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Benthic Habitats of the Northern Tiwi Islands

November 2026 | Report No. 26/48



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Benthic Habitats of the Northern Tiwi Islands

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Cover image: Intertidal seagrass meadow. Below image: Subtidal survey team. Photos: TropWATER, JCU.



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EXECUTIVE SUMMARY

This project provides the most comprehensive assessment to date of benthic habitats across Tiwi Sea Country, combining intertidal helicopter surveys, subtidal boat-based surveys, drop-camera imagery, sediment grabs, sled tows, GIS mapping, and Tiwi Ranger knowledge. Surveys covered the northern coastline of Bathurst and Melville Islands, from Pajuwapura/ Rocky Point through Apsley Strait and across to Boradi Bay.

Diverse and culturally important habitats were mapped, including seagrass meadows, coral and rocky reefs, macroalgal communities, benthic macroinvertebrate communities and soft-sediment habitats. These habitats support species of high ecological and cultural importance, including dugong, marine turtles, fish, sea cucumbers and other invertebrates. Most structured benthic habitats were concentrated in shallow, nearshore and sheltered waters.

A total of 2,079 intertidal sites and 548 subtidal sites were surveyed in November 2023, November 2024 and April 2025. Seagrass was recorded at 489 intertidal sites and 41 subtidal sites. Eight seagrass species were identified. Seagrass was most common in protected bays, inlets, nearshore banks and areas sheltered by fringing reefs.

The project mapped 137 seagrass meadows covering approximately 2,551 ha, comprising 1,212 ha of intertidal seagrass and 1,339 ha of subtidal seagrass. Most meadows were small and fragmented. Intertidal meadows generally supported higher density seagrass than subtidal meadows. Dense *Enhalus acoroides* meadows, such as those at Karslake Island and Shark Bay, were among the most structurally complex seagrass habitats. In contrast, the largest subtidal meadow occurred in Kwanipiri Bay and was dominated by sparse *H. decipiens*.

Dugong feeding trails were recorded at 31 intertidal sites. Feeding trails occurred in several areas identified by Tiwi Rangers as important dugong habitat. These observations confirm the importance of Tiwi seagrass meadows as foraging habitat for dugong and turtles, both of which are culturally significant to Tiwi people.

Algal communities were recorded at 823 sites, with turf algae, erect macroalgae, calcareous algae and filamentous algae occurring across intertidal and subtidal habitats. Algae were most common in shallow habitats associated with reef, rock, sand and mud substrates.

Benthic macroinvertebrates were recorded at 422 sites. Hard corals were the most common habitat-forming group, particularly around Karslake Island and between Lethbridge Bay and Kwanipiri Bay. Subtidal habitats also supported sponges, soft corals, hydroids, ascidians and bryozoans, though generally at low cover. Sled tow samples confirmed a diverse invertebrate assemblage.

The resulting habitat dataset provides an important baseline for Tiwi Traditional Owners, Rangers and research partners. It will support Sea Country planning, monitoring, management of culturally important species, and future assessment of climate and water-quality pressures. Key next steps could include continued seagrass monitoring at existing sites, expanding monitoring north of Pirlangimpi in Apsley Strait, completing baseline mapping for the southern Tiwi Islands, incorporating fish surveys using baited underwater cameras, and integrating habitat monitoring with water-quality, temperature, dugong, and turtle monitoring programs.

1 INTRODUCTION

Tiwi people have long-standing connections to the unique natural values of the Tiwi Sea Country. Extensive estuaries, bays, rocky reefs and beaches support rich food resources, including mussels, oysters, crabs, fish, sea cucumber, dugong and marine turtles (Gambold 2021). The coastal zone also contains ceremonial campsites and many culturally significant places (Tiwi Land Council 2018). Habitats such as reefs, seagrass and mudflats function as important nursery and feeding grounds for marine life. While seafloor features are well known, named and classified by Tiwi people , western scientific knowledge of coastal habitats in this region remains limited and has not been comprehensively mapped.

The Tiwi Islands are located approximately 80 km north of Darwin in the Northern Territory and form part of the Tiwi–Cobourg bioregion (DCCEEW,(2025). Melville Island is the largest Island in Australia, and together with Bathurst Island and numerous smaller Islands, have more than 1,000km of coastline and cover more than 8,000 km^2 of land (Tiwi Land Council 2018). The islands experience a highly seasonal monsoonal climate, with very high rainfall relative to the mainland Northern Territory, driven partly by the formation of the consistent Hector thunderstorm system (Tiwi Land Council and Tiwi Resources 2023). This climate supports diverse terrestrial ecosystems, including monsoon rainforest and eucalypt forests, and contributes to the productivity of nearshore marine environments.

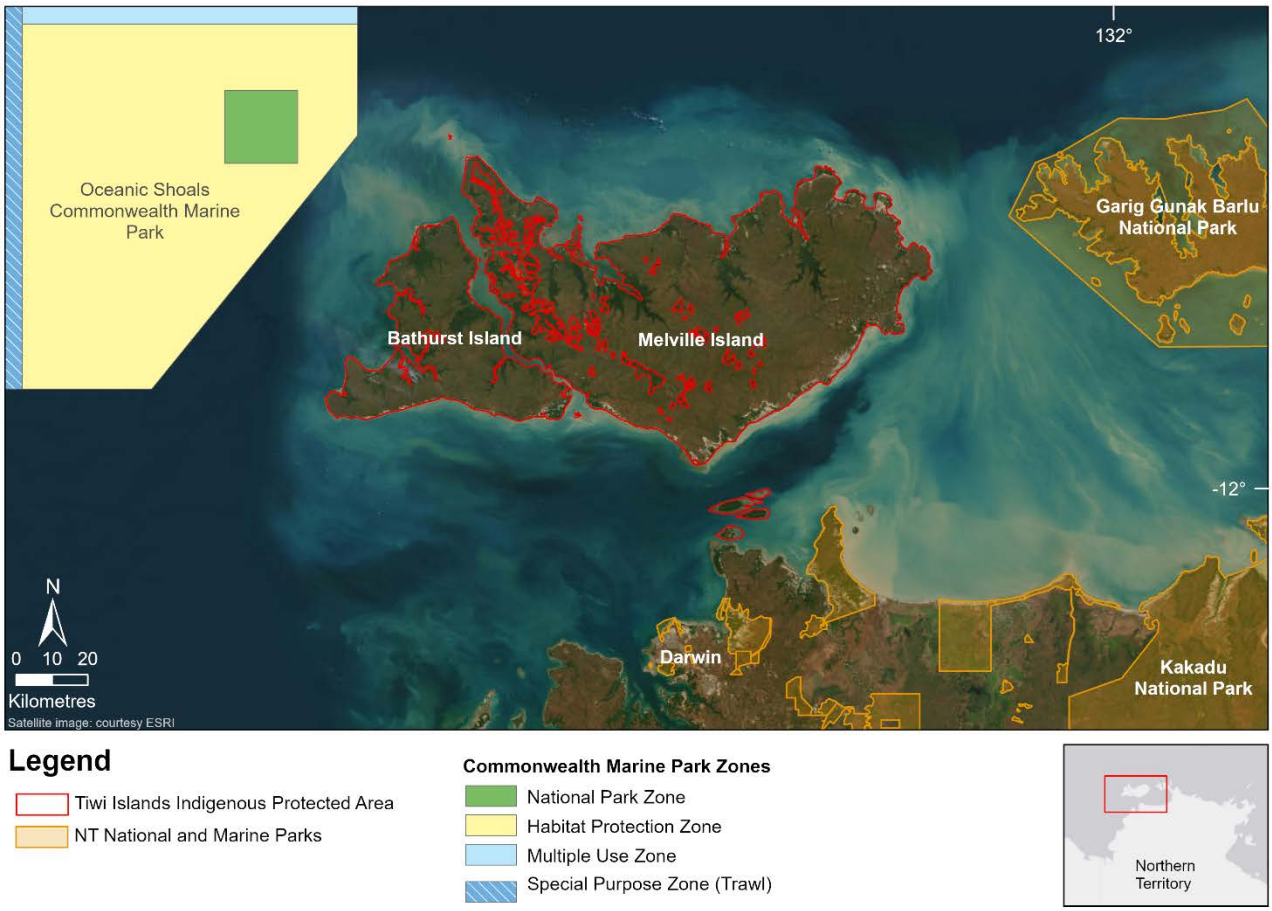

FIGURE 1. TIWI ISLANDS INDIGENOUS PROTECTED AREA (IPA), WITH ADJACENT PROTECTED AREAS IN THE NORTHERN TERRITORY.

The Tiwi Islands are one of northern Australia's most significant refugia for biodiversity due to their size, isolation and relatively intact ecosystems (Harrison et al. 2009). The region supports internationally important wetlands, endemic species, and large populations of migratory seabirds, shorebirds, dolphins, whales, dugongs and marine turtles (Harrison et al. 2009, Gambold 2021, Tiwi Land Council and Tiwi Resources 2023). The north-western tip of Melville Island at Cape Van Diemen supports a globally significant breeding colony of crested terns (Chatto 2001). Long sandy beaches on western Bathurst Island and northern Melville Island are critical nesting areas for vulnerable flatback turtles, while the north-west coast of Melville Island supports major rookeries of the endangered olive ridley turtle (EPBC Act , Tiwi Land Council 2018, Tiwi Land Council and Tiwi Resources 2023). Green turtles and hawksbill turtles also nest on Tiwi beaches (Tiwi Land Council and Tiwi Resources 2023). Marine turtles hold deep cultural, subsistence and ceremonial importance for Tiwi people, and safeguarding healthy populations remains a high priority for Traditional Owners (Tiwi Land Council 2018).

Tiwi people have continuously occupied the Tiwi Islands. The islands are home to approximately 2,400 residents, the majority of whom identify as Aboriginal (ABS 2021). The Tiwi Land Council represents eight clan groups and ensures activities on Country occur with appropriate community governance (Tiwi Land Council 2018). Tiwi Rangers play a central role in caring for Sea Country through monitoring, compliance, marine debris removal, visitor management and community engagement (Tiwi Land Council 2018, Barnett et al. 2023). In 2025, the Tiwi Islands were declared an Indigenous Protected Area (IPA), strengthening long-term protection of cultural values, biodiversity and self-determination (Tiwi Land Council and Tiwi Resources 2023). Tiwi people seek to build on this and establish a Marine IPA and further develop their role as Sea Country managers (Gambold 2021).

Coastal environments are increasingly exposed to multiple pressures, including fishing activity, tourism, marine debris, shipping run-off and climate change (Tiwi Land Council 2017, Pearce et al. 2020). Climate change is among the greatest concerns for Tiwi people (Gambold 2021), with sea-level rise, increasing air and sea temperatures, intensifying cyclones and altered rainfall patterns expected to exacerbate coastal erosion, flooding and ecosystem stress (Tiwi Land Council 2017, Pearce et al. 2020). Tiwi people have expressed concern about the resilience of coastal habitats and culturally important species, and the need for greater knowledge of these habitats to guide Sea Country management (Tiwi Land Council 2018, Barnett et al. 2023).

This knowledge gap is also a scientific one: despite their cultural and ecological significance, the benthic habitats of the Tiwi Islands have never been comprehensively mapped, and no consistent baseline exists to support Sea Country planning, monitoring and management. The objectives of this work were to map and characterise the intertidal and subtidal benthic habitats of the northern Tiwi Islands – including seagrass meadows, reefs, and algal and macroinvertebrate communities – and to establish a baseline that supports culturally informed Sea Country planning, monitoring and management, and strengthens Tiwi capacity to care for Sea Country into the future.

2 METHODS

2.1 SURVEY AREA

The survey focused on seagrass and benthic communities within intertidal and subtidal waters of the northern coastline of the Tiwi Islands, from Pajuwapura (Rocky Point) on Bathurst Island in the west to Tinganoo Bay on Melville Island in the east (Figure 2). Exposed intertidal banks were surveyed at low tide by helicopter from 14–18 November 2023 (Figure 3). Subtidal waters were surveyed by boat from 19–26 November 2024 and 14–17 April 2025 (Figure 4). The area was surveyed by Tiwi Rangers, and scientists from James Cook University, Charles Darwin University and Edith Cowan University.

A total of 2079 intertidal sites and 548 subtidal sites were surveyed. Subtidal surveys used a combination of drop and towed camera, van Veen grab, and benthic sled net tows (Figure 2, Table 1).

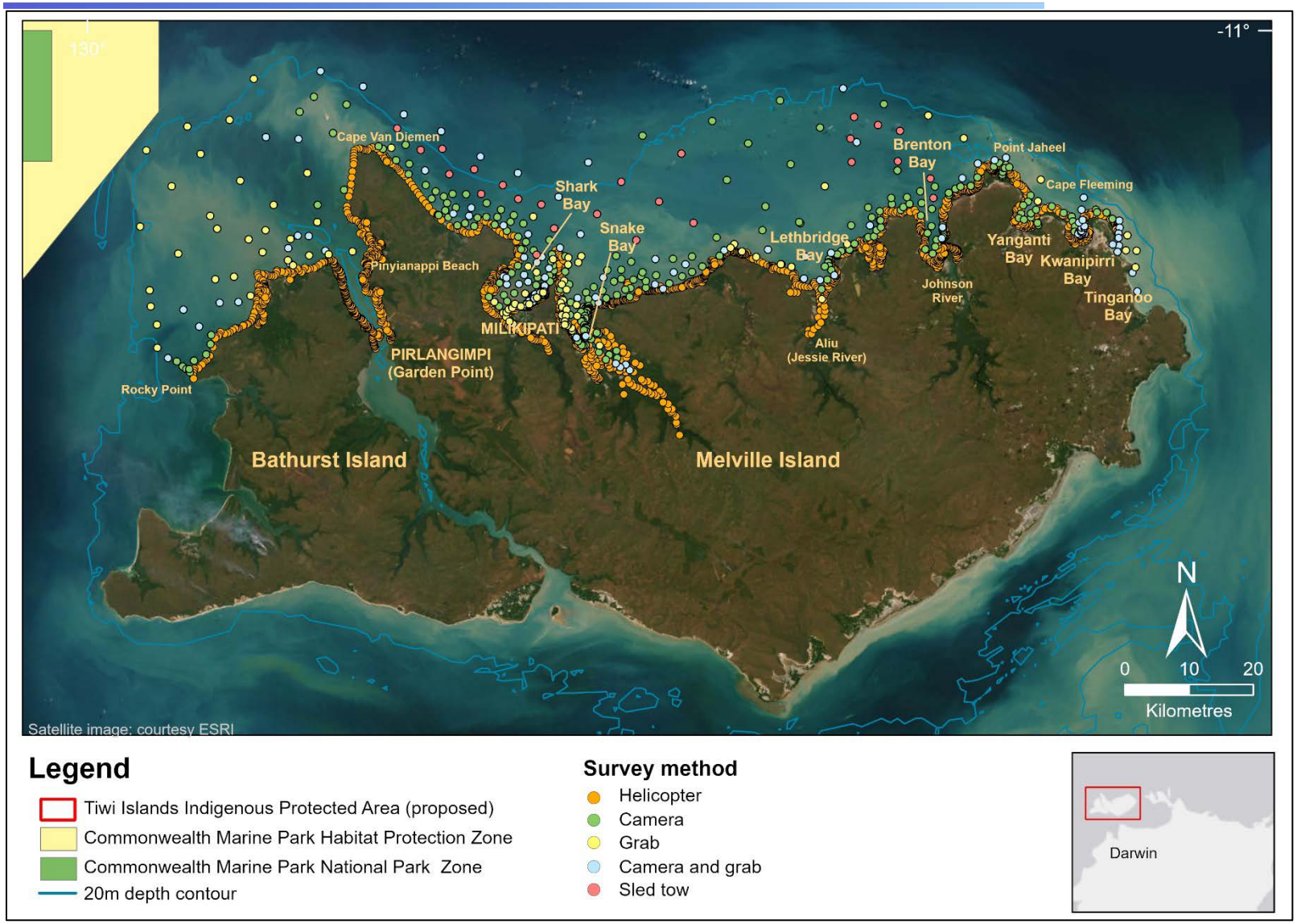

FIGURE 2. MAP OF SURVEY AREA WITH METHOD USED AT EACH SITE.

TABLE 1. SURVEY METHOD AND COUNT OF SITES UTILISING EACH METHOD.

Survey method	Tidal	Sites surveyed
Helicopter	Intertidal	2079
Drop camera only	Subtidal	320
Drop camera and grab	Subtidal	111
Grab only	Subtidal	92
Sled tow	Subtidal	25



FIGURE 3. TIWI ISLAND INTERTIDAL SURVEY USING HELICOPTER SHOWING A) SURVEY TEAM AND B) HELICOPTER IN A LOW HOVER TO ASSESS BENTHIC HABITATS.

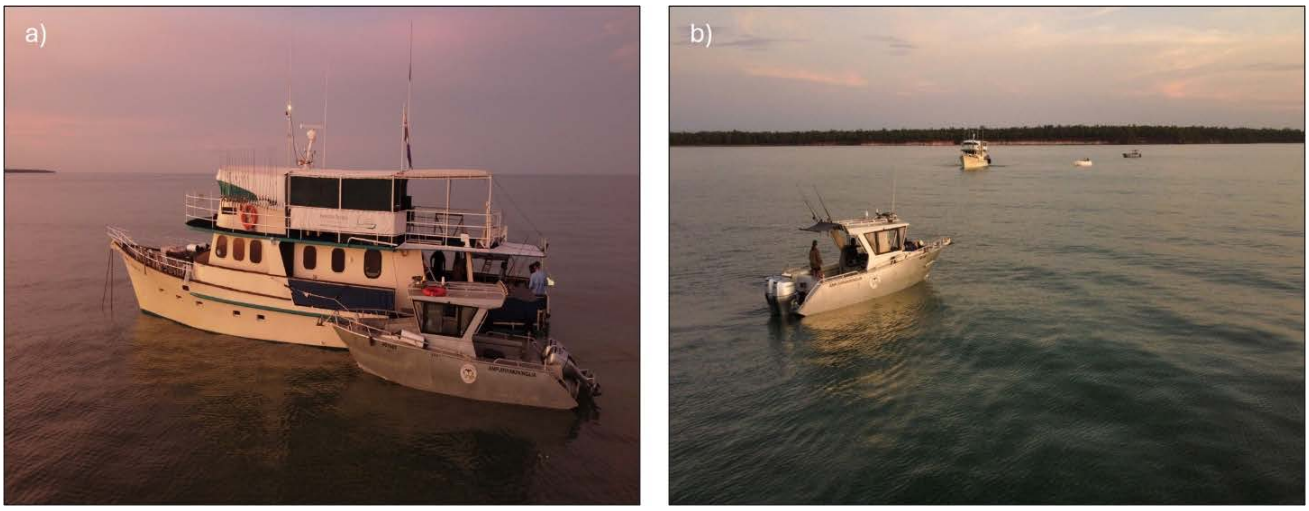

FIGURE 4. SUBTIDAL SURVEY VESSELS SHOWING A) THE RESEARCH VESSEL MV *SWORDFISH* WITH TIWI SEA RANGER VESSEL *AMPJIRRAKININGIJA* AND B) SEA RANGER VESSEL MV *AMPJIRRAKININGIJA WITH MV SWORDFISH, MARINE RANGER 3,* AND *FRONTIER,* THE TENDER TO MV *SWORDFISH* IN THE BACKGROUND.

2.2 BENTHIC HABITAT SURVEYS

Surveys were conducted using benthic survey methods applied in other Northern Territory areas (Collier et al. 2022, Carter et al. 2023, Carter et al. 2025, Groom et al. 2025). At each site, site number, time, latitude and longitude, depth and sediment type were recorded. Depth below mean sea level (MSL) was calculated using tidal data downloaded from the CSIRO Tidal Data Collection. Tidal heights were extracted using *TidePredictionTool.exe* and combined with field-recorded depth measurements collected during each survey to estimate depth relative to mean sea level at each site, and recorded sites between 1 and 40m deep (Herzfeld et al. 2020). Where more than one sediment category was recorded, categories were listed from most to least dominant.

2.2.1 BENTHIC HABITAT OBSERVATIONS AND SAMPLING

2.2.1.1 HELICOPTER

Helicopters were utilised to survey exposed intertidal habitats due to their capacity to move rapidly across large spatial areas (Figure 3). Sites were assigned during the survey to ensure coverage of the intertidal extent, based on exposed areas, significant habitat transitions, and Traditional Owner priorities. Where seagrass was present, additional sites were incorporated to better resolve meadow extent and to improve precision. Sites were surveyed whilst the helicopter maintained a low hover above the exposed substrate. At each site, a visual estimate was made of benthic habitat within three 0.25m^2 replicate quadrats within a 10 m^2 circular site. Where seagrass formed distinct meadows, meadow boundaries were mapped using GPS while flying around the edge.

2.2.1.2 DROP-CAMERA

Subtidal sites were surveyed from Tiwi Ranger vessels *Ampjirrakiningija* and *Marine Ranger 3,* and from *Frontier,* the tender to MV *Swordfish.* Benthic habitat video footage was recorded using an underwater camera (DJI Osmo) (field of view ~0.25m^2) attached to a metal camera frame at approximately 0.5 m off the ground, with the camera facing straight down. A Seavu cable attached to the camera relayed footage to a Samsung tablet on board, enabling real-time observation. At each site, the camera and frame were lowered to the seafloor 10 times with a 1–2 metre drift between each replicate drop (Figure 5a, b). Benthic habitat was observed on a tablet on board the vessels and video recorded for post-field trip processing (Figure 5c, d). Video footage was processed after the field trip using a trained observer.

Subtidal survey sites were generated prior to field work using a spatially balanced sampling design to provide even, randomised coverage of the survey area up to the 20 m depth contour. Additional sites were added where significant habitat transitions occurred.

2.2.1.3 VAN VEEN GRAB

When visibility was low, and habitat and seagrass species could not be readily identified with the drop camera, a van Veen grab (grab area 0.0625 m^2) was deployed over the side of the vessel to collect a sample (Figure 5a, b). Sediment and specimens collected by the van Veen grab were photographed and contents recorded on the data sheet, and immediately returned to the water. Where underrepresented seagrass species were found, fragments were kept and pressed for the Northern Territory Herbarium.



FIGURE 5. SUBTIDAL SITES WERE SURVEYED BY (A, B) A DROP CAMERA SYSTEM THAT WAS DEPLOYED AND LOWERED TO THE SEA FLOOR WITH (C, D) VIDEO DISPLAYED IN REAL TIME AND (E, F) VAN VEEN GRAB WHERE VISIBILITY WAS LOW.

2.2.1.4 TOWED VIDEO

This method was used on MV *Swordfish* and is designed for detailed assessments using larger vessels with towing capability. At each site, a sled frame with an underwater CCTV camera (SpotX) system was winched from the vessel to the sea floor (Figure 6a, b). A GoPro was attached to the sled frame as a back-up camera system. At each transect, the camera was towed at drift speed (< 1 knot) for approximately 100m. Benthic habitat was observed on a monitor and video recorded. Ten still images were captured at random time points along the transect for habitat assessments by a trained observer post-field trip.

