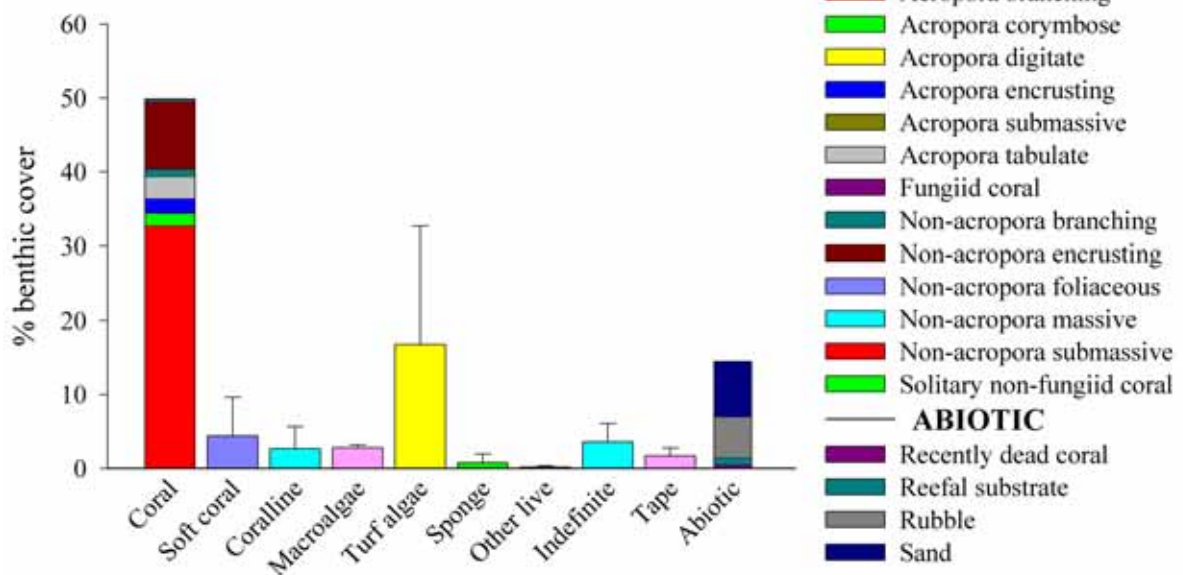
Average taxonomic distinctness $\Delta+ = 89/92$ (actual vs expected)

Coral cover = $89 \pm \%$

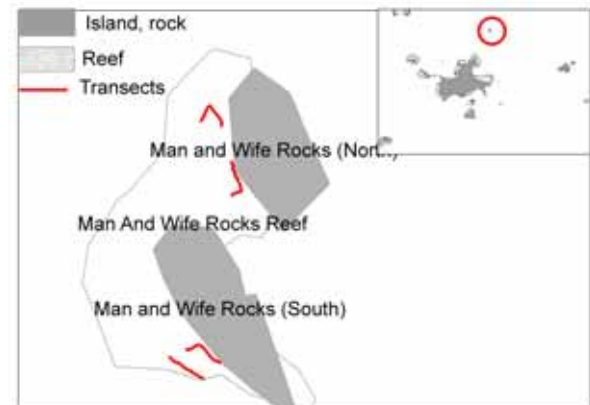
Macro-algal cover = $<1\%$



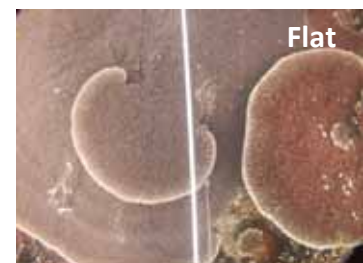
Coral cover Humpy 2008



Man and Wife Rocks reefs (GBR-ID 23008)



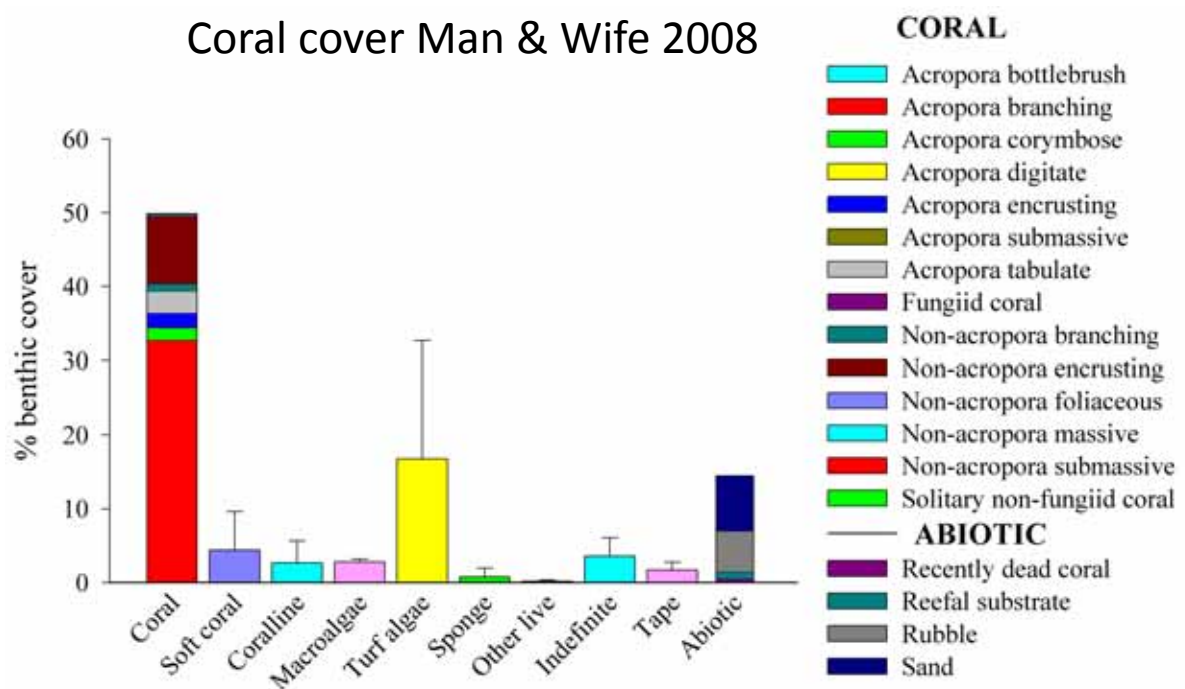
Man and Wife rocks lies ~4km to the north east of Great Keppel Island. The two rocks are surrounding by extensive deep reef slopes interspersed by sparser inter-reefal substrate. Coral cover is relatively high but species diversity is relatively low for this region. There is little macro-algal cover on these reefs.



