# Critical Marine Habitats and Marine Debris in the Great North East Channel, Torres Strait – Poruma to Ugar Islands

## DPI&F Information Series
## 2008 ATLAS

RISK ASSESSMENT

HABITAT MANAGEMENT

HABITAT ASSESSMENT

RISK MANAGEMENT

Queensland Government
Department of Primary Industries and Fisheries

MARINE ECOLOGY GROUP

Natural Heritage Trust
*Helping Communities*
*Helping Australia*
An Australian Government Initiative

Australian Government

Torres Strait Regional Authority

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## 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, most notably marine debris, threatens the viability of the wildlife and in turn, the way of life for the local communities. Marine debris comes from a wide variety of sources, both on and off the shore, involves multiple jurisdictions, and ocean circulation patterns are likely to concentrate floating debris before dumping it on shorelines. One type of marine debris that requires special attention is derelict fishing gear, composed of both whole and large sections of nets, as well as discarded fishing line and plastic parts associated with traps and nets. While it is uncertain what quantities of debris are affecting the Torres Strait and the level of impact they are having, studies along other parts of the Australian coastline and anecdotal evidence suggests that the problem could be considerable. Marine debris poses a threat to local fishery resources, wildlife and habitat, as well as human health and safety. Although the impact of marine debris on turtles is relatively well known through the efforts of various Ranger groups in northern Australia, the impacts on seagrass beds, forming important habitat for dugongs and other significant marine species, are largely unknown.

In addition to marine debris, other potential impacts to Torres Strait marine habitats include those associated with shipping activities.

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 a heightened 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

The Queensland Department of Primary Industries and Fisheries' (QDPI&F) Marine Ecology Group with support from the Torres Strait Regional Authority and National Heritage Trust has developed a program to examine areas of these MEHRA's where there is a lack of detailed information on key marine habitats. The group has already published three atlases in the series, one focusing on the Inner Shipping Route (Rasheed *et al*. 2005), one on the Hydrographers Passage Shipping Channel (Rasheed *et al*. 2006), and the most recent on the Prince of Whales and Adolphus Shipping Channels (Rasheed and Thomas 2006). The focus of this atlas is on the Great North East (GNE) channel in the Torres Strait. Many ecologically and economically valuable intertidal marine habitats that occur in this area may be vulnerable to oil, fuel or chemical spills from a shipping accident and concentrated marine debris including ghost nets and derlict fishing gear. This atlas provides fine scale maps of these vulnerable marine habitats. 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. This atlas further provides the first detailed aerial survey of marine debris in the Inner Island Cluster and GNE channel. The distribution and quantities of marine debris, and its location in relation to seagrass, algae and coral communities and shipping lanes will provide necessary baseline data from which to develop the most feasible, long term approaches to tackle the issue. Data presented in this atlas was obtained from surveys conducted in February 2008.

## Why survey the Torres Strait region?

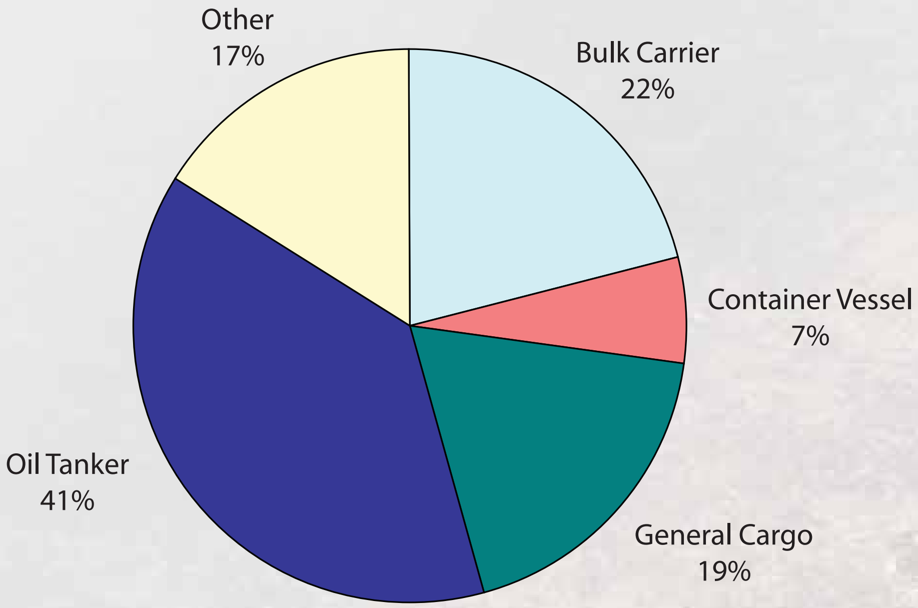
The Great North East Shipping Channel was selected for investigation for a number of reasons including:

- It is one of the six identified MEHRA's for Queensland
- It contains a high diversity of intertidal habitats (including seagrass and coral reefs) in close proximity to the shipping channel
- The channel is very complicated to navigate, with complex tidal streams and currents, has limited water depth and is 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 GNE channel is a major channel used primarily by large vessels trading between ports in southern Asia, Australia and New Zealand, South America, Papua New Guinea and Pacific Island nations. It runs in a southwest to northeast direction from Poruma Island in the south to Ugar Island in the north (Map 1). The channel is narrow in a number of sections, being only a few hundred metres wide at its narrowest, and is bordered by important marine habitats including seagrass beds, coral reefs and extensive dugong habitat.

In 2006/2007, nearly 2200 voyages were undertaken by shipping vessels through the GNE channel, making it a high use passage in Queensland waters (Neil Trainor, Australian Maritime Safety Authority, Pers. comm., 2008). 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 19 separate accidents recorded back to 1970, seventeen 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 19 accidents, four caused large quantities of oil and fuel to be spilt into the sea (John Wright, Maritime Safety Queensland, 2006).

**Figure 1** The vessel types using the Great North East Channel



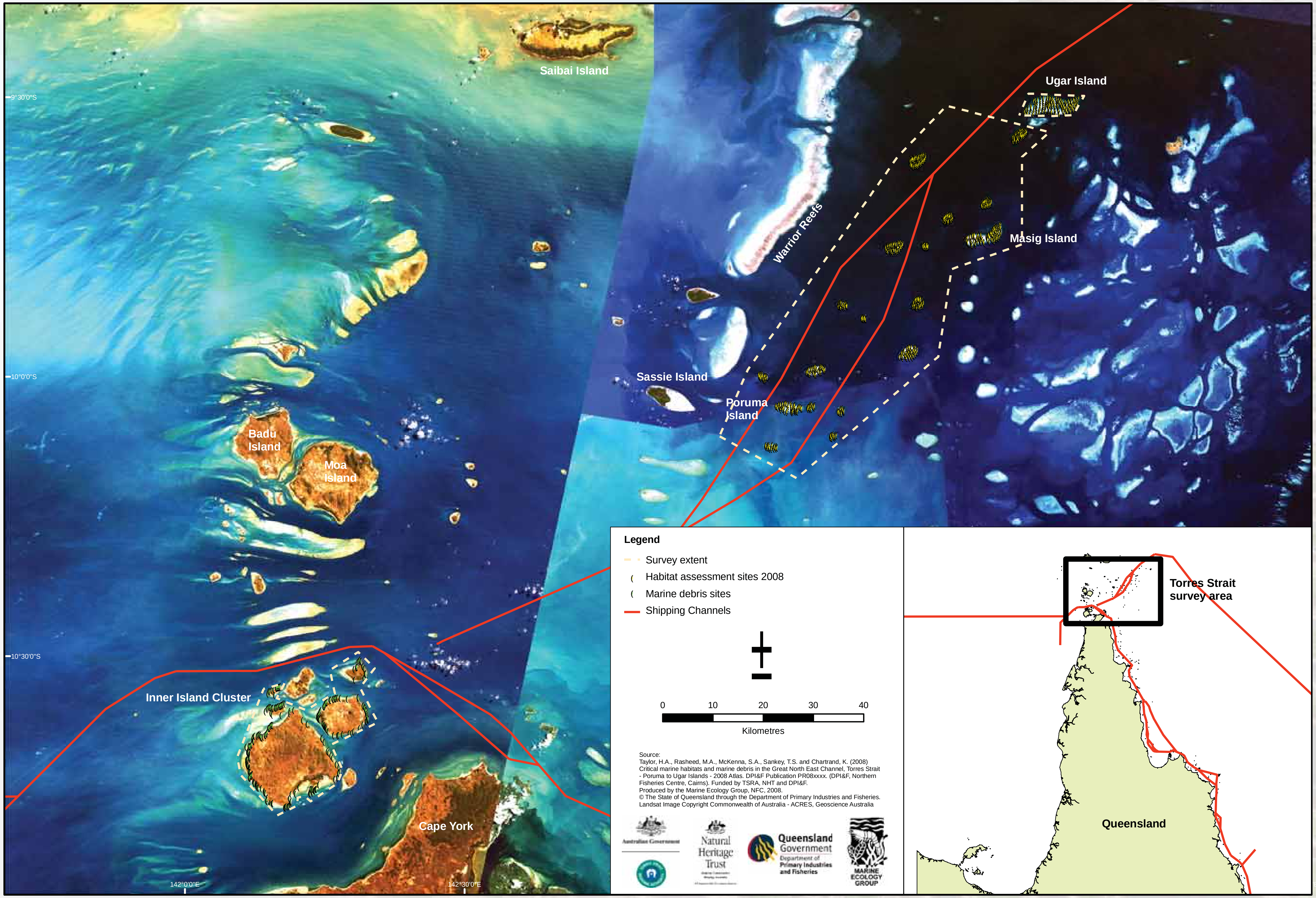
Shipping accidents in Torres Strait also pose a serious risk to commercial and Indigenous fishing. There are a large number of commercial fisheries operating in the region including the northern prawn, tropical rock lobster, trochus, and beche-de-mer fisheries. The northern prawn fishery alone generated in excess of $74 million dollars in 2003 / 2004 (Australian Fisheries Management Authority, 2006). The extensive seagrass habitats located around the GNE channel provides vital nursery ground habitats for juvenile prawns associated with the fishery.

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 including the well known dugong and turtle. Past surveys have indicated that Torres Strait Islanders mainly target dugong, turtle, fish and crayfish, collecting an average of over 2000 kilograms worth of these species in a typical fishing day (Harris *et al*. 1995). As traditional inhabitants of the Torres Strait, the people are able to fish for both commercial and non-commercial fish species. The tropical rock lobster fishery is the second most valuable commercial fishery in the Torres Strait ($14 million pa.), and 92% of recorded catch by Islanders is sold as commercial catch (Caton & McLoughlin, 2004).

Marine debris poses a serious threat to the marine biodiversity of 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 was recently listed as a threatening process under the Environment Protection and Biodiversity Conservation Act. Surveys of nearby regions including the Northern Gulf of Carpentaria have found high numbers of ghost net entanglements of threatened and endangered turtle species each year (Department of Environment and Heritage, 2005). Community groups within the Inner Island Cluster have volcalised concerns over the impacts that concentrated marine debris may have on their coastal assets. Identifying the presence and impact of marine debris, specifically derelict fishing gear, in the Torres Strait will provide a better understanding of how to focus and reduce the impact on the local environment and those who depend on it for their livelihood.

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

Map 1. Torres Strait survey area, marine debris sites and habitat assessment sites around the Great North East shipping channel, 2008



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Produced by the Marine Ecology Group, NFC, 2008.

## Survey Methodology

Methods used in these surveys were based on those developed by QDPI&F for similar surveys in other Queensland locations (e.g. Rasheed *et al.* 2005; 2004; 2003). Three main mapping and survey techniques were used to collect marine habitat data for the maps presented in this atlas:

### 1. Helicopter Aerial Surveys

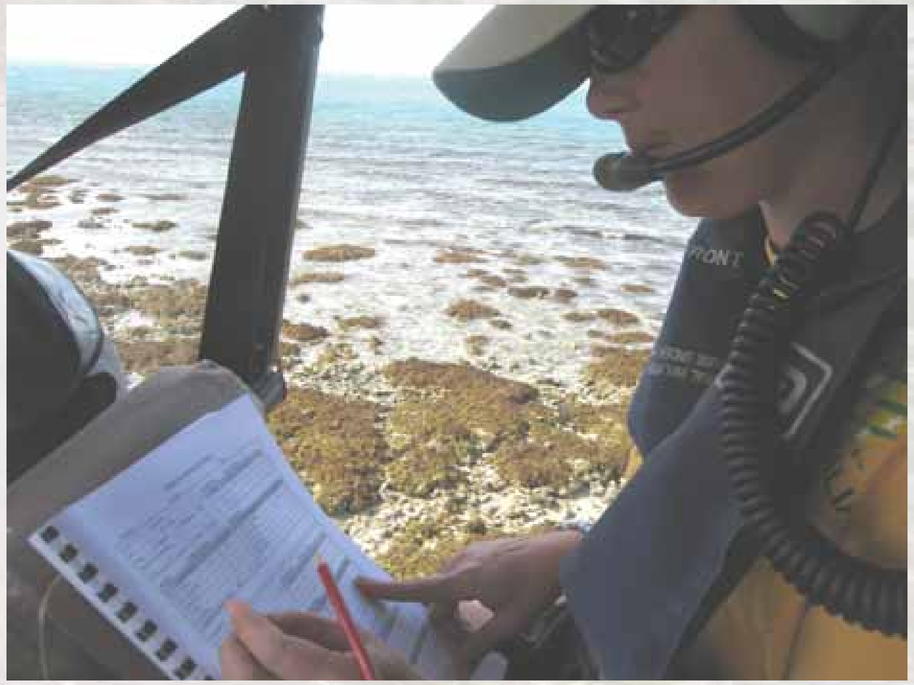
Intertidal habitat boundaries, characteristics and species composition were determined using a helicopter around spring low tides when habitats were exposed. Observers in a helicopter hovered directly over the habitat at a height of <10m and the position was fixed using a Global Positioning System (GPS), accurate to ± 5 m. Habitat characterisation sites were scattered randomly within the mapped habitat boundaries with a greater intensity of sites in areas with high habitat complexity.

### 2. Marine Debris Surveys

Marine debris was recorded at intertidal sites previously mapped throughout the Inner Island Cluster (Rasheed and Thomas, 2006) and at all habitat characterization sites in the GNE channel. A description of all marine debris present and number of fishing nets at a site was recorded for later mapping.

### 3. Aerial Photography and Satellite Imagery

Existing aerial photography of the survey area (Beach Protection Authority, 1992, 1:50000), aerial photographs taken during the helicopter surveys and available satellite imagery (LANDSAT 7 ETM+, Commonwealth of Australia: Ikonos; Quikbird) were used to aid in mapping and determination of habitat boundaries for intertidal communities.



Aerial photography of Thursday Island in Torres Strait (Beach Protection Authority)

Fishing net washed up at low tide

## 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. While methods of observing habitat characterisation sites varied (i.e. helicopter/camera), the information collected for seagrass, algae and benthic macro-invertebrate (BMI) habitat at each site was consistent:

### 1. Seagrass

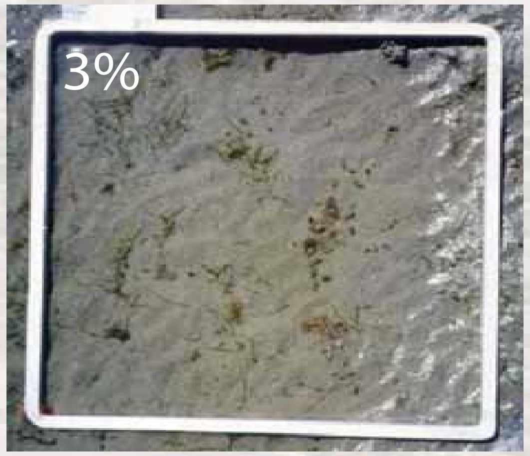
At sites where seagrass was present the seagrass species composition, seagrass above ground biomass, percent cover, sediment type and time were recorded. Seagrass above ground biomass was determined using a modified "visual estimates of biomass" technique described by Mellors (1991). This technique involves 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.

Seagrass quadrat for "visual estimate of above ground biomass"

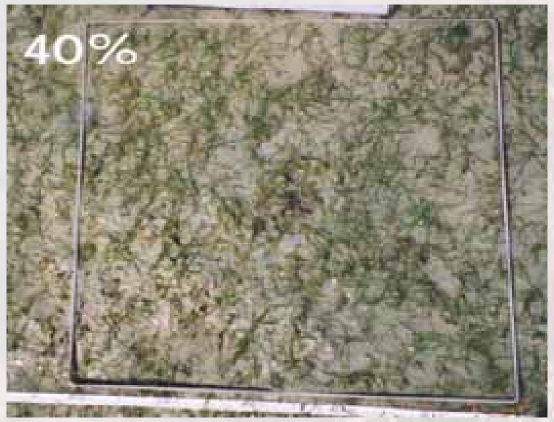
In addition, a visual estimate was made of the overall percent cover of seagrass at each site. All sites within a seagrass region were grouped to provide a mean percent cover of seagrass for that region. This percent cover was presented as a range in five categories:

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

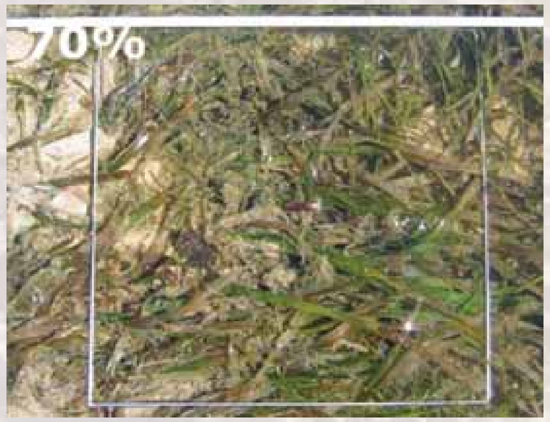


Very Low percent cover
(0 - 10%)

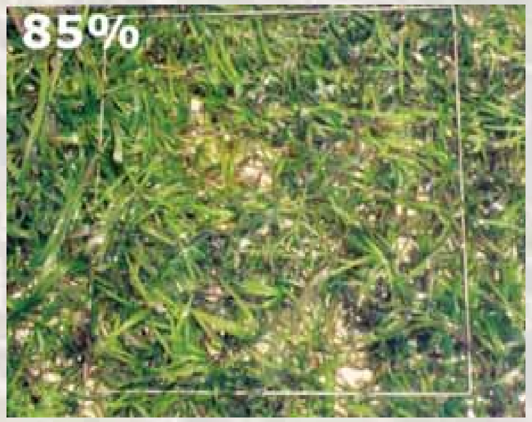
Low percent cover
(10 - 30%)



Moderate percent cover
(30 - 50%)



High percent cover
(50 - 75%)



Very High percent cover
(75 - 100%)

## Habitat Characterisation continued...

### 2. Algae

For this atlas algae habitat occurring in the intertidal zone was mapped. At sites where algae were present, they were identified 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)

For this atlas 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.


Erect Macrophytes with Seagrass


Erect Calcareous Algae


Encrusting and Turf Algae
on Coral Rubble


Filamentous Algae


Hard Coral


Soft Coral


Sponges

## Geographic Information System (GIS)

All data were entered into a Geographic Information System (GIS) developed for Torres Strait. Rectified colour aerial and satellite imagery of the region (Beach Protection Authority and Commonwealth of Australia), combined with aerial photography and videotape footage 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, algae and benthic macro-invertebrate (BMI) 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. Large subtidal areas where seagrass meadow boundaries could not be seen from the surface had the lowest mapping precision. For these seagrass meadows, boundaries were based on the mid-point between the last site where seagrass was present and the next non-seagrass site.

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, algae and BMI regions to ± 50 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).

Distribution of marine debris was overlayed onto habitat boundaries and seagrass composition maps. Density of debris was assigned to a graduated color-coded system.

Mapping intertidal habitat boundaries by helicopter

**Table 1** Mapping precision and methodology for seagrass, algae and benthic macro-invertebrate regions in the Torres Strait survey area, 2008

| Mapping precision | Mapping methodology |
|---|---|
| < 5 m | Seagrass meadow boundaries mapped in detail by GPS from helicopter<br>All regions intertidal and exposed or visible at low tide<br>Relatively high density of mapping and survey sites<br>Recent aerial and satellite imagery aided in mapping |
| 10 m | Region boundaries determined from helicopter surveys<br>Inshore seagrass boundaries mapped from helicopter<br>Offshore seagrass boundaries interpreted from survey sites and aerial photography<br>Algae/BMI regions all intertidal<br>Relatively high density of mapping and survey sites<br>Recent aerial and satellite imagery aided in mapping |
| 20 m | Seagrass meadow boundary interpreted from helicopter surveys<br>Algae/BMI region boundaries based on distance between survey sites<br>All seagrass meadows subtidal<br>Algae/BMI regions all intertidal<br>Relatively high density of survey sites<br>Recent aerial and satellite imagery aided in mapping |
| 50 m | Seagrass meadow boundaries interpreted from helicopter surveys<br>Algae/BMI region boundaries based on distance between survey sites<br>All seagrass meadows subtidal<br>Algae/BMI regions all intertidal<br>Relatively low density of survey sites<br>Recent aerial and satellite imagery aided in mapping |
| 75 m | Seagrass meadow boundaries interpreted from helicopter surveys<br>Applied to subtidal seagrass meadows only<br>Relatively low density of survey sites<br>Recent aerial and satellite imagery aided in mapping |

Confirming species identifications in intertidal meadow

**Table 2** Nomenclature for seagrass community types in the Torres Strait survey area, 2008

| 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 theTorres Strait survey area, 2008

| Density (biomass) category | Dominant seagrass species in meadow (g DW $m^{-2}$) | | | | | |
|---|---|---|---|---|---|---|
| | ***Halophila ovalis*** | ***Halodule uninervis*** **(thin)** | ***Halodule uninervis*** **(wide)** | ***Cymodocea rotundata*** | ***Thalassia hemprichii*** | ***Enhalus acoroides*** |
| **Light** | < 0.5 | < 1 | < 5 | < 5 | < 5 | < 40 |
| **Moderate** | 0.5-5 | 1-4 | 5-25 | 5-25 | 5-25 | 40-100 |
| **Dense** | > 5 | > 4 | > 25 | > 25 | > 25 | > 100 |

## Marine Debris in the Inner Island Cluster and the Great North East Channel

A total of 1119 marine debris sites were surveyed in intertidal regions adjacent to the Inner Island Cluster and Great North East channel during February 2008 (Map 1).

Of the 277 marine debris sites identifed, 274 were recorded in the intertidal and mangrove regions of the Inner Island Cluster whereas only 3 sites of debris were found adjacent to the GNE channel (Map 2).

The predominant type of debris found was ghost fishing nets ranging in size from fragments of nets to large rolls of nets. There were many other forms of marine debris recorded including ropes, oyster cages and fuel drums.

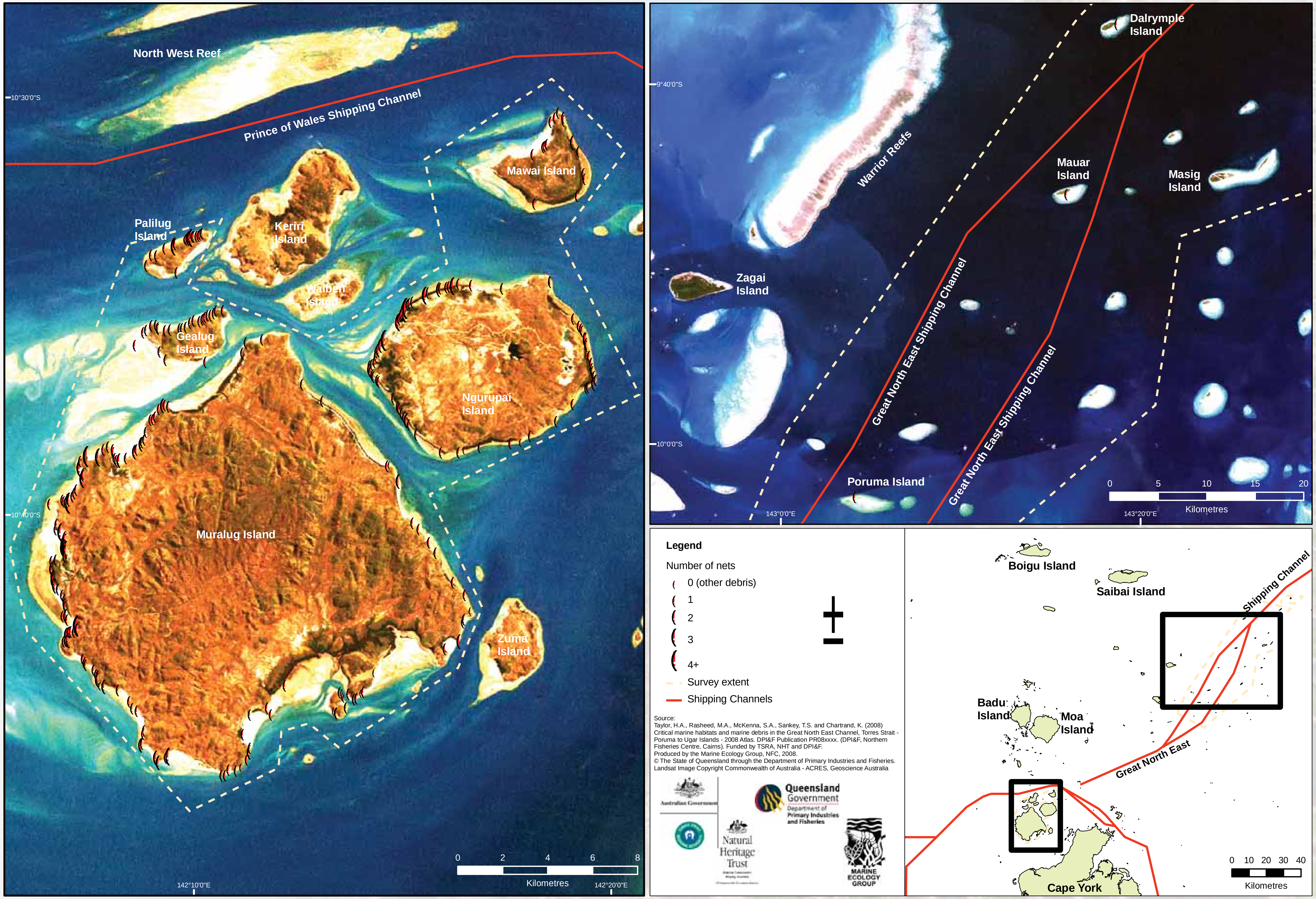
Distirbution and density of marine debris varied around the Inner Island Cluster. The north-west side of the islands consistently had a greater density of debris, with the exception of Mawai (Wednesday) Island. Muralug (Prince of Wales) Island had the greatest density of debris with over 50% of all debris recorded being found there.


