Critical Marine Habitats in High Risk Areas
Torres Strait
Woiz Reef to Kaliko Reef

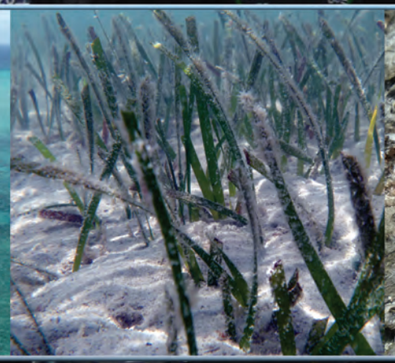
2012 ATLAS

RISK ASSESSMENT

RISK MANAGEMENT

HABITAT MANAGEMENT

HABITAT ASSESSMENT



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Executive Summary

The Torres Strait region covers an area of more than 35,000 km^2 and is located on one of the world's most extensive continental shelves. It comprises 247 islands, eighteen of which are permanently inhabited. Local island communities in the Torres Strait are deeply connected to their sea country through their culture, economy, spirituality and social way of life. The health of their marine resources has been, and continues to be, vital to Torres Strait Islanders from a subsistence, commercial and cultural point of view. The region has long been recognised for its ecological complexity and biodiversity. A total of 6.2% of the area is tidally inundated flats which include ecologically important coral reefs, algal beds, seagrass meadows and sand cays which are potentially at high risk from Australia's ever increasing shipping activity.

Fisheries Queensland's Marine Ecology Group and the Torres Strait Regional Authority developed a program to examine areas throughout the Torres Strait that have been identified as being at high risk from shipping and where there was a lack of detailed information on key marine habitats. To date seven comprehensive atlases have been completed for the Torres Strait that have concentrated on key areas including the Prince of Wales, Adolphus and Great North East (GNE) Shipping Channels as well as the Western Islands region. The 2012 survey focused on areas eastward of the GNE Shipping Channel and the data presented in the maps in this atlas was obtained from surveys conducted in March 2012.

Introduction

Coastal marine habitats in the Torres Strait are important to island communities for subsistence as well as having strong cultural and spiritual value. Despite the remote location of the Torres Strait region, increasing pollution, particularly associated with shipping activities, threatens the viability of the habitat, wildlife and in turn, the way of life for the local communities.

The ports and shipping industry is an essential component of Australia's trade and underpins the viability of many of Australia's export and import industries. Designated shipping lanes have been developed in many areas of Queensland to provide a means for large vessels to access ports. Many of these shipping lanes pass through economically and ecologically important natural habitats and are often in areas that contain significant navigation hazards. In these areas there is a heightened risk of shipping accidents, including collisions and groundings of vessels, that may result in oil, fuel and chemical spills. Many marine habitats such as seagrasses, algae, mangroves and coral reefs are vulnerable to oil and fuel spills, particularly when they occur in intertidal areas. In many instances there is a lack of detailed information on the marine habitats that occur adjacent to these shipping lanes (Rasheed et al. 2005).

Queensland Transport and the Great Barrier Reef Marine Park Authority completed an oil spill and shipping accident risk assessment for coastal waters of Queensland and the Great Barrier Reef Marine Park in 2000 (Queensland Transport and the Great Barrier Reef Marine Park Authority, 2000). The risk assessment identified six marine environment high-risk areas (MEHRA's) for Queensland's shipping lanes and ports where there was an increased risk of accidents as well as heightened consequences. The six MEHRA's identified in the risk assessment were:

1. Prince of Wales Channel (Torres Strait)
2. Great North East Channel (Torres Strait)
3. Inner Shipping Route between Cape Flattery and Torres Strait
4. Whitsunday Islands and Passages
5. Hydrographers Passage
6. Moreton Bay

Fisheries Queensland's Marine Ecology Group, with support from other agencies including the Torres Strait Regional Authority, developed a program to examine areas of these MEHRA's where there was a lack of detailed information on key marine habitats. The group has already published seven atlases in the series;

- the Inner Shipping Route (Rasheed et al. 2005),
- Hydrographers Passage Shipping Channel (Rasheed et al. 2006),
- Prince of Wales and Adolphus Shipping Channels (Rasheed and Thomas 2005)
- central and eastern regions of the Great North East (GNE) shipping channel in the Torres Strait (Taylor et al. 2008),
- the west and north regions of the GNE channel (Taylor et al. 2009),
- western islands region, Torres Strait (Taylor et al. 2010 & 2011)

Many ecologically and economically valuable intertidal marine habitats that occur in these areas may be vulnerable to oil, fuel or chemical spills from a shipping accident and concentrated marine debris including ghost nets and derelict fishing gear. This atlas provides fine scale maps of vulnerable marine habitats eastwards of the GNE Shipping Channel. The detailed information collected on the location and nature of habitat types presented in this atlas will be included in the Geographic Information System (GIS) database for the Oil Spill Response Atlas (OSRA), an important resource aiding decision making and emergency response to shipping accidents and oil spills.

Data presented in the maps in this atlas was obtained from surveys conducted in March 2012.

Why survey the Torres Strait region?

Torres Strait was created as an island archipelago approximately 9,000 years ago as a result of the post-glacial sea level rise and consequent inundation of the Sahul Shelf — the land bridge connecting Australia with Papua New Guinea (Barham and Harris 1983; Harris et al. 2008). The Torres Strait covers some 48,000 km^2 and has biogeographical importance as it represents the meeting of two ocean systems – the Pacific Ocean (Coral Sea) and the Indian Ocean (Arafura Sea). The resulting tidal influence greatly affects the region's biodiversity, and coupled with a large freshwater and sediment input from nearby rivers further influences this unique marine ecosystem (Australian Maritime Safety Authority, 2002). The Strait is mostly shallow (predominately less than 15m deep) and has numerous continental and volcanic islands, coral cays, mangroves, and complex coral reef systems as well as extensive seagrass beds (Coles et al. 2003).

Eighteen of the 247 islands in the Torres Strait are permanently inhabited. The inhabited islands are separated into four distinct regional groups: high continental Western Islands; swampy Top Western Islands adjacent to the Papua New Guinea mainland; low, sandy, Central Island group; and volcanic Eastern Islands (Harris et al. 2008; Johannes and MacFarlane 1991). Local island communities in the Torres Strait are deeply connected to their sea country through their culture, economy, spirituality and social way of life. The health of their marine resources has been, and continues to be, vital to Torres Strait Islanders from a subsistence and cultural point of view.

The Torres Strait became a Particularly Sensitive Sea Area in July 2005, following submissions made to the International Maritime Organization (IMO) by the Australian and Papua New Guinean governments. Particularly Sensitive Sea Areas (PSSAs) are areas of the marine environment that need special protection through action by IMO because of significance for recognised ecological, socio-economic, or scientific attributes where such attributes may be vulnerable to damage by international shipping activities. Two associated protective measures were approved by IMO for application in the Torres Strait – a new two way shipping route (Great North East (GNE) Channel) and an extension of the system of pilotage that had applied in the Great Barrier Reef since 1990. These measures were selected to improve the safety of navigation in the area (Australian Maritime Safety Authority, 2008).

The GNE and Prince of Wales (POW) Shipping Channel's were selected for investigation for a number of reasons including:

- They are two of the six identified MEHRA's for Queensland
- They contain a high diversity of intertidal habitats (including seagrass and coral reefs) in close proximity to the shipping channels
- They are very complicated to navigate, with complex tidal streams and currents, have limited water depth and are in close proximity to islands and reefs
- There was a lack of fine scale information on intertidal habitats in the area
- Torres Strait Islanders have a high reliance on fisheries that depend on these habitats

The selection process included an examination of existing habitat information and consultation with shipping management agencies in Queensland (Maritime Safety Queensland and the Torres Strait Regional Authority). The Torres Strait is a vital economic link, being the only link between the Arafura and Coral Seas. The GNE and POW channel's are used primarily by large vessels trading between ports in southern Asia, Australia, New Zealand, South America, Papua New Guinea and Pacific Island nations. The GNE channel runs in a southwest to northeast direction from Kirkcaldie Reef in the south to Bramble Cay in the north. The POW channel runs in an east to west direction and passes between the Inner Island Cluster of Waibene (Thursday Island), Ngurupai (Horn Island), Keriri (Hammond Island), Gealug (Friday Island), Mawai (Wednesday Island), Muralug (Prince of Wales Island) and Palilug (Goods Island) and Zuguin (No. 1) Reef (Map 1). The channel's are narrow in a number of sections, being only a few hundred metres wide at its narrowest, and are bordered by important marine habitats including seagrass beds, coral reefs and extensive dugong habitat.

Approximately 3000 voyages are undertaken by shipping vessels through the GNE channel each year, making it a high use passage in Queensland waters (Neil Trainor, Australian Maritime Safety Authority, pers. comm., 2008). The rate of passage through the POW channel is less clear, as this is not a compulsory pilotage channel. Of these ships passing through the Torres Strait, the majority were oil and product tankers, and general cargo ships (Figure 1; Neil Trainor, Australian Maritime Safety Authority, 2008). The Torres Strait region has a high rate of shipping incidents compared to other shipping passages. There are at least 20 separate accidents recorded back to 1970, 18 of which were ship groundings on reefs, with the remaining two being discharge accidents while docked at the Port of Thursday Island (Queensland Transport and the Great Barrier Reef Marine Park Authority, 2000). Of these 20 accidents, four caused large quantities of oil and fuel to be spilt into the sea (John Wright, Maritime Safety Queensland, 2006). The most recent incident occurred in February 2009, where a products tanker grounded on Kirkcaldie Reef. Luckily, there was no damage to the ship and therefore no spill of pollutants, however, there was damage to the reef flat and associated habitats (Australian Maritime Safety Authority, 2009).

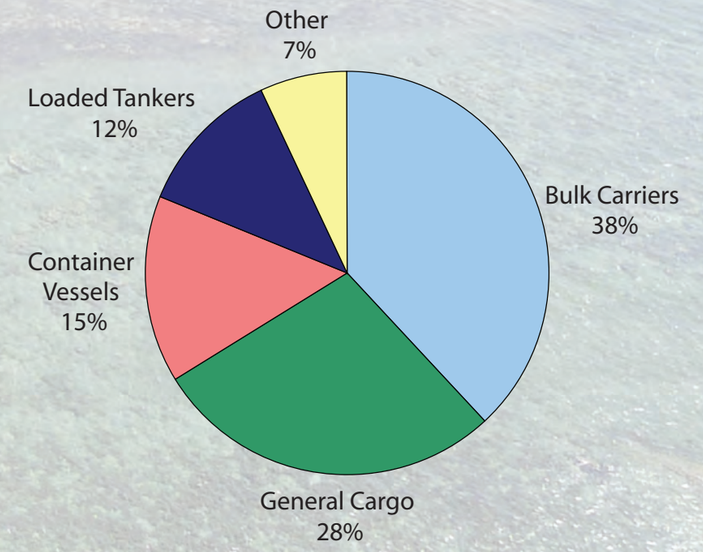


Figure 1 Vessel types using the Great North East Channel

Shipping accidents in Torres Strait also pose a serious risk to commercial and Indigenous fishing. Commercial fishing is one of the most economically important activities in the Torres Strait and provides a significant opportunity for financial independence for community fishers. As traditional inhabitants of the Torres Strait, the people are able to fish for both commercial and non-commercial fish species. Historically, however, licences were often issued to non-traditional inhabitants. Since 1985, new licences have only been issued to traditional inhabitants and buy-back schemes have been employed to reduce the total number of licences in various fisheries and to reduce the number of non-traditional fishers to zero (Torres Strait Protected Zone Joint Authority, 2009).

There are a large number of commercial fisheries operating in the region including the Torres Strait prawn, tropical rock lobster, trochus, finfish and beche-de-mer fisheries. The Torres Strait prawn fishery is the most valuable commercial fishery with 907 tonnes of product taken in the 2008 fishing season valued in excess of $10 million (Australian Fisheries Management Authority, 2009). The extensive seagrass habitats located around the GNE and POW channel's provides vital nursery ground habitats for juvenile prawns associated with the fishery. The tropical rock lobster fishery is the second most valuable commercial fishery in the Torres Strait and is very important to many islanders. There are 13 licensed primary vessels in the fishery and a further 428 Traditional Inhabitant Boat licences, with 92% of recorded catch by Islanders sold as commercial product (Australian Fisheries Management Authority, 2009; Caton & McLoughlin, 2004).

Traditionally, Torres Strait Islanders' spiritual and cultural heritage is linked with the land and the sea and many Islanders rely on a wide range of marine species for subsistence and cultural uses. Torres Strait Islanders fish for a large range of species with dugong, turtle and crayfish being the main target species (Harris et al. 1995). A reduction in the take of dugong and turtle is currently being managed by traditional inhabitants at a community level with many communities developing and implementing Dugong and Turtle Management Plans.

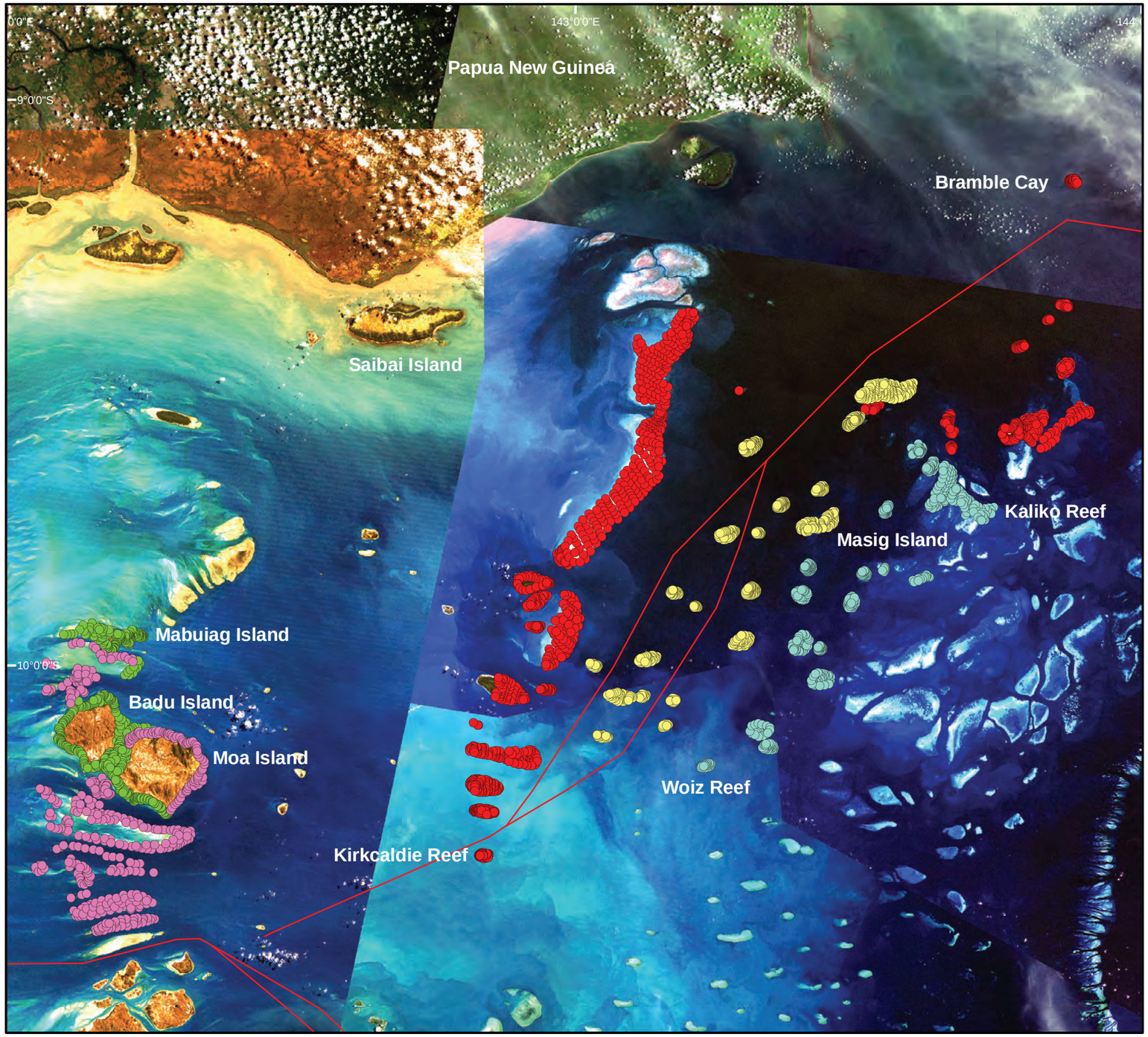
Marine debris poses a serious threat to the marine biodiversity on which the Torres Strait Islanders so depend. In particular, ghost nets threaten the environmental, economic, cultural and aesthetic well-being of the island communities in this region and were recently listed as a threatening process under the Environment Protection and Biodiversity Conservation Act. Surveys of the GNE channel and Inner Island Cluster in 2008 located high densities of ghost nets, fuel drums and oyster cages along intertidal banks (Taylor et al. 2008). The ghost nets have the potential to "continue fishing", catching fish, marine mammals and turtles, many of which are threatened or endangered. Surveys in the Northern Gulf of Carpentaria have found high numbers of ghost net entanglements of threatened and endangered turtle species each year (Ghost Nets Australia, 2009).

The high fisheries, indigenous and ecological values of the habitats that surround the GNE and POW channels, coupled with the high incidence of accidents and increasing shipping use and threat of marine debris, make the Torres Strait region an area of particular interest.

Poruma Island community

Ship wreck on Bet Reef

Map 1. Torres Strait survey area and habitat assessment sites in areas of high risk, 2008-2012



Legend

- Habitat Assessment Sites 2012
- Habitat Assessment Sites 2011
- Habitat Assessment Sites 2010
- Habitat Assessment Sites 2009
- Habitat Assessment Sites 2008
- Major shipping channels

N

0 10 20 30 40

Kilometres

Source:
Taylor HA and McKenna SA (2012) Critical marine habitats in high risk areas, Torres Strait - Woiz Reef to Kaliko Reef - 2012 Atlas. DAFF Publication (Fisheries Queensland, Northern Fisheries Centre, Cairns). Funded by TSRA and DAFF. Produced by the Marine Ecology Group, 2012. © The State of Queensland through the Department of Agriculture, Fisheries and Forestry.
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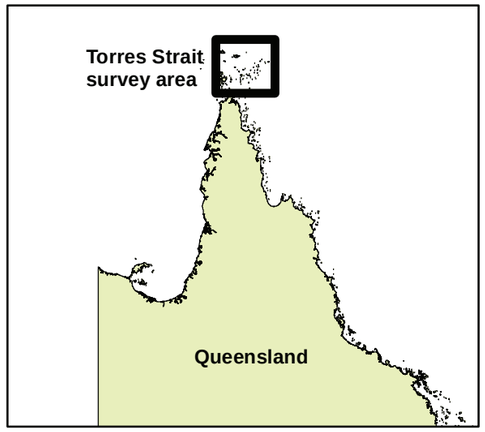


Survey Methodology

Methods used in these surveys were based on those developed by Fisheries Queensland's Marine Ecology Group for similar surveys in other Queensland locations (e.g. Rasheed et al. 2005; 2004; 2003), and were the same as those used in the 2008-2010 surveys. A spring low tide window was utilised to survey the area between the 26-30th March 2011. Two main mapping and survey techniques were used to collect marine habitat data for the maps presented in this atlas:

1. Helicopter Aerial Surveys

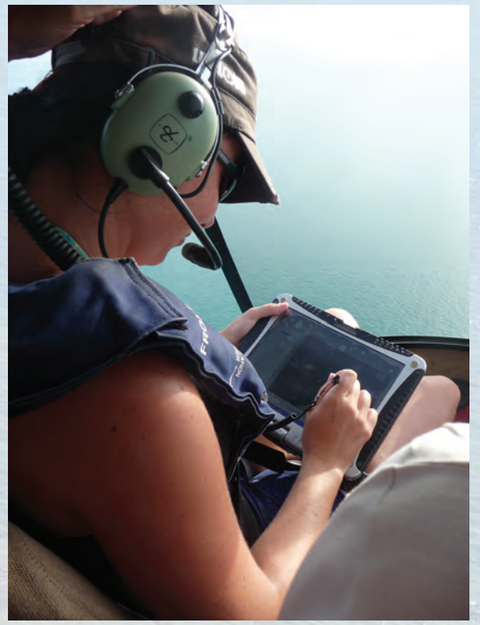
Intertidal habitat boundaries, characteristics and species composition were determined using a helicopter around spring low tides when habitats were exposed. Observers in a helicopter hovered directly over the habitat at a height of <5m and the position was fixed using a Global Positioning System (GPS), accurate to ± 5 m. Habitat characterisation sites were scattered haphazardly within the mapped habitat boundaries with a greater intensity of sites in areas with high habitat complexity.

2. Aerial Photography and Satellite Imagery

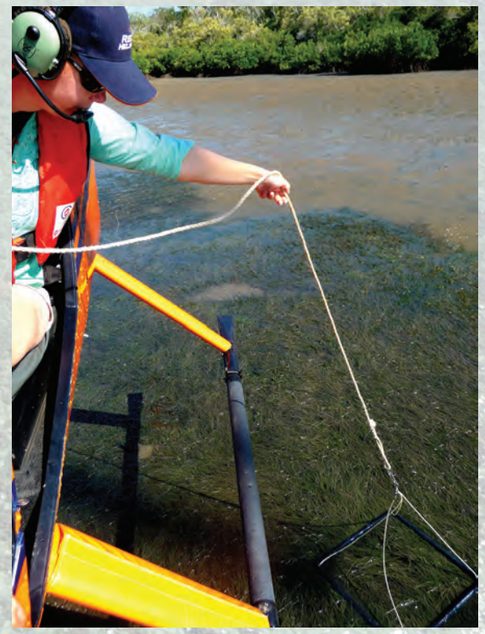
Existing aerial photography of the survey area (Beach Protection Authority, 1992, 1:50,000), aerial photographs taken during the helicopter surveys and available satellite imagery (LANDSAT 7 ETM+, Commonwealth of Australia; Spot5; Ikonos; Quikbird) were used to aid in mapping and determination of habitat boundaries for intertidal communities.

Data entry

Using GIS mapping techniques in the helicopter



Collecting seagrass biomass data using a quadrat



Habitat Characterisation

Habitat characterisation was based on survey sites that encompassed a circular area of the substratum of approximately 10 m^2. The position of each site was recorded using GPS. The information collected for seagrass, algae and benthic macro-invertebrate (BMI) habitat at each site was consistent:

1. Seagrass

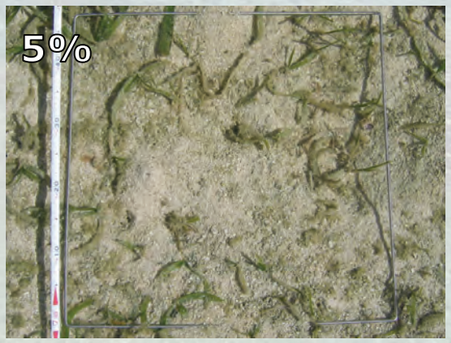
At sites where seagrass was present the seagrass species composition, seagrass above-ground biomass, percent cover, sediment type and time were recorded. Seagrass above-ground biomass was determined using a modified "visual estimates of biomass" technique described by Mellors (1991). This technique involves an observer ranking seagrass biomass in the field in three random placements of a 0.25 m^2 quadrat at each site. Ranks were made in reference to a series of quadrat photographs of similar seagrass habitat for which the above-ground biomass has previously been measured. Three separate biomass ranges were used, low-biomass, high-biomass and an *Enhalus* scale. The relative proportion of the above-ground biomass (percentage) of each seagrass species within each survey quadrat was also recorded. Field biomass ranks were then converted into above-ground biomass estimates in grams dry weight per square metre (g DW m^{-2}). At the completion of sampling each observer ranked a series of calibration quadrats that represented the range of seagrass biomass in the survey. After ranking, seagrass in these quadrats was harvested and the actual biomass determined in the laboratory. A separate regression of ranks and biomass from these calibration quadrats was generated for each observer and applied to the field survey data to determine above ground-biomass estimates.

The presence or absence of seagrass at each site was defined by the above-ground biomass. Where above-ground biomass was absent, the presence of rhizome/root and seed bank material was reported. Survey sites with no seagrass can be found within meadows because seagrass cover within meadows is not always uniform, and may be patchy and contain bare gaps or scars.

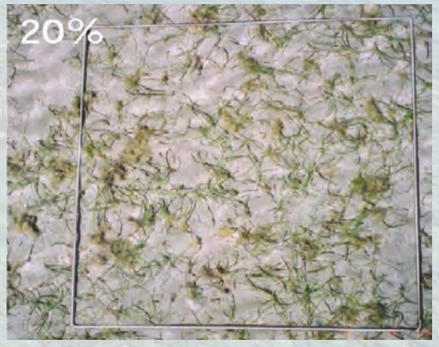
In addition, a visual estimate was made of the overall percent cover of seagrass at each site. All sites within a seagrass region were grouped to provide a mean percent cover of seagrass for that region. This percent cover was presented as a range in five categories:

- Very Low (0-10%)
- Low (10-30%)
- Moderate (30-50%)
- High (50-75%)
- Very High (75-100%)

Seagrass quadrat from helicopter for "visual estimate of above-ground biomass"

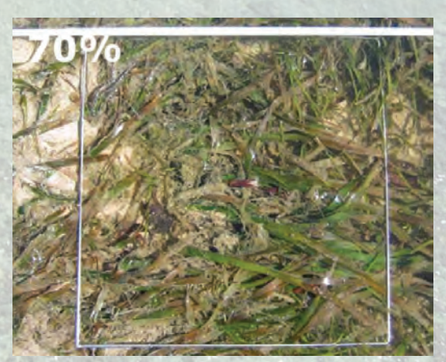


Very Low percent cover
(0-10%)

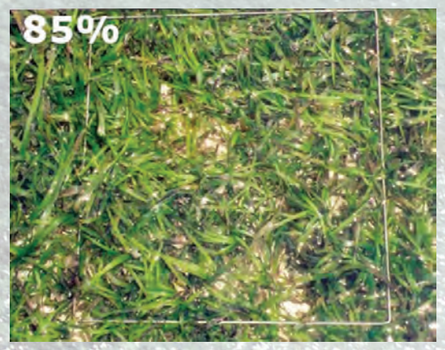


Low percent cover
(10-30%)

Moderate percent cover
(30-50%)



High percent cover
(50-75%)



Very High percent cover
(75-100%)

2. Algae

For this atlas, algae habitat occurring in the intertidal zone was mapped. At sites where algae were present, they were classified into the following five functional groups:

- Erect macrophytes - Macrophytic algae with an erect growth form and high level of cellular differentiation e.g. *Sargassum*, *Caulerpa* and *Galaxaura* species
- Erect calcareous - Algae with erect growth form and high level of cellular differentiation containing calcified segments e.g. Halimeda species
- Filamentous - Thin thread-like algae with little cellular differentiation
- Encrusting - Algae growing in sheet like form attached to substrate or benthos e.g. coralline algae
- Turf Mat - Algae that forms a dense mat or "turf" on the substrate

At each site, a visual estimate was made of the overall percent cover of algae as well as the relative proportion of the total cover made up of each of the five algal functional groups. All sites within an algae region were grouped to provide a mean percent cover of algae for that region. This percent cover was presented as a range in five categories:

- Very Low (0-10%)
- Low (10-30%)
- Moderate (30-50%)
- High (50-75%)
- Very High (75-100%)

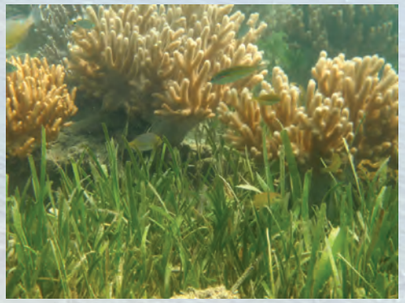
3. Benthic macro-invertebrates (BMI)

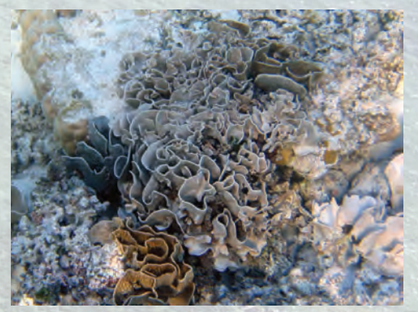
Benthic macro-invertebrate (BMI) habitat occurring in the intertidal zone was mapped. At sites where BMI were present, they were identified into the following four broad taxonomic groups:

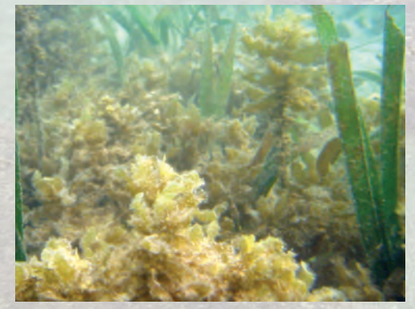
- Hard corals - All massive, branching, tabular, digitate and mushroom scleractinian corals
- Soft corals - All alcyonarian corals i.e. corals lacking a hard limestone skeleton
- Sponges - All sponges were grouped together
- Other BMI - Any other BMI identified e.g. ascidians, bivalves, gastropods and holothurians

At each site, a visual estimate was made of the overall percent cover of each of the BMI broad taxonomic groups.

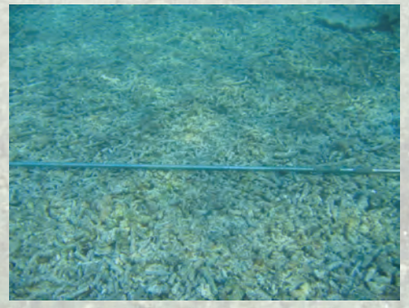

Hard coral with seagrass in background

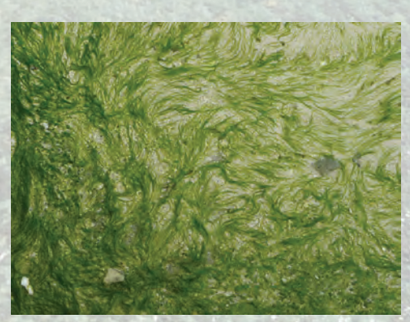

Soft coral with seagrass


Sponges


Erect macrophytes with seagrass


Erect calcareous algae


Encrusting and turf algae on coral rubble


Filamentous algae

Geographic Information System (GIS)

All data were entered into a Geographic Information System (GIS) developed for the Torres Strait. Rectified colour aerial and satellite imagery of the region (Beach Protection Authority and Commonwealth of Australia), combined with aerial photography taken from the helicopter during surveys assisted with mapping. Other information including substrate type, the shape of existing geographical features such as reefs and channels, and evidence of strong wave energy or tidal currents was also interpreted and used in determining habitat boundaries.

The precision of determining seagrass and algae region boundaries depended on the range of mapping information and methods available for each region. Intertidal region boundaries followed with GPS had the highest precision. Seagrass and algae meadows whose boundaries extended into the subtidal region had the lowest precision.

Each habitat region was assigned a mapping precision estimate (in metres) based on mapping methodology utilised for that region (Table 1). Mapping precision ranged from ± 10 m for isolated intertidal seagrass and algae regions to ± 100 m (Table 1). The mapping precision estimate was used to calculate a range of area for each region and was expressed as a reliability estimate (R) in hectares. Additional sources of mapping error associated with digitising and rectifying aerial photographs onto base maps and with GPS fixes for survey sites were assumed to be embedded within the reliability estimates.

Seagrass community types were determined according to overall species composition. A standard nomenclature system was used to name each of the seagrass meadows in the survey area. This system was based on the percent composition of biomass contributed by each species within the meadow (Table 2). This nomenclature also included a measure of meadow density that was determined by the mean-above ground biomass of the dominant species within the community (Table 3).

Table 1 Mapping precision and methodology for seagrass and algae regions in the Torres Strait survey area, 2012

Mapping precision	Mapping methodology
10 m	Algae, BMI & seagrass boundaries mapped from helicopter surveys All regions all intertidal Relatively high density of mapping and survey sites Recent aerial and satellite imagery aided in mapping
50 m	Seagrass meadow boundaries interpreted from helicopter surveys and distance between sites Algae/BMI region boundaries based on distance between survey sites Algae/BMI regions all intertidal Relatively low density of survey sites Recent aerial and satellite imagery aided in mapping
100 m	Seagrass/algae/BMI boundaries interpreted from helicopter survey and recent aerial and satellite imagery Relatively low density of survey sites

Table 2 Nomenclature for seagrass community types in the Torres Strait survey area, 2012

Community type	Species composition
Species A	Species A is 90-100% of composition
Species A with Species B	Species A is 60-90% of composition
Species A with Species B/Species C	Species A is 50-60% of composition
Species A/Species B	Species A is 40-60% of composition

Table 3 Density (biomass) categories and mean above-ground biomass ranges for each species used in determining seagrass community density in the Torres Strait survey area, 2012

Density (biomass) category	Dominant seagrass species in meadow (g DW m^{-2})		
	H. ovalis	***C. rotundata***	***T. hemprichii***
Light	< 0.5	< 5	< 5
Moderate	0.5-5	5-25	5-25
Dense	> 5	> 25	> 25

Critical Marine Habitats of Torres Strait

A total of 602 habitat assessment sites were surveyed in intertidal regions in the western islands section of the Torres Strait during March 2012 (Map 1). The survey assessed the benthic habitat in a total of 18 intertidal island and reef areas. Algae were the dominant habitat type (excluding open substrate) in the survey area (Figure 2), although there were also large areas dominated by hard and soft coral and seagrass. Seagrass, algae and BMI often occurred together within the same habitat characterisation sites and hence had overlapping distributions.

Seagrasses

Extensive, diverse and healthy intertidal seagrass habitat occurred throughout the Torres Strait western islands survey area and covered an area of 2,561 ± 322 ha (Table 4; Maps 3-9). Seagrass was the fifth most dominant habitat type identified and was present on the many of intertidal island/reef regions surveyed. Seagrass presence and distribution was greatest in the northern most part of the survey limits (Figure 2).

Percent cover of intertidal seagrass meadows was generally very low (0-10%). Only two meadows were identified as having a cover of greater than 10% (Table 4). The first low cover meadow (10-30% cover) was a single isolated patch of seagrass located on Woiz Reef (Map 3), while the other was located on Mimi Islet (Map 4).

Three seagrass species were identified in 4 distinct community types and 15 meadows (Figure 3; Table 4; Maps 10-16). All of the seagrass communities identified were dominated by large, slow growing species which are highly vulnerable to oil spills and associated dispersants. The majority of these were dominated by *Thalassia hemprichii* (Table 4). *Cymodocea rotundata* dominated meadows were the second most commonly identified. The meadows identified were typically comprised of aggregated patches of cover with some meadows having isolated patches of seagrass. Seagrass meadows generally occupied the inner intertidal zone adjacent to islands, and in many cases extended to the inside edge of the reef crest.

It is important to note that seagrasses may have a much larger extent than reported here, as subtidal areas were not surveyed.

