EASTERN TORRES STRAIT INTERTIDAL BENTHIC SURVEY:

UGAR, CAMPBELL AND NEPEAN ISLANDS

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Acknowledgments

We acknowledge the Traditional Owners of the Sea Country on which this research took place, and pay our respects to Elders past, present and future. We honour their continuing culture, knowledge, beliefs and spiritual relationship and connection to Country. We also recognise Aboriginal and Torres Strait Islander peoples as the Traditional Owners of the land and sea, and as Australia's first scientists.

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Acronyms

Benthic macro-invertebrate (BMI)

Geographic Information System (GIS)

Grams dry weight per square metre (g DW m-2)

Inverse distance weighted (IDW)

James Cook University (JCU)

Land and Sea Management Unit (LSMU)

Northern Great Barrier Reef (nGBR)

Reliability estimate (R)

Standard error (SE)

The Centre for Tropical Water & Aquatic Ecosystem Research (TropWATER)

Torres Strait Regional Authority (TSRA)

EXECUTIVE SUMMARY

- Torres Strait's Eastern Cluster is an ecologically important region in the traditional land and sea country of the Kemer Kemer Meriam Nation. The area contains important seagrass foraging grounds for green turtles, and the most important green turtle rookeries in Torres Strait for the northern Great Barrier Reef population. Seagrass meadows also provide food for dugong, and habitat for sea cucumbers that are an important fisheries resource in the region.
- This report describes a large-scale survey in March 2022 of reef-top and island intertidal benthic habitats, including seagrass, algae and coral at Ugar, Nepean and Campbell Islands and surrounding reefs.
- 1604 $\pm$ 260 hectares of intertidal seagrass was mapped across seven intertidal meadows. Ugar Island (Stephens) had the largest meadow (1397 $\pm$ 222 hectares) with the highest biomass and species diversity. The six smaller, low biomass meadows occurred on reef-tops close to Ugar, and at Nepean and Campbell Islands.
- Seven seagrass species were recorded during the survey, but most meadows were dominated by two common reef-associated species *Thalassia hemprichii* and *Cymodocea rotundata*.
- The meadows are similar in area and species composition to surveys conducted 13 years prior, which indicates the region's intertidal meadows provide a relatively stable habitat and foraging ground for marine herbivores.
- Extensive algae habitat and coral communities were also mapped. Erect macrophyte algae was the dominant algae community. Hard coral cover was as high as 90% at some survey sites.
- Seagrass information presented in this report is available on eAtlas (eatlas.org.au) and can be used to inform the Ugaram Dugong and Turtle Management Plans.

We recommend the establishment of long-term, meadow-scale monitoring at Ugar Island to improve condition assessments and management of seagrass and other benthic habitats in the Kemer Kemer Meriam Nation.

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INTRODUCTION

Extensive seagrass meadows flourish in intertidal and shallow subtidal waters in Torres Strait, home to some of the greatest seagrass species diversity in the Indo-Pacific (Carter et al. 2014b; Coles et al. 2003; Poiner and Peterkin 1996) (Figure 1). Seagrass meadows provide numerous ecosystem services, including food for megaherbivores (e.g. dugong and green turtle), macroherbivores (e.g. fish and urchins) and mesoherbivores (e.g. amphipods and gastropods) and a detrital food chain for sea cucumbers (Floren et al. 2021; Scott et al. 2018). In Torres Strait, seagrass provides food for the largest dugong population in the world (Marsh et al. 2011) and a globally significant green turtle population (Miller and Limpus 1991), and habitat that supports important fisheries including sea cucumbers (TSRA 2016). Dugong and green turtle have high conservation value as listed species under the *Environment Protection and Biodiversity Conservation Act* (1999), and immense cultural and spiritual significance as cultural keystone species for Torres Strait Islanders (Butler et al. 2012). The sea cucumber fishery is an important, high economic value resource for the Torres Strait Islanders (Dutra et al. 2021). Sea cucumbers play an important role as bioturbators, improving sediment within the seagrass meadow (Floren et al. 2021).

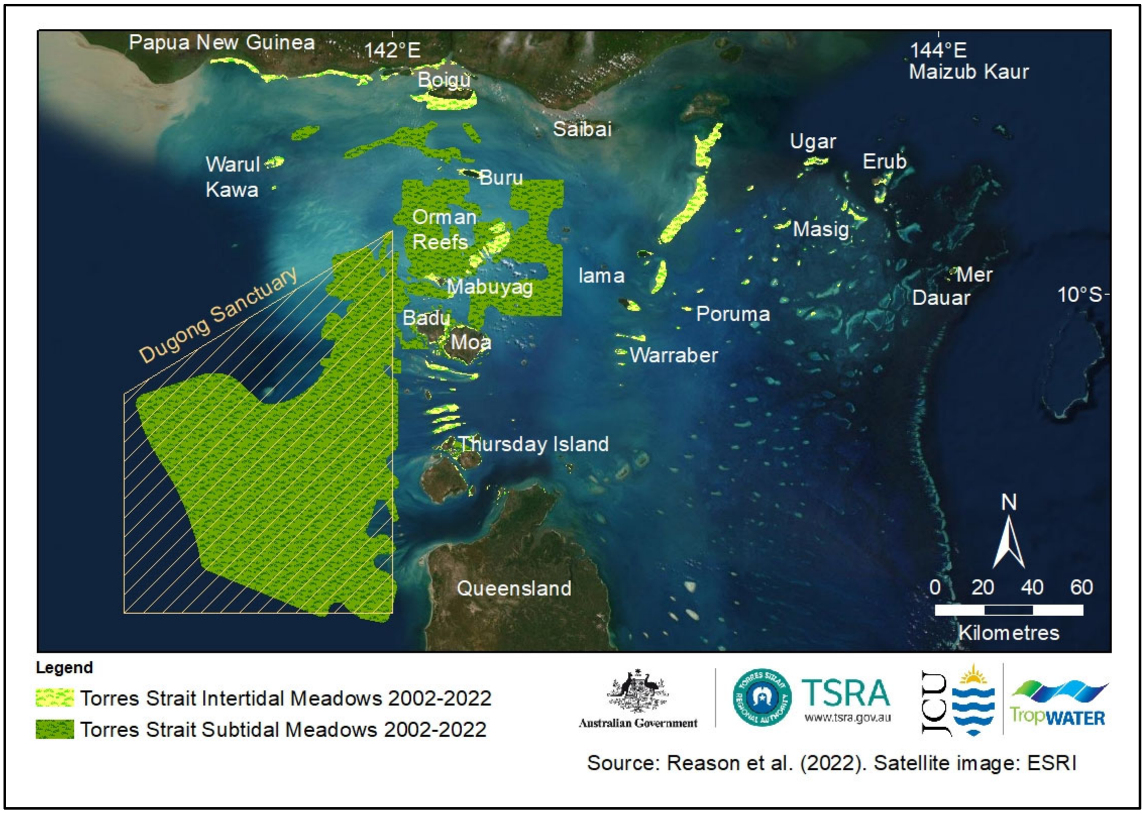

FIGURE 1. INTERTIDAL AND SUBTIDAL SEAGRASS MEADOWS MAPPED ACROSS TORRES STRAIT, 2002-2022.

Torres Strait's Ugar, Campbell and Nepean Islands are part of an ecologically important region in the traditional land and sea country of the Kemer Kemer Meriam Nation in eastern Torres Strait. The Eastern Cluster includes the inhabited islands of Mer (Murray), Erub (Darnley) and Ugar (Stephen), Dauar and Waier Islands south of Mer, and Maizub Kaur (Bramble Cay) in the north. Maizub Kaur and Dauar Island are the most important rookeries for the northern Great Barrier Reef (nGBR) green turtle population in Torres Strait (4Seas Environmental Consulting 2020), making eastern Torres Strait seagrass meadows potentially important foraging grounds. The region also is a likely thermal refuge for coral reefs due to tidally induced upwelling along the continental shelf near Mer Island (Bainbridge et al. 2015). The reefs and seagrass meadows throughout the Eastern Cluster, including around Ugar, Campbell and Nepean Islands, provide important habitat for sea cucumbers which in turn supports seagrass productivity (Wolkenhauer et al. 2010).

The Centre for Tropical Water & Aquatic Ecosystem Research (TropWATER), in collaboration with the Torres Strait Regional Authority (TSRA) Land and Sea Management Unit (LSMU), have been mapping and monitoring Torres Strait seagrass since 2002 (Carter et al. 2014b) (Figure 1). Large-scale intertidal mapping surveys at Ugar, Campbell, Nepean and Erub Islands and surrounding reefs were undertaken between 2008 and 2009 (Taylor et al. 2009; Taylor et al. 2008), but there remained a large gap in seagrass mapping in the far eastern region surrounding and including Mer Island. To remedy this, a large-scale intertidal mapping exercise of the Eastern Cluster was undertaken by TropWATER and TSRA in September 2020 to update benthic habitat maps for previously surveyed areas, and to map new areas (Carter et al. 2021b). Tide restrictions prevented a survey of all islands at that time, and Ugar, Campbell and Nepean Islands were identified as priority areas for a future survey. This is because assessing and managing Torres Strait seagrass and the important species that rely on these meadows requires current information on seagrass presence/absence, seagrass biomass, species composition, and meadow area, plus ongoing monitoring to understand variation over time and detect seagrass change. Our objectives for this survey were to:

(1) Conduct large-scale benthic habitat assessments and mapping of the intertidal reef-tops around Ugar, Campbell and Nepean Islands;
(2) Compare the 2022 survey results with historical seagrass data for these locations and with the 2020 survey of the Eastern Cluster; and
(3) Provide recommendations on the establishment of long-term monitoring.

METHODS

FIELD SURVEYS

TropWATER's approach for intertidal surveys is to sample entire exposed banks, reef-tops, and islands by helicopter. This allows for rapid surveys across large areas (Figure 2). Seagrass surveys in Torres Strait are largely conducted between September and March to incorporate the peak seagrass growing period and ensure data among years and other locations are comparable. The Ugar Island baseline survey was conducted in March 2022.

FIGURE 2. INTERTIDAL SITES WERE SURVEYED BY HELICOPTER.