Abandoned oil drums


Abandoned fishing net


Oyster cages and abandoned fishing net

Map 2. Location of marine debris sites and quantity of ghost nets around the Great North East shipping channel, 2008



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## Critical Marine Habitats of Torres Strait

A total of 842 habitat assessment sites were surveyed in intertidal regions adjacent to the Great North East shipping channel during February 2008 (Map 1). The survey assessed the benthic habitat in a total of 19 intertidal island and reef areas. Algae was the dominant habitat type in the survey area (Figure 2), although there were also large areas dominated by benthic macro-invertebrates (BMI), seagrass and open substrate. Seagrass, algae and BMI often occurred together within the same habitat characterisation sites and hence had overlapping distributions. In terms of percent cover of the bottom, algae, BMI and open substrate combined made up an average of more than 91% of the sites surveyed (Figure 2). Seagrass formed a relatively small but important component of the overall benthic habitat within the survey area (Figure 2).

## Seagrasses

Extensive intertidal seagrass habitat occurred throughout the Torres Strait survey and covered an area of 4179 ± 144 ha (Table 4; Map 3-12). Of the 19 intertidal island and reef areas surveyed, 14 were found to have a seagrass community present. Despite the fact that seagrasses covereed such a large area of the intertidal regions surveyed, it comprised it comprised a relatively small overall cover in proportion to other habitat types (Figure 2).

Percent cover for the majority of intertidal seagrass meadows was generally very low (0-10%), with the remaining meadows having a low (10-30%) cover of seagrass (Maps 3 & 4). Five seagrass species were identified in five distinct community types and fourteen meadows (Figure 3; Table 4; Maps 5-12).

Seagrass communities were dominated by *Thalassia hemprichii,* with many of the meadows having a mix of species present (Table 4). The meadows identified were typically comprised of aggregated patches and tended to extend to the outer edges of the intertidal regions surveyed.

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

**Figure 2** Mean percent cover of the major benthos types in the Torres Strait survey area

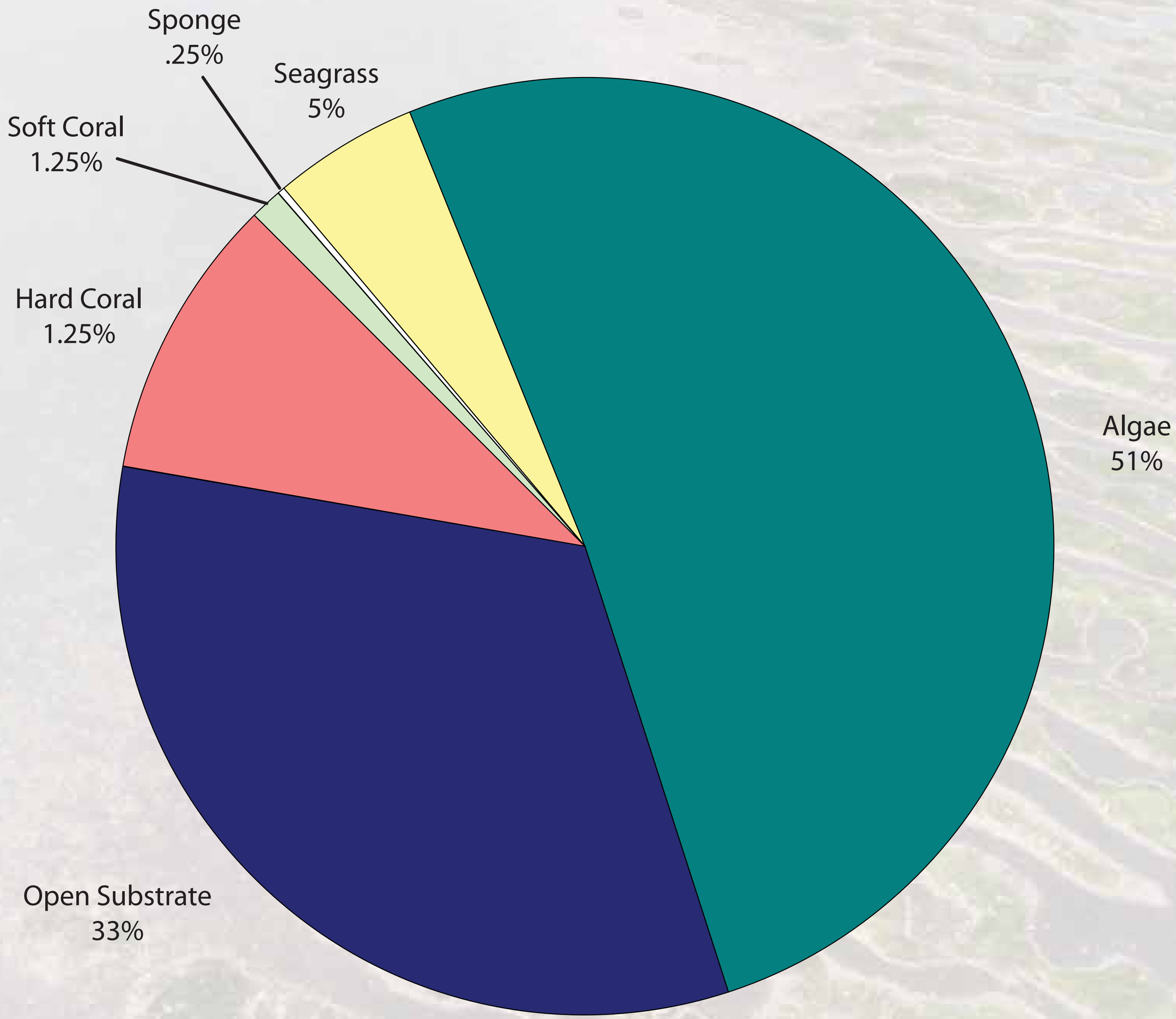


**Table 4** Seagrass community type, biomass, and area (ha) around the Torres Strait survey area, 2008

| Monitoring Meadow | Location | Community Type | Cover | Species Present | Mean Biomass (g dw m$^{2}$) | Area ± R (ha) |
|---|---|---|---|---|---|---|
| 1 | Richardson Reef | Light *T. hemprichii* | Aggregated Patches | *T. hemprichii*, *H. uninervis* (narrow) | 0.78 ± 0.70 | 75.16 ± 3.56 |
| 2 | Poruma Island | Light *T. hemprichii* with mixed species | Continuous Cover | *T. hemprichii*, *C. rotundata*, *H. uninervis* (wide), *H. ovalis* | 9.73 ± 2.53 | 364.71 ± 14.99 |
| 3 | Uhu Islet | Light *T. hemprichii* | Aggregated Patches | *T. hemprichii* | 4.32 ± 2.43 | 63.59 ± 3.74 |
| 4 | Roberts Island | Light *T. hemprichii* | Aggregated Patches | *T. hemprichii* | 2.28 ± 0.99 | 192.69 ± 6.82 |
| 5 | Aureed Island | Light *T. hemprichii* with *H. ovalis* / *H. uninervis* (narrow) | Aggregated Patches | *T. hemprichii*, *H. ovalis*, *H. uninervis* (narrow) | 0.71 ± 0.26 | 268.34 ± 8.28 |
| 6 | Garboy Island | Light *T. hemprichii* | Aggregated Patches | *T. hemprichii* | 0.1 ± 0.03 | 64.43 ± 3.15 |
| 7 | Layoak Island | Light *T. hemprichii* | Aggregated Patches | *T. hemprichii*, *H. ovalis* | 0.12 ± 0.03 | 106.14 ± 4.27 |
| 8 | Mauar Island | Light *T. hemprichii* | Aggregated Patches | *T. hemprichii*, *H.uninervis* (wide), *H. ovalis* | 3.0 ± 0.90 | 238.39 ± 10.45 |
| 9 | Masig Island | Light *T. hemprichii* with mixed species | Aggregated Patches | *T. hemprichii*, *H. uninervis* (wide & narrow), *H. ovalis*, *C. rotundata* | 4.26 ± 0.97 | 770.29 ± 27.58 |
| 10 | Eegarbu Island | Light *T. hemprichii* / *H. ovalis* | Aggregated Patches | *T. hemprichii*, *H. ovalis* | 0.89 ± 0.48 | 61.95 ± 5.61 |
| 11 | Homogar Island | Light *T. hemprichii* | Aggregated Patches | *T. hemprichii* | 0.20 ± 0.06 | 56.10 ± 3.60 |
| 12 | Damuth Island | Light *T. hemprichii* | Aggregated Patches | *T. hemprichii* | 4.11 ± 1.04 | 255.03 ± 9.88 |
| 13 | Tappoear Island | Light *T. hemprichii* with *H. ovalis* | Aggregated Patches | *T. hemprichii*, *H. ovalis* | 1.48 ± 0.58 | 147.81 ± 6.80 |
| 14 | Ugar Island | Light *T. hemprichii* with mixed species | Aggregated Patches | *T. hemprichii*, *E. acoroides*, *H. ovalis*, *C. rotundata*, *H. uninervis* (wide & narrow) | 5.25 ± 0.97 | 1514.63 ± 35.16 |

*Thalassia hemprichii* with mixed species

**Figure 3** Five seagrass species (from two families) identified around the Torres Strait survey area, 2008

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

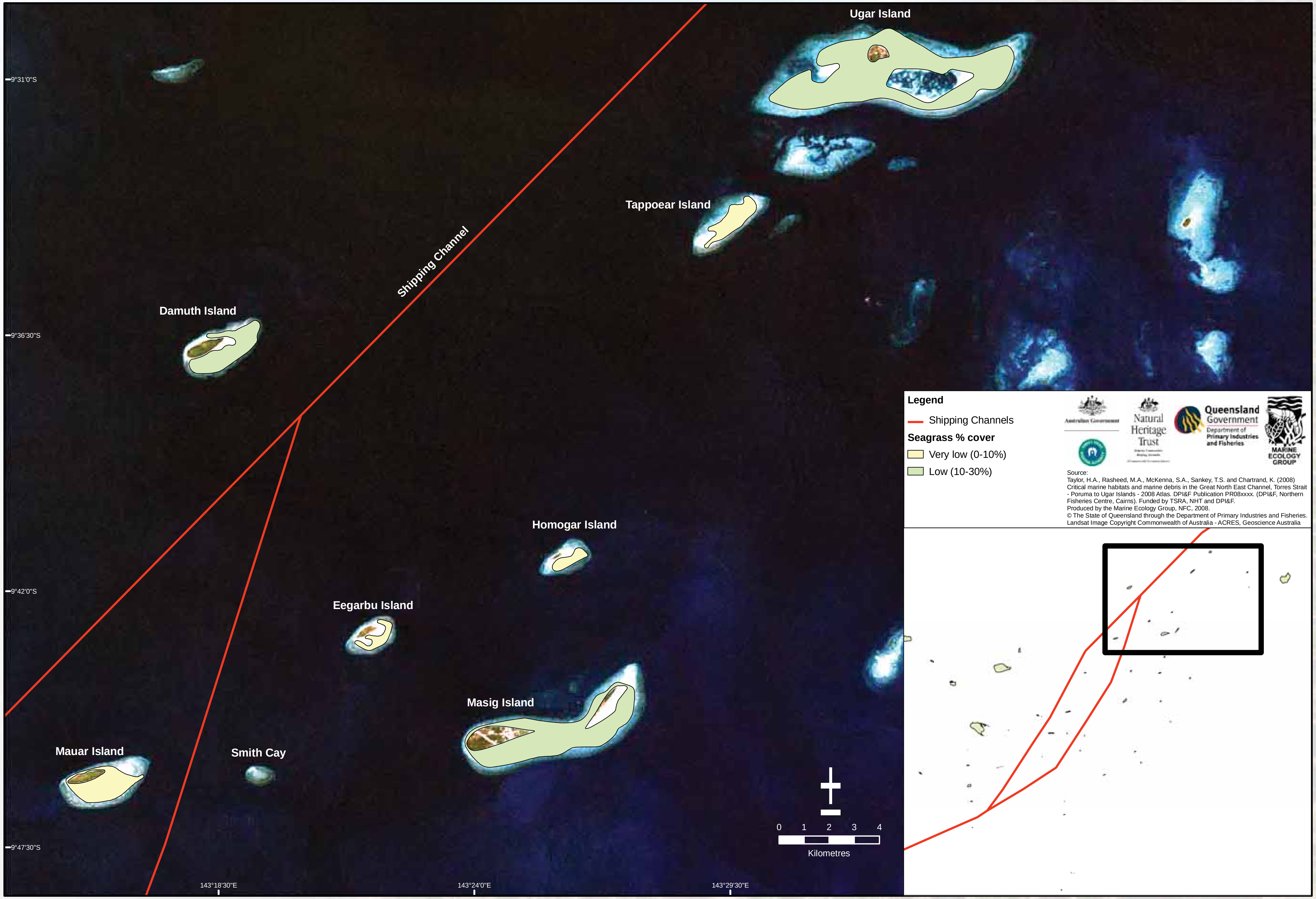
*Halodule uninervis*
(wide and narrow leaf morphology) (Forsk.)
Aschers. in Boissier

**Family** HYDROCHARITACEAE Jussieu:
*Enhalus acoroides*
(L.F.) Royle

*Thalassia hemprichii*
(Ehrenb.) Aschers. in Petermann

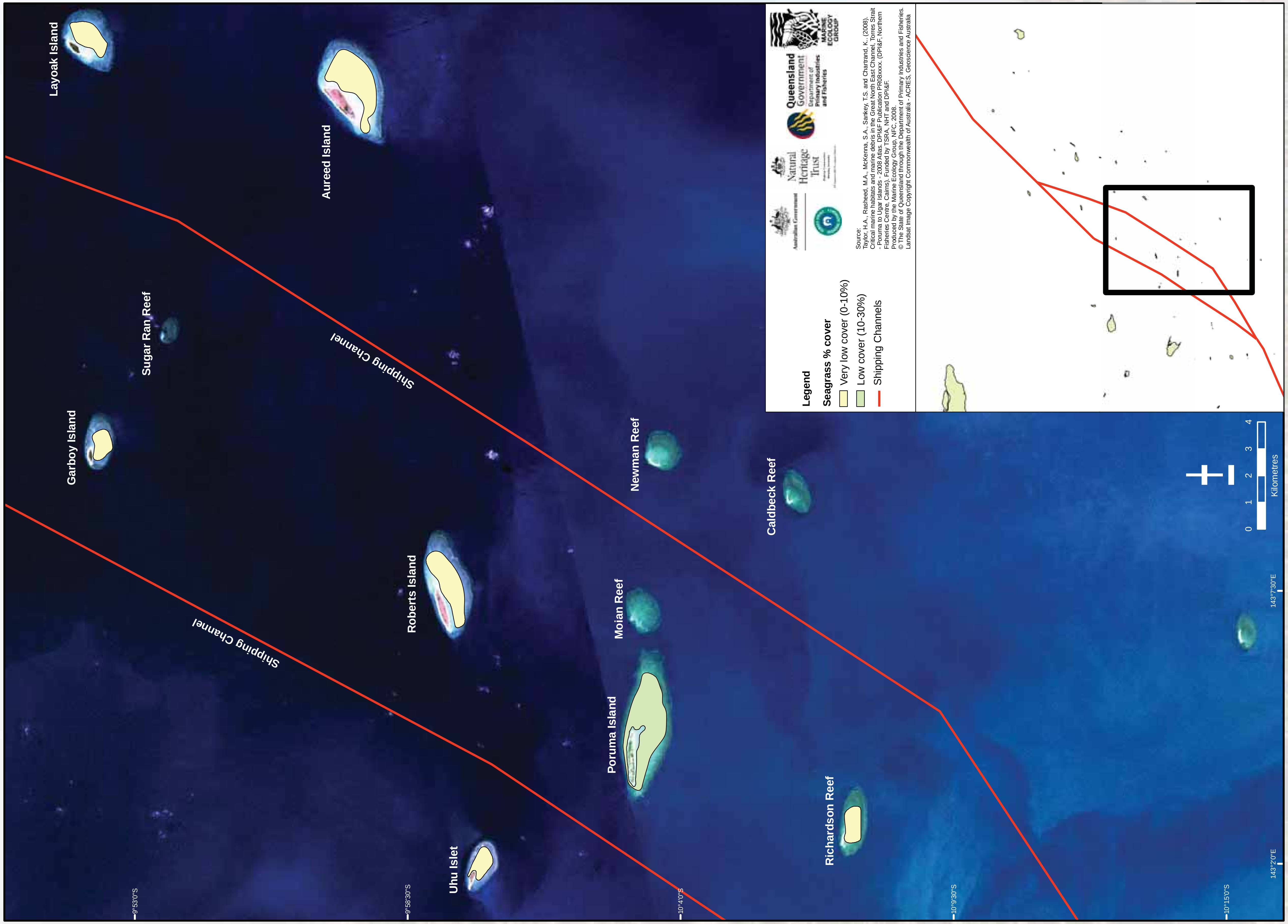
*Halophila ovalis*
(R. Br.) Hook. F.

Map 3. Seagrass distribution and percent cover in the northern section of the Torres Strait survey area, 2008



Source:
Taylor, H.A., Rasheed, M.A., McKenna, S.A., Sankey, T.S. and Chartrand, K. (2008) Critical marine habitats and marine debris in the Great North East Channel, Torres Strait - Poruma to Ugar Islands - 2008 Atlas. DPI&F Publication PR08xxxx. (DPI&F, Northern Fisheries Centre, Cairns). Funded by TSRA, NHT and DPI&F.
Produced by the Marine Ecology Group, NFC, 2008.

Map 4. Seagrass distribution and percent cover in the southern section of the Torres Strait survey area, 2008



**Legend**

**Seagrass % cover**
- 🟨 Very low cover (0-10%)
- 🟩 Low cover (10-30%)
- 🟥 Shipping Channels

Source:
Taylor, H.A., Rasheed, M.A., McKenna, S.A., Sankey, T.S. and Chartrand, K., (2008). Critical marine habitats and marine debris in the Great North East Channel, Torres Strait - Poruma to Ugar Islands - 2008 Atlas. DPI&F Publication PR08xxxx. (DPI&F, Northern Fisheries Centre, Cairns). Funded by TSRA, NHT and DPI&F.
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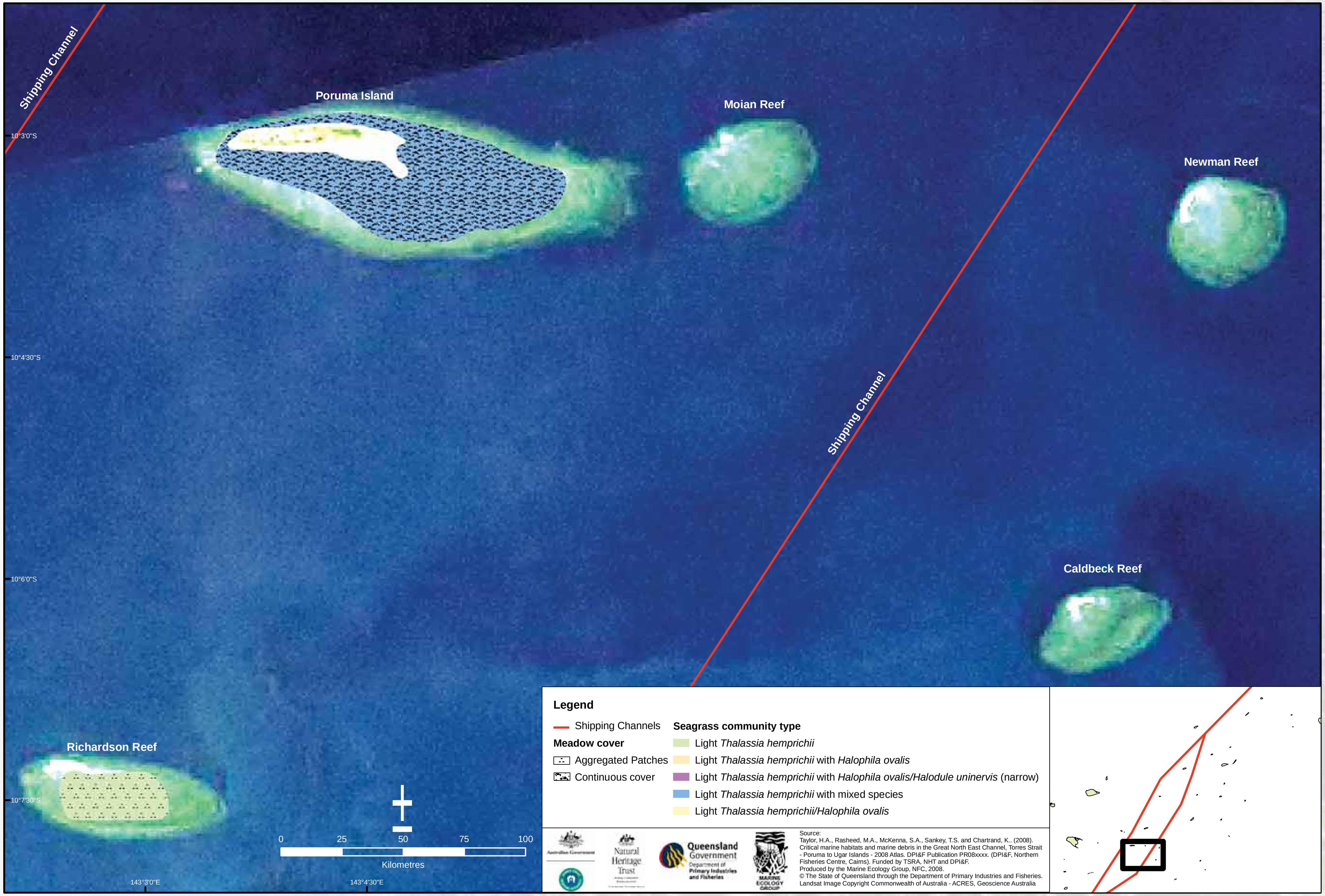
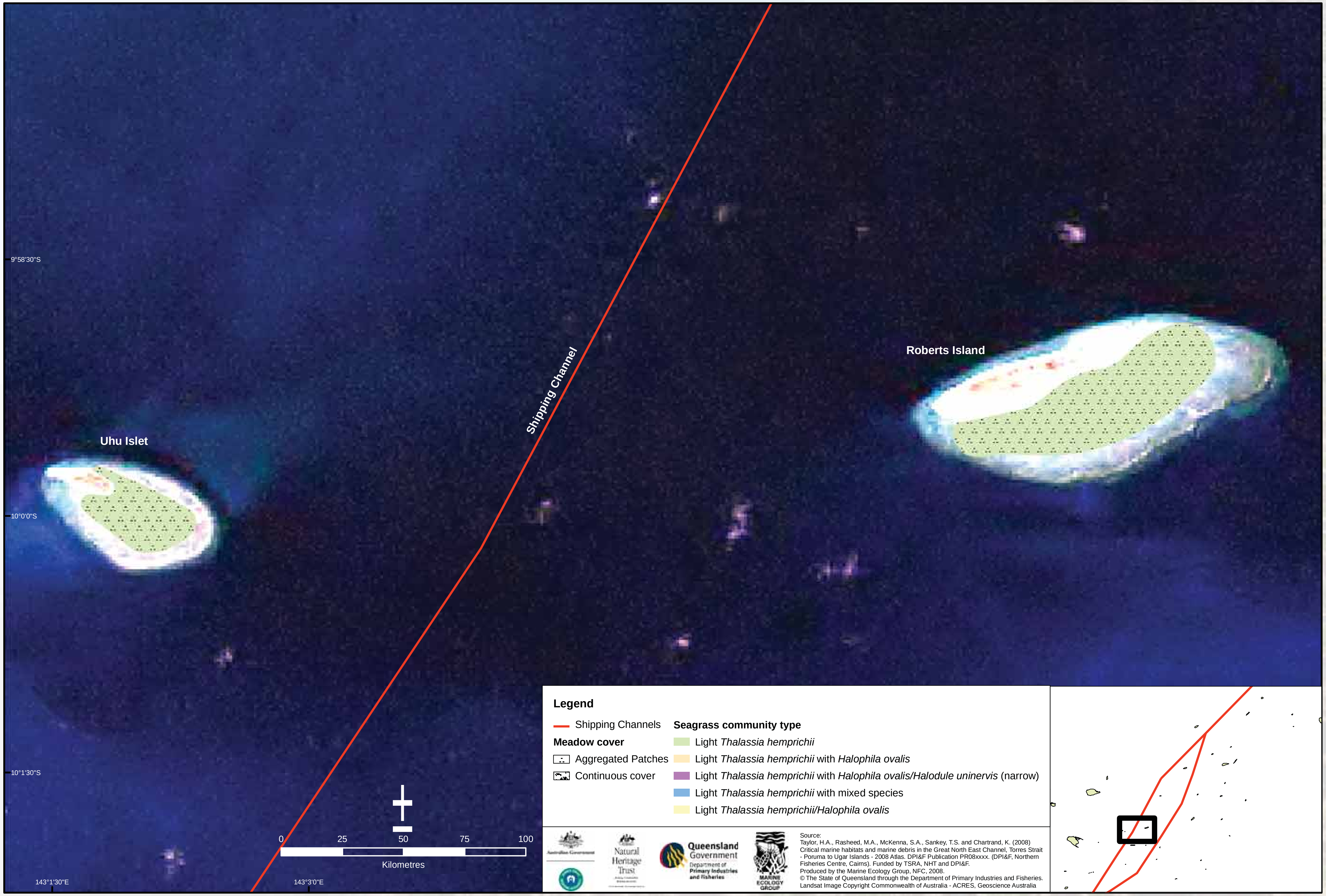
Map 5. Intertidal seagrass community types and meadow cover around Poruma Island, Moian Reef, Newman Reef, Caldbeck Reef and Richardson Reef, Torres Strait, February 2008



Source:
Taylor, H.A., Rasheed, M.A., McKenna, S.A., Sankey, T.S. and Chartrand, K.. (2008). Critical marine habitats and marine debris in the Great North East Channel, Torres Strait - Poruma to Ugar Islands - 2008 Atlas. DPI&F Publication PR08xxxx. (DPI&F, Northern Fisheries Centre, Cairns). Funded by TSRA, NHT and DPI&F.
Produced by the Marine Ecology Group, NFC, 2008.