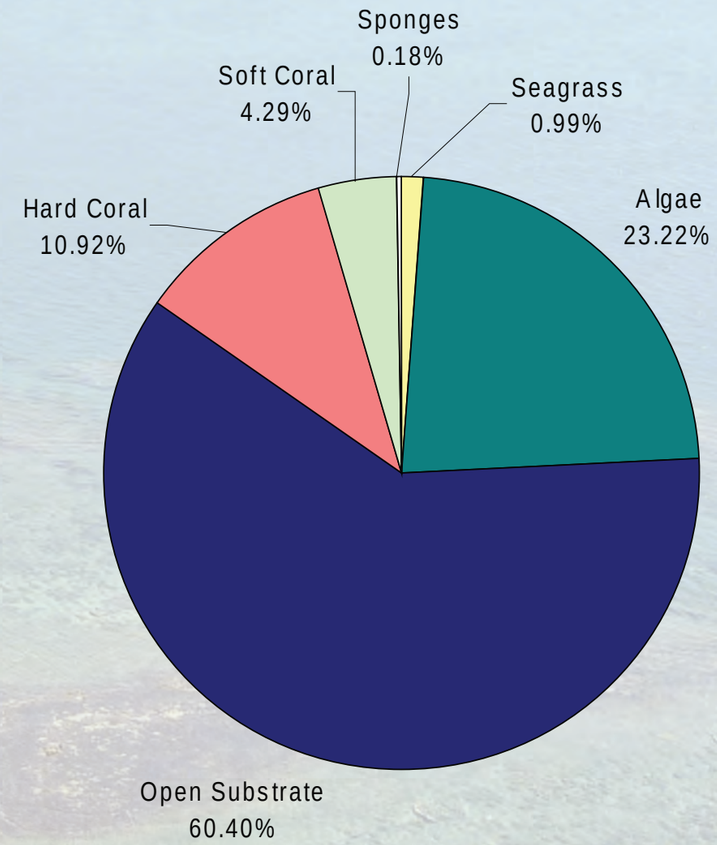


Figure 2 Mean per cent cover of major benthos types in the Torres Strait survey area, 2012

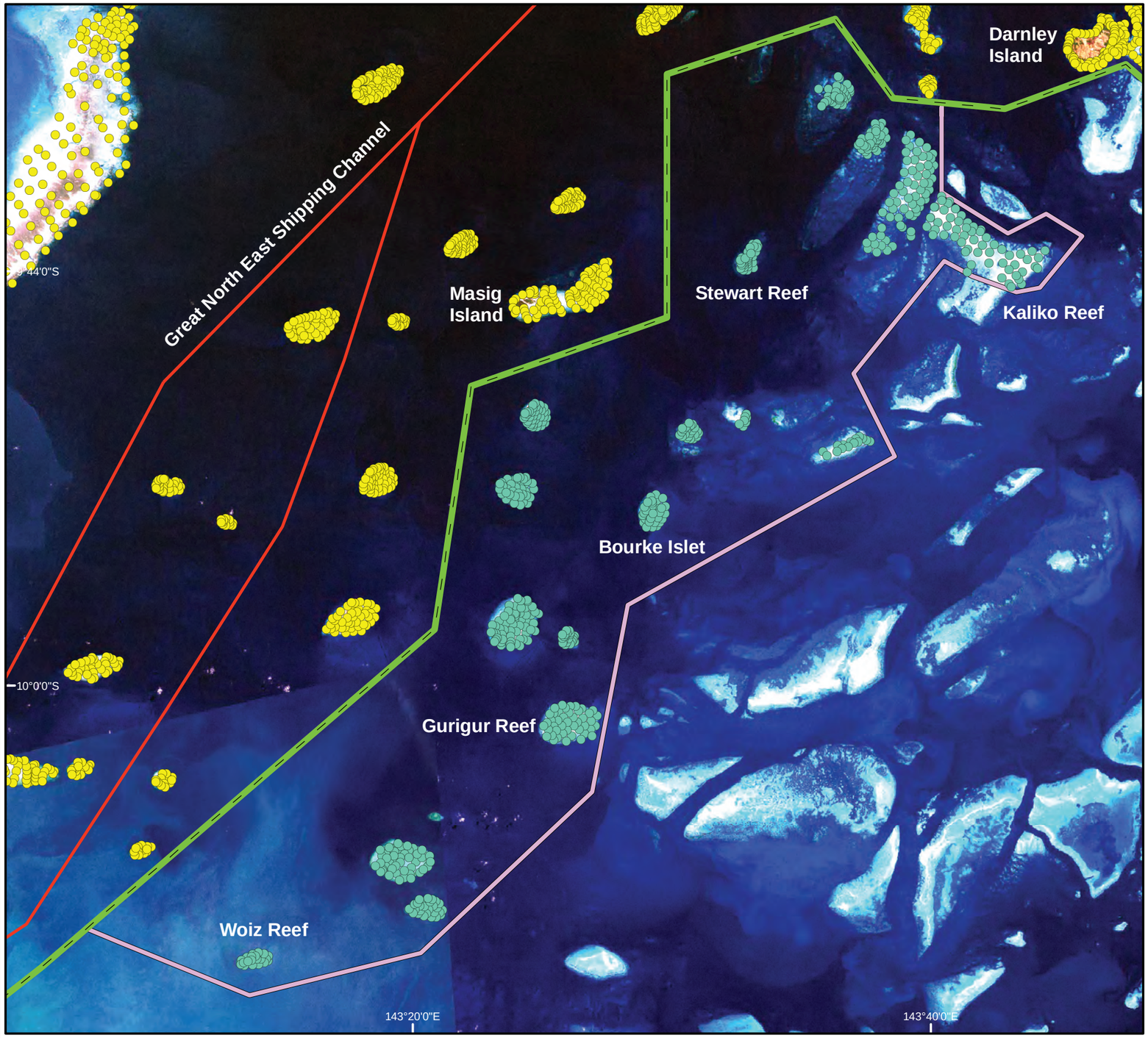
Family CYMODOCEACEAE Taylor:
Cymodocea rotundata
Ehrenb. et. Hempr. ex Aschers

Family HYDROCHARITACEAE Jussieu:
Halophila ovalis
(R. Br.) Hook. F.

Thalassia hemprichii
(Ehrenb.) Aschers. in Petermann

Figure 3 Three seagrass species (from two families) identified in the Torres Strait survey area, 2012

Map 2. Torres Strait survey area and habitat assessment sites in areas of high risk, 2012



Legend

- Habitat Assessment Sites 2008
- Habitat Assessment Sites 2012
- Shipping Channel
- Survey extent 2008
- Survey extent 2012

N

0 5 10 15 20

Kilometres

Source:
Taylor HA and McKenna SA (2012) Critical marine habitats in high risk areas, Torres Strait - Woiz Reef to Kaliko Reef - 2012 Atlas. DAFF Publication (Fisheries Queensland, Northern Fisheries Centre, Cairns). Funded by TSRA and DAFF. Produced by the Marine Ecology Group, 2012. © The State of Queensland through the Department of Agriculture, Fisheries and Forestry.
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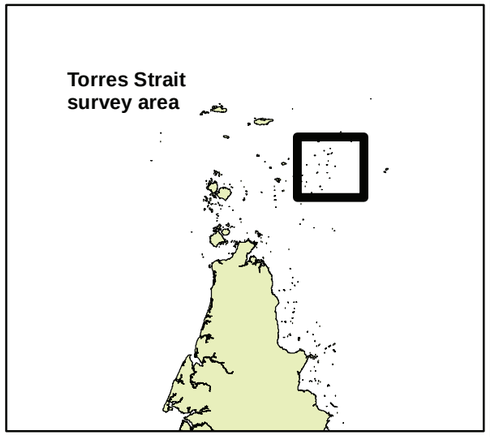
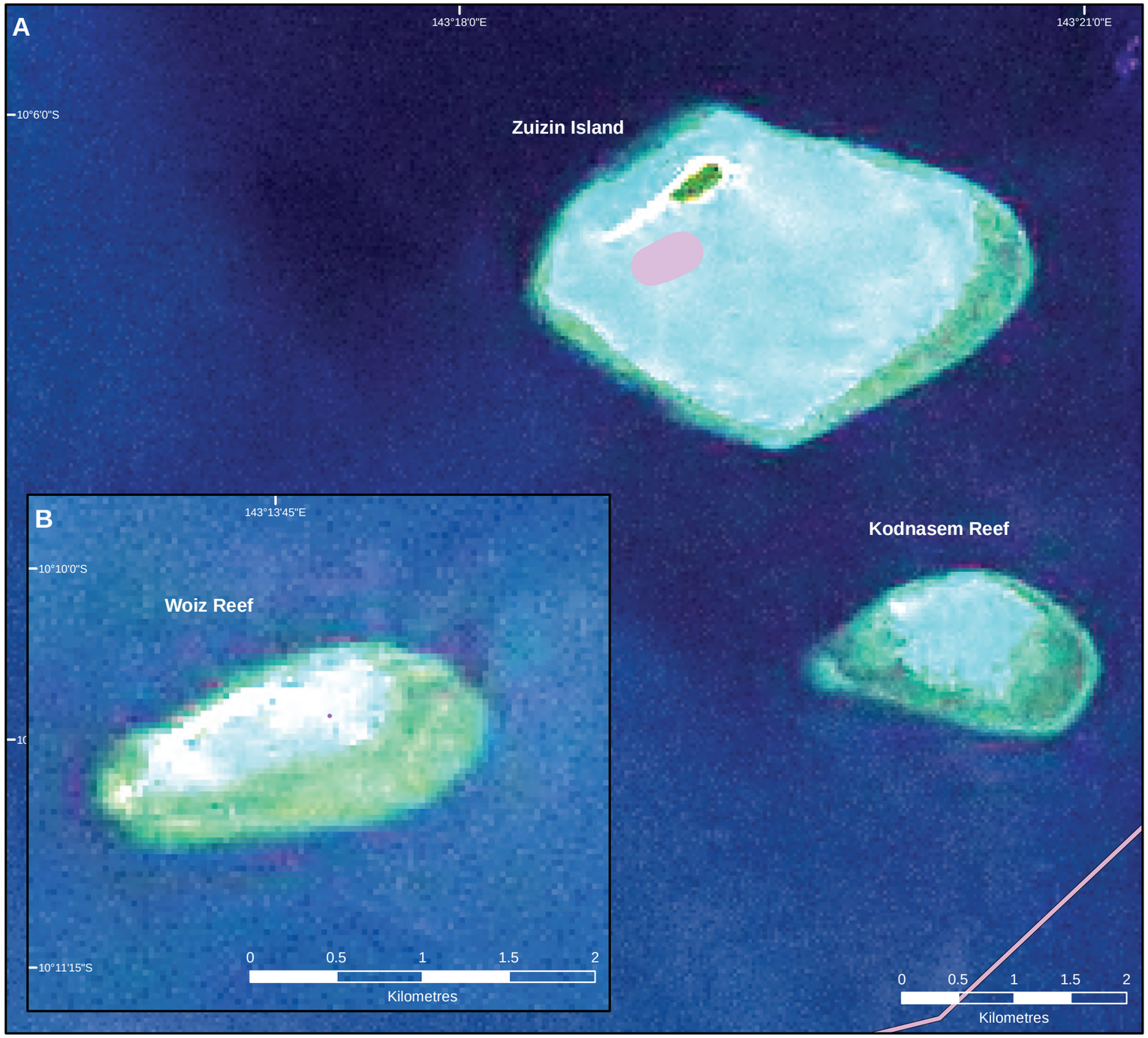


Table 4 Seagrass community type, biomass and area (ha) between Woiz and Kaliko Reef, Torres Strait, 2012

Meadow ID	Location	Community Type	Cover	Species Present	Mean Biomass (g dw m^{-2})	Area ± R (ha)
94	Woiz Reef	Moderate *Thalassia hemprichii*	Isolated Patches	*Thalassia hemprichii*	NR	0.05 ± 0.01
95	Zuizin Island	Light *Thalassia hemprichii*	Isolated Patches	*Thalassia hemprichii*	NR	21.34 ± 1.76
96	Gurigur Reef	Light *Cymodocea rotundata* with *Thalassia hemprichii*	Aggregated Patches	*Thalassia hemprichii, Cymodocea rotundata*	NR	42.75 ± 16.79
97	Aukane Islet	Light *Thalassia hemprichii*	Aggregated Patches	*Thalassia hemprichii*	3.46 ± 1.23	163.6 ± 29.7
98	Bourke Islet	Light *Thalassia hemprichii*	Aggregated Patches	*Thalassia hemprichii*	1.01 ± 0.61	160.21 ± 29.7
99	Kabbikane Islet	Light *Thalassia hemprichii*	Aggregated Patches	*Thalassia hemprichii*	1.05 ± 0.58	102.84 ± 19.94
100	Unnamed reef 2	Light *Thalassia hemprichii*	Aggregated Patches	*Thalassia hemprichii*	2.02 ± 1.75	19.97 ± 9.12
101	Unnamed reef 3	Light *Thalassia hemprichii*	Isolated Patches	*Thalassia hemprichii*	NR	2.94 ± 0.64
102	Unnamed reef 4	Light *Thalassia hemprichii*	Aggregated Patches	*Thalassia hemprichii*	0.04 ± 0.03	64.84 ± 21.59
103	Stewart Reef	Light *Thalassia hemprichii*	Aggregated Patches	*Thalassia hemprichii*	1.1 ± 0.51	69.17 ± 22.75
104	Unnamed reef 5	Light *Thalassia hemprichii*	Aggregated Patches	*Thalassia hemprichii*	0.28 ± 0.28	6.76 ± 6.1
105	Unnamed reef 6	Light *Thalassia hemprichii*	Aggregated Patches	*Thalassia hemprichii*	0.47 ± 0.33	31.51 ± 10.91
106	Unnamed reef 7	Light *Thalassia hemprichii*	Aggregated Patches	*Thalassia hemprichii, Halophila ovalis*	1.5 ± 0.47	500.4 ± 68.71
107	Kaliko Reef	Light *Thalassia hemprichii*	Aggregated Patches	*Thalassia hemprichii, Halophila ovalis*	3.01 ± 0.9	1298.07 ± 64.7
108	Mimi Islet	Moderate *Cymodocea rotundata* with *Thalassia hemprichii*	Aggregated Patches	*Cymodocea rotundata, Thalassia hemprichii*	10.42 ± 0.99	77.0 ± 19.4

NR - (not recorded) signifies seagrass present but too sparse to record biomass

Map 3. Seagrass distribution and percent cover on Woiz Reef, Kodnasem Reef and Zuizin Island, Torres Strait, March 2012



Legend

Seagrass % Cover

- Very Low (0-10%)
- Low (10-30%)
- Shipping Channel
- Survey extent 2012

N

Source:
Taylor HA and McKenna SA (2012) Critical marine habitats in high risk areas, Torres Strait - Woiz Reef to Kaliko Reef - 2012 Atlas. DAFF Publication (Fisheries Queensland, Northern Fisheries Centre, Cairns). Funded by TSRA and DAFF. Produced by the Marine Ecology Group, 2012. © The State of Queensland through the Department of Agriculture, Fisheries and Forestry.
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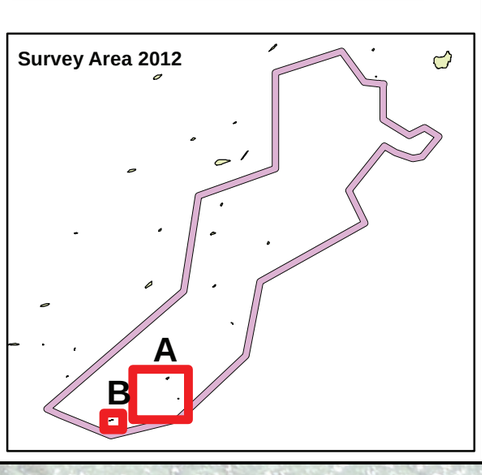
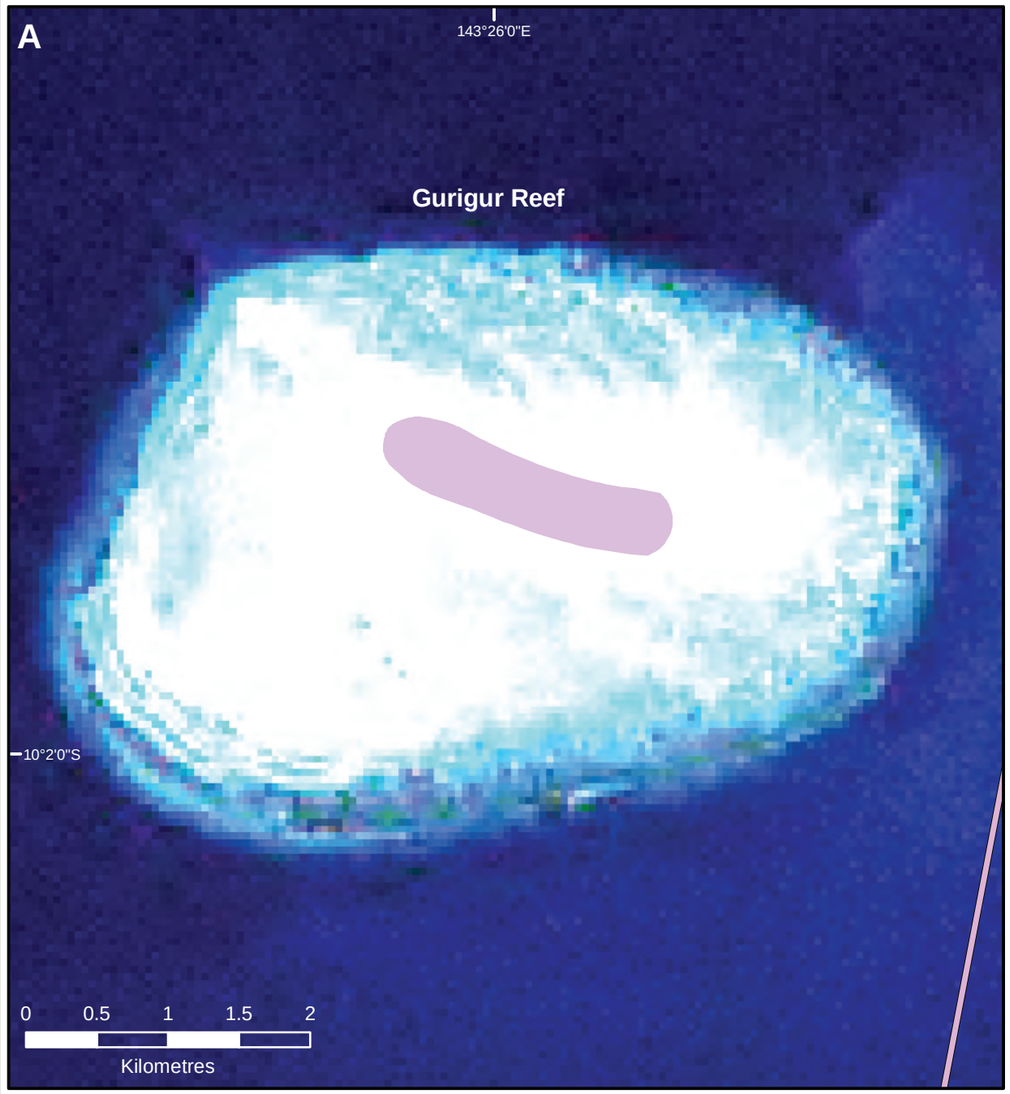
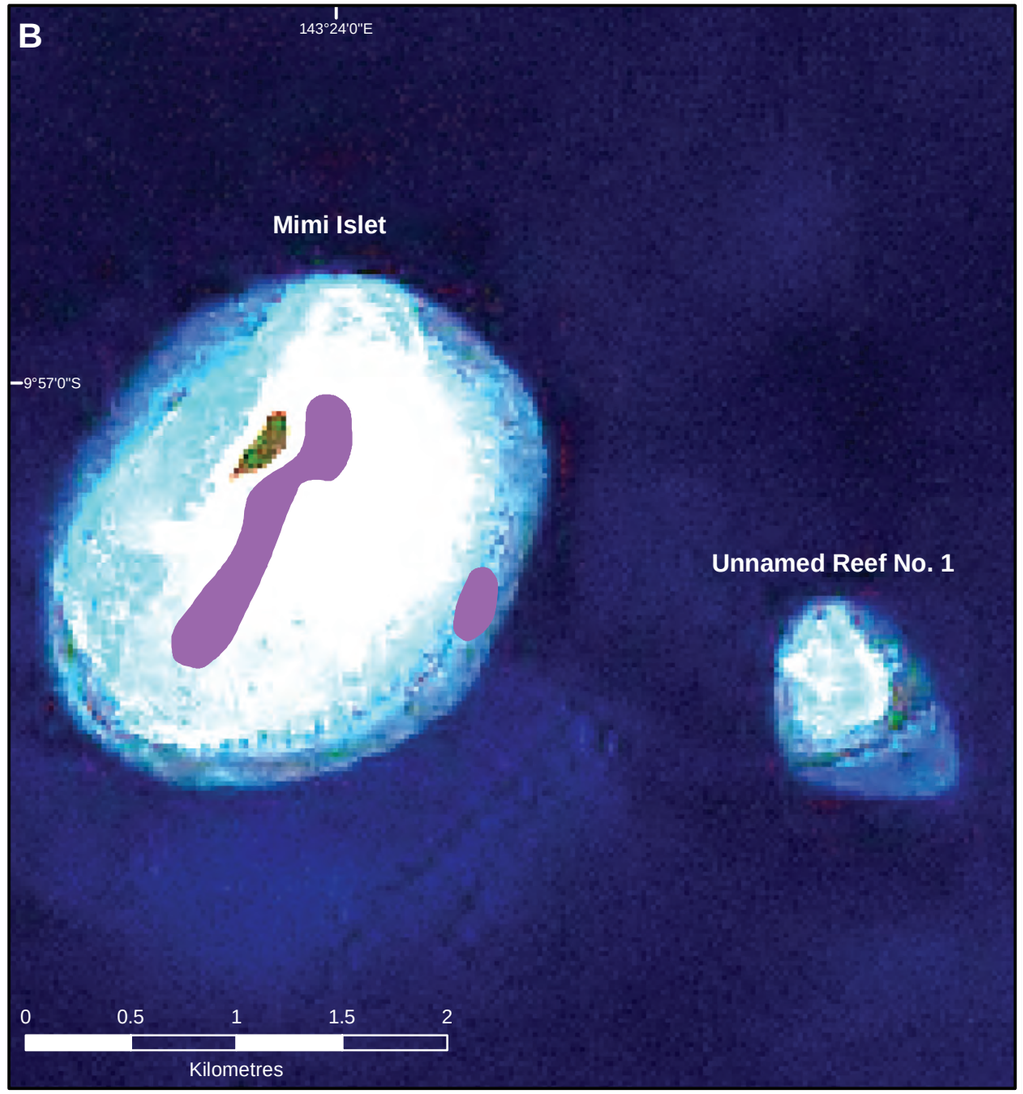


Map 4. Seagrass distribution and percent cover on Gurigur Reef, Mimi Islet and Unnamed Reef No. 1, Torres Strait, March 2012





Legend

Seagrass % Cover

- Very Low (0-10%)
- Low (10-30%)
- Shipping Channel
- Survey extent 2012

N

Source:
Taylor HA and McKenna SA (2012) Critical marine habitats in high risk areas, Torres Strait - Woiz Reef to Kaliko Reef - 2012 Atlas. DAFF Publication (Fisheries Queensland, Northern Fisheries Centre, Cairns). Funded by TSRA and DAFF. Produced by the Marine Ecology Group, 2012. © The State of Queensland through the Department of Agriculture, Fisheries and Forestry.
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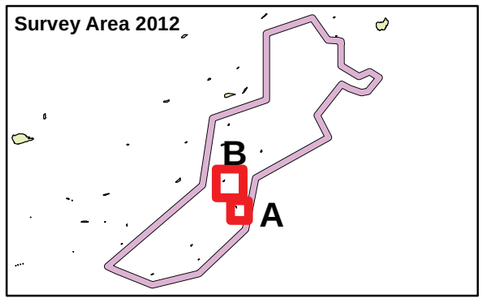
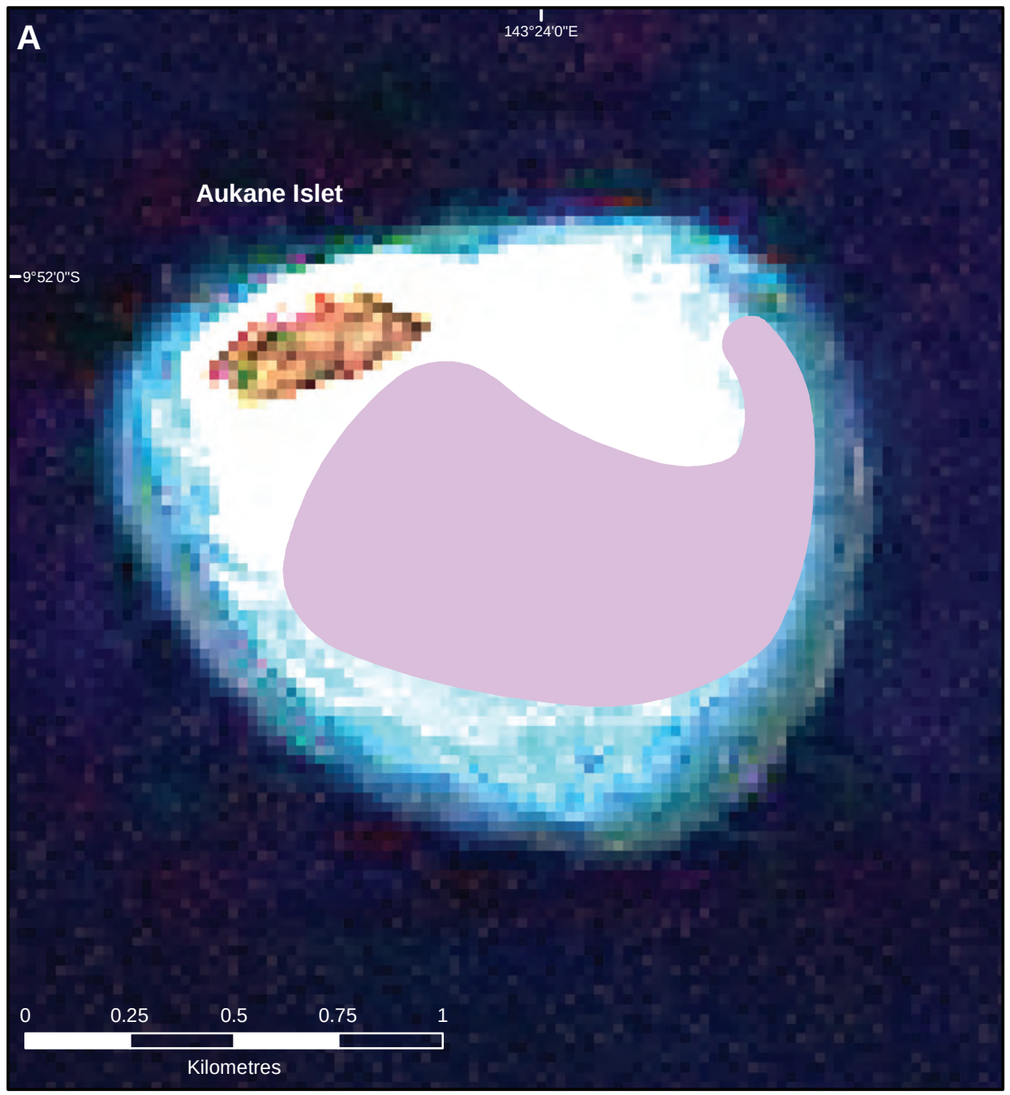
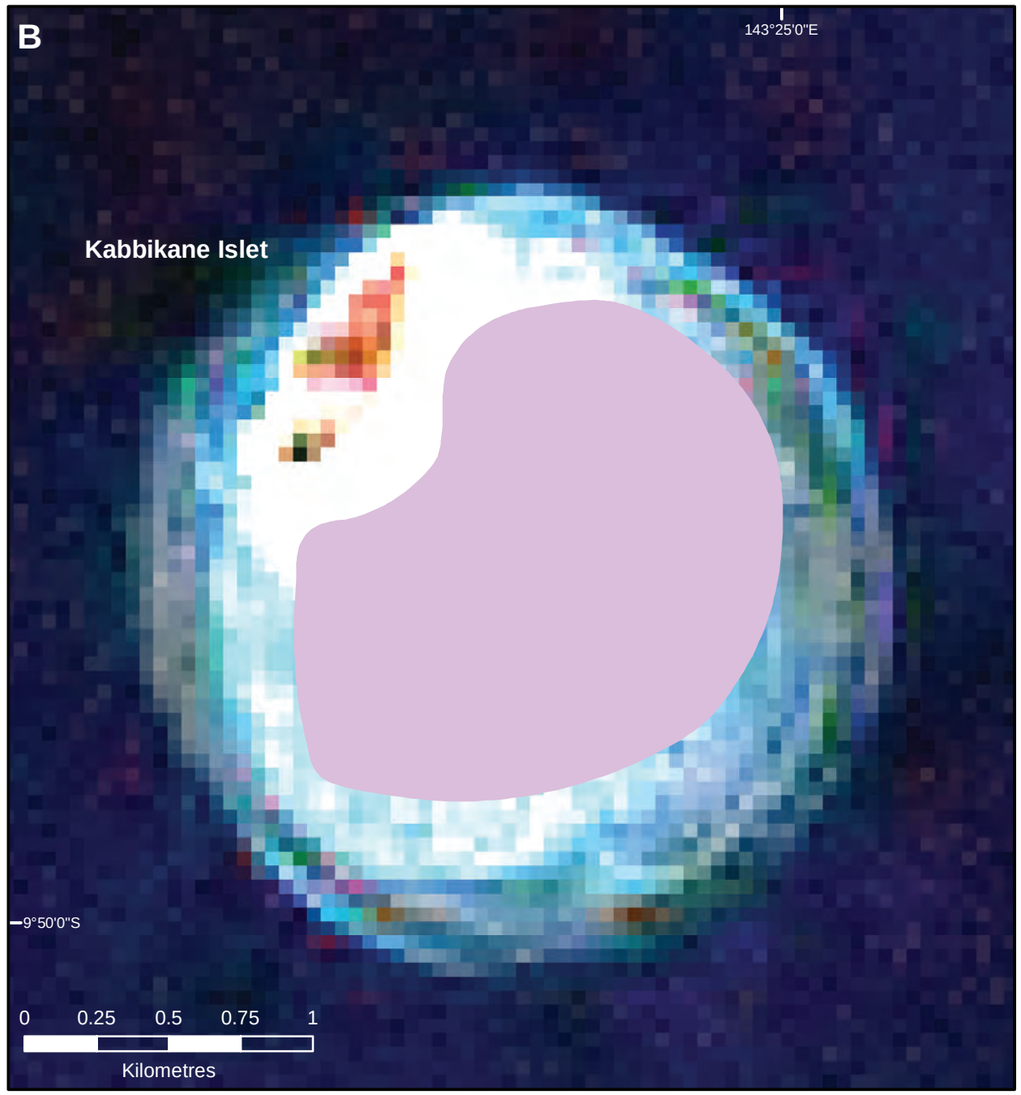


Map 5. Seagrass distribution and percent cover on Aukane and Kabbikane Islets, Torres Strait, March 2012





Legend

Seagrass % Cover

- Very Low (0-10%)
- Low (10-30%)
- Shipping Channel
- Survey extent 2012

N

Source:
Taylor HA and McKenna SA (2012) Critical marine habitats in high risk areas, Torres Strait - Woiz Reef to Kaliko Reef - 2012 Atlas. DAFF Publication (Fisheries Queensland, Northern Fisheries Centre, Cairns). Funded by TSRA and DAFF. Produced by the Marine Ecology Group, 2012. © The State of Queensland through the Department of Agriculture, Fisheries and Forestry.
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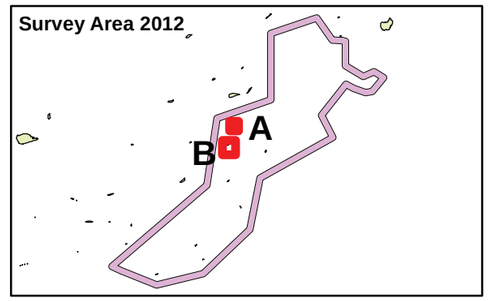
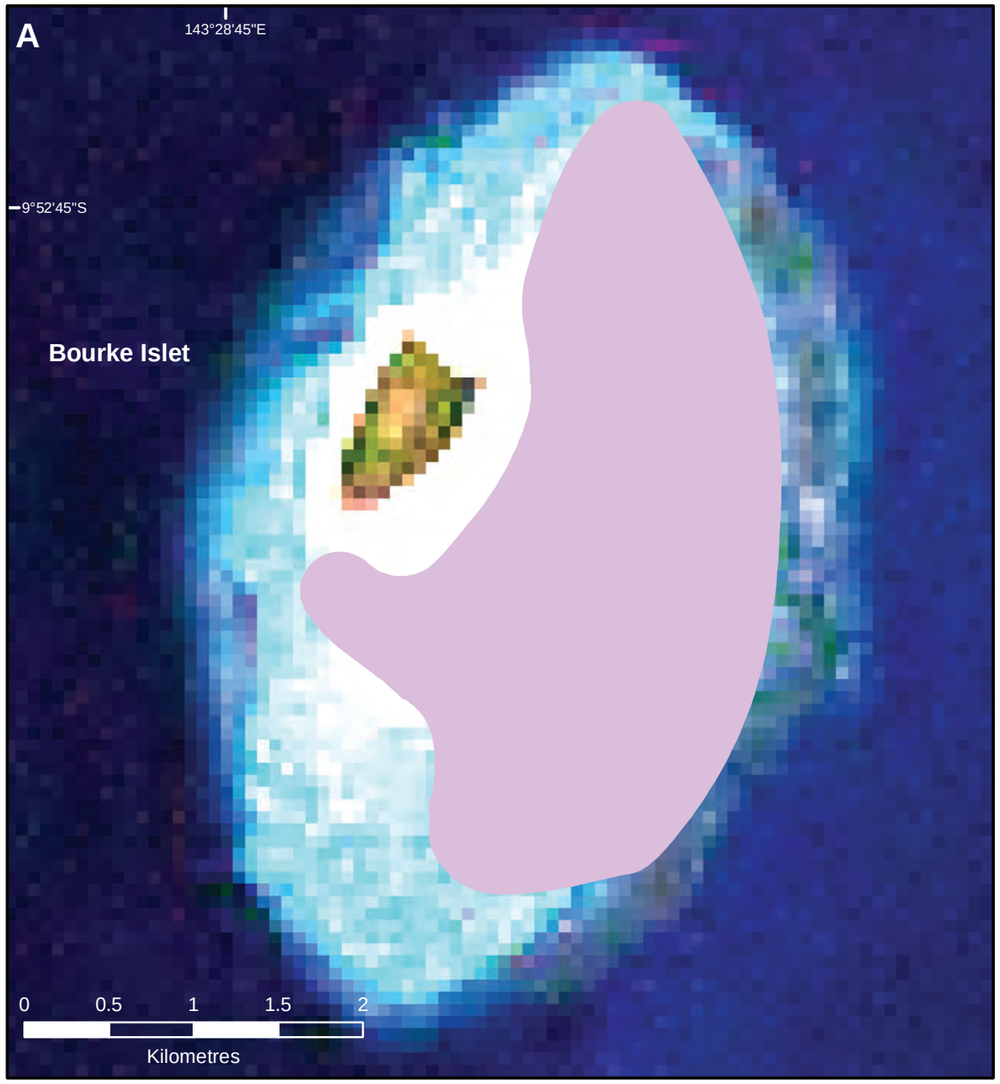
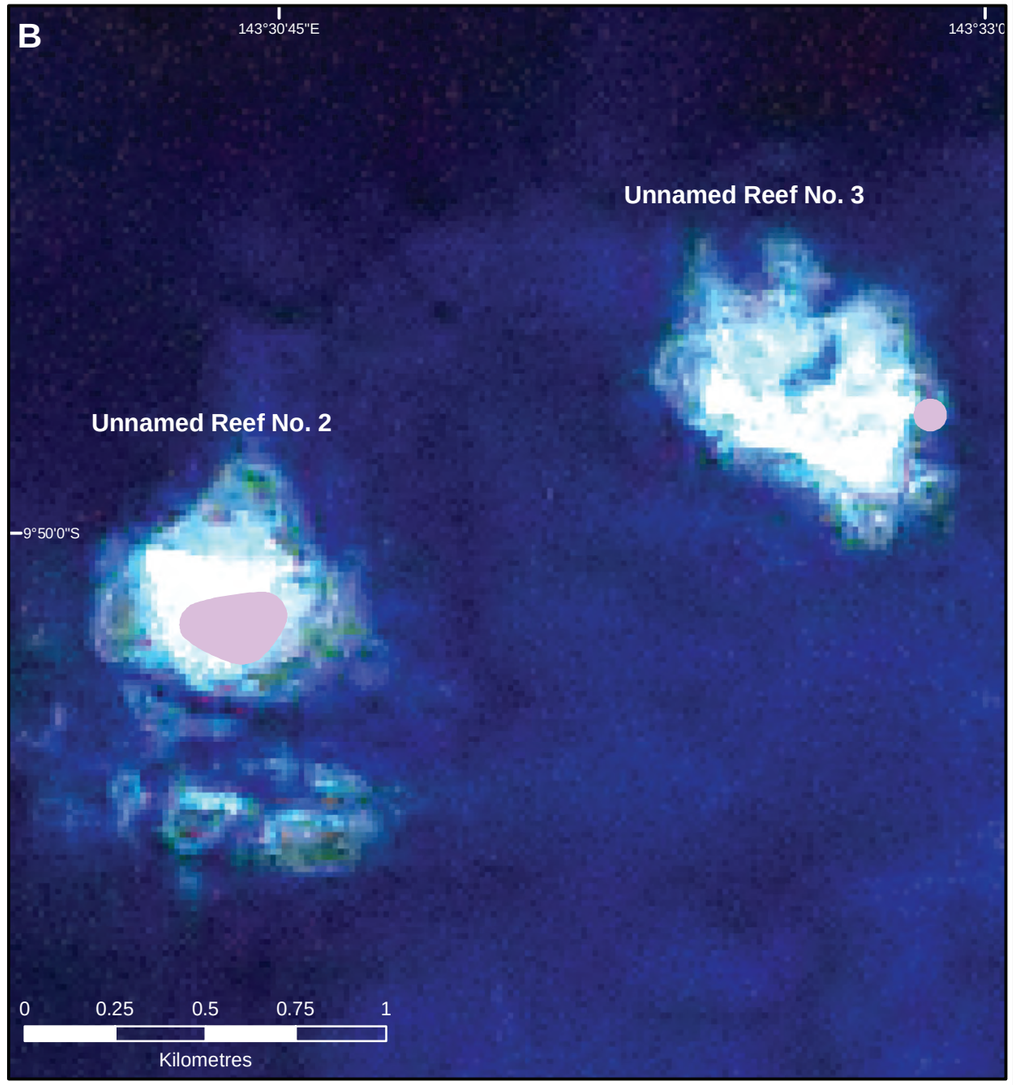


