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A description of Northern *Pisonia grandis* populations in Australia

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A Great Barrier Reef Joint Field Management Program Priority Project

We acknowledge the Traditional Owners of Country throughout the Great Barrier Reef and across Australia and recognise their continuing connection to lands, waters and community.

Table of Contents

Version control

Version	Title	Prepared by	Reviewed by	Date prepared
v0.1	A description of Northern *Pisonia grandis* populations in Australia	David Fell, Charlotte Page, Andrew Palmer-Brodie	Naomi Maxwell Sam Gibbs (Reef Authority)	10/12/2025
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1 Introduction

This report is a review completed as part of the Restoration of Reef Islands (RORI) Project (the Project) which aims to facilitate the rehabilitation or enhancement of habitat values for selected islands in the Great Barrier Reef World Heritage Area. The Project is an initiative of the Great Barrier Reef Marine Park Authority and Queensland Parks and Wildlife Services through the Reef Joint Field Management Program. The project was delivered using funding supplied by the Reef Trust administered by the Australian Government Department of Climate Change, Energy, the Environment and Water (DCCEEW).

The Project includes two components:

- Component 1 which focusses on islands with known threats (such as weeds and pests), and
- Component 2 which focusses on understanding potential threats to islands with *Pisonia grandis.*

Pisonia grandis (*P. grandis*) is a key component of island ecosystems throughout Queensland and the wider Asia-Pacific region. Beyond its role in forming and stabilising islands, *P. grandis* maintains an important ecological relationship with seabirds, providing nesting habitat for a variety of species and facilitating seed dispersal. Its sticky seeds, which often adhere to bird feathers and can cause mortality, play a crucial ecological role by returning nutrients to the island vegetation and surrounding fringing reefs. In Australia, the majority of *P. grandis* populations occur in Queensland, predominantly on uninhabited coral cays along the central Queensland coast, extending north to Torres Strait.

While the islands supporting *P. grandis* forests in the southern Great Barrier Reef are well understood, it is unclear whether northern forests (located north of Townsville) are currently declining, stable or improving, or how the forests may respond to climate change and other threatening processes. The Project is focussed on islands in the northern Great Barrier Reef to address part of this knowledge gap.

1.1 Aims and objectives

The aim of this report is to enhance understanding of the structure, function, and composition of *P. grandis* forests on northern islands of the Great Barrier Reef, building knowledge of their resilience and informing future management and conservation of these important habitats.

This report presents the results of a review of *P. grandis* on islands north of Townsville, summarising key information from rapid ecological assessments conducted by Aestra and David Fell (Aestra 2024, Aestra 2025a, Aestra 2025b; Fell et al 2024, Fell 2025) and a desktop review of northern *P. grandis* populations. Specifically, this report identified key information with reference to the:

- biogeographical distribution of *P. grandis.*
- structure of *P. grandis* communities.
- associated ecological communities.
- condition of *P. grandis.*
- threats to *P. grandis.*

In doing so, this report highlights the key habitat functions likely provided by *P. grandis* in the northern Great Barrier Reef Islands. It also identifies major threats to *P. grandis*, outlining potential current and future risks to populations across the region.

2 *Pisonia grandis*

Pisonia grandis (family *Nyctaginaceae*) (also known as bird lime-tree, cabbage tree, lettuce tree, and grand devils-claw), is a broad-leafed shrub or tree widespread in the Indo-Pacific region, occurring along Queensland's (Qlds) Great Barrier Reef (GBR), in South-East Asia, Malesia, and the Pacific Islands as far east as the Tuamoto Archipelago in the Pacific, and as far west as the Mascarene Islands and Seychelles in the Indian Ocean (Airy-Shaw 1952; Cribb & Cribb 1985; Walker 1991).

The genus *Pisonia* comprises around 35 species, mostly in the Americas (approximately 20), with one pantropical species (*Pisonia aculeata*) and the remainder in the Old-World tropics, from the Indian Ocean islands to continental Asia, Malesia, and Oceania. In Malesia (comprising Malaysia, Philippines, New Guinea, Timor-Leste, Singapore, Indonesia, Brunei), eight species occur, five of which are also found in Australia and/or the Oceanic islands.

Within Australia, the genus includes three taxa*: P. grandis, Pisonia umbellifera* (a tree of tropical lowland rainforest), and the scrambling vine *Pisonia aculeata*, both of which occur in lowland and coastal rainforests of the Wet Tropical Coast and Cape York Peninsula bioregions (Zich et al. 2020).

P. grandis is a buttressed, often multi-stemmed tree with smooth, pale bark, growing up to 20–30 m in height and a basal area of up to 200 cm (Figure 1). It has simple, alternate, elliptic leaves with long petioles up to 50 mm and fruit segments with longitudinal rows of sticky warts (Figure 1). During the dry season, under moisture stress, the tree is typically deciduous, shedding leaves that accumulate as a dense humus layer on the ground. *P. grandis* has a shallow root system, and its brittle wood and spreading crown make it prone to tree falls during storms. Its soft wood decays quickly once on the ground. *P. grandis* reproduces via seedlings as well as vegetative coppicing and suckering following tree or branch falls.

Figure 1: Pisonia grandis flowers (left) and forest (right), Images: David Fell, 2024

2.1 Biological significance

Pisonia grandis populations play key ecological roles on islands. Developed *P. grandis* trees help stabilise sandy cays, protecting islands from erosion during cyclones. *P. grandis* trees also provide nesting and breeding habitat for a range of birds (Watson 2014). Throughout its distribution, the tree is associated with colonies of the black noddy (Anous minutus) (Figure 2) and the Bridled Tern (Sterna anaethetus), (Watson 2014). In addition, White-bellied sea-eagles (Haliaeetus leucogaster), and wedge-tailed shearwaters (Ardenna pacifica) have been recorded nesting in *P. grandis* trees within the central islands of Bak and Yaok in the Torres Strait (Fell & Arnall 2019). In turn, birds recycle critical nutrients to the island and forest environments via their guano.

The birds associated with *P. grandis* are critical in the tree's life cycle, being largely responsible for seed dispersal and propagation. *P. grandis* also contribute to island nutrient recycling through a unique relationship with the black noddy (and other sea birds) (Figure 2). *P. grandis* fruit segments have longitudinal rows of sticky warts which adhere to the bird, eventually leading to their demise (Cribb & Cribb 1985) (Figure 2). The decaying bird provides the tree with key nutrients and may offer a competitive edge for the plant's establishment and growth.

Figure 2: Noddy terns nesting in a P. grandis tree. Images: J.Jones © Commonwealth of Australia (GBRMPA), 1997

2.2 Cultural significance

Various cultural uses have been recorded throughout the distribution of *P. grandis* in the Indo-Pacific region. The soft wood has been used in light construction (canoes, floats, bailers, fence posts), and for fires (Thaman et al. 2017). In the central islands of Torres Strait the tree has a language name and is considered culturally significant for its qualities as a light and easily worked timber (Warraberalgal and Porumalgal RNTBC 2023). It is also known as a medicinal plant, with wound healing properties (Elumalai et al. 2012).

2.3 Conservation status

Pisonia grandis forests are rare and highly significant for conservation due to their unique floristic assemblages, disjunct distribution, the fragility of island ecosystems they occupy, and their susceptibility to a range of threatening processes (Airy Shaw 1952, Walker 1991, Fell & Arnall 2019). *P. grandis* is not listed as a threatened species under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), and is 'Least Concern' under the Qld *Nature Conservation Act 1992* (NC Act), while its biodiversity status and conservation status under the Qld *Vegetation Management Act 1999* (VM Act) are both 'of concern'.

These unique ecosystems are protected as part of threatened regional ecosystems in Qld, occurring in three Regional Ecosystems (RE) that are of conservation concern (3.2.29, 12.2.20, 12.2.21). While the latter two REs occur in southeast Qld, RE 3.2.29 '*P. grandis* closed forest restricted to a few scattered sand cays' occurs in the Cape Yorke Peninsula bioregion, in addition to being described on Douglas and Cairncross Islets (Aestra 2024) (see Table 1). It is listed 'Of Concern' on the VM Act and has an 'Endangered' Biodiversity Status as per the NC Act. In addition, it is given a 'High' status within the Qld 'Back on Track' prioritization framework, which aims to prioritize Qld native species to guide conservation management and recovery (DETSI 2024). The northern populations of *P. grandis* are therefore of high conservation value for protection of RE 3.2.29.

