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Final Report

Final report on coral reef surveys in Torres Strait

Hugh Sweatman, Kerryn A. Johns, Michelle J. Jonker, Ian R. Miller and K. Osborne

Australian Government
Department of the Environment

Reef & Rainforest RESEARCH CENTRE

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January 2015

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Acronyms Used In This Report

AIMS .... Australian Institute of Marine Science

COTS .... Crown-of-thorns starfish

CSIRO .... Commonwealth Scientific and Industrial Research Organisation

DoE .... Department of the Environment

GBR .... Great Barrier Reef

GBRMPA .... Great Barrier Reef Marine Park Authority

LSMU .... [TSRA] Land and Sea Management Unit

LTMP .... Long-term Monitoring Program

MTQ .... Museum of Tropical Queensland

NERP .... National Environmental Research Program

OBIS .... Ocean Biodiversity Information System

QPWS .... Queensland Parks and Wildlife Services

RHIS .... Reef Health and Impact Surveys

RRRC .... Reef and Rainforest Research Centre Limited

TSRA .... Torres Strait Regional Authority

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Introduction

Torres Strait is a shallow, submerged land bridge between PNG and the northern tip of Cape York that includes an extensive area of shallow tropical continental shelf with at least 274 islands and associated reefs, plus many more shoals. The reefs of Torres Strait are a key component of the lives and livelihoods of local communities. There have been many studies of the commercially harvested species in Torres Strait over several decades by the CSIRO (distributions summarised by Haywood et al. 2007), and studies of the corals of Torres Strait reefs go back more than a century (Vaughan 1918). However, there have been no dedicated and detailed studies of biodiversity of coral reefs in Torres Strait, and there is no systematic collection of information on "health" of reefs in the region that are important to local communities as sources of food and income. Compared to the GBR, little is known about the biodiversity of coral reefs in Torres Strait or about reef condition and how it has changed through time. In line with the global situation for coral reefs, Torres Strait reefs are threatened by a variety of local and global agents: climate change, outbreaks of the coral-feeding crown-of thorns starfish (*Acanthaster planci*) (Murphy et al. 2011), increasing shipping traffic and increasing occurrence of coral diseases. Widespread coral bleaching was recorded for the first time in Torres Strait in 2010 (Bainbridge and Berkelmans 2014). Improved knowledge of Torres Strait coral reefs and monitoring their status and health will help identify problems and enable managers to respond accordingly.

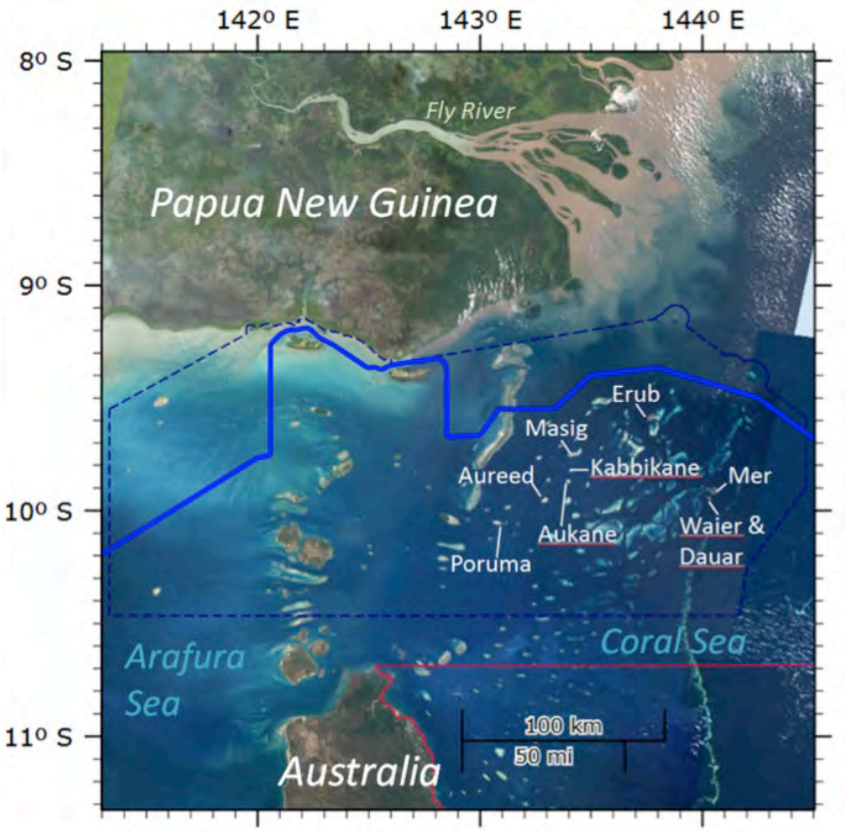

Figure 1. Location of reefs in the Torres Strait region surveyed by AIMS and TSRA through NERP Tropical Ecosystems Project 2.3. The Torres Strait region is bounded by Papua New Guinea in the north and Australia in the south. Solid blue line: Australian exclusive economic zone. Dashed dark blue line: Australia–Papua New Guinea Protected Zone. Red solid line: Northern boundary of GBR Marine Park. Source: e-Atlas 2014.

With the Coral Sea to the east, the Arafura Sea to the west, the Fly River to the north (Figure 1), and a tidal range of up to 3 m, strong physical drivers operate throughout the Torres Strait region and the character of the >1,200 coral reef communities reflect these gradients. The great majority of biological datasets from the Torres Strait show a major divide along a line running from ESE to WNW across the region (Haywood et al. 2007). Coral habitats dominate in the clearer water on the eastern shelf edge while seagrass habitats dominate in the more turbid and sediment-laden conditions in the west and closer to the Gulf of Papua. Hard coral cover is greatest on the margins of reefs in the east, and the composition of the coral communities also changes across the Torres Strait region.

Some of the earliest records of the scleractinian corals from the Torres Strait come from collections from around Mer (Murray) Island by Alfred G. Mayer in 1913 and described by Vaughan in 1918. These included a detailed baseline from surveys for a site on the southeastern reef flat at Mer Island referred to as "Line No. 1." In the 1970s and 1980s, corals were collected from Torres Strait reefs as part of a major taxonomic study of Eastern Australian corals (Veron and Pichon 1976, Veron and Pichon 1980, Veron and Pichon 1982, Veron and Wallace 1984) and these collections are held by the Museum of Tropical North Queensland (MTQ). There is also a large body of research in the Torres Strait by CSIRO focussed on the relationship between habitat types, fishes, benthic organisms and environmental drivers (Haywood et al. 2007). Publications from the CSIRO contain detailed information about fish species (Haywood et al. 2007), however, the data on corals was focussed on habitat description and corals were not identified to species. Some areas in the central islands were gazetted as an indigenous protected area within Australia's National Reserve System in July 2014; knowledge of the species that inhabit these areas will be important in designing and selecting future reserves.

The aims of this project were to update knowledge on coral and fish species that are found in the Torres Strait, and to initiate a program to monitor the condition of reefs in the Torres Strait, involving staff from the Torres Strait Regional Authority's Land and Sea Management Unit (TSRA LSMU) so that they could gain experience in coral reef monitoring and be able to continue with a program of their own. Fish biodiversity data was gathered using visual surveys while coral biodiversity data involved both visual surveys and limited collections of specimens. The monitoring component focused on sampling by snorkel diving using two survey methods: the Great Barrier Reef Marine Park Authority's Reef Health and Impact Surveys (RHIS) and manta tow surveys. The RHIS survey method is a component of the Integrated Eye on the Reef Program of GBRMPA. RHIS is used by Field Management staff from the GBRMPA and Queensland Parks and Wildlife Service (QPWS) for opportunistic surveys of reef sites across the Great Barrier Reef Marine Park. Manta tow surveys are used by the Australian Institute of Marine Science (AIMS) Long-term Monitoring Program (LTMP) for broad-scale assessments of coral cover on a reef, as well as for detecting causes of coral mortality such as bleaching and crown-of-thorns starfish (COTS) predation. The project involved two field trips over two years. Members of the AIMS LTMP and a coral taxonomist from MTQ collected data on fish diversity in 2013 and coral diversity in 2013 and 2014. AIMS LTMP staff also trained TSRA LSMU staff in the manta tow survey method in 2013 and 2014. Accredited trainers from the GBRMPA and James Cook University trained the TSRA LSMU staff in the RHIS survey method in 2013 and 2014.

The objective of this report is to synthesise the results of the biodiversity and monitoring surveys conducted in Torres Strain in February 2013 and January 2014. An in depth analysis of biodiversity data from 2013 was previously report (Osborne et al. 2013). Manta tow survey results have also been reported previously (Sweatman et al. 2014) although the report focus was on the field operations themselves. Here we update the biodiversity assessment with new hard coral data gathered in 2014, and report on monitoring results on a reef by reef basis using a combination of manta tow, RHIS and photo transects techniques to assess the health of select coral reefs within Torres Strait.

Methods

A variety of methods were used to survey coral reefs. Manta tows and RHIS were done on snorkel and enabled AIMS LTMP staff to train TSRA LSMU staff in these techniques. Photo transects and biodiversity surveys of coral and fishes were done on scuba by AIMS LTMP.

Manta tow

Broadscale surveys were conducted by manta tow. A key feature of the method is that it is standardised with well-defined criteria for its use, described in the Standard Operational Procedure (Miller et al. 2009). Manta tow surveys are used to survey the perimeter of a reef. At each reef, two teams start from the same point and work from that starting point in opposite directions around the reef to each survey about half the reef perimeter. A team consists of a minimum of three people: a boat driver, a surface attendant and a snorkel observer who is towed behind the boat on a manta board. For training purposes, two manta boards can be linked in line with each other (Figure 2). At two-minute intervals the boat stops, allowing the observer to record the data for that tow on a datasheet attached to the manta board (Figure 3). Data include percent cover of living hard and soft coral as well as counts of COTS and associated feeding scars or any other conspicuous organisms of interest (e.g. coral trout, giant clams and sharks).

Figure 2. Manta tow training. The boat driver checks the snorkelers are ready to start manta towing. Here there are two observers in the water, for manta tow training. The manta boards are connected in a line and each observer holds onto the manta board.

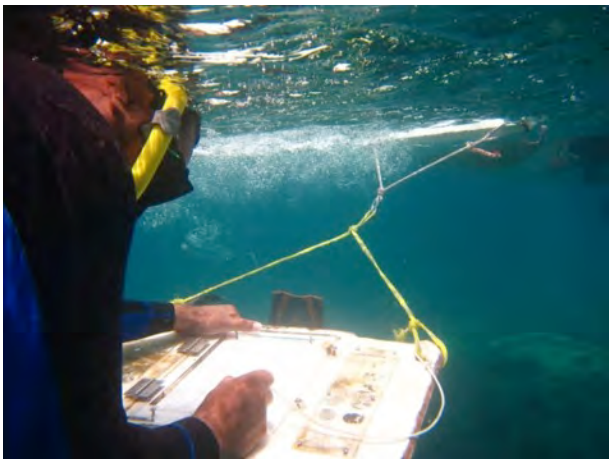

Figure 3. A manta tow observer records the data on underwater datasheets.

Reef Health Impact Surveys (RHIS)

As well as the photo transects mentioned above, RHIS sites were established and surveyed in the zone of the reef crest or the shallow part of the reef slope (2-3 m). RHIS are one component of the GBRMPA's Eye on the Reef Program, and are intended to be a quick and efficient way to provide a snapshot of reef health at any time, on any reef (Beeden et al. 2014).

Seven TSRA LSMU staff were trained in RHIS technique by GBRMPA staff in 2013. In 2014, an additional eight TSRA LSMU staff were trained and four staff completed their second year of training.

Figure 4. TRSA LSMU staff taking part in RHIS training.

Coral cover (photo transects)

Photo transects were taken in representative habitats on each island to provide context for the biodiversity assessments and to establish baseline data on benthic community composition. Habitats sampled included the reef flat, reef crest, reef slope and lower reef slope. The depth range of the reef slope varied from the central to eastern islands. The lower slope transects were near the base of the reef slope. The slope transects were typically around 4-6 m depth but were not located randomly, as areas of higher coral cover were being targetted for the biodiversity surveys. For this reason the estimates of cover from patchy habitats would be expected to be higher than if transects were randomly located. The standard methods established by the AIMS LTMP (Jonker et al. 2008) were modified for the surveys in Torres Strait and are outlined below.

At each site, 3 x 10 m transects were laid out and sampled by taking a photograph of the substrate at 50 cm intervals from a distance of 50 cm from the substrate, giving a total of 20 photos per transect. The benthos was analysed using "Reefmon" image analysis software developed at AIMS for the LTMP. On each photograph, the benthic organisms under 5-points arranged in a quincunx were identified, resulting in 100 samples of benthos per transect. This data was converted to percent cover.

Biodiversity surveys

Biodiversity of hard corals

Lists of scleractinian coral species were made in February 2013 at Poruma Island Reef, Aureed Island Reef, Masig Island Reef, Erub Island Reef and Mer Island Reef (Figure 1). The results of the preliminary biodiversity surveys were published in Osborne et al. (2013). In January 2014 an additional survey of scleractinian coral species was made and specimens were collected and identified at MTQ. Hard corals were photographed and some specimens were collected. Taxonomic references were used to assist with identifying corals (Veron 2000, Veron and Pichon 1976, Veron and Pichon 1980, Veron and Pichon 1982, Veron and Wallace 1984, Wallace 1999, Wallace et al. 2012).

Figure 5. A diver searches for new coral species.

Biodiversity of reef fishes

In February 2013, surveys of fish biodiversity using scuba recorded all visually conspicuous 'bony fish' (Actinopterygii). Reef fishes were surveyed in the same locations as the hard coral biodiversity surveys. Observers ranged haphazardly over the reef slope over a depth range of 1–12 m for periods of about one hour. Sightings of all visually obvious species were recorded but the abundance of each species was not recorded. Fish identification was based primarily on Randall et al. (1997) and Allen et al. (2003). Previously, Haywood et al. (2007) have reported on fish biodiversity within the Torres Strait region, and a list of additional species observed by the AIMS LTMP was given in Osborne et al. (2013).

Results

Biodiversity

Comprehensive survey results for biodiversity of fish and corals from 2013 were reported in Osborne et al. (2013). Here we update the 2013 results.

Figure 6. Reefs where biodiversity surveys were completed in 2013.

Hard coral biodiversity

In February 2013, coral biodiversity surveys were completed at Aureed Island Reef, Masig Island Reef, Poruma Island Reef, Erub Island Reef and Mer Island Reef. In January 2014, coral biodiversity surveys and specimen collection were completed at Aureed Island Reef, Poruma Island Reef, Mer Island Reef and Waier Island Reef.

Figure 7. Taxonomist Dr Paul Muir shows Kevin Lui and Laura Pearson some of the corals collected.

Seventy-seven new hard coral (Scleractinian) species for the Torres Strait region have been added to the records of the MTQ (Table 1). Specimens of 15 of these were collected and have been deposited at MTQ. Of the 62 species that were not collected and are new to Torres Strait, many will need to be validated with skeletal specimens to have a lasting legacy. This includes five species that were new records for the Great Barrier Reef and Torres Strait. These were *Acropora spicifera, Cantharellus jebbi, Herpolitha weberi, Montipora palawanensis and Pavona bipartita*.

A total of 246 coral species were recorded during biodiversity surveys in 2013 and 2014 (Appendix 1). Of the 246 species recorded, 174 species were the same as those listed in the MTQ's collection based on previous collections by AIMS. The MTQ collection represents the most comprehensive record of corals in Torres Strait and provides a useful baseline by which to put the current survey into context. Seventy-three species were recorded with no prior records in the museum collection. An additional 68 species are held at MTQ and were not recorded in these surveys, thus bringing the known number of species for Torres Strait to 314.