Map 6. Seagrass distribution and percent cover on Bourke Islet and Unnamed Reefs No. 2 and 3, Torres Strait, March 2012





Legend

Seagrass % Cover

- Very Low (0-10%)
- Shipping Channel
- Survey extent 2012

N

Source:
Taylor HA and McKenna SA (2012) Critical marine habitats in high risk areas, Torres Strait - Woiz Reef to Kaliko Reef - 2012 Atlas. DAFF Publication (Fisheries Queensland, Northern Fisheries Centre, Cairns). Funded by TSRA and DAFF. Produced by the Marine Ecology Group, 2012. © The State of Queensland through the Department of Agriculture, Fisheries and Forestry.
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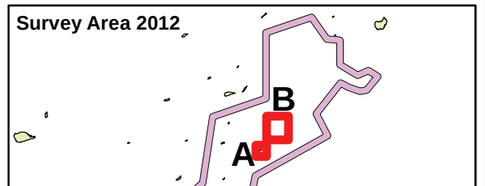
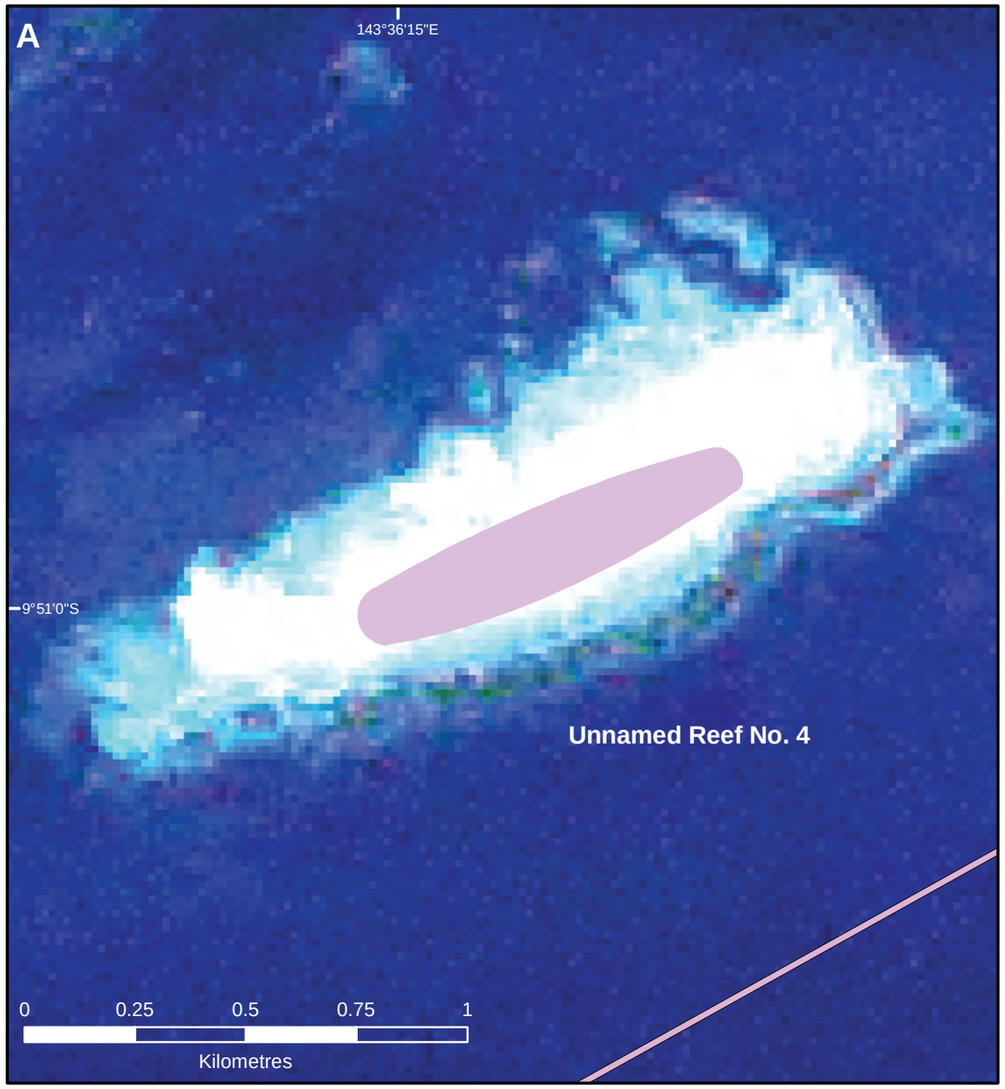
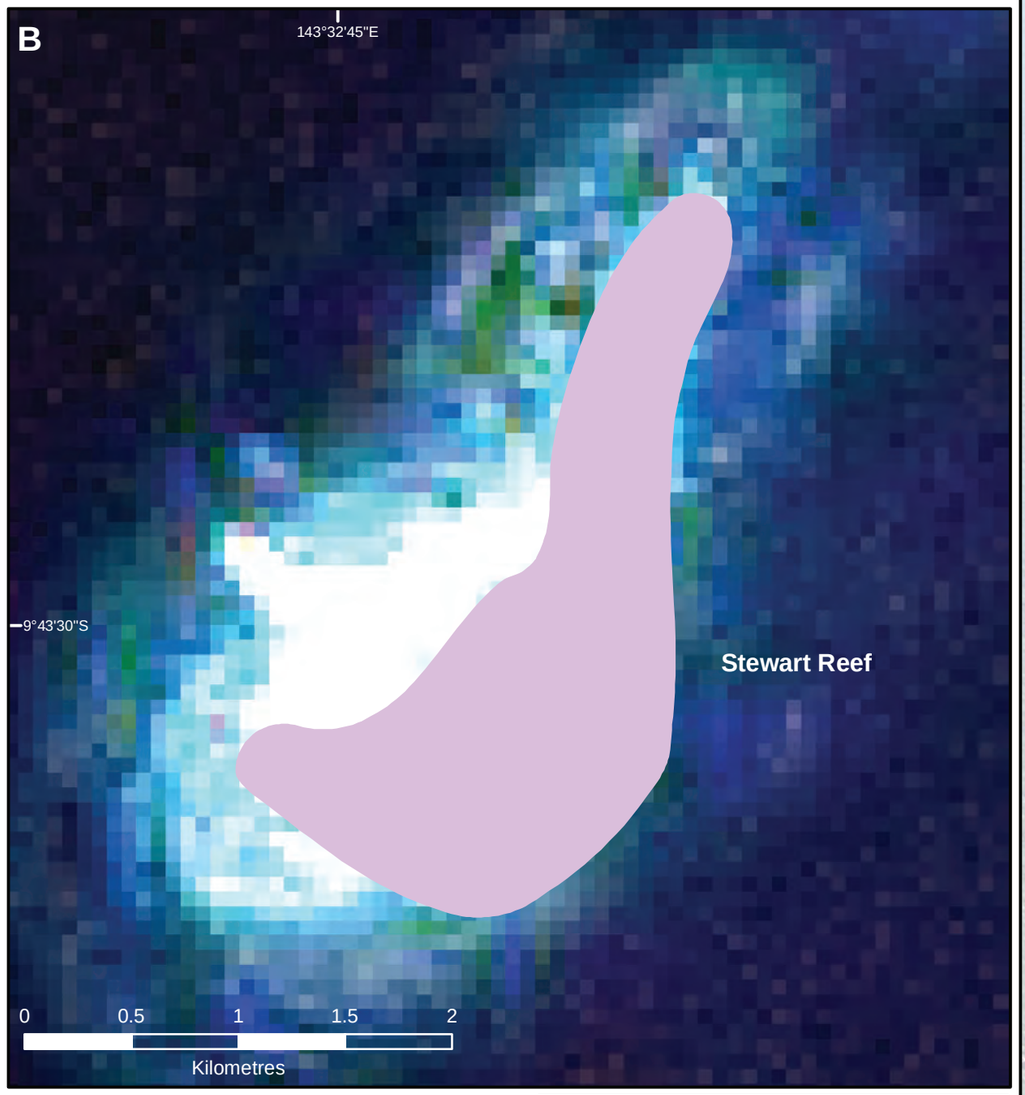


Map 7. Seagrass distribution and percent cover on Unnamed Reef No. 4 and Stewart Reef, Torres Strait, March 2012





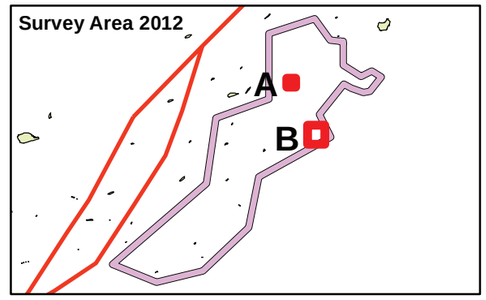
Legend

Seagrass % Cover

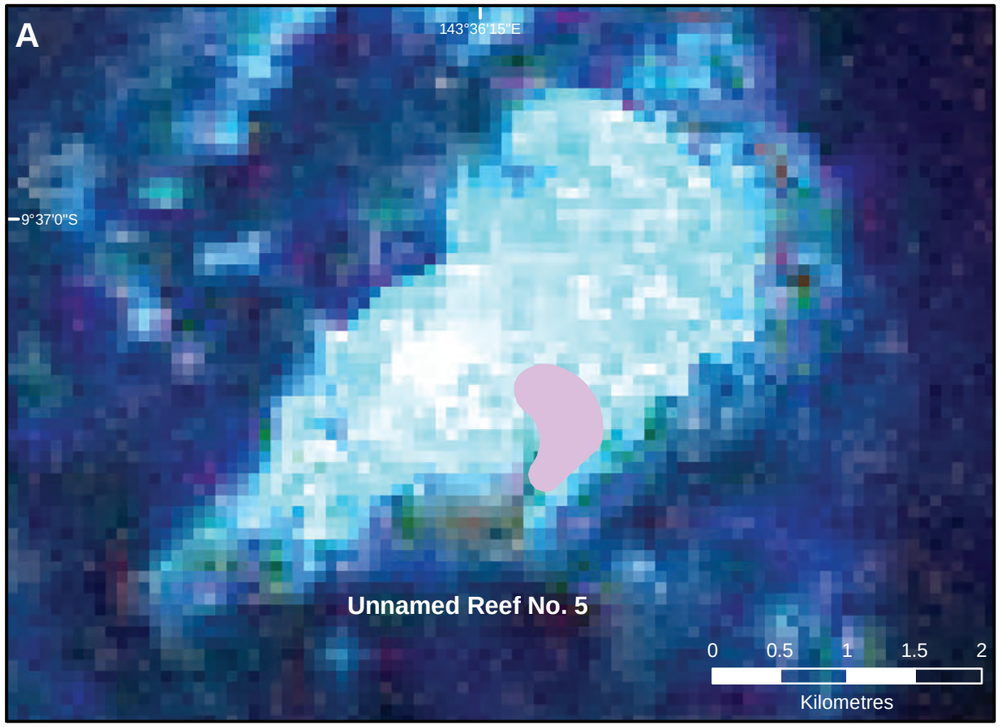
- Very Low (0-10%)
- Low (10-30%)
- Shipping Channel
- Survey extent 2012

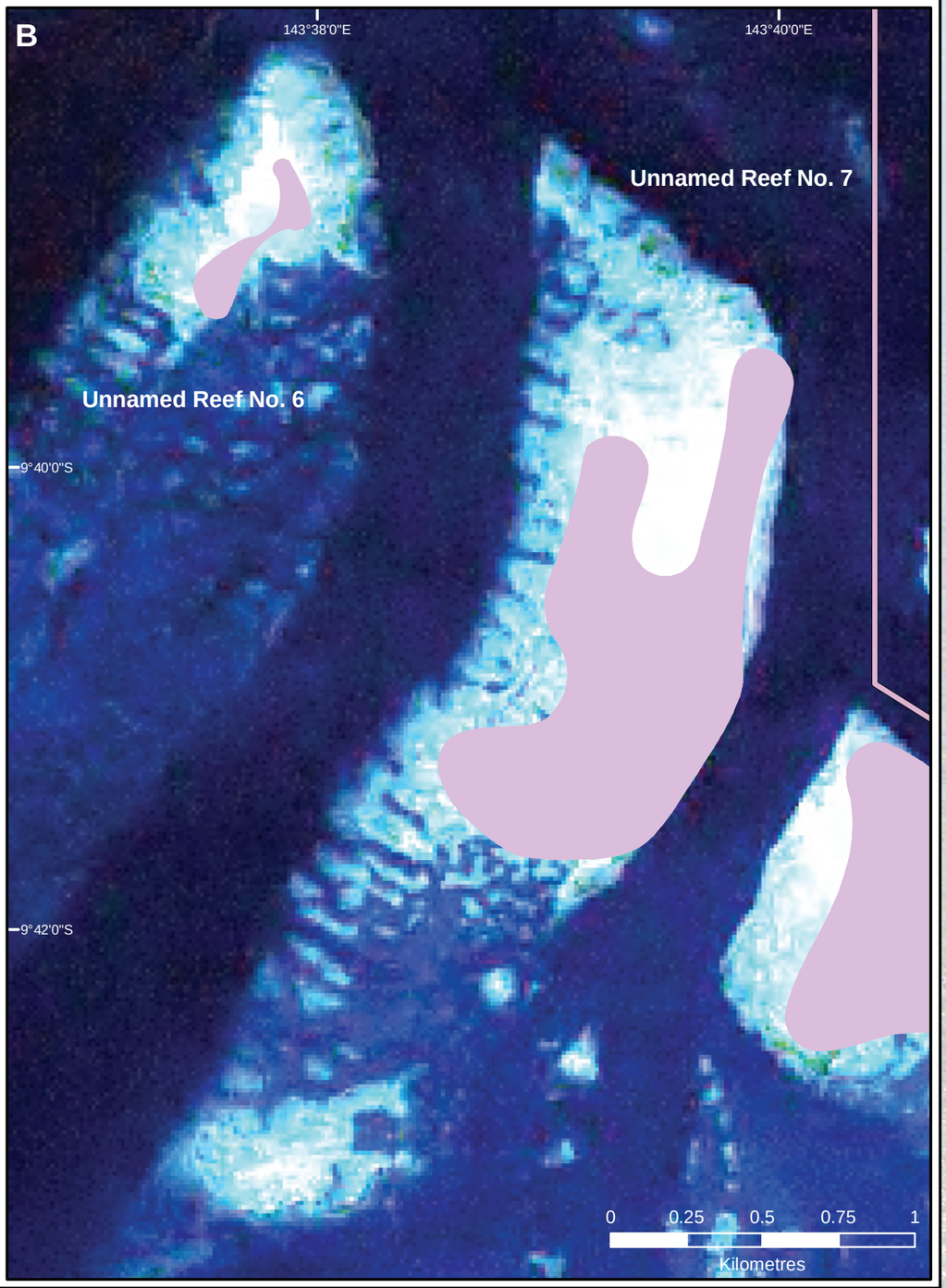
N

Source:
Taylor HA and McKenna SA (2012) Critical marine habitats in high risk areas, Torres Strait - Woiz Reef to Kaliko Reef - 2012 Atlas. DAFF Publication (Fisheries Queensland, Northern Fisheries Centre, Cairns). Funded by TSRA and DAFF. Produced by the Marine Ecology Group, 2012.



Map 8. Seagrass distribution and percent cover on Unnamed Reefs No. 5, 6 and 7, Torres Strait, March 2012





Legend

Seagrass % Cover

- Very Low (0-10%)
- Low (10-30%)
- Shipping Channel
- Survey extent 2012

N

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TSRA www.tsra.gov.au
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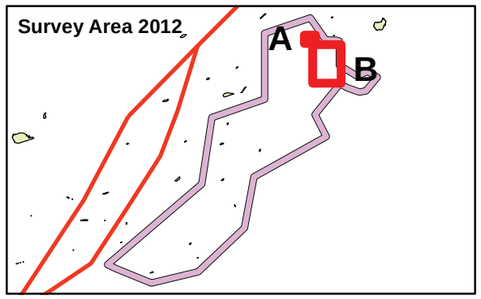
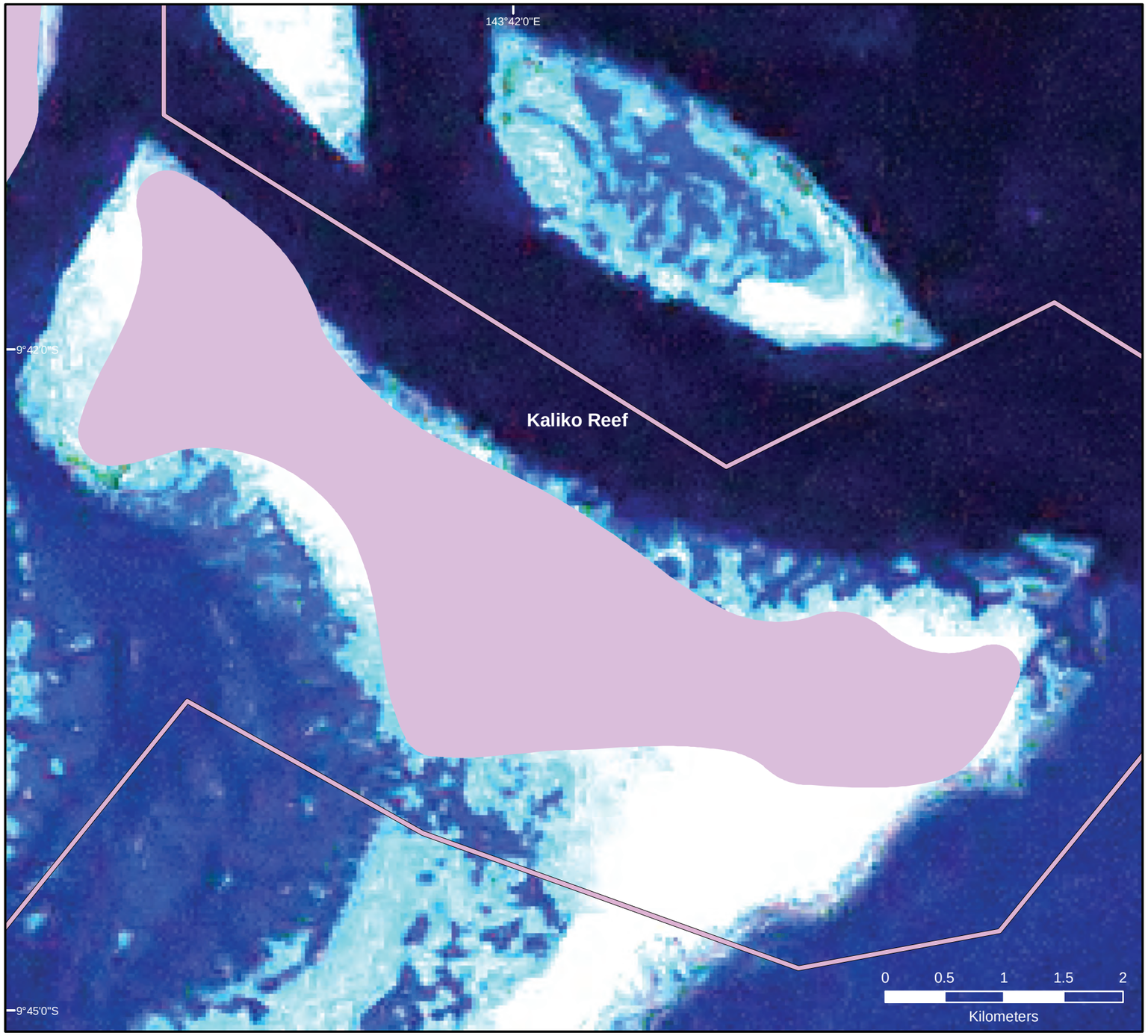


Source:
Taylor HA and McKenna SA (2012) Critical marine habitats in high risk areas, Torres Strait - Woiz Reef to Kaliko Reef - 2012 Atlas. DAFF Publication (Fisheries Queensland, Northern Fisheries Centre, Cairns). Funded by TSRA and DAFF. Produced by the Marine Ecology Group, 2012.

Map 9. Seagrass distribution and percent cover on Kaliko Reef, Torres Strait, March 2012



Legend

Seagrass % Cover

- Very Low (0-10%)
- Low (10-30%)
- Shipping Channel
- Survey extent 2012

N

Source:
Taylor HA and McKenna SA (2012) Critical marine habitats in high risk areas, Torres Strait - Woiz Reef to Kaliko Reef - 2012 Atlas. DAFF Publication (Fisheries Queensland, Northern Fisheries Centre, Cairns). Funded by TSRA and DAFF. Produced by the Marine Ecology Group, 2012. © The State of Queensland through the Department of Agriculture, Fisheries and Forestry.
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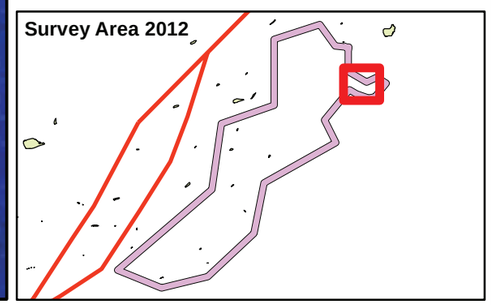
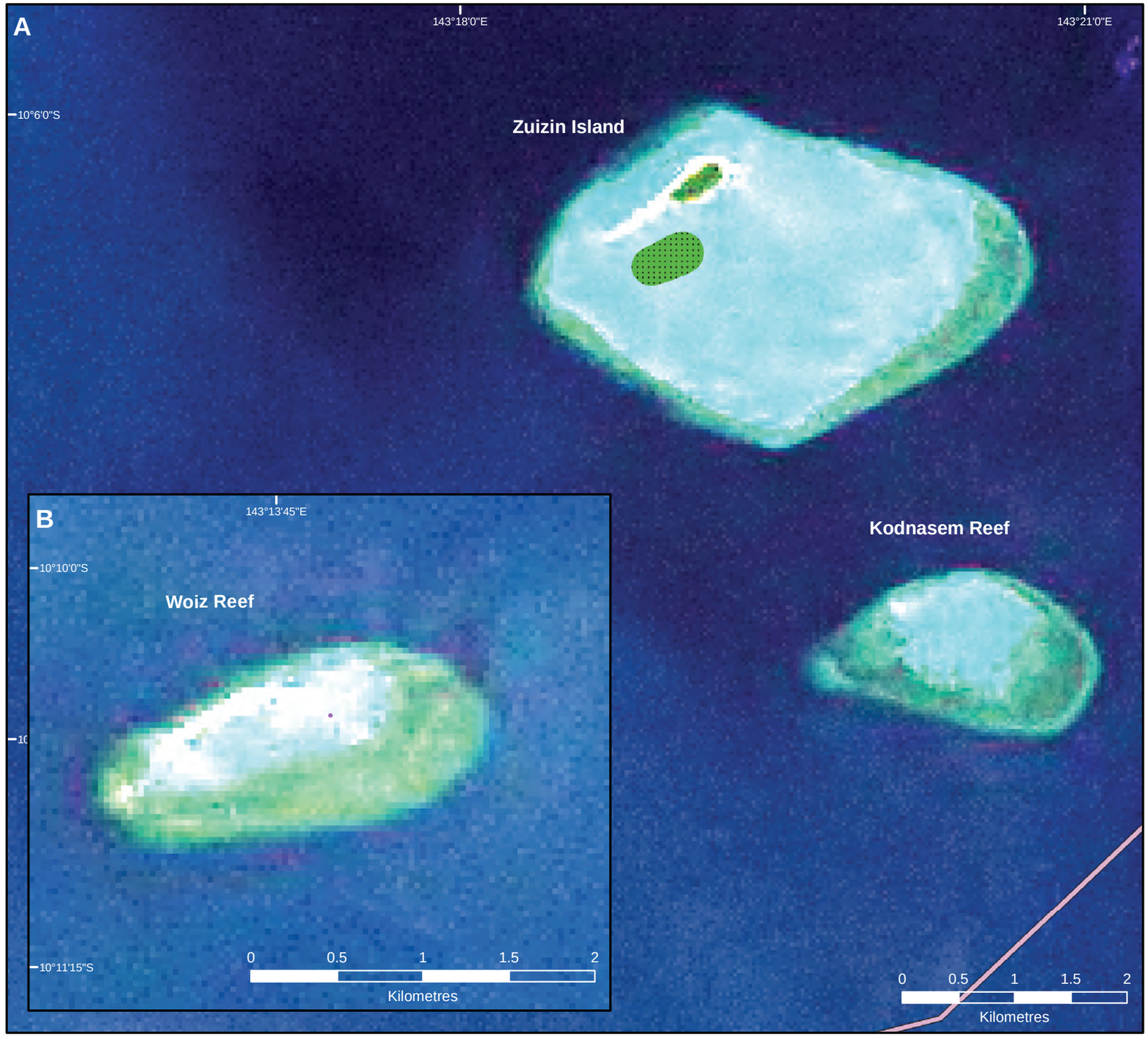


Map 10. Seagrass community and cover type on Woiz Reef, Kodnasem Reef and Zuizin Island, Torres Strait, March 2012



Legend

Cover type

- Isolated patches

Seagrass community

- Light *Thalassia hemprichii*
- Shipping Channel
- Survey extent 2012

N

Source:
Taylor HA and McKenna SA (2012) Critical marine habitats in high risk areas, Torres Strait - Woiz Reef to Kaliko Reef - 2012 Atlas. DAFF Publication (Fisheries Queensland, Northern Fisheries Centre, Cairns). Funded by TSRA and DAFF. Produced by the Marine Ecology Group, 2012. © The State of Queensland through the Department of Agriculture, Fisheries and Forestry.
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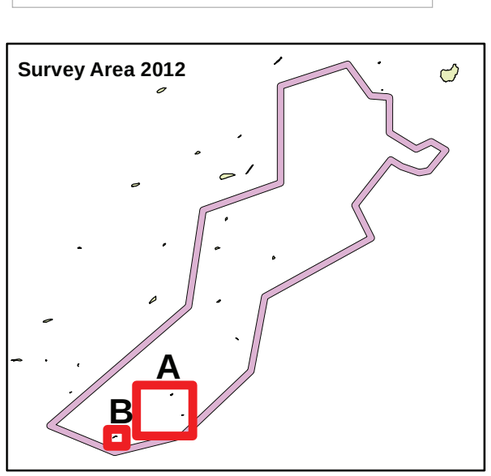
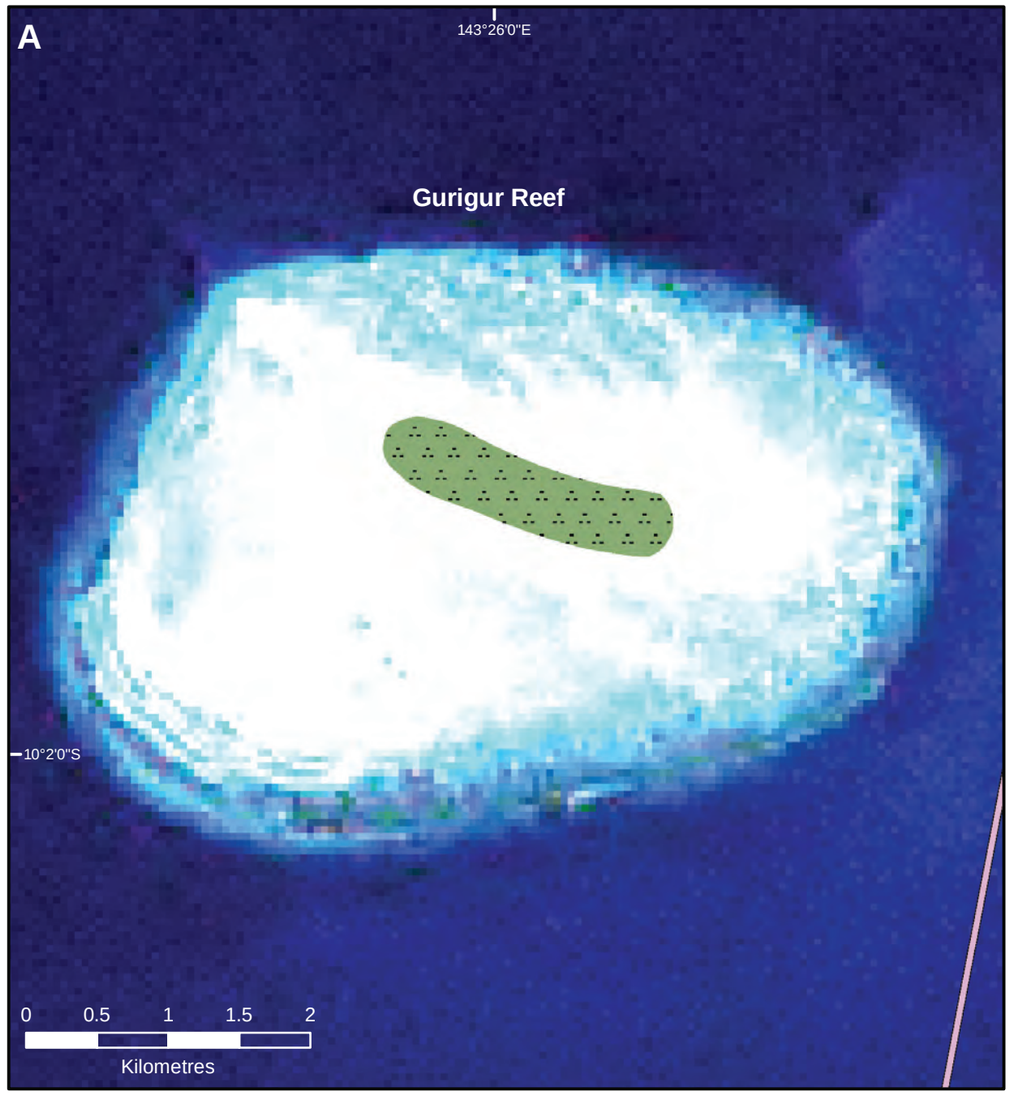
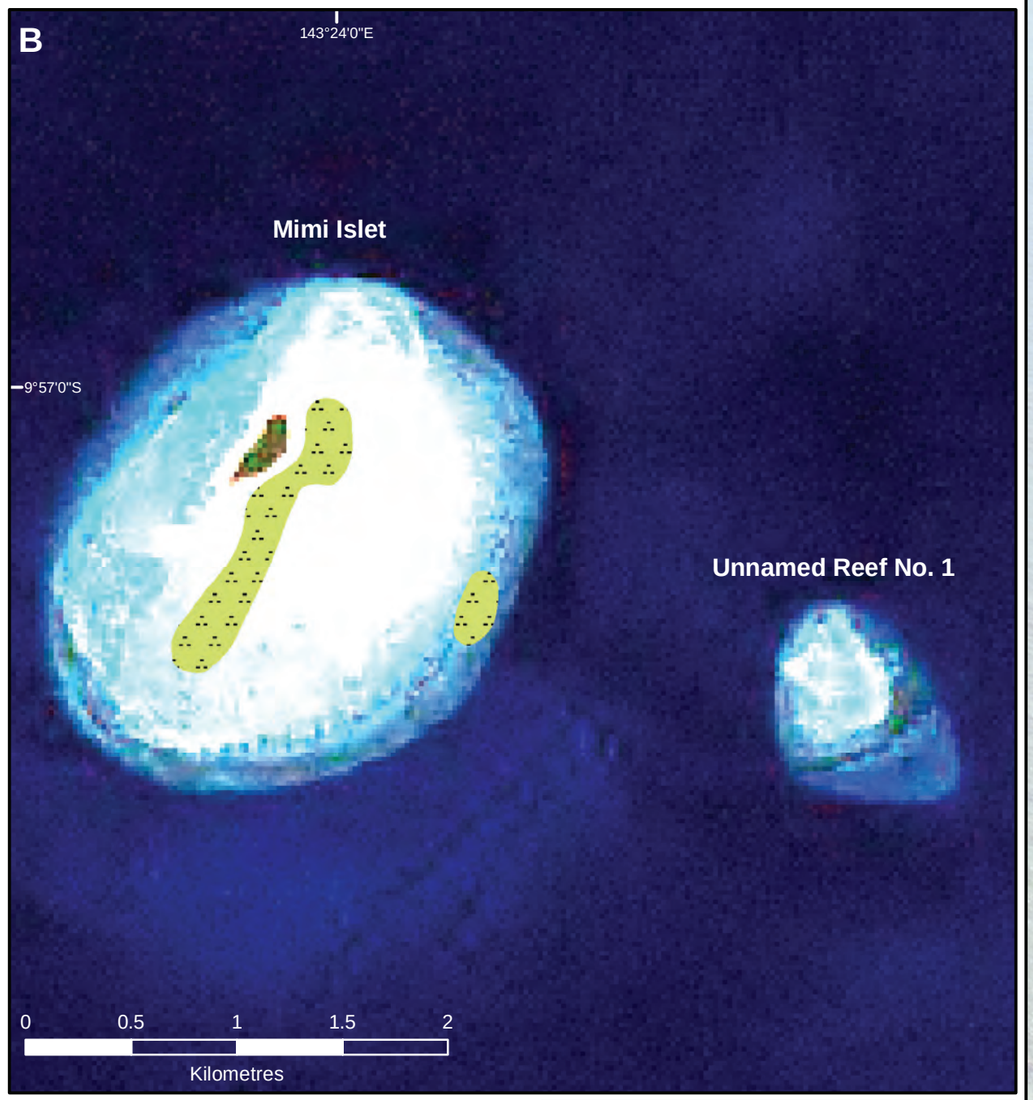


Map 11. Seagrass community and cover type on Gurigur Reef, Mimi Islet and Unnamed Reef No. 1, Torres Strait, March 2012





