Comparison with previous vegetation surveys

According to the 1963 report by Hindwood, North Cay (Willis islets) was unvegetated at that time.

There are no other previous reports on the vegetation of North Cay (Willis Islets) and no specimens from this cay in any of the major Australian herbaria.

BioCondition monitoring site data

One permanent BioCondition monitoring site (M20) was established and surveyed on North Cay (Willis Islets). The location of the centre transect of this site is shown as the red line in *Figure 62.*

Table 82 contains the data recorded at this site. The photographs included with the BioCondition attribute data are four of the 10 site photographs taken of this site. Photographs shown are all taken from the centre point of the centre transect, the first facing along the transect bearing and then consecutively facing 90^{o}, 180^{0} and 270^{0} from the direction of the centre transect bearing.

Biocondition attributes

Table 82 BioCondition attributes recorded in monitoring site M20, North Cay (Willis Islets) on 06 June 2000

Site M20	
Cay	North Willis
Vegetation community description	closed herbland dominated by *Boerhavia albiflora* var. *albiflora*, *Stenotaphrum micranthum* and *Portulaca oleracea*
Transect start (WGS 84)	-16.112418 150.00349
Transect centre (WGS84)	-16.112525 150.003292
Transect end (WGS 84)	-16.112627 150.003078
Transect bearing (degrees)	236
Median canopy height/range (metres)	0.4/0.15-0.6
Tree canopy cover %	n/a
Shrub canopy cover %	n/a
Basal area m^2/ha (at 30 cm height, calculated from stem diameters)	n/a
Total number of large trees/ha	0
Total no of trees per ha	n/a
Total number of tree stems/ha	n/a
Total no. shrubs/ha	0
Total no. shrub stems/ha	n/a
Large shrubs - mean diameter at 30 cm height	n/a
Recruitment of ecologically dominant layer (%)	n/a
Tree species richness	0
Tree species present	n/a
Shrub species richness	0
Shrub species present (layer in brackets)	n/a
Median ground layer height/range (metres)	0.4/0.15-0.6
Total ground layer cover of native cay species (%)	79.4
Grass species richness	2
Grass cover (%)	22.6%
Grass species present in order of decreasing cover - most abundant first (cover in brackets)	*Stenotaphrum micranthum* (16.8%), *Lepturus repens* (5.8%)
Forb (including vines) species richness	3
Forb species cover (%)	56.8%
Forb species present in order of decreasing cover - most abundant first (cover in brackets)	*Boerhavia albiflora* var. *albiflora* (32%), *Portulaca oleracea* (18.2%), *Tribulus cistoides* (6.6%)
Native shrub ground cover (%)	0%
Non-native plant cover (all strata) (%)	0%
Litter cover (%)	13.2%
Bare ground (%)	7.4%
Woody debris (m/ha of logs >0.5m long and >10cm wide)	0
Soil pH	0-10 cm = 8.62, 10-20cm = 9.48, 20-30cm = 9.65; 9.25 (average)

Photo 149
Monitoring site M20, North Cay (Willis Islets) facing WSW

Photo 150
Monitoring site M20, North Cay (Willis Islets) facing NNW

Photo 151
Monitoring site M20, North Cay (Willis Islets) facing ENE

Photo 152
Monitoring site M20, North Cay (Willis Islets) facing SSE

Joy Brushe ©

Soil data

Soil samples were collected from BioCondition monitoring site M20 on North Cay (Willis Islets).

Refer to *Appendix 5* for results of all the soil analyses for M21 and the other sites sampled during the 2022 voyage. For comparison of M21 soil analysis data with data from previous Coral Sea and Southern GBR soil surveys, refer to the Soils section under *Methodologies, general results and discussion* in this report.

The herbland site, M20, in the interior of North cay (Willis Islets) had a much higher pH than all other interior herbland locations.

Electrical conductivity, total nitrogen, total and Colwell phosphorus, exchangeable calcium, exchangeable potassium, exchangeable sodium, cation exchange capacity, copper, iron manganese and zinc levels were lower than at other herbland locations sampled in 2022 and at most other interior herbland locations.

Total potassium and total sodium levels were lower than at other interior herblands sampled in 2022 but higher than at Diamond Islet and Lihou Reef cays.

Total carbon, total calcium and aluminium levels were similar to those at other interior herbland locations.

Total magnesium levels were relatively high compared to other interior herbland locations whilst exchangeable magnesium was slightly lower than at most interior herbland locations.

Organic carbon was within the range of other interior herbland locations but lower than other interior herbland sites sampled in 2022.

These data indicate that the soil in the interior of North Cay (Willis islets) has less soil development than the interior of other cays sampled suggesting that this site is in earlier stages of vegetation establishment and soil development The lower elevation of this cay may increase vulnerability to impacts of ocean wave over wash and salt water incursion with associated leaching of nutrients.

Total sulphur levels at all 2022 sample sites were high – Refer to *Figure 13* and explanatory text in the Soils section under *Methodologies, general results and discussion* in this report.

Photo 153 Strawberry hermit crab, *Coenobita perlatus* finding refuge within one of the numerous giant clam shells Andrew McDougall © Queensland Government

Photo 154 Green turtle, *Chelonia mydas* Andrew McDougall © Queensland Government

2.17.4 Birds

Table 83 Bird species and their breeding status – North Cay, Willis Islets

North Cay	5/06/2022	Breeding stages present			Breeding pairs	Adolescents and adults
common name	**scientific name**	Nests	Chicks	Young		
red-tailed tropicbird	*Phaethon rubricauda roseotinctus*	0	0	0	0	1
Herald petrel	*Pterodroma heraldica*	0	0	0	0	0
wedge-tailed shearwater	*Ardenna pacifica*	0	0	0	0	0
great frigatebird	*Fregata minor*	0	0	0	0	0
lesser frigatebird	*Fregata ariel*	0	0	0	0	2
masked booby	*Sula dactylatra dactylatra*	36	1	0	37	53
brown booby	*Sula leucogaster*	0	0	0	0	P
red-footed booby	*Sula sula*	0	0	0	0	P
sooty tern	*Onychoprion fuscatus*	41000-43500			41K-43.5K	>43500
bridled tern	*Onychoprion anaethetus*	0	0	0	0	0
crested tern	*Thalasseus bergii*	32	0	0	32	61
roseate tern	*Thalasseus bengalensis*	0	0	0	0	0
black-naped tern	*Sterna sumatrana*	10	0	0	10	15
New Caledonian fairy tern	*Sternula nereis exsul*	0	0	0	0	0
black noddy	*Anous minutus*	0	0	0	0	0
brown noddy	*Anous stolidus*	7200-8500			7200-8500	>8500
buff-banded rail	*Gallirallus philippensis tounelieri*	0	0	0	0	0
purple swamphen	*Porphyrio melanotus*	0	0	0	0	0
sacred kingfisher	*Todiramphus sanctus*	0	0	0	0	0
white-faced heron	*Egretta novaehollandiae*	0	0	0	0	0
Pacific golden plover	*Pluvialis fulva*	0	0	0	0	3
ruddy turnstone	*Arenaria interpres*	0	0	0	0	3
wandering tattler	*Tringa incana*	0	0	0	0	1
grey-tailed tattler	*Tringa brevipes*	0	0	0	0	0
lesser sand plover	*Charadrius mongolus*	0	0	0	0	0

Notes

- Large populations of sooty terns and brown noddies were present, and low numbers of other breeding species considering the size of the cay. The cay could host significantly larger breeding numbers as much of the space was not utilised.
- Breeding stages for sooty tern and brown noddy breeding efforts were summarised as division into nests, chicks and young was not feasible.
- Nesting was absent from large portions of the vegetated sections of the cay. Tribulus areas were devoid of nesting and roosting.
- No threats were observed.

Photo 155 Part of the extensive sooty tern and brown noddy colony
Andrew McDougall © Queensland Government

Photo 156 Masked booby with a rare, three egg clutch Andrew McDougall © Queensland Government

Photo 157 Western end of the sooty tern and brown noddy colony
Collette Bagnato © Queensland Government

2.17.5 Pest and invertebrate sampling

(Refer to Health Check section for map)

5/6 June 2022

Table 84 Rodents

Collection period	Sampling methods	Sampling sites	Rodent species
overnight	Baited ink pad tunnels	6	0

Table 85 Invertebrates

Collection period	Sampling methods	Sampling sites	Species
daylight search	bait stations and ground search	6	0

2.17.6 Health Checks and Island Watch

Five Health Checks (HC) were assessed at North Cay, Willis Islets.

The overall condition class of the cay's vegetation communities was **Good** (the highest rating, see *Table 86*).

Detailed criteria for each HC site are in included in *Appendix 8*.

Table 86 Assessed condition class for each HC site

	North Cay, Willis Islets			
HC Site	Overall condition class			
HC47	Good	Good with concern	Significant concern	Critical
HC48	Good	Good with concern	Significant concern	Critical
HC49	Good	Good with concern	Significant concern	Critical
HC50	Good	Good with concern	Significant concern	Critical
HC51	Good	Good with concern	Significant concern	Critical

Table 87 Summary of vegetation communities around each HC site (reference with *Figure 64*)

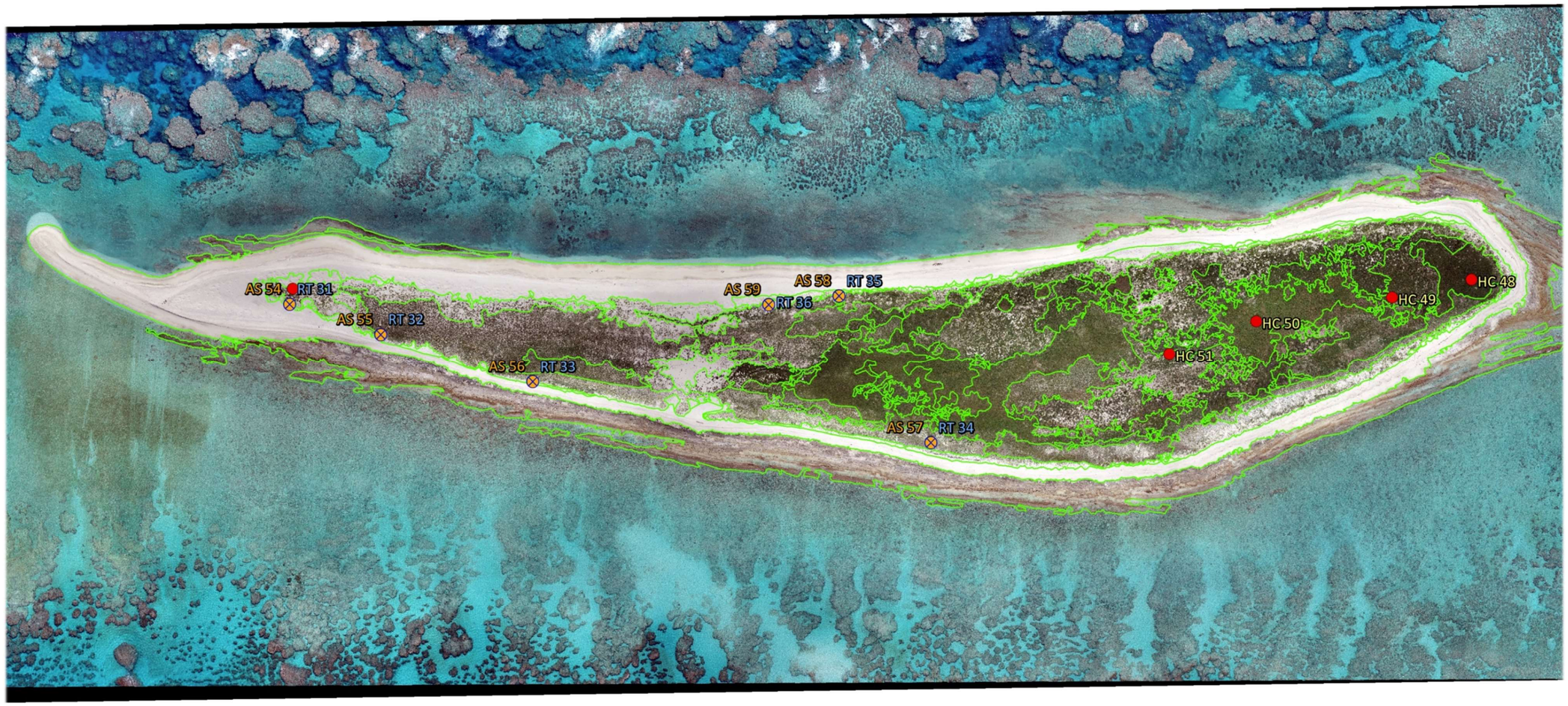
HC Site	Ecosystems/vegetation communities				
HC47	1a	5a	5b		
HC48	6e				
HC49	3a	5b	6e	16a	16c
HC50	16a				
HC51	3a	4	4a		

Photo 158 Health Check site HC49 West

Photo 159 Health Check site HC50 East

Island Watch

A summarised table of all Island Watch information can be found in *Appendix 9.*



North Cay, Willis Islets

Area: 18.9 ha (area above HAT)

- Vegetation communities
- Health check
- Rodent tunnel
- Ant bait station

N W E S

0 20 40 80 120 160 200 Metres

Printed on: 25/11/2022

Coordinate System: WGS 1984 Web Mercator Auxiliary Sphere
Projection: Mercator Auxiliary Sphere
Datum: WGS1984

Figure 64 Health Check, rodent tunnel and ant bait station sites on North Cay, Willis Islets

2.18 Mid Islet, Willis Islets

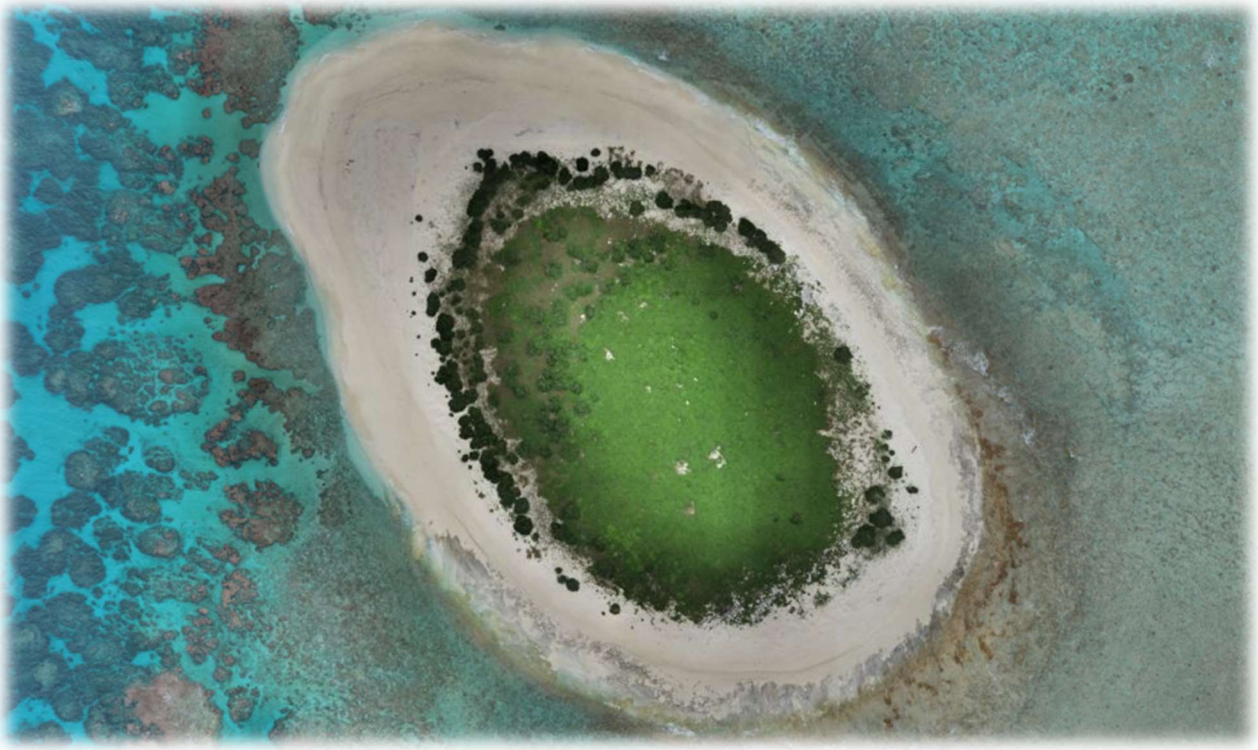


Figure 65 Mid Islet Jake Sanders © Queensland Government

2.18.1 Drone imagery

3/4 June 2022:

- Drone - Phantom 4 RTK
- Image capture height 60m
- Resolution 1.8cm/px
- Map stitching software – Drone Deploy

2.18.2 Physical description

- Low tide extent 351m x 232m
- Approximate high tide extent 299m x 182m
- Approximate area above high tide 4.28ha
- Vegetated area 3.4 ha

Mid Islet (Willis Islets), shown in *Figure 65*, is located 480 km ENE of Cairns at -16.214 degrees latitude and 149.992 degrees longitude. *Figure 66* shows surface elevation profiles of Mid Islet (Willis Islets).

2.18.3 Vegetation

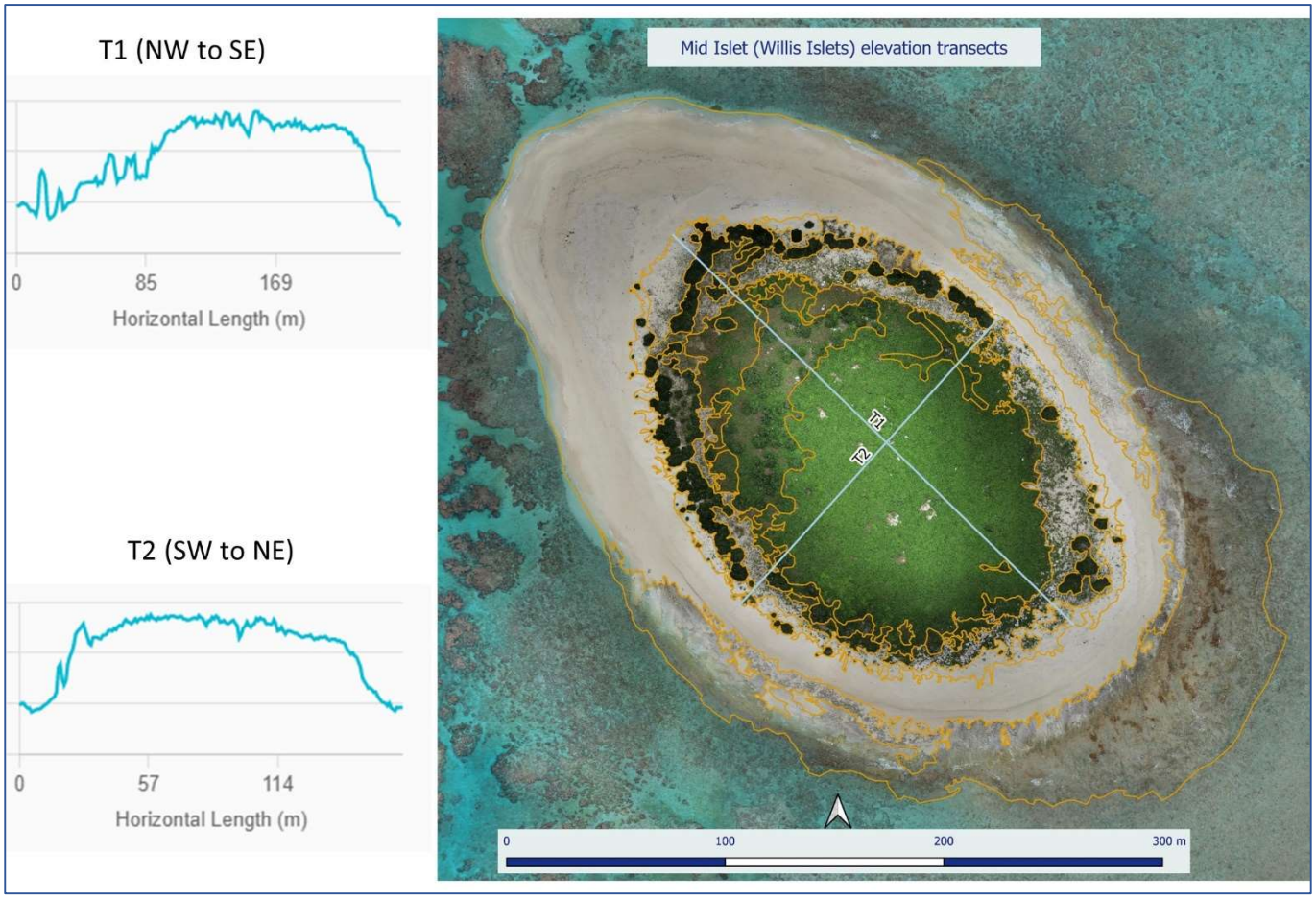


Figure 66 Surface profiles of Mid Islet (Willis Islets)

Note: Maximum elevation is approximately 7.5 metres ASL. Vertical heights and scale are not included in surface profile diagrams as accurate datum information was not available.