SURVEY SITES

Intertidal sites were sampled while the helicopter maintained a low hover. At each site a visual estimate was made of percent cover of seagrass, benthic macro-invertebrates (BMI), algae, and open substrate within a 10m^2 circular area.

The following details were recorded at all sites:

1. Site number
2. Survey date
3. Latitude/longitude
4. Seagrass presence/absence
5. Seagrass above-ground biomass (total and for each species present)
6. Benthic habitat (percent cover of seagrass, algae functional groups, macro-invertebrate groups, and open substrate)
7. Sediment type
8. Sampling method
9. Relevant comments

SEAGRASS BIOMASS AND SPECIES COMPOSITION

Seagrass biomass and species composition was estimated in three replicate 0.25 m^2 quadrats placed randomly within each 10m^2 site (Figure 2). Seagrass biomass was determined using the "visual estimates of biomass" technique (Mellors 1991). This involves using trained observers to rank seagrass biomass within each quadrat while referring to a series of quadrat photographs of similar seagrass habitats where above-ground biomass was harvested and measured. Three separate biomass scales were used: low biomass, high biomass, and *Enhalus* biomass. The percent contribution of each seagrass species to total above-ground biomass within each quadrat was recorded.

At the completion of the survey each observer ranked a series of calibration quadrats. A linear regression was calculated of the relationship between the observer ranks and the harvested values. This regression was used to calibrate above-ground biomass estimates for all ranks made by that observer. Biomass ranks were then converted to above-ground biomass in grams dry weight per square metre (g DW m^{-2}). Site biomass (total and for each species) was calculated by averaging the biomass for the three replicate quadrats.

ALGAE GROUPS

Percent cover of algae was divided into five functional groups:

- Erect macrophyte – Macrophytic algae with an erect growth form and high level of cellular differentiation, e.g. *Sargassum*, *Caulerpa* and *Galaxaura* species (Figure 3a).
- Filamentous – Thin, thread-like algae with little cellular differentiation (Figure 3b).
- Encrusting – Algae that grows in sheet-like form attached to the substrate or benthos, e.g. coralline algae (Figure 3Figure 3c).
- Turf mat – Algae that forms a dense mat on the substrate (Figure 3d).
- Erect calcareous – Algae with erect growth form and high level of cellular differentiation containing calcified segments, e.g. *Halimeda* species (Figure 3e).

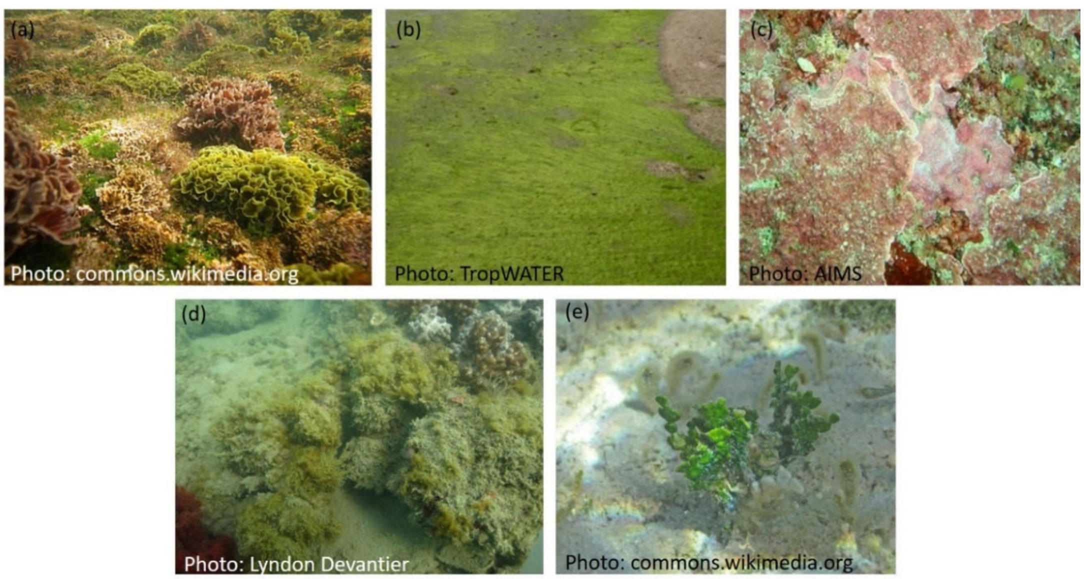

FIGURE 3. ALGAE FUNCTIONAL GROUPS (A) ERECT MACROPHYTE, (B) FILAMENTOUS, (C) ENCRUSTING, (D) TURF MAT AND (E) ERECT CALCAREOUS.

BENTHIC MACRO-INVERTEBRATES

At each site percent cover of benthic macro-invertebrates (BMI) and algae were recorded. Percent cover of benthic macro-invertebrates was divided into four broad taxonomic groups:

- Hard coral – All scleractinian corals including massive, branching, tabular, digitate and mushroom (Figure 4Figure 4a).
- Soft coral – All alcyonarian corals, i.e. corals lacking a hard limestone skeleton (Figure 4b).
- Sponge (Figure 4Figure 4c).

- Other BMI – Any other BMI identified, e.g. hydroid, ascidian, barnacle, oyster, and mollusc (Figure 4d). Other BMI are listed in the “comments” column of the GIS site layer.

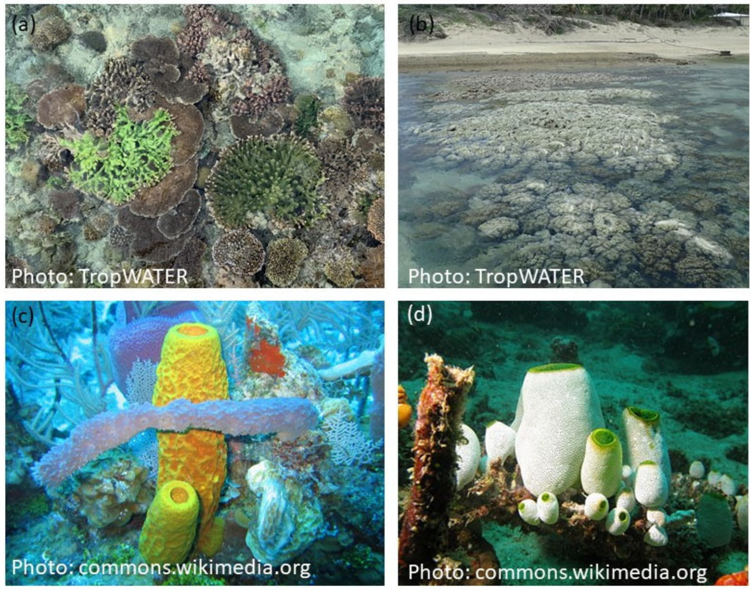

FIGURE 4. BENTHIC MACRO-INVERTEBRATES: (A) HARD CORAL, (B) SOFT CORAL, (C) SPONGE AND (D) ASCIDIAN.

GEOGRAPHIC INFORMATION SYSTEM (GIS)

Survey data was entered into a Geographic Information System (GIS) using ArcGIS 10.8 (Redlands, CA: Environmental Systems Research Institute, ESRI). Georeferenced satellite imagery of reefs and islands in the Eastern Cluster (Source: ESRI, Landsat 2022), field notes, and aerial photographs taken during the helicopter survey were used to identify geographical features such as reef tops, channels and deep-water drop-offs to assist in determining seagrass meadow boundaries. For each location, three GIS layers were created to describe spatial features of intertidal reef-tops: (1) a site layer (containing all site data), (2) a seagrass meadow (polygon) layer, (3) and a seagrass biomass interpolation (raster) layer. All spatial layers are publicly available at eAtlas (eatlas.org.au).

The seagrass meadow layer summarises information for all sites within the meadow, including seagrass species present, meadow community type, meadow density, mean meadow biomass ± standard error (SE), meadow area ± reliability estimate (R), and number of sites. Meadow polygon boundaries were drawn using seagrass presence/absence site data and meadow boundaries mapped using GPS points recorded while flying along the intertidal meadow edge. Mapping precision estimates (in metres) were based on the mapping method used for that meadow (Table 1). These estimates were used to calculate an error buffer around each meadow; the area of this buffer is expressed as a meadow reliability estimate (R) in hectares.

Meadow community type was determined according to seagrass species composition within a meadow. Species composition was based on the percent each species’ biomass contributed to mean meadow biomass. A standard nomenclature system was used to categorize each meadow (Table 2). This nomenclature also included a measure of meadow density categories (light, moderate, dense) determined by mean biomass of the dominant species within the meadow (Table 3).

An inverse distance weighted (IDW) interpolation was applied to seagrass site data to describe spatial variation in seagrass biomass across each meadow. The interpolation was conducted in ArcMap 10.8.

TABLE 1. MAPPING PRECISION AND METHODS FOR SEAGRASS MEADOWS.

Mapping precision	Mapping method
1-20 m	Meadow boundaries mapped in detail by GPS from helicopter Intertidal meadows completely exposed or visible at low tide Relatively high density of mapping and survey sites Recent aerial photography and satellite imagery aided in mapping
20-50 m	Parts of meadow boundary mapped in detail by GPS from helicopter Parts of meadow boundary determined from presence/absence site data and satellite imagery Relatively high density of mapping and survey sites

TABLE 2. NOMENCLATURE FOR INTERTIDAL SEAGRASS MEADOW COMMUNITY TYPES.

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% of composition
Species A/Species B	Species A is 40-60% of composition

TABLE 3. DENSITY CATEGORIES AND MEAN ABOVE-GROUND BIOMASS RANGES FOR EACH SPECIES USED IN DETERMINING INTERTIDAL SEAGRASS MEADOW COMMUNITY DENSITY.

	Mean above-ground biomass (g DW m^{-2})			
Density	*H. uninervis* (thin)	*H. ovalis* *H. decipiens*	*C. rotundata* *T. hemprichii*	*E. acoroides* *T. cilliatum*
Light	< 1	< 1	< 5	< 40
Moderate	1-4	1-5	5-25	40-100
Dense	> 4	> 5	> 25	> 100

RESULTS

SEAGRASS

Extensive intertidal seagrass meadows were mapped around Ugar and Campbell Islands, and patchy seagrass meadows at Nepean Island (Figure 5). Seagrass was present at 50% of the 404 intertidal sites surveyed and consisted of patchy to continuous cover of seagrass within the meadows (Figure 5, Figure 6). During the survey a dugong was observed on the seagrass meadow at Ugar Island.

