NORFOLK ISLAND

Protecting an Ocean Jewel

2017
NOVEMBER

invasive species council

ISLAND CONSERVATION
Preventing Extinctions

Recommendations for stronger biosecurity for the Norfolk Island group

Commitment to collaboration

We support the principle that decisions about the management of Norfolk Island should be developed in collaboration with the inhabitants of Norfolk Island.

Acknowledgements

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Inquiries

Invasive Species Council
PO Box 166, Fairfield Vic 3078, Australia
Email: contact@invasives.org.au | Web: invasives.org.au | ABN: 27 101 522 829

About the Invasive Species Council

The Invasive Species Council was formed in 2002 to seek stronger laws, policies and programs to keep Australian biodiversity safe from weeds, feral animals, exotic pathogens and other invaders. The goal is to establish a biosecurity system for Australia and the south west Pacific that stops new invasive species and reduce the impacts from existing invasive species. The Invasive Species Council is a not-for-profit charitable organisation funded almost entirely by donations from supporters and philanthropic organisations.

About Island Conservation

Island Conservation began in California as a network of conservationists in 1994. It prevents extinctions by working worldwide where the concentration of both biodiversity and species extinction is greatest—islands. Working together with local communities, government management agencies, and conservation organizations, Island Conservation selects islands that have the greatest potential for preventing the extinction of globally threatened species; develops comprehensive and humane plans for the removal of invasive species; implements the removal of invasive species; and conducts research.

Emily Bay, Norfolk Island, looking out to Phillip Island and Nepean Island. Photo: © Danny Hayes

"Perroquets, parrots, Doves, & other birds we saw in great quantitys & so very tame that they might have been knocked down with sticks …

The pines which are very numerous are of an incredible growth, one of them which had been blown down, or fell by age, measured 140 feet …"

– Philip Gidley King, Commandant Norfolk Island, 1788-1790. King established the first European settlement on Norfolk Island.

CONTENTS

Executive summary

One of many changes resulting from the revocation of self-governance on Norfolk Island in July 2016 is the federal government assuming responsibility for most pre-border and border biosecurity. This transition offers the opportunity to establish an exemplary island biosecurity system. Stronger biosecurity is very much needed, for invasive species are the major driver of extinctions on Norfolk and Phillip Islands and new harmful exotic species continue to arrive and establish on the islands.

This report was prepared to highlight the considerable conservation values of the Norfolk Island group and the importance of rigorous biosecurity to prevent the establishment of new invasive species and to limit harm from existing invaders. We describe the existing and potential arrangements for biosecurity and make recommendations for building a more robust biosecurity system.

There are many special things about the Norfolk Island group – their cliff-ringed beauty and fascinating human history, teeming seabird colonies, and a plethora of species found nowhere else in the world. A substantial proportion of species on these islands are endemic – including 43 plants (almost a quarter of the native flora), 15 birds (species and subspecies), and hundreds of invertebrates. A few additional species, including two lizards, are restricted to the Norfolk Island and Lord Howe Island groups. Many of these endemic species have unfortunately also acquired the conservation significance of rarity, due in large part to the introduction of species from all over the world. Some are extinct. Fifty-eight Norfolk species are listed as threatened under Australia's national environmental law: 46 plants, five birds (four land birds and one seabird), two reptiles and five land snails.

Invasive species

Indigenous plant species are far outnumbered on Norfolk Island by exotic species. Some 430 exotic plant species have established, more than twice as many as the 182 known indigenous species. Without intensive management, weeds would destroy most of the remnant vegetation. Competition from weeds is a threat to all 46 nationally listed threatened plant species, and managing the woody weeds that dominate substantial areas of the national park is the major demand on park funding.

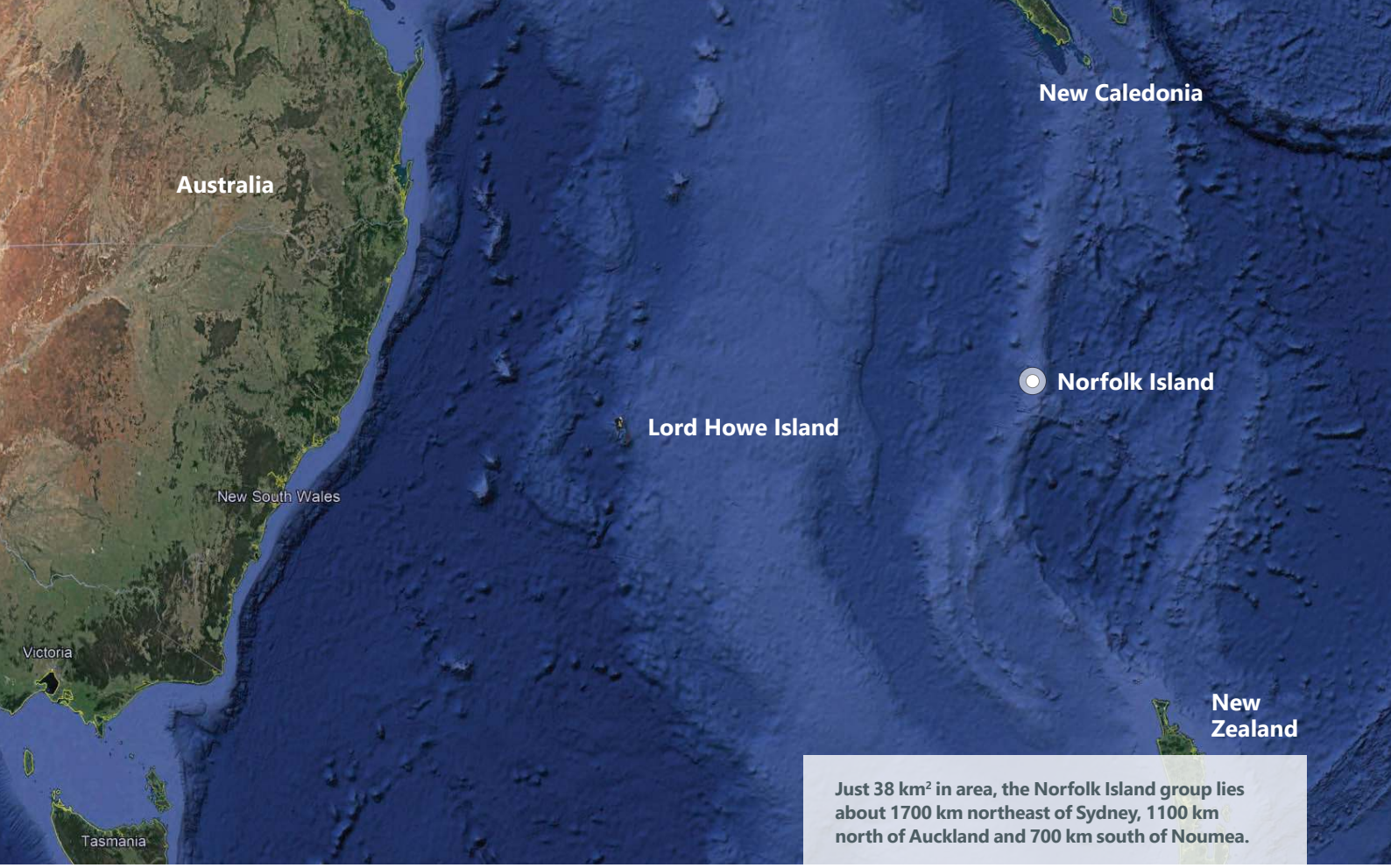
Feral cats and two rodent species (Polynesian rat and black rat) are the major threat to birds, reptiles and invertebrates on Norfolk Island. Keeping them off Phillip and Nepean Islands is a high conservation priority.

The Argentine ant, first detected in 2005 and currently being eradicated, is likely to cause serious harm to wildlife if it spreads across Norfolk Island, due to its aggression and need for protein. The local loss of other ant species would compromise ecosystem processes such as soil aeration, nutrient cycling and seed dispersal.

Biosecurity arrangements and activities

From 1979 to mid-2016, Norfolk Island was a self-governing external territory of Australia with most of the powers of a national government, including for biosecurity. When self-governance was rescinded on 1 July 2016, the federal government assumed responsibility for most pre-border and border biosecurity under the *Biosecurity Act 2015* and the *Environment Protection and Biodiversity Conservation Act 1999* (the latter for live animal imports).

The federal government intends that from 1 July 2018 NSW laws will also apply to Norfolk Island. Whether this will include NSW's *Biosecurity Act*



Previous system (prior to July 2016)	Interim system (from July 2016)	Proposed system
Norfolk Island laws	**Federal laws + Norfolk Island laws**	**Federal laws + NSW laws**
• Animals (Importation) Act 1983 • Plant and Fruit Diseases Act 1959 • Noxious Weeds Act 1916	• Biosecurity Act 2015 • Environment Protection and Biodiversity Conservation Act 1999 (live animal imports)	• Biosecurity Act 2015 (federal) • Environment Protection and Biodiversity Conservation Act 1999 (federal re. live animal imports)
Administered by Norfolk Island Government	Administered by Department of Agriculture and Water Resources	Administered by Department of Agriculture and Water Resources
	• Animals (Importation) Act 1983 • Plant and Fruit Diseases Act 1959 • Noxious Weeds Act 1916	• Biosecurity Act 2015 (NSW)
	Administered by Norfolk Island Regional Council	Administration arrangements unknown but likely major role for Norfolk Island Regional Council.

Table 1. Biosecurity arrangements for Norfolk Island – past, present and as proposed by the federal government.

2015 is not clear and will depend on agreement by the NSW government and funding from the federal government. If NSW's biosecurity laws do apply, it is likely that NSW authorities would have limited involvement with the island and that many powers under the act would be delegated to local authorities. In the interim, the Norfolk Island biosecurity laws still apply and are mostly administered by the Norfolk Island Regional Council, although the extent of their application for pre-border and border biosecurity appears to be limited.

We should expect the new biosecurity regime on Norfolk Island under Australian laws to provide exemplary protection – given the modern laws and resources of the new regulator, and the high values on the island requiring protection. Stronger biosecurity is certainly needed, as demonstrated by recent detections of the Argentine ant (2005), Asian house gecko (2005), potato/tomato psyllid and South African mantis (these two species were among many previously unrecorded exotic species detected during a quarantine survey, 2012-2014), myrtle rust (2016) and palm seed borer (2016). The island does not yet have a comprehensive risk-based biosecurity system, particularly for environmental risks.

In recognition of the 'unique animal and plant pest and disease status of Norfolk Island', the Australian government has established a legal instrument –

the *Biosecurity (Prohibited and Conditionally Non-Prohibited Goods—Norfolk Island) Determination 2016* – which lists prohibited imports and the conditions for importing goods where they differ from conditions for importing goods to the mainland. However, the legal instrument contains few prohibitions and conditions specific for Norfolk Island's conservation values. Apart from a few exceptions, it allows the importation of seeds on Australia's permitted list or seeds whose origins are Australia, whether or not they are potentially weedy. The importation of live animals requires an import permit, but we do not know whether risks for indigenous wildlife are taken into account when applications are assessed, for risk assessments and import decisions are not published.

The biosecurity agency is reviewing conditions for seed imports but this will take 'a considerable amount of time'. It is also working with the Department of Environment and Energy regarding the regulation of biosecurity risks for the environment on Norfolk Island. The implication is that until these processes are complete and relevant biosecurity measures are implemented, some biosecurity risks for Norfolk Island are unacceptably high, particularly for seed imports.

Protecting Norfolk Island's unique wildlife requires intensive management of invasive species. Much of this occurs in the national park and botanic garden, funded by Parks Australia. It includes weed management (the major demand on funding), trapping and removing cats and subsidising a desexing program, killing rats, and protecting threatened species from invasive species (eg. rat-proofing the breeding sites of birds).

Outside the national park, a major effort is being made to eradicate Argentine ants. There has been considerable success in containing the ants and eliminating them over small areas. A 2017 CSIRO review recommended a two year program, currently under way, to demonstrate the feasibility of methods for treating larger and logistically difficult areas, as well as for surveying previously treated areas to confirm eradication of the ant. Once these challenges have been met, eradication is likely to require about $2 million over five years.

Biosecurity challenges and opportunities

Deficient harmonisation: So far, harmonisation between federal and Norfolk Island officials appears to be deficient under the interim biosecurity arrangements. The lack of a state level participant in Norfolk Island biosecurity and the apparent reluctance of the federal agency to integrate federal and local priorities could be impediments to effective biosecurity.

Underwhelming environmental focus: The current arrangements for Norfolk Island indicate insufficient priority is accorded to environmental biosecurity, particularly evident with the limited restrictions on seed imports from Australia. The federal biosecurity agency's review of seed imports and identification of environmental risks should be expedited. Protecting Norfolk's unique wildlife is important for economic as well as environmental reasons, with nature tourism offering the potential to boost the local economy.