Survey intensity

Two people each spent approximately 4.4 hours surveying the vegetation of Mid Islet (Willis Islets). Vegetation data was recorded at 22 ground-truthing sites and one permanent BioCondition monitoring site (M21). The locations of these sites are shown in *Figure 67.* The yellow lines are the boundaries of the vegetation communities shown on the vegetation map in *Figure 68.*

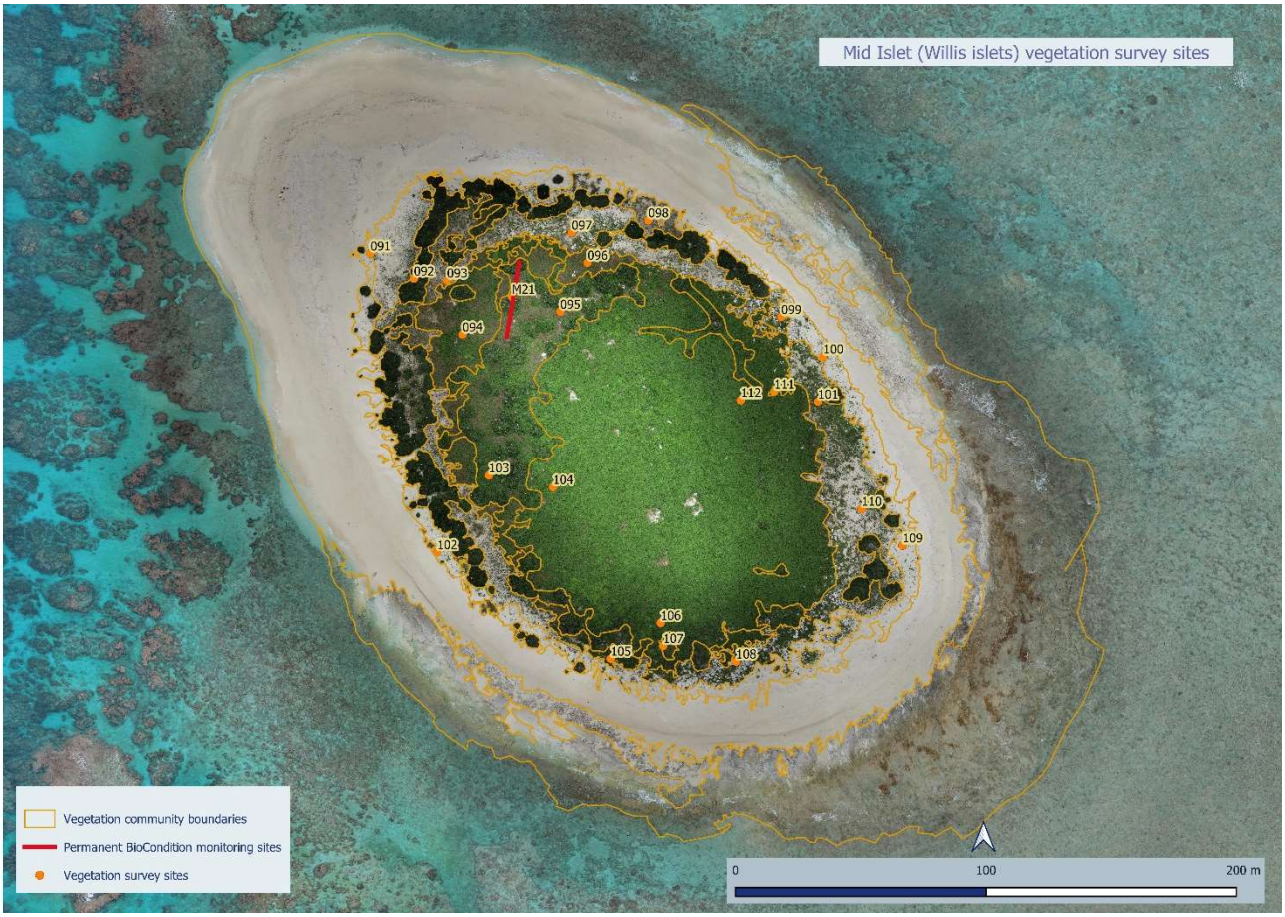


Figure 67 Mid Islet (Willis Islets) showing the number and location of ground-truthing vegetation survey sites and the BioCondition monitoring site relative to the vegetation map unit boundaries.

Vegetation condition

Some minor dieback was present in a couple of *Argusia argentea* (octopus bush) shrubs on the southwestern coastline. Otherwise, the vegetation was all in very good condition at the time of the survey.

Floristic data

Seven plant species were recorded on Mid Islet (Willis Islets).

Boerhavia albiflora var. *albiflora* (tar vine) was the most widespread species across the cay. *Sporobolus virginicus* (marine couch), *Achyranthes aspera* (chaff flower) and *Boerhavia albiflora* var. *albiflora* were the most abundant species present at the time of the survey.

Plant species recorded during the 2022 survey are listed in *Table 88* together with frequency in sites, the averaged cover for each species for sites in which the species was present and their averaged cover over the entire cay. Data for species cover at each site plus occurrence of each species in relation to vegetation community and landform are contained in *Table 90.*

Table 88 Plant Species recorded on Mid Islet (Willis Islets) (06/06/2022)

Layers: (G) = ground

Lifeform: G = grass, Ga = annual grass, Gp = perennial grass, H= herb, Ha = annual herb, Hp = perennial herb, S = shrub, ST = large shrub/small tree

Scientific name	Common name	Family	Life form	Presence in sites (% of sites)	Average % cover for each layer (averaged cover only for sites in which species was present	Overall average % cover for each layer- (averaged cover over all sites including 0% covers at sites where species was absent
Abutilon albescens	lantern bush	Malvaceae	S	17.4%	8.8% (G)	1.5% (G)
Achyranthes aspera	chaff flower	Amaranthaceae	Ha	65.2%	27.8% (G)	18.2% (G)
Argusia argentea	octopus bush	Boraginaceae	ST	26.1%	34.2% (S!), 37.5% (G)	8.9% (S1),1.6% (G)
Boerhavia albiflora var. *albiflora*	tar vine	Nyctaginaceae	Hp	95.7%	15.2% (G)	14.6% (G)
Lepturus repens	stalky grass	Poaceae	G	8.7%	2.5% (G)	0.2% (G)
Portulaca oleracea	pig weed	Portulaceae	H	43.5%	14.5% (G)	6.3% (G)
Sporobolus virginicus	marine couch	Poaceae	Gp	60.9%	36.6% (G)	22.3% (G)
Stenotaphrum micranthum	beach buffalo grass	Poaceae	Ga	8.7%	2.5% (G)	0.2% (G)
Tribulus cistoides	bulls head burr	Zygophyllaceae	Ha	34.8%	5.6% (G)	2.0% (G)
Total no of species = 9						

Vegetation communities

The shrub *Argusia argentea* (octopus bush) formed shrubland to open shrubland communities around the perimeter and also on the flats and lower slopes in the northwestern interior of the cay. No other trees or large shrub communities were present.

Achyranthes aspera (chaff flower) communities dominated the remainder of the interior of the cay. The short-lived shrub, *Abutilon albescens* (lantern bush) was present in low abundance in the ground layer within this unit but did not form a shrubland community. The vegetation in the interior of the cay was typically very dense, although there were numerous bare patches within it that were utilized by nesting sooty terns and brown noddies.

Boerhavia albiflora var. *albiflora* (tar vine) open vegetation communities were present landward of the coastal *Argusia argentea* community. *Boerhavia albiflora* var. *albiflora* open herblands were also present on rubble banks and other locations along the coastline.

Vegetation communities present on Mid Islet (Willis Islets) in June 2022, the area of each and representative survey sites within each vegetation community are listed in *Table 89.* The spatial distribution and extent of the vegetation communities on Mid Islet (Willis Islets) are shown in the vegetation map in *Figure 68.*

Comparisons with equivalent and similar communities on other Coral Sea cays are shown in *Appendix 3.*

Table 89 Vegetation communities on Mid Islet (Willis Islets)

Veg map unit	Summary description	Additional description	Total area (ha)	Sites
Unvegetated areas				
A	sandy shores		2.604	
B	lithified shores		1.811	
C	rubble banks		0.259	
Vegetation of shorelines, beaches and sand spits				
1a	sparse to open herbland on sandy shorelines		0.359	100, 102
2a	*Argusia argentea* open shrubland to isolated shrubs on shorelines and sand spits	*Argusia argentea* open shrubland to isolated shrubs on shorelines and sand spits with sparse to very sparse ground layer	0.050	91, 109
2b	coastline *Argusia argentea* shrubland	coastline *Argusia argentea* shrubland with a sparse ground layer	0.345	92
Grasslands				
17	*Sporobolus virginicus* closed grassland		0.154	96, 107, 111
Herblands				
6a	*Boerhavia albiflora* var. *albiflora/ Portulaca oleracea* open herbland to herbland		0.285	101, 108, 110
6f	*Boerhavia albiflora* var. *albiflora/ Sporobolus virginicus* open herbland		0.302	93, 97, 98
6g	*Boerhavia albiflora* var. *albiflora/ Sporobolus virginicus/ Portulaca oleracea* closed herbland	*Boerhavia albiflora* var. *albiflora/ Sporobolus virginicus/ Portulaca oleracea* closed herbland with *Abutilon albescens* and *Achyranthes aspera*	0.023	105
8	*Achyranthes aspera/ Boerhavia albiflora* var. *albiflora* herbland	*Achyranthes aspera/ Boerhavia albiflora* var. *albiflora* herbland with *Portulaca oleracea*	0.019	99
8d	*Achyranthes aspera* closed herbland	*Achyranthes aspera* closed herbland +/- Abutilon *albescens* +/- *Boerhavia albiflora* var. *albiflora* +/- *Sporobolus virginicus*; contains some bare patches utilised by nesting seabirds	1.492	94, 104, 106, 112
Interior shrublands				
11c	*Argusia argentea* interior shrubland	*Argusia argentea* interior shrubland with dense ground layer dominated by *Sporobolus virginicus* or *Achyranthes aspera*, with *Boerhavia albiflora* var. *albiflora* and *Tribulus cistoides*	0.396	95, 103, M21
		Total vegetated area (ha)	3.425	

Note: Areas of sandy shores and rocky shores, particularly those of the rocky shores are only approximate due to the difficulty in determining the location of the boundary between the edge of the shoreline and the surrounding reef flat using the imagery.

The following pages contain photographs and detailed descriptions of all the vegetation communities observed at the time of the June 2022 survey.

Photographs and descriptions of Mid Islet (Willis Islets) vegetation communities

Shoreline, beaches and sand spit vegetation

1a sparse to open herbland on sandy shorelines

ground truthing sites 100, 102

Photo 160 Veg map unit 1a, Site 100 Mid Islet (Willis Islets)
Joy Brushe ©

Vegetation community 1a was present around the entire shoreline and consisted of sparse, newly establishing vegetation variously dominated by *Boerhavia albiflora* var. *albiflora* (tar vine), *Portulaca oleracea* (pig weed), *Lepturus repens* (stalky grass) and *Sporobolus virginicus* (marine couch).

2a *Argusia argentea* open shrubland to isolated shrubs on shorelines and sand spits with sparse to very sparse ground layer

ground truthing sites 91, 109

Vegetation community 2a was present at various locations along the shoreline, typically present in association with vegetation community 1a. *Argusia argentea* (octopus bush) shrubs were between 1 metre and 2 metres tall. The ground layer at sites 91 and 109 consisted of sparse plants of *Boerhavia albiflora* var. *albiflora* (tar vine).

Photo 161 Veg map unit 2a, Site 91 Mid Islet (Willis Islets)
Joy Brushe ©

2b coastline *Argusia argentea* shrubland with a sparse ground layer

ground truthing site: 92

Photo 162 Veg map unit 2b, Site 92 Mid Islet (Willis Islets)
Joy Brushe ©

Vegetation community 2b was located intermittently around the entire shoreline, but was most extensive along the western, northwest and northern coastlines where it formed a continuous band of shrubland around the shoreline. Shrubs were typically about two metres tall. The sparse ground layer was dominated by *Boerhavia albiflora* var. *albiflora* (tar vine). Some minimal soil development was evident with soil consistng of light grey-brown coarse sand with some organic content and surface coral rubble.

Grasslands

17 *Sporobolus virginicus* closed grassland

ground truthing sites: 96, 107, 111

Photo 163 Veg map unit 17, Site 96 Mid Islet (Willis Islets)
Joy Brushe ©

Photo 164 Veg map unit 17, Site107 Mid Islet (Willis Islets)
Joy Brushe ©

Vegetation community 17 was located on the near-coastal flats and lower slopes. It was most extensive on the northwestern flats. *Boerhavia albiflora* var. *albiflora* (tar vine) and *Achyranthes aspera* (chaff flower) were also present in this community. Soil was typically dark brown sand with organic content. Occasional large coral fragments were present on the surface.

Herblands

6a ***Boerhavia albiflora* var. *albiflora*/ *Portulaca oleracea* open herbland to herbland**

ground truthing sites: 101, 108, 110

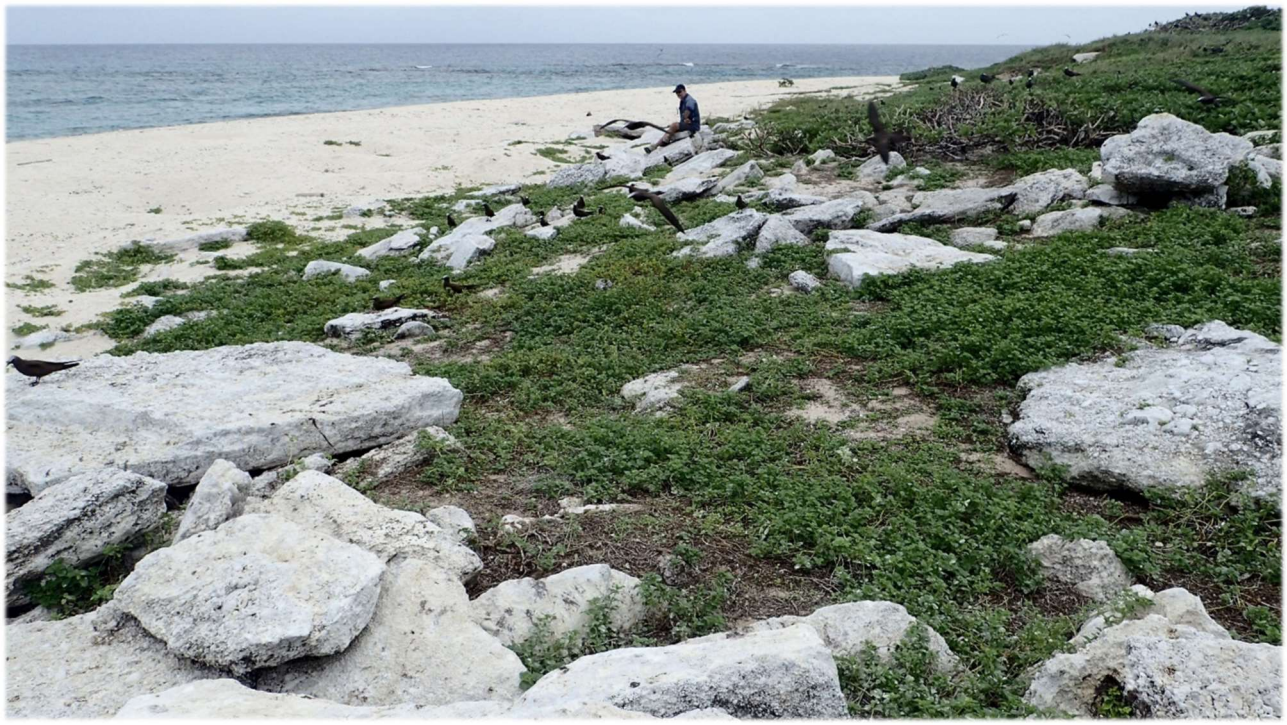


Photo 165 Veg map unit 6a, Site 108 Mid Islet (Willis Islets) growing on rubble banks adjacent to the shoreline Joy Brushe ©

Vegetation community 6a was growing on shoreline rubble banks and on slopes adjacent to the southeastern shoreline. Soil was brown coarse sand with some organic content and contained fine coral rubble.

6f ***Boerhavia albiflora* var. *albiflora*/ *Sporobolus virginicus* open herbland**

ground truthing sites: 93, 97, 98

Vegetation community 6f formed open communities on lower slopes adjacent to the northern and western shorelines just landward of the low coastal dunes. *Portulaca oleracea* (pig weed) and *Tribulus cistoides* (bulls head burr) were present in some places. Soil was typically grey-brown sand with some organic content and contained fine coral rubble. Some surface rock outcropping was present in this community.

Photo 166 Veg map unit 6f, Site 93 Mid Islet (Willis Islets)

Joy Brushe ©

Photo 167 Veg map unit 6f, Site 93 Mid Islet (Willis Islets)
Joy Brushe ©

6g ***Boerhavia albiflora* var. *albiflora*/ *Sporobolus virginicus*/ *Portulaca oleracea* closed herbland with *Abutilon albescens* and *Achyranthes aspera***

ground truthing site 105

Photo 168 Veg map unit 6g, Site 105 Mid Islet (Willis Islets) Joy Brushe ©

A small patch of vegetation community 6g was present on a slope adjacent to the southwest coastline. Soil was light coloured sand.

8 ***Achyranthes aspera*/ *Boerhavia albiflora* var. *albiflora* herbland with *Portulaca oleracea***

ground truthing site: 99

Photo 169 Veg map unit 8, Site 99 Mid Islet (Willis Islets) Joy Brushe ©

Vegetation community 8 was growing on a rubble bank adjacent to the northeast coastline. Soil was light coloured coarse sand with abundant coral fragments.

8d ***Achyranthes aspera*** **closed herbland +/-** ***Abutilon albescens*****+/-** ***Boerhavia albiflora*** **var.** ***albiflora*** **+/-** ***Sporobolus virginicus*****; contains some bare patches utilised by nesting seabirds**

ground truthing sites: 94, 104, 106, 112

Photo 170 Veg map unit 8d, Site 104 Mid Islet (Willis Islets)
Joy Brushe ©

Photo 171 Veg map unit 8d, Site 106 Mid Islet (Willis Islets)
Joy Brushe ©

Vegetation community 8d dominated the areas of higher elevation in the cay interior forming a very dense vegetation cover at the time of the 2022 survey. Soil was light brown sand with some organic content.

Interior shrublands

11c ***Argusia argentea* shrubland with dense ground layer dominated by *Sporobolus virginicus* or *Achyranthes aspera*, with *Boerhavia albiflora* var. *albiflora* and *Tribulus cistoides***

ground truthing sites: 95, 103; BioCondition monitoring site:M21

Photo 172 a and b: Veg map unit 11c, Site 95 Mid Islet (Willis Islets)
Joy Brushe ©

Vegetation community 11c formed a large area of shrubland on the lower slopes at the northwest end of the cay. The ground layer was dense and dominated by *Sporobolus virginicus* (marine couch) on the seaward side and by *Achyranthes aspera* (chaff flower) higher on the slope to the interior plateau. Soil was light coloured, coarse sand and minor rock outcropping was present.

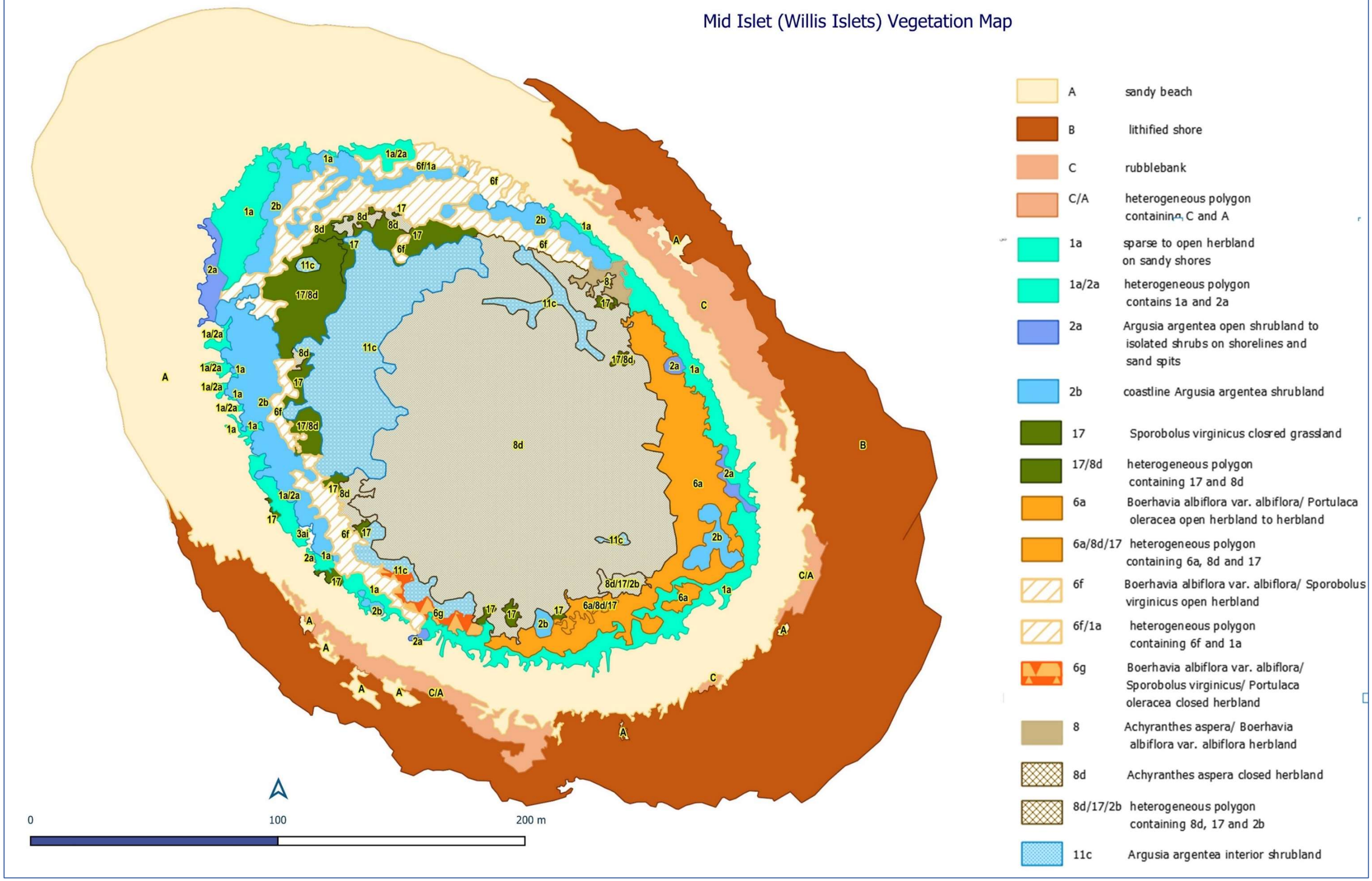


Figure 68 Mid Islet (Willis Islets) vegetation map

Table 90 Site data recorded on Mid Islet (Willis Islets) on 06/06/2022

Datum = WGS 84; green shading = site dominants

											Upper shrub layer	Ground Layer									Non plant ground cover									
Site	Lat	Long	Number of photos	Landform	Aspect	Estimated altitude	Soil description	Total weed cover %	Veg map unit code	Community	Argusia argentea	Abutilon albescens	Achyranthes aspera	Argusia argentea	Boerhavia albiflora var. albiflora	Lepturus repens	Portulaca oleracea	Sporobolus virginicus	Stenotaphrum micranthum	Tribulus cistoides	Litter	Plant specimens collected	Notes	Birds	Turtle activity	Start	Finish	Dominant growth form	Shrub Layer Height	T/S Canopy Crown Cover	Ground FPC
091	-16.213144	149.991384	2	beach		1	white coarse sand with occasional coral rubble fragments in soil medium coral rubble surface fragments	0	2a	Argusia argentea open shrubland with very sparse ground layer dominated by Boerhavia albiflora var. albiflora	5-25%				5-25%				trace-5%		trace-5%			some masked boobies	high	10:37:13	10:41:46	shrub 1-2m	1	very sparse (<20%)	very sparse (<10%)
092	-16.213234	149.991540	2	dune		1	light grey-brown coarse sand with some organic content, medium coral rubble surface fragments	0	2b	Argusia argentea shrubland with sparse ground layer dominated by Boerhavia albiflora var. albiflora	50-75%		trace-5%		5-25%					5-25%	25-50%	Argusia argentea		large numbers red-footed boobies, large numbers sooty terns		10:43:55	10:51:15	shrub 1-2m	2	mid-dense (>50-80%)	sparse (10-30%)
093	-16.213241	149.991659	2	lower slope	NW	2	grey-brown sand with some organic content, occasional coral rubble surface fragments and minor rock outcropping	0	6f	Boerhavia albiflora var. albiflora open herbland					5-25%		trace-5%	5-25%		trace-5%	5-25%			abundant sooty terns		10:53:03	10:58:09	herb			sparse (10-30%)
094	-16.213435	149.991714	3	lower slope	NW	4	light brown sand with some organic content	0	8d	Achyranthes aspera closed herbland			25-50%		5-25%			25-50%		trace-5%	5-25%			large numbers brown noddies		11:01:07	11:08:03	herb			dense (>70)
095	-16.213353	149.992065	3	mid slope	NW	4	light coloured coarse sand and minor rock outcropping	0	11c	Argusia argentea shrubland with dense ground layer dominated by Sporobolus virginicus and Boerhavia albiflora var. albiflora	25-50%		5-25%		5-25%			50-75%		trace-5%	5-25%			some red-footed boobies, some brown noddies		11:11:01	11:17:34	shrub 1-2m	2	sparse (20-50%)	dense (>70)
096	-16.213177	149.992163	2	lower slope	N	3	dark brown coarse sand with high organic content, occasional large coral rubble surface fragments	0	17	Sporobolus virginicus closed grassland			5-25%		5-25%			75-95%			trace-5%	Sporobolus virginicus		some brown noddies		11:20:09	11:24:46	grass			dense (>70)
097	-16.213069	149.992106	0	lower slope	NW	2	grey-brown sand with some organic content, occasional coral rubble surface fragments and minor rock outcropping	0	6f	Boerhavia albiflora var. albiflora open herbland					5-25%		trace-5%	5-25%		trace-5%	5-25%	Boerhavia albiflora var. albiflora, Tribulus cistoides		abundant sooty terns		11:26:15	0:00:00	herb			sparse (10-30%)
098	-16.213025	149.992381	3	dune		1	light coloured coarse sand with occasional fine coral rubble fragments in soil coral rubble surface fragments	0	6f	Boerhavia albiflora var. albiflora/ Sporobolus virginicus open herbland					5-25%			5-25%	trace-5%		5-25%	Stenotaphrum micranthum		abundant sooty terns, some brown noddies	medium	11:30:23	11:35:04	herb			sparse (10-30%)