South of Princess Charlotte Bay, *P. grandis* forests are within the classification criteria of the Littoral Rainforest and Coastal Vine Thickets of Eastern Australia endangered ecological community. This community is listed as Endangered under the EPBC Act. This listing includes occurrences on islands in the Wet Tropics bioregion where *P. grandis* is known to occur within RE7.2.1 and RE7.12.11 (Table 1). Northern Island *P. grandis* forests are also found in national parks and Indigenous Protected Areas. *P. grandis* is conserved within the Three Islands Group National Park (NP), the Denham Group NP, and the Barnard Group (Aestra 2024). *P. grandis* is also associated with RE3.2.29 and 3.2.28 in the Torres Strait and is conserved with three IPAs (Fell & Arnall 2019).

Table 1: Regional ecosystems of conservation significance recorded as occurring in association with P. grandis on Northern islands.

Regional Ecosystem	Description	Status EPBC Act	Status NC Act	Status VM Act
3.2.29	*P. grandis* low closed forest	Endangered. Included in Littoral Rainforest and Coastal Vine Thickets ecological community	Endangered	Of concern
3.2.28	Evergreen notophyll vine forest restricted to beach fringes on coral atolls, shingle cays and sand cays. Restricted to a few scattered sand cays.	Endangered. Included in Littoral Rainforest and Coastal Vine Thickets ecological community	Endangered	Of concern
7.2.1	Mesophyll vine forest on beach ridges and sand plains of beach origin	Endangered. Included in Littoral Rainforest and Coastal Vine Thickets ecological community	Endangered	Endangered
7.12.11	Simple to complex notophyll vine forest and semi-evergreen notophyll vine forest of rocky areas and talus on moist foothills and uplands on granites and rhyolites	Endangered. Included in Littoral Rainforest and Coastal Vine Thickets ecological community	Of concern	Least concern

2.4 Threats to *Pisonia grandis*

2.4.1 Invertebrate threats

One of the biggest threats to the species are outbreaks of soft scale and other invertebrates which have caused severe impacts to *P. grandis* forests in the Southern Great Barrier Reef (e.g., Smith et al. 2004). *Pulvinaria urbicola* (Cockerell) (Hemiptera: Coccidae) is a soft scale thought to be native the West Indies but which has now spread to over 60 countries across the globe, including Australia (confirmed through discussions with H. Nahrung, M. Gorton, P. Gullen and T.K. Q in *pers comm*.; García Morales et.al. 2016). The species has a large host range and is known to feed on 91 genera and 45 families (García Morales et.al. 2016). Despite the broad range of hosts, it was not considered a significant pest in Australia until outbreaks in the Great Barrier Reef Marine Park in the early 1990s.

The species (Figure 3) had been recorded on several coral cays in the Great Barrier Reef for several decades (R. Bull, cited in Olds 2018). However, it wasn't until the mid to late 1990's that *P. urbicola* (Cockerell) came to land managers attention when it caused complete destruction of a 16 ha *P. grandis* forest on Coringa Southwest Islet in the Coringa-Herald National Nature Reserve, and a few years later was threatening *P. grandis* forest on nearby cays (Smith et al. 2004).

Figure 3: Inside of green tree ant (Oecophylla smaragdina) nest showing soft scale (P. urbicola) on P. grandis leaf (left, green ants with immature scale, right, mature scale insects). Images: Anthony Rice, 2024

Figure 4: Cryptolaemus larva feeding on urbicola scale on P. grandis leaf (left, Image: A. Rice, 2024), Cryptolaemus larva and scale (right, Image: Naomi Maxwell, 2024).

In a diverse, balanced ecosystem, soft scales are well controlled by a suite of invertebrate natural enemies which comprise predators such as the native ladybird beetle (*Cryptolaemus montrouzieri)* and parasitoids which lay their eggs in the scale (Figure 4). It is only when this controlling guild of natural enemies is disrupted that scale insects can multiply, and the population become eruptive causing significant damage to its host species. Disruption of natural enemy's control of scale can be man-made (e.g., by using pesticides which impact natural enemies) or can occur naturally.

Ants attending scale insects in mutualistic relationships can help protect the scale from natural enemy attack and can lead to increased scale infestations (Figure 3). As protein levels in plant sap tend to be low, scale insects must imbibe large quantities of sap to fulfill their dietary requirements. This results in an excess of sugars that the scale insect exudes. This exuded sugar is very attractive to ants and in return for a sugary meal, some ant species will protect and farm the scale, moving them to fresh parts of the plant as populations increase and protecting them from natural enemy attack. This attendant ant behaviour allows scale populations to flourish as the pressure from natural enemies is reduced.

Another compounding factor that enables scales to proliferate at the expense of its host is moisture stress. While drought can negatively impact many herbivorous insect species, the increased nutrient value of the sap in water stressed trees can benefit those insects that feed on it. Plants that are water stressed, especially during droughts, tend to have higher levels of nitrogen which has been shown to improve the reproductive rate of scale (various authors cited in Frank 2021). In addition, temperatures tend to be higher at times of drought which can also increase the reproductive rate of scale insects, increase the reproductive rate of attending ants and make their periods of activity longer. This improves the ant's efficacy in protecting and tending the scale insects. In conjunction, parasitoids that don't feed on their reproductive hosts, rely on floral nectaries and pollen from flowers that may not be as abundant during drought conditions. As a result, the populations of nature predators, and as a result their efficacy as regulation agents, may be reduced (Jactel et al. 2019). The cumulative impact of these factors to *P. grandis* is shown in Figure 5.

If, as indicated above, *P. urbicola* has been widespread in *P. grandis* forest in the Great Barrier Reef Marine Park for decades without causing significant damage, it suggests that a suite of natural enemies has also been present and keeping scale in check. Consequently, the outbreaks on Coringa South West Islet, North East Herald and other islands in the 1990's and early 2000's seems to have indicated a collapse of the natural enemy populations of the scale insect (Smith et al. 2004). Moreover, because the release of natural enemies and control of exotic ants restored stability back to the island ecosystem, the balance between scale/ant mutualism and natural enemy efficacy appears to be a key driver of the stability of the *P. grandis* forests with the Great Barrier Reef.

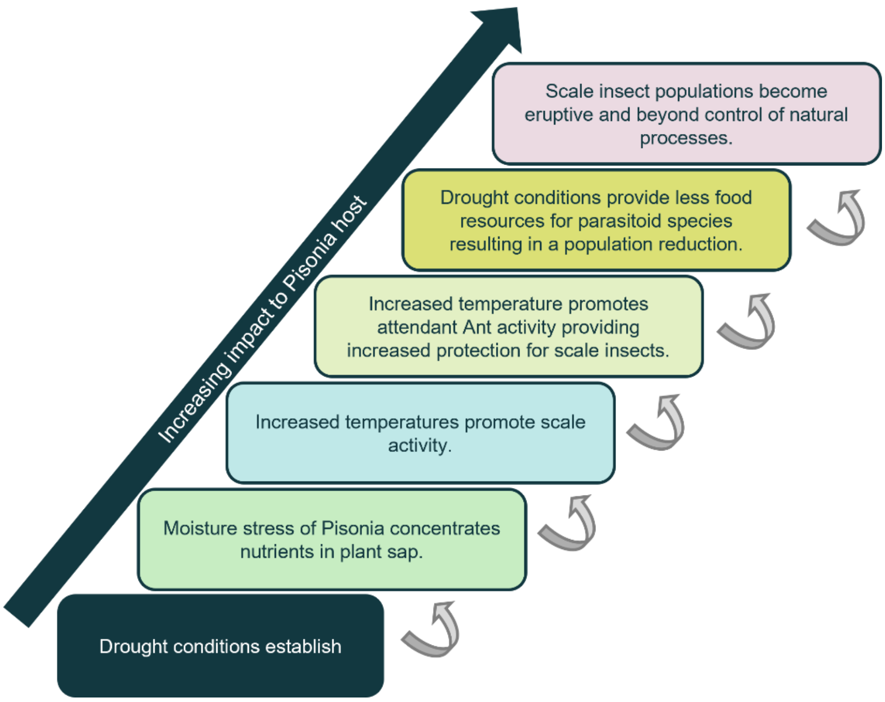

Figure 5: Scale insects have an increased impact to host species such as P. grandis under drought conditions.