Growing biosecurity risks: The continued global spread of invasive species, including to mainland Australia and New Zealand, heightens the risks of new incursions to Norfolk Island, exemplified by the arrival of myrtle rust on the island just six years after being detected in Australia. With the intended increase in trade for Norfolk Island will inevitably come greater biosecurity risks, including new pathways for invasive species. Risks may also increase due to new port arrangements allowing vessels to moor near land.

Out of sight, out of mind: With a small population far from mainland Australia, the Norfolk Island community has a major challenge to ensure

sufficient attention from the mainland is directed to island priorities. There is often scant recognition in the Australian government of the special environmental values and challenges of islands.

Limited resources: Although not a problem unique to Norfolk Island, one of the greatest impediments to managing invasive species has been a lack of resources. The small population and rate base have greatly restricted funding available for management. One benefit of the integration of Norfolk Island into Australia is the potential to gain greater access to national funding and grants programs.

Eradication opportunities: Eradications offer the exciting potential on Norfolk Island to reverse the declines of many threatened endemic species and save on the large amounts of funding needed to conserve threatened species. They would also improve the island's appeal as a nature tourism destination. Recent achievements on islands elsewhere indicate that eradication of rats and feral cats from the 35km^2 Norfolk Island is achievable.

Creating an exemplar: The transition in biosecurity arrangements offers an excellent opportunity to create an exemplary biosecurity system for Norfolk Island – to demonstrate the value of the new federal and NSW biosecurity laws for island conservation and the commitment of the federal government to protect the special values of the Norfolk Island group.

Recommendations

Harmonise biosecurity arrangements

Effective biosecurity on Norfolk Island can only be achieved through strong cooperation between the managers of biosecurity at different levels to achieve a strong pre-border, at-border and post-border biosecurity continuum.

1. Negotiate an agreement for NSW's Biosecurity Act 2015 to apply on Norfolk Island.
2. Establish a Norfolk Island biosecurity committee with representation from the different levels of government, including biosecurity and environmental agencies, to formulate biosecurity policies and priorities for Norfolk Island and to foster harmonisation.
3. Develop a memorandum of understanding between the levels of governments to facilitate cooperation, designate roles and responsibilities, and specify funding commitments.
4. Create mechanisms for engaging industry, environmental and community stakeholders in developing and implementing biosecurity laws, policies and programs.
5. While local laws still apply, strengthen the protection they afford for environmental values, including by requiring that decisions be guided by assessments of risks for the environment as well as the economy and human health and that a precautionary approach be applied.

Conduct risks and pathways analysis

Consistent with accepted biosecurity practice, the biosecurity arrangements and priorities for Norfolk Island should be informed by a comprehensive analysis of risks – for the environment, economy and human wellbeing.

6. Commission an independent analysis of biosecurity risks and pathways: Identify the values to be protected and the known and potential biosecurity risks to these values. Prioritise risks and identify the pathways of medium to high priority risks. Recommend risk prevention, emergency response measures and mitigation strategies.
7. Make this risk analysis publicly available and update it as new information becomes available. Review and update the risk and pathway analysis every five years.

Develop a Norfolk Island biosecurity strategy

A strategy is needed to guide the development of a strong biosecurity system for Norfolk Island based on the risks and pathways analysis recommended above.

8. Commission an independent expert to develop a biosecurity strategy for Norfolk Island in close consultation with all levels of government; community, industry and environmental stakeholders; and biosecurity and ecological experts.
9. Focus the strategy on the highest priority risks and threats. Identify impediments to effective biosecurity. Develop strategies, with approximate costings, for preventing and mitigating biosecurity risks and overcoming impediments. Identify the best legislative and policy tools to achieve those outcomes.
10. Commit adequate resources and skills to implement the strategy.
11. Publicly release the final strategy and report annually on implementation. Review and update the biosecurity strategy following the update of the risk and pathway analysis every five years.

Declare Norfolk Island a biosecurity zone

Modern biosecurity laws offer flexible tools that can be moulded to meet the specific biosecurity challenges of islands. One option to facilitate island-specific biosecurity measures is to declare Norfolk Island a biosecurity zone under NSW's Biosecurity Act and develop regulations and policies to help implement the island's biosecurity strategy.

12. Declare the Norfolk Island group a biosecurity zone under NSW's Biosecurity Act 2015.
13. Develop zone-specific regulations and policies to optimise biosecurity for the Norfolk Island group and to implement the biosecurity strategy. This would include, for example, additional import restrictions and conditions, powers and protocols to facilitate rapid responses to new incursions and eradications, and measures to limit the risks of organisms being spread between islands of the Norfolk group.

Secure commitment from all biosecurity participants

Effective biosecurity is increasingly recognised as a shared responsibility of all participants. A new principle encoded in NSW's Biosecurity Act – the general biosecurity duty – offers a way of legally requiring people to take responsibility for biosecurity. It should be used to embed good biosecurity practices within the Norfolk community and those who interact with the island, such as transport company staff.

14. Develop and communicate a clear understanding of what the general biosecurity duty requires of Norfolk Island residents, visitors and transport operators. Operationalise this understanding through agreements, codes of practice and awareness-raising programs.
15. Develop a behavioural change strategy that uses principles of social science to motivate responsible biosecurity behaviours. Engage with local schools to foster biosecurity awareness.
16. Provide training for people who participate in activities with high levels of biosecurity risk or those who contribute to risk or threat mitigation.

Prepare for new incursions

Most of the effort to prevent new invaders should go to the pre-border and border work of limiting the risks of deliberate or accidental introduction of harmful new organisms, but preparations also need to be made to respond if they arrive on the island.

17. Develop contingency plans for responding to incursions of the potentially harmful organisms identified in the risks and pathways analysis.
18. Develop a biosecurity plan for activation during

emergency responses such as for ship wrecks and cyclones, when biosecurity is commonly neglected and risks are high.

19. Implement surveillance for high-risk arrivals. Use detector dogs for both surveillance and deterrence. Establish sentinel sites for high risk invasive species around areas such as the airport, wharves and cargo depots. Support and train a network of motivated community members willing to regularly conduct surveillance activities.

Undertake eradications

Eradicating the most harmful invasive animals from Norfolk Island – rats, cats and Argentine ants – would create a more secure future for wildlife, bring economic benefits for the tourism industry and reduce the need for government funding for management. There may also be the potential to eradicate some invasive plant species before they become serious weeds. It is essential that any eradication program is developed and implemented in close cooperation with the community.

20. Continue to pursue eradication of Argentine ants as outlined in the CSIRO 2017-2018 plan.

21. Identify and pursue opportunities to eradicate invasive animal and plant species on Norfolk Island where it is socially acceptable and feasible, in cooperation with the local community. The black rat, Polynesian rat, feral cat, Asian house gecko, and crimson rosella, as well as emerging weed species, are potential targets for eradication.

Establish Norfolk Island as an NRM region

Securing a future for many threatened and endemic species on Norfolk and surrounding islands requires ongoing management of invasive species. To help locals address the major biosecurity challenges on Norfolk Island, the island group should be established as an NRM region of Australia. This would facilitate greater access to expertise and funding, and trigger the development of a natural resources management plan.

22. Establish the Norfolk Island group as an NRM region of Australia and develop an NRM plan for the islands.

23. Seek funding for NRM priorities, including weed and invasive animal management.

Develop partnerships with other island managers

Because of the shared biosecurity challenges faced by island inhabitants, it could be beneficial for island environmental and biosecurity managers (including community representatives) to share strategies and expertise and to jointly work for greater mainland support for their biosecurity responsibilities. Also needed, because of the particular challenges and opportunities of island biosecurity, is an islands unit within government to develop and advance policies for island biosecurity. There would be mutual synergies in involving New Zealand, given their strong track record of island eradications and commitment to island biosecurity, and the Pacific Island Learning Network (PILN) that is operated by the Pacific intergovernmental environment agency SPREP.

24. Island managers (including from Australia and New Zealand) establish formal and informal partnerships to work together on island biosecurity issues and share expertise.

25. Establish an islands unit within government, involving federal, state and local biosecurity and environmental agencies, to develop and advance policies for island biosecurity.

1. Introduction

Some 3 million years ago a volcano erupted in the southern Pacific Ocean on a ridge of the largely submerged continent of Zealandia.[1] The larva that flowed from multiple eruptions over the next 700,000 or so years built up into a mountain that emerged from the sea.[2] Thus was born land far from any other land mass.

Mount Bates and Mount Pitt on Norfolk Island are thought to be eroded cone remnants near the central vent area of that volcano.[3] Phillip Island is what remains of a smaller volcanic centre that erupted on the slopes of the large volcano. The Norfolk Island group are the only terrestrial parts of the Norfolk Ridge, which extends from New Zealand to New Caledonia.

Currently just 38km^2 in area, these islands lie about 1700 km northeast of Sydney, 1100 km north of Auckland and 700 km south of Noumea. The largest – Norfolk Island, 35km^2 – has about 1400 human residents, supplemented by up to 600 tourists at a time.[4] Phillip Island (190 hectares), the limestone Nepean Island (10 hectares) and other small islets in the group are not inhabited by people.

The geographic isolation of Norfolk Island also means biological, social and political isolation. As with islands elsewhere, this biological isolation has given rise to a highly endemic flora and fauna, whose species are highly susceptible to decline when that isolation is breached by humans and human-introduced species.

The earliest human inhabitants of Norfolk Island were Polynesians, who arrived perhaps 800 years ago but abandoned the island long before the arrival of Europeans.[5] The history of European occupation is as old as that of mainland Australia. A party of convicts and settlers under the command of Philip Gidley King was dispatched from Port Jackson (Sydney) to harvest pines and cultivate flax and food for the new colony, and to prevent French colonisation.[6] The tumultuous history of convicts, mutineers and settlers since then, which we won't go into, has had a massive impact on the biology of these islands, mainly due to extensive clearing and the introduction of species from other parts of the world. For much of the islands' recent history there has been a major effort to repair the damage and protect the much depleted populations of indigenous wildlife.

There is a strong awareness on Norfolk Island that protecting the island's values requires rigorous biosecurity – keeping out new invasive species and controlling weeds and exotic predators that threaten indigenous species. The importance has been highlighted by recent breaches of quarantine resulting in the establishment of new harmful species such as the Argentine ant, now the focus of an eradication program.

One of many changes resulting from the revocation of self-governance on Norfolk Island in July 2016 is with arrangements for biosecurity. Responsibility for border regulation has passed to Australia's federal biosecurity agency in the Department of Agriculture and Water Resources, while some aspects of the local biosecurity laws also still apply, probably as a temporary measure. Future biosecurity arrangements have not been finalised, but are likely to include application of NSW's biosecurity laws.

This report was prepared to highlight the considerable conservation values of the Norfolk Island group and the importance of rigorous biosecurity to prevent the establishment