Legend

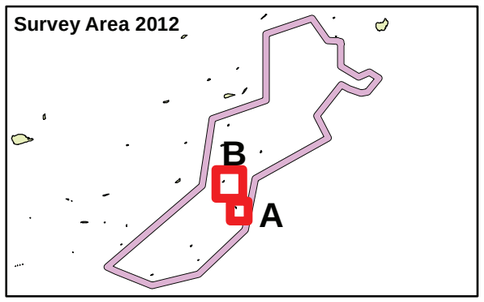
Cover type

- Aggregated patches

Seagrass community

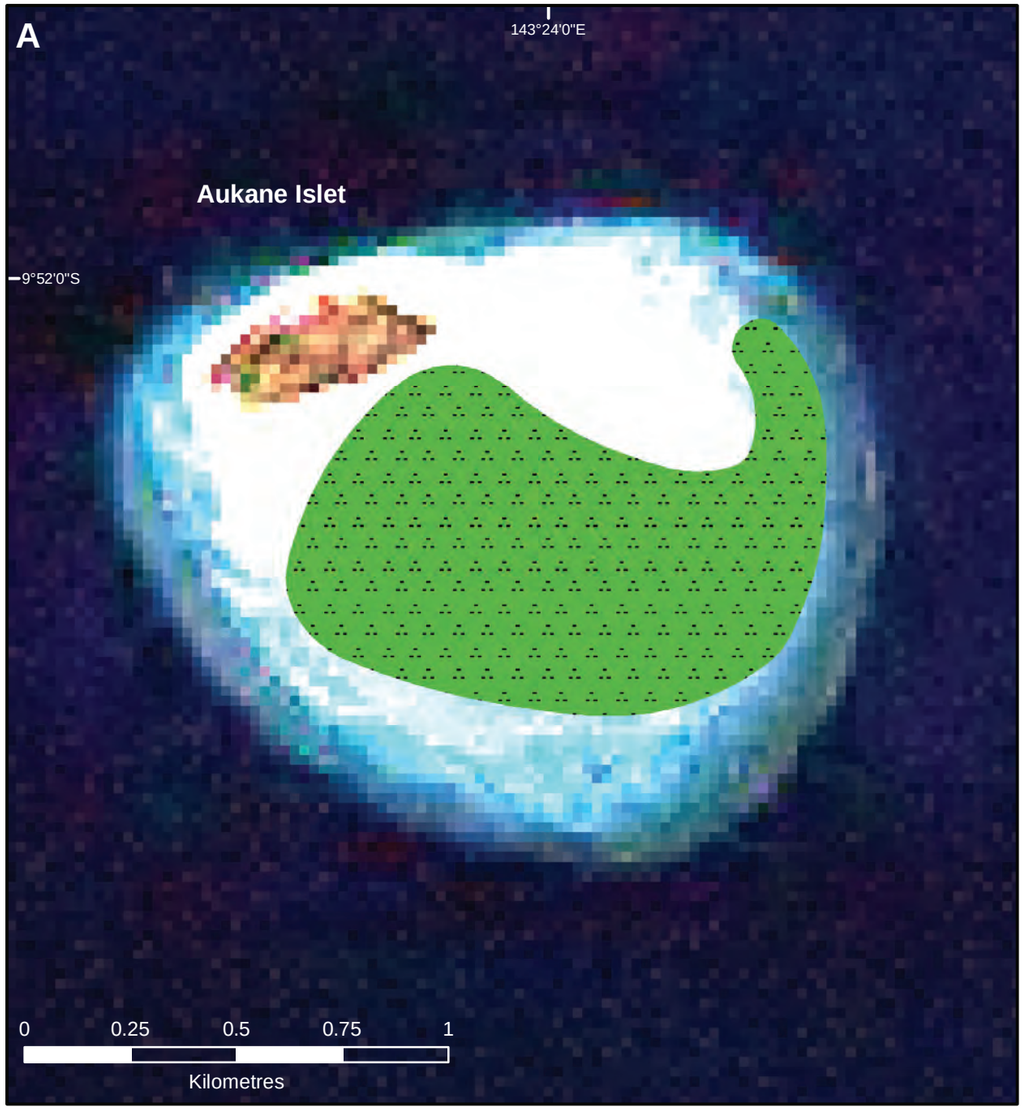
- Light *Cymodocea rotundata* with *Thalassia hemprichii*
- Moderate *Cymodocea rotundata* with *Thalassia hemprichii*
- Shipping Channel
- Survey extent 2012

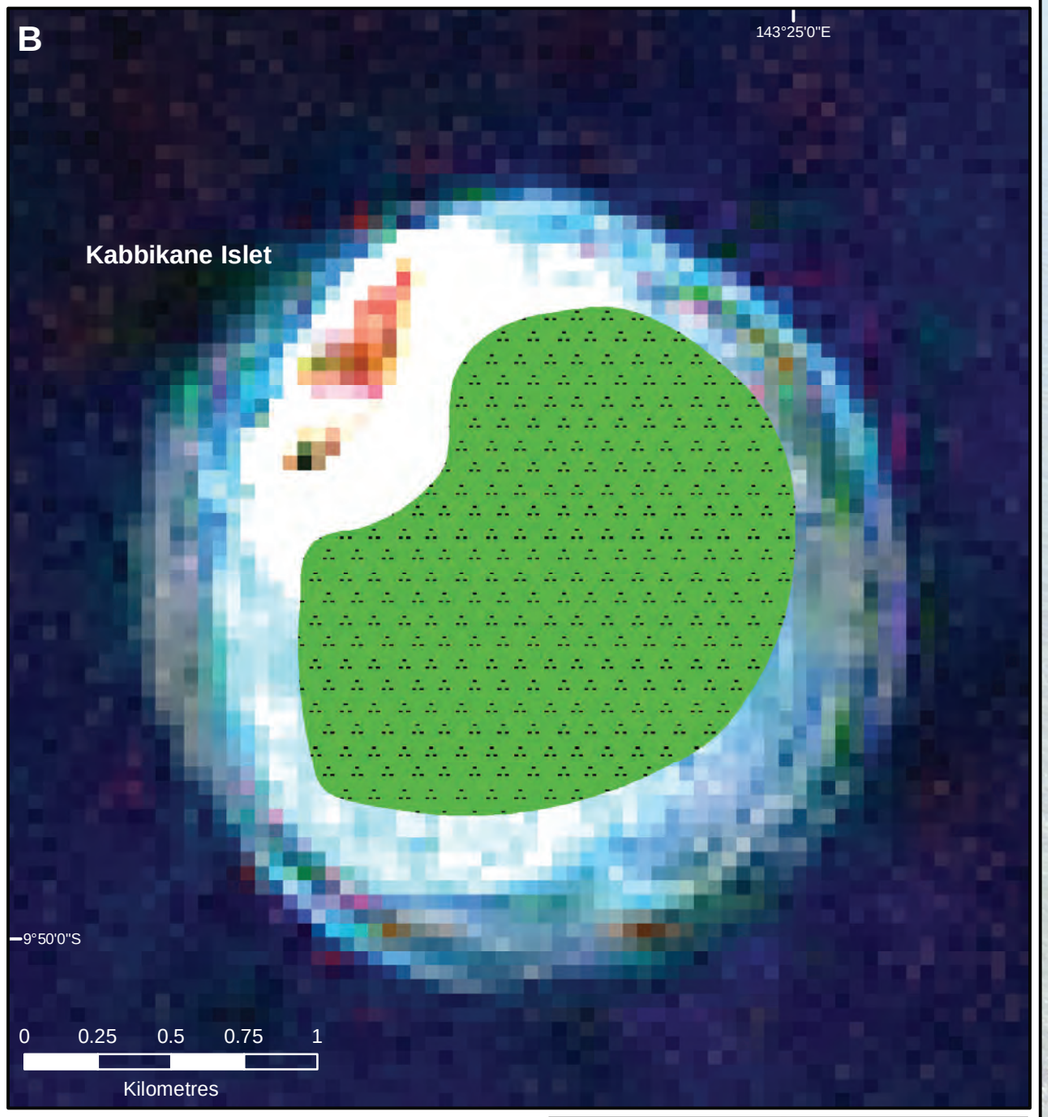
N



Source:
Taylor HA and McKenna SA (2012) Critical marine habitats in high risk areas, Torres Strait - Woiz Reef to Kaliko Reef - 2012 Atlas. DAFF Publication (Fisheries Queensland, Northern Fisheries Centre, Cairns). Funded by TSRA and DAFF. Produced by the Marine Ecology Group, 2012.

Map 12. Seagrass community and cover type on Aukane and Kabbikane Islet, Torres Strait, March 2012





Legend

Cover type

- Aggregated patches

Seagrass community

- Light *Thalassia hemprichii*
- Shipping Channel
- Survey extent 2012

N

Source:
Taylor HA and McKenna SA (2012) Critical marine habitats in high risk areas, Torres Strait - Woiz Reef to Kaliko Reef - 2012 Atlas. DAFF Publication (Fisheries Queensland, Northern Fisheries Centre, Cairns). Funded by TSRA and DAFF. Produced by the Marine Ecology Group, 2012. © The State of Queensland through the Department of Agriculture, Fisheries and Forestry.
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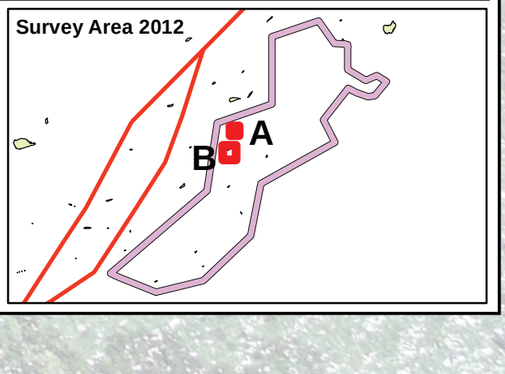
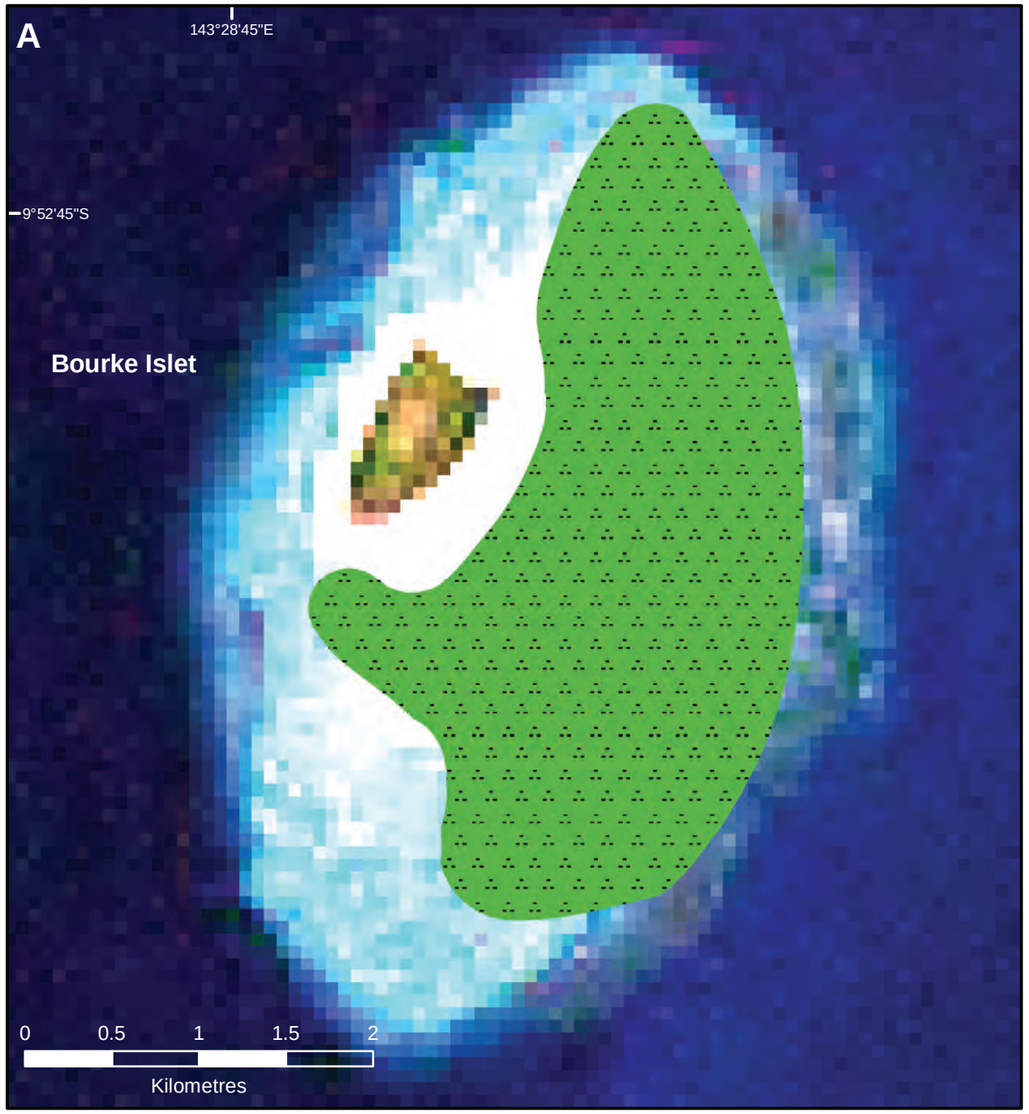
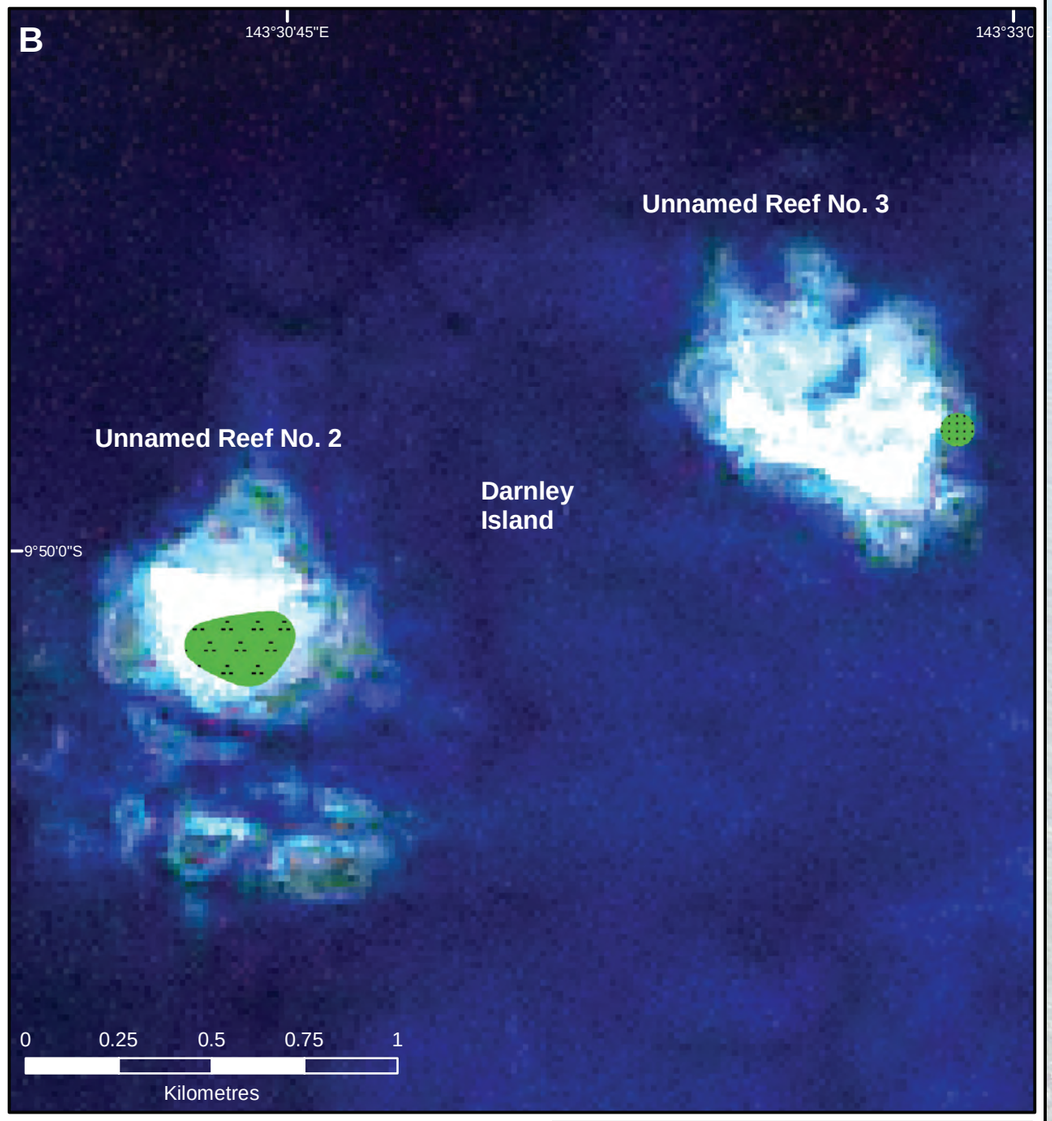


Map 13. Seagrass community and cover type on Bourke Islet and Unnamed Reefs No. 2 and 3, Torres Strait, March 2012





Legend

Cover type

- Aggregated patches

Seagrass community

- Light *Thalassia hemprichii*
- Shipping Channel
- Survey extent 2012

N

Source:
Taylor HA and McKenna SA (2012) Critical marine habitats in high risk areas, Torres Strait - Woiz Reef to Kaliko Reef - 2012 Atlas. DAFF Publication (Fisheries Queensland, Northern Fisheries Centre, Cairns). Funded by TSRA and DAFF. Produced by the Marine Ecology Group, 2012. © The State of Queensland through the Department of Agriculture, Fisheries and Forestry.
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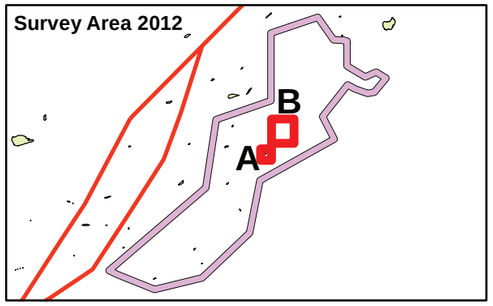
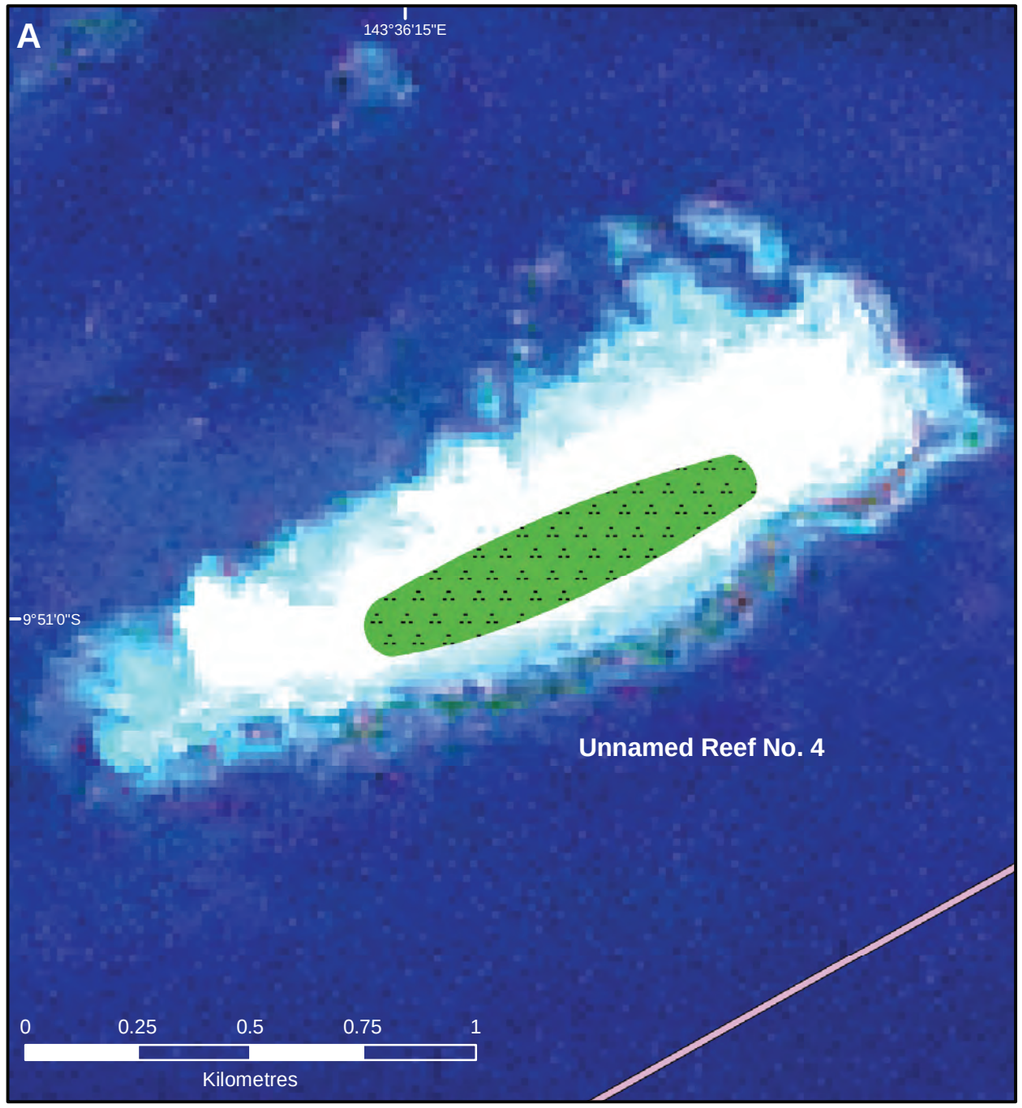
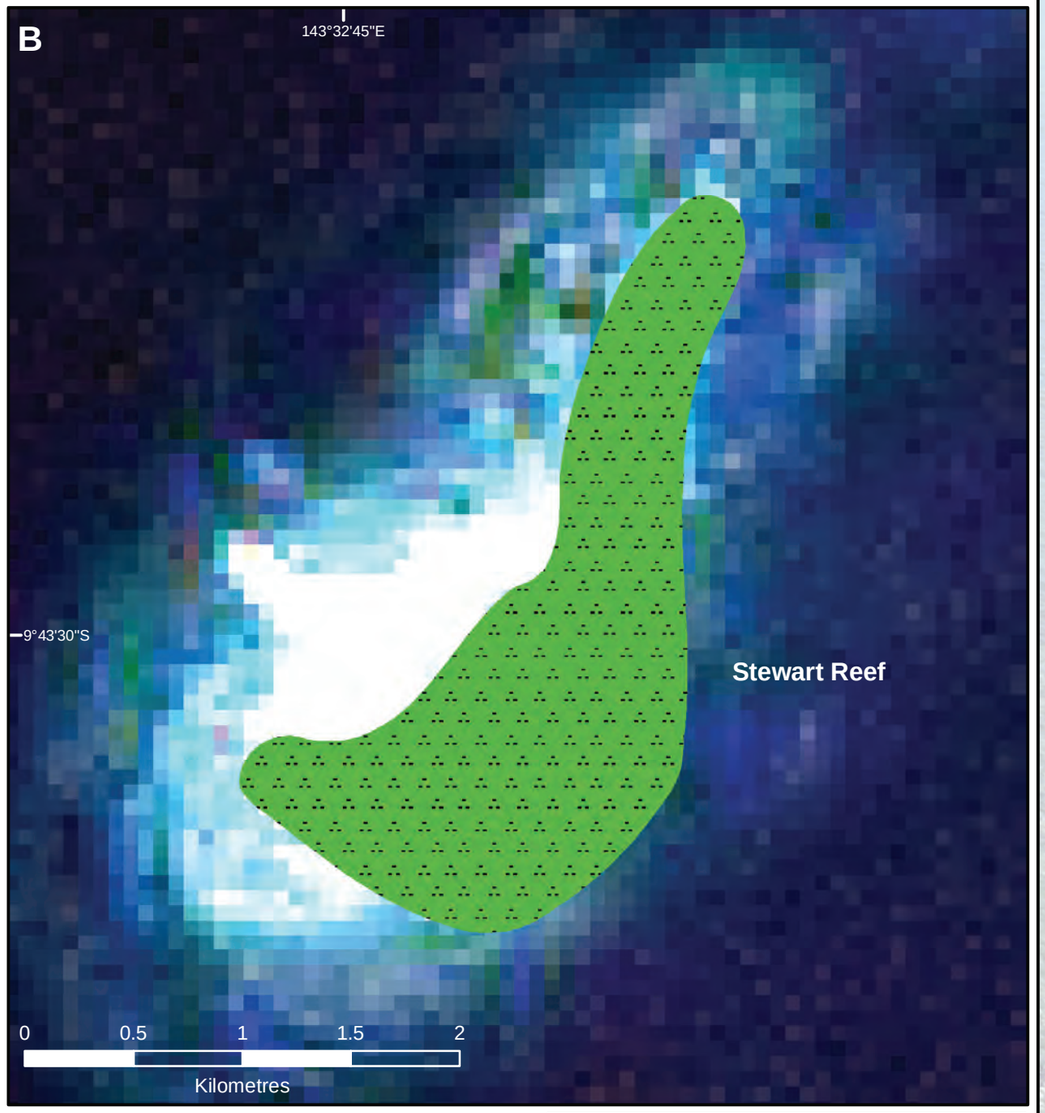


Map 14. Seagrass community and cover type on Unnamed Reef No. 4 and Stewart Reef, Torres Strait, March 2012





Legend

Cover type

Aggregated patches

Seagrass community

Light *Thalassia hemprichii*

Shipping Channel

Survey extent 2012

N

Source:
Taylor HA and McKenna SA (2012) Critical marine habitats in high risk areas, Torres Strait - Woiz Reef to Kaliko Reef - 2012 Atlas. DAFF Publication (Fisheries Queensland, Northern Fisheries Centre, Cairns). Funded by TSRA and DAFF. Produced by the Marine Ecology Group, 2012. © The State of Queensland through the Department of Agriculture, Fisheries and Forestry.
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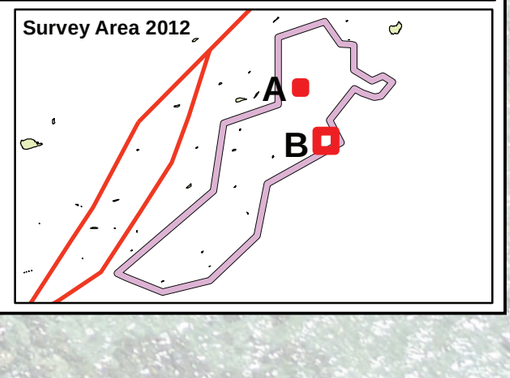
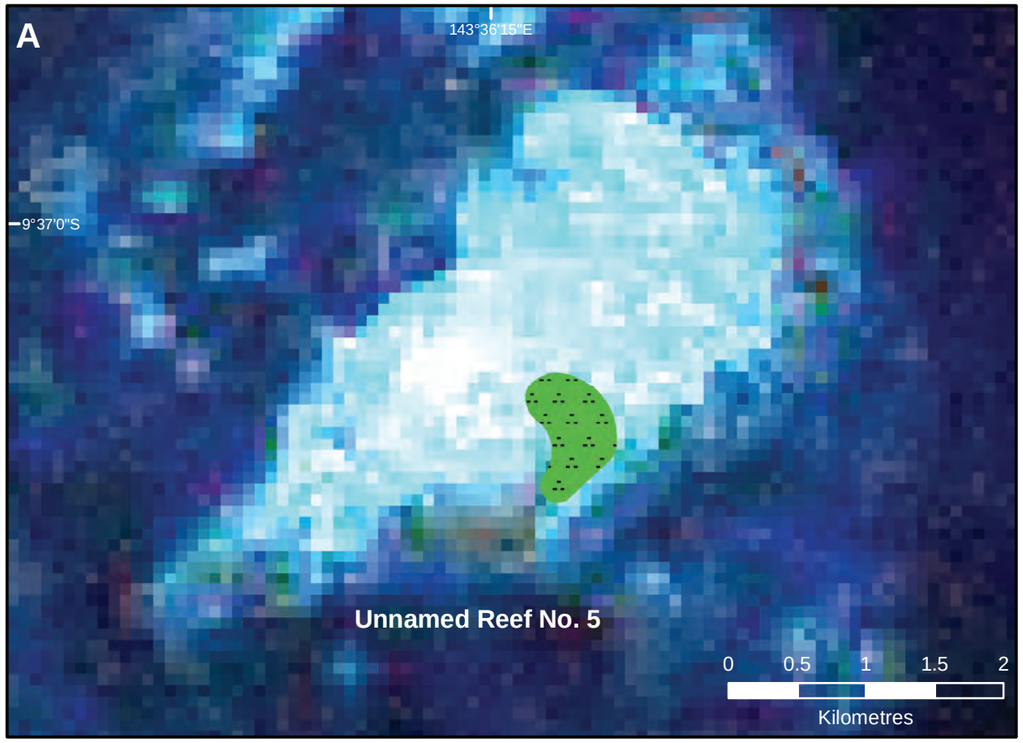
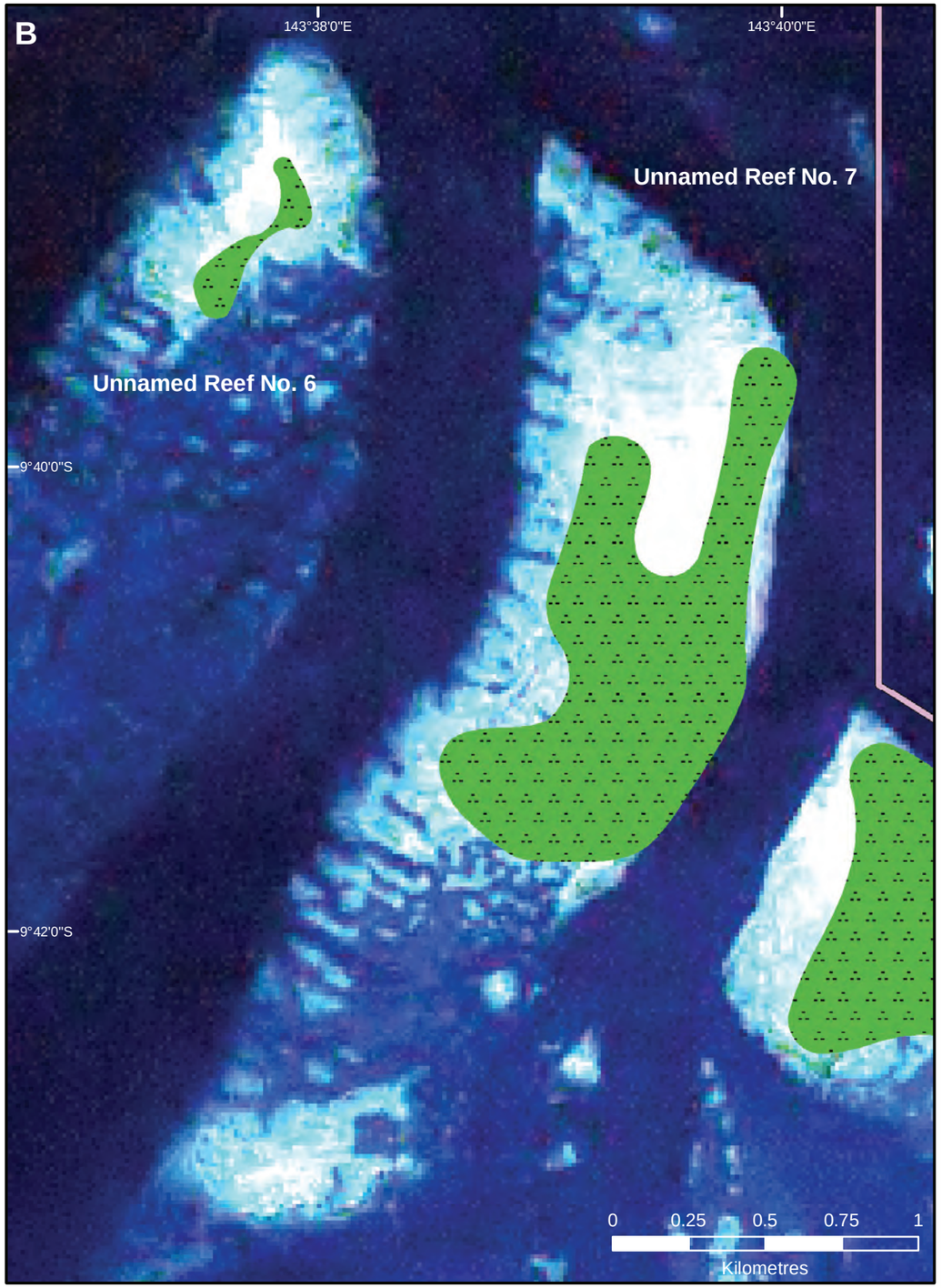


Map 15. Seagrass community and cover type on Unnamed Reefs No. 5, 6 and 7, Torres Strait, March 2012





Legend

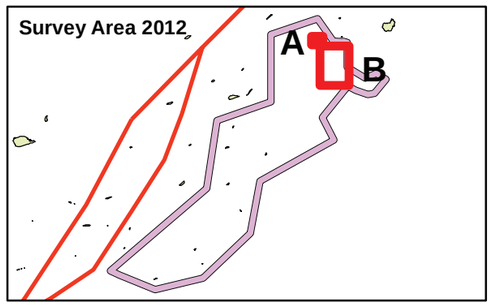
Cover type

- Aggregated patches

Seagrass community

- Light *Thalassia hemprichii*
- Shipping Channel
- Survey extent 2012

N



Source:
Taylor HA and McKenna SA (2012) Critical marine habitats in high risk areas, Torres Strait - Woiz Reef to Kaliko Reef - 2012 Atlas. DAFF Publication (Fisheries Queensland, Northern Fisheries Centre, Cairns). Funded by TSRA and DAFF. Produced by the Marine Ecology Group, 2012. © The State of Queensland through the Department of Agriculture, Fisheries and Forestry.
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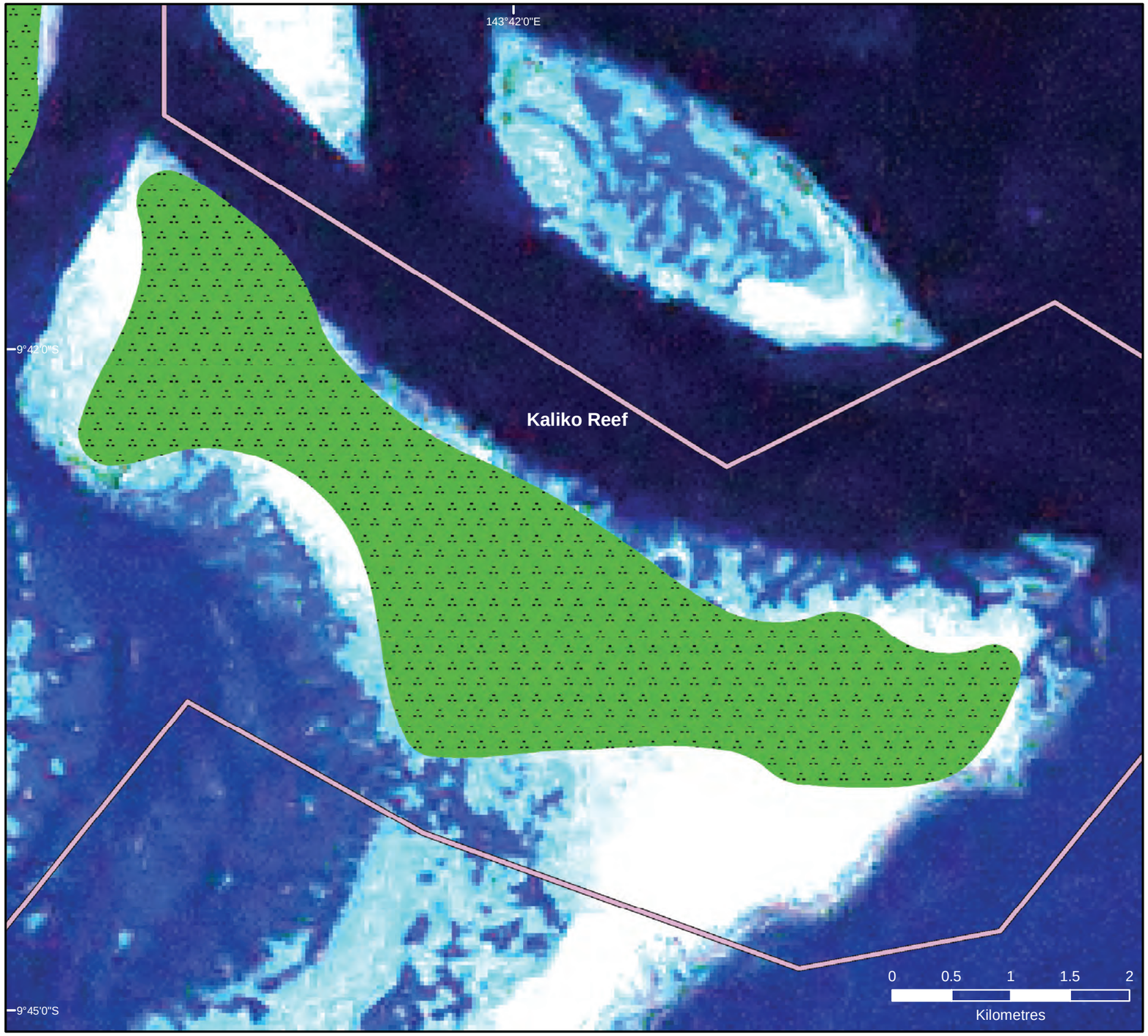
Map 16. Seagrass community and cover type on Kaliko Reef, Torres Strait, March 2012



Legend

Cover type

Aggregated patches

Seagrass community

Light *Thalassia hemprichii*

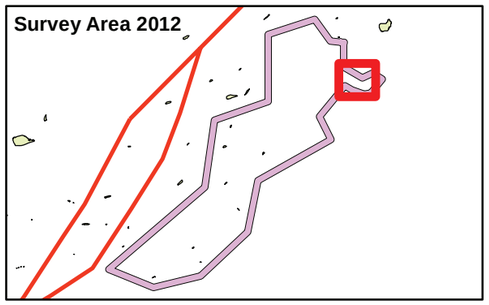
Shipping Channel

Survey extent 2012

N

Source:
Taylor HA and McKenna SA (2012) Critical marine habitats in high risk areas, Torres Strait - Woiz Reef to Kaliko Reef - 2012 Atlas. DAFF Publication (Fisheries Queensland, Northern Fisheries Centre, Cairns). Funded by TSRA and DAFF. Produced by the Marine Ecology Group, 2012.

