Environmental Assessment of the Coringa Islets and Herald Cays in the Coral Sea Marine Park

December 2019

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Queensland Government

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Contents

1.0 Executive Summary

Between 29 November and 18 December 2019, a team of experts from Queensland Parks and Wildlife Service and Parks Australia visited six islands in the Coringa-Herald islets and cays of the Coral Sea Marine Park (CSMP) to collect, analyse and document data on the health status of terrestrial island ecosystems, and species using the islands, to establish baselines for future trend analysis.

The conditions were very dry at the time of the survey, and marine debris was noted on every island. The assessment included:

- vegetation condition, with emphasis on the condition of *Pisonia* (*Pisonia grandis*) communities and associated beneficial and detrimental invertebrates;
- surveys for invasive species;
- updating vegetation mapping
- collecting high resolution imagery using a drone;
- evaluating seabird presence and breeding;
- turtle monitoring including nesting, tagging and satellite tracking; and
- sand temperature assessment.

Maps were created for each vegetated island, to help determine whether the extent and distribution of vegetation is changing. Drone imagery was also used to validate counts of larger nesting seabirds.

Vegetation

Pisonia communities are currently found on North East Herald and South East Magdelaine. Prior to a scale outbreak in the late 1990s *Pisonia* occupied most of the interior of South West Coringa (Hicks 1985). There was no evidence, in the current survey, that it had ever been present on South West Coringa. *Pisonia* communities are known to be susceptible to decline or complete collapse with unchecked pest insect outbreaks and can have major structural change because of cyclones.

The estimated age and unidirectional nature of swaths of fallen *Cordia subcordata* on North East Herald suggests that they may have been blown or washed over by wind or storm surge from a tropical cyclone such as tropical cyclone Yasi in 2011. *C. subcordata* is now much less abundant on all islands than in 2006-2007 and appears to have almost died out on some of the islands in the CSMP. Where there were once large patches there are now dead stems with few if any leaves and in some cases, there are swaths of fallen dead trees.

Quantitative BioCondition monitoring (Eyre *et al.* 2015) sites were established in *Pisonia* communities on North East Herald and South East Magdelaine. All sites are within BioCondition Class 1 – this being the best of four classes. Qualitative condition monitoring was undertaken for a range of vegetation communities across all islands using Health Checks (Melzer *et al.* 2019). The overall condition for most of the communities was “Good”. The exception was the clumps or patches of *C. subcordata* which had an overall condition rating of “Significant Concern”.

Health Checks are likely to be adequate for monitoring the condition of most vegetation communities on the islands. Additional BioCondition monitoring every five to ten years is likely to be adequate for the *Pisonia* communities unless there is cause (e.g. cyclone impact) to trigger earlier re-monitoring.

Future vegetation mapping and monitoring, particularly quantitative monitoring requiring intensive assessment of individual sites, should be undertaken outside of the breeding season for wedge-tailed shearwaters because of the significant risk of collapsing active burrows.

Birds

The data suggests an internationally significant population of wedge-tailed shearwaters breeding across five of the six cays surveyed. Wedge-tailed shearwater burrows were abundant in North East Herald and South East Magdelaine, and a significant population of wedge-tailed shearwaters occupied North East Cay.

If intensive wedge-tailed shearwater monitoring is considered in the future then it is important to consider the potentially damaging impact of ground counts, particularly in the densest and most fragile substrates within closed *Pisonia grandis* communities.

A channel-billed cuckoo observation is likely to be a new record for the CSMP, and range extension.

Future surveys should be conducted consistently in May or June if targeting breeding red-tailed tropicbirds, red-footed booby (which appear to breed year-round), great frigatebirds and lesser frigatebirds. However, summer surveys are recommended if targeting wedge-tailed shearwaters, brown booby and red-footed booby.

Turtles

A total of 387 individual green turtles were encountered nesting during the survey. Of these, 296 had not been tagged during a previous survey or at another study location, 27 were inter-season re-migrants (turtles that had been tagged previously and had returned to CSMP to nest again). Seven were inter-season retags (they possessed tag scars on their flippers, indicating they had been tagged previously but had subsequently lost their tags). Four turtles had been tagged while foraging and were recaptured attempting to nest in the CSMP. Two turtles had been originally tagged while foraging at Clack Reef and two at Combe Reef near Princess Charlotte Bay, on the eastern coast of Cape York Peninsula.

Three turtles were recorded changing their nesting location during the survey period, two moving from Chilcott to South West Coringa Islet and one individual migrating approximately 120km from North-East Herald Cay to South East Madelaine Cay. These small-scale migrations indicate strong nest site fidelity to a region rather than an individual island.

Eight female turtles were successfully fitted with satellite tags. Four of the eight turtles had successfully nested in the CSMP in the past, including one that had originally been tagged in 1991.

While the brevity of the site visit precluded confident conclusions the 2019/2020 nesting season appeared to be of a similar density as the highest recorded season in 1999/2000.

Over 100 genetic samples were collected to gain a contemporary understanding of the genetic structure within this nesting aggregation. This is an important metric for monitoring impact or change, either negative or positive, that may be occurring within a foraging area.

To date a total of 3508 green turtles have been tagged in the CSMP. This study site now represents one of the largest datasets for a green turtle nesting rookery in the Pacific region. In terms of Australian east coast and Gulf of Carpentaria turtle monitoring, it is the third largest data set for nesting green turtles behind Raine Island (Northern Great Barrier Reef GBR) and the Capricorn Bunker Group (Southern GBR). Continued tagging over a set period in each nesting season is crucial to establishing links to foraging grounds.

Pests

The prevailing hot, dry conditions were not conducive to invertebrate surveys. Autumn would therefore be a more appropriate time to assess insect populations on the CSMP islands.

No invasive rodents, such as rats and mice, were found on any of the islands. However, the scale insect *Pulvinaria urbicola* was found at North East Herald, and invasive ants were found on all islands except North West Magdelaine. Two species of hawkmoth, *Hippotion velox* and *Agrius convolvuli* were recorded. The only evidence of the predatory beetle *C. montrouzieri* was a single larva and a few eaten egg masses at one of the sites on North East Herald. None of the three species of parasitoid wasps that were released with *C. montrouzieri* between 2002 to 2007 were observed in the survey.

To ensure biosecurity risks are minimised, it is recommended that all camping, regardless of the purpose (e.g. recreational, commercial, educational, scientific), be prohibited. It is further recommended that day-visitors, for recreational and commercial purposes, be restricted to the beaches and not be permitted to take equipment (e.g. tables, chairs) ashore. No fresh food, including cooked or uncooked meats, breads, fruit and vegetables should be taken ashore.

When moving between islands field equipment and boots must be thoroughly cleaned in VirkonS® or similar. Wearing clean clothes washed in detergent and water at >40°C for each new island and washing and inspecting hats and backpacks including Camelbacks®, will also reduce the chances of transporting pests between islands. Signs and building materials including site and transect markers and other installations must be new and sourced from authorised/guaranteed clean suppliers.

2.0 Recommendations

Determine the key values, threats and management options

While any well-planned monitoring program will provide potentially useful information, targeting monitoring to prioritised management needs is a more cost-effective approach. We strongly recommend that Parks Australia conduct a process to identify the values that are most important (the 'key values') and to identify the indicators that are best to monitor to inform management of those key values. The process ('values assessment') should identify where the key values occur, the most significant threats to them, the current condition based on the best available information and the desired condition.

The more detailed the values assessment the easier it will be to design a cost-effective monitoring program. It will inform what to monitor and decisions regarding the level of change that is acceptable (or desirable) and so, in turn, inform method selection and frequency of visitation. One option would be to use the Queensland Parks and Wildlife Service and Partnerships (QPWS&P) Values Based Management Framework (VBMF) https://parks.des.qld.gov.au/managing/framework/ as a 'template'. QPWS&P has extensive experience regarding the values assessment process that underpins the VBMF and can recommend contractors with experience of this system.

The values assessment prioritises values, risks and management responses, and informs decisions around where monitoring is vital for management, useful or a low priority.

Biosecurity

The Coral Sea Marine Park (CSMP) cays are possibly among the most vulnerable to disturbances from tropical cyclones and other extremes in weather. These place stress on the ecosystems and although such disturbances are natural, it is certain such extremes will increase with climate change. Additional stresses from invasive species could push things beyond tipping points. For example, SW Coringa island has undergone a phase shift in which the *Pisonia grandis* forest, and associated black noddy nesting habitat, has been completely lost in under 25 years as a result of a tiny scale insect in facultative mutualism with an equally inconspicuous introduced ant.

It is recommended that all camping, regardless of the purpose (e.g. recreational, commercial, educational, scientific), be prohibited in the CSMP to minimise the biosecurity risk. The equipment campers typically use provides significant opportunities for invasive species to 'stow away' and thereby be introduced to the relatively naïve ecosystems of the CSMP. Camping is unnecessary given that all vessels will need to have overnight accommodation in order to legally (i.e. ship's survey certification) transport visitors to the CSMP from Australian mainland ports.

It is further recommended that day-visitors, for recreational and commercial purposes, be restricted to the beaches and not be permitted to take equipment (e.g. tables, chairs) ashore. Shade structures, water containers, first aid gear and other equipment that could be considered necessary from a health and safety perspective should not be taken above the highest tidemark. Ideally all such equipment would be brand new at the start of trips from the mainland or otherwise very thoroughly cleaned. All equipment must be inspected and sprayed (e.g. crawling insect surface spray) before going ashore and between each island. Multilayered containers and structures made from materials such as corflute should not be taken aboard vessels nor ashore.

No fresh food, including cooked or uncooked meats, breads, fruit and vegetables should be taken ashore. The timing and average length of stay on an island should be such that only drinking water and pre-packaged snacks (e.g. muesli bars, dried fruits, sweets etc.) are needed. Obviously formulated packaged medications are acceptable.

Visitors undertaking research and/or monitoring on the CSMP islands should adhere to similar protocols, as recreational and commercial visitors regarding food and equipment, but will need additional protocols, particularly when working above the high tide mark. For example, when moving between islands they must ensure that their field equipment and boots are thoroughly cleaned in VirkonS® or similar. Wearing clean clothes washed in detergent and water at >40°C for each new island, and washing and inspecting hats and backpacks including Camelbacks®, will also reduce the chances of transporting pests between islands.

Signs and building materials including site and transect markers and other installations must be new and sourced from authorised/guaranteed clean suppliers. Immediately prior to installation, such material must be thoroughly cleaned and inspected before deployment and again before being redeployed or repurposed. For example, during the 2019 island health trip exotic Pennant ant *Tetramorium bicarinatum* workers and eggs were inadvertently transported to SW Herald. They were in a length of electrical conduit that had been used as a transect marker on NE Herald since the 1990’s and was being repurposed (Plate 1.1). Fortunately, they were detected early and destroyed. The same ant species was subsequently found to be already established at several locations on the island.

The biosecurity protocols adhered to on the current survey trip are provided in Appendix 1.

Plate 1.1 Pennant ant *Tetramorium bicarinatum* workers and eggs found inside the transect marker.

Willis Island has higher biosecurity risks than other islands in the CSMP because of the staffed meteorological station. It is the only island in the CSMP where the African big-headed ant *Pheidole megacephala* has been recorded. Willis Island should therefore be the last island visited on a trip to CSMP. It is recommended that managers of the CSMP work closely with the Australian Bureau of Meteorology to enhance the biosecurity protocols for the island and minimise the risk of spreading invasive species to other CSMP islands. Other islands with structures including unmanned or defunct meteorological stations should be targeted for invasive species surveys to determine if establishment has occurred, and so determine an appropriate course of action.

It is recommended that a study be commissioned to identify the most significant biosecurity risks to island values, along with their likely sources, vectors and pathways of introduction. The QPWS&P Great Barrier Reef (GBR) and Marine Parks Region has received its first contracted biosecurity assessment: for the Capricornia Cays National Park. One output is a model of vectors, pathways and intervention points that will be applicable to other locations.

The best season for detecting pest invertebrate and weeds

Although November/December was excellent in terms of sea conditions, autumn is a better time to survey insects and detect weeds on the CSMP islands. Insects with the potential to impact on the key vegetation communities on the islands in the CSMP would be most abundant following the growth flushes induced by the summer wet season. Autumn is also ideal for detecting and identifying weeds as they are likely to be actively growing and fertile in this season.

Evaluate value of eradicating invasive ants

Consideration should be given to assessing the feasibility and likely benefits of eradicating the exotic ant species, all of which have known, albeit varied impacts on native Australian wildlife and may cause significant impact to naïve ecosystems on remote islands such as those in the CSMP.

Evaluate whether invertebrates have contributed to the decline of *Cordia subcordata*

The estimated age and unidirectional nature of swaths of fallen *Cordia subcordata* on NE Herald suggests that they may have been blown or washed over by wind or storm surge from a tropical cyclone such as TC Yasi in 2011. This species is in apparent decline on all the islands on which is occurs. Defoliation from moth larvae along with prolonged dry spells may have contributed to the decline. Better understanding of the impact of invertebrates on the health of this species is important for developing an effective biological control program should it be required in the future.

Undertake Island Watches on each island each visit

The Island Watch tool (refer section 3) was developed by QPWS&P as an early warning system for pest incursions (biosecurity surveillance) and the detection of other threats or changes to natural values, so that early management intervention can be undertaken. An Island Watch survey should be completed for each island visited during a trip.

Undertake Health Checks on key values

Health Checks (refer section 5.3) provide a simple and rapid means to regularly evaluate the condition of ecosystems and associated habitats on the cays. They can be undertaken by non-scientists – assessors do not require experience in scientific methods nor scientific equipment. Basic training in the method and concepts, and a camera, clipboard and datasheets, are sufficient.

It is recommended that the most important ecosystems or habitat be selected (‘key values’) for monitoring into the future. Once the number of key values is agreed, then decisions can be made regarding the frequency of monitoring and the season in which to monitor. While season per se is not critical to Health Checks it is preferable that they be undertaken in the same season each time, and when weeds will be easiest to detect and identify (typically late summer through autumn – post wet season). Given the distance between islands it is recommended that Health Checks for each key value be undertaken separately for each island.

Keep an eye out for scale during health checks

The methods used to control *P. urbicola* outbreaks on NE Herald and SE Magdelaine in 2002, Wilson Island in 2006, and Cousine Island in 2011 have proven effective in protecting *P. grandis* forests from the destructive impacts of multiple generations of *P. urbicola* (refer section 8.2). Managers of the CSMP islands do not need to use detailed surveillance programs involving quantitative scale monitoring unless an outbreak is occurring. Such programs are resource intensive and may not be effective in predicting outbreaks, which can develop in less than six months. Outbreak conditions are obvious and should easily be detected by basic monitoring programs such as the QPWS&P Health Check protocol (refer section 5.3), which targets a range of ecosystem health indicators and, because it is rapid, can be undertaken at a relatively large number of sites. A rapid scale assessment could also be added to Island Watch surveys for *Pisonia* islands if a Health Check is not planned during a visit. The early detection of outbreaks would allow a suitable response to be developed in order to prevent any significant impact to the *P. grandis* forests of the CSMP.

Drone Mapping

Drones provide an efficient means to monitor changes in island profile and gross changes in vegetation structure and composition, and hence roosting and nesting habitat. The imagery is also highly valuable for informing ground truthing for vegetation mapping.

Consideration should be given to procuring a differential GPS and set of ground control point markers to improve spatial precision of resulting maps. Spatial precision commensurate with the very high resolution of the maps would enable detailed assessments of beach volumes, vegetation shifts and other changes.

Vegetation mapping and BioCondition – every five to 10 years unless some major trigger

Vegetation maps are foundational 'tools' for land management and ecological assessment providing, for example, the means to select locations for targeted actions including monitoring. They can also, providing the limitations of scale are considered, be a means for monitoring change in the extent and distribution of vegetation communities over time. Detailed vegetation mapping is resource intensive. However, vegetation changes detectable via vegetation mapping usually occur relatively slowly and so re-mapping is unlikely to be required at intervals of less than a minimum of 10 years.

Health Checks are likely to be adequate for monitoring the condition of most vegetation communities on the islands. Additional quantitative monitoring is warranted for at least the *Pisonia grandis* communities – *Pisonia* being a keystone species (refer section 5) and known to be susceptible to significant structural change as a consequence of cyclones and to be highly susceptible to unchecked scale outbreaks. BioCondition (refer section 5.2) – Queensland's standard quantitative method for monitoring the condition of ecosystems, is an appropriate 'tool' for monitoring the *P. grandis* communities in the CSMP and has the advantage of enabling direct comparison with similar communities on GBR islands. A minimum frequency of five years is likely to be adequate for BioCondition monitoring unless a significant disturbance triggers an earlier re-evaluation.

Vegetation mapping and monitoring, particularly quantitative monitoring requiring intensive assessment of individual sites, should be undertaken outside of the breeding season for wedge-tailed shearwaters because of the significant risk of collapsing active burrows.

Seabird Surveys

A process, such as a values assessment, is needed to determine which species and locations Parks Australia deems of greatest importance. Such decisions are critical to informing the development of a monitoring program – very different data sets will be obtained depending on the season and location in which surveys are undertaken.

Information is available to help inform the selection of indicator species, season and frequency of monitoring required to detect trends useful for informing management (e.g. Fuller and Dhanjal-Adams 2012). Such information was used, together with an understanding of operational resources and constraints, to develop the Coastal Bird Monitoring and Information Strategy (Hemson *et al*. 2015). QPWS&P has commenced a review of the Strategy based on the analysis of the data collected through the implementation of the Strategy together with a power analysis conducted through the Reef Integrated Monitoring and Reporting Program (RIMREP) (Woodworth *et al*. 2020).

Seabird Methods

It is recommended that ground counts be continued at present. The counts enable the observer to estimate the abundance of seabirds nesting in burrows, on the ground and in vegetation. The specifics of the methods including decisions about the continued use of transects versus other sampling designs should be evaluated once decisions about which species and populations are most important.

Consideration should be given to "automated species recognition" or manual counts from drone imagery and/or acoustic methods as these technologies mature and tests are completed. The limitations of the technology must be understood. For example, tropicbirds generally hide under overhanging structures and so drone imagery is unlikely to be useful for surveying this species; acoustic methods work best for birds which nest in large, predictably located colonies or across large areas of islands. Drones require people to be present whereas acoustics capture information for the duration of their deployment which can be up to a year.

All surveys will collect useful information, but the frequency of visitation required for trend analysis with reasonable statistical power may be unattainable for some species. It is difficult, for example, to obtain robust data for black noddies and common noddies because the former are typically under-canopy breeders and the latter have a wide variety of habitat preferences. Obtaining robust data for red-footed booby may also be problematic – they breed year round and we do not know whether individual boobies consistently nest at a particular time of year, so estimates of overall abundance will be based on several assumptions regarding the timing of breeding.

Winter Seabird Surveys

We recommend surveys be conducted consistently in May or June if targeting breeding red-tailed tropicbirds, red-footed booby (which appear to breed year-round), great frigatebirds and lesser frigatebirds.

The bulk of breeding effort for these species falls within this period and it may be the most appropriate time to capture nesting or adolescent tropicbirds and nesting frigatebirds.

It may be difficult to obtain robust trend data for terns, such as sooty terns, if peak breeding is not recorded during annual or biannual surveys. More information on when these peaks of breeding occur will be important to evaluate whether monitoring of these species will be worthwhile.

Summer Seabird Surveys

Summer surveys are recommended if targeting wedge-tailed shearwaters, brown booby and red-footed booby (which appear to breed year-round).

Sea Turtles

The Commonwealth has an international responsibility to protect its sea turtle nesting sites. As one of the few sites for which it has total responsibility it is recommended that the Commonwealth support a marine turtle monitoring program to aid in management decisions for the CSMP. The nesting aggregation of marine turtles in the Coral Sea Island Territories is a distinct genetic stock and should be viewed as a separate management unit.

There are several options for monitoring sea turtles in the CSMP. The most basic method is to monitor annual nesting abundance on NE Herald Cay, during peak nesting periods, using standardised methods to allow comparison with other Queensland nesting genetic stocks. NE Herald Cay would be used as the index beach indicative for the islands in the CSMP. Typically, annual nesting densities of all three Great Barrier Reef genetic stocks are in synchrony (Limpus and Nicholls 1988); if the Coral Sea stock falls out of synchrony further investigations can be undertaken.

Additional monitoring is required to obtain information on inter-season nesting intervals and to gain further information on population trends. A minimum of 20 years data is recommended. A further seven years of active monitoring is required to achieve this minimum data set.

Additional useful information would be obtained from:

- Continued tagging, measuring, and determining hatching success. As one of the few offshore nesting sites with a history of monitoring this would build on the work that has already been accomplished.
- Expanding nesting related research on the islands; for example, determining the exchange among islands, by intensive simultaneous monitoring of multiple sites.
- Expanding monitoring period duration to a minimum of two weeks, to enable determination of the annual nesting abundance and inter-nesting interval.
- Research into the foraging grounds for populations nesting in the CSMP.

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3.0 Introduction

John Olds

The Coral Sea Marine Park (CSMP) is located east of the Great Barrier Reef adjacent to the Great Barrier Reef Marine Park (Fig 2.1). It extends from Cape York Peninsula to just north of Bundaberg in Queensland, Australia. There are approximately 34 reefs, and 56 cays and islets in the CSMP including the Coringa-Herald and Lihou Reefs and Cays Ramsar site. The site comprises near-pristine oceanic islet and reef habitats that are representative of the Coral Sea. The undisturbed sandy habitats at several islets are nesting sites for globally threatened marine turtles, while the foreshores and vegetation support important breeding populations of seabirds (Director of National Parks, 2018).

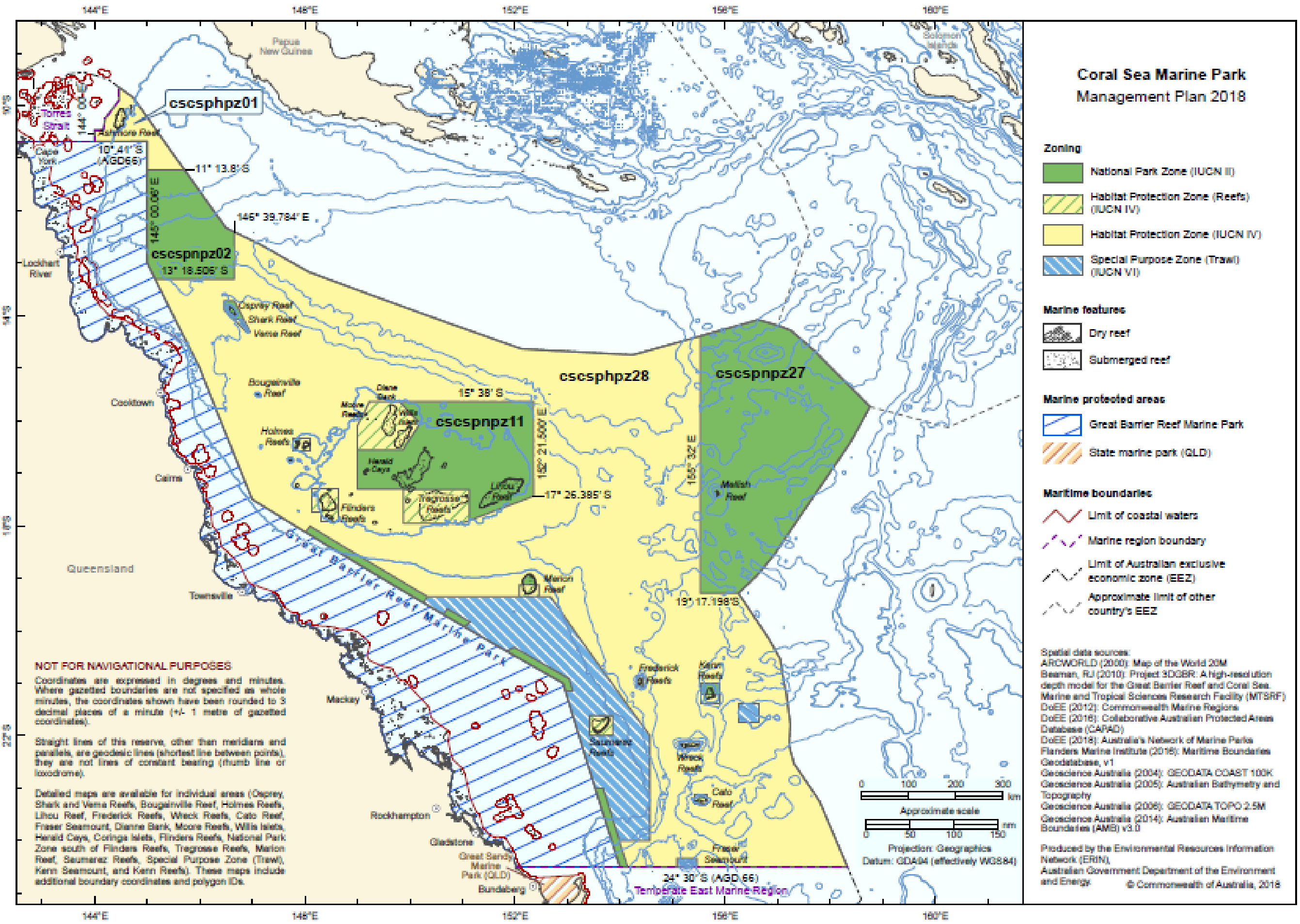

Fig. 2.1 Coral Sea Marine Park {from CSMP Management Plan, Director of National Parks (2018)}.

Parks Australia Division (PAD) manages the CSMP under the *Coral Sea Marine Park Management Plan 2018*. PAD and the Great Barrier Reef Marine Park Authority (GBRMPA) have a Memorandum of Understanding (MOU) to enable management efficiencies between the two marine parks. As part of this MOU, the GBRMPA Field Management Program (FMP) has been assisting PAD with the delivery of field management activities in the CSMP, such as monitoring and managing species and habitats.

A collaborative pilot trip to the islands of the CSMP was undertaken in late 2019. The MV Phoenix was chartered by PAD to provide transport, accommodation, and a working platform for a team of experts from PAD and the Queensland Department of Environment and Science (DES), Queensland Parks and Wildlife Service and Partnerships (QPWS&P). Departing Port Douglas on 29 November and returning 11 December, the team visited six islands in the Coringa-Herald section of the CSMP to pilot methods to collect, analyse and document the health status of terrestrial island ecosystems, and species using the islands, to establish baseline data for future trend analysis. This included:

- assessment of island and vegetation condition, with particular emphasis on the condition of *Pisonia grandis* communities and associated beneficial and detrimental invertebrates, and the presence of invasive species;
- updating vegetation mapping;
- evaluating seabird presence and breeding;
- turtle monitoring including nesting, tagging and satellite tracking, and sand temperature assessment; and
- aerial mapping using a drone.

The results reported in the following pages, along with the broader outcomes and lessons learnt from the pilot trip will be used to develop a longer-term monitoring program under a service delivery agreement between PAD, GBRMPA, DES and QPWS&P.

The location of the six islands is shown in Fig 2.2. They were North East Cay (Herald Cays), South West Cay (Herald Cays), South West islet (Coringa Islets), Chilcott Islet (Coringa Islets), South East Cay (Magdelaine Cays) and North West Islet (Magdelaine Cays). The islands are generally referred to in the report as NE Herald, SW Herald, SW Coringa, Chilcott, SE Magdelaine and NW Magdelaine.

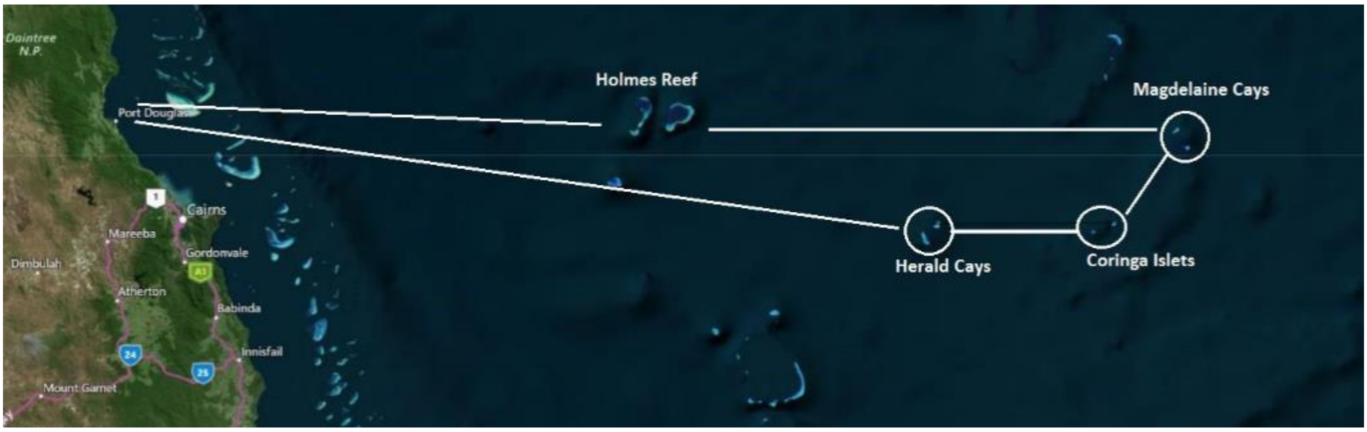

Fig 2.2. Location of the six islands visited on the pilot trip.

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3.0 Island Watch

Bridget Armstrong

Introduction

The Island Watch tool (Armstrong 2017) was developed by Queensland Parks and Wildlife Service and Partnerships (QPWS&P) as an early warning system for pest incursions (biosecurity surveillance) and the detection of other threats or changes to natural values, so that early management intervention can be undertaken if required.

It is a simple and rapid tool, intended to be used at sites where rangers are deployed to undertake scheduled field management activities. These sites tend to be those with higher public use numbers, such as campgrounds and other recreational use areas, and sites with higher natural values where rangers undertake activities such as seabird surveys or weed control. Such sites are priorities for a higher level of biosecurity surveillance as they represent either the most likely sites for pest invasion, or the sites where pest impacts will cause the greatest concern.

In addition, the Island Watch tool is used to document changes or concerns about other factors affecting island health, such as saltwater intrusion into wetlands or new turtle and seabird nesting sites. Another application of the tool, especially for seldom-visited islands, is the ability for users to retrieve electronically stored information about recommended future works when preparing for subsequent visits. The tool prompts staff to be vigilant and to report on any observations relevant to park management.

Conditions were very dry at the time of the survey. It is possible that more weeds may be detectable during the active growth season (the wet season). Similarly, pest insects and their impacts may be more detectable during less dry periods.

Methods

The Island Watch tool is available electronically on the Field Reporting Software application developed by the Great Barrier Reef Joint Field Management Program. It is also available as a questionnaire style, double-sided A4 hardcopy page (refer Appendix 2), to make it convenient to carry on a clipboard. The prompts to “check for change” are in text boxes that refer to observations about new or changing (spreading) weeds, pest animals, fires, seabirds, turtle tracks and nests, any monitoring or collections that took place, and where spatial data and photographs will be stored.

The form is largely self-explanatory, as the intent is for anyone to be able to answer the questions without special training. All information that would usually get entered into existing QPWS&P systems must still be entered there (e.g. FLAME for fire and pests, and WildNet for bird surveys), with a short note in Island Watch referring to the system entry for additional details. More detailed information is thus able to be retrieved later, from the other QPWS&P systems, if needed. It is not intended for the Island Watch tool to replace any existing systems or databases used by QPWS&P staff.

For the CSMP trip, the Island Watch tool was completed in paper format, as the Field Reporting Software application is preloaded for use on QPWS-managed islands only.

Results

A summary of results is presented in Table 3.1.

Table 3.1 Island Watch information for the five vegetated cays.

Island Watch Category	Information for cays					
	NEH	SWH	SWC	Chilcott	SEM	NWM
Bird surveys						
Full bird survey on foot by Andrew McDougall, complemented by drone imagery	yes	yes	yes	yes	yes	yes
Any new or unusual sightings, or are there any changes to the condition of the nesting/roosting habitat?	no	no	no	no	no	no
Turtles						
Nesting turtle survey by Ian Bell	yes	yes	yes	yes	yes	yes
Flipper tagging of nesting green turtles	yes	yes	yes	yes	yes	yes
Satellite tagging	Yes	no	yes	no	Yes	no
Any new or unusual sightings, or are there any changes to the condition of the nesting habitat?	no	no	no	no	no	no
Crocodiles						
Crocodile sightings and other observations	nil	nil	nil	nil	nil	nil
Is this a new or unusual sighting, change in abundance, or any cause for safety concerns?	no	no	no	no	no	no

Table 3.1 cont.

Island Watch Category	**Information for cays**					
	NEH	SWH	SWC	Chilcott	SEM	NWM
Weeds						
Does the island appear weed-free?	yes	yes	yes	yes	yes	yes
Species observed and brief description.	Thoroughly traversed, no weeds detected	Thoroughly traversed, no weeds detected	Thoroughly traversed, no weeds detected	Thoroughly traversed, no weeds detected	Thoroughly traversed, no weeds detected	Unvegetated except for a single coconut palm, about 60cm tall.
Any new weeds for this site, or has the previous extent changed (bigger or smaller)?	no	no	no	no	no	no
Likely risk of future weed invasion?	Low if visitation level remains low, and recommended hygiene is practised.	Low if visitation level remains low and recommended hygiene is practised.	Low if visitation level remains low and recommended hygiene is practised.	Low if visitation level remains low and recommended hygiene is practised.	Low if visitation level remains low, and recommended hygiene is practised.	Low if visitation level remains low and recommended hygiene is practised.
Future actions needed.	Prevention (biosecurity) formalised. Many weeds on Willis Island.	Prevention (biosecurity) formalised. Many weeds on Willis Island.	Prevention (biosecurity) formalised. Many weeds on Willis Island.	Prevention (biosecurity) formalised. Many weeds on Willis Island.	Prevention (biosecurity) formalised. Many weeds on Willis Island.	Prevention (biosecurity) formalised. Many weeds on Willis Island.
Wildfire						
Signs of wildfire?	No	No	No	No	No	No
Is management action required – mitigation, especially for seabird and turtle habitat?	No	No	No	No	No	No

Table 3.1 cont.