											Upper shrub layer	Ground Layer									Non plant ground cover									
Site	Lat	Long	Number of photos	Landform	Aspect	Estimated altitude	Soil description	Total weed cover %	Veg map unit code	Community	Argusia argentea	Abutilon albescens	Achyranthes aspera	Argusia argentea	Boerhavia albiflora var. albiflora	Lepturus repens	Portulaca oleracea	Sporobolus virginicus	Stenotaphrum micranthum	Tribulus cistoides	Litter	Plant specimens collected	Notes	Birds	Turtle activity	Start	Finish	Dominant growth form	Shrub Layer Height	T/S Canopy Crown Cover	Ground FPC
099	-16.213372	149.992858	2	rubble bank		1	light coloured coarse sand with abundant coral rubble fragments in soil abundant large coral rubble surface fragments	0	8	Achyranthes aspera/ Boerhavia albiflora var. albiflora herbland			5-25%		5-25%		5-25%				5-25%			large numbers brown noddies		11:39:46	11:44:32	herb			mid-dense (>30-70%)
100	-16.213514	149.993009	2	dune		1	white coarse sand with abundant coral rubble fragments in soil abundant coral rubble surface fragments	0	1a	Boerhavia albiflora var. albiflora/ Portulaca oleracea open herbland					5-25%		5-25%							some masked boobies, some brown noddies	high	11:46:12	11:49:43	herb			sparse (10-30%)
101	-16.213676	149.992990	3	mid slope	NE	2	light brown coarse sand with some organic content, abundant fine coral rubble fragments in soil, coral rubble surface fragments	0	6a	Boerhavia albiflora var. albiflora/ Portulaca oleracea herbland					25-50%		25-50%				5-25%			abundant sooty terns, large numbers brown noddies		11:51:23	11:56:23	herb			mid-dense (>30-70%)
102	-16.214218	149.991623	2	dune		1	white coarse sand with fine coral rubble fragments in soil coral rubble surface fragments	0	1a	Boerhavia albiflora var. albiflora/ Lepturus repens/ Portulaca oleracea/ Sporobolus virginicus open herbland					trace-5%	trace-5%	trace-5%	trace-5%				trace-5%	Lepturus repens Portulaca oleracea			high	12:20:13	12:24:19	herb			sparse (10-30%)
103	-16.213943	149.991809	2	mid slope	W	7	light brown coarse sand	0	11c	Argusia argentea shrubland with dense ground layer dominated by Achyranthes aspera and Sporobolus virginicus	25-50%		25-50%		trace-5%			25-50%		trace-5%	trace-5%			large numbers red-footed boobies, some brown noddies		12:28:10	12:34:29	shrub 1-2m	2	sparse (20-50%)	dense (>70)
104	-16.213985	149.992039	3	crest		8	brown sand with high organic content, occasional coral rubble surface fragments	0	8d	Achyranthes aspera closed herbland/		5-25%	75-95%		trace-5%			trace-5%			trace-5%	Abutilon albescens, Achyranthes aspera	Siting pole in the site. Ground layer is 0.6 m tall and very dense	some brown noddies, occasional wedgetail shearwater burrows		12:40:32	12:46:43	herb			dense (>70)
105	-16.214599	149.992246	3	mid slope	S	2	light coloured sand	0	6g	Boerhavia albiflora var. albiflora/ Portulaca oleracea/ Sporobolus virginicus closed herbland		trace-5%	5-25%		25-50%		25-50%	5-25%			trace-5%			large numbers brown noddies		13:23:35	13:28:33	herb			dense (>70)
106	-16.214471	149.992425	4	flat		7	light brown sand with some organic content	0	8d	Achyranthes aspera closed herbland		trace-5%	75-95%		5-25%			5-25%			trace-5%			large numbers brown noddies		13:33:30	13:38:56	herb			dense (>70)
107	-16.214553	149.992434	2	flat		5	brown sand with some organic content, occasional large coral rubble surface fragments	0	17	Sporobolus virginicus closed grassland			trace-5%		trace-5%			75-95%			trace-5%		Small patch	large numbers brown noddies		13:40:10	13:43:51	grass			dense (>70)

											Upper shrub layer	Ground Layer									Non plant ground cover									
Site	Lat	Long	Number of photos	Landform	Aspect	Estimated altitude	Soil description	Total weed cover %	Veg map unit code	Community	Argusia argentea	Abutilon albescens	Achyranthes aspera	Argusia argentea	Boerhavia albiflora var. albiflora	Lepturus repens	Portulaca oleracea	Sporobolus virginicus	Stenotaphrum micranthum	Tribulus cistoides	Litter	Plant specimens collected	Notes	Birds	Turtle activity	Start	Finish	Dominant growth form	Shrub Layer Height	T/S Canopy Crown Cover	Ground FPC
108	-16.214609	149.992696	2	rubble bank	SSE	1	brown coarse sand with some organic content, fine coral rubble surface fragments	0	6a	Boerhavia albiflora var. albiflora/ Portulaca oleracea herbland			trace-5%		25-50%		5-25%				5-25%			large numbers brown noddies		13:47:49	13:52:58	herb			mid-dense (>30-70%)
109	-16.214194	149.993293	2	dune		1	white coarse sand with coral rubble fragments in soil coral rubble surface fragments	0	2a	Argusia argentea open shrubland with sparse ground layer dominated by Boerhavia albiflora var. albiflora	5-25%		trace-5%		5-25%		trace-5%				trace-5%			large numbers sooty terns, occasional masked boobies, occasional brown noddies	high	13:56:27	14:01:55	shrub 1-2m	2	very sparse (<20%)	sparse (10-30%)
110	-16.214063	149.993146	2	lower slope	E	2	light coloured coarse sand with coral rubble surface fragments	0	6a	Boerhavia albiflora var. albiflora/ Portulaca oleracea open herbland					5-25%		5-25%				5-25%			abundant sooty terns	medium	14:04:47	14:08:50	herb			sparse (10-30%)
111	-16.213640	149.992833	2	mid slope	ENE	3	brown sand with high organic content	0	17	Sporobolus virginicus closed grassland			5-25%		5-25%	trace-5%		50-75%		trace-5%	trace-5%			some brown noddies		14:13:17	14:18:17	grass			dense (>70)
112	-16.213671	149.992713	2	mid slope	ENE	6	light brown sand with some organic content	0	8d	Achyranthes aspera closed herbland		5-25%	75-95%								trace-5%					14:20:59	14:24:49	herb			dense (>70)
M21	-16.213299	149.99189	10					0	11c	Argusia argentea shrubland with a dense ground layer dominated by Sporobolus virginicus and lower foliage of Argusia shrubs	25-50%		trace-5%	25-50%	trace-5%			50-75%		5-25%	5-25%		Currently site is 30m x 10 m. On next visit move the S post 20 m further south and survey the entire 50x10 site	red-footed boobies in Argusia		15:15	15:35	shrub	2	sparse (20-50%)	dense (>70)

Comparison with previous surveys

In 1963, Hindwood reported the presence of *Sporobolus virginicus* (marine couch)*, Portulaca* (pig weed) and *Boerhavia* (tar vine) but did not mention *Achyranthes aspera* (chaff flower) which now dominates much of the central interior of the cay.

In 1995, Donaldson reported that there were only two small plants of *Argusia argentea* (octopus bush) on Mid Islet (Willis Islets). The presence of only two plants of this species was confirmed by Wilgar in 1994. According to Wilgar, these two *Argusia argentea* plants were located on the southwestern foreshore. Shrublands dominated by this species now exist around much of the shoreline as well as on the flats and lower slopes in the northwestern interior of the cay.

BioCondition monitoring site data

One permanent BioCondition monitoring site (M21) was established and surveyed on Mid Islet (Willis Islets). The location of the centre transect of this site is shown as the red line in *Figure 67*. *Table 91* contains the data recorded at this site. The photographs included with the BioCondition attribute data are four of the 10 site photographs taken of this site. Photographs shown are all taken from the centre point of the centre transect, the first facing along the transect bearing and then consecutively facing 90^{o}, 180^{0} and 270^{0} from the direction of the centre transect bearing.

Biocondition attributes

Table 91 BioCondition attribute data recorded in monitoring site M21, Mid Islet (Willis Islets) on 05 June 2022

Site M21	
Cay	Mid Willis
Vegetation community description	*Argusia argentea* shrubland with a dense ground layer dominated by *Sporobolus virginicus* and lower foliage of *Argusia* shrubs
Transect start (WGS 84)	-16.213441 149.991876
Transect centre (WGS84)	-16.213299 149.991892
Transect end (WGS 84)	-16.213174 149.991921
Transect bearing (degrees)	362
Median canopy height/range (metres)	1.8/1.6-2.0
Tree canopy cover %	n/a
Shrub canopy cover %	29.3%
Basal area m^2/ha (at 30 cm height, calculated from stem diameters)	n/a
Total number of large trees/ha	0
Total no of trees per ha	n/a
Total number of tree stems/ha	n/a
Total no. shrubs/ha	167
Total no. shrub stems/ha	n/a
Large shrubs - mean diameter at 30 cm height	n/a
Recruitment of ecologically dominant layer (%)	n/a
Tree species richness	0
Tree species present	n/a
Shrub species richness	0
Shrub species present (layer in brackets)	*Argusia argentea* (S1)
Median ground layer height/range (metres)	0.75/0.2-0.8
Total ground layer cover of native cay species (%)	87.2
Grass species richness	1
Grass cover (%)	52.8%
Grass species present in order of decreasing cover - most abundant first (cover in brackets)	*Sporobolus virginicus* (52.8%)
Forb (including vines) species richness	3
Forb species cover (%)	12.4%
Forb species present in order of decreasing cover - most abundant first (cover in brackets)	*Tribulus cistoides* (6%), *Achyranthes aspera* (5%), *Boerhavia albiflora* var. *albiflora* (1.4%)
Native shrub ground cover (%)	22%
Non-native plant cover (all strata) (%)	0%
Litter cover (%)	12.6%
Bare ground (%)	0.2%
Woody debris (m/ha of logs >0.5m long and >10cm wide)	0
Soil pH	0-10cm = 9.27, 10-20cm= 9.57, 20-30cm = 9.65, average= 9.5

Photo 173
Monitoring site M21 Mid Islet (Willis Islets) facing N

Photo 174
Monitoring site M21 Mid Islet (Willis Islets) facing E

Photo 175
Monitoring site M21 Mid Islet (Willis Islets) facing S

Photo 176
Monitoring site M21 Mid Islet (Willis Islets) facing W

Joy Brushe ©

Soil data

Soil samples were collected from BioCondition monitoring site M21 on Mid Islet (Willis Islets).

Refer to *Appendix 5* for results of all the soil analyses for M21 and the other sites sampled during the 2022 voyage. For comparison of M21 soil analysis data with data from previous Coral Sea and Southern GBR soil surveys, refer to the Soils section under *Methodologies, general results and discussion* in this report.

Although coastal *Argusia argentea* soils typically have high pH and low EC, the site M21 sample had higher pH and lower EC than any of the Coral Sea and Capricorn Bunker cays sites sampled so far.

This site also had the lowest total nitrogen, Colwell phosphorus, exchangeable calcium, exchangeable potassium, exchangeable magnesium, exchangeable sodium, cation exchange capacity, aluminium, copper, iron and manganese of the 2022 samples and most other *Argusia argentea* shrubland locations.

Total phosphorus levels were also relatively low.

Organic carbon and zinc levels were within the range of other coastal *Argusia argentea* communities whilst total carbon levels were relatively high.

Although M21 was located on the lower interior of the cay, the low nutrient status of the soil at this site indicates a low level of soil development, possibly due to either relatively recent sand accumulation and more recent vegetation establishment or recent disturbance to soil and vegetation at this location. It is likely that this site is located in an area of former coastline.

Total sulphur levels at all 2022 sample sites were high – Refer to *Figure 13* in the Soils section under *Methodologies, general results and discussion* in this report.

2.18.4 Birds

Table 92 Bird species and their breeding effort – Mid Islet, Willis Islets

Mid Islet	6/06/2022	Breeding stages present			Breeding pairs	Adolescents and adults
common name	**scientific name**	Nests	Chicks	Young		
red-tailed tropicbird	*Phaethon rubricauda roseotinctus*	1	1	0	2	3
Herald petrel	*Pterodroma heraldica*	0	0	0	0	0
wedge-tailed shearwater	*Ardenna pacifica*	0	0	0	0	0
great frigatebird	*Fregata minor*	0	0	0	0	1
lesser frigatebird	*Fregata ariel*	0	0	0	0	7
masked booby	*Sula dactylatra dactylatra*	47	0	0	47	67
brown booby	*Sula leucogaster*	1	0	0	1	46
red-footed booby	*Sula sula*	485	2	unknown	487	553
sooty tern	*Onychoprion fuscatus*	P	P	P	9295	9479
bridled tern	*Onychoprion anaethetus*	0	0	0	0	0
crested tern	*Thalasseus bergii*	9	0	0	9	32
roseate tern	*Thalasseus bengalensis*	0	0	0	0	0
black-naped tern	*Sterna sumatrana*	0	0	0	0	2
New Caledonian fairy tern	*Sternula nereis exsul*	0	0	0	0	0
black noddy	*Anous minutus*	0	0	0	0	P
brown noddy	*Anous stolidus*	P	P	P	P	P
buff-banded rail	*Gallirallus philippensis tounelieri*	0	0	0	0	0
purple swamphen	*Porphyrio melanotus*	0	0	0	0	0
sacred kingfisher	*Todiramphus sanctus*	0	0	0	0	0
white-faced heron	*Egretta novaehollandiae*	0	0	0	0	0
Pacific golden plover	*Pluvialis fulva*	0	0	0	0	0
ruddy turnstone	*Arenaria interpres*	0	0	0	0	0
wandering tattler	*Tringa incana*	0	0	0	0	0
grey-tailed tattler	*Tringa brevipes*	0	0	0	0	0
lesser sand plover	*Charadrius mongolus*	0	0	0	0	0

Notes

- An overall breeding pair total for sooty terns has been provided. An accurate break up of nests, chicks and young was not practical.
- Brown noddy breeding numbers were not possible as many birds were in the middle of the vegetated sections of the cay. Lower altitude drone imagery may be able to assist with future counts.
- Red-footed booby nest counts were aided by drone imagery.

Photo 177 Adult and adolescent red-footed boobies at a typical roost site
Collette Bagnato © Queensland Government

Photo 178 Sooty terns nested throughout the *Argusia* dominated communities
Collette Bagnato © Queensland Government

2.18.5 Pest and invertebrate sampling

(Refer to Health Check section for map)

6 June 2022

Table 93 Rodents

Collection period	Sampling methods	Sampling sites	Rodent species
day	Baited ink pad tunnels	2	0

Table 94 Invertebrates

Collection period	Sampling methods	baited sites	Species
daylight	Bait station and ground search	7	See below

Order	Family	Species identification	Common name
Araneae	Salticidae	"*Saitis*" sp.	jumping spider
Coleoptera	Tenebrionidae	*Gonocephalum* sp. A	darkling beetle
Embioptera		Embioptera	web spinner
Hemipera	Pentatomidae	Pentatomidae	shield bug
Hymenoptera	Formicidae	*Cardiocondyla nuda / atalanta*	ant
Hymenoptera	Formicidae	*Tetramorium lanuginosum*	wooly ant
Hymenoptera	Scelionidae	*Scelio* sp.	parasitic wasp
Ixodida	Argasidae	*Ornithodoros capensis*	Argasid tick

2.18.6 Health check and Island Watch

Three Health Checks (HC) were assessed at Mid Islet, Willis Islets.

The overall condition class of the vegetation communities was **Good** (the highest rating, see *Table 95*).

Detailed criteria for each HC site are included in *Appendix 8*.

Table 95 Assessed condition class for each HC site

	Mid Islet, Willis Islets			
HC Site	Overall condition class			
HC52	Good	Good with concern	Significant concern	Critical
HC53	Good	Good with concern	Significant concern	Critical
HC54	Good	Good with concern	Significant concern	Critical

Table 96 Summary of vegetation communities around each HC site (reference with *Table 89 and Figure 69)*

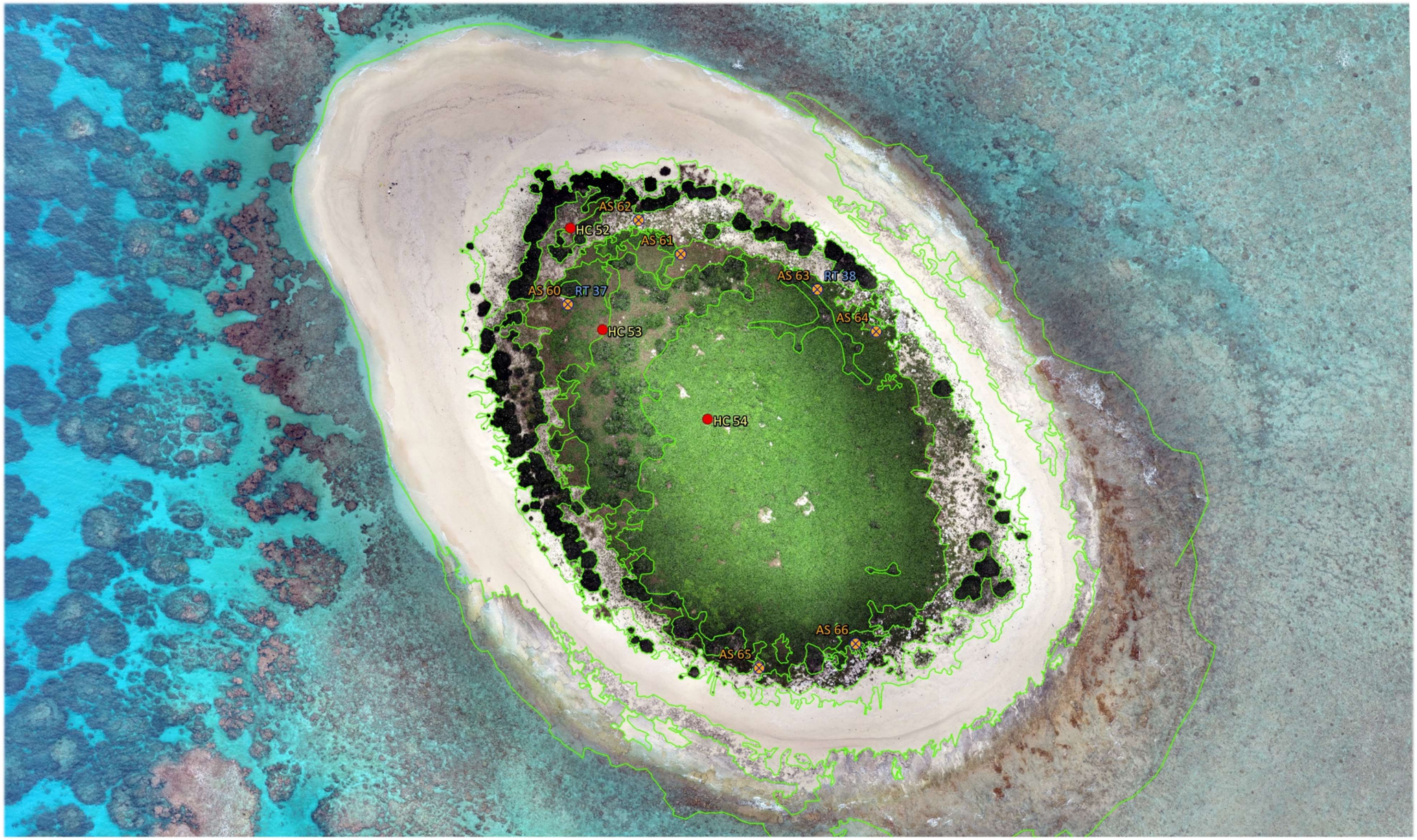
HC Site	Ecosystems/vegetation communities		
HC52	1a	2b	6f
HC53	8d	11c	17
HC54	8d		

Photo 179 Health Check site HC53 East

Photo 180 Health Check site HC54 East

Island Watch

A summarised table of all Island Watch information can be found at *Appendix 9*.



Mid Islet, Willis Islets

Area: 3.4 ha (area above HAT)

- Vegetation communities
- Health check
- Rodent tunnel
- Ant bait station

N W E S

0 5 10 20 30 40 50 Metres

Printed on: 25/11/2022

Coordinate System: WGS 1984 Web Mercator Auxiliary Sphere
Projection: Mercator Auxiliary Sphere
Datum: WGS1984

Figure 69 Health Check, rodent tunnel and ant bait station sites on Mid Islet, Willis Islets

2.19 Sand (Bianca) Cay, Dianne Bank

Figure 70 Sand Cay Jake Sanders © Queensland Government

2.19.1 Drone imagery

7 June 2022:

- Drone - Phantom 4 RTK
- Image capture height 65m
- Resolution 1.9cm/px
- Map stitching software – Drone Deploy

2.19.2 Physical description

- Low tide extent 404m x 188m
- Approximate high tide extent 350m x 151m
- Approximate area above high tide 4.12ha

Sand Cay, shown in *Figure 70,* is an unvegetated sand and coral rubble cay located 449km northeast of Cairns, Queensland at -15.721 degrees latitude and 149.619 degrees longitude.

2.19.3 Vegetation

On 7 June 2022 Sand Cay was unvegetated.