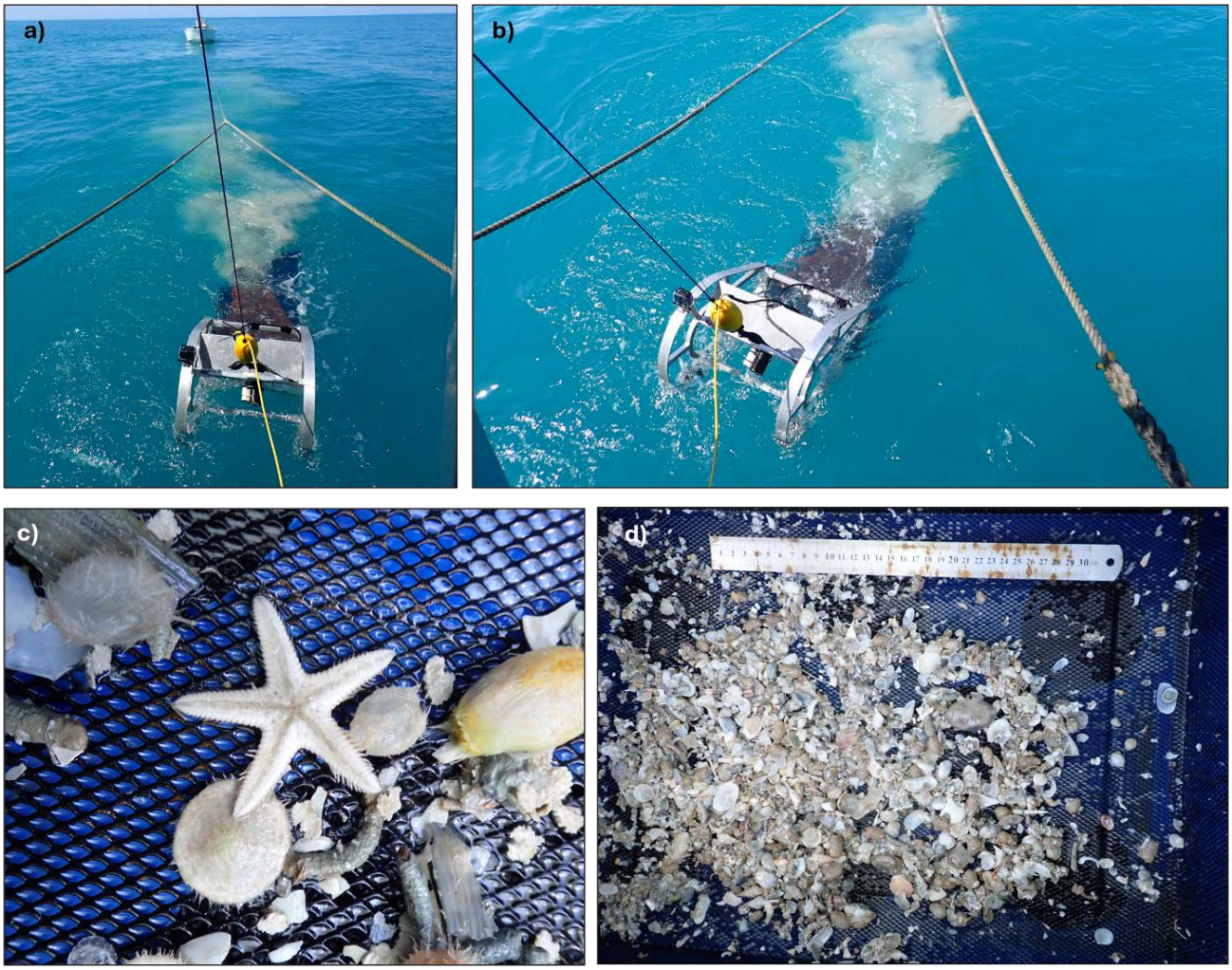

FIGURE 6. TOWED VIDEO AND SLED NET FOR BENTHIC SURVEYS: (A, B) A SLED WITH CAMERA AND NET ATTACHED WAS DEPLOYED FROM MV *SWORDFISH* AND (C, D) SAMPLES FROM THE SLED NET WERE SORTED FOR IDENTIFICATION.

2.2.1.5 SLED NET

A small net was attached to the back of the sled frame to collect a benthic sample at each site to confirm sediment type (Figure 6d&e). Sled net contents, including mobile and sessile invertebrates, were sorted and photographed for species identification before being returned to the sea.

2.2.2 SEAGRASS BIOMASS AND PERCENT COVER

Seagrass above-ground biomass and percent cover were estimated for each 0.25 m^2 replicate quadrat from the helicopter, and each camera drop and camera tow still image. Seagrass biomass was determined using the 'visual estimates of biomass' technique (Mellors 1991). This involves ranking seagrass biomass while referring to a series of quadrat photographs of similar seagrass habitats for which the above-ground biomass

has been previously measured. Low, high and *Enhalus* biomass scales were used for this survey. The percent contribution of each seagrass species to total above-ground biomass within each quadrat was also estimated. At the completion of the helicopter survey and the subtidal video analysis, each observer ranked a series of calibration quadrats. A linear regression was then calculated for the relationship between observer ranks and the harvested values and used to calibrate above-ground biomass estimates for all ranks made by that observer. Biomass ranks were converted to above-ground biomass in grams dry weight per square metre (gDW m^{-2}) and averaged among replicates to provide mean total seagrass above-ground biomass, and contribution to total above-ground biomass for each species, for each site. Seagrass cover and seagrass species percent cover also were estimated for each quadrat using a series of quadrat photographs for which percent cover was previously estimated.

2.2.3 Algae communities

The habitat assessment for each quadrat included percent cover of algae from five functional groups (Table 2).

Table 2 Algae community functional groups and their descriptions.

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

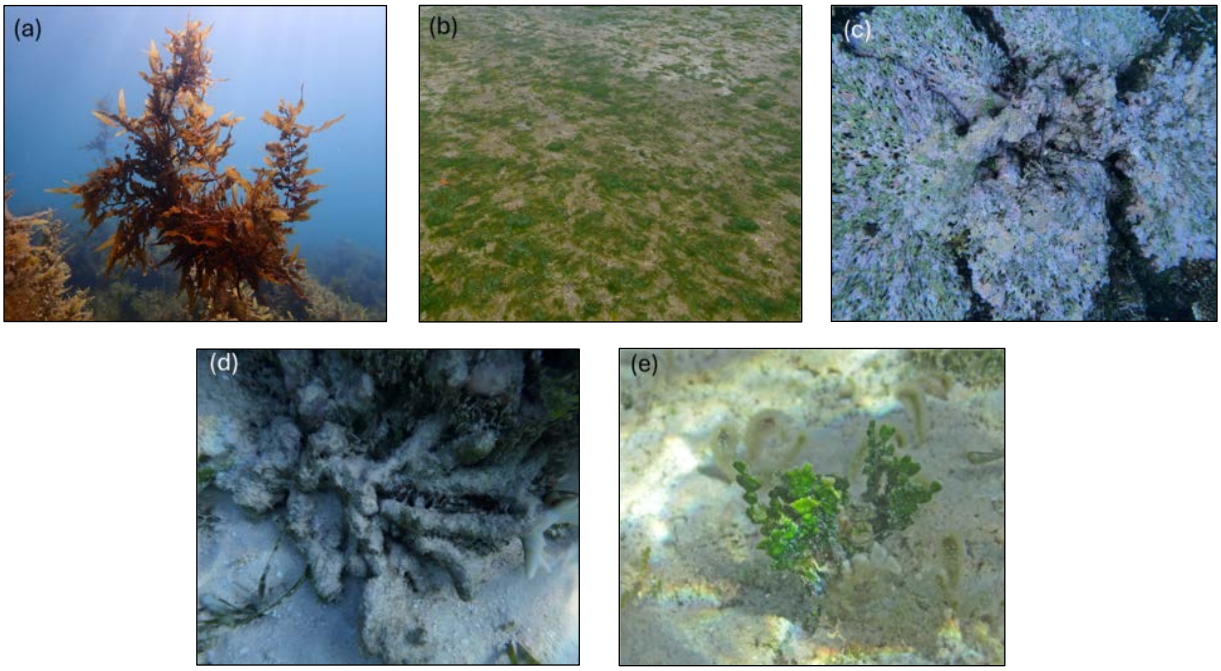

FIGURE 7. EXAMPLES OF ALGAE FUNCTIONAL GROUPS (A) ERECT MACROPHYTE, (B) FILAMENTOUS, (C) ENCRUSTING, (D) TURF MAT AND (E) ERECT CALCAREOUS.

2.2.4 BENTHIC MACROINVERTEBRATE COMMUNITIES

The percent covers of habitat-forming benthic macroinvertebrates (BMI) was estimated for each quadrat according to broad taxonomic groups: hard coral, soft coral, sponge, and other BMI (Table 3). Sessile and mobile invertebrates photographed in the sled net contents were identified to the lowest taxonomic level.

TABLE 3 BENTHIC MACROINVERTEBRATE (BMI) FUNCTIONAL GROUPS AND THEIR DESCRIPTIONS.

Functional group label	Description
Hard coral	All scleractinian corals, e.g. massive, branching, tabular, digitate and solitary
Soft coral	All alcyonarian corals, i.e. corals lacking a hard calcareous skeleton
Sponge	All sponges, e.g. vase, tube, branching, barrel or encrusting forms
Other BMI	Other BMI identified, e.g., bryozoans, hydroids, ascidians, barnacles, oysters, and habitat-forming molluscs such as clams and are listed in the 'comments' column of the GIS site layer

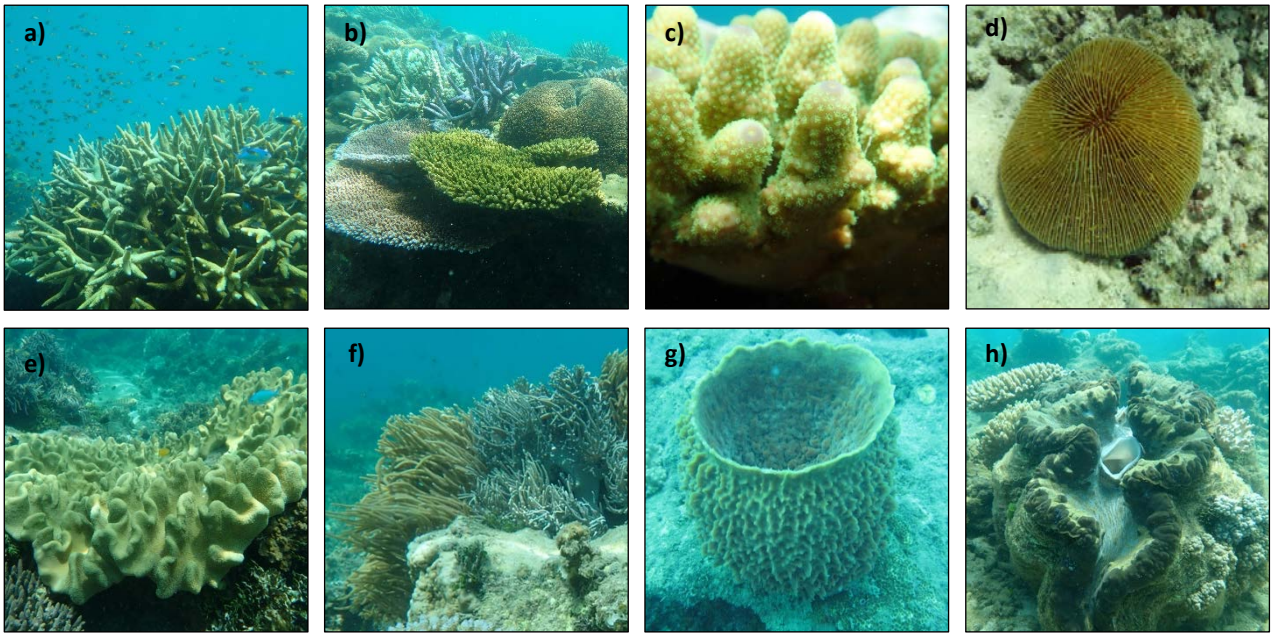

FIGURE 8. EXAMPLES OF (A-D) HARD CORALS (BRANCHING, TABULAR, DIGITATE, SOLITARY), (E, F) SOFT CORALS, (G) SPONGE AND (H) OTHER BENTHIC MACROINVERTEBRATE (GIANT CLAM).

2.2.5 ADDITIONAL INFORMATION

Sea cucumbers were counted at each site and are included in the data sets but are not included as habitat-forming invertebrates in percent benthic cover assessments. Dugong feeding trails (presence/absence) were recorded at each intertidal site surveyed by helicopter. At subtidal sites, the presence of dugong, turtle and dolphins was recorded.

2.2.6 GEOGRAPHIC INFORMATION SYSTEM (GIS)

All survey data was entered into a Geographic Information System (GIS) using ArcGIS Pro 3.6 (Environmental Systems Research Institute, ESRI). Data structures and attribute fields were designed to align with spatial data standards for other northern Australian seagrass datasets. Three GIS layers were created to describe spatial habitats in the region: a habitat site layer, seagrass meadow layer and seagrass biomass interpolation layer.

2.2.7 HABITAT SITE LAYER

This shapefile contains point data collected at each survey site and includes:

- temporal details of survey date and time
- spatial details of location, tidal zone, latitude/longitude and depth below mean sea level (dbMSL; subtidal sites only)
- sediment type
- seagrass-specific information of seagrass presence/absence, mean total above-ground biomass ± standard error (SE), mean biomass for each species, mean total percent cover seagrass, and mean percent cover for each species
- percent cover of algae and algal types, BMI and BMI types, and bare substrate
- sampling method and survey vessel name

- the presence of dugong feeding trails (intertidal sites), sea cucumbers (intertidal and subtidal sites), and turtles, dugongs or dolphins (subtidal sites) observed at the site
- comments.

2.2.8 SEAGRASS MEADOW LAYER

This layer contains polygon features representing discrete seagrass meadows. Each polygon summarises key seagrass attributes for the sites located within that meadow, including:

- temporal details, i.e. survey date
- seagrass meadow information, including meadow identification (ID) code, meadow area in hectares, seagrass species present, meadow community type, meadow density, mean meadow above-ground biomass ±, and number of total and biomass sites within the meadow
- sampling method
- comments.

Intertidal seagrass meadows were defined using a combination of field notes, mapped meadow boundaries and seagrass presence/absence site data collected during the helicopter survey, the intertidal extent model (Bishop-Taylor et al. 2019) and visual interpretation of satellite imagery from a low-tide PlanetScope composite. The composite was generated by selecting the best available scenes and applying a median compositing approach to 42 downloaded scenes acquired between 1 September 2023 and 30 November 2023. Where the imagery was difficult to interpret, such as areas affected by cloud, sun glint or insufficient tidal exposure, or where the habitat was complex, comprising a mix of rock, reef and seagrass, the remotely sensed polygons were manually adjusted using the field data to estimate meadow boundaries, including the transition to subtidal areas. Subtidal seagrass meadow boundaries were defined using the distance between presence and absence sites and the intertidal-subtidal boundary.

The meadow community type was determined according to seagrass species composition. Species composition was based on the percent each species' biomass contributed to the mean meadow biomass. A standard nomenclature system was used to categorise each meadow (Table 4). This nomenclature also included a measure of meadow density categories (light, moderate, dense) determined by the mean biomass of the dominant species within the meadow (Table 5).

TABLE 4. 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 5. 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. ovalis* *H. decipiens*	*H. uninervis* *C. serrulata* *C. rotundata* *S. isoetifolium*	*T. hemprichii*	*E. acoroides*
Light	< 1	< 5	< 15	< 40
Moderate	1–5	5–25	15–35	40–100
Dense	> 5	> 25	> 35	> 100

2.2.9 BIOMASS INTERPOLATION RASTER

An inverse distance weighted (IDW) interpolation was applied to total seagrass above-ground biomass point data (using the site layer) to describe spatial variation in biomass across seagrass meadows. The interpolation was conducted in ArcGIS Pro 3.6.

3 RESULTS

The northern Tiwi coastline supports a diverse assemblage of marine habitats, including seagrass meadows, algal communities, benthic macroinvertebrate communities and well-developed coral reefs. These habitats were readily observed at low-tide in the 2023 helicopter surveys, with extension into adjacent shallow subtidal waters confirmed by boat in 2024. The substrate for much of the subtidal survey area was fine mud sediments that readily re-suspended, resulting in very high turbidity particularly close to the sea floor. The substrate in the remainder of the survey area was a combination of rock, reef, sand or shell.

3.1 SEAGRASS

3.1.1 SEAGRASS PRESENCE AND ABSENCE

Seagrass was present at 489 (24%) of intertidal sites (Figure 9) and concentrated in the Apsley Strait between Pirlangimpi and Cape Van Diemen on Melville Island, and the adjacent coastline of Bathurst Island. Seagrass was present in Shark Bay, Snake Bay, and between the Jessie River and Kwanipiri Bay (Figure 10, Figure 11). There were 41 (7.5%) subtidal sites with seagrass present. Subtidal seagrass was primarily found in the shallow waters of Shark Bay, Snake Bay and Kwanipiri Bay at a depth of 1.3m to 5.2m below mean sea level (dbMSL). The average depth of subtidal seagrass was 2.12m dbMSL. Subtidal seagrass was primarily found between 140–1500 metres from the coastline, except for one site northwest of Cape van Diemen that was ~10km from the shore at a depth of 3.3m.

Seagrass occurred in protected habitats within bays and inlets, while along the coast it occurred behind fringing rock or coral reefs, particularly in the northeast of Melville Island. Seagrass in Apsley Strait was only intertidal and close to the shore where it is protected from the strong tidal currents, although it is possible that there was shallow subtidal seagrass that could not be accessed during the boat-based surveys.

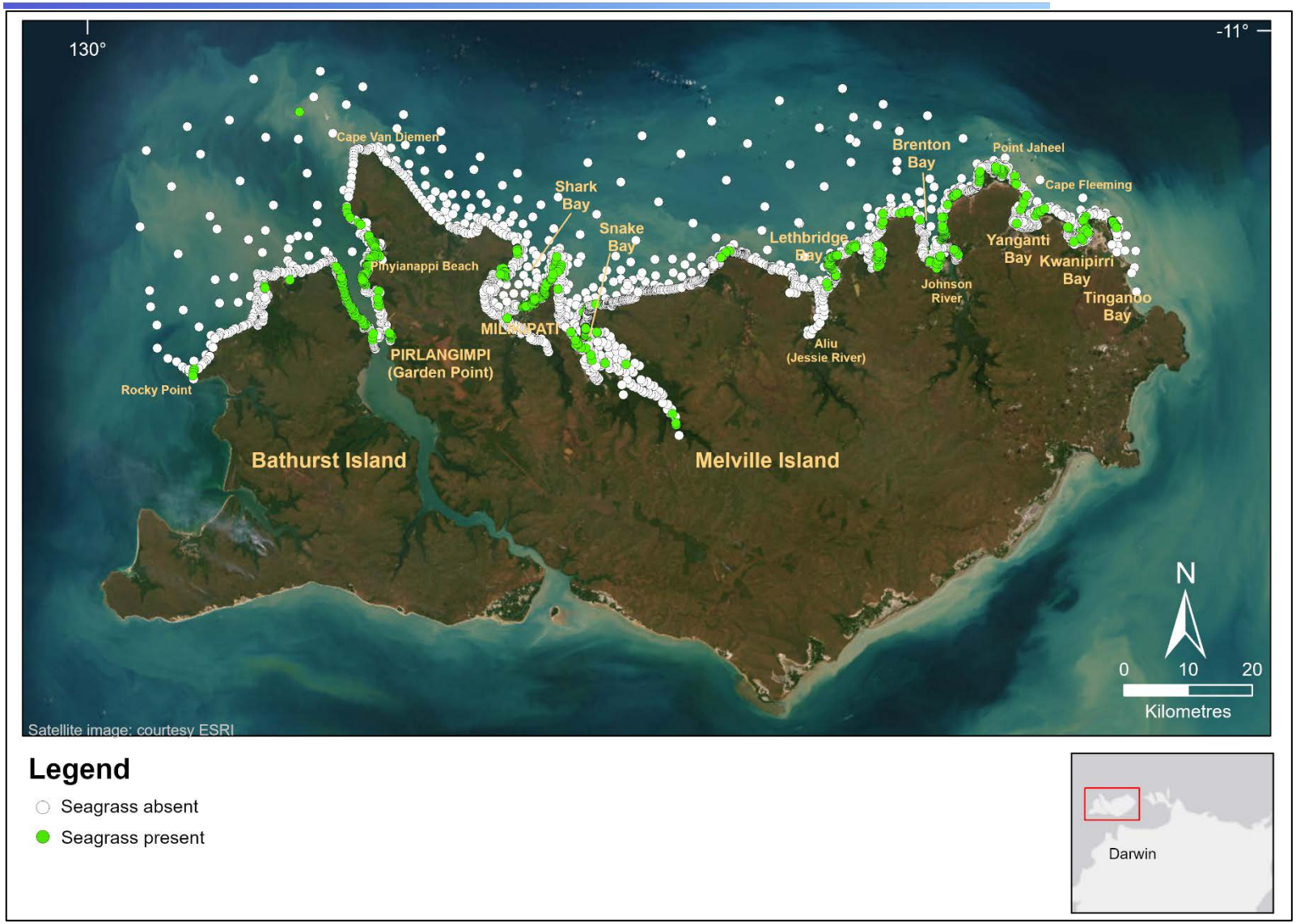

FIGURE 9. SEAGRASS PRESENCE AND ABSENCE AT SURVEY SITES IN THE NORTHERN TIWI ISLANDS.

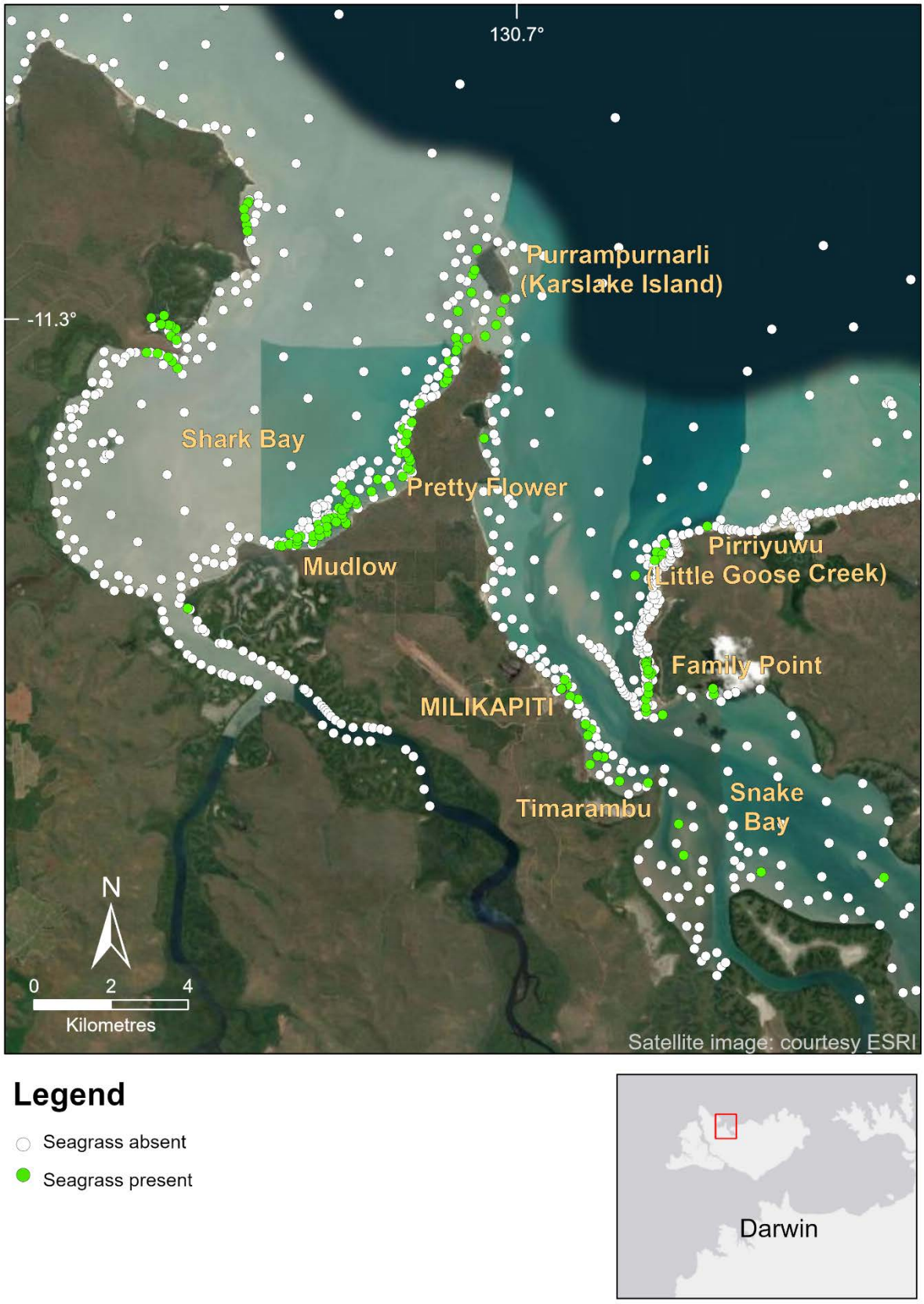

FIGURE 10. SEAGRASS PRESENCE AND ABSENCE AT SURVEY SITES IN SHARK BAY AND SNAKE BAY.