Island Watch Category	Information for cays					
	NEH	SWH	SWC	Chilcott	SEM	NWM
Pest animals						
Any signs of pest animals? Includes invertebrates.	yes	yes	yes	yes	yes	no
Species observed and brief description.	*Pulvinaria* scale on *Pisonia*. No rodent signs. Tramp ants - *Tetramorium bicarinatum, Cardiocondyla* sp. and a single possible *Nylanderia bourbonica.*	Tramp ant - *Monomorium pharaonis*. No rodent signs.	Tramp ant - *Monomorium pharaonis*. No rodent signs. Rats were eradicated in 1996	Tramp ant - *Monomorium pharaonis*. No rodent signs.	No *Pulvinaria* scale on *Pisonia* – free since 2002. Tramp ant - *Monomorium pharaonis*. No rodent signs.	No rodent signs, no ants detected.
Pest monitoring or control work done?	Ant and scale survey. Rodent ink tunnels placed out overnight	Ant survey, invertebrate survey with light trap	Ant survey. Rodent ink tunnels placed out overnight	Ant survey. Rodent ink tunnels	Ant survey. Rodent ink tunnels placed out overnight	Ant survey. Rodent ink tunnels
Any new pest animals for this site, or has the previous extent changed (bigger or smaller)?	*Pulvinaria* scale and *Tetramorium bicarinatum* previously recorded	*Tetramorium bicarinatum*	*Monomorium pharaonis*	*Monomorium pharaonis*	*Monomorium pharaonis*	no
Future actions needed.	Prevention of new pests. Monitor impacts of scale and respond if needed.	Prevention of new pests	Prevention of new pests	Prevention of new pests	Prevention of new pests; be particularly alert for scale and ants of concern.	Pests unlikely to establish in absence of vegetation.

Table 3.1 cont.

Island Watch Category	Information for cays					
	NEH	SWH	SWC	Chilcott	SEM	NWM
Native fauna and flora						
Anything of interest, and changes or concerns?	Vegetation very dry and largely moribund. *Cordia* patches were mostly dead. Occasional small living trees. Abundant shearwater burrows in *Pisonia* forests.	Vegetation very dry and largely moribund. Abundant stands of *Plumbago* which were mostly seasonally senescent.	Vegetation very dry and largely moribund. *Pisonia* was present in the past but disappeared about 1996/97. Stands of *Cordia* appear to be struggling to survive; mostly defoliated. Most are smothered by *Ipomoea* vines. Many *Argusia* shrubs are also smothered by vines in places.	Vegetation very dry and largely moribund. *Cordia* stands struggling but were the healthiest observed on the expedition. Some leaves were present at about knee height and at about 2m height.	Vegetation very dry and largely moribund. Stands of *Cordia* and *Pisonia* were more extensive than anticipated or previously mapped. *Cordia* thickets were seemingly dead until closer inspection revealed a few leaves; one thicket had fairly good foliage.	Unvegetated
Any other risks						
Any other changes or concerns?	Swamping by sand of *Argusia* trees on beach fringe – not unexpected in this dynamic zone. Marine debris noted, but impacts are not well understood.	Swamping by sand of *Argusia* trees on beach fringe – not unexpected in this dynamic zone. Marine debris noted, but impacts are not well understood.	Marine debris noted, but impacts are not well understood.	Marine debris noted, but impacts are not well understood.	Island was apparently heavily impacted by Cyclone Yasi in 2011 and other cyclones since then. Marine debris noted, but impacts are not well understood.	Lots of large items of marine debris trapped amongst the broken rocks on the windward side of the island – appeared to be mostly appliances and equipment from large ships.

Table 3.1 cont.

Island Watch Category	Information for cays					
	NEH	SWH	SWC	Chilcott	SEM	NWM
Cultural values						
Anything observed, anything new or of concern?	No	no	Metal dory stranded in middle of cay	no	no	no
Infrastructure						
Condition of infrastructure, any work required?	Commonwealth island sign in poor condition and buried in bushes.	Commonwealth island sign not readable, covered in guano.	Commonwealth island sign was sun-faded.	Commonwealth island sign was sun-faded.	Sign was not seen.	No sign
Monitoring and collections						
Any other monitoring or surveys undertaken?	Vegetation surveys, mapping and botanical collections, Health Checks – R. Melzer & B. Armstrong, aerial mapping by drone – G. Hemson	Vegetation surveys, mapping and botanical collections, Health Checks – R. Melzer & B. Armstrong, aerial mapping by drone – G. Hemson	Marine debris survey – Parks Australia. Vegetation surveys, mapping and botanical collections, Health Checks – R. Melzer & B. Armstrong, aerial mapping by drone – G. Hemson	Marine debris survey – Parks Australia. Vegetation surveys, mapping and botanical collections, Health Checks – R. Melzer & B. Armstrong, aerial mapping by drone – G. Hemson	Vegetation surveys, mapping and botanical collections, Health Checks – R. Melzer & B. Armstrong, aerial mapping by drone – G. Hemson	Aerial mapping by drone – G. Hemson
By whom and where is information stored?	Botanical specimens lodged with Qld Herbarium, all other information provided to Parks Australia and stored in QPWS systems. Contact person – John Olds.	Botanical specimens lodged with Qld Herbarium, all other information provided to Parks Australia and stored in QPWS systems. Contact person – John Olds.	Botanical specimens lodged with Qld Herbarium, all other information provided to Parks Australia and stored in QPWS systems. Contact person – John Olds.	Botanical specimens lodged with Qld Herbarium, all other information provided to Parks Australia and stored in QPWS systems. Contact person – John Olds.	Botanical specimens lodged with Qld Herbarium, all other information provided to Parks Australia and stored in QPWS systems. Contact person – John Olds.	All information provided to Parks Australia and stored in QPWS systems. Contact person – John Olds.

Island Watch Category	Information for cays					
	NEH	SWH	SWC	Chilcott	SEM	NWM
Areas of island visited						
	Most of the island was traversed and spot – about 14 hours over 2 days.	Whole island was thoroughly traversed – about 6 hours spent on island	Zigzag traverses and spot checks on most of the island traversed – about 6. 5 hours spent on island.	Zigzag traverses and spot checks on most of the island – about 6 hours spent on island.	Whole island crisscrossed – about 11 hours over 3 days spent on island.	Zigzag traverses and spot checks on most of the island – about 3 hours spent on island.

Fig. 3.1 Marine debris on NW Magdelaine island. Refrigeration equipment and similar debris were also observed.

Discussion

Once identifications of other invertebrates are obtained from the Queensland Museum, the pest animal list may be expanded. Other invertebrates collected include hawkmoths and grasshoppers. Refer section 8. 2 for further details.

Marine debris was noted on every island. Ingestion by birds of small plastic debris, and the feeding of it by adult birds to chicks, has been well documented on other Australian islands and is an obvious threat to the health of the seabird populations. Nesting of birds alongside larger pieces of marine debris is also common, most likely because the birds are afforded some shade and protection from wind. Parks Australia has monitored marine debris on the islands for some years, and the data is collated and analysed by Tangaroa Blue.

The Island Watch tool provided a useful snapshot of the condition of the islands, and the work undertaken during the expedition. It is recommended that this tool continues to be used by Parks Australia and researchers to the island to build a database into the future. Little expertise is required, and information can be supplemented by photographs and collections for later identification if required.

Literature cited

Armstrong B. (2017) Island Watch tool: Checking for change. Report prepared for Department of Environment and Science, Queensland Parks and Wildlife Service, Great Barrier Reef & Marine Parks Region, Technical Support, Cairns.

4.0 Drone imagery

Graham Hemson

Introduction

Parks Australia requested high definition maps of the islands we visited. These maps were primarily to provide an accurate record of the vegetation and morphology of the islands at high resolution. The existing imagery available had resolution of between 30cm/pixel to 2m/pixel. We aimed to provide imagery of better than 3cm/pixel for all the vegetated islands visited. These images were used in the development of the vegetation maps (refer section 5.1) and could be used to track changes in vegetation over time.

Methods

We used two DJI drones to acquire imagery of the islands. The first drone deployed was a DJI Phantom 4 Advanced. Unfortunately, this drone crashed while acquiring wide angle video for communication purposes at South West Herald Cay. Subsequently we used a DJI Mavic 2 Pro drone. This drone was much smaller than the Phantom but used a camera with comparable resolution.

Both drones used a 1-inch CMOS sensor although the Phantom 4 Advanced generated slightly lower resolution (ground sampling distance) imagery as its lens was wider (28mm in 35mm equivalent) than the Mavic (24mm in 35mm equivalent). This translates to a difference of 1. 61 cm/pixel for the Phantom and 1. 18 cm/pixel for the Mavic when flown at 50m above ground. The Phantom features a mechanical shutter in its camera which aids in the acquisition of very sharp images. In practice the slightly reduced image quality from the electronic rolling shutter in the Mavic appears to result in equivalent imagery.

Flights were flown at 50m or 60m above ground. Sixty metre altitude flights were used on larger islands where the lower altitudes would have required more batteries than the three available (total safe flight time of approximately an hour) for the Mavic. Flight duration and the space mapped were all calculated using the DroneDeploy app and online service. The areas to be mapped were estimated using Google Earth imagery and DroneDeploy.

Flights were fully automated using DroneDeploy and imagery recorded to high capacity micro SD cards before being transferred to a PC. Flights generally required two battery changes to complete and were recommenced at the image where the flight ceased. Images were planned for 80% side and front flap to ensure large numbers of points for the software to stitch with. These are unusually high values that resulted in extended flight times per unit area but the cost of failed map stitching was extremely high. No differential GPS ground points were used.

All images were uploaded to DroneDeploy on return to the mainland. We used a DroneDeploy Pro licence to create the subsequent imagery, digital surface and digital elevation models.

Where possible two flights were conducted on each island.

Results

Maps of 2cm/pixel or better resolution were created for each vegetated island. These maps generally aligned well with the rectified background imagery from google earth, and with the ground-truthed vegetation points obtained by our team and to known locations such as the shade tent used for storing gear.

An unanticipated benefit of creating two orthomosaics for North East and South West Herald, Chilcott and South Magdelaine were that we were able to overlay these mosaics. When we did, it was apparent that there was a 1-2m difference between mosaics. This in effect means that while the resolution of the imagery is extremely high (2cm) the spatial accuracy is moderate (Fig. 4.1).

Discussion

We produced maps of all the vegetated cays visited. These maps helped to improve the accuracy and detail in the vegetation maps described in section 5. 1 and would have even more so had they been available prior to ground truthing. While resolution was high the spatial accuracy was moderate. This limited accuracy means that there is a limit to how reliable inferences of change in vegetation and morphology are.

The gross morphology of cays will be important when considering whether they may be overtopped by rising sea levels and/or storm surges or whether lenses of fresh water may be inundated with seawater. Capturing fine details of beach morphology will help with understanding the relative value of different beaches and cays to turtle nesting as sea levels rise. Detailed mapping of patches of different vegetation will be useful when determining whether the abundance and distribution of vegetation is changing. With the existing accuracy significant changes will still be clearly visible but inferences will have to be made using easily identified and static features in the landscape such the Hercules boat in Figure 4.2 and rock formations. The only way to improve accuracy is to use differential GPS ground control points as references within the image. To achieve this, future teams would need to bring a differential GPS and either record the location of conspicuous and persistent landscape features and/or deploy highly visible ground control points and record their location. These approaches create reliable reference points for the software to use to anchor the orthomosaic consistently against the real location. At least four such points per hectare is recommended.

One drone was lost during the trip and on several occasions seabirds flying above the island got close enough to the drone to trigger the automated collision avoidance response. While it is likely that a faulty battery was the cause of the drone loss, it is possible that future loss may occur. It is highly recommended that at least two drones are transported on future trips to ensure sufficient contingency and that all suspect components are double checked and retired before use in the CSMP. It is also highly recommended that several SD cards be used, and data downloaded onto a portable drive after each flight to limit wasted time in the event of drone loss.

Fig. 4.1 Examples of the variation in spatial accuracy between orthomosaics. Arrows point to identical features in two orthomosaics of the same location.

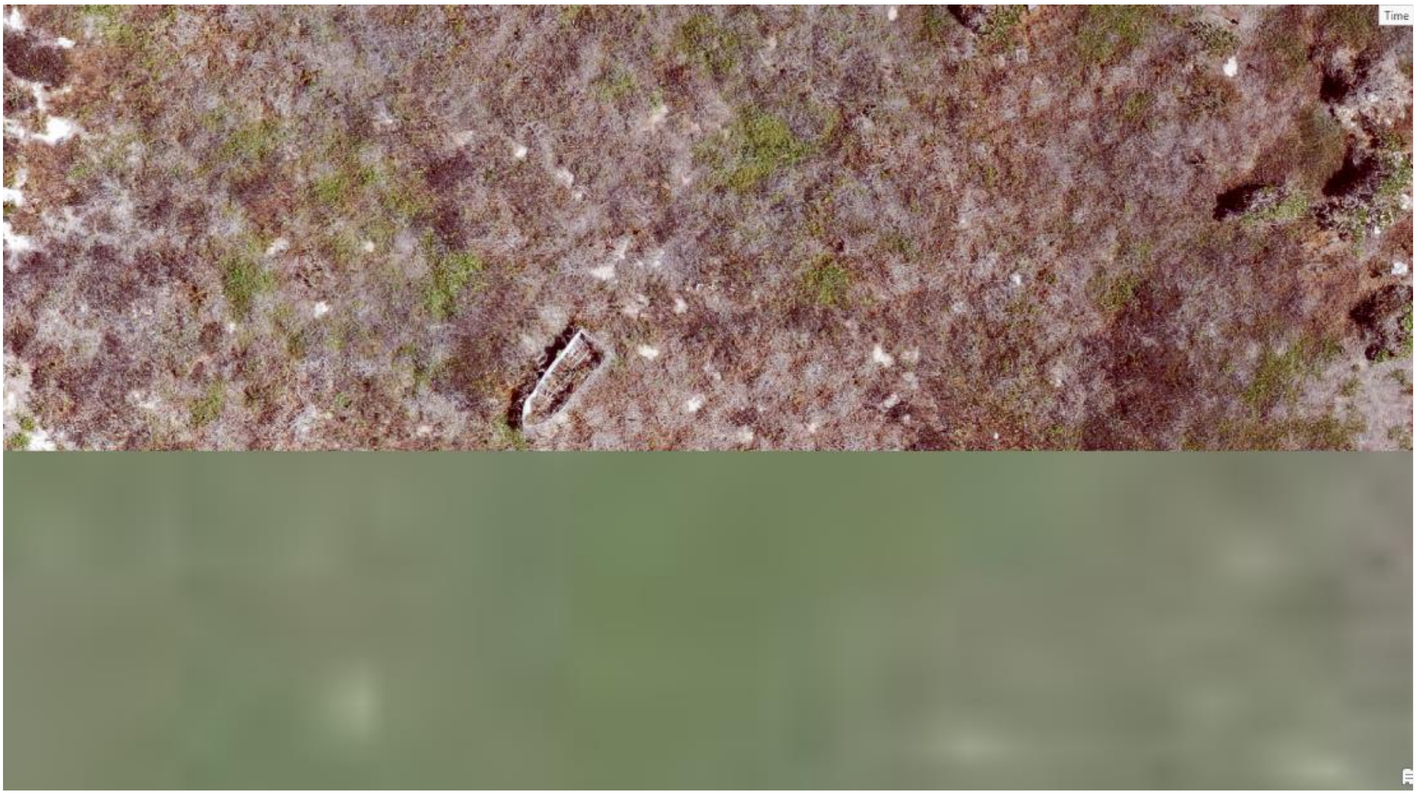

Fig. 4.2 The upper section of the image shows the resolution and detail obtained from the drone on South West Islet and the abandoned aluminium Hercules boat. The lower section shows the typical resolution from global satellite data sets.

5.0 Vegetation

R. Melzer, B. Armstrong and M. Harte

5.1 Vegetation mapping

Introduction

Vegetation mapping of islands in the then Coringa-Herald National Nature Reserve was undertaken by Batianoff *et al.* (2008) as part of surveys conducted from 2006-2007 for the Australian Government Department of the Environment, Water, Heritage and the Arts. A major component of the pilot program reported here was the production of contemporary vegetation maps for the same five islands – NE Herald, SW Herald, SW Coringa, Chilcott and SE Magdelaine.

Conditions were very dry at the time of the current survey (November-December 2019).

Methods

Preliminary map units were delineated, prior to the field trip, using satellite imagery acquired for the purpose by Parks Australia. The imagery was captured by Airbus Defence and Space in September/October 2019. In the absence of recent aerial photographs this imagery was essential to the task and generally proved invaluable. The black and white imagery had a resolution of 30cm pixels for SW Herald, 40cm for NE Herald, SW Coringa and Chilcott, and 50cm pixels for SE Magdelaine. The colour augmented imagery had a resolution of 1m, 1.5 and 2m, respectively.

Ground truthing occurred over one or two days for the smaller and larger islands, respectively. Drone imagery (refer chapter 4) was obtained during the trip but was not available for ground truthing. It was however used to help refine the vegetation maps subsequent to the field trip.

The satellite imagery for SE Magdelaine proved too coarse for accurate detailed mapping, with clear patterns difficult or impossible to discern in parts of the imagery. This resulted in some patterns being missed or inadequately sampled during ground truthing such that they could not be attributed with certainty using the subsequently available drone imagery.

The basic vegetation units used by Batianoff *et al.* (2008) have been adopted in this report, as far as possible, for consistency and to facilitate comparison through time. The structural component of the descriptions follows the 'structural formations of Australia' (Neldner *et al.* 2019). Some *Abutilon and Plumbago* shrublands were less than 1m tall at the time of the survey. These would be defined as dwarf in the structural formations of Australia (Neldner *et al.* 2019). The term dwarf has not been used here however, because the conditions at the time of the survey were very dry and the stands are likely to reach at least 1m under more moderate conditions.

Vegetation map units and descriptions

Map units are listed in Table 5.1. Maps for the five vegetated islands in the CHNNR are provided in Figures 5.1-5.5.

Descriptions for the vegetated units are provided below. An equivalent Regional Ecosystem (RE) code is provided where possible. The RE description (https://apps.des.qld.gov.au/regional-ecosystems/) and status and associated Broad Vegetation Group (Neldner *et al.* 2019) is provided in Appendix 3.

The plant species recorded on each cay during the current trip and those recorded by Batianoff *et al*. 2008 are listed in Appendix 4. Specimens were collected and lodged with Queensland Herbarium where it was possible to obtain suitable material.

There were two species recorded by Batianoff *et al*. 2008 and not found on the current trip –*Colubrina asiatica* (Asian naked wood) and the annual herb *Lepidium englerianum* (beach peppercress). The former was only found, by Batianoff *et al.* (2003), on SE Magdelaine and then rarely. We searched one known location but failed to detect it. Batianoff *et al*. (2008) found *L. englerianum* infrequently on the seaward margins of four of the islands (the exception being South Magdelaine). Its absence during the current survey is not surprising given the dry conditions and the significant turtle activity along shorelines. One species was detected on the current trip but not recorded by Batianoff *et al.* (2008) – *Digitaria bicornis* (lodged with Qld Herbarium), a native species not endemic to Australia and listed as Least Concern in Queensland. It was found on SW Coringa and SE Magdelaine.

Table 5.1 Vegetation map units.

Presence of the map unit on a cay is denoted by an asterisk.

Map units	Occurrence on cays				
	NEH	SWH	SWC	Chil	SEM
Unvegetated units					
Sandy shores	*	*	*	*	*
Lithified shores	*	*	*	*	*
Vegetated units					
Grasslands and herblands:					
Littoral grassland/herbland		*	*	*	*
Lepturus repens open to closed grassland			*	*	*
Sporobolus virginicus open to closed grassland	*	*			*
Boerhavia albiflora herbland			*	*	
Achyranthes aspera herbland		*	*	*	*
***Ipomoea violacea* vineland**		*	*	*	
Shrublands (*Abutilon/Plumbago* dominated):					
Abutilon albescens open shrubland to shrubland	*	*	*	*	*
Abutilon albescens open shrubland to shrubland with emergent dead *Cordia subcordata*	*				
Plumbago zeylanica shrubland to closed shrubland		*	*	*	*
***Argusia argentea* communities:**					
Argusia argentea open shrubland to open scrub	*	*	*	*	*
Argusia argentea tall open shrubland to tall shrubland	*		*	*	*
Argusia argentea open to closed scrub	*				
***Cordia subcordata* communities:**					
Cordia subcordata open shrubland to tall shrubland					*
Cordia subcordata closed shrubland to closed scrub			*	*	*
Patches of fallen dead *Cordia* stems over bare sand	*				
***Pisonia grandis* communities:**					
Pisonia grandis open shrubland to tall shrubland					*
Pisonia grandis closed scrub	*				*
Pisonia grandis wind-sheared closed scrub	*				*
Pisonia grandis closed scrub to low closed forest	*				*

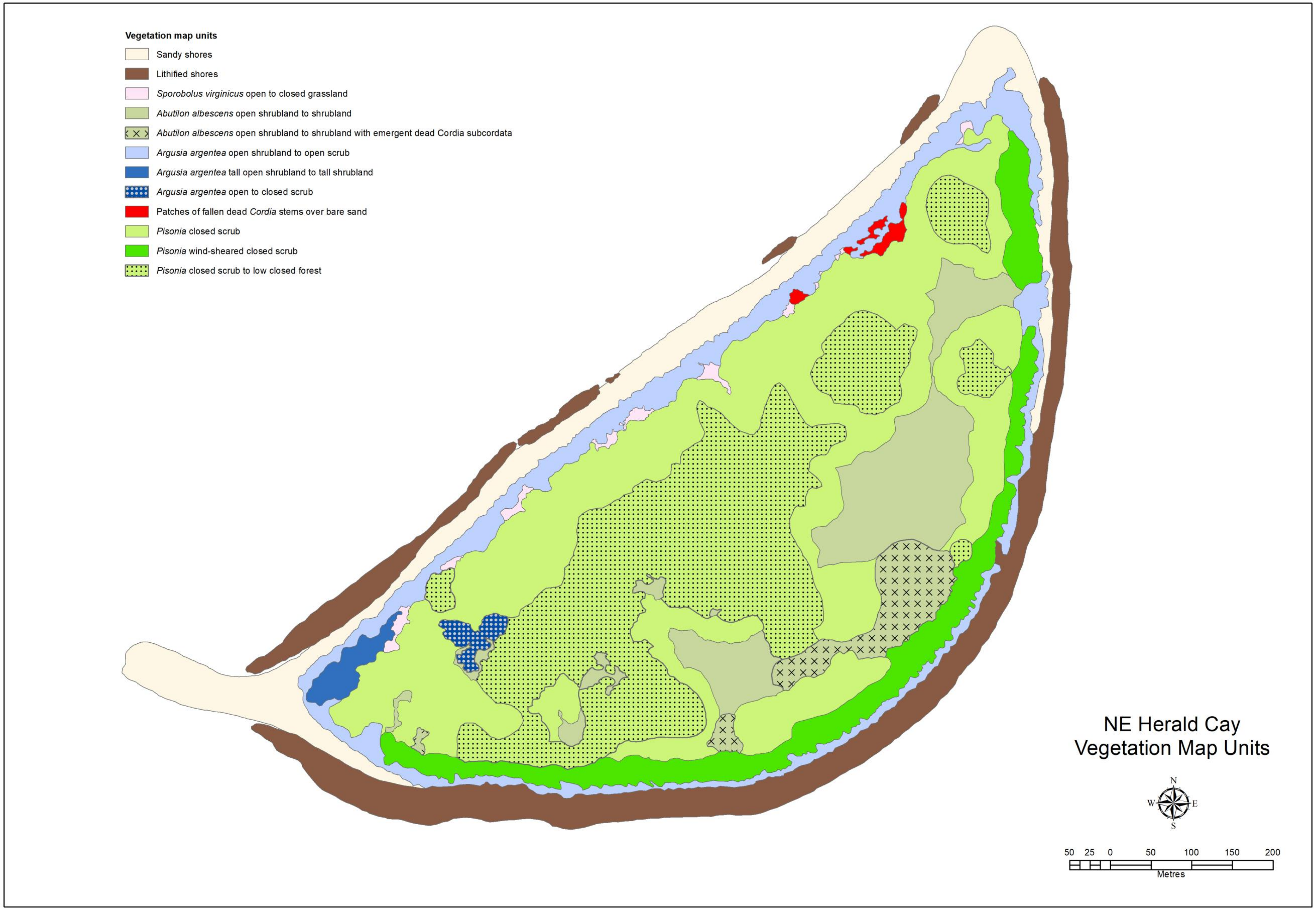

Fig. 5.1 NE Herald vegetation map.

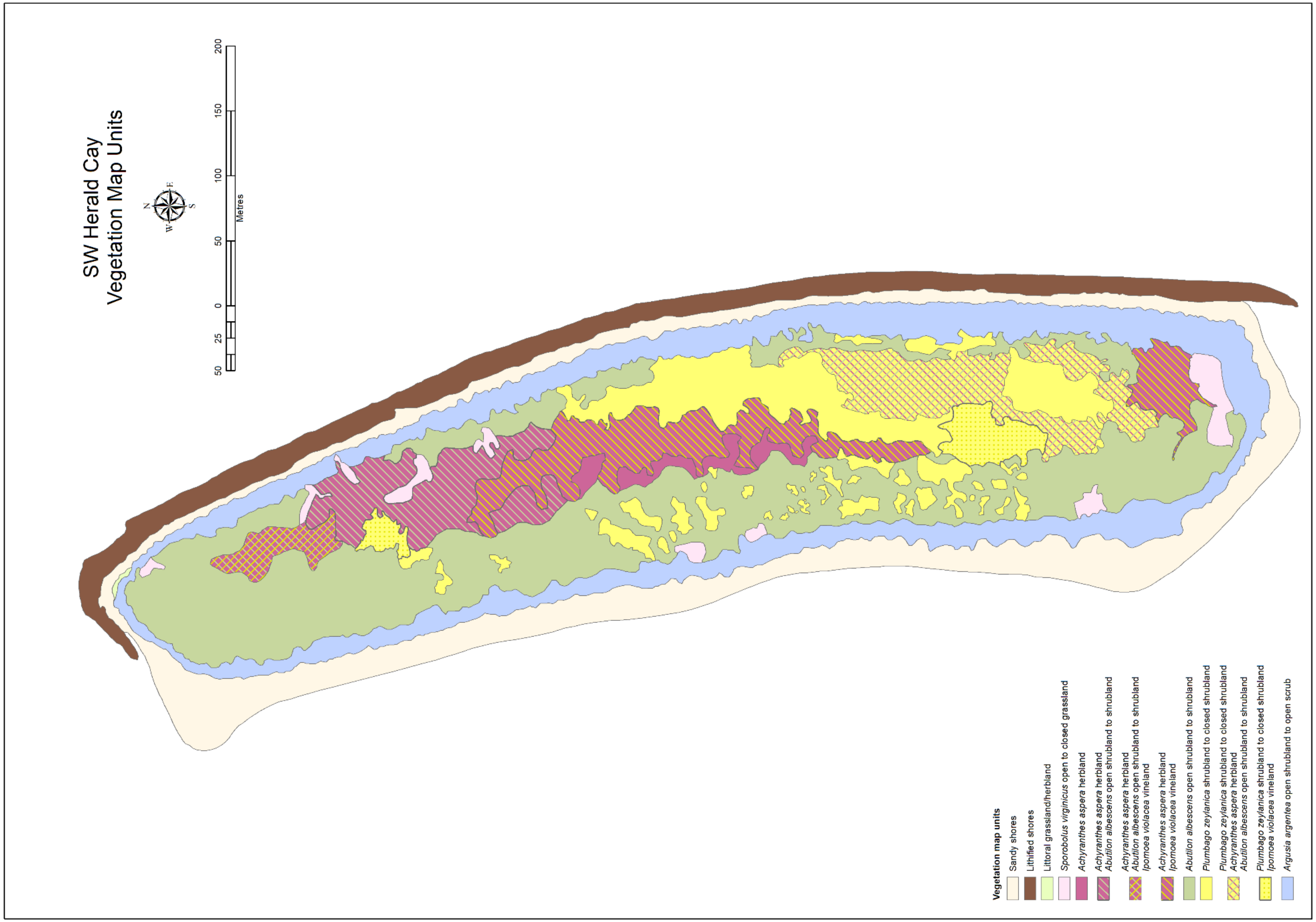

Fig. 5.2 SW Herald vegetation map.

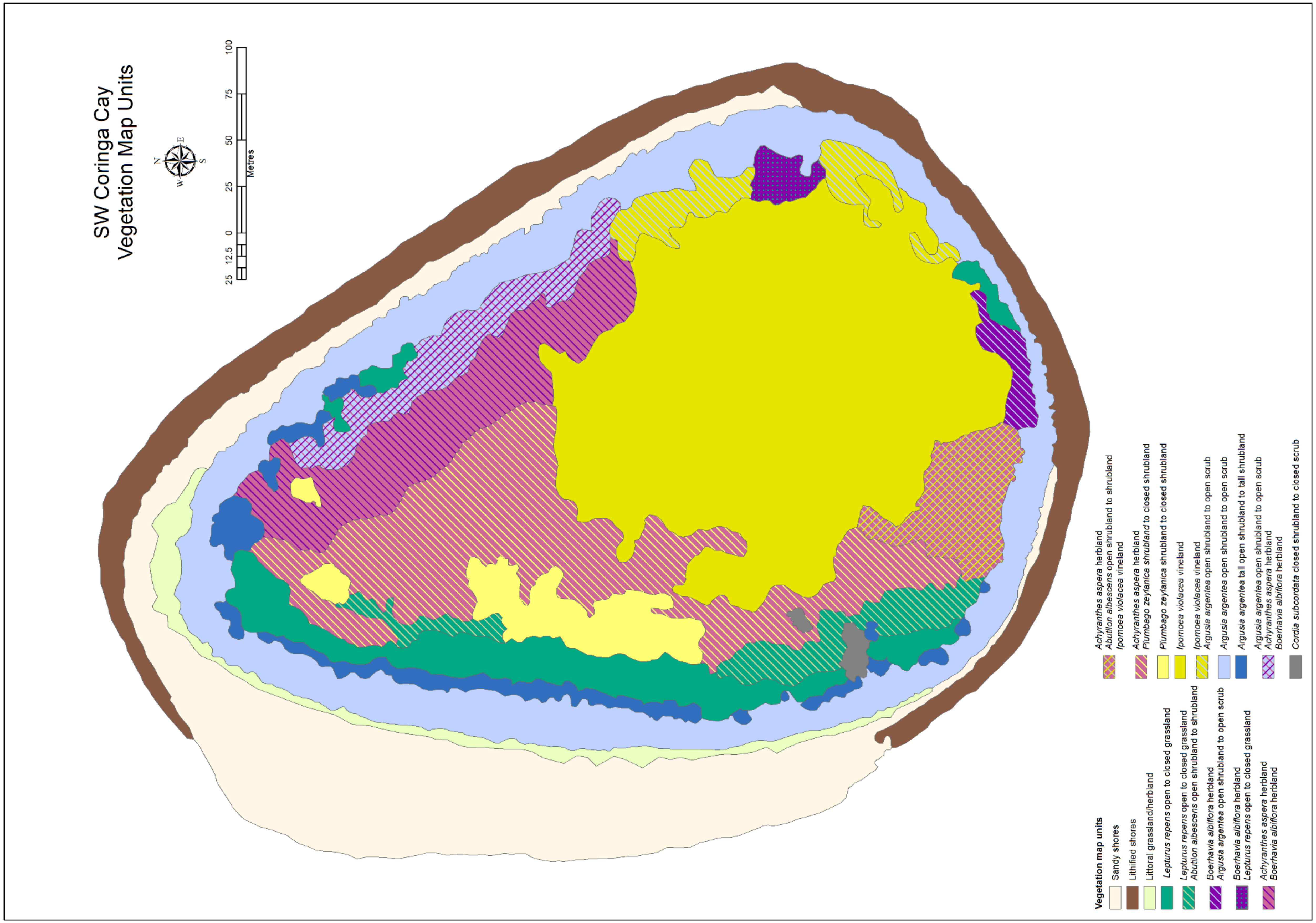

Fig. 5.3 SW Coringa vegetation map.

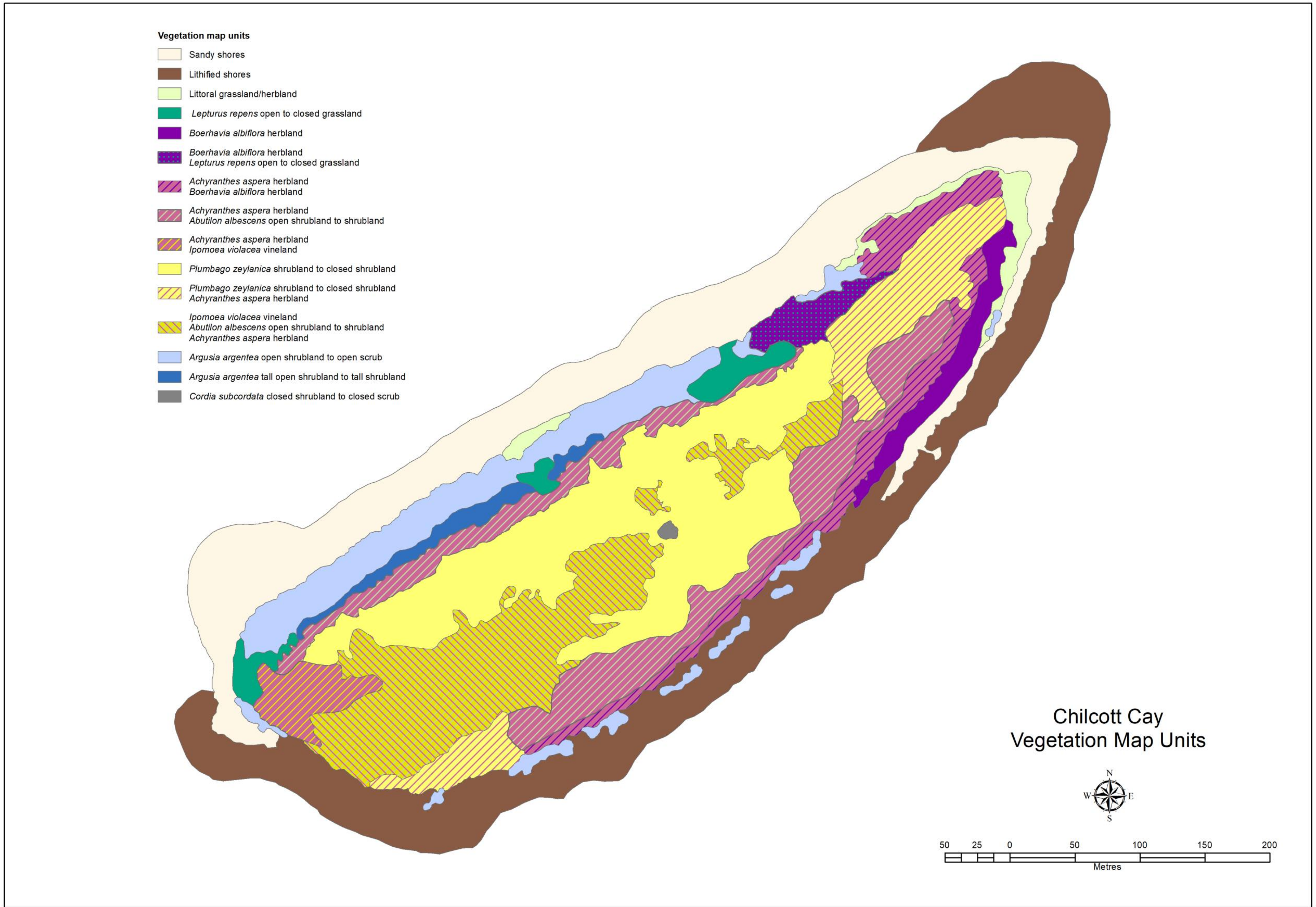

Fig. 5.4 Chilcott vegetation map.