Survey Area 2012



Algae

Extensive areas of intertidal algae habitat were identified throughout the survey region with a total of 7,758 ± 868.9 ha mapped. Algae was the most dominant benthic habitat type identified (excluding open substrate), accounting for 23% of the benthos (Figure 2). There were five dominant algal groups recorded, however most communities were comprised of a mixture of groups (Figure 4).

The majority of algae habitat had either low (10-30%) or moderate (30-50%) cover and were dominated by turf mat and erect macrophyte species. Erect macrophyte's, which have a low tolerance to oil spill and shipping impacts, were more commonly found in shallow pools on the reef flat or in partially subtidal reef crest and slope areas (Maps 16-24). Erect macrophyte communities included genera such as *Sargassum* and *Caulerpa*. Algal turf mats formed extensive communities on many of the exposed reef flats and often occurred in conjunction with both seagrass meadows and reef communities. Algal turf mats have a higher tolerance to oil spill and shipping impacts than erect macrophytes.

Erect calcareous, encrusting and filamentous algal functional groups made up a moderate proportion of the algal community in the survey area. These groups were more commonly found on reef or rocky substrates (Maps 16-24). Erect calcareous species, such as *Halimeda* spp, have a low tolerance to oil spills and shipping impacts, whilst filamentous algae is more hardy.

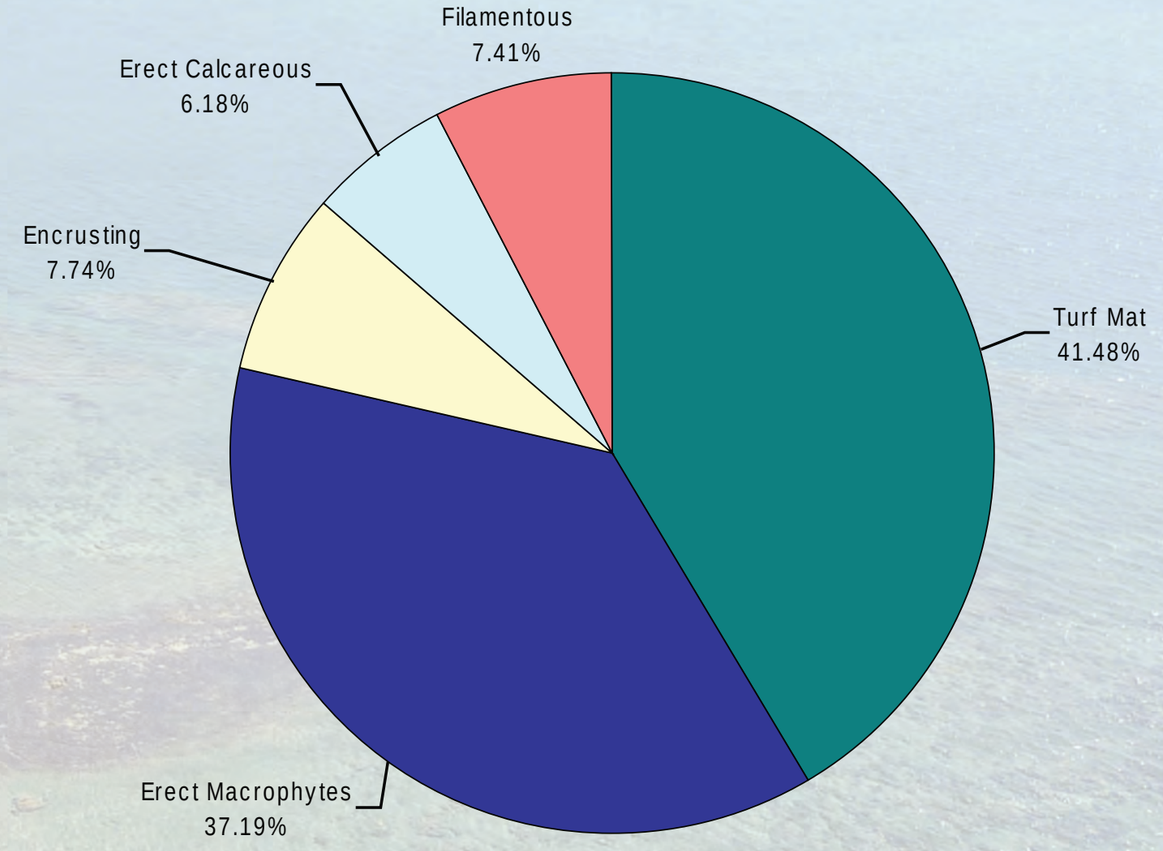
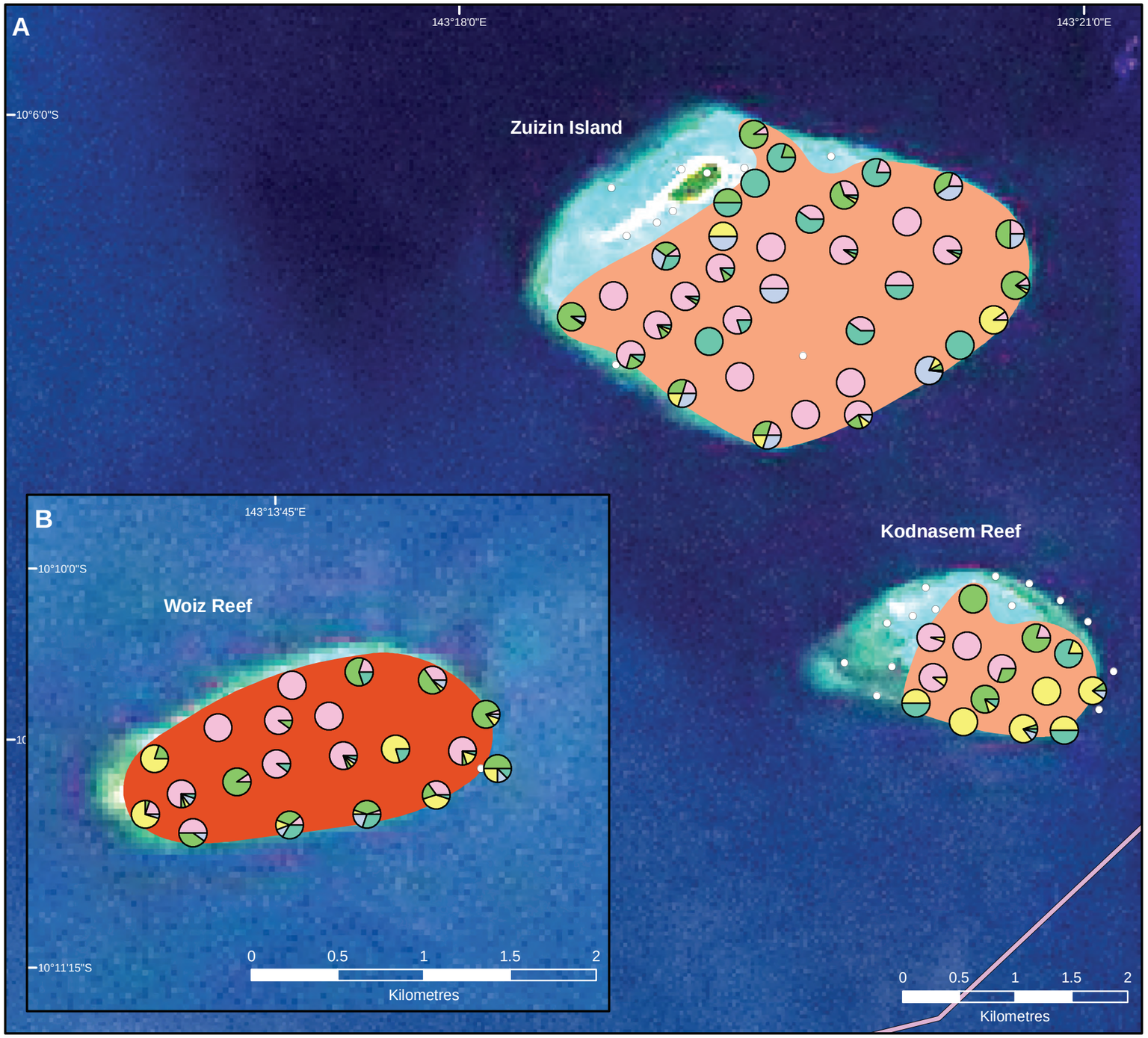


Figure 4 Mean percent cover of algal types in the Torres Strait survey area, 2012

Filamentous green algae

Mixed erect macrophyte algae and seagrass community

Map 17. Algae percent cover and algae type for sites on Woiz Reef, Kodnasem Reef and Zuizin Island, Torres Strait, March 2012



Legend

- Habitat Assessment Sites 2012

Algae type

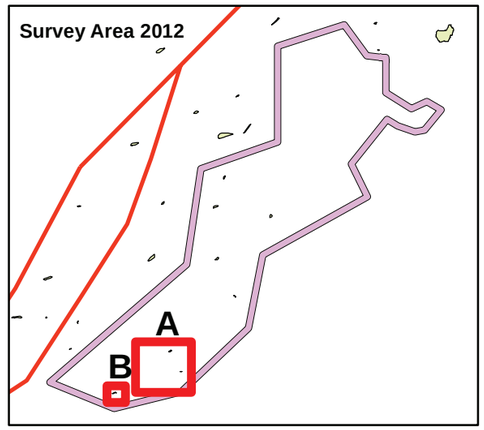
- Turf Mat
- Erect Macrophytes
- Encrusting
- Erect Calcareous
- Filamentous

Algae percent cover

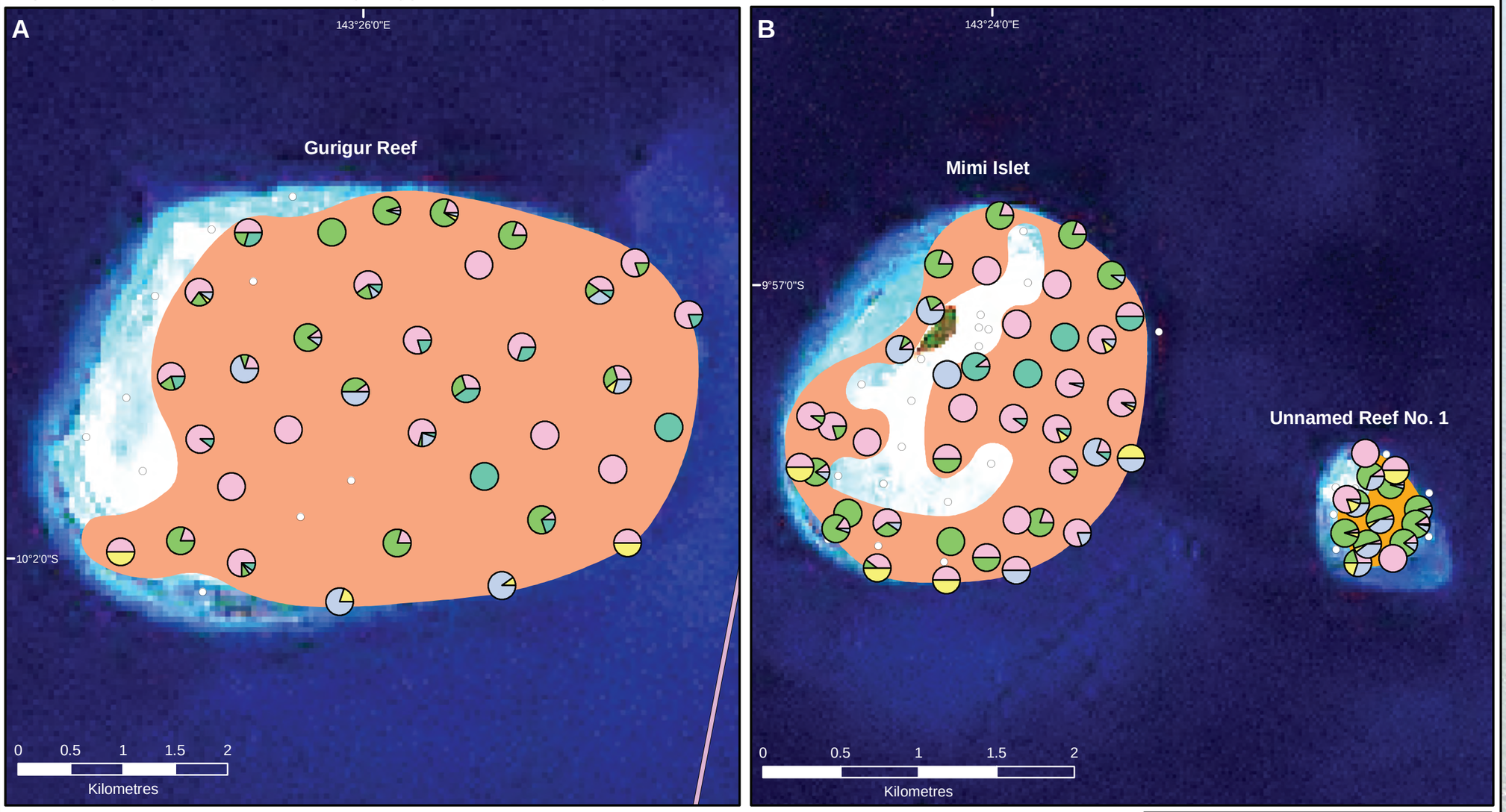
- Very Low (0-10%)
- Low (10-30%)
- Moderate (30-50%)
- High (50-75%)
- Shipping Channel
- Survey extent 2012

Source:
Taylor HA and McKenna SA (2012) Critical marine habitats in high risk areas, Torres Strait - Woiz Reef to Kaliko Reef - 2012 Atlas. DAFF Publication (Fisheries Queensland, Northern Fisheries Centre, Cairns). Funded by TSRA and DAFF. Produced by the Marine Ecology Group, 2012.

N



Map 18. Algae percent cover and algae type for sites on Gurigur Reef, Mimi Islet and Unnamed Reef No. 1, Torres Strait, March 2012



Legend

Algae type

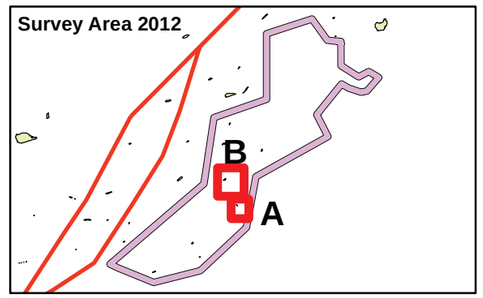
- Turf Mat
- Erect Macrophytes
- Encrusting
- Erect Calcareous
- Filamentous

Algae percent cover

- Very Low (0-10%)
- Low (10-30%)
- Moderate (30-50%)
- High (50-75%)
- Habitat Assessment Sites 2012
- Shipping Channel

- Survey extent 2012

N



Source:
Taylor HA and McKenna SA (2012) Critical marine habitats in high risk areas, Torres Strait - Woiz Reef to Kaliko Reef - 2012 Atlas. DAFF Publication (Fisheries Queensland, Northern Fisheries Centre, Cairns). Funded by TSRA and DAFF. Produced by the Marine Ecology Group, 2012. © The State of Queensland through the Department of Agriculture, Fisheries and Forestry.
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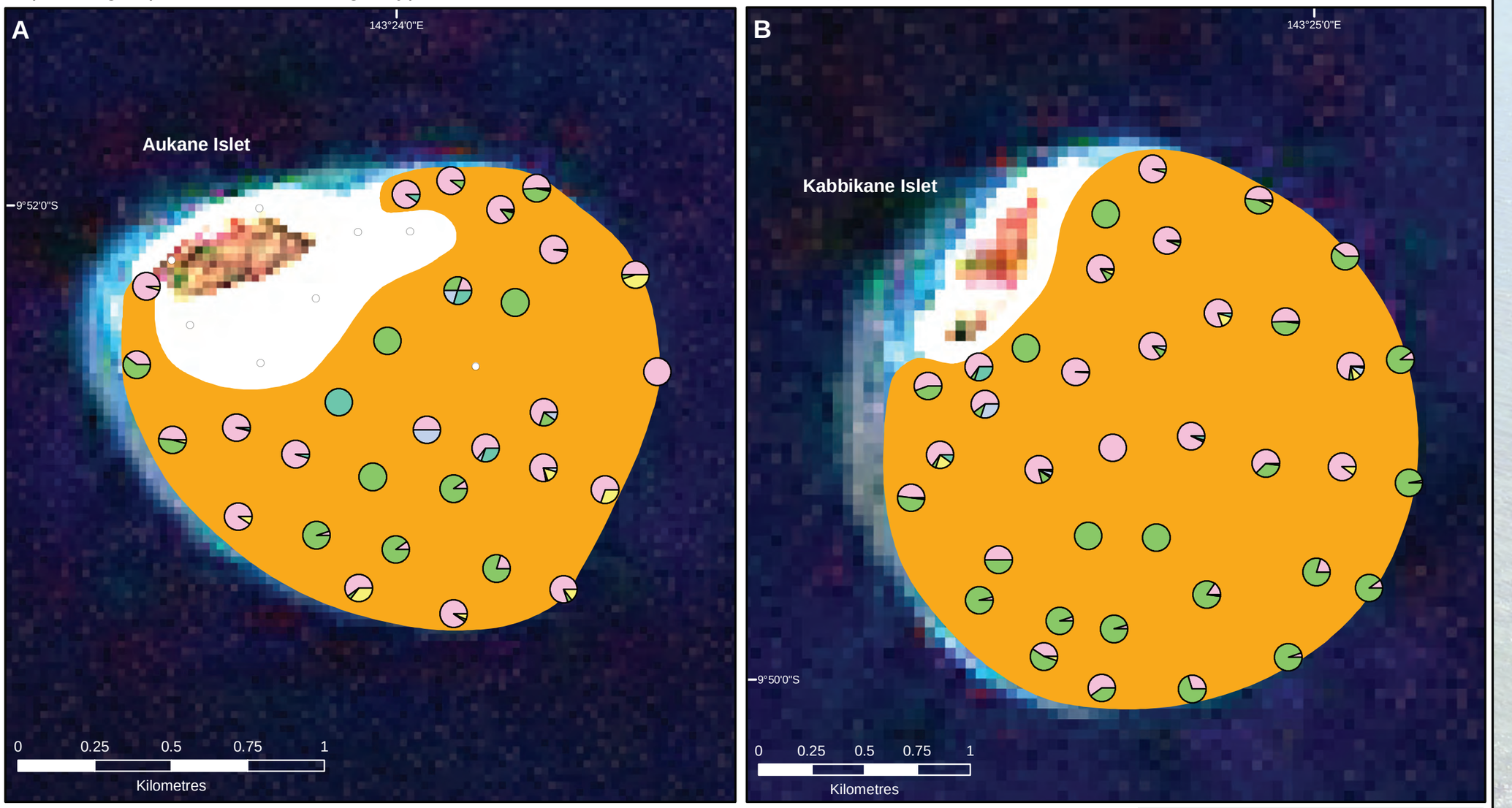
Map 19. Algae percent cover and algae type for sites on Aukane and Kabbikane Islets, Torres Strait, March 2012



Legend

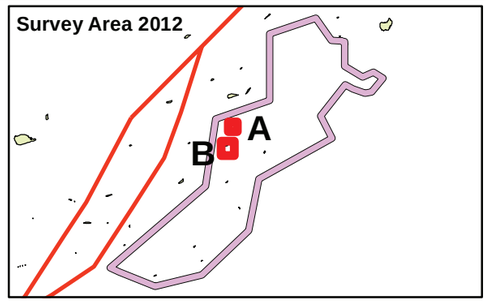
Algae type

- Turf Mat
- Erect Macrophytes
- Encrusting
- Erect Calcareous
- Filamentous

Algae percent cover

- Very Low (0-10%)
- Low (10-30%)
- Moderate (30-50%)
- High (50-75%)
- Habitat Assessment Sites 2012
- Shipping Channel
- Survey extent 2012

N



Source:
Taylor HA and McKenna SA (2012) Critical marine habitats in high risk areas, Torres Strait - Woiz Reef to Kaliko Reef - 2012 Atlas. DAFF Publication (Fisheries Queensland, Northern Fisheries Centre, Cairns). Funded by TSRA and DAFF. Produced by the Marine Ecology Group, 2012. © The State of Queensland through the Department of Agriculture, Fisheries and Forestry.
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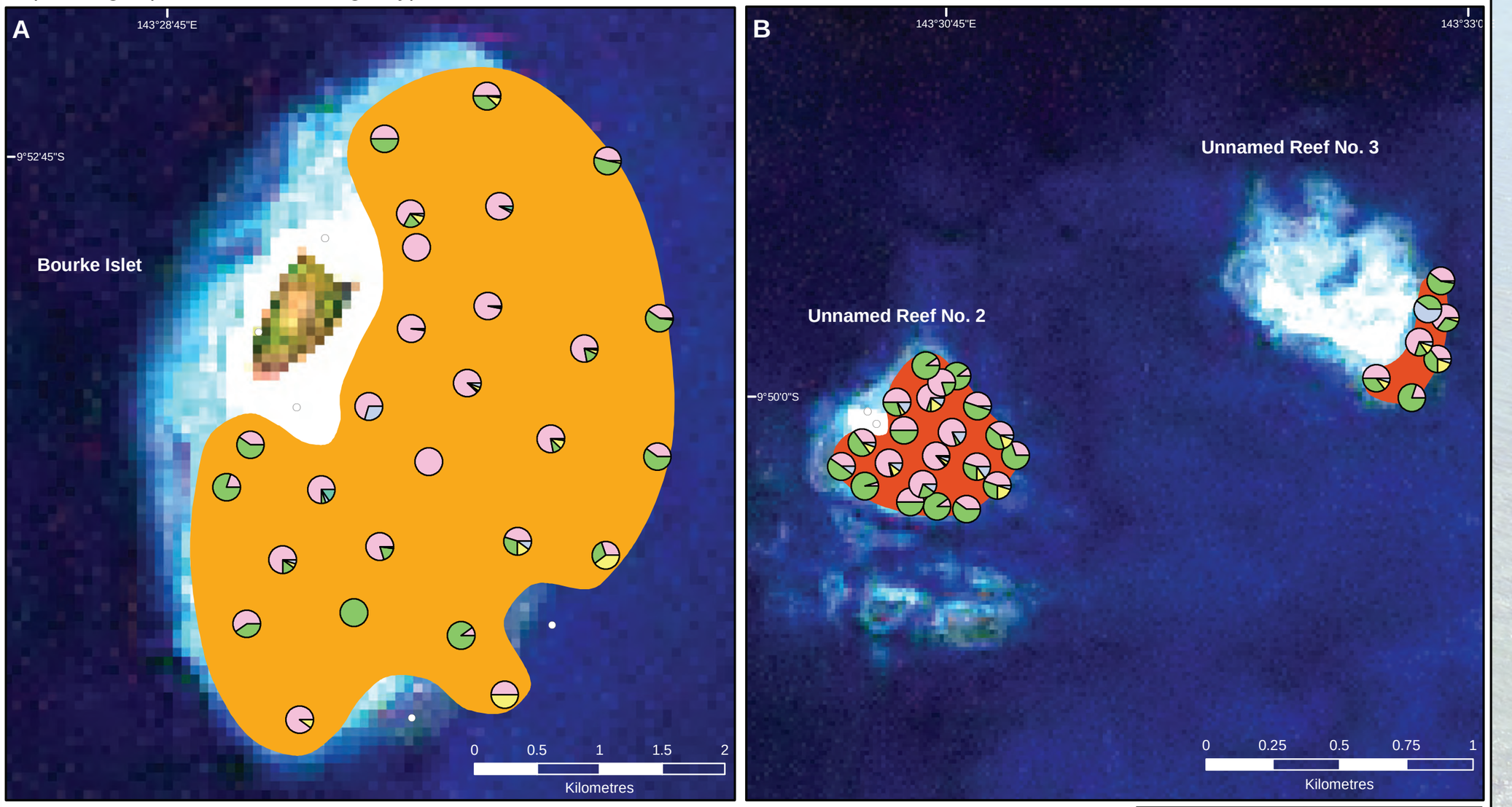
Map 20. Algae percent cover and algae type for sites on Bourke Islet and Unnamed Reefs No. 2 and 3, Torres Strait, March 2012



Legend

Algae type

- Turf Mat
- Erect Macrophytes
- Encrusting
- Erect Calcareous
- Filamentous

Algae percent cover

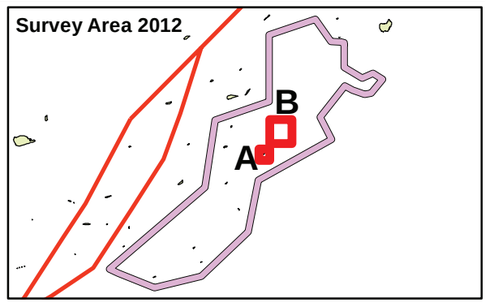
- Very Low (0-10%)
- Low (10-30%)
- Moderate (30-50%)
- High (50-75%)

Habitat Assessment Sites 2012

Shipping Channel

Survey extent 2012

N



Source:
Taylor HA and McKenna SA (2012) Critical marine habitats in high risk areas, Torres Strait - Woiz Reef to Kaliko Reef - 2012 Atlas. DAFF Publication (Fisheries Queensland, Northern Fisheries Centre, Cairns). Funded by TSRA and DAFF. Produced by the Marine Ecology Group, 2012. © The State of Queensland through the Department of Agriculture, Fisheries and Forestry.
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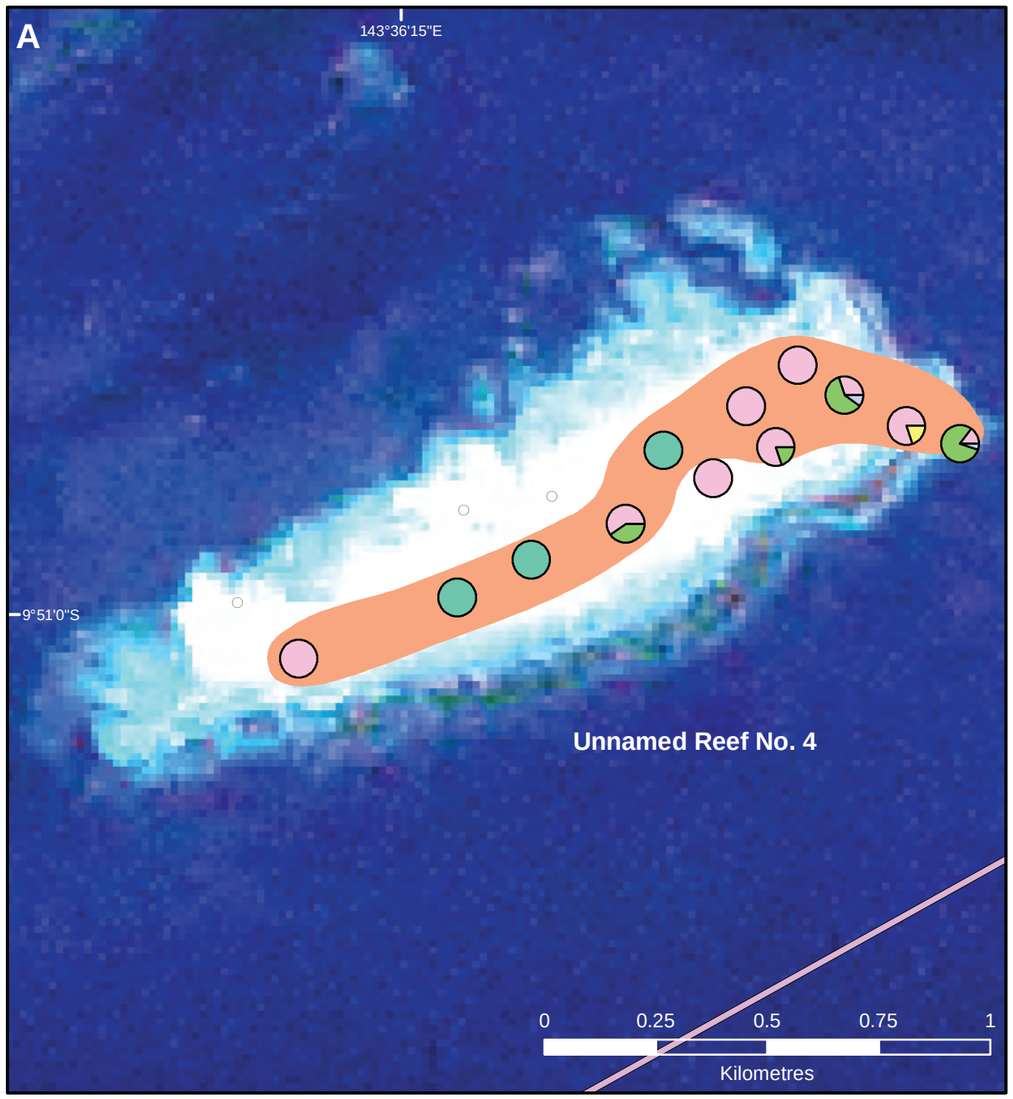
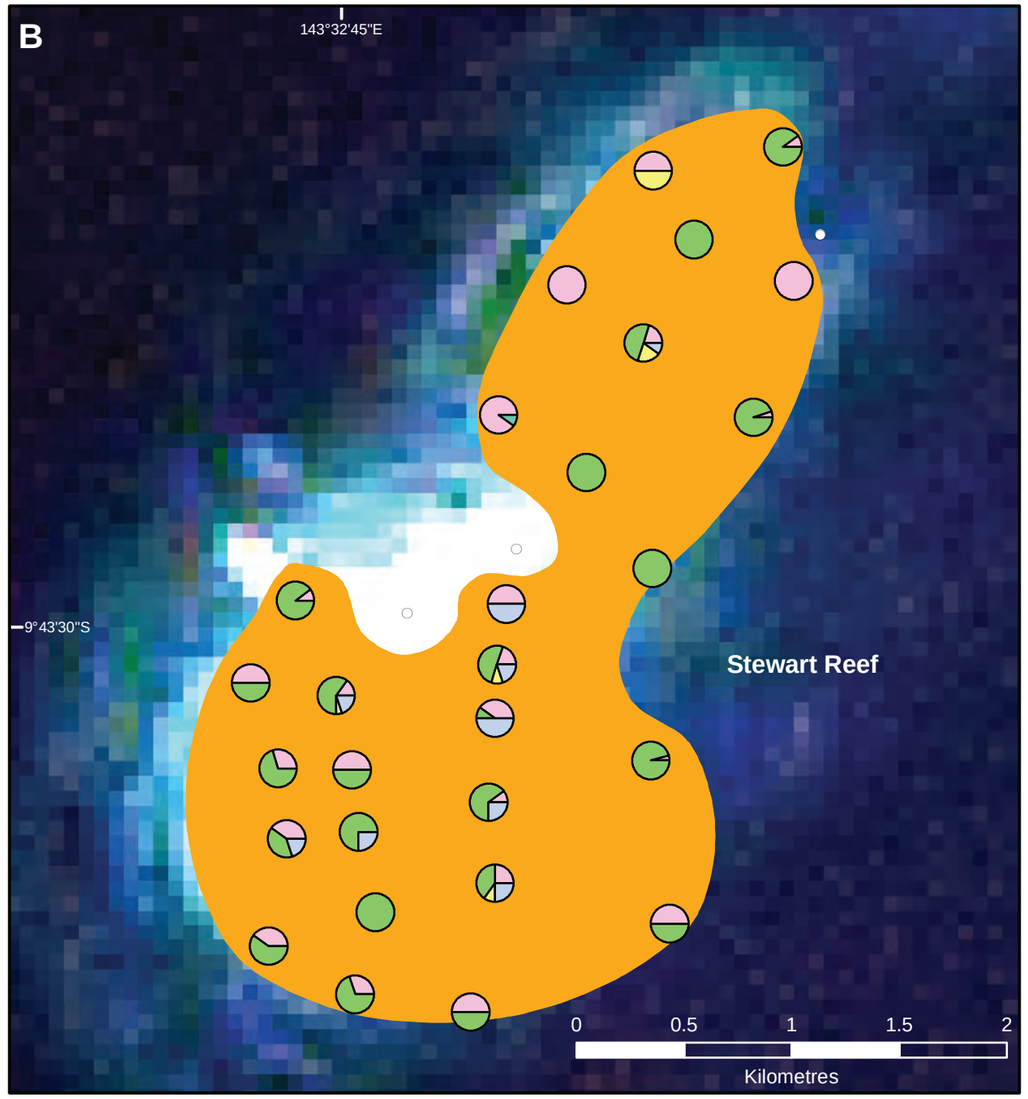
Map 21. Algae percent cover and algae type for sites on Unnamed Reef No. 4 and Stewart Reef, Torres Strait, March 2012





Legend

Algae type

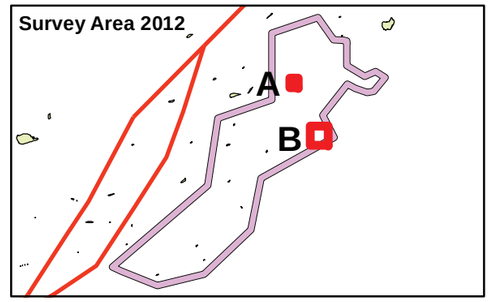
- Turf Mat
- Erect Macrophytes
- Encrusting
- Erect Calcareous
- Filamentous

Algae percent cover

- Very Low (0-10%)
- Low (10-30%)
- Moderate (30-50%)
- High (50-75%)
- Habitat Assessment Sites 2012
- Shipping Channel

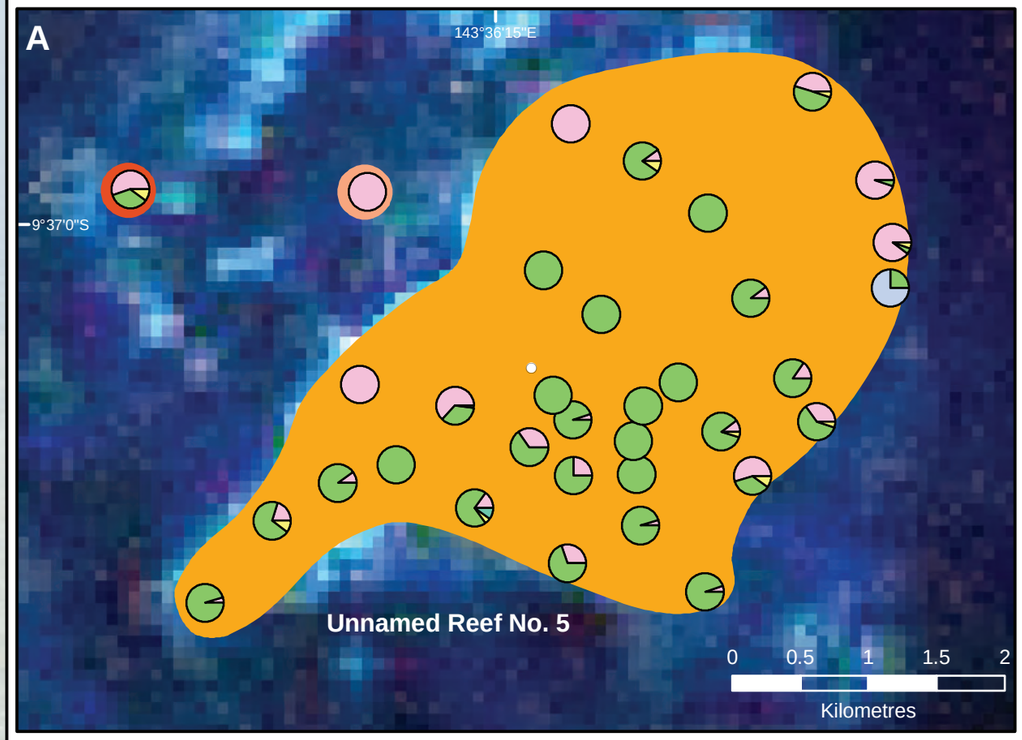
- Survey extent 2012

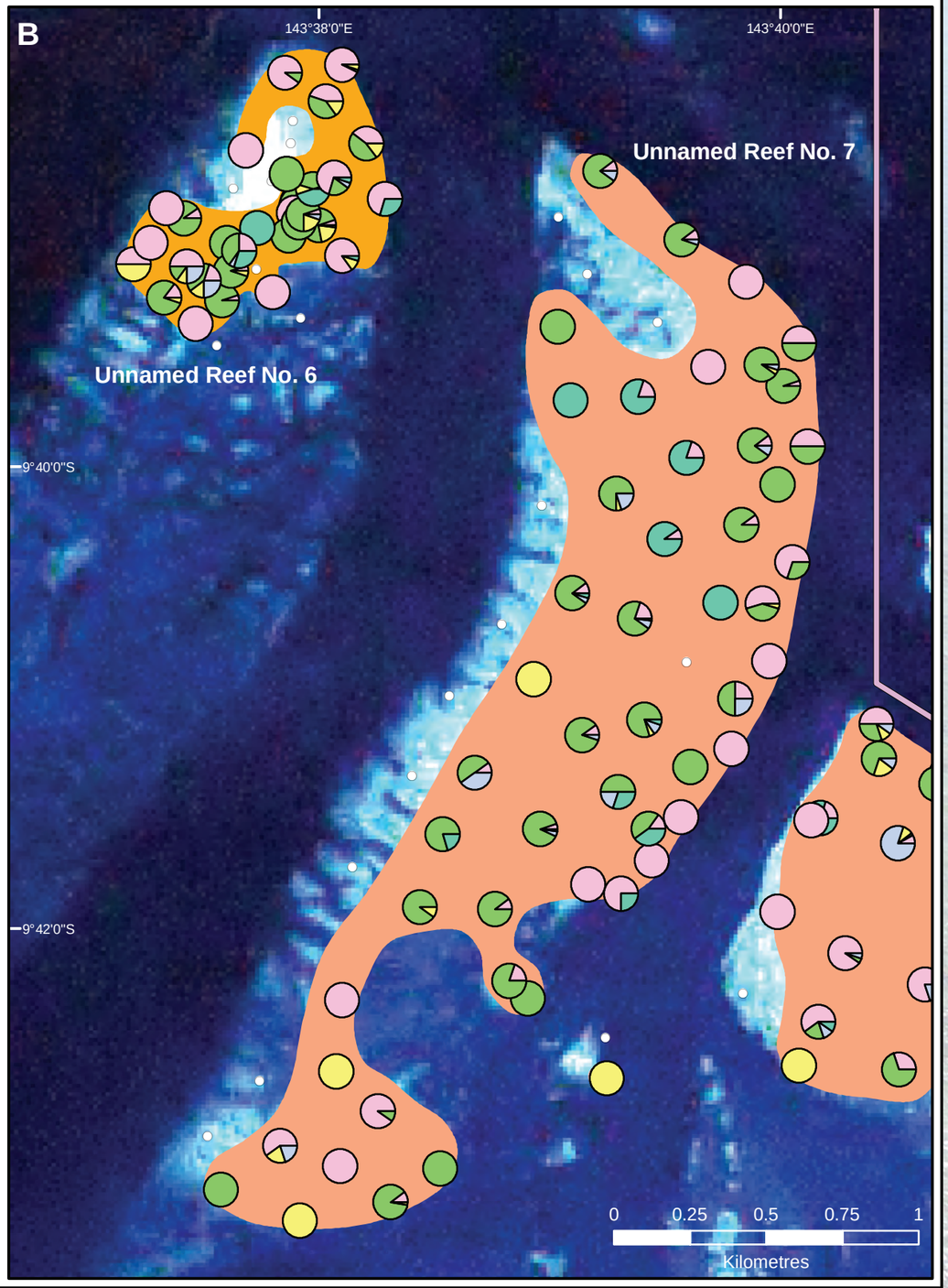
N



Source:
Taylor HA and McKenna SA (2012) Critical marine habitats in high risk areas, Torres Strait - Woiz Reef to Kaliko Reef - 2012 Atlas. DAFF Publication (Fisheries Queensland, Northern Fisheries Centre, Cairns). Funded by TSRA and DAFF. Produced by the Marine Ecology Group, 2012.