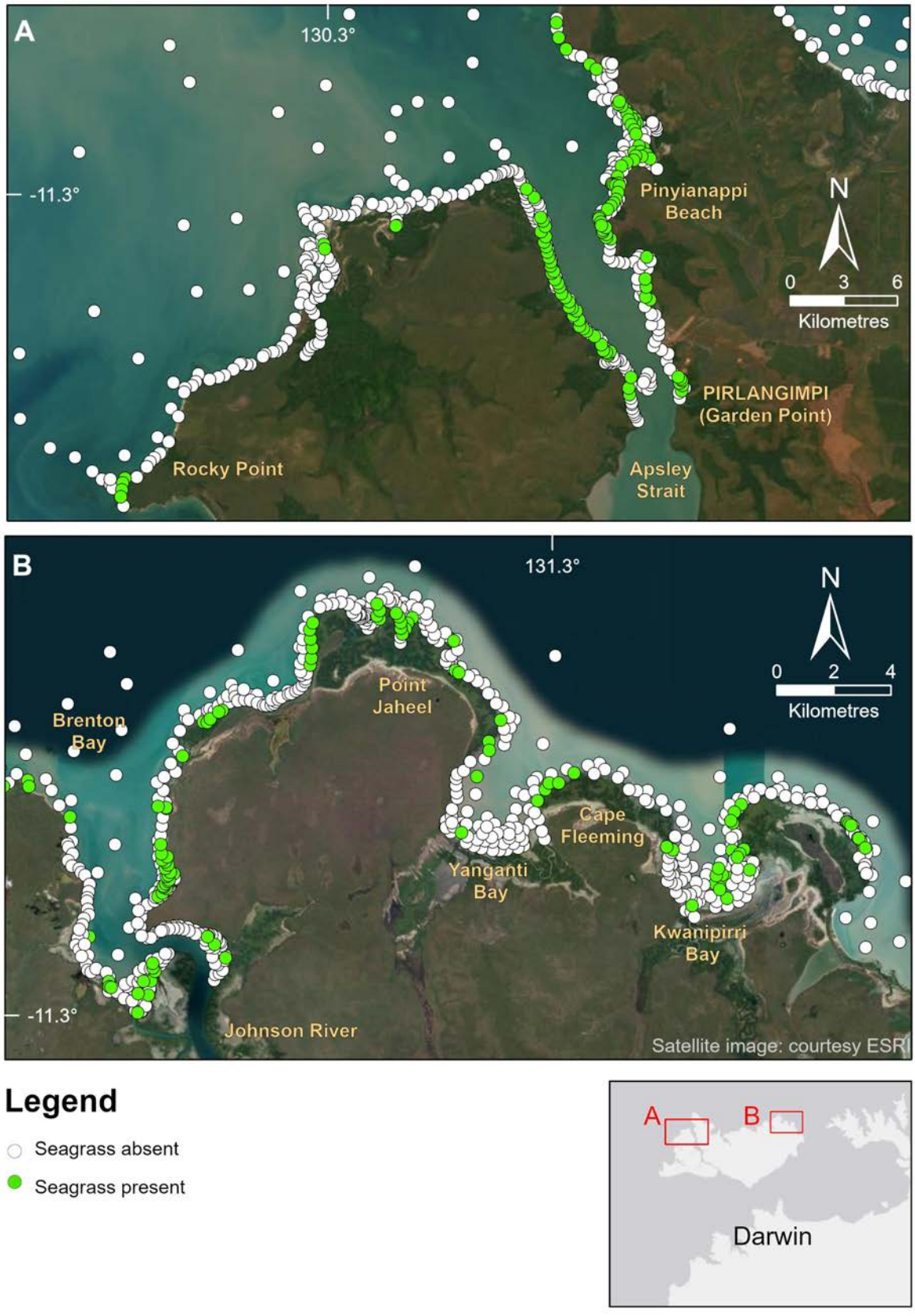

FIGURE 11. SEAGRASS PRESENCE AND ABSENCE AT SURVEY SITES IN (A) APSLEY STRAIT AND (B) BRENTON BAY TO KWANIPIRI BAY

3.1.2 SEAGRASS SPECIES

Eight seagrass species from two families were recorded during the survey: *Enhalus acoroides*, *Thalassia hemprichii*, *Cymodocea serrulata*, *Cymodocea rotundata*, *Syringodium isoetifolium*, *Halodule uninervis*, *Halophila ovalis* and *Halophila decipiens* (Figure 12).

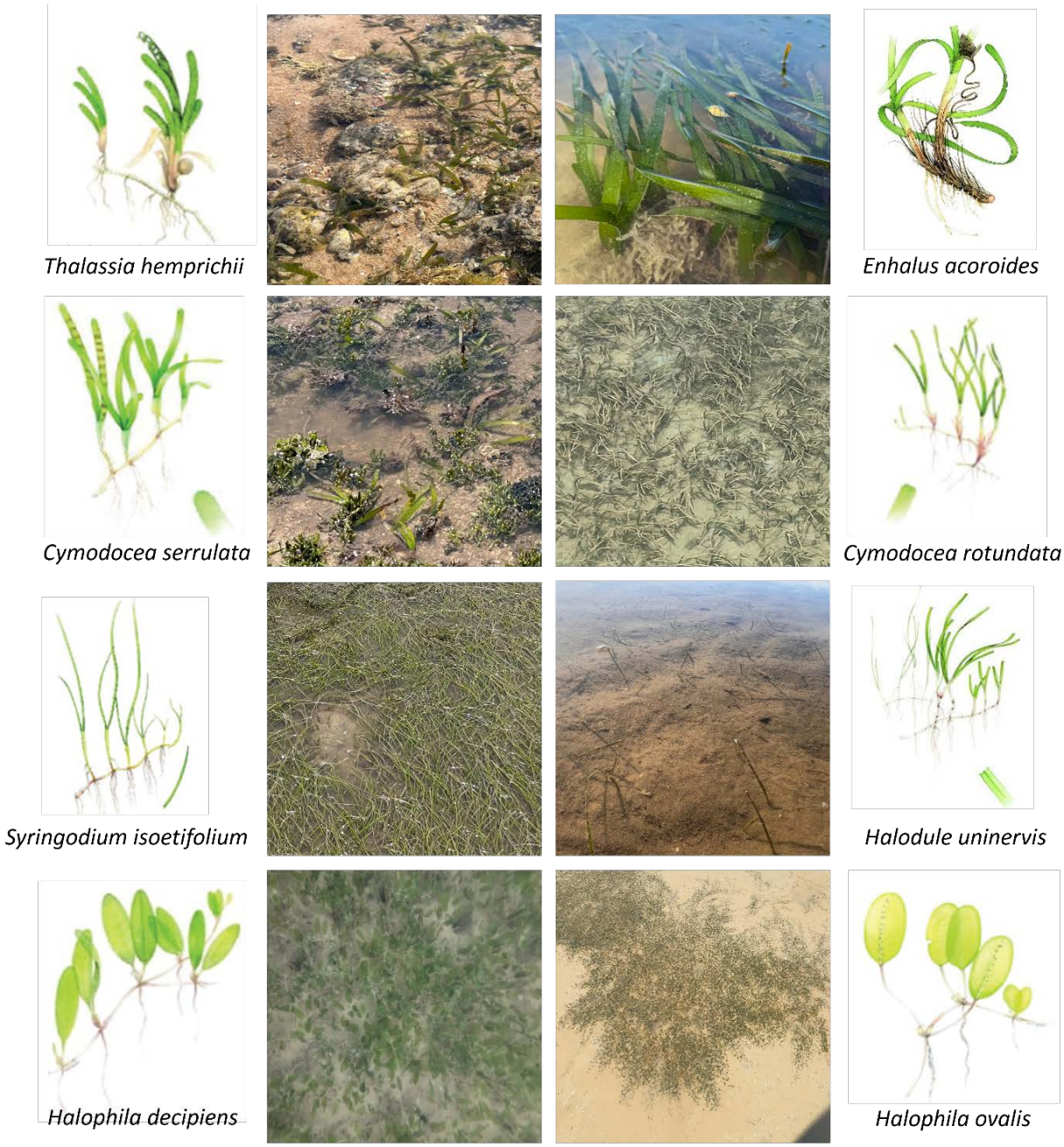

FIGURE 12. SEAGRASS SPECIES PRESENT DURING SURVEYS.

Halophila ovalis and *Halodule uninervis* were the most widespread and abundant species (Figure 14). Both are common throughout northern Australia and are tolerant of a broad range of environmental conditions. *H. ovalis* is a colonising species, typically occurring in disturbed habitats, including areas subject to tidal exposure, wave action, or dugong grazing in shallow coastal environments. On the Tiwi Islands, *H. ovalis* was dominant at most intertidal sites at Rocky Point and Apsley Strait, and occurred in patches at other locations.

H. uninervis frequently co-occurred with *H. ovalis* in the Apsley Strait, was common in Shark and Snake Bays and along the northeast coast of Melville Island (Figure 15, Figure 16). In contrast to *H. ovalis*, *H. uninervis* frequently extended into subtidal habitats and formed a distinct subtidal meadow at Jipinu, the northeast entrance to Snake Bay. Both species were associated with soft sand or muddy sediment.

Halophila decipiens occupied similar sedimentary habitats and was typically observed in shallow subtidal areas, either mixed with *H. ovalis* and *H. uninervis* or occurring as monospecific patches. This species is a low-light, deepwater specialist compared with other species recorded (Table 6). It was the only seagrass observed offshore, occurring at a single site 10km from Cape Van Diemen (Figure 14).

Thalassia hemprichii and *Cymodocea rotundata* were associated with reef habitats (Table 6), predominantly in intertidal zones. Sand or mud were the dominant substrates, but both commonly had reef, rock, or rubble as substrates as well. These species were common near Karslake Island and along the north-eastern coast of Melville Island (Figure 14, Figure 16). *Cymodocea serrulata* was also found in intertidal waters in muddy and rocky habitat types (Figure 14).

Enhalus acoroides was a common species in the northern Tiwi Islands but exhibited a relatively narrow habitat range. It was typically found in sheltered bays or in areas protected by reefs, often growing adjacent to mangroves. Dense *E. acoroides* meadows were observed at sites such as Karslake Island and Pretty Flower in Shark Bay (Figure 13, Figure 15). At other locations, including Robinson Inlet, Johnson River and Timarambu, the species occurred as isolated patches and frequently formed characteristic ring-shaped structures (Figure 13). *E. acoroides* was restricted to very shallow intertidal environments and observed at just one subtidal site (Table 6). Flowering was recorded at one site east of Kwanipiri Bay. *Syringodium isoetifolium* was the least frequently recorded species, although it formed a notably dense meadow within the intertidal lagoon at Family Point (Table 6, Figure 15).

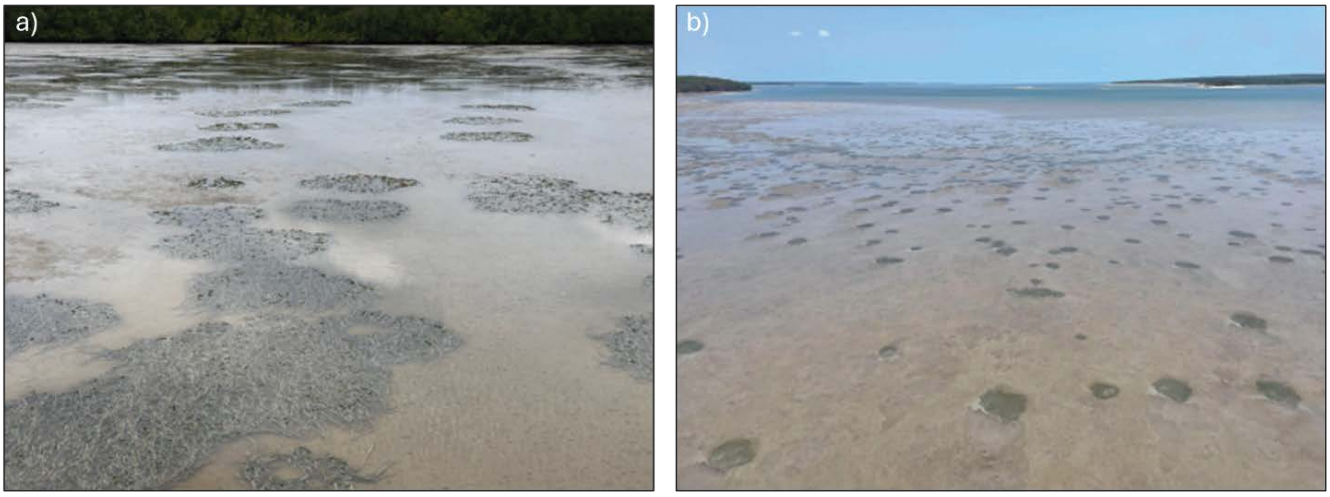

FIGURE 13. PATCHES OF *E. ACOROIDES* AT (A) KARSLAKE ISLAND AND (B) TIMARAMBU IN SNAKE BAY.

TABLE 6. COUNT OF INTERTIDAL AND SUBTIDAL SITES WHERE EACH SEAGRASS SPECIES WAS PRESENT, DEPTH RANGE AND DOMINANT SUBSTRATE ACROSS THE TIWI ISLANDS.

Seagrass species	Intertidal sites	Subtidal sites	Minimum Depth (m)	Maximum Depth (m)	Dominant substrates	Total Sites
Enhalus acoroides	119	1	0	2.9	Mud	120
Thalassia hemprichii	62	3	0	1.9	Sand	65
Cymodocea serrulata	14	3	0	2.6	Mud/Sand	17
Cymodocea rotundata	37	1	0	1.9	Mud	38
Halodule uninervis	108	14	0	5.0	Sand	122
Syringodium isoetifolium	15	0	0	0	Sand	15
Halophila spinulosa	1	0	0	0	Mud	1
Halophila decipiens	8	19	1.3	5.1	Mud	27
Halophila ovalis	125	0	0	0	Mud	125

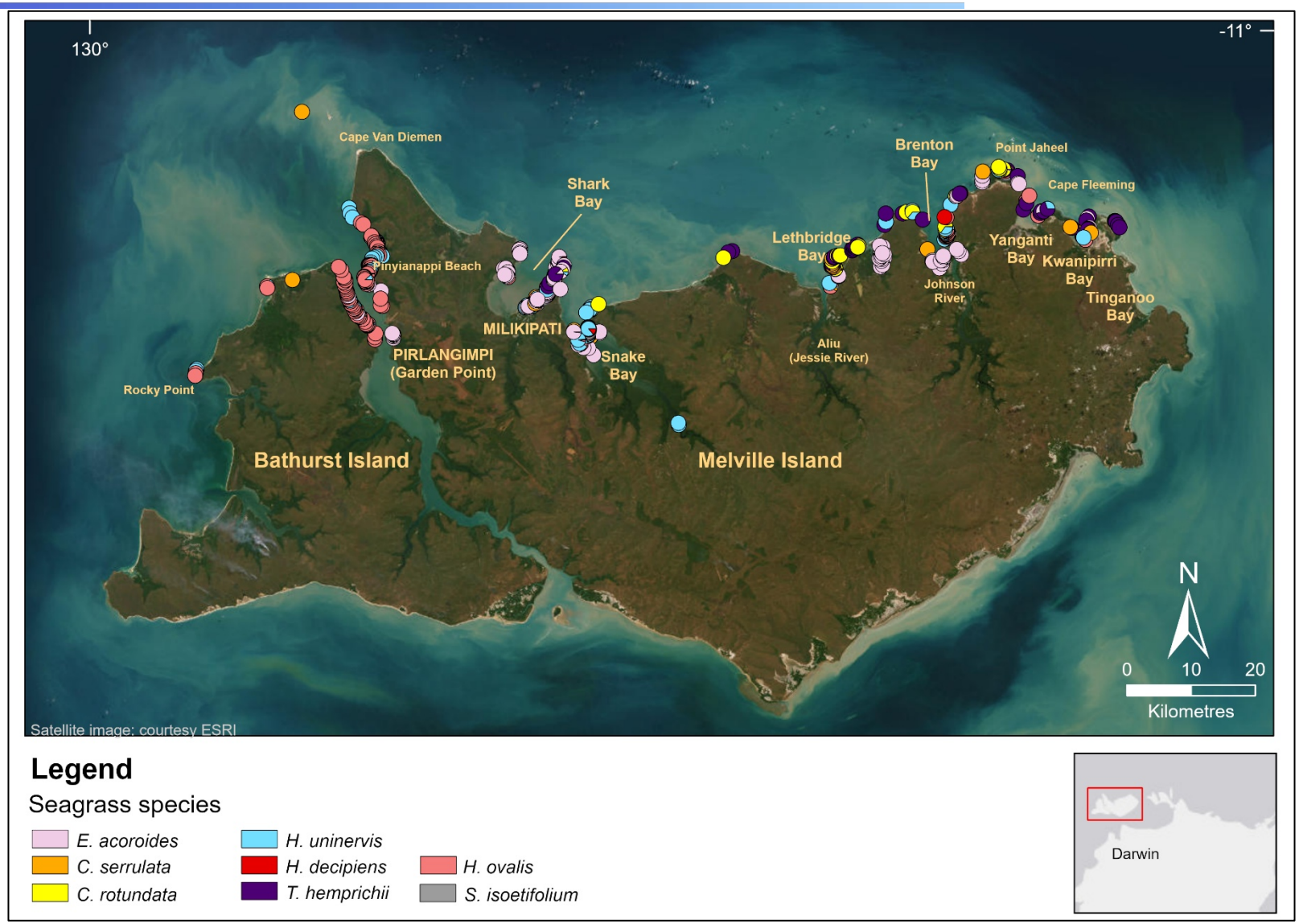

FIGURE 14. SEAGRASS SPECIES COMPOSITION AT SURVEY SITES.

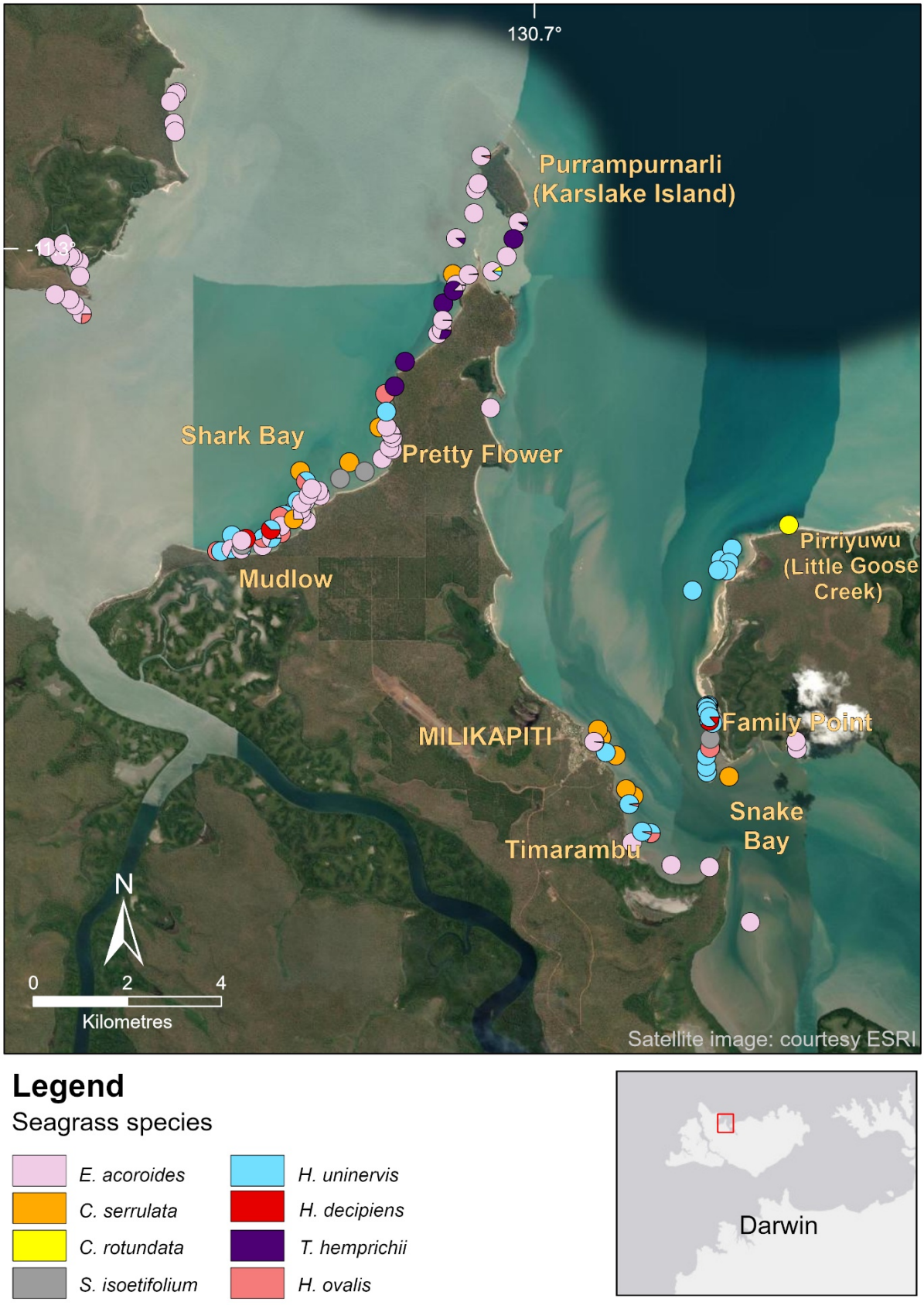

FIGURE 15. SEAGRASS SPECIES COMPOSITION IN SHARK BAY AND SNAKE BAY.

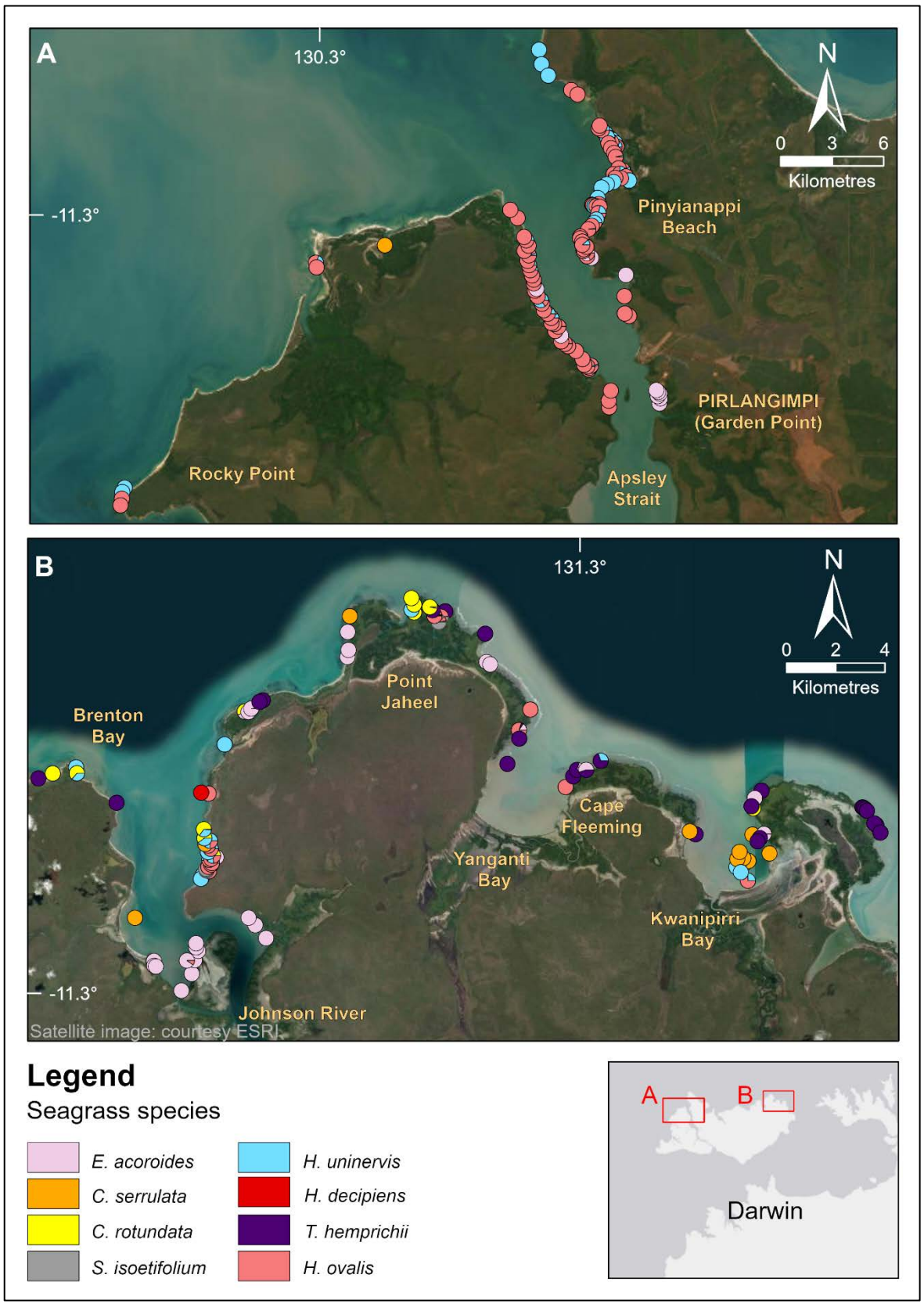

FIGURE 16. SEAGRASS SPECIES COMPOSITION IN (A) APSLEY STRAIT AND (B) BRENTON BAY TO KWANIPIRI BAY.