The combined species total of 246 coral species from biodiversity surveys in 2013 and 2014 is lower than reported after the 2013 surveys. This is because some species were removed from the list published in 2013 as they were not easily recognised *in situ* and could not be validated. Surveys in 2014 were hampered by bad weather and as result the sampling effort was much lower than the previous year. In 2014, Dr Paul Muir, a coral taxonomist from MTQ, compiled lists of species easily recognized *in situ* and collected specimens of skeletons, tissue for genetics for those groups not recognizable *in situ*. 137 species were in common with the surveys from 2013 (55%) and 21 were new records for corals not seen in 2013. Most were common species where specimens aided identification. Dr Muir also recorded *Micromussa sp.*, a genus previously unrecorded in Torres Strait. A number of species in the 2013 list were described or bought out of synonymy by Veron (2000) and that have either been synonymised recently (e.g. Wallace et al. 2012) or are yet to be assessed by other coral taxonomists.

The taxonomy of the family Faviidae (now called Merulinidae) is currently under review and is in a state of flux. A low priority was given to identifying Favids, although photographs were obtained for all of the species seen.

Table 1. List of newly recorded hard coral species from reefs in Torres Strait in 2013 and 2014. Triple asterisks (***) indicate a new record for Australia that needs validating with a specimen.

Scleractinian species	2013	2014	Specimen	New record
Acanthastrea hemprichii	✓			✓
Acanthastrea faviaformis	✓			✓
Acanthastrea regularis	✓			✓
Acropora cerealis	✓			✓
Acropora elseyi	✓	✓	✓	✓
Acropora glauca		✓	✓	✓
Acropora listeri	✓			✓
Acropora palmerae	✓			✓
Acropora prostrata	✓			✓
Acropora rosaria	✓			✓
Acropora spicifera ***		✓	✓	✓
Acropora striata		✓		✓
Australogyra zelli	✓	✓	✓	
*Cantharellus jebbi****	✓			✓
Coscinaraea exesa	✓	✓		✓
Ctenactis crassa				✓
Ctenactis echinata	✓			✓
Ctenactis simplex		✓		✓
Cycloseris costulata		✓		✓
Cycloseris spp.			✓	✓
Cyphastrea decadia	✓			✓
Echinopora pacificus	✓	✓	✓	✓
Favia danae	✓			✓
Favia lizardensis	✓	✓		✓
Favia maxima		✓		✓
Favia rosaria	✓			✓
Favia rotumana	✓	✓		✓
Favia rotundata	✓	✓		✓
Favia speciosa	✓			✓
Favia truncatus	✓	✓		✓
Favites abdita	✓	✓		✓
Favites complanata	✓			✓
Favites flexuosa	✓	✓	✓	✓

Scleractinian species	2013	2014	Specimen	New record
Favites halicora	✓			✓
Galaxea acrhelia	✓			✓
Galaxea longisepta		✓		✓
Goniopora eclipsensis		✓	✓	✓
Goniopora norfolkensis		✓	✓	✓
*Herpolitha weberi****	✓			✓
Hydnophora grandis	✓	✓		✓
Hydnophora microconos	✓			✓
Hydnophora pilosa	✓	✓		✓
Isopora cuneata		✓	✓	✓
Isopora palifera	✓	✓		✓
Leptastrea bewickensis	✓			✓
Leptastrea inaequalis	✓	✓	✓	✓
Leptastrea pruinosa	✓	✓		✓
Leptastrea transversa	✓		✓	✓
Lobophyllia diminuta		✓		✓
Lobophyllia flabelliformis	✓			✓
Lobophyllia robusta	✓			✓
Madricis kirbyii	✓			✓
Merulina scabricula	✓	✓		✓
*Micromussa spp. ****		✓		✓
Montastrea annuligera	✓			✓
Montastrea colemani	✓			✓
Montastrea curta	✓	✓		✓
Montastrea salebrosa	✓			✓
Montipora confusa	✓			✓
Montipora foveolata				✓
*Montipora palawanensis****	✓			✓
Oulophyllia bennettae	✓	✓		✓
Paraclavarina triangularis	✓			✓
*Pavona bipartita****	✓			✓
Platygyra pini	✓	✓		✓
Platygyra verweyi	✓	✓		✓
Pocillopora acuta	✓			✓
Pocillopora eydouxi	✓	✓		✓
Pocillopora meandrina	✓	✓		✓
Pocillopora verrucosa	✓	✓		✓
Podabacia motuporensis	✓			✓
Porites mayeri	✓		✓	✓
Porites murrayensis		✓	✓	✓
Psammocora contigua	✓			✓
Psammocora obtusangula	✓			✓
Seriatopora caliendrum	✓	✓	✓	✓

Fish biodiversity

Fish biodiversity was assessed at five reefs (Aureed Island Reef, Masig Island Reef, Poruma Island Reef, Erub Island Reef and Mer Island Reef) in February 2013. A total of 266 species were recorded in 2013 (Appendix 2). Of these, 143 were added to the list of species known from Haywood et al. (2007). This brought the list of species of coral reef associated fishes in the Torres Strait to 326. Range extensions were recorded for three species that had previously not been officially recorded in Torres Strait. These included one species previously known from New Guinea and the north-western Pacific, as well as two species that are rare or absent from the northern Great Barrier Reef.

The fish communities on the survey reefs in Torres Strait include elements from the northern GBR and to a lesser extent species normally associated with reefs further north in Papua New Guinea. Several range extensions may have been found. The observation of *Halichoeres richmondi* (Richmond's wrasse) at Erub Reef extends the known range from the Coral Triangle and Papua south into Torres Strait. This was cross-validated (IUCN 2010, Ocean Biogeographic Information System (OBIS) 2014). The fish community on Poruma Island Reef was particularly interesting because it included species found on the southern GBR that were rare or absent from the northern GBR (Osborne et al. 2013). The range of *Macropharyngodon choati* (Choat's wrasse) has been extended towards the equator as previous records were from the central and southern GBR (IUCN 2010, OBIS 2014). There are few records of *Chilomycterus reticulatus*, but this species appears to be distributed across the Indo-Pacific. This observation at Poruma extended the known range of the species.

Manta tow

In February 2013, manta tow surveys were completed at Aureed Island Reef, Aukane Island Reef, Kabbikane Island Reef, Masig Island Reef, Mer Island Reef and Waier and Dauar Island Reef. In January 2014, manta tow was only completed at Waier and Dauar Island Reef due to poor weather conditions.

Figure 8. Reefs where manta tow surveys were conducted in 2013 and 2014.

RHIS

RHIS were completed in February 2013 at Aureed Island Reef, Masig Island Reef, Poruma Island Reef, Dauar Island Reef, Erub Island Reef and Mer Island Reef. In January 2014, RHIS were completed at Aureed Island Reef, Poruma Island Reef and Mer Island Reef.

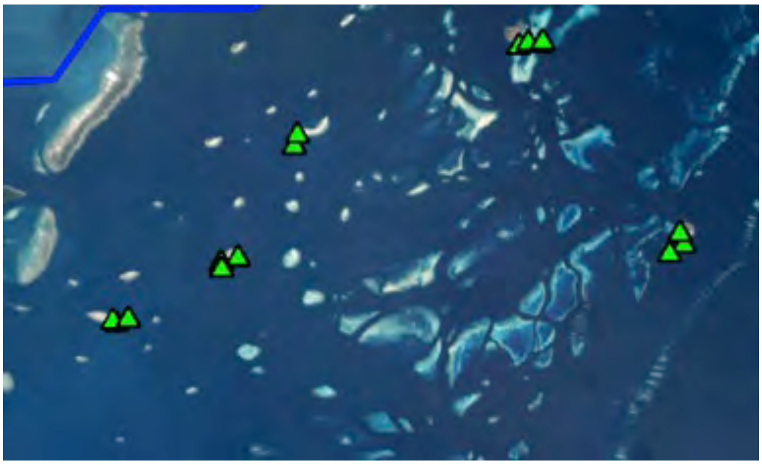

Figure 9. Reefs where RHIS were complete in 2013 and 2014 by TSRA LSMU staff.

Results of manta tow, RHIS and photo transects are presented for each reef, grouped into Kulkalgal (Central Islands) and Meriam Mir (Eastern Islands).

Central islands (Kulkalgal)

Aureed Island Reef

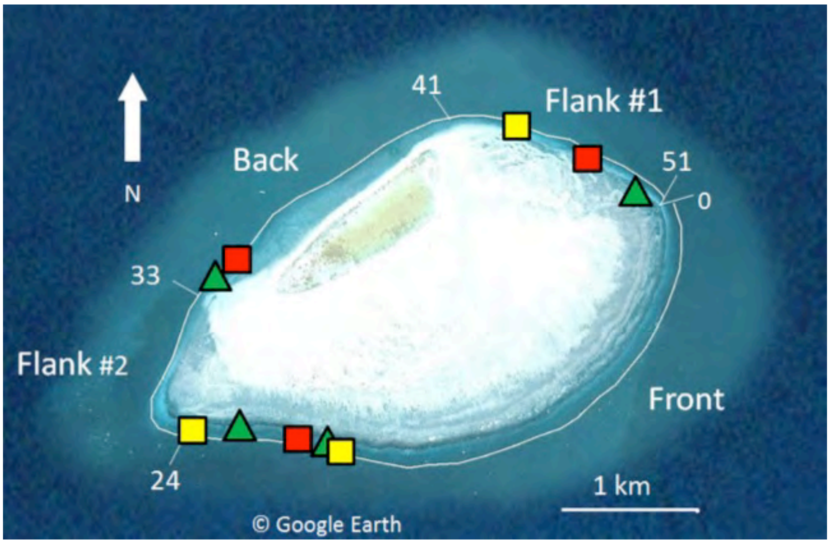

Figure 10. Satellite image of Aureed Island Reef. The white line indicates the tow path. Breaks in the line indicate different sections of the reef, with tow numbers for reference. Symbols: Green triangles indicate RHIS sites, Red squares indicate sites of 2013 Biodiversity surveys of fish and corals in 2013. Yellow squares indicate sites of Biodiversity surveys of corals in 2014.

Aureed Island Reef was surveyed for the first time using manta tow in 2013. Median reef-wide live coral cover was moderate (20-30%) and numbers of crown-of-thorns starfish were recorded at outbreak levels that may have some impact on coral cover. Signs of coral bleaching were restricted to small numbers of individual colonies on the back of the reef. No signs of black band disease or white syndrome were observed. Aureed Island Reef was classified as Incipient Outbreak in 2013. Aureed Island Reef was not surveyed in 2014 due to poor weather conditions.

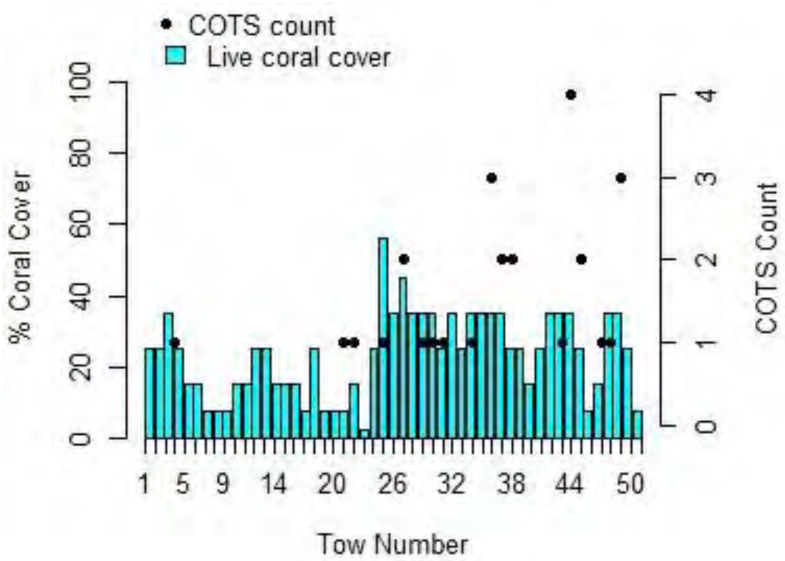

Figure 11. Percent cover of coral and number of COTS in each tow at Aureed Island Reef.

The survey sites were located on the reef flanks where the most continuous area of hard substrate was found. The reef slope was short and after 20-30 m the reef substrate transitioned to sand at around 6-9 m depth. Hard coral cover on the shallow reef slope was patchy with estimates from Reef Health and Impact Surveys (RHIS) being very variable between sites. In 2013, hard coral cover was low to very high (4-62%), while soft coral cover was low to moderate (2-12%). The very high coral cover was due to one site that faced a northeast aspect. In 2014, the average hard coral cover was moderate (12-15%), while soft coral cover was low (1.4 - 5.6%). The percentage of substrate covered by hard and soft coral was lower in 2014 because the northwest site was not surveyed. On the southwest, macroalgal cover was moderate in 2013 and 2014 (Table 2).

Table 2. RHIS results for benthic community at Aureed Island Reef expressed as the average percent cover with the range of cover values given in brackets.

Year	Aspect	Hard coral	Soft coral	Recently dead coral	Turf and coralline algae	Macro-algae	Rubble	Sand
2013	NW	62.2 (59.2 - 66.4)	11.5 (1.2 - 16.7)	0.7 (0 - 1)	13.3 (5 - 25)	0	5 (1 - 10)	7.3 (2 - 10)
	NE	13.9 (8 - 17.5)	3.7 (1.8 - 7.5)	0.3 (0 - 1)	13.7 (10 - 16)	0	38.3 (21 - 64)	30 (10 - 45)
	SW	4.9 (2.4 - 7.7)	2.5 (0.5 - 3.6)	0	35 (10 - 65)	15.7 (10 - 22)	33 (5 - 54)	9 (4 - 15)
2014	NE	11.9 (6 - 18)	5.6 (0.5 - 14)	3.5 (0 - 15)	12.3 (0 - 20)	6 (0 - 20)	18.2 (15 - 25)	42.5 (30 - 60)
	SW	15.3 (9.5 - 21.2)	1.4 (0 - 3.8)	0.3 (0 - 1)	28 (10 - 49)	11.7 (5 - 20)	20 (10 - 35)	23.3 (15 - 30)
	SW	12.3 (9 - 18)	4.3 (1 - 10)	0	11.7 (5 - 20)	21.7 (0 - 50)	25 (15 - 35)	25 (5 - 40)

Photo transects were sampled from the reef flat and the reef slope at Aureed Island Reef. The reef flat was dominated by extremely high cover of algae (88%), composed of brown macroalgae (41%) and turfing algae (47%). The remainder of the benthos was mostly sand (10%).

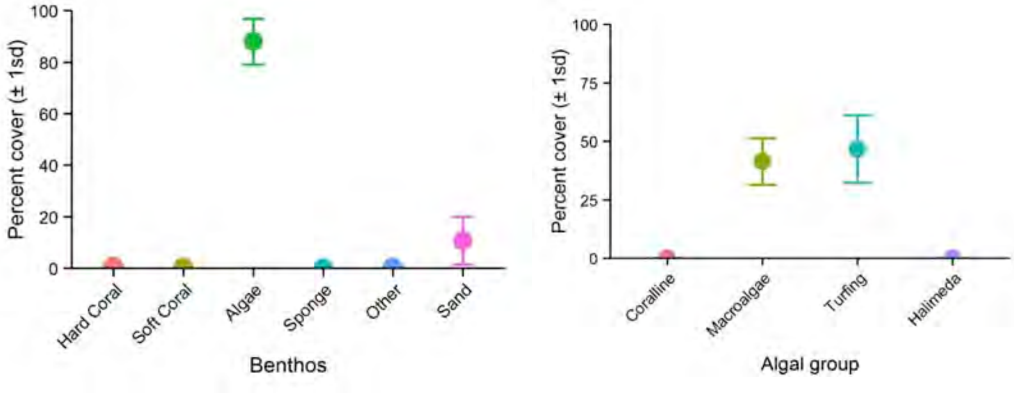

Figure 12. Aureed Island Reef reef flat: a) Coral reef benthos and b) Algal groups.