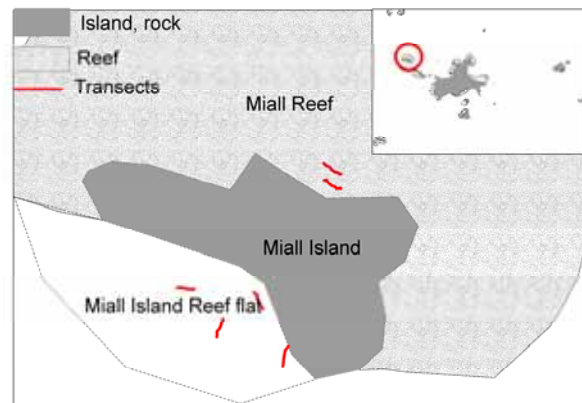
Species richness $S = 28/167$ (site richness vs total for all sites)
Average taxonomic distinctness $\Delta+ = 79/92$ (actual vs expected)
Coral cover = $61 \pm 7\%$
Macro-algal cover = $<1\%$



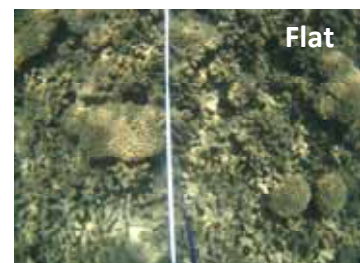
Coral cover Man & Wife 2008



Miall Island reefs (GBR-ID 23009)



Miall Island is situated to the West of Great Keppel Island and Middle Island. The southern side of Miall is a shallow, silt based reef flat extending gradually to a slope of ~6m maximum depth. The reef flat is dominated by small colonies of *A. millepora* interspersed with other branching *Acropora* and the deeper slope by large, deep clumps of mostly *A. formosa* and *A. nobilis*. The northern side of Miall Island has higher species richness and coral cover than the southern side.



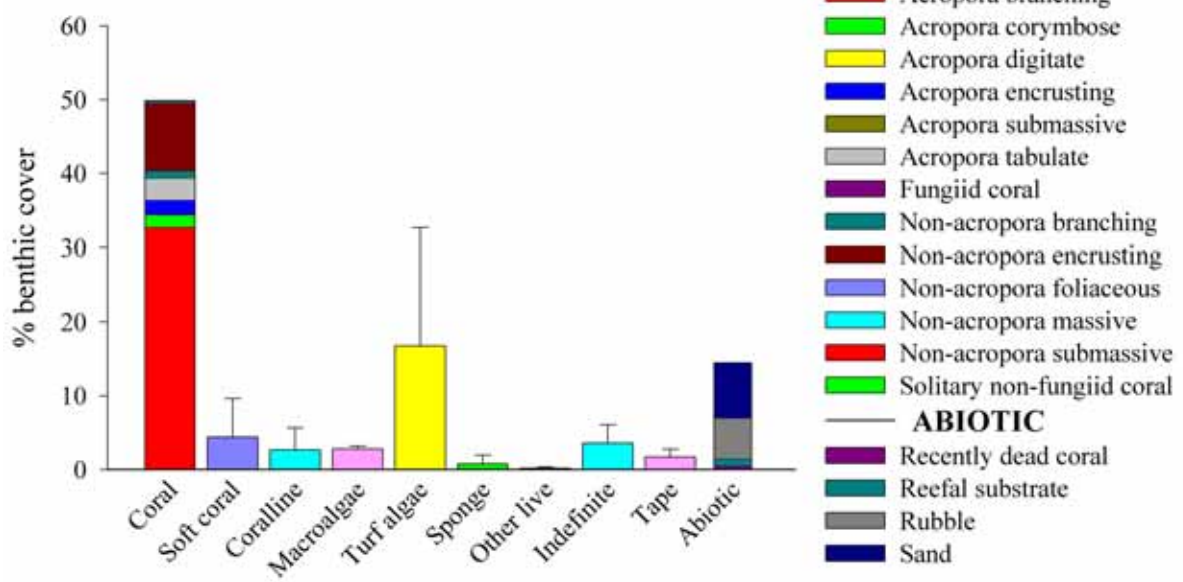
Species richness $S = 39/167$ (site richness vs total for all sites)

Average taxonomic distinctness $\Delta+ = 79/92$ (actual vs expected)

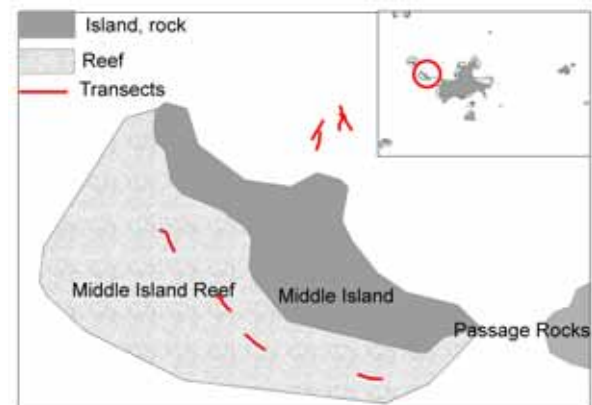
Coral cover = $43 \pm 38\%$

Macro-algal cover = $<7 \pm 10\%$

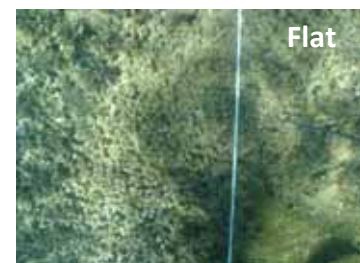
Coral cover Miall 2008



Middle Island reefs (GBR-ID 23010)



Middle island is situated to the West of Great Keppel Island. The southern side is characterised by shallow reef flats with approximately half the coral cover (26-38%) of the deeper slope. The reef on the northern side at Olive Point is more diverse with higher coral cover on both flat and slope (ranging from 59-87%).



Species richness $S = 47/167$ (site richness vs total for all sites)

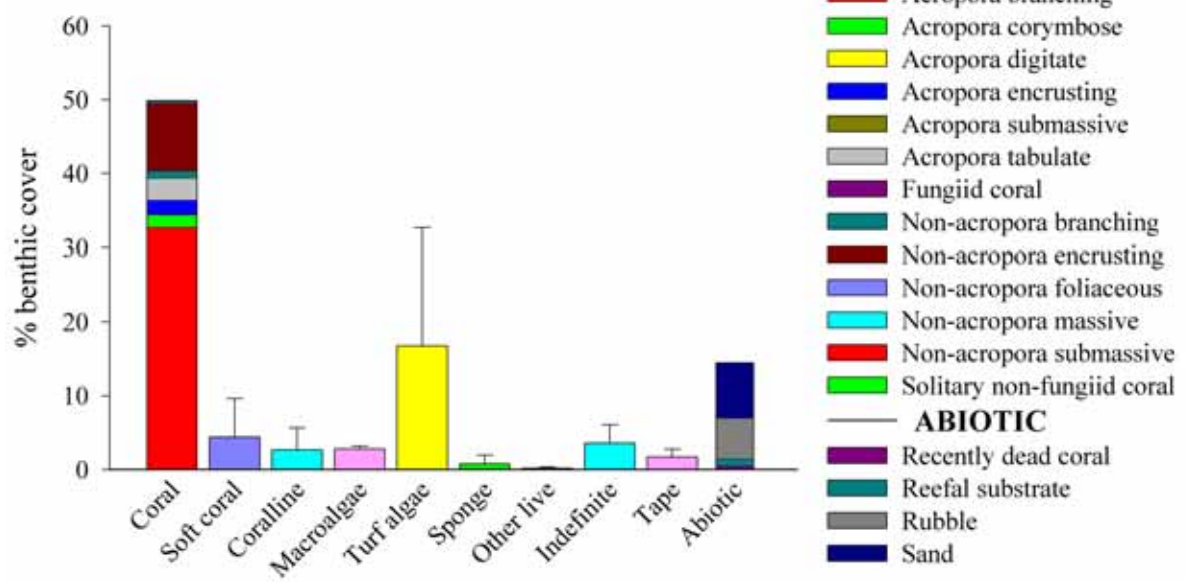
Average taxonomic distinctness $\Delta+ = 84/92$ (actual vs expected)