3.2 SEAGRASS MEADOWS

A total of 1,212 ha of intertidal seagrass was mapped across 119 meadows and 1,339 ha of subtidal seagrass across 18 meadows, giving 137 meadows covering a combined 2,551 ha within the survey area (Figure 17). Seagrass meadows were mostly small and highly fragmented. In several locations, adjacent meadows were classified as separate intertidal and subtidal meadows, or where there was a clear difference in dominant species, such as the coastal meadow in Shark Bay (Figure 18–Figure 21).

Meadows dominated by *E. acoroides* accounted for approximately 25% of the total mapped seagrass area (Figure 18–Figure 21). This included extensive and dense intertidal meadows at Karslake Island and Shark Bay, extending south-west along the coastline from Pretty Flower to Mudlow (Figure 19). Meadows dominated by *H. ovalis* comprised approximately 21% of the total meadow area and were primarily distributed along Apsley Strait and other nearshore intertidal environments across the survey region (Figure 18). *T. hemprichii* meadows accounted for approximately 17% of the mapped area and occurred predominantly on reef platforms along the north-eastern coast of Melville Island (Figure 21).

Many meadows were spatially constrained by local geomorphology. In reef-associated systems, meadow extent was limited seaward by fringing reefs and shoreward by mangroves. In soft-sediment environments, meadows on mud banks and beaches were frequently interrupted by rocky or reef headlands, particularly within Apsley Strait.

The largest mapped subtidal meadow occurred in Kwanipiri Bay (Figure 21), accounting for more than 55% of the total subtidal seagrass area, though sparse *H. decipiens* characterised it. By contrast, a smaller subtidal meadow at Jipinu in northwest Snake Bay supported relatively dense *H. uninervis* and represents an important hunting area (Figure 19).

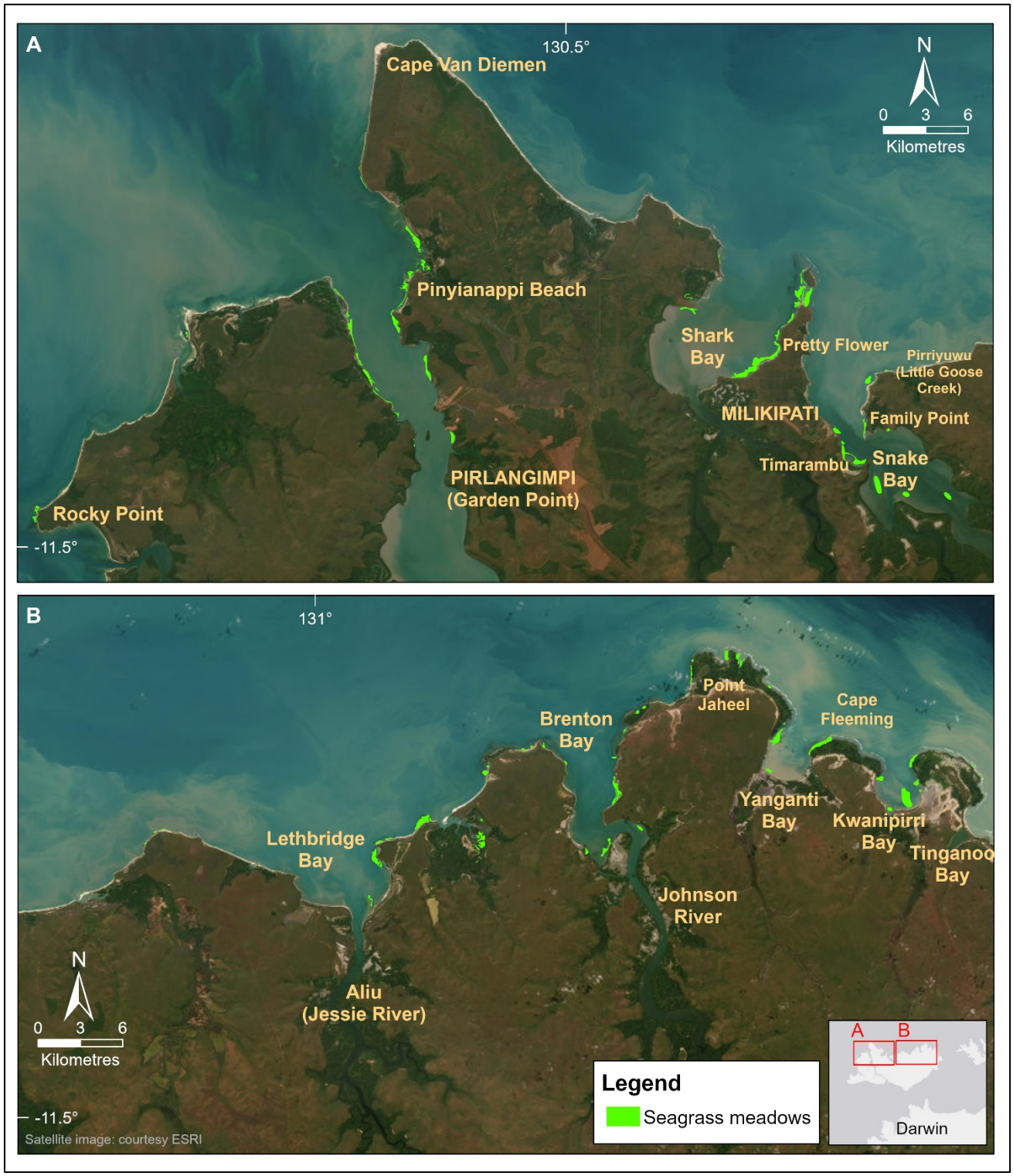

FIGURE 17. TIWI ISLANDS SEAGRASS MEADOWS AT (A) PAJUWAPURA (ROCKY POINT) TO SNAKE BAY AND (B) JESSIE RIVER TO KWANIPIRI BAY.

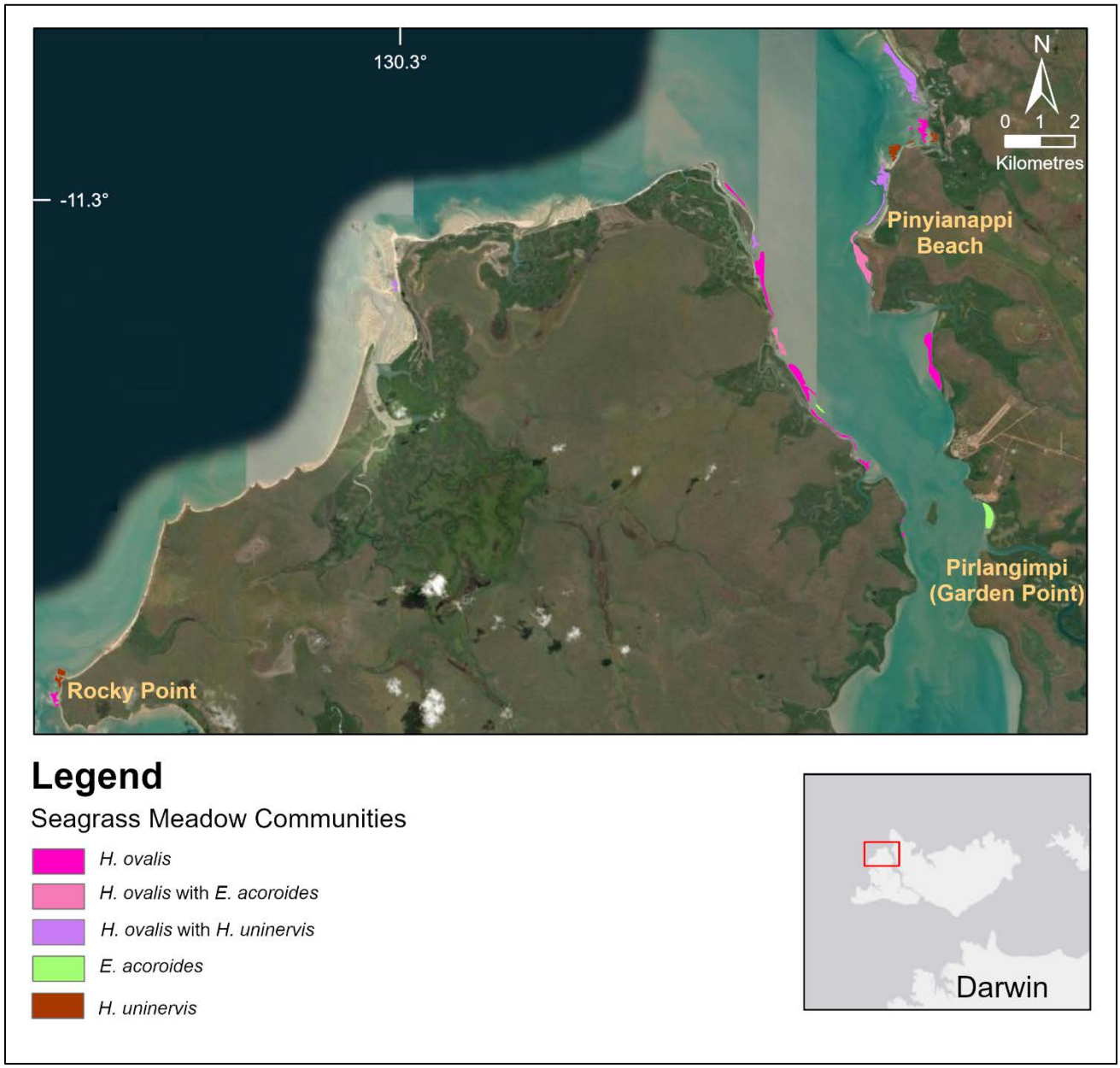

FIGURE 18. SEAGRASS MEADOW COMMUNITIES FROM ROCKY POINT TO APSLEY STRAIT.

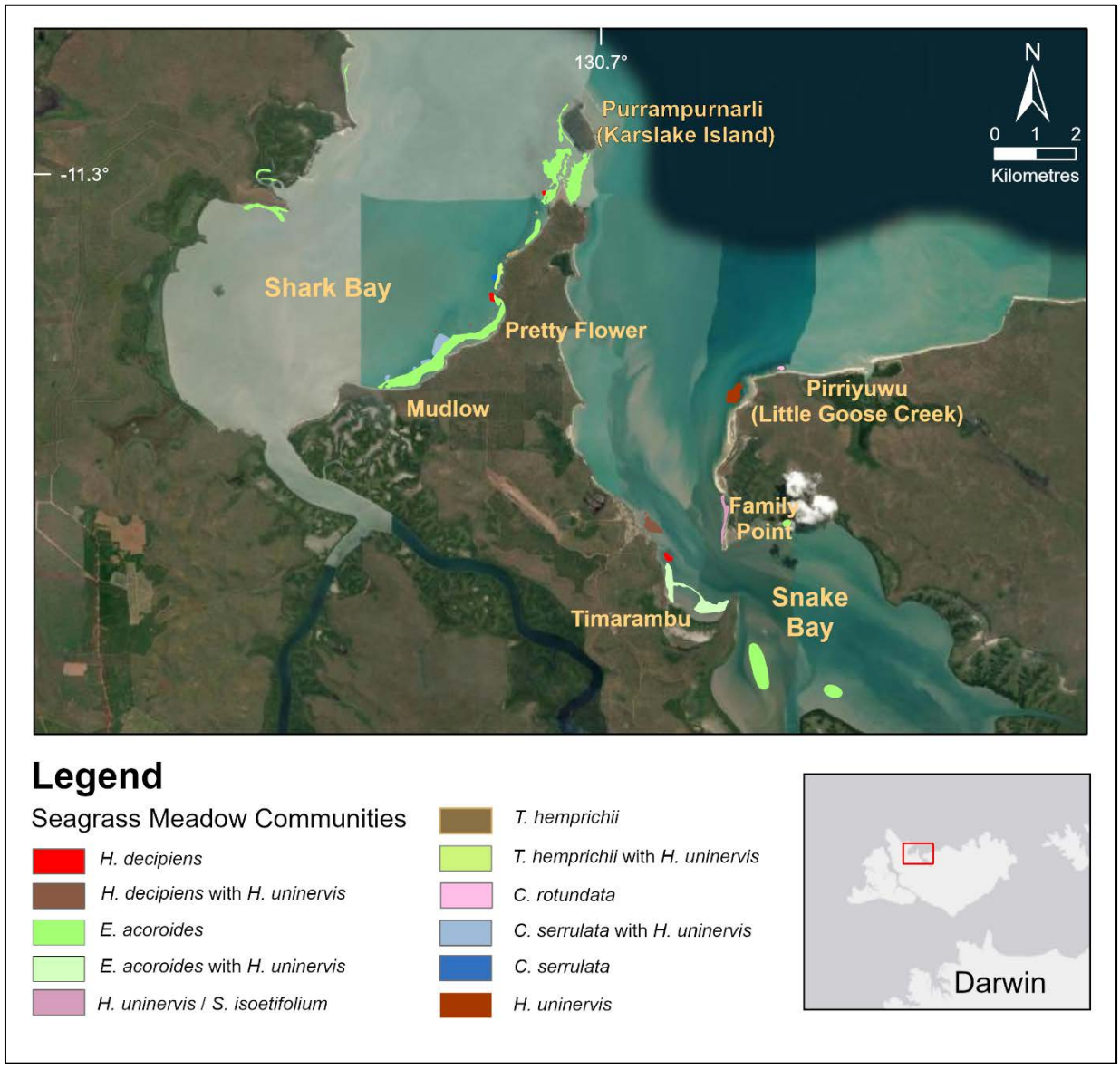

FIGURE 19. SEAGRASS MEADOW COMMUNITIES IN SHARK BAY AND SNAKE BAY.

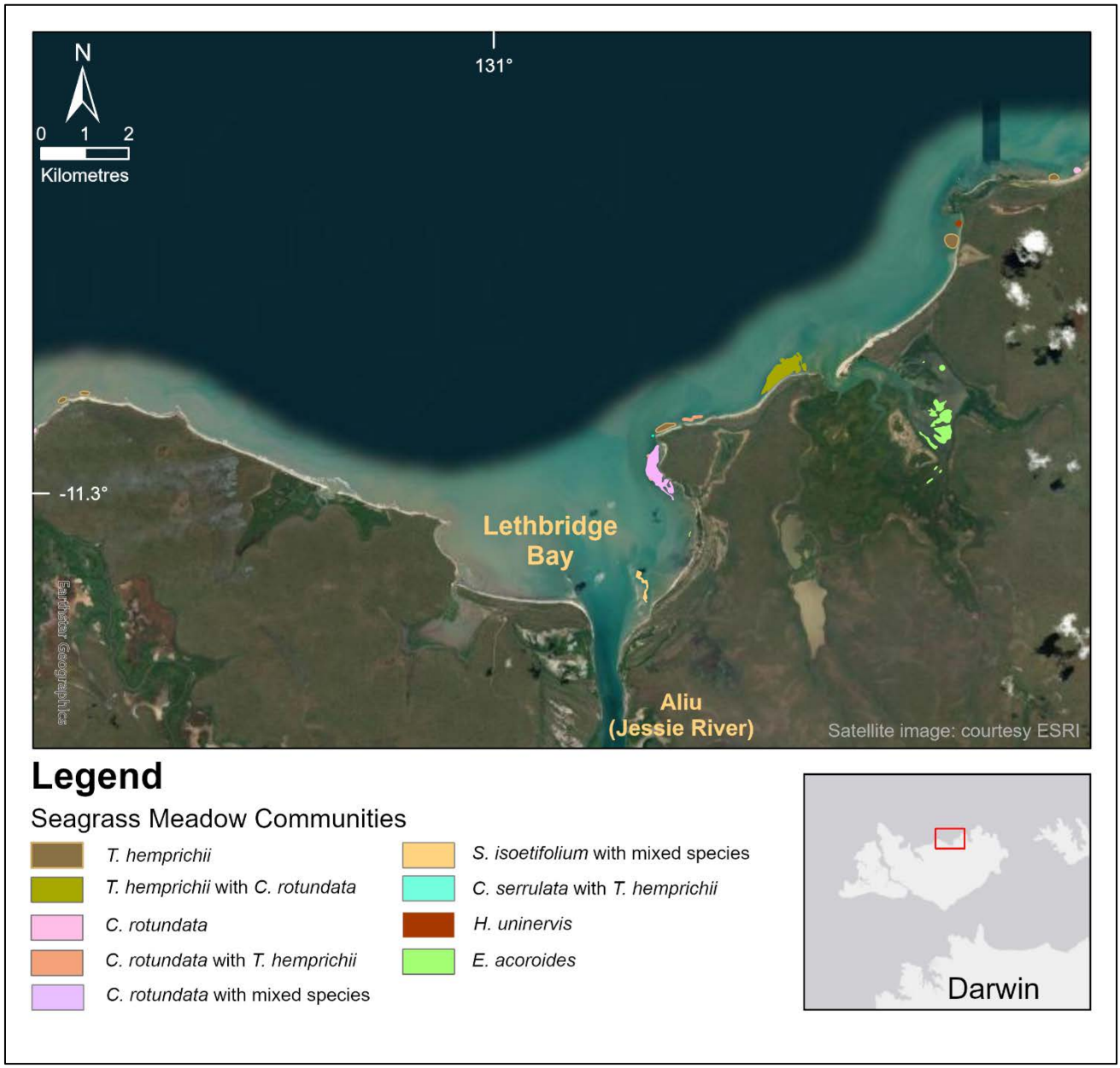

FIGURE 20. SEAGRASS MEADOW COMMUNITIES IN LETHBRIDGE BAY.

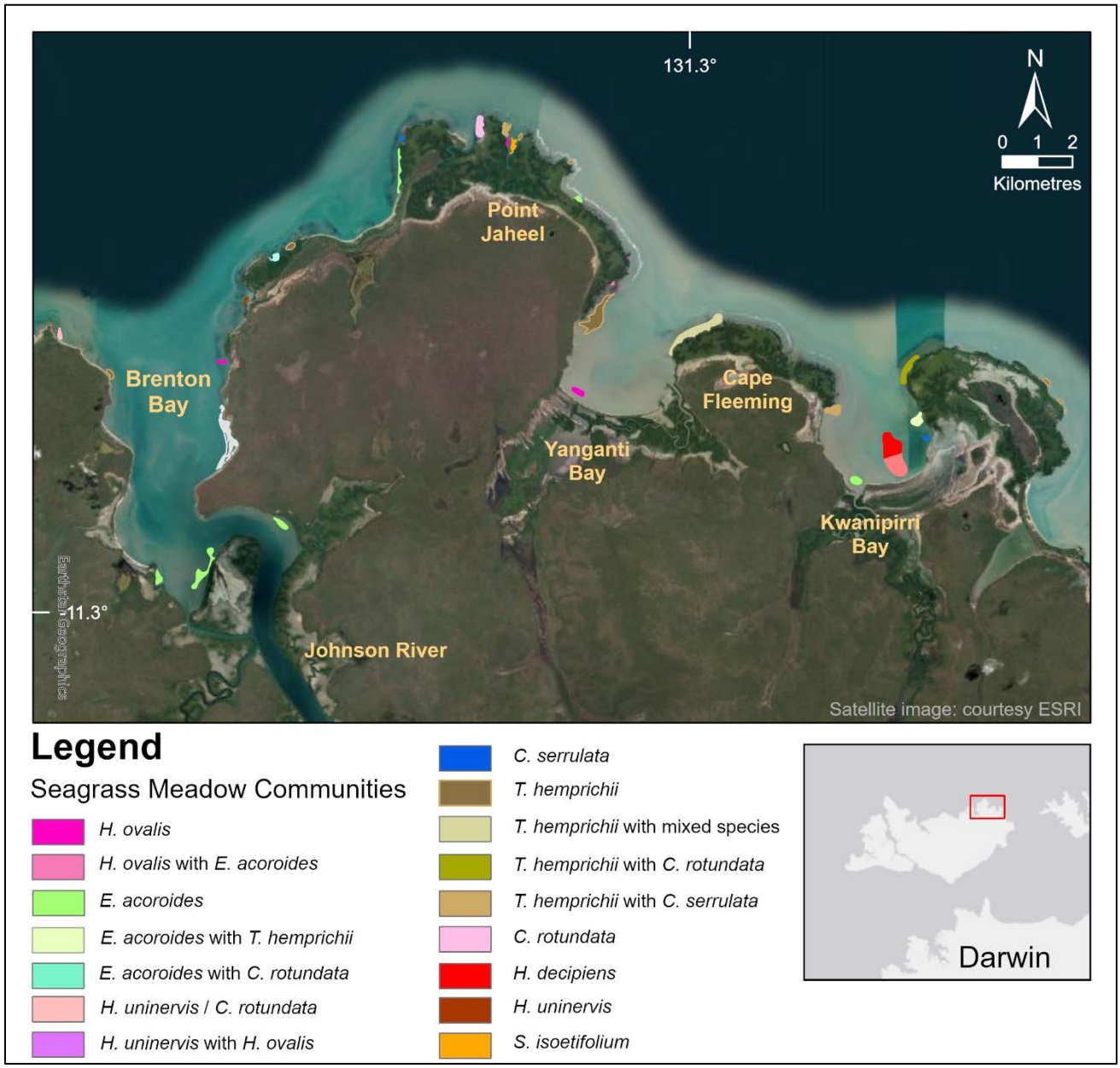

FIGURE 21. SEAGRASS MEADOW COMMUNITIES FROM BRENTON BAY TO KWANIPIRI BAY.

3.2.1 SEAGRASS BIOMASS AND PERCENT COVER

Intertidal seagrass percent cover ranged from 0.1 to 95%, with a mean of 11% (Figure 22–Figure 25). Subtidal seagrass percent cover ranged from 0.1 to 63%, with a mean of 5.7%. Most sites had <40% cover, but those with higher cover (16 sites) were dominated by *H. ovalis* (6 sites), *E. acoroides* and *H. uninervis* (4 sites each, with the highest per cent cover of 95%), and *S. isoetifolium* and *H. decipiens* (1 site each). All were intertidal sites except for the *H. decipiens* site.

Seagrass biomass at intertidal sites ranged from 0.02 to 62.7 g DW m^{-2} with a mean of 8.2 g DW m^{-2}. Biomass at subtidal sites was lower, ranging from <0.01 to 14.9 g DW m^{-2} (Figure 22–Figure 25). The dominant species at high-biomass sites was generally *E. acoroides*, and these sites were intertidal. Sites where *E. acoroides* was present had a higher mean biomass (11.5 g DW m^{-2}). Other sites with high biomass were dominated by *S. isoetifolium*, *H. uninervis* and C*. rotundata*.

Mean intertidal meadow biomass ranged from 0.62–7.91 g DW m^{-2}. *E. acoroides* mostly dominated the largest biomass meadows and were around Karslake Island (Figure 23). Six intertidal meadows ranging in size from 0.01 to 17.1 ha were detected using satellite imagery; no biomass estimates were made for these meadows.