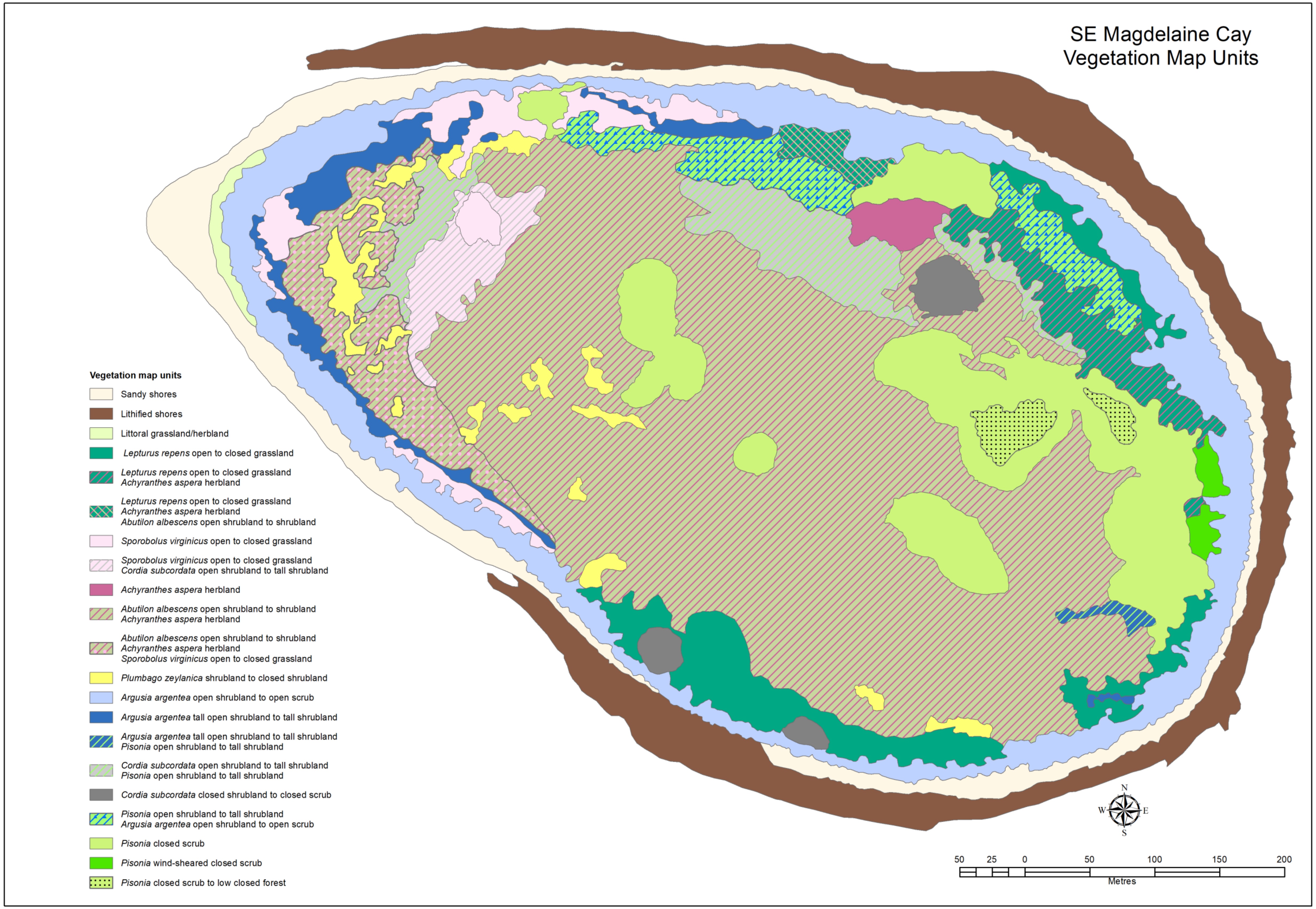

Fig. 5.5 SE Magdelaine vegetation map.

Vegetated Units

Littoral grassland/herbland

(RE 12.2.14g, 12.2.14i)

Plates 5.1, 5.2

These sparse to open grasslands/herblands occurred, on most islands, in small, narrow bands on unconsolidated sands on the seaward margins of other vegetation communities – most often the *Argusia argentea* (octopus bush) communities. *Lepturus repens* (stalky grass) (Plate 5.3) and *Stenotaphrum micranthum* (beach buffalo grass) (Plates 5.4a, b) were the typically occurring species. Scattered juvenile *Argusia argentea* were often present. This ecosystem was absent from NE Herald at the time of the survey although a small patch of juvenile *Argusia* on unconsolidated sands on the northern tip was present – representing a site where the community would typically occur and one where it was mapped by Batianoff *et al.* (2008).

Plate 5.1 Littoral grassland/herbland, Chilcott.

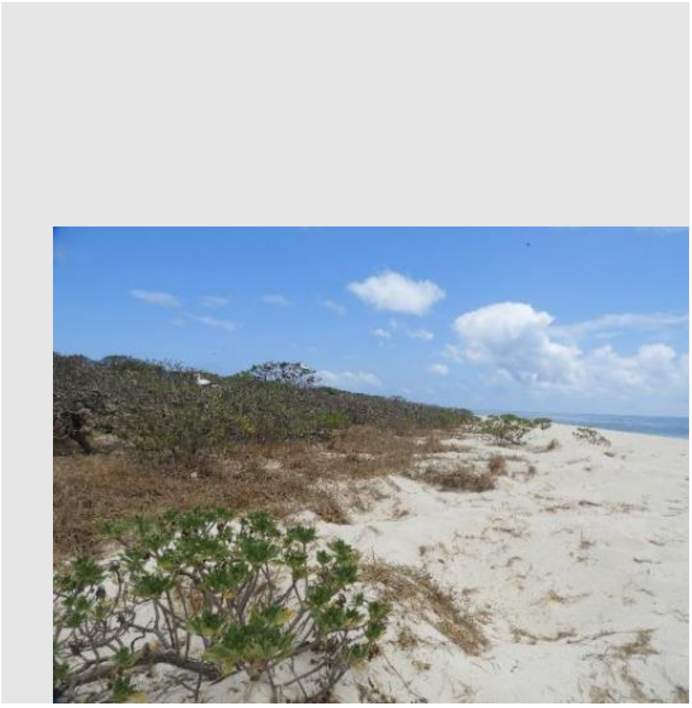

Plate 5.2 Littoral grassland/herbland, SW Coringa.

Plate 5.3 *Lepturus repens* inflorescence. Plates 5.4a, b *Stenotaphrum micranthum,* SE Magdelaine.

Lepturus repens (stalky grass) grasslands

(RE 12.2.17)

Plate 5.5

Lepturus repens open to closed grassland occurred as a unit, and or co-dominant in mixed polygons (e.g. with *Argusia* shrublands), on SW Coringa, Chilcott and South Magdelaine cays and occurred as small, often dense, patches within other units on SW Herald. In places *Lepturus* formed dense, virtually monospecific stands whereas in others *Achyranthes aspera* (chaff flower) and the shrubs *Abutilon albescens* (coastal lantern flower) and *Plumbago zeylanica* (native plumbago) were relatively common including within dense stands of *Lepturus*. The herb, *Boerhavia albiflora* (white-flowered tar vine) was common in places, particularly where the grasslands occurred on the margins of the cays. More open grasslands included *Tribulus cistoides* (beach caltrop, bull's head vine) and *Portulaca oleracea* (common purslane, pigweed) – the latter consisted largely of dead stems at the time of the survey.

Plate 5.5 *Lepturus repens* grassland, SW Coringa.

Sporobolus virginicus **(sand couch) grasslands**

(RE 12.2.14d for frontal areas)

Plate 5.6

Sporobolus open to closed grassland occurred on NE Herald, SW Herald and SE Magdelaine. It was most prevalent on the latter two with dense and in some cases almost monospecific stands. Other herbaceous species such as *Lepturus repens, Boerhavia albiflora, Achyranthes aspera* and *Portulaca oleracea* were sometimes present*. Tribulus cistoides* was sometimes prevalent in particularly sparse patches (e.g. western margin of NE Herald). *Abutilon albescens*, *Argusia argentea* and *Pisonia grandis* occurred as emergent shrubs in places – particularly along seaward margins.

While only small patches appear on the vegetation map for SW Herald there were substantial areas that have been mapped as *Abutilon* shrubland but because of the dry conditions (*Abutilon* mostly evident as dead stems), at the time of the assessment, had the appearance of *Sporobolus* grasslands to closed grasslands.

The boundaries between the *Sporobolus* and *Lepturus* grasslands on the island's margins were not able to be determined with certainty for SE Magdelaine.

Plate 5.6 *Sporobolus virginicus* grassland, SE Magdelaine.

Boerhavia albiflora (white-flowered tar vine) herbland

(RE 12.2.17)

Plate 5.7

The herb, *Boerhavia albiflora* (Plate 5.8) was a common component of many of the vegetation communities on the cays but only formed a mappable vegetation unit on Chilcott and SW Coringa. The *Boerhavia* and other herbaceous species such as *Portulaca oleracea* and *Stenotaphrum micranthum* formed a low, 'ground cover' community, occasionally with *Achyranthes aspera, Abutilon albescens* and *Ipomoea violacea* (coastal moonflower) as emergents. *Lepturus repens* and *Tribulus cistoides* were sometimes present – the latter particularly in more open patches within the herblands.

Plate 5.7 *Boerhavia albiflora* herbland, Chilcott.

Plate 5.8 *Boerhavia albiflora*, SW Herald.

Achyranthes aspera **(chaff flower) herbland**

Plate 5.6

These herblands to closed herblands were present on most of the islands – the exception being NE Herald. They occurred as monospecific patches of *Achyranthes* on South Magdelaine to, more usually, mixed with species such as *Abutilon albescens*, *Boerhavia albiflora* and *B. mutabilis* (pink-flowered tar vine), *Portulaca oleracea, Sporobolus virginicus*, *Ipomoea violacea* and/or *Tribulus cistoides*. *Lepturus repens* was sometimes abundant. At the time of the survey the *Achyranthes* largely consisted of dead or dry stems, sometimes with resprouts.

Complexes (mapped as mixed polygons) consisting of patches of *Achyranthes* herbland, *Abutilon* shrubland, *Boerhavia* herbland, *Plumbago* shrubland and/or *Ipomoea* viny-herbland were common, particularly on SW Herald, Chilcott and SW Coringa.

Plate 5.6 *Achyranthes aspera* herbland, SE Magdelaine.

***Ipomoea violacea* vineland**

Plate 5.7

Ipomoea violacea (Plate 5.8a, b) was scattered through a range of the vegetation communities including *Achyranthes* herbland and *Abutilon* shrubland but in places dominated large enough patches to be mapped in its own right or included as a co-dominant in a mixed polygon. The largest single patch (approximately 3.7ha) occurred on SW Coringa. This patch was effectively a closed vineland and, at the time of the survey, appeared to be a monoculture of *Ipomoea* across most of the patch. It occupied some areas previously mapped as *Abutilon* shrubland, *Achyranthes* mixed herbland-*Abutilon* shrubland, and *Achyranthes* mixed herbland-*Boerhavia* herbland (Batianoff *et al.* 2008). *Ipomoea* was overtopping individual *Argusia* shrubs/trees in parts of SW Coringa (units have been mapped as *Ipomoea* vineland/ *Argusia* shrubland), and *Cordia* and *Pisonia* on SE Magdelaine.

Plate 5.7 *Ipomoea violacea* vineland, SW Coringa.

Plate 5.8a *Ipomoea violacea*, SW Coringa.

Plate 5.8b *Ipomoea violacea* fruit, SW Herald.

Abutilon albescens (coastal lantern flower) communities

(RE 12.2.18c)

- *Abutilon albescens* open shrubland to shrubland
- *Abutilon albescens* open shrubland to shrubland with emergent dead *Cordia subcordata*

Abutilon albescens open shrubland to shrubland

Plate 5.9

These shrublands occurred on all the islands either as a unit (e.g. the 'glades' on NE Herald and patches on SE Magdelaine, although the latter could not be consistently/accurately delineated from *Achyranthes* herblands with available imagery) or co-dominant in mixed polygons. In places (e.g. SW Herald and parts of NE Herald) the *Abutilon* consisted of dead or dry stems, with scattered leaves enabling confirmation of identification.

The 'glades' (as referenced by Batianoff *et al.* 2008) on NE Herald, are expansive, virtually monospecific (scattered *Boerhavia mutabilis* and *Ipomoea violacea* were present in places) shrublands, and an obvious 'feature' on imagery with *Abutilon* from approximately 1-1.4m in height. Batianoff *et al.* (2008) mapped two patches of Abutilon open-heath with emergent Pisonia. One of these appears to have been overgrown by *Pisonia* and the other substantially so – the remaining area has been mapped here as *Abutilon* open shrubland to shrubland.

On islands other than NE Herald, species such as *Achyranthes aspera, Boerhavia albiflora, Ipomoea violacea, Tribulus cistoides, Sporobolus virginicus* and *Lepturus repens* were variously present.

Plate 5.9 *Abutilon albescens* shrubland – one of the 'glades' on NE Herald.

Abutilon albescens open shrubland to shrubland with emergent dead *Cordia subcordata*

Areas mapped by Batianoff *et al.* (2008), on the south, south-east side of NE Herald as *Cordia* closed scrub to low closed forest appeared to be dead, albeit with an occasional individual shrub with leaves. These areas are now *Abutilon* shrublands with Abutilon up to 2m in places. At the time of their survey in 2006-2007, Batianoff *et al.* (2008) noted that up to 50% of Cordia stands on NE Herald showed symptoms of dieback. Patches mapped as *Cordia* on the western side of NE Herald are now bare sand between *Argusia* and *Pisonia,* and evident only from fallen dead *Cordia* stems and one live plant, 2.2m tall.

Plumbago zeylanica (native plumbago) **shrubland to closed shrubland**

(RE 12.2.18b)

Plate 5.10

The *Plumbago* shrublands were present on most islands, the exception being NE Herald. They were most prominent on Chilcott forming dense stands from approximately 0.8-1.0m in height. Other species often occurred within the shrublands including *Abutilon albescens, Achyranthes aspera, Boerhavia* spp., *Ipomoea violacea, Lepturus repens* and *Tribulus cistoides*. *Plumbago* consisted of mostly leafless, dead-looking, stems at the time of the survey and appeared as deep purple patches on drone imagery obtained during the current survey.

Mixed polygons including *Plumbago* shrubland as a co-dominant community, most commonly with *Achyranthes* herbland, were prevalent on Chilcott, SW Herald and SW Coringa.

Plate 5.10 *Plumbago zeylanica* shrubland, SW Herald.

Plates 5.11, 5.12 A ‘rare’ (for the time of the survey) green *Plumbago zeylanica* and flowers, SW Coringa.

Argusia argentea **(octopus bush) communities**

(RE 12.2.19)

- *Argusia* open shrubland to open scrub
- *Argusia* tall open shrubland to tall shrubland
- *Argusia* open to closed scrub

Argusia **open shrubland to open scrub**

Plates 5.13-5.16

The community formed a narrow, sometimes broken, band of *Argusia* shrubs/low trees, typically 1-1.5m in height and rarely reaching 2m, around the perimeter of the cays. Along the lithified shores the *Argusia* shrubs were often growing amongst piles of jumbled beach rock (Plate 5.14) and had little or no understory. In contrast the *Argusia* communities along the sandy shores (Plate 5.15) often had an open to closed ground stratum dominated by *Sporobolus virginicus* (e.g. NE Herald, SW Herald, SE Magdelaine) or *Lepturus repens* (e.g. SW Coringa, Chilcott, SE Magdelaine). Other species sometimes present included *Boerhavia albiflora, Abutilon albescens, Achyranthes aspera* and *Portulaca oleracea*.

The *Argusia* shrubland on the southern tip of SW Herald was suffering dieback (refer section 5.3) at the time of the survey perhaps as a consequence of the combined effects of the very dry conditions, exposure and sand accretion. Sand build up around the shrubs was substantial (Plate 5.16).

Plate 5.13 Argusia argentea shrubland SE Magdelaine.

Plate 5.14 *Argusia* shrubland on lithified shore.

Plate 5.15 *Argusia* shrubland on sandy shore, NE Herald.

Plate 5.16 Dieback, southern tip, SW Herald.

Patches of *Argusia* in the south-west corner of SW Coringa were being overtopped by *Ipomoea violacea.* They have been mapped as *Ipomoea* vineland/ *Argusia* shrubland. It seems likely that the *Argusia* will eventually disappear from these patches (Plate 5.17).

Plate 5.17 *Argusia* being overtopped by *Ipomoea violacea*, SW Coringa.

***Argusia* tall open shrubland to closed scrub**

Plate 5.18

The community typically formed a very narrow band (sometimes a single line of trees) or small open patches of *Argusia*, inland of the *Argusia* shrubland to open scrub. It was distinguished from the latter in being slightly taller (2-3.5m).

Plate 5.18 *Argusia* tall open shrubland, SE Magdelaine.

***Argusia* open to closed scrub**

A small patch of *Argusia* open to closed scrub, together with *Abutilon* open shrubland, occurred in the interior of NE Herald surrounded by *Pisonia* ecosystems, indicating the location of a previous shoreline. The *Argusia* was approximately 2m in height with a ground stratum of bare sand and leaf litter.

***Pisonia grandis* (*Pisonia*) communities**

(RE 12.2.21)

- *Pisonia* open shrubland to shrubland
- *Pisonia* closed scrub
- *Pisonia* wind-sheared closed scrub
- *Pisonia* closed scrub to low closed forest

Pisonia communities are currently found on NE Herald and SE Magdelaine. Prior to a scale outbreak in the late 1990s *Pisonia* occupied most of the interior of SW Coringa (Hicks 1985). However, it was absent by the time Batianoff *et al.* (2008) undertook their field assessments in the mid-2000s. There was no evidence, in the current survey, that it had ever been present on SW Coringa.

***Pisonia* open shrubland to tall shrubland**

Plate 5.19

Narrow strips of this ecosystem occurred on the northern perimeter of SE Magdelaine inland of *Argusia* and grassland communities. Some of these areas were previously mapped as *Pisonia* closed scrub to low closed forest (Batianoff *et al.* 2008). *Argusia* and *Cordia* were sometimes present. Ground stratum species included *Achyranthes aspera, Abutilon albescens* and *Lepturus repens*. Fallen logs and branches were evident in places, as shown in Plate 5.19.

Plate 5.19 *Pisonia grandis* open shrubland, SE Magdelaine.

***Pisonia* closed scrub**

Plate 5.20 – 5.22

These monospecific stands varied in height from approximately 2-5m, had multi-stemmed or slender stemmed individuals, and, other than on their margins or in canopy gaps, had no ground cover species. They had a marked rounded or domed appearance where they adjoined lower and/or more open communities such as the large patches ('glades') of *Abutilon* shrubland on NE Herald (Plate 5.22). Litter cover was frequently sparse or absent in many of these communities because of the activity of wedge-tailed shearwaters (Plate 5.21).

These stands generally occupied areas mapped by Batianoff *et al.* (2008) as *Pisonia* closed scrub to low closed forest, reflecting the impacts of insect attach and Cyclone Yasi and subsequent recovery.

Plate 5.20 *Pisonia grandis* closed scrub, NE Herald.

Plate 5.21 *Pisonia grandis* closed scrub, NE Herald.

Plate 5.22 'Domed' edge of *Pisonia grandis* closed scrub adjoining an *Abutilon* 'glade' on NE Herald.

***Pisonia* wind-sheared closed scrub**

Plate 5.23, 5.24

The wind-sheared closed scrubs are simply the exposed margins of *Pisonia* patches on the eastern and southern side of NE Herald and eastern side of SE Magdelaine. On these exposed, seaward margins the ecosystem graded up from a height of about 1m to often no taller than 2.5m but occasionally up to 4m. The *Pisonia* communities 'sheltered' behind the wind-sheared scrubs have been mapped separately. They are described above (*Pisonia* closed scrub) and below (*Pisonia* closed scrub to low closed forest).

The wind-sheared scrubs were monospecific, consisting of multi-stemmed shrubs of small diameter. Ground cover species were rare or absent.


Plate 5.23 and 5.24 *Pisonia* wind-sheared closed scrub, NE Herald.

***Pisonia* closed scrub to low closed forest**

Plates 5.25-5.27

These monospecific communities are similar to the *Pisonia* closed scrubs but include a mix of slender single or multi-stemmed individuals and larger (typically also multi-stemmed) individuals, and are taller (5-8m) on average.

They generally occurred in areas mapped by Batianoff *et al.* (2008) as *Pisonia* old-growth open to closed forest, reflecting the impacts of Cyclone Yasi and subsequent recovery. Dead tops of *Pisonia* trees were emergent (in places on SE Magdelaine (Plate 5.25) – epicormic regrowth was often evident lower down these stems.

Ground cover species were absent except on their margins or in canopy gaps. Litter cover was frequently sparse or absent in many of the communities because of the activity of wedge-tailed shearwaters (Plate 5.26). An exception was an area on the northern end of NE Herald where a BioCondition site (refer Section 5.2) was established (Plate 5.27) – here there was litter to a depth of 3.5cm over greater than 70% of the ground surface.

Plate 5.25 *Pisonia grandis* closed scrub to low closed forest, SE Magdelaine.

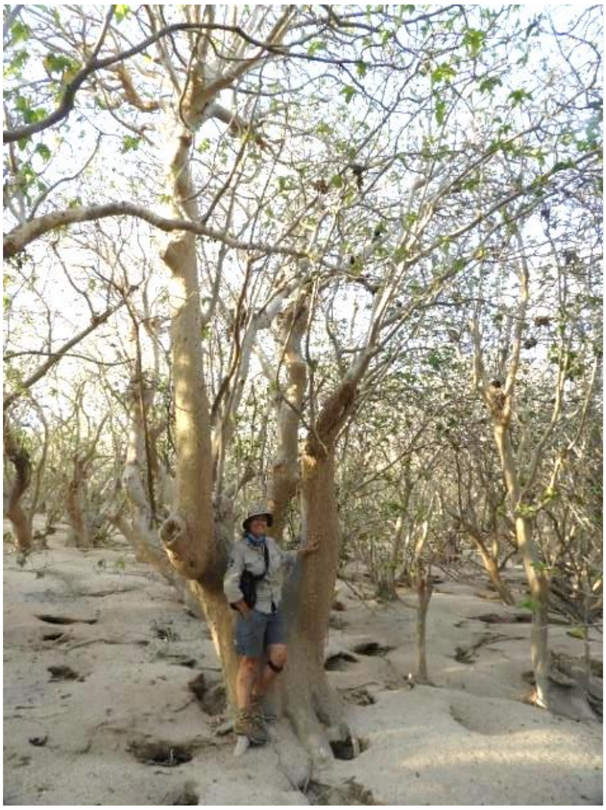

Plate 5.26 *Pisonia* closed scrub to low closed forest NE Herald.

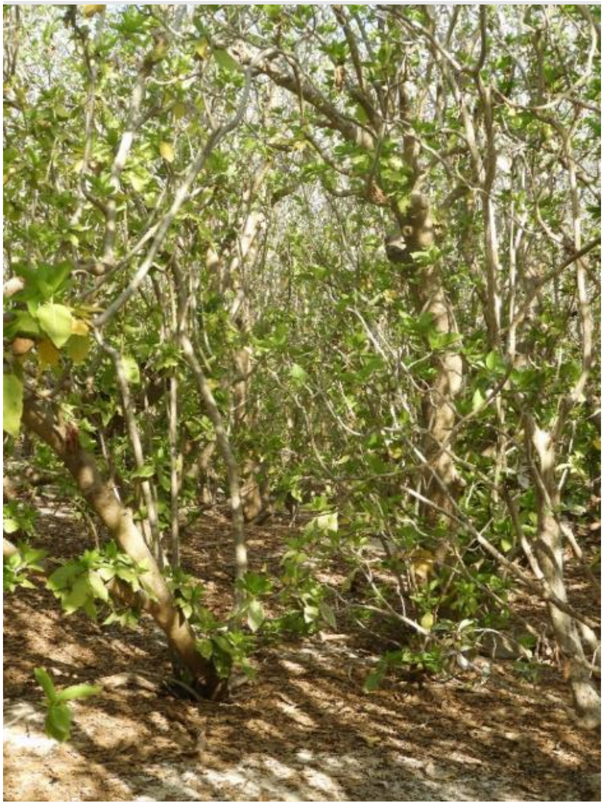

Plate 5.27 *Pisonia* closed scrub to low closed forest a BioCondition site NEH02, NE Herald.

Cordia subcordata **(sea trumpet) communities**

- *Cordia* open shrubland to tall shrubland
- *Cordia* closed shrubland to closed scrub

Cordia communities were recorded on SE Magdelaine, SW Coringa and Chilcott – although these were effectively just small clumps on the latter two cays. As noted earlier, areas mapped by Batianoff *et al.* (2008), on the south and south-east side of NE Herald as *Cordia* closed scrub to low closed forest appeared to be dead, albeit with an occasional individual shrub with leaves. These areas are now *Abutilon* shrublands with Abutilon up to 2m in places. At the time of their survey in 2006-2007, Batianoff *et al.* (2008) noted that up to 50% of *Cordia* stands on NE Herald showed symptoms of dieback. All extant stands of *Cordia* were suffering significant dieback during the current survey. Refer section 8.2 for discussion on likely causes.

Ipomoea violacea was growing into and over the *Cordia* shrublands and closed scrubs in places on SW Coringa and SE Magdelaine.

Some patches mapped as *Cordia* on NE Herald by Batianoff *et al.* (2008) are evident only from fallen dead stems in between *Argusia* and *Pisonia*. These are mapped in red. One live plant (2.2m tall) was noted in one such patch on the western side of NE Herald.

 

Plates 5.28 and 5.29 *Cordia subcordata* flower and fruit, SE Magdelaine.

Cordia **open shrubland to tall shrubland**

These shrubland occurred on SE Magdelaine with Cordia shrubs reaching 2.5m tall. There was a dense ground stratum of *Achyranthes aspera* and *Lepturus repens* with occasional clumps of *Plumbago zeylanica*.

Cordia **closed shrubland to closed scrub**

Plates 5.30, 5.31

Two small patches of dense, slender stems, 2-2.5m in height, were located on SW Coringa and one on Chilcott (Plate 5.30). Three of sufficient size to map were located on SE Magdelaine. These were 3-4m in height with many small stems but also some larger, dead and fallen stems (Plate 5.31). All patches were completely leafless, or nearly so, at the time of the survey.

Species present in the ground stratum included *Abutilon albescens, Achyranthes aspera, Lepturus repens* and *Sporobolus virginicus*. These were sometimes limited to the perimeter of the clump with the centre having little or no ground stratum but a cover of leaf litter. However, ground cover in the clumps on the margins of SE Magdelaine, where old dead and fallen stems were prevalent, was dense and dominated by *Sporobolus virginicus* and *Lepturus repens.*

Plate 5.30 Patch of *Cordia subcordata* on Chilcott.

Plate 5.31 Patch of *Cordia*, SE Magdelaine; live plants were present in this patch.

5. 2 Vegetation monitoring – BioCondition

Introduction

Quantitative BioCondition (Box 5.1) monitoring (Eyre *et al.* 2015) programs were initiated on the trip.

Given time constraints, BioCondition monitoring was limited to the *Pisonia* communities – these being significant in terms of their: limited occurrence world-wide; limited protection outside of Australia; importance in the stabilisation of soils and associated provision of suitable substrate for nesting wedge-tailed shearwaters; and provision of habitat for tree nesting species. The intention had been to establish quantitative monitoring in *Cordia* communities also. The idea was abandoned given the very small size of the remaining patches and time constraints.

Box 5.1

BioCondition is a site-based, quantitative, repeatable, condition assessment methodology that provides a measure (expressed as a BioCondition score between 0 and maximum of 1 and BioCondition Class of 1, 2, 3 or 4 – one being the best) of how well a terrestrial ecosystem is functioning for biodiversity values. A suite of attributes (e.g. tree canopy cover, coarse woody debris, native plant species richness, litter cover) are assessed at a site and evaluated against benchmarks for those attributes. The benchmarks for attributes are derived from *a reference state* for the regional ecosystem – the latter being the natural variability in attributes of an ecosystem relatively unmodified since the time of European settlement (Eyre *et al.* 2015).

Whilst the Coral Sea islands do not occur within a Bioregion of Queensland and have no regional ecosystem mapping it was considered reasonable to use the equivalent regional ecosystems on the Capricornia Cays (J. Neldner pers. comm.). The Queensland Herbarium used the data collected from the three BioCondition reference sites established on this trip (refer below) and 18 Queensland Herbarium CORVEG sites (Neldner *et al.* 2019) in the Capricornia Cays to derive a *reference state* for RE 12.2.21b – *Pisonia grandis* closed forest.

The BioCondition Assessment Manual (Eyre *et al.* 2015) is available in full at https://www.qld.gov.au/__data/assets/pdf_file/0029/68726/biocondition-assessment-manual. pdf

Methods

Full reference sites (i.e. standard BioCondition methodology plus additional attributes to facilitate the development of a reference state) were undertaken. Plot sizes were reduced from the standard (John Neldner, Qld Herbarium, was consulted prior to the trip in the expectation that this would be necessary) given limited area within a vegetation structural type and, in particular, to minimise impact on wedge-tailed shearwater burrows. The latter were dense and contained chicks at the time of the survey.

Two sites were established on NE Herald (NEH01, NEH02) (Fig. 5.6), and one on SE Magdelaine (SEM01) in *Pisonia* closed scrub to low closed forest (Fig. 5.7).

Standard site data (e.g. landform element, slope, soil type, disturbance) was recorded at each site together with the attributes described below. Photographs were taken, north, south, east and west, from the start of each transect using the ContextCam app. A copy of the data sheets is provided in Appendix 5.

Overstorey/woody strata

Woody cover – the cover for individual tree and shrub species, by stratum, determined by line intercept along a 50m transect in NEH01 and NEH02, and a 30m transect in SEM01.

Basal area (m^2/ha) – determined from one Bitterlich sweep (Grosenbaugh 1952, Loetsch *et al.* 1973) undertaken at the halfway point along the transect.

Tree count (plus range & mean height) – Number of individuals per species (by stratum) in 50x10m plot in NEH01 and NEH02, and a 30x10m plot in SEM01. Number of individual stems (>10cm girth at breast height) were also counted in the plots.

Shrub count (+ range & mean height) – Number of individuals per species (by stratum) in 50x10m plot in NEH01 and NEH02, and a 30x10m plot in SEM01. Number of stems were also counted in NEH01 and NEH02.

Diameter of large trees –The diameter of all trees with a diameter at breast height (DBH) > 20cm in 50x10m plot in NEH01 and NEH02, and a 30x10m plot in SEM01.

Recruitment – proportion of woody perennials in the ecologically dominant layer that have recruits (i.e. individuals with DBH<5cm).

Species list – all species present in 50x10m plot at NEH01 and NEH02, and in the 30x10m plot at SEM01.

Ground stratum

Ground cover of species and species types – determined from 10 plots (1x1m) along the 50m transects in the NE Herald sites and from five plots (1x1m) along the 30m transect in the SE Magdelaine site, using the method of Daubenmire (1959).

Ground cover (e.g. bare ground, rock, litter, cryptophyte) – as above.

Litter depth – average from a measure in at least five quadrats.

Herbaceous species list – all species present in 50x10m plot at NEH01 and NEH02, and in the 30x10m plot at SEM01.

Course woody debris – length of all woody debris >10cm in diameter and >/= 0.5m long and >80% in contact with the ground in a 50x20m plot at NEH01 and NEH02, and in a 30x10m plot at SEM01.

Non-native plant cover (all strata) – Visual assessment across entire 50x10m plot.