In addition to scale insects, there are other invertebrate herbivores that potentially represent threats to *P. grandis* forests. These include native hawkmoth caterpillars *Hippotion spp,* (Lepidoptera: Sphingidae) and native giant, grasshoppers *Valanger irregularis* (Orthoptera: Acrididae) (Olds et al. 2019). Outbreaks of hawkmoth in 2001 caused sever defoliation at North East Herald Island and South East Magdelaine Island leading to releases of the native egg parasitoids *Trichogramma pretiosum* and *T. carverae* to control the outbreak (Smith et al. 2004).

It is unclear what led to these outbreaks but as with the scale outbreaks mentioned above, the efficacy of the natural enemies that normally keep these herbivores in check appears to have been compromised.

2.4.2 Invasive species

On Pulu-Keeling NP (North Keeling Island) in Australia's Indian Ocean Territory, the invasive yellow crazy ant (*Anoplolepis gracilipes*) is documented as a possible threat to *P. grandis* habitat given that yellow crazy ants are associated with protecting large populations of scale insects from predation (Neumann et al. 2011).

Further impacts to *P. grandis* forests are associated with invasion of feral black rats in the far north west of Torres Strait, where rat predation over many years is thought to have reduced populations of nesting seabirds in well-developed *P. grandis* forest and prevented seedling regeneration (Buelow et al. 2020; Bock et al. 2022; Maluilgal (Torres Strait Islander) Corporation RNTBC 2017; Fell & Greenhalgh 2017; Fell 2018; Waller 2013; Watson 2013).

Invasive weeds have relatively limited documented impacts on *P. grandis* forests; however, vine species such as *Ipomoea* spp. (morning glory) can pose a localised threat. These vines can dominate ground and canopy cover, smothering native vegetation, and, in severe cases, preventing the recruitment of native ground-cover species.

2.4.3 Climate change

Climate change has the potential to result in increases or changes in the presence of pests and diseases which may impact on the condition or resilience of the island ecosystems and their vegetation (Turner & Batianoff, 2007).

Sand and coral cays are vulnerable to climate change as they are extremely low lying and only have shallow freshwater lens. Their low elevation makes them subject to increased inundation, erosion and overtopping because of sea level rise and increased storm intensity and frequency. Sea level rise associated with climate change is a current and rising threat to Torres Strait and GBR islands and therefore are vulnerable to erosion and inundation from storm surges and rising sea levels (Green, 2006). Global average sea level rises are predicted to be approximately 9 to 88cm by year 2100, but recent modelling has shown short-term larger than average variations around the Cape York Peninsula and Torres Strait regions (White et al. 2005; Green 2006). Although tropical cyclones in the GBR are predicted to decrease in frequency under some climate models by 2100, their intensity is expected to increase – indeed, the proportion of time in which a tropical cyclone escalates to a category 4 or 5 has already increased globally (Earth Systems and Climate Change Hub 2021).

Further, changes in precipitation regimes and increasing temperatures may cause water and heat stress for ecological communities, as well as increasing the risk of wildfire. Reduced rainfall under climate change scenarios reduces recharge of the freshwater lens which can lead to saltwater intrusion (Turner & Batianoff, 2007). The intrusion of saltwater into the freshwater lens impacts on vegetation that relies on that lens which can lead to loss of vegetative cover.

Whilst *P. grandis* is adapted to environmental stressors such as drought and short-term inundation by seawater, in situations where there is prolonged inundation *P. grandis* vegetation will not be able to persist and over time will become replaced by more saline tolerant species such *as Abutilon albescens, Argusia argentia, Achyranthes aspera, Boerhavia spp, Ipomoea spp., Lepturus repens* and *Sporobolus virginicus*. The effect of this process would be the transformation of the vegetation communities dominating the cay from a forest structure to a shrubland or grassland matrix (Turner and Batianoff, 2007). The loss of *P. grandis* may also result in replacement by more salt-tolerant tree/shrub species including coastal she-oak (*Casuarina equisetifolia*), *Cordia subcordata, Guettarda speciosa, Pemphis acidula, Premna serratifolia* and *Scaevola taccada*.

In addition, changes to ocean currents may alter the deposition regimes of islands, both biotic (e.g., waterborne colonising plant species) and abiotic (e.g., nutrients). Increased atmospheric carbon dioxide is also predicted to lead to ocean acidification, reducing the ability of marine organisms such as coral to accumulate calcium carbonate and ultimately reducing the available building supplies for coral and sand islands (Turner & Batianoff, 2007).

3 Northern *Pisonia grandis* populations

Within Australian territory *P. grandis* is known from Christmas and Cocos-Keeling Islands, along the islands of the GBR off the Northern Territory, Gulf of Carpentaria, Torres Strait, eastern Cape York Peninsula, northeast Qld, and coastal central Qld (Walker 1991; Du Puy 1993) (Figure 6). On the GBR it is reported on 44 islands, extending from the northeast coast of Cape Yorke Peninsular to south central Qld. Its distribution occupies a total area of at least 160 hectares (ha) with some 94% found on the southern coral cays of the Capricorn and Bunker Groups and Lady Elliot Island (Walker 1991).

In Qld, the northernmost distribution of *P. grandis* occurs in the Torres Strait region, where it is found on remote coral cay islands across the top western, central, and eastern island groups, as well as on one central continental island (Fell & Arnall 2019) (Figure 6). There is an approximate 80 km gap between the southernmost Torres Strait population on Atub (Dugong Island) and the next known occurrence in the Denham Group within the northern GBR. Walker (1991) documented *P. grandis* stands on Douglas Islet, Cairncross Islets and Wallace Islet, describing them as well-developed and floristically diverse.

Records of *P. grandis* in the northern GBR and Torres Strait are primarily from coral cays. The species has also been recorded on five high islands: Mitirinchi (Quoin Island), Rocky Islets (No 1 & 2), Bajigal (Stephens Island) and Brook (North) Island (Aestra 2024, 2025a,b; Fell et al 2024, 2025; Walker 1991; Worboys & Zorn 2024). On the high islands of Bajigal (Stephens Island) and North (Brook) Islands, *P. grandis* occurs on fringing dune deposits (Aestra 2024, Aestra 2025a, Aestra 2025b; Fell et al 2024, Fell 2025) (Figure 6).

Where islands were visited by Aestra, we give in-depth summaries of findings including *P. grandis* structure, associated vegetation communities and active threats present (Aestra 2024, Aestra 2025a, Aestra 2025b; Fell et al 2024, Fell 2025) (Table 1) (Figure 6).

Table 1. Northern islands surveyed by Aestra included in this review.

Island	Aestra rapid survey year	Island group	Sea Country
Douglas Islet	2024	Yamarrinh Wachangan (Denham)	Ipima Ikaya
Cairncross Islets	2024	Yamarrinh Wachangan (Denham)	Ipima Ikaya
Wallace Islet	2024	Yamarrinh Wachangan (Denham)	Ipima Ikaya
North (Brook) Island	2025	NA	Girramay and Bandjin
Eva Island	2025	NA	Girramay and Bandjin
Bajigal (Stephens Island) and Bimi (Sisters Island)	2025	Barnard	Mandubarra