Figure 5. (a) Seagrass in fish traps at Ugar Island; (b) fringing reef; (c) a dense seagrass patch of *T. ciliatum* and *E. acoroides* in the Ugar Island meadow; (d) meadow with continuous seagrass cover off the southern coast of Ugar Island; (e) low biomass reef-top meadow near Nepean Island; (f) a typical Campbell Island low biomass seagrass site; and (g) patchy seagrass cover.

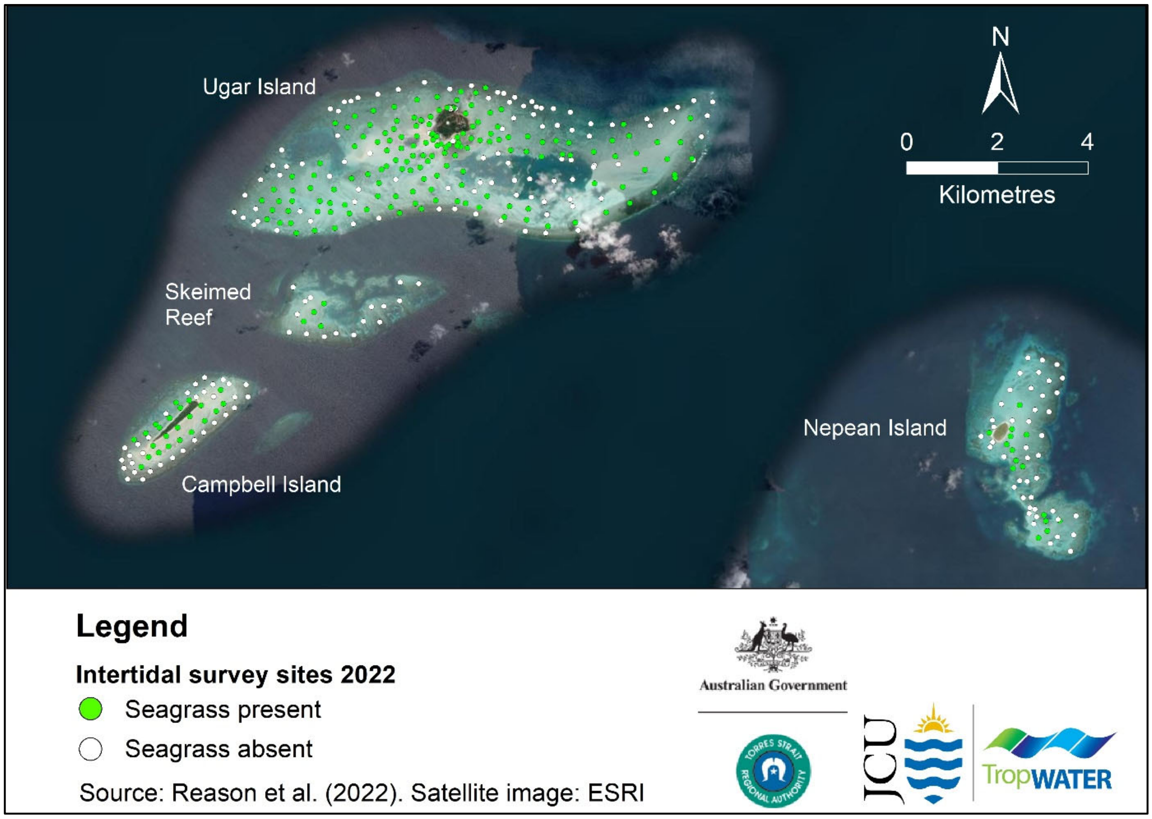

FIGURE 6. SEAGRASS PRESENCE AND ABSENCE AT SURVEY SITES ACROSS UGAR, CAMPBELL AND NEPEAN ISLANDS.

The total area of meadows mapped around Ugar, Nepean and Campbell Islands and their reef-tops was 1604 ± 260 ha (Table 4). Seven seagrass species were recorded (Figure 7). Most meadows were dominated by a light cover of *T. hemprichii* and/or *C. rotundata* and *H. ovalis* (Figure 8, Figure 9). Species diversity was greatest at meadows surrounding the continental island of Ugar with all seven species present (Figure 8). *T. hempricii* was the only species recorded on Skeimed Reef's intertidal meadow (Meadow 2; Figure 8).

The largest seagrass meadow mapped was around Ugar Island which covered most of the intertidal reef-top (Meadow 1; 1397 ± 222 ha). Large meadows also occurred on the eastern sides of Campbell Island (Meadow 4; 89 ± 12 ha) and Nepean Island (Meadow 7; 54 ± 9 ha) (Figure 8, Figure 9, Table 4). Smaller meadows were mapped on the reef top north of Campbell Island (Meadow 3; 25± 9 ha), at Skeimed Reef south of Ugar Island (Meadow 2; 21 ± 5 ha), south of Nepean Island (Meadow 5; 18 ± 5 ha) and west of Nepean Island (Meadow 6; 0.1 ± 0.1 ha) (Figure 8, Figure 9, Table 4).

The largest meadow - Meadow 1 at Ugar Island - also had the highest biomass (>5 g DW m^{-2}). *T. hemprichii* was the dominant species across the entire meadow, but areas with high seagrass biomass close to the island where due to the presence of high biomass species *E. acoroides* and *C. rotundata* (Figure 8; Figure 10). Three small hotspots with very high biomass of *T. cilliatum* were observed in the north and west of this meadow. These three sites were considered biomass outliers and excluded from the assessment of meadow community type. The biomass in all other meadows (Meadows 2 - 7) was uniformly low, with mean biomass <1 g DW m^{-2} (Figure 9, Figure 11, Table 4).

TABLE 4. UGAR, CAMPBELL, AND NEPEAN ISLANDS INTERTIDAL SEAGRASS MEADOWS. INCLUDES MEADOW DENSITY, COMMUNITY TYPE, AREA, AND MEAN BIOMASS (G DW M^{-2} ± STANDARD ERROR (SE)). MEADOW IDENTIFICATION (ID) NUMBERS FEATURE ON FIGURE 8 AND FIGURE 9. BIOMASS SE INCLUDED WHERE THE NUMBER OF SITES IN A MEADOW IS >1. SEE TABLES 2 AND 3 FOR MEADOW DENSITY AND COMMUNITY TYPE DEFINITIONS.

Meadow ID	Meadow Density	Meadow Community Type	Area (ha ± R)	Biomass (mean ± SE)
UG-1	Light	*T. hemprichii* with mixed species (**T.cilliatum* is excluded due to very high biomass)	1397 ± 222	5.60 ± 1.65
SK-2	Light	*T. hemprichii*	21 ± 5	0.39 ± 0.15
CB-3	Light	*C. rotundata* with *H. ovalis/ T. hemprichii*	25 ± 7	0.16 ± 0.09
CB-4	Light	*T. hemprichii*	89 ± 12	0.58 ± 0.10
NP-5	Light	*C. rotundata/ T. hemprichii*	18 ± 5	0.16 ± 0.06
NP-6	Light	*H. ovalis*	0.1 ± 0.1	0.01
NP-7	Light	*H. ovalis with T. hemprichii/C. rotundata*	54 ± 9	0.25 ± 0.13

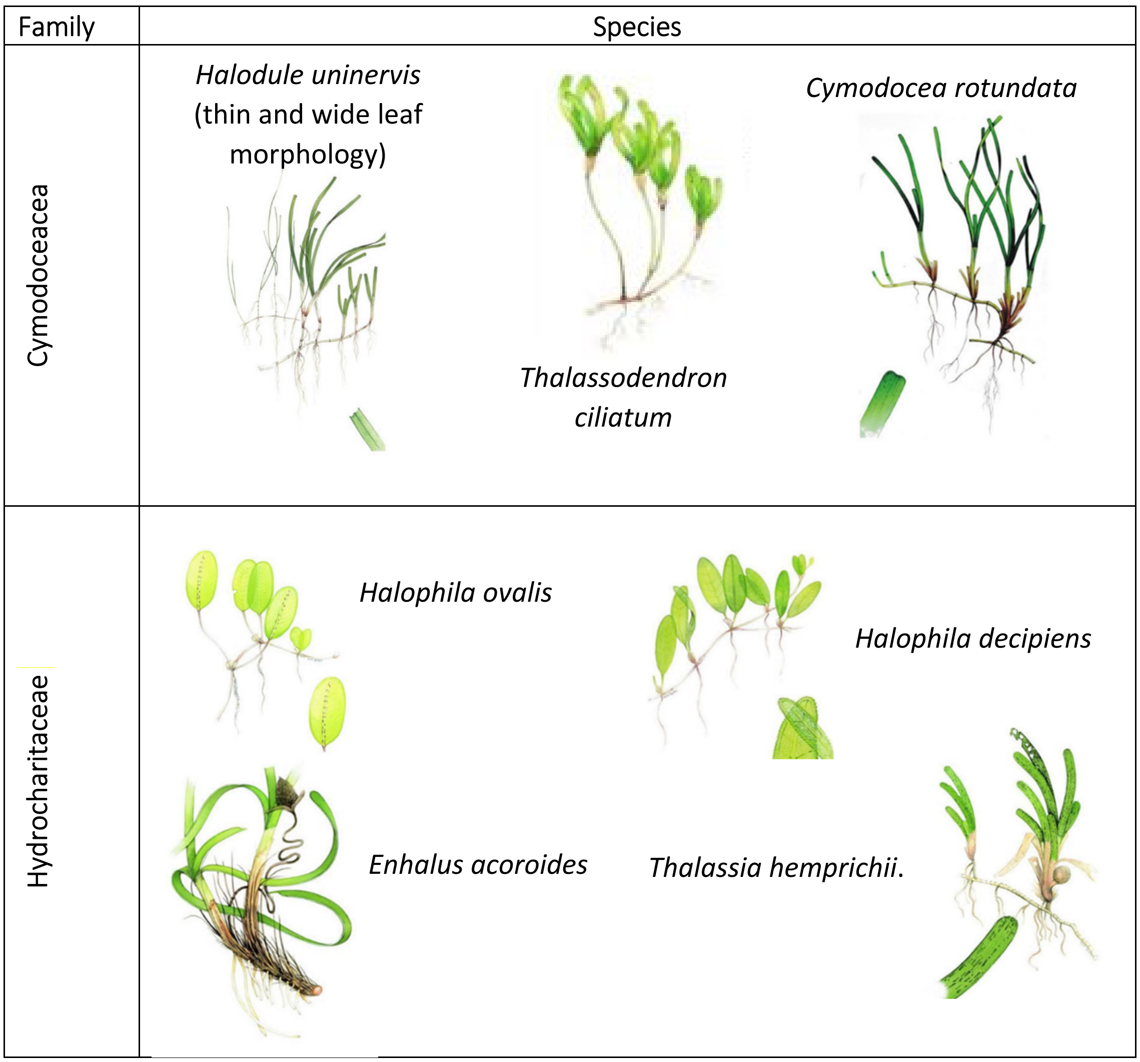

FIGURE 7. SEAGRASS SPECIES PRESENT AT UGAR, CAMPBELL AND NEPEAN ISLAND SEAGRASS MEADOWS.