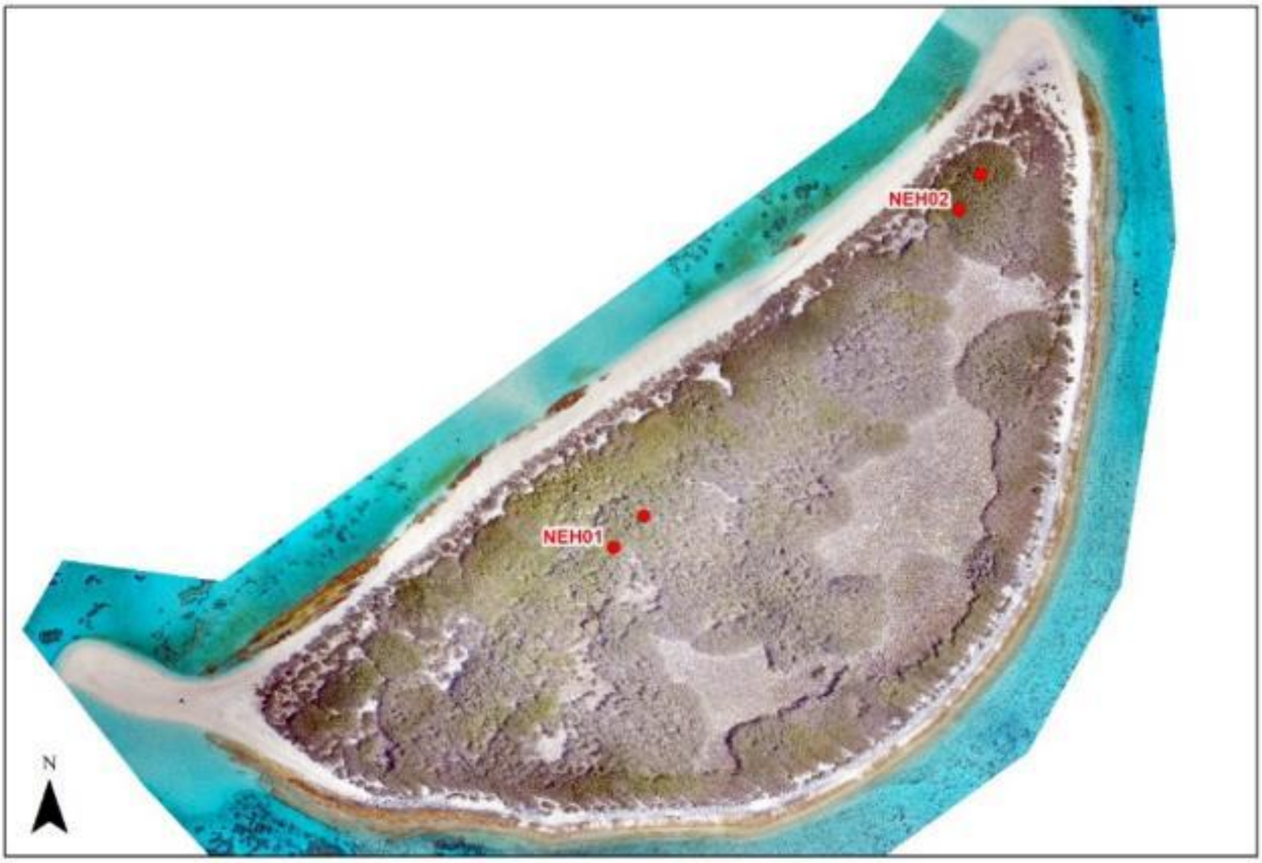

Fig. 5.6 Location of BioCondition sites NEH01 and NEH02 on NE Herald. Red dots denote the start and end of the transect.

Fig. 5.7 Location of BioCondition site SEM01 on SE Magdelaine. Red dots denote the start and end of the transect.

Results

The BioCondition scores for sites NEH01, NEH02 and SEM01 were 0.95, 0.86 and 0.92, respectively. As such all sites are within BioCondition Class 1 – this being the best of four classes.

Summary data for the attributes assessed at the sites are provided in Table 5.2.

Pisonia grandis was the only species present in sites NEH01 and NEH02. An *Abutilon albescens* shrub was also present in SEM01.

Wedge-tailed shearwater burrows were abundant in NEH01 and SEM01 – a fact reflected in the paucity of litter at these two sites.

Site photos are provided in Plate 5.32 (a-d) to 5.34 (a-d).

Plate 5.32 (a-d) Reference photographs for BioCondition site NEH01, NE Herald.

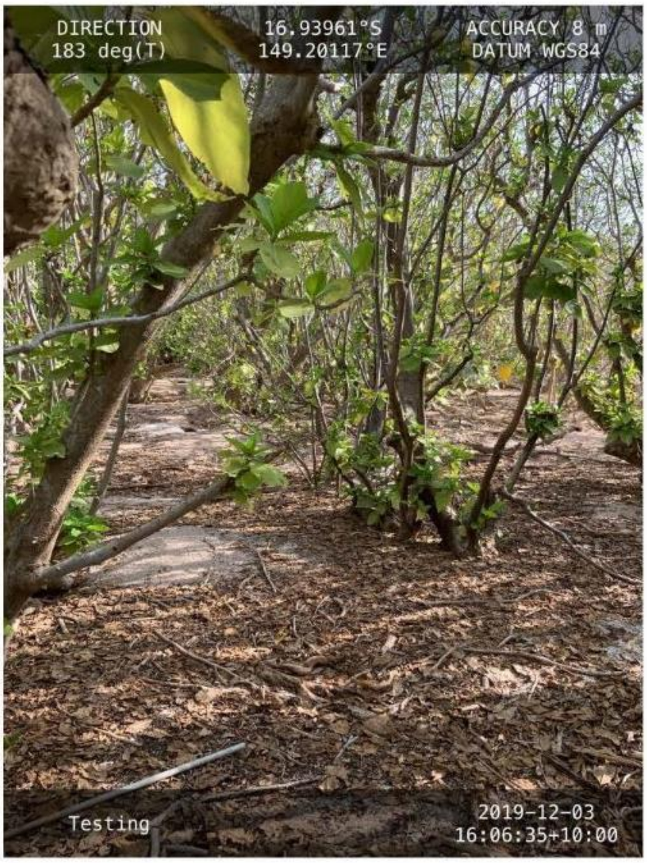

Plate 5.33 (a-d) Reference photographs for BioCondition site NEH02, NE Herald.

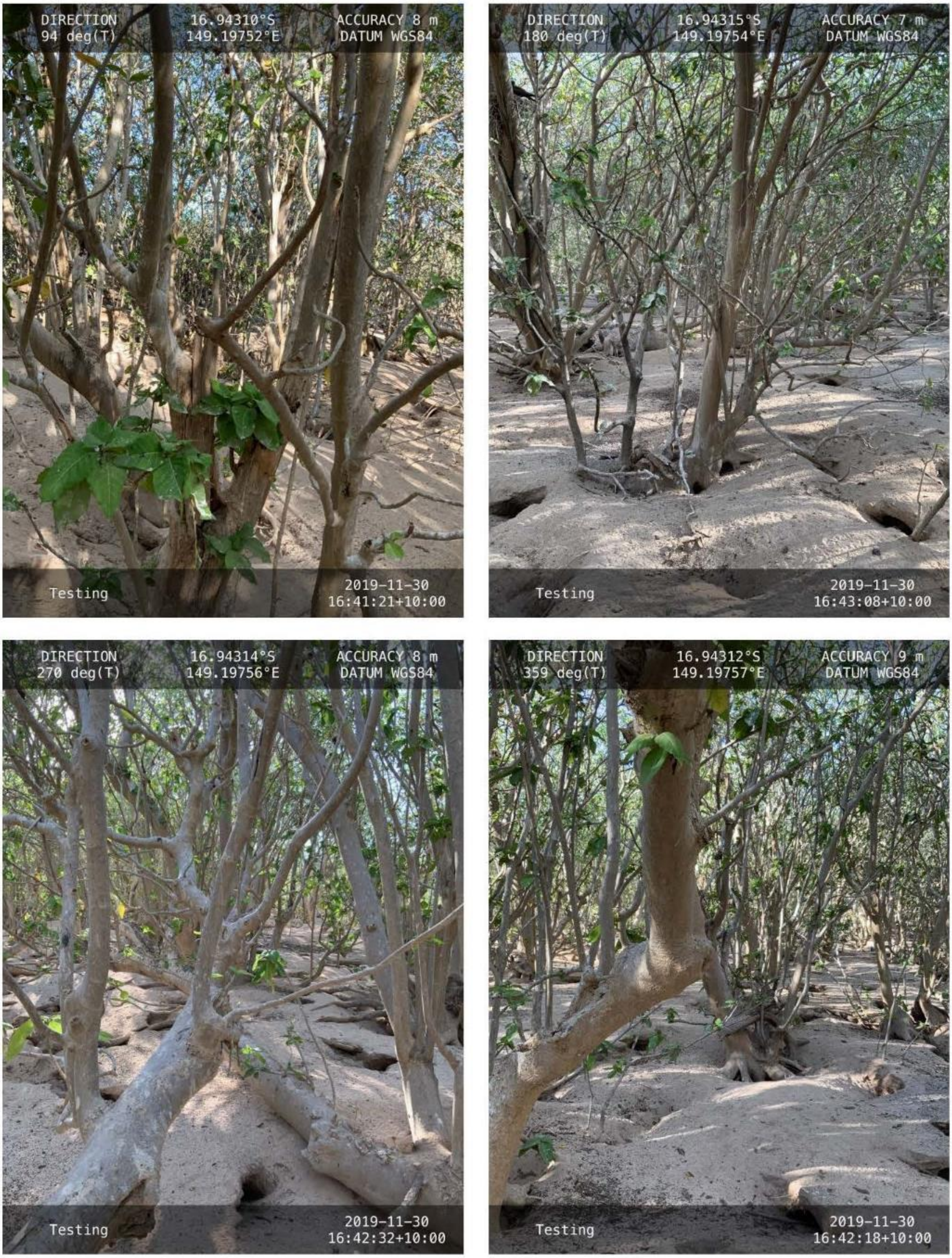

Plate 5.34 (a-d) Reference photographs for BioCondition site SEM01, SE Magdelaine.

Table 5.2 BioCondition site attributes at each BioCondition site.

Site/ Attribute	NEH01	NEH02	NEH03
Transect start	55 734032 8125420	55 734425 8125811	56 216024 8162618
Transect end	55 734066 8125456	55 734450 8125852	56 216020 8162588
Transect bearing	30º	30º	190º
Median tree canopy height (m)	7	5. 5	6. 5
Tree canopy cover (%)	96. 7	98. 2	96. 0
Shrub canopy cover (%)	0. 4	0. 4	0
Basal area m^2/ha	46	58	36
Total no. large trees/ha	36	22	16
Large trees - mean diameter at breast height (cm)	25. 8	24. 4	27. 8
Total no. trees/ha	760	1140	967
Total no. tree stems/ha	3060	3320	Not collected
Total no. shrubs/ha	400	300	1067
Total no. shrub stems/ha	560	400	Not collected
Recruitment of ecologically dominant layer (%)	100	100	100
Tree species richness	1	1	1
Shrub species richness	1	1	2
Grass species richness & cover	0	0	0
Forb species richness & cover	0	0	0
Native shrub ground cover (%)	0	0	0
Non-native plant cover (all strata) (%)	0	0	0
Litter cover (%)	11	64	5
Bare ground (%)	89	36	95
Woody debris (length m/ha)	220	259	743
Average litter depth (cm)	0. 2	2. 3	0
Soil pH		Not collected	

Discussion

Pisonia grandis qualifies as a ‘keystone species’ – these being species that have a disproportionately large effect on their natural environment relative to their abundance, are critical to maintaining the structure of an ecological community and help to determine what other species inhabit or use the community; without them the ecosystem would be dramatically different of cease to exist altogether (definition from Wikapedia; accessed 16/4/2020). Given this, and the fact that the *Pisonia* communities are known to be susceptible to decline or complete collapse with unchecked pest insect outbreaks, and can have major structural change as a consequence of cyclones, they warrant more detailed monitoring than is provided by Health Checks (refer section 5.3).

The BioCondition sites established in December 2019 provide opportunity for quantitatively evaluating the condition and recovery of the *Pisonia grandis* community on NE Herald and SE Magdelaine over time with events such as cyclones or pest insect outbreaks.

A frequency of five to ten years is likely to be adequate for BioCondition monitoring unless there is cause (e.g. cyclone impact) to trigger earlier re-monitoring.

Additional sites could be established (e.g. a second site on SE Magdelaine) though consideration would need to be given to site independence given the small size of the islands. Inclusion of different structural types (e.g. *Pisonia* closed scrub) may be of interest. It is recommended that advice be sought from Queensland Herbarium, including with respect to the equivalence of the various structural types to currently defined *Pisonia grandis* Regional Ecosystems, before establishing additional sites.

BioCondition monitoring at the three sites, coupled with Health Check monitoring (section 5.3) across the *Pisonia* vegetation communities, is likely to be adequate for evaluating their condition in the Coringa-Herald group overtime.

It could be argued that *Cordia subcordata* and *Argusia argentea* are also ‘keystone species’ and so warrant quantitative monitoring. However, the *Cordia* patches are now so small in extent on the islands that it is unlikely to be useful; they should continue to be monitored using drone imagery and Health Checks. The *Argusia* communities form narrow, usually monospecific (with respect to the woody strata) bands and are likely to be adequately monitored using drone imagery and Health Checks. Additional quantitative monitoring could be triggered if the latter indicate there is a concerning decline in their condition.

5.3 Vegetation Monitoring – Health Checks

Introduction

Health Checks are qualitative tools for efficiently and routinely monitoring the condition of key values on reserves in Queensland. They use criteria that can be applied state-wide across a diversity of values and are based on threatening processes and their impacts (e.g. infestations of pest plants, trampling, cyclone impacts, dieback), or particular parameters (e.g. faunal habitat features, ground cover, recruitment of canopy species), that are good indications of condition. The assessor scores the condition of the value (e.g. a vegetation community or regional ecosystem) for each indicator, at representative sites, using simple, predetermined visual cues. The Health Check report uses the International Union for Conservation of Nature condition categories (Good, Good with Some Concern, Significant Concern, Critical) and definitions (Osipova *et al.* 2014) to describe the overall condition of a value across a reserve based on all the Health Check indicators relevant to the value (Melzer *et al.* 2019).

Methods

The guide for undertaking Natural Values Health Checks (Melzer 2019) is available at https://parks.des.qld.gov.au/managing/framework/monitoring/

Health Check monitoring was undertaken in a range of vegetation communities on the cays:

- *Pisonia* – NE Herald, SE Magdelaine
- *Cordia* – Chilcott, SW Coringa, SE Magdelaine,
- *Argusia* – NE Herald, SW Herald, SW Coringa, Chilcott, SE Magdelaine
- *Abutilon* – NE Herald, SW Herald
- Mixed shrublands/herblands of *Abutilon* ± *Plumbago* ± *Ipomoea* and *Achyranthes* – Chilcott, SW Coringa
- *Achyranthes* herbland – Chilcott
- *Ipomoea* vineland – SW Coringa
- *Boerhavia* herbland – SW Coringa
- *Lepturus* grassland – SW Coringa

Results

The record of the condition class for each community type is provided in Appendices 6a-i.

The overall condition rating for most of the communities was Good. The exception were the clumps or patches of *Cordia* which had an overall condition rating of Significant Concern on each of the three islands. They typically consisted of many apparently dead stems with scattered leaves and in places were being overtopped *by Ipomoea violacea.*

Discussion

Health Checks provide a simple means to regularly evaluate the condition of ecosystems and associated habitats on the cays. Assessors do not require experience in scientific methods nor scientific equipment. Basic training in the method and concepts, and a camera, clipboard and datasheets, are sufficient.

A range of ecosystems were 'health checked' during the November-December 2019 trip. It is recommended that the most important ecosystems or habitat be selected ('key values') for monitoring into the future. Once the number of key values is agreed, then decisions can be made regarding the frequency of monitoring and the season in which to monitor. While season per se is not critical to Health Checks it is preferable that they be undertaken in the same season each time, and when weeds will be easiest to detect and identify (typically late summer through autumn – post wet season). Given the distance between islands it is recommended that Health Checks for key values be undertaken separately for each island.

Literature cited

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6.0 Birds

Andrew McDougall

Introduction

Bird surveys of the Coringa-Herald section (CHs) of the then Coral Sea Marine Park (CSMP) have traditionally been conducted between June and August.

November/December surveys provide opportunity for the collection of temporal data relating to breeding effort, species movements and breeding success (possibly from winter breeding effort).

Data collected during the November-December 2019 surveys included pelagic sightings, seabird diversity, breeding and abundance, shorebird diversity and abundance, and observations of any other bird species.

Conditions were very dry resulting in sparse ground cover in non-forested communities and reduced canopy cover in forested communities.

Birdlife International recognises the “Coringa-Herald Reefs Important Bird Area” due to its importance for breeding seabirds.

Methods

Pelagic (at sea) observations

Incidental, boat-based data collection was undertaken on the forward and returning legs of the trip.

A seamount (-16.5192, 147.1612 GDA94) approximately 75km west of the Holmes Reef complex was targeted due to it being the only significant bathymetric structure between the Great Barrier Reef outer boundary, Holmes Reef and the islands of the CHs.

Generally, birds are only detected within 1000m of a boat, and that distance is dependent on suitable weather conditions.

Islets/Cays

Methods for island-based counts were determined by target species, terrain, available observation time, number of observers and available equipment. General observations were also undertaken.

Extrapolated counts:

- **Active burrow counts** for wedge-tailed shearwaters were undertaken within 10m diameter circles (78.54 m²) randomly placed within similar vegetation types. As many counts were undertaken as practical. Species numbers were averaged and extrapolated over the full area of each vegetation community sampled.
- **Ground nest counts** for common noddy within 20mx 20m (400m²) quadrats in open areas. Quadrat counts were averaged and extrapolated across the full area of each vegetation community sampled.

Linear/perimeter vegetation counts:

Counts were undertaken along fringing vegetation communities, such as *Argusia* shrublands, for red-footed booby, great frigatebird, brown booby, black noddy, and masked booby.

Full breeding effort, species and diversity counts were made using this method.

Beach rock platforms, rubble and associated vegetation counts:

Counts were undertaken amongst rubble and natural cavities in rock platform areas. Windward areas were prioritised if surveys were limited by time.

Open vegetation communities (grasslands, herblands) counts:

Ground and drone counts of ground nesting species.

General observations – all vegetation types, beach, tidal flats/reef flats.

All other incidental records.

Plate 6.1 A frigatebird kleptoparasiting a red-footed booby.

Results

Pelagic and islet/cay results are provided separately.

Pelagic

Sightings are presented from west to east rather than by date of observation with those sightings west of Holmes Reef (Fig. 6.1) provided in Table 6.1 and those between Holmes Reef and Herald Cays (Fig 6.2) provided in Table 6.2.

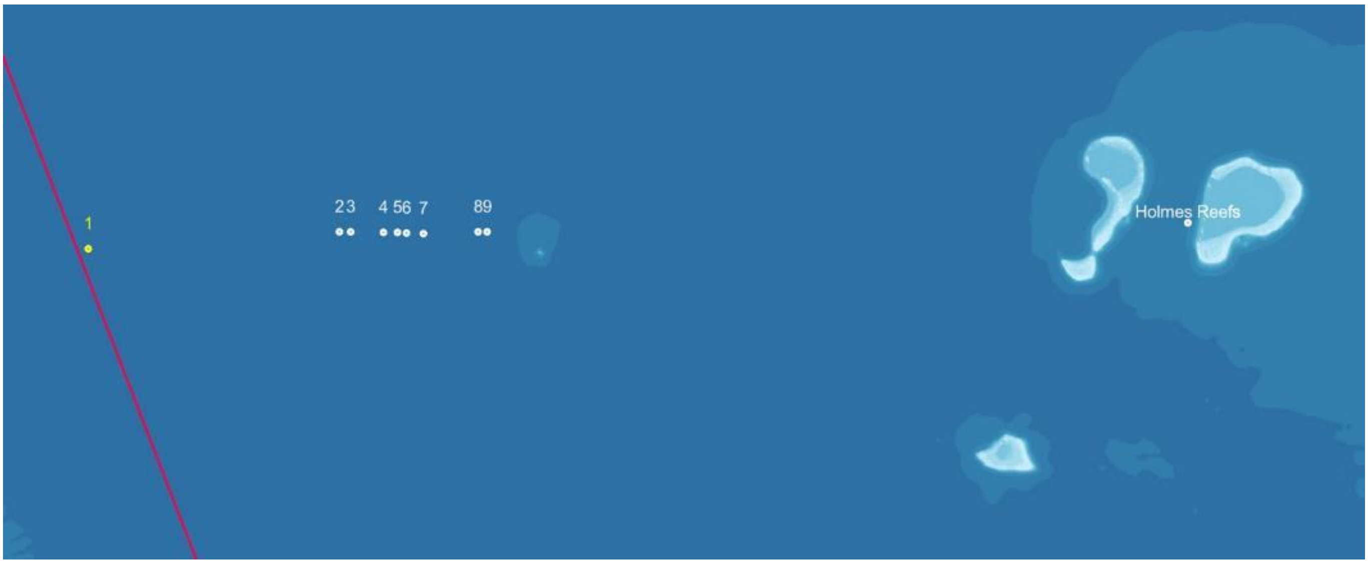

Fig. 6.1 Great Barrier Reef boundary to seamount.

Table 6.1 Sightings between Great Barrier Reef boundary and the seamount.

Date	Location reference (see Fig. 6. 1)	Coordinates GDA94. Sightings have a precision of 500m.	Species and count	Notes
29/11/2019	1	-16.5126, 146.6175	wedge-tailed shearwater x16, bridled tern x10, red-footed booby x2	
10/12/2019	2	-16.4929, 146.9232	Tahiti petrel, wedge-tailed shearwater	
10/12/2019	3	-16.493, 146.9364	red-footed booby x2	
10/12/2019	4	-16.4936, 146.9768	wedge-tailed shearwater	
10/12/2019	5	-16.486, 146.9937	sooty tern	
10/12/2019	6	-16.4938, 147.0049	Tahiti petrel	
10/12/2019	7	-16.4944, 147.0255	Bulwer's petrel, red-footed booby	Bulwer's petrel is a rare species in this part of the Pacific Ocean.
10/12/2019	8	-16.493, 147.0917	red-footed booby	
10/12/2019	9	-16.4929, 147.1025	Tahiti petrel	

Fig. 6.2 Holmes Reef to Herald Cays.

Table 6.2 Sightings between Holmes Reefs and Herald Cays.

Date	Location reference (see Fig. 6. 2)	Coordinates GDA94. Sightings have a precision of 500m.	Species and count	Notes
30/11/2019	10	-16.8421, 148.5017	white-tailed tropicbird x2, red-footed booby, wedge-tailed shearwater	
30/11/2019	11	-16.8533, 148.5571	sooty tern	
30/11/2019	12	-16.9195, 148.8292	great frigatebird (adolescent), wedge-tailed shearwater	
30/11/2019	13	-16.9351, 148.9003	brown booby, masked booby, red-footed booby x6	

Islets and Cays

North East Cay (Herald)

Records are provided in Table 6.3.

Key findings:

- A significant population of wedge-tailed shearwaters occupied North East Cay. This population would trigger recognition as an international Key Biodiversity Area by meeting the 1% global population threshold for a species (1% of wedge-tailed shearwater population is 52,000 adults). Although numbers for this survey are indicative and not the result of a more comprehensive survey, the total active shearwater burrow count for the CHs will certainly exceed the 1% threshold.
- No live adult red-tailed tropicbirds were recorded. Nine dead adolescent birds were located in beach rock rubble areas, presumably from the winter breeding event. No official summer counts of red-tailed tropicbirds were available to determine if those findings were unusual.
- Buff-banded rails showing examples of leucism. See Plate 6.2,
- The channel-billed cuckoo observation is likely to be a new record and range extension.
- Metal leg bands on two adult (live) masked boobies were identified using photos and spotting scope, Bird one sighted 30/11/2019 was banded on North East Cay on 14/08/2003, a recovery time of 16 years, three months and 16 days. Bird two was sighted 03/12/2019 and was originally banded at North East Cay on 20/07/2004, a recovery time of 15 years, four months and 13 days.

Table 6.3 Bird records, North East Cay (Herald Cays).

Species	Nests	Chicks	Young	Adolescents	Adults	Notes
black noddy	P	P	P	P	P	**P= Present not counted**
black-naped tern	0	0	0	0	17	
bridled tern	unknown	0	0	0	10	Nesting behaviour.
brown booby	11	6	15	P	P	
buff-banded rail	0	0	0	0	>8	At least two leucistic
channel-billed cuckoo	0	0	0	0	1	Unusual record.
common noddy	P	P	P	P	P	
great frigatebird	P		P	P	P	
lesser frigatebird	P		P	P	P	
masked booby	11	2	14	P	P	
Pacific golden plover	0	0	0	0	1	
purple swamphen	0	0	0	0	1	
red-footed booby	P	P	P	P	P	
red-tailed tropicbird	0	0	0	9 dead	0	
ruddy turnstone	0	0	0	0	2	
wandering tattler	0	0	0	0	2	
wedge-tailed shearwater	223,049	unknown	unknown	unknown	P	

South West Cay (Herald)

Records are provided in Table 6.4.

Key findings:

- The summer breeding pairs of red-footed booby and masked booby were at least as high as previous winter breeding numbers (refer Discussion).
- A count of 230 young/adolescent great frigatebirds indicated a normal winter/spring breeding event occurred (based on previous winter breeding records).
- Metal leg bands were identified on three live, adult masked boobies. Two birds, observed on 2/12/2019, were both banded on South West Cay on the same day 17/08/2003 which is a recovery time of 16 years, three months and 15 days. Bird three, observed on 02/12/2019, was banded on South West Cay on 22/07/2004, a recovery time of 15 years, four months and ten days

Table 6.4 Bird records, South West Cay (Herald Cays)

Species	Nests	Chicks	Young	Adolescents	Adults
black noddy	0	0	0	0	5
brown booby	253	69	60	1	427
buff-banded rail	0	0	0	0	3
common noddy	0	0	0	0	13
crested tern	0	0	0	0	5
great frigatebird	0	0	230	0	4
masked booby	26	16	8	4	57
Pacific golden plover	0	0	0	0	4
purple swamphen	0	0	0	0	1 dead
red-footed booby	54	8	193	524	682
red-tailed tropicbird	0	0	0	0	0
ruddy turnstone	0	0	0	0	5
sooty tern	unknown	0	4	0	200
wedge-tailed shearwater	9010	unknown	unknown	unknown	unknown

Plate 6.2 Leucistic buff-banded rail.

Plate 6.3 An adolescent red-footed booby managing the extreme heat. Nest-bound young and fledged adolescents displayed this behaviour. Note the head and neck of this bird is completely shaded by the shadow cast by its body. The ground timber may provide fractional relief from the sand's radiant heat.

South West Islet (Coringa)

Records are provided in Table 6.5.

Key findings:

- Approximately 2,598 black noddies had recently nested on South West Islet. Nests were heavily caked with guano, suggesting they may have been reused over a couple of seasons.
- Common noddies nested across the whole of the island. Breeding effort numbers were from extrapolated counts.
- Three separate sooty tern colonies were observed, the third starting egg laying on the second day of surveys.
- An indicative count of 14,447 active wedge-tailed shearwater burrows was recorded.

Table 6.5 Bird records, South West Islet (Coringa).

Species	Nests	Chicks	Young	Adolescents	Adults	Notes
black noddy	2, (*)	0	17	0	P	*2598 recent nests
brown booby	8	4	12	2	280	
buff-banded rail	0	0	0	0	7	
common noddy	1692			P	P	
masked booby	0	3	2	5	7	
nankeen night-heron	0	0	0	0	1	
red-footed booby	7	2	36	58	174	
red-tailed tropicbird	0	0	0	0	0	
ruddy turnstone	0	0	0	0	4	
sooty tern	1, *16	0	28	2	240	*new records, day 2.
wandering tattler	0	0	0	0	1	
wedge-tailed shearwater	14474	unknown	unknown	unknown	P	

Plate 6.4 Black noddy nests possibly reused from a previous breeding season.

Chilcott Islet (Coringa)

Records are provided in Table 6.6.

Key findings

- Brown booby breeding pairs – 325
- Indicative count of 3756 wedge-tailed shearwater burrows.
- Possibly second largest lesser frigatebird colony in CHs. Nests were generally guano-caked platforms on raised grasses and shrubs through the centre of the island.
- One live red-tailed tropicbird adolescent was observed on beach rock rubble.

Table 6.6 Bird records, Chilcott Islet.

Species	Nests	Chicks	Young	Adolescents	Adults	Notes
black noddy	0	0	2	0	P	
brown booby	101	85	139	3	141	325 breeding pairs
buff-banded rail	0	0	0	0	17	
crested tern	0	0	0	0	2	
eastern reef egret	0	0	0	0	1	Dark phase, very yellow feet
great frigatebird	0	0	11		P	~520 “frigatebirds” in thermals
grey-tailed tattler	0	0	0	0	1	
lesser frigatebird	0	0	700-850		P	Young/ adolescents combined.
Pacific golden plover	0	0	0	0	4	
red-footed booby	3	7	36	56	90	
red-tailed tropicbird	0	0	0	1	0	
sooty tern	0	0	0	0	4	
wandering tattler	0	0	0	0	1	
wedge-tailed shearwater	3756	unknown	unknown	unknown	P	

Plate 6.5 Columns of 500 to 1000 frigatebirds were common on several cays. This picture is a subset of birds on Chilcott Islet.

South East Cay (Magdelaine)

Records are provided in Table 6.7.

Key findings

- Large wedge-tailed shearwater colony of around 90,881 active burrows.
- Burrows scattered across cay with greatest densities of around 1.27 burrow entrances per square metre in mature stands of *Pisonia grandis*.

Table 6.7 Bird records, South East Cay (Magdelaine).

Species	Nests	Chicks	Young	Adolescents	Adults	Notes
brown booby	0	0	10	0	18	
common noddy	P	P	P	P	P	
crested tern	0	0	0	0	2	
great frigatebird				P	P	Breeding effort not assessed.
lesser frigatebird				P	P	Breeding effort not assessed.
masked booby	0	4	13	5	16	
Pacific golden plover	0	0	0	0	2	
red-footed booby	15	0	112	66	464	
red-tailed tropicbird	0	0	0	0	0	
ruddy turnstone	0	0	0	0	1	
wedge-tailed shearwater	90,881	unknown	unknown	unknown	P	
white-faced heron	0	0	0	0	1	Plates 6.6 & 6.7

Plate 6.6 1600hrs 07/12/2019 white-faced heron (Photo J. Raven)

Plate 6.7 1000hrs 08/12/2019 Heron carcass 18hrs later.

North West Islet (Magdelaine)

Records are provided in Table 6.8.

Key findings

- Crested tern colony with 19 chicks. Only active crested tern colony within CHs. Adult crested terns were scarce throughout all surveys.
- Five migratory shorebird species observed. Site may be an important stopover area.
- Potential nesting site for New Caledonian fairy tern. Island devoid of vegetation and no threats would be expected (i.e. no turtle nesting) between May and September (breeding window for birds in New Caledonia).

Table 6.8 Bird records, North West Islet (Magdelaine).

Species	Nests	Chicks	Young	Adolescents	Adults	Notes
brown booby	0	0	0	0	2	
crested tern	0	19	0	0	37	
great frigatebird	0	0	0	0	2	
great knot	0	0	0	0	1	
lesser sand plover	0	0	0	0	2	
New Caledonian fairy tern	0	0	0	0	1	
Pacific golden plover	0	0	0	0	4	
red-footed booby	0	0	0	1	1	
red-tailed tropicbird	0	0	0	0	0	
ruddy turnstone	0	0	0	0	3	
wandering tattler	0	0	0	0	1	Unusual pale patches on both wings

Plate 6.8 North West Islet (Magdelaine Cays). More suited to birds than turtles.

Cay on Holmes Reef

Incidental observations are provided in Table 6.9.

Table 6.9 Incidental bird observations – Cay on Holmes Reef.

Species	Nests	Chicks	Young	Adolescents	Adults
black noddy	0	0	0	0	252
brown booby	0	0	0	0	13
common noddy	0	0	0	0	1008
crested tern	0	0	0	0	5
masked booby	0	0	0	0	50
red-footed booby	0	0	0	0	85

Discussion and observations

Time constraints and observer capacity limited the thoroughness of wedge-tailed shearwater population sampling (compared to the previously adopted transect methodologies (Baker 2013)). No burrow occupancy rates were attempted.

While the wedge-tailed shearwater results are indicative only, the data suggests an internationally significant population of wedge-tailed shearwaters breeding on five of the six cays surveyed (no breeding on North West Islet – Magdelaine group).

If intensive wedge-tailed shearwater monitoring is considered in the future then it is important to take into account the potentially damaging impact of ground counts, particularly in the densest and most fragile substrates within closed *Pisonia grandis* communities.

No discernible shearwater "runways" were observed on South East Cay (Magdelaine group). Runways are cleared corridors created by birds to exit vegetation via clear take off areas – often at beach edges. Shearwaters observed at South East Cay managed by taking vertical "jumps" from their burrow entrances and flying off.

Common noddies showed no preference for nest type/construction throughout the five locations they were observed breeding. Nests types included:

- Bare ground or rock platform with no lining,
- Ground or rock platform or infilled rock base with lining of shells and/or coral,
- Ground or rock platform or infilled rock base with lining of vegetative materials,
- Nest on flattened grass,
- Nest platform on low shrubs lined with guano and vegetative material,
- Reused nest of lesser frigatebird, and
- Tall shrub or tree nests lined with vegetative material including leaves and various sized sticks. Tree nesting is not known from the Great Barrier Reef World Heritage area, although they do nest on platforms on shrubs e.g. Raine Island.

Species trend analyses should consider species which breed in summer and winter because a single season count does not represent the island population. Red-footed booby and masked booby had similar summer breeding populations to those recorded in winter in some locations (Baker and Holdsworth 2013).

Summer breeding populations could represent:

- separate populations, thereby increasing the overall population,
- successional breeding indicating a protracted season,
- a shift in breeding timing,
- second attempt breeding after a weather event, or
- the main breeding population i.e. winter trends may not be representing the majority breeding effort.

Planning for summer surveys requires consideration of risks to birds and human observers because of the extreme heat. Nests, chicks and young could easily perish due to exposure if observers are not experienced in minimising disturbance. The risk to wedge-tailed shearwater chicks in burrows, of trampling by observers, must also be considered.

Plate 6.9 Black noddy (left) and common noddy (right) with their respective tree nests.

Literature cited

Baker G. B. and Holdsworth M. (2013) Seabird monitoring study at Coringa Herald National Nature Reserve 2012. Report prepared for Department of Sustainability, Environment, Water, Populations and Communities, Canberra.

7.0 Marine turtle monitoring

Ian Bell, Jeremy Raven and Col Limpus

Summary

A survey of NE and SW Herald Cays, SW Coringa and Chilcott Islets, and NW Magdelaine Islet and SE Magdelaine Cay was conducted to assess the population of green turtles (*Chelonia mydas*) nesting within the Coral Sea Marine Park (CSMP) during the 2019/2020 nesting season. The survey was undertaken from 29th November to 9th December 2019 and focused on collecting data to address the following aims to:

- tag all turtles coming ashore to nest during the nine-night survey, to collect a representative sub-sample of the total green turtle nesting cohort for the 2019/2020 nesting season within the CSMP;
- identify green turtles returning to the CSMP, which have been tagged during previous nesting seasons or tagged from foraging studies within Queensland and neighbouring countries, to determine foraging areas, re-nesting intervals and migration patterns;
- deploy eight Fastloc satellite transmitters on nesting turtles to determine inter-nesting habitat, migration pathways and foraging area[s];
- collect morphometric information on nesting turtles to characterise the population;
- collect approximately 100 genetic tissue samples; and,
- place three temperature data loggers at sites (shade, partial shade, sun) to collect sand temperatures that were representative of the majority of nesting effort.

