

## The recovery of burrowing petrels on Macquarie Island following invasive predator control

### In brief

World Heritage listed Macquarie Island is internationally recognised for its natural features including wildlife. Macquarie Island was once heavily invaded by cats, rabbits, rats and mice, and these predators led to the decline of numerous seabirds. After an extensive pest eradication program, the island was declared free of invasive mammals in 2014. We aimed to determine whether the population of four bird species were recovering once the threat from invasive animals had been removed.

We conducted whole island surveys in 2017-2018 for two established species, Antarctic prions (*Pachyptila desolata*) and white-headed petrels (*Pterodroma malessonii*), and two recolonising species that were locally extinct in the 1900s, blue petrels (*Halobaena caerulea*) which

persisted on offshore rock stacks and grey petrels (*Procellaria cineria*) which had disappeared entirely. We mapped their contemporary distribution and abundance and compared this with previous work from 1970-2000s.

The populations of all four species have increased, with the recolonising species having substantially smaller populations than the established species. The current size and increasing trends of blue and white-headed petrel populations suggests that they are no longer threatened with extinction in Australia, and we recommend that they be delisted from both state and federal legislation. Grey petrels will likely also warrant delisting by 2026 if their population continues to grow at its current rate.

Invasive species eradication has been a highly effective tool for preventing extinction and aiding the recovery of seabirds on Macquarie Island. However, while these birds are recovering, the current sizes of petrel populations are still orders-of-magnitude below their potential sizes, and petrels are not yet fulfilling the important ecological roles they played before the island was invaded. Full recovery is likely to take several more decades.

### Background

Petrels can naturally number in the millions on Southern Ocean islands, and consequently play an important role in marine food webs. The petrels transfer vast amounts of nutrients to land, which influences island ecosystems and surrounding coastal waters.

Macquarie Island is located midway between Tasmania and Antarctica. The 34 km-long treeless island is covered in dense tussock grasslands, herbfields and tundra-like vegetation. Today, the island is recovering from decades of impacts from humans and invasive species. Penguin and elephant seal populations are no longer harvested and are recovering, but invasive mammals led to the extinction of the endemic Macquarie Island rail and [parakeet species](#), and massive declines in seabirds. By the 1970s, several burrowing petrel species were locally extinct and those that remained were declining rapidly. The birds and their eggs were preyed on by cats and rats, and rabbits destroyed nesting habitat.

Of 14 petrel species known or thought likely to have bred on Macquarie Island at one time, just three species remained on the main island by the 1970s, and were experiencing declines, while a further three species were recorded only on offshore rock stacks.



Petrels flying at night. Image: Jeremy Bird.



## Background (continued)

Today eight of the 14 petrel species from Macquarie Island are listed as threatened on state and/or federal legislation and/or international agreements, but all species survive elsewhere on other subantarctic islands.

To address the threat to petrels, Tasmania Parks and Wildlife Service commenced pest management in the 1970s, removing cats by 2001 and culminated in the joint federal and state-funded Macquarie Island Pest Eradication Program from 2011 to 2014 which removed the rabbits, rats and mice. Macquarie Island was declared free of invasive mammals in 2014.

## Aims

We aimed to determine whether the burrowing petrel populations were recovering on Macquarie Island since the threat from invasive mammals had been removed, and where on the island the birds were now occurring.



*Jeremy Bird and Julie McInnes conducting field surveys on Macquarie Island. Image: Jeremy Bird*



*A petrel within a burrow on Macquarie Island. Image: Jeremy Bird*

## What we did

We spent 2017-2018 on Macquarie Island surveying seabirds, with a particular focus on white-headed petrels, Antarctic prions, blue petrels and grey petrels. In the 1970s, the blue petrels and grey petrels could no longer be found on the main island, but they have been recolonising it since the successful control of feral mammals.

Petrels are very difficult to survey because they nest in underground burrows to avoid predatory birds. Burrows are often hidden under dense vegetation, and the petrels only return to the burrows at night-time and at certain times of year. Different habitat use by the four species meant we needed to use a range of field survey approaches to reliably estimate the population of each species to inform future monitoring and management.