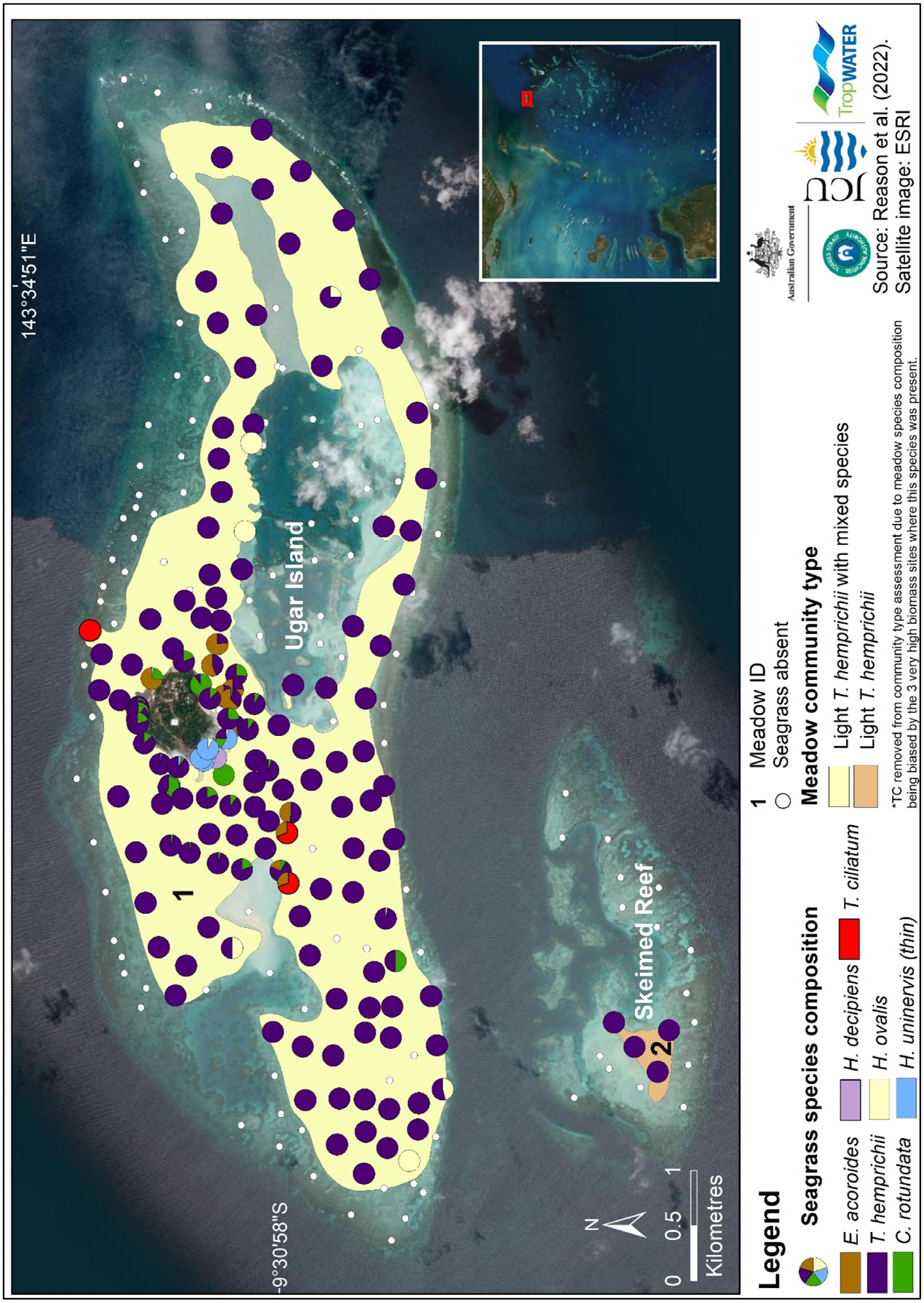

FIGURE 8. SEAGRASS MEADOW COMMUNITY TYPES AND VARIATION IN SEAGRASS SPECIES COMPOSITION WITHIN SITES AT UGAR ISLAND.

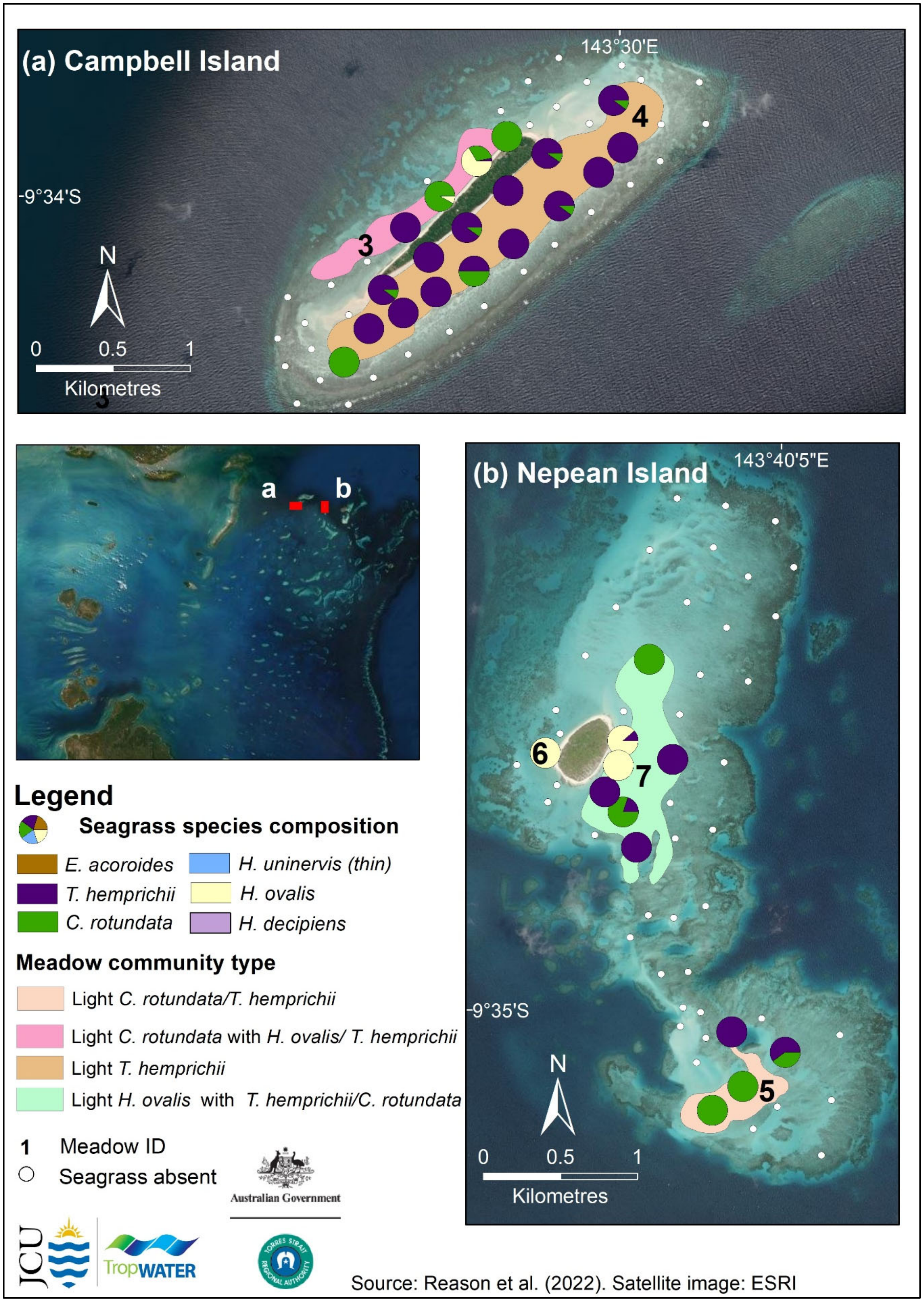

FIGURE 9. SEAGRASS MEADOW COMMUNITY TYPES AND VARIATION IN SEAGRASS SPECIES COMPOSITION WITHIN SITES AT (A) CAMPBELL AND (B) NEPEAN ISLANDS.