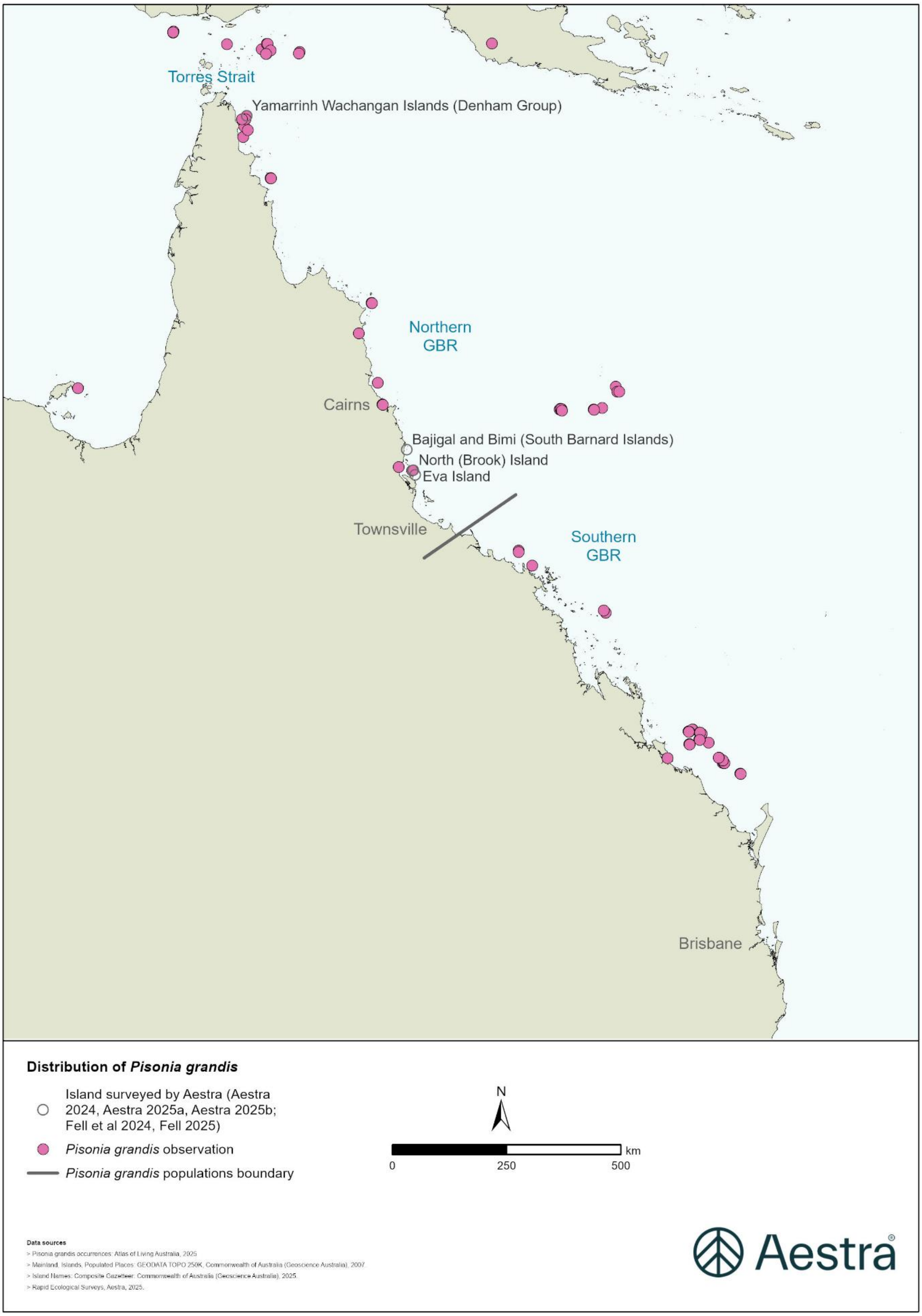

Figure 6: Distribution of P. grandis (pink dots are P. grandis observations in Australia based on specimen and observation records; open circles with labels are locations of Aestra surveys included in this review).

3.1 *Pisonia grandis* in the Torres Strait

In the Torres Strait, *P. grandis* occurs across the island chain (see Table 2).

Table 2. Distribution of P. grandis in the Torres Strait

Group	*Pisonia description*
Far northwest	A well-developed population on a vegetated coral cay within the Ugul Malu Kawal Indigenous Protected Area (IPA) (Fell 2012; Maluilgal (TSI) Corporation RNTBC 2017).
Central islands	A conserved population on Atub (Dugong Island) within the Warraberalgal Porumalgal IPA (Fell & Watson 2014; Warraberalgal & Porumalgal RNTBC 2023).
Eastern islands	Multiple coral cays within the Masigalgal IPA: Bak, Igab, Kodal, Masig, Memay, Umaga and Yauk (Walker 1991; 3D Environmental 2012; Fell et al. 2017; Fell & Arnall 2019; Masigalgal RNTBC 2025).
Continental island	A single recorded tree on Gebar Island represents the only known continental occurrence in the Torres Strait (Fell et al. 2018).

Additional isolated occurrences have been documented on Edgor and Bara islands (Fell & Watson 2014) while historical reports of *P. grandis* on Garboi (MacGillivray 1852) and Uttu (Walker 1991) have since been discounted (Fell et al. 2017).

Across the central and eastern coral cays of the Torres Strait, *P. grandis* typically forms a dominant component of low closed littoral forests (RE 3.2.29). These forests range from approximately 12 to 22 m in height and include associated species such as *Manilkara kauki, Terminalia muelleri, Planchonella obovata, Diospyros maritima, Cordia subcordata* and *Celtis paniculata* (Fell et al. 2017). Stands of *P. grandis* are commonly bordered by dense littoral vine thickets, deciduous shrublands and grassland-herbland communities (Fell et al. 2017).

In the far northwest, within the Ugul Malu Kawal IPA, very well-developed stands reach 20–25 m in height and exhibit large basal buttressing (Fell 2012). On one higher island in the central group, a single *P. grandis* tree occurs on a deflated beach ridge along the landward edge of mangrove forest (Fell et al. 2017).

3.2 *Pisonia grandis* in the Northern GBR

3.2.1 Douglas Islet

Figure 8: Douglas Islet P. grandis tree canopy (right) and P. grandis seedlings (left) on Douglas Islet. Images: David Fell, 2024.

3.2.1.1 *Pisonia grandis* and co-occurring vegetation communities

Douglas Islet is dominated by *P. grandis* closed forest, which covers most of the 2.5 ha island and forms the island's primary habitat. The forest supports large, mature *P. grandis* trees reaching 18–24 m in height and 80–230 cm DBH, with abundant seedlings (Figure 8) (Aestra 2024). Vegetation structure varies around the island, with coastal margins and dune areas supporting grassland, forbland, and shrubland communities consistent with mapped Regional Ecosystems (Aestra 2024)

The dominant *P. grandis* closed forest aligns with RE 3.2.29. The subcanopy is sparse and includes *P. grandis*, *Manilkara kauki*, and occasional *Garuga floribunda*. Vines such as *Cayratia acris*, *Ipomoea violacea*, *Tinospora smilacina*, and *Dioscorea bulbifera* are common, particularly in light gaps and along the forest margins. A sparse to mid-dense shrub layer is characterised by *Capparis lucida*, *C. nummularia*, *Phyllanthus novae-hollandiae*, and *P. grandis* saplings (Figure 8), with rare saplings of *Celtis philippensis*, *Antiaris toxicaria* var. *macrophylla*, *Ficus virens*, *F. drupacea*, and *Diospyros maritima*. The groundcover contains abundant *P. grandis* seedlings and dense patches of bird-dispersed rainforest species including *Calophyllum sil*, *Aglaia* sp., and *Podocarpus grayae*. *Pouzolzia zeylanica* and *Achyranthes aspera* are common herbs throughout, overlaying a thick humus and leaf-litter layer (Aestra 2024).

Vegetation community variation occurs at both ends of the island: the exposed southern tip supports herbland–grassland dominated by *Sesuvium portulacastrum*, *Lepturus repens* and *Ipomoea pes-caprae* subsp. *brasiliensis*, transitioning into low closed shrubland of *Clerodendrum inerme*, *Suriana maritima* and *Abutilon albescens*. The northern end contains low closed forest with shorter *P. grandis* (7–9 m), fringing *Premna serratifolia* shrubland, and emergent *Gyrocarpus americanus*. Beach and dune margins support mixed open tussock grassland and fringing shrubland consistent with RE 3.2.24c (Mixed open tussock grassland and open forblands) (Aestra 2024, Walker 1991).

3.2.1.2 Threats summary

The soft scale *P. urbicola* was present on *P. grandis* trees across all five sampling sites on Douglas Islet, although at low densities (1–50 scales per site). Four of the five sites had attendant ants. The *P. grandis* trees appeared healthy, and the scale is unlikely to cause significant short-term damage (Aestra 2024).

Field surveys also detected a fungal pathogen affecting *P. grandis* leaves. While the pathogen has not yet been definitively identified, it is likely a species of *Septoria*, previously recorded on Heron, North West, Mast Head, and North East Herald Cay between 1968 and 1999 (K. Grice pers. comm).

Some sand accretion was noted on the western side, which was covering low branches and trunks, although the trees retained full leaf.