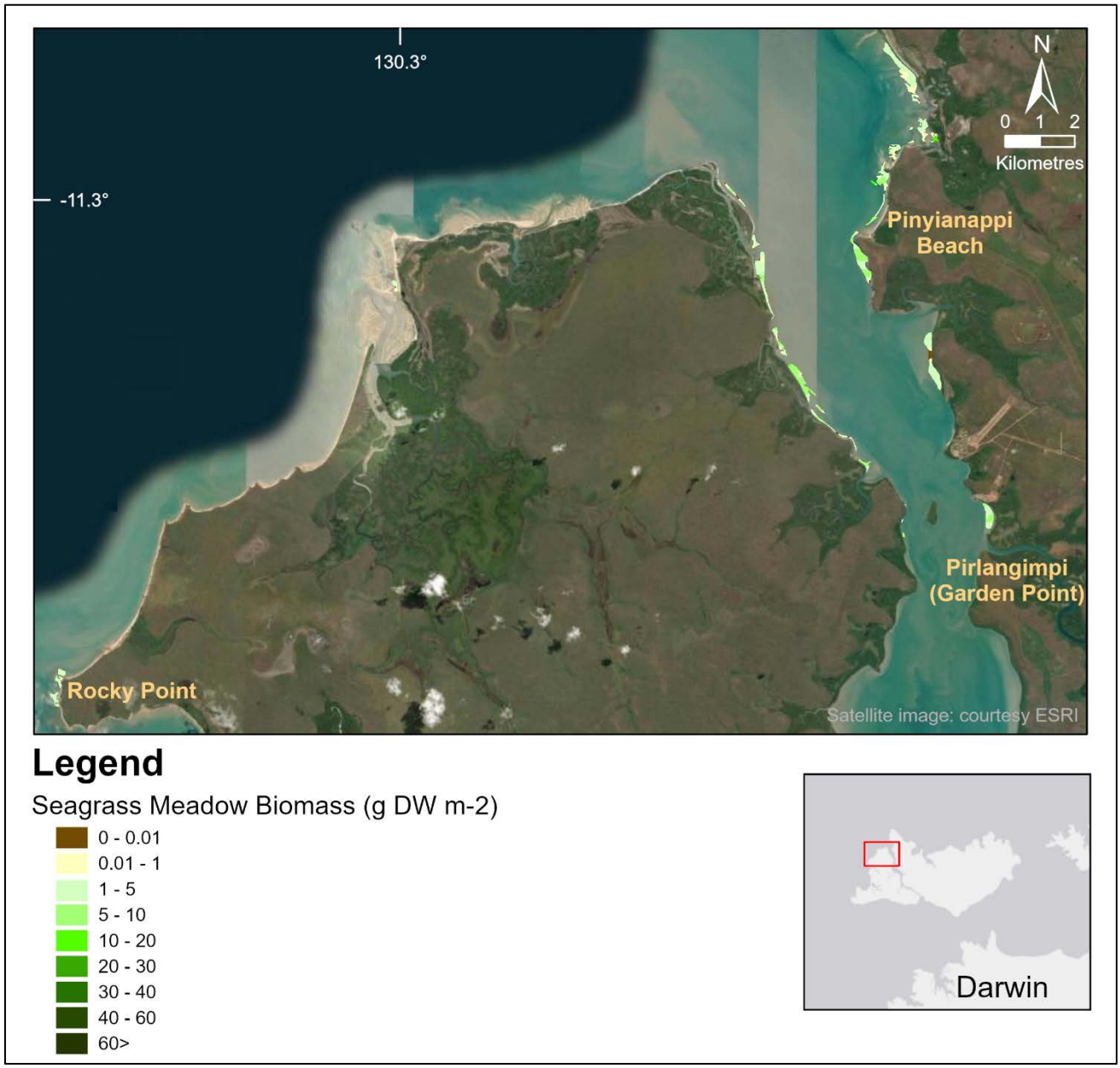

FIGURE 22. VARIATION IN SEAGRASS BIOMASS ACROSS MEADOWS FROM ROCKY POINT TO APSLEY STRAIT.

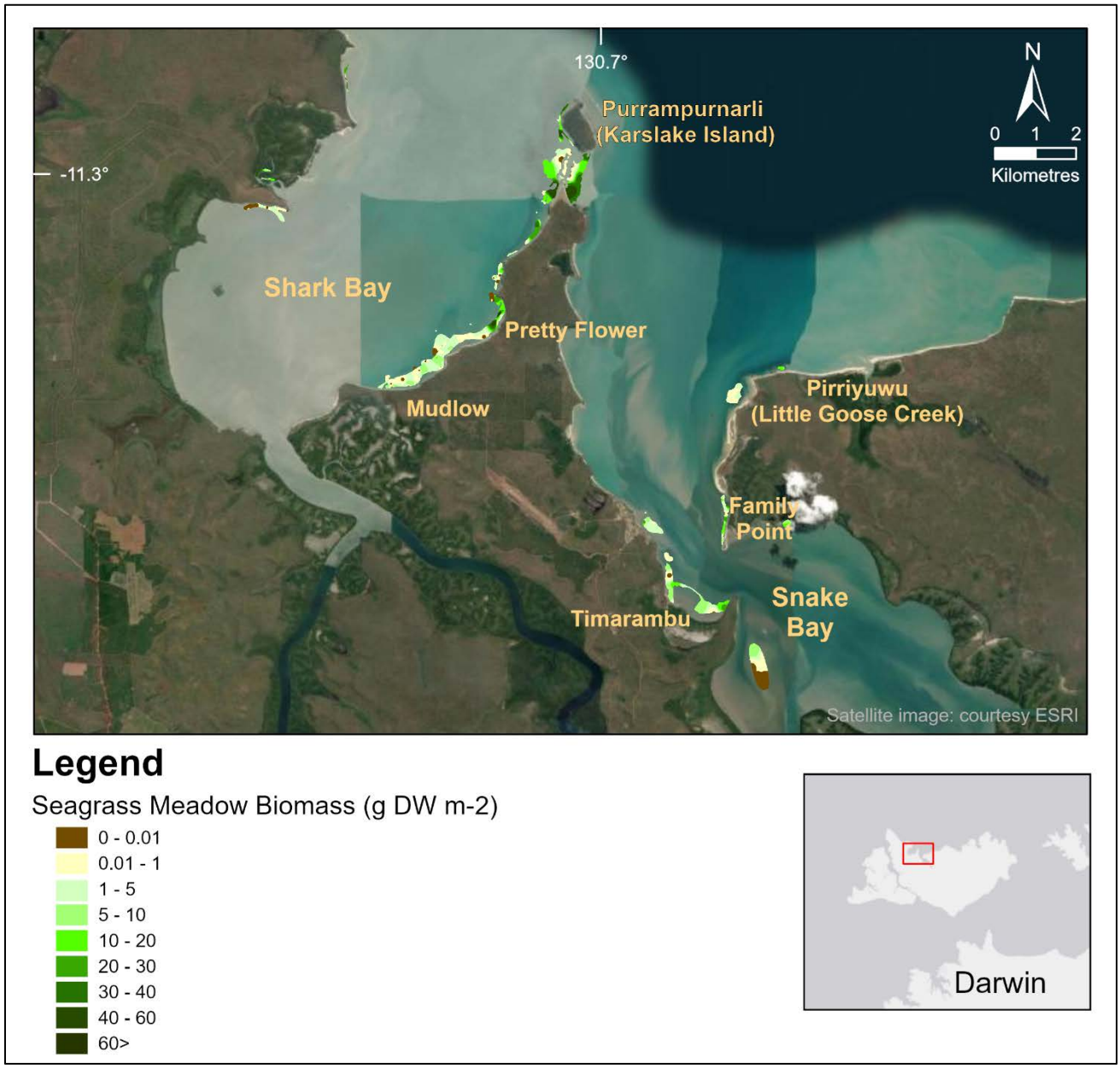

FIGURE 23. VARIATION IN SEAGRASS BIOMASS ACROSS MEADOWS IN SHARK BAY AND SNAKE BAY.

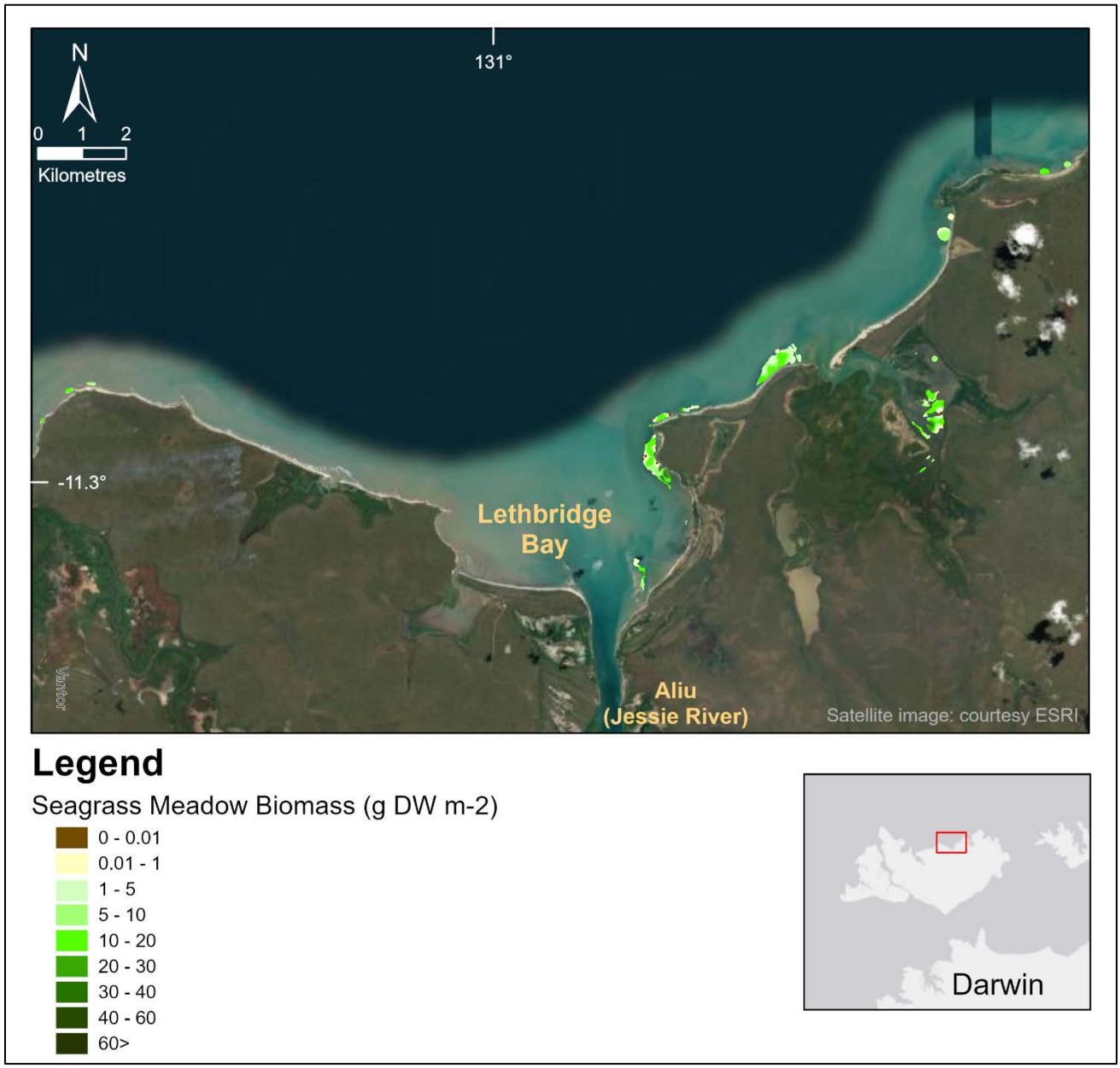

FIGURE 24. VARIATION IN SEAGRASS BIOMASS ACROSS MEADOWS AROUND LETHBRIDGE BAY.

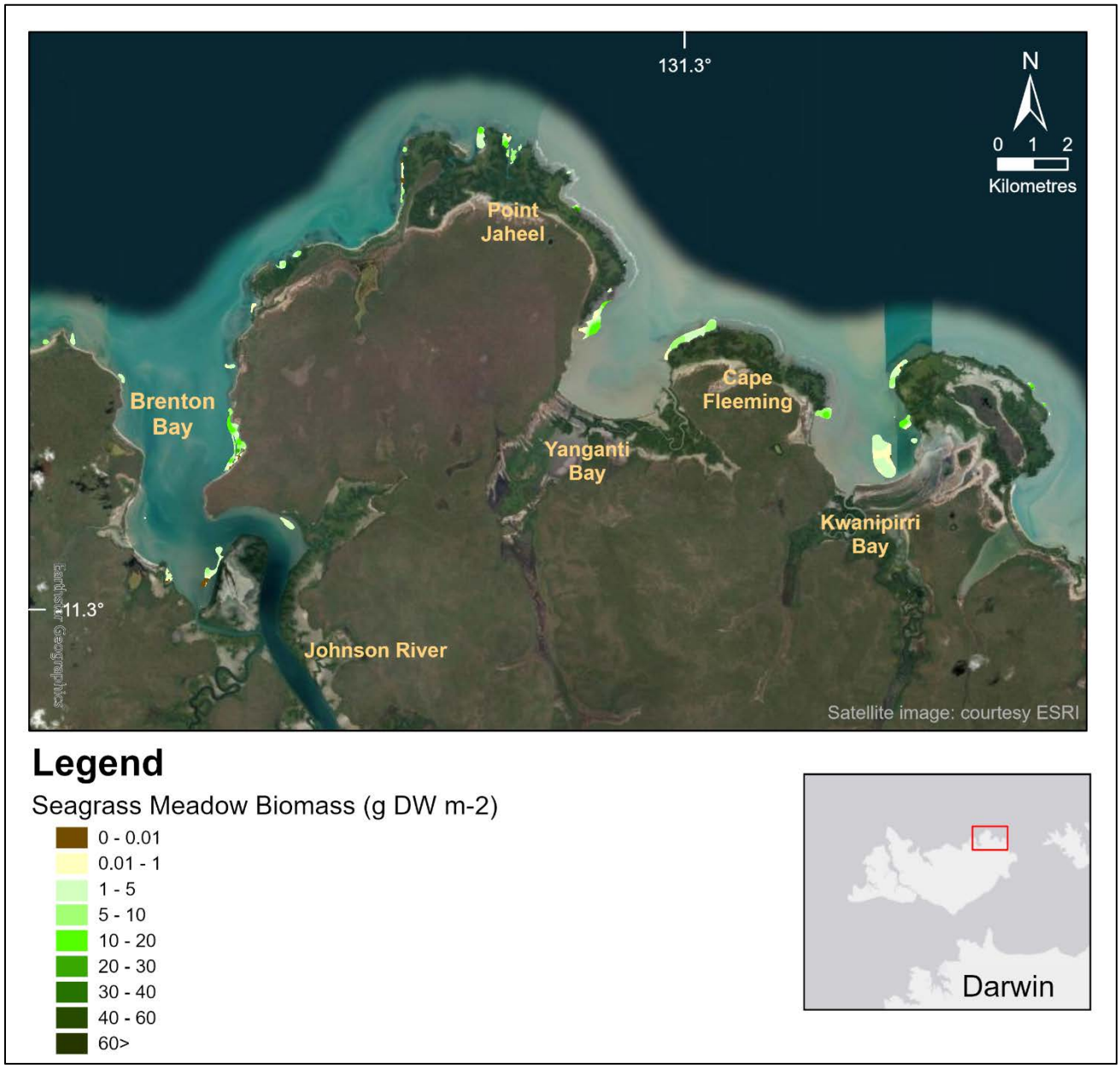

FIGURE 25. VARIATION IN SEAGRASS BIOMASS ACROSS MEADOWS FROM BRENTON BAY TO KWANIPIRI BAY.

3.3 DUGONG FEEDING TRAILS AND OTHER OBSERVATIONS

Dugong feeding trails were observed at 31 intertidal sites where *H. ovalis* and *H. uninervis* were present (Figure 26). There were many sites with feeding trails on the northwest of Melville Island at Pinyianappi Beach and Luxmore Head, and on the adjacent side of the channel at northeast Bathurst Island (Figure 27). Feeding trails also occurred at Rocky Point, Family Point and Timarambu in Snake Bay, in northeast Melville Island in Lethbridge Bay at the mouth of the Jessie River, Brenton Bay at the mouth of the Johnson River, and in the meadow behind the fringing reef at Point Jahleel (Figure 27). Feeding trails were observed at Karslake Island but were not present in the survey sites.

Other notable observations were the presence of manta rays, turtles, dolphins and dugongs. There were 50 intertidal sites with sea cucumbers. There were also several ghost nets observed from the helicopter surveys.

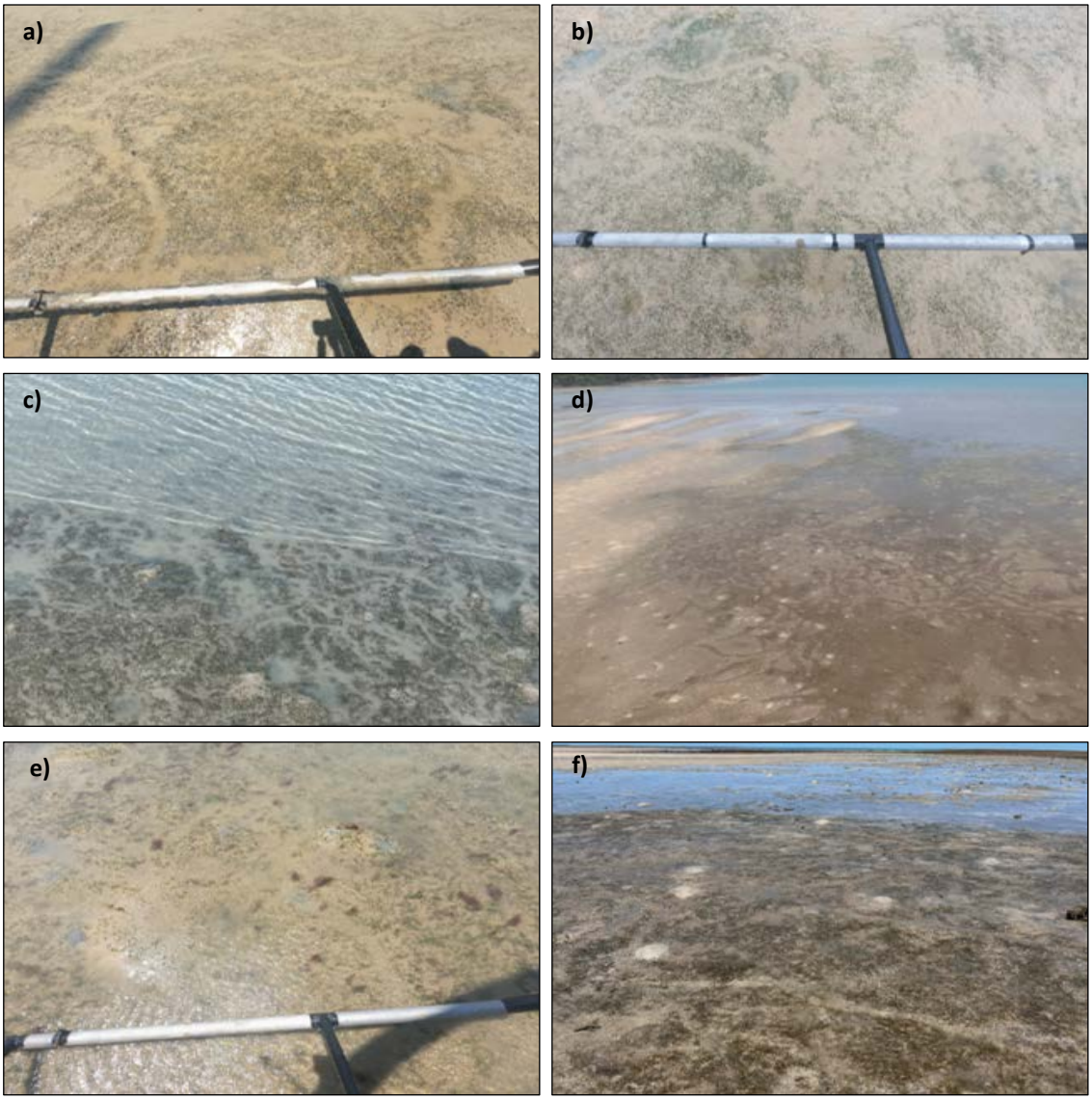

FIGURE 26. DUGONG FEEDING TRAILS AT (A) BATHURST ISLAND, (B) PINYIANAPPI BEACH, (C) KARSLAKE ISLAND, (D) SNAKE BAY, (E) BRENTON BAY AND (F) POINT JAHEEL.

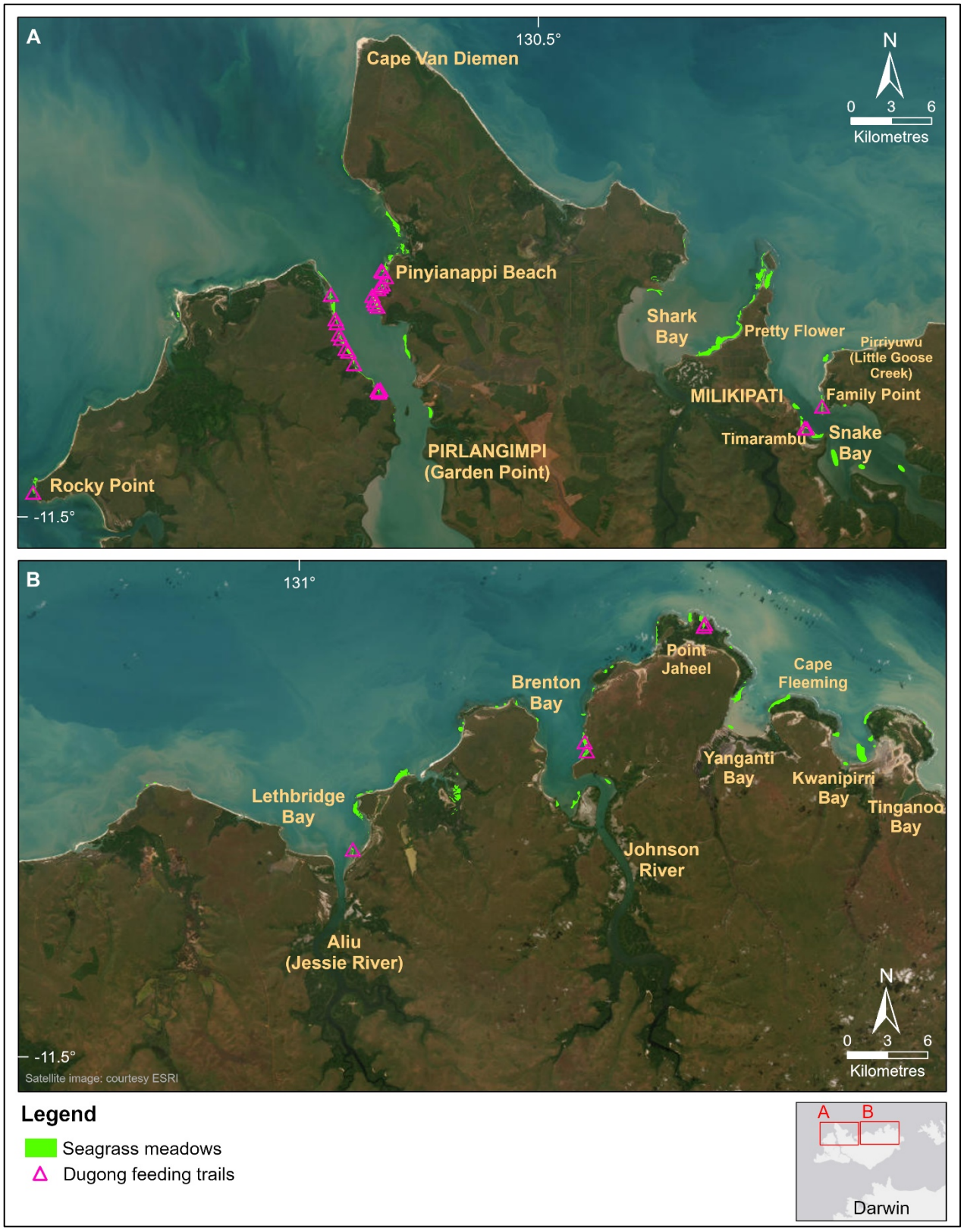

FIGURE 27. DUGONG FEEDING TRAIL PRESENCE IN INTERTIDAL SEAGRASS MEADOWS.