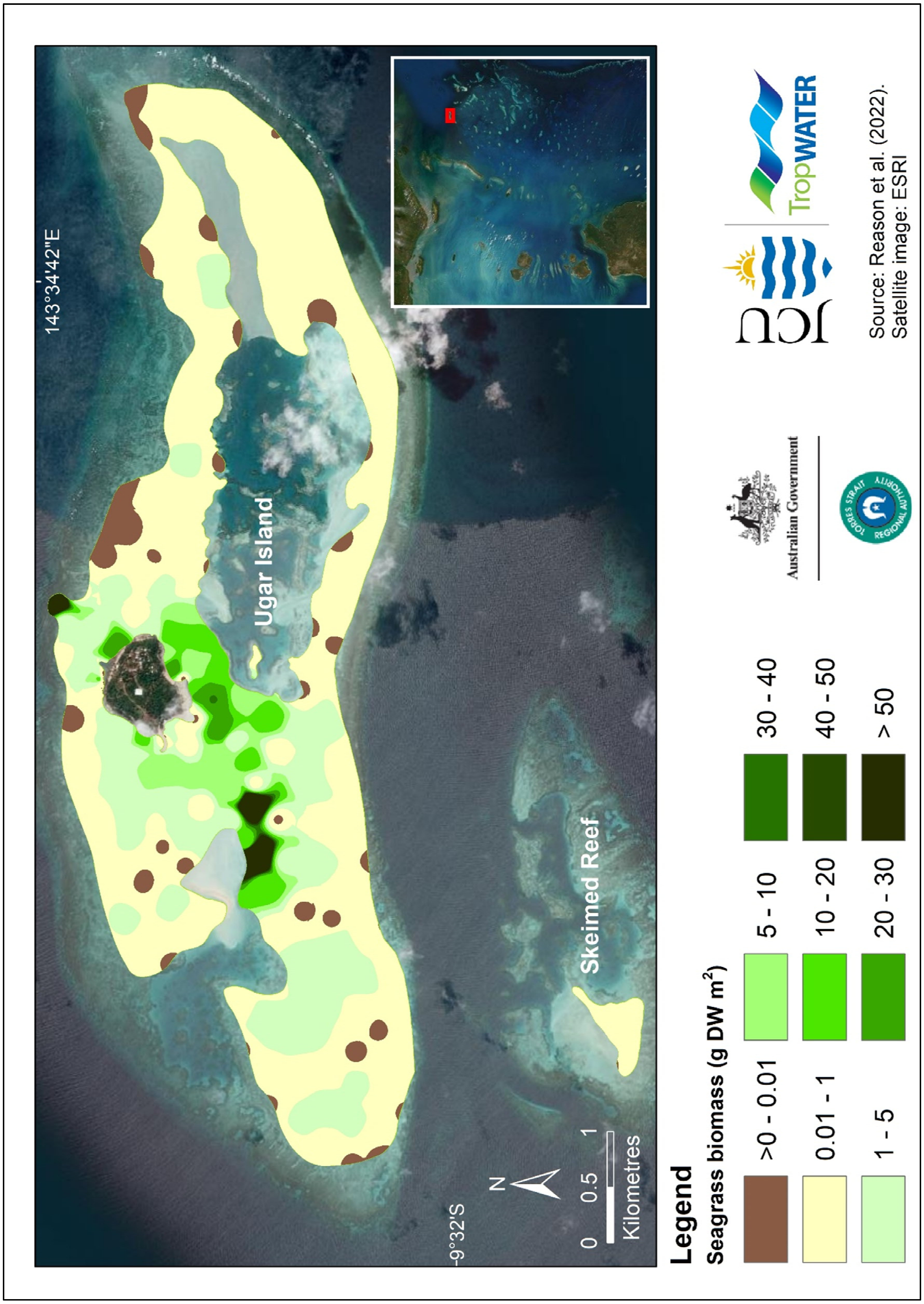

FIGURE 10. VARIATION IN SEAGRASS BIOMASS AT UGAR ISLAND.

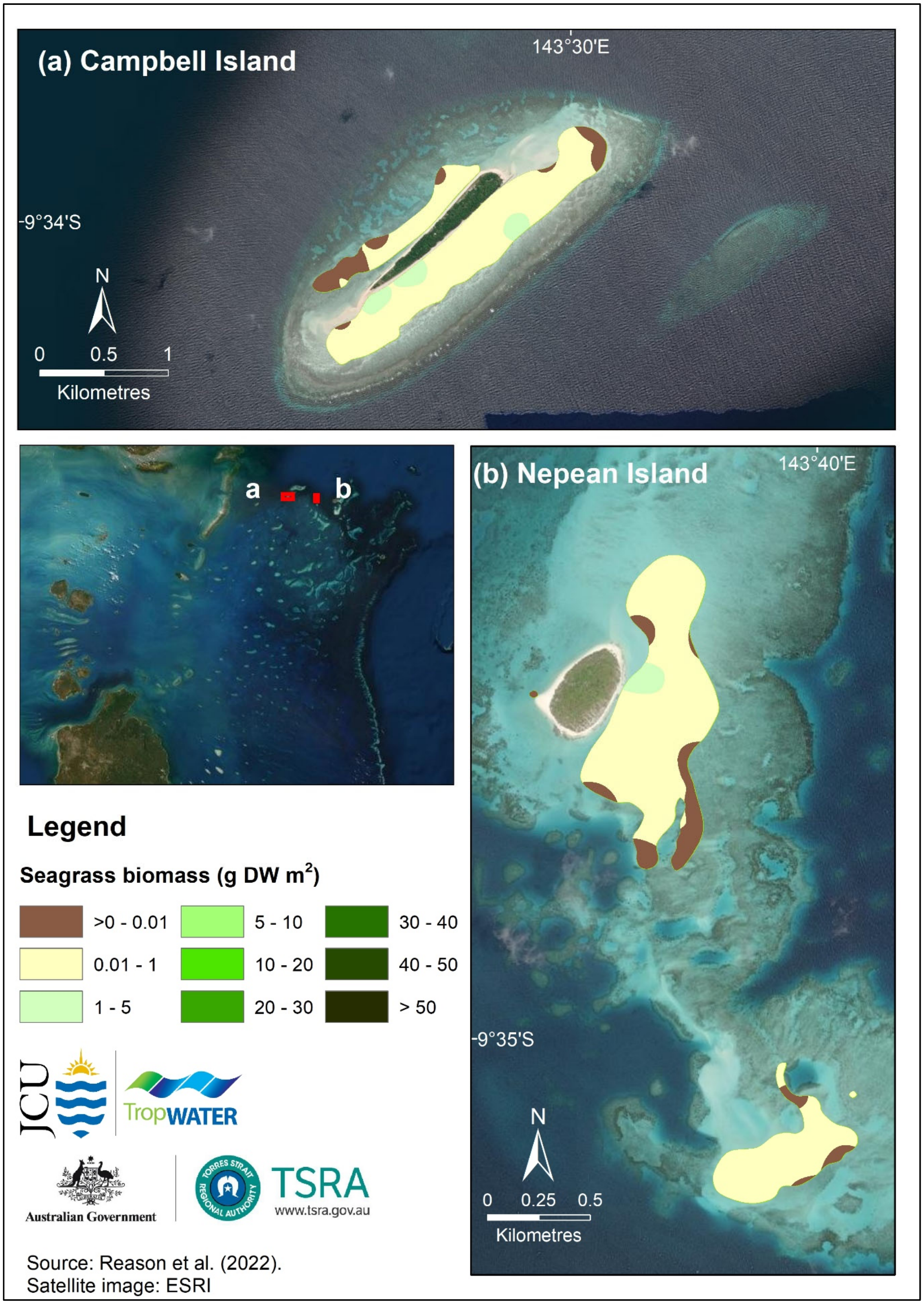

FIGURE 11. VARIATION IN SEAGRASS BIOMASS AT (A) CAMPBELL AND (B) NEPEAN ISLANDS.

COMPARISON WITH PREVIOUS SEAGRASS SURVEYS

The seagrass meadows around Ugar, Campbell and Nepean Islands were in remarkably similar condition in 2022 compared to when they were surveyed in 2008 and 2009. Meadow 2 on Skeimed Reef and Meadow 5 on southern Nepean Island were mapped for the first time in 2022 (no seagrass present in 2008-2009; Figure 12). The seagrass on these new meadows was typical of reef top meadows found in the Eastern Cluster survey in 2021 (Carter et al. 2021b).

The Ugar Island meadow in 2022 continued to cover the majority of the intertidal reef-top, and at 1397 $\pm$ 222 ha was just 7% smaller than the 1515 $\pm$ 35 ha mapped 13 years earlier (Figure 12; Table 4) (Taylor et al. 2008). *T. hemprichii* was the dominant species in both surveys, with smaller contributions of *E. acoroides*, *C. rotundata*, *H. uninervis* and *H. ovalis*. *T. cilliatum* was not present in the meadow in 2008 but recorded at three sites in 2022. Meadow biomass was similar in 2022 (5.6 $\pm$ 1.6 g DW m^{-2}) and 2008 (5.3 $\pm$ 1.0 g DW m^{-2}) (Taylor et al. 2008).

The Campbell Island meadow was mapped as a single meadow in 2008, but separate meadows running along either side of the island in 2022. Seagrass meadow area for these two meadows in 2022 was 114 ± 19 ha, 22% less than meadow area in 2008 (148 ± 6.8 ha; Figure 12; Table 4) (Taylor et al. 2008). Meadow community type was dominated by *T. hemprichii* in 2008 and for the larger southern meadow in 2022. Meadow biomass was also greater in 2008 (1.5 ± 0.6 g DW m^{-2}) (Taylor et al. 2008) compared with <1 g DW m^{-2} in 2022 (Figure 12; Table 4).

Seagrass meadows at Nepean Island in 2009 were generally smaller, lower biomass and less diverse than meadows than in 2022 (Figure 12; Table 4). In 2022 the seagrass was mapped as three separate meadows. Meadow 7 east of the island was more than double the area in 2022 (54 ± 3.2 ha) compared with 2009 (23 ± 3.2 ha) (Taylor et al. 2009). Meadow biomass was ~0.2 g DW m^{-2} for both surveys and *H. ovalis* and *T. hemprichii* characterised the Nepean Island meadows in both years, but with the addition of *C. rotundata* in 2022 (Taylor et al. 2009).