After surveying the whole island by distance sampling petrel burrows along a randomised transect survey design, we had only encountered two of our four target species. For the other two species we ran night-time spotlighting surveys to search for active colonies which we could return to and search for by day. We also trialled novel survey methods like camera-traps and acoustic recorders, and novel analytical approaches like species distribution models to provide contemporary estimates of nesting occupancy, breeding success and overall abundance and distribution of each species on Macquarie Island. In addition, we resurveyed monitoring sites established by Tasmania Parks and Wildlife Service in the 1990s to understand population trends through time.



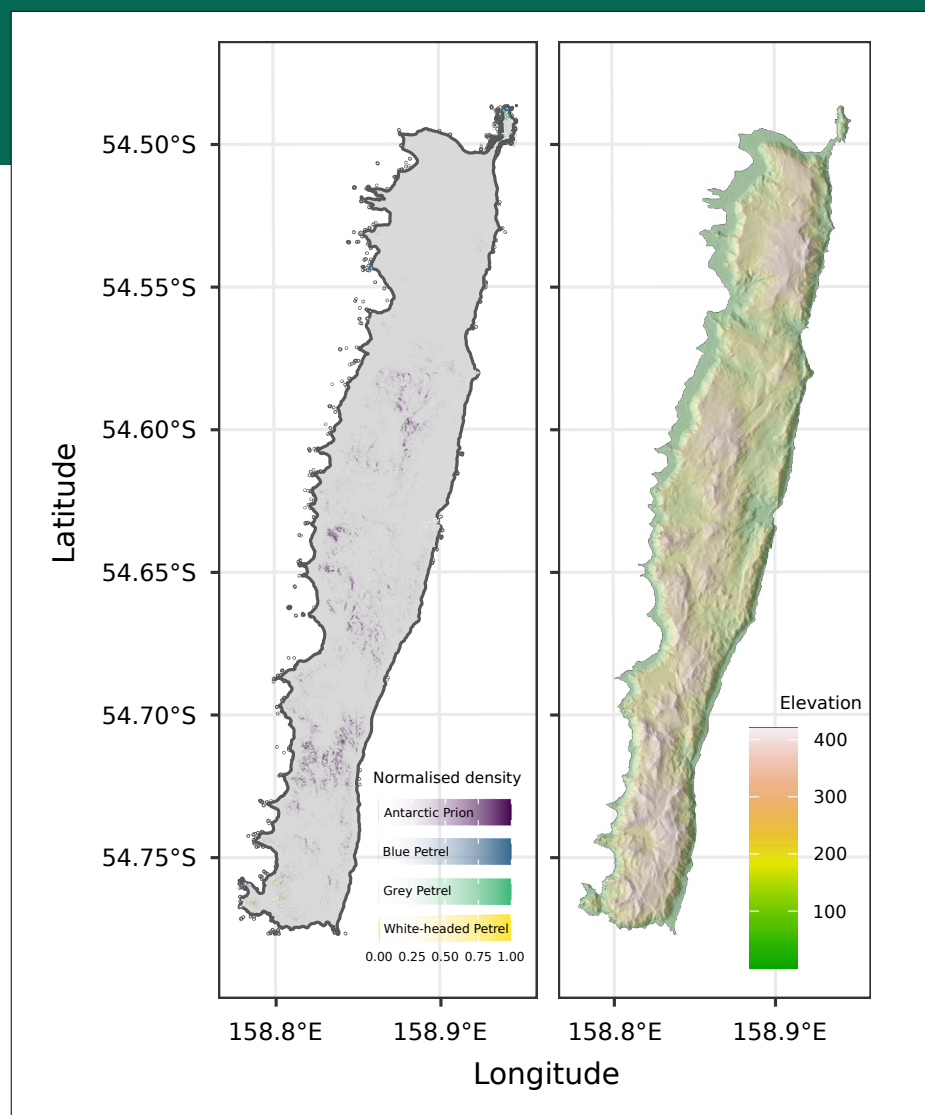
## Key findings

Since the eradication of cats in 2001, all four species of burrowing petrel have increased their populations (Bird et al (2021c)), but their rates and spatial patterns of response have varied. We estimated that the populations of the two species that survived invasive predators to be now approximately 160,000 breeding pairs of Antarctic prions and 12,500 breeding pairs of white-headed petrels. The two recolonising species remain much rarer, with 5500 pairs of blue petrels and currently just 250 pairs of grey petrels. However, these recolonising species are both increasing at high rates of 12% per year for blue petrels and 15% per year for grey petrels.