Coral cover = $60 \pm 21\%$

Macro-algal cover = $<1\%$



Coral cover Middle 2008



Monkey and Shelving reefs (GBR-ID 23012B, E)



Monkey and Shelving reefs comprise three reef platforms that lie on the western side of Great Keppel Island. The reefs are shallow with relatively wide flats and narrow slopes extending from ~0.5-5m depth. The coral cover is sparse but the all three sites host abundant anemone and anemonefish populations and are important for tourism because of their easy access from Great Keppel Island and protected status.



Species richness $S = 37/167$ (site richness vs total for all sites)

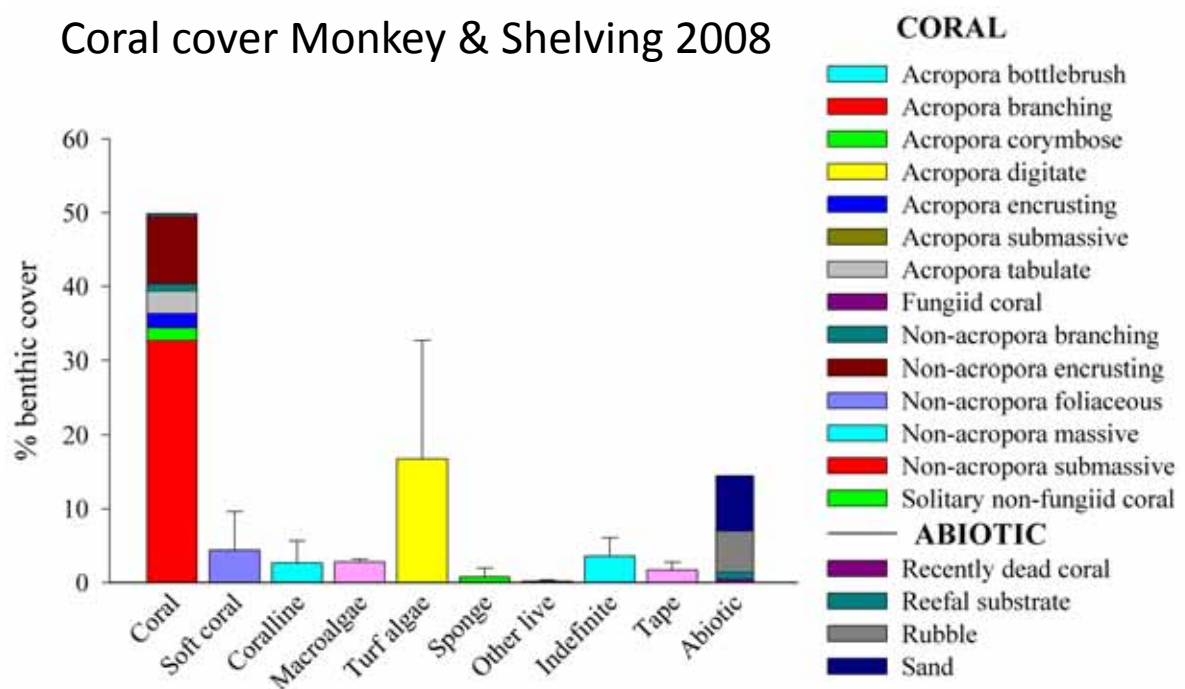
Average taxonomic distinctness $\Delta+ = 84/92$ (actual vs expected)

Coral cover = $55 \pm 24\%$, $28 \pm 28\%$ (Monkey, Shelving)

Macro-algal cover = $16 \pm 29\%$, $59 \pm 29\%$ (Monkey, Shelving)



Coral cover Monkey & Shelving 2008



North Keppel Island reefs (GBR-ID 23004)



North Keppel is situated to the north of Great Keppel Island. There are extensive reefs on the western, southern and northern sides but little reef development on the eastern side. Shallow reef flats on the southern side of the island at Maizie Bay were the focus of these surveys. The reef flats and slopes have relatively high coral cover and lower than average species richness.



Species richness $S = 32/167$ (site richness vs total for all sites)

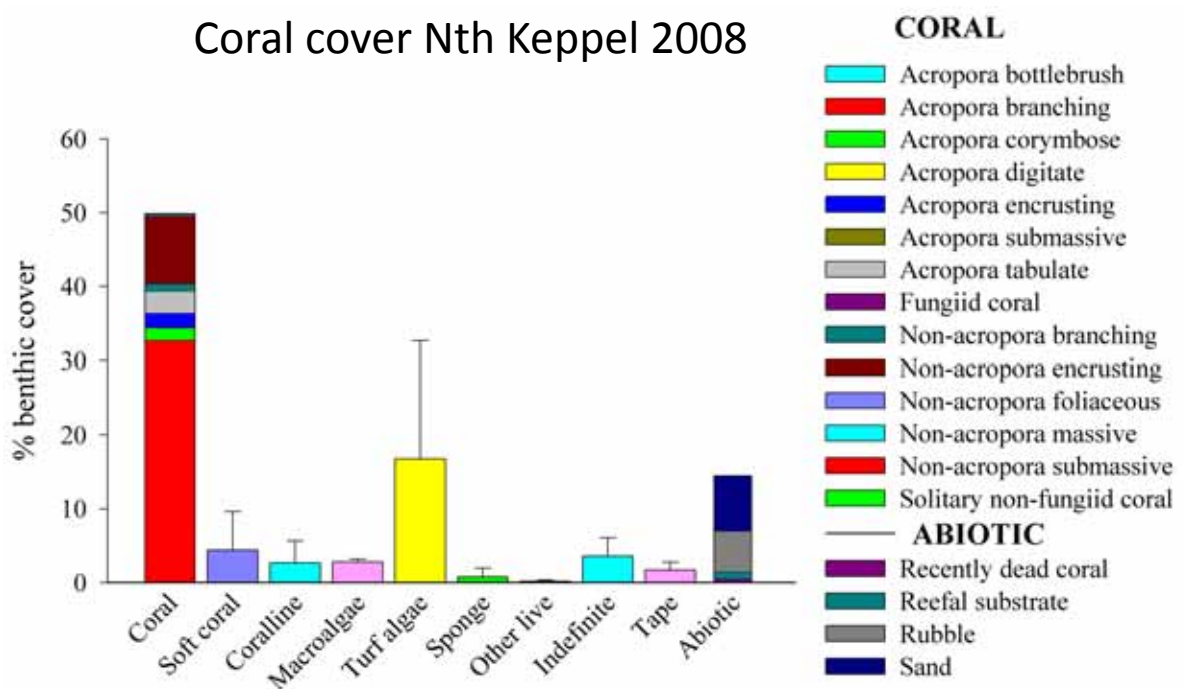
Average taxonomic distinctness $\Delta+ = 86/92$ (actual vs expected)