On the reef slope hard coral cover was high at 50%. Poritidae was the dominant hard coral family with 28% cover, followed by the mixed family group at 13% and Faviidae at 4%. Soft coral abundance was low (4%). Algal cover was high (40%), composed predominantly of turfing algae (37%).

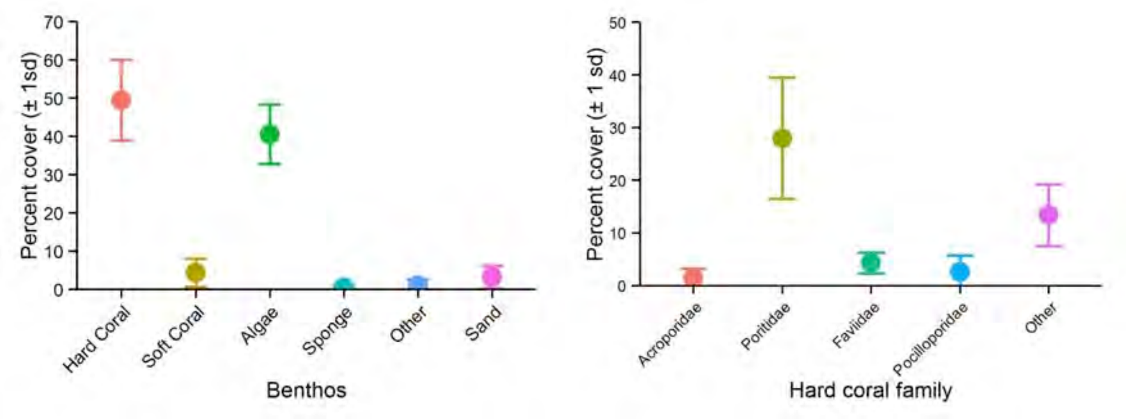

Figure 13. Aureed Island Reef reef slope: a) coral reef benthos and b) hard coral families.

Aukane Island Reef

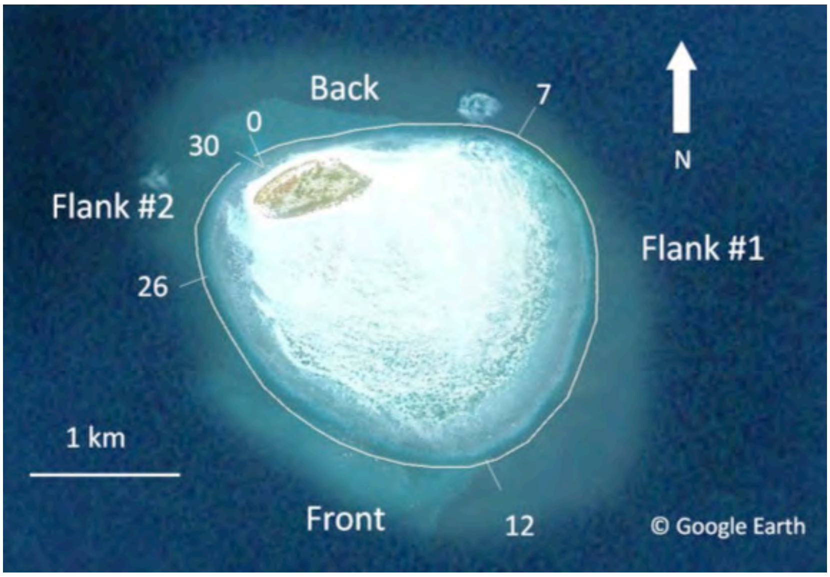

Figure 14. Satellite image of Aukane Island Reef. The white line indicates the manta tow path. Breaks in the line indicate different sections of the reef, with tow numbers for reference.

Aukane Island Reef was surveyed for the first time using manta tow in 2013 (Figures 14 and 15). Median reef-wide live coral cover was moderate (10-20%) and low numbers of COTS were recorded below outbreak levels. Signs of white syndrome were restricted to small numbers of individual colonies on the back and flanks of the reef perimeter during surveys in 2013. No bleaching or signs of black band disease were observed. Aukane Island Reef was classified as No Outbreak.

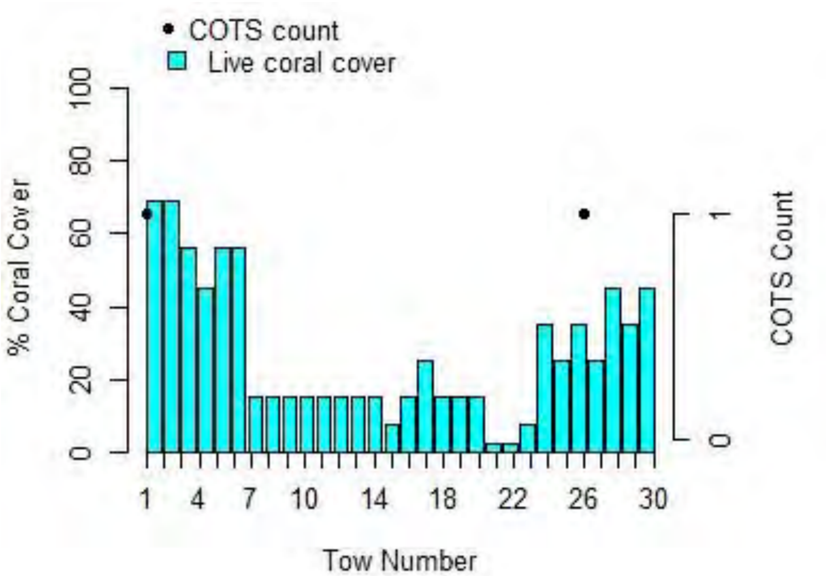

Figure 15. Percent cover of coral and number of COTS in each tow at Aukane Island Reef.

Kabbikane Island Reef

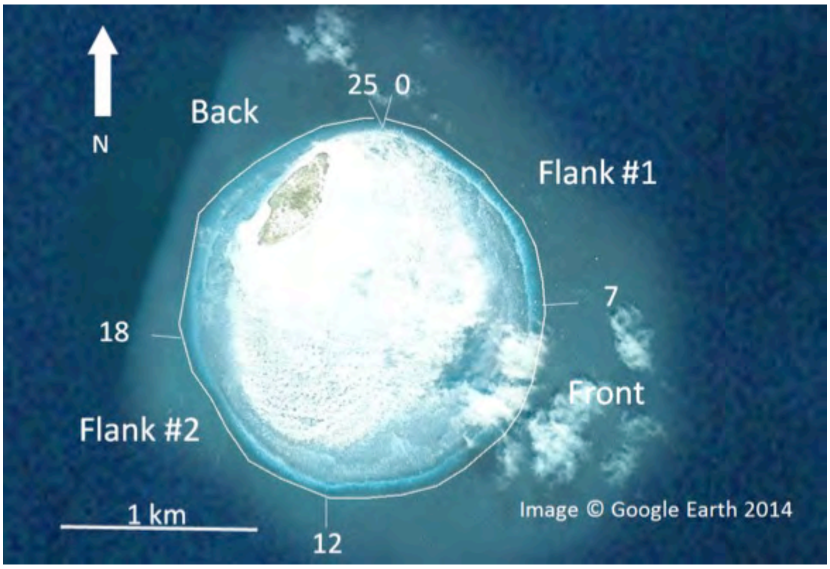

Figure 16. Satellite image of Kabbikane Island Reef. The white line indicates the tow path. Breaks in the line indicate different sections of the reef, with tow numbers for reference.

Kabbikane Island Reef was surveyed for the first time using manta tow in 2013 (Figure 16). Median reef-wide live coral cover was moderate (10-20%) and low numbers of COTS were recorded below outbreak levels (Figure 17). Signs of white syndrome were restricted to small numbers of individual colonies on the first flank during surveys in 2013. No bleaching or signs of black band disease were observed. Kabbikane Island Reef was classified as No Outbreak.

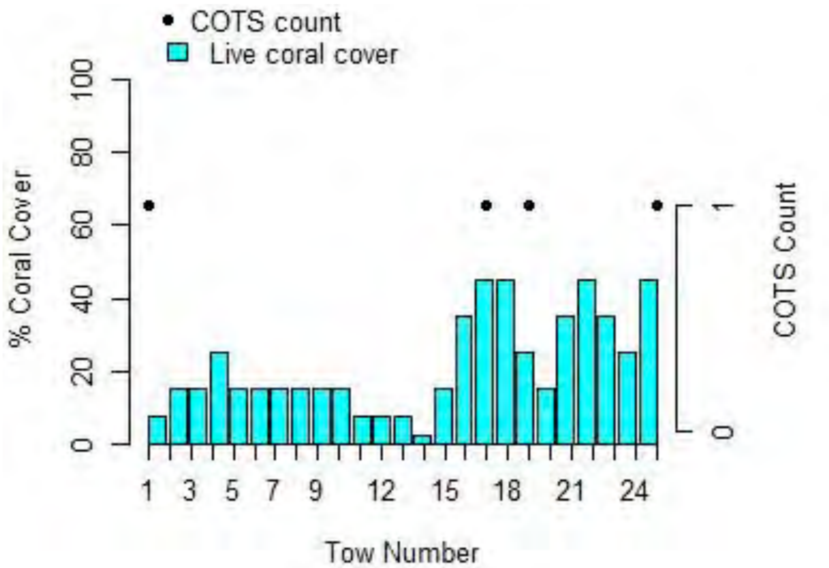

Figure 17. Percent cover of coral and number of COTS in each tow at Aureed Island Reef.

Masig (Yorke Island)

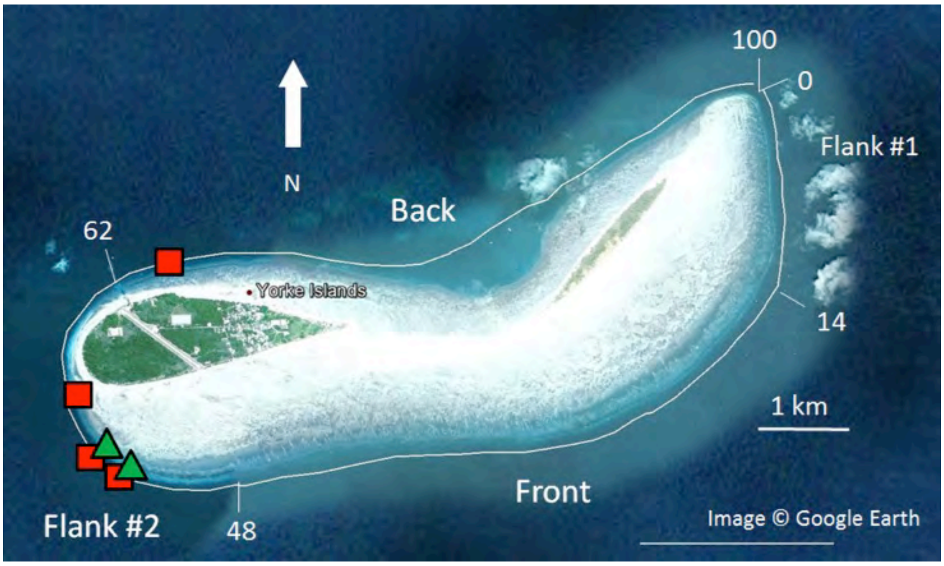

Figure 18. Satellite image of Masig Island Reef. The white line indicates the manta tow path. Breaks in the line indicate different sections of the reef, with tow numbers for reference. Symbols: Green triangles indicate RHIS sites, red squares indicate sites of 2013 Biodiversity surveys of fish and corals.

Masig Island Reef was surveyed for the first time using manta tow in 2013 (Figure 18). Median reef-wide live coral cover was moderate (10-20%) and low numbers of COTS were recorded below outbreak levels (Figure 19). Signs of white syndrome and coral bleaching were restricted to small numbers of colonies on the back reef during surveys in 2013. No signs of black band disease were observed. Masig Island Reef was classified as No Outbreak.

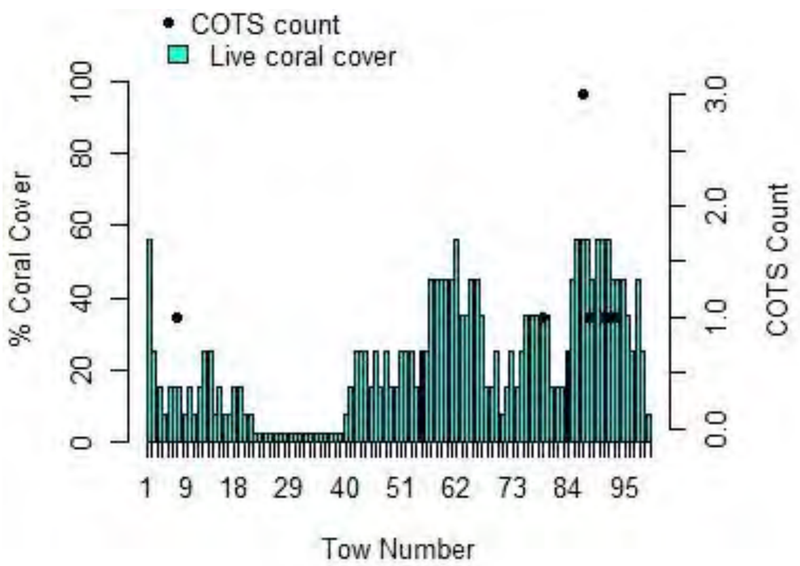

Figure 19. Percent cover of coral and number of COTS in each tow at Masig Island Reef.

At Masig Island Reef there was some formation of a reef crest community and in some places the coral community extended down the reef slope to 10-12 m. Estimates of coral cover on the reef crest from RHIS was moderate (22.7-32%) for hard coral and low (6.7-8%) for soft coral.

The cover the cover of sand and rubble accounted for 21% of benthos, while macroalgae varied (0-10%).

Table 3. Results of RHIS for benthic community at Masig Island Reef expressed as percent cover with the range of cover values given in brackets.

Year	Aspect	Hard coral	Soft coral	Recently dead coral	Turf and coralline algae	Macro-algae	Rubble	Sand
2013	SW	22.7 (16.4 - 32)	6.7 (3.6 - 8.4)	0	39 (20 - 57)	10.3 (1 - 25)	9.3 (5 - 15)	12 (6 - 20)
	SW	32	8	0	15	0	44	1

Photo transects were sampled from the reef flat, the reef crest and the reef slope at Masig Island Reef (Figures 20, 21 and 22). The reef flat was dominated by extremely high cover of algae, composed of brown macroalgae (71%) and turfing algae (16%). Sand covered 6% of the reef flat whilst hard coral covered 5% on the reef flat. Poritidae, Acroporidae and Pocilloporidae occupied 2%, 1% and 1% of the reef flat benthos. There was no soft coral on the reef flat.