Map 6. Intertidal seagrass community types and meadow cover around Uhu Islet and Roberts Islet, Torres Strait, February 2008



Source:
Taylor, H.A., Rasheed, M.A., McKenna, S.A., Sankey, T.S. and Chartrand, K. (2008) Critical marine habitats and marine debris in the Great North East Channel, Torres Strait - Poruma to Ugar Islands - 2008 Atlas. DPI&F Publication PR08xxxx. (DPI&F, Northern Fisheries Centre, Cairns). Funded by TSRA, NHT and DPI&F.
Produced by the Marine Ecology Group, NFC, 2008.
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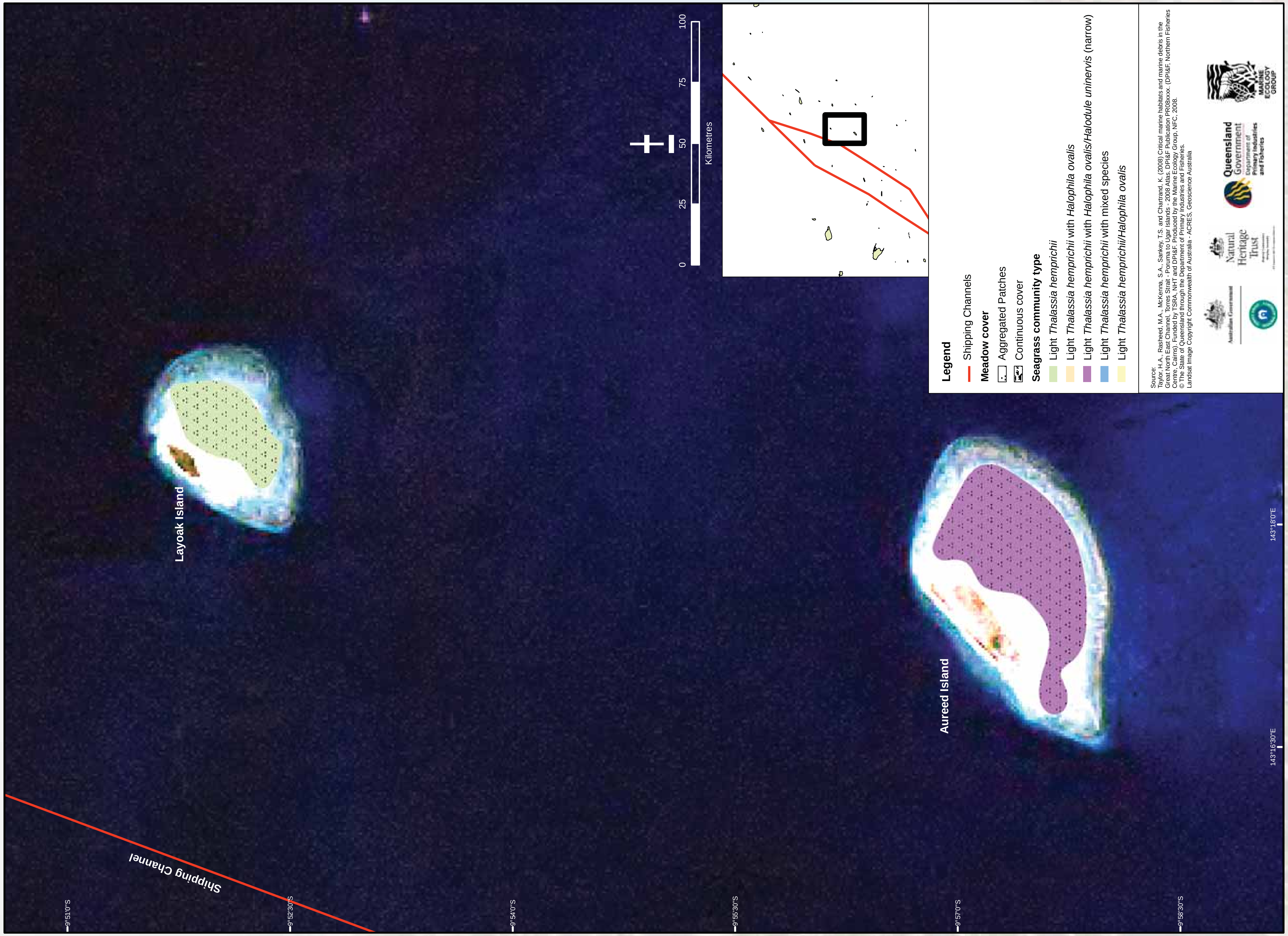
Map 7. Intertidal seagrass community types and meadow cover around Layoak Island and Aureed Island, Torres Strait, February 2008



Source:
Taylor, H.A., Rasheed, M.A., McKenna, S.A., Sankey, T.S. and Chartrand, K. (2008) Critical marine habitats and marine debris in the Great North East Channel, Torres Strait - Poruma to Ugar Islands - 2008 Atlas. DPI&F Publication PR08xxxx. (DPI&F, Northern Fisheries Centre, Cairns). Funded by TSRA, NHT and DPI&F. Produced by the Marine Ecology Group, NFC, 2008.
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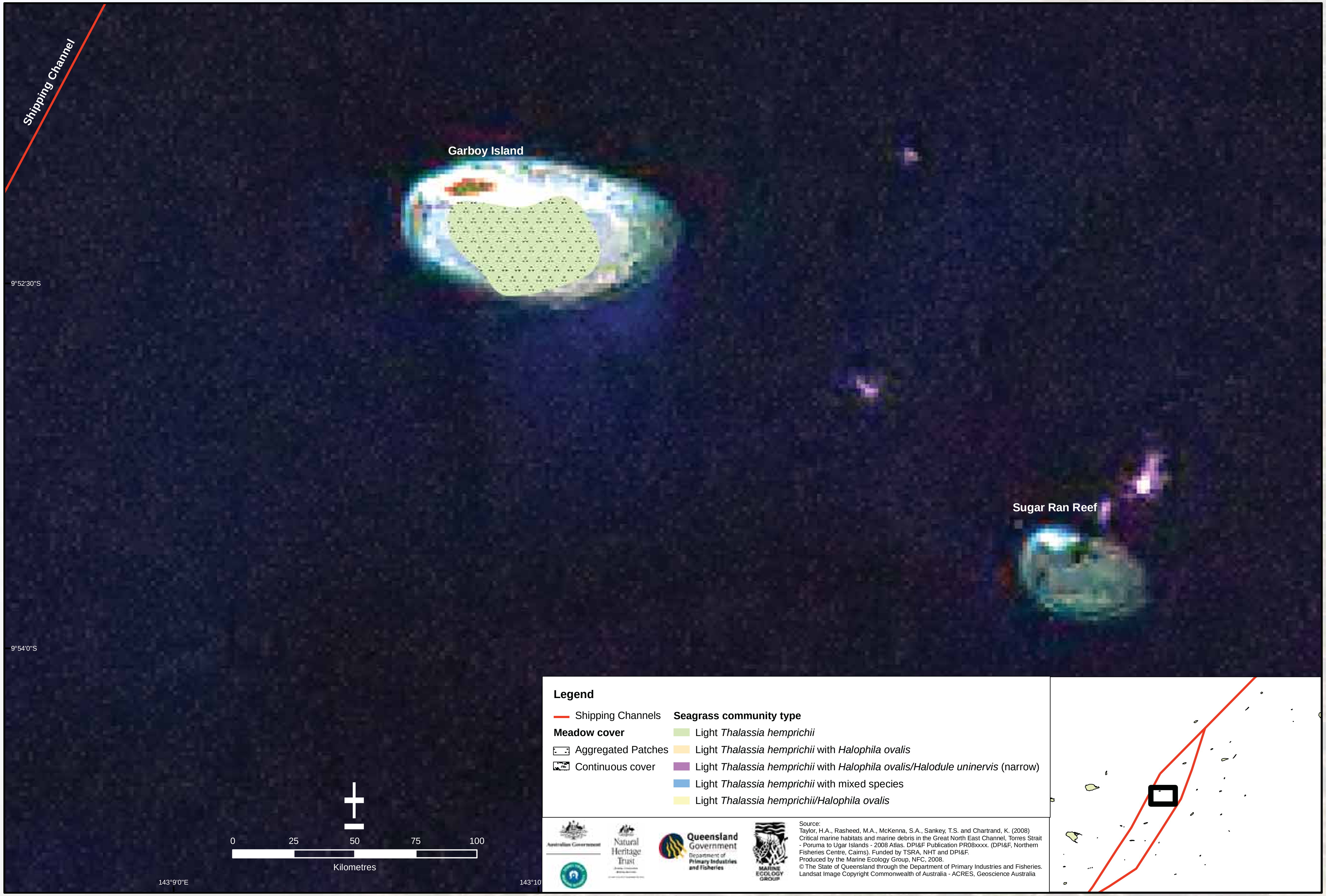
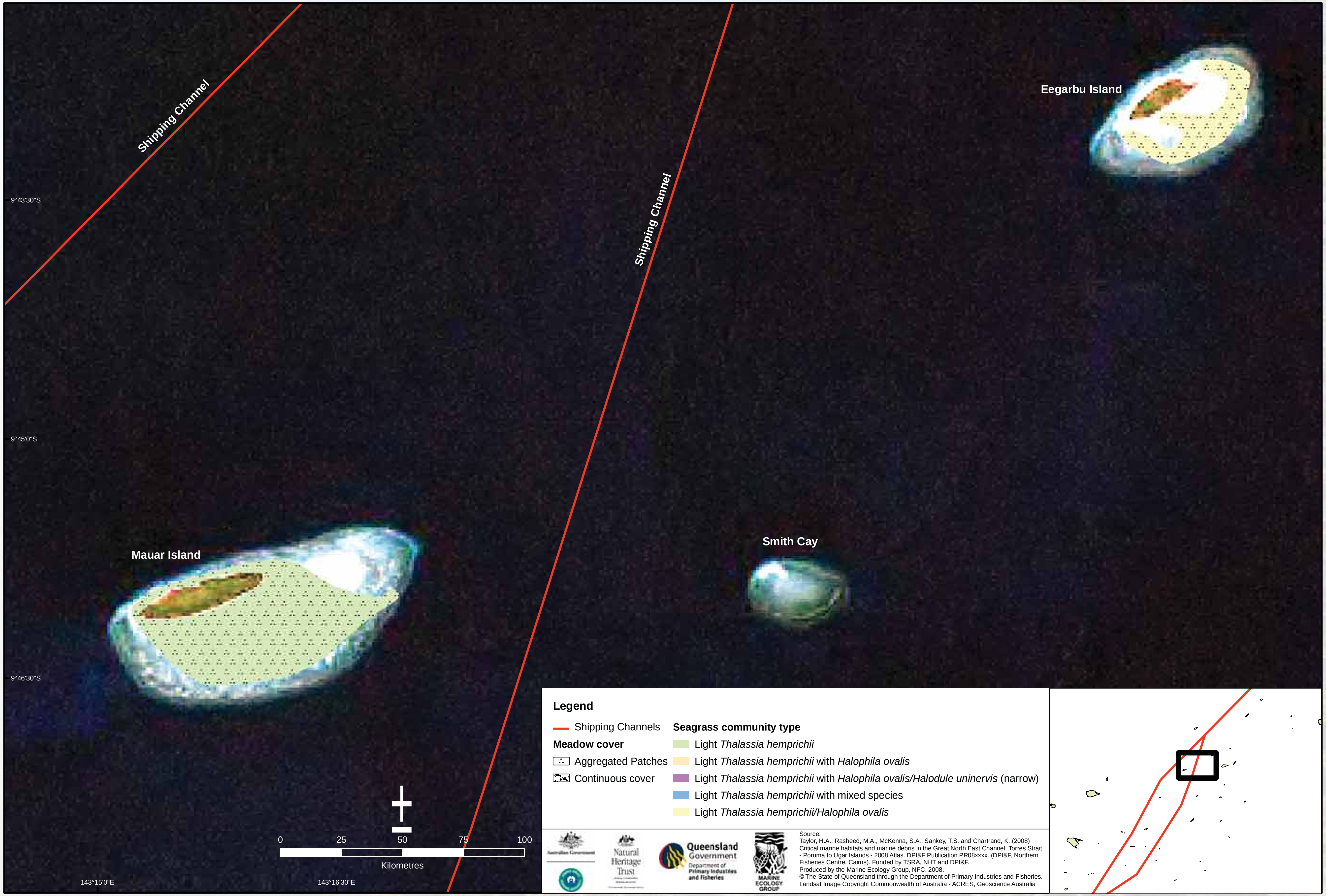
Map 8. Intertidal seagrass community types and meadow cover around Garboy Island and Sugar Ran Reef, Torres Strait, February 2008



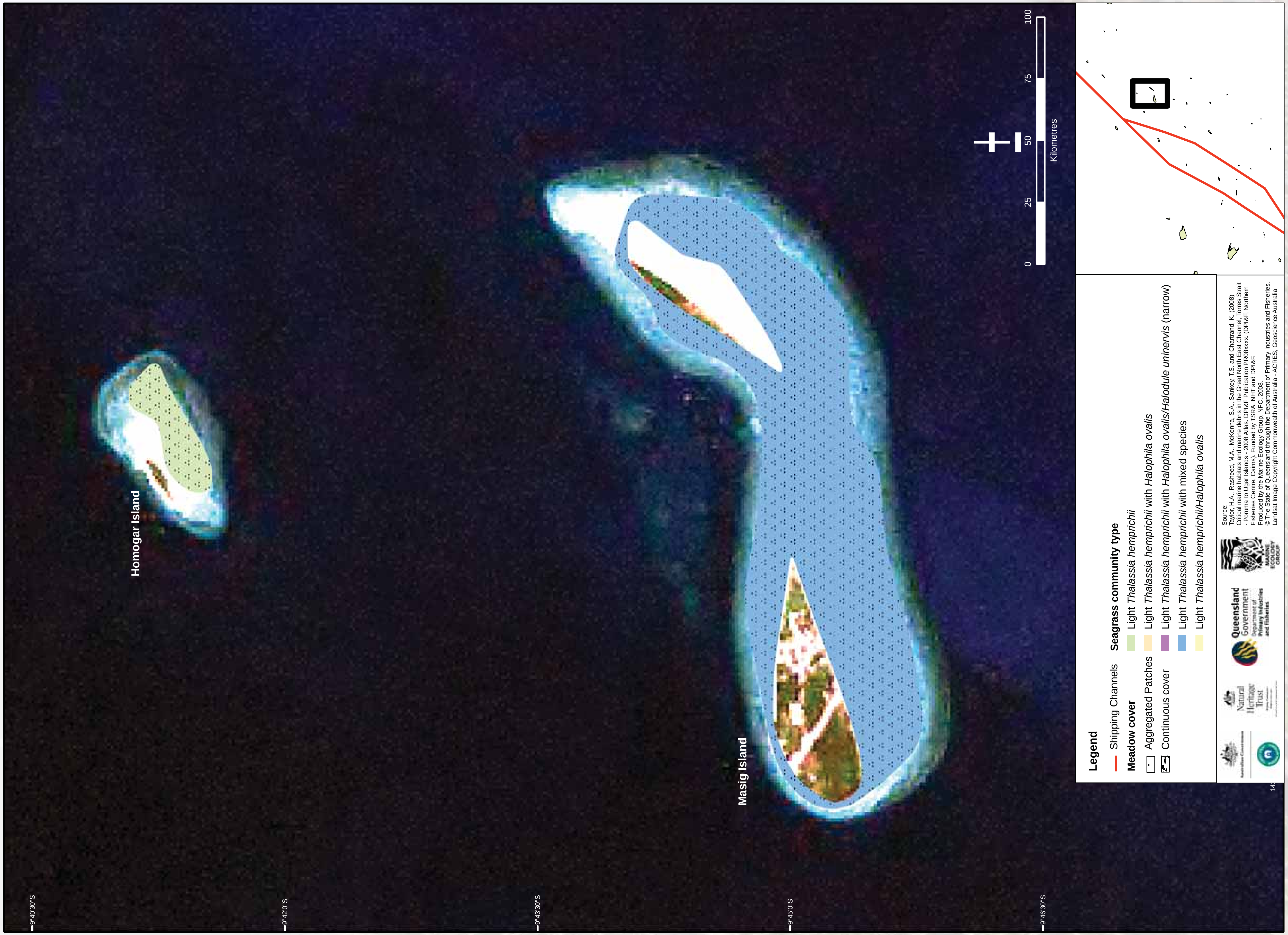
Source:
Taylor, H.A., Rasheed, M.A., McKenna, S.A., Sankey, T.S. and Chartrand, K. (2008) Critical marine habitats and marine debris in the Great North East Channel, Torres Strait - Poruma to Ugar Islands - 2008 Atlas. DPI&F Publication PR08xxxx. (DPI&F, Northern Fisheries Centre, Cairns). Funded by TSRA, NHT and DPI&F.
Produced by the Marine Ecology Group, NFC, 2008.

Map 9. Intertidal seagrass community types and meadow cover around Mauar Island, Smith Cay and Eegarbu Island Torres Strait, February 2008



Source:
Taylor, H.A., Rasheed, M.A., McKenna, S.A., Sankey, T.S. and Chartrand, K. (2008) Critical marine habitats and marine debris in the Great North East Channel, Torres Strait - Poruma to Ugar Islands - 2008 Atlas. DPI&F Publication PR08xxxx. (DPI&F, Northern Fisheries Centre, Cairns). Funded by TSRA, NHT and DPI&F.
Produced by the Marine Ecology Group, NFC, 2008.

Map 10. Intertidal seagrass community types and meadow cover around Masig Island and Homogar Island, Torres Strait, February 2008



Source:
Taylor, H.A., Rasheed, M.A., McKenna, S.A., Sankey, T.S. and Chartrand, K. (2008)
Critical marine habitats and marine debris in the Great North East Channel, Torres Strait
- Poruma to Ugar Islands - 2008 Atlas. DPI&F Publication PR08xxxx. (DPI&F, Northern
Fisheries Centre, Cairns). Funded by TSRA, NHT and DPI&F.
Produced by the Marine Ecology Group, NFC, 2008.
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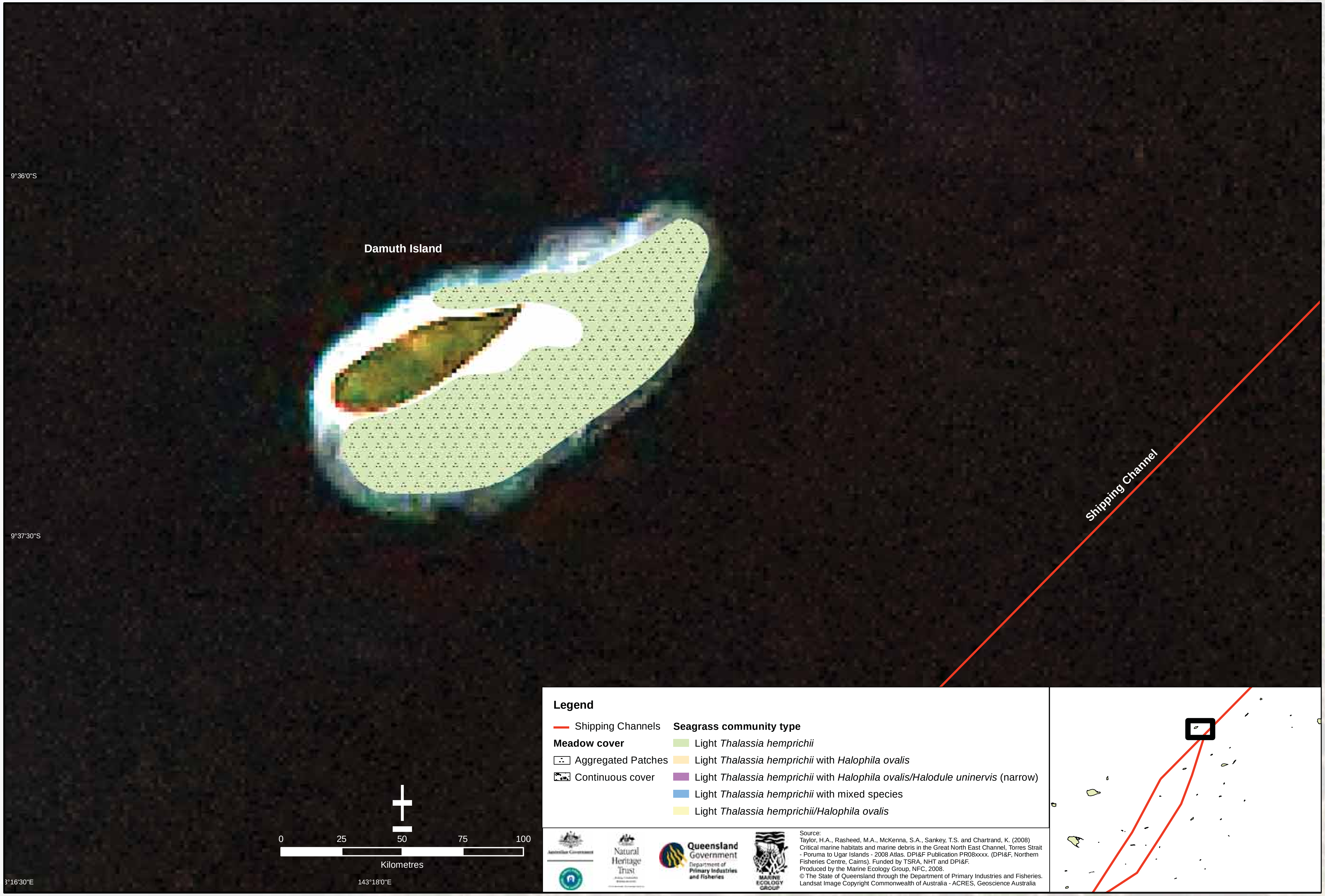
## Map 11. Intertidal seagrass community types and meadow cover around Damuth Island, Torres Strait, February 2008