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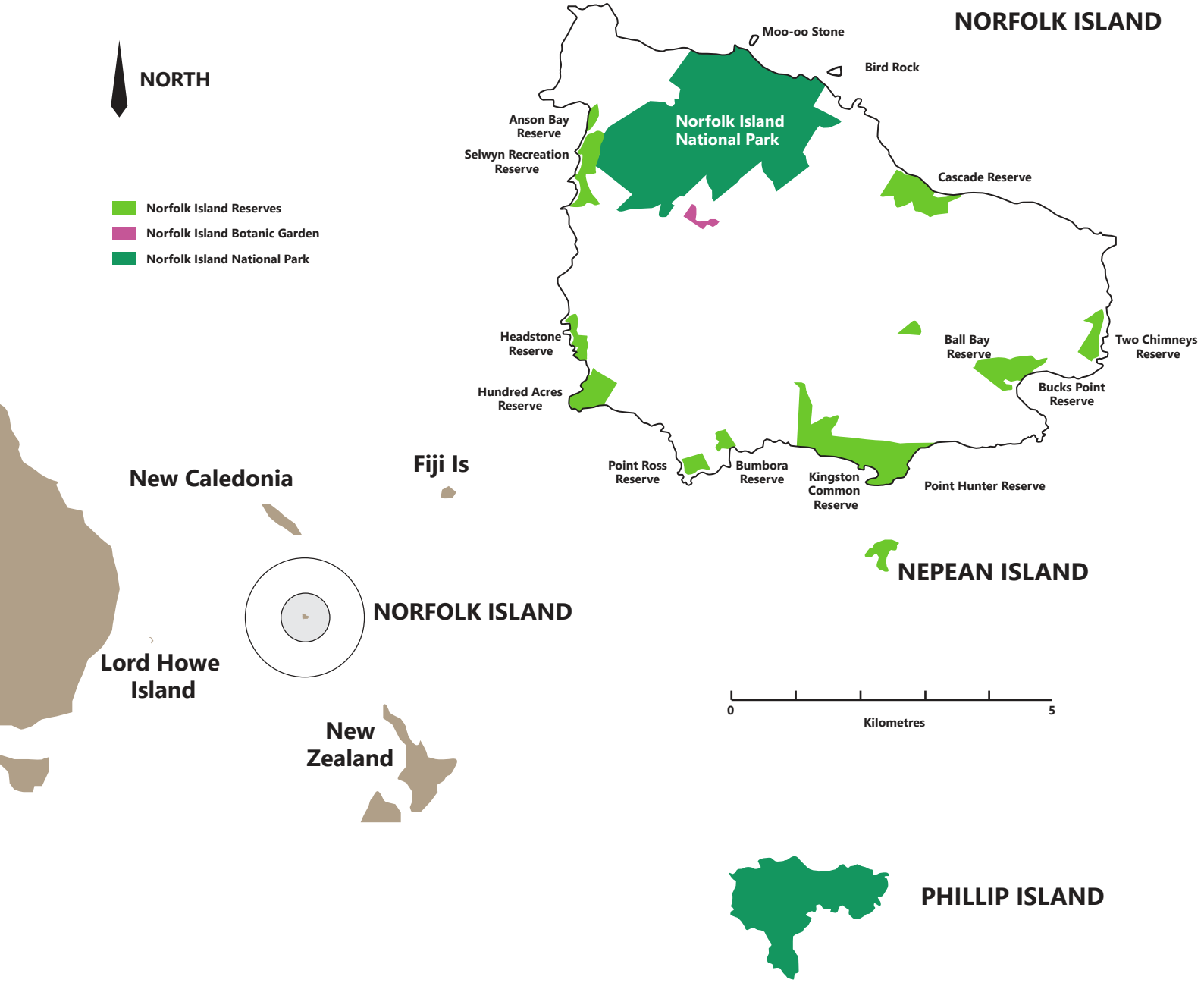


of new invasive species and to limit harm from existing invaders. We briefly outline the environmental values of the Norfolk Island group, the invasive species that threaten those values and the biosecurity risks that need to be managed. We describe the existing and potential arrangements for biosecurity and conclude with recommendations for building a more robust biosecurity system.

We use the term 'biosecurity' broadly to encompass pre-border, border and post-border regulations, policies and activities intended to prevent, eradicate or manage harmful non-indigenous organisms. Our focus is environmental, but effective biosecurity is essential also to protect human health and economic assets.

The transition in governance arrangements for Norfolk Island offers Australia the opportunity to establish an exemplary island biosecurity system. This is very much needed, for islands are hotspots of extinction due to invasive species, including two of three animal extinctions in Australia during the past decade.[7] Protecting rare and iconic species is also of immense importance for developing Norfolk Island's attraction as a nature tourism destination and fostering climate change resilience.

2. Environmental values

There are many special things about the Norfolk Island group – their cliff-ringed beauty and fascinating human history, teeming seabird colonies, and a plethora of species found nowhere else in the world. These endemic species have evolved due to the islands' isolation, with the closest land mass currently 680 km away. Many of them have unfortunately also acquired the conservation significance of rarity since human colonisation, due to habitat destruction and the introduction of exotic species from all over the world.

Of course, these islands only have indigenous wildlife because their isolation has been repeatedly breached by species arriving in the 2.5 or so million years since Norfolk rose from the sea. Birds and insects flew or blew; seeds and spores floated, blew or hitchhiked with birds; and other species swam or drifted on logs or fragments of other lands to colonise the fertile new islands. Some colonising species evolved and diversified into new forms as they adapted to the pressures and opportunities on the islands.

Species indigenous to the islands include about 180 plants, 50 macrofungi, 50 birds (an additional 70 or so are vagrants or non-breeding migrants), and several hundred invertebrate species, including more than 60 land snails.[8] Apart from birds, vertebrate animals were rare colonists: just two bat species, two lizards and two freshwater eels are indigenous.[9] There are also many lichens and bryophytes.

The natural process of colonisation still goes on. Recent bird arrivals include two woodswallow and three petrel species.[10] A 13-year moth survey found that almost 40% of the species on Norfolk Island were non-residents, most having come (presumably blown) from Australia.[11] However, the rate of new species' arrival has dramatically escalated, with most of the hundreds of new species establishing in the past 230 years having been brought by or hitchhiked with humans. Some of these are causing a great deal of damage, by preying on or competing with native wildlife or degrading their habitat (discussed in section 3).

2.1 Endemic and rare species

A substantial proportion of the indigenous species on Norfolk and Phillip Islands are endemic – 43 plants (almost a quarter of the native flora), 15 birds (species and subspecies), 3 marine fishes, and hundreds of invertebrates (including 60+ land snails, 65 beetles, 30 moths, 12 thrips, 11 booklice, 3 katydids, springtails, and a cricket, cicada, centipede and ant).[12] A few additional species, including two lizards, are restricted to the Norfolk Island and Lord Howe Island groups.

When Europeans arrived in 1788, Norfolk and Phillip Islands were densely forested, with the endemic Norfolk Island pine (*Araucaria heterophylla*) dominant in the canopy. Now less than 10% of the original forest survives, mostly within the national park on Mt Pitt and Mt Bates.[13] The bald rolling hills of Norfolk are densely covered in kikuyu grass (an introduced species), and the Norfolk Island pine is threatened.[14]

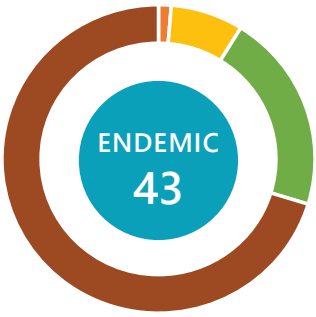
When Europeans arrived in 1788, Norfolk and Phillip Islands were densely forested, with the endemic Norfolk Island pine (Araucaria heterophylla) dominant in the canopy. Now less than 10% of the original forest survives...

The critically endangered Norfolk Island green parrot (or parakeet) has the 'dubious honour of having to be rescued from the brink of extinction not once, but twice'.[37] In 1988 the population was reduced to 32 birds due to predation by rats and cats and competition from crimson rosellas and starlings. Numbers rebounded to about 200 in 2008 due to a recovery program, but by late 2013 they had sunk again to no more than 100, including just 11 breeding-age females. A rescue effort since then has involved setting up rodent-proof nesting sites and spreading chicks among parents to improve survival rates.[38] A project is under way to establish an insurance population on Phillip Island. Photo: Luis Ortiz-Catedral

PLANTS

*Extinct: 8
Threatened: 46
Introduced: 430
Other native: 128
Total native: 182

* 6 locally extinct & 2 globally extinct.



Land clearing, hunting and invasive species have led to the loss and decline of many native species. Among the globally extinct species are two plants, seven birds and six land snails (table 2). Now, Norfolk Island's major challenge is to keep other native and endemic species from also disappearing. Fifty-eight Norfolk species are listed as threatened under Australia's national environmental law (*Environment Protection and Biodiversity Conservation Act 1999* [EPBC Act]): 46 plants, five birds (four land birds and one seabird), two reptiles and five land snails.

2.2 Plants

Of the 46 plant species listed as threatened under the EPBC Act, 30 are endemic, two are shared with the Lord Howe Island group, and one is known beyond Norfolk Island from a single individual.[18] Two entire genera are unique to the islands, each represented by a single species, although one is recently extinct (Phillip Island glory pea, *Streblorrhiza speciosa*) and the other (Norfolk Island bastard oak, *Ungeria floribunda*) is threatened.

Globally extinct taxa	Likely major causes
Bridal flower (*Solanum bauerianum*)	Unknown, but probably clearing and rabbits. The species was previously also known from Lord Howe Island.
Phillip Island glory pea (*Streblorrhiza speciosa*)	Grazing by rabbits, goats and pigs.
Norfolk Island pigeon (*Hemiphaga novaeseelandiae spadicea*)	Overhunting, predation by feral cats.
Norfolk Island long-tailed triller (*Lalage leucopyga leucopyga*)	Predation by black rats.
Norfolk Island kaka (*Nestor productus*)	Overhunting.
Grey-headed blackbird (*Turdus poliocephalus poliocephalus*)	Predation by black rats.
White-chested white-eye (*Zosterops albogularis*)	Predation by black rats and clearing.
Norfolk Island starling (*Aplonis fusca fusca*)	Predation by black rats.
Norfolk Island ground dove (*Alopecoenas norfolkensis*)	Predation by feral cats, overhunting.
Stoddart's helicarionid land snail (*Quintalia stoddartii*)	Predation by rats.
Campbell's helicarionid land snail (*Advena campbellii*)	Predation by rats.
Posticobia norfolkensis	Predation by rats.
Quintalia flosculus	Predation by rats.
Nancibella quintalia	Predation by rats.
Panulena perrugosa	Predation by rats.

Table 2. Extinct plants and animals, Norfolk Island group.[15] Right, the now extinct Phillip Island glory pea (*Streblorrhiza speciosa*) was once cultivated in Europe.

2.3 Animals

Norfolk and Nepean Islands are listed by Birdlife Australia as an Important Bird Area (among Earth's most exceptional places for birds) for supporting the entire populations of the white-chested white-eye (*Zosterops albogularis*), slender-billed white-eye (*Zosterops tenuirostris*), green parrot (*Cyanoramphus cookii*) and Norfolk gerygone (*Gerygone modesta*), as well as over 1% of the world populations of wedge-tailed shearwater and red-tailed tropicbird.[20] Phillip Island is separately designated as an Important Bird Area for supporting populations of the globally threatened providence and white-necked petrels and more than 1% of the world's population of the grey ternlet.

Of the 15 species or subspecies of endemic land birds known from Norfolk Island at the time of European settlement, six are listed as extinct under the EPBC Act, two are listed as critically endangered and two as vulnerable. The main causes of extinction and decline have been extensive forest loss and introduced predators and competitors.

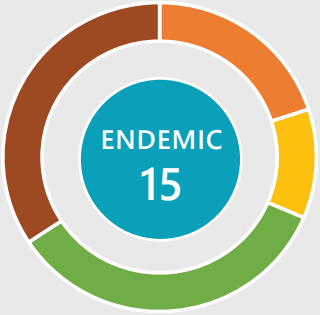
As the only land in a vast area of ocean, the Norfolk Island group offers important breeding and roosting sites for seabirds. Twenty-two birds listed as migratory or marine under the EPBC Act occur on the islands.[21] This includes a threatened subspecies of Kermadec petrel (*Pterodroma neglecta neglecta*), for which Phillip Island is one of two Australian breeding sites. Phillip Island, Nepean Island and other islets are particularly important sanctuaries, for they are free of the rats and cats that have decimated seabird colonies on Norfolk Island.

The only two native mammals known from Norfolk Island – Gould's wattled bat (*Chalinolobus gouldii*) and the eastern freetail bat (*Mormopterus norfolkensis*) – are thought to be locally extinct, due

LAND & FRESHWATER BIRDS*

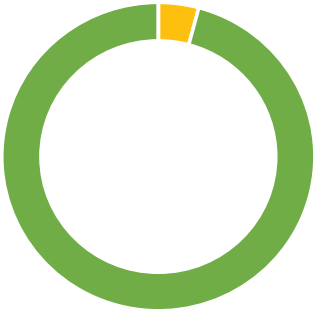
Extinct: 7
Threatened: 4
Other native: 12
Introduced: 12
Total native: 23

* Resident species only.



SEABIRDS

Threatened: 1
Other native: 23



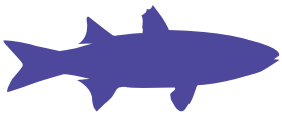
MAMMALS

Extinct: 2*
Introduced: 4

* Locally extinct.

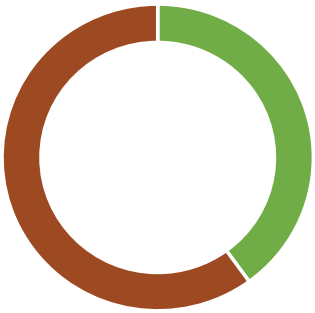
LIZARDS

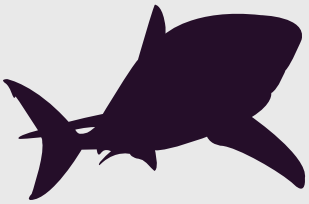
Threatened: 2
Introduced: 1



FRESHWATER FISHES

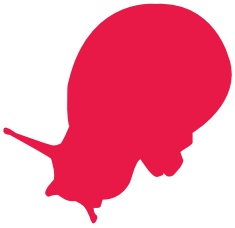
Native: 2 Introduced: 3





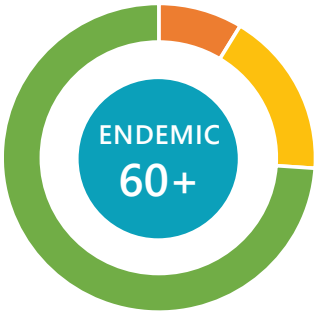
MARINE FISHES

Threatened: 1 Other native: 217



SNAILS

Extinct: 6 Threatened: 12 Other native: 51
Total native: 69



to habitat loss and predation by rats and cats.[22] These species exist in Australia.

