Pest Eradication on Macquarie Island

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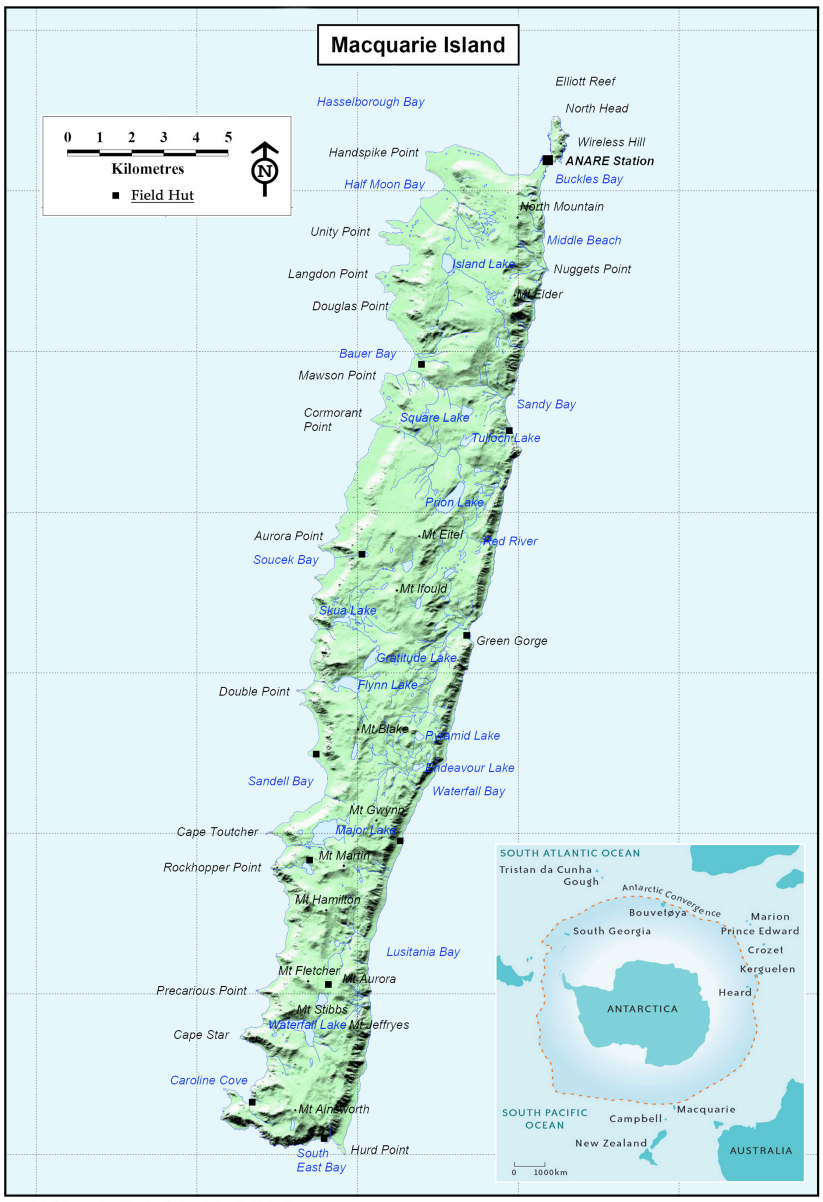
Summary