3.2.2 Cairncross Islets

3.2.2.1 Pisonia grandis and co-occurring vegetation communities

Cairncross Islets, comprising three islands with a total area of 14 ha, support a diverse range of habitats and are among the most ecologically diverse coral cay ecosystems in the Great Barrier Reef (Walker 1991). The island has a mature stand of 22 *P. grandis* trees in the centre, reaching around 25 m in height and consistent with the mapped RE 3.2.29 (*P. grandis* closed forest). The trees were recorded as robust and well developed, with no dieback and no obvious trunk rot or senescence observed (Aestra 2024). Historical records indicate *P. grandis* has been present on Cairncross Islets since the 1840s–1850s, with early reports describing trees up to 17.4 m tall and six metres in diameter (MacGillivray 1865). Surveys in 1988 identified approximately 20 mature trees in the island's centre, forming part of a well-developed closed canopy forest up to 20 m tall with species such as *Garuga floribunda, Ficus virens, and Gyrocarpus americanus* (Walker 1991).

The island also features semi-deciduous notophyll vine forest dominated by *Manilkara kauki* (RE 3.2.29/3.2.28a, ~80% of the island), *Pemphis acidula* low closed forest (RE 3.2.30, ~20%), and various coastal shrubland, woodland, and grassland types. Overall, the vegetation is structurally complex, with a diverse canopy, subcanopy, shrub, vine, and groundcover layers supporting a mix of rainforest and coastal species.

The *P. grandis* forest supports additional rainforest species, including *Antiaris toxicaria var. macrophylla, Garuga floribunda, and Gyrocarpus americanus*, forming a deciduous notophyll forest at the forest margins. The subcanopy features *Manilkara kauki, Diospyros maritima, and Antiaris toxicaria*, while the shrub layer is highly diverse, including *Phyllanthus novae-hollandiae, Capparis lucida, Aglaia elaeagnoidea, Celtis philippensis, Pleomele angustifolia, Mimusops elengi, Ganophyllum falcatum, Ptychosperma elegans, Glycosmis trifolia, Micromelum minutum, Capparis sepiaria, Salacia disepala, Diospyros compacta, Drypetes deplanchei, Carrisa laxiflora, and Eugenia reinwardtiana*. Vines are common, *including Cayratia acris, I. violacea, Flagellaria indica,* *Tinospora smilacina, Causonis trifolia, Pachygone australis, Cansjera leptostachya, Trophis scandens, and Dioscorea bulbifera*. Groundcover is generally sparse, with patches *of Pouzolzia zeylanica, Achyranthes aspera, Tacca leontopetaloides,* and *Priophys amboinensis,* alongside dense seedlings of *Antiaris toxicaria*; *P. grandis* seedlings and saplings were present but rare (Aestra 2024).

On the margins of the *P. grandis* forest, evergreen notophyll vine forest dominated by *Manilkara kauk*i (RE 3.2.28a) occurs, with canopy heights from 7–9 m on wind-exposed southeastern sides to 10–12 m in more sheltered locations. Occasional species in this forest type include *Garuga floribunda, Celtis philippensis, Terminalia muelleri*, and *Vavaea amicorum*, with a shrub layer of *Flagellaria indica, V. amicorum, Drypetes deplanchei, Glycosmis trifolia, Ptychosperma elegans, Eugenia reinwardtiana, Cansjera leptostachya*, *and Antiaris toxicaria,* and sparse groundcover of *Panicum trichoides* and *Priophys amboinensis*.

Additional vegetation types on Cairncross Islets include:

- Coastal shrubland with emergent *Garuga floribunda* and *Manilkara kauki* (RE 3.2.31)
- *Casuarina equisetifolia* woodland (RE 3.2.6)
- Dense *Pemphis acidula* shrubland (RE 3.2.30)
- Herbland and grassland communities (RE 3.2.24b)

These diverse vegetation types, along with the central *P. grandis* and *Manilkara*-dominated forests, create a structurally and floristically complex coral cay ecosystem supporting both coastal and rainforest species (Aestra 2024; Walker 1991; DESI 2024).

3.2.2.2 Threats summary

The soft scale *P. urbicola* was present on *P. grandis* but at very low densities, with only 1–50 scales recorded on shoots within reach at two of six sampled sites; the other four sites had no scale. The trees appeared healthy and under no immediate threat from the insect. Several ant species capable of forming mutualistic relationships with the scale were recorded, including two *Crematogaster* species, at least one *Pheidole* sp., and the green tree ant (*Oecophylla smaragdina*), which can contribute to scale outbreaks under favourable conditions. No natural enemies of the scale were observed, likely due to its scarcity in accessible foliage (Aestra 2024).

3.2.3 Wallace Islet

Figure 9: Pisonia grandis on Wallace Islet. Image: David Fell 2024.

3.2.3.1 Pisonia grandis and co-occurring vegetation communities

Wallace Islet, an oval-shaped coral sand cay, supports a mosaic of vegetation types including low closed *P. grandis* forest (RE 3.2.29) (Figure 9), mixed tussock grassland and herbland, and fringing *Casuarina equisetifolia* woodland (King 1989; Walker 1991; Aestra 2024). The *P. grandis* forest is generally 5–9 m tall, with a few emergent trees reaching 12–14 m and is largely multi-stemmed (5–89 cm DBH). Canopy structure is wind-sheared on the eastern side, reaching its maximum height in the central northern area. Canopy health is good with minimal dieback, though there was little seedling regeneration observed. Surrounding vegetation includes grassland-herbland (RE 3.2.24b) and *Casuarina* woodland along the western shoreline, with limited introduced species such as *Dactyloctenium aegyptium* and *Ipomoea nil* (Aestra 2024). A few recruiting saplings of *P. grandis* and approximately five *P. grandis* seedlings were noted to have established under the *Casuarina* stand, however, these individuals were in poor condition.

The forest is notably species-poor: within the *P. grandis* stand, only three *Manilkara kauki* shrubs (1.5–3 m) and vines of *I. violacea* were recorded. A sparse shrub layer, negligible groundcover, and a deep leaf litter layer dominate the forest floor (Aestra 2024).

The surrounding vegetation includes grassland-herbland communities consistent with RE 3.2.24b and *Casuarina equisetifolia var. incana* woodland on the western shoreline. The *P. grandis* forest is largely healthy, with full leaf canopies and limited evidence of dry rot in some trunks (Aestra 2024). Seedling regeneration within the forest is absent.

3.2.3.2 Threats Summary

Pulvinaria urbicola was abundant on Wallace Islet but unevenly distributed, with highest densities associated with nests of green tree ants (*Oecophylla smaragdina*), which protect the scale and prevent predation. The predatory ladybird *Cryptolaemus montrouzieri* was present, but there was no evidence that they predated on scale located within ants nests (Figure 10). Very limited evidence of scale parasitism was observed, with only one parasitoid (*Coccophagus ceroplastae*) recorded away from ant nests. Two other parasitoids (Pteromalidae and Chalcididae) were found but are unlikely to affect scale. A fungal pathogen, likely *Septoria* sp., was also observed on *P. grandis* trees (Aestra 2024).

Introduced species are minimal, including scattered *Dactyloctenium aegyptium* and Ipomoea nil, the latter being common in grasslands and climbing the lower *P. grandis* edges. Plastics scattered through the forest suggest recent tidal incursion, and there was also evidence of some erosion on the eastern side of the islands reducing the grassland buffer to the adjacent Pisonia forest by two to three metres (Aestra 2024).

Figure 10: Mature Cryptomlaemus montrouzieri, Wallace Islet. Image: Naomi Maxwell, 2024.

3.2.4 North (Brook) Island

3.2.4.1 Pisonia grandis and co-occurring vegetation communities

The presence of *P. grandis* on North (Brook) Island was first documented by Walker (1991), who recorded two trees at the northern end of the island. During the recent survey, a small population of three mature, multi-stemmed *P. grandis* trees was confirmed, measuring eight to twelve metres in height with DBH of 30–50 cm (Aestra 2025b) (Figure 11). The trees appeared healthy, producing new leaves from branchlet tips following a period of deciduousness during the hot dry season, with no evidence of senescence or fungal activity. They occur along the margin the foredune margin in littoral rainforest habitat (Aestra 2025b).