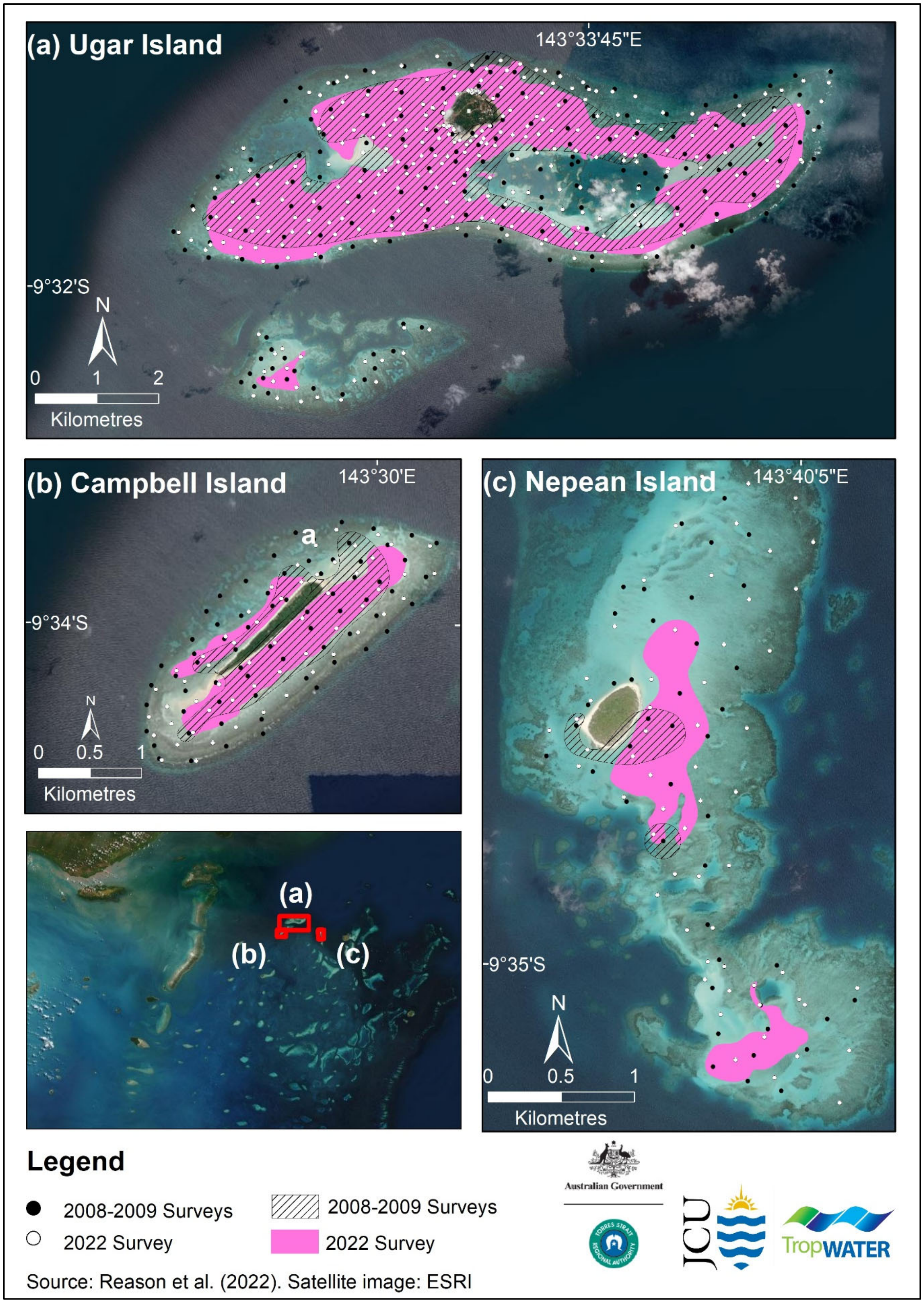

Figure 12. Comparison of intertidal seagrass meadows and site coverage for surveys conducted in 2008-2013 and 2022 at (a) Ugar Island and surrounding reefs, (b) Campbell Island, and (c) Nepean Island.

ALGAE GROUPS

Algae cover on intertidal reef-tops was extensive, with some form of algae present at 81% of sites (Figure 13, Figure 14). Most sites were dominated by erect macrophyte algae, with turf mat, filamentous, calcareous, or encrusting algae contributing smaller amounts to the algal community (Figure 13, Figure 14).

Algae cover at Ugar Island was high and dominated by erect macrophyte algae, particularly on the northern and southern reef edges and around the central lagoon (Figure 13). A mix of other algal forms were found inside the reef edge - predominantly turf algae, filamentous and calcareous algae. Skeimed Reef south of Ugar Island was also dominated by erect macrophyte algae on the reef edge; sites in the inner lagoon had a combination of turf mat algae and erect macrophyte algae (Figure 13).

At Campbell Island the highest density of algae was located on the south-west end, close to the vegetated cay or on the reef edge (Figure 14). The dominant algae type was erect macrophyte, but most sites included a smaller mix of turf, erect calcareous, encrusting, and filamentous algae (Figure 14).

At Nepean Island algae cover was greatest on the eastern side along the reef edge (Figure 14). Erect macrophyte was the dominant algae, with small amounts of encrusting, calcareous or turf algae also present at a few sites (Figure 14).

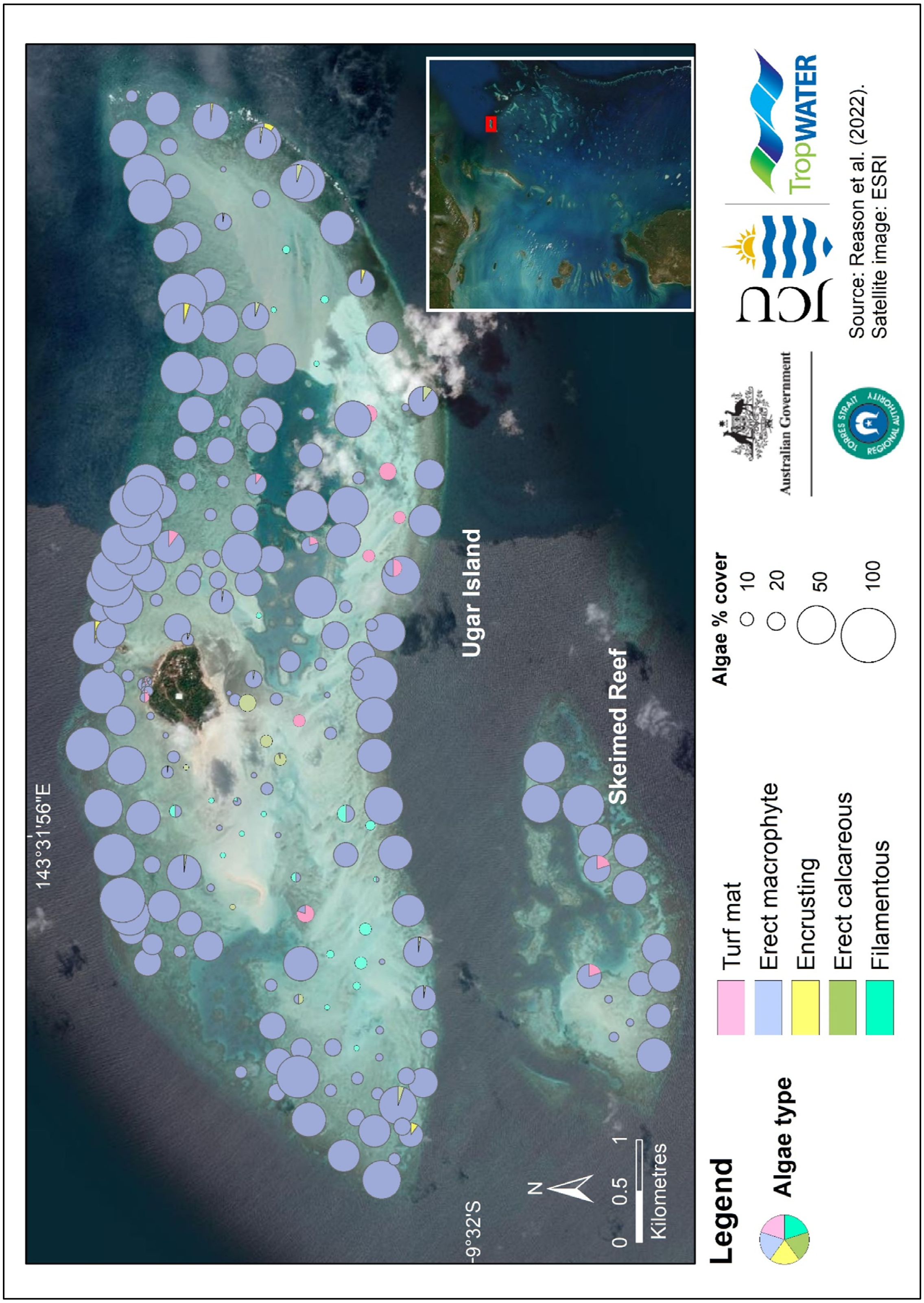

FIGURE 13. DISTRIBUTION OF ALGAE PERCENT COVER AND ALGAE TYPE AT UGAR ISLAND AND SKEIMED REEF.