Coral cover = $44 \pm 18\%$

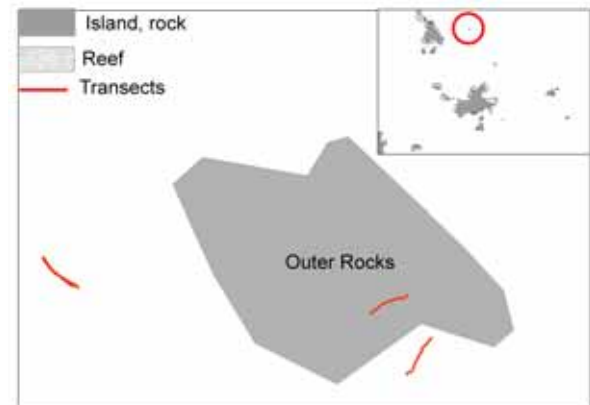
Macro-algal cover = $19 \pm 8\%$



Coral cover Nth Keppel 2008



Outer Rock reef (GBR-ID 23003)



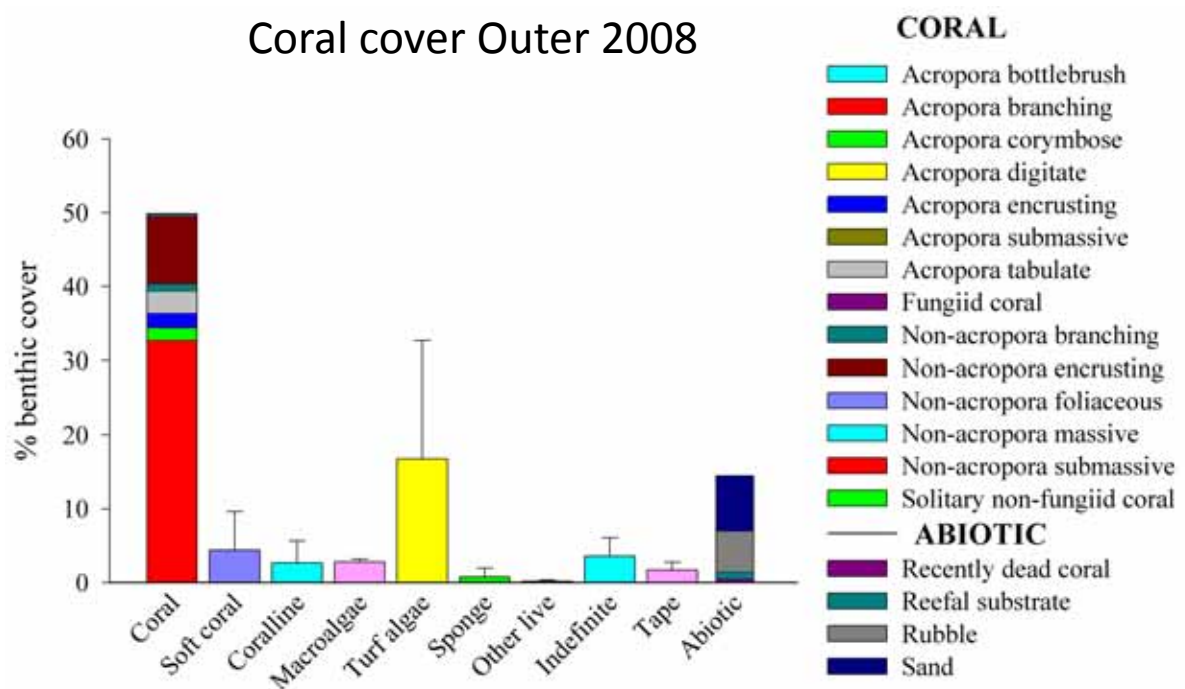
Outer Rock is situated to the north of Great Keppel Island and to the East of North Keppel. Reefs surround the rock are characterised by high diversity and coral cover and low macro-algal cover. Coral diversity is lower than at similar sites. Light levels are high and temperatures are low.



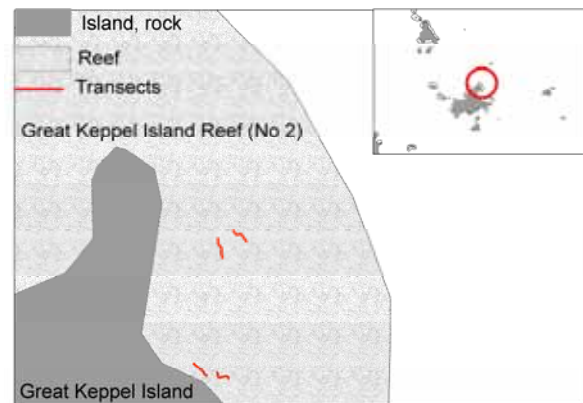
Species richness $S = 46/167$ (site richness vs total for all sites)
Average taxonomic distinctness $\Delta+ = 84/92$ (actual vs expected)
Coral cover = $80 \pm 7\%$
Macro-algal cover = $<1\%$



Coral cover Outer 2008



Parkers bommie and Big Peninsula (GBR-ID 23012)



Big Peninsula is situated at the eastern-most point of Great Keppel Island. The peninsula is surrounded by sharply sloping, extensive fringing reefs on the ocean side (~15m) and a shallow reef platform (~3m) extending to a deeper reef slope (~12m) on the northern side. Parker's bommies lie in ~15m water on the eastern side. The bommies are covered in diverse marine life. The coral species diversity is highest on the eastern side of the peninsula.