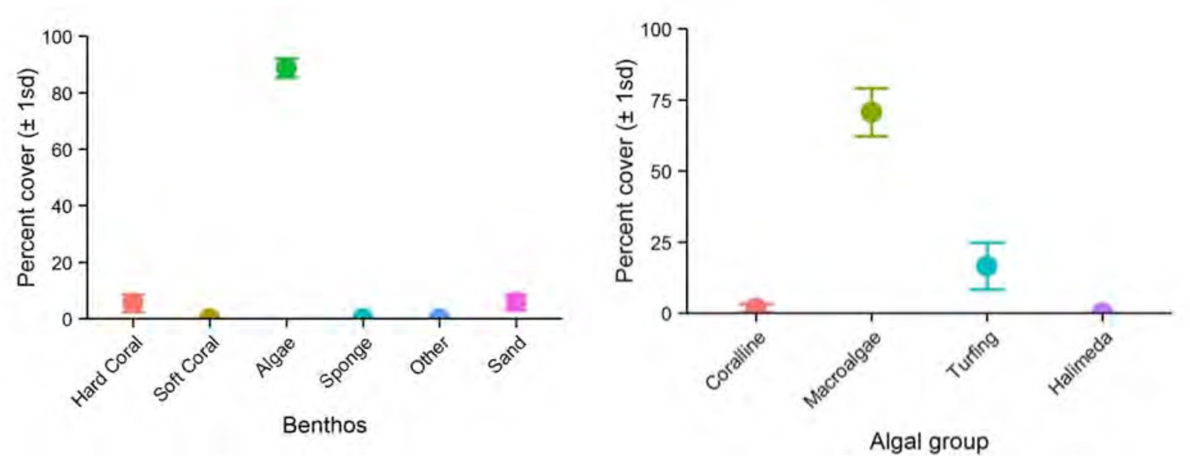

Figure 20. Masig Island Reef reef flat: a) coral reef benthos and b) algal groups.

The reef crest and reef slope were similar, with around 40% hard coral cover, but had a different composition. Poritidae was the dominant hard coral family, with 20% cover on the reef crest and 26% cover on the slope. The reef crest had higher cover of Acroporidae (13%) and Faviidae (4%) than the reef slope (4% and 1% respectively). On the reef slope other hard coral families covered 8% of the benthos. Soft coral cover was similar between the reef crest (8%) and the reef slope (10%). Soft coral was predominantly composed of Alcyoniidae and was variable between sites on the reef crest (6-15%) and reef slope (5-12%). The algal community had moderate cover on the reef crest and reef slope, composed predominantly of turf algae (35% and 40% respectively).

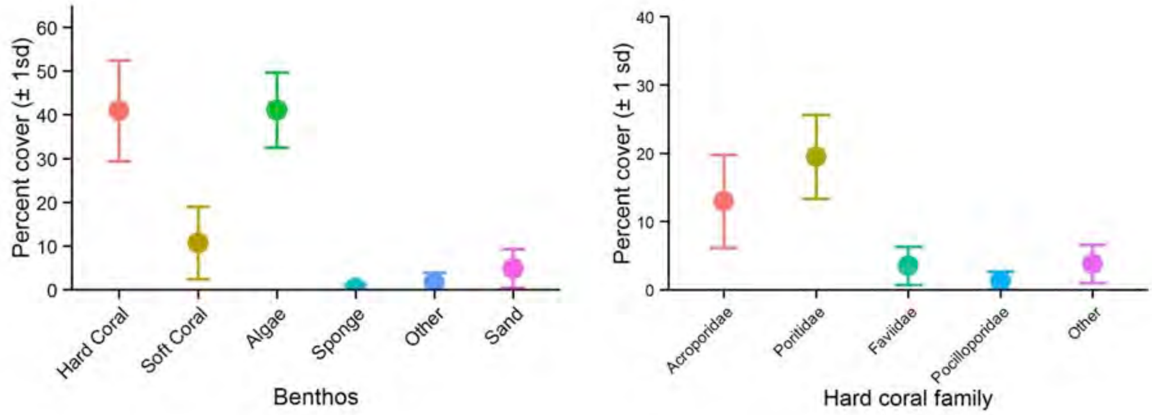

Figure 21. Masig Island Reef reef crest: a) coral reef benthos and b) hard coral families.

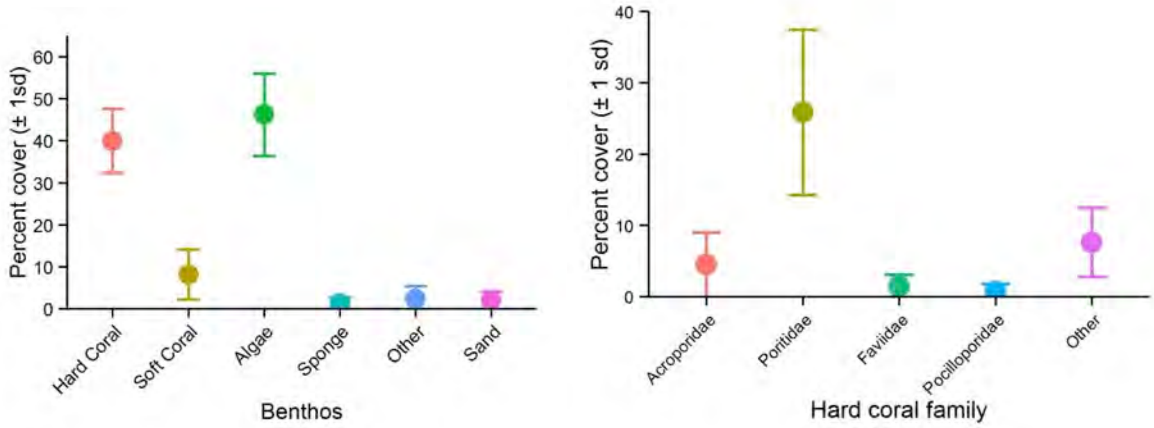

Figure 22. Masig Island Reef reef slope: a) coral reef benthos and b) hard coral families.

Poruma (Coconut Island).

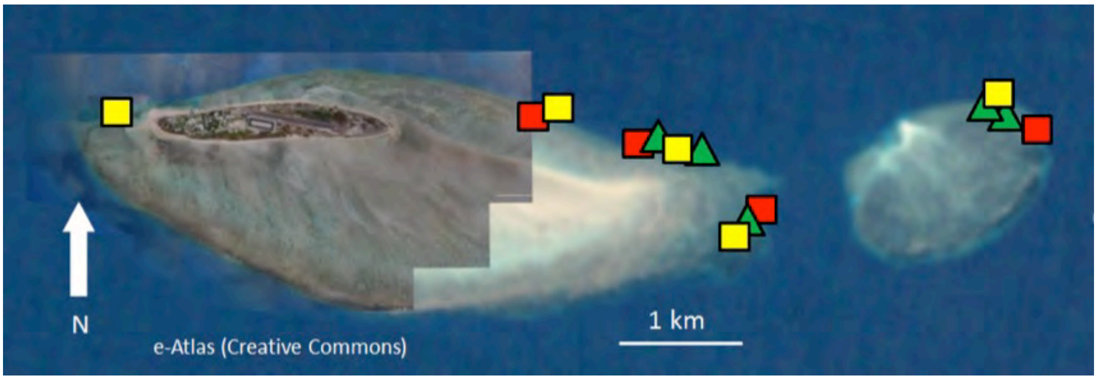

Figure 23. Satellite image of Poruma Island Reef. Symbols: Green triangles indicate RHIS sites, Red squares indicate sites of 2013 Biodiversity surveys of fish and corals in 2013. Yellow squares indicate sites of Biodiversity surveys of corals in 2014.

There were no manta tow surveys at Poruma Island Reef in 2013 or 2014 due to poor visibility. The adjacent small reef, Moain was sampled using RHIS and photo transects and is included within Poruma Island Reef for the purposes of reporting, but denoted as Moain in Table 4. The shallow reef flat areas at Poruma Island Reef were dominated by brown macroalgae. The reef slope was short and after 20-30 m the reef substrate changed to sand at around 6-9 m depth. Coral cover on the shallower part of the reef slope was patchy.

Average estimates of coral cover from RHIS were 7-25% for hard coral and 9-38% for soft coral in 2013. In 2014, the average hard coral cover estimates were more variable (averaging 19-29%), while soft coral cover estimates were lower (11-20%). A lot more rubble was observed at Moain than on Poruma in both 2013 and 2014. More macroalgae was observed on Poruma than on Moain.

Table 4. Results of RHIS for benthic community at Poruma Island Reef expressed as percent cover with the range of cover values given in brackets. Entries with an asterisk (*) were on Moain, the small reef to the east of Poruma.

Year	Aspect	Hard coral	Soft coral	Recently dead coral	Turf and coralline algae	Macro-algae	Rubble	Sand
2013	E	22.1	11.9	0	58	1	2	5
	NE	7.2	37.8	0	15	35	2	3
	NE*	23.7 (22.5 - 24.9)	8.8 (7.5 - 10.2)	0	25	0	42.5 (40 - 45)	0
2014	NE	19.2	15.8	0	25	25	5	10
	NE	24.8	20.3	0	25	15	5	10
	NE*	29.1 (22.8 - 40.5)	10.9 (4.5 - 16)	0	31.7 (25 - 35)	0.3 (0 - 1)	21.7 (15 - 25)	6.3 (4 - 10)

Benthos were sampled using photo transects on the reef slope and the lower reef slope at Poruma Island Reef (Figures 24 and 25). Hard coral cover was high in both habitats but was higher (42%) on the reef slope than on the lower reef slope (33%), which was also more variable (compare Figure 24 and 25). The hard coral community was dominated by Poritidae on both the lower reef slope and the reef slope (23% and 28% respectively). The breakdown of the other coral families differed between the reef slope and the lower reef slope. On the reef slope other families covered 6%, Acroporidae covered 5% and Faviidae covered 2% of the benthos. On the lower reef slope Faviidae covered 6%, other families covered 2% and Acroporidae covered 1% of the benthos. Soft coral abundance was very low (<3%). Algal cover was higher on the lower reef slope (63%) than the reef slope (52%) and was composed almost entirely of turf algae.

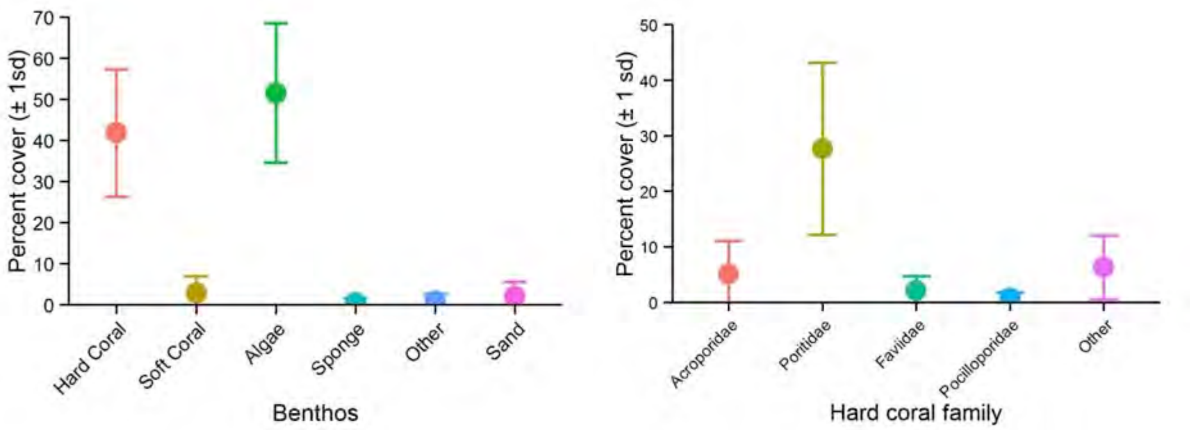

Figure 24. Poruma Island Reef reef slope: a) coral reef benthos and b) hard coral families.

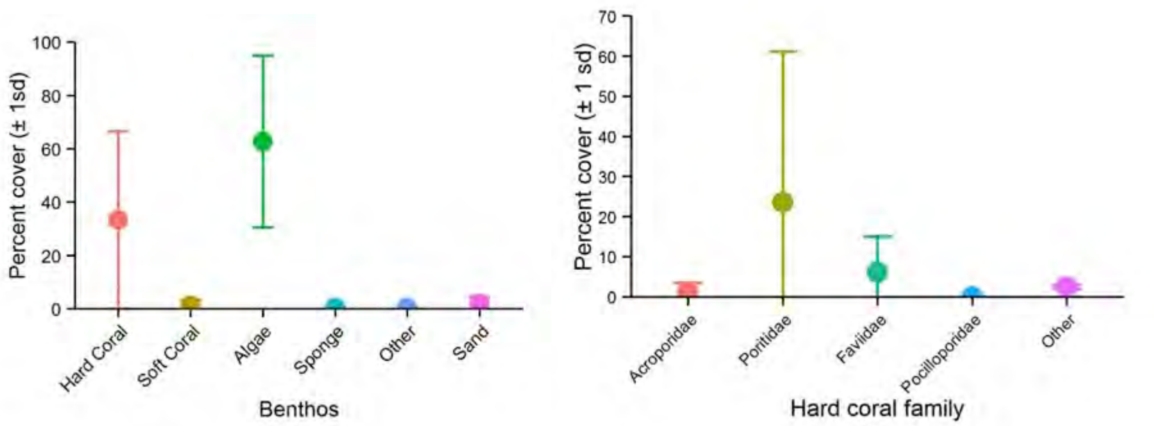

Figure 25. Poruma Island Reef lower slope: a) coral reef benthos and b) hard coral families.

Eastern Islands (Meriam Mir nation)

Erub

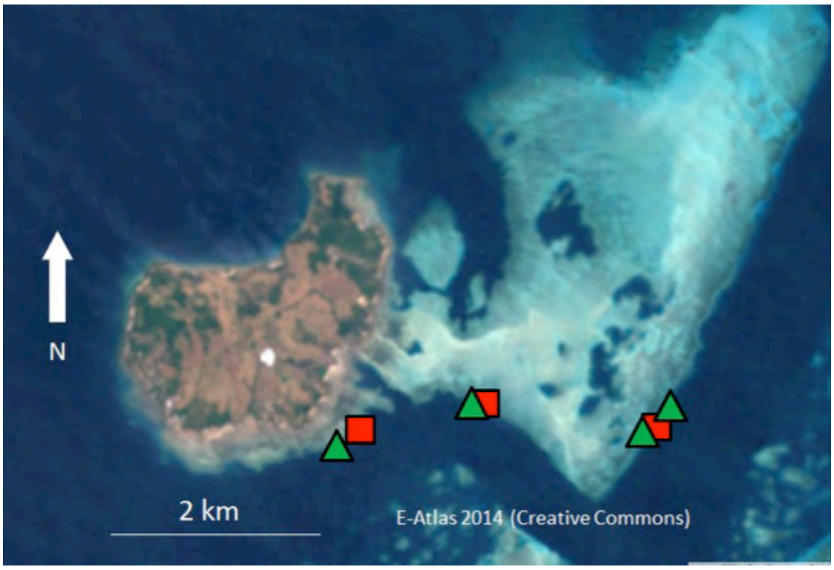

Figure 26. Satellite image of Erub Island Reef. Symbols: Green triangles indicate RHIS sites, red squares indicate sites of 2013 Biodiversity surveys of fish and corals.

There were no manta tow surveys at Erub Island Reef in 2013 or 2014. At Erub Island Reef there was some formation of a reef crest community. One site on the southeastern aspect was located on the seaward edge of a broad reef flat and had a more exposed setting. Estimates of coral cover on the reef crest from RHIS averaged 21% for hard coral and 28% for soft coral on southern aspects that were close to the island and 50% for hard coral and 3% for soft coral on the site with a more exposed south eastern aspect. Overall cover of macroalgae was very low at Erub Island Reef (0-1%).

Table 5. Results of RHIS for benthic community at Erub Island Reef expressed as the average percent cover with the range of cover values given in brackets.