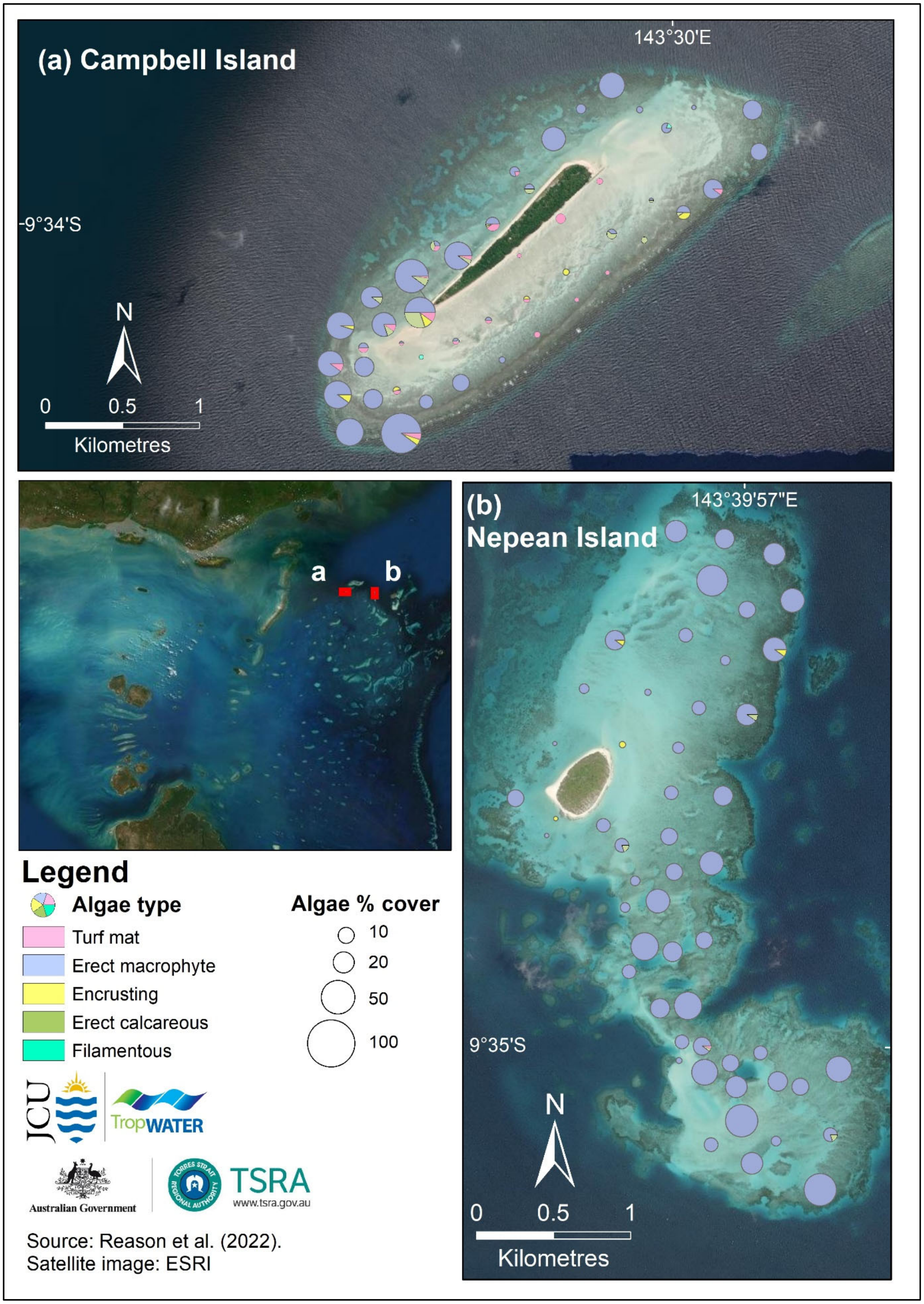

FIGURE 14. DISTRIBUTION OF ALGAE PERCENT COVER AND ALGAE TYPE AT (A) NEPEAN AND (B) CAMPBELL ISLANDS.

BENTHIC MACRO-INVERTEBRATES

The majority of benthic macro-invertebrate (BMI) cover was made up of hard coral (up to 90% cover at a site), soft coral (up to 50% cover), sponges (up to 5% cover), and clams, ascidians and hydroids (up to 2% cover, classed as "other BMI") (Figure 15). On Ugar Island these communities were most common along reef edges where hard coral dominated (Figure 16). Soft coral was present on the eastern and western reef edges. Sponges were most common close to the island. Ascidians (other BMI) were often found within the Ugar Island meadow (Figure 16). Skeimed Reef was dominated by hard corals (Figure 15).

Hard coral was the dominant benthic cover along Campbell Island's reef edges, while sponges and ascidians (other BMI) were the dominant invertebrates close to the island (Figure 17). Large numbers of sea urchins were observed along the southern reef edge at Campbell Island but these were not included as benthic habitat. Nepean Island had very low coral cover compared with Ugar and Campbell Islands (<5% cover). Invertebrate communities were predominantly hard coral or ascidians (other BMI) (Figure 17).

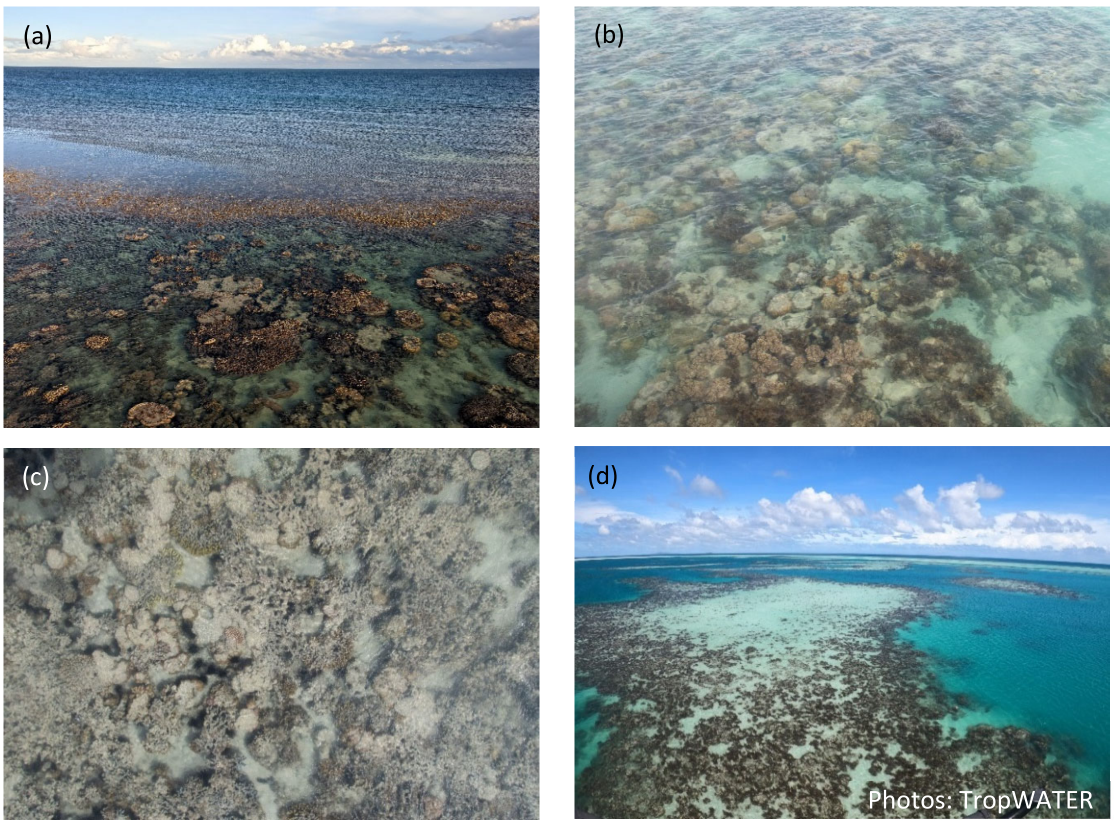

FIGURE 15. (A, B) CORAL COMMUNITIES AT UGAR ISLAND, (C) HIGH CORAL COVER ON REEF TOPS, (D) NEPEAN ISLAND REEF.

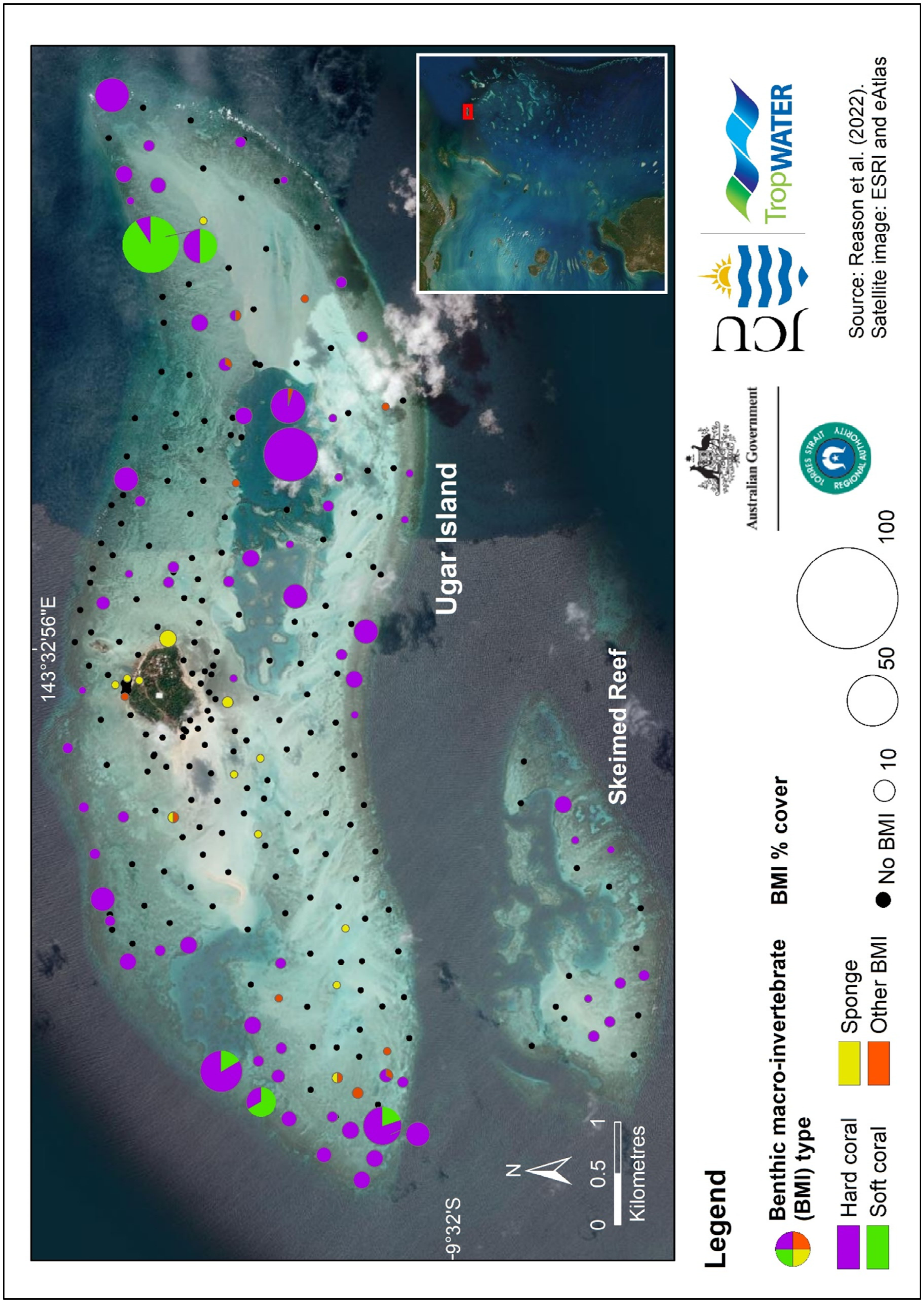

FIGURE 16. BENTHIC MACRO-INVERTEBRATE DISTRIBUTION AND COVER AT UGAR ISLAND AND SKEIMED REEF.