Map 22. Algae percent cover and algae type for sites on Unnamed Reefs No. 5, 6 and 7, Torres Strait, March 2012





Legend

- Habitat Assessment Sites 2012

Algae type

- Turf Mat
- Erect Macrophytes
- Encrusting
- Erect Calcareous
- Filamentous

Algae percent cover

- Very Low (0-10%)
- Low (10-30%)
- Moderate (30-50%)
- High (50-75%)
- Shipping Channel
- Survey extent 2012

N

Source:
Taylor HA and McKenna SA (2012) Critical marine habitats in high risk areas, Torres Strait - Woiz Reef to Kaliko Reef - 2012 Atlas. DAFF Publication (Fisheries Queensland, Northern Fisheries Centre, Cairns). Funded by TSRA and DAFF. Produced by the Marine Ecology Group, 2012. © The State of Queensland through the Department of Agriculture, Fisheries and Forestry.
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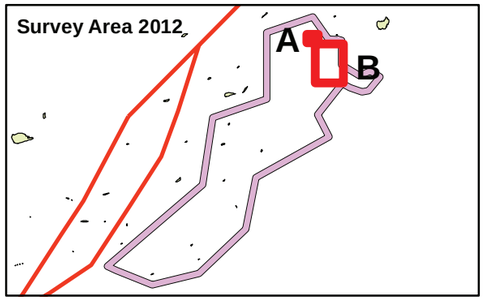
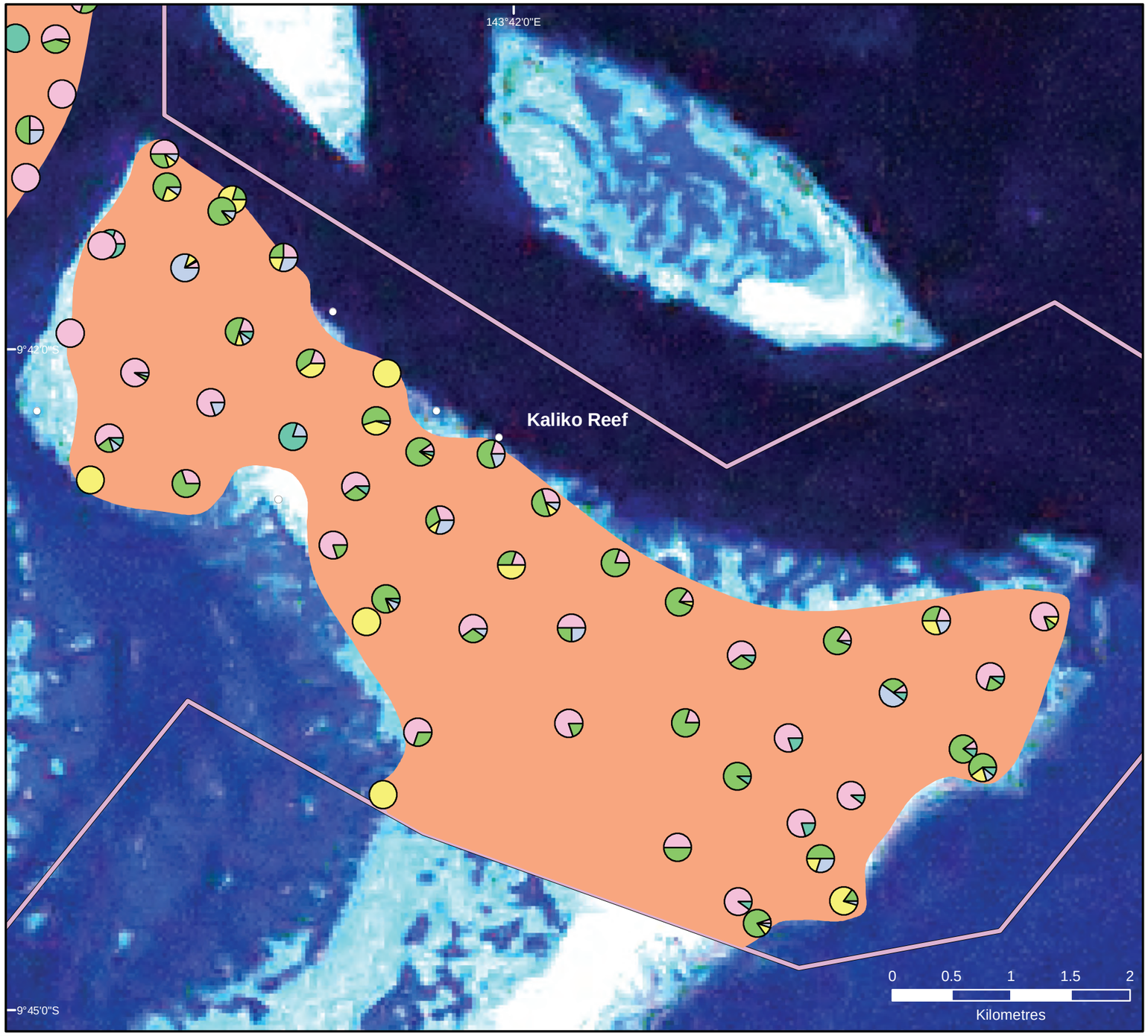


Map 23. Algae percent cover and algae type for sites on Kaliko Reef, Torres Strait, March 2012



Legend

Habitat Assessment Sites 2012

Algae type

Turf Mat
Erect Macrophytes
Encrusting
Erect Calcareous
Filamentous

Algae percent cover

Very Low (0-10%)
Low (10-30%)
Moderate (30-50%)
High (50-75%)

Shipping Channel
Survey extent 2012

N

Source:
Taylor HA and McKenna SA (2012) Critical marine habitats in high risk areas, Torres Strait - Woiz Reef to Kaliko Reef - 2012 Atlas. DAFF Publication (Fisheries Queensland, Northern Fisheries Centre, Cairns). Funded by TSRA and DAFF. Produced by the Marine Ecology Group, 2012.

Other benthos and benthic macro-invertebrates (BMI)

Other benthos (excluding seagrass and algae) made up approximately 70% of the benthic habitat cover in the survey (Figure 2), within which open substrate comprised the largest fraction of benthic type. Open substrate was typically found in conjunction with seagrass, algae and BMI communities. BMI within reef habitat communities were dominated by hard and soft corals (Maps 24 - 30).

Hard and soft coral communities often formed a ring around the outside of the intertidal reef areas surveyed, dominating the reef crest and extending into the subtidal region. This pattern was clearly evident on Kodnasem Reef (Map 24). Where present, hard and soft coral cover was typically moderate (30-50%), however there were a large number of areas in which cover was much greater. Almost 40% of the 18 intertidal reef or island areas surveyed contained areas of hard or soft coral cover that exceeded 75%. Sponges had a low presence across the survey area. The intertidal areas that are more exposed on low tide were more typically dominated by open substrate.

Other benthic taxa including ascidians, bivalves and holothurians formed obvious components of the benthic habitat at only a few sites in the survey area.

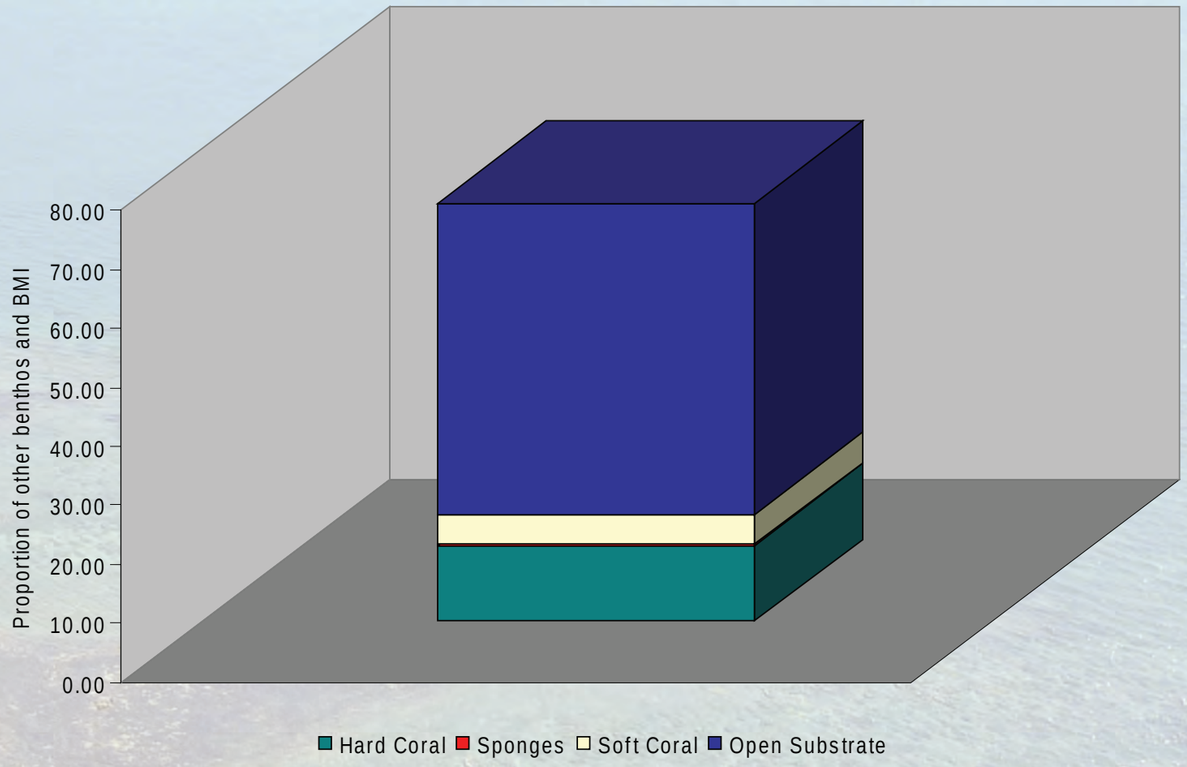
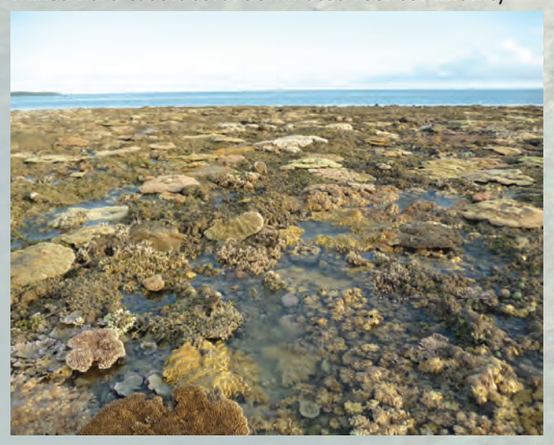
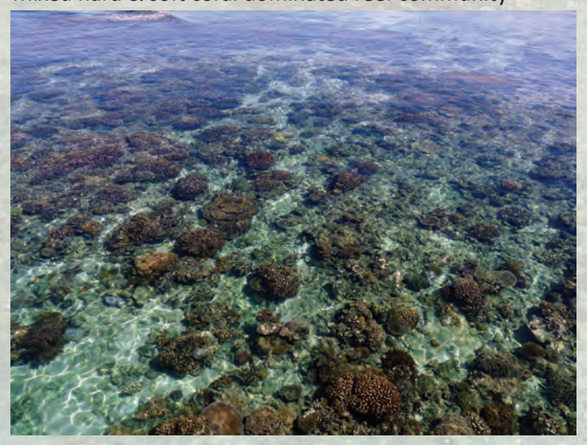


Figure 5 Mean per cent cover (at each site) of benthic macro-invertebrate type in Torres Strait survey area 2012

Mixed hard & soft coral dominated reef community

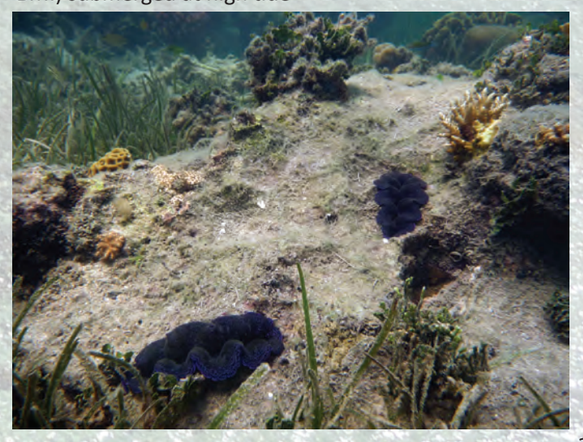


Mixed hard & soft coral dominated reef community

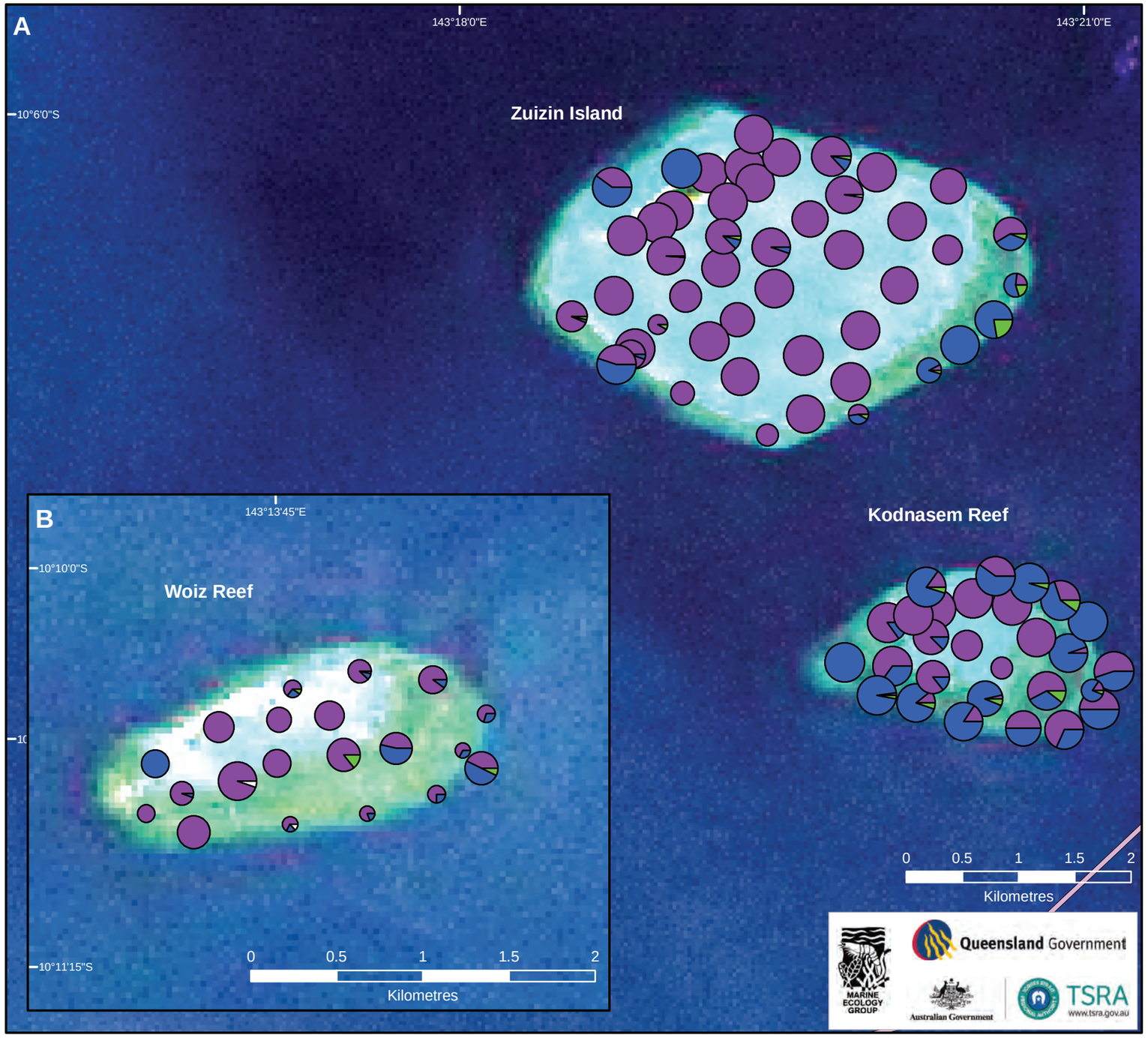


Predominantly open substrate habitat with *Thalassia hemprichii* and turf mat algae

Mixed habitat of seagrass, algae, corals and clams (other BMI) submerged at high tide



Map 24. Other benthos (excluding seagrass and algae) and benthic macro-invertebrate distribution and abundance for sites on Woiz Reef, Kodnasem Reef and Zuizin Island, Torres Strait, March 2012



Legend

- Habitat Assessment Sites 2012

Benthic macro-invertebrate type

- Open substrate
- Hard coral
- Soft coral
- Sponge
- Other
- Shipping Channel
- Survey extent 2012

Benthic macro-invertebrate % cover

- 5
- 10
- 50
- 100

Source:
Taylor HA and McKenna SA (2012) Critical marine habitats in high risk areas, Torres Strait - Woiz Reef to Kaliko Reef - 2012 Atlas. DAFF Publication (Fisheries Queensland, Northern Fisheries Centre, Cairns). Funded by TSRA and DAFF. Produced by the Marine Ecology Group, 2012. © The State of Queensland through the Department of Agriculture, Fisheries and Forestry. Landsat Image Copyright Commonwealth of Australia - ACRES , Geoscience Australia

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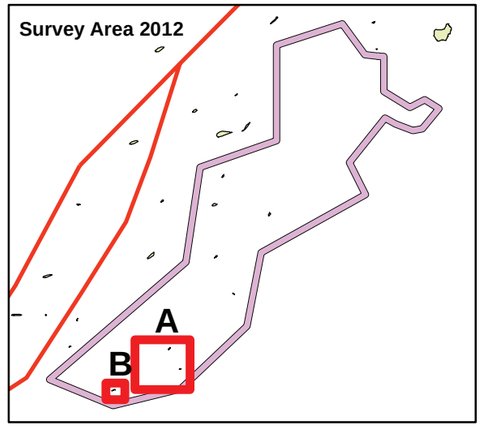
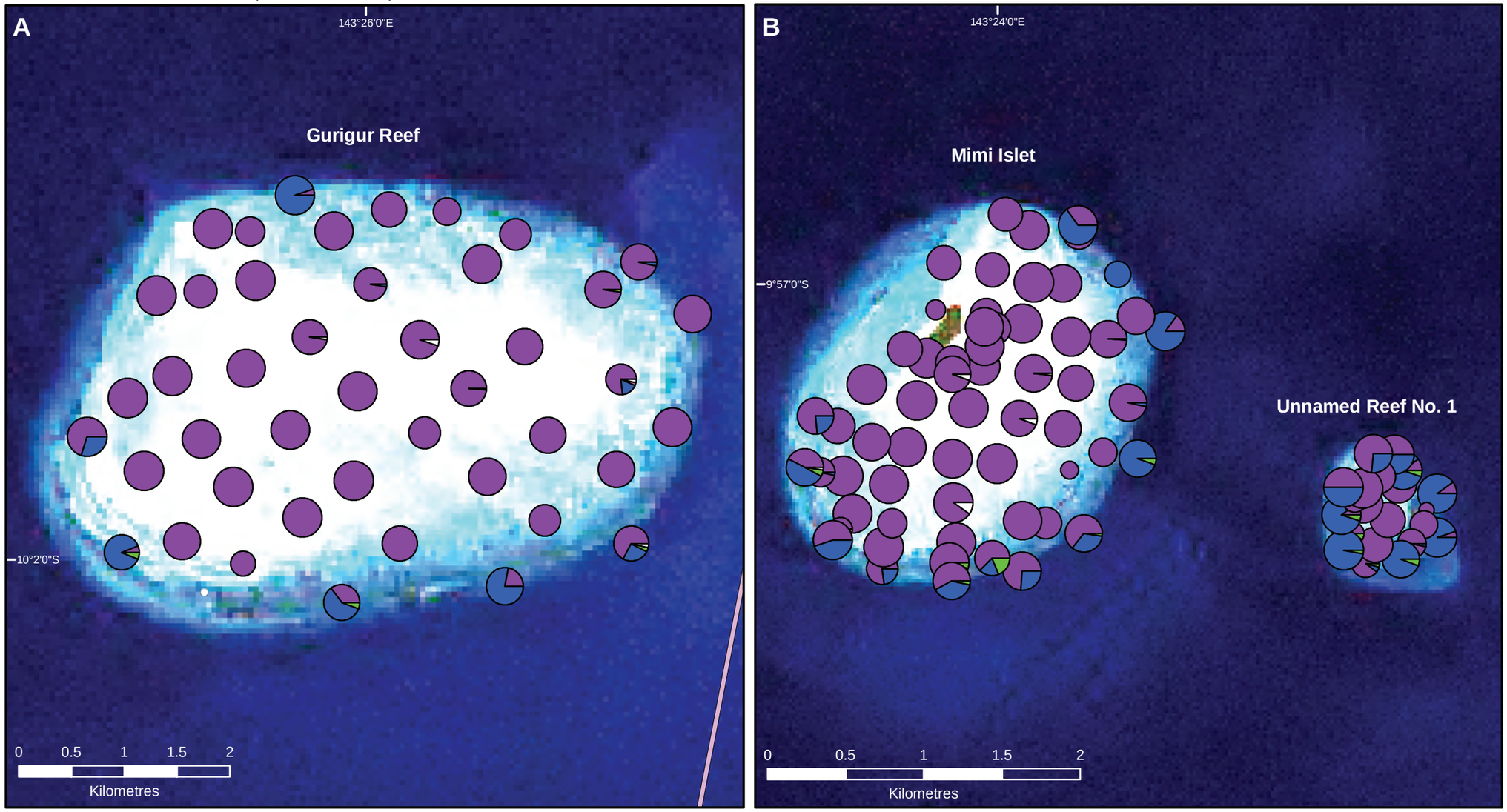


Map 25. Other benthos (excluding seagrass and algae) and benthic macro-invertebrate distribution and abundance for sites on Gurigur Reef, Mimi Islet and Unnamed Reef No. 1, Torres Strait, March 2012



Legend

Benthic macro-invertebrate type

Open
Hard coral
Soft coral
Sponge
Other

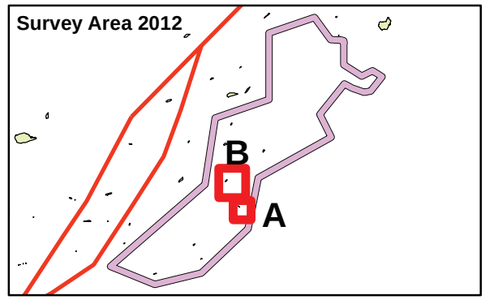
Shipping Channel
Habitat Assessment Sites 2012
Survey extent 2012

Benthic macro-invertebrate % cover

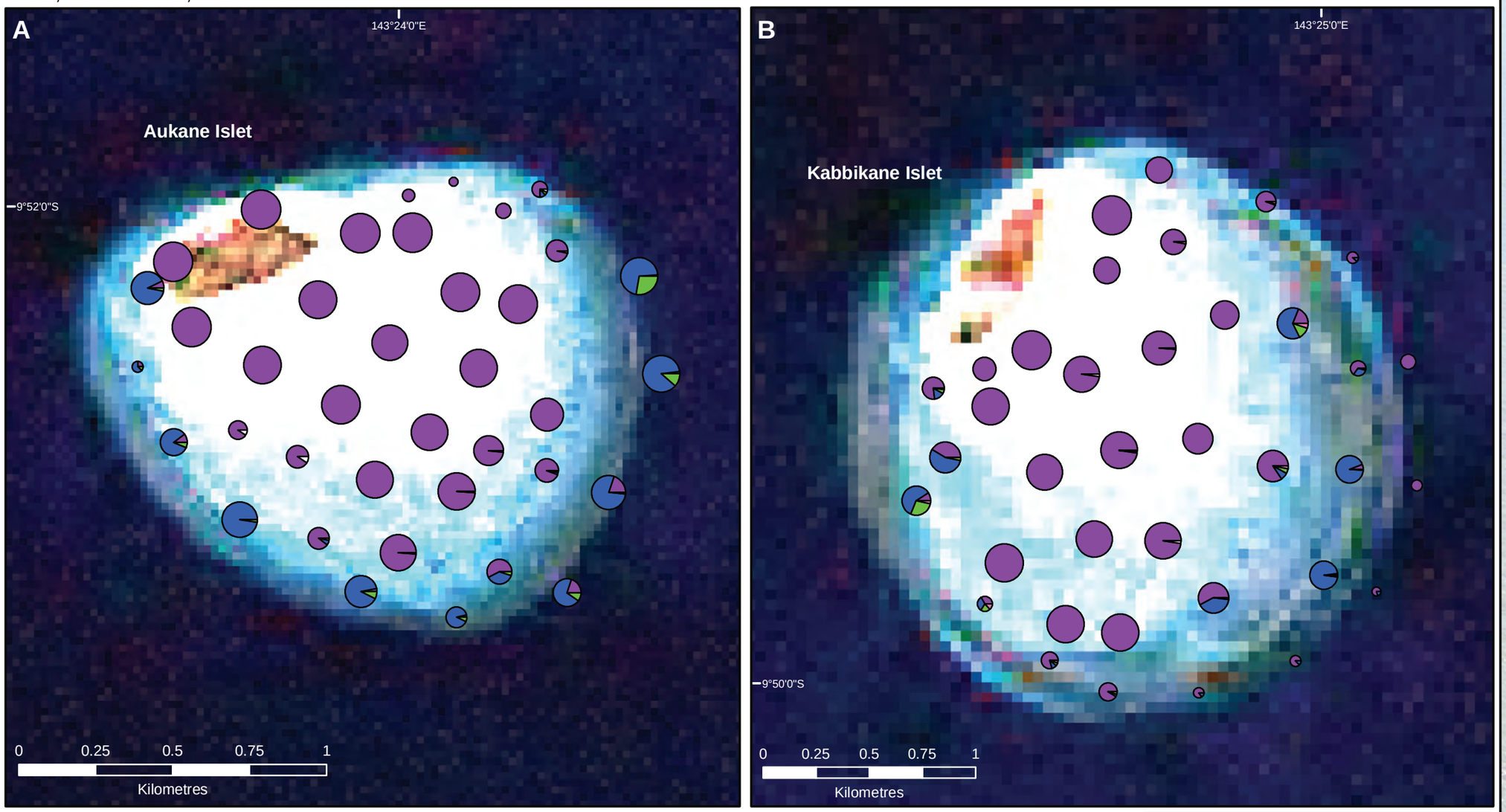
5
10
50
100

N

Source:
Taylor HA and McKenna SA (2012) Critical marine habitats in high risk areas, Torres Strait - Woiz Reef to Kaliko Reef - 2012 Atlas. DAFF Publication (Fisheries Queensland, Northern Fisheries Centre, Cairns). Funded by TSRA and DAFF. Produced by the Marine Ecology Group, 2012.



Map 26. Other benthos (excluding seagrass and algae) and benthic macro-invertebrate distribution and abundance for sites on Aukane and Kabbikane Islets, Torres Strait, March 2012



Legend

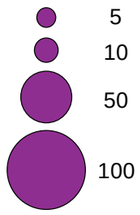
Benthic macro-invertebrate type

Shipping Channel

Habitat Assessment Sites 2012

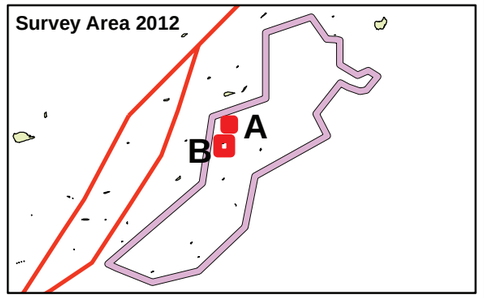
Survey extent 2012

Benthic macro-invertebrate % cover

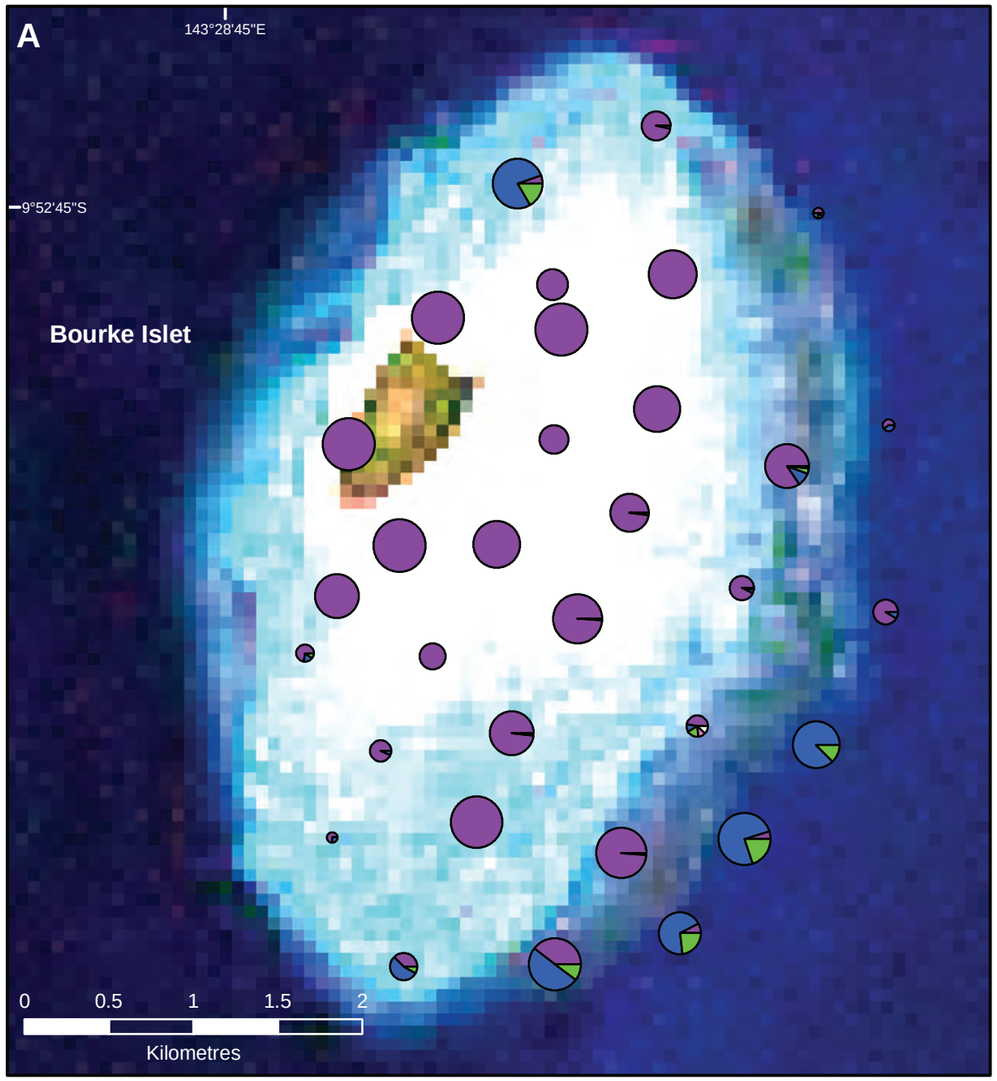


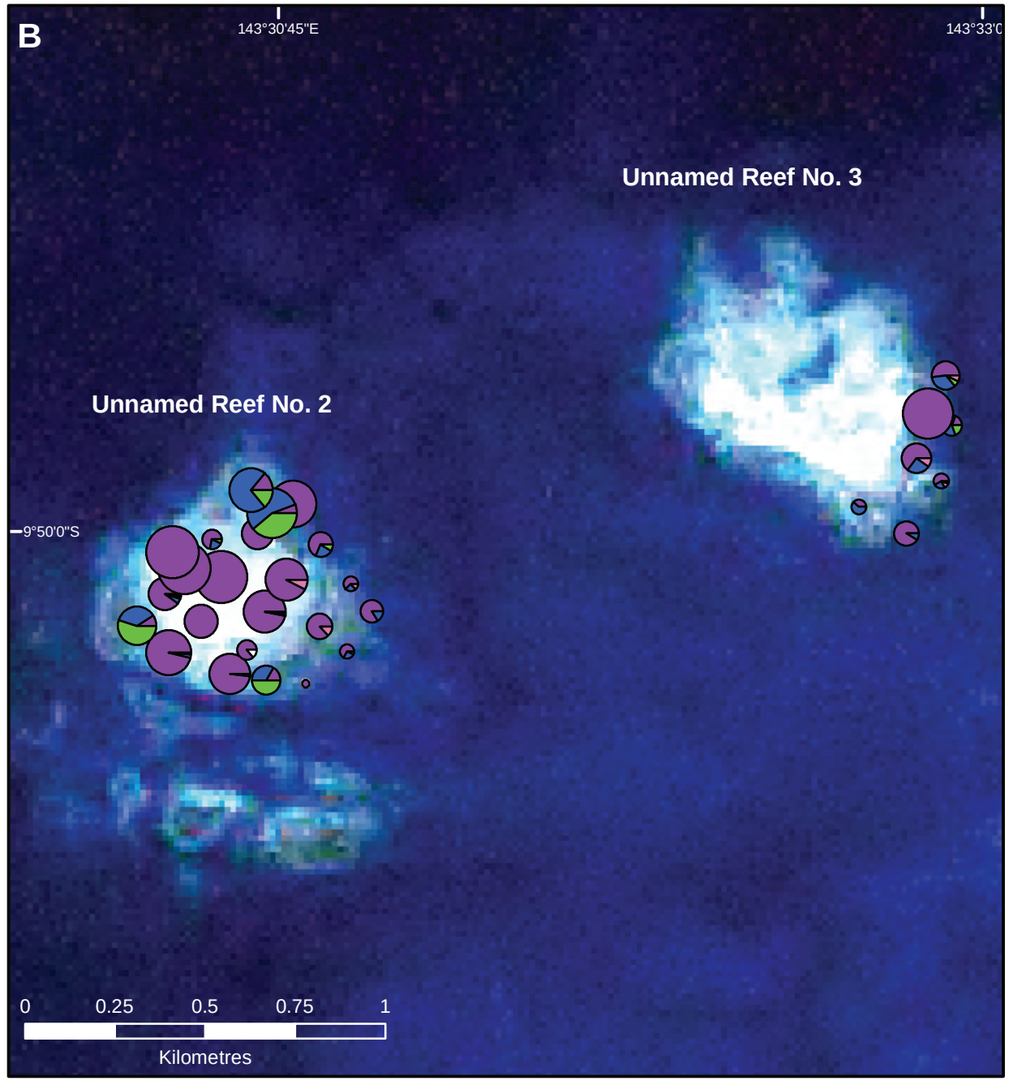
N

Source:
Taylor HA and McKenna SA (2012) Critical marine habitats in high risk areas, Torres Strait - Woiz Reef to Kaliko Reef - 2012 Atlas. DAFF Publication (Fisheries Queensland, Northern Fisheries Centre, Cairns). Funded by TSRA and DAFF. Produced by the Marine Ecology Group, 2012. © The State of Queensland through the Department of Agriculture, Fisheries and Forestry. Landsat Image Copyright Commonwealth of Australia - ACRES, Geoscience Australia