Species richness $S = 34/167$ (site richness vs total for all sites)

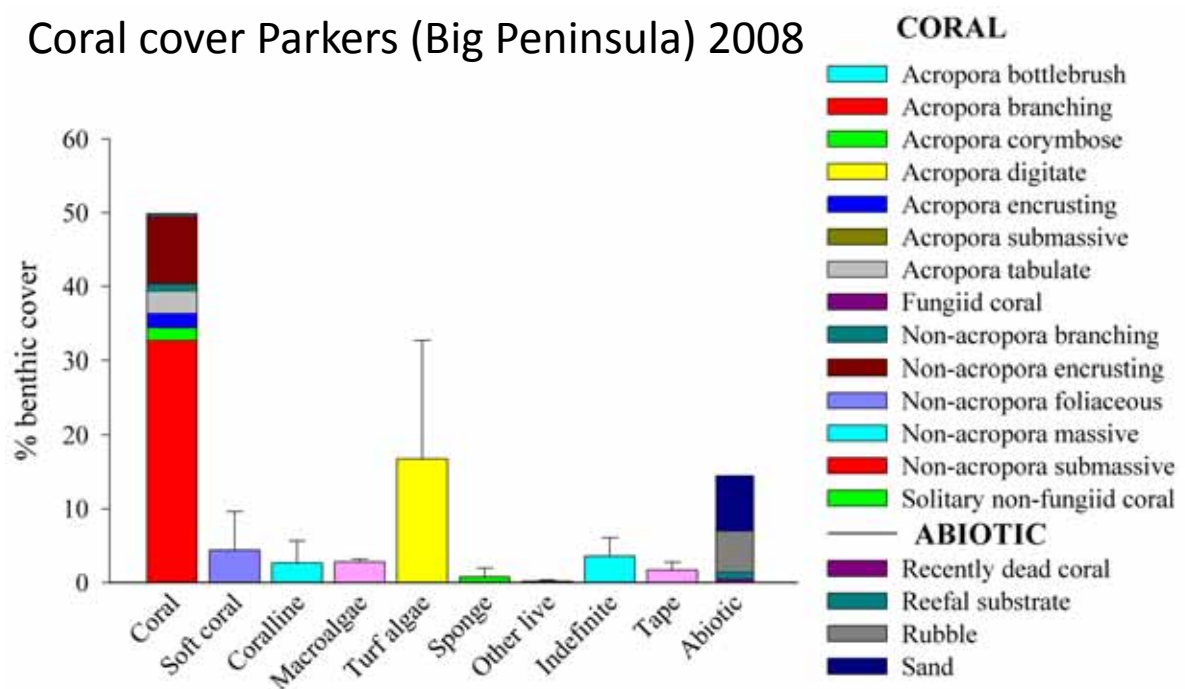
Average taxonomic distinctness $\Delta+ = 83/92$ (actual vs expected)

Coral cover = $43 \pm 13\%$

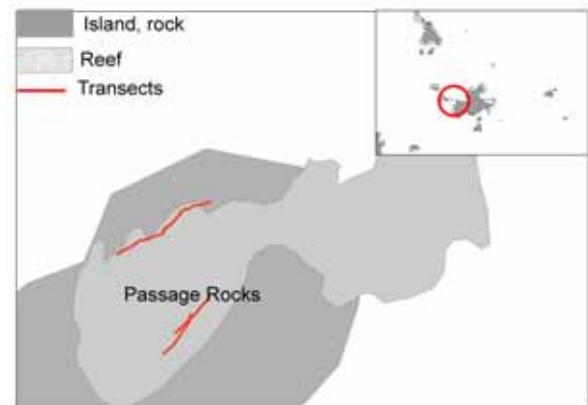
Macro-algal cover = $<1\%$



Coral cover Parkers (Big Peninsula) 2008



Passage Rocks reef (GBR-ID 23822)



Passage Rocks has extremely high species richness. A relatively small site, the reef at Passage Rocks is in the middle of a relatively deep channel (~6-9m) to the west of Great Keppel Island, east of Middle Island and is subject to strong currents. The site is comprised of two main clusters of rocks on a sandy substrate approximately 100m wide by 460m long. While studies are yet to confirm these links, its species richness strongly suggest that Passage plays an important part in connectivity between southern and northern reefs given the prevailing south-north longshore current direction in the region.



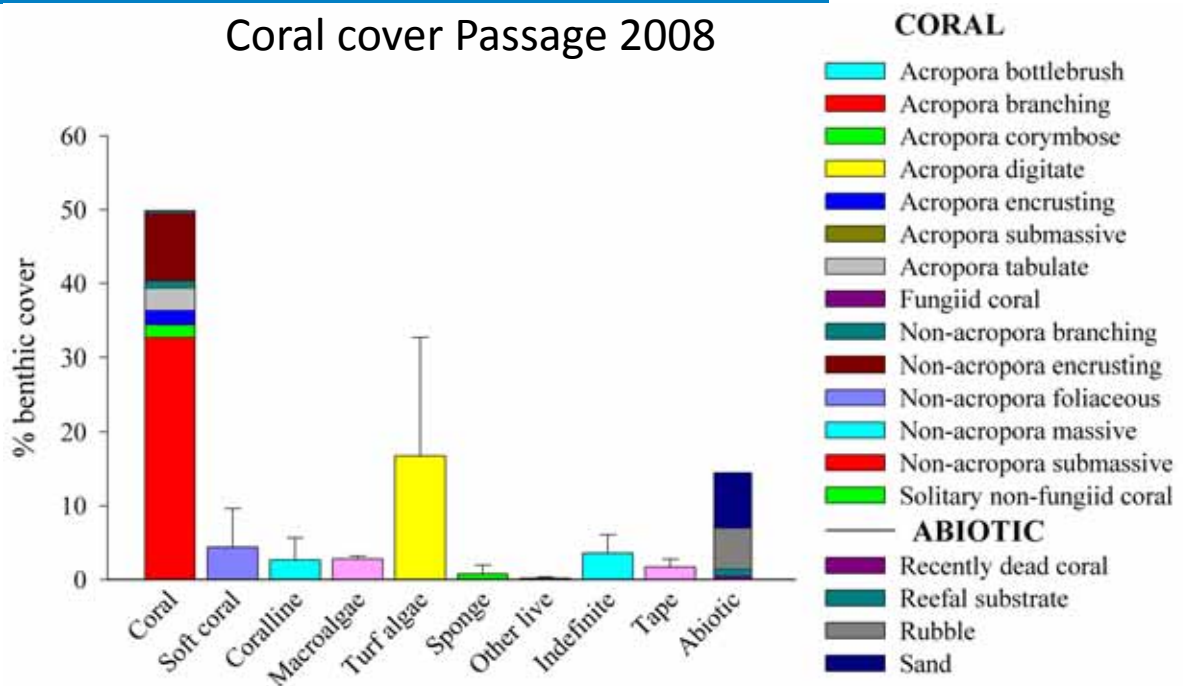
Species richness $S = 53/167$ (site richness vs total for all sites)

Average taxonomic distinctness $\Delta+ = 88/92$ (actual vs expected)

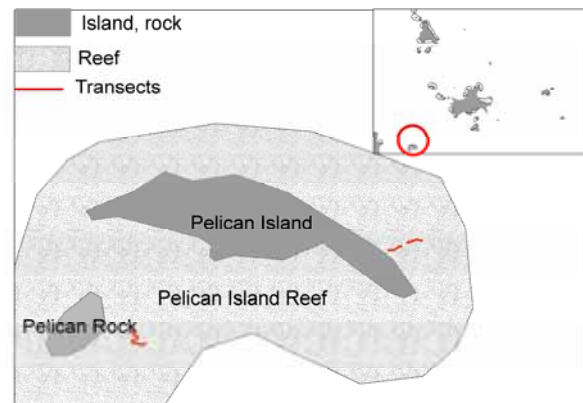
Coral cover = $57 \pm 11\%$

Macro-algal cover = $10 \pm 11\%$

Coral cover Passage 2008



Pelican Island reefs (GBR-ID 23017)



Pelican Island is situated inside the terrigenous sediment wedge south-west of Great Keppel Island close to the mouth of the Fitzroy River and the mainland coast. Reefs around Pelican are sparse with low diversity but extremely high taxonomic distinctness. The site is subject to high temperatures, high turbidity and freshwater influx from the seasonal river flows. Because of the marginal conditions, coral species at this site are likely to be extremely resilient to environmental perturbations and selection for bleaching and low salinity resistant species may have occurred.