The Lord Howe Island skink (*Oligosoma lichenigera*) and the Lord Howe Island gecko (*Christinus guentheri*), restricted to the Norfolk and Lord Howe Island groups, have both been lost from Norfolk Island, probably due to Polynesian rat.[23] The skink survives on Phillip Island (and Lord Howe islands), and the gecko on Phillip and Nepean Islands and small islets (as well as the Lord Howe Island group).

Just two freshwater fish species occur on Norfolk Island – two eels, which also exist in Australia and on other Pacific islands.[24] No frogs have colonised Norfolk Island.

The main threatened invertebrates on Norfolk Island are land and freshwater snails. Of the 69 recorded species, almost all endemic, six are presumed extinct on the IUCN Red List and 12 are threatened.[25] The main threats are environmental degradation and exotic predators.

As one of three subtropical island groups in the south-west Pacific Ocean (along with the Lord Howe Island group to the west and the Kermadec Islands to the east) the Norfolk Island group provides important feeding and breeding grounds for marine species. The alternating influence of warm and cool currents creates a transition

Like most other endemic birds on Norfolk Island, the Norfolk Island golden whistler (*Pachycephala pectoralis xanthoprocta*), listed as vulnerable, is threatened by rats and cats. These introduced predators also prevent most seabird species nesting on Norfolk Island. White terns (*Gygis alba*) gain some protection by nesting high in trees. The chick shown here has hatched from an egg laid in a depression on a tree branch.

zone resulting in an unusual mix of tropical and temperate species. The inshore waters support one of the southern-most coral assemblages in the world, and one of the few known transitional algal and coral assemblages.[26]

With Norfolk Island in the path of the East Australian current, most of the 220 marine fish species (85%) in the area are also in Australian mainland waters.[27] Whales, dolphins, sharks and turtles also inhabit Norfolk Island waters.

2.4 Protected areas

Much of Norfolk Island's remnant vegetation is protected in the Norfolk Island National Park, managed by Parks Australia. This park consists of 460 hectares on the mainland and 190 hectares on Phillip Island.[35] The Norfolk Island Botanic Garden, also managed by Parks Australia, covers 5.5 hectares. Other public reserves, managed by the local Conservator of Public Reserves, include the 10 hectare Nepean Island.

The vegetation remnants protected in the national park include palm and tree fern forest, hardwood forest, and Norfolk pine-dominated forest. The botanic garden contains a small remnant of the subtropical viney hardwood forest which once covered the island foothills.[36] Their small size renders these remnants very sensitive to disturbance.

Little is known about the invertebrate fauna of Norfolk Island. Five years ago, just three species of thrips had been recorded on Norfolk Island.[39] The quarantine survey from 2012 to 2014 added an additional 63 species to the inventory.[40] A dozen species (about 20%) are endemic or presumed endemic. About 30% are probably native to Norfolk as well as other lands, but the largest proportion – almost 50% – are widespread invasive species which feed on horticultural and vegetable crops.

Photo: Laurence Mound, CSIRO

3. Invasive species

Island wildlife can be highly susceptible to harm from invasive species. Evolving with fewer competitors, predators and parasites than wildlife on continents, island species often have poor defences against invaders. Species introduced by or arriving with humans are often very different to indigenous island species and could not travel across oceans under natural conditions. They can thrive on islands due to fewer predators, competitors and pathogens than in their land of origin, and vacant ecological niches.[41] As a result, invasive species on islands have been responsible for a great proportion of global extinctions over the past few centuries. Three-quarters of the recorded extinctions of terrestrial vertebrate animals have occurred on islands, mostly caused by invasive species.[42]

Norfolk and Phillip islands exemplify the vulnerability of island species to invasive species. As shown in the graph on page 21, invasive species – particularly weeds, rats and feral cats – constitute the major threat to the islands' wildlife. For example, the threats go beyond predation and competition. By decimating seabird colonies on Norfolk Island, rats and cats have seriously compromised ecological processes, due to the reduction in phosphorous previously deposited in the guano of millions of seabirds.[43]

The story of Phillip Island exemplifies the habitat devastation that can be wrought by invasive species. Goats, pigs and rabbits almost completely denuded the island, resulting in severe erosion, with the loss of probably some two metres of soil in most places.[44] Since the eradication of pigs and goats in the early 1900s and rabbits in 1986, some vegetation has regenerated, mainly in the gullies. The island's flora now consists of 42 indigenous species and 60 exotic species, including some serious weeds.[45]

3.1 Weeds

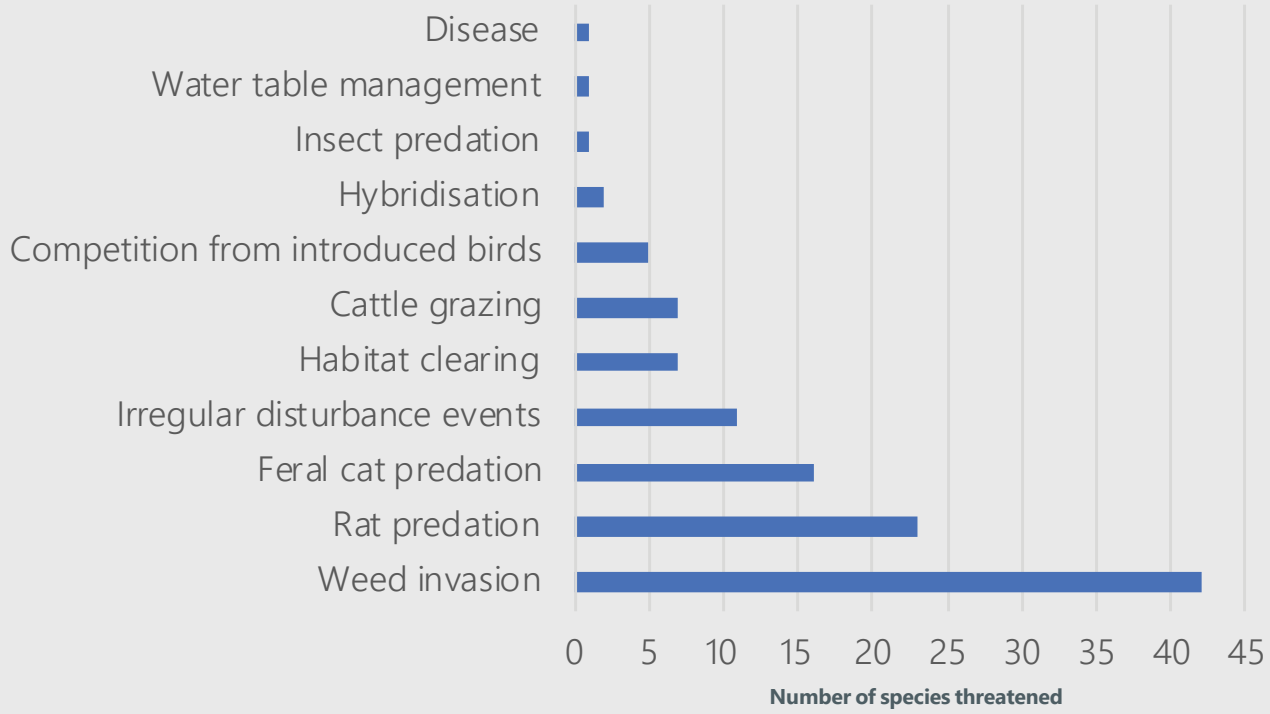
Indigenous plant species are far outnumbered on the Norfolk Island group by exotic species. Some 430 exotic plant species have established, more than twice as many as the 182 known indigenous species.[47] More than 50 were recorded for the first time during a quarantine survey in 2012-2014.[48] The situation could get worse if new species continue to be introduced from mainland Australia without being assessed for weed risk, for, as noted in the quarantine survey report, many mainland weed species are absent from Norfolk Island.

Weeds have transformed many ecological communities on Norfolk and Phillip Islands – suppressing and eliminating native plants, altering the structure of the vegetation and depriving animals of essential habitat elements.[49] For example, by changing the forest structure, weeds have reduced the number of nesting hollows available for boobook/morepork owls and green parrots.[50] Areas with dense stands of red guava or African olive tend to have lower surface soil moisture, resulting in the death of mature Norfolk Island pines due to competition for moisture.

Weeds have transformed many ecological communities on Norfolk and Phillip Islands – suppressing and eliminating native plants, altering the structure of the vegetation and depriving animals of essential habitat elements.

A wall of red guava (*Psidium cattleianum*) – one of Norfolk Island's worst weeds – backs a recently treated area, where native plants are now regenerating. In the background are Norfolk Island pines. Photo: Kevin Mills

MAJOR THREATS TO NORFOLK ISLAND GROUP SPECIES



Source: Norfolk Island Region Threatened Species Recovery Plan.

Without intensive management, weeds 'would destroy most park and botanic garden values', says the national park management plan.[51] Managing the woody weeds that dominate substantial areas of the park – red guava, African olive and Brazilian pepper – is the major demand on park funding. Competition from weeds is a threat to all 46 listed threatened plant species, most of which are endemic.[52]

Red guava (*Psidium cattleianum*):[53] Introduced for its edible fruit, this weed forms dense thickets with mats of feeder roots that make it difficult for other species to grow. It dominates the understorey in parts of the national park. The fruit is a food source for birds such as the green parrot as well as rats. When the fruits decompose they can alter soil chemistry.

African olive (*Olea europaea* subsp. *cuspidata*): This weed established on Norfolk Island soon after settlement and has created dense forests that dominate parts of the national park, particularly the drier aspects. It inhibits native plant germination and growth. It established on Phillip Island after the removal of rabbits and is now the main woody weed on the island and a threat to rare plants. However, it also helps mitigate soil erosion, and on Norfolk provides a year round source of food for birds such as the green parrot.

Brazilian pepper/Hawaiian holly (*Schinus terebinthifolius*): Introduced as a garden plant, this weed can displace native species in undisturbed sites. It prevents the re-establishment of other species due to the release of allelopathic substances. The fruits have been implicated in bird intoxication and death. It is difficult to manage as the sap can cause allergic reactions and skin lesions.

Lantana (*Lantana camara*): Introduced as a garden plant, this is an aggressive weed of open areas that suppresses regeneration of native species.

Mist flower/William Taylor (*Ageratina riparia*): Introduced as a garden plant, this weed of open areas shades out small native plants. It dominates the understorey in parts of the national park.

Kikuyu grass (*Cenchrus clandestinus*): Introduced for pasture and erosion control, kikuyu severely restricts regeneration of native plants by forming a thick sward that can rarely be penetrated by seedlings of other species. It has the potential to degrade habitat for ground nesting seabirds. The grass chokes burrows and has been reported to strangle birds on Lord Howe Island.

Madeira vine (*Anredera cordifolia*): This fleshy climber invades the margins of rainforests smothering small trees and shrubs. It is difficult to control.

Coast morning glory (*Ipomoea cairica*): This twining plant rapidly invades open areas where trees have fallen or woody weeds have been removed.

Formosan lily (*Lilium formosanum*): This vigorous, shade tolerant species produces large numbers of seeds and is difficult to remove. It often grows in disturbed sites.

The regional threatened species recovery plan has identified several additional species on Norfolk Island that have the potential to become serious weeds, including African boxthorn (*Lycium ferocissimum*), asparagus fern (*Protasparagus aethiopicus*), coral berry (*Rivina humilis*) and honeysuckle (*Lonicera japonica*).[54] Others of great concern are cotoneaster (*Cotoneaster glaucophyllus*) and ochna (*Ochna serrulata*).

3.2 Invasive vertebrates

Most animal extinctions and declines on the Norfolk Island group have been caused by introduced predators – two rat species and the domestic cat.[55] The Polynesian rat was introduced by Polynesian explorers probably some 800 years

The black rat (*Rattus rattus*) shown in this photo, taken in New Zealand, is preying on a fantail while it sits on its nest. Photo: © Nga Manu Images

Rats are considered to be the most destructive predator on Norfolk Island, responsible for the loss of several endemic bird species and the two lizard species, which are no longer present on the main island.

ago, the black rat may have come ashore from a shipwreck in 1942, and the cat was brought by early European settlers. Other vertebrates that have caused great damage in the past are rabbits, goats and pigs, all eradicated from Phillip Island.