Year	Aspect	Hard coral	Soft coral	Recently dead coral	Turf and coralline algae	Macro-algae	Rubble	Sand
2013	S	15.9 (11.7 - 20)	26.7 (20 - 33.3)	0.5 (0 - 1)	15	0.5 (0 - 1)	19.5 (19 – 20)	22 (19 – 25)
	S	26.8 (12 - 45.5)	29.9 (19.5 - 42.25)	0	21 (15 – 25)	0	15 (10 – 20)	7.3 (2 – 15)
	SE	50.4 (38.6 - 73.5)	2.6 (0.4 - 5.9)	1	9.3 (3 – 20)	0	31.3 (20 – 40)	5.3 (0 – 15)

Photo transects of the benthos were sampled from the reef crest, reef slope and the lower reef slope at Erub Island Reef (Figures 27, 28 and 29). Hard coral cover was moderate in all habitats (17-30%), declined with depth and was quite variable within sites (17-38%). In each habitat, hard coral families all had cover equivalent to 10% or less. Soft coral abundance increased with depth. Soft coral cover was moderate on the crest and slope, whilst very high (55%) on the lower slope and was composed almost exclusively of Alcyoniidae. Algal cover was highest on the crest and slope (34-36%) and lowest on the lower slope (27%) was composed almost entirely of turf algae (25-32%). The cover of sand (14%) was moderate on the slope habitat, but negligible on the crest and lower slope.

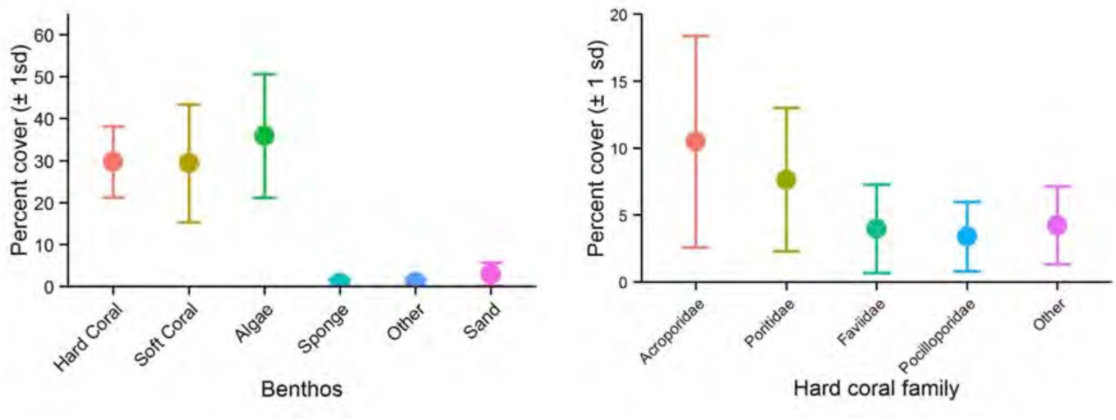

Figure 27. Erub Island Reef reef crest: a) coral reef benthos and b) hard coral families.

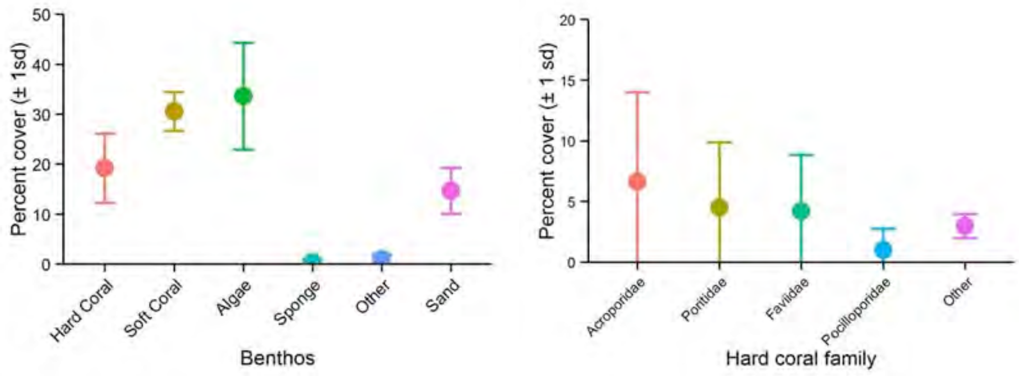

Figure 28. Erub Island Reef reef slope: a) coral reef benthos and b) hard coral families.

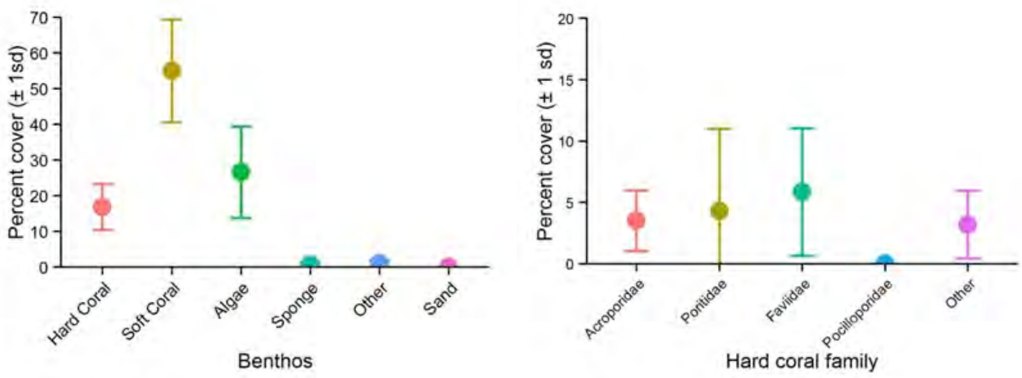

Figure 29. Erub Island Reef lower slope: a) coral reef benthos and b) hard coral families.

Mer (Murray Island)

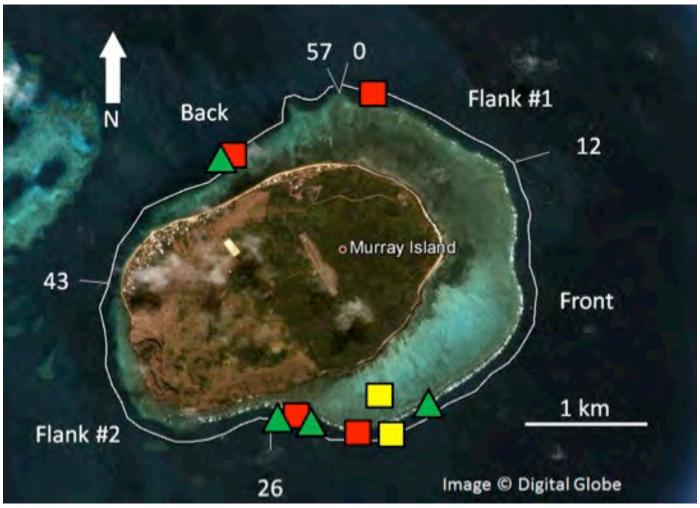

Figure 30. Satellite image of Mer Island Reef. The white line indicates the manta tow path. Breaks in the line indicate different sections of the reef, with tow numbers for reference. Symbols: Green triangle-RHIS site, Red squares indicate sites of 2013 Biodiversity surveys of fish and corals, Yellow squares indicate sites of 2014 Biodiversity surveys of corals.

Mer Island Reef was surveyed for the first time using manta tow in 2013. Median reef-wide live coral cover was moderate (20-30%) and low numbers of COTS were recorded below outbreak levels. Signs of coral bleaching were restricted to small numbers of individual colonies scattered around the reef perimeter during surveys in 2013. Signs of white syndrome disease were observed on a few scattered coral colonies on the first flank and front of the reef. White syndrome was common on the back reef where it affected more than 10 colonies per 2-minute manta tow. No signs of black band disease were observed. Mer Island Reef was classified as No Outbreak.

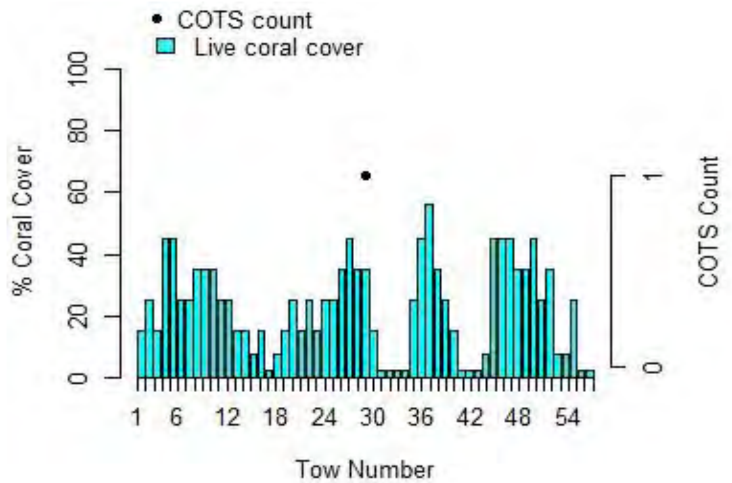

Figure 31. Percent cover of coral and number of COTS in each tow at Mer Island Reef.

Structural heterogeneity of the reef was higher than other reefs sampled in the Torres Strait region. There was a distinct reef crest and greater diversity of reef slope habitats around the island. Estimates of coral cover on the reef crest from RHIS were variable both within and between sites. Hard coral ranged from 2-48% and soft coral from less than 1% to 55%. In 2013 and 2014, hard and soft coral cover were lower on the southern sites than the northern site (Table 6). Rubble was higher on the northern site. Overall macroalgae at Mer Island Reef was low (0 -3%).

Table 6. Results of RHIS for benthic community at Mer Island Reef expressed as the average percent cover with the range of cover values given in brackets.

Year	Aspect	Hard coral	Soft coral	Recently dead coral	Turf and coralline algae	Macro-algae	Rubble	Sand
2013	S	4.8 (1.74 - 10)	10.2 (0.26 - 30)	0	84.3 (60 - 97)	0.3 (0 - 1)	0.3 (0 - 1)	0
	N	38.9 (23.7 - 48)	39.1 (30 - 55.3)	0.7 (0 - 1)	17.3 (12 – 23)	0.7 (0 – 1)	3 (1 - 7)	0.3 (0 - 1)
2014	S	21.8 (16 - 25.5)	14.8 (4.5 - 24)	1.7 (0 - 5)	61.7 (55 – 70)	0	0	0
	N	41.5 (30 - 54.8)	29.9 (18.3 - 45)	1	14.3 (13 - 15)	1.7 (1 - 3)	11.3 (10 - 14)	0.3 (0 - 1)
	SE	15.7 (17.5 - 36)	6.3 (2.5 - 9)	1.7 (0 - 5)	66.7 (55 – 75)	0	0	0

Photo transects were sampled on the reef crest, the reef slope and the lower reef slope at Mer Island Reef (Figures 32 – 34). The reef crest and reef slope habitats had similar hard coral cover (41% and 44% respectively) while the lower reef slope had 25% cover. The composition of the hard coral assemblages differed among the three habitats.

Acroporidae (23%) was the dominant hard coral family on the reef crest site followed by Pocilloporidae (8%), Faviidae (6%) and Poritidae (4%). On the reef slope Acroporidae and Poritidae were equally abundant at 18% while Pocilloporidae had 4%. On the lower reef slope Acroporidae was the most dominant family with 10% cover, followed by Pocilloporidae (6%), a mixture of families (6%), Poritidae (2%) and Faviidae (1%).

Soft coral cover, predominantly composed of Alcyoniidae, increased with depth from 2% on the reef crest to 20% on the lower slope and was variable between sites. The algae community was high (41- 56% cover), fairly consistent between habitats and was composed of turfing algae (31%) and coralline algae (13%).

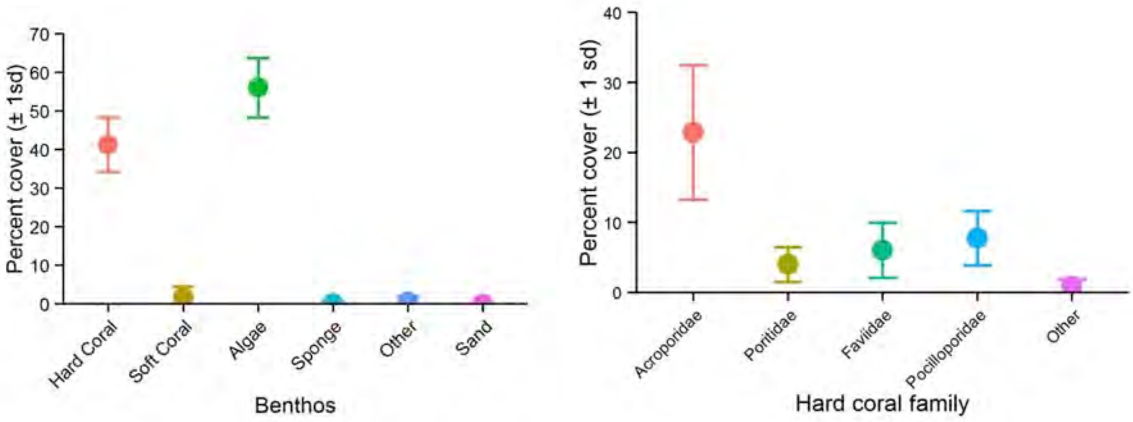

Figure 32. Mer Island Reef reef crest: a) coral reef benthos and b) hard coral families.

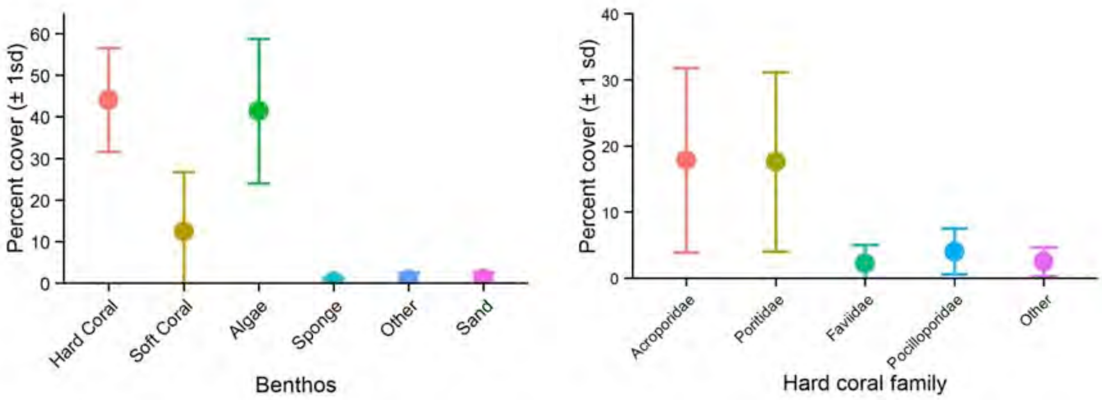

Figure 33. Mer Island Reef reef slope: a) coral reef benthos and b) hard coral families.

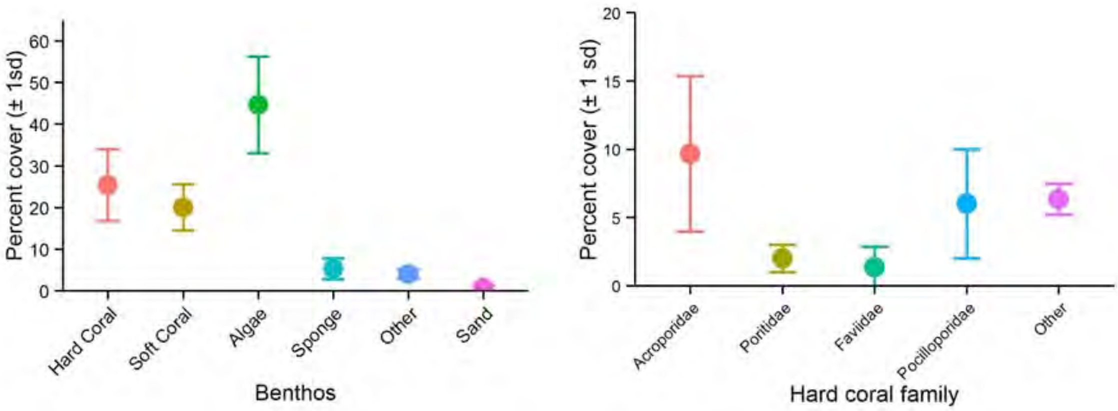

Figure 34. Mer Island Reef lower slope: a) coral reef benthos and b) hard coral families.