A total of 387 individual green turtles were encountered nesting during the November-December 2019 survey. Of these, 296 were primary taggings (i.e. they had not been tagged during a previous survey or at another study location), 27 were inter-season re-migrants (turtles that had been tagged previously and had returned to CSMP to nest again). Seven were inter-season retags (they possessed tag scars on their flippers, indicating they had been tagged previously but had subsequently lost their tags). Four turtles had been tagged while foraging and were recaptured attempting to nest in the CSMP. Two turtles that had been originally tagged while foraging at Clack Reef and two at Combe Reef near Princess Charlotte Bay, on the eastern coast of Cape York Peninsula.

Three turtles were recorded changing their nesting location during the survey period, two moving from Chilcott to SW Coringa Islet and one individual migrating approximately 120km from North-East Herald Cay to SE Madelaine Cay. These small-scale migrations indicate strong nest site fidelity to a region rather than an individual island.

Key Recommendations

Green turtle nesting populations – Coral Sea Marine Park

- Continue to quantify the regional nesting populations by tagging a representative subset of the total nesting population for each nesting season over a minimum two-week sampling period at an index nesting site – preferably North East Herald;
- Continue to assess the quality of nesting habitat by determining the nesting density/success, fecundity, hatching success, and thermal profiles of the nesting habitat to provide baseline and climate change data for comparison with other marine turtle rookeries in northern Australia;
- Assess the impact of Papua New Guinean, Aboriginal and Torres Strait Islander harvest on the marine turtle populations utilising the CSMP; and
- Conduct geomorphology mapping of the islands to determine their resilience to sea level rise.

Introduction

The green turtle (*Chelonia mydas*) is identified as a vulnerable species under the EPBC Act. The green turtles that breed on the islands of the CSMP (Fig. 7.1) are part of the Coral Sea genetic stock (management unit) that extends from the Australian Coral Sea Platform to the chesterfield Reefs of New Caledonia (FitzSimmons and Limpus 2014; Reed *et al*. 2015; Jensen *et al*. 2019). It should be noted that there are reports of green turtle nesting occurring on several islands in the southern CSMP. The genetic provenance of these turtles has yet to be identified. The green turtles that breed within the Coral Sea genetic stock range have been recorded primarily at foraging areas in the Gulf of Carpentaria, Torres Strait and the far northern GBR (Fig. 7.2) However, the foraging range also extends to southern PNG and southward to SE Queensland (Fig. 7.3) (Read *et al*. 2014).

This report summarises the results of turtle population monitoring studies conducted at NE and SW Herald Cays, SW Coringa and Chilcott Islets, NW Magdelaine Islet and SE Magdelaine Cay during the 2019/2020 turtle nesting season.

The objectives of this trip were:

- To quantify relative nesting density of marine turtles on selected islands in the CSMP.
- To check for identifying tags and to tag a series of breeding females for subsequent identification of:

♦ migration and foraging areas;
♦ remigration intervals; and,
♦ growth rates, through repeated measurements of curved carapace length (CCL).

- To document foraging behaviour by satellite tagging eight turtles.
- To collect at least 100 tissue samples to further advance our understanding of the genetic stock structure within the western Pacific.

Based on the number of green turtles that were preparing to breed (determined via laparoscopic and ultrasound examination of gonads and external morphology) during 2019 foraging ground studies in Queensland, a high-density green turtle nesting season was predicted for north Queensland during the 2019/2020 nesting season.

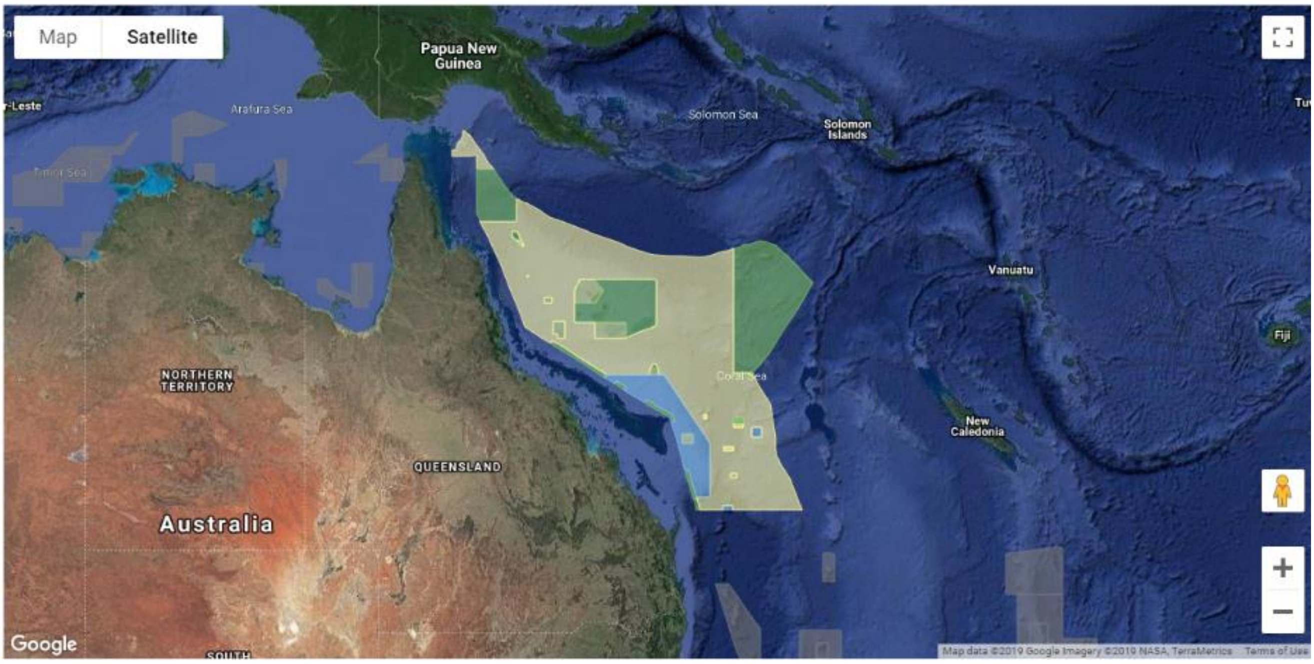

Fig. 7.1 Map of the Coral Sea Marine Park.

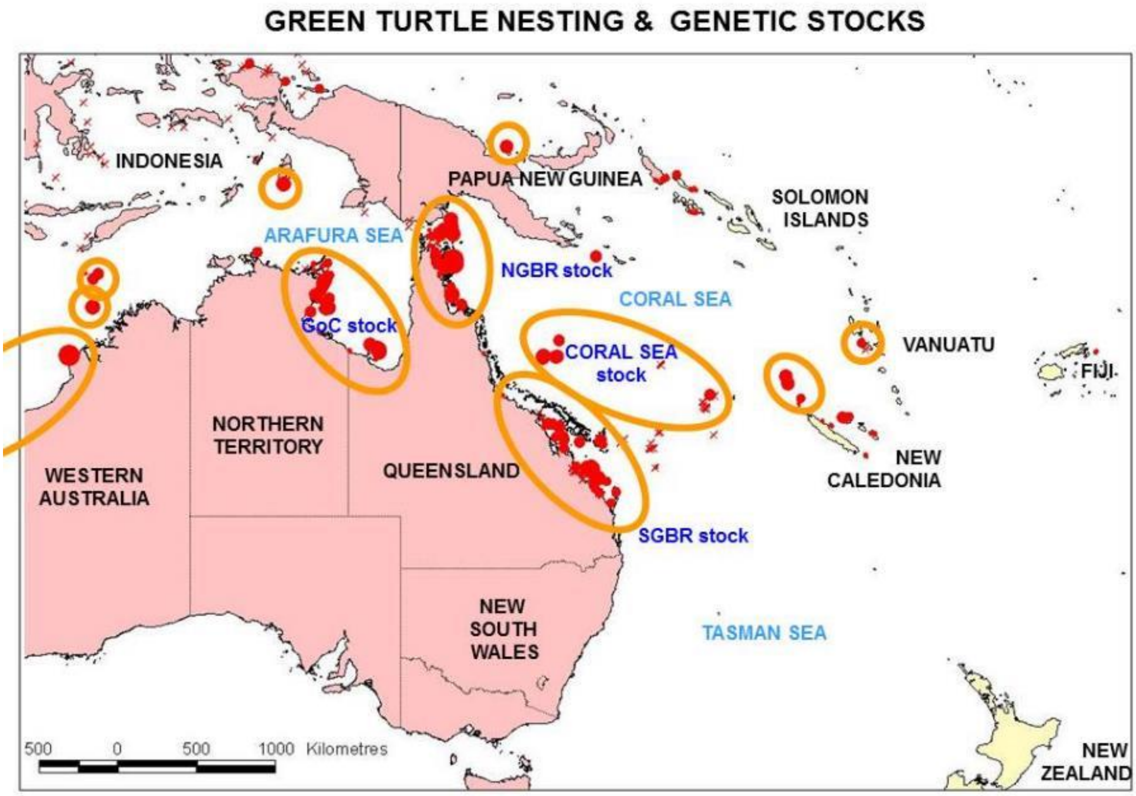

Fig. 7.2 Distribution of recognised genetic stocks of green turtles breeding in Queensland and the Coral Sea region.

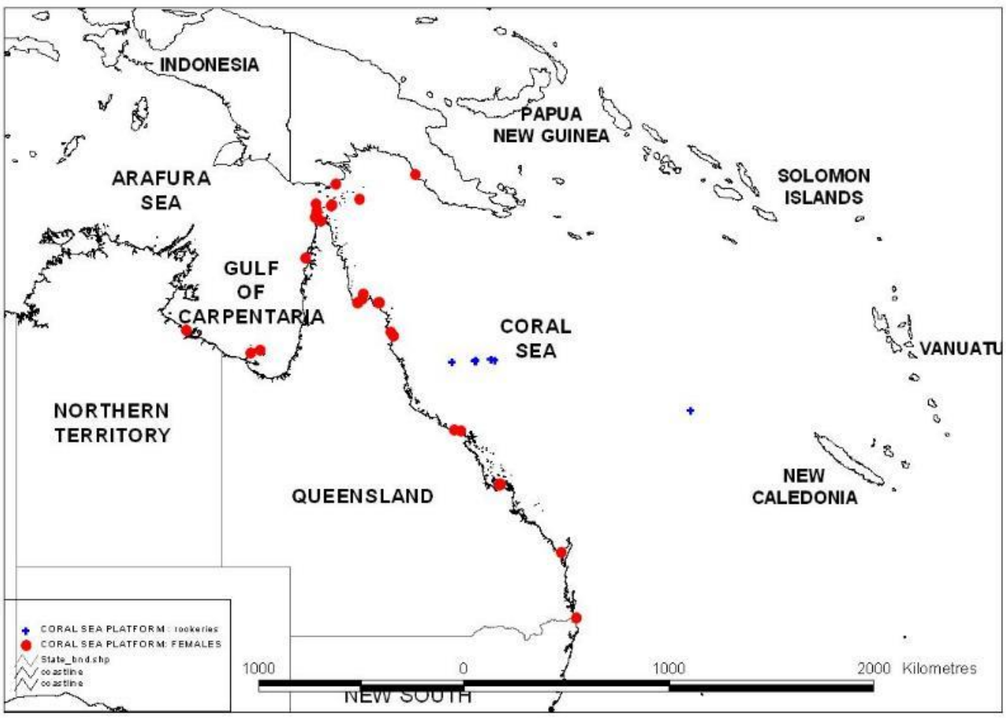

Fig 7.3 Known distribution of foraging grounds for green turtles recorded as breeding on islands supporting the Coral Sea genetic stock based on 34 flipper tag recoveries recorded in the Queensland Turtle Conservation Data Base prior to the 2019-2020 breeding season. Red dots denote recorded foraging sites from Coral Sea nesting beaches (blue crosses).

Methods

Deepwater access is available to the main nesting beaches on most cays throughout all tidal ranges: therefore, the majority of nesting attempts occurred shortly after sunset. In light of these nesting patterns, patrols commenced within an hour of sunset and continued until the majority of nesting turtles had emerged for the evening.

Primary data collection

Surveys focused on tagging and/or checking tags on every turtle coming ashore to nest each night. Untagged turtles were identified by placing a titanium tag with a unique serial number (Stockbrands Pty. Ltd. Western Australia) through the axillary scale on the trailing edge of the left front flipper (Limpus 1992).

The tag condition of re-migrant turtles was assessed, and a secondary tag was applied in the right front flipper if required. All turtles attempting to nest at CSMP were classified as follows:

- Primary (P) – untagged turtle with no tag scars.
- Inter-season re-migrant (ISR) – turtle tagged in a previous nesting season and returning to nest in the CSMP.
- Inter-season retag (ISR-RTA) – turtle with a healed tag scar (an area of hard scar tissue) indicating the turtle had been tagged during a previous nesting season or at another locality. The turtle was re-tagged and included in the total count for turtles during that nesting season.
- Within season return (WSR) – turtle that had been tagged previously within the current nesting season and recorded as nesting or attempting to nest again.
- Ex-feeding ground (XFG) – first capture at the rookery of a turtle previously tagged at a feeding ground during a foraging ground study.

Curved carapace length (CCL) [distance from the anterior-most point of the nuchal scute to the posterior-most projection of the post-centrals (Limpus *et al*. 1983)] was measured with a flexible fibreglass tape measure (± 0.5 cm) on the majority of turtles encountered. Growth of inter-season remigrants was recorded as 0.0 cm if the more recent CCL measurement was smaller than the original. Differences in CCL measurements between successive captures were calculated as the difference between the largest and smallest measurement for any given individual. These differences were expressed as a percent (%) of the largest measurement or as an absolute difference, expressed in centimetres.

The preferential nest-site habitat or the location where the turtle was processed was recorded- beginning from high water and continuing through to closed vegetation (see Appendix 7 - example of data sheet used).

The health and condition of each turtle was noted, particularly the presence of commensals, propeller damage, wap (or spear) holes, obvious external diseases (such as fibropapillomitis) or shark bites.

If possible, the success of individual nesting attempts was recorded to determine re-nesting intervals and disturbance levels.

Satellite Tracking

Wildlife Computers SPLASH10 tags (Fig. 7.4) were fitted to eight nesting females. These tags are data-archiving, Argos satellite transmitting tags designed for tracking vertical and horizontal movements of free-range marine animals. A SPLASH10 tag works on any animal that exposes the tag above the surface of the water. SPLASH10 tags contain an array of sensors including depth, temperature, light level, and wet/dry. During deployment, data are collected, summarized, and compressed for Argos transmission. The full archive is available upon recovery of the tag.

Tag specifications:

- Sensors Depth, Temperature, Wet/Dry, Fastloc
- Depth Sensor Range 0-2000 m
- Depth Sensor Resolution 0.5 m
- Depth Sensor Accuracy ±1% of reading
- Temperature Sensor Range -40°C to 60°C
- Temperature Sensor Resolution 0.05°C
- Temperature Sensor Accuracy ±0.1°C
- Operating Temperature Rating (°C) -20°C to 50°C
- Memory 1 Gigabyte


Model: SPLASH10-351

Fig. 7.4 Wildlife Computers SPLASH10 tag.

Genetic Samples

For the purposes of genetic analysis, a small tissue sample (0.5g) was taken from the trailing edge of one front flipper. These samples were stored in a vial containing 20% DSMO in saturated sodium chloride (NaCl).

Results

Tagging Census

A total of 387 individual green turtles were encountered while attempting to nest (Table 7.1). Of these, 296 were primary taggings (i.e. they had not been tagged during a previous survey or at another study location) and 27 were inter-season re-migrants (turtles that had been tagged previously and had returned to CSMP to nest again). Seven were inter-season retags (they possessed tag scars on their flippers, indicating they had been tagged previously but had subsequently lost their tags). Four turtles had been tagged while foraging and were recaptured attempting to nest in the CSMP. Fifty turtles were re-encountered within the same nesting season.

Nesting Attempts

Nesting success was extremely low during the 2019/20 season due to very dry sand conditions which resulted in sand collapse when egg chambering. During the nine-night monitoring period, a total of 387 nesting attempts were made of which 23 (6%) were successful.

Nesting Site Fidelity

Three turtles were recorded changing their nesting location during the survey period, two moving from Chilcott to SW Coringa and one individual moved approximately 65nm from NE Herald Cay to attempt nesting on SE Madelaine Cay. These small-scale migrations indicate strong nest site fidelity to a region rather than an individual island.

Size of nesting turtles

The mean curved carapace length (CCL) of green turtles tagged for the first-time nesting in the CSMP in November-December 2019 was 105. 6cm, while the mean CCL for those tagged previously while nesting in the CSMP was 108.9cm (Table 7.2). There was a significant difference in the mean size of turtles nesting turtles tagged for the first time and those tagged previously while nesting in the CSMP (One-way ANOVA: $p<0.05$).

Table 7.1 Summary of the green turtles (*Chelonia mydas*) encountered during the survey of the Coral Sea Marine Park between 30th November and 8th December 2019.

Island	Date	Tagging Status				No. Nesting Attempts*
		P	ISR	ISR RTA	XFG	
NE Herald	30/11/19	22	12	1	0	35
NE Herald	1/12/19	31	6	1	1	38
NE Herald	2/12/19	28	3	1	1	33
NE Herald	3/12/19	19	6	0	0	25
Chilcott	4/12/19	35	0	0	1	36
SW Coringa	5/12/19	37	1	0	1	39
SW Coringa	6/12/19	40	0	0	0	40
SE Madelaine	7/12/19	41	0	0	0	41
NW Madelaine	8/12/19	48	0	0	0	48

* Denotes the number of successful nesting attempts observed per evening census. It may not accurately reflect the number of successful nesting attempts for that night.

Table 7.2 Summary of mean curved carapace lengths for green turtles (*Chelonia mydas*) measured in the Coral Sea Marine Park between 23rd November and 16th December 2019.

Tag status	Descriptive statistic				
	Mean	STD.	Min.	Max.	Number
All Primary taggings	105. 6	4. 56	91. 0	120. 6	294
All ISRs (excluding ISR-RTA's)	108. 9	4. 9	98. 1	116. 5	27

Recaptures - CSMP recorded turtles tagged or captured elsewhere.

Four turtles that had been tagged while feeding were re-encountered while attempting to nest in the CSMP during the 2019/20 season (Table 7.3): two turtles that had been originally tagged while foraging at Clack Reef and two at Combe Reef near Princess Charlotte Bay, on the east coast of Cape York Peninsula (Fig. 7.5).

Table 7.3 Summary of green turtles (*Chelonia mydas*) recorded nesting in the CSMP tagged or captured at inter-nesting habitat.

Primary tag	Location	Season tagged	Recapture date	Recapture location
QA40235	Combe Reef	2014	4/12/19	Chilcott Islet
QA94647	Combe Reef	2019	5/12/19	SW Coringa Islet
T55987	Clack Reef, Princess Charlotte Bay	1991	2/12/19	NE Herald
T47046	Clack Reef, Princess Charlotte Bay	1989	3/12/19	NE Herald

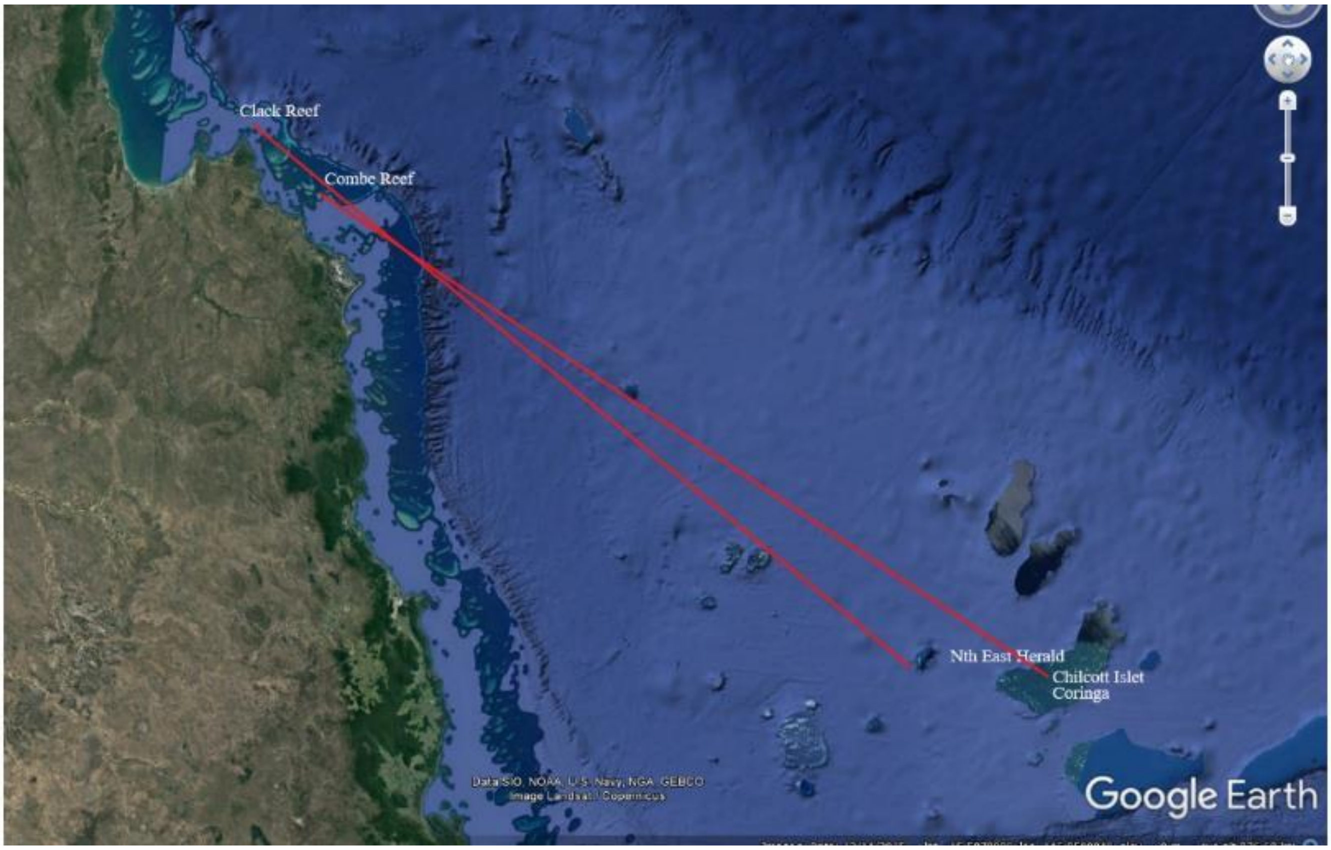

Fig. 7.5 Foraging area turtle recaptures in the Coral Sea Marine Park.

Satellite Tracking

Eight turtles were successfully fitted with Wildlife Computer “Splash 10” satellite tags. Four of the eight turtles had successfully nested in the CSMP in the past. One turtle (T57452) had originally been tagged in 1991. These turtles, that had been tagged nearly 30 years ago were selected to determine where their “protected” foraging areas were located. Four turtles were new to the study (Table 7.4). A summary of the GPS satellite telemetry study is provided in Appendix 8.

Table 7.4 Summary of turtles fitted with satellite trackers**.**

Prefix	Tag number	Status	Date tagged	PTT #	Genetic sample	CCL	Original tagging and subsequent recapture year	Location
CA	1681	ISR	2/12/2019	181924	GM0307	104. 4	1996/2002	NE Herald
CA	3589	ISR	30/11/2019	181921	GM0553	109. 5	1999	NE Herald
T	57452	ISR	30/11/2019	133769	GM0273	110. 4	1991/1998	NE Herald
CA	1853	ISR	1/12/2019	181920	GM0651	116. 4	1996/2002	NE Herald
CA	8251	P	30/11/2019	133768	GM0265	101. 5	N/A	NE Herald
CA	8480	P	4/12/2019	181923	GM0536	110. 7	N/A	SW Coringa
CA	8377	P	30/11/2019	133767	GM0581	112. 5	N/A	NE Herald
CA	8435	P	7/12/2019	181922	GM0554	108. 4	N/A	SE Madelaine

Genetic Samples

One hundred and eight tissue samples were successfully taken for genetic analysis.

Discussion

The 2019/2020 nesting season appeared to be of a similar density as the highest recorded season in 1999/2000 (Table 7.5). Large annual fluctuations in green turtles nesting density appear to be a normal part of the species life cycle, with the magnitude of these fluctuations have been linked to the *El Nino* Southern Oscillation Index (Limpus and Nicholls 1988).

Given that nesting was likely to have commenced in October 2019 and will continue until mid-April 2020, these data provide a sub-set of the total number of green turtles nesting within the CSMP for the 2019/2020 season.

During the December 2019 survey, approximately 94% of turtles failed to nest on their first (observed) attempt, emerging over consecutive nights to attempt laying. As outlined in previous reports (see Bell *et al*. 1998) there are several possibilities for this including:

- Normal behaviour by a small proportion of the nesting population.
- Disturbance during the crawl up the beach or while digging the nest. This can happen as a result of the tagging/checking for tags process or clouds, shadows, lightning, storms, and debris. The relatively high density of nesting for this season may also have meant that some turtles were unable to successfully nest on a particular night because of disturbance from other nesting turtles.
- Unsuitable nest site. A turtle will return to the water if attempts at digging a nest are unsuccessful. This can result from dry sand collapsing the egg chamber or roots, rocks, etc. obstructing the digging process. Dry sand is often a feature of the dryer earlier weeks of the nesting season (Limpus *et al*. 2001).
- Damaged rear flippers. Animals with damaged or missing hind flippers may experience considerable problems during the egg chambering process, which may lead to a failure to lay eggs.

Table 7.5 Number of green turtles (*Chelonia mydas*) recorded nesting on islands in the CSMP during each survey period.

Survey	**Number of turtles recorded**	**Number of nesting records**	**Duration of survey (days)**	**No. turtles/night**
Dec. 1991	105	240	8	13
Feb 1992	40	160	6	7
Dec 1993	235	565	9	26
Apr 1994	1	10	14	>1
Dec 1994	34	97	13	3
Mar 1995	12	28	29	>1
Dec 1995	373	695	14	27
Feb 1996	66	194	14	5
Dec 1996	734	*	15	50
Dec 1997	211	263	14	15
Dec 1998	60	102	17	3.5
Dec 1999	1715	*	40	43
Dec 2000	12	*	10	1
Dec 2001	687	*	9	76
Dec 2002	714	*	21	34
Dec 2003	288	*	22	13
Nov/Dec. 2019	**387**	*	9	43

* Track counts were not conducted each morning, so the number of nesting attempts cannot be accurately calculated.

Table 7.6 Number of inter-season re-migrant green turtles encountered in each season (expressed as a percentage of total turtles encountered nesting in that survey).

Nesting season	Inter-season remigrants %
1991/92	0
1993/94	0
1994/95	0
1995/96	0. 9
1996/97	2
1997/98	6. 3
1998/99	3. 3
1999/00	13. 4
2000/2001	12. 5
2001/02	32. 6
2002/03	38. 2
2003/04	28. 1
2019/00	12. 8

The lack of inter-season remigrants during the first three years of surveys and tagging is expected as there is an average remigration interval of approximately five years for the northern genetic stock of green turtles (Limpus *et al*. 2003).

As a nesting female ages, her remigration interval shortens on average over successive breeding seasons from the first to the fourth breeding attempt (C. Limpus unpublished data). Remigration interval appeared to be increasing until monitoring stopped in 2003/04 in response to increasing numbers of tagged turtles across the 13 years (Table 7.6). Limpus *et al*. (2003) determined that approximately a decade of systematic tagging was required to define the remigration interval for the northern GBR green turtle stock breeding at Raine Island.

One hundred and eight genetic samples were successfully collected to gain a contemporary understanding of the genetic structure within this nesting aggregation. This is an important metric for monitoring impact or change, either negative or positive, that may be occurring within a foraging area.

Historically the application of flipper tags was the only method available to determine and monitor demographic change, elucidate reproductive migration pathways or determine breeding areas (Limpus 1994). However, tag loss (Limpus 1992, Parmenter 1993a,b), the logistical challenges of tagging hatchlings (Limpus 1985) and typically a low tag recovery rate (Balazs 1999, Chaloupka and Musick 1997) in the absence of comprehensive multi-study site (Limpus *et al*. 2005, 2009) have hindered attempts to determine the source of green turtles within feeding aggregations. It is now hoped that genetic markers combined with flipper tag returns, will provide a reliable metric for identifying distinct natal regions and the breeding destinations of mature green turtles within feeding areas.

Recommendations for future turtle monitoring

To date a total of 3508 green turtles have been tagged in the CSMP. This study site now represents one of the largest datasets for a green turtle nesting rookery in the Pacific region. In terms of Australian east coast and Gulf of Carpentaria turtle monitoring, it is the third largest data set for nesting green turtles behind Raine Island (Northern Great Barrier Reef GBR) and the Capricorn Bunker Group (Southern GBR).

The survival of this population relies in part on informed management decisions based upon tag-return data that can only be obtained from long-term monitoring studies. It is important to note that the isolation of these nesting sites means that the most significant non-natural impacts on this population are occurring both locally (climate change impacts on island habitats) and elsewhere in the dispersed foraging areas, migratory corridors and oceanic post-hatchling pelagic foraging range.

The CSMP turtle population (all size classes and sexes) is likely to suffer threats to their conservation status by the following anthropogenic factors, albeit to an unknown extent:

Resource Use – Annual subsistence and commercial take of green turtles through Indonesia, Timor, Papua New Guinea, and western Pacific countries may be in excess of 100 000. Tag recoveries obtained to date indicate that at least some proportion of the CSMP population is subjected to Indigenous take pressure in northern Australia and Papua New Guinea.

Climate Change – Impact on nesting beaches from loss of nesting habitat associated with sea level rise.

Commercial fishing – Threats to the foraging population from entanglement and subsequent drowning in the trawl fisheries, long line fisheries and in-shore gill net fishery remains unquantified, especially outside of Australian waters.

Loss of foraging habitat – Green turtles are herbivorous grazers, primarily feeding on *Halophila* and *Halodule* species in sea grass meadows and selected algal species on reefs and in mangrove areas. Localities that provide shelter and water conditions ideal for seagrasses are often the target for port developments and at the down-stream end of severely affected catchments (Lee Long and Coles 1997).

Marine pollution – This can have obvious impacts through destruction or degradation of foraging habitat and impact on nesting sites. Current collaborative studies between Exeter University and Department of Environment and Science (DES) Aquatic Threatened Species Program are indicating that the mortality from ingestion of micro-plastics by post-hatchling green turtles foraging on surface plankton in oceanic pelagic water is emerging as a major threat to species survival (C. Limpus, unpublished data).

Disease – This has recently been highlighted as a growing concern in the marine environment. While there does not appear to be significant signs of disease in the CSMP population this warrants monitoring into the future.

Most of these threatening processes occur away from the monitored nesting sites in the CSMP. At present the foraging sites of the CSMP nesting population are considered to be very similar to those of the nGBR genetic stock and this issue should be highlighted when addressing management of the nGBR stock. Any future attempts at management of the CSMP for turtle habitat will be inadequate if there is not adequate management of impacts in foraging habitat.

Continued tagging over a set period in each nesting season is crucial to establishing links to foraging grounds. Links have already been established between the CSMP nesting population and foraging grounds within Princess Charlotte Bay and Torres Strait – both these areas are subject to high levels of indigenous hunting.

While some of the other impacts may not be as prevalent in the northern GBR genetic stock {e.g. habitat loss, boat strike, disease (spirorchid blood flukes; fibropapilloma)}, these may increase over time as coastal development and resource utilisation in northern coastal areas grows.

It is recommended to continue monitoring nesting turtle populations to include:

- Minimum of two weeks of tagging census at one or more “index” beaches (i.e. NE Herald) to determine if significant trends in population abundance are emerging.
- Quantification of hatching and emergence success to determine if significant trends are occurring.

- Continuation of monitoring morphometrics (particularly curved carapace measurements) as an indicator of threats to the population, specifically the loss to the population of adult females to indigenous harvesting or changes in coastal habitat quality.
- Comparison of CSMP with northern and southern Great Barrier Reef genetic stocks (Raine, Milman Island, Heron Island, Mon Repos identified in the Queensland Marine Turtle Conservation Strategy) to determine and compare trends.
- Use of CSMP as an independent baseline model, to provide a nesting site that is isolated, and removed from most human influence (e.g. lights, boats, coastal development, catchment management and pollution, and recreational use) compared to the breeding sites within the GBR.
- Support for green turtle foraging ground studies that establish and enhance further links with the CSMP nesting population.
- Encouraging State and Federal management agencies to maximise tag returns from far northern indigenous communities, perhaps through funding a tag collection program.
- Aerial surveillance (at start and middle of the nesting seasons) to determine commencement of nesting season.
- Documentation of the courtship habitat and density of mating pairs prior to the start of the nesting season.
- Track counts on cays to assess comparative nesting density though out CSMP.
- Coastal geomorphological modelling of impact of projected sea level rise on available nesting habitat.

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8.0 Introduced species (pests)

8.1 Rodents

Graham Hemson

Introduction

Rodents are a major threat to seabird and turtle nesting islands and may significantly impact on the reproductive potential of breeding populations by consuming eggs and hatchlings and may attack and kill adult seabirds. While rats (*Rattus* spp.) are widely acknowledged as the most significant rodent threat, mice have also been found to have major impacts (*Mus* spp*.*) (Caravaggi *et al.* 2018, Wanless *et al*. 2007). Rodents are a significant biosecurity threat, readily stowing away on vessels and/or in transported equipment. In preceding centuries, it is highly likely that any landing by a vessel or shipwreck would have carried with it a very high probability of rodents getting ashore.

This element of the project aimed to provide an objective assessment of whether rodents were established on any of the vegetated cays visited. This information can be used to inform and prioritise future management options.

Methods

We deployed rodent tracking tunnels baited with peanut butter for 1-3 nights. Each tunnel contained a thin card tracking pad with a waterproof section in the middle. This waterproof area was liberally covered in a slow drying ink and approximately 1cm^3 of peanut better was placed in the centre of this ink using a teaspoon. The traps work on the principal that rodents attracted to the bait must walk through the ink and then on leaving the tunnel leave tracks.