Polynesian rat (*Rattus exulans*), **black rat** (*Rattus rattus*): These two rat species prey on land birds and seabirds (including eggs and nestlings), reptiles, and invertebrates, including land snails. They are considered to be the most destructive predator on Norfolk Island, responsible for the loss of several endemic bird species and the two lizard species, which are no longer present on the main island. Rats threaten the endemic golden whistler, Norfolk Island robin, green parrot, gerygone, slender-billed white-eye, fantail, most nesting seabirds and land snails. The black rat threatens some plants by eating their seeds and fruits, which compromises regeneration. It is vital that Phillip and Nepean Islands are kept rat-free as they provide refuges for many species threatened by rats and could become refuges for other species at risk on the main island such as the green parrot. There is a third invasive rodent present on Norfolk Island – the house mouse (*Mus musculus*) – but its impacts are unknown.[56]

Feral cat (*Felis catus*): Common throughout Norfolk Island, this predator is a threat to the boobook/morepork owl, green parrot, golden whistler, Norfolk Island robin, and most nesting seabirds. Keeping cats off Phillip and Nepean Islands is a high conservation priority.

Feral chicken/fowl (*Gallus gallus*): Scratching of leaf litter and removal of soil invertebrates by feral chickens disturbs the natural nutrient cycle on Norfolk Island, and their removal of seedlings compromises the regeneration of endangered native plants. They feed on native invertebrates, including endangered land snails, and are a reliable food source for cats and rats. Keeping them off Phillip Island is vital.

Crimson rosella (*Platycercus elegans*), **European starling** (*Sturnus vulgaris*): The use of nest hollows by these introduced birds threatens endangered native birds. They fill hollows with nesting material, preventing use by the boobook/morepork owl and green parrot. Crimson rosellas also compete with green parrots for food, destroy their eggs and evict them from nesting hollows.

Asian house gecko (*Hemidactylus frenatus*): Detected on Norfolk Island in 2005, this species could threaten the indigenous gecko if it became established on Phillip or Nepean Islands.

3.3 Invasive invertebrates

Close to 1200 invertebrate taxa were recorded on Norfolk Island by the 2012-2014 quarantine survey, which focused mainly on species associated with crop, amenity and introduced plants.[57] The survey recorded 421 species not previously known for Norfolk Island. It's not clear from the survey report how many of the invertebrates on Norfolk are exotic or invasive, and it can often be difficult to tell. The impacts of exotic invertebrate species are also often hard to tell. Concerns have been expressed about the European wasp (*Vespula germanica*) and Asian paper wasp (*Polistes chinensis*), for example, but their impacts have not been studied.[58]

A new arrival on Norfolk is the palm seed borer (*Coccotrypes dactyliperda*), an invasive 1.5-2.5 mm beetle that breeds in palm seeds, compromising plant reproduction. It is considered a serious pest of the date palm industry and could potentially impact on the island's kentia palm industry, but the likely impacts on Norfolk's one indigenous palm species (*Rhopalostylis baueri*, found also on the Kermadec Islands), are unknown.[59]

Argentine ant (*Linepithema humile*): First detected in 2005, this invasive ant is likely to cause serious harm to Norfolk Island's wildlife if not eradicated (see section 4). The species has invaded many countries, including the Australian mainland, where it forms super-colonies and competitively displaces most other ant species.[60] On Norfolk Island, the diversity and abundance of other ant species has been noticeably reduced around Argentine ant colonies. The local loss of other ants can compromise ecosystem processes such as soil aeration, nutrient cycling and seed dispersal.

It is thought that the Argentine ant could threaten a substantial proportion of Norfolk Island's vertebrates and invertebrates due to its aggression and need for protein.[61] Ground-nesting seabirds and rare species such as the green parrot and Norfolk Island robin are at greatest risk. Other species such as the two indigenous lizards would be at great risk if the Argentine ant spread to Phillip Island.

European honey bee (*Apis mellifera*): Colonies of honey bees often occupy tree hollows, a resource in short supply for the green parrot and other bird species.[62] Hives are removed from the national park where practicable.

American cockroach (*Periplaneta americana*): This cockroach may have eliminated an endemic cricket on Norfolk Island through competition and is considered a potential threat to the native cockroach on Phillip Island should it establish there.[63]

3.4 Pathogens

The two main pathogens of conservation concern on Norfolk Island – psittacine circovirus disease and root rot fungus – may occur naturally there, as they do in Australia, but their incidence is exacerbated by environmental factors. Other pathogens of native plants and animals on the islands are poorly known.[64] A serious fungal disease of plants in the Myrtaceae family – myrtle rust (*Puccinia psidii*) – has recently arrived on Norfolk Island, detected in 2016. There are no Myrtaceae plants indigenous to Norfolk Island, but its arrival highlights the risks of new disease introductions and it could become a source for transmission to other locations.[65]

Psittacine circovirus disease: This virus is known to infect more than 60 parrot species, including Norfolk Island's critically endangered green parrot.[66] Also known as parrot beak and feather

disease, the virus kills feather and beak cells and is often fatal. It is thought to have been responsible for an epidemic that killed many green parrots on Norfolk Island during the 1970s.[67]

Root rot fungus (*Phellinus noxius*): This is the main pathogen causing dieback of Norfolk Island pines.[68] It attacks tree roots, causing decay and cutting off water and nutrient supply to the crown, resulting in tree death.[69] The fungus is a natural component of rainforests in many countries, but its impacts are exacerbated by low levels of soil phosphorous, highlighting the link between seabirds and the island's ecosystem.[70]

3.5 Marine organisms

No information could be found regarding exotic marine organisms in Norfolk waters and no surveys have been publicly reported.

3.6 Future risks

The recent arrivals of the Argentine ant, Asian house gecko, myrtle rust and palm seed borer on Norfolk Island by unknown means exemplify the risks of new invasive species being introduced. The *Norfolk Island Region Threatened Species Recovery Plan* emphasises the great risks of new disease introductions, particularly of 'extremely dangerous plant pathogens' and bird diseases.[71] The catastrophe that can result was demonstrated in Hawaii when avian malaria, which arrived with an accidentally introduced mosquito species, led to extinction of almost the entire endemic bird fauna below 600 metres altitude. Other high risk groups with the potential to severely impact on island values include well known invaders such as the yellow crazy ant (*Anoplolepis gracilipes*), big-headed ant (*Pheidole megacephala*) and cane toad (*Rhinella marina*).[72] But given the unpredictability of impacts and the susceptibility of island species, many other species not recognised as invasive – including those indigenous to Australia or New Zealand – could cause harm.

The quarantine survey report notes that once a species is introduced to Norfolk Island, a lack of biological barriers almost guarantees it will spread rapidly across the entire island. This was demonstrated recently by tomato/potato psyllid (*Bactericera cockerelli*), which was found during the survey. The psyllid carries a bacterium that causes disease in a wide range of vegetable crops. It was initially found at extremely low levels, implying it had arrived only recently and potentially could be eradicated. By the survey's end, the population had 'increased exponentially' and eradication was no longer possible.[73]

Vital for the survival of several species is the ocean barrier between Norfolk Island and the other islands and rock stacks serving as refuges for several species wiped out on Norfolk. A major conservation priority must be to keep these islands free of invasive species found on the main island, particularly the black rat, Polynesian rat, feral cat, Asian house gecko and Argentine ant.

4. Biosecurity arrangements for Norfolk Island

From 1979 to mid-2016, Norfolk Island was a self-governing external territory of Australia with most of the powers of a national government, including for biosecurity.[74] The Norfolk Island government regulated biosecurity under the *Animals (Importation) Act 1983*, *Plant and Fruit Diseases Act 1959* and *Noxious Weeds Act 1916*.

When self-governance was rescinded on 1 July 2016, the Australian government assumed responsibility for most pre-border and border biosecurity on Norfolk Island under the federal *Biosecurity Act 2015* and the *Environment Protection and Biodiversity Conservation Act 1999* (the latter for live animal imports). The federal government intends that from 1 July 2018 NSW laws will also apply to Norfolk Island, and several already do so.[75] Whether this will also include NSW's *Biosecurity Act 2015* is not clear and will depend on agreement by the NSW government and funding from the federal government.[76] The proposed starting date of July 2018 is probably unrealistic. If NSW's biosecurity laws do apply, it is likely that NSW authorities would have limited involvement with the island and that many powers under the act would be delegated to local authorities.

In the interim, the Norfolk Island biosecurity laws listed above still apply and are administered by the Norfolk Island Regional Council, although the extent of their application for pre-border and border biosecurity appears to be limited. They will be repealed if NSW's Biosecurity Act is applied.

In this section we describe biosecurity arrangements and activities on Norfolk Island and consider some biosecurity challenges and opportunities.

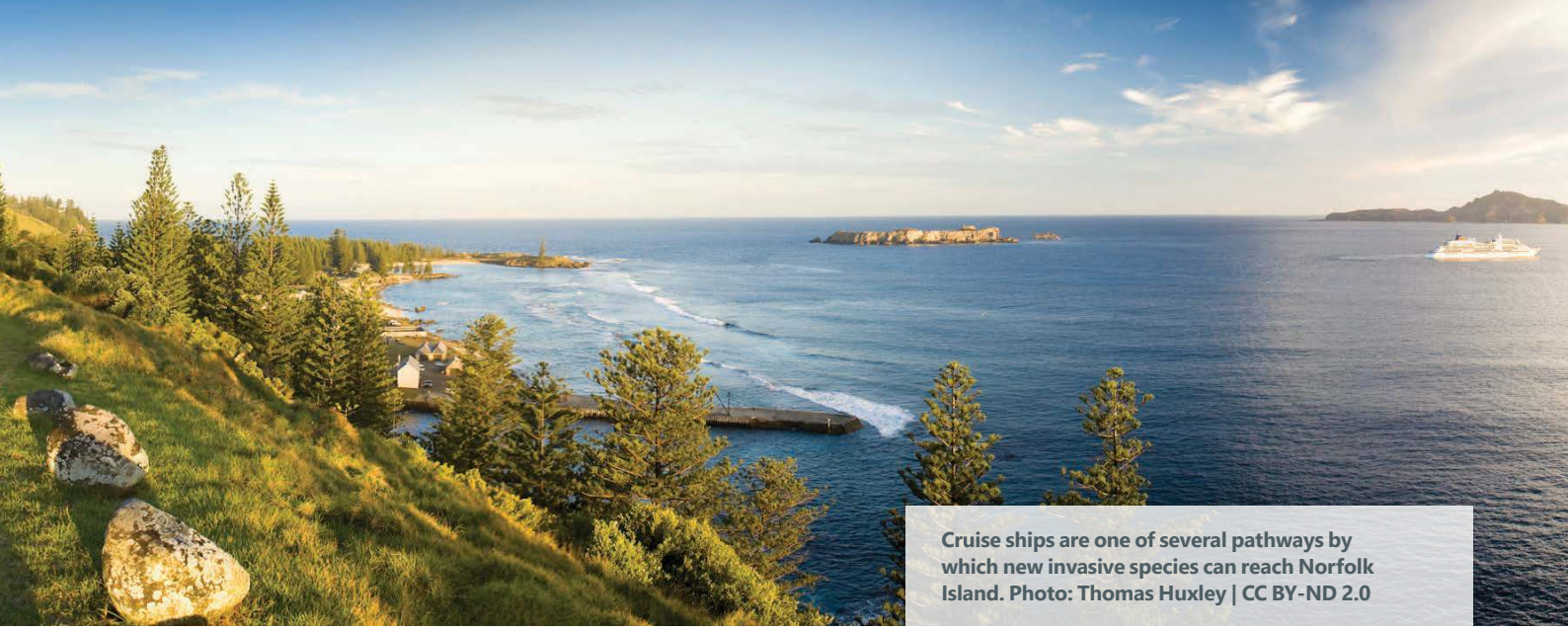
4.1 Pre-border and border biosecurity (quarantine)

Keeping Norfolk Island safe from harmful new invasive species requires assessing the risks associated with imported goods and travellers, restricting goods that present unacceptable risks and applying import conditions to prevent accidental introductions. Working with transport companies and undertaking border inspections are important to limit the risks of accidental or illegal introductions.

We should expect the new biosecurity regime on Norfolk Island under Australian laws to provide exemplary protection – given the modern laws and resources of the new regulator, and the high values on the island requiring protection. Stronger biosecurity is certainly needed, as demonstrated by recent detections of the Argentine ant (2005), Asian house gecko (2005), potato/tomato psyllid and South African mantis (*Miomantis caffra*) (these two species were among many previously unrecorded exotic species detected during the quarantine survey, 2012-2014), myrtle rust (2016) and palm seed borer (2016). The island does not yet have a comprehensive risk-based biosecurity system, particularly for environmental risks.