Waier Island and Dauar Island Reef

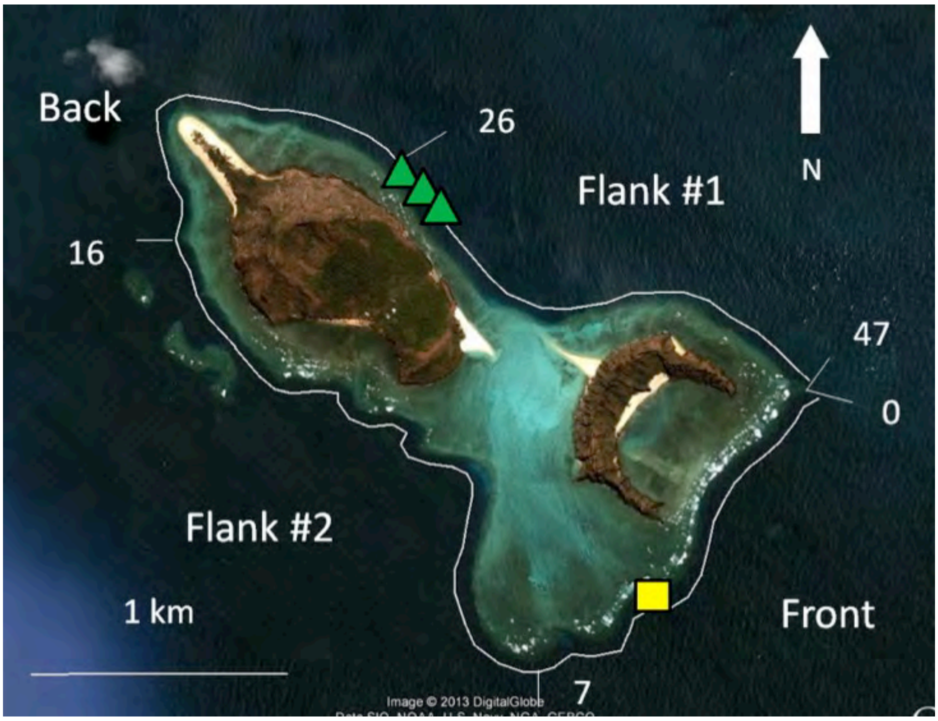

Figure 35. Satellite image of Waier and Dauar Island Reef. The white line indicates the tow path. Breaks in the line indicate different sections of the reef, with tow numbers for reference. Symbols: Green triangles indicate RHIS sites, Yellow squares indicate sites of 2014 Biodiversity surveys of corals.

Waier Island and Dauar Island Reef was surveyed for the first time using manta tow in 2013. In 2013, median reef-wide live coral cover was moderate (20-30%) and numbers of COTS were recorded at outbreak levels. In 2014, median reef-wide coal cover had declined (10-20%) due to predation by COTS that were recorded at outbreak levels in 2013. Signs of coral bleaching were restricted to small numbers of individual colonies on the second flank of the reef in 2013. Similar low level signs of white syndrome were observed on scattered coral colonies on the back, front and second flank of the reef in 2013, while in 2014 low level signs of white syndrome were observed on the front, first and second flanks. No signs of black band disease were observed. Waier Island and Dauar Island Reef was classified as Incipient Outbreak in 2013 and 2014.

Figure 35 shows the approximate locations of numbered tows around the reef perimeter. The number of tows required to survey the reef perimeter varies with speed of towing, currents and winds. There were no photo transects were recorded in 2013 or 2014 but estimates from one RHIS site on the reef crest at Dauar Island in 2013 indicated that hard coral cover was high (49-70%) and soft coral was low (>5%). The cover of macroalgae was very low. RHIS indicated COTS and some coral diseases were present. There were no RHIS surveys undertaken at Waier Island and Dauar Island Reef in 2014.

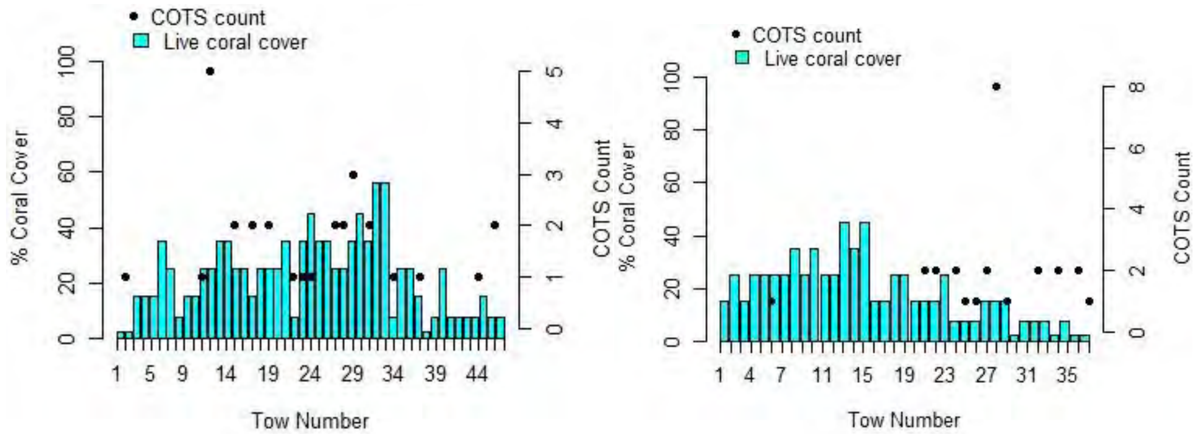

Figure 36. Distribution of crown-of-thorns starfish (right hand axis) and percent hard coral cover by tow number (left hand axis) around the perimeter of Waier and Dauar Reef, (a) in February 2013; (b) in January 2014.

Table 7. Results of RHIS for benthic community at Dauar Island Reef expressed as the average percent cover with the range of cover values given in brackets.

Year	Aspect	Hard coral	Soft coral	Recently dead coral	Turf and coralline algae	Macroalgae	Rubble	Sand
2013	N	61.6 (49 - 69.3)	1.7 (0.7 - 3.5)	1	33.7 (25 – 49)	0.3 (0 - 1)	1.7 (0 - 3)	0

Discussion

The status of reefs in Torres Strait

This project has gathered data on a select number of reefs in the central and eastern Torres Strait so any inferences must be treated with great caution. Without a long-term baseline as a guide, it is impossible to draw conclusions about trends. The obvious point of reference is the reefs of the GBR to the south, but there are some important differences, such as a much lower incidence of cyclones in the more equatorial Torres Strait than most reefs in the GBR will experience (Puotinen 2004). The coral cover on the crests and slopes of the reefs that were surveyed in Torres Strait was moderate to high by GBR standards, as might be expected in a region with fewer cyclones. Coral disease was absent or at low levels in all sites except on the back reef at Mer, though this area had reasonably high coral cover. COTS were seen at all reefs that were surveyed by manta tow and were at outbreak densities (by GBR standards) at Aureed and at Waier and Dauar reefs. COTS have been known from Torres Strait for a long time; several COTS were recorded at Mer in 1913 but reports from recent CSIRO surveys (Murphy et al. 2011) suggest that COTS numbers have been increasing regionally in recent years. On the GBR, outbreaks follow a reasonably distinct pattern of spread, but the timing and spread of COTS outbreaks in the Torres Strait have not been recorded. While COTS certainly reduce coral cover, the low human population in the region makes it unlikely that local human activities have caused the outbreaks and it is also not clear what could be done to prevent them.

Capacity Building

Trips in both 2013 and 2014 had specific advantages and disadvantages with regards to capacity building. In 2013, good weather and a higher trainer to ranger ratio produced successful training outcomes and set high expectations for future trips. A downside was insufficient capacity in the tenders, which slowed access to sites and reduced the time available for training. In 2014, the trainer/ranger ratio was lower and the weather was consistently rough. As a result, capacity building was restricted to reinforcing the previous year of work where possible. Several TSRA rangers for whom 2014 was a second trip were able to pass on their knowledge of the RHIS techniques to others.

This project has made a start at building skills to establish and sustain a reef monitoring program in Torres Strait, but a number of issues remain to be addressed. To date, the focus has been on the central and eastern Torres Strait where the water is relatively clear. Effective techniques for monitoring reefs in the turbid waters and strong currents of western Torres Strait remain to be developed and trialled. A very important component of a monitoring program is data management and reporting. As part of the integrated Eye on the Reef program, the RHIS has an established data entry system and database that will most likely be the basis tool for future monitoring in the region, while the Torres Strait e-Atlas will have an important role in reporting and presenting the results. The joint workshop between TSRA LSMU staff, AIMS, CSIRO, GBRMPA and JCU in October 2014 canvassed these issues and made some recommendations (see Bainbridge et al. 2015).

An important consideration raised by TSRA staff is the need for rangers to participate in surveys at frequent intervals (more often than once a year) in order to maintain their skills. This would fit well with the rangers based in communities using small TSRA boats to take advantage of windows of fine weather to survey nearby reefs, rather than depending on an annual campaign using expensive charter vessels for a set period, regardless of the weather. A photo database has been created on the e-Atlas to assist with maintaining the knowledge acquired during the project. Other resources on the internet associated with integrated Eye on the Reef Program are also available to refresh skills.

Biodiversity of hard corals

While there is a long history of coral reef surveys in Torres Strait, the results from this project and the increasing perception of Torres Strait as an Australian biodiversity hotspot suggest that there are many more species to be discovered if appropriate resources were available to explore a full range of habitats and depths. Surveys of corals on the central and eastern reefs confirmed previous knowledge that the coral fauna is dominated by GBR species. It is likely that more species from the Coral Triangle will be found in the future, especially if the range of habitats surveyed is expanded.

There are insufficient data to determine if there has been any species loss since the collections in the 1970s and 1980s. Species in the MTQ collection that were not resampled by AIMS and MTQ in 2013 and 2014 come from a range of genera and they are mostly species that can only be identified from skeletons. In particular, there are numerous *Montipora* and *Fungia* spp. There are photographic records for some of these species from these recent surveys, but they were not included in the final species list as they could not be verified without a specimen. Any future sampling could focus the species in the original collection that were not detected to ensure the baseline has not been modified.

Changing taxonomy is unavoidable when recording coral species. We have addressed this issue with two strategies. The assistance of Dr Paul Muir from MTQ in 2014 resulted in an expanded collection of specimens and the first collection of genetic samples from corals surveyed in 2014. Secondly, good quality photos of all the identified species have been databased, along with photographs of many corals that were only identified to genus. Reference photos of species are available through the e-Atlas. A number of species recorded in 2013 (Osborne et al. 2013) are species that were described or bought out of synonymy by Veron (1999) and that have either recently been synonymised (e.g. Wallace et al. 2012) or are yet to be assessed by other coral taxonomists. The reallocation of some corals, especially in the family Faviidae, to a new classification is not reflected here, but will need to be considered in the future.

Biodiversity of reef fishes

It is generally easier to identify reef fish species than coral species, but even with the limited scope of surveys in this project we were able to increase the numbers of reef fish species that have been recorded in Torres Strait. While the AIMS surveys focussed on small reef associated species to a greater extent than resource-orientated surveys by CSIRO, hundreds of small cryptic species certainly remain undetected. The occurrence in Torres Strait of species like *Macropharyngodon choati,* that are common on reefs of the southern GBR but rare or unknown in the northern GBR begs an explanation, but there are likely to be many more species like *Halichoeres richmondi* whose centre of distribution is in the Coral Triangle to the north, but whose range extends into Torres Strait.

References

Allen, GR, R Steene, P Human, N DeLoach. 2003. Reef fish identification: tropical Pacific. New World Publications, Jacksonville, Florida.

Bainbridge, S., Berkelmans R (2014) The use of climatologies and Bayesian models to link observations to outcomes; an example from the Torres Strait. Environmental Science: Processes & Impacts. **16**, 1041-1049. **DOI:** 10.1039/C3EM00675A

Beeden, RJ, Turner MA, Dryden J, Merida F, Goudkamp K, Malone C Marshall PA, Birtles A, Maynard JA. (2014) Rapid survey protocol that provides dynamic information on the reef condition to managers of the Great Barrier Reef. Environmental Monitoring Assessment. 186: 8527-8540.

Haywood MDE, Browne M, Skewes T, Rochester W, McLeod I, Pitcher R, Dennis D, Dunn J, Cheers S, Wassenberg T (2007) Improved knowledge of Torres Strait seabed biota and reef habitats. Report to the Marine and Tropical Sciences Research Facility. Reef and Rainforest Research Centre Limited, Cairns (115 pp.).

International Union for Conservation of Nature (IUCN) 2010. *Halichoeres richmondi*. The IUCN Red List of Threatened Species. Version 2014.3 See: http://maps.iucnredlist.org/map.html?id=187507

International Union for Conservation of Nature (IUCN) 2010. *Macropharyngodon choati.* The IUCN Red List of Threatened Species. Version 2014.3 See: http://maps.iucnredlist.org/map.html?id=187388

Jonker M, Johns K, Osborne K (2008) Surveys of benthic reef communities using underwater digital photography and counts of juvenile corals. Australian Institute of Marine Science SOP 10. Townsville, Australia, p 85

Miller IR, Jonker M, Coleman G (2009). Crown-of-thorns starfish and coral surveys using the manta tow and SCUBA search techniques. Standard operational procedure number 9(3). Australian Institute of Marine Science, Townsville, Qld.

Murphy NE, Skewes TD, Dovers E, Rochester W, Long B (2011) Incipient outbreak of Crown-of-thorns starfish (*Acanthaster planci)* in Torres Strait, Australia. Final Report to AFMA. CSIRO Wealth from Oceans, Dutton Park. 30 pp.

Ocean Biogeographic Information System (2014) Data from the Ocean Biogeographic Information System. Intergovernmental Oceanographic Commission of UNESCO.

Available at: http://www.iobis.org (accessed 18 November 2014).

Osborne K, Miller I, Johns K, Jonker M, Sweatman H (2013) Preliminary report on surveys of biodiversity of fishes and corals in Torres Strait. Australian Institute of Marine Science, Townsville, Qld.

Puotinen, ML (2004) Tropical Cyclones in the Great Barrier Reef, Australia, 1910–1999: a First Step towards Characterising the Disturbance Regime. Australian Geographical Studies. 42: 378-392

Randall JE, Allen GR, Steene RC (1997) Fishes of the Great Barrier Reef and Coral Sea. University of Hawaii Press, Honolulu.

Sweatman, H., Johns, K., Jonker, M., Miller, I., and Osborne, K. (2014) Report on second monitoring field trip to Torres Strait, January 2014 Report to the National Environmental Research Program. Reef and Rainforest Research Centre Limited, Cairns (10 + iv pp.)

Vaughan TW (1918) Some shoal-water corals from Murray Island (Australia), Cocos-Keeling Islands and Fanning Island. Pap. Dep. Mar Biol. Carnegie Inst. Wash. 213: 49-234.

Veron JEN (2000) In: Stafford-Smith, M (ed) Corals of the World, 3 vols. Australian Institute of Marine Science, Townsville

Veron JEN, Pichon M (1976) Scleractinia of Eastern Australia. Vol 1. Australian Institute of Marine Science, Townsville. p 86

Veron JEN, Pichon M (1980) Scleractinia of Eastern Australia. Vol 4. Australian Institute of Marine Science, Townsville. p 422

Veron JEN, Pichon M (1982) Scleractinia of Eastern Australia. Vol 5. Australian Institute of Marine Science, Townsville. p 159

Veron JEN, Wallace CC (1984) Scleractinia of Eastern Australia. Vol 6. Australian Institute of Marine Science, Townsville. p 485

Wallace CC (1999) Staghorns of the World. A revision of the Genus Acropora. CSIRO publishing.