2.19.4 Birds

Table 97 Bird species and their breeding status – Sand Cay, Dianne Bank

Sand Cay	7/06/2022	Breeding stages present				
common name	**scientific name**	Nests	Chicks	Young	Breeding pairs	Adolescents and adults
red-tailed tropicbird	*Phaethon rubricauda roseotinctus*	0	0	0	0	0
Herald petrel	*Pterodroma heraldica*	0	0	0	0	0
wedge-tailed shearwater	*Ardenna pacifica*	0	0	0	0	0
great frigatebird	*Fregata minor*	0	0	0	0	1
lesser frigatebird	*Fregata ariel*	0	0	0	0	0
masked booby	*Sula dactylatra dactylatra*	145	1	0	146	164
brown booby	*Sula leucogaster*	23	0	0	23	100
red-footed booby	*Sula sula*	0	0	0	0	0
sooty tern	*Onychoprion fuscatus*	0	0	0	0	15
bridled tern	*Onychoprion anaethetus*	0	0	0	0	0
crested tern	*Thalasseus bergii*	0	0	0	0	27
roseate tern	*Thalasseus bengalensis*	0	0	0	0	0
black-naped tern	*Sterna sumatrana*	0	0	0	0	0
New Caledonian fairy tern	*Sternula nereis exsul*	0	0	0	0	0
black noddy	*Anous minutus*	0	0	0	0	0
brown noddy	*Anous stolidus*	0	0	0	0	201
buff-banded rail	*Gallirallus philippensis tounelieri*	0	0	0	0	0
purple swamphen	*Porphyrio melanotus*	0	0	0	0	0
sacred kingfisher	*Todiramphus sanctus*	0	0	0	0	0
white-faced heron	*Egretta novaehollandiae*	0	0	0	0	0
Pacific golden plover	*Pluvialis fulva*	0	0	0	0	0
ruddy turnstone	*Arenaria interpres*	0	0	0	0	0
wandering tattler	*Tringa incana*	0	0	0	0	0
grey-tailed tattler	*Tringa brevipes*	0	0	0	0	0
lesser sand plover	*Charadrius mongolus*	0	0	0	0	0

Notes

- The brown noddy count represents mostly adolescent birds. These adolescent birds occupied a recent nesting area and are likely progeny from a recent breeding event on this cay.
- The fine substrate and lack of vegetation makes this an ideal nesting location for masked boobies.
- No threats were observed.

Photo 181 Typical masked booby nesting area Collette Bagnato © Queensland Government

Photo 182 Brown noddy adolescent birds roosting near the former breeding colony site
Collette Bagnato © Queensland Government

2.19.5 Pest and invertebrate sampling

7 June 2022

Rodents – unvegetated cay, no rodent tunnels deployed. No rodents observed.

Table 98 Invertebrates

Collection period	Sampling methods	baited sites	Species
daylight search	ground search	0	0

2.19.6 Health Checks and Island Watch

Two Health Checks (HC) were assessed at Sand Cay, Diane Banks.

The overall condition class of the cay's ecosystem was **Good** (the highest rating, see *Table 99*).

Detailed criteria for each HC site are included in *Appendix 8*.

Table 99 Assessed condition class for each HC site

	Sand (Bianca) Cay, Diane Banks			
HC Site	Overall condition class			
HC55	Good	Good with concern	Significant concern	Critical
HC56	Good	Good with concern	Significant concern	Critical

Table 100 Summary of ecosystem type around each HC site (reference with *Figure 71*)

HC Site	Ecosystems/vegetation communities
HC55	Unvegetated, sandy substrate, fine sediments with coral rubble
HC56	Unvegetated, sandy substrate, fine sediments with coral rubble

Photo 183 Health Check site HC56 West

Island Watch

A summarised table of all Island Watch information can be found at *Appendix 9.*

Sand Cay, Dianne Bank

Area: Approx. 4.349 ha (area above HAT)
Approx. 6.344 ha (total area of cay)

- Health check

N
W E
S

0 5 10 20 30 40 50
Metres

Printed on:
17/11/2022

Coordinate System: WGS 1984 Web Mercator Auxiliary Sphere
Projection: Mercator Auxiliary Sphere
Datum: WGS1984

Figure 71 Health Check sites on Sand Cay, Dianne Bank

Part 3: Pelagic bird records

The following data represent bird observations made at sea during the voyage.

The tables do not show areas where observer effort was considerable, but birds were absent.

Photo 184 Black-bellied storm-petrel Andrew McDougall © Queensland Government

Photo 185 Red-footed boobies were common pelagic birds Andrew McDougall © Queensland Government

Table 101 Pelagic sightings, Great Barrier Reef to Cato Island

Southern Coral Sea reef systems Great Barrier Reef to Cato Island				
Date	latitude	longitude	species	number
24/05/2022	-23.74778	152.26772	black noddy	55
24/05/2022	-23.7295	152.31036	wedge-tailed shearwater	1
24/05/2022	-23.71732	152.39572	brown booby	2
24/05/2022	-23.71101	152.4378	brown booby	1
24/05/2022	-23.69416	152.55231	Hutton's shearwater	2
24/05/2022	-23.65462	152.81448	Hutton's shearwater	3
24/05/2022	-23.65287	152.82715	Hutton's shearwater	1
24/05/2022	-23.64599	152.873	white-faced storm-petrel	1
24/05/2022	-23.64599	152.873	wedge-tailed shearwater	1
24/05/2022	-23.59678	153.1956	shy albatross	2
24/05/2022	-23.58981	153.24379	Wilson's storm petrel	2
24/05/2022	-23.58981	153.24379	black-bellied storm petrel	3
24/05/2022	-23.58981	153.24379	white-faced storm-petrel	1
24/05/2022	-23.58758	153.2589	white-faced storm-petrel	1
24/05/2022	-23.58758	153.2589	Wilson's storm petrel	1
24/05/2022	-23.58195	153.29478	Kermadec petrel	1
24/05/2022	-23.57888	153.31476	black-bellied storm petrel	1
24/05/2022	-23.57768	153.3213	white-faced storm-petrel	1
24/05/2022	-23.57703	153.32649	white-faced storm-petrel	1
24/05/2022	-23.57357	153.34987	Wilson's storm petrel	1
24/05/2022	-23.56988	153.37259	white-bellied storm-petrel	1
24/05/2022	-23.5694	153.37718	wedge-tailed shearwater	1
24/05/2022	-23.5694	153.37718	black-bellied storm petrel	1
24/05/2022	-23.56716	153.38918	white-faced storm-petrel	1
24/05/2022	-23.56599	153.39906	black-bellied storm petrel	1
24/05/2022	-23.56389	153.41299	black-bellied storm petrel	2
25/05/2022	-23.30247	155.04926	black-bellied storm petrel	1
25/05/2022	-23.29986	155.06407	black-bellied storm petrel	1
25/05/2022	-23.2953	155.09402	providence petrel	1
25/05/2022	-23.2953	155.09402	black-bellied storm petrel	1
25/05/2022	-23.29271	155.10884	black-bellied storm petrel	1
25/05/2022	-23.288	155.13962	brown booby	1
25/05/2022	-23.24503	155.39812	brown booby	
25/05/2022	-23.24503	155.39812	lesser frigatebird	
25/05/2022	-23.24503	155.39812	brown noddy	
25/05/2022	-23.24503	155.39812	sooty tern	140
25/05/2022	-23.24503	155.39812	white tern	
25/05/2022	-23.24503	155.39812	red-footed booby	
25/05/2022	-23.24503	155.39812	masked booby (adolescent)	
25/05/2022	-23.23634	155.44525	white-faced storm-petrel	1

See *Figure 72* for overview of sighting locations.

Table 102 Pelagic sightings, South of Wreck Reefs

Southern reef systems South of Wreck Reefs				
Date	latitude	longitude	species	number
27/05/2022	-22.45338	155.26282	sooty tern	2
27/05/2022	-22.45338	155.26282	red-footed booby	1
27/05/2022	-22.42977	155.25439	sooty tern	15
27/05/2022	-22.42977	155.25439	red-footed booby	5
27/05/2022	-22.36088	155.22937	unidentified storm petrel	1
27/05/2022	-22.36088	155.22937	sooty tern	2
27/05/2022	-22.34466	155.22348	brown booby	2
27/05/2022	-22.34466	155.22348	sooty tern	2
27/05/2022	-22.33057	155.21838	brown booby	2
27/05/2022	-22.33057	155.21838	red-footed booby	1
27/05/2022	-22.29591	155.20584	black-bellied storm petrel	1
27/05/2022	-22.29017	155.20372	white-faced storm-petrel	2
27/05/2022	-22.2826	155.20105	brown noddy	2
27/05/2022	-22.27713	155.19902	brown noddy	2
27/05/2022	-22.27713	155.19902	sooty tern	1
27/05/2022	-22.25986	155.19279	brown booby	3
27/05/2022	-22.25986	155.19279	brown noddy	1

See *Figure 72* for overview of sighting locations.

Table 103 Pelagic sightings, Marion Reefs

Southern reef systems Marion Reefs				
Date	latitude	longitude	species	number
31/05/2022	-19.83938	152.90662	male lesser frigatebird	1
31/05/2022	-19.83938	152.90662	adolescent red-footed booby	1
31/05/2022	-19.83194	152.89677	wedge-tailed shearwater	1
31/05/2022	-19.81811	152.87839	sooty tern	1
31/05/2022	-19.79712	152.85049	black-bellied storm petrel	2
31/05/2022	-19.65175	152.65756	Tahiti petrel	1
31/05/2022	-19.60962	152.60191	brown booby	4
31/05/2022	-19.54645	152.51857	masked booby	1
31/05/2022	-19.54645	152.51857	brown booby	1
31/05/2022	-19.49939	152.45648	brown booby	1
31/05/2022	-19.35556	152.26697	brown booby	1
31/05/2022	-19.34525	152.25348	crested tern	1
31/05/2022	-19.33599	152.24129	masked booby	1
1/06/2022	-18.99529	152.23746	brown booby	1
1/06/2022	-18.98377	152.22156	brown booby	2
1/06/2022	-18.87763	152.14148	red-footed booby	2
1/06/2022	-18.8621	152.12213	black-bellied storm petrel	2
1/06/2022	-18.80084	152.04723	red-footed booby	3
1/06/2022	-18.80084	152.04723	sooty tern	2
1/06/2022	-18.80084	152.04723	brown booby	1

See *Figure 72* for overview of sighting locations.

Table 104 Pelagic sightings, Sand Cay to Holmes Reefs

Central reef systems Sand Cay to Holmes Reefs				
Date	latitude	longitude	species	number
7/06/2022	-15.7616	149.53532	sooty tern	2
7/06/2022	-15.77184	149.51234	sooty tern	3
7/06/2022	-15.79769	149.45451	masked booby	1
7/06/2022	-15.82063	149.40303	sooty tern	230
7/06/2022	-15.82955	149.3828	masked booby	1
7/06/2022	-15.84032	149.35869	great frigatebird adolescent	1
7/06/2022	-15.84032	149.35869	sooty tern	3
7/06/2022	-15.8726	149.28606	brown noddy	1
7/06/2022	-15.89441	149.23692	sooty tern	2
7/06/2022	-15.9255	149.16704	red-footed booby	1
7/06/2022	-15.99812	149.0029	frigatebird	3
7/06/2022	-15.99812	149.0029	sooty tern	130
7/06/2022	-15.99812	149.0029	brown noddy	30
7/06/2022	-15.99812	149.0029	red-footed booby	2
7/06/2022	-15.75034	149.64127	tree martin	1

See *Figure 73* for overview of sighting locations.

Table 105 Pelagic sightings, Holmes Reefs to the Great Barrier Reef

Central reef systems Holmes Reefs to the boundary of the Great Barrier Reef				
Date	latitude	longitude	species	number
8/06/2022	-16.49858	147.57437	black-bellied storm petrel	1
8/06/2022	-16.5002	147.48613	red-footed booby	1
8/06/2022	-16.5002	147.48613	black-naped tern	2
8/06/2022	-16.50771	146.98381	black-bellied storm petrel	1
8/06/2022	-16.50771	146.98381	black noddy	1
8/06/2022	-16.50775	146.96716	Tahiti petrel	1
8/06/2022	-16.50775	146.96716	black-bellied storm petrel	2

See *Figure 73* for overview of sighting locations.

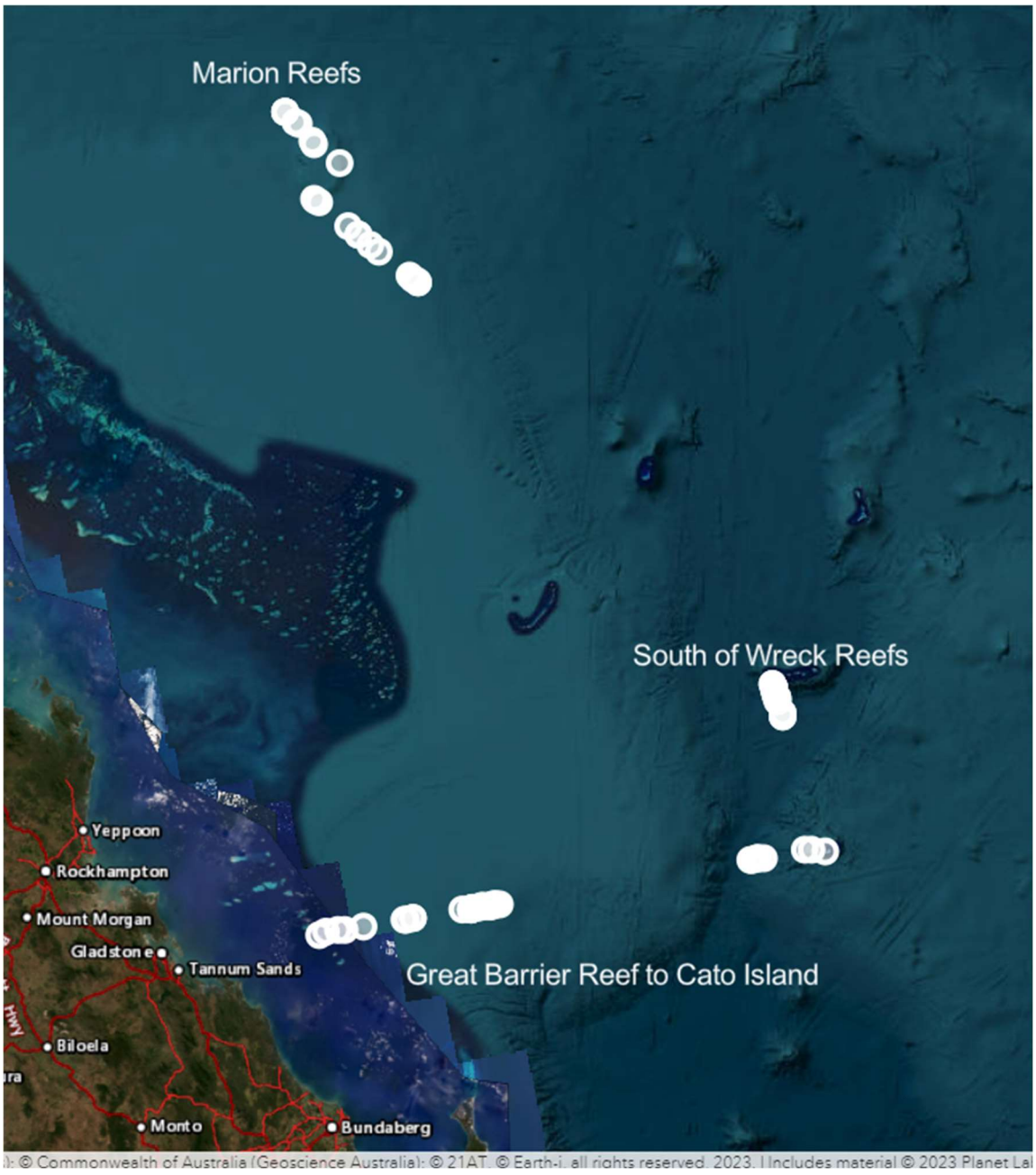


Figure 72 General locations for pelagic seabird sightings in the southern reef system @Queensland Globe

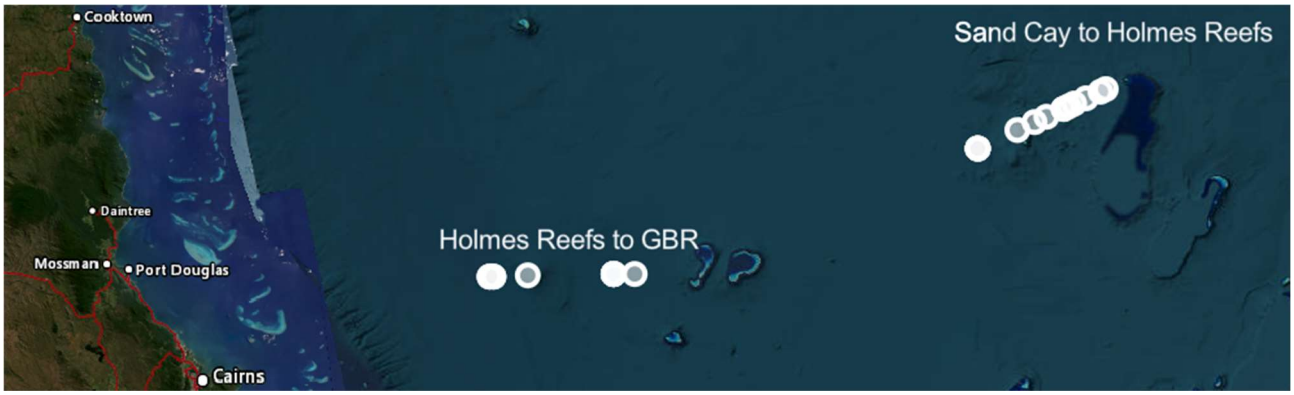


Figure 73 General locations for pelagic seabird sightings in the central reef system @Queensland Globe

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Appendices

Appendix 1 Comparisons of vegetation survey intensity

Cay	Number of ground-truthing sites	Number of BioCondition monitoring sites	Other	Hours spent surveying cay (excluding meal breaks)
Systematic surveys				
Cato Island	25	2 (M16 and M17)	species inventory	7.6
Porpoise Cay (Wreck Reef)	10	0	species inventory	1.3
Bird Islet (Wreck Reef)	20	2 (M18 and M19)	species inventory	7.4
North Cay (Willis Islet)	32	1 (M20)	species inventory	6.2
Mid Islet (Willis Islets)	22	1 (M21)	species inventory	4.4
Total	109	6		26.9
Opportunistic surveys				
East Diamond Islet (Tregrosse Reef)	0	1 (M06)	Weed survey traverse and revisit *Cordia* patch and *Scaevola* site	4.0
NE Herald Cay	3 (*Cordia* patches)	0	Weed survey	6.5
SW Herald Cay	0	0	Weed survey	2.0

Note: work on Cato Island was slowed and interrupted by wet windy weather

Average time per site	
Ground-truthing sites	BioCondition monitoring sites
Average of 6.4 minutes per site (11.7 minutes including traversing time)	Average of 44.3 minute (range = 20- 55 minutes)

Appendix 2 Plant species recorded on all Coral Sea cays

Native cay plant species

black ticks (✓) confirm current or recent occurrence on cay (recorded during 2019 to 2022 Parks Australia ecological assessment voyages and /or the 2016 Bush Blitz voyage)

red tick (✓) indicates species was recorded prior to 2016

dates in red are the latest date recorded for species not recorded during 2016 to 2022 voyages. Dates are from herbarium records and the following reports:

(Hindwood Keith & Serventy 1963, Heatwole 1967, Heatwole 1969, Stokes 1979, Stokes and McNamara 1979, Stokes and Skeat 1980, Skeat 1981, Skeat and Henry 1981, Shaughnessy and Hill 1983, Hicks 1983, Telford, 1991, Donaldson 1994, Batianoff 1997, Batianoff et al. 2008, Wilgar 93-93)

Mellish Reef has not been surveyed during the recent Parks Australia ecological assessment voyages. Information on species present on Mellish in this table was obtained from Hindwood et al.1963 report - the only available information.

Life form (LF): Ha = annual/short-lived herb; Hp = perennial herb; V = vine; ST = tall shrub/small tree (2-5m); T = tree (>2m).