Species richness $S = 28/167$ (site richness vs total for all sites)

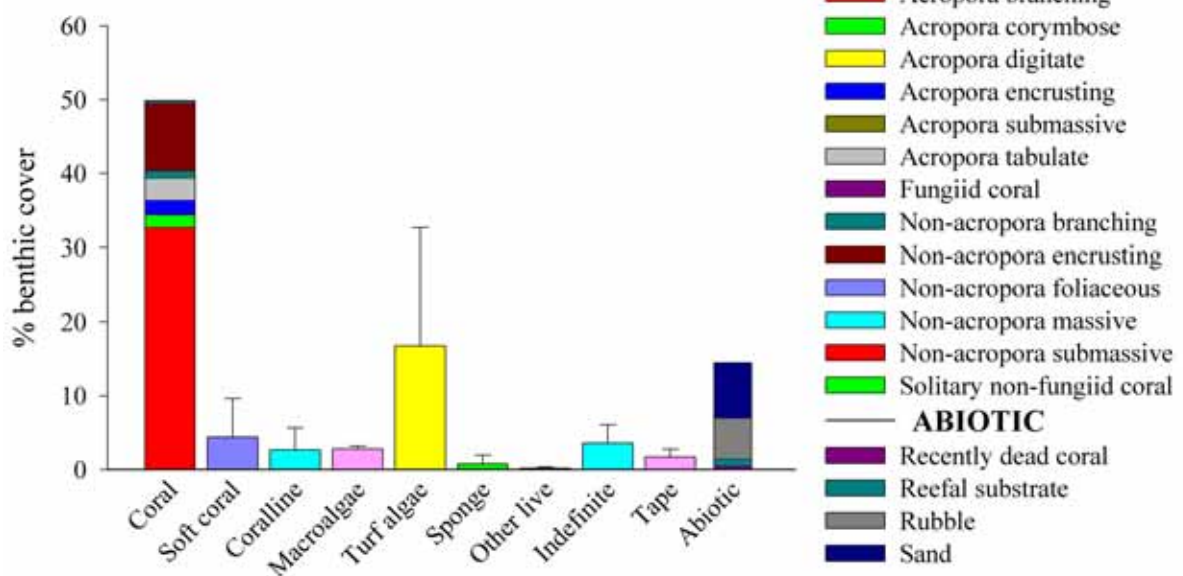
Average taxonomic distinctness $\Delta+ = 91/92$ (actual vs expected)

Coral cover = $33 \pm 14\%$

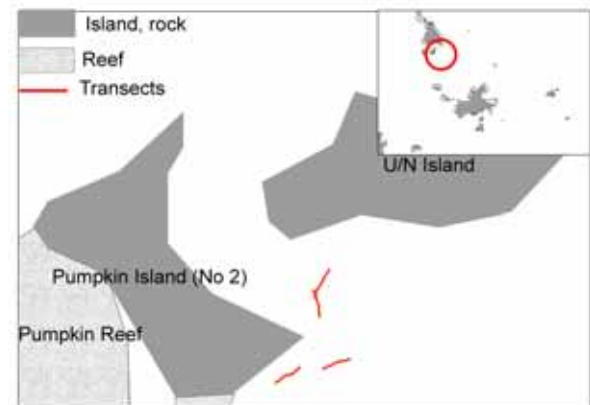
Macro-algal cover = $9 \pm 10\%$



Coral cover Pelican 2008



Pumpkin Island reef (GBR-ID 23005)



Pumpkin Island is situated on the southern side of North Keppel Island and is surrounded by extensive fringing reefs. There is a channel of high coral diversity between the northern and southern sections of the island. There is higher diversity on the eastern side of the island but a large, less diverse but healthy reef flat on the western side. The site is characterised by high coral cover and medium coral species diversity with high taxonomic distinctness.



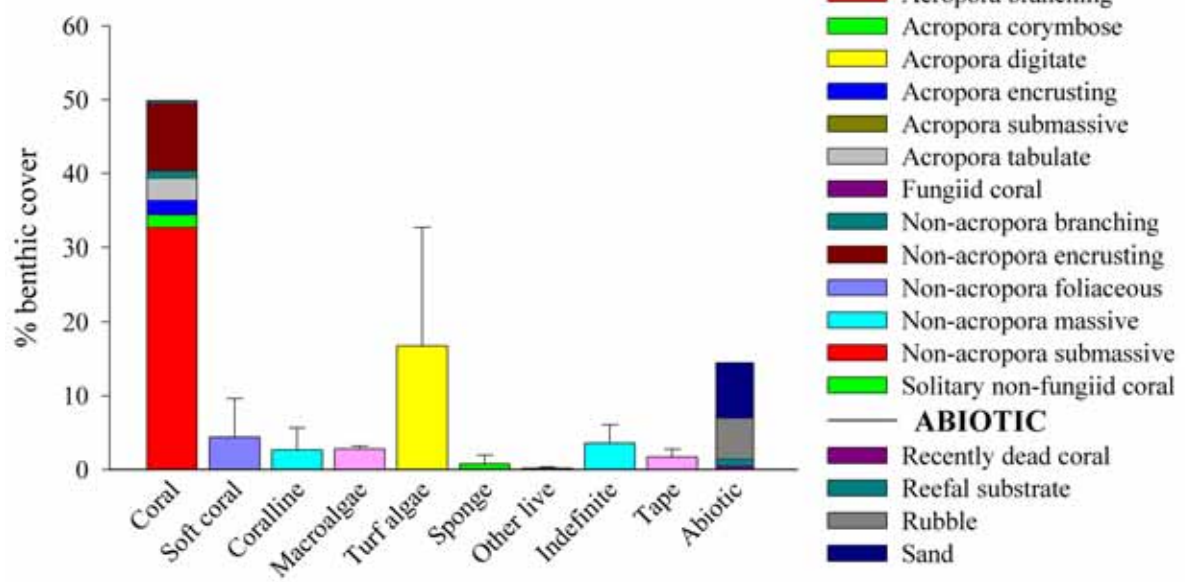
Species richness $S = 40/167$ (site richness vs total for all sites)

Average taxonomic distinctness $\Delta+ = 89/92$ (actual vs expected)

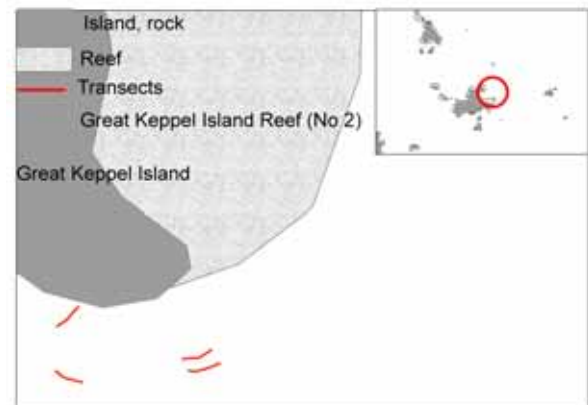
Coral cover = $71 \pm 22\%$

Macro-algal cover = $5 \pm 5\%$

Coral cover Pumpkin 2008



Wreck Beach reef (GBR-ID 23012B)



Wreck reef is situated on the far eastern side of Great Keppel Island. The bay at Wreck has high coral cover which is mostly low diversity being comprised of branching *Acropora*. There is a small section of reef that is protected from swell that is higher diversity than less protected areas. Macro-algal cover is low and the reef flat is fringed by an extensive reef slope stretching to a sandy bottom at about 8-9m.