The littoral rainforest is closed (80–90% canopy cover) and includes foreshore species such as *Hibiscus tiliaceus, Sophora tomentosa, Pandanus tectorius, Guilandina bonduc, Guettarda speciosa*, and *Clerodendrum inerme.* This habitat is consistent with RE 7.2.1 (mesophyll vine forest on beach ridges and sand plains of beach origin).

Characteristic foreshore species include *Hibiscus tiliaceus*, *Sophora tomentosa*, *Pandanus tectorius*, *Guilandina bonduc*, *Guettarda speciosa*, and *Clerodendrum inerme*. Canopy species typical of sandplain mesophyll vine forest (RE 7.2.1) include *Aglaia elaeagnoidea*, *Terminalia arenicola*, *Terminalia muelleri*, *Macaranga tanarius*, *Mimusops elengi*, *Melia azedarach*, *Pleiogynium timorense*, *Miliusa brahei*, and *Celtis philippensis*. The subcanopy and understorey are diverse, with species such as *Diospyros hebecarpa*, *D. compacta*, *Drypetes deplanchei*, *Elaeodendron melanocarpum*, *Eugenia reinwardtiana*, *Glycosmis trifolia*, *Ixora timorensis*, *Kopsia arborea*, *Monoom australe*, *Ochrosia elliptica*, and *Sterculia quadrifida*.

The northern sand spit supports open dune woodland (RE 7.2.7) dominated by *Casuarina equisitifolia* var. *incana*, with scattered shrubs including *Scaevola taccada*, *Guettarda speciosa*, *Myoporum montanum*, *Sophora tomentosa*, and *Eugenia reinwardtiana*. Inland from the casuarina stand, low vine thicket (RE 7.2.2) occurs at 5–10 m height, forming multi-species groves of shrubs and small trees, including *Mimusops*, *Diospyros compacta*, *Drypetes deplanchei*, *Sophora tomentosa*, *Eugenia reinwardtiana*, and scattered emergent *Pandanus tectorius* (Aestra 2025b).

Figure 11: Three P. grandis trees located on the northern foreshore of North (Brook) Island in littoral rainforest. Image: David Fell, 2024.

3.2.4.2 Threats Summary

No *P. urbicola* soft scales were observed on *P. grandis* trees, which were emerging from a period of senescence. A single soft scale was found on nearby *Clerodendrum inerme*, likely representing a different species. Ants from several genera, including potential scale mutualists such as *Pheidole* spp., *Crematogaster spp., Tapinoma melanocephalum, Tetramorium lanuginosum,* and *Oecophylla smaragdina*, were present. Given the absence of significant scale infestations and the healthy condition of the trees, no immediate management actions are required, though opportunistic monitoring of scale and tree health by Girringun Rangers was recommended (Aestra 2025b).

3.2.5 Eva Island

Figure 12: Pisonia grandis on the granite slopes of Eva Island. Image: David Fell 2024

3.2.5.1 Pisonia grandis and co-occurring vegetation communities

Eva Island supports a scattered but significant population of *P. grandis* growing on steep granite boulder slopes within an RE 7.12.11d littoral rainforest community. Previous studies on Eva Island are limited to those reported by Walker (1991) and the more recent surveys of Worboys and Zorn (2024) and Aestra (2025b). Walker (1991) documented several trees and shrubs on rocky outcrops in mixed forest not exceeding 10 m in height. Recent assessments (Aestra 2025b) estimate up to 50 individuals, many of which were observed in good condition with fresh leaf growth and no signs of fungal attack or senescence (Figure 12). The *P. grandis* occur within low vine forest to thicket dominated by *Ficus* spp., palms such as *Arenga australasica*, and abundant sprawling vines. Groundcover is sparse due to the rocky terrain, but *Pisonia* persists as a notable and healthy component of the island's vegetation (Aestra 2025b).

Worboys and Zorn (2024) observed the island's vegetation as vine forest on steep granite boulder slopes with an open 8–10 m canopy dominated by *Ficus drupacea* and *Ficus rubiginosa forma glabrescens*, abundant palms (*Arenga australasica* and *Ptychosperma elegans*), and a heavy cover of sprawling vines including *Cissus hastata, I. violacea*, and *Flagellaria indica*. Combined survey efforts by Aestra in 2025 recorded 34 plant species for the island, including one introduced species, *Paspalum vaginatum*. Groundcover was limited to gaps in the rock outcrops with *Commelina ensifolia, Lepturus repens,* and *Cyperus javanicus* common. Other conspicuous species include *Terminalia catappa, Schefflera actinophylla, Trema orientalis* and *Pandanus tectorius* (Aestra 2025).

3.2.5.2 Threats Summary

A single *P. grandis* tree examined on Eva Island was heavily infested with soft scale (*Pulvinaria* sp.), affecting 68% of terminal shoots and beginning to colonise new leaf growth. Immature grasshoppers, likely *Valanga irregularis*, a known defoliator of *P. grandis*, were also present, along with a single hawkmoth (*Sphingidae*) egg (Figure 13). Monitoring of collected scale revealed emergence of two native parasitoids (*Coccophagus ceroplastae*). While the *P. grandis* trees appear in good overall health, the high prevalence of scale and the presence of defoliating insects indicate the need for ongoing monitoring of tree health and scale abundance every two years (Aestra 2025b).

Figure 13: Valangar irregularis (giant grasshopper), Eva Island, December 2024. Image: A. Rice, 2024.

3.2.6 Bajigal (Stephens Island) and Bimi (Sisters Island)

3.2.6.1 P. grandis and co-occurring vegetation communities

A rare stand of *P. grandis* occurs just behind the shoreline on the margin of strand coastal shrublands and littoral rainforest on Bajigal. This stand comprises four mature trees positioned above the shoreline on the north-western side of the island, forming part of a vegetation unit that, together *with Ipomoea pes-caprae* – dominated herbland on the western sand spit, is consistent with RE 7.2.7a (Fell et al. 2024; Aestra 2025a). The *P. grandis* population represents an important range extension for the species in the Wet Tropics bioregion and is a new record for both Bajigal and the broader Barnard Islands Group (Fell et al. 2024). The surrounding vegetation is dominated by rainforest communities on basalt slopes and littoral sands, with Bajigal supporting a diverse vascular flora of 184 species. No *P. grandis* individuals were recorded on neighbouring Bimi (Aestra 2025a).

Rainforest is the predominant vegetation across Bajigal, occurring on both basalt slopes and littoral sands, with three rainforest communities recognised. The vascular flora totals 184 species across 72 families and 149 genera, including both field observations and WildNet records; 23 species (13%) are introduced. Further detail on the island's vegetation is provided in the Ecological Assessment of Bajigal (Stephens Island) (Fell et al. 2024).

No *P. grandis* was observed on neighbouring Bimi. Vegetation on Bimi comprises six communities across five remnant Regional Ecosystems and one non-remnant unit. Closed forest and rainforest dominate the basalt slopes and littoral sands, with vegetation condition varying from relatively intact areas with limited weed presence to patches in poor or critical condition. Additional information is available in the Bimi Vegetation Assessment (Fell, 2025).

3.2.6.2 Threats summary

The small stand of *P. grandis* on Bajigal had only recently recovered from a period of senescence, with minimal mature foliage present at the time of survey. *P. urbicola* soft scale was detected at very low densities, but active tending by the invasive ant *Pheidole megacephala* was observed, an important concern given this species' well-documented role in amplifying scale outbreaks. *P. megacephala* is the dominant ant on the island and is known to displace native invertebrates and facilitate pest proliferation, posing an ongoing threat to *P. grandis* health. While scale levels were low during the survey, the presence of this ant–scale mutualism represents a key risk requiring continued monitoring (Aestra, 2025a). Field surveys also recorded a total of 23 introduced flora species, which is 13% of the total flora of the island. The most concerning weed is the morning glory vina (*Ipomea* spp.) which can dominate canopies, prohibiting recruitment on ground cover.

3.2.7 Combe Island

Worboys and Zorn (2024) surveyed Combe Island in the Howick group off Cape Melville but could not confirm the presence of *P. grandis* due to lack of on-ground surveys. They further noted that previous surveys by Fosberg and Stoddart (1991), Stoddart and Fosberg (1991), and Walker (1991) had not recorded or collected Pisonia. Therefore, the presence of Pisonia and the validity of RE 3.2.29 which is currently mapped over the island is questioned, requiring further ground surveys (Worboys and Zorn 2024).