Wallace CC, Done BJ, Muir PR (2012) Revision and catalogue of worldwide staghorn corals *Acropora* and *Isopora* (Scleractinia: Acroporidae) in the Museum of Tropical Queensland. *Memoirs of the Queensland Museum. Nature. 57 (2): 1 - 255.*

Appendix 1 – Coral species

List of hard coral species recorded from reefs in Torres Strait in 2013 and 2014. Triple asterisks (***) indicate a new record for Australia that needs validating with a specimen.

Scleractinian species	2013	2014	Specimen	New record
Acanthastrea echinata	✓	✓		
Acanthastrea hemprichii	✓			✓
Acanthastrea faviaformis	✓			✓
Acanthastrea regularis	✓			✓
Acropora abrotanoides	✓	✓		
Acropora aculeus	✓	✓		
Acropora acuminata	✓		✓	
Acropora anthocercis	✓	✓		
Acropora aspera	✓	✓		
Acropora austera	✓	✓	✓	
Acropora cerealis	✓			✓
Acropora clathrata	✓	✓	✓	
Acropora cytherea	✓	✓	✓	
Acropora digitifera	✓	✓	✓	
Acropora divaricata	✓	✓	✓	
Acropora donei	✓	✓	✓	
Acropora elseyi	✓	✓	✓	✓
Acropora florida	✓	✓		
Acropora gemmifera	✓	✓		
Acropora glauca		✓	✓	✓
Acropora grandis	✓	✓	✓	
Acropora granulosa			✓	
Acropora horrida	✓	✓	✓	
Acropora humilis	✓	✓		
Acropora hyacinthus	✓	✓	✓	
Acropora intermedia	✓	✓		
Acropora latistella	✓	✓	✓	
Acropora listeri	✓			✓
Acropora longicyathus	✓	✓		
Acropora loripes	✓	✓	✓	
Acropora lutkeni	✓	✓	✓	
Acropora microclados	✓	✓	✓	
Acropora microphthalma	✓	✓		
Acropora millepora	✓	✓		
Acropora monticulosa	✓	✓		
Acropora muricata	✓	✓	✓	
Acropora nana	✓	✓	✓	
Acropora nasuta	✓	✓	✓	

Scleractinian species	2013	2014	Specimen	New record
Acropora palmerae	✓			✓
Acropora paniculata	✓	✓	✓	
Acropora polystoma	✓	✓	✓	
Acropora prostrata	✓			✓
Acropora pulchra	✓	✓	✓	
Acropora robusta	✓	✓	✓	
Acropora rosaria	✓			✓
Acropora samoensis	✓	✓	✓	
Acropora sarmentosa	✓	✓		
Acropora secale	✓	✓	✓	
Acropora selago	✓	✓	✓	
Acropora solitaryensis		✓	✓	
Acropora spicifera ***		✓		✓
Acropora striata		✓		✓
Acropora subulata	✓		✓	
Acropora tenuis	✓	✓	✓	
Acropora valenciennesi	✓	✓	✓	
Acropora valida	✓	✓	✓	
Acropora vaughani	✓	✓	✓	
Acropora verweyi		✓	✓	
Acropora yongei	✓	✓	✓	
Alveopora catalai	✓			
Alveopora spongiosa	✓			
Astreopora gracilis	✓	✓		
Astreopora listeri	✓			
Astreopora myriophthalma	✓	✓	✓	
Astreopora ocellata	✓			
Australogyra zelli	✓	✓	✓	✓
*Cantharellus jebbi****	✓			✓
Caulastrea furcata	✓	✓	✓	
Coeloseris mayeri	✓			
Coscinaraea columna	✓	✓		
Coscinaraea exesa	✓	✓		✓
Ctenactis crassa				✓
Ctenactis echinata	✓			✓
Ctenactis simplex		✓		✓
Cycloseris costulata		✓		✓
Cycloseris spp.			✓	✓
Cyphastrea chalcidicum	✓	✓	✓	
Cyphastrea decadia	✓			✓
Cyphastrea microphthalma	✓	✓	✓	
Cyphastrea serailia	✓	✓		
Diploastrea heliopora	✓	✓		

Scleractinian species	2013	2014	Specimen	New record
Echinophyllia aspera	✓	✓	✓	
Echinophyllia echinoporoides	✓		✓	
Echinophyllia orpheensis	✓	✓		
Echinopora gemmacea	✓	✓		
Echinopora horrida	✓	✓		
Echinopora lamellosa	✓	✓	✓	
Echinopora mammiformis	✓	✓		
Echinopora pacificus	✓	✓	✓	✓
Euphyllia ancora	✓			
Euphyllia cristata	✓			
Favia danae	✓			✓
Favia favus	✓			
Favia laxa	✓			
Favia lizardensis	✓	✓		✓
Favia maritima	✓			
Favia matthaii	✓			
Favia maxima		✓		✓
Favia pallida	✓		✓	
Favia rosaria	✓			✓
Favia rotumana	✓	✓		✓
Favia rotundata	✓	✓		✓
Favia speciosa	✓			✓
Favia stelligera	✓	✓	✓	
Favia truncatus	✓	✓		✓
Favites abdita	✓	✓		✓
Favites complanata	✓			✓
Favites flexuosa	✓	✓	✓	✓
Favites halicora	✓			✓
Favites pentagona	✓			
Favites russelli				
Fungia horrida	✓	✓		
Fungia paumotensis	✓	✓		
Fungia scutaria	✓	✓		
Fungia valida		✓		
Galaxea acrhelia	✓			✓
Galaxea astreata	✓	✓		
Galaxea fascicularis	✓	✓		
Galaxea longisepta		✓		✓
Gardineroseris planulata	✓	✓		
Goniastrea aspera	✓	✓		
Goniastrea australensis	✓	✓		
Goniastrea edwardsi	✓			
Goniastrea favulus	✓	✓		

Scleractinian species	2013	2014	Specimen	New record
Goniastrea palauensis	✓			
Goniastrea pectinata	✓			
Goniastrea retiformis	✓			
Goniopora djiboutiensis	✓		✓	
Goniopora eclipsensis		✓	✓	✓
Goniopora fruticosa	✓	✓	✓	
Goniopora minor	✓	✓	✓	
Goniopora norfolkensis		✓	✓	✓
Goniopora somaliensis	✓	✓	✓	
Goniopora tenuidens	✓	✓	✓	
Halomitra pileus	✓			
Heliofungia actiniformis	✓	✓		
Herpolitha limax	✓			
*Herpolitha weberi****	✓			✓
Hydnophora exesa	✓	✓		
Hydnophora grandis	✓	✓		✓
Hydnophora microconos	✓			✓
Hydnophora pilosa	✓	✓		✓
Hydnophora rigida	✓	✓	✓	
Isopora cuneata		✓	✓	✓
Isopora palifera	✓	✓		✓
Leptastrea bewickensis	✓			✓
Leptastrea inaequalis	✓	✓	✓	✓
Leptastrea pruinosa	✓	✓		✓
Leptastrea purpurea	✓	✓		
Leptastrea transversa	✓		✓	✓
Leptoria phrygia	✓	✓		
Leptoseris explanata	✓			
Leptoseris mycetoseroides	✓			
Leptoseris yabei	✓	✓		
Lobophyllia corymbosa	✓	✓		
Lobophyllia diminuta		✓		✓
Lobophyllia flabelliformis	✓			✓
Lobophyllia hataii	✓			
Lobophyllia hemprichii	✓			
Lobophyllia pachysepta	✓	✓		
Lobophyllia robusta	✓			✓
Madricis kirbyii	✓			✓
Merulina ampliata	✓	✓		
Merulina scabricula	✓	✓		✓
Micromussa spp. ***		✓		✓
Montastrea annuligera	✓			✓
Montastrea colemani	✓			✓

Scleractinian species	2013	2014	Specimen	New record
Montastrea curta	✓	✓		✓
Montastrea magnistellata	✓			
Montastrea salebrosa	✓			✓
Montastrea valenciennesi		✓	✓	
Montipora aequituberculata	✓		✓	
Montipora confusa	✓			✓
Montipora corbettensis		✓	✓	
Montipora danae	✓		✓	
Montipora foliosa	✓		✓	
Montipora foveolata				✓
Montipora hispida	✓			
*Montipora palawanensis****	✓			✓
Montipora stellata	✓		✓	
Montipora undata	✓	✓	✓	
Montipora verrucosa	✓	✓		
Mycedium elephantotus	✓	✓		
Oulophyllia bennettae	✓	✓		✓
Oulophyllia crispa	✓	✓		
Oxypora glabra	✓	✓	✓	
Oxypora lacera	✓	✓	✓	
Pachyseris rugosa	✓	✓	✓	
Pachyseris speciosa	✓	✓		
Palauastrea ramosa	✓	✓	✓	
Paraclavarina triangularis	✓			✓
*Pavona bipartita****	✓			✓
Pavona cactus	✓	✓		
Pavona clavus	✓	✓		
Pavona decussata	✓	✓		
Pavona explanulata	✓		✓	
Pavona varians	✓			
Pavona venosa	✓	✓	✓	
Pectinia alcicornis	✓	✓		
Pectinia lactuca	✓	✓		
Pectinia paeonia	✓			
Physogyra lichtensteini	✓			
Platygyra daedalea	✓	✓	✓	
Platygyra lamellina	✓	✓		
Platygyra pini	✓	✓		✓
Platygyra sinensis	✓	✓		
Platygyra verweyi	✓	✓		✓
Plerogyra sinuosa	✓	✓		
Plesiastrea versipora	✓	✓		
Pocillopora acuta	✓			✓

Scleractinian species	2013	2014	Specimen	New record
Pocillopora damicornis	✓	✓		
Pocillopora eydouxi	✓	✓		✓
Pocillopora meandrina	✓	✓		✓
Pocillopora verrucosa	✓	✓		✓
Podabacia crustacea	✓	✓		
Podabacia motuporensis	✓			✓
Polyphyllia talpina	✓			
Porites annae	✓	✓	✓	
Porites cylindrica	✓	✓	✓	
Porites lichen	✓			
Porites lutea		✓	✓	
Porites mayeri	✓		✓	✓
Porites murrayensis		✓	✓	✓
Porites nigrescens	✓		✓	
Porites vaughani		✓	✓	
Psammocora contigua	✓			✓
Psammocora digitata	✓			
Psammocora obtusangula	✓			✓
Psammocora profundacella	✓			
Pseudosiderastrea tayami		✓		
Sandalolitha robusta	✓	✓		
Scapophyllia cylindrica	✓	✓		
Scolymia vitiensis	✓	✓		
Seriatopora caliendrum	✓	✓	✓	✓
Seriatopora hystrix	✓	✓		
Stylocoeniella armata	✓			
Stylocoeniella guentheri	✓			
Stylophora pistillata	✓	✓		
Symphyllia radians	✓			
Symphyllia recta	✓	✓		
Turbinaria frondens	✓			
Turbinaria mesenterina	✓	✓	✓	
Turbinaria patula		✓		
Turbinaria peltata	✓			
Turbinaria radicalis		✓	✓	
Turbinaria reniformis	✓	✓	✓	
Turbinaria stellulata	✓	✓		

Appendix 2 - Fish species

List of reef fish species recorded from reefs in Torres Strait in 2013

Family	Species	CSIRO	AIMS
Acanthuridae	*Acanthurus auranticavus*		✓
Acanthuridae	*Acanthurus blochii*	✓	✓
Acanthuridae	*Acanthurus dussumieri*	✓	
Acanthuridae	*Acanthurus grammoptilus*		✓
Acanthuridae	*Acanthurus lineatus*	✓	✓
Acanthuridae	*Acanthurus mata*	✓	
Acanthuridae	*Acanthurus nigricans*	✓	
Acanthuridae	*Acanthurus nigricauda*	✓	✓
Acanthuridae	*Acanthurus nigrofuscus*	✓	✓
Acanthuridae	*Acanthurus olivaceus*	✓	
Acanthuridae	*Acanthurus pyroferus*	✓	✓
Acanthuridae	*Acanthurus thompsoni*	✓	
Acanthuridae	*Acanthurus triostegus*	✓	✓
Acanthuridae	*Acanthurus xanthopterus*	✓	
Acanthuridae	*Ctenochaetus binotatus*	✓	✓
Acanthuridae	*Ctenochaetus striatus*	✓	✓
Acanthuridae	*Naso annulatus*	✓	
Acanthuridae	*Naso brevirostris*	✓	✓
Acanthuridae	*Naso lituratus*	✓	
Acanthuridae	*Naso tuberosus*	✓	✓
Acanthuridae	*Naso unicornis*	✓	✓
Acanthuridae	*Naso vlamingii*	✓	
Acanthuridae	*Paracanthurus heptatus*	✓	
Acanthuridae	*Zebrasoma scopas*	✓	✓
Acanthuridae	*Zebrasoma veliferum*	✓	✓
Apogonidae	*Apogon compressus*		✓
Apogonidae	*Apogon properuptus*		✓
Apogonidae	*Cheilodipterus macrodon*		✓
Apogonidae	*Cheilodipterus quinquelineatus*		✓
Apogonidae	*Sphaeramia nematoptera*		✓
Aulostomidae	*Aulostomus chinensis*		✓
Balistidae	*Balistapus undulatus*		✓
Balistidae	*Balistoides conspicillum*		✓
Balistidae	*Balistoides viridescens*		✓
Balistidae	*Pseudobalistes flavimarginatus*		✓
Balistidae	*Rhinecanthus rectangulus*		✓
Balistidae	*Sufflamen chrysopterus*		✓
Blenniidae	*Aspidontus dussumieri*		✓
Blenniidae	*Crossosalarias macrospilus*		✓
Blenniidae	*Ecsenius stictus*		✓

Family	Species	CSIRO	AIMS
Blenniidae	*Meiacanthus atrodorsalis*		✓
Blenniidae	*Meiacanthus grammistes*		✓
Blenniidae	*Plagiotremus laudandus*		✓
Blenniidae	*Plagiotremus rhinorhynchos*		✓
Caesionidae	*Caesio caerulaurea*	✓	✓
Caesionidae	*Caesio cuning*	✓	✓
Caesionidae	*Caesio teres*	✓	✓
Caesionidae	*Pterocaesio marri*	✓	✓
Caesionidae	*Pterocaesio tile*	✓	✓
Caesionidae	*Pterocaesio trilineata*	✓	
Carangidae	*Carangoides fulvoguttatus*		✓
Carangidae	*Carangoides gymnostethus*		✓
Carangidae	*Carangoides orthogrammus*		✓
Carangidae	*Caranx lugubricus*		✓
Carangidae	*Caranx melampygus*		✓
Carangidae	*Gnathanodon speciosus*		✓
Chaetodontidae	*Chaetodon aureofasciatus*	✓	✓
Chaetodontidae	*Chaetodon auriga*	✓	✓
Chaetodontidae	*Chaetodon baronessa*	✓	✓
Chaetodontidae	*Chaetodon bennetti*	✓	✓
Chaetodontidae	*Chaetodon citrinellus*	✓	
Chaetodontidae	*Chaetodon ephippium*	✓	✓
Chaetodontidae	*Chaetodon kleinii*	✓	✓
Chaetodontidae	*Chaetodon lineolatus*	✓	✓
Chaetodontidae	*Chaetodon lunula*	✓	✓
Chaetodontidae	*Chaetodon melannotus*	✓	✓
Chaetodontidae	*Chaetodon ornatissimus*	✓	✓
Chaetodontidae	*Chaetodon pelewensis*	✓	✓
Chaetodontidae	*Chaetodon plebeius*	✓	✓
Chaetodontidae	*Chaetodon rafflesii*	✓	✓
Chaetodontidae	*Chaetodon rainfordi*	✓	✓
Chaetodontidae	*Chaetodon speculum*	✓	✓
Chaetodontidae	*Chaetodon trifascialis*	✓	✓
Chaetodontidae	*Chaetodon trifasciatus*	✓	✓
Chaetodontidae	*Chaetodon ulietensis*	✓	✓
Chaetodontidae	*Chaetodon unimaculatus*	✓	✓
Chaetodontidae	*Chaetodon vagabundus*	✓	✓
Chaetodontidae	*Chelmon marginalis*	✓	✓
Chaetodontidae	*Chelmon muelleri*	✓	
Chaetodontidae	*Chelmon rostratus*	✓	
Chaetodontidae	*Coradion chrysozonus*		✓
Chaetodontidae	*Forcipiger flavissimus*	✓	
Chaetodontidae	*Forcipiger longirostrus*	✓	
Chaetodontidae	*Heniochus varius*		✓