Invasive vertebrate species have been present on Macquarie Island for over 200 years, and have had devastating impacts on flora, fauna and landforms. Weka (*Gallirallus australis*) were successfully eradicated by 1989 and feral cats (*Felis catus*) by 2001. Planning for the eradication of ship rats (*Rattus rattus*), house mice (*Mus musculus*) and European rabbits (*Oryctolagus cuniculus*) began in 2004. Funding of AUD$24.7M was secured in 2007 for a multi-year project based on aerial baiting that targeted rabbits and rodents, followed by hunting of any surviving rabbits. Following three years of planning, the first aerial baiting attempt in 2010 was abandoned after two months due to unfavourable weather and shipping delays. The degree of non-target seabird species mortality from the limited baiting in 2010 lead to a renewed examination of non-target mitigation options. Rabbit Haemorrhagic Disease Virus (RHDV) was introduced in February 2011, to reduce the pre-baiting rabbit population and thus minimise non-target mortality amongst scavenging seabirds. Aerial baiting resumed in May 2011 using four AS350 helicopters and a team of 27 people, and was completed by July 2011. No rodents have been detected post-baiting and the estimated rabbit population in excess of 150,000 has been reduced to less than an estimated 30 at the conclusion of baiting. Some rabbits were expected to survive baiting, and the hunting phase commenced in July 2011 using a team of 15 hunters and 12 dogs. By December 2011thirteen rabbits had been accounted for. Hunting efforts are ongoing, and together with a monitoring phase are planned to continue for five years. A minimum of two years monitoring for rabbits will be conducted. Continued effort each year will be based on annual progress reviews. Rodent detection dogs will deploy in 2013 to assist in determining rodent eradication success. After one summer since baiting, vegetation recovery is already evident and increased burrow-nesting seabird activity has also been observed in the first breeding season post-baiting.

Introduction

Macquarie Island (12,780 hectares) is a listed World Heritage site that lies in the Southern Ocean (54°37'53"S, 158°52'15"E) 1500 km from Hobart, Tasmania and 1000 km from Bluff, in southern New Zealand (Figure 1). It is part of the state of Tasmania. Discovered in July 1810 by sealers, early European activity centred on commercial exploitation of seals and later penguins, and continued until 1919 (Cumpston 1968). Sealing and oiling gangs deliberately or inadvertently introduced numerous mammal species. Five species (ship rats *Rattus rattus*, cats *Felis catus*, house mouse *Mus musculus*, European rabbits *Oryctolagus cuniculus* and weka *Gallirallus australis scotti* established feral populations and caused significant impacts on landscapes and native flora (Copson and Whinam 2001) and fauna (including extinction of two endemic land birds (Taylor 1979). Weka were eradicated by 1989 and cats by 2001. Increasing landscape and vegetation impacts from rabbit grazing (Jenkin 1975, Taylor 1955) combined with greater capacity to achieve larger scale eradications (e.g. Howald et al 2007) led to the consideration of undertaking such a project on Macquarie Island to eradicate the remaining three vertebrate pest species (PWS 2007). Public awareness and lobbying also increased with protection of world heritage values as a central theme. Following planning undertaken in 2004-5 and 2006-7, the Macquarie Island Pest Eradication Project was established in June 2007 following agreement between the Tasmanian and Australian governments to jointly fund A$24.6M toward the project, following a A$100,000 donation by Peregrine Adventures and WWF Australia.



Spatial data provided by Australian Antarctic Data Centre

Figure 1. Macquarie Island

Planning

With full funding for the duration of the project secured, implementation of the Macquarie Island Pest Eradication Plan proceeded. By that stage a justification and overview had already been prepared, as had a detailed operational plan, and these had formed the basis for securing funding. Planning continued with aspects of regulatory work, environmental impact assessment, staff recruitment, tenders for major services, contract management, field equipment procurement and training of dogs.. The approved plan was based on a two-phase project with aerial baiting using brodifacoum baits spread by helicopters, followed by ground hunting of surviving rabbits. Based on the experience gained from previous projects elsewhere, aerial baiting was expected to achieve rodent eradication and reduce the rabbit population by >99%.

A three year timeframe was required to get dogs trained to the required standards (including a tender process, acquisition of pups, training and certification), to secure all regulatory approvals (38 approvals and permits were required), recruit staff and to procure all supplies, equipment and services required. The logistics operation needed to aerially bait an island of this size was considerable. Three hundred and five tonnes of Pestoff 20R bait containing brodifacoum at 20ppm was ordered (Animal Control Products, Wanganui, New Zealand). A tender process resulted in Helicopter Resources Pty Ltd (Tasmania, Australia) being contracted to supply two AS350BA and two AS350B2 helicopters, along with engineering support, helicopter spares, pilots and ground crew experienced at aerial baiting operations, bait spreading buckets, switching gear and Tracmap GPS systems (Mosgiel, New Zealand). A team of 19 staff were recruited (additional to the helicopter team) to provide bait loading, non-target mitigation, safety, and GIS technical support. Other support was received from the Australian Antarctic Division and Bureau of Meteorology staff at the Macquarie Island station where the aerial baiting team was accommodated. A ship was chartered with the capacity to deliver the large quantities of bait and helicopter fuel to Macquarie Island, along with the baiting team, helicopters and other equipment.