3.2.8 Rocky Islets (No 1 and No 2)

Walker (1991) reports Rocky Islets as having the second highly developed *P. grandis* forest on the northern Great Barrier Reef. Rocky Islet is a small granitic continental island located within the Three Islands Group National Park about 92 km north of Cooktown. The island supports a stand of *P. grandis forest* covering 3.7 ha (Walker 1991, Worboys and Zorn 2024).

3.2.9 Mitirinchi (Quoin Island)

Located off the north-east coast of Cape York Peninsula, approximately 20 km east of Weymouth Bay and 50 km north of Lockhart River, Mitirinchi (Quoin Island) is a 1.5 ha island which is recognised as a significant seabird breeding island (DETSI 2025). Managed a jointly managed national park it is one of only three recorded breeding sites for great frigate birds in the northern Great Barrier Reef and supports a significant nesting colony (over 5,000 pairs) of black noddies. *P. grandis* is restricted to a 0.2 ha stunted thicket growing on rock (King & Buckley 1985, Walker 1991). A wildfire lit by travelling fishermen is reported to have heavily impacted the *P. grandis* stand (J. Pritchard pers. comm. 2025).

3.3 Discussion

3.3.1 Variability in Northern *Pisonia grandis*

The desktop review alongside surveys of the northern *P. grandis* islands reveal substantial variability in *P. grandis* extent, structure and associated ecological communities.

Pisonia grandis extent has been recorded across the northern islands occurring as:

- a single tree.
- in small groups of trees.
- dominant in a discrete vegetation community adjacent to other vegetation communities.
- completely dominating the whole of an island.
- occurring as RE 3.2.29 "*P. grandis grandis* low closed forest".
- occurring within endangered "Littoral Rainforest and Coastal Vine Thickets of Eastern Australia".

In the northern GBR, substantial variations in the vegetation association (Table 3), and structural form of *P. grandis* were observed. For example, some islands supported only a small number of isolated individuals – North (Brook) Island held only three mature trees, while Bajigal supported just four individuals.

In contrast, Wallace Islet held a small, wind-shaped forest of 5–9 m tall trees, and Cairncross Islets hosted a stand of 22 *P. grandis* trees. Eva Island contained a scattered but sizeable population of up to 50 trees across steep granite slopes. At the other extreme, Douglas Islet supported a dense 2.5 ha closed forest dominated by mature *P. grandis*, and Rocky Islet may contain one of the region's largest remaining stands (~3.7 ha). These patterns illustrate a gradient from highly fragmented, residual populations to large, structurally complex forests that remain key strongholds for the species. In the Torres Strait, populations similarly ranged from a single tree on Gebar and two mature trees on Masig to extensive, towering stands (20–25 m) on cays within the Ugul Malu Kawal IPA.

The structure of *P. grandis* and associated vegetation communities differed markedly among islands. Torres Strait cays typically supported low closed littoral forests (RE 3.2.29) with a rich mix of coastal and rainforest species, particularly within the central and eastern cays. RE 3.2.29 was also recorded at Douglas Islet, Cairncross Islets and Wallace Islet (Table 3).

On Douglas Islet, the primary *P. grandis* forest aligned strongly with RE 3.2.29, with smaller *P. grandis* trees on the northern side of the island embedded within a mosaic of grassland, shrubland, and dune edge communities. *P. grandis* populations on Cairncross Islets and Wallace Islet also aligned with RE 3.2.29. Cairncross Islets has a diverse 14 ha forest system where the *P. grandis* tree stand occurred in association with deciduous trees *Antiaris toxicaria var. macrophylla*, *Garuga floribunda* and *Gyrocarpus americanus*. Wallace Islet, by contrast, was species-poor, with *P. grandis* forming a simple closed stand with limited subcanopy development. On Eva Island, *P. grandis* trees were present within RE 7.12.11, and on Brook (North) Island were present on the margins of littoral rainforest and foredunes. Surveys by Aestra confirmed a range expansion of *P. grandis* within the wet tropics, recording four mature trees on the western end of Bajigal.

Table 3: Regional ecosystems of conservation significance recorded as occurring in association with P. grandis on Northern P. grandis Islands as collected by Aestra (Aestra 2024, Aestra 2025a, Aestra 2025b; Fell et al 2024, Fell 2025).

Regional Ecosystem	Description	Islands	Status EPBC Act	Status NC Act	Status VM Act
3.2.29	*P. grandis* low closed forest	Islands Torres Strait, Douglas Islet, Cairncross Islets, Wallace Islet	Endangered. Included in Littoral Rainforest and Coastal Vine Thickets ecological community	Endangered	Of concern
3.2.28	Evergreen notophyll vine forest restricted to beach fringes on coral atolls, shingle cays and sand cays. Restricted to a few scattered sand cays.	Cairncross Islets, Islands in the Torres Strait	Endangered. Included in Littoral Rainforest and Coastal Vine Thickets ecological community	Endangered	Of concern
3.2.30	*Pemphis acidula* low closed forest. Restricted to coral atolls, shingle cays and sand cays.	Cairncross Islets	N/A	Of concern	Of concern
3.2.31	*Premna serratifolia* closed scrub. Restricted to coral atolls, shingle cays and sand cays.	Cairncross Islets	Endangered, Littoral Rainforest and Coastal Vine Thickets ecological community	Of concern	Of concern
3.2.24	Mixed open tussock grassland and open forblands or shrublands on exposed foredunes and islands	Douglas Islet, Cairncross Islets, Wallace Islet	N/A	Of concern	Least concern
3.2.6	*Casuarina equisetifolia* woodland to open forest on foredunes on mainland and islands	Cairncross Islets, Wallace Islet, Masig Island	N/A	Of concern	Of concern
7.2.1	Mesophyll vine forest on beach ridges and sand plains of beach origin	North (Brook) Island	Endangered. Included in Littoral Rainforest and Coastal Vine Thickets ecological community	Endangered	Endangered
7.2.2	Notophyll to microphyll vine forest on sands of beach origin	North (Brook) Island	Endangered. Included in Littoral Rainforest and Coastal Vine Thickets ecological community	Endangered	Of concern
7.2.7	*Casuarina equisetifolia +/- Corymbia tessellaris* open forest +/- groved vine forest shrublands on strand and foredunes	North (Brook) Island, Bajigal	N/A	Endangered	Of concern
7.12.11	Simple to complex notophyll vine forest and semi-evergreen notophyll vine forest of rocky areas and talus on moist foothills and uplands on granites and rhyolites	Eva Island	Endangered. Included in Littoral Rainforest and Coastal Vine Thickets ecological community	Of concern	Least concern

3.3.2 Northern *Pisonia grandis* health, threats and resilience

Tree health varied widely across islands, potentially reflecting differences in forest maturity, disturbance history, and the presence of biotic and abiotic stressors. On the northern GBR, the most structurally mature and healthy forests occurred on Douglas Islet, where a 2.5 ha *P. grandis* community supported abundant seedlings and tall, healthy trees (18–25 m), though soft scale and a fungal pathogen were present. Cairncross Islets also supported tall (up to 25 m), healthy individuals, despite low-level scale and ant presence. It is noted that fungal lesions on Douglas and Cairncross islets could have been facilitated by the above average rainfall on the islands prior to surveys.

Smaller or more exposed *P. grandis* forests exhibited reduced tree health and greater vulnerability to disturbance. On Wallace Islet, the wind-sheared canopy (5–9 m, with some individuals reaching 12–14 m) was accompanied by limited seedling regeneration, signs of dry rot in several trunks, and extensive scale infestations strongly associated with green tree ants. Predation on scale insects within green ant colonies appeared limited. In an almost-closed system such as Wallace, immigration of natural enemies is likely infrequent. As a result, refuges that allow *P. urbicola* to persist may provide an important stabilising role by ensuring a continuous food source for natural enemies. Evidence from agroecosystems demonstrates that without alternative prey, natural enemies cannot persist, and that maintaining small, non-damaging pest populations can help suppress larger outbreaks by supporting natural enemy populations.