Family	Species	CSIRO	AIMS
Chaetodontidae	*Parachaetodon ocellatus*	✓	✓
Cirrhitidae	*Paracirrhites arcatus*		✓
Cirrhitidae	*Paracirrhites forsteri*		✓
Diodontidae	*Chilomycterus reticulatus*		✓
Echeneidae	*Echeneis naucrates*		✓
Ephippidae	*Platax pinnatus*		✓
Ephippidae	*Platax teira*		✓
Gobiidae	*Amblygobius decussatus*		✓
Gobiidae	*Amblygobius rainfordi*		✓
Gobiidae	*Exyrias belissimus*		✓
Gobiidae	*Istigobius rigilius*		✓
Gobiidae	*Valenciennea puellaris*		✓
Haemulidae	*Diagramma pictum*		✓
Haemulidae	*Plectorhinchus celebicus*		✓
Haemulidae	*Plectorhinchus chaetodonoides*		✓
Haemulidae	*Plectorhinchus flavomaculatus*		✓
Haemulidae	*Plectorhinchus lessonii*		✓
Haemulidae	*Plectorhinchus lineatus*		✓
Haemulidae	*Plectorhinchus multivittatus*		✓
Haemulidae	*Plectorhinchus unicolor*		✓
Holocentridae	*Neoniphon sammara*		✓
Holocentridae	*Sargocentron rubrum*		✓
Kyphosidae	*Kyphosus bigibbus*		✓
Labridae	*Anampses caeruleopunctatus*		✓
Labridae	*Anampses meleagrides*		✓
Labridae	*Anampses neoguinaicus*		✓
Labridae	*Bodianus mesothorax*		✓
Labridae	*Cheilinus fasciatus*		✓
Labridae	*Cheilinus trilobatus*		✓
Labridae	*Cheilinus undulatus*	✓	
Labridae	*Choerodon anchorago*		✓
Labridae	*Choerodon cyanodus*		✓
Labridae	*Choerodon fasciatus*	✓	✓
Labridae	*Choerodon monostigma*		✓
Labridae	*Choerodon schoenleinii*		✓
Labridae	*Choerodon vitta*		✓
Labridae	*Cirrhilabrus exquisitus*		✓
Labridae	*Cirrhilabrus punctatus*		✓
Labridae	*Coris aygula*	✓	
Labridae	*Coris ballieui*		✓
Labridae	*Coris batuensis*		✓
Labridae	*Coris gaimard*	✓	
Labridae	*Epibulus insidiator*	✓	✓
Labridae	*Gomphosus varius*	✓	✓

Family	Species	CSIRO	AIMS
Labridae	*Halichoeres chloropterus*		✓
Labridae	*Halichoeres hortulanus*	✓	✓
Labridae	*Halichoeres maculipinna*		✓
Labridae	*Halichoeres margaritaceus*		✓
Labridae	*Halichoeres marginatus*		✓
Labridae	*Halichoeres melanurus*		✓
Labridae	*Halichoeres nebulosus*		✓
Labridae	*Halichoeres prosopeion*		✓
Labridae	*Halichoeres richmondi*		✓
Labridae	*Halichoeres trimaculatus*	✓	
Labridae	*Hemigymnus fasciatus*	✓	✓
Labridae	*Hemigymnus melapterus*	✓	✓
Labridae	*Labrichthys unilineatus*		✓
Labridae	*Labroides dimidiatus*		✓
Labridae	*Leptojulis cyanopleura*		✓
Labridae	*Macropharyngodon choati*		✓
Labridae	*Oxycheilinus digrammus*		✓
Labridae	*Oxycheilinus orientalis*		✓
Labridae	*Oxycheilinus unifasciatus*		✓
Labridae	*Pseudocoris yamashiroi*		✓
Labridae	*Stethojulis interrupta*		✓
Labridae	*Stethojulis strigiventer*		✓
Labridae	*Thalassoma amblycephalum*		✓
Labridae	*Thalassoma hardwicke*	✓	✓
Labridae	*Thalassoma jansenii*	✓	✓
Labridae	*Thalassoma lunare*	✓	✓
Labridae	*Thalassoma lutescens*	✓	
Labridae	*Thalassoma trilobatum*		✓
Lethrinidae	*Lethrinus atkinsoni*	✓	
Lethrinidae	*Lethrinus erythropterus*	✓	✓
Lethrinidae	*Lethrinus harak*	✓	✓
Lethrinidae	*Lethrinus laticaudis*	✓	✓
Lethrinidae	*Lethrinus lentjan*	✓	✓
Lethrinidae	*Lethrinus obsoletus*	✓	
Lethrinidae	*Lethrinus olivaceus*	✓	
Lethrinidae	*Lethrinus ornatus*	✓	
Lethrinidae	*Lethrinus rubrioperculatus*	✓	
Lethrinidae	*Lethrinus xanthochilus*	✓	
Lethrinidae	*Monotaxis grandoculis*		✓
Lutjanidae	*Lutjanus biguttatus*	✓	
Lutjanidae	*Lutjanus bohar*	✓	✓
Lutjanidae	*Lutjanus carponotatus*	✓	✓
Lutjanidae	*Lutjanus fulviflamma*	✓	✓
Lutjanidae	*Lutjanus fulvus*	✓	

Family	Species	CSIRO	AIMS
Lutjanidae	*Lutjanus gibbus*	✓	
Lutjanidae	*Lutjanus kasmira*	✓	✓
Lutjanidae	*Lutjanus monostigma*	✓	
Lutjanidae	*Lutjanus quinquelineatus*	✓	
Lutjanidae	*Lutjanus rivulatus*	✓	
Lutjanidae	*Lutjanus sebae*	✓	
Lutjanidae	*Lutjanus vitta*	✓	
Lutjanidae	*Symphorus nematophorus*	✓	
Microdesmidae	*Ptereleotris evides*		✓
Microdesmidae	*Ptereleotris microlepis*		✓
Monacanthidae	*Oxymonacanthus longirostris*		✓
Mullidae	*Parupeneus barberinus*		✓
Mullidae	*Parupeneus bifasciatus*		✓
Mullidae	*Parupeneus cyclostomus*		✓
Mullidae	*Parupeneus indicus*		✓
Mullidae	*Parupeneus multifasciatus*		✓
Nemipteridae	*Scolopsis bilineata*		✓
Nemipteridae	*Scolopsis lineatus*		✓
Nemipteridae	*Scolopsis margaritifer*		✓
Nemipteridae	*Scolopsis monogramma*		✓
Ostraciidae	*Ostracion cubicus*		✓
Ostraciidae	*Ostracion meleagris*		✓
Pinguipedidae	*Parapercis hexophtalma*		✓
Platycephalidae	*Cymbacephalus beauforti*		✓
Plotosidae	*Paraplotosus albilabrus*		✓
Pomacanthidae	*Centropyge bicolor*		✓
Pomacanthidae	*Centropyge vrolikii*		✓
Pomacanthidae	*Chaetodontoplus duboulayi*		✓
Pomacanthidae	*Pomacanthus sexstriatus*		✓
Pomacanthidae	*Pomacanthus xanthometopon*		✓
Pomacanthidae	*Pygoplites diacanthus*		✓
Pomacentridae	*Abudefduf bengalensis*	✓	✓
Pomacentridae	*Abudefduf sexfasciatus*	✓	✓
Pomacentridae	*Abudefduf vaigiensis*	✓	✓
Pomacentridae	*Abudefduf whitleyi*	✓	✓
Pomacentridae	*Acanthachromis polyacanthus*	✓	✓
Pomacentridae	*Amblyglyphidodon curacao*		✓
Pomacentridae	*Amblyglyphidodon leucogaster*	✓	✓
Pomacentridae	*Amphiprion akindynos*		✓
Pomacentridae	*Amphiprion clarkii*		✓
Pomacentridae	*Amphiprion melanopus*		✓
Pomacentridae	*Amphiprion percula*		✓
Pomacentridae	*Chromis acares*	✓	
Pomacentridae	*Chromis amboinensis*	✓	

Family	Species	CSIRO	AIMS
Pomacentridae	*Chromis atripectoralis*	✓	✓
Pomacentridae	*Chromis atripes*	✓	
Pomacentridae	*Chromis chrysura*	✓	
Pomacentridae	*Chromis iomelas*	✓	
Pomacentridae	*Chromis lepidolepis*	✓	✓
Pomacentridae	*Chromis margaritifer*	✓	
Pomacentridae	*Chromis nitida*	✓	
Pomacentridae	*Chromis retrofasciata*	✓	✓
Pomacentridae	*Chromis ternatensis*	✓	✓
Pomacentridae	*Chromis vanderliti*	✓	✓
Pomacentridae	*Chromis viridis*	✓	
Pomacentridae	*Chromis weberi*	✓	
Pomacentridae	*Chromis xanthura*	✓	
Pomacentridae	*Chrysiptera brownriggii*		✓
Pomacentridae	*Chrysiptera cyanea*	✓	
Pomacentridae	*Chrysiptera flavipinnis*	✓	✓
Pomacentridae	*Chrysiptera rex*	✓	✓
Pomacentridae	*Chrysiptera rollandi*	✓	✓
Pomacentridae	*Chrysiptera talboti*	✓	✓
Pomacentridae	*Dascyllus aruanus*	✓	✓
Pomacentridae	*Dascyllus reticulatus*	✓	✓
Pomacentridae	*Dascyllus trimaculatus*	✓	✓
Pomacentridae	*Dischistodus melanotus*		✓
Pomacentridae	*Dischistodus perspicillatus*		✓
Pomacentridae	*Dischistodus prosopotaenia*		✓
Pomacentridae	*Dischistodus pseudochrysopoecilus*		✓
Pomacentridae	*Hemiglyphidodon plagiometopon*		✓
Pomacentridae	*Neoglyphidodon melas*		✓
Pomacentridae	*Neoglyphidodon nigroris*		✓
Pomacentridae	*Neopomacentrus azysron*	✓	✓
Pomacentridae	*Neopomacentrus bankieri*	✓	✓
Pomacentridae	*Neopomacentrus cyanomos*	✓	✓
Pomacentridae	*Plectroglyphidodon dickii*	✓	✓
Pomacentridae	*Plectroglyphidodon johnstonianus*	✓	
Pomacentridae	*Plectroglyphidodon lacrymatus*	✓	✓
Pomacentridae	*Plectroglyphidodon leucozonus*		✓
Pomacentridae	*Pomacentrus adelus*		✓
Pomacentridae	*Pomacentrus amboinensis*	✓	✓
Pomacentridae	*Pomacentrus bankanensis*	✓	✓
Pomacentridae	*Pomacentrus brachialis*	✓	✓
Pomacentridae	*Pomacentrus chrysurus*	✓	✓
Pomacentridae	*Pomacentrus coelestis*	✓	✓
Pomacentridae	*Pomacentrus grammorhynchus*	✓	✓
Pomacentridae	*Pomacentrus lepidogenys*	✓	✓

Family	Species	CSIRO	AIMS
Pomacentridae	*Pomacentrus moluccensis*	✓	✓
Pomacentridae	*Pomacentrus nagasakiensis*	✓	✓
Pomacentridae	*Pomacentrus pavo*	✓	
Pomacentridae	*Pomacentrus phillipinus*	✓	
Pomacentridae	*Pomacentrus reidi*	✓	✓
Pomacentridae	*Pomacentrus taeniometapon*	✓	
Pomacentridae	*Pomacentrus vaiuli*	✓	
Pomacentridae	*Pomacentrus wardi*	✓	✓
Pomacentridae	*Stegastes apicalis*	✓	✓
Pomacentridae	*Stegastes fasciolatus*	✓	
Pomacentridae	*Stegastes nigricans*	✓	✓
Pseudochromidae	*Pseudochromis fuscus*		✓
Scaridae	*Cetoscarus bicolour*	✓	✓
Scaridae	*Chlorurus bleekeri*	✓	✓
Scaridae	*Chlorurus japanensis*	✓	✓
Scaridae	*Chlorurus microrhinos*	✓	✓
Scaridae	*Chlorurus sordidus*	✓	✓
Scaridae	*Hipposcarus longiceps*	✓	✓
Scaridae	*Scarus altipinnis*	✓	✓
Scaridae	*Scarus chameleon*	✓	✓
Scaridae	*Scarus dimidiatus*	✓	
Scaridae	*Scarus flavipectoralis*	✓	✓
Scaridae	*Scarus forsteni*	✓	
Scaridae	*Scarus frenatus*	✓	✓
Scaridae	*Scarus ghobban*	✓	✓
Scaridae	*Scarus globiceps*	✓	✓
Scaridae	*Scarus niger*	✓	✓
Scaridae	*Scarus oviceps*	✓	✓
Scaridae	*Scarus psittacus*	✓	✓
Scaridae	*Scarus rivulatus*	✓	✓
Scaridae	*Scarus rubroviolaceus*	✓	✓
Scaridae	*Scarus schlegeli*	✓	✓
Scaridae	*Scarus spinus*	✓	✓
Scombridae	*Scomberomorus commerson*		✓
Serranidae	*Anyperodon leucogrammicus*		✓
Serranidae	*Cephalopholis argus*		✓
Serranidae	*Cephalopholis boenak*		✓
Serranidae	*Cephalopholis cyanostigma*		✓
Serranidae	*Cephalopholis microprion*		✓
Serranidae	*Chromileptes altivelis*	✓	✓
Serranidae	*Diploprion bifasciatum*		✓
Serranidae	*Epinephelus fasciatus*		✓
Serranidae	*Epinephelus merra*		✓
Serranidae	*Epinephelus ongus*		✓

Family	Species	CSIRO	AIMS
Serranidae	*Epinephelus quoyanus*		✓
Serranidae	*Plectropomus areolatus*	✓	✓
Serranidae	*Plectropomus laevis*	✓	✓
Serranidae	*Plectropomus leopardus*	✓	✓
Serranidae	*Plectropomus maculatus*	✓	✓
Serranidae	*Variola louti*	✓	
Siganidae	*Siganus argenteus*	✓	✓
Siganidae	*Siganus corallinus*	✓	✓
Siganidae	*Siganus doliatus*	✓	✓
Siganidae	*Siganus javus*	✓	
Siganidae	*Siganus lineatus*	✓	✓
Siganidae	*Siganus puellus*	✓	✓
Siganidae	*Siganus punctatissimus*		✓
Siganidae	*Siganus punctatus*	✓	✓
Siganidae	*Siganus spinus*	✓	
Siganidae	*Siganus vulpinus*	✓	
Synodontidae	*Synodus jaculum*		✓
Synodontidae	*Synodus variegatus*		✓
Tetraodontidae	*Arothron caeruleopunctatus*		✓
Tetraodontidae	*Arothron nigropunctatus*		✓
Tetraodontidae	*Canthigaster papua*		✓
Zanclidae	*Zanclus cornutus*	✓	