Map 27. Other benthos (excluding seagrass and algae) and benthic macro-invertebrate distribution and abundance for sites on Bourke Islet and Unnamed Reefs No. 2 and 3, Torres Strait, March 2012





Legend

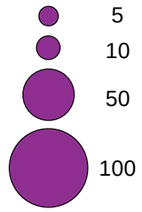
Benthic macro-invertebrate type

Shipping Channel

Habitat Assessment Sites 2012

Survey extent 2012

Benthic macro-invertebrate % cover



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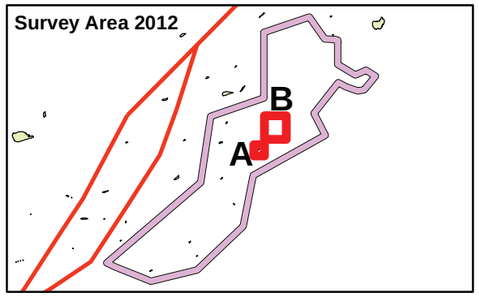
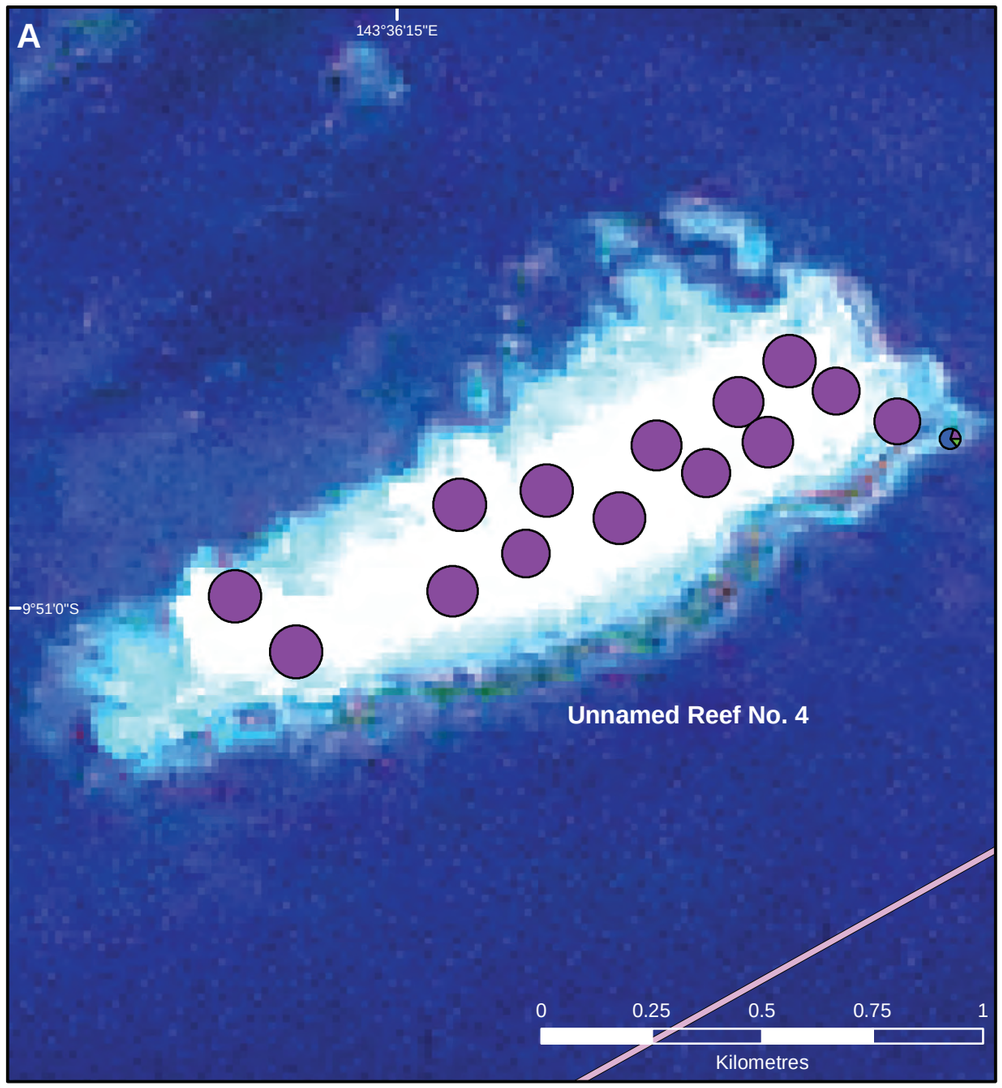
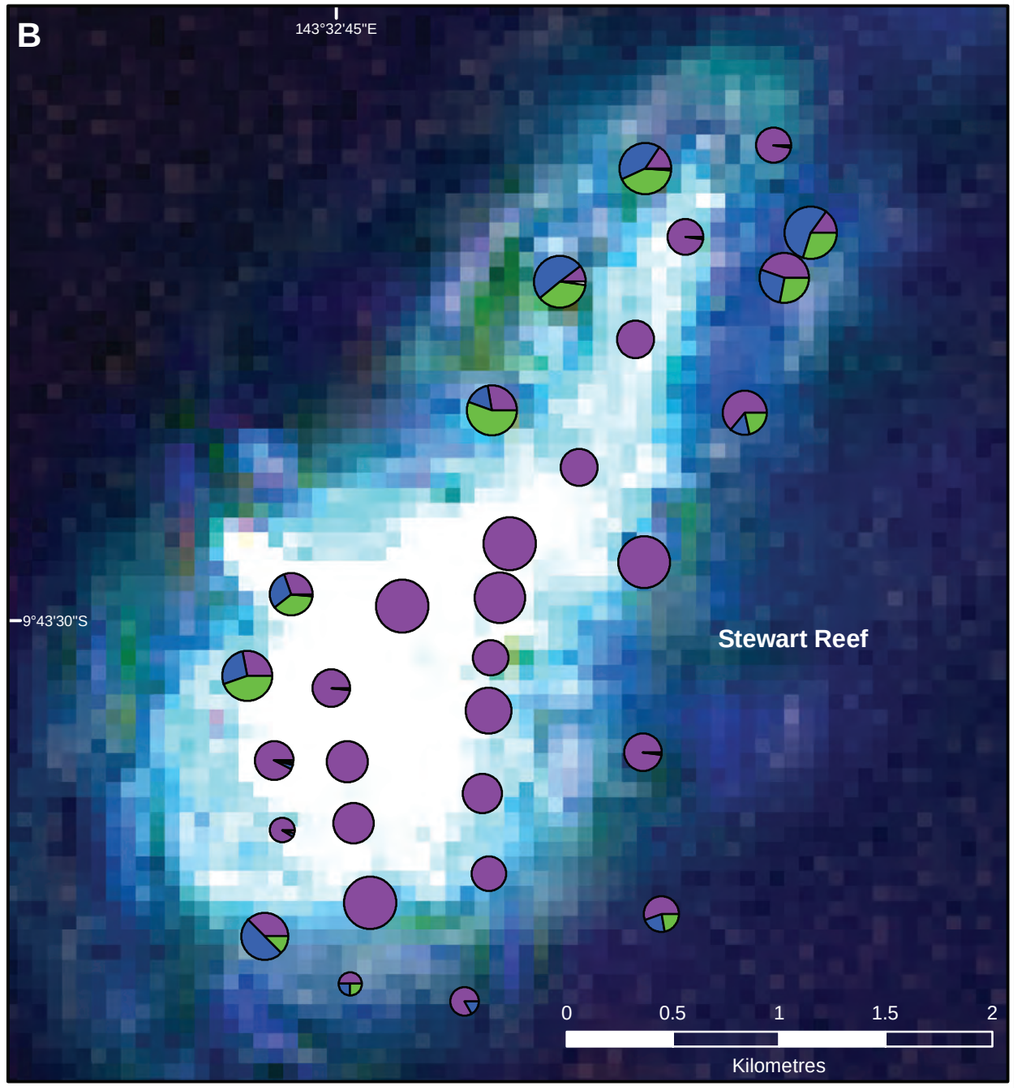
Source:
Taylor HA and McKenna SA (2012) Critical marine habitats in high risk areas, Torres Strait - Woiz Reef to Kaliko Reef - 2012 Atlas. DAFF Publication (Fisheries Queensland, Northern Fisheries Centre, Cairns). Funded by TSRA and DAFF. Produced by the Marine Ecology Group, 2012.



Map 28. Other benthos (excluding seagrass and algae) and benthic macro-invertebrate distribution and abundance for sites on Unnamed Reef No. 4 and Stewart Reef, Torres Strait, March 2012



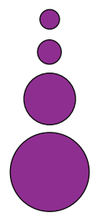


Legend

Benthic macro-invertebrate type

Shipping Channel
Habitat Assessment Sites 2012
Survey extent 2012

Benthic macro-invertebrate % cover



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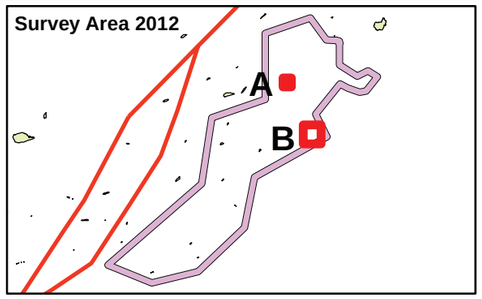
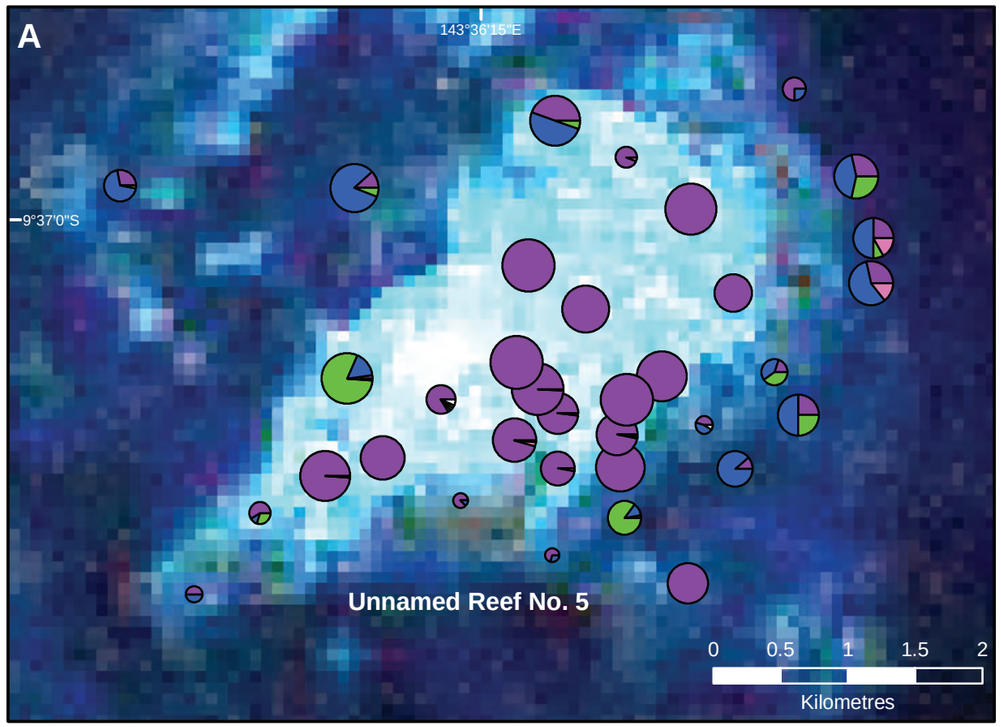
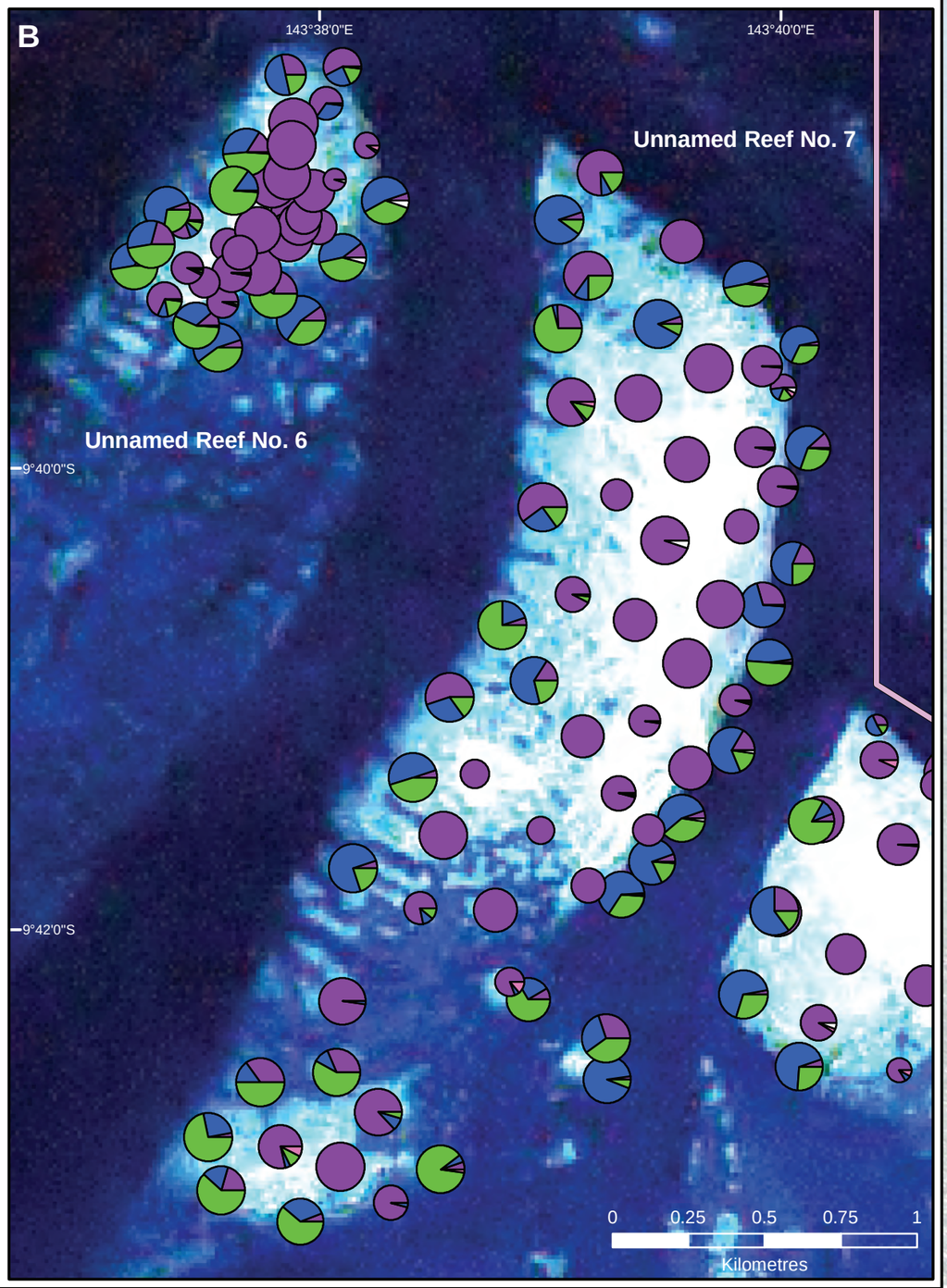
Source:
Taylor HA and McKenna SA (2012) Critical marine habitats in high risk areas, Torres Strait - Woiz Reef to Kaliko Reef - 2012 Atlas. DAFF Publication (Fisheries Queensland, Northern Fisheries Centre, Cairns). Funded by TSRA and DAFF. Produced by the Marine Ecology Group, 2012. © The State of Queensland through the Department of Agriculture, Fisheries and Forestry. Landsat Image Copyright Commonwealth of Australia - ACRES, Geoscience Australia



Map 29. Other benthos (excluding seagrass and algae) and benthic macro-invertebrate distribution and abundance for sites on Unnamed Reefs No. 5, 6 and 7, Torres Strait, March 2012





Legend

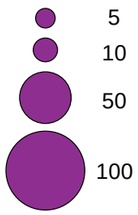
Benthic macro-invertebrate type

Shipping Channel

Habitat Assessment Sites 2012

Survey extent 2012

Benthic macro-invertebrate % cover



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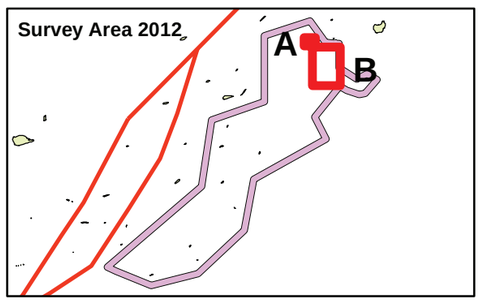
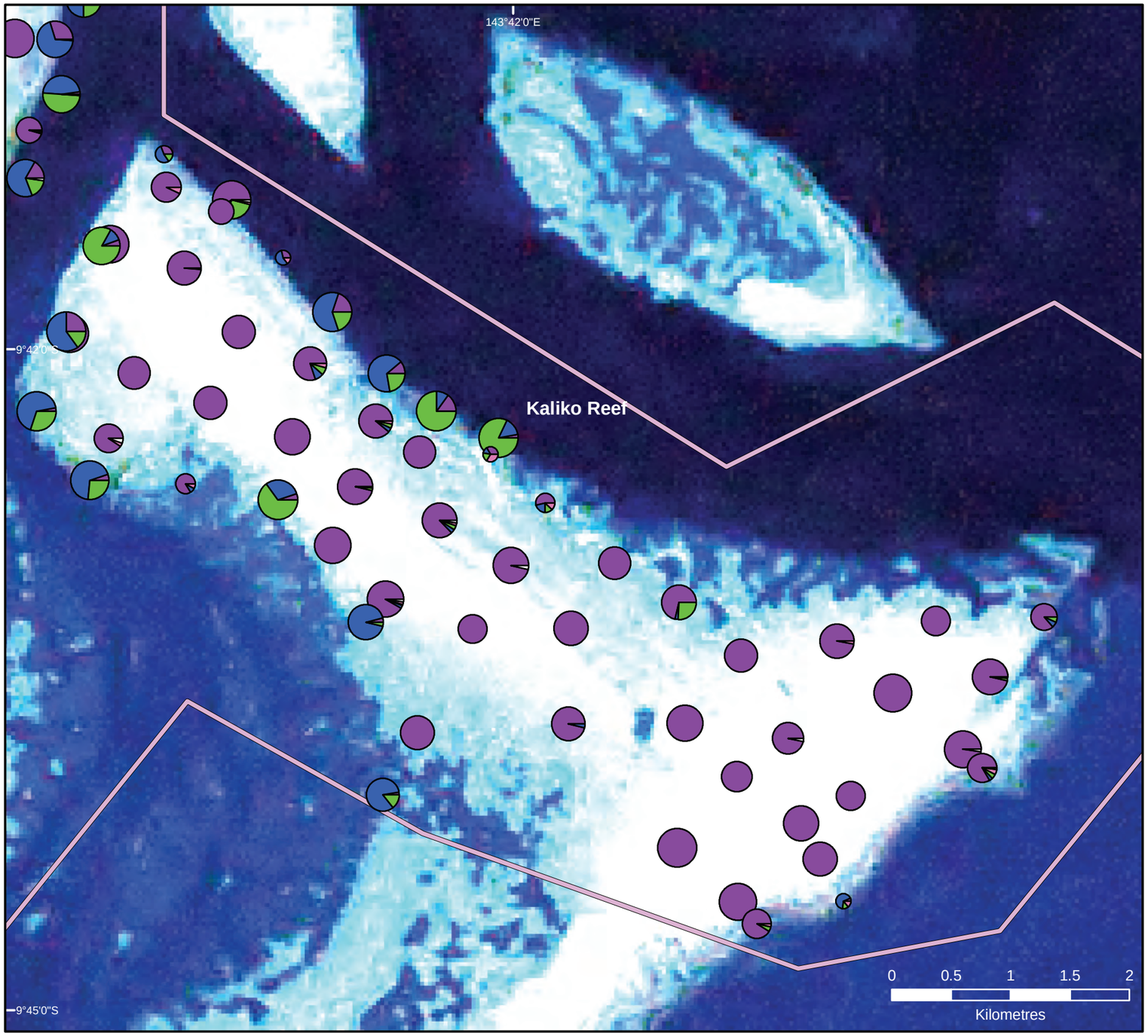
Source:
Taylor HA and McKenna SA (2012) Critical marine habitats in high risk areas, Torres Strait - Woiz Reef to Kaliko Reef - 2012 Atlas. DAFF Publication (Fisheries Queensland, Northern Fisheries Centre, Cairns). Funded by TSRA and DAFF. Produced by the Marine Ecology Group, 2012. © The State of Queensland through the Department of Agriculture, Fisheries and Forestry. Landsat Image Copyright Commonwealth of Australia - ACRES, Geoscience Australia



Map 30. Other benthos (excluding seagrass and algae) and benthic macro-invertebrate distribution and abundance for sites on Kaliko Reef, Torres Strait, March 2012



Legend

Benthic macro-invertebrate type

Open
Hard coral
Soft coral
Sponge
Other

Shipping Channel

Habitat Assessment Sites 2012

Survey extent 2012

Benthic macro-invertebrate % cover

5
10
50
100

Source:
Taylor HA and McKenna SA (2012) Critical marine habitats in high risk areas, Torres Strait - Woiz Reef to Kaliko Reef - 2012 Atlas. DAFF Publication (Fisheries Queensland, Northern Fisheries Centre, Cairns). Funded by TSRA and DAFF. Produced by the Marine Ecology Group, 2012. © The State of Queensland through the Department of Agriculture, Fisheries and Forestry.
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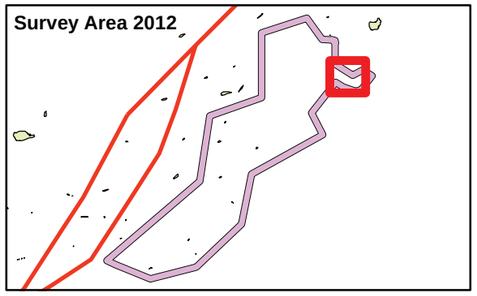
Survey Area 2012



Conclusions and Habitat Vulnerability

This atlas documents the incidence of ecologically and economically valuable intertidal marine habitats occurring in areas between Woiz Reef and Kaliko Reef, eastward of the Great North East (GNE) Shipping Channel in the Torres Strait. During the surveys, extensive areas of seagrass, algae and benthic macro-invertebrate (BMI) habitats were identified in areas at high risk from shipping activities. The diversity of habitats and their near pristine condition makes this area particularly valuable with the habitats described important for commercial fisheries and regional biodiversity. The region is also recognised as having a particularly high risk of shipping accidents as reef areas are very close to the GNE channel. The accident risk combined with the high habitat sensitivity means the area is likely to be highly sensitive to shipping accidents and oil spills.

In order to assist in priority setting for accident response we have combined the habitats mapped in these surveys into three distinct categories of habitat vulnerability from shipping accidents. The categories were based on habitats biological susceptibility to oils and habitat quality (Table 5; Map 31-37). While all of the intertidal area could be considered vulnerable, some ability to discriminate between areas was considered important when there may be limited resources available to deal with an oil spill or shipping accident.

Although all seagrass, coral and algae types found within the survey area are susceptible to damage from oil and also to some of the dispersants commonly used in oil spill management (e.g. Baca et al. 1996; Knap et al. 1983; O'Brien & Dixon 1976) they can vary substantially in their growth rates and ability to recover from damage. Small, fast growing seagrass species such as *Halophila* have the capacity for rapid recolonisation and recovery from disturbance when compared with larger slower growing species (eg. Rasheed 1999; 2004). Similarly, different algae types vary in their growth rates and ability to recolonise. Filamentous turf algae are rapid colonisers and are quick to recover from damage compared to the more structurally complex erect macrophyte and erect calcareous growth forms (e.g. Diaz-Pulido & McCook 2002; Littler & Littler 1980; McClanahan 1997).

Benthic habitats were assigned into seven different groups for determination of vulnerability by applying the known information on recovery rates and susceptibility to oil damage (Table 5). From this, a habitat vulnerability matrix that also accounted for density of habitat types was applied and regions were assigned into habitat vulnerability categories: low, moderate and high (Table 5). This information was overlaid onto the habitat vulnerability maps. Almost all intertidal areas were mapped into these categories, however areas that contained purely open substrate were occasionally omitted as their vulnerability to shipping accidents and oil spills is very low.

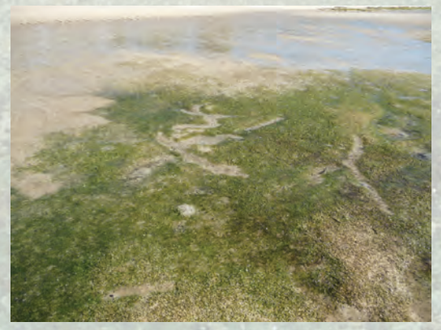
Table 5 Risk matrix for major habitat types between No 2 and Mabuiag Reefs, 2012

Habitat Type		Percent cover of habitat				
		Very Low (0 – 10)	**Low** (10 – 30)	**Moderate** (30 – 50)	**High** (50 – 75)	**Very High** (75 – 100)
Seagrass	Slow growing, long recovery time (TH, CR)*	M	H	H	H	H
	Fast growing, short recovery time (HO)*	M	M	M	M	H
Algae	Turf / Filamentous	L	L	L	L	L
	Encrusting	L	L	L	M	H
	Erect Macrophytes / Erect calcareous	L	L	M	H	H
BMI	Hard & Soft Coral	L	M	M	H	H
	Sponges	L	M	M	H	H

* TH: *Thalassia hemprichii*; CR: *Cymodocea rotundata;* HO: *Halophila ovalis*

Receeding tide exposes beach rock

Dugong feeding trails



Complex reef and seagrass habitat

The application of the habitat vulnerability matrix resulted in 60% of the intertidal areas in the survey area being moderately or highly vulnerable to shipping accidents and oil spills (Figure 6; Maps 31-37). All reefs and islands surveyed contained areas of all three vulnerability categories. Unnamed reef 1 had the greatest amount of highly vulnerable habitat, thanks largely to the high abundance of hard and soft coral present on the fringes of the reef (Map 32) while Gurigur Reef and Unnamed reef 4 consisted of large areas of lower vulnerability areas (Maps 32 & 35). The largest reef system surveyed, Kaliko Reef, had the smallest area of low vulnerability habitat. Moderately and highly susceptible seagrass and coral communities dominated this area (Map 37).

In most cases, highly vulnerable areas were those that retained shallow pools of water during low tide events with higher seagrass cover, algae and BMI, whereas fully exposed areas were typically at moderate or low vulnerability due to lower concentrations of structurally complex habitats forming there.

Care should be taken when using the maps in this atlas for shipping accident response. Despite some sections of the region being deemed at "low vulnerability" it should be remembered that this is a relative category and that these areas contained habitats that would be susceptible to damage from oil spills and shipping accidents. Many of the habitats described may also show intra- and inter-annual variability in distribution and density of habitat structure. Attempts at ground truthing the extent of these habitats as part of any response to an accident/oil spill is recommended.

The TSRA LMSU Indigenous Land and Sea Ranger Program is conducting a range of programs that focus on long-term monitoring of their valuable habitat resources. Managers, rangers and community members will be able to utilise the information in this atlas as a baseline on which habitat community monitoring programs could be established. Seagrass has been identified by managers and rangers as an area of particular interest, with Rangers from many communities identifying long-term seagrass monitoring a key priority of the local ranger program.

The Great North East Shipping Channel has a high frequency of shipping traffic, complex navigation through reef and island habitat and have highly diverse marine habitat with only limited information previously available. The information in this atlas will be made available to be incorporated into the National Oil Spill Response Atlas (OSRA) to assist in the planning and management of shipping accidents in the Torres Strait.

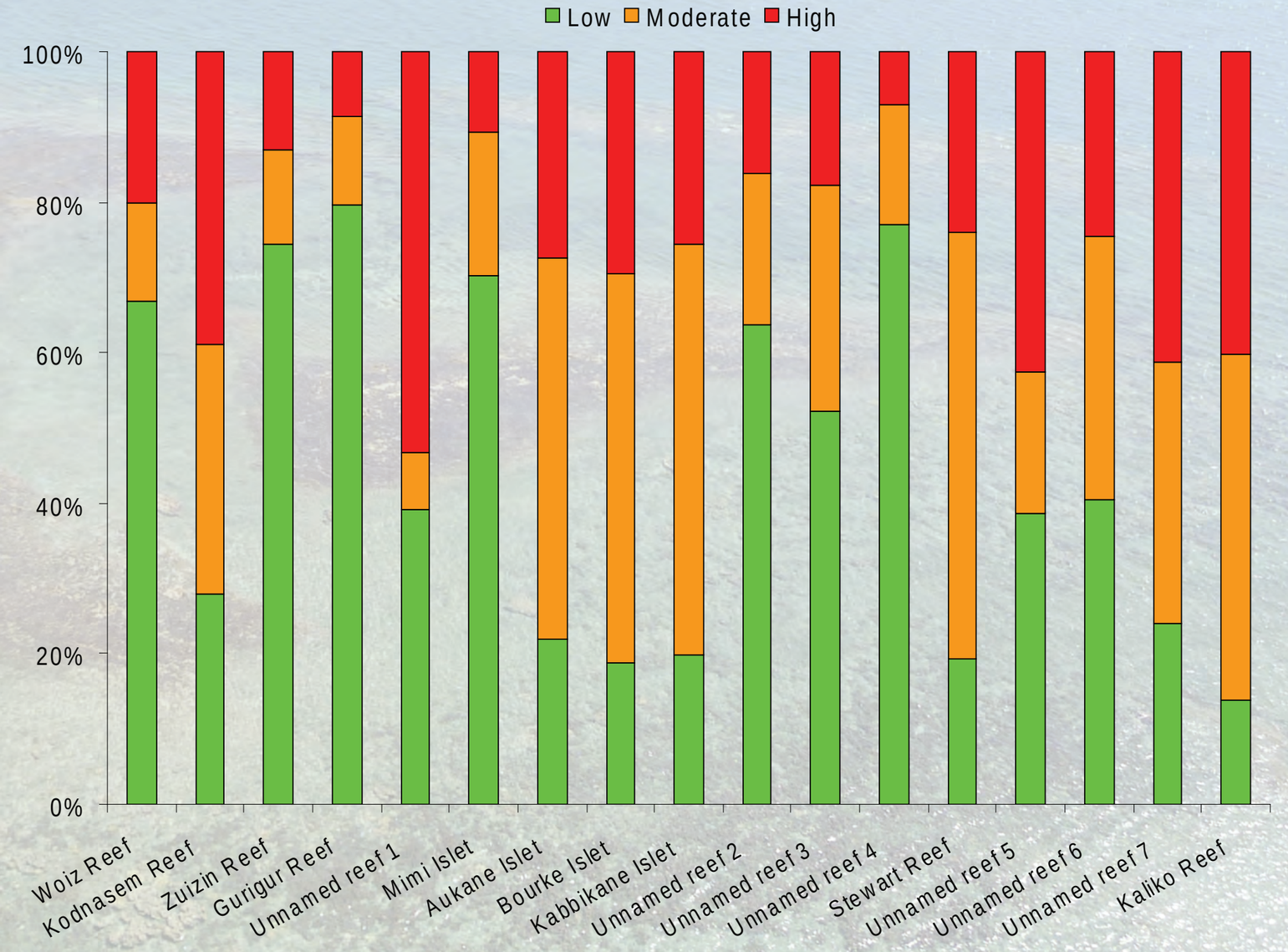
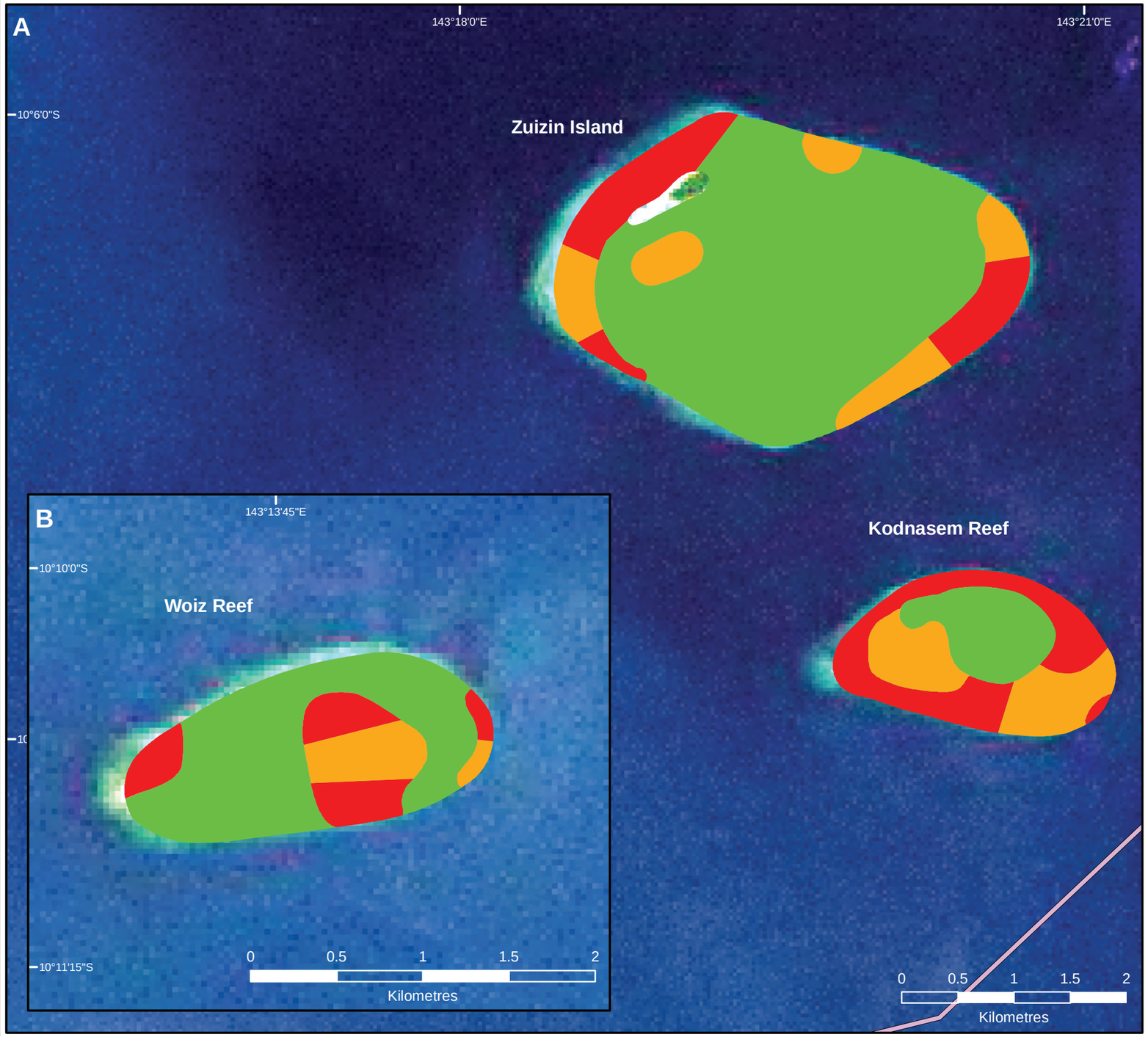