Operational

2010 aerial baiting

Due to circumstances beyond the project's control, the selected ship was unavailable for the required departure date in April 2010. Consequently a delay of four weeks was experienced before the team could be delivered to the island. On arrival, a small amount of baiting was conducted (<1300 ha) before persistent strong winds and low cloud precluded helicopter operations for extended periods. Eventually, with winter ending and the imminent return of many seabird species to the island, the lack of progress forced a decision to cease operations and for the team to withdraw with only 8% of the bait spread over about 10% of the island. Although non-target mortality had been predicted in the Environmental Impact Statement (PWS 2009), the Australian government initiated a review of the project because of the extent of the non-target mortality experienced after the limited baiting in 2010. About 960 individual birds of six species were found dead on the island from a total of 27 native species known to be present. Eventually approval was given for the project to proceed in 2011with additional mitigation measures in place. The lack of experience and familiarity with this type of operation meant that regulators proposed measures that were largely impractical or increased the risk of eradication failure, and were delivered with a strong 'policing' approach, rather than accepting that the eradication project team were already exploring improved mitigation measures amongst peers, and had a good understanding both of the island and of the operational limitations of some proposed techniques.

2011 aerial baiting

Previous suppliers of helicopters, bait, bait pods, shipping and helicopter fuel were engaged to repeat the baiting operation in 2011. Additional bait was procured because although the bait pods left on the island were expected to retain the bait in good condition, there was no guarantee that it would be usable by the middle of the following year. In the event that a large portion of the bait had spoiled, the project would fail as there would be no opportunity to replenish the amount of bait required at short notice. Therefore replacement bait to undertake two bait drops was ordered. This ensured that sufficient fresh bait would be on the island to complete the majority of baiting, with the 2010 bait as a contingency and to do a third bait application in high-density areas and off-shore rock stacks.

Aerial baiting

The 2011 baiting team totalled 27 people. This comprised a helicopter team of eight (four pilots, two engineers and two ground/equipment support), a management team of three (project manager, operations/safety officer, GIS technician), a bait loading team of 11 (two x five person teams plus one rotating out for a break to allow continuous operation of the loading) and a non-target mitigation team of five. Further support was provided by the Australian Antarctic Division who maintain a station on Macquarie Island and provide infrastructure support.

Following arrival at Macquarie Island in late April, ship to shore operations commenced to establish three bait depots, each taking approximately a day. Following a 'shakedown' baiting of North Head to test systems and familiarise teams with their roles, aerial baiting commenced in early May. Baiting began at the south end of the island and progressed north, following the principle of a 'rolling baiting front' to ensure there were no isolated pockets of land left unbaited if weather interrupted proceedings. The first bait drop was finished by 21st May 2011.

Although a period of 10-14 days is usually left between bait drops to allow time for animals to locate bait and die from the toxin (which may be about 8-9 days for rats and longer for mice) the rate of baiting progress up the island meant that by the time the first drop was completed the second could commence immediately, being about 3 weeks from the start of the first drop. The second bait drop was completed by June 19th. A third drop was undertaken that focused on rock stacks (both on and offshore), in areas of previously high rabbit density, and around areas attractive to rodents such as penguin colonies. In addition, baiting was conducted by helicopter onto islands in lakes, and by hand in all buildings and caves.

Helicopters used TracMap GPS systems (http://www.tracmap.com/) to generate flight lines 40 metres apart and guide the pilot in maintaining the flight line. The swath width of bait spread from the bucket was 80 metres so the 40 metre flight line separation gave a 50% overlap and reduced the likelihood of gaps in bait coverage. Light bars on the top of the instrument console aided in maintaining position on the designated flight line. ArcView 9.0 GIS (www.esri.com) was used to digitise baiting blocks for loading into GPS units, to evaluate actual versus plotted flight lines and to determine any areas that needed re-sowing to cover suspected gaps in bait coverage. Baiting operations were not undertaken if (constant) wind speed was above 25 knots, but would proceed after snowfalls, pending other factors also being considered.