The first step in the transition arrangements was an intensive survey of species on Norfolk Island – the Norfolk Island Quarantine Survey – conducted by the federal agriculture department from 2012 to 2014. This was to provide baseline information for formulating options for future biosecurity arrangements for Norfolk Island and to identify pests and diseases of potential quarantine significance for mainland Australia. The survey

Working with transport companies and undertaking border inspections are important to limit the risks of accidental or illegal introductions.



Cruise ships are one of several pathways by which new invasive species can reach Norfolk Island. Photo: Thomas Huxley | CC BY-ND 2.0

BIOSECURITY ARRANGEMENTS FOR NORFOLK ISLAND

Previous system (prior to July 2016)	Interim system (from July 2016)	Proposed system
Norfolk Island laws	**Federal laws + Norfolk Island laws**	**Federal laws + NSW laws**
• Animals (Importation) Act 1983 • Plant and Fruit Diseases Act 1959 • Noxious Weeds Act 1916	• Biosecurity Act 2015 • Environment Protection and Biodiversity Conservation Act 1999 (live animal imports)	• Biosecurity Act 2015 (federal) • Environment Protection and Biodiversity Conservation Act 1999 (federal re. live animal imports)
Administered by Norfolk Island Government	Administered by Department of Agriculture and Water Resources	Administered by Department of Agriculture and Water Resources
	• Animals (Importation) Act 1983 • Plant and Fruit Diseases Act 1959 • Noxious Weeds Act 1916	• Biosecurity Act 2015 (NSW)
	Administered by Norfolk Island Regional Council	Administration arrangements unknown but likely major role for Norfolk Island Regional Council.

Table 3. Biosecurity arrangements for Norfolk Island – past, present and as proposed by the federal government.

found more than 140 invertebrate and pathogen species on Norfolk Island not known from mainland Australia (with more to be taxonomically described). Seven species known to attack crops were described as of 'significant quarantine concern' and another 10 of 'some quarantine concern'.[77] The survey report noted there are a large number of species on mainland Australia not found on Norfolk Island, including many weeds and bacterial and fungal plant pathogens. The report was focused mainly on agricultural risks, presumably in part due to limited knowledge of environmental risks. It also reflects the dominance of agricultural pests and diseases in Australia's national biosecurity focus.[78]

In recognition of the 'unique animal and plant pest and disease status of Norfolk Island', the Australian government has established a legal instrument – the *Biosecurity (Prohibited and Conditionally Non-Prohibited Goods—Norfolk Island) Determination 2016* – which lists prohibited imports and the conditions for importing goods where they differ from conditions for importing goods to the mainland.[79] The biosecurity agency says it has strengthened conditions for some imports, including livestock, some agricultural supplies such as stockfeed, and poultry products from New Zealand.[80] These are intended in large part to protect primary industries on Norfolk Island and mainland Australia from risks originating from New Zealand, from where all sea cargo enters Norfolk Island.[81]

The legal instrument contains few prohibitions and conditions specific for Norfolk Island's conservation values. Apart from a few exceptions, for example, it allows the importation of seeds on Australia's permitted list or seeds whose origins are Australia. This means that the seeds of potential new weed species from Australia can be imported under this instrument (provided their botanical name is listed).[82]

A federal permit is required for importing live animals to Norfolk Island, but the criteria applied in assessing import applications are unknown. Because risk assessments and import decisions are not published, we do not know if the specific risks for Norfolk Island, such as the potential for imported animals to establish on the island or bring new diseases, are assessed, or if – as with seed imports – the general approach is to permit on Norfolk Island the species that are permitted in Australia.[83] One concern is that permitting the importation to Norfolk Island of parrots as pets (which has not been allowed for the past 30 years) would increase disease risks for the critically endangered green parrot. Not all risks can be effectively mitigated. For example, the diagnostic tests for avian bornoviruses, which cause an often fatal disease that has been recorded in pet parrots in Australia, are not sensitive enough to detect all cases.

The biosecurity agency is reviewing conditions for seed imports to 'ensure the permitted seeds list is appropriate and adapted for Norfolk Island', but the review process (being undertaken in parallel with the development of conditions for other plants and plant products) 'will take a considerable amount of time to be completed'.[84] The agency is also working with the Department of Environment and Energy regarding the regulation of biosecurity risks for the environment on Norfolk Island (particularly for live animals and pest species).[85]

The implication is that until these reviews are complete and relevant biosecurity measures are implemented, some biosecurity risks for Norfolk Island are unacceptably high, particularly for seed imports. While the Australian government evidently has a strong commitment to preventing new diseases or pests arriving on the mainland from Norfolk Island, we question whether there is a similarly strong commitment to preventing potential new weeds and other environmental invaders arriving on Norfolk Island. As noted above, the Norfolk Island quarantine survey found that the island is free of many invasive species inhabiting Australia.

Under the interim arrangements, with the local Norfolk Island laws still applying, the importation of certain plants and animals may also require approval by the Norfolk Island Regional Council.[86] These laws could be used to keep out harmful species not covered by the federal regime. Under the Animals (Importation) Act, a permit must be granted by the Norfolk Island Regional Council for any imports of live animals, in addition to the permit required from federal authorities. According to the council's website, its role is 'to assess the appropriateness of certain dog breeds and animal species that are imported to the island.'[87] The council's authority for assessing these imports has been delegated from the Australian Minister for Local Government and Territories.[88] Under the Plant and Fruit Diseases Act, any plant or animal can be declared a pest, and thus be prohibited from importation.[89] Powers under this act have been delegated to various federal officers and regional council staff.[90] However, there is no mention on the council's website or any other Australian government websites of any biosecurity requirements under the Plant and Fruit Diseases Act.

There is no clear linkage between the permitting processes of the federal biosecurity agency and the regional council, and the federal Department of Agriculture and Water Resources does not appear to fully recognise the council's role or publicly communicate the need for council approval of some imports.[91]

The Norfolk Island biosecurity laws provide for a great deal of discretion by decision-makers about which products can be permitted or denied entry. The Animals (Importation) Act permits but does not require the administrator to take environmental considerations into account and the Plant and Fruit Diseases Act does not mention any environmental considerations. If the local laws are retained, they need strengthening to require that decisions be guided by consideration of risks for the environment,

as well as other factors. The import procedures under these local laws should be integrated with arrangements under the federal laws.

The Department of Agriculture and Water Resources has placed biosecurity officers on Norfolk Island and bolstered some quarantine capabilities, for example by providing a detector dog.[92] One difference in biosecurity practices that has generated concern by islanders is there are no longer routine inspections of vessels arriving at Norfolk Island. The Norfolk Island Plant and Fruit Diseases Act requires that 'Immediately upon the arrival of a vessel or aircraft at Norfolk Island, an Inspector shall board the vessel or aircraft and shall search and inspect the vessel or aircraft for the purpose of ascertaining whether any plants, fruit or goods are infected or whether any disease or pest exists on the vessel or aircraft.' This no longer occurs. Federal biosecurity officers 'only board vessels arriving at Norfolk Island if there is a biosecurity imperative to do so' – if, for example, there are any concerns raised by the pre-arrival report.[93] There is now much greater reliance on port operators, shipping agents and stevedores taking responsibility for biosecurity. This reflects the process that occurs on mainland Australia. However, federal biosecurity officers do undertake surveillance of cargo when it is offloaded onto the Norfolk Island wharf. According to the biosecurity agency, this level of surveillance on goods 'is in excess to what would normally occur on the Australian mainland'.[94]

4.2 Post-border biosecurity

Protecting Norfolk Island's unique wildlife requires intensive management of invasive species. Much of this occurs in the national park and botanic garden, funded by Parks Australia. According to the 2008-2018 management plan for the national park and botanic garden, protecting their values 'depends fundamentally on reducing or managing adverse impacts of plants, animals and pathogens …, rehabilitating natural ecosystems … and rigorous quarantine measures'.[95] Priority is given to improving the conservation status of threatened species. This includes weed management (the major demand on management resources), trapping and removing cats and subsidising a desexing program, killing rats, and protecting threatened species from invasive species (eg. rat-proofing the breeding sites of birds and removing starling nesting material from boobook/morepork nest boxes). There is also considerable effort on revegetating denuded areas and areas cleared of weeds. The management plan emphasises the importance of improving quarantine to prevent new weeds, predators, competitors and pathogens from entering Norfolk Island or from crossing to Phillip Island (which remains free of rats, cats and fowl/chickens).

Outside the park, a major effort is being made to eradicate Argentine ants. There has been considerable success in containing the ants and eliminating them over small areas. A 2017 CSIRO review reported a 'consensus between Norfolk Island residents and people globally involved in ant eradications that eradication … is achievable'.[96] It recommended a two year program, currently underway, to demonstrate the feasibility of methods for treating larger and logistically difficult areas, as well as for surveying previously treated areas to confirm eradication of the ant (using a detector dog). Once these challenges have been met, eradication is likely to require about $2 million over five years. The current program will be reviewed in June 2018.

If the eradication program was to be abandoned, Argentine ants would eventually spread over the entire island, with many adverse consequences for wildlife and horticulture.[97] Argentine ants are established in many sites on mainland Australia and in New Zealand, so there is an ongoing biosecurity challenge to ensure the species is not transported to Norfolk Island again.

There is also work outside the national park to control rats. At Anson Bay, adjacent to the national park in the north-west corner of Norfolk Island, local landholders have installed a network of rat bait stations. Locals volunteer their time to make, install and bait the stations, with materials supplied by Wild Mob and the Invasive Species Council.

4.3 Risks, challenges and opportunities

Here we briefly summarise some of the biosecurity challenges and opportunities for the Norfolk Island group which should be addressed as the new biosecurity system is developed.

Deficient harmonisation: There has recently been a strong emphasis in Australian biosecurity on the importance of harmonising arrangements between different levels of government to achieve a seamless system. The new federal regime was established around the recommendations of the 2008 Beale review, with this theme of harmonisation reflected in the title of the final report, *One Biosecurity: A Working Partnership*.[98] So far, harmonisation between federal and Norfolk Island officials appears to be deficient under the interim arrangements (as exemplified above for animal imports). The lack of a state level participant in Norfolk Island biosecurity and the apparent reluctance of the federal agency to integrate federal and local priorities could be impediments to effective biosecurity.

Underwhelming environmental focus: The current arrangements for Norfolk Island indicate insufficient priority accorded to environmental biosecurity, particularly evident with the limited restrictions on seed imports from Australia. The species of quarantine concern highlighted in the report of the quarantine survey of 2012-2014 were mostly those of agricultural concern, and there does not appear to be any list of environmental risks for Norfolk Island to inform quarantine priorities. The federal department responsible for biosecurity has indicated the intention to review seed imports and identify environmental risks, but this needs to be accorded a higher priority. Safeguarding the island's wildlife from new (and established) invasive species should also be a high priority for economic reasons – for example, by providing a more secure future for nature-based tourism and limiting the costs of managing the impacts of invasive species on natural values (costs mostly borne by Parks Australia).[99]

Growing biosecurity risks: The continued global spread of invasive species, including to mainland Australia and New Zealand, heightens the risks of new incursions to Norfolk Island, exemplified by the arrival of myrtle rust on the island just six years after it was first detected in Australia. With the intended increase in trade for Norfolk Island will inevitably come greater biosecurity risks, including new pathways for invasive species.[100] Risks may also increase due to new port arrangements that will allow vessels to moor near land.[101] Currently, vessels moor about 100 metres from the island and cargo is brought ashore by smaller watercraft. This limits the risk of hitchhiker organisms on ships making it to shore, although insects such as the burnt pine longicorn beetle (Arhopalus ferus) could fly to land while a vessel is anchored offshore.[102]

Biosecurity for Norfolk Island is aided by the limited pathways by which species can be introduced, some of which are listed in Table 4. Apart from mail, almost all goods entering Norfolk Island originate from mainland Australia or New Zealand. However, these two lands have many thousands of species not found on Norfolk Island, including a plethora of potential invaders. Two cargo vessels service Norfolk Island, each arriving at six weekly intervals from Auckland.[103] Goods from Australia are first shipped to New Zealand. The quarantine survey report noted several poorly managed risks in the transit area at Auckland, where cargo can be held for several weeks before loading and which lack quarantine isolation. There is no quarantine inspection of in-transit cargo.[104]

Out of sight, out of mind: With a small population

TABLE 4: EXAMPLES OF POTENTIAL INVASION PATHWAY

Group	Pathways
Weeds	Permitted introductions of garden seeds.
	Illegal importation of garden plants or seeds.
	Accidental introduction of weed seeds, eg. attached to travellers boots and gear or imported goods.
	Spread of weeds from Norfolk to Phillip or Nepean Island, eg via birds.
Pathogens	Accidental introduction of pathogens with imported goods or with travellers and baggage.
	Illegal introductions of plant material.
Invasive animals	Accidental introductions of animals with imported goods, travellers, and from ships, yachts and aircraft.
	Natural introductions, eg. through flying, floating, blowing, attachment to birds. (This is not a preventable risk, but eradication can be feasible if new species are detected in time.)
	Permitted or illegal introductions of pets or domestic animals.
Marine species	Hull fouling is the major risk.

far from mainland Australia, the Norfolk Island community has a major challenge to ensure sufficient attention from the mainland is directed to island priorities. There is often scant recognition in the Australian government of the special environmental values and challenges of islands.[105] There would be benefits in island managers working with each other and with mainland groups to generate more focus on island priorities.