Figure 6 Habitat vulnerability (per cent) for intertidal islands and reefs in the Torres Strait survey area, 2012

Map 31. Habitat vulnerability on Woiz Reef, Kodnasem Reef and Zuizin Island, Torres Strait, March 2012



Legend

Habitat Vulnerability Category

- High
- Moderate
- Low
- Shipping Channel
- Survey extent 2012

N

Source:
Taylor HA and McKenna SA (2012) Critical marine habitats in high risk areas, Torres Strait - Woiz Reef to Kaliko Reef - 2012 Atlas. DAFF Publication (Fisheries Queensland, Northern Fisheries Centre, Cairns). Funded by TSRA and DAFF. Produced by the Marine Ecology Group, 2012. © The State of Queensland through the Department of Agriculture, Fisheries and Forestry.
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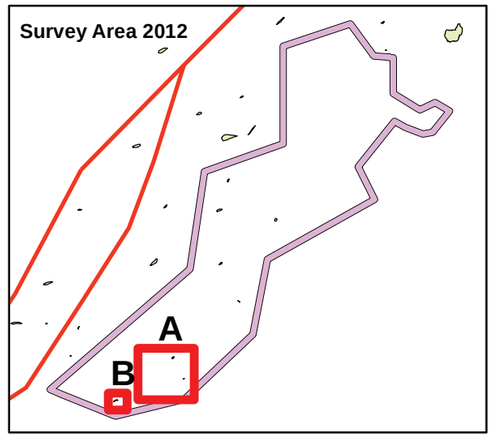
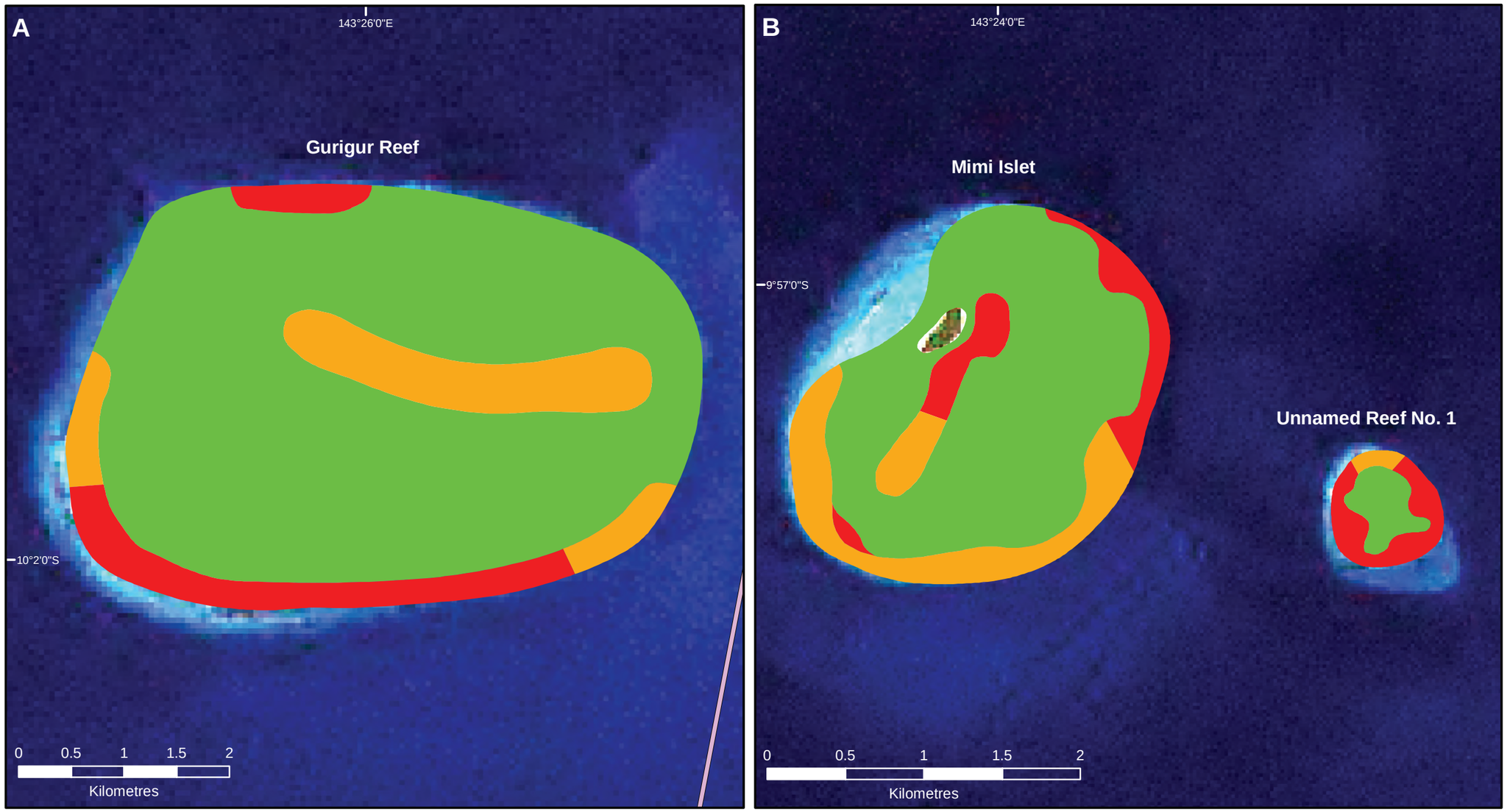


Map 32. Habitat vulnerability on Gurigur Reef, Mimi Islet and Unnamed Reef No. 1s, Torres Strait, March 2012



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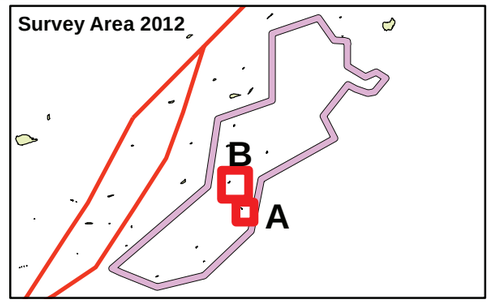
Habitat Vulnerability Category

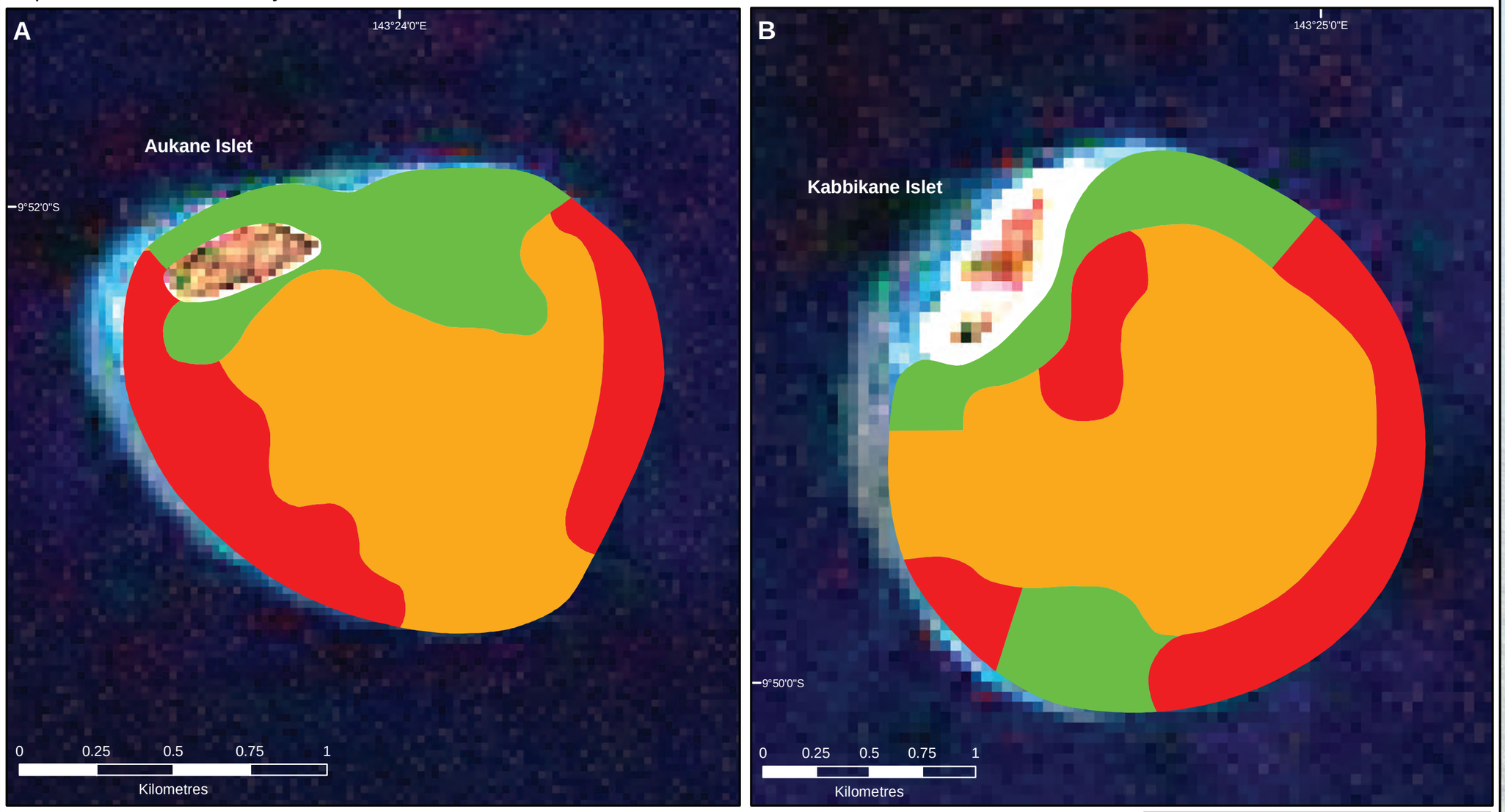
- High
- Moderate
- Low
- Shipping Channel
- Survey extent 2012

N



Source:
Taylor HA and McKenna SA (2012) Critical marine habitats in high risk areas, Torres Strait - Woiz Reef to Kaliko Reef - 2012 Atlas. DAFF Publication (Fisheries Queensland, Northern Fisheries Centre, Cairns). Funded by TSRA and DAFF. Produced by the Marine Ecology Group, 2012.

Map 33. Habitat vulnerability on Aukane and Kabbikane Islets, Torres Strait, March 2012



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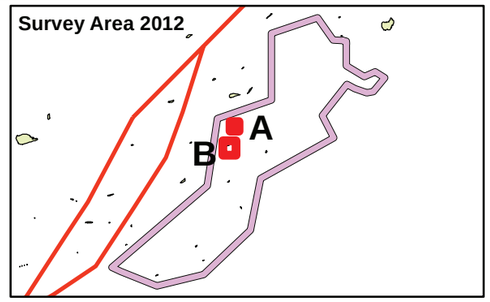
Habitat Vulnerability Category

- High
- Moderate
- Low
- Shipping Channel
- Survey extent 2012

N



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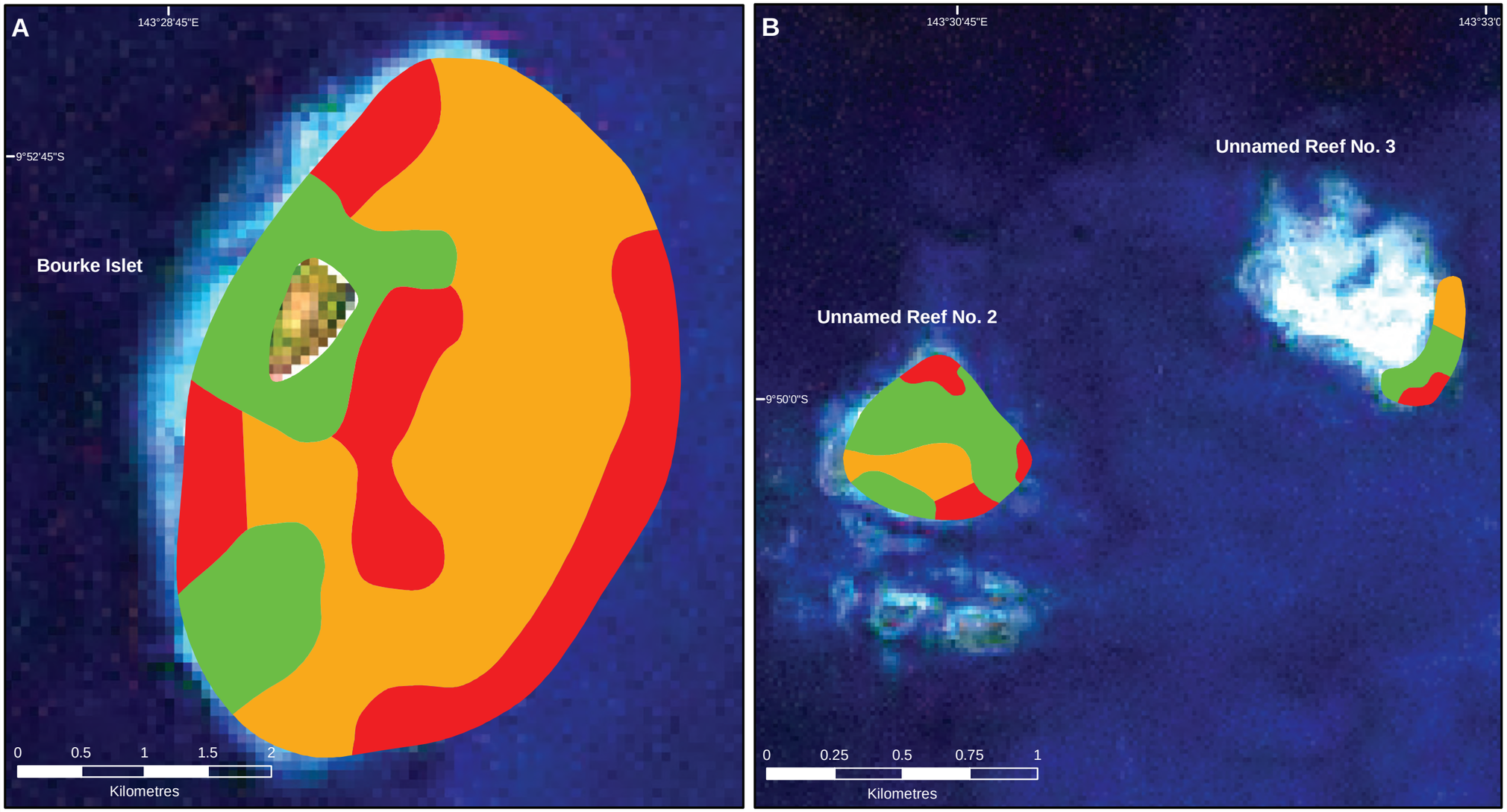
Map 34. Habitat vulnerability on Bourke Islet and Unnamed Reefs No. 2 and 3, Torres Strait, March 2012

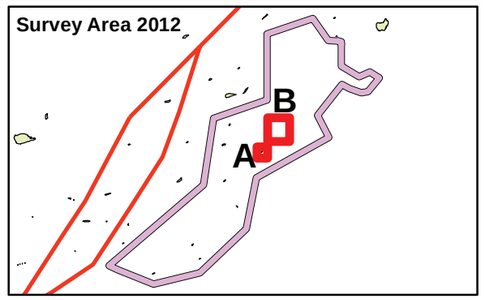


Legend

Habitat Vulnerability Category

- High
- Moderate
- Low
- Shipping Channel
- Survey extent 2012

N



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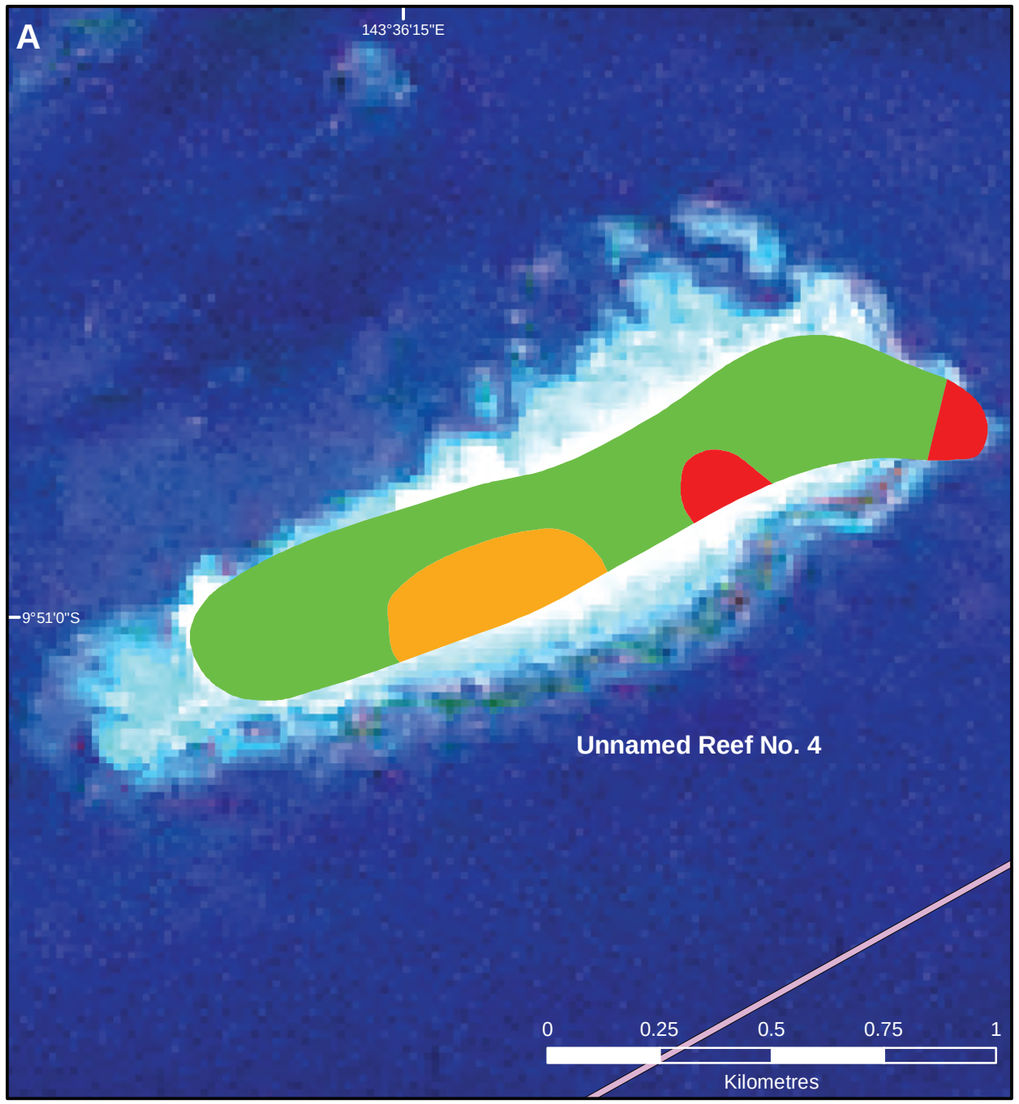
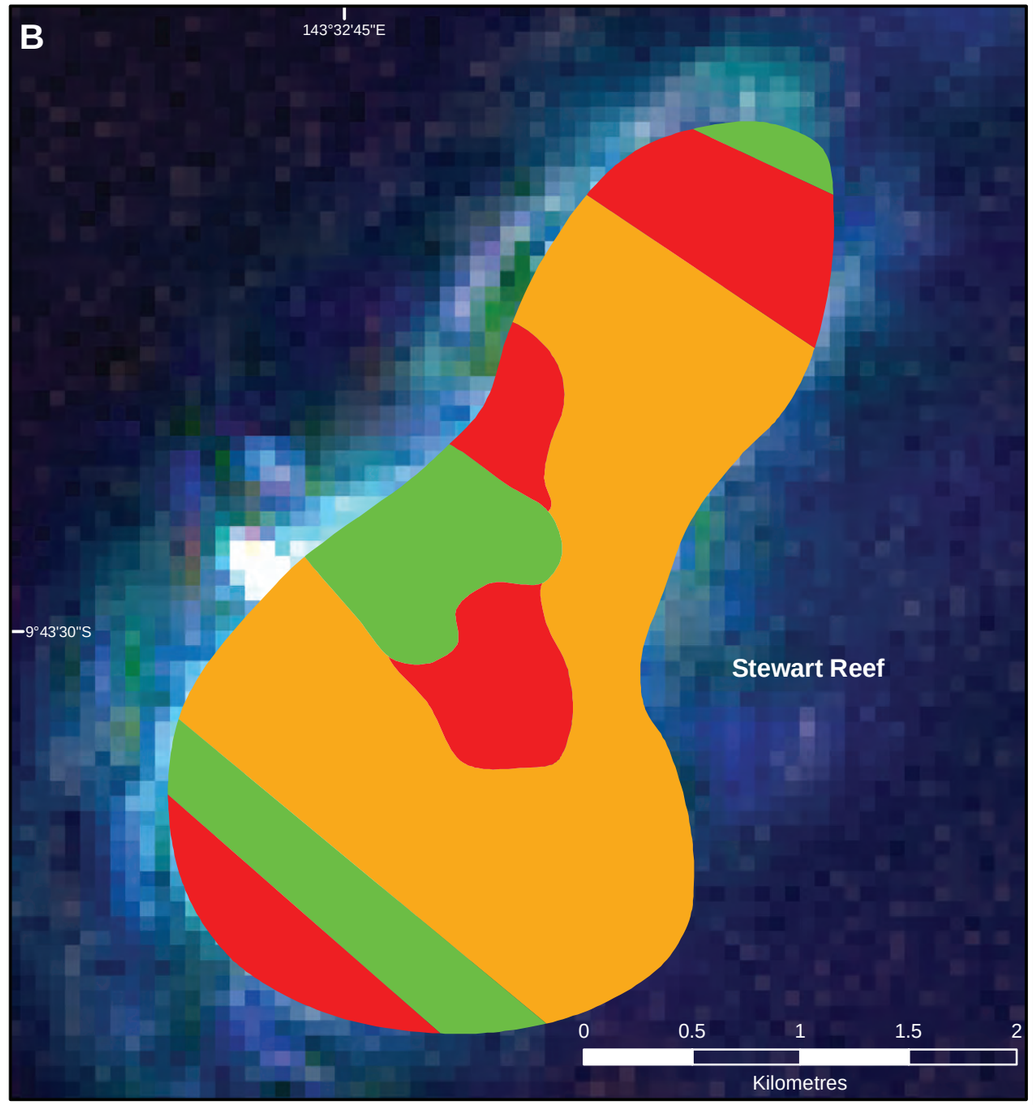
Map 35. Habitat vulnerability on Unnamed Reef No. 4 and Stewart Reef, Torres Strait, March 2012





Legend

Habitat Vulnerability Category

- High
- Moderate
- Low
- Shipping Channel
- Survey extent 2012

N

Source:
Taylor HA and McKenna SA (2012) Critical marine habitats in high risk areas, Torres Strait - Woiz Reef to Kaliko Reef - 2012 Atlas. DAFF Publication (Fisheries Queensland, Northern Fisheries Centre, Cairns). Funded by TSRA and DAFF. Produced by the Marine Ecology Group, 2012. © The State of Queensland through the Department of Agriculture, Fisheries and Forestry.
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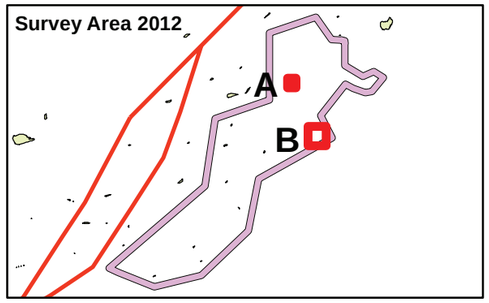
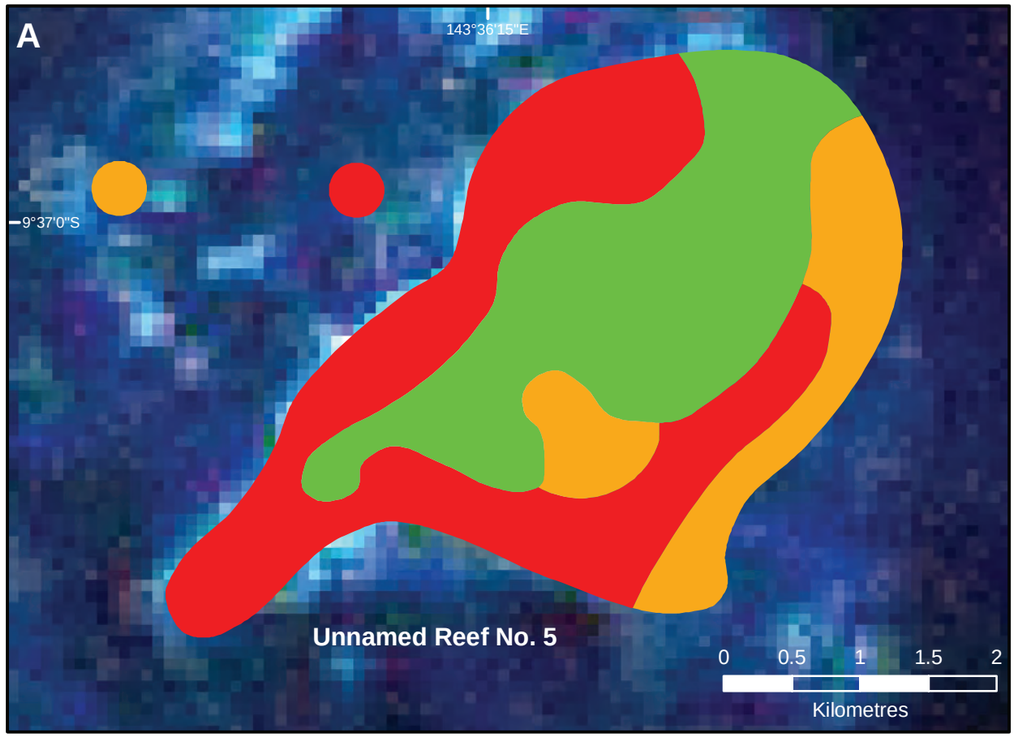
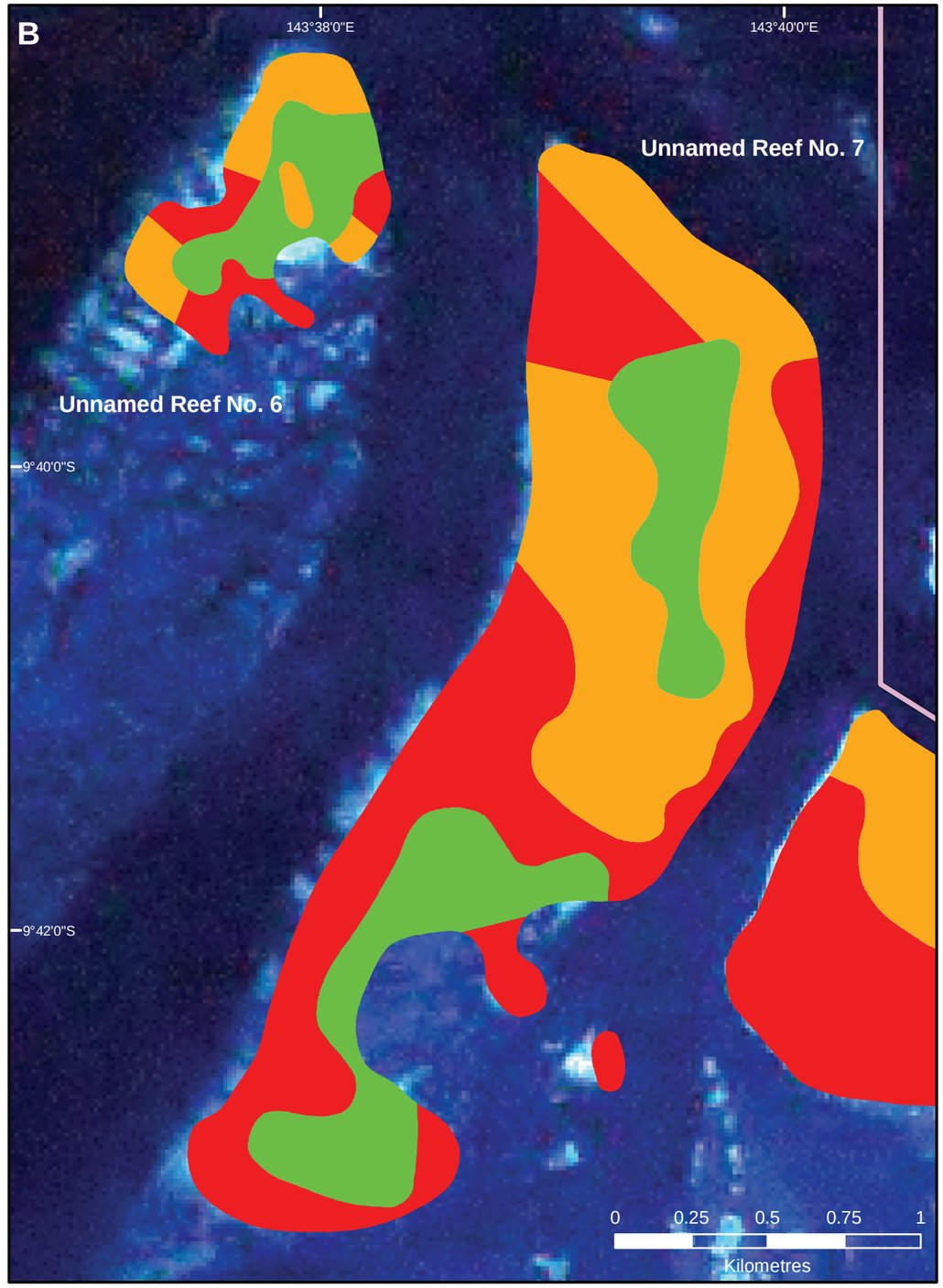


Map 36. Habitat vulnerability on Unnamed Reefs No. 5, 6 and 7, Torres Strait, March 2012





Legend

Habitat Vulnerability Category

- High
- Moderate
- Low
- Shipping Channel
- Survey extent 2012

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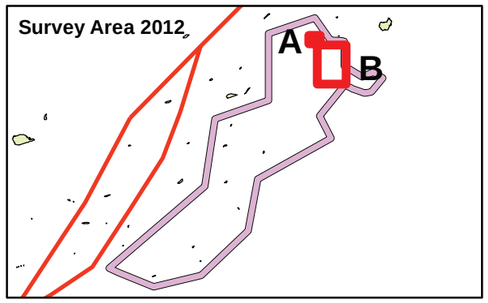

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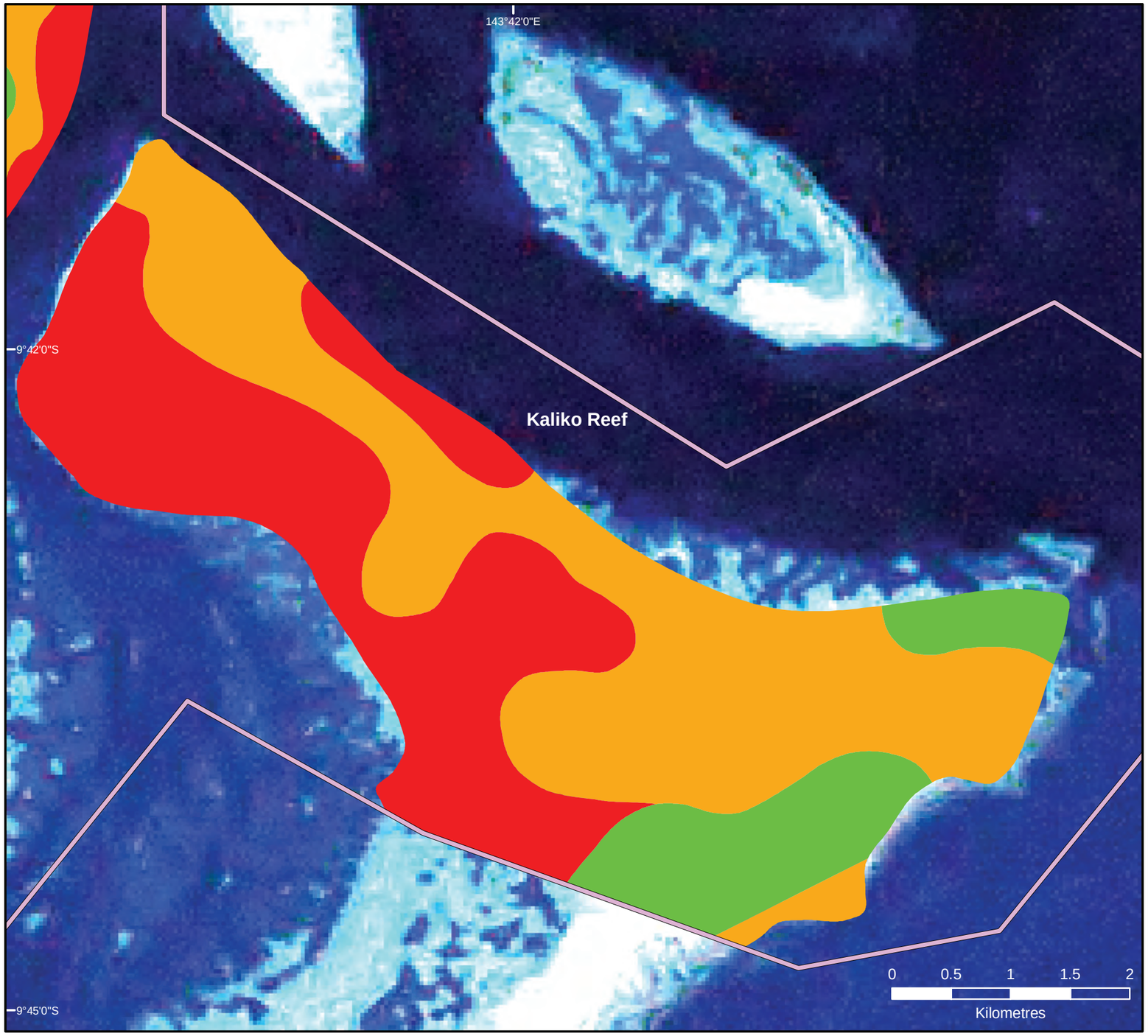
Map 37. Habitat vulnerability on Kaliko Reef, Torres Strait, March 2012



Legend

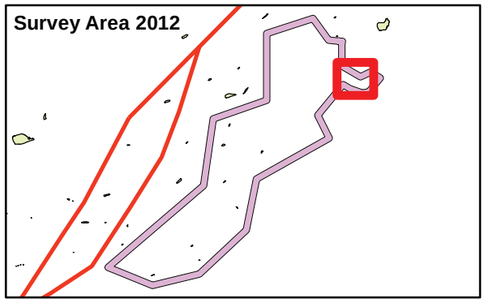
Habitat Vulnerability Category

- High
- Moderate
- Low
- Shipping Channel
- Survey extent 2012

N

Source:
Taylor HA and McKenna SA (2012) Critical marine habitats in high risk areas, Torres Strait - Woiz Reef to Kaliko Reef - 2012 Atlas. DAFF Publication (Fisheries Queensland, Northern Fisheries Centre, Cairns). Funded by TSRA and DAFF. Produced by the Marine Ecology Group, 2012.

Survey Area 2012



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