3.4 ALGAE COMMUNITIES

Algae were present at 823 (32%) of subtidal and intertidal sites. Where algae were present, average cover was 33%; across all sites, the average was 10% (Table 7, Figure 29). Most algae occurred across combinations of sand, mud, reef and rock substrates, with sand being the most common substrate for erect macroalgae and filamentous algae, and rock being the most common for erect calcareous, turf and encrusting algae (Figure 28).

Algae were present at 739 intertidal sites (36%), with cover ranging from 0.1 to 100%; the highest cover was associated with turf algae (Table 7, Figure 29–Figure 31). Average cover was 33% at sites where algae were present and 12% across all intertidal sites. Turf algae were dominant, occurring at 71% of sites with algae and averaging 31% cover at those sites. Erect macroalgae was present at 46% of sites with algae, averaging 8.4% cover. Erect calcareous algae were present at 237 (32%) of intertidal sites with algae, averaging 9% cover. Filamentous algae were present at 232 (31%) of intertidal sites with algae, averaging 12% cover. Encrusting algae was least common, present at 94 (13%) of intertidal sites with algae and averaging 4% cover.

Algae were present at 84 (15%) subtidal sites. Total algae cover ranged from 0.1 to 32% (Figure 29–Figure 31). Average cover was 5% at sites where algae were present and 1% across all subtidal sites (Table 7, Figure 29). Erect macroalgae was most common, occurring at 69 sites (13%) and averaging 1% cover. Turf algae was also common, present at 66 sites (12%) and averaging 4% cover. Erect calcareous algae was present at 40 (7%) of subtidal sites with algae, averaging 9% cover. Filamentous algae was present at 10 sites (2%), averaging 0.2% cover. Encrusting algae was least common, present at just 4 sites (0.1%) and averaging 0.1% cover, though encrusting forms are harder to detect via drop camera than during helicopter surveys. Filamentous algae was most prevalent in Apsley Strait and in the northeast of Melville Island around Lethbridge Bay to Kwanipiri Bay. Most sites were in the northwest of Melville Island between Cape Van Diemen and Aliu (Jessie River) (Figure 29–Figure 31).

TABLE 7. ALGAE PRESENCE AT INTERTIDAL AND SUBTIDAL SITES, INCLUDING COUNT OF SITES WITH EACH TYPE PRESENT, MEAN COVER AT THOSE SITES, THE DEPTH RANGE AND DOMINATE SUBSTRATE COMPOSITION.

Algal type	Intertidal		Subtidal		All sites		
	# Sites	Mean % cover	# Sites	Mean % cover	Min. depth (m)	Max. depth (m)	Dominant substrate
Turf	527	31	68	4	0	11.5	Rock
Erect Macrophytes	341	8	69	1	0	11.5	Sand
Encrusting	94	4	4	0.1	0	11.5	Rock
Calcareous	237	9	40	0.5	0	7.9	Rock
Filamentous	232	12	10	0.2	0	6.3	Sand



FIGURE 28. ALGAE HABITATS INCLUDED (A) FILAMENTOUS ALGAE, (B) TURF ALGAE COVERING REEF RUBBLE NORTHERN BATHURST ISLAND, (C) ERECT CALCAREOUS ALGAE ON A FRINGING REEF, AND (D) ERECT MACROALGAE BEHIND A FRINGING REEF.

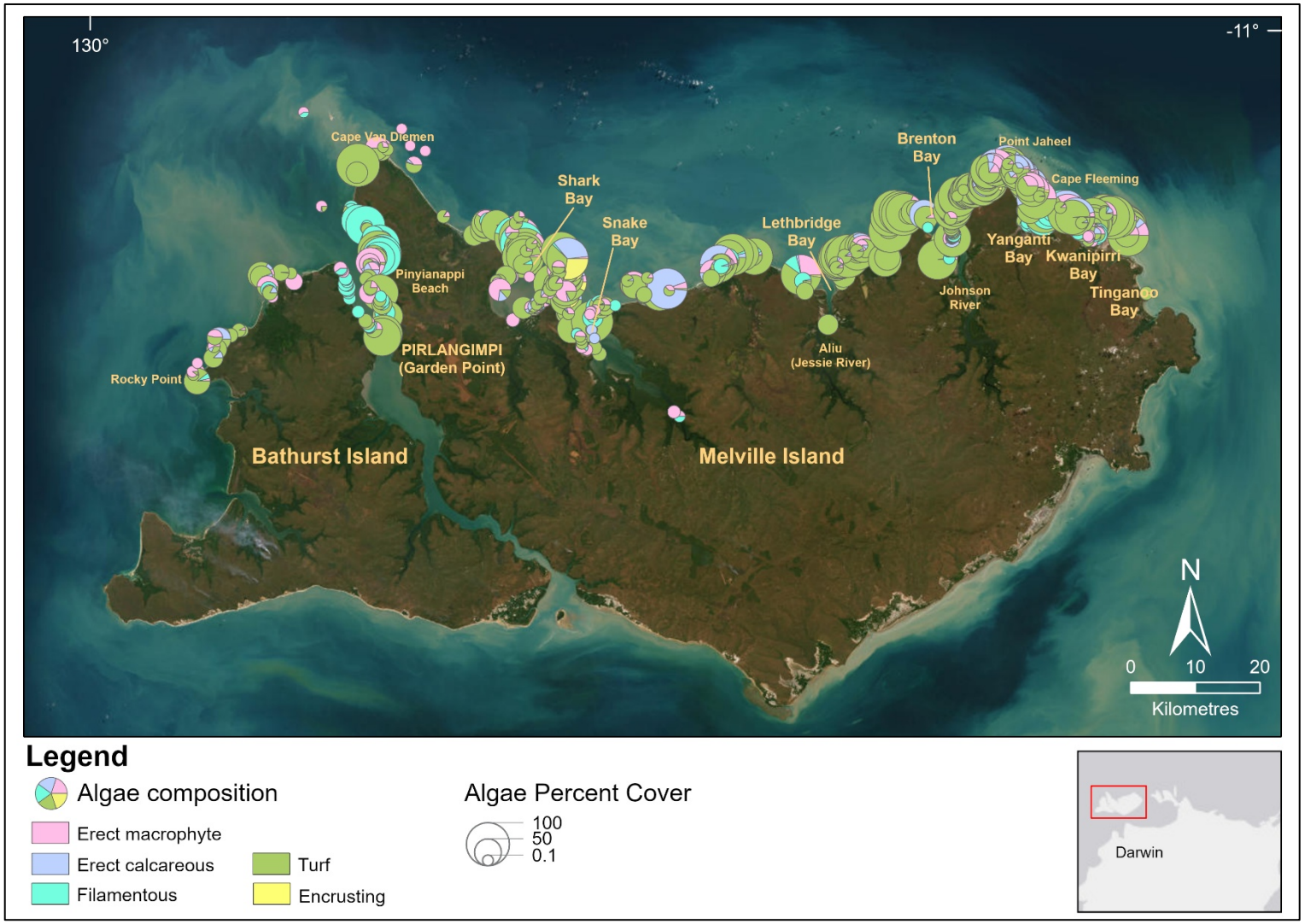

FIGURE 29. ALGAE COMMUNITY COMPOSITION AND COVER AT SURVEY SITE.

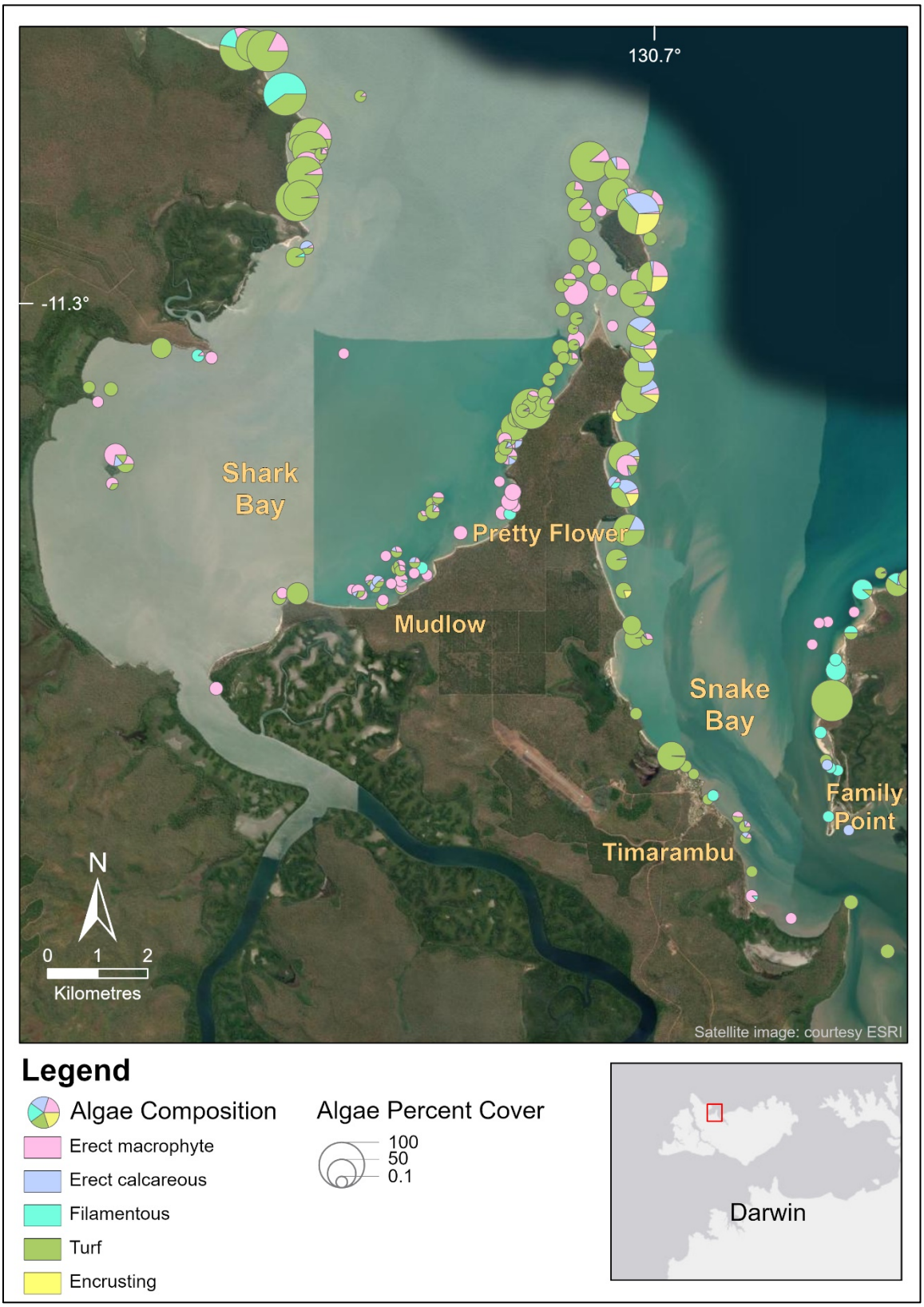

FIGURE 30. ALGAE COMMUNITY COMPOSITION AND COVER AT SHARK BAY AND SNAKE BAY.

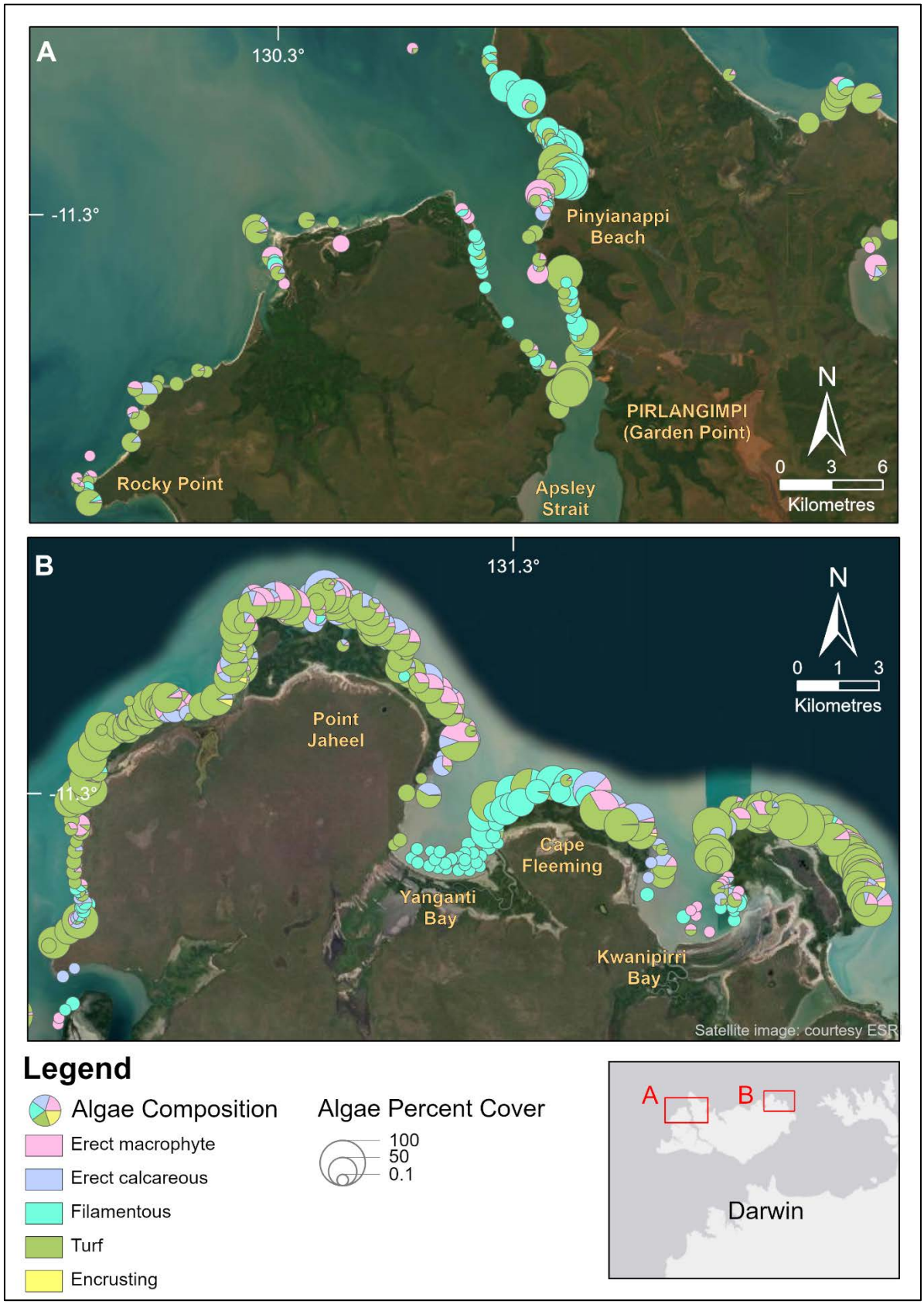

FIGURE 31. ALGAE COMMUNITY COMPOSITION AND COVER AT SURVEY SITES IN (A) APSLEY STRAIT AND (B) BRENTON BAY TO KWANIPIRRI BAY.

3.5 BENTHIC MACROINVERTEBRATES

Benthic macroinvertebrates (BMI) were recorded at 422 of 2,608 sites (16%) (Figure 33–Figure 35, Table 8). Where BMI were present, the mean cover was 9%; across all sites, the mean was 1%. Hard coral was the most commonly recorded BMI, present at 286 sites (11%) with a mean cover of 10% at those sites.

Benthic macroinvertebrates were most commonly found, and with the highest cover, on rocks and reefs around Karslake Island and between Lethbridge Bay and Kwanipiri Bay (Figure 32–Figure 35, Table 8). Hard coral and other BMI (e.g. oysters) predominated on reef substrate, while soft corals, sponges, ascidians and hydroids were more common on sand.

In intertidal waters, BMI were recorded at 324 sites (16%) (Figure 32–Figure 35, Table 8). Hard coral was most prevalent, found at 235 sites (11%) with up to 85% cover. Sponges were recorded at 122 sites and soft corals at 65 sites. Other BMI including ascidians, bryozoans, chitons, anemones and oysters, were recorded at 34 sites (Figure 33).

In subtidal waters, BMI were recorded at 98 sites (18%) (Figure 32–Figure 35, Table 8). Sponges were most common, present at 73 sites (13%). Hard coral was recorded at 51 sites (9%) with up to 17% cover, and soft corals at 55 sites (10%) with low cover (≤2.5%). Other BMI including hydroids and bryozoans, were recorded at 18 sites (<3%), averaging 1% cover (Table 8).

Post-processing of drop camera imagery enabled a more detailed breakdown of BMI types at subtidal sites. Massive coral was the most common hard coral form, followed by branching coral (Table 9, Figure 36, Figure 37). Among soft corals, other soft coral and gorgonians were the most common types (Table 9, Figure 38, Figure 39).

TABLE 8. BENTHIC MACROINVERTEBRATE (BMI) OCCURRENCE (COUNT OF SITES) AND MEAN COVER AT INTERTIDAL AND SUBTIDAL SITES, THE TOTAL NUMBER OF SITES, THE MINIMUM AND MAXIMUM DEPTH, AND THE DOMINANT SUBSTRATE THEY WERE FOUND ON.

	Intertidal sites		Subtidal sites		All sites			
BMI category	# Sites	% cover (mean)	# Sites	% cover (mean)	# Sites	Min. depth (m)	Max. depth (m)	Dominant substrate
Hard coral	235	11.3	51	2.4	286	0	13.5	Reef
Soft coral	65	4.5	56	0.6	121	0	22.1	Sand
Sponges	122	2.5	73	1.6	195	0	27.0	Sand
Ascidians	0	0	13	0.1	13	1.3	11.5	Sand
Bryozoans	0	0	2	0.1	2	7.5	8.6	Reef/Sand
Hydroids	0	0	16	0.3	16	3.9	11.5	Sand
Other BMI	35	8.6	3	0.5	38	0	11.5	Rock

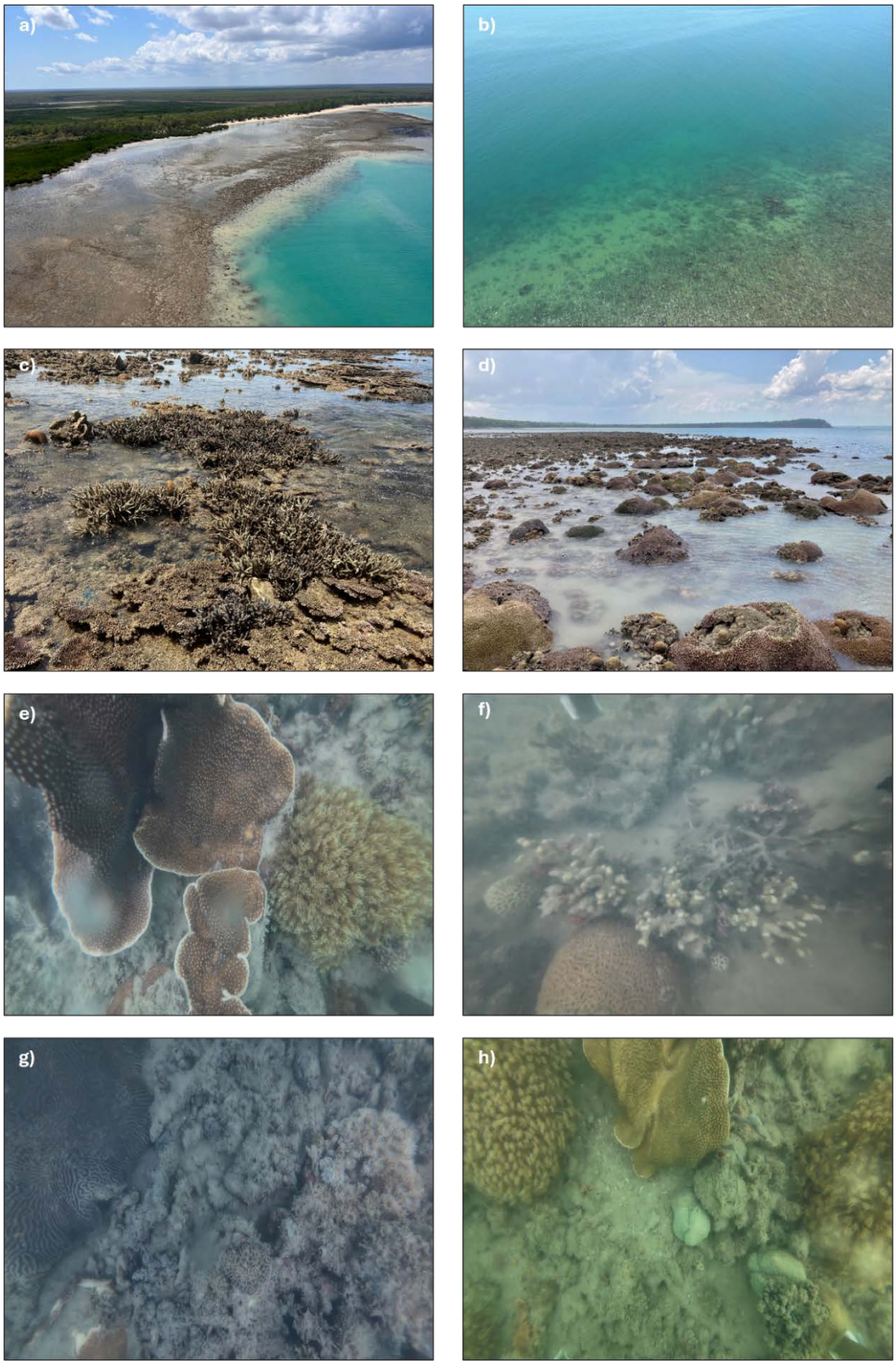

FIGURE 32. REEF SUPPORTING HARD CORAL, SOFT CORAL, SPONGES AND ALGAE AT (A, B) KARSLAKE ISLAND, (C, D) POINT JAHLEEL, AND (D-G) PRETTY FLOWER TO MUDLOW.

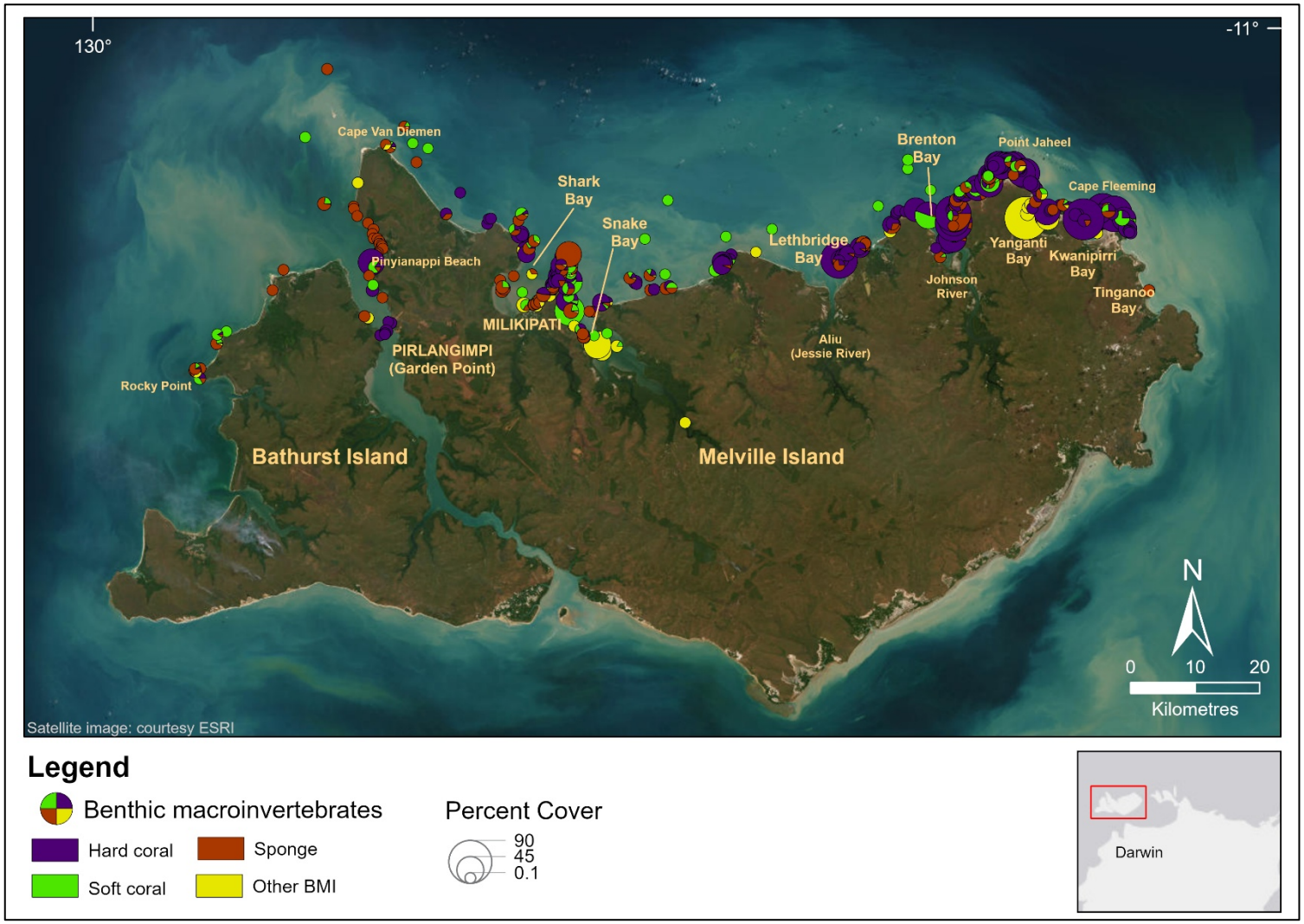

FIGURE 33. BENTHIC MACROINVERTEBRATE COMPOSITION AND COVER AT SURVEY SITES.