Limited resources: Although not a problem unique to Norfolk Island, one of the greatest impediments to managing invasive species has been a lack of resources, including funding and technical expertise. The small population and rate base has greatly restricted funding available for management. One benefit of the integration of Norfolk Island into Australia is the potential to gain greater access to national funding and grants programs. There is need to strengthen local capacity for surveillance and identifying new incursions as well as participating in biosecurity programs. Ideally, there would be a local conservation group and education centre to foster expertise and participation.

Eradication opportunities: Being small and isolated can also be advantageous for biosecurity – by limiting pathways for invasive species and making eradications much more feasible than on the mainland. Eradications offer the exciting potential on Norfolk Island to reverse the declines of many threatened endemic species and save on the large amounts of funding needed to conserve threatened species. They would also improve the island's appeal as a nature tourism destination.[106]

Much progress has been made on eradication techniques, including for Norfolk Island's most harmful species – rats and cats. Globally, there have been more than a thousand eradications of invasive species (mostly mammals) on islands.[107] Australia and New Zealand have been at the forefront of this effort, with each achieving more than 200 successful eradications on islands.[108] New Zealand has declared a goal of eliminating all invasive vertebrate predators from the country by 2050.[109] Australia has recently eliminated cats from the 630km^2 Dirk Hartog Island, the largest ever cat eradication.[110] Such experience indicates that eradication of rats and cats from the 35km^2 Norfolk Island is probably achievable. Eradications can be more complicated on inhabited than on uninhabited islands and will require commitment and support from locals.

Creating an exemplar: The transition in biosecurity arrangements offers an excellent opportunity to create an exemplary biosecurity system for Norfolk Island – to demonstrate the value of the new federal and NSW biosecurity laws island conservation and the commitment of the federal government to protect the special values of the Norfolk Island group.

5. Recommendations

Protecting the high conservation values of Norfolk Island demands a high level of biosecurity.[74] Australia should apply optimal methods and tools to achieve this and establish Norfolk Island as an exemplar of island biosecurity. For this, it will be vital to engender strong local engagement.

We presume (and support), as flagged in the proposed legislative arrangements for Norfolk Island, that NSW's Biosecurity Act 2015 will eventually apply in addition to the federal Biosecurity Act 2015. If this occurs, there will presumably be considerable delegation of powers under the state law to local authorities, which will need to be well funded to supplement the island's limited local capacity. Whatever the legislative arrangements, the approach should be to identify the desired biosecurity outcomes and then apply the best legislative and policy tools to achieve them. Modern biosecurity laws are flexible enough to allow for this.

5.1 Harmonise biosecurity arrangements

Effective biosecurity on Norfolk Island can only be achieved through strong cooperation between the managers of biosecurity at federal and local levels – and also at a state level if NSW's laws are applied – and by harmonising arrangements to achieve a strong pre-border, at-border and post-border biosecurity continuum. As discussed in section 4, there appear to be gaps in the current regime with the federal focus mainly on preventing pests and diseases that would be new to mainland Australia and a lack of integration with or full application of the temporarily retained local laws.

Recommendations

1. Negotiate an agreement for NSW's Biosecurity Act 2015 to apply on Norfolk Island.
2. Establish a Norfolk Island biosecurity committee with representation from the different levels of government, including biosecurity and environmental agencies, to formulate biosecurity policies and priorities for Norfolk Island and to foster harmonisation.
3. Develop a memorandum of understanding between the levels of governments to facilitate cooperation, designate roles and responsibilities, and specify funding commitments.
4. Create mechanisms for engaging industry, environmental and community stakeholders in developing and implementing biosecurity laws, policies and programs.
5. While local laws still apply, strengthen the protection they afford for environmental values, including by requiring that decisions be guided by assessments of risks for the environment as well as the economy and human health and that a precautionary approach be applied.

5.2 Conduct risks and pathways analysis

Consistent with accepted biosecurity practice, the biosecurity arrangements and priorities for Norfolk

Whatever the legislative arrangements, the approach should be to identify the desired biosecurity outcomes and then apply the best legislative and policy tools to achieve them.

All goods shipped to Norfolk Island are unloaded offshore and brought ashore by a smaller boat. This provides some protection against hitchhiker organisms on ships making it to shore. A new wharf is being built that will allow ships to moor alongside – one of many ways in which biosecurity risks are changing on Norfolk Island. Photo: thinboyfatter | Flickr | CC BY 2.0

Island should be informed by a comprehensive analysis of risks – for the environment, economy and human wellbeing.

Recommendations

6. Commission an independent analysis of biosecurity risks and pathways: Identify the values to be protected and the known and potential biosecurity risks to these values. Prioritise risks and identify the pathways of medium to high priority risks. Recommend risk prevention, emergency response measures and mitigation strategies.

7. Make this risk analysis publicly available and update it as new information becomes available. Review and update the risk and pathway analysis every five years.

5.3 Develop a Norfolk Island biosecurity strategy

A strategy is needed to guide the development of a strong biosecurity system for Norfolk Island based on the risks and pathways analysis recommended above.

Recommendations

8. Commission an independent expert to develop a biosecurity strategy for Norfolk Island in close consultation with all levels of government; community, industry and environmental stakeholders; and biosecurity and ecological experts.

9. Focus the strategy on the highest priority risks and threats. Identify impediments to effective biosecurity. Develop strategies, with approximate costings, for preventing and mitigating biosecurity risks and overcoming impediments. Identify the best legislative and policy tools to achieve those outcomes.

10. Commit adequate resources and skills to implement the strategy.

11. Publicly release the final strategy and report annually on implementation. Review and update the biosecurity strategy following the update of the risk and pathway analysis every five years.

5.4 Declare Norfolk Island a biosecurity zone

Modern biosecurity laws offer flexible tools that can be moulded to meet the specific biosecurity challenges of islands. One option to facilitate island-specific biosecurity measures is to declare Norfolk Island a biosecurity zone under NSW's Biosecurity Act and develop regulations to help implement the island's biosecurity strategy. The memorandum of understanding recommended above would need to include a commitment by federal authorities to assist in seamlessly implementing the state-level measures that intersect with their pre-border and border responsibilities.

Recommendations

12. Declare the Norfolk Island group a biosecurity

zone under NSW's Biosecurity Act 2015.

13. Develop zone-specific regulations and policies to optimise biosecurity for the Norfolk Island group and to implement the biosecurity strategy. This would include, for example, additional import restrictions and conditions, powers and protocols to facilitate rapid responses to new incursions and eradications, and measures to limit the risks of organisms being spread between islands of the Norfolk group.

5.5 Secure commitment from all biosecurity participants

Not all biosecurity actions can be mandated by specific laws. Effective biosecurity is increasingly recognised as a shared responsibility of all participants. This requires people to be aware of the specific biosecurity risks of their activities and to take responsibility for mitigating them. Particularly on islands, where biosecurity officers and experts are scarce, effective biosecurity requires citizens to be vigilant – reporting unusual sightings, for example – and to participate in surveillance and management. A new principle encoded in NSW's Biosecurity Act – the general biosecurity duty – offers a way of legally requiring people to take responsibility for biosecurity.[111] It should be used to embed good biosecurity practices within the Norfolk community and those who interact with the island, such as transport company staff.

Recommendations

14. Develop and communicate a clear understanding of what the general biosecurity duty requires of Norfolk Island residents, visitors and transport operators. Operationalise this understanding through agreements, codes of practice and awareness-raising programs.

15. Develop a behavioural change strategy that uses principles of social science to motivate responsible biosecurity behaviours. Engage with local schools to foster biosecurity awareness.

16. Provide training for people who participate in activities with high levels of biosecurity risk or those who contribute to risk or threat mitigation.

5.6 Prepare for new incursions

Most of the effort to prevent new invaders should go to the pre-border and border work of limiting the risks of deliberate or accidental introduction of harmful new organisms, but preparations also need to be made to respond if they arrive on the island. This means developing contingency plans and conducting surveillance for high risk organisms.

Recommendations

17. Develop contingency plans for responding to incursions of the potentially harmful organisms identified in the risks and pathways analysis.

18. Develop a biosecurity plan for activation during emergency responses such as for ship wrecks and cyclones, when biosecurity is commonly neglected and risks are high.

19. Implement surveillance for high-risk arrivals. Use detector dogs for both surveillance and deterrence. Establish sentinel sites for high risk invasive species around areas such as the airport, wharves and cargo depots. Support and train a network of motivated community members willing to regularly conduct surveillance activities.

5.7 Undertake eradications

As discussed in section 4.3, it is potentially feasible (based on experience elsewhere) to eradicate the most harmful invasive animals from Norfolk Island – rats, cats and Argentine ants. This would create a more secure future for wildlife, bring economic

benefits for the tourism industry and reduce the need for government funding for management. The benefits of eradication have been amply demonstrated by the eradication of pigs, goats and rabbits from Phillip Island. There may also be the potential to eradicate some invasive plant species before they become serious weeds (e.g. species mentioned in section 3.1.) As the experience with the planned eradication of rodents on Lord Howe Island demonstrates, it is essential that any eradication program is developed and implemented in close cooperation with the community.[112]

Recommendations

20. Continue to pursue eradication of Argentine ants as outlined in the CSIRO 2017-2018 plan.

21. Identify and pursue opportunities to eradicate invasive animal and plant species on Norfolk Island where it is socially acceptable and feasible, in cooperation with the local community. The black rat, Polynesian rat, feral cat, Asian house gecko, and crimson rosella, as well as emerging weed species, are potential targets for eradication.

5.8 Establish Norfolk Island as an NRM region

Securing a future for many threatened and endemic species on Norfolk and surrounding islands requires ongoing management of invasive species. To help locals address the major biosecurity challenges on Norfolk Island, the island group should be established as an NRM region of Australia. This would facilitate greater access to expertise and funding, and trigger the development of a natural resource management plan. A draft NRM plan was developed in 2009 but never implemented.[113]

Recommendations

22. Establish the Norfolk Island group as an NRM region of Australia and develop an NRM plan for the islands.

23. Seek funding for NRM priorities, including weed and invasive animal management.

5.9 Develop partnerships with other island managers

Because of the shared biosecurity challenges faced by island inhabitants, it could be beneficial for island environmental and biosecurity managers (including community representatives) to share strategies and expertise and to jointly work for greater mainland support for their biosecurity responsibilities. Given the challenges shared by Norfolk Island and Lord Howe Island, their geographical and botanical similarities and their potential links under NSW law, it could be particularly beneficial for these islands' managers to work together. Also needed, because of the particular challenges and opportunities of island biosecurity, is an islands unit within government to develop and advance policies for island biosecurity. There would be mutual synergies in involving New Zealand given their strong track record of island eradications and commitment to island biosecurity. Another opportunity for learning, capacity building and information exchange is provided by the Pacific Island Learning Network (PILN) that is operated by the Pacific intergovernmental environment agency SPREP.[114]

Recommendations

24. Island managers (including from Australia, New Zealand and PILN) establish formal and informal partnerships to work together on island biosecurity issues and share expertise.

25. Establish an islands unit within government, involving federal, state and local biosecurity and environmental agencies, to develop and advance policies for island biosecurity.