Dispersal mechanisms: B = Birds, O = Ocean Currents, W = Wind, H = Human activity,

Scientific name	Common name	Family	Life form	Dispersal mechanism	Reef or island group	Magdelaine Cays	Herald Cays		Coringa Islets		Tregrosse Reef				Willis Islets			Cato Reef	Lihou Reef					Wreck Reef		Total number of cays on which the species was recorded in 2022	Total number of all cays currently with each species	Mellish Reef (not recently visited)
					Cay	South Cay	North East Cay	South West Cay	Chilcott Islet	South West Islet	East Diamond	West Diamond	Central Diamond	South Diamond	South Islet	Mid Islet	North Cay	Cato Island	South West Cay	Hermit Crab Islet	Turtle Islet	Lorna Cay	Georgina Cay	Bird Islet	Porpoise Cay			Herald Beacon Islet
					Vegetated area (ha)	32	42.7	14.7	13	10	10.4	9.8	10.9	4.2	6	3.4	18.9	14.8	5.7	8.1	2.5	6.4	2.8	8.4	0.2			?
					Max elevation (m)	12	5	7	8	13.5	8	6	8	12	?6?9	7.5	?3	6	5	5	6	?3	6	3.5	3			2
Achyranthes aspera	chaff flower	Amaranthaceae	Ha	B		✓ ✓	2006	✓ ✓	✓ ✓	✓ ✓	✓ ✓	✓	✓	✓ ✓	✓ ✓	✓ ✓	✓	✓ ✓	✓ ✓	✓ ✓	✓ ✓	✓	✓ ✓	✓ ✓	✓	5	20	
Boerhavia albiflora var. *albiflora*	tar vine	Nyctaginaceae	Hp	B		✓ ✓	2006	✓ ✓	✓ ✓	✓ ✓	✓ ✓	✓	✓	✓	✓ ✓	✓ ✓	✓	✓ ✓	✓ ✓	✓ ✓	✓ ✓	✓	✓ ✓	✓ ✓	✓ ✓	5	20	1961
Portulaca oleracea	pig weed	Portulaceae	Hap	O,B		✓ ✓	✓ ✓	✓	✓ ✓	✓ ✓	✓	✓	✓	✓ ✓	✓ ✓	✓ ✓	✓	✓ ✓	✓ ✓	✓ ✓	✓ ✓	✓	✓	✓ ✓	✓	5	20	
Lepturus repens	stalky grass	*Poaceae*	Gp	O,B		✓ ✓	✓ ✓	✓ ✓	✓ ✓	✓ ✓	✓ ✓	✓	✓	✓ ✓	✓ ✓	✓	✓	✓ ✓	✓ ✓	✓ ✓	✓ ✓	✓	1984	✓ ✓	✓	5	19	1961
Stenotaphrum micranthum	beach buffalo grass	Poaceae	Ga	O		✓ ✓	2006	2006	✓ ✓		✓ ✓	✓	✓	✓	✓	✓	✓	✓ ✓	✓ ✓	✓ ✓	✓ ✓	✓	✓ ✓	✓ ✓		4	18	
Tribulus cistoides	bulls head burr	Zygophyllaceae	Hap	B, O		✓ ✓	✓ ✓	✓ ✓	✓ ✓	✓ ✓	✓ ✓	✓	✓	✓ ✓	✓ ✓	✓ ✓	✓	✓ ✓	✓	✓ ✓	✓ ✓	✓		✓		4	18	
Abutilon albescens	lantern bush	Malvaceae	S	B, W		✓ ✓	✓ ✓	✓ ✓	✓ ✓	✓ ✓	✓ ✓	✓	✓	✓	2007	✓ ✓			✓ ✓	✓ ✓	✓ ✓		✓ ✓			1	14	
Argusia argentea	octopus bush	Boraginaceae	ST	O		✓ ✓	✓ ✓	✓ ✓	✓ ✓	✓ ✓	✓ ✓	✓	✓	✓ ✓	✓ ✓	✓ ✓ (2 plants only)		✓ (single plant only)				✓ (single plant only)				2	13	
Ipomoea violacea	moon flower	Convolvulaceae	Vp	O, B		✓ ✓	✓ ✓	✓ ✓	✓ ✓	✓ ✓	✓ ✓	✓	✓								1983					0	8	
Plumbago zeylanica	native plumbago	Plumbaginaceae	Hp	B		✓ ✓		✓ ✓	✓ ✓	✓ ✓	✓ ✓	✓	✓	✓ ✓							1980					0	8	
Sporobolus virginicus	marine couch	Poaceae	Gp	O, B		✓ ✓	✓ ✓	✓ ✓	2007						✓ ✓	✓ ✓	✓									2	7	
Cordia subcordata	sea trumpet	Boraginaceae	ST	O		✓ ✓	✓ ✓		✓ ✓	✓ ✓	✓ ✓	✓														0	6	
Lepidium englerianum	beach peppercress	Brassicaceae	Ha	O		2007	✓ (recorded in 2022, not recorded in 2019) ✓	1983	2007	2007	✓ ✓						✓									1	6	
Boerhavia mutabilis	pink flower tar vine	Nyctaginaceae	Hp	B		✓ ✓	✓ ✓	✓		✓ ✓																0	4	
Canavalia rosea	beach bean	Fabaceae	Vp	O		✓ ✓					✓ ✓	1961	✓													0	3	
Digitaria bicornis	crabgrass	Poaceae	Ga	?B		✓				✓																0	2	1961
Ipomoea pes-caprae subsp. *brasiliensis*	goats foot convolvulus	Fabaceae	Vp	O							✓				✓ ✓						1984					0	2	1961
Pisonia grandis	pisonia	Nyctaginaceae	T	B		✓ ✓	✓ ✓			1991																0	2	
Ximenia americana	yellow plum	Olacaceae	ST	?O			1997					✓ ✓														0	1	
Colubrina asiatica	Asian naked wood	Rhamnaceae	S	O		2007																				0	?0	
Calophyllu inophyllum	Alexandrian laurel	Clusiaceae	ST	O			1996 - transient																			0	?0	
Cocos nucifera	coconut	Arecaceae	T	H, O			1997- transient								✓ (transient - single juvenile plant) ✓ (planted)							✓ (transient -single seedling only)				0	?0	2019 (5 remaining of 100 planted in 1911)
Digitaria ctenantha	comb finger grass	Paceae	Ga	?B		1987	1997			1984																0	?0	
Guilandina bonduc	knicker nuts	Caelalpiniaceae	Vp	O			✓ (transient - single seedling only)																			0	?0	
Scaevola taccada	Cardwell cabbage	Goodeniaceae	S	O							2021 (Juvenile transient- not present in 2022)															0	0	
Current total no of native-cay species = 20						18	14	13	13	13	14	12	11	9	9	9	8	7	7	7	7	7	5	6	4		Total Number of Cays = 20	?

Weed species recorded on Coral Sea cays

black ticks (✓) confirm current or recent occurrence on cay (recorded during 2019 to 2022 Parks Australia ecological assessment voyages)

Red tick (✓) indicates species was recorded prior to 2019

dates in red are the latest date recorded for species not recorded during 2019 to 2022 voyages (dates are from herbarium records and reports -Donaldson 1994, Batianoff et al. 2008)

Mellish Reef has not been surveyed during the recent Parks Australia ecological assessment voyages.

Life form (LF): Ha = annual/short-lived herb; H = perennial herb

According to Batianoff et al 2012, weeds are introduced and spread by human activity

Scientific name	Common name	Family	Life form	Dispersal mehanisms	Willis Islets	Wreck Reef	Total Number of Cays with each species
					South Islet	Bird Islet	
Alternanthera pungens	kahki weed	Amaranthaceae	Ha	H	1995		1
Amaranthus viridis	green amaranth	Amaranthaceae	Ha	H	✓ ✓	✓	2
Cenchrus echinatus	Mossman River grass	Poaceae	Ha	H	✓ ✓		1
Cynodon dactylon var. dactylon	common couch	Poaceae	Hp	H	2007	✓ ✓	2
Dactyloctenium aegyptium	coast button grass	Poaceae	Ha	H	✓ ✓		1
Eleusine indica	crows foot grass	Poaceae	Ha	H	2007		1
Euphorbia cyathophora	dwarf poincettia	Euphorbiaceae	Ha	H	✓ ✓		1
Euphorbia prostrata	red caustic creeper	Euphorbiaceae	Ha	H	✓ ✓		1
Solanum americanum	nightshade	Solanaceae	Ha	H		✓	1
Trianthema portulacastrum	black pigweed	Aizoaceae	Hp	H	✓ ✓		1
Tridax procumbens	tridax daisy	Asteraceae	Ha	H	2007		1

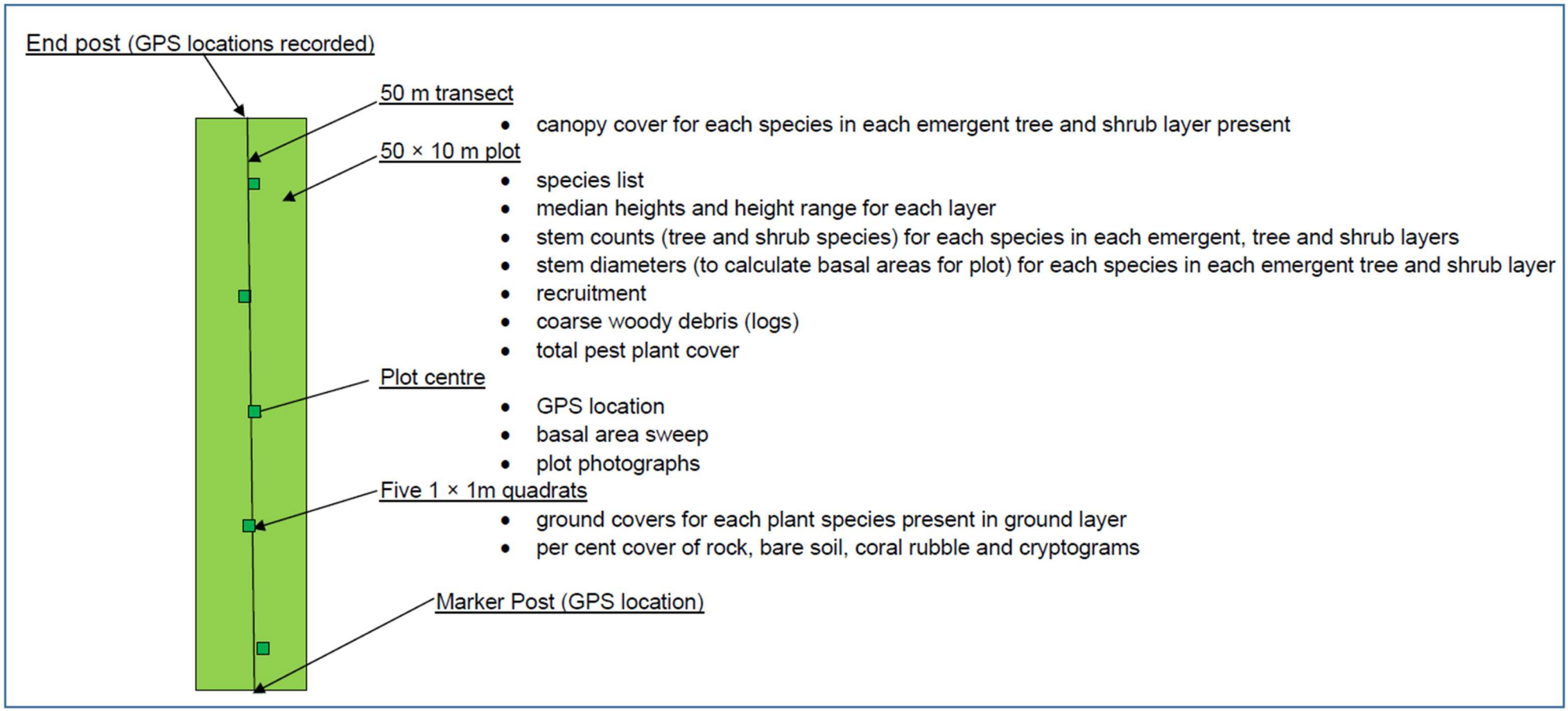
Appendix 3 Extent and distribution of Coral Sea Cays vegetation communities2019 to 2022

			Area (ha) % of total vegetated area																								
		Islet/cay group	Coringa Herald						Willis Islets				Diamond Islets					Lihou Reef						Cato	Wreck Reefs			Mellish Reef
		Islet/cay	NE Herald	SW Herald	SW Coringa	Chilcot	SE Magdelaine	Total area Coringa Herald group	Mid Islet	North Cay	South Islet	Total area Willis Islets	Central Diamond	East Diamond	South Diamond	West Diamond	Total area Diamond Islets	Georgina Cay	Hermit Crab Islet	Lorna Cay	SW Cay	Turtle Islet	Total area Lihou reef cays	Cato Island	Bird Islet	Porpoise Cay	Total area Wreck Reefs cays	Herald Beacon Islet
		Total vegetated area (including naturally bare)	41.5	14.5	12.1	12.0	30.9	111.4	3.4	18.9	4.7	27.0	10.9	10.4	4.2	9.8	35.2	2.8	8.1	6.4	5.7	2.5	25.5	14.8	8.4	0.2	8.5	
Unvegetated areas		Sandy shores	5.42	3.35	2.76	3.37	2.72	17.63	2.60	7.47	3.22	13.29	2.69	4.84	1.97	2.69	12.19	3.70	3.59	10.16	3.33	2.39	23.16	4.63	2.787	0.53	3.32	
		Lithified shores	6.32	1.59	1.47	3.75	4.23	17.35	1.81	6.17	0.33	8.31	5.12	2.54	1.76	2.62	12.04	2.17	1.50	4.03	1.89	1.39	10.98	4.19	2.943	0.89	3.83	
		Rubble banks							0.26			0.26	0.41	0.34	0.40	0.62	1.78	0.10	0.10		0.30		0.50	0.31	0.024		0.02	
		bare/ dead vegetation	0.17					0.17																				
		Human use and infrastructure									0.75	0.75		0.006			0.01							0.006				
Vegetation communities	shoreline sparse grassland/ herbland	sparse to open grassland or herbland on sandy shores		0.01 0.06	0.31 2.56	0.28 2.33	0.14 0.45	0.74 0.66	0.36 10.49	0.63 3.34	0.06 1.27	1.05 3.89	0.54 5.01	0.30 2.86	0.28 6.67	0.19 1.93	1.31 3.72	0.55 19.52	0.15 1.83	0.35 5.48	0.14 2.55	0.05 2.14	1.25 4.89	0.17 1.15	0.31 3.73	0.05 25.02	0.36 4.18	
		sparse herbland on shoreline rubble banks											0.01 0.05			0.07 0.69	0.07 0.20				0.16 2.79		0.16 0.62	0.02 0.11	0.00 0.02			
	Coastal *Argusia argentea* shrublands	*Argusia argentea* open shrubland to isolated shrubs on shorelines and sand spits							0.05 1.46			0.05 0.18	0.05 0.41	0.22 2.09	0.05 1.15	0.36 3.69	0.67 1.90							0.12 0.79				
		Coastline Argusia argentea dwarf open shrubland/ dwarf shrubland/ open shrubland/shrubland/ open scrub	4.50 10.84	3.27 22.45	2.61 21.54	1.36 11.34	4.46 14.45	16.48 14.80	0.34 10.06		0.68 14.41	1.02 3.79	2.03 18.71	0.94 8.97	0.08 1.84	2.40 24.61	5.44 15.45							0.53 3.60				
	shrublands	Interior and subcoastal *Argusia argentea* dwarf shrubland/ shrubland/ tall open shrubland/ tall shrubland/closed scrub	0.69 1.66		0.39 3.22	0.25 2.08	0.83 2.69	2.16 1.94	0.40 11.56		0.39 8.26	0.79 2.91	0.34 3.14	0.14 1.34	0.61 14.58	2.04 20.89	3.13 8.88											
		Cordia subcordata open to closed shrublands/closed scrub			0.05 0.41	0.02 0.17	1.46 4.75	1.53 1.38						0.20 1.91		0.00 0.02	0.20 0.57											
		Argusia argentea shrubland with occasional *Cordia subcordata* and a ground layer dominated by Lepturus repens														0.00 0.03	0.00 0.01										
		Abutilon albescens open shrubland to shrubland with emergent dead Cordia subcordata	1.52 3.66					1.52 1.36																			
		Abutilon albescens open shrubland/ shrubland	4.39 10.57	5.73 39.40	0.24 1.98	1.29 10.73	9.10 29.49	20.75 18.64							0.26 6.28		0.26 0.75	0.01 0.35			1.04 18.32		1.05 4.10					
		Ximenia americana shrublands														0.05 0.50	0.05 0.14										
	grasslands	*Stenotaphrum micranthum* open to closed grassland -coastal/subcoastal								5.53 29.31	0.04 0.85	5.57 20.62			0.08 1.89		0.08 0.22	0.80 28.40	0.00 0.01	0.50 7.74	0.26 4.67	0.69 27.69	2.25 8.82	0.02 0.16	0.76 9.08		0.76 8.89	
		Lepturus repens/Stenotaphrum micranthum grassland-coastal subcoastal								2.33 12.35		2.33 8.63		0.20 1.87			0.20 0.55		0.10 1.28		0.23 4.03	0.26 10.50	0.59 2.32		0.52 6.23		0.52 6.10	
		Lepturus repens open to closed grassland			1.06 8.75	0.41 3.41	2.10 6.80	3.57 3.20		1.73 9.17	0.25 5.30	1.98 7.33	3.54 32.60	6.83 65.45	1.96 46.91	4.64 47.57	16.97 48.17		1.60 19.71	1.67 25.82	2.57 45.44	1.35 54.34	7.18 28.15	0.07 0.51	0.12 1.43	0.14 74.98	0.26 3.00	
		Sporobolus virginicus open to closed grassland	0.31 0.75	0.33 2.26			1.52 4.93	2.16 1.94	0.15 4.50	0.09 0.46	1.93 40.89	2.17 8.03																
		Sporobolus virginicus closed grassland with emergent Argusia argentea									0.16 3.39	0.16 0.59															
		Cynodon dactylon var. *dactylon* naturalised closed grassland																							0.67 8.06		0.67 7.89	
	herblands	*Boerhavia albiflora var. albiflora* sparse herbland to closed herbland			0.50 4.15	0.80 6.65		1.30 1.17	0.61 17.81	4.16 22.03	0.97 20.55	5.74 21.24		0.79 7.54	0.03 0.76	0.01 0.08	0.83 2.34	0.27 9.62	0.22 2.66	2.85 44.17	0.49 8.68	0.13 5.33	3.96 15.52	0.18 1.24	1.35 16.17		1.35 15.83	
		Achyranthes aspera herbland to closed herbland		2.02 13.90	1.96 16.20	2.90 24.12	5.46 17.69	12.35 11.09	1.51 44.12		0.08 1.69	1.59 5.89	2.30 21.18	0.11 1.01	0.57 13.64		2.98 8.45	1.19 42.10	6.04 74.51	1.08 16.79	0.77 13.53		9.08 35.58	9.05 61.12	3.88 46.38		3.88 45.40	
		Portulaca oleracea herbland to closed herbland								4.41 23.34		4.41 16.30												4.64 31.31	0.74 8.89		0.74 8.70	
		Plumbago zeylanica herbland/ shrubland/ closed shrubland		2.58 17.73	1.02 8.42	3.45 28.69	0.70 2.27	7.75 6.96					1.80 16.62		0.26 6.28		2.07 5.87											
	Vinelands	*Ipomoea violacea* vineland		0.61 4.20	3.97 32.76	1.26 10.48		5.84 5.25					0.25 2.28	0.72 6.88			0.97 2.74											
		Ipomoea pes-caprae subsp. *brasiliensis*/ *Sporobolus virginicus* vineland/ herbland									0.16 3.39	0.16 0.59		0.01 0.10			0.01 0.03											
	Pisonia grandis communities	Windsheared *Pisonia grandis* closed scrub	3.72 8.96				0.15 0.47	3.87 3.47																			
		Pisonia grandis open shrubland/ tall shrubland					1.17 3.79	1.17 1.05																			
		Pisonia grandis closed scrub/ low closed forest	26.40 63.57				3.77 12.23	30.17 27.10																			

No data available

Appendix 4 Plot orientation and data recorded at permanent monitoring sites

Plots are located in representative areas within a vegetation community.



Data recorded at each site

(using methodology of Neldner et al., 2019 for secondary sites)

Site descriptions

Site descriptions for each site are documented. These descriptions include all site attributes that do not change including GPS coordinates and location description, area/width of the vegetation represented by the plot, a position in landscape diagram, landform element, landform pattern, slope, altitude, substrate, plot size and plot orientation.

Other data recorded

- site number, recorder names, date, start and finish time
- GPS location of plot centre and end points (WGS84 datum), location description, transect bearing
- vegetation structural layers present, median height and height range of each layer
- comprehensive species list for each layer
- ground layer per cent foliage projected cover for each vascular plant species, litter, bare ground, rock outcrop and cryptograms
- per cent crown cover by species for each layer for the emergent, tree and shrub layers (if present)
- from the species list and cover measurements, the following can be derived:
    - total vegetation cover in each layer
    - native cover in each layer
    - non-native cay cover in each layer
    - species richness – total and differentiated by growth form
    - native species richness – total and differentiated by growth form
    - non-native cay species richness – total and differentiated by growth form
    - species richness in each layer present – total and differentiated by growth form
    - native species richness in each layer present – total and differentiated by growth form
    - non-native cay species richness in each layer present – total and differentiated by growth form
    - estimate of overall non-native cay plant cover (including herbaceous and woody weeds and plantings)
- stem counts of woody species (if present) per species per layer in the tree and shrub layers; including standing dead plants (count per hectare can be calculated for each species, growth form and layer)
- basal area sweep measurements of woody species (if present) per species per layer
- girth measurements for woody species if present to obtain average diameter of large trees or shrubs (basal area per hectare can be calculated for each species, growth form and layer)
- evidence of recruitment of woody species
- topsoil depth, colour and texture
- soil samples are collected for full nutrient analysis
- total length of logs (coarse woody debris)
- presence of shearwater burrows or other evidence of bird nesting
- evidence of turtle nesting
- other disturbance type (e.g., evidence of wind damage to vegetation, wind erosion, saltwater inundation, fire, mowing/slashing, other human disturbance) and severity
- patch size
- community extent
- community area
- community context (extent of connectivity to other native vegetation communities)

- evidence of disease, death, dieback, presence of scale, insect attack and leaf drop
- recent mean monthly climatic data
- ten site photographs- a landscape and portrait from 0m looking along the transect and eight from the plot centre – a landscape and portrait photo facing the direction of the bearing and at 90, 180 and 270 degrees from the direction of the bearing.

Structure of vegetation communities was determined using *Table 106* (Neldner et al., 2019).

Table 106 Vegetation structure classifications based on growth form, height and cover.