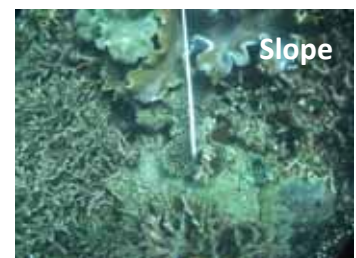


Species richness $S = 35/167$ (site richness vs total for all sites)

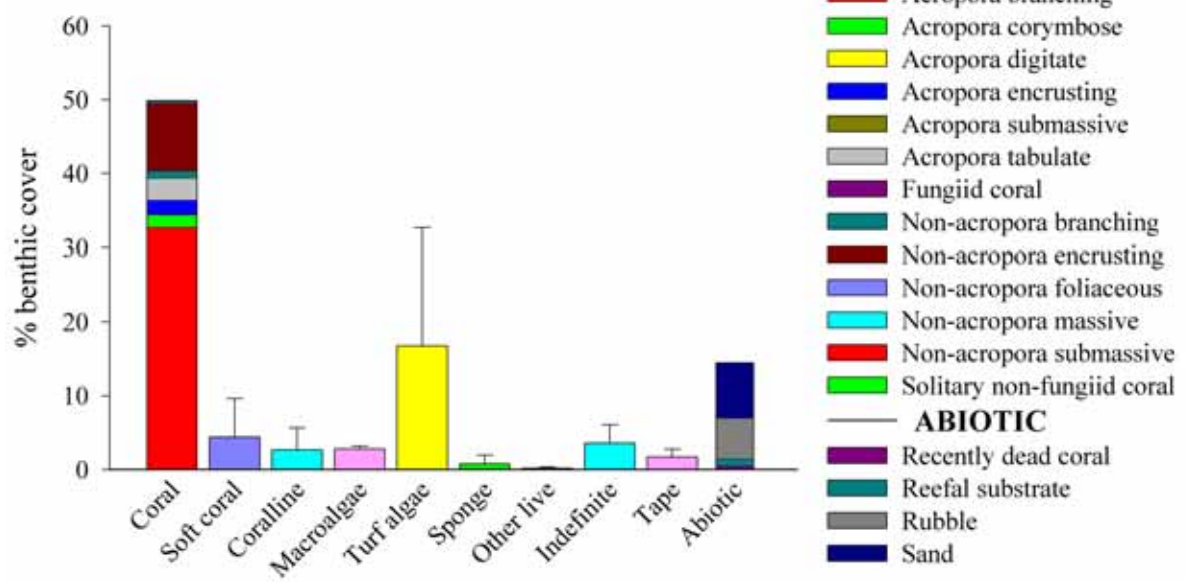
Average taxonomic distinctness $\Delta+ = 81/92$ (actual vs expected)

Coral cover = $47 \pm 20\%$

Macro-algal cover = 1%



Coral cover Wreck 2008



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Photograph by James Than JCU/AIMS 2008

APPENDIX 1

Volunteers

Many thanks to the many volunteers (some of who are listed below):

Jill Windle
Alana Brekelmans
Mark Jeffries
Rachel Fountain
Brett Griesel
Mick Barker
John Stewart
Scott and Anita Bowman
Barry Mullane
Wayne Gardner
Roslyn Scott
Kerry Lawrie
Christine Lebillon
Ryan Clare

Angie Jones-Field
Stewart Dunlop
John Dooley
Jacqueline Dupavillon
Sharon Kearney
Lisa Venagkua
Johanna Backen
Jodie O'Dell
Jacqueline Sanders
Lorella Mattioli
Kael Harker
Raewyn Ramage
Peter Williams
Scott Gardner

head⇨under⇩water

COMMUNITY MONITORING OF BIODIVERSITY IN THE KEPPEL ISLANDS (WOPPPAGURRA) REGION OF THE GREAT BARRIER REEF

An Australian Government initiative



APPENDIX 2

Coral cover data

Site	Bald				Barren				Egg			
	Flat		Slope		Flat		Slope		Flat		Slope	
	MEAN	STD. DEV.	MEAN	STD. DEV.	MEAN	STD. DEV.	MEAN	STD. DEV.	MEAN	STD. DEV.	MEAN	STD. DEV.
HARD CORAL	35.24	33.84	32.95	10.90	45.49	23.88	54.25	26.98	36.65	23.18	28.76	7.98
SOFT CORAL	9.38	10.79	11.24	15.62	5.04	7.13	3.78	5.35	21.94	14.85	23.48	15.14
ABIOTIC	7.62	3.56	21.34	2.84	21.74	16.49	16.28	5.60	4.84	3.48	9.91	6.85
CORALLINE ALGAE	9.41	9.57	0.69	0.70	3.80	4.52	1.53	1.02	0.44	0.43	4.78	4.20
MACROALGAE	8.83	9.29	12.01	6.95	2.74	0.39	2.84	0.55	1.56	0.79	1.36	0.59
TURF ALGAE	23.93	20.74	18.72	3.64	16.97	23.14	16.53	15.09	27.26	14.08	27.40	7.19
SPONGE	0.09	0.13	0.20	0.00	1.23	1.75	0.31	0.43	1.54	1.35	0.73	0.91
OTHER LIVE	3.41	4.28	0.00	0.00	0.10	0.15	0.20	0.29	3.05	4.14	0.55	0.60
INDETERMINATE	2.08	2.67	2.84	0.72	2.88	4.07	4.27	0.25	2.72	2.91	3.03	2.10