Source:
Taylor, H.A., Rasheed, M.A., McKenna, S.A., Sankey, T.S. and Chartrand, K. (2008) Critical marine habitats and marine debris in the Great North East Channel, Torres Strait - Poruma to Ugar Islands - 2008 Atlas. DPI&F Publication PR08xxxx. (DPI&F, Northern Fisheries Centre, Cairns). Funded by TSRA, NHT and DPI&F.
Produced by the Marine Ecology Group, NFC, 2008.
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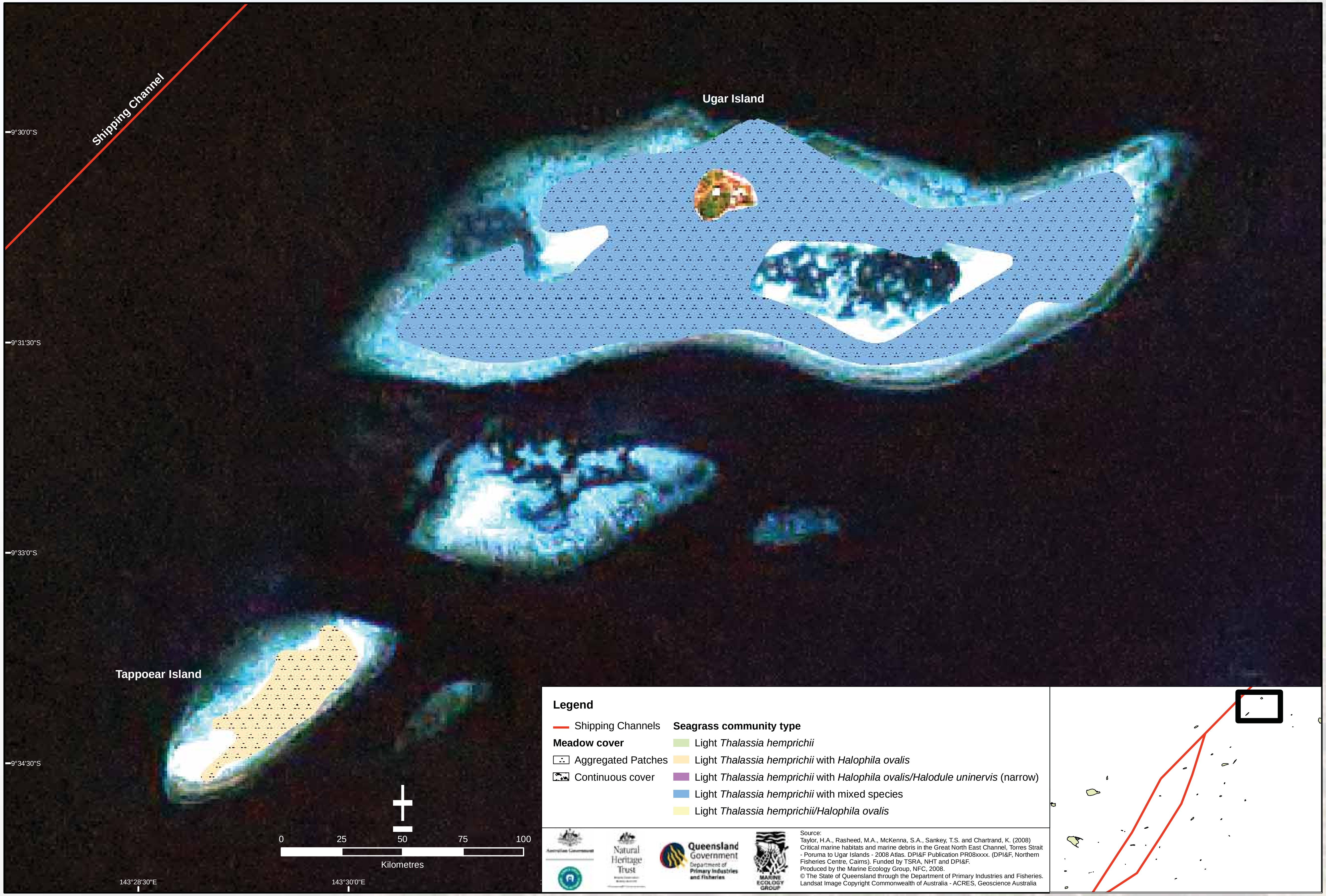
Map 12. Intertidal seagrass community types and meadow cover around Ugar Island and Tappoear Island, Torres Strait, February 2008



Source:
Taylor, H.A., Rasheed, M.A., McKenna, S.A., Sankey, T.S. and Chartrand, K. (2008) Critical marine habitats and marine debris in the Great North East Channel, Torres Strait - Poruma to Ugar Islands - 2008 Atlas. DPI&F Publication PR08xxxx. (DPI&F, Northern Fisheries Centre, Cairns). Funded by TSRA, NHT and DPI&F.
Produced by the Marine Ecology Group, NFC, 2008.

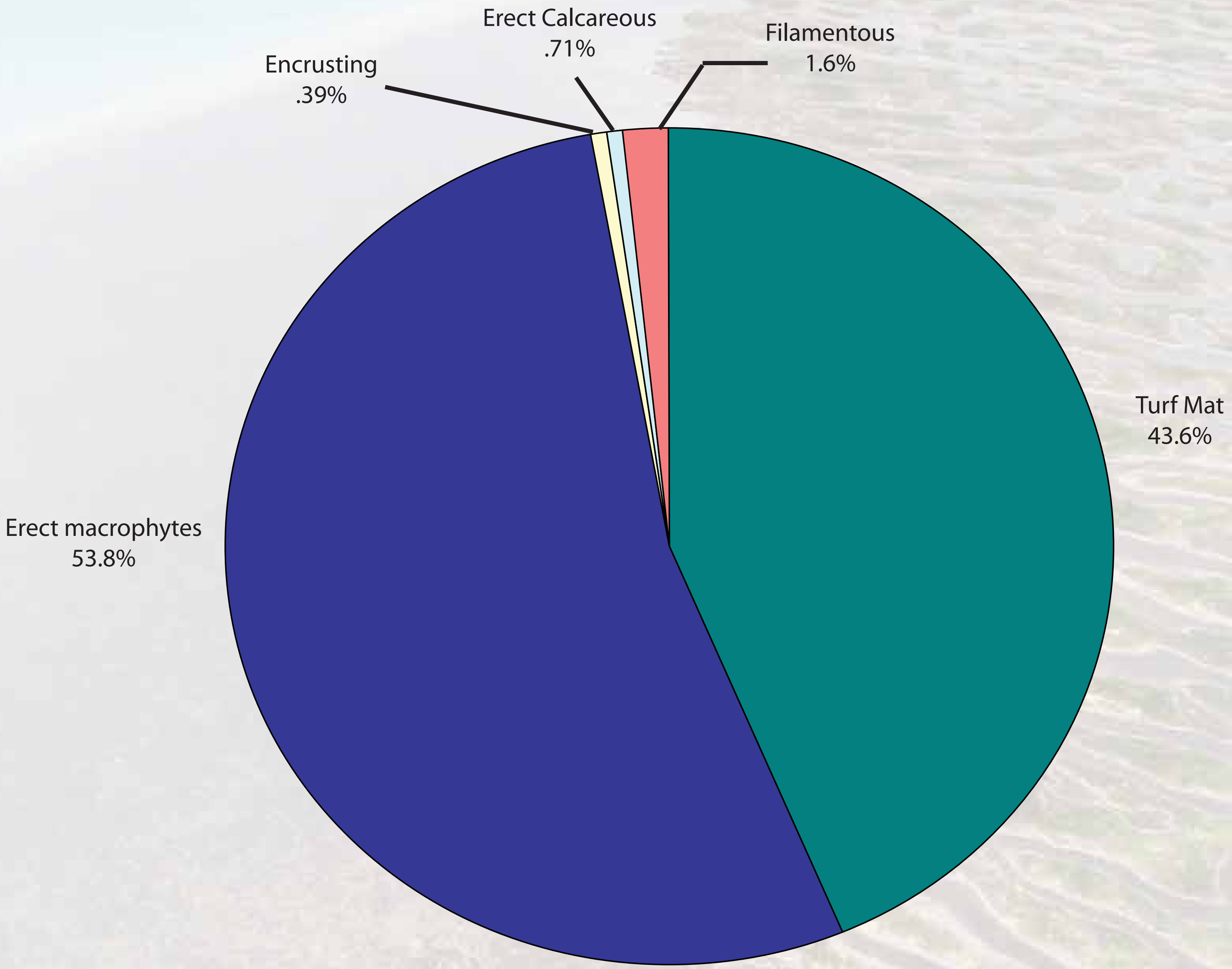
## Algae

Extensive areas of intertidal algae habitat were identified throughout the survey region with a total of 7752 ± 201 ha mapped. Algae was the dominant benthic habitat type identified, accounting for over 50% 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 high (50-75%) cover and were dominated by either erect marcophyte or algal turf mat species. Erect marcophyte species were more commonly found in shallow pools on the reef flat or in partially subtidal reef crest and slope areas (Maps 13-20). 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. Erect macrophyte communities included genera such as *Sargassum* and *Caulerpa*.

Erect calcareous, encursting and filamentous algal functional groups made up a very small proportion of the algal community in the survey area.

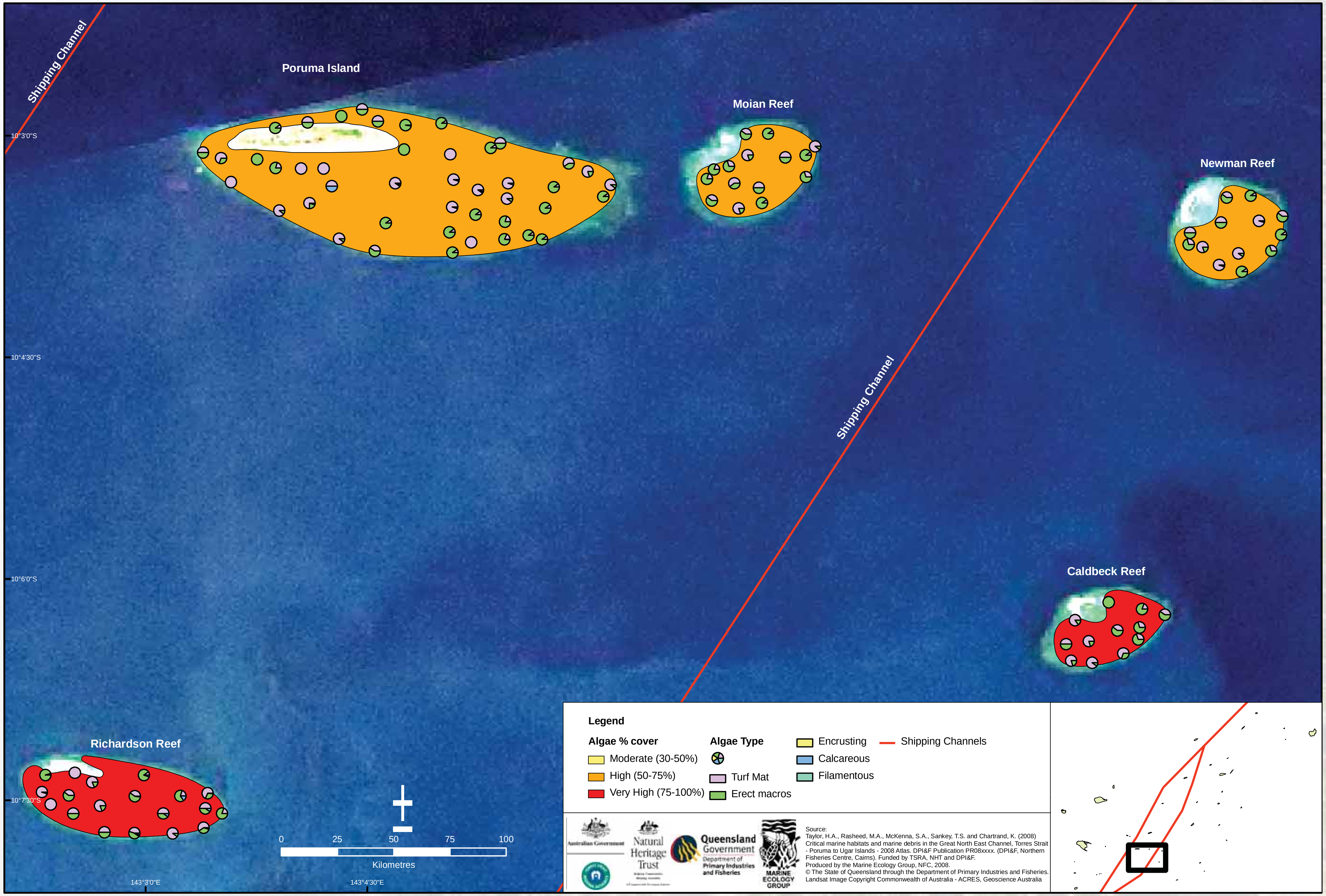
**Figure 4** Mean percent cover of algal types in the Torres Strait survey area, 2008




Typical erect macrophyte community in a shallow pool

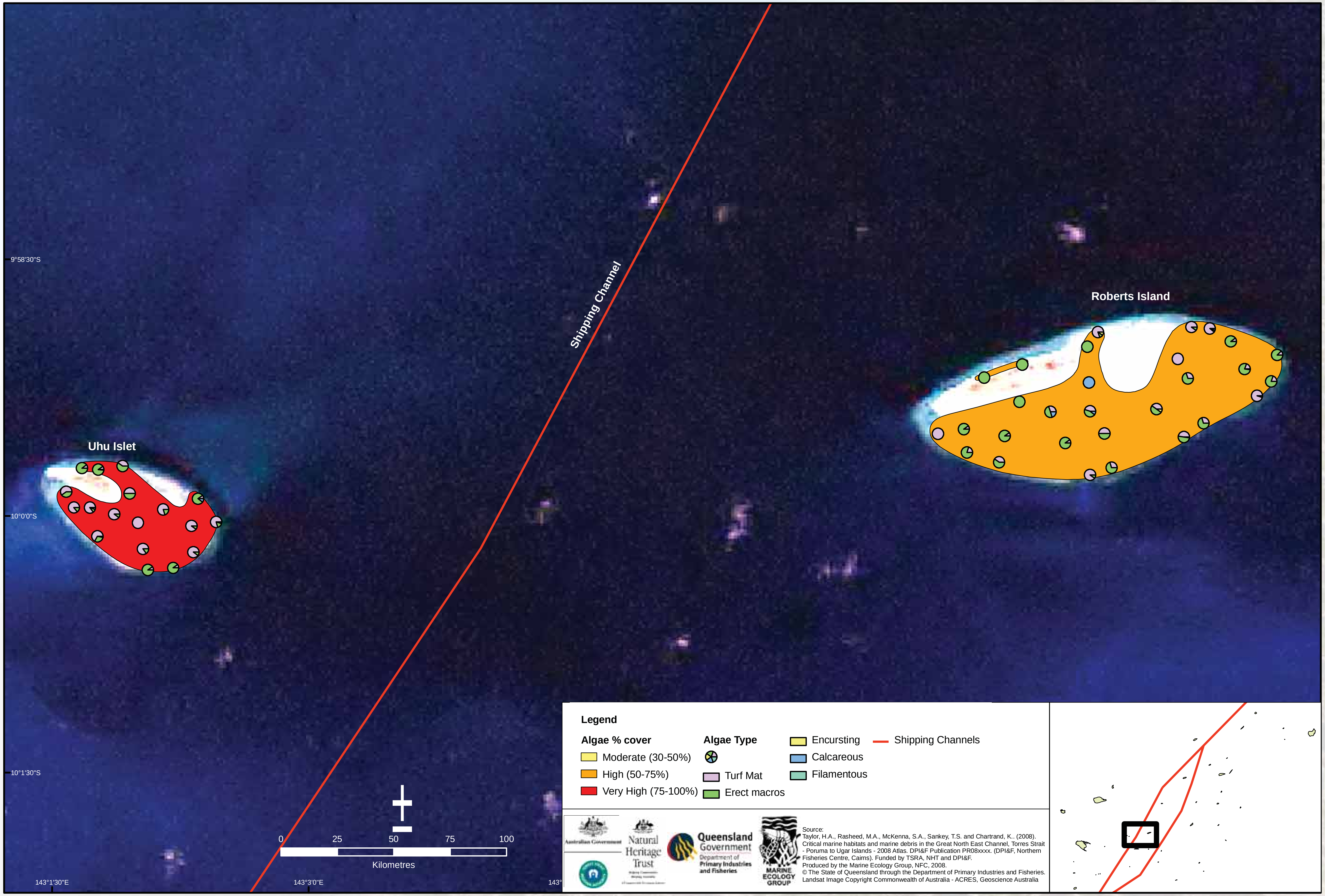

Erect macrophytes with mixed species of hard coral

Map 13. Algae cover and types for sites on Poruma Island, Moian Reef, Newman Reef, Caldbeck Reef and Richardson Reef, Torres Strait, February 2008



Source:
Taylor, H.A., Rasheed, M.A., McKenna, S.A., Sankey, T.S. and Chartrand, K. (2008) Critical marine habitats and marine debris in the Great North East Channel, Torres Strait - Poruma to Ugar Islands - 2008 Atlas. DPI&F Publication PR08xxxx. (DPI&F, Northern Fisheries Centre, Cairns). Funded by TSRA, NHT and DPI&F.
Produced by the Marine Ecology Group, NFC, 2008.

Map 14. Algae cover and types for sites on Uhu Islet and Roberts Island, Torres Strait, February 2008



**Legend**

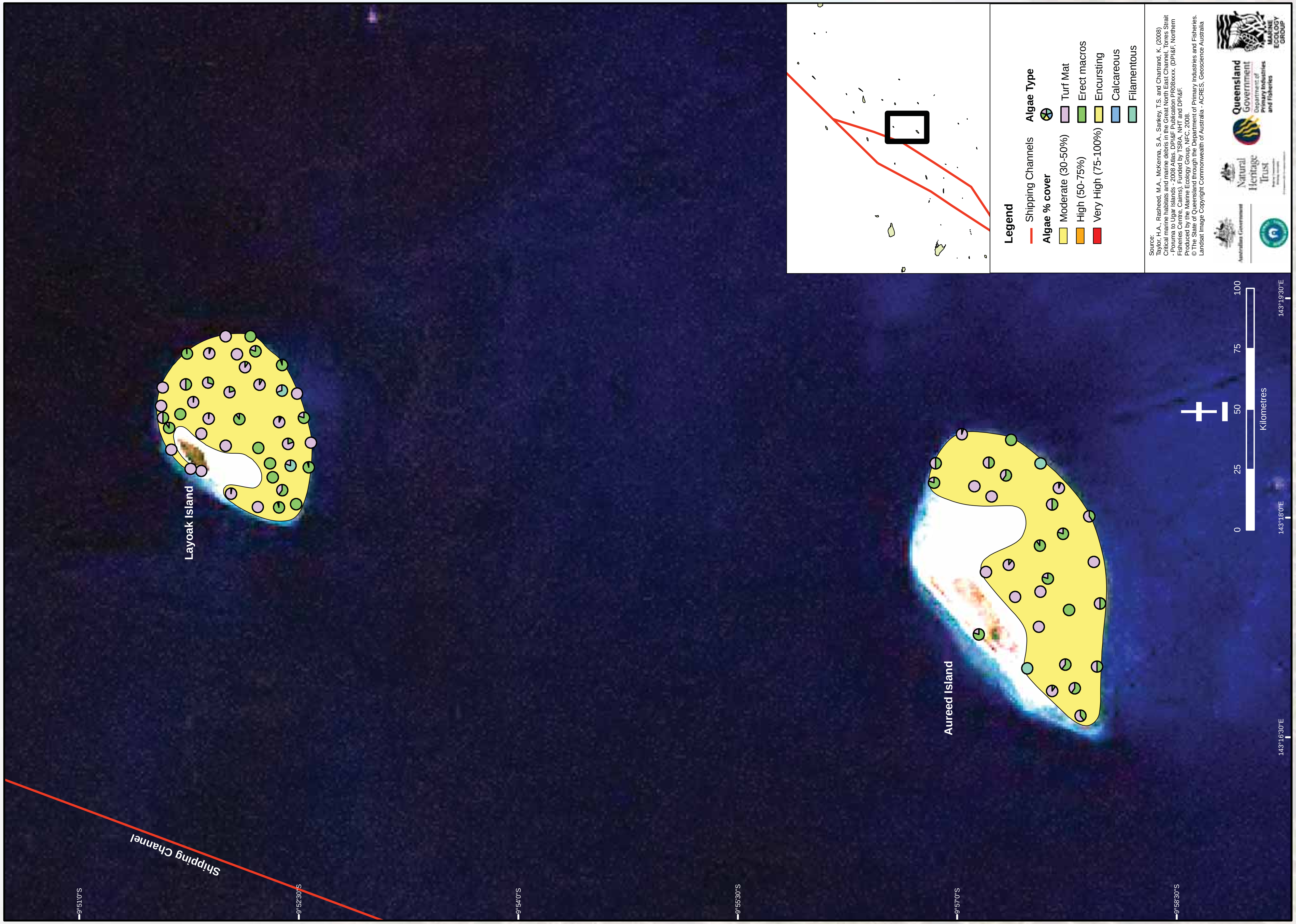
**Algae % cover**
🟨 Moderate (30-50%)
🟧 High (50-75%)
🟥 Very High (75-100%)

**Algae Type**
Turf Mat
🟩 Erect macros
Encursting
🟦 Calcareous
Filamentous

Shipping Channels

Source:
Taylor, H.A., Rasheed, M.A., McKenna, S.A., Sankey, T.S. and Chartrand, K.. (2008). Critical marine habitats and marine debris in the Great North East Channel, Torres Strait - Poruma to Ugar Islands - 2008 Atlas. DPI&F Publication PR08xxxx. (DPI&F, Northern Fisheries Centre, Cairns). Funded by TSRA, NHT and DPI&F.
Produced by the Marine Ecology Group, NFC, 2008.

Map 15. Algae cover and types for sites on Layoak Island and Aureed Island, Torres Strait, February 2008



Source:
Taylor, H.A., Rasheed, M.A., McKenna, S.A., Sankey, T.S. and Chartrand, K. (2008) Critical marine habitats and marine debris in the Great North East Channel, Torres Strait - Poruma to Ugar Islands - 2008 Atlas. DPI&F Publication PR08xxxx. (DPI&F, Northern Fisheries Centre, Cairns). Funded by TSRA, NHT and DPI&F.
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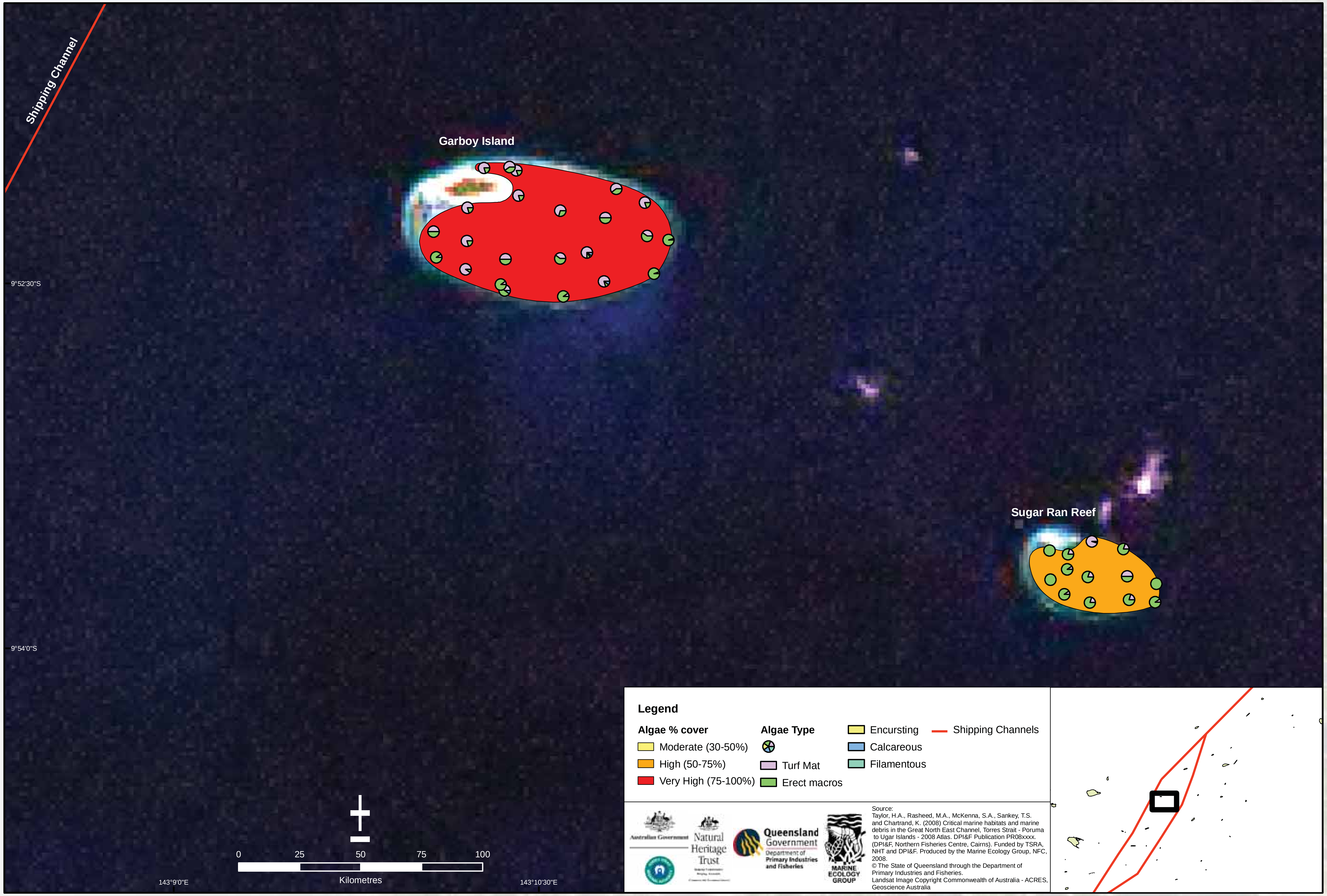
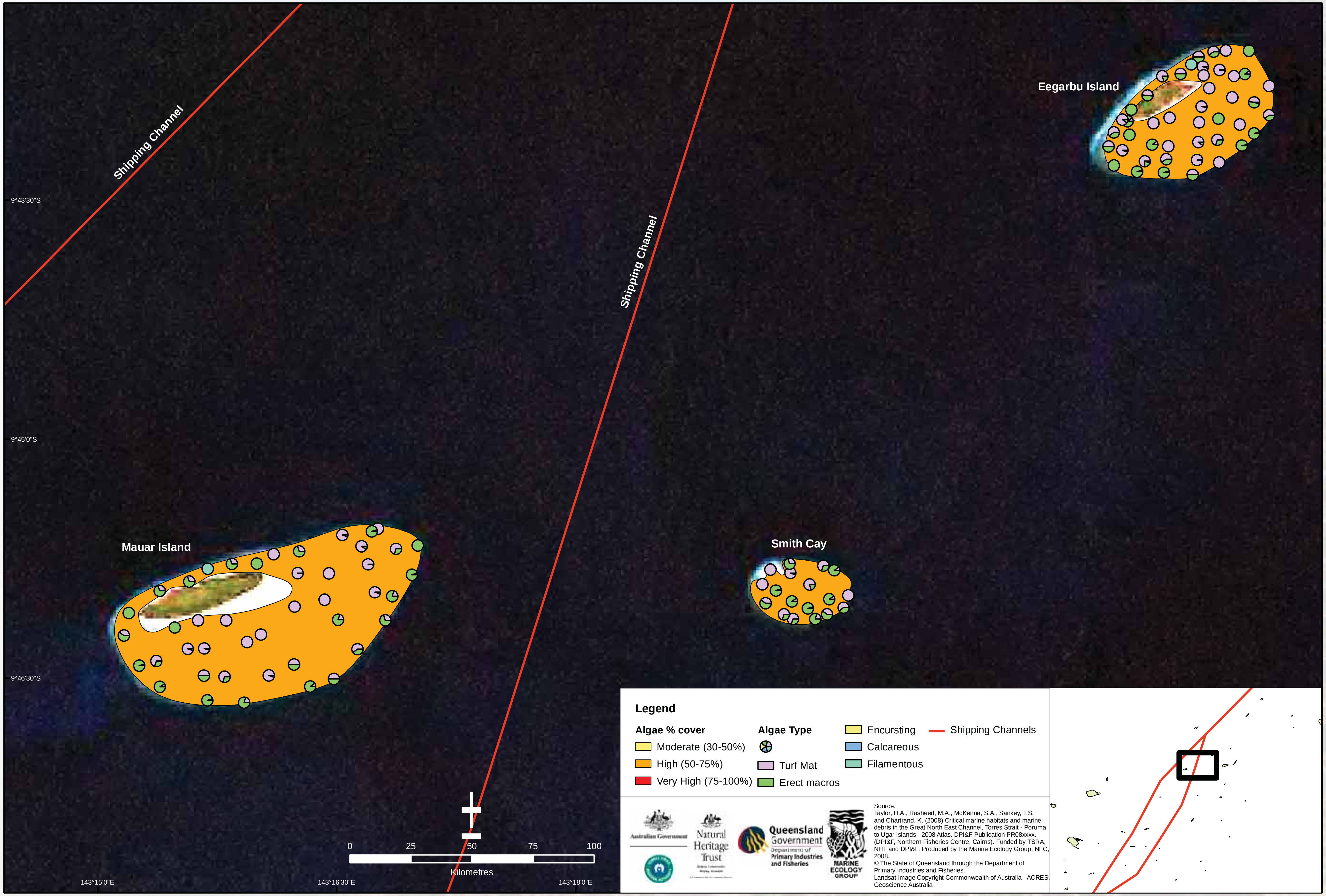
Map 16. Algae cover and types for sites on Garboy Island and Sugar Ran Reef, Torres Strait, February 2008