Proj. foliage cover	>70%	>30–70%	10–30%	<10%
Crown class	Dense/closed	Mid-dense	Sparse	Very sparse
Crown cover %[1]	>80%	>50–80%	20–50%	<20%
GROWTH FORM[2]	**Structural formation classes (qualified by height)**			
Trees >30 m	tall closed forest TCF	tall open forest TOF	tall woodland TW	tall open woodland TOW
Trees 10–30 m	closed forest CF	open forest OF	woodland W	open woodland OW
Trees 2–10 m	low closed forest LCF	low open forest LOF	low woodland LW	low open woodland LOW
Shrubs 2– 8 m	closed scrub CSC	open scrub OSC	tall shrubland TS	tall open shrubland TOS
Shrubs 1–2 m	closed heath CHT or closed shrubland CS	open heath OHT or shrubland S	shrubland S	open shrubland OS
Shrubs <1 m	dwarf closed shrubland DCS	dwarf open heath DOHT	dwarf shrubland DS	dwarf open shrubland DOS
Succulent shrub	NA	succulent shrubland	succulent shrubland SS	open succulent shrubland OSS
Hummock grasses	NA	NA	hummock grassland HG	open hummock grassland
Tussock grasses	closed tussock grassland CTG	tussock grassland TG	open tussock grassland OTG	sparse tussock grassland STG
Herbs[3]	closed herbland CH	herbland H	open herbland OH	sparse herbland SH
Forbs	closed forbland CFB	forbland FB	open forbland OFB	sparse forbland SFB
Rush	closed rushland CR	rushland R	open rushland OR	sparse rushland SR
Vines	closed vineland CVI	vineland VI	open vineland OVI	sparse vineland SVI
Ferns	closed fernland CFN	fernland FN	open fernland OFN	sparse fernland SFN
Sedges	closed sedgeland CV	sedgeland V	open sedgeland OV	sparse sedgeland SV

Appendix 5 2022 Soil analysis results

Provided 15-Aug-22

Cato Island (26/05/2022) samples 1-6

Bird Islet, Wreck Reef (28/05/2022) samples 7-12

North Cay (Willis Islets) (06/06/2022) samples 13-15

Mid Islet (Willis Islets) (06/06/2022) samples 16-18

Sample	Site	Depth	pH	EC	TN	TC	TOC	Col P	Ca	K	Mg	Na	CEC	P	Al	Ca	Cu	Fe	K	Mg	Mn	Na	S	Zn
				dS/m	Wt %	Wt %	Wt %	mg/kg	cmol (+)/kg	cmol (+)/kg	cmol (+)/kg	cmol (+)/kg	Cmol (+)/kg	Wt %	mg /kg	Wt %	mg/kg	mg /kg	mg /kg	Wt %	mg /kg	Wt %	Wt %	mg /kg
1	M16	0-10	8.52	0.337	0.151	14.05	9.02	1097	11.53	0.13	1.66	0.19	13.52	0.98	5	39.1	2.1	18	261	0.718	3	0.407	0.468	27
2	M16	10-20	8.57	0.357	0.360	13.26	7.12	893	13.00	0.14	1.84	0.25	15.23	1.07	6	39.2	2.8	21	237	0.722	3	0.402	0.480	40
3	M16	20-30	8.52	0.444	0.319	12.12	2.29	942	13.85	0.11	1.94	0.25	16.15	1.54	8	38.8	4.2	28	229	0.706	4	0.405	0.516	64
4	M17	0-10	8.28	0.484	0.330	9.84	3.07	1249	12.38	0.23	1.20	0.76	14.57	4.96	12	35.6	14.4	73	334	0.171	7	0.383	0.505	110
5	M17	10-20	8.24	0.480	0.383	9.59	4.07	1236	13.10	0.23	0.91	0.68	14.92	5.22	17	35.5	17.3	75	365	0.169	8	0.393	0.541	118
6	M17	20-30	8.15	0.679	0.358	9.92	2.87	1063	13.54	0.22	0.85	0.63	15.23	4.58	12	35.7	14.5	62	316	0.147	7	0.360	0.495	101
7	M18	0-10	8.73	0.187	0.285	10.12	2.91	1043	11.80	0.14	1.28	0.19	13.41	4.70	20	36.6	21.8	88	282	0.286	8	0.373	0.525	133
8	M18	10-20	8.60	0.239	0.263	10.26	3.27	1030	12.13	0.10	1.07	0.17	13.47	4.39	17	35.5	18.6	76	230	0.272	8	0.373	0.512	120
9	M18	20-30	8.54	0.330	0.238	10.16	2.25	987	12.37	0.11	1.02	0.24	13.74	4.50	18	36.0	19.7	77	237	0.293	8	0.370	0.518	122
10	M19	0-10	8.35	0.474	0.652	14.30	5.58	1430	14.00	0.26	3.16	0.43	17.86	3.82	23	37.5	11.9	71	417	0.470	8	0.374	0.550	94
11	M19	10-20	8.22	0.516	0.571	13.08	4.90	1271	13.90	0.27	2.47	0.45	17.09	4.41	26	36.8	14.6	68	420	0.367	8	0.354	0.534	98
12	M19	20-30	8.49	0.441	0.301	9.92	2.84	1567	13.24	0.18	1.36	0.34	15.12	4.92	16	36.2	14.8	50	276	0.221	5	0.349	0.488	76
13	M20	0-10	8.62	0.482	0.208	11.81	0.94	586	11.59	0.11	1.64	0.21	13.55	0.34	6	40.2	1.5	8	240	1.311	3	0.325	0.446	8
14	M20	10-20	9.48	0.096	0.122	10.44	2.31	353	10.52	0.02	1.37	0.09	11.99	0.43	32	40.1	1.7	19	114	1.405	3	0.311	0.443	8
15	M20	20-30	9.65	0.090	0.182	10.13	1.31	278	9.55	0.01	0.92	0.07	10.55	0.26	5	40.2	0.9	4	94	1.526	2	0.286	0.425	4
16	M21	0-10	9.27	0.096	0.183	12.20	0.72	364	9.48	0.03	0.93	0.08	10.52	0.40	2	40.2	1.2	10	125	0.944	2	0.356	0.437	8
17	M21	10-20	9.57	0.078	0.056	12.28	0.56	184	9.36	0.01	0.76	0.08	10.21	0.40	2	40.2	1.0	3	116	0.841	2	0.369	0.436	7
18	M21	20-30	9.65	0.066	0.053	12.12	0.37	151	9.73	0.01	0.80	0.07	10.60	0.28	0	40.1	0.6	2	106	0.960	2	0.358	0.435	5

Methodology abstracts

Handbook section refers to "Soil Chemical Methods - Australasia"

Rayment GE and Lyons DJ, CSIRO publishing 2011

pH / EC

1: 5 soil water extracts are prepared and mixed for 1 hour. Conductivity and pH electrodes are used to measure the respective properties.

Handbook section: 3A1, p20 and 4A1, p38.

Colwell P

1: 50 soil solution extracts in 0.5 M sodium bicarbonate are prepared and mixed for 16 hrs, with the extracted phosphorous present being determined colorimetrically on centrifuged and filtered extracts using a SEAL AQ400 discreet analyser and the ammonium molybdate / ascorbic acid colour reaction with potassium antimonyl tartrate added to control the reaction rate.

Calculation: Sample concentrations obtained above in mg/L are converted to mg/kg by multiplying by the volume and dividing by the weight.

Handbook section: 9B1, p162.

Exchangeable bases (Ca, K, Mg and Na) and CEC

1: 10 soil solution extracts are prepared in 1 M ammonium chloride and mixed for 1hr, with the exchangeable bases being determined on centrifuged and filtered extracts using a Thermo iCAP ICPOES instrument.

Calculation: Sample concentrations obtained above in mg/L are converted to mg/kg by multiplying by the volume and dividing by the weight. Conversion to meqv or centimoles per unit charge is done by dividing the mg/kg results by the atomic molecular weight and then by dividing again by either 10 for monovalent species (Na and K) or 5 for divalent species (Ca and Mg).

The CEC result is the summation of the meqv results for each of the 4 cations. ESP is the sodium percentage of the CEC result, while SAR is the sodium concentration divided by the square root of half the combined results for calcium and magnesium.

Handbook section: 15A1, p293.

Carbon and nitrogen

1.0 g of sample is weighed out into a ceramic boat which is placed into the induction furnace of a LECO 928 CN combustion analyser set at 1200 degrees C and calibrated on EDTA. The carbon present is combusted to CO2 which is determined with an infra-red detection cell. The nitrogen present is combusted to N2, NO2 and NO. The oxides are reduced to N2 which is determined quantitatively using a thermal conductivity cell.

For organic carbon the samples are treated with acid to remove inorganic carbonates prior to combustion.

Calculation:Results are automatically expressed as weight percentages. To convert to mg/kg multiply the Wt % result by 10000.

Handbook section: 6B2, p75.

Total Organic Carbon

0.25 g of sample weighed out and reacted with 0.167 M potassium dichromate and conc sulfuric acid then heated for half an hour at 135°C. Samples diluted then analysed colorimetrically at 600 nm on a UV-vis spectrophotometer and calibrated with sucrose standards.

Handbook section: 6B1, 71.

Total Elemental (microwave digestion)

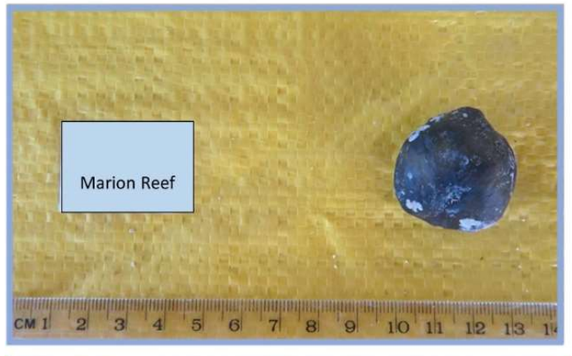
500 mg of sample is weighed out into a teflon vessel. To this is added 10 mL of water, 5 mL of conc nitric acid, 4 mL of conc hydrofluoric acid and 2 mL of conc hydrochloric acid. The samples are left to predigest for 16 hours prior to closed vessel digestion using a Milestone Ethos-1 microwave digestor at 200°C power for 40 minutes.

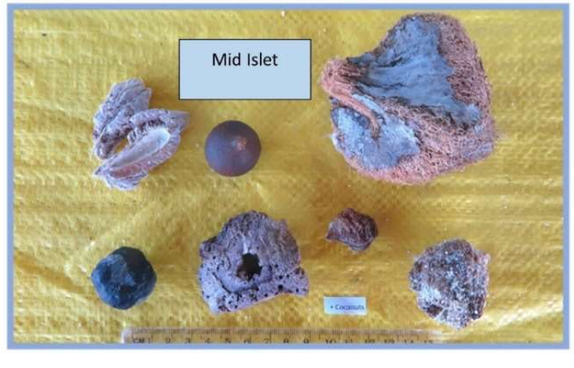
The digests are then made to a volume of 50 mL with 4 mL of saturated boric acid added to each digest to react with excess HF. The digests are then analysed using a Thermo iCAP ICPOES instrument running at 1150 W forward power.

Reference: Based on USEPA method 3052 titled "Microwave Assisted Acid Digestion of Silaceous and Organically Based Matrices", Kingston HM and Walter PJ.

Handbook section: 17A2, p369.

Appendix 6 Photographs of drift seeds collected during 2922 voyage





Joy Brushe ©

Appendix 7 List of bird species recorded during the voyage.

Coral Sea voyage May/June 2022, species summary.

Family	common name	Scientific name
Ardeidae	white-faced heron	*Egretta novaehollandiae*
Charadriidae	Pacific golden plover	*Pluvialis fulva*
Charadriidae	lesser sand plover	*Charadrius mongolus*
Diomedeidae	shy albatross	*Thallassarche cauta*
Fregatidae	great frigatebird (B)	*Fregata minor*
Fregatidae	lesser frigatebird (B)	*Fregata ariel*
Halcyonidae	sacred kingfisher	*Todiramphus sanctus*
Hirundinidae	tree martin	*Petrochelidon nigricans*
Laridae	black noddy (B)	*Anous minutus*
Laridae	black-naped tern (B)	*Sterna sumatrana*
Laridae	brown noddy (B)	*Anous stolidus*
Laridae	crested tern (B)	*Thalasseus bergii*
Laridae	New Caledonian fairy tern (B)	*Sternula nereis exsul*
Laridae	sooty tern (B)	*Onychoprion fuscatus*
Laridae	white tern	*Gygis alba*
Oceanitidae	black-bellied storm-petrel	*Fregetta tropica*
Oceanitidae	Wilson's storm-petrel	*Oceanites oceanicus*
Oceanitidae	white-bellied storm-petrel	*Fregetta grallaria*
Oceanitidae	white-faced storm-petrel	*Pelagodroma marina*
Phaethontidae	red-tailed tropicbird (B)	*Phaethon rubricauda*
Procellariidae	Hutton’s shearwater	*Puffinus huttoni*
Procellariidae	Kermadec petrel	*Pterodroma neglecta*
Procellariidae	providence petrel	*Pterodroma solandri*
Procellariidae	Tahiti petrel	*Pseudobulweria rostrata*
Procellariidae	wedge-tailed shearwater (B)	*Ardenna pacifica*
Rallidae	buff-banded rail (B)	*Gallirallus phillipensis tounelieri*
Rallidae	purple swamphen	*Porphyrio melanotus*
Scolopacidae	ruddy turnstone	*Arenaria interpres*
Scolopacidae	wandering tattler	*Tringa incana*
Sulidae	brown booby (B)	*Sula leucogaster*
Sulidae	masked booby (B)	*Sula dactylatra*
Sulidae	red-footed booby (B)	*Sula sula*

(B) Breeding effort observed during these surveys.

Appendix 8 All Health Check criteria by Health Check site

Health Check criteria	HC01	HC02	HC03	HC04	HC05	HC06	HC07	HC08	HC09	HC10	HC11	HC12	HC13	HC14	HC15	HC16	HC17	HC18	HC19	HC20	HC21	HC22	HC23	HC24	HC25	HC26	HC27	HC28	HC29	HC30	HC31	HC32	HC33	HC34	HC35	HC36	HC37	HC38	HC39	HC40	HC41	HC42	HC43	HC44	HC45	HC46	HC47	HC48	HC49	HC50	HC51	HC52	HC53	HC54	HC55	HC56
1. Ecosystem changing pest plants	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	SC	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G
2. Pest plants other than ecosystem-changers	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	GC	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G
3. Risk of future invasion by significant pest plants not already present	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G
4. Rainforest invasion	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G
5. Woody thickening (other than by rainforest species)	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G
6. Over-grazing/over-browsing by feral animals, stray stock or natives	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G		
7. Trampling, digging or rooting by feral or native animals or trampling by visitors	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G
8. Impacts on wetlands																																																									
9. Vehicle impacts	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G
10. Dumping	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G
11. Ground cover	G	G	G	G	G	G	G	G	G	G				G	G	G	G	G	G	G	G	G	G	G													G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G		
12. Fire damage to fire-sensitive ecosystems that are not fire dependant	G	G	G	G	G	G	G	G	G	G				G	G	G	G	G	G	G	G	G	G	G													G	G	G	G	G	G	G	G	G	G	G	G	G	G	G					
13. Fire damage to peat-based systems																																																								
14. Age class distribution in fire-adapted ecosytems in zones where the primary purpose is conservation																																																								
15. Sever wildfire in fire-adapted wooded ecosystems																																																								
16. Severe storm, cyclone or tornado in wooded ecosystems	G	G	G	G	G	G	G	G	G	G				G	G	G	G	G	G	G	G	G	G	G													G	G	G	G	G	G	G	G	G	G	G	G	G	G	G					
17. Overtopping, erosion and associated impacts resulting from tidal inundation, major flooding, storm	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	GC	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G
18. Tree/shrub health and dieback	G	G	G	G	GC	G	G	G	G	G				G	G	G	G	G	G	G	G	G	G	G													G	G	G	G	G	G	G	G	G	G	G	G	G	G	G					
19. Key features for faunal biodiversity in terrestrial ecosystems	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G
20. Recruitment of canopy species	G	G	G	G	G	G	G	G	G	G																												G	G	G	G	G	G	G	G	G					G	G	G			

Key: **G = good**; **GC = good with some concern**; SC = significant concern; **C – critical**; NA = not applicable

HC01 to HC10 – Cato Island

HC11 – West Islet

HC12 to HC13 – Hope Cay

HC14 to HC16 – Porpoise Cay

HC17 to HC24 – Bird Islet

HC25 to HC27 – South West Cay (Kenn Reefs)

HC28 – Observatory Cay (Kenn Reefs)

HC29 – unnamed cay (Kenn Reefs)

HC30 – Observatory Cay (Frederick Reefs)

HC31 to HC32 – Lighthouse Cay

HC33 to HC34 – Brodie Cay

HC35 – Paget Cay

HC36 to HC37 – Carola Cay

HC38 to HC46 – North East Cay

HC47 to HC51 – North Cay

HC52 to HC54 – Mid Islet

HC55 to HC56 – Sand Cay

Appendix 9 Island watch summary

Cays 1 – 8

Island Watch – Summary								
Island Watch category	**1. Cato Island (Cato Reef)**	**2. West Islet (Wreck Reefs)**	**3. Hope Cay (Wreck Reefs)**	**4. Porpoise Cay (Wreck Reefs)**	**5. Bird Islet (Wreck Reefs)**	**6. South West Cay (Boulder Cay) (Kenn Reefs)**	**7. Observatory Cay (Kenn Reefs)**	**8. North Cay (Kenn Reefs)**
Birds								
Formal bird survey by A. McDougall	Y	Y	Y	Y	Y	Y	Y	Y
Any new or unusual sightings, or any changes to condition of nesting/roosting habitat?	N	N	N	N	N	N	N	N
Turtles								
Turtles seen on island	Nil (Outside breeding season)	Nil (Outside breeding season)	Nil (Outside breeding season)	Nil (Outside breeding season)	Nil (Outside breeding season)	Nil (Outside breeding season)	Nil (Outside breeding season)	Nil (Outside breeding season)
Number of nests/body pits	A few body pits on NW side of island	N	Approx. 20 old body pits in central high point of island	A few body pits on SW side of cay	N	Numerous old body pits	N	N
Any new or unusual sightings, or any changes to the condition of nesting habitat?	N	N	N	N	N	N	N	N
Crocodiles								
Crocodile sightings & other observations	N	N	N	N	N	N	N	N
Weeds								
Does the island appear weed-free?	Y (Verified by J. Brushe)	Unvegetated	Unvegetated	Y	N	Unvegetated	Unvegetated	Unvegetated
Weeds								
Species observed and brief description.	Conducted detailed survey – nil weeds detected	Nil	Nil	Nil	2 large *Solanum nigrum* on north western side of island in middle of *Achyranthes aspera* patch (HC19) Large area of *cynodont dactylon* and 6 *amaranthus viridis* plants found on south western side of island (HC22)	Nil	Nil	Nil
Likely risk of future weed invasion?	Low if visitation remains low. Low if gear and equipment is not taken onto cays , no walking through island – all visitors.	Low	Low	Low	Low if visitation remains low. Low if gear and equipment is not taken onto cays , no walking through island – all visitors.	Low	Low	Low
Future actions needed.	Prevention through adopted biosecurity procedures ALL cays	Biosecurity framework	Biosecurity Framework	Biosecurity framework	Prevention through adopted biosecurity procedures	Biosecurity framework	Biosecurity framework	Biosecurity framework

Island Watch category	1. Cato Island (Cato Reef)	2. West Islet (Wreck Reefs)	3. Hope Cay (Wreck Reefs)	4. Porpoise Cay (Wreck Reefs)	5. Bird Island (Wreck Reefs)	6. South West Cay (Boulder Cay) (Kenn Reefs)	7. Observatory Cay (Kenn Reefs)	8. North Cay (Kenn Reefs)
Wildfire								
Signs of wildfire?	N	Unvegetated	Unvegetated	N	N	Unvegetated	Unvegetated	Unvegetated
Is management action required – mitigation, especially for seabird and turtle habitat?	N	Unvegetated	Unvegetated	N	N	Unvegetated	Unvegetated	Unvegetated
Pest animals								
Any signs of pest animals? Includes invertebrates.	Nil signs of rodents	N	N	Nil signs of rodents	Nil signs of rodents	N	N	N
Species observed and brief description.	NA	NA	NA	NA	NA	NA	NA	NA
Pest monitoring or control work done?	Ant baiting stations Rodent tunnels placed overnight	N	N	Ant baiting stations Rodent tunnels placed overnight	Ant baiting stations Rodent tunnels placed overnight	N	N	N
Any new pest animals for this site, or has the previous extent changed (bigger or smaller)?	N	N	N	N	N	N	N	N
Native flora & fauna								
Anything of interest, and changes or concerns?	N	N	N	Numerous land hermit crabs	Numerous land hermit crabs	Numerous land hermit crabs	N	N
Other risks								
Any other changes or concerns	Note. Marine debris impacts – Ingestion by birds, turtles and other marine organisms and visual impact of debris on remote, high conservation value cays ALL cays							
	Evidence of fire on beach							
Cultural values								
Anything observed, anything new or of concern?	N	N	N	N	N	N	N	N
Infrastructure								
Condition of infrastructure, any work required?	Weather tower, some surrounding infrastructure in poor condition, needs to be removed	N	N	New sign installed	N	N	N	N
Monitoring and collections								
Any other monitoring or surveys undertaken	Notes. Vegetation survey and mapping, botanical specimens, soil samples, drift seeds – Joy and Larry Brushe Marine Debris collected – Matilde Gordon Health Checks – Collette Bagnato Rodent tunnels, ant baits and opportunistic invertebrates collected – Dan Clifton and Alex Gorman Drone mapping – Jake Sanders							
By whom and where is information stored?	Notes. Botanical specimens and drift seeds lodged with Qld Herbarium Soil samples Invertebrates lodged with Qld Museum for ID All other information provided to PAD and stored in QPWS systems. Contact person – Collette Bagnato							
Areas of island visited								
	Whole island surveyed	Whole island surveyed	Whole island surveyed	Whole island surveyed	Whole island surveyed	Whole island surveyed	Whole island surveyed	Whole island surveyed

Cays 9 - 17

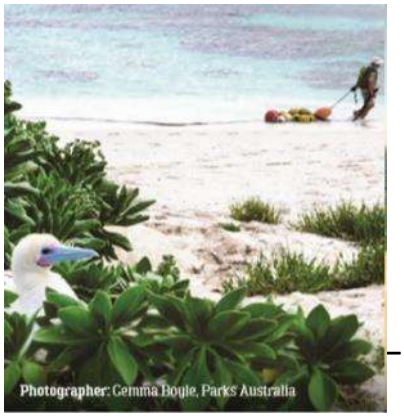
Island Watch category	9. Observatory Cay (Frederick Reefs)	10. Lighthouse Cay (Frederick Reefs)	11. Brodie Cay (Marion Reefs)	12. Paget Cay (Marion Reefs)	13. Carola Cay (Marion Reefs)	14. North East Cay (Herald Cays)	15. North Islet (Willis Group)	16. Mid Islet (Willis Group)	17. Diane Banks

Birds									
Formal bird survey by A. McDougall	Y	Y	Y	Y	Y	Y	Y	Y	Y
Any new or unusual sightings, or any changes to condition of nesting/roosting habitat?	tidal inundation 25 common noddy nests abandonded	N	N	New Caledonian fairy terns in breeding plumage (Refer Birds A. McDougall)	N	High number of Red Tailed tropic birds nesting. (Refer Birds A. McDougall)	High number of breeding sooty and common terns . (Refer Birds A. McDougall)	Red Tailed tropic birds nesting. (Refer Birds A. McDougall)	N
Turtles									
Turtles seen on island	Nil (Outside breeding season)	Nil (Outside breeding season)	Nil (Outside breeding season)	Nil (Outside breeding season)	Nil (Outside breeding season)	Nil (Outside breeding season)	Nil (Outside breeding season)	Nil (Outside breeding season)	1 old dead green turtle in centre of cay (Outside breeding season)
Number of nests/body pits	N	N	N	N	Y	A few old body pits on western side of cay	Numerous body pits	A few old body pits around perimeter of island	Numerous body pits across cay
Any new or unusual sightings, or any changes to the condition of nesting habitat?	N	N	N	N	N	N	N	N	N
Crocodiles									
Crocodile sightings & other observations	N	N	N	N	N	N	N	N	N
Weeds									
Does the island appear weed-free?	Unvegetated	Unvegetated	Unvegetated	Unvegetated	Unvegetated	Y	Unvegetated	Y	Unvegetated
Species observed and brief description.	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Weeds									
Likely risk of future weed invasion?	Low	Low	Low	Low	Low	Low	Low	Low	Low
Future actions needed.	Biosecurity framework	Biosecurity framework	Biosecurity framework	Biosecurity framework	Biosecurity framework	Biosecurity framework	Biosecurity framework	Biosecurity framework	Biosecurity framework
Wildfire									
Signs of wildfire?	Unvegetated	Unvegetated	Unvegetated	Unvegetated	Unvegetated	N	Unvegetated	N	N
Is management action required – mitigation, especially for seabird and turtle habitat?	Unvegetated	Unvegetated	Unvegetated	Unvegetated	Unvegetated	N	Unvegetated	N	N
Island Watch category	**9. Observatory Cay (Frederick Reefs)**	**10. Lighthouse Cay (Frederick Reefs)**	**11. Brodie Cay (Marion Reefs)**	**12. Pagent Cay (Marion Reefs)**	**13. Corola Cay (Marion Reefs)**	**14. North East Cay (Herald Cays)**	**15. North Islet (Willis Group)**	**16. Mid Islet (Willis Group)**	**17. Diane Banks**
Pest animals									
Any signs of pest animals? Includes invertebrates.	N	N	N	N	N	Nil signs of rodents	N	N	N
Species observed and brief description.	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pest monitoring or control work done?	N	N	N	N	N	Ant baiting stations Rodent tunnels placed overnight	Ant survey	Ant survey	N

Any new pest animals for this site, or has the previous extent changed (bigger or smaller)?	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Native flora & fauna									
Anything of interest, and changes or concerns?	N	N	N	N	N	N	N	N	N
Other risks									
Any other changes or concerns	Marine debris impacts – Ingestion by birds, turtles and other marine organisms and visual impact of debris on remote, high conservation value cays ALL cays								
Cultural values									
Anything observed, anything new or of concern?	N	N	N	N	N	N	N	N	N
Infrastructure									
Condition of infrastructure, any work required?	N	N	N	N	N	N	N	N	N
Monitoring and collections									
Any other monitoring or surveys undertaken	Notes. Notes. Vegetation survey and mapping, botanical specimens, soil samples, drift seeds – Joy and Larry Brushe Marine Debris collected – Matilde Gordon Health Checks – Collette Bagnato Rodent tunnels, ant baits and opportunistic invertebrates collected – Dan Clifton and Alex Gorman Drone mapping – Jake Sanders								
By whom and where is information stored?	Notes. Botanical specimens and drift seeds lodged with Qld Herbarium Soil samples Invertebrates lodged with Qld Museum for ID All other information provided to PAD and stored in QPWS systems. Contact person – Collette Bagnato								
Areas of island visited									
	Whole island surveyed	Whole island surveyed	Whole island surveyed	Whole island surveyed	Whole island surveyed	Whole island surveyed	Whole island surveyed	Whole island surveyed	Whole island surveyed

Appendix 10 Biosecurity checklist

Coral Sea Marine Park. Island biosecurity checklist
Joint Parks Australia and QPWS field trips



Trip date: _

Officer in Charge (OIC) name and position: _____

Person responsible for overseeing biosecurity for this trip: _____

Vessel owner (QPWS, Federal government, other): _____

Vessel name: _____

Working version: 21/10/2019

Updates:

1) PRE-TRIP PLANNING AND LOADING:

Action	Date achieved	Comments
Professional fumigation of vessel prior to the trip. The closer to departure date, the better. Target insects, arachnids, rodents.		
Personal biosecurity instructions provided • Before leaving home (vessel joining instructions) • onboard vessel briefing and induction • pre-island transfer briefing * If not using a QPWS vessel, supply participants with extract from Reef Ranger joining instructions (in appendix)		.
All clothes, including hats, are freshly washed in water hotter than 40^{0}C with detergent before leaving home. Or wash on board before accessing Coral Sea Marine Park islands and between island 'groups'.		
Equipment and materials, including gear normally stored at ranger bases, is thoroughly cleaned of soil, plant material etc. and sterilised with Virkon. Includes camping chairs, tools, cameras, acoustic gear.		

