Science for Saving Species

Research findings factsheet

Project 4.2.3

Threatened Species Recovery Hub

National Environmental Science Programme

Invertebrate monitoring as a tool to measure ecosystem change on sub-Antarctic islands following pest species eradications

In brief

Pest species eradications were recently completed on sub-Antarctic Macquarie and Antipodes Islands. Monitoring ecosystem response is important to help quantify the conservation return-on-investment and to inform eradications on other islands, such as those planned for sub-Antarctic Gough and Marion Islands.

We tested the use of invertebrates as a tool to measure recovery following pest eradications and examined the utility of different invertebrate groups as indicators of environmental change.

We found that invertebrates are a valuable tool to monitor and quantify environmental change following pest species eradication. Due to their short life cycles they respond rapidly, providing a much faster indication of change than larger, longer-lived species.

We found that the best invertebrate group to monitor varies with the type of pest species eradicated and subsequent recovery that is occurring. Where the pest species eradicated had significant habitat and vegetative impacts, as occurred on Macquarie Island where there were rabbits, plant-eating invertebrate species are good indicators of long-term ecosystem trends. Where the pest species eradicated has negligible impacts on vegetation, such as the mice on Antipodes Island, large invertebrate species that can be mice prey, such as beetles, centipedes, amphipods and spiders are good indicators of recovery.

Additionally, we examined which non-native invertebrate species pose the greatest future biosecurity threat to the Macquarie Island ecosystem, finding that small, wingless species that feed on dead plant or animal matter present the greatest risk due to their likelihood of successfully establishing and as they are least likely to be detected during biosecurity surveillance.

Sweep-netting in Pleurophyllum herbfield habitat on the plateau, Macquarie Island. Photo: Melissa Houghton

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Background

Islands and the species they support have high conservation value globally. Non-native species introduced to islands are the primary cause of extinctions on islands and of island ecosystem disruptions world-wide.

Programs to eradicate invasive species from islands are increasing in number, and have met with increasing success, including on Australian islands.

Monitoring recovery helps to calculate return-on-investment, understand the conservation benefits of management and inform conservation decision-making for current and future restoration programs. However, few studies have been undertaken to document island ecosystem recovery following mammalian invasive species eradications. And even fewer examine how small, non-charismatic species recover.

Macquarie Island

Sub-Antarctic Macquarie Island is located approximately halfway between Tasmania and Antarctica, 1500 km south-east of Tasmania. A UNESCO World Heritage nature reserve managed by the Tasmanian Parks and Wildlife Service, Macquarie Island is home to unique flora and millions of seabirds and marine mammals, including 12 animal and bird species listed as threatened under Australian environmental law (the EPBC Act).

Isolation and climate have protected Southern Ocean Islands from non-native species introductions. However, some species have made it there and established. Whalers and sealers introduced a variety of species over 140 years ago, and of these weka, cat, rabbits, mice and rats survived and thrived. They have had wide ranging negative impacts of the island ecosystem.

The Tasmanian Parks and Wildlife Service began eradicating these pest animals in the 1970s, beginning with weka. By 2000, cats were eradicated, and in 2014 success was declared in the simultaneous eradication of rabbits and rodents from the island. Collectively, it is one of the largest and most logistically challenging eradication programs so far, worldwide.

A post-eradication monitoring project tracked the responses of burrowing seabirds, predatory seabirds and invertebrates on the island. This factsheet outlines the findings of invertebrate monitoring undertaken by Melissa Houghton as a PhD project.

Antipodes Island

Sub-Antarctic Antipodes Island is located 1500 km north-east of Macquarie Island and is managed by the New Zealand Department of Conservation. The only pest mammal on Antipodes Island was the house mouse (M*us musculus*), which was a predator of native species but did not have a noticeably significant impact on vegetation, unlike rabbits on Macquarie Island. Mice were eradicated from Antipodes Island in 2018.

Antipodes Island was included in this study as it presents a valuable opportunity to compare invertebrate monitoring and response on another sub-Antarctic Island with a recent eradication.