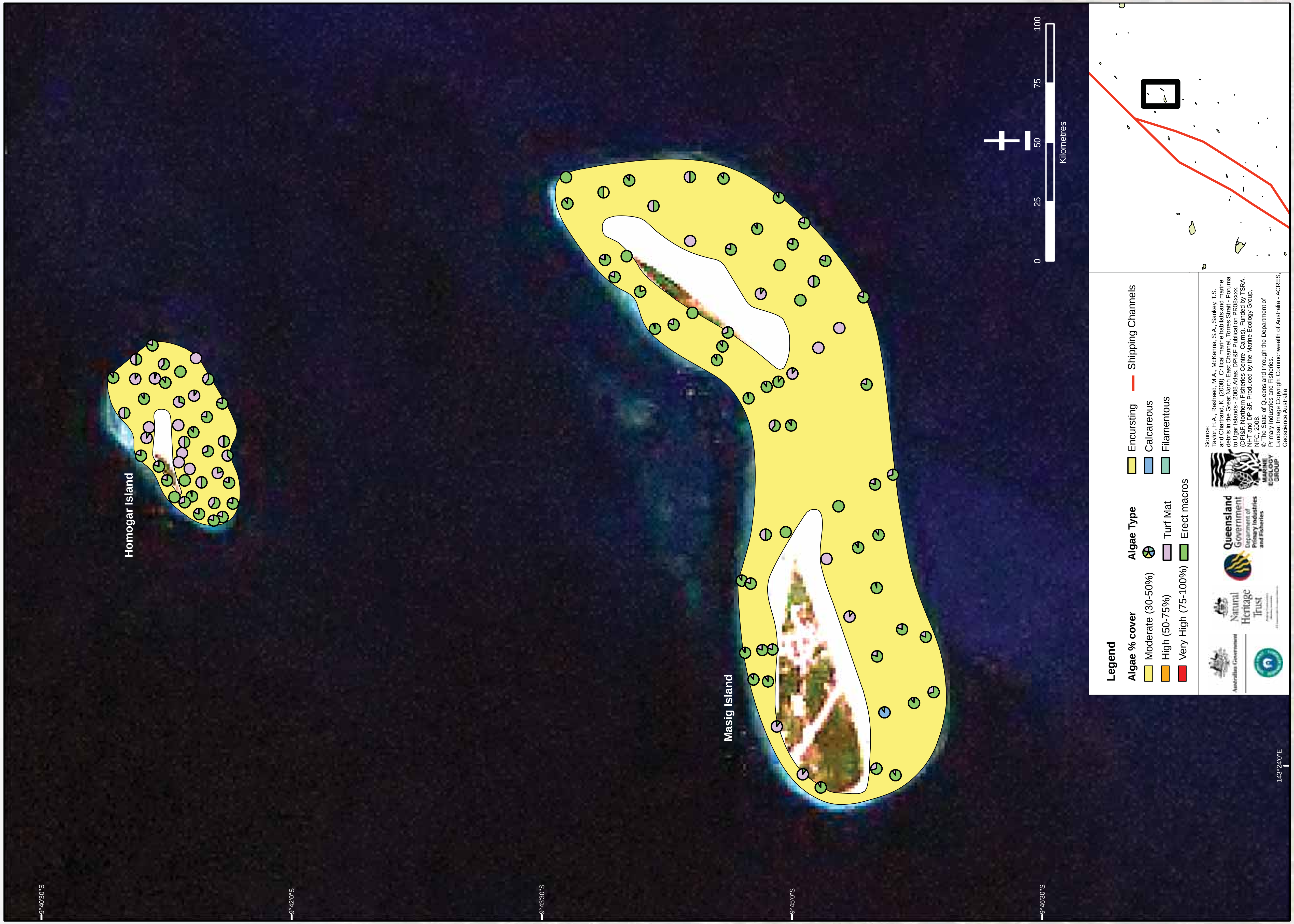
Source:
Taylor, H.A., Rasheed, M.A., McKenna, S.A., Sankey, T.S. and Chartrand, K. (2008) Critical marine habitats and marine debris in the Great North East Channel, Torres Strait - Poruma to Ugar Islands - 2008 Atlas. DPI&F Publication PR08xxxx. (DPI&F, Northern Fisheries Centre, Cairns). Funded by TSRA, NHT and DPI&F. Produced by the Marine Ecology Group, NFC, 2008.

Map 17. Algae cover and types for sites on Mauar Island, Smith Cay and Eegarbu Island, Torres Strait, February 2008



Source:
Taylor, H.A., Rasheed, M.A., McKenna, S.A., Sankey, T.S. and Chartrand, K. (2008) Critical marine habitats and marine debris in the Great North East Channel, Torres Strait - Poruma to Ugar Islands - 2008 Atlas. DPI&F Publication PR08xxxx. (DPI&F, Northern Fisheries Centre, Cairns). Funded by TSRA, NHT and DPI&F. Produced by the Marine Ecology Group, NFC, 2008.

Map 18. Algae cover and types for sites on Masig Island and Homogar Island, Torres Strait, February 2008



Source:
Taylor, H.A., Rasheed, M.A., McKenna, S.A., Sankey, T.S. and Chartrand, K. (2008). Critical marine habitats and marine debris in the Great North East Channel, Torres Strait - Poruma to Ugar Islands - 2008 Atlas. DPI&F Publication PR08xxxx. (DPI&F, Northern Fisheries Centre, Cairns). Funded by TSRA, NHT and DPI&F. Produced by the Marine Ecology Group, NFC, 2008.
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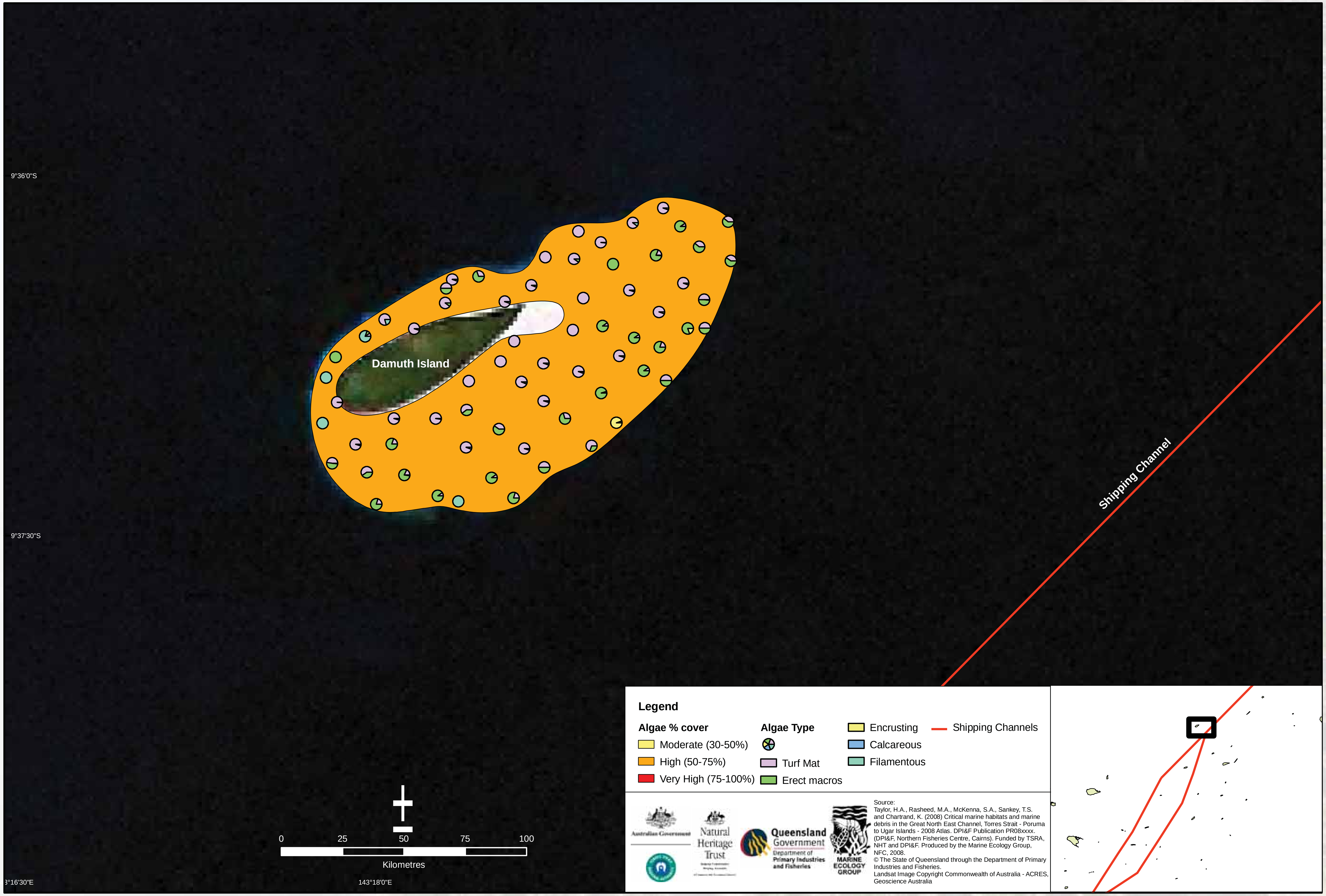
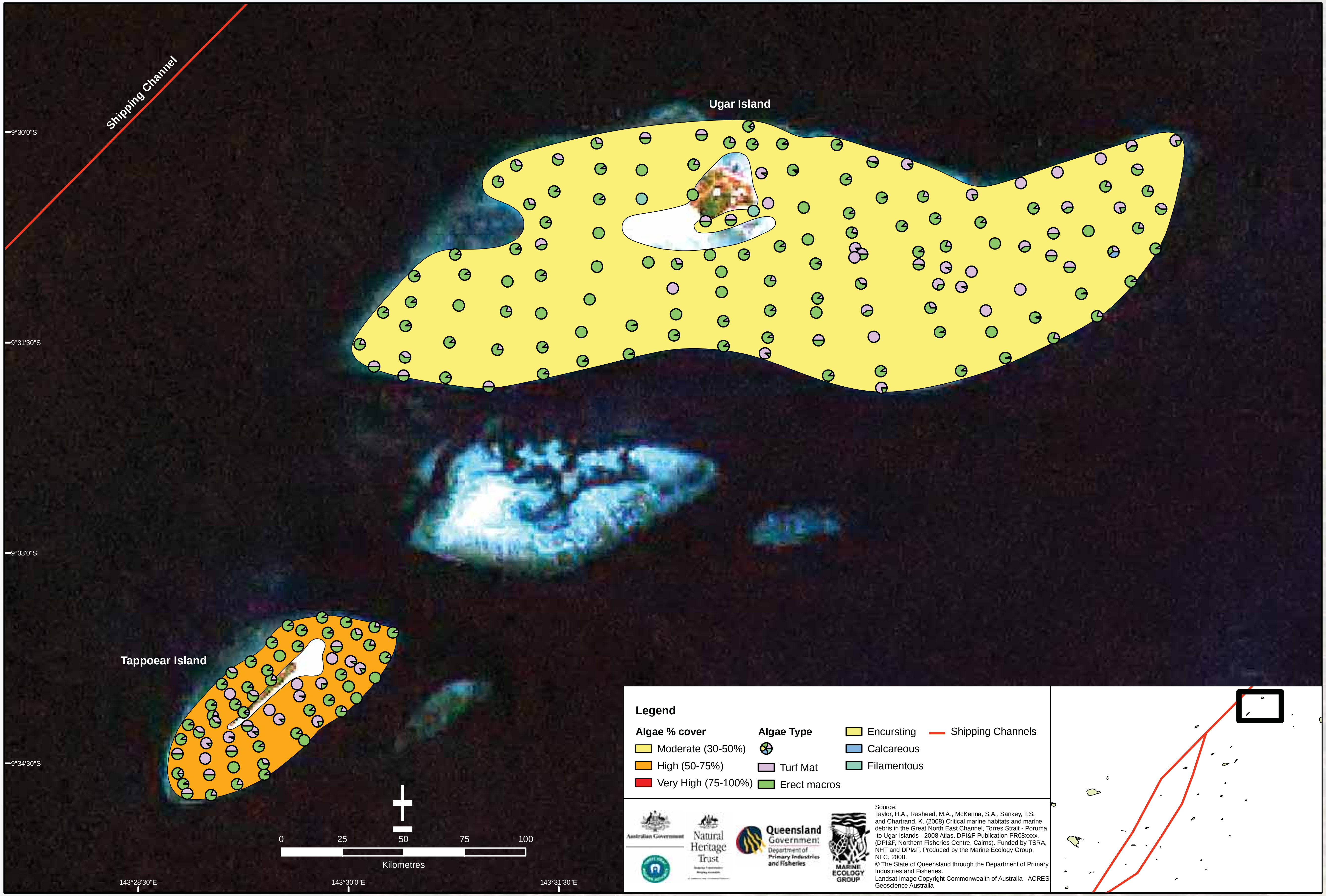
Map19. Algae cover and types for sites on Damuth Island, Torres Strait, February 2008



Source:
Taylor, H.A., Rasheed, M.A., McKenna, S.A., Sankey, T.S. and Chartrand, K. (2008) Critical marine habitats and marine debris in the Great North East Channel, Torres Strait - Poruma to Ugar Islands - 2008 Atlas. DPI&F Publication PR08xxxx. (DPI&F, Northern Fisheries Centre, Cairns). Funded by TSRA, NHT and DPI&F. Produced by the Marine Ecology Group, NFC, 2008.

Map 20. Algae cover and types for sites on Ugar Island and Tappoear Island, Torres Strait, February 2008



Source:
Taylor, H.A., Rasheed, M.A., McKenna, S.A., Sankey, T.S. and Chartrand, K. (2008) Critical marine habitats and marine debris in the Great North East Channel, Torres Strait - Poruma to Ugar Islands - 2008 Atlas. DPI&F Publication PR08xxxx. (DPI&F, Northern Fisheries Centre, Cairns). Funded by TSRA, NHT and DPI&F. Produced by the Marine Ecology Group, NFC, 2008.

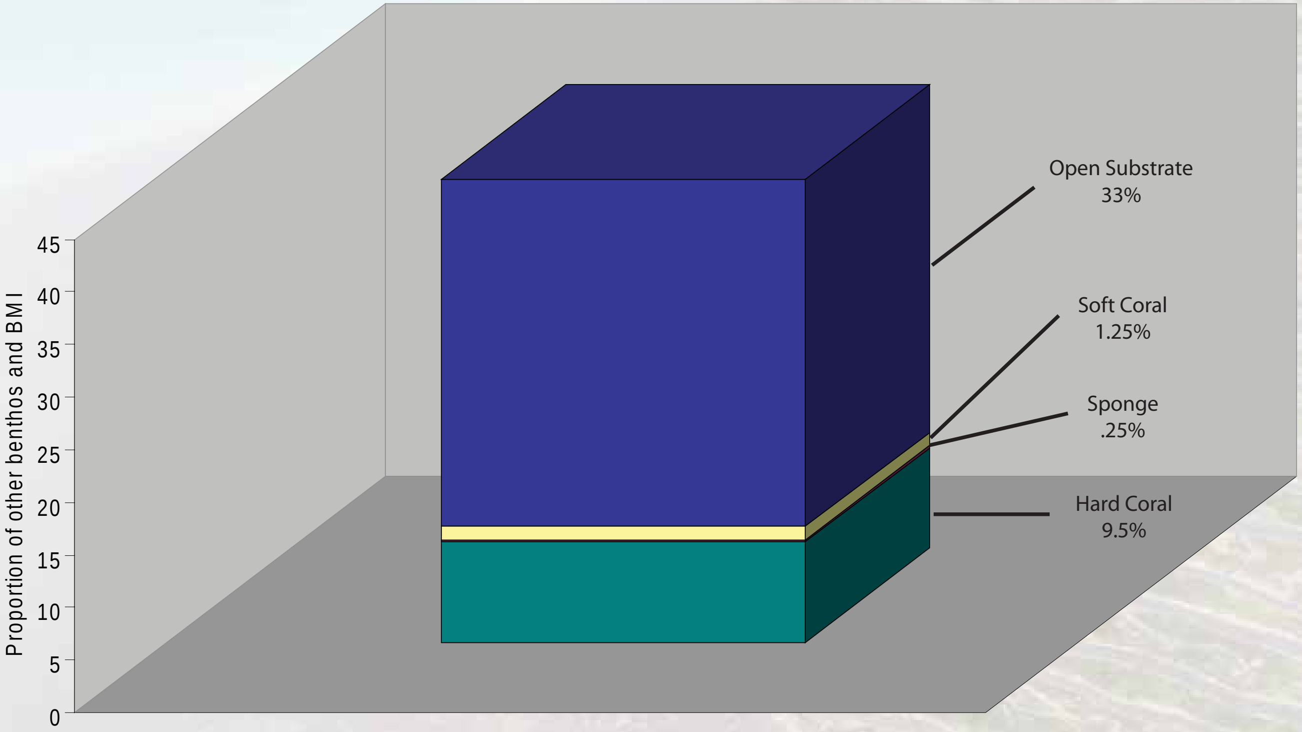
## Other benthos and benthic macro-invertebrates (BMI)

Other benthos (excluding seagrass and algae) made up a significant component of the benthic habitat cover in the survey (Figure 1), 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 soft and hard corals (Maps 21 - 28).

Generally, hard and soft coral communtiies formed a ring around the outside of the intertidal areas surveyed, dominating the reef crest and extending into the subtidal region. This pattern was clearly evident on Layoak, Homogar (Keats) and Damuth (Dalrymple) Islands (Maps 23, 26 and 27). Where present, hard and soft coral cover was typically very high (>75%). 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 3** Mean percent cover (at each site) of benthic macro-invertebrate type around the Torres Strait survey area, 2008