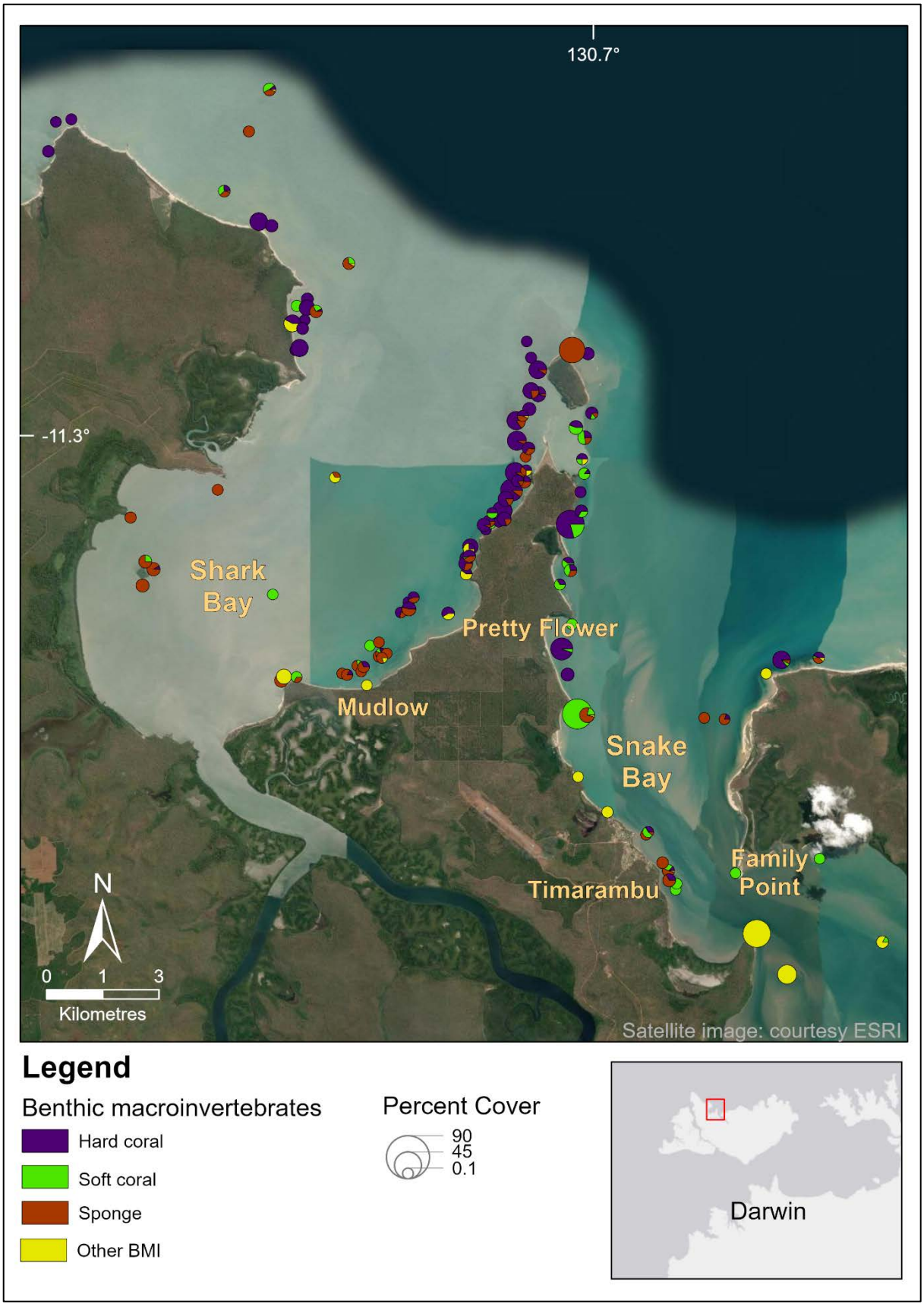

FIGURE 34. BENTHIC MACROINVERTEBRATE COMPOSITION AND COVER AT SURVEY SITES.

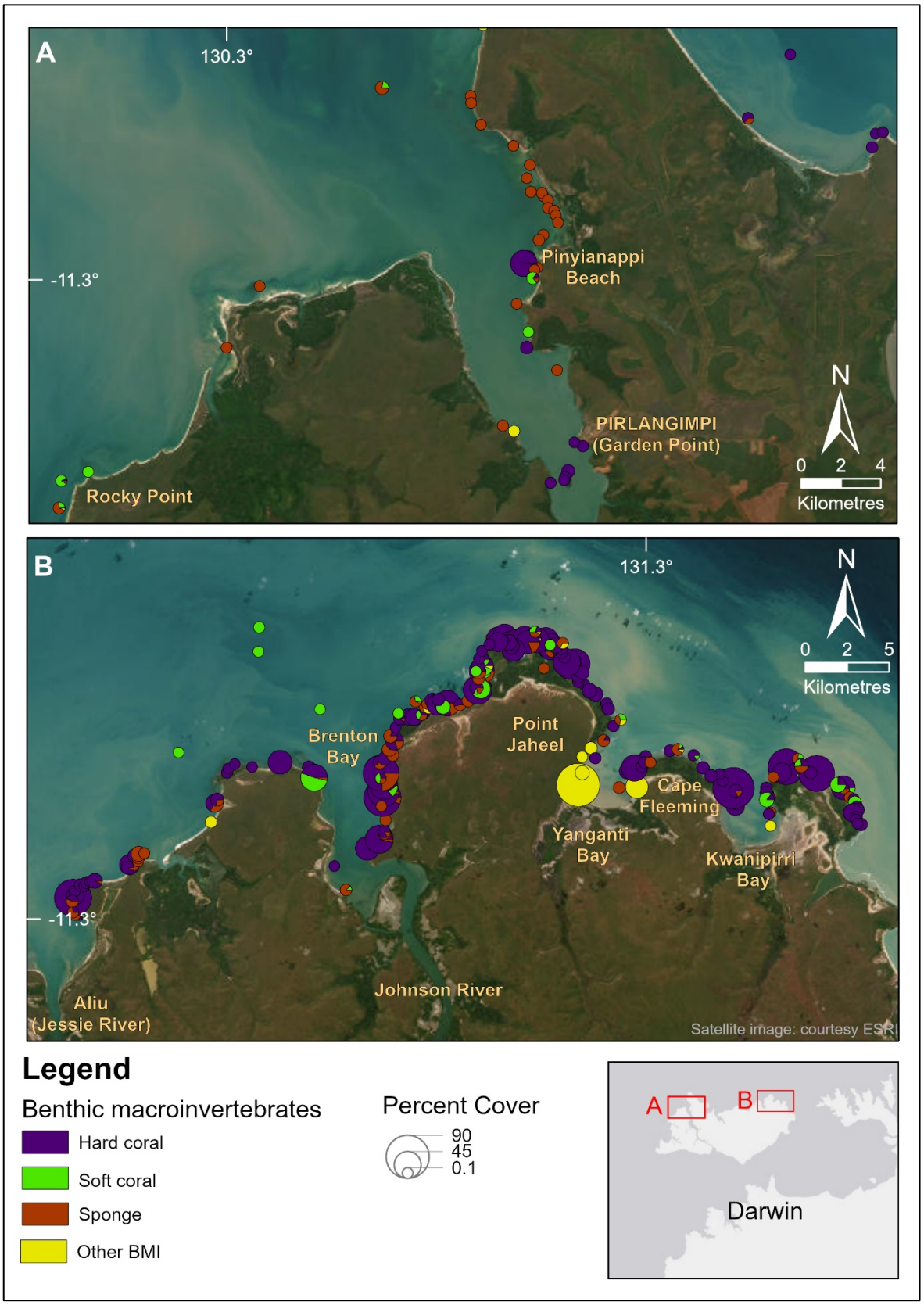

FIGURE 35. BENTHIC MACROINVERTEBRATE COMPOSITION AND COVER AT (A) APSLEY STRAIT AND (B) ALIU TO KWANIPIRI BAY.

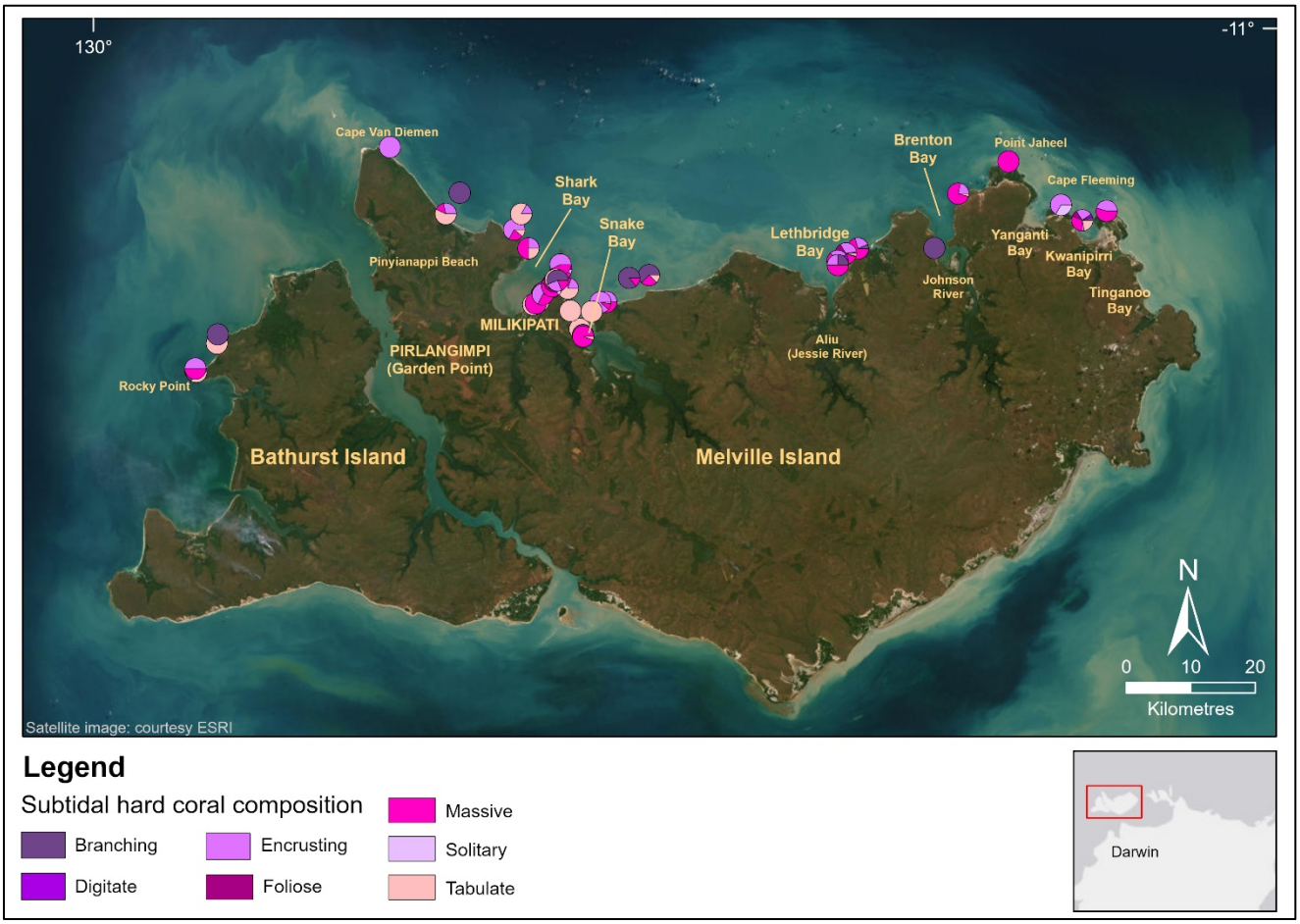

FIGURE 36. HARD CORAL COMPOSITION AND COVER AT SUBTIDAL SITES.

TABLE 9. OCCURRENCE (COUNT) AND PERCENTAGE OF SUBTIDAL SITES WITH EACH HARD AND SOFT CORAL CATEGORY, AND THE MEAN % COVER (WHEN PRESENT).

Category	# Sites	% of subtidal sites	Mean cover
Hard coral, branching	20	3.60%	0.65
Hard coral, digitate	7	1.30%	0.68
Hard coral, encrusting	27	4.90%	1.54
Hard coral, foliose	3	0.50%	2.57
Hard coral, massive	36	6.60%	1.15
Hard coral, solitary	8	1.50%	0.53
Hard coral, tabulate	21	3.80%	0.34
Soft coral, pennatulacean	12	2.20%	0.16
Soft coral, gorgonian	29	5.30%	0.62
Soft coral, whip	14	2.60%	0.15
Other soft coral	33	6.00%	0.41

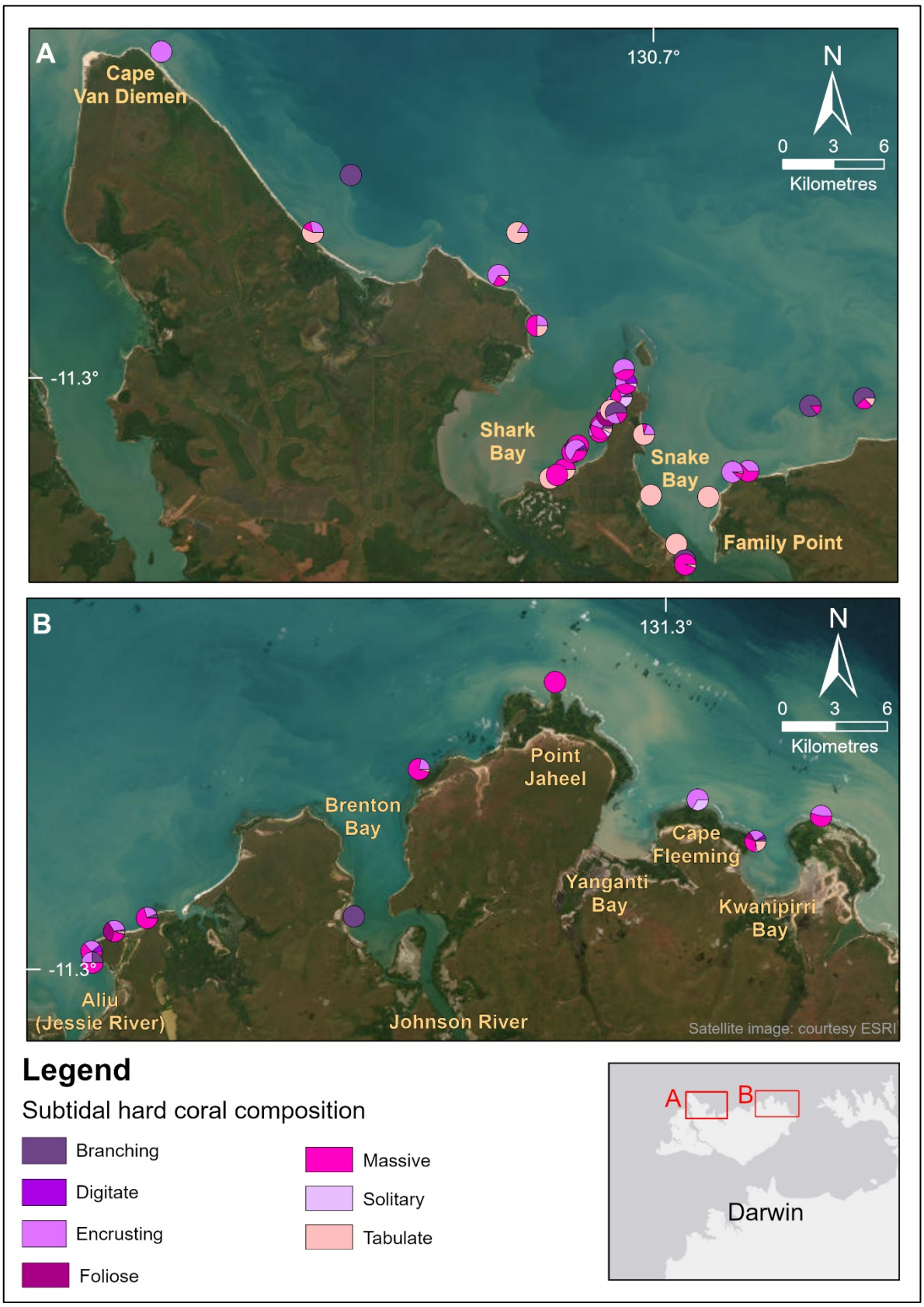

FIGURE 37 HARD CORAL COMPOSITION AND COVER AT SUBTIDAL SITES.

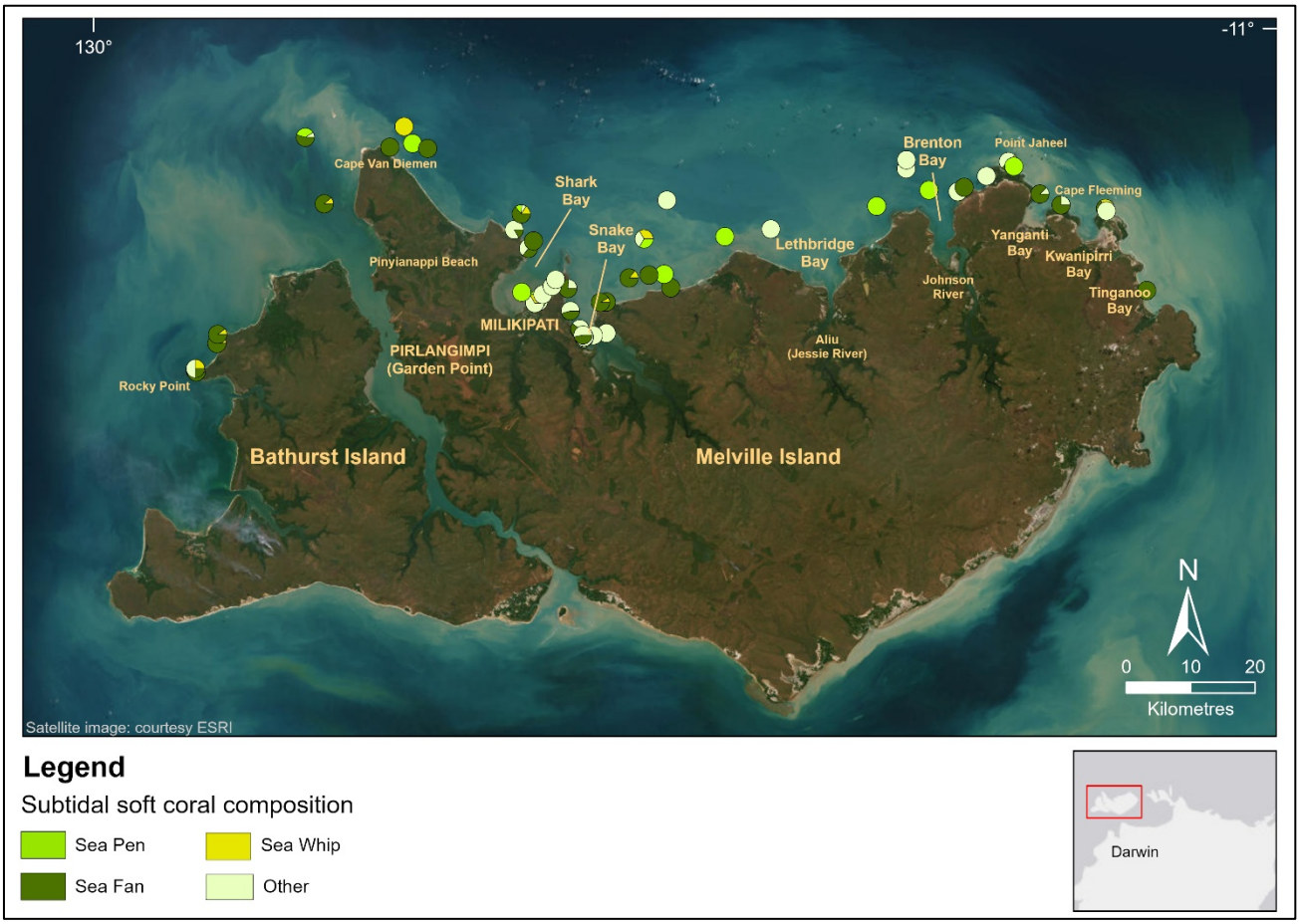

FIGURE 38. SOFT CORAL COMPOSITION AND COVER AT SUBTIDAL SITES.

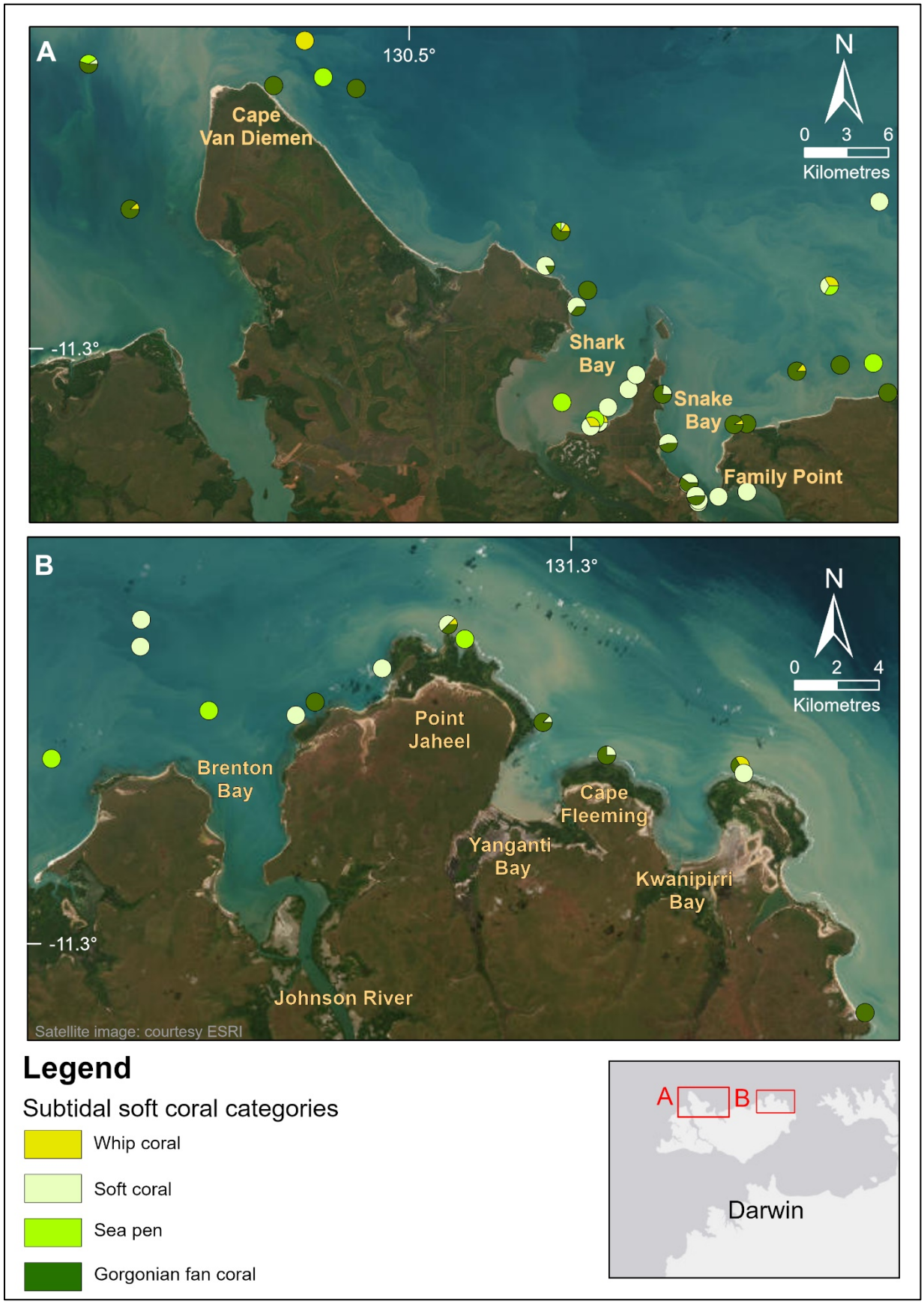

FIGURE 39. SOFT CORAL COMPOSITION AND COVER AT SUBTIDAL SITES.