The duration that traps were deployed was determined by broader trip logistics; shorter deployment reflected the narrow windows of opportunity at some sites. Two thirds of traps were spaced approximately evenly in vegetation within 10m of the edge of the island's vegetation. The remaining third were deployed in association with invertebrate survey sites in vegetation through island's interiors. Refer Figure 8.1 for an example from North East Herald.

All traps were collected at the end of the deployment and the cardboard tracking pads were examined for rodent tracks.

Fig. 8.1 The location of rodent monitoring tunnels on North East Herald.

Results

No rodent tracks were observed on any tunnels. Droppings, superficially like rodents, were observed in some tunnels placed near beach rock which had unusual collections of tiny crescent-like tracks. Subsequent observations of crabs and their droppings in the inter tidal zone led the team to conclude that these droppings and tracks were from hermit crabs which were very abundant.

Discussion

Despite traps being set on some islands for less than the preferred three nights, the absence of rodent tracks in all tunnels, the absence of any sightings of rodents, tracks and droppings during our visits and the abundance of breeding seabirds, supports the conclusion that there were no rodents on any of the islands surveyed.

It is possible that the shortened duration of deployment and uneven distribution of traps could have missed a small localised population of rodents. However, a small localised distribution would most likely equate to a recently introduced rodent population that had as yet not reproduced and spread across an island. As very few vessels visit these islands and access is almost exclusively via small tenders the probability of a recent infestation seems implausible. Rodent infestations were more likely to occur in the past when vessels more regularly ran aground and when islands were visited to examine commercial opportunities (e.g. turtle canning and guano mining). If rodents had become established on an island in the decades prior to the current survey it is highly unlikely that they would not be well established right across it.

An alternative explanation is that rodents were present but were not interested in the peanut butter bait. This explanation seems unlikely because: peanut butter bait is extremely widely used; has recently proven to be successful in attracting rodents at North West Island in the Capricornia Cays and; the islands visited were very dry such that natural food sources were likely to have been scarce.

On balance the most likely explanation for the results observed is that there were no rodents on the islands surveyed.

The deployment of rodent tracking tunnels is a rapid and cost-effective way of surveying for the presence of rodents. We recommend that all islands be surveyed for rodents every few years. The frequency of surveys could be informed by the frequency of visitation by all vessels. Island Watch surveys, Health Checks and seabird surveys are also good opportunities to check for signs of rodent presence. Any tracks or droppings of unknown provenance, gnawed bird carcasses or other materials, and unexplained declines in seabird presence or nesting could all be used as cues to deploy rodent tracking tunnels.

Before deploying tunnels, in the future, we recommend that alternatives to the corflute tunnels, or reliable methods of ensuring they remain free of biosecurity risks, be explored. The corflute has significant volumes of hidden space in which ants or other small invertebrates could stow away. It might be possible to pressure wash the tunnels on the mainland to ensure all spaces are blasted out and then pack them flat in sealed storage containers for transport to islands. They should not be redeployed between islands before they have been re-cleaned.

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8.2 Invertebrates: scale, ants and moths – key threats to *Pisonia grandis*

J. Olds, A. Congram and A. McDougall

Introduction

The forest at SW Coringa Island was completely destroyed by an outbreak of *Pulvinaria urbicola* during the 1990's (Smith *et al.* 2004). NE Herald was also affected, but the infestation was not severe when assessed in 1997 (O'Neill *et al.* 1997). Significant levels of infestation and tree deaths were observed in August 2000 (Hallam, pers. comm.) and a survey was conducted to determine the extent of the problem. No effective natural enemies of the scale were found during the survey and so a biological control program was implemented from 2001-2007 (Freebairn 2007). Three species of scale parasitic wasps (*Coccophagus ceroplastae*, *Euryischomyia flavithorax* and *Metaphycus luteolus*) and a native predatory beetle (*Cryptolaemus montrouzieri*) from the mainland were released and became established on islets including NE Herald (Smith *et al.* 2004).

Ants form facultative mutualisms by harvesting honeydew from scales and in return protecting them from predators and parasitoids and moving them between host plants (Buckley 1987). Thus, both ant and scale densities can reach higher population levels than either species could attain in isolation, with devastating effects on host plants and vegetation structure (O'Dowd *et al.* 2003). In the Capricornia Cays the African big-headed ant (*Pheidole megacephala*) was associated with scale outbreaks (Kay *et al.* 2003; Olds 2018). The pennant or Guinea ant (*Tetramorium bicarinatum*) was associated with scale outbreaks on cays in the Coral Sea (Smith *et al.* 2004). *P. megacephala*, possibly in combination with *T. bicarinatum*, was associated with an outbreak at Palmyra Atoll (Handler *et al.* 2007). In the Seychelles the yellow crazy ant (*Anoplolepis gracilipes*) has exacerbated scale outbreaks (Hill *et al.* 2003).

P. urbicola, its mutualistic ant *T. bicarinatum and* the ladybird beetle predator *C. montrouzieri* where not detected on the most recent Bush Blitz surveys in the (then) CSCMR in 2016 (Commonwealth of Australia, 2017). However, the sampling was limited (Commonwealth of Australia, 2017) and so it was not possible to conclude that these species were absent. Only two species of ant, *Nylanderia bourbonica* (an introduced widespread tropical tramp ant) and *Cardiocondyla atalanta* (considered an Australian native), were collected in the 2016 Bush Blitz surveys. *C. atalanta* is a cryptic sister species to *C. nuda*, which was previously collected and possibly erroneously identified. The record of *N. bourbonica* was the first for this species in the CSMP.

Scale outbreaks remain a recognised key threat to *P. grandis* throughout its range. The 2019 survey therefore focused on the species associated with outbreaks and included targeted scale and ant surveys primarily within the *P. grandis* forests of the CSCMR. Concurrent, incidental predator surveys and assessment of scale parasitism levels by previously introduced scale predators and parasitoid wasps were also conducted.

During the scale monitoring programs from 2001 to 2007, three species of defoliating caterpillars were found to represent a threat to the *Pisonia* and *Cordia* forests; principal amongst these was the hawkmoth *Hippotion velox*, the large larvae of which can defoliate up to 80% of a *Pisonia* forest (Freebairn 2007). In 2019, light traps were used to determine presence/absence and relative abundance of these species in the CSCMR. Relative levels of impact from these species and incidental occurrences were also recorded in the scale surveys.

Methods

Scale

A map of historic transects (established 1982) on NE Herald was obtained from Mark Hallam (Coral Sea National Nature Reserve warden 1980's to 2000's) prior to the field trip. All transects were surveyed in 2007 by Freebairn (2007) but because of time constraints a subset (1, 3, 6, 9 and 11) was selected for re-surveying in 2019 (Figure 8.2).

Satellite imagery, together with more detailed drone imagery obtained on site (refer section 4), was used to identify additional sites in *P. grandis* for targeted *P. urbicola* survey.

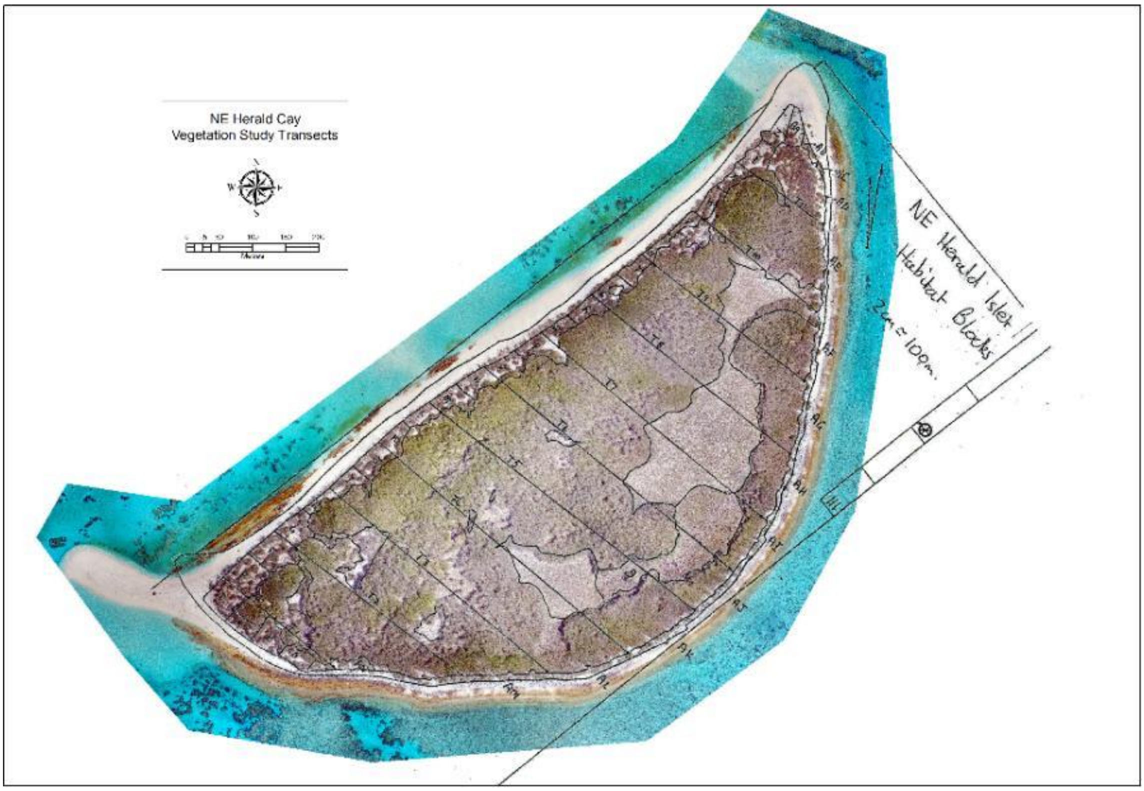

Fig. 8.2 Drone imagery (2019) of NE Herald Cay overlayed with the transects established in 1982.

The 10-branch-end method was used to survey scale in 2019. The method was developed by Chris Freebairn for monitoring scale at NE Herald and has also been used in the Capricornia Cays (Olds 2018). It overcame the limitations of the original six-leaf method which, at low scale levels often does not detect any scale, and usually fails to detect the predator *C. montrouzieri* and parasitoids such as *C. ceroplastae* (Freebairn 2006a). The method also increased the number of leaves sampled per site by about 30-fold with no increase in time compared to the six-leaf method (Freebairn 2007).

Ten branch-ends, with approximately 10 leaves each, were randomly selected per site from *P. grandis* trees in reach of surveyors. These were visually assessed (Plates 8.1 and 8.2) and assigned abundance scores/infestation categories (number of scale per 10 leaves): 0; 1-50; 50-500; and >500. A copy of the scale data sheet is provided in Appendix 9.

Plate 8.1 Andrew Congram inspecting leaves for scale.

Plate 8.2 *Pulvinaria urbicola* with egg masses.

Ants

The presence/absence of ant species was assessed on all islands by using baits comprised of peanut paste and tuna (cat food) (Plates 8.3 and 8.4). Both types of baits were used because of their efficacy in attracting different ant species based on their food preferences. The peanut paste proved the longest lasting in the conditions experienced on the trip.

At NE Herald, baits were laid at 22 stations along the five transects used for the scale survey. Baits were laid at stations along a single central transect along the long axis of the remaining five islands (i.e. SW Herald, SW Coringa, Chilcott, SE Magdelaine and NW Magdelaine). The baits were left for at least 30 minutes, after which they visually assessed. Abundance scores: 0; 1-50; 50-100; 100-500; and >500 were recorded for each ant species attending the bait. Voucher specimens of all species were collected and stored in vials of alcohol for later identification by Queensland Museum (QM). A copy of the data sheet is provided in Appendix 10.

Incidental hand collecting of ants was undertaken on all six islands.

Plate 8.3 Ant bait and dead booby chick at marked survey point.

Plate 8.4 *Monomorium pharaonic* workers (length 0.2cm) on bait at SE Magdelaine.

Moths and other insects

One light trap was deployed for one night on each island, except NW Magdelaine, to survey moths and other light-attracted species (Plate 8.5). The trapped contents were firstly killed in killing jars and then sorted and stored in alcohol or, in the case of moths and grasshoppers, were pinned out. Voucher specimens were sent to QM entomologists for identification and to include in the QM collection.

Plate 8.5 Andrew Congram (standing) and Andrew McDougall collecting insects from light trap on SW Herald.

Results

Scale

NE Herald

In 2007, scale was detected on ten (91%) of the 11 transects surveyed at that time. It was detected across 49 (73%) of the 67 sites on the transects, and 169 (25%) of the 670 branch ends. Of the 670 branch ends sampled, 75% (501 branch ends), 14% (96), 7% (47) and 4% (26) had 0, 1-50, 50-500 & >500 scales, respectively. For scale infested branch ends, 57% had 1-50 scales, 28% 50-500 and 15% more than 500 scales (Table 8.1 and Figure 8.3).

Twelve years later in 2019, there was scale across all five transects surveyed, however it was detected at only nine of the 19 sites (47%) and 16 (8%) of the 190 branch ends. Of the 190 branch ends surveyed, 92% (174 branch ends), 7% (13), 1% (3) and 0% (0) had 0, 1-50, 50-500 & >500 scales respectively. For scale infested branch ends, 81% had 1-50 scales, 19% 50-500 and 0% more than 500 scales (Table 8.1 and Figure 8.3).

Table 8.1 NE Herald 2007 and 2019 scale survey results.

Parameter	Number		Percent (%)		% of infested	
	2007	2019	2007	2019	2007	2019
Transects	11	5				
With scale	10	5	91	100		
Sites	67	19				
With scale	49	9	73	47		
With parasitism (of infested b/ends)	27	1	55	5		
With *C. montrouzieri*	6	1	9	5	12	11
Leaves	~6700	~1900				
Branch ends	670	190				
With no scale	501	174	75	92		
Scale > 0	169	16	25	8		
Scales 1 - 50	96	13	14	7	57	81
Scales 50 - 500	47	3	7	1	28	19
Scales > 500	26	0	4	0	15	0

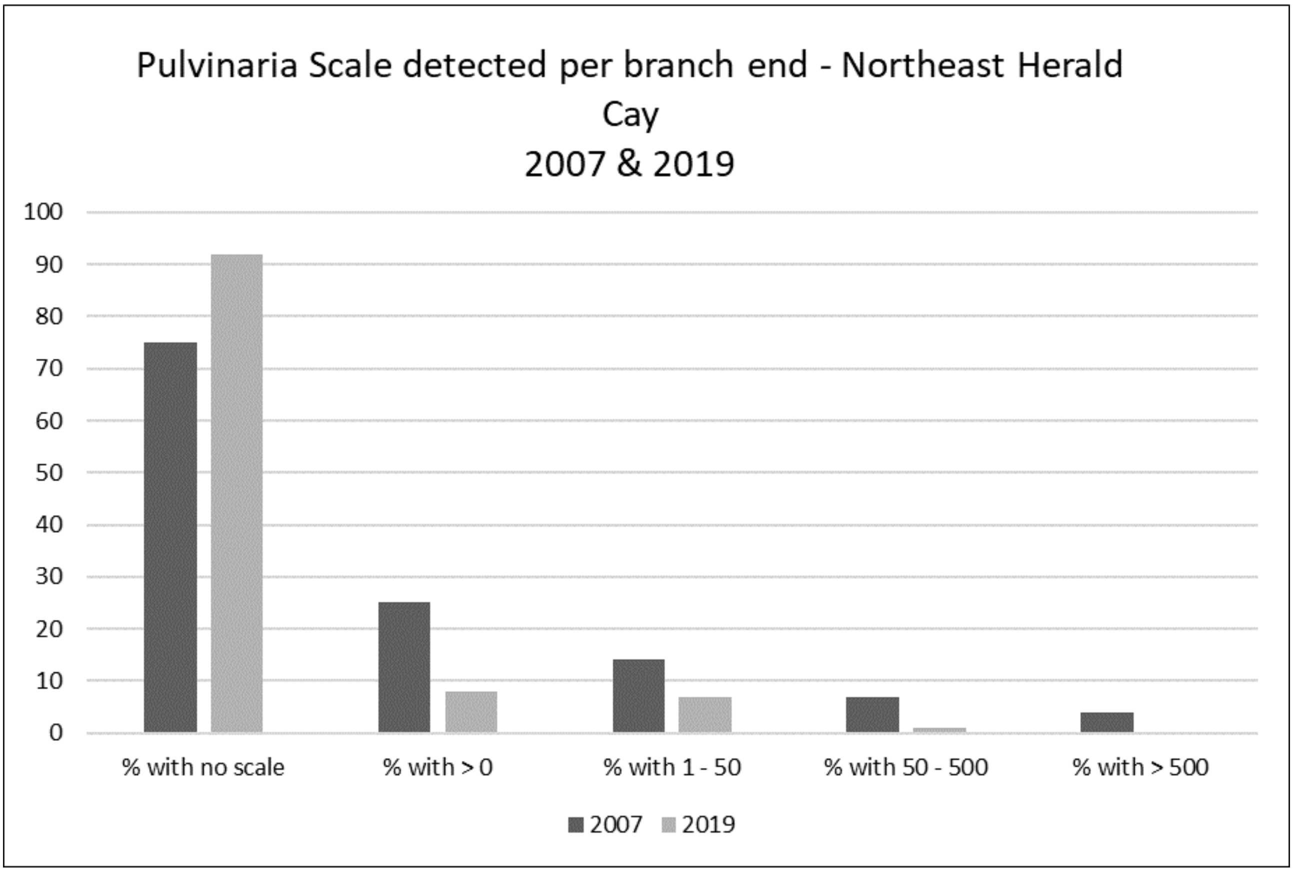

Fig. 8.3 Comparison of scale survey results from NE Herald in 2007 and 2019.

SE Magdelaine

No *Pulvinaria* scale was detected at SE Magdelaine.

Ants

NE Herald

Ants were attracted to 12 of the 22 bait stations placed along the five transects. All ants attending baits had an abundance score of 1-50.

T. bicarinatum was the most abundant and widespread species and was recorded at seven stations. A *Cardiocondyla* sp. (either *C. atalanta* or *C. nuda*) was recorded at four stations. One individual black ant, possibly *Nylanderia bourbonica,* was recorded at one station.

The only species recorded at NE Herald in 2007 was *T. bicarinatum;* however, ants were not specifically surveyed at that time (Freebairn 2007). Had this method been used in 2007, abundance scores would have all been much higher (J. Olds pers. obs.).

SW Herald

No ants were attracted to any of the seven bait stations at SW Herald. *T. bicarinatum* was observed however, on the sand below patches of shoreline grass, where it may have been scavenging or possibly tending a homopteran (e.g. scale, mealy bug) feeding on the sap from grass roots.

SW Coringa

One species, *Monomorium pharaonis,* was attracted to the bait stations. It was recorded at two of the seven bait stations with abundance scores of 1-50 at one station and 100-500 at the other.

Chilcott

One species, *M. pharaonis,* was attracted to the bait stations. It was recorded at all six bait stations with an abundance score of 1-50 at three stations and 50-100 at the other three.

SE Magdelaine

One species, *M. pharaonis,* was attracted to the bait stations. It was recorded at five of the eight bait stations, with an abundance score of 1-50 at two stations and 100-500 at the other three.

NW Magdelaine

No ants were attracted to any of the six bait stations.

Moths and other insects

Two species of hawkmoth, *Hippotion velox* and *Agrius convolvuli* were recorded with vouchers specimens taken from the light traps on all the cays. The identification of these two hawkmoth species was confirmed, from photographs, by Chris Burwell from the QM and Max Moulds an Australian authority on hawkmoths.

Hawkmoth defoliation was old, recovering and low (10% or less) at NE Herald compared to the high levels recorded in 2007 on much of the island. Similarly, at SE Magdelaine the *Pisonia* forest was recovering from a very low level of damage (5% or less), although no records of previous levels of damage were available as a comparison.

Other moths and a number of other species of insect, including some grasshoppers, were collected with the light traps. Several specimens of what appeared to be a single species of mealybug, presumably *Ferrisia malvastra* as reported by Freebairn (2007), were hand collected from *Abutilon albescens*, *Argusia argentea*, and particularly the roots of *Achyranthes aspera*.

Confirmation of the identification of all insect specimens is currently awaiting review by the QM.

Discussion

A significant caveat on the results herein relates to the conditions experienced during November and December 2019. While proving an excellent time in terms of sea conditions, the prevailing hot, dry conditions were not conducive to invertebrate surveys. It is well known that insect populations tend to fluctuate in response to growth flushes in their host plants and consequently the natural enemies of the insects follow these cycles as well. Autumn would therefore be a more appropriate time to assess insect populations on the CSMP islands. Insects with the potential to impact the key vegetation communities, and their natural enemies, would be abundant, or relatively so, in that season.

Other than at NE Herald, there was very little evidence of the scale *P. urbicola* on the islands surveyed in 2019. Although the 2019 scale survey was not able to be conducted across all eleven transects at NE Herald, there is no doubt that the data shows a marked reduction in *P. urbicola* numbers since the last most detailed survey (Freebairn 2007). The only evidence of the native predatory beetle *C. montrouzieri* was a single coccinellid larva and a few eaten eggs masses at one of the sites on NE Herald. None of the three species of parasitoid wasps that were released with *C. montrouzieri* between 2002 to 2007 were observed in the field in 2019. However, some maye sorted from the light trap collections currently with the QM. There was one site where 10% of scale on one ten branch end were parasitised – all other sites had less than 10%, and the amount of scale with eggs suggested parasitoid numbers were very low on NE Herald. No scale nor associated predators were detected in the Bush Blitz surveys in 2016 on the four islands surveyed (East Diamond, SW Coringa, NE Herald, SW Herald), although they were very time limited (Commonwealth of Australia, 2017).

The following summary of *P. urbicola* infestations in the CSMP may shed some light on the current situation. An infestation of *P. urbicola* and associated defoliation of *Pisonia,* was first noticed on SW Coringa by Australian National Parks and Wildlife staff in 1991 (Smith *et al*. 2004). By 1997, 80% of the 16 ha forest on SW Coringa had been destroyed and heavy infestations – in some cases apparently leading to death, were observed on other plant species, including *Boerhavia albiflora* and *Tribulus cistoides,* on SW Herald, Chilcott, Willis, Anne and Georgina Islets (O'Neill *et al.* 1997). SE Magdelaine was not visited in 1997. By 2001 the former *P. grandis* forest area on SW Coringa Islet had been replaced by a dense herbland with *Achyranthes aspera*, *Portulaca oleracea*, *T. cistoides* and *Ipomoea* spp. heavily infested with *P. urbicola* (Smith *et al.* 2004). In the same year, the *P. urbicola* outbreak on NE Herald was reported by Smith *et al*. (2004). They found no evidence of parasitoids or coccinellid predators such as *C. montrouzieri* in the (then) CSCMR (Smith *et al*. 2004). SE Magdelaine, one of the least visited islands showed no evidence of *P. urbicola* in 2001, when it was first surveyed for scale. An infestation of *P. urbicola* was found on SE Magdelaine the following year at one site (Smith *et al*. 2004). It is possible that the biosecurity measures mentioned in Smith and Papacek (2001) may not have been adequate to prevent the transfer of *P. urbicola* to SE Magdelaine from the infested islands.

Measures were undertaken to reduce the impact of the scale as discussed in Smith *et al*. (2004) and Freebairn (2007). These included localised baiting of the mutualistic ants and periodic releases of *C. montrouzieri.* Approximately 50,000 *C. montrouzieri* were released between 2002 to 2007. Most of these releases occurred on NE Herald but some were also made on SE Magdelaine and SW Coringa. A release of 2000 *C. montrouzieri* adults was undertaken on SE Magdelaine in 2002, during the same visit that the infestation was detected. The early intervention, and the island's isolation and lower visitation, is most likely why *P. urbicola* has not been found on that island on subsequent visits. Strict biosecurity measures were adhered to on the current trip to minimise the risk of transferring *P. urbicola* between islands.

It is evident that the development of *P. urbicola* is being kept in check on NE Herald and almost certainly also on the other islands where previous infestations were recorded. *C. montrouzieri* is probably a key factor. It appears, as is typical of many predatory coccinellids, that *C. montrouzieri* increased to large numbers when its' host was abundant and declined to low numbers as the host became scarce. A valuable alterative host for *C. montrouzieri* is most likely the mealybug, *F. malvastra*, which was first recorded on NE Herald in 2006, where it was observed being consumed by larval *C. montrouzieri* (Freebairn 2007). Mealybugs were observed on all islands visited in 2019 and appeared most common on the roots of *Achyranthes aspera,* an apparent refuge and food source during dry spells. Mealy bugs are the preferred food source of *C. montrouzieri* and may enable it to survive periods when *P. urbicola* scale levels are low and/or during periods of extreme weather conditions.

The releases of *C. montrouzieri* to control *P. urbicola* outbreaks on NE Herald and SE Magdelaine in 2002 (Smith *et al*. 2004) and Wilson Island in 2006 (Olds, 2018) were effective in protecting *P. grandis* forests from the destructive impacts of multiple generations of *P. urbicola*. Early detection is however imperative to enable early intervention and prevent significant impact on *P. grandis* forests in the future. Managers of the CSMP islands do not need to use detailed surveillance programs involving quantitative scale monitoring. Such programs are resource intensive and may not be effective in predicting outbreaks, which can develop in less than six months

(Olds, 2018). Outbreak conditions are obvious and should easily be detected by basic monitoring programs such as the QPWS&P Health Check protocol (Melzer 2019), which targets a range of ecosystem health indicators and, because it is rapid, can be undertaken at a relatively large number of sites.

M. pharaonis was recorded on three of the six islands surveyed and was the most common and abundant ant species in 2019. It is a new species record for CSMP having previously been recorded as *Monomorium* sp. (Smith *et. al*. 2004). Although exotic to Australia, the ant has most likely been on the CSMP cays for a long time as it is an 'old world' species and has been in Queensland since early European settlement (Chris Burwell, pers. comm.). The species is a known symbiont and the abundance and monospecificity of the ants found at SW Coringa indicates that *M. pharaonis* was almost certainly the ant species associated with *P. urbicola* and the subsequent loss of the *Pisonia* forest on that island.

The exotic *T. bicarinatum* was the dominant ant on NE Herald in 2019, as it was in 2007 (Freebairn 2007), but it was much less abundant in the recent survey – most likely as a result of the lower scale numbers.

The single individual of *Monomorium* sp. that was reported as a black ant from NE Herald in 2007, could have been *Cardiocondyla* sp. (*C. atalanta* or *C. nuda)*. The latter was found in the Bush Blitz surveys in 2016 and in the 2019 survey.

Fortunately, the exotic *Pheidole megacephala*, recorded from Willis Island (Farrow 1984) was absent from the islands visited in 2019. The feasibility and likely benefits of eradicating all of the exotic ants from the islands of the CSMP should be considered. All of them have known negative, albeit varied, impacts on native Australian wildlife and may cause significant impact to naïve ecosystems on remote islands. Eradication protocols would need to include strict biosecurity measures to ensure other, and potentially more damaging, invasive species were not introduced and that the species targeted for eradication were not reintroduced.

Hawkmoth damage at NE Herald and SE Magdelaine was first detected on aerial imagery in March 2001 as a grey, possibly defoliated patch in the *P. grandis* forest (Smith *et al*. 2004). Severe defoliation of *P. grandis* by the larvae of the sphingid or hawkmoth *H. velox* was subsequently observed during the scale monitoring trip that year (Smith and Papacek, 2001). Another hawkmoth *Theretia* sp. was observed doing similar damage on the same trip (Smith and Papacek, 2001) but the species was not confirmed and there have been no subsequent records. In response to the hawkmoth damage, the egg parasitoids *Trichogramma pretiosum* and *Trichogramma carverae* were released on NE Herald and on SE Magdelaine in 2002 (Smith *et. al*. 2004). Hawkmoth damage was considered a possible precursor to scale outbreaks and releases of the parasitoids continued over the following years until at least 2007 (Smith *et. al*. 2004; & Freebairn, 2007). Although *H. velox* was collected in the light traps in 2019, the impact of the parasitoids, first released over a decade ago, may explain the considerable decrease in damage by hawkmoth larvae in 2019 compared to 2007. The larvae of *A. convolvuli*, the other hawkmoth species collected in 2019, feed on plants in Convolvulaceae. The hawkmoth *Hippotion celerio* was identified during the Bush Blitz surveys in 2016 but, unless it is among specimens collected in the light traps and sent to the QM, it was not found in 2019. It is a species that could potentially impact *P. grandis.* The egg parasitoids mentioned above may however, continue to be efficacious against this hawkmoth species as well as *H. velox*.

Freebairn (2007) mentions that the *Cordia subcordata* at NE Herald were largely defoliated in 2007 and reported that the larvae of a nolid or tuft moth *Armactica columbina* and/or a gelechioid moth (i.e. case-bearers, twirler moths) *Ethmia* sp. had been seen and were the two most likely species causing the defoliation. He also noted that giant grasshoppers, *Valanga* sp., were also defoliating the *C. subcordata*, and that ants (*T. bicarinatum)* were observed chewing floral parts, presumably seeking moisture. Another nolid moth, as well as several noctuid (i.e. owlet moths, cutworms or armyworms) and gelechioid moth species, were collected in the Bush Blitz survey in 2016 (Commonwealth of Australia, 2017). This array of species are capable of causing the considerable damage to *C. subcordata* observed on the islands in 2019.

Plate 8.6 Andrew Congram and patch of fallen dead *C. subcordata* on NE Herald.

C. subcordata is now much less abundant on all islands than in 2006-2007 (Batianoff *et al.* 2008) and appears to have almost died out on some of the islands in the CSMP (refer section 5). Where there were once large patches there are now dead stems with few if any leaves and in some cases, there are swaths of fallen dead trees. The estimated age and unidirectional nature of these swaths on NE Herald suggests that they may have been blown or washed over by wind or storm surge from a tropical cyclone such as TC Yasi in 2011. Defoliation from moth larvae along with prolonged dry spells however may have been the precursors to the substantial loss of *C. subcordata.* The entomological component of this complex problem may have been reduced had a biological control program similar to that used for the *P. grandis* forests been implemented.

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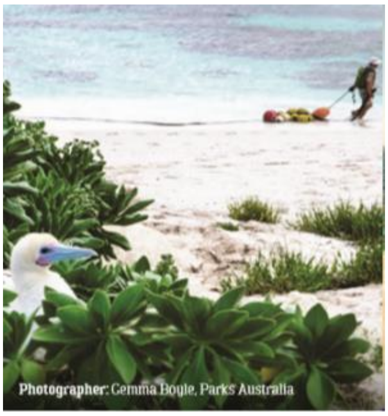
Appendices

Appendix 1. Island 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 40^0C 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.		
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 <u>personal</u> 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, <u>or</u> 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'		
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 <u>raw</u> meats (especially chicken), <u>raw</u> 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°C with detergent <u>or</u> 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 traps around these areas when trip is completed. 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°C with detergent <u>or</u> 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 Parks Australia.		
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.		
Alert AQIS (Australian Quarantine and Inspection Service) and Biosecurity Queensland of any pests or diseases that could be a risk.		

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		
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		

6) APPENDIX

6.1 Extract from Reef Ranger joining instructions (version Oct 2018)

Send to participants well ahead of each trip

Island Biosecurity

It is important to prevent new pests and diseases from reaching islands, particularly National Park islands. Whilst aboard Reef Ranger, it is particularly important that we lead the way in keeping our Islands biologically secure (i.e. we practice biosecurity).

Some important things to remember with Island Biosecurity before and during your trip:

- All your equipment and gear needs to be clean and checked before boarding

- Before boarding, make sure all clothing is laundered in ≥40^0 C water with detergent and footwear is thoroughly cleaned (inside and out). Turn pockets inside out before washing. Check Velcro (in particular) for seeds.

- If you have had contact with aviaries or poultry in the previous 3 months, and particularly if you are visiting a seabird island, you may have to follow Super Hygiene procedures (including wash down in antibacterial solutions); Check with OIC for more information.

- As you go, please maintain a close 'hygiene' eye on gear and equipment before it comes onto or leaves the boat.

- Exceptional value Islands (e.g. Raine Island) will have strict biosecurity procedures on-site. Please make yourself familiar with these by checking with the OIC.

- If your trip is accessing islands with high level biosecurity requirements then before entering the vessel, a physical inspection of your bag (and personal items) including a sign off, may be required by the trip OIC.

6. 2 VIRKON S

6. 2a General information

Virkon S is the current product of choice. There is a limited range of suitable products that kill bacteria, viruses and fungus. There is a new player on the market, a liquid called F10, that seems equivalent to Virkon.

Virkon is available as a concentrated liquid; powder in bulk buckets or single-dose sachets; and tablets. The choice is up to the project manager, the trip OIC and the vessel master.

QPWS usually uses the powder form in the sachets, as the dose is pre-measured. Tablets are hard to obtain and expensive. Liquids carry the risk of spills on the vessel during rough seas.

There is a safety risk with the powder form during mixing, as the powder can cause serious eye damage and respiratory irritation. Use of Virkon should be supervised by someone trained to use it, preferably holding an ACDC licence. The diluted solution is noncorrosive to skin and eyes.

Prevention: Wear protective gloves and eye/face protection. Use only in a well-ventilated area. Avoid breathing dust. Wash hands thoroughly after handling.

- Virkon S label for powder form available here: http://websvr. infopest. com. au/LabelRouter?LabelType=L&Mode=1&ProductCode=68503

- Virkon MSDS (material safety data sheet) available here: http://virkon. us/wp-content/uploads/sites/15/2017/11/VirkonTM-S-USA. pdf

Appendix 2. Island Watch datasheet.

GBRMP Island Watch - QPWS

Scope: To provide information about the condition and trend of all islands and cays so that changes and risks can be tracked, assessed and actioned.
Does not replace or duplicate existing systems. This serves as a cover sheet to collate all info.
All records must still be entered into the appropriate systems (eg Wildnet, FLAME). This form does not replace that.