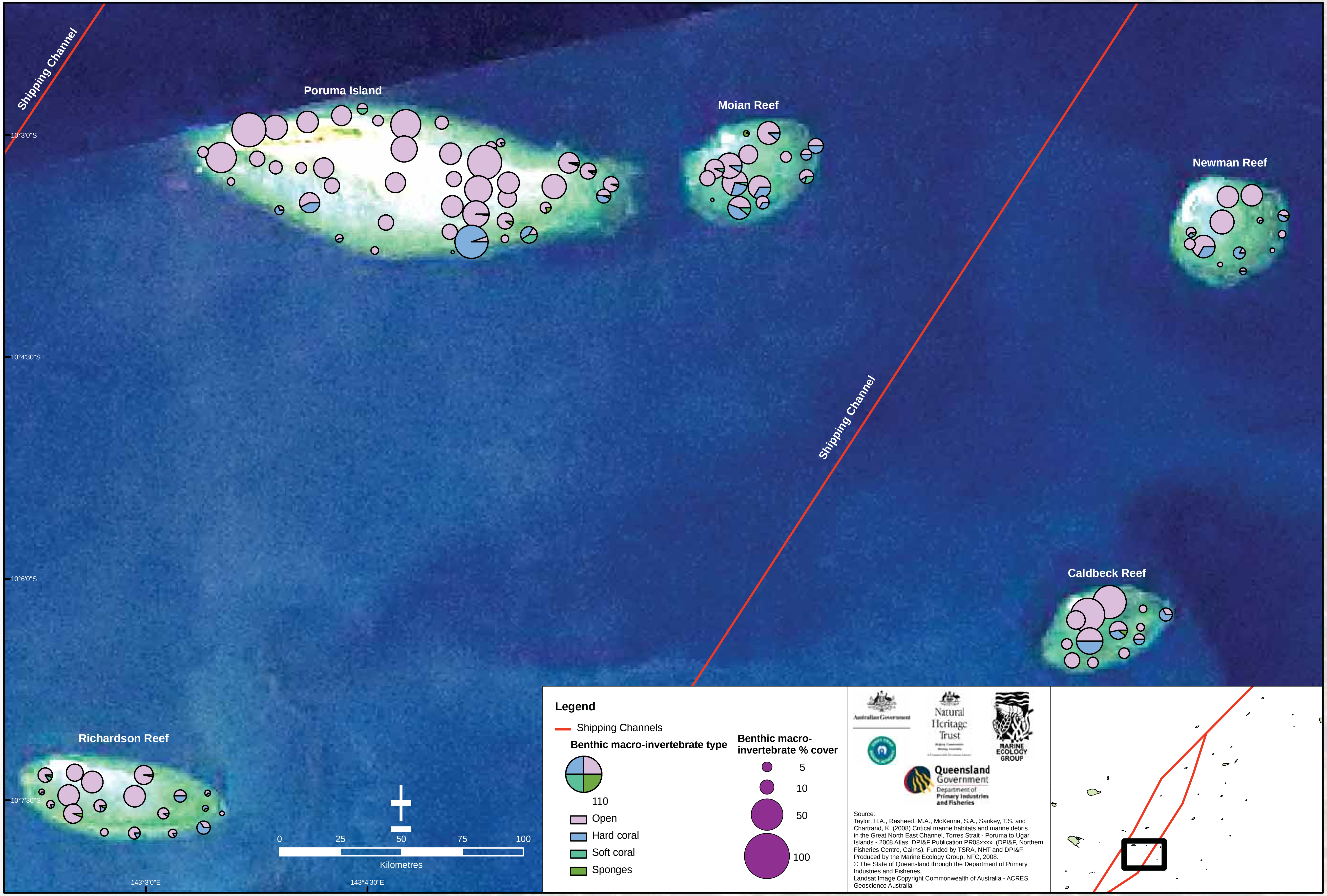


Mixed seagrass, algae and open substrate community

Mixed hard/soft coral dominated reef community

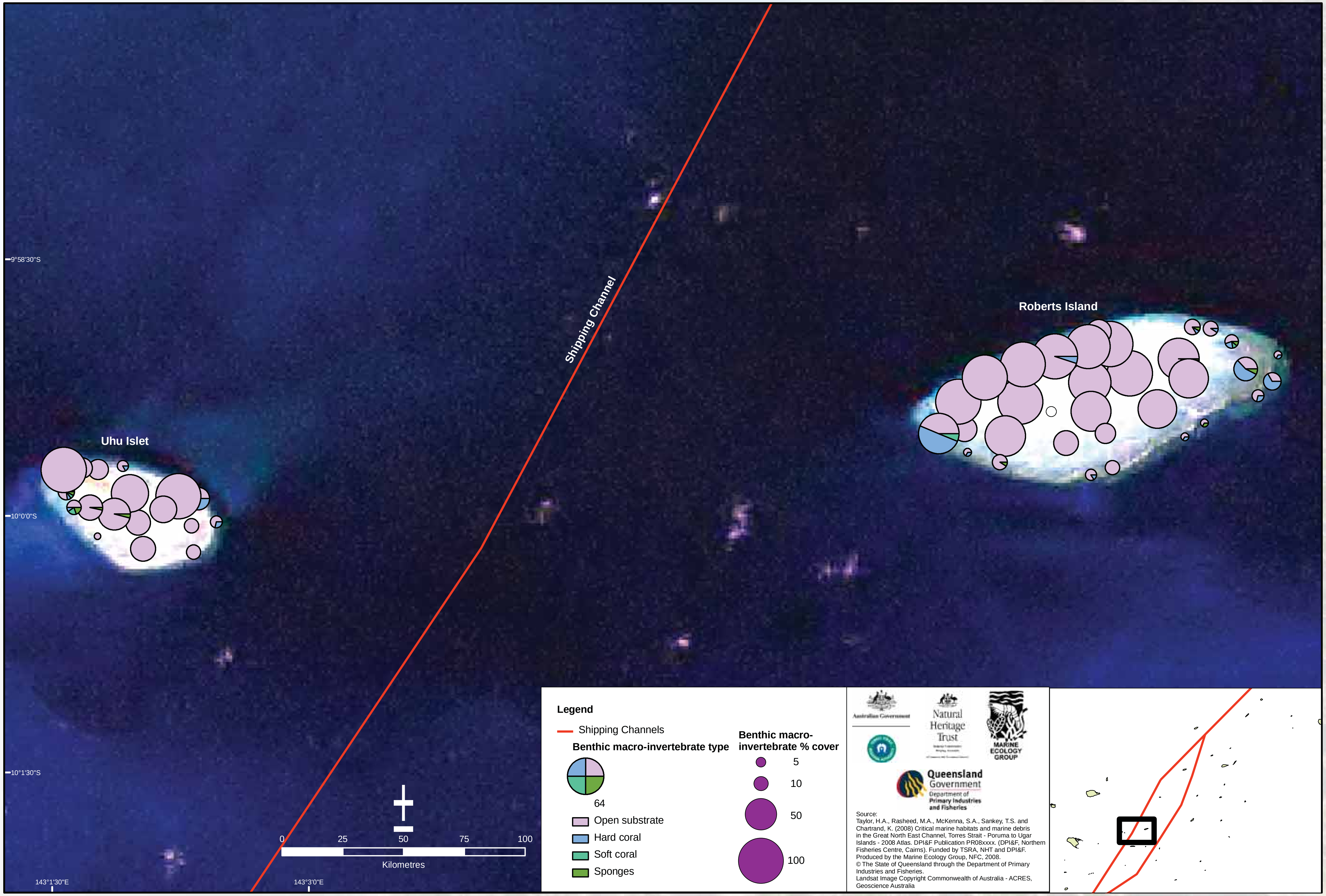
Soft coral dominated reef community

## Map 21. Benthic macro-invertebrate distribution and abundance for sites on Poruma Island, Moian Reef, Newman Reef, Caldbeck Reef and Richardson Reef, Torres Strait, February 2008



Source:
Taylor, H.A., Rasheed, M.A., McKenna, S.A., Sankey, T.S. and Chartrand, K. (2008) Critical marine habitats and marine debris in the Great North East Channel, Torres Strait - Poruma to Ugar Islands - 2008 Atlas. DPI&F Publication PR08xxxx. (DPI&F, Northern Fisheries Centre, Cairns). Funded by TSRA, NHT and DPI&F.
Produced by the Marine Ecology Group, NFC, 2008.

Map 22. Benthic macro-invertebrate distribution and abundance for sites on Uhu Islet and Roberts Island, Torres Strait, February 2008



Source:
Taylor, H.A., Rasheed, M.A., McKenna, S.A., Sankey, T.S. and Chartrand, K. (2008) Critical marine habitats and marine debris in the Great North East Channel, Torres Strait - Poruma to Ugar Islands - 2008 Atlas. DPI&F Publication PR08xxxx. (DPI&F, Northern Fisheries Centre, Cairns). Funded by TSRA, NHT and DPI&F.
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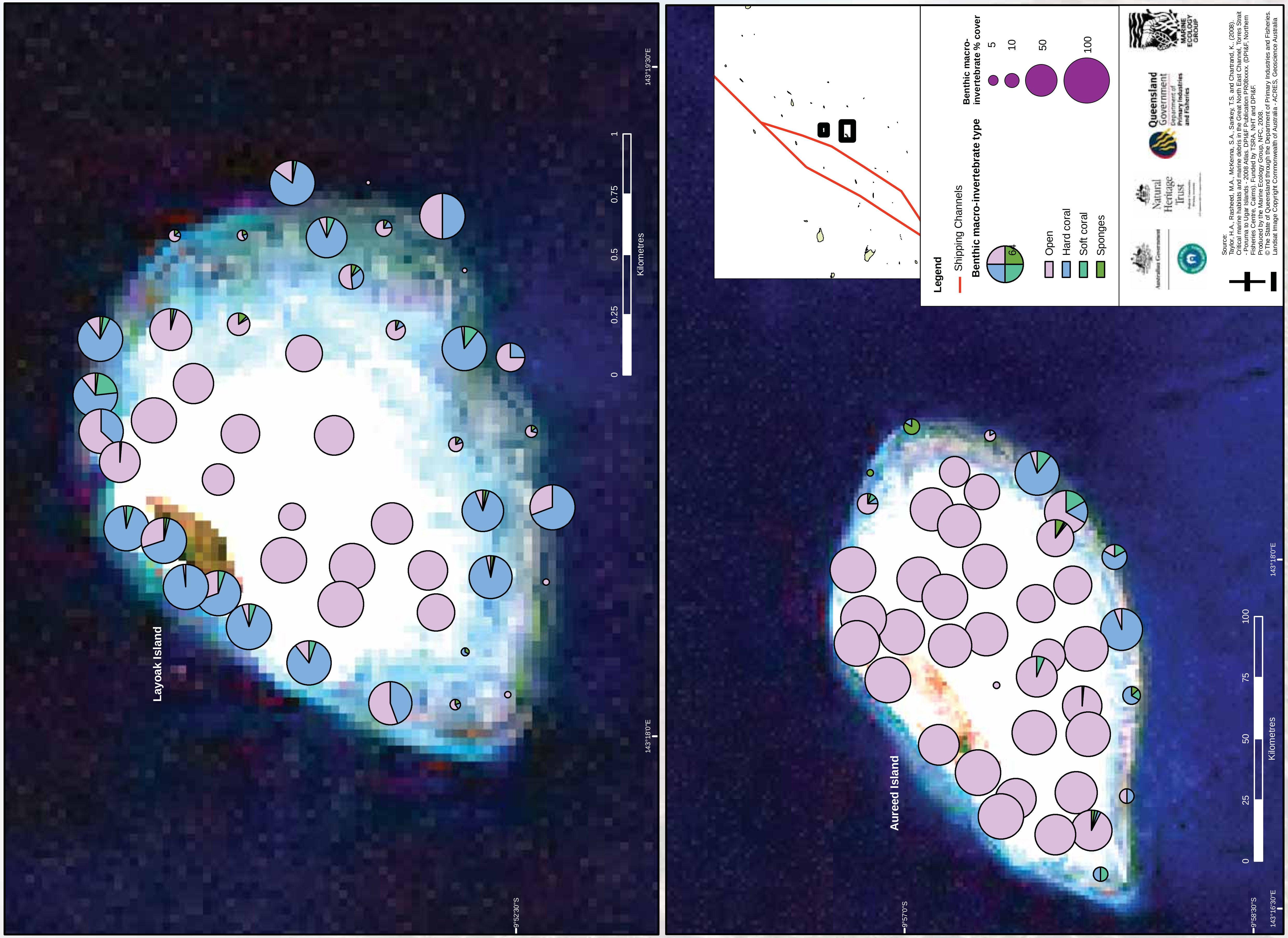
Map 23. Benthic macro-invertebrate distribution and abundance for sites on Layoak Island and Aureed Island, Torres Strait, February 2008



Source:
Taylor, H.A., Rasheed, M.A., McKenna, S.A., Sankey, T.S. and Chartrand, K.. (2008). Critical marine habitats and marine debris in the Great North East Channel, Torres Strait - Poruma to Ugar Islands - 2008 Atlas. DPI&F Publication PR08xxxx. (DPI&F, Northern Fisheries Centre, Cairns). Funded by TSRA, NHT and DPI&F.
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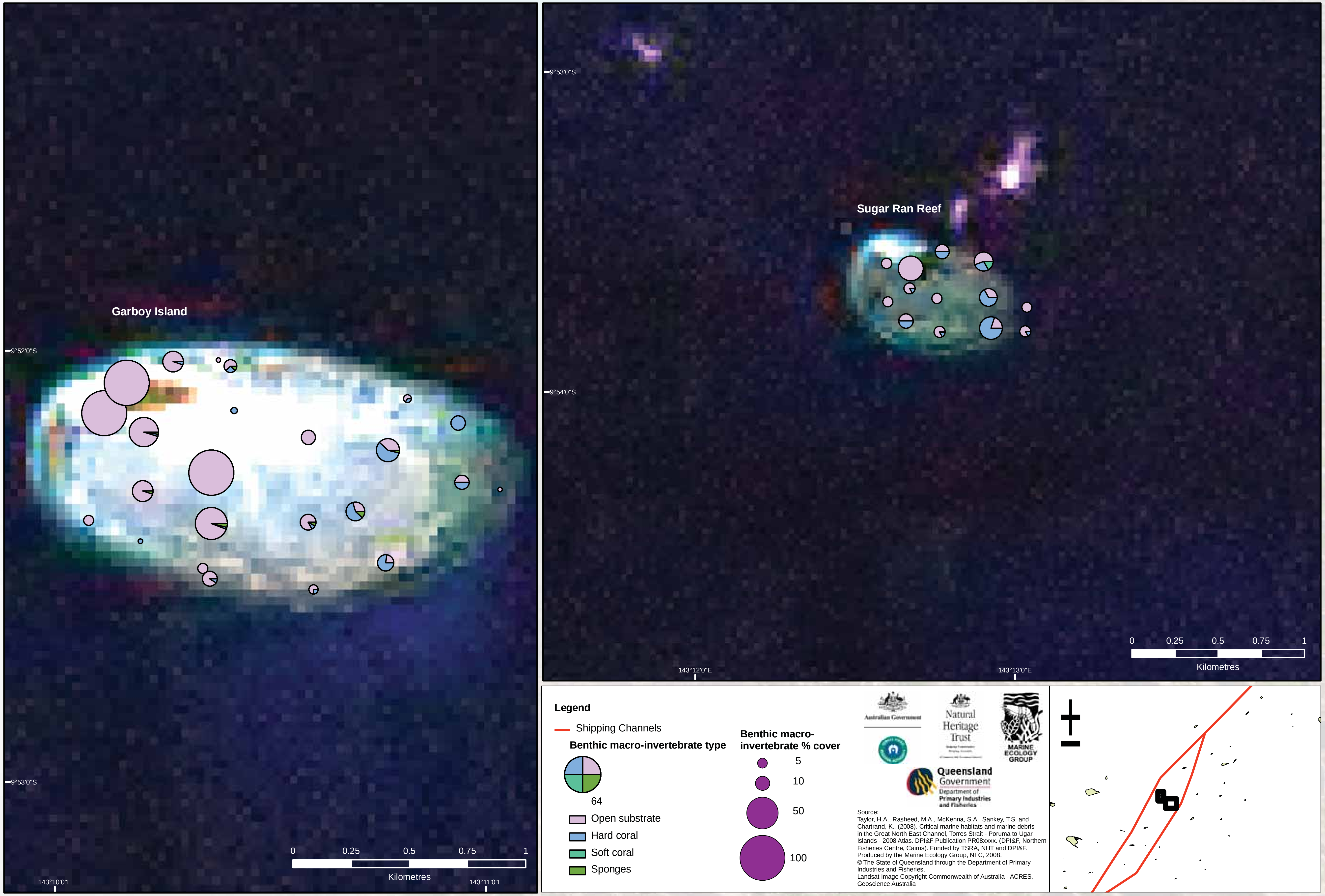
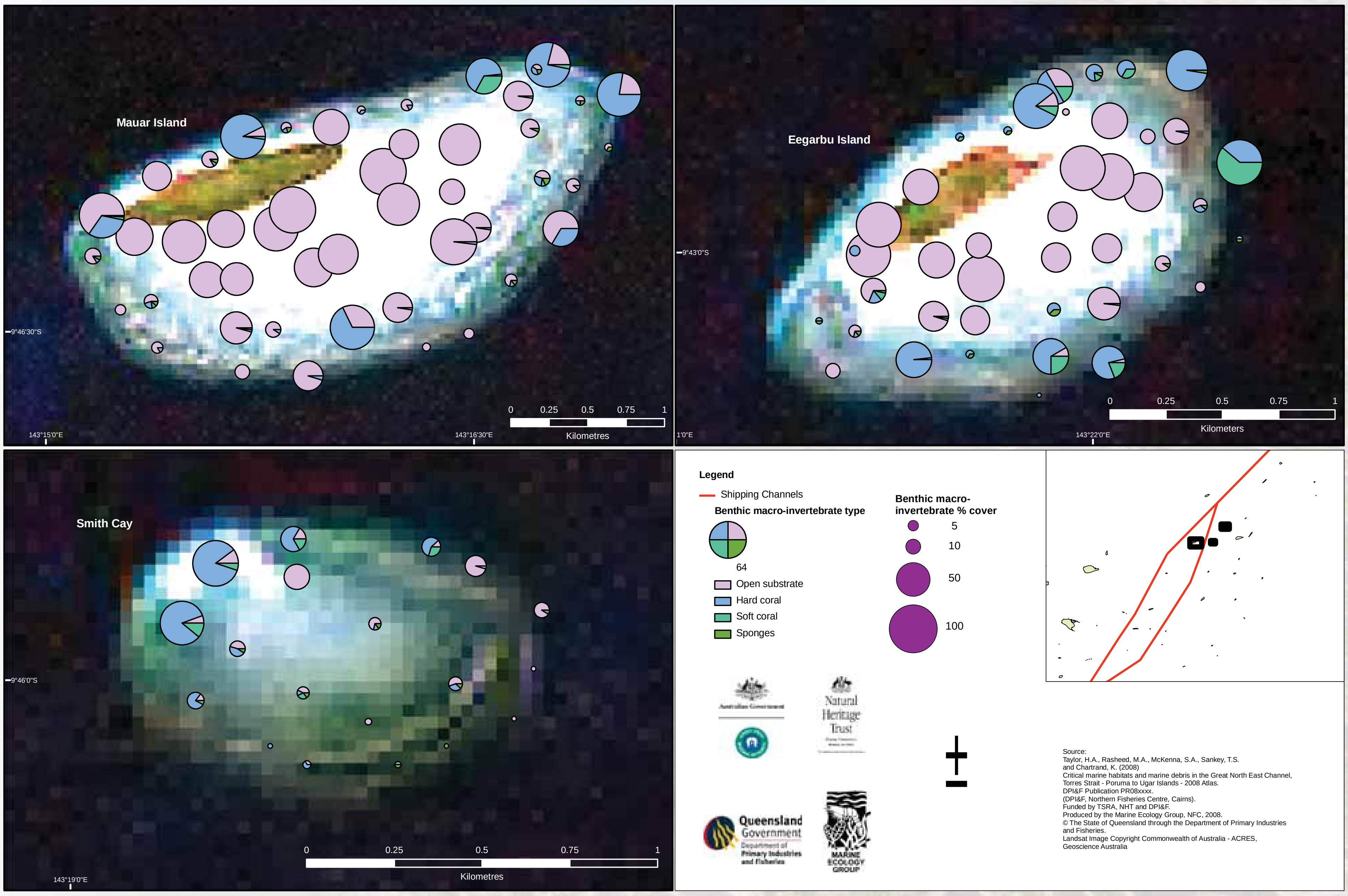
## Map 24. Benthic macro-invertebrate distribution and abundance for sites on Garboy Island and Sugar Ran Reef, Torres Strait, February 2008



Source:
Taylor, H.A., Rasheed, M.A., McKenna, S.A., Sankey, T.S. and Chartrand, K.. (2008). Critical marine habitats and marine debris in the Great North East Channel, Torres Strait - Poruma to Ugar Islands - 2008 Atlas. DPI&F Publication PR08xxxx. (DPI&F, Northern Fisheries Centre, Cairns). Funded by TSRA, NHT and DPI&F.
Produced by the Marine Ecology Group, NFC, 2008.

Map 25. Benthic macro-invertebrate distribution and abundance for sites on Mauar Island, Eegarbu Island and Smith Cay, Torres Strait, February 2008



Source:
Taylor, H.A., Rasheed, M.A., McKenna, S.A., Sankey, T.S.
and Chartrand, K. (2008)
Critical marine habitats and marine debris in the Great North East Channel,
Torres Strait - Poruma to Ugar Islands - 2008 Atlas.
DPI&F Publication PR08xxxx.
(DPI&F, Northern Fisheries Centre, Cairns).
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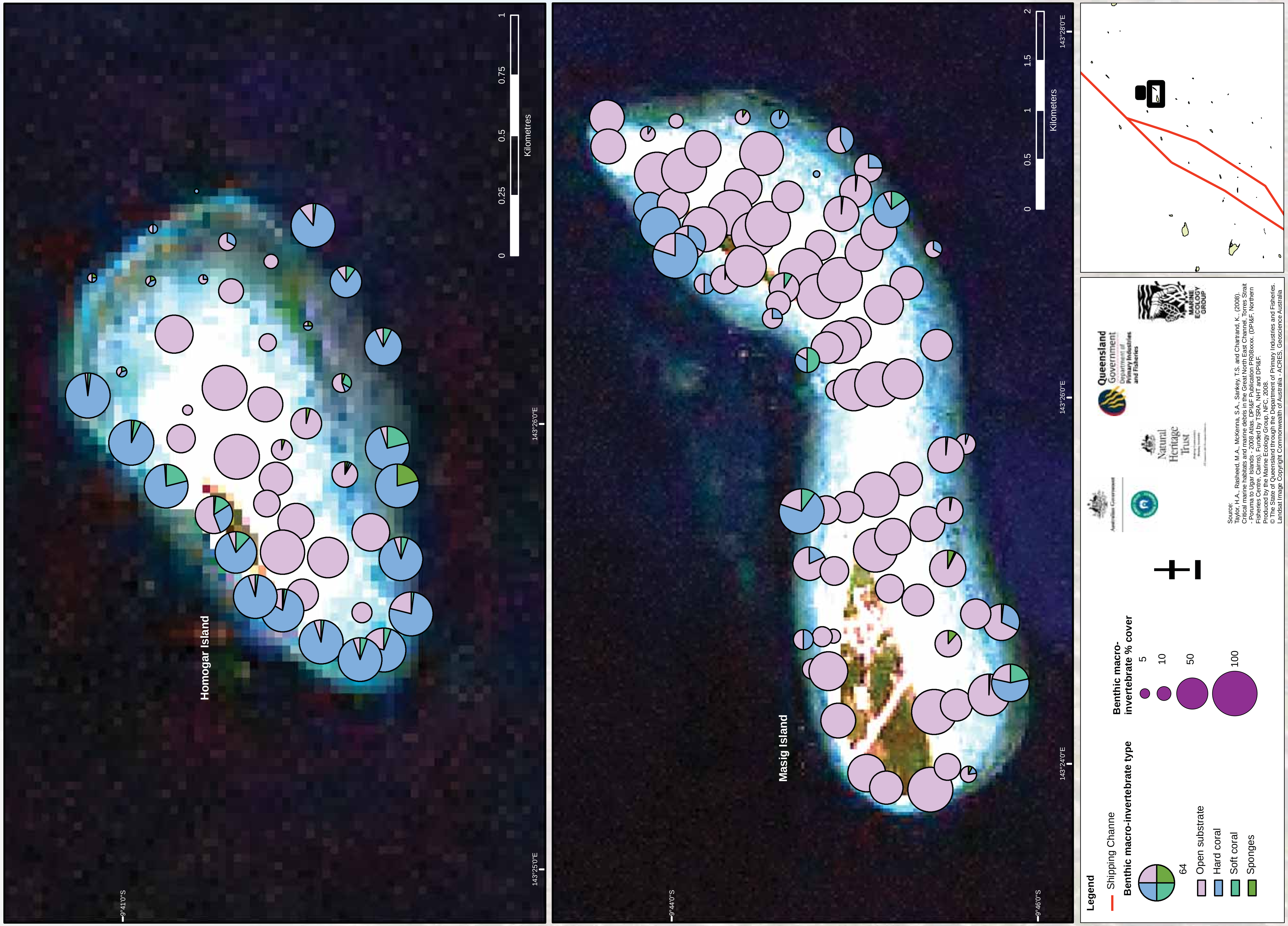
Map 26. Benthic macro-invertebrate distribution and abundance for sites on Homogar Island and Masig Island, Torres Strait, February 2008



Source:
Taylor, H.A., Rasheed, M.A., McKenna, S.A., Sankey, T.S. and Chartrand, K.. (2008).
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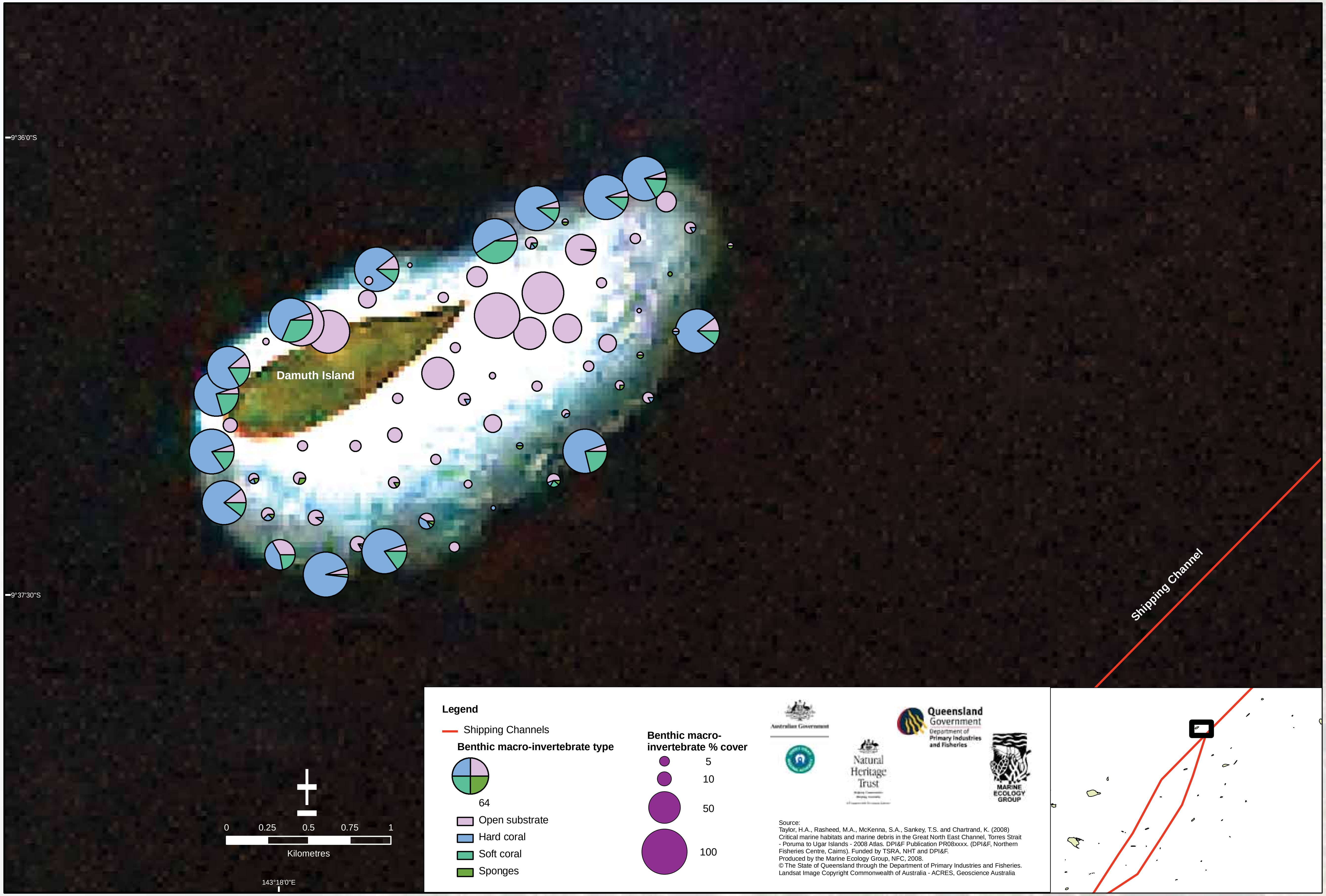
Map 27. Benthic macro-invertebrate distribution and abundance for sites on Damuth Island, Torres Strait, February 2008