Focus on invertebrates

Invertebrates are Macquarie Island's main terrestrial fauna. Like the seabirds, they were heavily preyed upon by rodents, and their habitat was drastically altered by rabbit activity.

Invertebrates are a keystone ecological group, and they are abundant, diverse and respond quickly to environmental fluctuations, making them good biological indicators of ecosystem change.

In contrast to species such as albatrosses that may respond slowly and have long life cycles, invertebrates, with their shorter life cycles, make effective monitoring indicators as they can respond quickly to landscape-scale changes as are occurring on Macquarie Island following the eradication.

Samples in Berlese funnels undergoing extraction for invertebrates in the laboratory on the island. Photo: Melissa Houghton

Research aims

This project aimed to test the effectiveness of terrestrial invertebrates as indicators to track the progress of ecosystem change on two sub-Antarctic islands following large-scale invasive mammal eradications.

In addition to quantifying the response of invertebrates over time since the eradications, we also set out to measure the ecological drivers of invertebrate diversity and abundance in these ecosystems, including the activity of non-native invertebrates remaining in the ecosystem.

Finally, the project aimed to use a traits-based analysis to identify non-native invertebrate species that pose a future biosecurity threat to the Macquarie Island ecosystem.

Non-native springtails (Collembola). *Photo: Melissa Houghton*

What we did

We carried out post-eradication monitoring of invertebrates over three consecutive seasons on Macquarie Island (2015/16, 2016/17, 2018). On Antipodes Island, we carried out pre-eradication monitoring (2016) and post-eradication monitoring (2018). The data from pre-eradication historical sampling for both islands was also incorporated into our analyses (Macquarie Island – 1986, 1993 2009; Antipodes Island – 2011, 2013)

We deployed pitfall traps at historically monitored sites on both islands. On Macquarie Island, we also used a variety of trapping methods, including litter sampling, timed counts, sweep netting and yellow pan trapping to not only capture invertebrate diversity in different vegetation types and habitats, but also to examine which trapping methods were most effective for monitoring of invertebrates in the changing ecosystem. On Macquarie Island, we also recorded microclimate and vegetation composition and structure.

We investigated the post-eradication responses of invertebrate fauna on each island and compared the results for the two islands. We performed modelling to contrast the pre- and post-eradication numbers and diversity of invertebrates, to analyse their responses over time to habitat recovery following the removal of herbivorous rabbits and predatory rodents. We paid particular attention to rodent prey species such as beetles, spiders, centipedes and amphipods.

Finally, we compiled information about the body size, guild and winged status of a large suite of invertebrates intercepted by biosecurity surveillance en route to Macquarie Island and analysed the frequency of these traits in invertebrate species already established on the island. From this, we predicted which species were most likely to establish if introduced and pose the greatest threat to the Macquarie Island ecosystem.

Key findings

On Antipodes Island, we found that invertebrates responded following eradication with significant increases in the numbers of species and their abundance. Increases of between two and 35 times pre-eradication numbers were found for groups preyed upon by mice. Importantly, on this island, mice were the sole predator, and they had minimal impact on vegetation or habitat.

On Macquarie Island we found more complex responses, although we also detected conservation benefits there for invertebrates following the eradication program through increases in number of invertebrate species. On Macquarie Island, mice, rats and rabbits had been simultaneously eradicated, and large-scale habitat destruction had taken place due to rabbit burrowing and vegetation grazing.

This disparity in invertebrate responses between the two islands suggested that there were additional factors to rodent predation that were influencing the responses by invertebrates on Macquarie Island. These factors potentially include rabbit-induced habitat changes, climatic change, and/or interactions with remaining non-native invertebrate species. Our modelling showed that the abundance of non-native invertebrates can influence native species, usually negatively.

Best invertebrate indicators

Which invertebrate types are the best candidates to reflect eradication response varied with the type of impact that the pest species were having and therefore what kind of response occurred following eradication.