GBRMP Island Watch
Ver. 17_10

Person completing form (full name)	**Additional observers on the island and affiliation** (eg Wildmob/volunteers/Indigenous ranger group):	
Date	**Purpose of visit:**	**Amount of time spent on island (hours/days)**
Island name	**GBR Island number *or* NP name *or* general locality** (In case of duplicate names)	

		Yes/ No	COMMENTS/ FUTURE ACTIONS NEEDED
BIRDS All data to be entered into QPWS bird database.	**Incidental bird survey done**		
	Coastal Bird Monitoring and Information Strategy survey done (essential/significant site)		
	Is this a new or unusual bird sighting, or are there any changes to condition of nesting/roosting habitat?		
TURTLES Photos of tracks with an object to indicate size is very useful for ID. Entries should be made in Wildnet or Strandnet where relevant.	**Turtles seen on island** (Species and number) Specify live or dead - measure CL and cause of death if possible		
	Number of nests /bodypits (each nest will have two tracks – one up and one down)		
	Any signs of nest predation (include number of nests affected & predator if known eg dog, pig, goanna)		
	Tracks seen (species and number) (or specify if hatchling tracks)		
	Is this a new or unusual sighting, or are there any changes to condition of nesting habitat ?		
CROCODILES Complete Wildnet entry/ croc sighting form	**Number of crocs or slides seen, size estimates, general location**		
	Is this a new or unusual sighting, change in abundance, or any cause for safety concerns?		
WEEDS *Sketch rough location on next page if needed* Infestation classes: Rare <5% Light 5-15 % Moderate 15-50% Heavy >50% Extent of island infested: Give estimate of diameter (m) or proportion of island infested. (Info requested here feeds directly into statewide Health Checks)	**Does the island/cay appear weed-free ?** (If not, please complete rows below)		
	Species and brief description (Eg *"Lantana, rare, eastern half of island, 50cm tall"* to describe scattered isolated plants; or *"Mossman River Grass, moderate, 30m diameter, flowering"* to describe a localized infestation with 30m diameter) Take photos or samples if you are not sure of identification – can send to Tech Support or Herbarium for confirmation. Use the space at the end of the form to make sketches if needed Remember to still enter weed info in more detail into FLAME		
	Any new weeds for this site, or has previous extent changed (bigger or smaller)?		
	Weed control work undertaken ? If so, give brief description.		
	Risk of future weed invasion ? Any weeds in adjacent areas/islands that may become a threat ? Record species, current location, potential vectors.		

WILDFIRE Remember to enter detailed info into FLAME. (Info requested here feeds directly into statewide Health Checks)	**Signs of wildfire?**		Include severity, scorch height, extent of fire, veg type (eg beach scrub, foredunes, open woodland, grassland).
	Rehabilitation required (revegetation) ? Particularly for habitat or food trees, or nesting birds, or fire sensitive veg.		
PEST ANIMALS Remember to enter detailed info into FLAME Be alert for ants at infestation levels – bring back a sample for ID – can store in turps, metho, spirit alcohol – send to CSIRO or Island Watch coordinator for ID	**Any signs of pest animals?** Includes pigs, rodents, ants, cockroaches, cane toads. Take photos and specimens if appropriate.		Include signs and intensity of trampling and rooting by ferals. Abundance of dung/scats , signs of grazing, rodent or cat tracks, etc.
	Pest control work undertaken? Give brief description eg goat culling, ant baiting.		
	Any new pests for this site, or has previous extent or abundance changed?		
NATIVE FAUNA AND FLORA Complete Wildnet entry and/or submit photo or sample to Tech Support, herbarium or other.	**Anything of interest, species records, any changes or concerns?**		
OTHER RISKS eg disease on plants, cyclone damage, marine debris, overtopping, vehicle impacts, any other changes observed. Take photos if possible.	Include compliance concerns eg littering, veg clearing, signs of fishing in green zone (opened oyster shells, fish cleaning).		
CULTURAL VALUES Report to supervisor and complete Cultural Heritage record if relevant.	**Anything new or any changes?** eg Artefacts or artwork, scar trees, middens, graves, wells. Any damage or changes to known sites?		
INFRASTRUCTURE Deterioration in condition of signs, tracks, toilets etc and any work required. Any graffiti or littering? Report to your RIC.			
MONITORING & COLLECTIONS	**Any photo monitoring, botanical or faunal surveys, etc ?**		
	If so, by whom and where is info stored? (eg QLD Herbarium)		
SPATIAL DATA & PHOTOGRAPHS	Details of where photos or GPS data will be stored, to show weeds, turtle tracks, etc.		
AREAS VISITED: Describe which parts of the island were visited, how much of the perimeter was walked, which bays were accessed, etc. Or sketch below.			

Sketch of island/cay and rough location of anything of interest: (use additional pages if needed)

Please scan and email form to Bridget Armstrong, QPWS GBRR Technical Support within 3 weeks (Bridget.Armstrong@npsr.qld.gov.au). Ph 07 40479613.

Appendix 3. Details of equivalent Regional Ecosystems.

(From: Queensland Herbarium (2019) Regional Ecosystem Description Database (REDD). Version 11. 1 (April 2019) (Queensland Department of Environment and Science: Brisbane).

https://www.qld.gov.au/environment/plants-animals/plants/ecosystems/descriptions

BVG 1M – Broad Vegetation Group 1:1 million scale (refer Neldner *et al.* 2019).

RE code	RE description	RE Biodiversity Status	BVG code
12. 2. 9	*Argusia argentea* low woodland to open scrub. Restricted to coral, shingle and sand cays.	Of concern	28a
12. 2. 14d	*Sporobolus virginicus* closed tussock grassland. Exposed frontal areas	No concern at present	28a
12. 2. 14g	Very sparse herbland, mainly sand. Exposed frontal areas.	No concern at present	28a
12. 2. 14i	Seashore mixed herbland. Exposed frontal areas.	No concern at present	28a
12. 2. 17	Mixed closed tussock grassland to closed herbland. Restricted to coral, shingle and sand cays. Littoral open to-sparse grassland/herbland (0.3 m, 5-35% FPC) comprised of seasonally variable short-lived and/or ephemeral species. *Lepturus repens* (0.3 m, up to 15% FPC) and *Thuarea involuta* are frequently dominant. Other species include the short-lived grass *Stenotaphrum micranthum* (0.15-0.5 m, 10% FPC) and the annual herb *Lepidium englerianum* (0.03-0.07 m, 3-5% FPC). On landward margins, *Boerhavia albiflora* var. *albiflora* (0.02 m, 1-5% FPC) and *Portulaca oleracea* (0.03-0.05 m, 1-2% FPC) may also be present. *Argusia argentea* seedlings (0.05 m, up to 5% FPC) seasonally establish during beach accreting periods.	Of concern	28d
12. 2. 18b	*Plumbago zeylanica / Canavalia rosea / Lepturus repens* herbland. Restricted to coral, shingle and sand cays.	No concern at present	28d
12. 2. 18c	*Abutilon albescens* shrubland. Restricted to coral, shingle and sand cays.	Of concern	28a
12. 2. 21	*Pisonia grandis* low closed forest. Restricted to established cays. *Pisonia grandis* communities range from low open to closed forest (6-12 m in height, 60-80% FPC) with relatively large and distinctive tree canopies. The mean height of the *Pisonia grandis* old-growth forest is 8 m. The trees are multi-stemmed with 3-6 basal stems, and exhibit an extensive branching habit. The main trunk diameters ranged from 30-150 cm with an average of 50.3 cm. There are no understorey shrubs or groundcover species found under the intact closed forest canopies. However, open forest gaps and glades within the old-growth open forest to closed forest are commonly colonised by *Abutilon albescens* and *Achyranthes aspera* (10-40% FPC). Infrequent species include *Boerhavia* spp., *Ipomoea violacea, Lepturus repens, Portulaca oleracea, Sporobolus virginicus* and *Tribulus cistoides* (2-5% FPC). Restricted to established cays.	Of concern	3a

BVG code	BVG description
3a	Evergreen to semi-deciduous, notophyll to microphyll vine forest/ thicket on beach ridges and coastal dunes, occasionally *Araucaria cunninghamii* (hoop pine) microphyll vine forest on dunes. *Pisonia grandis* on coral cays.
28a	Complex of open shrubland to closed shrubland, grassland, low woodland and open forest, on strand and foredunes.
28d	Sand blows to closed herblands of *Lepturus repens* (stalky grass) and herbs on sand cays and shingle cays

Appendix 4. Plant species recorded on current trip and by Batianoff *et al*. (2008).

Note: All of the species in the table are considered to be native to Australia and/or native to the Coral Sea islands (Batianoff *et al*. 2008).

*recorded on current trip
recorded by Batianoff *et al.* (2008) for 2006/07
Where a species was recorded by Batianoff *et al*. (2008) but not on the current trip we have included, in parentheses, the frequency of occurrence ascribed by Batianoff *et al.* (2008). I = infrequent; F = frequent; R = rare

Scientific name	Common name	Family	NE Herald	SW Herald	Chilcott	SW Coringa	SE Magdelaine
Abutilon albescens	coastal lantern flower	Malvaceae	*#	*#	*#	*#	*#
Achyranthes aspera	chaff flower	Amaranthaceae	#	*#	*#	*#	*#
Argusia argentea	octopus bush	Boraginaceae	*#	*#	*#	*#	*#
Boerhavia albiflora	white flower tar vine	Nyctaginaceae	#(F)	*#	*#	*#	*#
Boerhavia mutabilis	pink flower tar vine	Nyctaginaceae	*#	*		*#	*#
Canavalia rosea	beach bean	Fabaceae					*#
Colubrina asiatica	Asian naked wood	Rhamnaceae					# (R)
Cordia subcordata	sea trumpet	Boraginaceae					
Digitaria bicornis		Poaceae				*	*
Ipomoea violacea (prev. *I. macrantha*)	coast moon flower	Convolvulaceae	*#	*#	*#	*#	*#
Lepidium englerianum	beach peppercress	Brassicaceae	#(I)	#(I)	#(I)	#(I)	
Lepturus repens	stalky grass	Poaceae	#(I/F)	*#	*#	*#	*#
Pisonia grandis	pisonia	Nyctaginaceae	*#				*#
Plumbago zeylandica	native plumbago	Plumbaginaceae		*#	*#	*#	*#
Portulaca oleracea	common purslane	Portulaceae	*#	*#	*#	*#	*#
Sporobolus virginicus	sand couch	Poaceae	*#	*#	#(I)		*#
Stenotaphrum micranthum	beach buffalo grass	Poaceae	#(I)	#(I)	*#		*#
Tribulus cistoides	beach caltrop	Zygophyllaceae	*#	*#	*#	*#	*#

Appendix 5. Copy of vegetation data sheets

Site Description Sheet

Header

	Date (eg. 12 Mar 12)							Recorder/s	Plot area[1]

Site location (Reserve name/property description & distance (as crow flies) & bearing from a named point feature)..

....

Position

AMG

Zone	Eastings	Northings

Lat/Long

Latitude	Longitude

Datum:	Precision: m	Derivation:

Waypoint no......

Altitude: m	Derivation:

Plot Bearing........° Aspect ....°

Landform pattern	**Landform element**	**Land surface**
Name:	Name:	Microrelief type:
Erosional type:	Slope value (°) or class:	Fragment abundance:
	Morphological type:	Fragment size:
		Rock outcrop:

Geology Map sheet name, no. & geol. code[2]: ______________ CORVEG code[2]: ____ Source: ____ Reliability: ____

Soil type CORVEG ___ Source ___ Reliability ___ **Texture** ____ **Colour** CORVEG ____ Munsell (circle **wet** / **dry**) __________ **pH** ____

Disturbance

Type	Severity	% site impacted	Date/Age	Notes

Stratum	Height (m)[3]			Cover class or measure
	Max	min	Med.[4]	
Emergent				
T1				
T2				
T3				
S1				
S2				
Ground				

Overstorey % cover circle CC / FC / PFC
%

Site basal area
m²/ha

Photos		
No.	Bearing	Notes
	N	
	S	
	E	
	W	

Veg. classification (circle) - A. Specht B. Walker & Hopkins C. Webb **Veg. Type**..

Structural and floristic description (include all strata)..

.... **Regional Ecosystem:** ....

Dominant/characteristic species (use 8 letter code)

Emergent	T1	T2	T3	S1	S2	Ground

[1] Standard Corveg site = 50x10m; BioCondition = 100x50m (tree spp richness, large trees, canopy recruitment) & 50x10m (shrub & herb spp richness; exotic cover)
[2] The descriptions must be entered in full in Wildnet Lite.
[3] Height to uppermost leaves/tallest foliage. Height ranges for strata should not overlap.
[illegible] spp = height that has >50% of canopy trees taller and shorter than it.

Footer

[illegible] single stemmed from base or within 20cm of ground. Shrub: <8m & multi-stemmed or if 1-stemmed then <2m. Note: S1 layer can include low trees.

Queensland Parks and Wildlife Service

Flora Species List

Site title	Date (eg. 12 Mar 99)	Person/s primarily responsible for content of the record

Plot size (m) (trees)		100x50		50x10		Other (record):
Plot size (m) (shrubs, herbs)		50x20		50x10		Other (record):

Scope of survey (tick one)	
A	Comprehensive list
B	Woody spp.
C	Woody + perennial herbs
D	Dominant/ characteristic spp./ incomplete
E	Other (e.g. weed survey)
F	Complete but not suitable for tech. description because of disturbance e.g. drought or weeds.

Relative abundance rating
1 rare
2 rare – occas.
3 occasional
4 occas - common
5 common
6 common - [illegible]
7 abundant

Code for 'other'
X Collected
? Id. uncertain
P Patchy [illegible] locally abundant
+ Pres. outside site only
C Cultivated

Fire Response codes (based on mature plants subject to 100% canopy scorch)			
Plants die; non-resprouters		Plants survive; resprout from:	
1	Canopy stored seed	4	Root suckers, rhizomes
2	Soil-stored seed	5	Basal stem buds e.g. lignotuber
3	No propagules on site	6	Epicormic shoots
8	1-3 but which is unknown	7	Unharmed, usually terminal, aerial buds
		9	4-7 but which is unknown

Species	Presence & abundance (or cover/basal area/stem density)							Reproductive State (tick for present or % of population)			Other	Fire Response Code/s	NOTES
8 letter code if possible	[illegible]	T1	T2	T3	S1	S2	Ground	Flowering	Fruiting	Fertile			

Queensland Parks and Wildlife Service

Crown Cover

(see Neldner et al. 2019)

Location____________________ Site__________________________ Date________________

Crown cover: _____________% Transect Length: ______________m Site No:_________________

DIST−Distance Interval, intercept at start and end of crown, e.g. 4.2-5.8m; CR−Crown diameter estimate (m), e.g. 1.6m

TREE SPECIES	Strata	Dist	CR	Dist	CR	Dist	CR	Dist	CR	Dist	CR	Dist	CR	Total
SHRUB SPECIES	**Strata**	**Dist**	**CR**	**Dist**	**CR**	**Dist**	**CR**	**Dist**	**CR**	**Dist**	**CR**	**Dist**	**CR**	**Total**

Stem counts & heights - trees, shrubs & sub-shrubs

Park: | Site: | Date:

(Regardless of size but not including shrubs or seedlings in ground layer)

Recorder/s:

Plot size *(circle)*:	TREES	**50x10m**		
bold - Corveg & BioCondition	SHRUBS	**50x10m**	50x5m	50x2m

1. Tree that branches into 2 or > stems above 30cm above the ground is counted as one individual.
2. Mallee trees (multiple stems at ground level) - count no. of stems & no. individuals.
3. For shrubs - usually count individuals only (can be problematic at times); exception is if the purpose is to monitor change at a site - then may be justifiable to count individual stems.

Shrub - scope *(circle)*: Individual shrubs only / Individual stems / Dependent on spp. (provide details)

	Count								Height for species (m)	
Species	**E**	**T1**	**T2**	**T3**	**S1**	**S2**	**Total no./spp.**		**Range**	**Mean**
							Indiv.	stem		
Total										

Large Trees (see Eyre *et al.* 2015 – BioCondition manual)

Park: Site: Date: Recorder/s:

Plot size (tick)	☐ 100 x 50m (preferred size) ☐ 100 x 20m ☐ 100 x 10m	☐ m^2
Eucalypt E or Non-Eucalypt (N) Diameter Breast Height (DBH) – Measured at 1.3m high Note: Measure all eucalypts >30cm DBH and all non-eucalypts >20cm for a benchmark reference site.		
Species	**E/N**	**DBH(cm)**
Eucalypts:	Average DBH(threshold)= cm	
	Number of trees ≥ benchmark:	
Non-eucalypts	Average DBH(threshold)= cm	
	Number of trees ≥ benchmark:	

Proportion of dominant woody, perennial species in the ecologically dominant layer[1] with evidence of recruitment[2]

1. EDL equates to the canopy for forests & woodlands, plus the emergent & subcanopy layers if they contribute a significant amount of biomass. Where the EDL is the shrub layer, then then the recruitment of the dominant species from this layer and any emergent tree layer are included in this measure.
2. That is, have individuals with a DBH <5cm.

Plot size (tick) ☐ 100 x 50m (preferred size) ☐ Other – record size ….X….m

…………………%

Coarse Woody Debris (see Eyre *et al.* 2015 – BioCondition manual)

Park: Site: Date: Recorder/s:

Plot size (tick): ☐ 20 x 50m ☐ other (___ x ___ m)

Record length in metres of all debris that is: **>10cm in diameter and ≥0.5m long and >80% in contact with the ground**

TOTAL (m): in plot /ha

Basal Area (see Neldner *et al.* 2019 – Methodology for surveying & mapping REs & veg. communities in Qld)

Single sweep from centre of plot. Record all stems (incl. divided trunks) at breast height that appear > gap in gauge. Ideally get 8-15 counts (will usually be achieved with BAF1 for closed forests, open forests, woodlands; use smaller BAF for more open communities). Multiplying by the appropriate 'factor' for the gauge 'gap' converts the count to m^2/ha.

BAFactor (tick): ☐ 1cm (multiply by 1) ☐ 0.71cm (multiply by 0.5) ☐ 0.5cm (multiply by 0.25)

Species	**Count**						Total m2/ha
	E	**T1**	**T2**	**T3**	**S1**	Outside plot	
Total (all spp.)							

Ground stratum cover (Daubenmire 1959) & litter depth

Park: Site: Transect No. Date: Recorders:

Attribute name	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	Mean
Total foliage cover																					
Bare ground (other than rock)																					
Rock																					
Litter																					
Dung (feral species/stock only)																					
Cryptophyte																					
Charcoal																					
Native perennial grass																					
Native annual grass																					
Non-native grass																					
Native forbs & other species (non-grass)																					
Non native forbs & other species (non-grass)																					
Native shrubs (<1m tall)																					
Non native shrubs (<1m tall)																					
Litter depth (cm)																					

Range	0-5	5-25	25-5(	50-7!	75-9!	95-100
Midpoint of range	2.5	15	37.5	62.5	85	97.5

BioCondition description & scores for total (all layers together) non-native plant cover in 50x10m plot

> 50% of veg. cover is non-native	0
≥ 25-50%	3
≥ 5-25%	5
< 5%	10

Ground stratum species cover (Daubenmire 1959)

Park: Site: Transect No. Date: Recorders:

Species Name	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	Mean hgt (m)
Range	0-5	5-25	25-5	50-7	75-9	95-100															
Midpoint of range	2.5	15	37.5	62.5	85	97.5															

Appendix 6. Record of the Health Check condition class for each community type.

Appendix 6a. *Pisonia grandis* scrubs/low closed forests

North East Herald

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

Health Check Indicator	Condition Class						General impression
	Site 1	Site 2	Site 3	Site 4	Site 5		Not an 'average'!
1. Infestations of ecosystem-changing pest plants	G	G	G	G			G
2. Infestations of pest plants other than ecosystem-changers	G	G	G	G			G
3. Risk of future invasion by significant pest plants not already present	G	G	G	G			G
4. Rainforest invasion	G	G	G	G			G
5. Woody thickening (other than by rainforest species)	G	G	G	G			G
6. Overgrazing/browsing by feral animals, stray stock or natives	G	G	G	G			G
7. Trampling, digging or rooting …. . or trampling by visitors	G	G	G	G			G
8. Impacts on wetlands	-	-	-	-			-
9. Vehicle impacts	G	G	G	G			G
10. Dumping	G	G	G	G			G
11. Ground cover	C[1]	GC	C[1]	G			GC
12. Fire damage to fire-sensitive and non fire-dependent ecosystems	G	G	G	G			G
13. Fire damage to peat-based ecosystems	-	-	-	-			-
14. Age class distribution in fire-adapted ecosystems in conservation….	-	-	-	-			-
15. Severe wildfire in fire-adapted wooded ecosystems	-	-	-	-			-
16. Severe storm, cyclone or tornado in wooded ecosystems	G	G	G	G			G
17. Overtopping, erosion and associated impacts resulting……… from……	G	G	G	G			G
18. Tree/shrub health and dieback	G	G	G	G			G
19. Key features for faunal biodiversity in terrestrial ecosystems	GC[2]	G	GC[2]	G			GC
20. Recruitment of canopy species	G	G	G	G			G
Overall Condition Class							**GC**

1. Although ground cover is rated critical, based on the health check criteria for this indicator, there is no concern – the lack of ground cover is due to extensive shearwater burrows.
2. Currently little leaf litter and fallen woody debris.

South Magdelaine

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

Health Check Indicator	Condition Class						General impression
	Site 1	Site 2	Site 3	Site 4	Site 5		Not an 'average'!
1. Infestations of ecosystem-changing pest plants	G	G	G				G
2. Infestations of pest plants other than ecosystem-changers	G	G	G				G
3. Risk of future invasion by significant pest plants not already present	G	G	G				G
4. Rainforest invasion	G	G	G				G
5. Woody thickening (other than by rainforest species)	G	G	G				G
6. Overgrazing/browsing by feral animals, stray stock or natives	G	G	G				G
7. Trampling, digging or rooting …. . or trampling by visitors	G	G	G				G
8. Impacts on wetlands	-	-	-				-
9. Vehicle impacts	G	G	G				G
10. Dumping	G	G	G				G
11. Ground cover	C	SC[1]	SC[1]				SC
12. Fire damage to fire-sensitive and non fire-dependent ecosystems	G	G	G				G
13. Fire damage to peat-based ecosystems	G	G	G				G
14. Age class distribution in fire-adapted ecosystems in conservation….	-	-	-				-
15. Severe wildfire in fire-adapted wooded ecosystems	-	-	-				-
16. Severe storm, cyclone or tornado in wooded ecosystems	G	G	G				G
17. Overtopping, erosion and associated impacts resulting……… from……	G	G	G				G
18. Tree/shrub health and dieback	G	G	G				G
19. Key features for faunal biodiversity in terrestrial ecosystems	GC[2]	GC[2]	GC[2]				GC
20. Recruitment of canopy species	G	G	G				G
Overall Condition Class							**G**

1. Although ground cover is rated SC, based on the health check criteria for this indicator, there is no concern – the lack of ground cover is due to extensive shearwater burrows.

2. Currently little leaf litter and fallen woody debris.

Appendix 6b. *Cordia subcordata* shrubland/scrubs

South West Coringa

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

Health Check Indicator	Condition Class						General impression
	Site 1	Site 2	Site 3	Site 4	Site 5		Not an 'average'!
21. Infestations of ecosystem-changing pest plants	G						G
22. Infestations of pest plants other than ecosystem-changers	G						G
23. Risk of future invasion by significant pest plants not already present	G						G
24. Rainforest invasion	G						G
25. Woody thickening (other than by rainforest species)	G						G
26. Overgrazing/browsing by feral animals, stray stock or natives	G						G
27. Trampling, digging or rooting …. . or trampling by visitors	G						G
28. Impacts on wetlands	-						-
29. Vehicle impacts	G						G
30. Dumping	G						G
31. Ground cover	G						G
32. Fire damage to fire-sensitive and non fire-dependent ecosystems	G						G
33. Fire damage to peat-based ecosystems	-						-
34. Age class distribution in fire-adapted ecosystems in conservation….	-						-
35. Severe wildfire in fire-adapted wooded ecosystems	-						-
36. Severe storm, cyclone or tornado in wooded ecosystems	G						G
37. Overtopping, erosion and associated impacts resulting……… from……	G						G
38. Tree/shrub health and dieback	C[1]						C
39. Key features for faunal biodiversity in terrestrial ecosystems	GC						GC
40. Recruitment of canopy species	C[2]						C
	Overall Condition Class						SC

1. Clump appears almost completely dead (bare 'sticks') with the exception of a few scattered leaves on the lower stems.
2. One juvenile north of the clump.

Chilcott

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

Health Check Indicator	Condition Class						General impression
	Site 1	Site 2	Site 3	Site 4	Site 5		Not an 'average'!
21. Infestations of ecosystem-changing pest plants	G						G
22. Infestations of pest plants other than ecosystem-changers	G						G
23. Risk of future invasion by significant pest plants not already present	G						G
24. Rainforest invasion	G						G
25. Woody thickening (other than by rainforest species)	G						G
26. Overgrazing/browsing by feral animals, stray stock or natives	G						G
27. Trampling, digging or rooting …. . or trampling by visitors	G						G
28. Impacts on wetlands	-						-
29. Vehicle impacts	G						G
30. Dumping	G						G
31. Ground cover	G						G
32. Fire damage to fire-sensitive and non fire-dependent ecosystems	G						G
33. Fire damage to peat-based ecosystems	-						-
34. Age class distribution in fire-adapted ecosystems in conservation….	-						-
35. Severe wildfire in fire-adapted wooded ecosystems	-						-
36. Severe storm, cyclone or tornado in wooded ecosystems	G						G
37. Overtopping, erosion and associated impacts resulting……… from……	GC						
38. Tree/shrub health and dieback	SC[1]						
39. Key features for faunal biodiversity in terrestrial ecosystems	G						G
40. Recruitment of canopy species	C[2]						
	Overall Condition Class						SC

1. Clump of many apparently dead stems but with scattered leaves.
2. Some coppicing present but no juveniles.

South Magdelaine

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

Health Check Indicator	Condition Class						General impression
	Site 1	Site 2	Site 3	Site 4	Site 5		Not an 'average'!
1. Infestations of ecosystem-changing pest plants	G	G	G				G
2. Infestations of pest plants other than ecosystem-changers	G	G	G				G
3. Risk of future invasion by significant pest plants not already present	G	G	G				G
4. Rainforest invasion	G	G	G				G
5. Woody thickening (other than by rainforest species)	G	G	G				G
6. Overgrazing/browsing by feral animals, stray stock or natives	G	G	G				G
7. Trampling, digging or rooting …. . or trampling by visitors	G	G	G				G
8. Impacts on wetlands	-	-	-				-
9. Vehicle impacts	G	G	G				G
10. Dumping	G	G	G				G
11. Ground cover	G	G	G				G
12. Fire damage to fire-sensitive and non fire-dependent ecosystems	G	G	G				G
13. Fire damage to peat-based ecosystems	-	-	-				-
14. Age class distribution in fire-adapted ecosystems in conservation….	-	-	-				-
15. Severe wildfire in fire-adapted wooded ecosystems	-	-	-				-
16. Severe storm, cyclone or tornado in wooded ecosystems	GC	GC	GC				GC
17. Overtopping, erosion and associated impacts resulting……… from……	G	G	G				G
18. Tree/shrub health and dieback	SC[1]	SC[1]	SC[1]				SC
19. Key features for faunal biodiversity in terrestrial ecosystems	GC	GC	SC				GC
20. Recruitment of canopy species	C[2]	SC[2]	C[2]				SC
	Overall Condition Class						SC

1. Clump of many apparently dead stems but with scattered leaves.

2. No juveniles.

Appendix 6c. *Argusia argentea* shrubland/scrubs

North East Herald

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

Health Check Indicator	Condition Class						General impression
	Site 1	Site 2	Site 3	Site 4	Site 5		Not an 'average'!
41. Infestations of ecosystem-changing pest plants	G	G					G
42. Infestations of pest plants other than ecosystem-changers	G	G					G
43. Risk of future invasion by significant pest plants not already present	G	G					G
44. Rainforest invasion	G	G					G
45. Woody thickening (other than by rainforest species)	G	G					G
46. Overgrazing/browsing by feral animals, stray stock or natives	G	G					G
47. Trampling, digging or rooting …. . or trampling by visitors	G	G					G
48. Impacts on wetlands	-	-					-
49. Vehicle impacts	G	G					G
50. Dumping	G	G					G
51. Ground cover	G	G					G
52. Fire damage to fire-sensitive and non fire-dependent ecosystems	G	G					G
53. Fire damage to peat-based ecosystems	-	-					-
54. Age class distribution in fire-adapted ecosystems in conservation….	-	-					-
55. Severe wildfire in fire-adapted wooded ecosystems	-	-					-
56. Severe storm, cyclone or tornado in wooded ecosystems	GC	GC					G
57. Overtopping, erosion and associated impacts resulting……… from……	G	GC					G
58. Tree/shrub health and dieback	GC	G					G
59. Key features for faunal biodiversity in terrestrial ecosystems	G	G					G
60. Recruitment of canopy species	G	G					G
	Overall Condition Class						**G**

South West Herald

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

Health Check Indicator	Condition Class						General impression
	Site 1	Site 2	Site 3	Site 4	Site 5		Not an 'average'!
3. Infestations of ecosystem-changing pest plants	G	G	G				G
4. Infestations of pest plants other than ecosystem-changers	G	G	G				G
5. Risk of future invasion by significant pest plants not already present	G	G	G				G
6. Rainforest invasion	G	G	G				G
7. Woody thickening (other than by rainforest species)	G	G	G				G
8. Overgrazing/browsing by feral animals, stray stock or natives	G	G	G				G
9. Trampling, digging or rooting …. . or trampling by visitors	G	G	G				G
10. Impacts on wetlands	-	-	-				-
11. Vehicle impacts	G	G	G				G
12. Dumping	G	G	G				G
13. Ground cover	G	G	GC				G
14. Fire damage to fire-sensitive and non fire-dependent ecosystems	G	G	G				G
15. Fire damage to peat-based ecosystems	-	-	-				-
16. Age class distribution in fire-adapted ecosystems in conservation….	-	-	-				-
17. Severe wildfire in fire-adapted wooded ecosystems	-	-	-				-
18. Severe storm, cyclone or tornado in wooded ecosystems	G	GC	GC				G
19. Overtopping, erosion and associated impacts resulting……… from……	G	GC	GC				G
20. Tree/shrub health and dieback	G	SC[1]	GC				G
21. Key features for faunal biodiversity in terrestrial ecosystems	G	G	G				G
22. Recruitment of canopy species	-	-	-				-
Overall Condition Class							**G**

1. Many plants partially buried in sand; some dead; upper branches commonly dead but with reshooting occurring from lower parts.

South West Coringa

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

Health Check Indicator	Condition Class						General impression
	Site 1	Site 2	Site 3	Site 4	Site 5		Not an 'average'!
23. Infestations of ecosystem-changing pest plants	G	G	G	G	G		G
24. Infestations of pest plants other than ecosystem-changers	G	G	G	G	G		G
25. Risk of future invasion by significant pest plants not already present	G	G	G	G	G		G
26. Rainforest invasion	G	G	G	G	G		G
27. Woody thickening (other than by rainforest species)	G	G	G	G	G		G
28. Overgrazing/browsing by feral animals, stray stock or natives	G	G	G	G	G		G
29. Trampling, digging or rooting …. . or trampling by visitors	G	G	G	G	G		G
30. Impacts on wetlands	-	-	-	-	-		-
31. Vehicle impacts	G	G	G	G	G		G
32. Dumping	G	G	G	G	G		G
33. Ground cover	G	G	G	G	G		G
34. Fire damage to fire-sensitive and non fire-dependent ecosystems	G	G	G	G	G		G
35. Fire damage to peat-based ecosystems	-	-	-	-	-		-
36. Age class distribution in fire-adapted ecosystems in conservation….	-	-	-	-	-		-
37. Severe wildfire in fire-adapted wooded ecosystems	-	-	-	-	-		-
38. Severe storm, cyclone or tornado in wooded ecosystems	G	G	G	G	G		G
39. Overtopping, erosion and associated impacts resulting……… from……	G	G	G	G	G		G
40. Tree/shrub health and dieback	SC[1]	G	G	G	G		GC
41. Key features for faunal biodiversity in terrestrial ecosystems	G	G	G	G	G		G
42. Recruitment of canopy species	-	-	-	-	-		-
Overall Condition Class							**G**

1. *Argusia argentea* is being smothered by *Ipomoea violacea*.