Site	Halftide				Halfway				Humpty			
	Flat		Slope		Flat		Slope		Flat		Slope	
	MEAN	STD. DEV.	MEAN	STD. DEV.	MEAN	STD. DEV.	MEAN	STD. DEV.	MEAN	STD. DEV.	MEAN	STD. DEV.
HARD CORAL	47.67	10.73	33.91	0.54	31.17	5.05	88.72	0.17	83.07	12.82	93.52	2.94
SOFT CORAL	15.40	4.58	22.22	3.93	1.10	0.71	0.00	0.00	0.62	0.32	0.50	0.15
ABIOTIC	4.52	4.98	20.57	1.59	1.20	0.00	0.00	0.00	2.17	1.68	2.16	1.35
CORALLINE ALGAE	0.10	0.14	0.00	0.00	0.00	0.00	0.00	0.00	4.26	4.35	0.10	0.14
MACROALGAE	0.10	0.14	0.00	0.00	0.00	0.00	0.00	0.00	4.26	4.35	0.10	0.14
TURF ALGAE	2.76	1.92	3.61	2.47	0.00	0.00	0.00	0.00	0.60	0.26	0.50	0.71
SPONGE	27.13	10.95	17.97	2.92	66.53	4.35	11.28	0.17	9.07	6.44	3.23	2.58
OTHER LIVE	0.61	0.28	0.41	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
INDETERMINATE	0.60	0.56	1.00	0.83	0.00	0.00	0.00	0.00	0.10	0.15	0.00	0.00
INDETERMINATE	1.21	1.13	0.30	0.13	0.00	0.00	0.00	0.00	0.10	0.15	0.00	0.00

APPENDIX 2

Coral cover data cont'd

Site	Man & Wife				Miall				Middle			
	Flat		Slope		Flat		Slope		Flat		Slope	
	MEAN	STD. DEV.	MEAN	STD. DEV.	MEAN	STD. DEV.	MEAN	STD. DEV.	MEAN	STD. DEV.	MEAN	STD. DEV.
HARD CORAL	55.83	2.40	65.93	6.71	29.43	48.93	56.30	26.81	45.58	17.09	73.99	13.50
SOFT CORAL	3.67	3.16	10.99	6.59	1.72	1.32	0.67	0.71	0.68	1.35	0.19	0.38
ABIOTIC	9.34	1.83	1.77	1.38	10.31	6.80	23.67	15.13	0.24	0.48	7.55	8.03
CORALLINE ALGAE	4.24	0.42	4.64	2.68	1.07	0.33	0.07	0.12	0.00	0.00	0.00	0.00
MACROALGAE	1.20	0.82	0.20	0.01	9.11	14.91	5.01	4.50	0.00	0.00	0.24	0.36
TURF ALGAE	24.92	2.95	14.83	0.81	47.96	37.10	14.00	7.61	53.51	17.65	17.55	5.92
SPONGE	0.20	0.01	0.31	0.16	0.20	0.35	0.07	0.12	0.00	0.00	0.00	0.00
OTHER LIVE	0.10	0.14	0.42	0.31	0.07	0.12	0.00	0.00	0.19	0.00	0.19	0.00
INDETERMINATE	0.51	0.16	0.92	0.10	0.13	0.23	0.20	0.20	0.00	0.19	0.77	0.58

Site	Monkey & Shelving				Nth Keppel				Outer			
	Flat		Slope		Flat		Slope		Flat		Slope	
	MEAN	STD. DEV.	MEAN	STD. DEV.	MEAN	STD. DEV.	MEAN	STD. DEV.	MEAN	STD. DEV.	MEAN	STD. DEV.
HARD CORAL	34.16	37.32	48.10	17.99	54.33	20.28	33.87	10.79	78.07	9.72	83.25	2.39
SOFT CORAL	0.45	0.67	0.25	0.51	0.39	0.68	3.54	6.13	1.12	0.45	1.30	0.71
ABIOTIC	9.21	7.89	12.84	4.89	9.19	7.21	13.12	5.25	4.05	1.65	9.32	5.80
CORALLINE ALGAE	34.16	37.32	48.10	17.99	0.41	0.35	0.13	0.23	0.00	0.00	0.60	0.85
MACROALGAE	0.45	0.67	0.25	0.51	13.52	5.35	24.04	7.10	0.20	0.00	0.10	0.14
TURF ALGAE	2.25	2.18	0.74	0.69	22.10	11.32	24.58	5.55	16.06	11.63	4.82	4.26
SPONGE	42.99	48.00	31.72	24.48	0.00	0.00	0.13	0.23	0.00	0.00	0.10	0.14
OTHER LIVE	10.25	10.04	6.20	8.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
INDETERMINATE	0.29	0.34	0.10	0.20	0.07	0.11	0.60	0.53	0.50	0.71	0.50	0.71

APPENDIX 2

Coral cover data cont'd

Site	Parkers/Big Peninsula				Passage				Pelican			
	Flat		Slope		Flat		Slope		Flat		Slope	
	MEAN	STD. DEV.	MEAN	STD. DEV.	MEAN	STD. DEV.	MEAN	STD. DEV.	MEAN	STD. DEV.	MEAN	STD. DEV.
HARD CORAL	40.37	18.32	45.32	13.29	65.52	10.60	49.06	0.61	35.29	21.95	30.95	7.99
SOFT CORAL	6.45	4.66	12.56	8.78	4.07	3.51	4.98	0.69	10.91	5.47	14.26	0.04
ABIOTIC	41.28	32.56	37.00	8.86	3.17	1.13	23.24	2.49	7.38	1.30	7.16	4.26
CORALLINE ALGAE	1.02	0.61	0.10	0.14	0.59	0.56	0.49	0.69	0.00	0.00	0.20	0.28
MACROALGAE	0.41	0.30	0.31	0.43	18.62	11.47	3.27	1.73	14.27	13.59	3.65	2.39
TURF ALGAE	4.10	3.29	2.76	2.76	7.13	3.91	17.76	4.67	31.56	14.86	42.13	12.25
SPONGE	4.25	5.73	1.43	1.16	0.20	0.28	0.10	0.14	0.30	0.15	0.59	0.83
OTHER LIVE	0.00	0.00	0.10	0.14	0.00	0.00	0.31	0.43	0.00	0.00	0.20	0.28
INDETERMINATE	2.12	0.35	0.41	0.00	0.69	0.42	0.80	0.26	0.29	0.42	0.88	0.97

Site	Pumpkin				Wreck			
	Flat		Slope		Flat		Slope	
	MEAN	STD. DEV.	MEAN	STD. DEV.	MEAN	STD. DEV.	MEAN	STD. DEV.
HARD CORAL	85.94	9.17	56.48	22.10	21.77	21.84	44.18	25.77
SOFT CORAL	2.04	1.23	10.80	3.13	0.79	0.82	1.16	1.09
ABIOTIC	6.11	4.24	9.01	9.10	21.77	25.01	34.46	34.48
CORALLINE ALGAE	0.78	0.27	0.00	0.00	0.49	0.41	0.58	0.27
MACROALGAE	2.52	2.74	6.66	6.39	1.30	0.10	1.25	0.40
TURF ALGAE	2.42	0.41	15.59	3.54	26.72	4.64	18.27	10.61
SPONGE	0.19	0.27	0.20	0.29	0.00	0.00	0.00	0.00
OTHER LIVE	0.00	0.00	0.32	0.16	0.00	0.00	0.10	0.14
INDETERMINATE	0.00	0.00	0.94	0.18	0.10	0.14	0.00	0.00