For Macquarie Island we found that invertebrates (which rely on habitat) are good candidates for indicating long-term ecosystem trends.

For Antipodes Island the abundance and distribution of larger invertebrates such as beetles, pseudoscorpions, amphipods, worms, centipedes and spiders are good indicators of predation pressure – and of predation release following eradication.

Ecological drivers

Elevation and vegetation were the two environmental variables that explained the most variation in invertebrate communities on Macquarie Island. The highest richness and abundance in invertebrates were found in habitats that were the most impacted by rabbits prior to their eradication. The abundance of non-native invertebrates was found to be negatively correlated with native invertebrate abundance.

Trapping methods

Although pitfalls trapped high numbers of some species, they did not typically reflect overall invertebrate diversity, being dominated by particular groups such as Colelmbola (springtails). The range of trapping methods we used allowed for detailed analyses of abundance across all invertebrate groups and at different strata of the vegetation; we found that pitfall traps were effective for ground-active groups such as beetles and spiders that were preyed on by mice, but monitoring of moth caterpillars, a principal food source for rodents, required a targeted trapping technique such as timed hand searching or vegetation sweeping. Thus, we learned that understanding target species and the environment informs the design and interpretation of trapping surveys, and species life history must be considered when designing trapping aimed at informing management. Litter sampling proved to be most efficient single technique for capturing the greatest abundance and diversity of invertebrates.

Potential future invaders

Previous work had detected a large suite of invertebrates invading Macquarie Island. This work builds on that previous work by incorporating three groups of Macquarie Island invertebrates: native species; non-native species that have become established in the Macquarie Island environment; and species that are regularly introduced but not breeding on the island.

We found that small, wingless non-native species that feed on dead plant or animal matter present the greatest biosecurity threat to Macquarie Island, upon reaching the island they are more likely to successfully establish, and such species are least likely to be detected during biosecurity surveillance.

*Native spider (*Myro Kergueliensis*). Photo: Melissa Houghton*

Implications

The results of our post-eradication monitoring have implications that are relevant to conservation managers, policy-makers and conservation decision-makers.

The global island conservation research community is eagerly watching what happens on Macquarie Island following the eradications of invasive mammals. Monitoring the transformation will be important in guiding island eradication programs worldwide. Efficient and effective approaches to ecosystem monitoring can help assess management successes, inform future ecosystem management and optimise conservation funding.

Invertebrate monitoring is often overlooked in conservation programs in favour of monitoring more charismatic species; however, our examination of the invertebrate community response following eradication at Macquarie and Antipodes Islands confirms that invertebrate monitoring is an ideal tool for tracking ecosystem change.

Invertebrate bioindicators can give key insights into the landscape-scale restoration of islands following mammal eradication programs, thereby quantifying their conservation return-on-investment.

The baseline data on invertebrate communities on Macquarie and Antipodes islands that we have established will be valuable to ongoing monitoring and conservation planning on those islands.

Our findings on insect indicator types will also be valuable to inform pre- and post-eradication monitoring of other islands with planned eradications, such as sub-Antarctic Gough and Marion Islands where rodent eradications are planned.

The traits-based analysis of invasive invertebrates will be fundamental to informing and improving Antarctic biosecurity screening for all national programs to protect the region from non-native species. Given that the findings relate directly to the Australian Antarctic Division, this work will be of particular relevance to Australian Government biosecurity practices for the sub-Antarctic region.

Sweep-netting in tussock grass on Wireless Hill, Macquarie Island. Photo: Melissa Houghton

Pitfall trapping in Stilbocarpa *cabbage at Lustania Bay, Macquarie Island. Photo: Melissa Houghton*

Recommendations

We recommend that:

- future island eradication projects consider invertebrate monitoring as means of assessing landscape-scale conservation gains
- improvements to biosecurity of the Antarctic and Southern Ocean Island region be made by focusing on high-risk invertebrates – small, wingless species that feed on dead plant and animal matter.

Cited material

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