Shoreline erosion represents an additional major threat to the *P. grandis* stand on Wallace Islet. Increased sand loss and saltwater inundation are likely to reduce forest size and health by removing trees and intensifying edge effects, including higher exposure to wind, salt spray, and microclimatic fluctuations. While the western side of the islet shows signs of sand accretion, colonisation by *Casuarina* spp., and early *P. grandis* succession, indicating a potential long-term shift in vegetation distribution. Sand accretion around tree bases was also observed on Douglas Islet; however, no adverse effects on tree health were detected during the survey. Nonetheless, shoreline erosion remains a predicted long-term threat for coral cays more broadly. These low-lying landforms possess shallow freshwater lenses and minimal elevation, leaving them highly susceptible to sea-level-rise-driven inundation and erosion particularly under increased storm intensity and frequency. Together, these processes pose significant risks to the persistence and stability of *P. grandis* forests across the northern GBR.

Eva Island's steep-slope population of ~50 trees appeared generally healthy but was heavily infested with *P. urbicola*, affecting 68% of terminal shoots, and supported defoliators such as grasshoppers and a hawkmoth larva, indicating potential for significant pressure despite overall good canopy condition. Bajigal contained a rare strand of four mature trees that had recently recovered from senescence and supported low-density scale tended by the invasive ant *Pheidole megacephala*, elevating future risk to this population. On North (Brook) Island, three mature trees remained in good condition with no scale and no evidence of fungal activity.

Recruitment patterns of *P. grandis* amongst islands ranged from abundant recruitment to almost complete absence. Douglas Islet exhibited dense cohorts of *P. grandis* seedlings, indicating strong ongoing recruitment. Cairncross Islets, despite its healthy mature trees, showed only rare *P. grandis* seedlings within the forest. At Wallace Islet, a few recruiting saplings and seedlings of *P. grandis* were noted however, these individuals were in poor condition, and Bajigal showed little to no sign of seedlings. Recruitment was not observed on North (Brook) Island and Eva Island, although there were constraints to surveys at these islands.

Recruitment can be closely linked to light availability and the presence of open space in the understory and ground layer, conditions that can be significantly constrained by dense vine growth. Invasive morning glory (*I. violacea*) was widespread across surveyed sites, though its abundance and impacts varied. It occupied light gaps within the subcanopy on Douglas Islet and was common on Cairncross Islets, where open groundcover was already limited. The species was also recorded on Wallace Islet. On Eva Island, sprawling vines dominated the vine forest, particularly within gaps among rocky outcrops. The most severe impacts occurred on Bajigal, where *I. violacea* heavily disturbed the rainforest, forming dense vertical towers that completely smothered tree crowns and canopy gaps. The prevalence of these vines poses a significant threat to the health of *P. grandis* forests and their associated ecological communities. Any future wind-driven disturbance that increases canopy openings will likely facilitate rapid invasion from the soil seed bank, further smothering vegetation and reducing space for *P. grandis* recruitment.

In summary, these site-specific differences highlight varying levels of forest resilience threat profiles across the northern *P. grandis* islands. Soft scale occurred on most islands but ranged from absent (North (Brook) Island) to severe (Eva Island, Wallace Islet). Ant associations varied, from native green tree ants on Wallace Islet to invasive *Pheidole megacephala* on Bajigal. Fungal pathogens were present only on some islands (Douglas and Wallace islets). Physical pressures, including erosion (Wallace Islet and Douglas Islet), fire (Mitirinchi, and extremely small population sizes (e.g., Gebar, Masig, Bajigal) - further shape *P. grandis* resilience. Recruitment ranged from abundant seedlings on Douglas Islet to scarce or absent regeneration on Cairncross Islets, Wallace

Islet, Bajigal, North (Brook) Island, and Eva Island (noting survey limitations at the latter two). Dense vine growth, particularly invasive morning glory was widespread, with impacts ranging from moderate (Douglas Islet, Cairncross Islets, Wallace Islet, Eva Island) to severe on Bajigal where vines smothered canopy gaps and tree crowns. Bird assemblages are also likely to influence forest condition, where large seabird colonies persisted on some islands (e.g., Douglas Islet), while others (e.g., Wallace Islet) supported fewer nesting species, potentially reducing nutrient inputs essential for *P. grandis* and wider ecosystem functioning.

3.3.3 Conservation considerations

Although *P. grandis* is not listed as threatened under the EPBC Act, its VM Act status ('Of Concern') and the 'Endangered' biodiversity status (NC Act) of RE 3.2.29 highlight the vulnerability and significance of northern populations. This is a rare and highly specialised ecosystem that is restricted to fragile islands; RE3.2.29 low closed *P. grandis* forests are currently recorded on three islands in the GBR (Douglas Islet, Cairncross Islets and Wallace Islet), and on several islands in the Torres Strait (Table 3).

Damage or loss of *P. grandis* populations on these northern islands has far-reaching consequences. Decline in populations will likely have impacts on population connectivity and effective population sizes (i.e. genetic diversity) in the northern Great Barrier Reef and Torres Strait. Decline can also have impacts on the stability of sand-islands (coral cays), and the survival of dependent wildlife such as nesting turtles and seabirds. The disjunct distribution, sensitivity to disturbance, and exposure to multiple threatening processes, including scale insects, invasive ants, erosion, fire, weeds and severe weather, underline the need for proactive, regionally coordinated targeted management to ensure long-term resilience and persistence of northern *P. grandis* populations.

Conservation priorities and actions can be targeted based on distinguishing between highly vulnerable and high-value *P. grandis* populations. For example, the most vulnerable populations could be categorised as the very small, isolated stands exposed to multiple threats, while the most valuable are the large, relatively intact *P. grandis* forests with low threat levels that support substantial seabird populations. Notably, both vulnerable and high-value populations occur across the northern Great Barrier Reef and the Torres Strait. Similarly, islands with RE 3.2.29 *P. grandis* low closed forest, in addition to *P. grandis* known to occur within RE 7.2.1 and RE 7.12.11 are of high conservation priority.

Some management and conservation considerations to help boost the resilience of northern *P. grandis* populations are listed below:

- Implement long-term monitoring and health assessment programs for *P. grandis* populations and associated sea bird colonies to help detect early decline in *P. grandis*.
    - This could leverage existing QPWS routine checks and/or incorporating monitoring into new and existing health check programs with Traditional Owners (e.g., biosecurity checks).
- Work with Traditional Owners and park managers to align management and conservation outcomes for *P. grandis* with cultural, ecological, and monitoring needs.
- Manage the threat of insect pests and mutualistic ants. This could include monitoring the distribution and severity of *P. urbicola* across northern islands and Torres Strait cays. Developing targeted response plans for high-risk islands where scale threatens forest stability, including:
    - management of invasive ant populations such as Pheidole megacephala and green tree ants where they promote scale outbreaks;
    - support for biocontrol agents where naturally occurring (e.g., predatory ladybirds); and
    - strict biosecurity protocols to prevent spread of scale and invasive ants.
- Manage the threat of fire through exclusion or visitor management where relevant.
- Monitor and manage for climate change related threats on *P. grandis* communities, including increased storm activity, drought, shore erosion and increased seawater inundation.
- Support natural regeneration and habitat connectivity through protecting areas with seedling recruitment and engaging in habitat restoration in areas where seedling recruitment is low or absent, including weed management activities.

4 Conclusions

Across the northern GBR and Torres Strait, *P. grandis* forests exhibit highly variable structural condition, regeneration capacity, and exposure to threats, resulting in differing levels of ecological resilience. Together, these findings illustrate that northern *P. grandis* populations are shaped by an interplay of structural, compositional, and functional traits, each modulated by unique environmental and biotic pressures. As such, site-specific conservation and management actions will be essential to maintaining resilience under future climate and disturbance regimes. Recommendations for future management include:

- Continuing to monitor the health and condition of northern *P. grandis* populations, particularly after large storm events that may remove trees and impact weed growth.
- Implement coordinated soft scale monitoring and control, recognising that scale is present across nearly all surveyed islands, including at severe levels.
- Support and resource Traditional Owners to undertake scale monitoring and cultural land and sea management in partnership with QPWS. Collaborative, Country-based approaches are essential for culturally informed, long-term stewardship.
- Continue to fill knowledge gaps, characterising the structural, compositional, and functional variability of northern *P. grandis* populations to better predict which islands are most at risk under future climate scenarios, particularly after large storm events (cyclone impacts).

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