Action	Date achieved	Comments
Avoid rust preventatives that are sticky and attract seeds.		
No timber or cardboard packaging to be used for materials and equipment – too hard to ensure it is pest-free. Take special note if transporting fencing, scaffolding, etc. • Purchase materials such as cement in plastic bags, rather than in paper or cardboard packaging. • Repackage goods that are on timber pallets – either on to plastic pallets or bundle with plastic strapping. • If no other option, ensure high-risk packaging is left on vessel and not brought onto the island. Spray with insecticide at last minute when removing from high-risk packaging.		
Pest control (e.g. baiting for rodents and ants) conducted in ranger sheds, and other storage areas, including outdoor storage areas if used, prior to departure.		
Last minute inspection of all project gear and equipment, including spraying with insecticide, prior to loading. Includes tripods, all sampling gear, camping chairs.		
Outwardly inspect all personal bags and gear before loading (where possible, otherwise do on back deck of vessel) and spray interiors with insecticide. Can put several bags in a large garbage bag, spray and hold closed for a few minutes. Ensure all zips and pockets are open so that spray can penetrate. Although intrusive, this method has flushed out several insects on previous trips. Ask people to first remove any food or gear sensitive to sprays, such as personal cameras.		

2) DAILY, WORKING ON ISLANDS:

Action	Achieved	Comments
Note – if working between islands, the "departure" actions below in step 3 must be undertaken between each island and at the end of each trip.		
Ensure all clothes, including hats, have been washed in water hotter than 40^{0}C with detergent before the first working day. (Best way to minimise risk of seeds, or air- or soil-borne pathogens on clothes).		
Before first visit, clean footwear and submerge in the Virkon bath and leave to drip dry in the shade. Do not rinse with fresh water. See instructions in appendix		
Inspect all clothes bags and field equipment on back deck before first visit to island. Spray everything with insecticide even if already sprayed prior to loading. Can put several bags in a large garbage bag, spray and hold closed for a few minutes. Ensure all zips and pockets are open so that spray can penetrate.		
Every time you leave or arrive back at the vessel: • Clean hands with soap and very hot water • Place footwear in nominated container on back deck for re-use later, or clean and disinfect with Virkon • Keep all gear, including backpacks, used on the island in a nominated area on back deck as a 'quarantine area'		

Action	Achieved	Comments
Have a large bottle of alcohol gel on back deck and provide each person with a personal use small bottle to keep in backpack. (Not a replacement for washing with hot water and soap on the vessel)		
Disinfect hands with alcohol gel before and after eating or toileting on the island, for protection of personal health as well as that of the turtles and seabirds.		
Bring rubbish back to the vessel each day. Do not stockpile rubbish on the island as it creates a food source for pests (e.g. rodents, ants and cockroaches) already there, and may attract or interfere with native animals.		
Fumigate daily rubbish brought back to the vessel before storing. Inspect and fumigate marine debris brought back to the vessel. Consider spraying with Virkon if appropriate. Alert AQIS (Australian Quarantine and Inspection Service) and Biosecurity Queensland of any pests or diseases that could be a risk.		
Fumigate or otherwise sterilise plant or animal material brought back to the vessel.		
Don't dispose of any food matter on the island including seeds and peel.		
Do not bury human waste. No human waste or toilet paper to remain on island. Use a portable toilet or otherwise store in plastic packaging and dispose of back on vessel.		
No raw meats (especially chicken), raw eggs or unpasteurised cheeses to be brought onto the island – risk of introducing new salmonella strains and other bacteria.		
Remain alert/ aware to potential incursions when on the island and report any suspicious pest sightings (e.g. rodents, reptiles, ant congregations, weeds) to the Officer in Charge for earliest possible intervention if required. Take photos and GPS marks, and collect a sample for verification.		

3) MOVING BETWEEN ISLANDS:

Action	Achieved	Comments
Inspect all clothes, bags and field equipment and spray everything with insecticide on the back deck. Can put several bags in a large plastic garbage bag, spray and hold closed for at least 3 minutes. Ensure all zips and pockets are open so that spray can penetrate. (Insects have crawled into gear on previous island trips and been brought back to the vessel.)		
Wash all clothing and footwear in water hotter than 40^{o}C with detergent or Virkon. Wash equipment and soak or spray down or soak with Virkon between islands and before visiting any other special areas.		
Thoroughly wash out all sand and debris from back deck and tenders. Spray surfaces with Virkon if travelling to other special areas		

4) AT FINAL DEPARTURE:

Action	Achieved	Comments
Spray long-lasting surface spray insecticide in and around containers and any equipment remaining on island. Place ant, cockroach, and rodent tunnels around these areas when trip is completed.		

Action	Achieved	Comments
Use lethal baits when there is no risk to native populations.		
Inspect all clothes, bags and field equipment before departing and spray everything with insecticide on the back deck. Can put several bags in a large plastic garbage bag, spray and hold closed for at least 3 minutes. Ensure all zips and pockets are open so that spray is able to penetrate. (Insects have crawled into gear on previous island trips and been brought back to the vessel.)		
Wash all clothing and footwear in water hotter than 40^{o}C with detergent or wash with Virkon. Wash equipment and soak or spray down or soak with Virkon between islands and before visiting any other special areas.		
Thoroughly wash out all sand and debris from back deck and tenders. Spray surfaces with Virkon if travelling to other special areas		
OIC to hold a post-trip review each time with all trip participants and communicate any biosecurity issues to PAD.		
During debrief, directly ask participants if any weeds or other pests were detected on the island. Document any observations or concerns for future pest control.		

5) EVERY TRIP, RESOURCES NEEDED.

Item	Obtained	Comments
Professional fumigation of vessel		
Virkon or equivalent (powder or liquid form) – lots, sufficient to disinfect all machinery and tools		
Small spray bottles for Virkon		
Large backpack sprayer for Virkon to disinfect large areas, including tenders		
Large containers to store used Virkon until it can be appropriately disposed of. Suggested minimum of 2 x 35 litre drums.		
Large funnel to dispense Virkon from footbath into disposal container.		
Two footbaths – one for water, one for Virkon		
Long handled brushes for footbaths (at least 2)		
Large bin or container for footwear to store on island and on back deck		

Item	Obtained	Comments
Alcohol gel, large bottle and personal sizes		
Insecticide spray - lots, both knockdown and long-lasting surface spray types		
If any gear will be left on islands: ant bait stations cockroach bait stations rodent bait stations sufficient baits for the stations – lethal bait if appropriate		
Portable toilets and environmentally sensitive toilet chemicals (or other toileting arrangements e.g. plastic bags). Two toilets may be needed to allow swopping over and cleaning each day, depending on type used.		
Toilet tent - pop up camping 'ensuite' for privacy on the island, regardless of whether a portable toilet is provided or not.		
Low-risk packaging materials (such as plastic pallets or straps) to replace timber pallets or any wood or cardboard packaging		

Appendix 11 Marine Debris (John Prichard)

Introduction

In May and June 2022, Parks Australia undertook a 22 days voyage into the Coral Sea Marine Park (CSMP) to assess the overall health of cays and islets (islands) in the southern and central regions of the CSMP. Of the 21 islands visited and cleaned of marine debris, a total of 8 were vegetated and the remaining 15 were unvegetated sand cays.
The islands visited included:

- Cato Island (v);
- Wreck Reefs (4 islands: West Islet, Hope Cay, Porpoise Cay (v) and Bird Islet (v));
- Kenn Reefs (4 islands: South West Cay and Observatory Cay, plus 2 x new uncharted cays: 'Russell Cay' and 'High Cay');
- Frederick Reefs (2 islands: Observatory Cay and Lighthouse Cay);
- Marion Reef (4 islands: Brodie Cay, Paget Cay and Carola Cay, plus a new uncharted cay… 'Nautilus Cay');
- Tregrosses Reefs (East Diamond Islet (v))
- Herald Cays (2 islands: North East Herald Cay (v) and South West Herald Cay (v));
- Willis Islets (2 islands: Mid Islet (v) and North Cay (v));
- Diane Bank (Sand Cay);
- Holmes Reef (2 islands: North Cay and South Cay) … Visited but did not go ashore due to height of tide inundating North Cay and wind and sea conditions at South Cay.

(v) = vegetated

One of the core undertakings of the Island Health Assessment voyage was to collect and remove all marine debris found on each of the islands to help maintain each island in as natural a state as possible. Collected marine debris was bagged, fumigated, sealed, named (by cay/islet) and dated before being removed from each island to the voyage vessel. Items of marine debris that were too large to be bagged (such as fishing nets, crates, fish attracting devices (FADS) and large lengths of ropes) were washed in the sea in situ and then sprayed/fumigated on shore before being taken to the vessel.

All marine debris was then examined on board the vessel, catagorised and recorded by Tangaroa Blue Foundation[1], (an Australia-wide not-for-profit organisation dedicated to the removal and prevention of marine debris) re-bagged and resealed. The collected marine debris was stored as compactly as possible on the upper deck of the vessel and secured for the return passage back to port at Yorkey's Knob (Cairns region); this amounted to approximately 10 cubic metres. Upon returning to Yorkey's Knob marina the marine debris was removed from the vessel and loaded into a truck and transported to the Yorkeys Knob recycling and rubbish transfer station.

[1] Tangaroa Blue Foundation(TBF) is an Australia-wide not-for-profit organisation dedicated to the removal and prevention of marine debris. TBF has been assisting Parks Australia with the removal and analysis of marine debris from the Coral Sea Marine Park since 2016.

Tangaroa Blue provided a detailed analysis of the marine debris collected from each island to Parks Australia on 14 October 2022. The report provided information on 260 separate categories down to individual types, numbers and source of origin of marine debris and an overall count and weight of marine debris collected off each cay/islet.

Using the analysis by Tangaroa Blue, this report summarises the distribution and loads of marine debris collected from the southern and central islands (by total items, rather than weight[2]) and examine possible reasons for this distribution.

Summary of marine debris collected

The analysis of the marine debris by Tangaroa Blues details 260 separate categories of marine debris, with a numerical value (number of items) assigned to each category from each of the islands.

A summary of the key debris information:

- 11,532 individual items were collected from 21 islands.
- 95 percent of the items (10,923 items) were made of synthetic materials such as plastics, rubber and PVC as follows:
  - hard pieces of plastic – 3,444
  - plastic lids and bottle tops – 1,600
  - plastic bottles - 593
  - rubber thongs - 564.
- 452 metres of synthetic rope of varying diameter and lengths was collected, with the longest single rope length being 80 metres. 44 square metres of synthetic fishing nets from lost or discarded fish aggregating devices (FADs) was also collected.
- 64 plastic fishing floats of varying sizes plus another 322 separate items were identified as originating in (point of manufacture) foreign countries.
- 269 glass wine, spirit and other drink bottles and jars.

Marine debris loads on individual cays and islands

The analysis of the marine debris by island, highlights the following:

- **North Cay (Willis Islets)**, (vegetated and approximately 1.4 km long x 0.230 km wide) with a southerly facing weather coast of 1.4 km had the highest marine debris load of the 21 islands, carrying 4,328 items equating to 37.6 percent of the total marine debris load. North Cay's relative long length and its east-west predominant axis is likely to be a contributing factor to its higher marine debris load.

[2] The total number of marine debris items collected from an island has been used in this summary rather than the weight collected because it provides a more accurate comparison of the level of marine debris 'pollution' on the islands. For example, hundreds of empty plastic bottles and other items might weigh just a portion of the weight of a single large item, such as a heavy boat rudder or a length of a large diameter ship's rope.

- **Cato Island** (vegetated) the southern-most island in the CSMP, and **North East (Herald) Cay** (vegetated) in the central region of the CSMP, carried very similar marine debris loads of 2,637 items (22.9 percent) and 2,504 items (21.7 percent) of the marine debris load respectvely. Cato Island is a considerably smaller island (approximately 0.81 km long x 0.26 km wide, with a south-south-easterly facing weather coastline of approximatley 1.1 km) than North East Herald Cay, (approximately 1.2 km long x 0.5 km wide with a long south-easterly facing weather coastline of approximately 1.6 km). These two islands are separated by a distance 964 km / 520 nm and over six degrees of latitude.
- **East Diamond Islet**, (vegetated), carried 7.7 percent (889 items) of the marine debris load. Its size (approximately 0.92 km long x 0.23 km wide with a south-easterly facing weather coastline of approximately 1.3 km) is comparable to both Cato Island and North East Herald Cay but its marine debris load was considerably lower; however, this is undoubtedly due to East Diamond Islet being cleared of all marine debris just 11 months prior in mid-July 2021, during which 1,142 marine debris items were removed. The collection of 889 marine debris items after 46 weeks indicates an average rate of marine debris accumulation of about 20 items per week or 3 items per day accumulates on East Diamond Islet.
  (**Note:** This estimated marine debris accumulation rate will be able to be further validated from marine debris collection visits scheduled for East Diamond Islet in November 2022 and May 2023.)
- **Kenn Reefs** (unvegetated) comprises four cays (South West Cay and Observatory Cay plus two additional previously uncharted/un-named sizeable cays), carried 3.5 percent (402 items) of the marine debris load, with SouthWest Cay carrying 97 percent (391 items) of that total.
- **South West Cay, Herald Cays**, (vegetated), (approximately 0.87 km long x 0.21 m wide with a south-southeasterly weather coast of only 0.19 km) carried 2.4 percent (280 items) of the marine debris load. The comparision with its nearest neigbouring island, North East Herald Cay, 7.6 km away, which carried 9 times the marine debris load is stark. The difference in the marine debris loads between these two closely and relatively similar sized islands is likely be due to the shape and longitudinal axis of each island with respect to prevailing localised current and wind patterns. South-West Herald Cay's main axis is virtually due north-south and it presents a very narrow weather coast (0.22 km) to prevailing winds and currents running south to north. North East Herald Cay, by comparison, presents a long south-easterly facing weather coastline of 1.6 km (Annex 3, diagram 1).
- **Mid Islet (Willis Islets)**, (vegetated), an oval-shaped island (approximately 0.3 km long x 0.18 km wide with a south-easterly weather coastline of approximatley 0.16 km) carried 1.5 percent (171 items) of the marine debris load. Mid Islet is in the same Willis Islets group as North Cay, which carried the largest amount of marine debris of the 21 cays and islets visited: 37.6 percent (4,328 items). These two islands are separated by 18 km. North Cay has a long weather coast (1.4 km) running east-west directly across any northerly flowing current while Mid Islet has a very small weather coast of about 0.16 km; (Annex 3, diagram 2).
- **Wreck Reefs**, Porpoise Cay and Bird Islet (vegetated), and West Islet and Hope Cay (unvegetated), carried just 1.3 percent of the marine debris load (149 items) of the marine debris load, with Bird Islet carrying 70 percent (104 items) of that total. All four island are relatively small, the largest being 0.14 km long x 0.04 km wide, presenting relatively small catchment coastlines for marine debris.
- **Marion Reef, Diane Bank and Frederick Reefs**
  Marion Reef (Brodie Cay, Paget Cay, Carola Cay, and a new uncharted cay) carried just 0.7 percent of the marine debris load (82 items). Diane Bank (Sand Cay) carried just 0.6 percent of the marine debris load (68 items)., and Frederick Reefs (Observatory Cay and Lighthouse Cay) carried just 0.1 percent of the marine debris load (13 items). These were all small cays presenting relatively small weather coastlines and providing smaller catchment areas for marine debris items, and would often be overswept by high seas and tides relatively frequently.

Observations and hypotheses

- North Cay (Willis Islets), Cato Island, North East Herald Cay and East Diamond Islet accounted for 90 percent of the total marine debris load collected from the 21 islands; (Appendix 1, Diagrams 1 and 2). All four islands have relatively long, south to south-east facing weather coastlines of 1.4 km, 1.1 km, 1.6 km and 1.3 km respectively.
    - (Note: The East Diamond Islet marine debris data does not provide a direct comparison with the other three islands as it was previously cleaned of marine debris in July 2021. This would have reduced its marine debris load compared to the other three islands which had not been cleaned of marine debris since 2016.)
- Cato Island (the southern-most island in the CSMP) is separated from the 3 other most heavily marine debrised islands in the central region of the CSMP by approximately 1,000 km and over 6 degrees of latitude (Appendix 2, Figure 3) . Despite this geographical separation and having the shortest length weather coast of the 4 islands (at 1.1 km), Cato Island's marine debris load was the second highest, indicating marine debris is being carried on currents throughout the CSMP. The reason that the central region of the CSMP is such a 'hotspot' for marine debris is likely to be due to the conglomeration of large islands found there as compared to elseware in the Park.
- The significantly larger marine debris loads on North Cay (Willis Islets), Cato Island, North East Herald Cay and East Diamond Islet as compared to the small loads on the remaining 17 islands indicates a direct correlation between marine debris loads and the length of the exposed weather coastlines and the longitudinal axis of islands; (Appendix 3, Diagrams 4 and 5).
- The differences in marine debris loads between close proximity islands, such as South West and North East Herald Cays only 7.6 km apart (Appendix 3, Figures 4 and 5) and the accummulation of marine debris on the weather coasts of islands such as North Cay (Willis Islets), and Cato Island (Appendix 4, Figure 6) may assist Parks Australia to better understand localised currents within the CSMP beyond the major South Equatorial Current.
- The marine debris loads on North Cay (Willis Islets), North East Herald Cay and East Diamond Islet also indicate that in addition to the major South Equatorial Current (SEC) running from east to west through the CSMP (Appendix 5, Figure 7), there could be other significant currents running north/north westerly through the central region of the CSMP, very probably driven by the South East Trade Winds; (Appendix 6, Figure 8).
  This hypothesis may further be supported by a GPS satellite telemetry study undertaken by C.J. Limpus and I. Bell (QPWS) to define inter-nesting, migratory pathways and foraging habitat for Coral Sea nesting Green turtles during the 2019-2020 breeding season.
  In this study, 8 mature female Green turtles were fitted with GPS trackers and released at North East Herald Cay, Coringa Islets and Magdelaine Cays in the central region of the CSMP. 6 of the 8 turtles migrated away from those islands on a north-westerly heading. 3 of those turtles, all released at North East Herald Cay, stayed on a predominantly north-westerly heading before closing the coast towards the top of Cape York Peninsula, (Appendix 7, Figures 9, 10 and 11). The other 3 turtles, released at Coringa Islets and Magdelaine Cays, remained on the north-westerly heading for a shorter period, before turning westward towards the Queensland coast, likely under the influence of the South Equatorial Current (SEC). They then travelled northward as the SEC turns into the north running Gulf of Papua Current (GPC) towards the top of Cape York Peninsula, (Appendix 7, Figures 12, 13 and 14). Of the 2 remaining turtles, one travelled on a predominantly westward heading into the Queensland coast and the other headed south, likely travelling with a south-running offshoot current of the SEC.
- As detailed above, the major current in the CSMP is the westwards flowing SEC, which enters the Coral Sea as a series of separate current streams between the Solomon Islands, Vanuatu and New Caledonia to the east of the CSMP. As currents influence where marine debris moves from and

arrives at across the ocean, it is hyothesised, as per the CSMP Marine Debris Report 2021, that the majority of marine debris removed from the CSMP during the 2022 voyage, particularly in the central region, has come from, or , through, the South pacific Ocean around the Solomon Islands, Vanuatu and New Caledonia regions.

- The fishing nets, FADs and floats collected are likely from foreign fishing vessels operating to the east outside the boundaries of the CSMP or in the high seas area to the south-east.

Recommendations

- From this analysis of marine debris accumulation, a recommended strategy to help reduce marine debris loads accumulating throughout the majority of islands in the CSMP (and also the Great Barrier Reef Marine Park) would include educational initiatives and encouragement of improved waste management practices targeting marine debris points of entry into the South Pacific Ocean (Solomon Islands, Vanuatu and New Caledonia regions) and foreign fishing fleets fishing to the south-east of the CSMP. It is recommended that such work be undertaken in conjuction with other relevant bodies such as the Great Barrier Reef Marine Park Authority.
- Tracking debris loads may help Parks Australia to better understand localised currents within the CSMP beyond the major South Equatorial Current. Understanding localised currents has a number of benefits, but pertaining to marine debris can help Parks Australia to target debris collecting efforts when planning future voyages.
- An examination of the effects of marine debris on key species within the CSMP is recommended to understand the threat debris poses, and accordingly the rate of removal required to maintain ecosystem health.
- Continued collection and analysis of marine debris is recommended for further comparison against baseline data – for example the return to East Diamond Islet has provided an understanding of the rate of accumulation. The storing and method of displaying data is an important consideration to best enable comparison.