Source:
Taylor, H.A., Rasheed, M.A., McKenna, S.A., Sankey, T.S. and Chartrand, K. (2008) Critical marine habitats and marine debris in the Great North East Channel, Torres Strait - Poruma to Ugar Islands - 2008 Atlas. DPI&F Publication PR08xxxx. (DPI&F, Northern Fisheries Centre, Cairns). Funded by TSRA, NHT and DPI&F.
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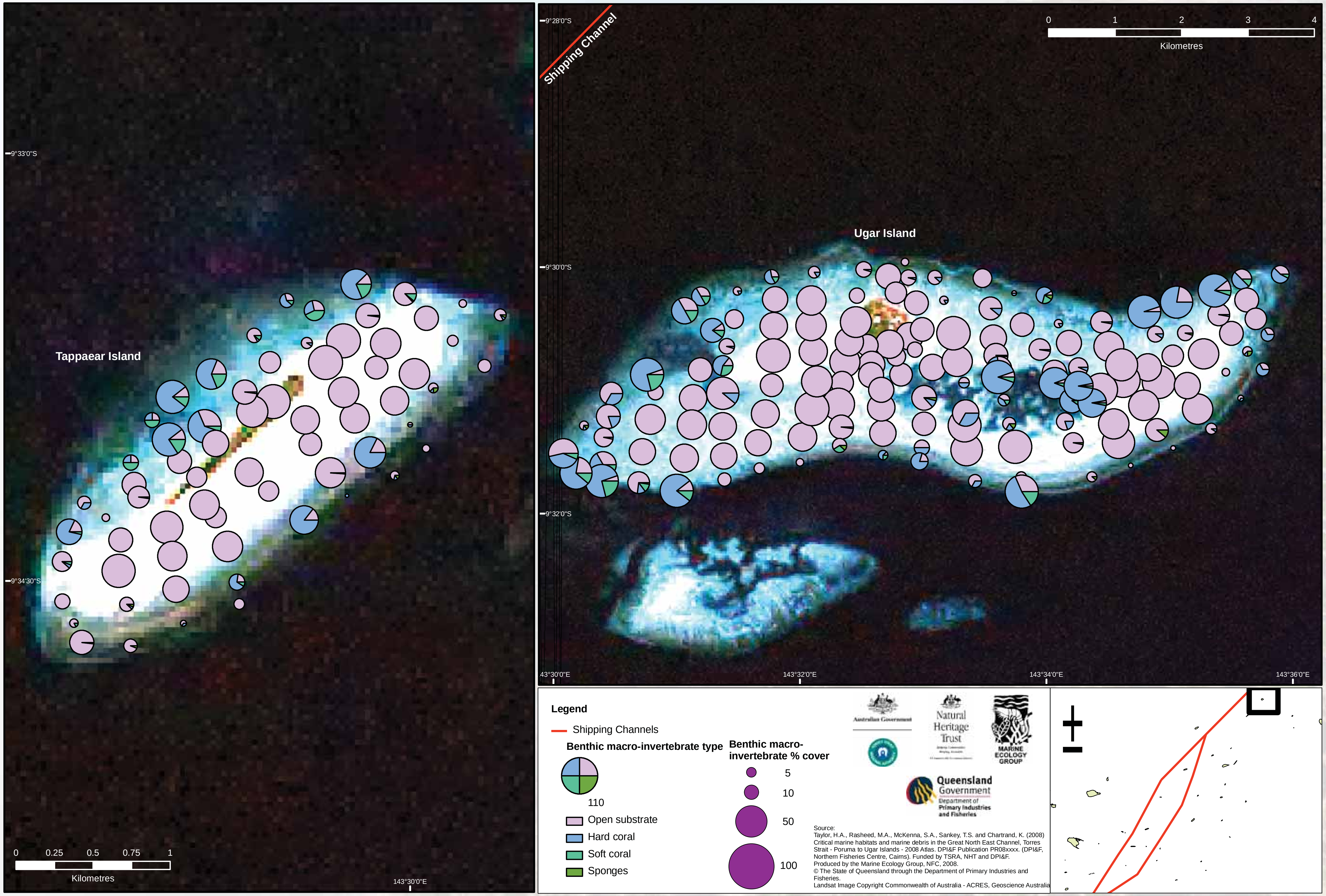
Map 28. Benthic macro-invertebrate distribution and abundance for sites on Tappoear Island and Ugar Island, Torres Strait, February 2008



Source:
Taylor, H.A., Rasheed, M.A., McKenna, S.A., Sankey, T.S. and Chartrand, K. (2008) Critical marine habitats and marine debris in the Great North East Channel, Torres Strait - Poruma to Ugar Islands - 2008 Atlas. DPI&F Publication PR08xxxx. (DPI&F, Northern Fisheries Centre, Cairns). Funded by TSRA, NHT and DPI&F.
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## Conclusions and Risk Assessment

This atlas documents the incidence of marine debris and ecologically and economically valuable intertidal marine habitats occurring adjacent to a section of the Great North East shipping channel and Inner Island Cluster (marine debris only) in the Torres Strait. In this survey a large amount of marine debris was found, particularly around the Inner Island Cluster and extensive areas of seagrass, algae and benthic macro-invertebrate (BMI) habitats were identified in proximity to the shipping channel. 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 area is also recognised as having a particularly high risk of shipping accidents as reef areas are in very close proximity to the 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 this survey into three distinct categories of impact risk from shipping accidents. The categories were based on habitats biological susceptibility to oils and habitat quality (Table 5; Map 29-36). While all of the intertidal area could be considered at risk, 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 risk by applying the known information on recovery rates and susceptibility to oil damage (Table 5). From this, a risk matrix that also accounted for density of habitat types was applied and regions were assigned into habitat risk categories: low risk, moderate risk and high risk (Table 5). This information was overlaid onto the risk maps. Almost all intertidal areas were mapped into these categories, however areas that contained purely open substrate were occasionally ommitted as they are at very low risk to shipping accidents and oil spills.

Table 5 Risk matrix for major habitat types for the Great North East Shipping Channels.

| 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 (EA, TH, CR)* | M | H | H | H | H |
| | Fast growing, short recovery time (HO, HUN)* | 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 |

* EA - *E. acoroides*; TH - *T. hemprichii*; CR - *C. rotundata*;
HO - *H. ovalis*; HUN - *H. uninervis* (thin)


Sea star and *Thalassia hemprichii* on open sandy substrate


Surveying from the helicopter on Poruma Island

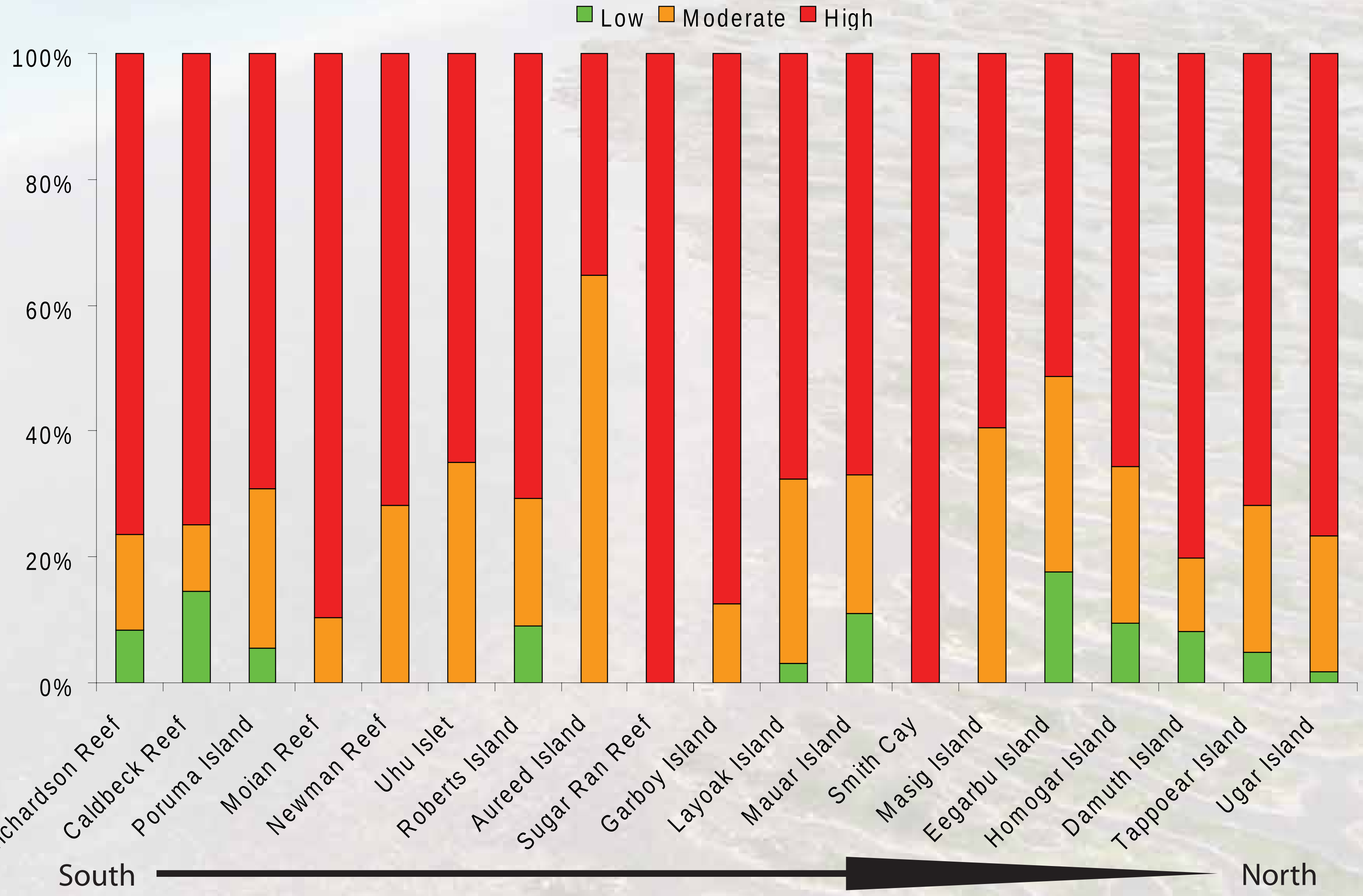
## Conclusions and Risk Assessment continued...

The application of the risk matrix resulted in 75% of the intertidal areas in the survey area being at high risk from shipping accidents and oil spills (Figure 6; Maps 29-36). Most reefs and islands surveyed contained areas of all three risk categories, however Sugar Ran Reef and Smith Cay were 100% high risk (Maps 32 & 33) while Aureed and Eegarbu Islands consisted of large areas of lower risk areas (Maps 31 & 33). In most cases, high risk areas were those that retained shallow pools of water during low tide events with higher algal cover, seagrass and BMI, whereas fully exposed areas were typically at moderate or low risk due to lower biomass.

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 risk" 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 Great North East Shipping Channel has a high frequency of shipping traffic, complex navigation through reef and island habitat and has highly diverse marine habitat with only limited previously available information. It stretches over 120km through the Torres Strait, however only a small section of the channel has been surveyed to date. It is anticipated that further surveys in 2009 will ensure that most, if not all, of the GNE Channel is investigated with this information to 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.

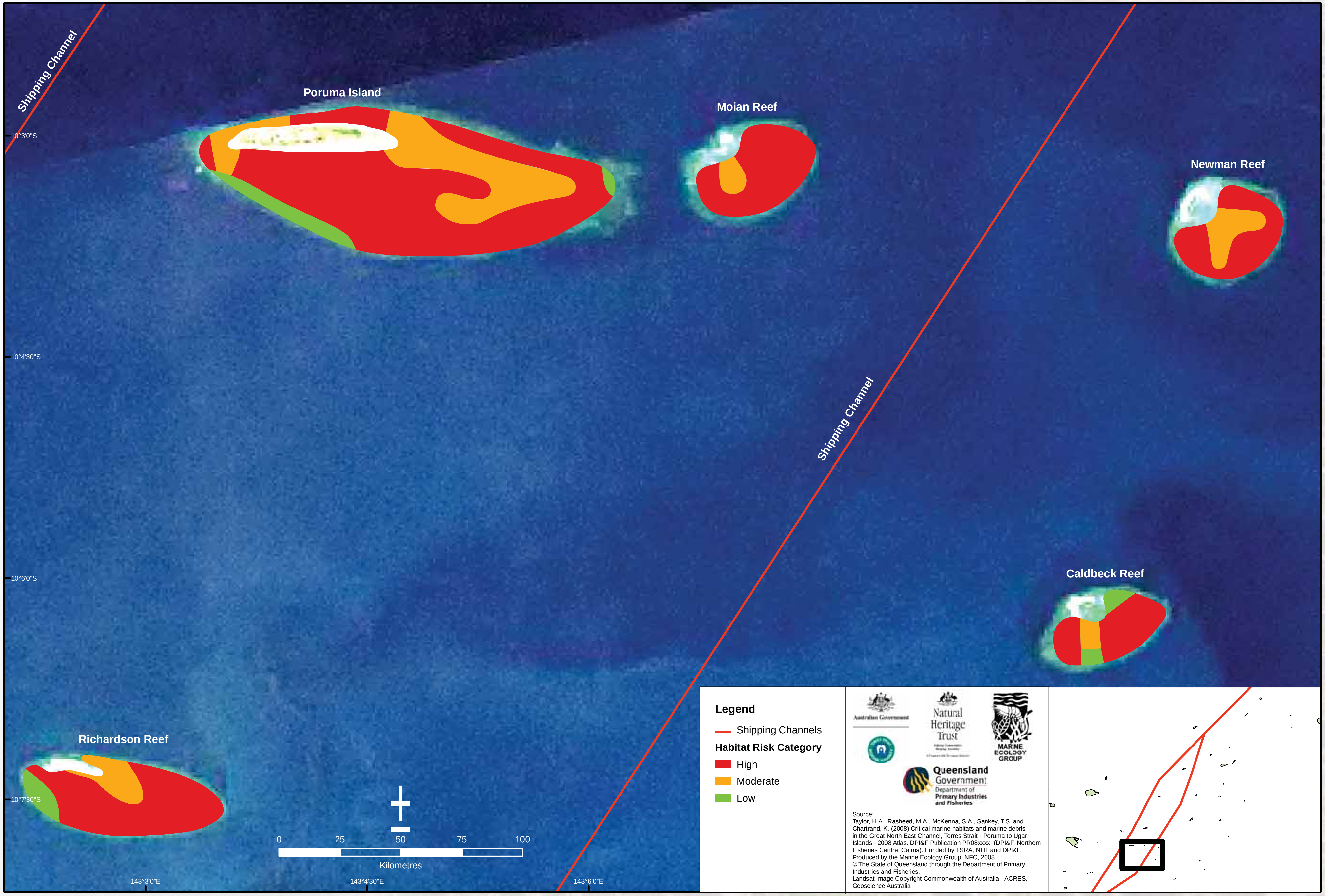
**Figure 6** Habitat risk category (percent) for intertidal islands and reefs in the Torres Strait survey area, 2008



Ship passing through the GNE Channel

Surveying from the helicopter on Ugar Island

Map 29. Habitat Risk Categories on Poruma Island, Moian Reef, Caldbeck Reef and Richardson Island, Torres Strait, February 2008



Source:
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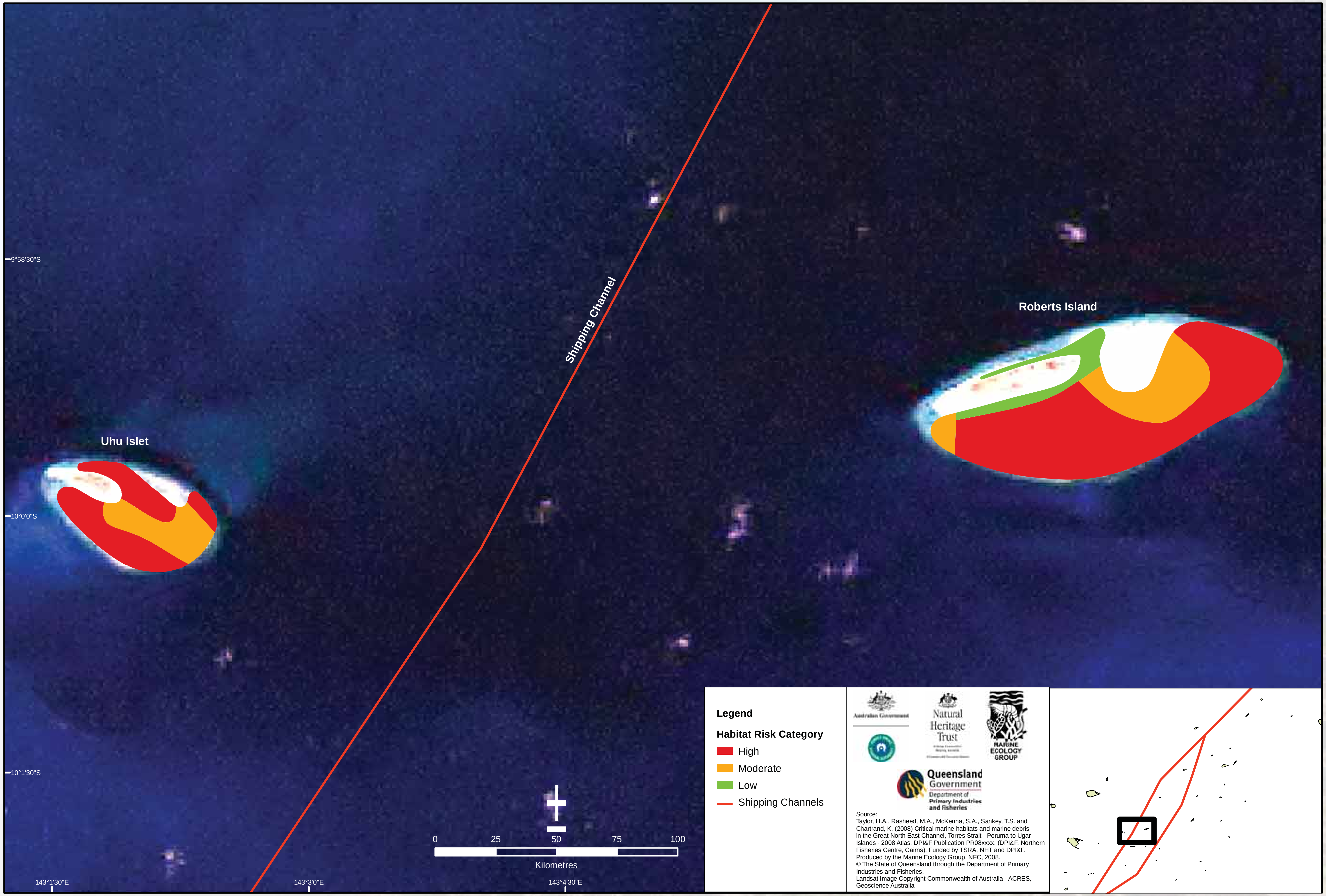
Map 30. Habitat Risk Categories on Uhu Islet and Roberts Island, Torres Strait, February 2008



Source:
Taylor, H.A., Rasheed, M.A., McKenna, S.A., Sankey, T.S. and Chartrand, K. (2008) Critical marine habitats and marine debris in the Great North East Channel, Torres Strait - Poruma to Ugar Islands - 2008 Atlas. DPI&F Publication PR08xxxx. (DPI&F, Northern Fisheries Centre, Cairns). Funded by TSRA, NHT and DPI&F.
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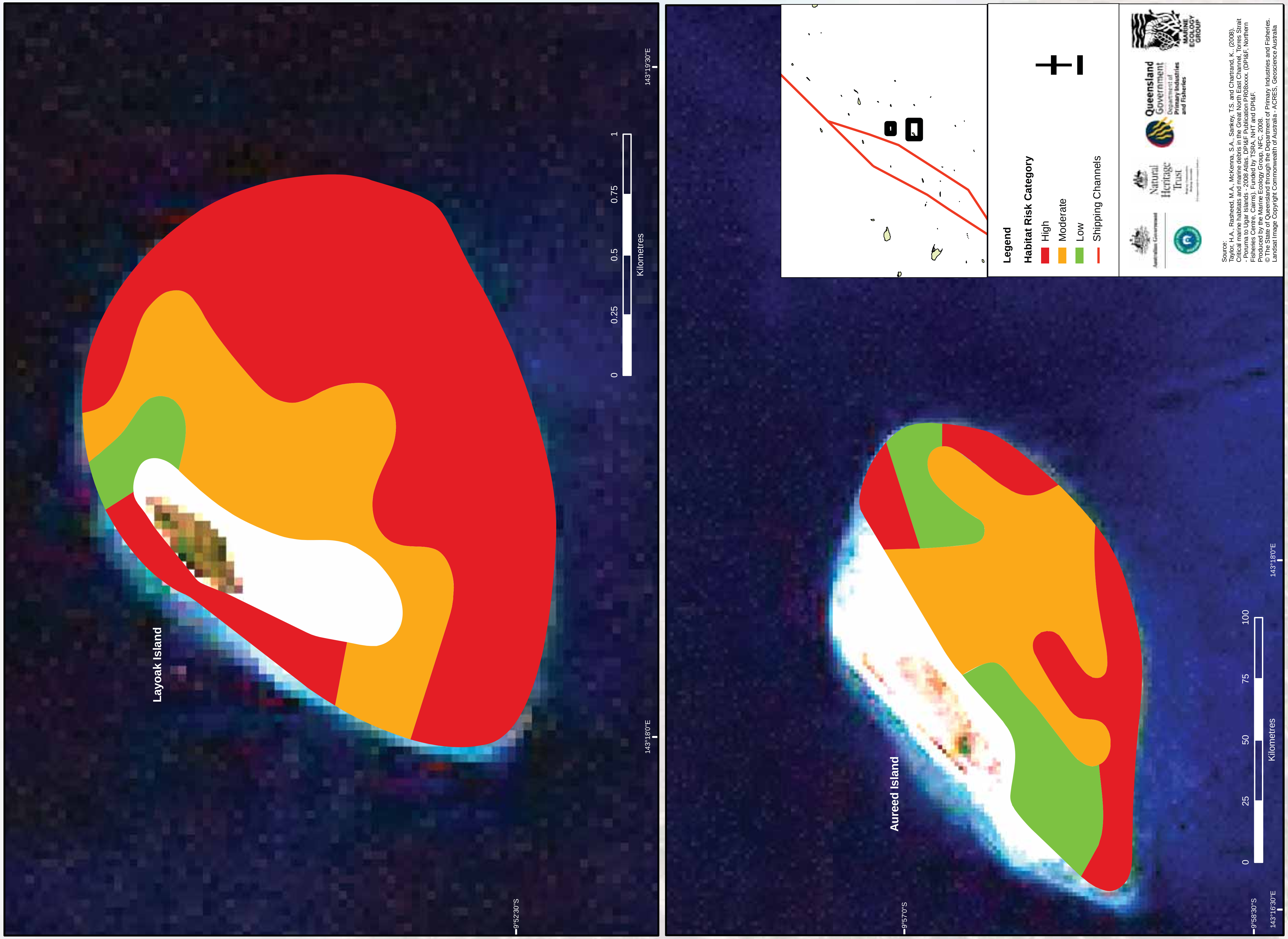
Map 31. Habitat Risk Categories on Layoak Island and Aureed Island, Torres Strait, February 2008