Endnotes

1 Mortimer et al. (2017).
2 Jones & McDougall (1973).
3 Green (1973).
4 Norfolk Online News (2016).
5 Anderson et al. (2001).
6 Gill (1975).
7 We refer to the Christmas Island pipistrelle (Pipistrellus murrayi) and the Christmas Island forest skink (Emoia nativitatis). The third extinction, of the Bramble Cay melomys (Melomys rubicola), was probably due to rising sea levels.
8 Department of the Environment and Energy (nd), Director of National Parks (2008), Director of National Parks (2010), Mills (2009b), Mills (2012), Ponder (1997), Smithers (1998).
9 Department of the Environment and Energy (nd).
10 Christian (nd), Coyne (2009).
11 Holloway (1990).
12 Bray (nd) (a&b), Department of the Environment and Energy (nd), Director of National Parks (2008), Director of National Parks (2010), Mills (2009b), Møller & Schwarzhans (2006), Mound & Wells (2015), Ponder (1997).
13 Director of National Parks (2008).
14 The species is listed as vulnerable in the IUCN Red List (Thomas 2011).
15 Cornell Lab of Ornithology (2017), Department of the Environment (2009), Department of the Environment and Energy (nd), IUCN Red List, Mills (2009b). Not all these species are recognised as extinct under the EPBC Act.
16 There are also locally extinct species such as two bat and six plant species.
17 This species, known only from a painting, is not recognised under the EPBC Act, but a global database of bird species managed by the Cornell Lab of Ornithology says it is now 'widely accepted' as a valid species (Cornell Lab of Ornithology 2017).
18 Director of National Parks (2010).
19 Department of Agriculture (2015), Director of National Parks (2010), Mills (2009b), Mills (2013).
20 Birds Australia & Birdlife International (2011).
21 Director of National Parks (2010).
22 Department of the Environment and Energy (nd).
23 Cogger et al. (2006), Department of the Environment and Energy (nd).
24 Department of the Environment and Energy (nd), McCormack & Coughran (2009).
25 Director of National Parks (2010).
26 Parsons Brinckerhoff Australia Pty Ltd (2009), citing Kuster (2001).
27 Parsons Brinckerhoff Australia Pty Ltd (2009), citing Mosley (2001).
28 Cornell Lab of Ornithology (2017), Department of the Environment and Energy (nd), Department of the Environment and Energy (nd) (b), Director of National Parks (2010), IUCN Red List.
29 Department of the Environment and Energy (nd) (b), Director of National Parks (2010).
30 Director of National Parks (2010).
31 Cogger et al. (2006), Director of National Parks (2010).
32 Department of the Environment and Energy (nd), McCormack & Coughran (2009).
33 Bray (nd) (a&b), Møller & Schwarzhans (2006), Parsons Brinckerhoff Australia Pty Ltd (2009).
34 Director of National Parks (2010), Ponder (1997).
35 Director of National Parks (2008).
36 Director of National Parks (2008).
37 Nias (2015).
38 Jeffery (2017).
39 Mound & Wells (2015).
40 Department of Agriculture (2015).
41 Convention on Biological Diversity (nd).
42 McCreless et al. (2016).
43 Nias & Saunders (2012).
44 Mills (2009a).
45 Mills (2009a).
46 Director of National Parks (2010).
47 Department of Agriculture (2015).
48 Department of Agriculture (2015).
49 Director of National Parks (2008).
50 Director of National Parks (2010).
51 Director of National Parks (2008).
52 Director of National Parks (2010).
53 Information about this and the other weed species comes mainly from the national park management plan (Director of National Parks 2008).
54 Director of National Parks (2010).
55 Director of National Parks (2010).
56 Most of the information in these profiles of invasive animals comes from the regional threatened species recovery plan (Director of National Parks 2010).
57 Department of Agriculture (2015).
58 Director of National Parks (2010).
59 Blumberg & Kehat (1982).
60 Hoffman (2017).
61 Hoffmann (2017).
62 Director of National Parks (2008).
63 Coyne (2009).
64 Director of National Parks (2008).
65 One indirect consequence of myrtle rust could be less food for endangered birds that rely on the fruit of cherry guava (Psidium cattleianum), an exotic Myrtaceae and widespread weed on Norfolk Island. Environmental managers remove such weeds gradually and replace them with suitable native plants so as not to suddenly deprive birds of an important food source.
66 Department of the Environment and Heritage (2004).
67 Director of National Parks (2010).
68 Director of National Parks (2008).

69 NZ Ministry for Primary Industries (2011).

70 Nias & Sanders (2012).

71 Director of National Parks (2010).

72 Yellow crazy ants had been intercepted a number of times on cargo (Director of National Parks 2010).

73 Department of Agriculture (2015).

74 Madden (2015).

75 Norfolk Island Applied Laws Ordinance 2016.

76 According to the Department of Infrastructure and Regional Development, agreement between the federal and NSW governments on application of the NSW Biosecurity Act 2015 is yet to be achieved (B. Woodruff personal communication 24 July 2017).

77 Department of Agriculture (2015).

78 Craik et al. (2017).

79 Department of Agriculture and Water Resources (2017). For example, section 24 of the Biosecurity Determination 2016 stipulates for imported seeds that they '(i) are brought or imported from a part of Australian territory (other than Christmas Island or Cocos (Keeling) Islands); or (ii) are listed permitted seeds.' They must be labelled with their botanical name, not be genetically modified, and meet Australian standards for seed contaminants and tolerances. See https://www.legislation.gov.au/Details/F2016L01061 for the determination.

80 Department of Agriculture and Water Resources (2017).

81 The quarantine survey report noted that 'New Zealand has a number of significant pests that are of concern to mainland Australia and that are not yet found on Norfolk Island, so if that pathway is not well controlled then the Australian mainland could be exposed to these risks; for example, varroa mite and bovine tuberculosis.'

82 Biosecurity (Prohibited and Conditionally Non-Prohibited Goods—Norfolk Island) Determination 2016.

83 In response to questions from the Invasive Species Council, the Department of Agriculture and Water Resources says: 'Upon receipt of import permit applications, the department undertakes a scientific assessment of the biosecurity risks associated with the proposed import in accordance with the Biosecurity Act 2015. Information about the criteria related to animal risk analysis can be found on the department's website: www.agriculture.gov.au/biosecurity/risk-analysis/animal. In undertaking biosecurity risk assessments for the importation of live animals for Norfolk Island, the department considers both the results from the Norfolk Island Quarantine Survey 2012–2014 and risk assessments already undertaken for Australia in assessing biosecurity risks and applicability for importation into Norfolk Island.' (Email 20 September 2017).

84 Department of Agriculture and Water Resources (2017).

85 The biosecurity agency is reviewing the import conditions for honey and bee products 'in order to further protect the pest and disease status of Norfolk Island bees' (Department of Agriculture and Water Resources 2017). But this is to protect European honeybees, which are invasive on the island and a likely threat to some bird species (Director of National Parks 2010).

86 For example, in April 2017 an application to import a cockatiel, peacock, galah and emu was being considered by the regional council (NIRC staff, personal communication, 26 April 2017).

87 See information at norfolkisland.gov.nf/services/environment-and-health/animal-importation.

88 Minister's Norfolk Island Delegation Instrument 2017 (No. 1). See https://tinyurl.com/yclmpp6x.

89 Under section 4, Plant and Fruit Diseases Act, 'The Minister may, by notice published in the Gazette … (b) declare any member of the animal or plant kingdom in any stage of development to be a pest for the purposes of this Act.'

90 Officers authorised under the Plant and Fruit Disease Act include various regional council officers and federal customs and border force officers.

91 According to a briefing by Department of Agriculture and Water Resources (2017), 'The NIRC does not have responsibility for the regulation of biosecurity on Norfolk Island—the Biosecurity Act is the primary legislation for management of biosecurity risks.'

92 Department of Agriculture (2015).

93 Department of Agriculture and Water Resources (2017).

94 Department of Agriculture and Water Resources (2017).

95 Director of National Parks (2008).

96 Hoffmann (2017).

97 Davis (2008).

98 Beale et al. (2008).

99 Tourism is the main economic activity on the island (SGS Economics and Planning Pty Ltd 2015).

100 Action 16.1 in the economic strategy for Norfolk Island is 'to implement new quarantine provisions that will facilitate the importing of seeds and animals for breeding, and the export of food to the mainland and beyond' (SGS Economics and Planning Pty Ltd 2015).

101 Department of Agriculture (2015).

102 Department of Agriculture (2015).

103 Department of Agriculture (2015).

104 Department of Agriculture (2015).

105 Nias et al. (2010).

106 Increasing nature tourism is one of the goals of the economic strategy for Norfolk Island (SGS Economics and Planning Pty Ltd 2015).

107 Owen (2017).

108 Island Conservation (nd).

109 Owen (2017).

110 Dawson (2017).

111 The general biosecurity duty (section 22 of the NSW Biosecurity Act 2015): 'Any person who deals with biosecurity matter or a carrier and who knows, or ought reasonably to know, the biosecurity risk posed or likely to be posed by the biosecurity matter, carrier or dealing has a biosecurity duty to ensure that, so far as is reasonably practicable, the biosecurity risk is prevented, eliminated or minimised.'

112 Slezak (2016).

113 Parsons Brinckerhoff Australia Pty Ltd (2009).

114 See http://www.sprep.org/piln

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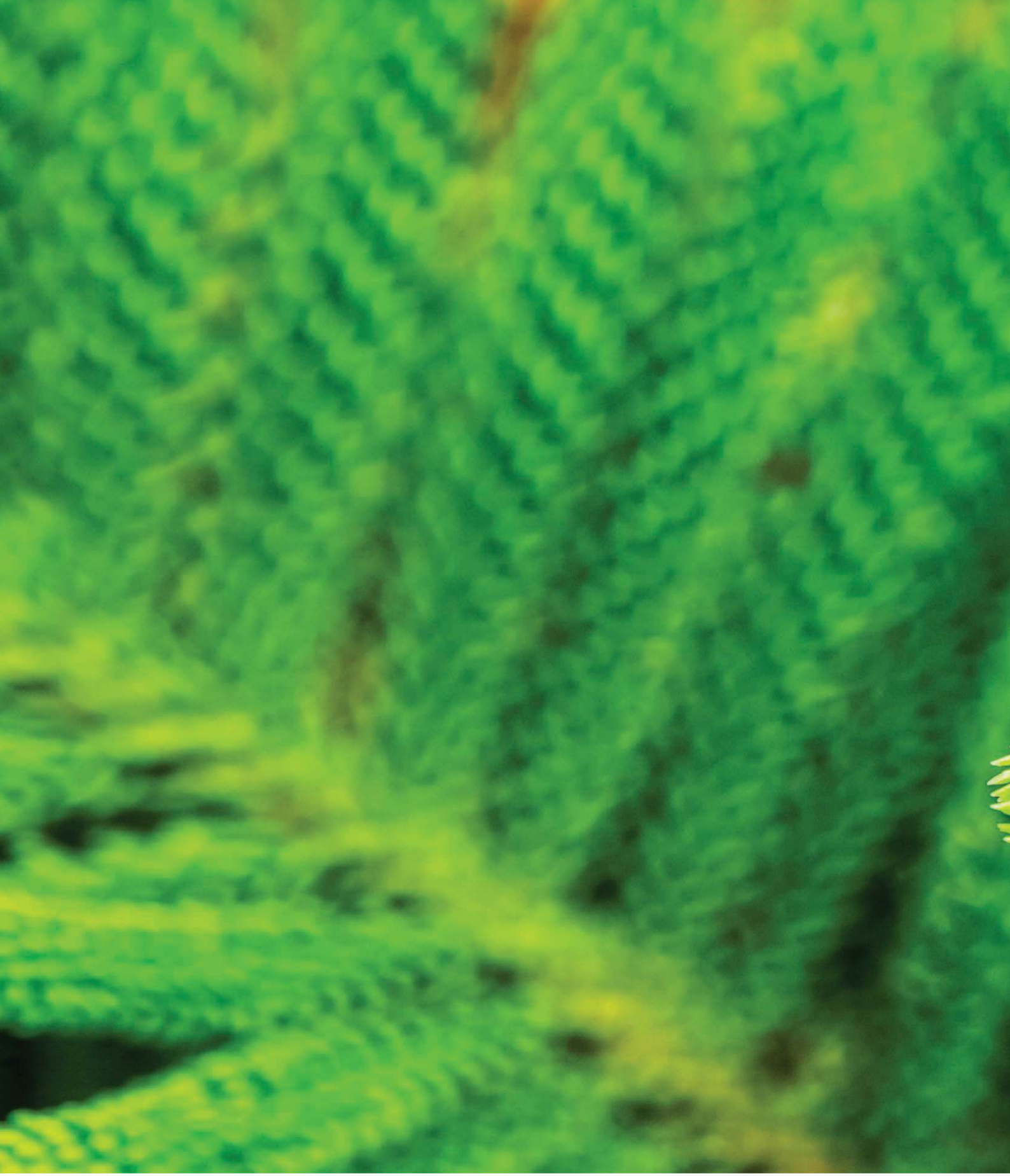

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islandconservation.org
info@islandconservation.org
facebook.com/preventingextinctions
@NoExtinctions

invasive species council

invasives.org.au
contact@invasives.org.au
facebook.com/invasivespeciescouncil
@ISCAustralia