3.5.1 Invertebrates in sled tows

Mobile (non-habitat forming) and sessile (habitat forming) invertebrates from a diverse range of taxa were identified from the benthic sled net samples (Figure 40, Table 10) including:

- Porifera (sponges)
- Urochordata (ascidians)
- Mollusca (gastropods, bivalves, scaphopods)
- Echinodermata (asteroids, crinoids, echinoids, holothuroids, ophiuroids)
- Crustacea (brachyurans, decapods, penaeids)
- Cnidaria (alcyonarians, scleractinians, hydrozoans)
- Bryozoa
- Annelida (segmented worms), and
- Pisces.



FIGURE 40. EXAMPLES OF MOBILE AND SESSILE INVERTEBRATES FOUND IN THE CONTENTS OF THE SLED NET IN THE TIWI ISLANDS.

TABLE 10. TAXA IDENTIFIED FROM THE SLED NET CONTENTS.

Item #	Phylum	Class	Order	Family	Genus	Species	Common Name
1	Annelid	Polychaete					Marine Bristle Worm
2	Arthropod/Crustacean	Malacostraca	Decapoda	Leucosiidae	*Ebalia*		Nut crab
3	Arthropod/Crustacean	Malacostraca	Decapoda	Leucosiidae	*Leucosia*		Pebble crab
4	Arthropod/Crustacean	Penaeid			*Penaeus*		Shrimp
5	Bryozoa	Gymnolaemata	Cheilostomata				Bryozoan
6	Cnidarian	Anthozoa	Alcyonaria				Soft coral
7	Cnidarian	Anthozoa	Scleractinia	Caryophylliidae	*Heterocyathus*	*aequicostatus*	Solitary Hard coral
8	Cnidarian	Anthozoa	Scleractinia	Dendrophylliidae	*Heteropsammia*	*cochlea*	Solitary Hard coral
9	Cnidarian	Hydrozoa					Hydroid
10	Echinoderm	Asteroidea			*Anthenea*		Sea star
11	Echinoderm	Asteroidea			*Astropecten*	*monocanthus*	Sea star
12	Echinoderm	Crinoidea	Comatulida				Feather star
13	Echinoderm	Echinoidea			*Salmacis*	*belli*	Sea urchin red/white spines
14	Echinoderm	Echinoidea	Spatangoida				Heart urchin
15	Echinoderm	Echinoidea	Clypeasteroida				Sand dollar
16	Echinoderm	Holothuroidea					Sea cucumber
17	Echinoderm	Ophiuroidea	Ophiurida				Brittle star
18	Mollusc	Gastropod		Muricidae			Murex sea snail
19	Mollusc	Scaphopoda					Tusk shell
20	Pisces	Actinopterygii		Paralychthyidae			Flounder
21	Porifera						Sponge
22	Urochordata	Ascidiacea					Sea squirt

4 DISCUSSION

This study provides the most comprehensive assessment of benthic habitats across Tiwi Sea Country to date. Surveys documented a diverse range of habitats, including coral reefs, seagrass meadows, macroalgal communities, and habitat-forming invertebrates, as well as a variety of animals living within the sediments collected using sled nets. The surveys extended further offshore than previous studies, substantially expanding the spatial coverage of benthic habitat information for the Tiwi Islands.

The work was undertaken through a co-designed research approach developed with Tiwi Traditional Owners and Rangers. Rangers contributed knowledge of local conditions, seasonal patterns, and culturally important places, helping guide survey design, site selection and interpretation of results. This two-way knowledge approach ensured the surveys addressed priorities identified by Tiwi people, particularly the need for improved baseline information to support management of Sea Country (Tiwi Land Council 2018, Barnett et al. 2023). The resulting dataset fills a critical knowledge gap and provides a foundation for future Ranger-led monitoring and planning.

The surveys showed that most benthic habitats were concentrated in shallow nearshore environments. Moving offshore, sediments rapidly became dominated by very fine mud easily resuspended by wind and tidal currents, resulting in extremely poor underwater visibility. These conditions limit the development of deeper benthic habitats and explain the limited occurrence of deep-water reefs or extensive deep-water seagrass in the survey area.

The new data also contributes to the growing body of habitat mapping across northern Australia. Recent mapping initiatives across the Northern Territory, northern Queensland and Western Australia (Collier et al. 2022, Carter et al. 2023, Carter et al. 2024, Groom et al. 2025) are progressively improving knowledge of northern coastal ecosystems. These efforts highlight the ecological importance of northern Australian seagrass systems and the central role of Traditional Owners in guiding Sea Country research and management.

4.1 SEAGRASS

By combining intertidal helicopter surveys boat-based video, grab and sled surveys, and local knowledge from Tiwi Rangers, this study provides the most comprehensive dataset to date for seagrass habitats across Tiwi Sea Country. The surveys documented more than 2,500 ha of previously unmapped seagrass, significantly improving regional understanding of seagrass distribution and establishing an important baseline for future monitoring and management.

Seagrass meadows were typically located in sheltered coastal environments, particularly within bays and inlets. Along exposed coastlines, seagrass commonly occurred behind fringing coral or rocky reefs that provide protection from waves and currents. This pattern was particularly evident along the northeast coast of Melville Island. In contrast, in the strong tidal currents of the Apsley Strait, seagrass was largely restricted to intertidal habitats near the shoreline, sheltered from the strongest flows.

Subtidal seagrass covered a larger area than intertidal seagrass habitat; however, subtidal seagrass was sparse and generally dominated by *H. decipiens* or *H. uninervis*. Most of the high biomass seagrass occurred in intertidal environments where meadows are periodically exposed to air or where it resides in shallow pools during low tide. The meadows exposed to air often grow on free-draining sand and mud banks, where

seagrass species are adapted to tolerate exposure and temperature fluctuations. Many plants remain moist by growing in shallow pools that form on reef flats or in depressions in the sediment. One of the largest examples of this occurred at Karslake Island, where a large shallow pool supported an extensive meadow dominated by *Enhalus acoroides*. Similar isolated pools that retain water at low tide were observed behind sand banks in several locations, including near Family Point.

Seagrass species diversity was high, with eight species identified during the surveys. This level of diversity is consistent with other regions in the Northern Territory, including in Limmen Bight, South East Arnhem Land and Yanyuwa Sea Country. The composition and extent of these meadows have important implications for culturally and ecologically significant species. For example, dugong and green turtles are closely associated with seagrass habitats across the Tiwi Islands. Dugongs preferentially feed on smaller, fast-growing species such as *Halophila* spp. and *H. uninervis*, which have higher nitrogen content and are more digestible than larger seagrasses such as *E. acoroides* (Preen 1995, Sheppard et al. 2007, Sheppard et al. 2010). Dugong feeding trails were observed throughout the intertidal survey area, including several hunting areas identified by Tiwi Rangers. The highest density of feeding trails occurred in intertidal seagrass meadows within the Apsley Strait where *H. ovalis* was the dominant species.

Traditional Owners also identify areas such as Kwanipiri Bay as important dugong habitats, although feeding trails were not observed during these surveys. This may reflect the difficulty of detecting feeding trails in sparse subtidal meadows dominated by *H. decipiens*, particularly when observations are made using drop cameras in turbid water.

A notable feature of the Tiwi seagrass communities was the widespread occurrence of *E. acoroides*. This species was common on the northern Tiwi Islands, although it was restricted to a relatively narrow habitat range on intertidal banks. Dense meadows were observed at locations such as Karslake Island and Pretty Flower in Shark Bay, suggesting these areas support stable and persistent seagrass meadows. At other locations, including Robinson Inlet between Johnson River and Lethbridge Bay, Johnson River and south of Milikapiti, *E. acoroides* occurred as isolated patches, often forming characteristic ring-shaped structures. Seagrass biomass was particularly high in areas dominated by *E. acoroides*. These large structural species contribute substantial habitat complexity and support a wide range of marine life.

Along the exposed north-east coast of Melville Island, reefs played a key role in creating sheltered environments where seagrass meadows could develop. These reefs, therefore, contribute to the persistence of seagrass habitats and form part of an interconnected coastal ecosystem that includes mangroves and other benthic habitats.

4.2 CORAL REEFS

Coral reefs were largely restricted to shallow subtidal and intertidal environments around the Tiwi Islands. Reef development was most extensive along the northeast coastline of Melville Island, particularly around Lethbridge Bay to Kwanipiri Bay, and in Shark Bay. In many locations, reefs provide important physical protection from waves and currents, creating conditions that allow seagrass meadows and other coastal habitats to develop along otherwise exposed shorelines. These habitats are often closely connected with adjacent mangroves, forming part of a broader network of coastal ecosystems that support the productivity and biodiversity of Tiwi Sea Country.

Subtidal reefs generally supported lower hard coral cover than reefs that are periodically exposed during low tide. This pattern may reflect differences in water quality, sediment dynamics and environmental conditions between habitats. In deeper subtidal areas, benthic habitats were more commonly characterised by sponges

and other habitat-forming invertebrates rather than reef-building corals. However, the sponge cover was generally low and typically consisted of scattered individual colonies rather than dense communities.

Coral reefs and associated benthic habitats support a wide range of marine life and contribute to the ecological health of Sea Country. They provide habitat, shelter, and feeding areas for fish, turtles, and many other species important to Tiwi people. Understanding the distribution and condition of these habitats provides an important foundation for future management and monitoring.

4.3 ALGAL COMMUNITIES

Macroalgal communities were common across shallow habitats. These communities play an important ecological role by providing food and habitat for a range of marine species. For example, green turtles may feed on both seagrass and algae, and their foraging behaviour is influenced by the availability of these resources . Some green turtle populations rely heavily on algae, particularly when seagrass availability is limited (Bjorndal 1980, Di Beneditto et al. 2016). However, green turtles generally do not switch frequently between feeding on algae and seagrass within a single foraging area because specialised gut microbiota are required to digest each food source (Bjorndal 1980). The presence of abundant seagrass and algae across Tiwi Sea Country, therefore, provides important feeding opportunities for green turtles. Algal communities also support diverse fish and invertebrate assemblages by providing habitat structure and shelter (Lim et al. 2016).

In some locations, the composition of algal communities provided insight into environmental conditions. For example, filamentous algae was common in Yanganti, Cape Fleeming and parts of the Apsley Strait (Figure 41, Figure 31). Filamentous algae can indicate elevated nutrient inputs, potentially associated with nearby tidal inlets and coastal runoff.

Turfs were the most common algae community, particularly in intertidal habitats. Turfs are ecologically important on reefs, being the primary source of food for herbivorous reef fish, which, in turn, reduces the density of turfs (Hughes et al. 2007). Turfs are also disturbance specialists, growing over reef surfaces following the loss of coral, and in turn suppressing their recruitment (Diaz-Pulido 2002).



FIGURE 41. FILAMENTOUS ALGAE AT (A, B) YANGANTI, (C, D) PORT FLEEMING, (E) APSLEY STRAIT, AND (F) NORTHEAST BATHURST ISLAND.

4.4 PRESSURES AND RISKS

Although seagrass habitats around the Tiwi Islands are relatively limited in area and density, they provide important foraging habitat for dugong and turtles, species of high cultural significance to Tiwi people. Seagrass habitats across northern Australia occur as a patchwork of meadows rather than a continuous expanse of suitable habitat, meaning that even relatively small meadow systems can have high ecological and conservation value. The Tiwi Islands therefore contribute important habitat within this broader network, supporting the movement and persistence of marine megafauna across northern Australian waters. This

underscores the importance of understanding and monitoring the condition of these habitats, as well as the pressures and risks that may affect them, to support informed management and protection of Sea Country.

Although the Tiwi Islands remain relatively remote, the coastal ecosystems of Sea Country are influenced by both local and broader environmental pressures. Climate change is expected to alter marine environments through rising sea temperatures, sea-level rise and changes in the frequency and intensity of extreme weather events. These changes have the potential to affect the distribution, condition and resilience of coastal habitats and the species that depend on them.

Seagrass habitats are particularly sensitive to changes in water quality and light availability. Increased sediment loads, turbidity and nutrient inputs can reduce the amount of light reaching the seabed, limiting seagrass growth and recovery. Across northern Australia, major rainfall and flood events have been associated with declines in seagrass abundance due to reduced water clarity and prolonged periods of light limitation.

Around the Tiwi Islands, strong tidal currents and the widespread occurrence of fine sediments mean that water clarity can vary considerably over time and space. As a result, natural fluctuations in turbidity, together with changes in rainfall, runoff and temperature, are likely to be important drivers of seagrass distribution, abundance and condition. Understanding these pressures and how they influence key habitats is important for supporting the long-term management and protection of Tiwi Sea Country.

Intertidal seagrass meadows may also be exposed to periods of thermal stress during low tides when plants are subjected to elevated temperatures. These effects can be intensified during marine heatwaves and may contribute to declines in seagrass condition where exposure is prolonged. Furthermore, like coral reef systems globally, reefs around the Tiwi Islands are vulnerable to pressures associated with climate change. Rising sea temperatures, marine heatwaves, sea-level rise, changing sediment dynamics and more frequent extreme weather events are all expected to influence reef condition over the coming decades (Halpern et al. 2019). These pressures may affect coral cover, species composition and the ability of reefs to recover following disturbance events.

4.5 RECOMMENDATIONS

Improving knowledge of coastal ecosystems is increasingly important as environmental pressures intensify. The habitat data collected during this project provides an important baseline for Tiwi Traditional Owners to support planning and management of Sea Country. Baseline habitat information allows communities to identify areas of ecological and cultural importance and helps guide decisions on monitoring, protection, and the sustainable use of marine resources.

Monitoring has now been established in Snake Bay and Shark Bay using a combination of drone surveys for intertidal meadows and drop-camera surveys for subtidal meadows. This monitoring program balances safety, accessibility and ranger capacity while ensuring that key habitats can be monitored over time. Continuing to track changes in seagrass extent, density and species composition will provide an important indication of environmental health.

Future monitoring will continue to integrate Traditional Owner knowledge with scientific approaches, ensuring that monitoring reflects both cultural priorities and ecological processes.

Key recommendations include:

- continue seagrass monitoring at existing sites and expand monitoring to areas north of Pirlangimpi in the Apsley Strait
- complete baseline intertidal and subtidal habitat mapping of the southern Tiwi Islands
- expand habitat mapping to include fish communities using Baited Remote Underwater Video (BRUV) surveys to understand how fish use different habitats across the seascape
- integrate habitat monitoring with environmental monitoring, including water quality and temperature measurements, and
- link habitat monitoring with species-focused programs, particularly for culturally important species such as dugong and green turtles.

Through continued collaboration between Traditional Owners, Rangers and research partners, these efforts will support a long-term, integrated monitoring program that strengthens knowledge, supports Sea Country management, and helps maintain the health of Tiwi marine ecosystems.

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APPENDICES

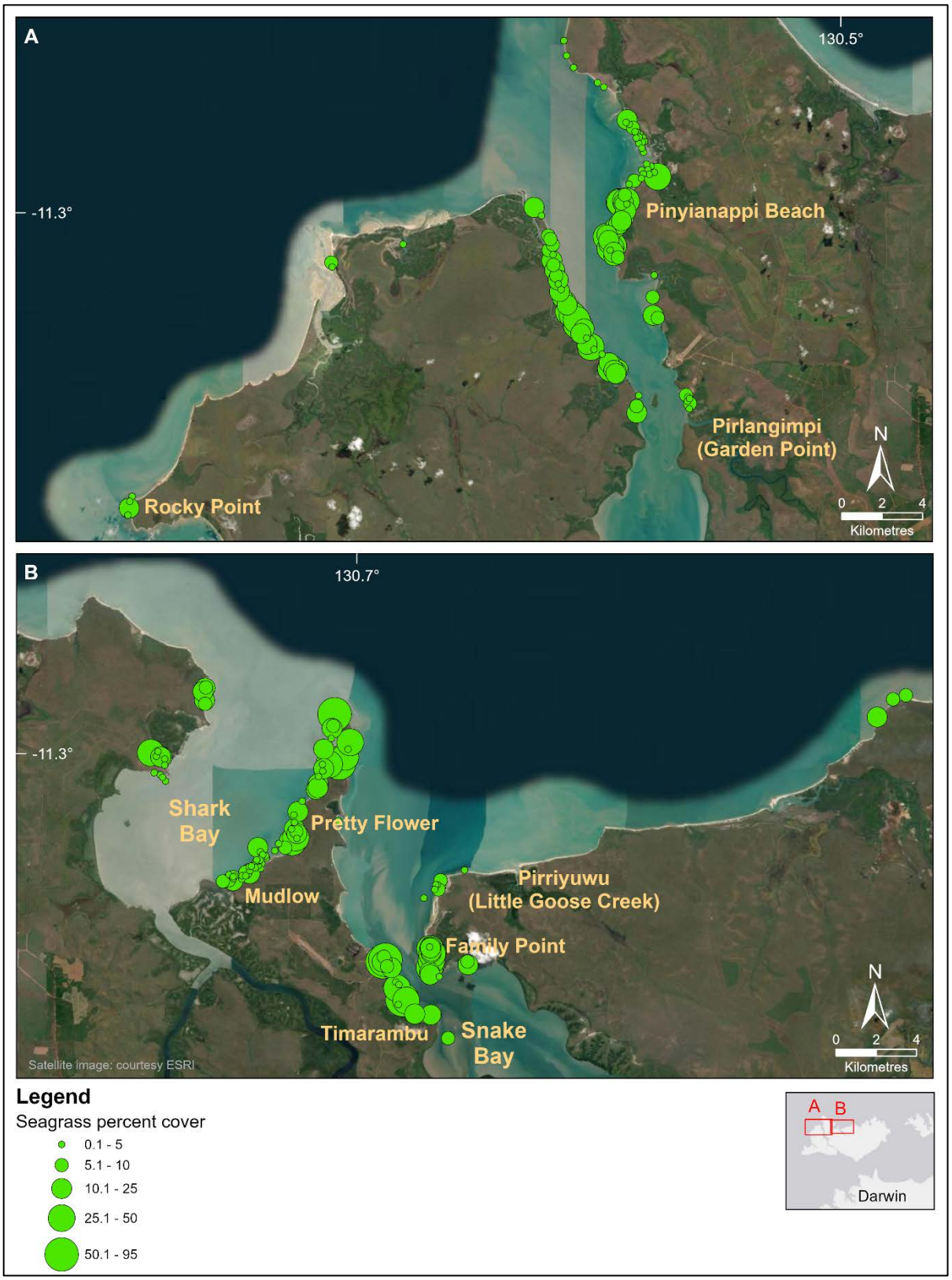

FIGURE 42 SEAGRASS PERCENT COVER FROM (A) ROCKY POINT TO (B) SNAKE BAY.

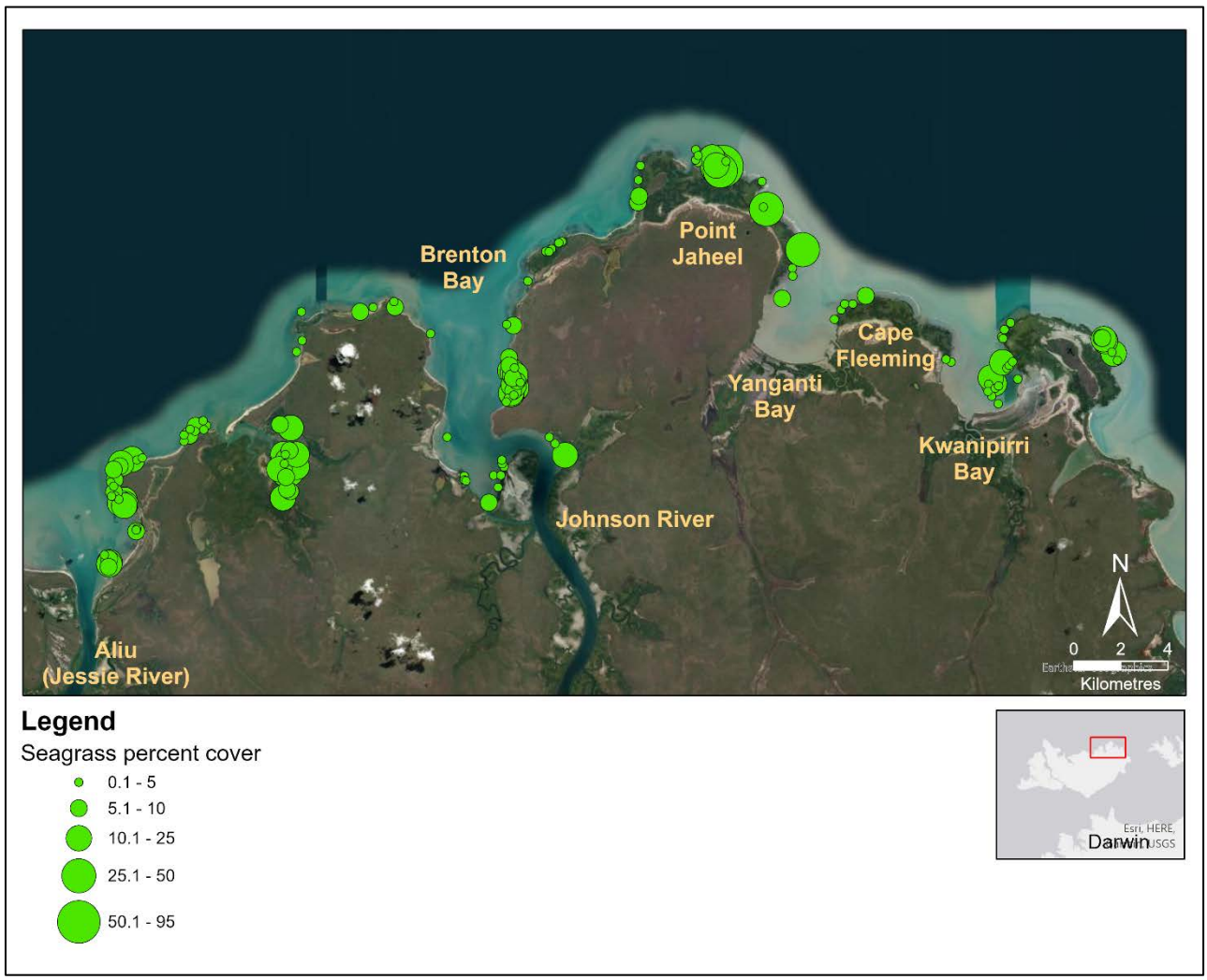

FIGURE 43. SEAGRASS PERCENT COVER FROM LETHBRIDGE BAY TO KWANIPIRI BAY.