Table 11.1 Summary of cay marine debris loads

Marine debris collected from southern and central cays and islets of the Coral Sea Marine Park	**Total count of marine debris items**	**Ranking of most impacted cay/islet to least as a percentage of total marine debris**	**Length of islands' weather coast in km**
1. Willis Islets – North Cay (vegetated)	**4,328**	**37.6 %**	**1.4 km**
2. Cato Island (vegetated)	**2,637**	**22.9 %**	**1.1 km**
3. North East Herald Cay (vegetated)	**2,504**	**21.7 %**	**1.6 km**
4. Diamond Islet - East (vegetated)	**889**	**7.7 %**	**1.3 km**
5. Kenn Reefs (4 x small sand cays)	**402**	**3.5 %**	**-**
6. South West Herald Cay (vegetated)	**280**	**2.4 %**	**0.19 km**
7. Mid Islet Willis Islets (vegetated)	**171**	**1.5 %**	**0.16 km**
8. Wreck Reefs (2 x vegetated, 2 x sand cays)	**149**	**1.3 %**	
9. Marion Reef (4 x small sand cays)	**82**	**0.7 %**	
10. Diane Bank (1 x small sand cay)	**68**	**0.6 %**	
11. Frederick Reefs (2 x small sand cays)	**13**	**0.1 %**	
Total rope/hawser length: 452 m.			
Totals	**11,523**		

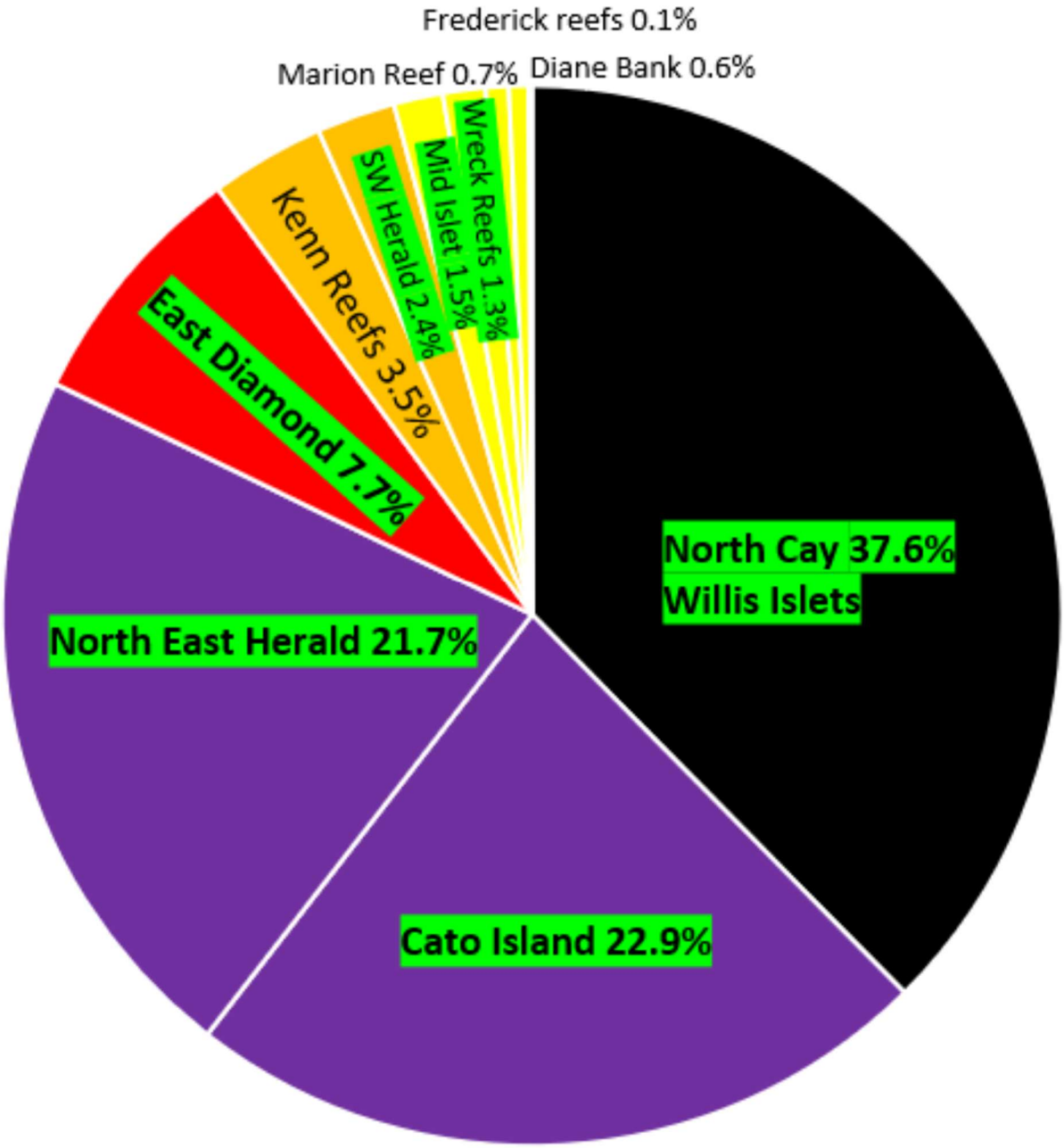


Figure 11.1 Comparison of cays and percentage of marine debris load

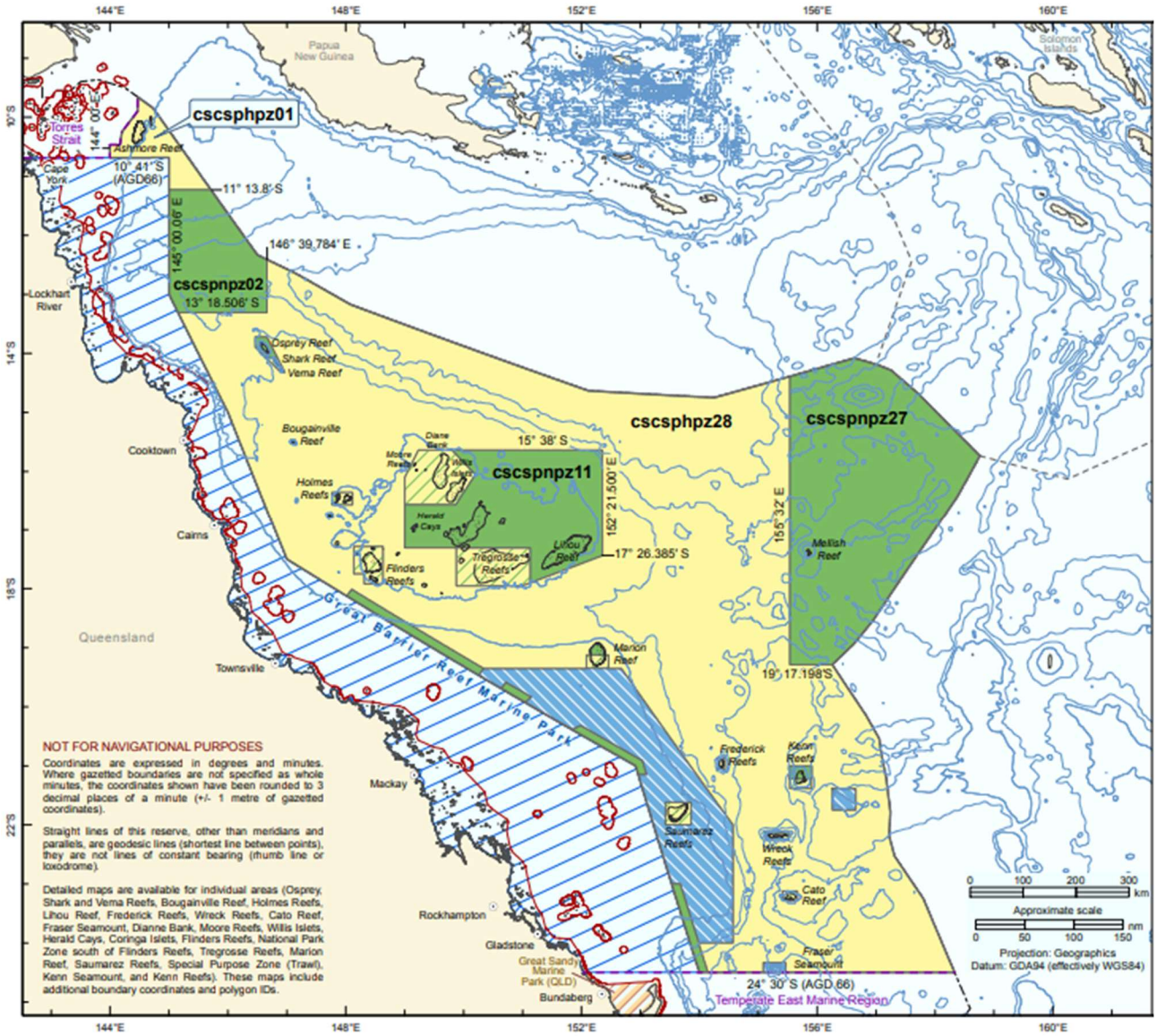


Figure 11.2 Distribution of marine debris on cays in the southern and central regions of the Coral Sea Marine Park

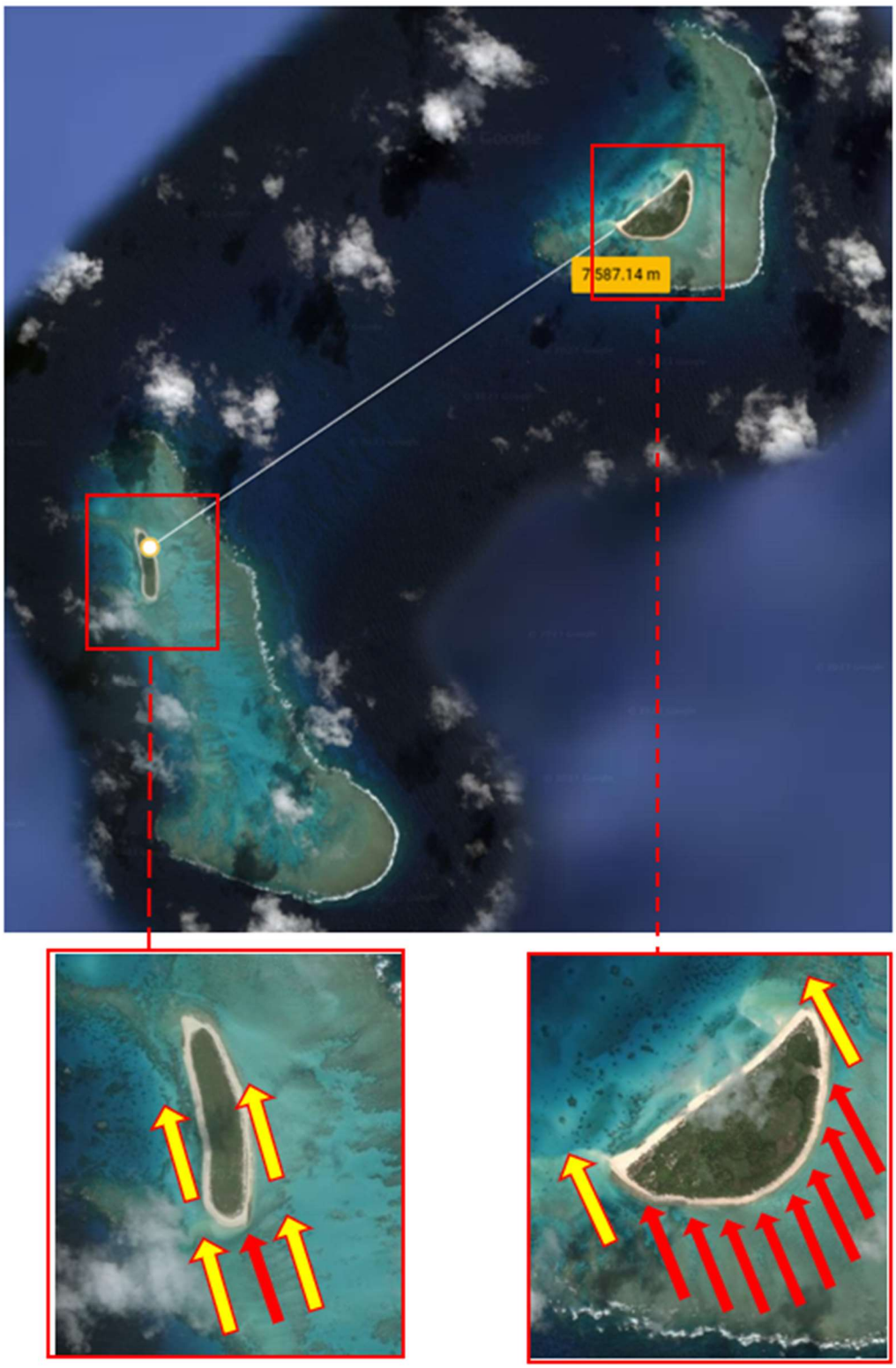


Figure 11.3 Direct comparison of marine debris loads on adjacent cays in the Coral Sea Marine Park – the influence of localised currents

South West Cay and North East Cay (Herald Cays), central region of the Coral Sea Marine Park (Figure 11.3) are only 7.6mk apart. The debris load on North East Cay (2504 items) was nine times greater than the load on South West Cay (280 items). North East Cay's weather coastline of approximately 1.6km is 8.4 times longer than South West Cay's weather coastline of 0.19km.

North Cay and Mid Islet in the Willis Islets, central region of the Coral Sea Marine Park (Figure 11.4), are separated by a distance of 18 km. North Cay has a weather coast approximately 1.4 km long with a longitudinal axis running east-west directly across northerly flowing current. This presents a large marine debris catchment area, which accounts for its significantly large marine debris load of 4,328 items (37.6 percent of marine debris load). This load was 25 times the amount gathered from Mid Islet (171 seperate items; 1.5 percent of the load), which has a very small semi-circular shaped weather coast of approximately 0.16 km.

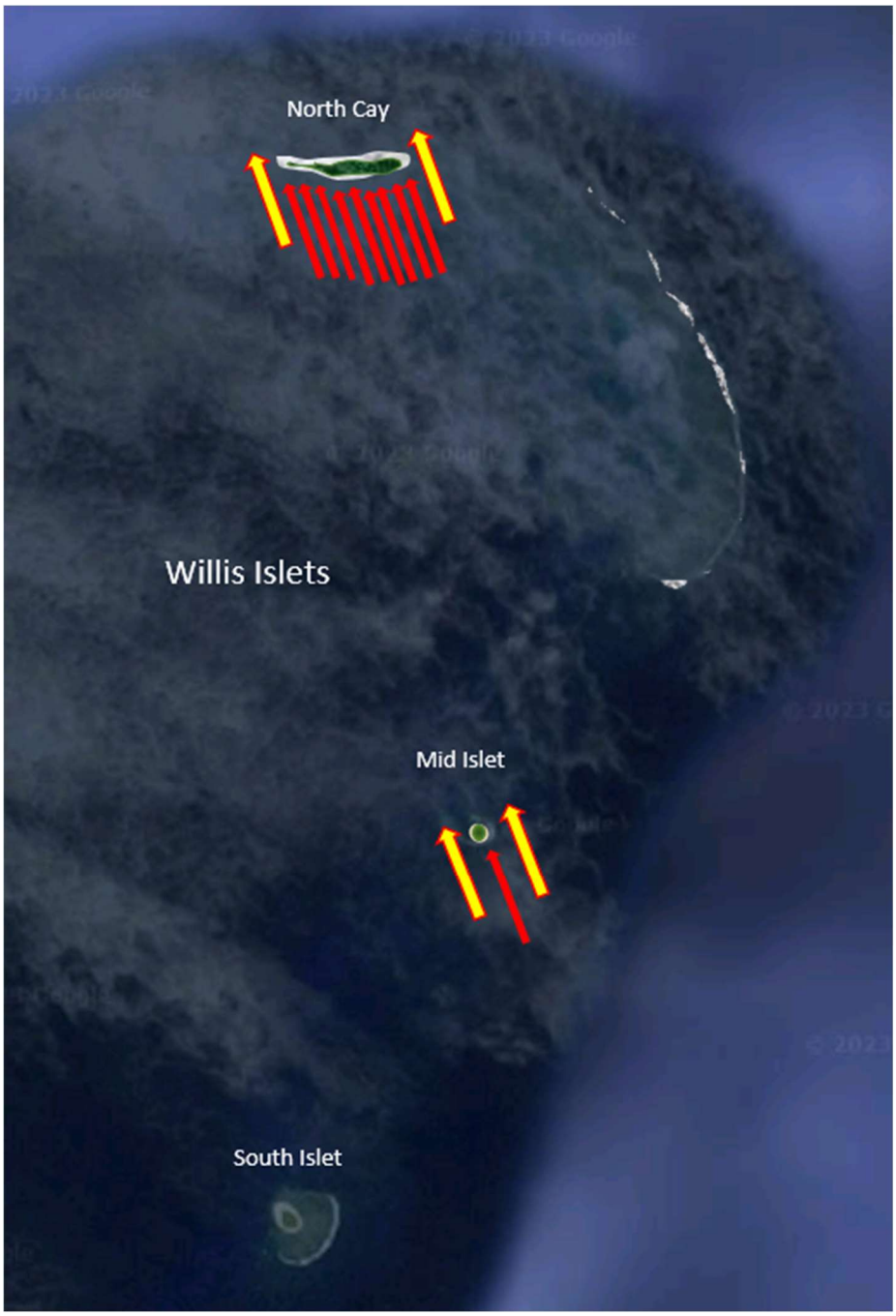


Figure 11.4 Direct comparison of marine debris loads on adjacent cays in the Coral Sea Marine Park – the influence of localized currents

Figure 11.5 Cato Island in the south of the Coral Sea Marine Park, influence of localized currents. Predominant marine debris load on the south-easterly weather coast

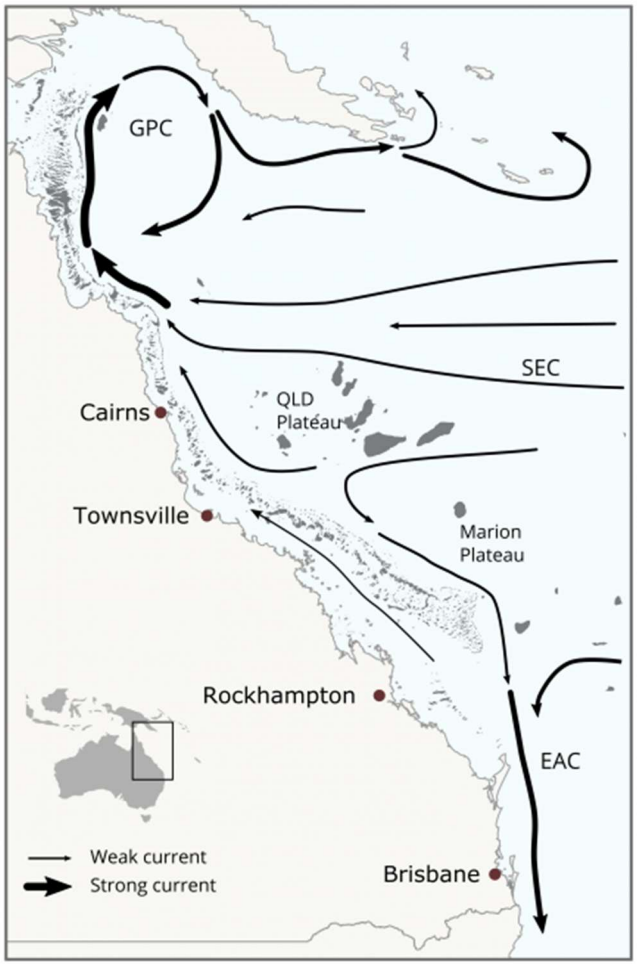


Figure 11.6 Major currents (April to November) influencing marine debris distribution in the Coral Sea Marine Park

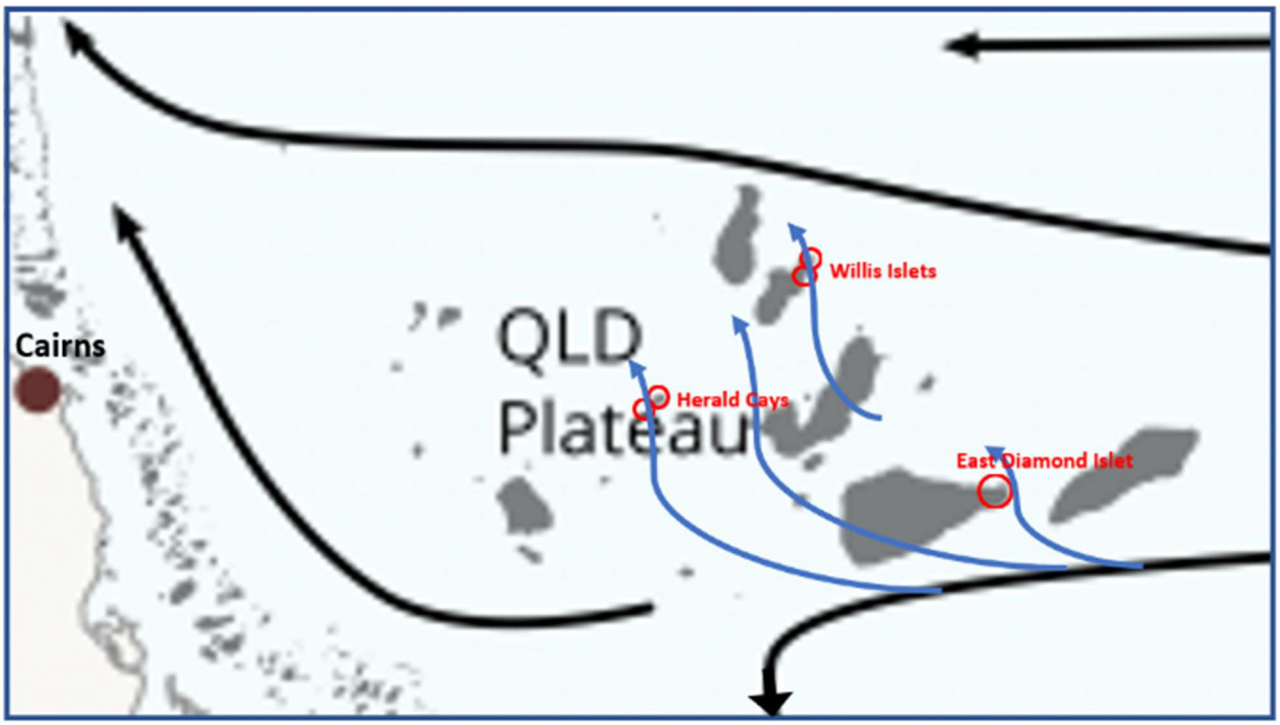


Figure 11.7 Potential minor currents flowing in the central region of the Coral Sea Marine Park based upon marine debris loads on cays (see detail in figures 11.3 and 11.4)

Coral Sea Islands Health Project May/June 2022 participants.
Photo Alex Gorham © Queensland Government.
Back row L to R: Alex Gorham QPWS, Collette Bagnato QPWS, Jesse Murphy PAD, Daniel Clifton QPWS, Jake Sanders QPWS.
Front row L to R: Larry Brushe and Joy Brushe Vegetation assessment, Mathilde Gordon Tangaroa Blue, John Prichard PAD, Martin Russell PAD, Russell Gueho PAD, Andrew McDougall QPWS.