South Magdelaine

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

Health Check Indicator	Condition Class						General impression
	Site 1	Site 2	Site 3	Site 4	Site 5		Not an 'average'!
1. Infestations of ecosystem-changing pest plants	G	G	G				G
2. Infestations of pest plants other than ecosystem-changers	G	G	G				G
3. Risk of future invasion by significant pest plants not already present	G	G	G				G
4. Rainforest invasion	G	G	G				G
5. Woody thickening (other than by rainforest species)	G	G	G				G
6. Overgrazing/browsing by feral animals, stray stock or natives	G	G	G				G
7. Trampling, digging or rooting …. . or trampling by visitors	G	G	G				G
8. Impacts on wetlands	-	-	-				-
9. Vehicle impacts	G	G	G				G
10. Dumping	G	G	G				G
11. Ground cover	GC	G	GC				
12. Fire damage to fire-sensitive and non fire-dependent ecosystems	G	G	G				G
13. Fire damage to peat-based ecosystems	-	-	-				-
14. Age class distribution in fire-adapted ecosystems in conservation….	-	-	-				-
15. Severe wildfire in fire-adapted wooded ecosystems	-	-	-				-
16. Severe storm, cyclone or tornado in wooded ecosystems	G	G	G				G
17. Overtopping, erosion and associated impacts resulting……… from……	G	GC	GC				
18. Tree/shrub health and dieback	G	G	G				G
19. Key features for faunal biodiversity in terrestrial ecosystems	G	G	G				G
20. Recruitment of canopy species	G	G	G				G
Overall Condition Class							**G**

Chilcott

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

Health Check Indicator	Condition Class						General impression
	Site 1	Site 2	Site 3	Site 4	Site 5		Not an 'average'!
1. Infestations of ecosystem-changing pest plants	G	G	G				G
2. Infestations of pest plants other than ecosystem-changers	G	G	G				G
3. Risk of future invasion by significant pest plants not already present	G	G	G				G
4. Rainforest invasion	G	G	G				G
5. Woody thickening (other than by rainforest species)	G	G	G				G
6. Overgrazing/browsing by feral animals, stray stock or natives	G	G	G				G
7. Trampling, digging or rooting …. . or trampling by visitors	G	G	G				G
8. Impacts on wetlands	-	-	-				
9. Vehicle impacts	G	G	G				G
10. Dumping	G	G	G				G
11. Ground cover	GC	G	GC				G
12. Fire damage to fire-sensitive and non fire-dependent ecosystems	G	G	G				G
13. Fire damage to peat-based ecosystems	-	-	-				
14. Age class distribution in fire-adapted ecosystems in conservation….	-	-	-				
15. Severe wildfire in fire-adapted wooded ecosystems	-	-	-				
16. Severe storm, cyclone or tornado in wooded ecosystems	G	G	G				G
17. Overtopping, erosion and associated impacts resulting……… from……	GC	G	G				G
18. Tree/shrub health and dieback	G	G	G				G
19. Key features for faunal biodiversity in terrestrial ecosystems	G	G	G				G
20. Recruitment of canopy species	G	G	G				G
Overall Condition Class							**G**

Appendix 6d. *Abutilon albescens* shrublands

North East Herald

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

Health Check Indicator	Condition Class						General impression
	Site 1	Site 2	Site 3	Site 4	Site 5		Not an 'average'!
61. Infestations of ecosystem-changing pest plants	G	G	G				G
62. Infestations of pest plants other than ecosystem-changers	G	G	G				G
63. Risk of future invasion by significant pest plants not already present	G	G	G				G
64. Rainforest invasion	G	G	G				G
65. Woody thickening (other than by rainforest species)	G	G	G				G
66. Overgrazing/browsing by feral animals, stray stock or natives	G	G	G				G
67. Trampling, digging or rooting …. . or trampling by visitors	G	G	G				G
68. Impacts on wetlands	-	-	-				-
69. Vehicle impacts	G	G	G				G
70. Dumping	G	G	G				G
71. Ground cover	SC	GC	GC				GC
72. Fire damage to fire-sensitive and non fire-dependent ecosystems	G	G	G				G
73. Fire damage to peat-based ecosystems	-	-	-				-
74. Age class distribution in fire-adapted ecosystems in conservation….	-	-	-				-
75. Severe wildfire in fire-adapted wooded ecosystems	-	-	-				-
76. Severe storm, cyclone or tornado in wooded ecosystems	G	G	G				G
77. Overtopping, erosion and associated impacts resulting……… from……	G	G	G				G
78. Tree/shrub health and dieback	G	G	G				G
79. Key features for faunal biodiversity in terrestrial ecosystems	G	G	G				G
80. Recruitment of canopy species	-	-	-				-
	Overall Condition Class						**G**

South West Herald

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

Health Check Indicator	Condition Class						General impression
	Site 1	Site 2	Site 3	Site 4	Site 5		Not an 'average'!
43. Infestations of ecosystem-changing pest plants	G	G	G				G
44. Infestations of pest plants other than ecosystem-changers	G	G	G				G
45. Risk of future invasion by significant pest plants not already present	G	G	G				G
46. Rainforest invasion	G	G	G				G
47. Woody thickening (other than by rainforest species)	G	G	G				G
48. Overgrazing/browsing by feral animals, stray stock or natives	G	G	G				G
49. Trampling, digging or rooting …. . or trampling by visitors	G	G	G				G
50. Impacts on wetlands	-	-	-				-
51. Vehicle impacts	G	G	G				G
52. Dumping	G	G	G				G
53. Ground cover	G	G	G				G
54. Fire damage to fire-sensitive and non fire-dependent ecosystems	G	G	G				G
55. Fire damage to peat-based ecosystems	-	-	-				-
56. Age class distribution in fire-adapted ecosystems in conservation….	-	-	-				-
57. Severe wildfire in fire-adapted wooded ecosystems	-	-	-				-
58. Severe storm, cyclone or tornado in wooded ecosystems	-	-	-				-
59. Overtopping, erosion and associated impacts resulting……… from……	G	G	G				G
60. Tree/shrub health and dieback	-	-	-				-
61. Key features for faunal biodiversity in terrestrial ecosystems	G	G	G				G
62. Recruitment of canopy species	-	-	-				-
Overall Condition Class							**G**

Appendix 6e. Mixed shrublands/herblands of Abutilon ± Plumbago ± Ipomoea and Achyranthes

North East Herald

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

Health Check Indicator	Condition Class						General impression
	Site 1	Site 2	Site 3	Site 4	Site 5		Not an 'average'!
81. Infestations of ecosystem-changing pest plants	G	G	G				G
82. Infestations of pest plants other than ecosystem-changers	G	G	G				G
83. Risk of future invasion by significant pest plants not already present	G	G	G				G
84. Rainforest invasion	G	G	G				G
85. Woody thickening (other than by rainforest species)	G	G	G				G
86. Overgrazing/browsing by feral animals, stray stock or natives	G	G	G				G
87. Trampling, digging or rooting …. . or trampling by visitors	G	G	G				G
88. Impacts on wetlands	-	-	-				-
89. Vehicle impacts	G	G	G				G
90. Dumping	G	G	G				G
91. Ground cover	G	G	G				G
92. Fire damage to fire-sensitive and non fire-dependent ecosystems	G	G	G				G
93. Fire damage to peat-based ecosystems	-	-	-				-
94. Age class distribution in fire-adapted ecosystems in conservation….	-	-	-				-
95. Severe wildfire in fire-adapted wooded ecosystems	-	-	-				-
96. Severe storm, cyclone or tornado in wooded ecosystems	-	-	-				-
97. Overtopping, erosion and associated impacts resulting……… from……	G	G	G				G
98. Tree/shrub health and dieback	G	G	G				G
99. Key features for faunal biodiversity in terrestrial ecosystems	G	G	G				G
100. Recruitment of canopy species	-	-	-				-
Overall Condition Class							**G**

South West Coringa

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

Health Check Indicator	Condition Class						General impression
	Site 1	Site 2	Site 3	Site 4	Site 5		Not an 'average'!
63. Infestations of ecosystem-changing pest plants		G					G
64. Infestations of pest plants other than ecosystem-changers		G					G
65. Risk of future invasion by significant pest plants not already present		G					G
66. Rainforest invasion		G					G
67. Woody thickening (other than by rainforest species)		G					G
68. Overgrazing/browsing by feral animals, stray stock or natives		G					G
69. Trampling, digging or rooting …. . or trampling by visitors		G					G
70. Impacts on wetlands		-					-
71. Vehicle impacts		G					G
72. Dumping		G					G
73. Ground cover		G					G
74. Fire damage to fire-sensitive and non fire-dependent ecosystems		G					G
75. Fire damage to peat-based ecosystems		-					-
76. Age class distribution in fire-adapted ecosystems in conservation….		-					-
77. Severe wildfire in fire-adapted wooded ecosystems		-					-
78. Severe storm, cyclone or tornado in wooded ecosystems		-					-
79. Overtopping, erosion and associated impacts resulting……… from……		G					G
80. Tree/shrub health and dieback		-					-
81. Key features for faunal biodiversity in terrestrial ecosystems		G					G
82. Recruitment of canopy species		-					-
Overall Condition Class							**G**

Appendix 6f. *Achyranthes aspera* herbland

Chilcott

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

Health Check Indicator	Condition Class						General impression
	Site 1	Site 2	Site 3	Site 4	Site 5		Not an 'average'!
101. Infestations of ecosystem-changing pest plants	G	G	G				G
102. Infestations of pest plants other than ecosystem-changers	G	G	G				G
103. Risk of future invasion by significant pest plants not already present	G	G	G				G
104. Rainforest invasion	G	G	G				G
105. Woody thickening (other than by rainforest species)	G	G	G				G
106. Overgrazing/browsing by feral animals, stray stock or natives	G	G	G				G
107. Trampling, digging or rooting …. . or trampling by visitors	G	G	G				G
108. Impacts on wetlands	-	-	-				-
109. Vehicle impacts	G	G	G				G
110. Dumping	G	G	G				G
111. Ground cover	G	G	GC				
112. Fire damage to fire-sensitive and non fire-dependent ecosystems	G	G	G				G
113. Fire damage to peat-based ecosystems	-	-	-				-
114. Age class distribution in fire-adapted ecosystems in conservation….	-	-	-				-
115. Severe wildfire in fire-adapted wooded ecosystems	-	-	-				-
116. Severe storm, cyclone or tornado in wooded ecosystems	G	G	G				G
117. Overtopping, erosion and associated impacts resulting………	G	G	G				G
118. Tree/shrub health and dieback	-	-	-				-
119. Key features for faunal biodiversity in terrestrial ecosystems	G	G	G				G
120. Recruitment of canopy species	-	-	-				-
Overall Condition Class							**G**

Appendix 6g. *Ipomoea violacea* vineland

North East Herald

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

Health Check Indicator	Condition Class						General impression
	Site 1	Site 2	Site 3	Site 4	Site 5		Not an 'average'!
121. Infestations of ecosystem-changing pest plants	G	G					G
122. Infestations of pest plants other than ecosystem-changers	G	G					G
123. Risk of future invasion by significant pest plants not already present	G	G					G
124. Rainforest invasion	G	G					G
125. Woody thickening (other than by rainforest species)	G	G					G
126. Overgrazing/browsing by feral animals, stray stock or natives	G	G					G
127. Trampling, digging or rooting …. . or trampling by visitors	G	G					G
128. Impacts on wetlands	G	G					G
129. Vehicle impacts	G	G					G
130. Dumping	G	G					G
131. Ground cover	G	G					G
132. Fire damage to fire-sensitive and non fire-dependent ecosystems	G	G					G
133. Fire damage to peat-based ecosystems	-	-					
134. Age class distribution in fire-adapted ecosystems in conservation….	-	-					
135. Severe wildfire in fire-adapted wooded ecosystems	-	-					
136. Severe storm, cyclone or tornado in wooded ecosystems	-	-					
137. Overtopping, erosion and associated impacts resulting………	G	G					G
138. Tree/shrub health and dieback	-	-					
139. Key features for faunal biodiversity in terrestrial ecosystems	G	G					G
140. Recruitment of canopy species	-	-					
	Overall Condition Class						**G**

Appendix 6h. *Boerhavia albiflora* herbland

South West Coringa

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

Health Check Indicator	Condition Class						General impression
	Site 1	Site 2	Site 3	Site 4	Site 5		Not an 'average'!
141. Infestations of ecosystem-changing pest plants			G				G
142. Infestations of pest plants other than ecosystem-changers			G				G
143. Risk of future invasion by significant pest plants not already present			G				G
144. Rainforest invasion			G				G
145. Woody thickening (other than by rainforest species)			G				G
146. Overgrazing/browsing by feral animals, stray stock or natives			G				G
147. Trampling, digging or rooting …. . or trampling by visitors			G				G
148. Impacts on wetlands			-				-
149. Vehicle impacts			G				G
150. Dumping			G				G
151. Ground cover			G				G
152. Fire damage to fire-sensitive and non fire-dependent ecosystems			G				G
153. Fire damage to peat-based ecosystems			-				-
154. Age class distribution in fire-adapted ecosystems in conservation….			-				-
155. Severe wildfire in fire-adapted wooded ecosystems			-				-
156. Severe storm, cyclone or tornado in wooded ecosystems			-				-
157. Overtopping, erosion and associated impacts resulting………			G				G
158. Tree/shrub health and dieback			-				-
159. Key features for faunal biodiversity in terrestrial ecosystems			G				G
160. Recruitment of canopy species			-				-
Overall Condition Class							**G**

Appendix 6i. *Lepturus repens* grassland

South West Coringa

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

Health Check Indicator	Condition Class						General impression
	Site 1	Site 2	Site 3	Site 4	Site 5		Not an 'average'!
161. Infestations of ecosystem-changing pest plants	G						G
162. Infestations of pest plants other than ecosystem-changers	G						G
163. Risk of future invasion by significant pest plants not already present	G						G
164. Rainforest invasion	G						G
165. Woody thickening (other than by rainforest species)	G						G
166. Overgrazing/browsing by feral animals, stray stock or natives	G						G
167. Trampling, digging or rooting …. . or trampling by visitors	G						G
168. Impacts on wetlands	-						-
169. Vehicle impacts	G						G
170. Dumping	G						G
171. Ground cover	G						G
172. Fire damage to fire-sensitive and non fire-dependent ecosystems	G						G
173. Fire damage to peat-based ecosystems	-						-
174. Age class distribution in fire-adapted ecosystems in conservation….	-						-
175. Severe wildfire in fire-adapted wooded ecosystems	-						-
176. Severe storm, cyclone or tornado in wooded ecosystems	-						-
177. Overtopping, erosion and associated impacts resulting………	G						G
178. Tree/shrub health and dieback	-						-
179. Key features for faunal biodiversity in terrestrial ecosystems	G						G
180. Recruitment of canopy species	-						-
	Overall Condition Class						**G**

Appendix 7. Example of data sheet used for green turtle nesting studies.

Coral Sea Islands 2019/20: Nesting datasheet

	Tag Number(s)	Posn
New		

	Tag Number(s).	Posn
Recapt		

Date
Time (24 hr)

Species	
imbricata	☐
depressus	☐
mydas	☐

Damage			
Carapace	☐	Head	☐
LFF	☐	LHF	☐
RFF	☐	RHF	☐

Sector Number

Nesting Success	
Laid	☐
No Lay	☐
Laid/Dist	☐
Don't know	☐

CCL cm (1):	CCL cm (2):
Min	**Min**
Max	**Max**
Measured by:	Measured by:

Nest location		
Dune grass (area on top of dune)	DG	☐
Dune sand (area on top of dune)	DS	☐
Dune (beneath tree, shrub, forest)	DT	☐
Front slope of dune in grass	SG	☐
Front slope of dune in sand	SS	☐
Front slope of dune under tree or shrub	ST	☐
Beach (between high tide and Slope)	B	☐
Below high tide	HW	☐
Don't know	?	☐

GPS (decimal)	
Lat: -11.	S
Long: 143.	E
Waypoint saved	☐
Waypoint No.: ________	

Notes:

Treatment	
Nest relocated	☐
Eggs measured	☐

Entered to:	
Tags	☐
Kapt	☐

Coral Sea Islands 2019/20: Nesting datasheet

	Tag Number(s)	Posn
New		

	Tag Number(s).	Posn
Recapt		

Date
Time (24 hr)

Species	
imbricata	☐
depressus	☐
mydas	☐

Damage			
Carapace	☐	Head	☐
LFF	☐	LHF	☐
RFF	☐	RHF	☐

Sector Number

Nesting Success	
Laid	☐
No Lay	☐
Laid/Dist	☐
Don't know	☐

CCL cm (1):	CCL cm (2):
Min	**Min**
Max	**Max**
Measured by:	Measured by:

Nest location		
Dune grass (area on top of dune)	DG	☐
Dune sand (area on top of dune)	DS	☐
Dune (beneath tree, shrub, forest)	DT	☐
Front slope of dune in grass	SG	☐
Front slope of dune in sand	SS	☐
Front slope of dune under tree or shrub	ST	☐
Beach (between high tide and Slope)	B	☐
Below high tide	HW	☐
Don't know	?	☐

GPS (decimal)	
Lat: -11.	S
Long: 143.	E
Waypoint saved	☐
Waypoint No.: ____________	

Notes:

Treatment	
Nest relocated	☐
Eggs measured	☐

Entered to:	
Tags	☐
Kapt	☐

Appendix 8. Summary of GPS satellite telemetry study.

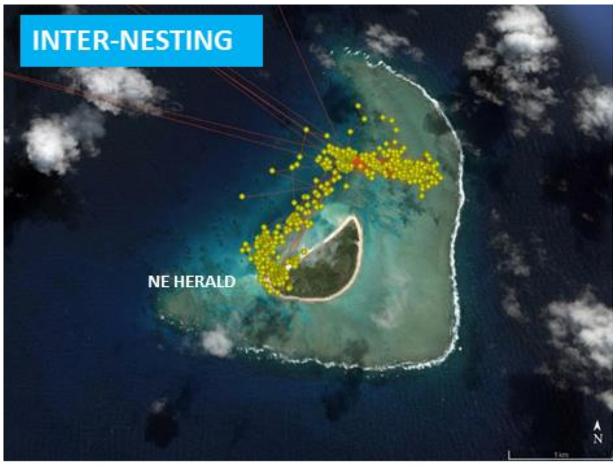
DATA SUMMARY
GPS SATELLITE TELEMETRY STUDY
TO DEFINE INTER-NESTING, MIGRTORY PATHWAYS AND FORAGING HABITAT
FOR CORAL SEA NESTING GREEN TURTLES, 2019-2020 BREEDING SEASON

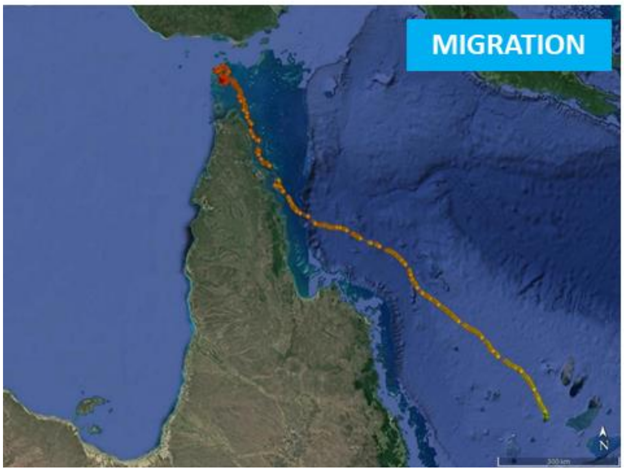
C. J. Limpus, I. Bell

Tags successfully deployed:	
• NE Herald Cay	6
• Coringa Islet	1
• Madelaine Cay	1
Completed tracking to foraging areas:	
• Post-nesting migration southward from nesting	
o GBR off shore from Whitsundays	1
• Post-nesting migration northward from nesting	
o GBR north of Cooktown	
▪ Howick Reefs	1
▪ Inshore South of Cape Grenville	1
o Torres Strait	4
o GoC: west of Torres Strait	1
Total tags	8

Chelonia mydas: CA1681
PTT ID = 181924
NE Herald nesting
Deployed: 2 Dec
Departed inter-nesting: 20 Jan
Arrived foraging area: 21 Feb

PREVIOUS HISTORY:
Nesting NE Herald
- 1996-97, 2002-03 seasons

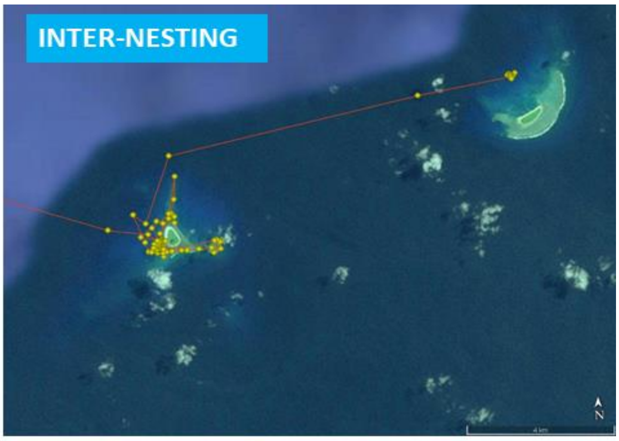


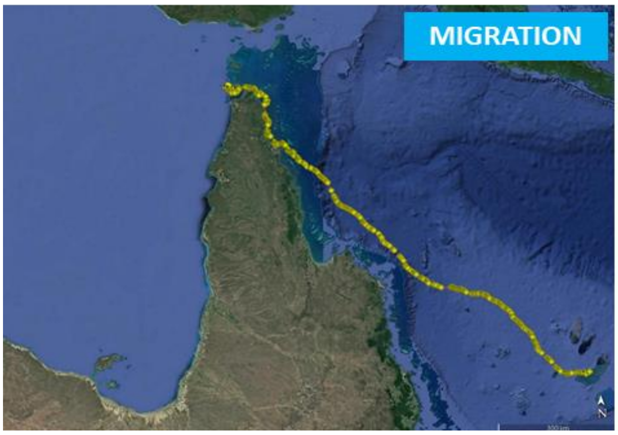


***Chelonia mydas*: CA8480**
PTT ID = 181923

Coringa Islet nesting
Deployed: 4 Dec
Departed inter-nesting: 9 Dec
Arrived foraging area: 30 Dec

PREVIOUS HISTORY:
Nil

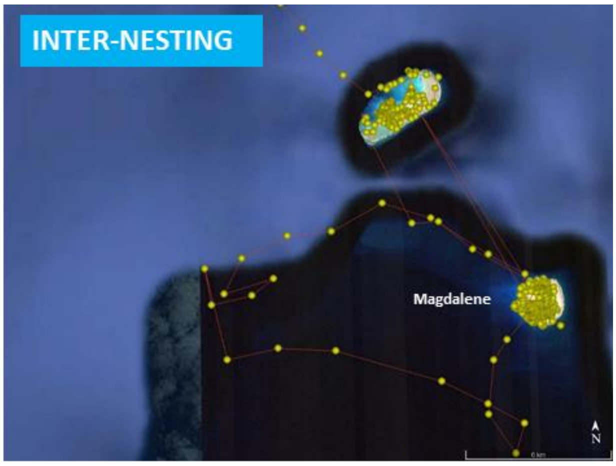


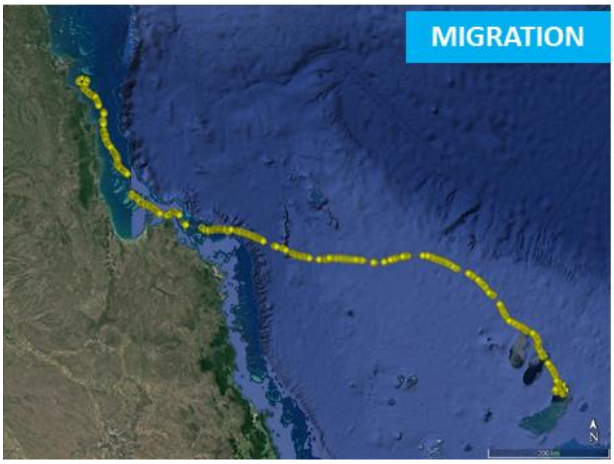


***Chelonia mydas*: CA8435**
PTT ID = 181022

Magdalene Cay nesting
Deployed: 7 Dec
Departed inter-nesting: 22 Jan
Arrived foraging area: 27 Feb

PREVIOUS HISTORY:
Nil

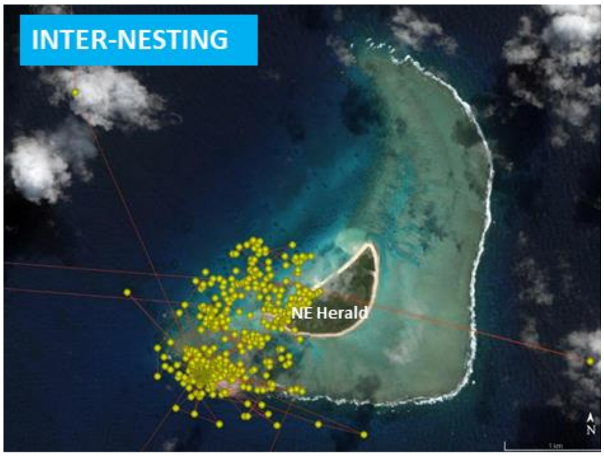


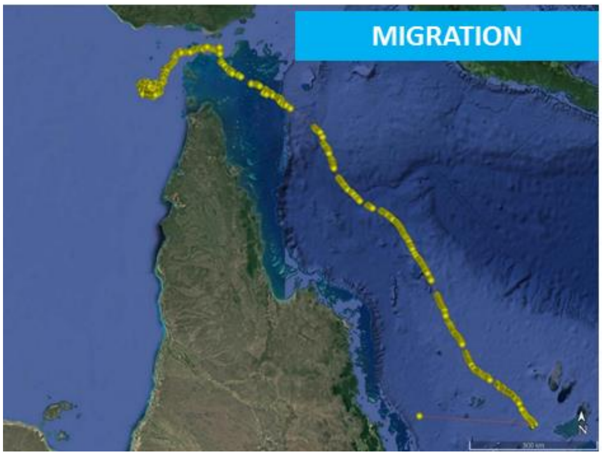


Chelonia mydas: CA3589
PTT ID = 181921

NE Herald Island nesting
Deployed: 30 Nov
Departed inter-nesting: 21 Jan
Arrived foraging area: 12 Feb

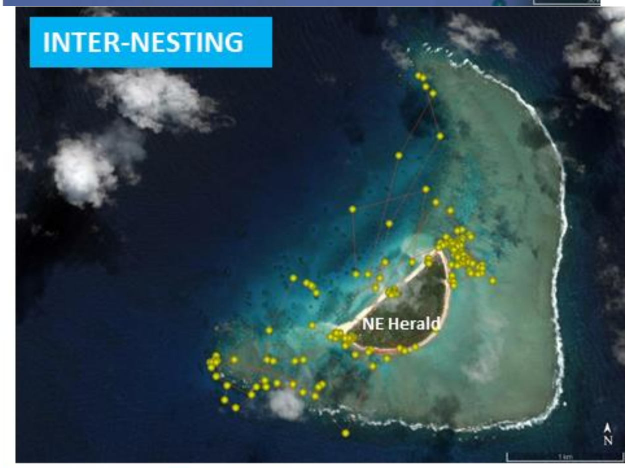
PREVIOUS HISTORY:
Nesting NE Herald Island
- 1999-00 season

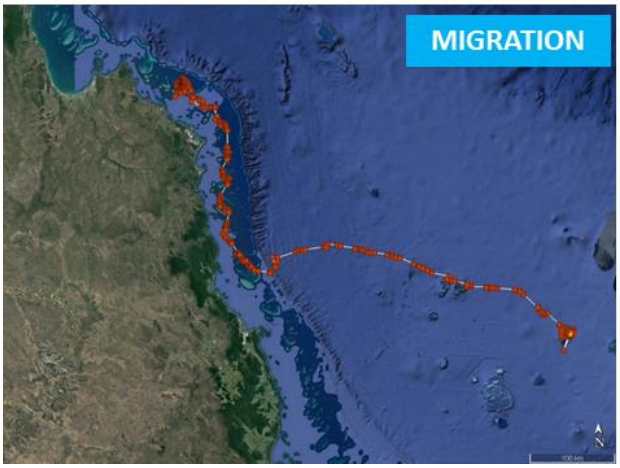


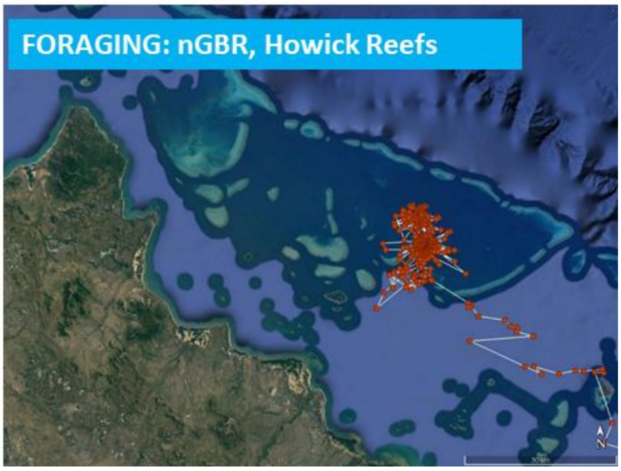


Chelonia mydas: CA1853
PTT ID = 181920
NE Herald Island nesting
Deployed: 1 Dec
Departed inter-nesting: 31 Jan
Arrived foraging area: 24 Mar
Early GPS failure; PTT tracking continuing

PREVIOUS HISTORY:
NE Herald Is. Nesting
1996-97, 2002-03 seasons



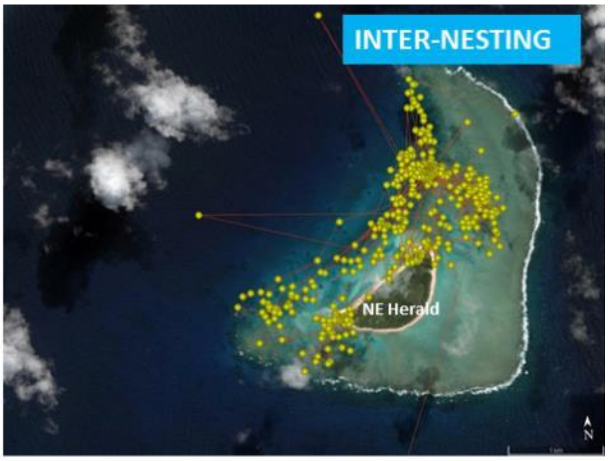


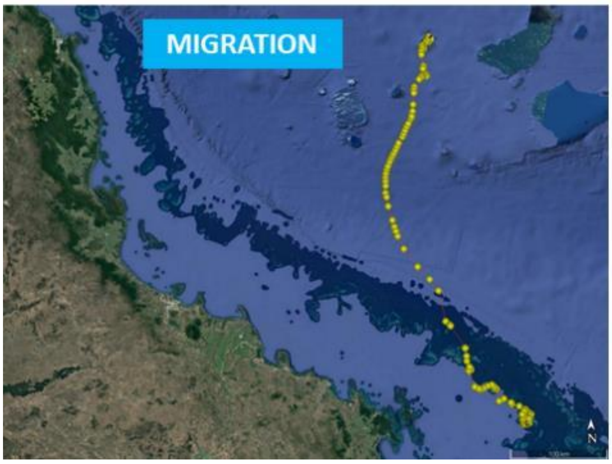


Chelonia mydas: T57452
PTT ID = 133769

NE Herald Island nesting
Deployed: 30 Nov
Departed inter-nesting: 16 Jan
Arrived foraging area: 26 Jan

PREVIOUS HISTORY:
Nesting NE Herald Island
- 1991-92, 1998-99 season

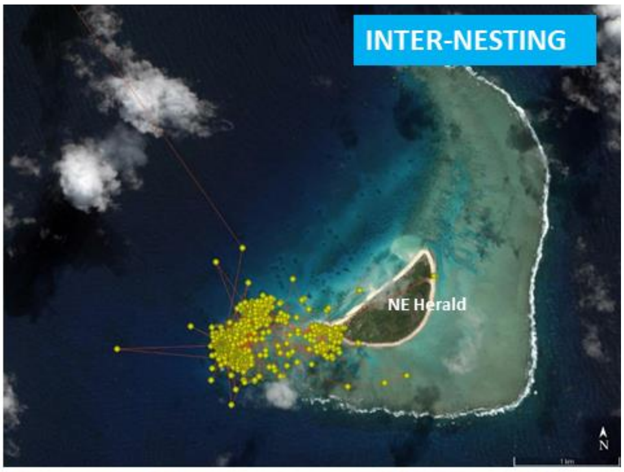


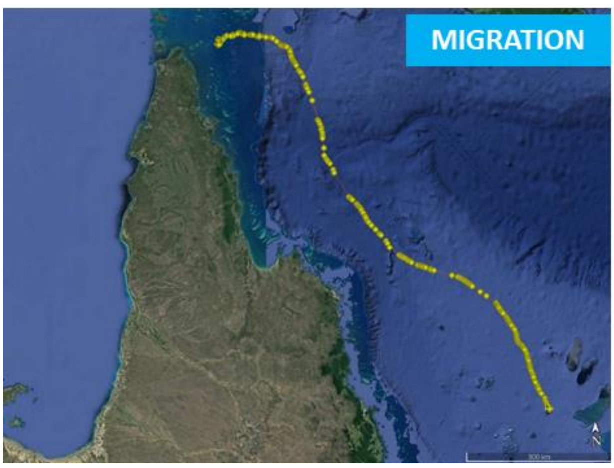


Chelonia mydas: CA8251
PTT ID = 133768

NE Herald Island nesting
Deployed: 30 Nov
Departed inter-nesting: 3 Feb
Arrived foraging area: 20 Feb

PREVIOUS HISTORY:
Nil

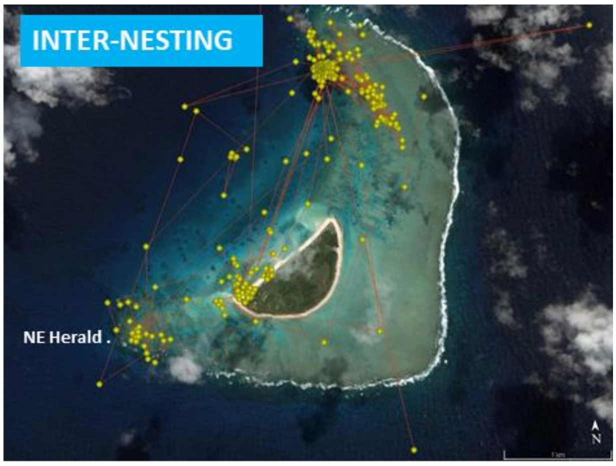


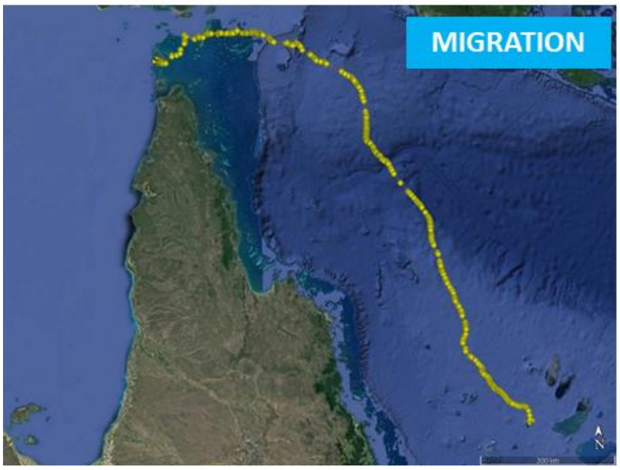


Chelonia mydas: CA8377
PTT ID = 133767

NE Herald Island nesting
Deployed: 30 Nov
Departed inter-nesting: 12 Jan
Arrived foraging area: 14 Feb

PREVIOUS HISTORY:
Nil





Appendix 9. *Pulvinaria* scale survey data sheet.

Island name								Date						Surveyors
Transect		Non Transect		Scale per 10 branch ends				Cm	Cocc.	%	Ants		Hawkmoth Canopy % Impact	Notes
Trans#	Interval (m)	Lat. (DD)	Long. (DD)	0	1-50	50-100	500+	Y/N	Y/N	Paras	#	Spp.		

Appendix 10. Ant survey data sheet.

Island name								Date			Surveyors
Transect (…… °M)		Non Transect		ANTS (attending bait post >30mins)					Species	Voucher	Notes
Trans#	Interval (m)	Lat. (DD)	Long. (DD)	0	1-50	50-100	100 -500	500+	(A,B,C….)	Y/N	