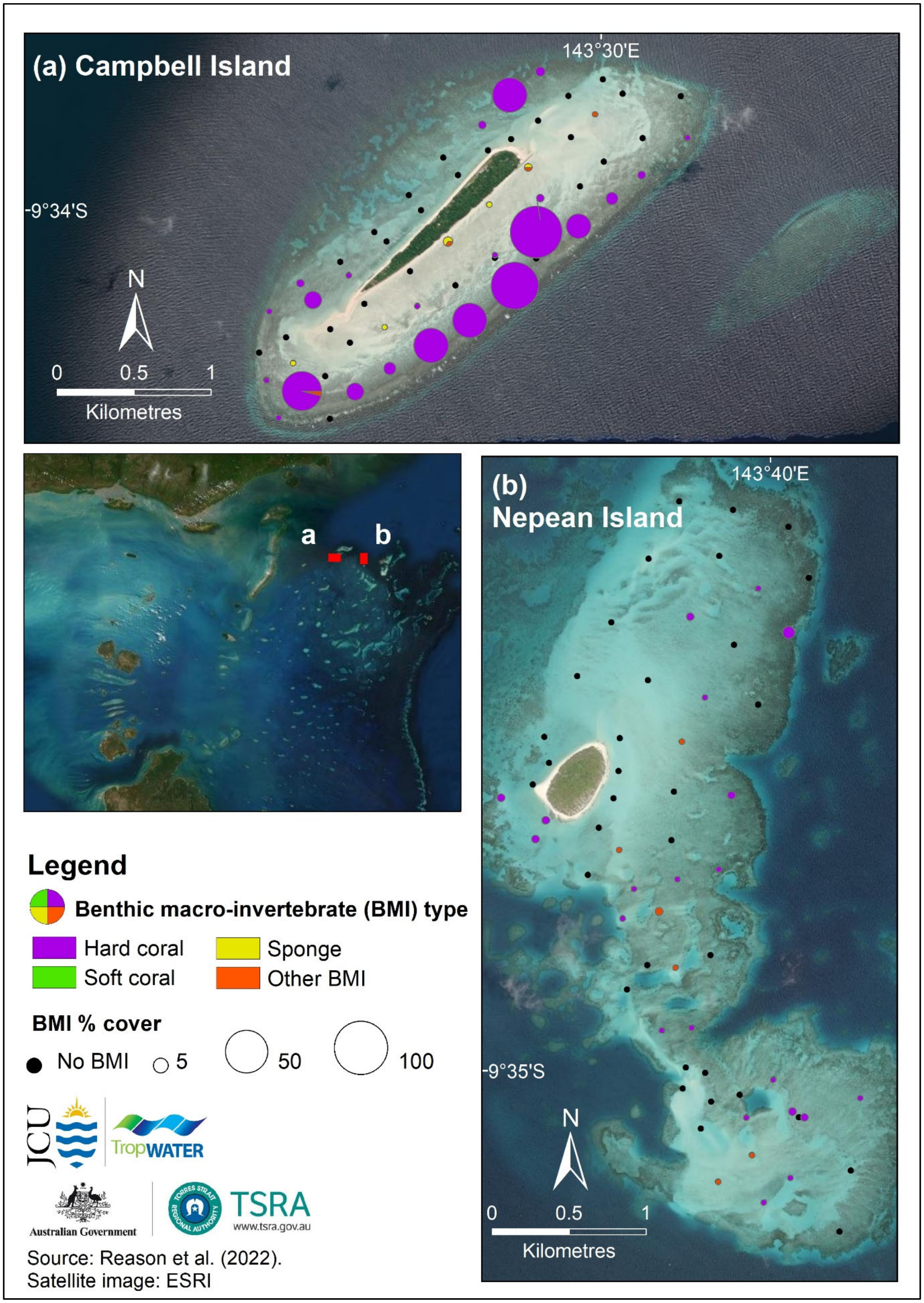

FIGURE 17. BENTHIC MACRO-INVERTEBRATE DISTRIBUTION AND COVER AT (A) CAMPBELL AND (B) NEPEAN ISLANDS.

DISCUSSION

SEAGRASS MEADOWS OF UGAR, CAMPBELL AND NEPEAN ISLANDS

Seagrass meadows around Ugar, Nepean and Campbell Islands ranged from a large, high biomass and diverse meadow at Ugar Island, to multiple small meadows dominated by *T. hempricii* and *C. rotundata* around Nepean and Campbell Islands. These intertidal meadows have high ecological importance because they account for the majority of seagrass habitat in eastern Torres Strait. Seagrasses are mostly found in shallow waters due to the high light requirements of most species (Carter et al. 2021a). Light availability has an important positive effect on seagrass growth and distribution in Torres Strait (Carter et al. 2014a) and the Great Barrier Reef (Chartrand et al. 2018; Collier et al. 2016). Inter-reef waters in the Eastern Cluster are relatively deep, declining to >20 m depth within a short distance from reef and island edges and often reaching >40 m depth. Because of this, the extensive subtidal seagrass habitat that occurs throughout the shallow waters (<20 m) west of the Warrior Reefs and into the Dugong Sanctuary (Figure 1; Carter et al. 2014b) do not occur in the eastern region (Haywood et al. 2008).

The presence of the most diverse and high biomass seagrass close to the continental island of Ugar follows the same trend throughout the Eastern Cluster, where similar meadows have been mapped around Erub, Mer, Dauar and Waier (Figure 18) (Carter et al. 2021b). This again suggests nutrient availability is a key factor in the distribution of intertidal seagrass in eastern Torres Strait. Seagrass productivity can be significantly reduced where nutrients are limited (Dennison et al. 1987; Short 1987). Sediment-nutrient interactions in tropical seagrass beds can vary significantly between terrigenous and carbonate sediments, including total carbon, organic carbon, total nitrogen, total phosphorus, exchangeable phosphorus and exchangeable ammonium (Erftemeijer and Middelburg 1993). The presence of seabirds also can significantly enhance seagrass growth and recovery following disturbance due to the nutrients delivered from seabird excrement (Kenworthy et al. 2018; Powell et al. 1989). Sea cucumbers within the Ugar Island meadow are likely to further enhance seagrass growth as they assist with bioturbaton of the sediment and recycling nutrients (Wolkenhauer et al. 2010). The addition of nutrients, whether through increased terrestrial input of organic matter from islands and cays and/or sea birds or sea cucumbers, appears to provide ideal growing conditions for seagrass at Ugar Island.

FIGURE 18. SEAGRASS PRESENCE AND ABSENCE AT SURVEY SITES IN THE TORRES STRAIT EASTERN CLUSTER, INCLUDING UGAR, CAMPBELL AND NEPEAN ISLANDS, 2020 - 2022.

EASTERN CLUSTER GREEN TURTLE AND DUGONG FORAGING GROUNDS

The location and quality of foraging grounds influences green turtle and dugong foraging behaviour and reproduction (Hagihara et al. 2016; Limpus and Nicholls 2000). Persistent seagrass species common in Torres Strait include *T. hemprichii*, *T. ciliatum* and *E. acoroides* which form enduring meadows in stable habitats; colonising genera such as *Halophila* tend to be transitory – they are quick to succumb to disturbances but are often the first species to recolonise (Kilminster et al. 2015). The overlap in seagrass meadow boundaries and the persistence of *T. hemprichii* as the dominant species in meadows from surveys conducted almost 15 years apart indicates Ugar, Campbell and Nepean Island's intertidal meadows provide a relatively stable foraging ground for marine herbivores. However, this assumption is based on only two surveys. Recent declines in intertidal seagrass at Orman Reefs and Mabuyag Island in western Torres Strait demonstrate seagrass can decline quickly and dramatically (Carter et al. 2021c). Establishing ongoing monitoring of a subset of these meadows would provide important information on natural variation in seagrass condition using indicators like meadow area, biomass, species composition, and provide a more robust benchmark for comparison should a seagrass dieback occur in the Kemer Kemer Meriam Nation.

The 2022 survey area included reefs and islands included in the Ugaram Turtle and Dugong Management Area, and this report provides important habitat information to inform management plans. The importance of eastern Torres Strait as the location of important rookeries for the northern Great Barrier Reef (nGBR) green turtle population, e.g. Maizub Kaur and Dauar Island, is well established (4Seas Environmental Consulting 2020). Stomach content analysis indicates green turtles consume seagrass and macroalgae in Torres Strait (André et al. 2005), and green turtles are often reef-associated and use the shallow 0-5m zone (Cleguer et al. 2016; Gredzens et al. 2014; Marsh et al. 2011). There also is recent anecdotal evidence of dugong movement into eastern Torres Strait following seagrass declines in the western region. Dugong feeding trails were evident in the Ugar Island meadow, and a dugong was sighted on Ugar Island by researchers conducting this survey. We mapped ideal foraging grounds in the intertidal seagrass meadows and algal communities around Ugar, Cambell and Nepean Islands. How green turtles and dugong use these foraging habitats should be a priority for future research.

RECOMMENDATIONS

Effective management and planning requires recent, spatially relevant seagrass information. The 2022 survey of intertidal habitats at Ugar, Campbell and Nepean Islands provides critical information against which future seagrass change and green turtle and dugong movement and foraging behaviour can be examined. Long-term monitoring in the Kemer Kemer Meriam Nation is limited to Mer Island, where two sites are monitored by the Meriam Gesep A Gur Keparem Le Rangers. This data is used to report on seagrass condition in the annual seagrass report card (Carter et al. 2021c). The addition of long-term meadow-scale monitoring at Ugar Island would provide important information on annual variation in reef-associated meadows in this important region of Torres Strait. Seagrass meadows that grow around the inhabited islands of Ugar are ideal for long-term monitoring as there are Rangers on the island, ease of access (helipad, fuel, accommodation), and because these meadows have some of the greatest species diversity in the region (Figure 7). The presence of colonising species (*H. ovalis*, *H. decipiens*), opportunistic species (*H. uninervis*, *C. rotundata*), and persistent species (*T. hemprichii*, *T. ciliatum*, *E. acoroides*) means the Ugar Island meadow is comprised of species with a large range of sensitivities to change and capacity to recover from impacts. Incorporating this meadow into the long-term monitoring program would also ensure a major seagrass meadow is monitored in the Ugaram Dugong and Turtle Management Area.

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