Source:
Taylor, H.A., Rasheed, M.A., McKenna, S.A., Sankey, T.S. and Chartrand, K.. (2008).
Critical marine habitats and marine debris in the Great North East Channel, Torres Strait - Poruma to Ugar Islands - 2008 Atlas. DPI&F Publication PR08xxxx. (DPI&F, Northern Fisheries Centre, Cairns). Funded by TSRA, NHT and DPI&F.
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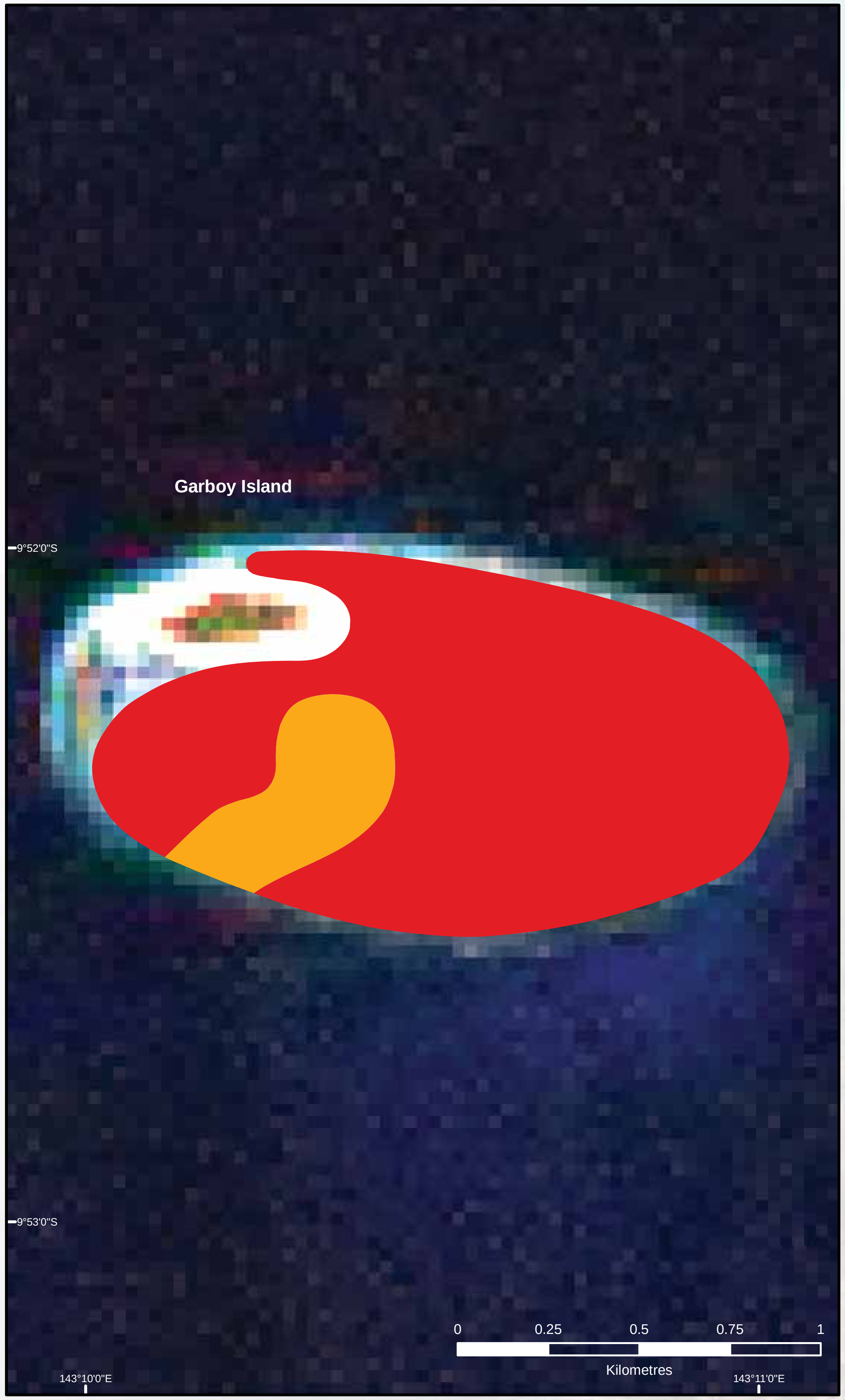
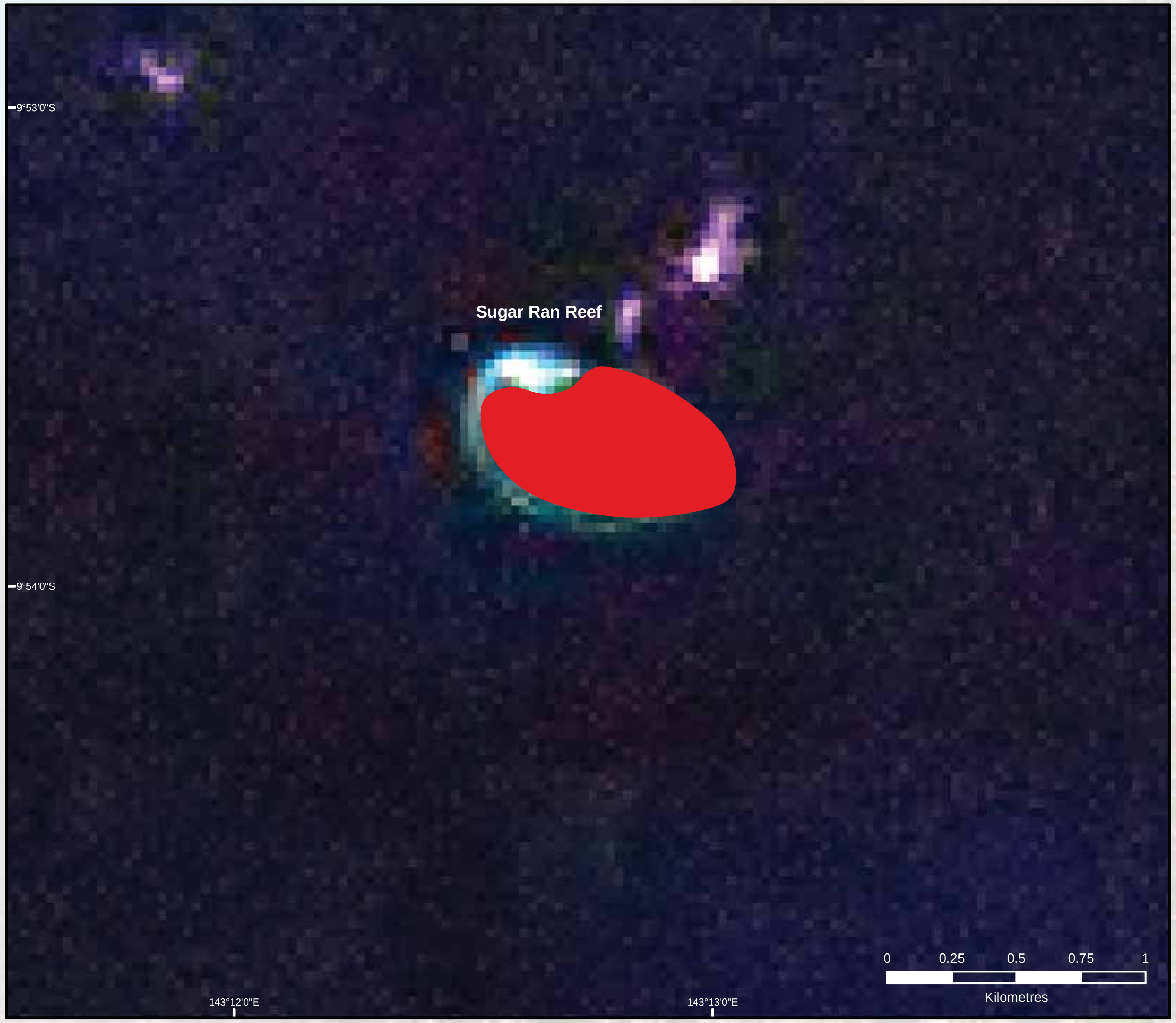
## Map 32. Habitat Risk Categories on Garboy Island and Sugar Ran Reef, Torres Strait, February 2008



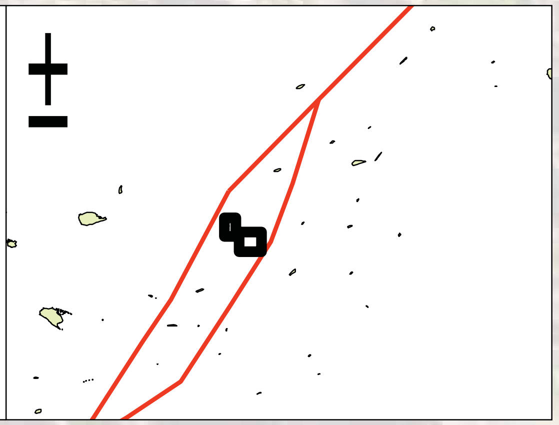


**Legend**

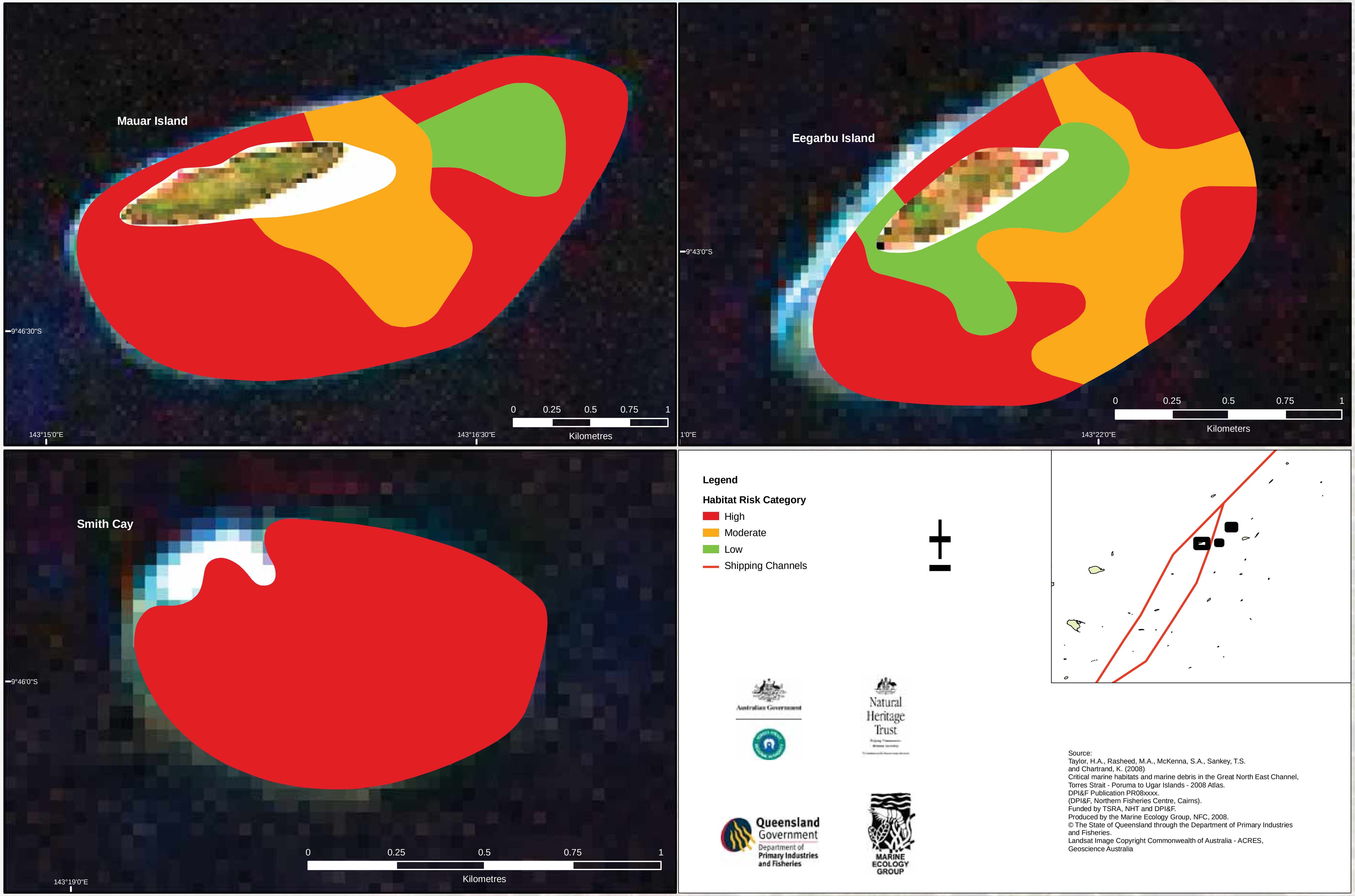
**Habitat Risk Category**

🟥 High
🟧 Moderate
🟩 Low
— Shipping Channels

Source:
Taylor, H.A., Rasheed, M.A., McKenna, S.A., Sankey, T.S. and Chartrand, K.. (2008). Critical marine habitats and marine debris in the Great North East Channel, Torres Strait - Poruma to Ugar Islands - 2008 Atlas. DPI&F Publication PR08xxxx. (DPI&F, Northern Fisheries Centre, Cairns). Funded by TSRA, NHT and DPI&F.
Produced by the Marine Ecology Group, NFC, 2008.

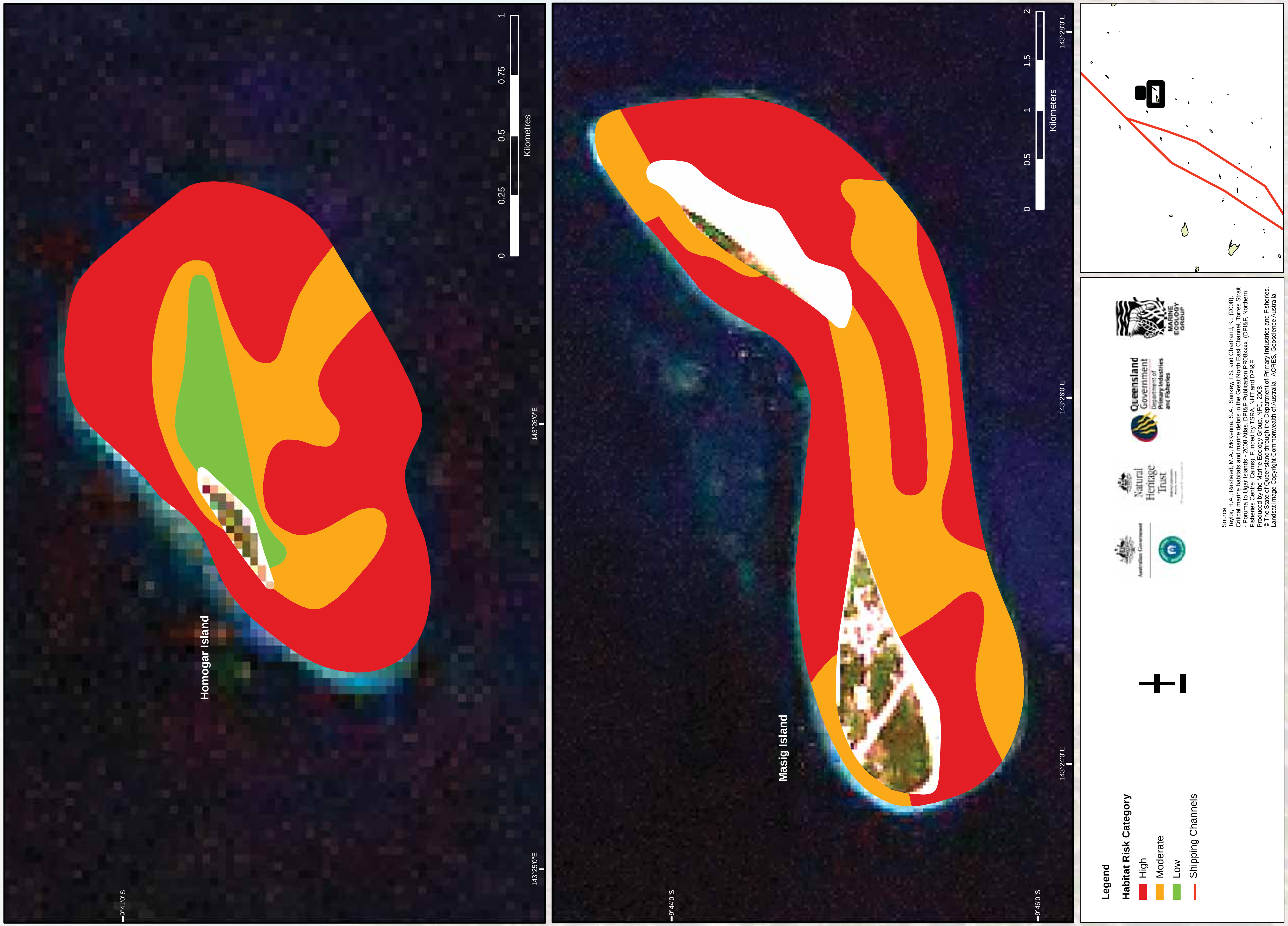


## Map 33. Habitat Risk Categories on Mauar Island, Eegarbu Island and Smith Cay, Torres Strait, February 2008



Source:
Taylor, H.A., Rasheed, M.A., McKenna, S.A., Sankey, T.S.
and Chartrand, K. (2008)
Critical marine habitats and marine debris in the Great North East Channel,
Torres Strait - Poruma to Ugar Islands - 2008 Atlas.
DPI&F Publication PR08xxxx.
(DPI&F, Northern Fisheries Centre, Cairns).
Funded by TSRA, NHT and DPI&F.
Produced by the Marine Ecology Group, NFC, 2008.

Map 34. Habitat Risk Categories on Homogar Island and Masig Island, Torres Strait, February 2008



Source:
Taylor, H.A., Rasheed, M.A., McKenna, S.A., Sankey, T.S. and Chartrand, K.. (2008).
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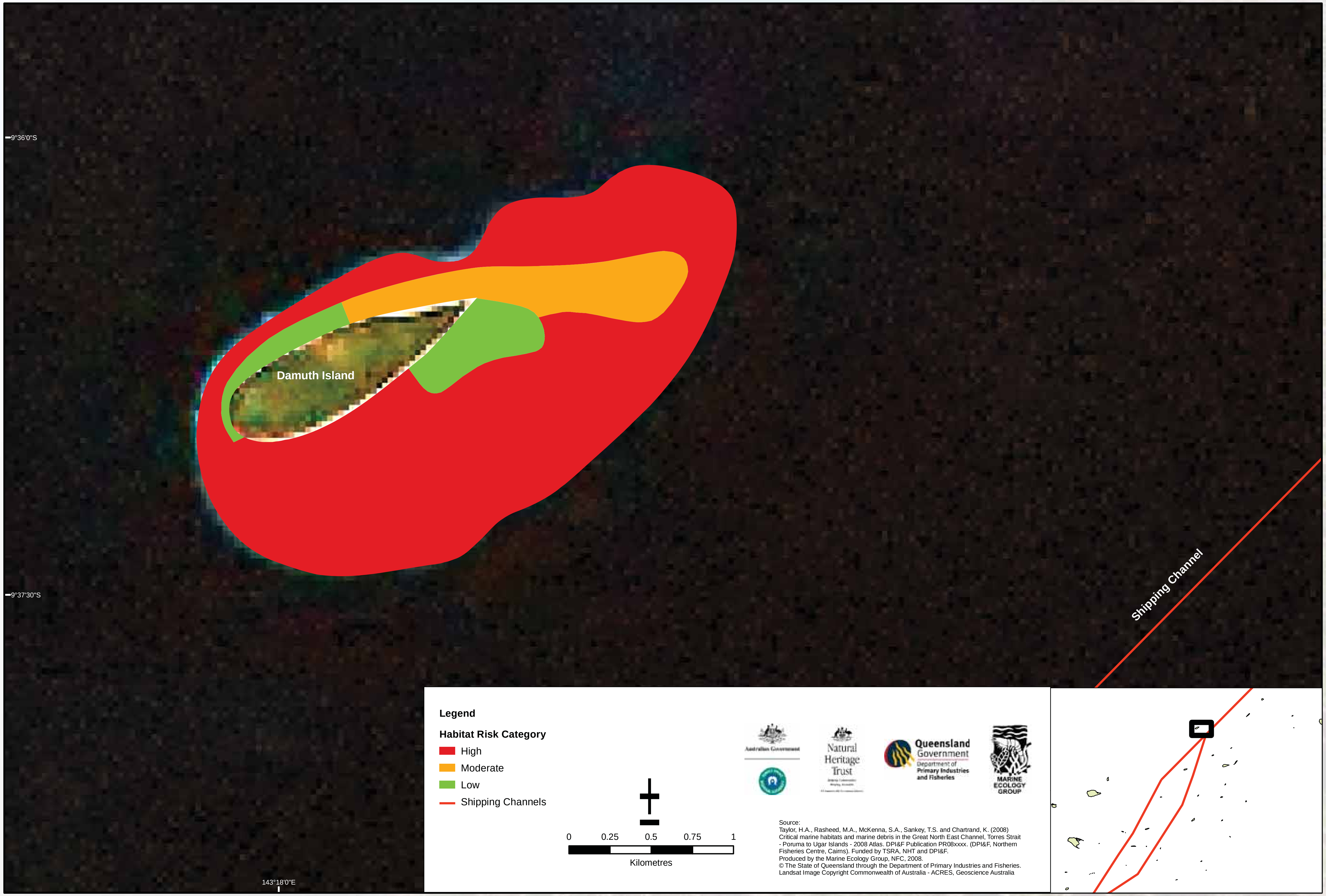
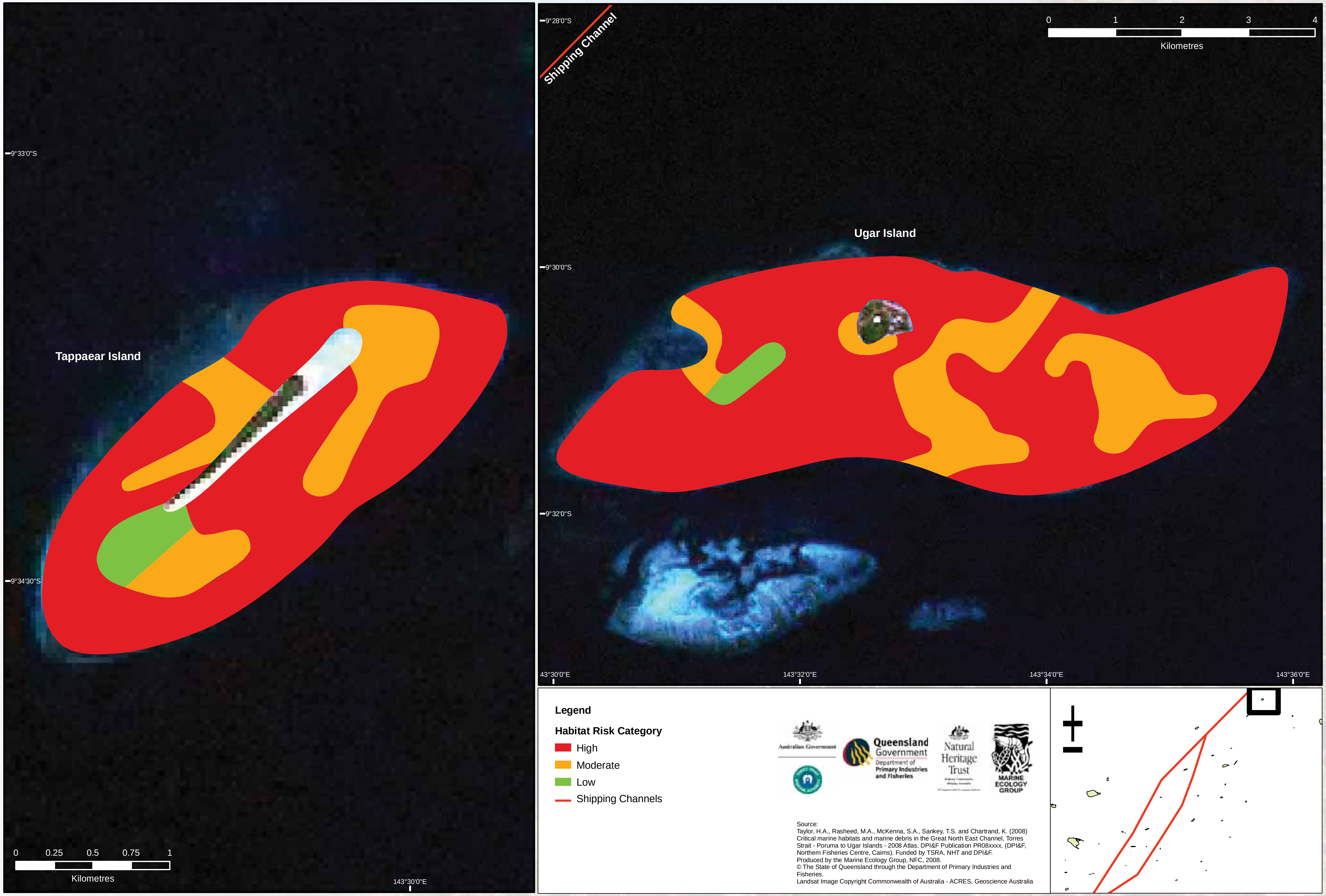
## Map 35. Habitat Risk Categories on Damuth Island, Torres Strait, February 2008



Source:
Taylor, H.A., Rasheed, M.A., McKenna, S.A., Sankey, T.S. and Chartrand, K. (2008) Critical marine habitats and marine debris in the Great North East Channel, Torres Strait - Poruma to Ugar Islands - 2008 Atlas. DPI&F Publication PR08xxxx. (DPI&F, Northern Fisheries Centre, Cairns). Funded by TSRA, NHT and DPI&F.
Produced by the Marine Ecology Group, NFC, 2008.

Map 36. Habitat Risk Categories on Tappoear Island and Ugar Island, Torres Strait, February 2008



**Legend**

**Habitat Risk Category**

- 🟥 High
- 🟧 Moderate
- 🟩 Low
- — Shipping Channels

Source:
Taylor, H.A., Rasheed, M.A., McKenna, S.A., Sankey, T.S. and Chartrand, K. (2008) Critical marine habitats and marine debris in the Great North East Channel, Torres Strait - Poruma to Ugar Islands - 2008 Atlas. DPI&F Publication PR08xxxx. (DPI&F, Northern Fisheries Centre, Cairns). Funded by TSRA, NHT and DPI&F.
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