During our bird surveys we also discovered common diving-petrels (*Pelecanoides urinatrix*) breeding on the main island for the first time, and we uncovered new locations for soft-plumaged petrels (*Pterodroma mollis*), fairy prions (*Pachyptila turtur*) and grey-backed storm-petrels (*Garrodia nereis*).

Antarctic prions are the most abundant petrel on the island. They appear more tolerant to a broader range of climatic and habitat conditions than other species, and their current distribution across the island is similar to that found in the 1970s. In contrast, the range of the larger white-headed petrels, whose burrows were large enough to be entered by cats, has contracted since the levels of the 1970s. Both species are now increasing their populations.

The populations of blue petrels and grey petrels, which had been extinct on the main island but recolonised it in the early 2000s, are also increasing. The current size and increasing trends of blue and white-headed petrel populations suggests



**Figure 1.** The combined area occupied by Antarctic prions, white-headed petrels, blue petrels and grey petrels from the 2018 surveys (left) and a shaded relief map of Macquarie Island (right) showing the coastal flats, coastal slopes and inland plateau.

that they are no longer threatened with extinction in Australia. With a population of less than 1000 mature individuals, grey petrels still meet the criteria for listing as Vulnerable. However, based on current rates of population growth, and a population of 252 breeding pairs in 2018, we project that they will exceed this threshold by 2026, and possibly sooner if breeding takes place in the high proportion of unused burrows we recorded during surveys.

We found there is little overlap in the areas occupied on the island by the four species. The densely vegetated coastal slopes of Macquarie Island appear to be the most favourable habitat, but these coastal slopes are largely devoid of breeding petrels today (Figure 1).

The Antarctic prions and white-headed petrels are still mainly nesting on the island's plateau, at a high elevation with lower vegetation cover and shallow soil. They survived in these refugial areas while populations in the lowlands disappeared due to the high rates of predation by invasive species. However, even though the threat has now been removed, the two species still appear confined to this sub-optimal habitat. It could be that the pull to breed near to the colony where they were raised is strong for these species. By contrast, the two species recolonising the island, blue petrels and grey petrels, are favouring more optimal habitat areas, particularly the coastal slopes.



## Implications and recommendations

The eradication of invasive species was a highly effective tool for preventing extinction and aiding the recovery of seabirds on Macquarie Island. Removing this threat from remote island ecosystems which are otherwise relatively free from human impacts also improves conditions for terrestrial and coastal ecosystems to develop new stable states. Only through quantitative post-eradication monitoring will we be able to determine the outcomes of such programs.

As a result of our research, we are recommending that several species be downlisted. The population of blue petrels and white-headed petrels has increased sufficiently such that they no longer meet the criteria for listing as threatened under Australia's *Environment Protection and Biodiversity Conservation Act 1999* or the *Tasmanian Threatened Species Protection Act 1995*. If the current rate of increase in the grey petrel population continues, they will also qualify for removal from

threatened species lists in Australia by around 2026. This is a major achievement, representing one of the goals of pest management on Macquarie Island: to avert further seabird extinctions and promote threatened species recovery.

However, while the populations are recovering, they are still far from their potential levels, which could number several million pairs. Naturally abundant

petrel populations drive primary production on islands and their coastal waters by collecting nutrients over vast ocean catchments and depositing them in their guano, influencing the entire island ecosystem. Populations on Macquarie are not yet sufficiently abundant to fulfil this important ecological role. Full recovery of populations, and restoration of the ecological functions they provide, may take decades.



*A white-headed petrel burrow on Macquarie Island.  
Image: Jeremy Bird.*

## Work cited

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## Further Information

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