Application rates varied between 18 and 36 kg/ha, depending on the part of the island (in terms of rat and rabbit habitat) being baited. Coastal areas that provided rat foraging areas in the intertidal zone and around penguin colonies received an additional 4 kg/ha, applied via a double swath flown parallel to the coast, with no overlap. The third bait drop applied to rock stacks and areas of high rabbit density added another 8 kg/ha.

Baiting results

Dead animals began to be found within four days of the first baiting. No confirmed sign of rats was found after the end of the first bait drop. Some mice were seen after the first bait drop however no evidence of surviving mice has been found since the second bait drop. Relatively few dead target animals were located despite extensive searches, consistent with the method of action of the toxin which leads to most animals dying in their nests or burrows.

Non-target species mitigation

The decision to undertake the aerial baiting program during winter (when days are shortest and the weather least favourable) was largely to avoid wildlife disturbance during the summer breeding season. There are large penguin colonies around the coastline in summer, and the risk of disruption to these colonies in the breeding season was considered too high to warrant further consideration of summer baiting. Other bird species such as giant petrels and albatross are also more susceptible to disturbance by helicopter over-flights during the summer breeding season, so overall impacts could be expected to be much higher in a summer operation. However, other factors also guided a winter operation. Natural food sources – birds, vegetation, and invertebrates – of the target animals are less available during winter, meaning that target animals are more likely to accept bait as an alternative food source, increasing chances of successful eradication.

Brodifacoum can pose a significant risk of primary and/or secondary poisoning to some non-target native species on Macquarie Island, in particular skua (*Catharacta lonnbergii*), kelp gulls (*Larus dominicus*), and northern and southern giant petrels (*Macronectes giganteus* and *M. halli*, both listed as threatened species). Hunting teams, helicopters, trapping equipment, firearms, and the use of dogs on the island also have the potential for additional non-target species impacts.

While brodifacoum is considered highly toxic and may pose a higher risk to non-target animals than some other anticoagulant toxins (Eason and Spurr 1995), the reason it is typically used for eradication projects on islands is that it has the highest success rate at achieving eradication of rodents. Given the high stakes and multiple risks of such projects, where successful pest eradication can literally prevent the extinction of native species, ways to reduce the chances of eradication failure are critical, and use of a method with the highest success rate is one such approach (Howald et al. 2007). Of course, a careful assessment of the extent of non-target impacts is critical, and it may be that in some circumstances the risks to non-target species outweigh potential benefits. In such cases a project may either not proceed, or alternative measures are implemented, albeit possibly with a higher risk of eradication failure.

As a joint Commonwealth and Tasmanian government funded project, the Macquarie Island Pest Eradication Project had undergone extensive and detailed environmental assessments and approvals at all stages of planning. In preparation for these approvals, and to inform planning requirements, trials were conducted over a period of five years to test for factors such as bait weathering, target and non-target species bait uptake, and disturbance to penguins by helicopter operations. Based on these trial results, a range of non-target species impact mitigation strategies were incorporated into the Project's Environmental Impact Statement (Parks and Wildlife Service 2009) and Operational Plan (Parks and Wildlife Service 2010). These included measures to minimise non-target species impacts through:

- Helicopter over-flight operating protocols and placement of observers when baiting over winter-resident king penguin (*Aptenodytes patagonicus*) colonies
- Placement of observers and removal of baits next to wandering albatross (*Diomedea exulans*) nests
- Collection of target species carcasses by search teams during the baiting operation
- Briefing of hunting teams as to locations of burrow-nesting seabird colonies, and
- Intensive training of rabbit detector dogs in relation to avoiding non-target species such as penguins.

Following mortality of non-target seabirds after the 2010 baiting, a further strategy to reduce the incidence of non-target mortality was the release of Rabbit Haemorrhagic Disease Virus (RHDV). This had the potential to be easily the most effective way of minimising further non-target mortality because it intended to kill a large proportion of rabbits well before aerial baiting commenced, so that fewer toxic carcasses would be available for scavenging by kelp gulls, skua and giant petrels. It would

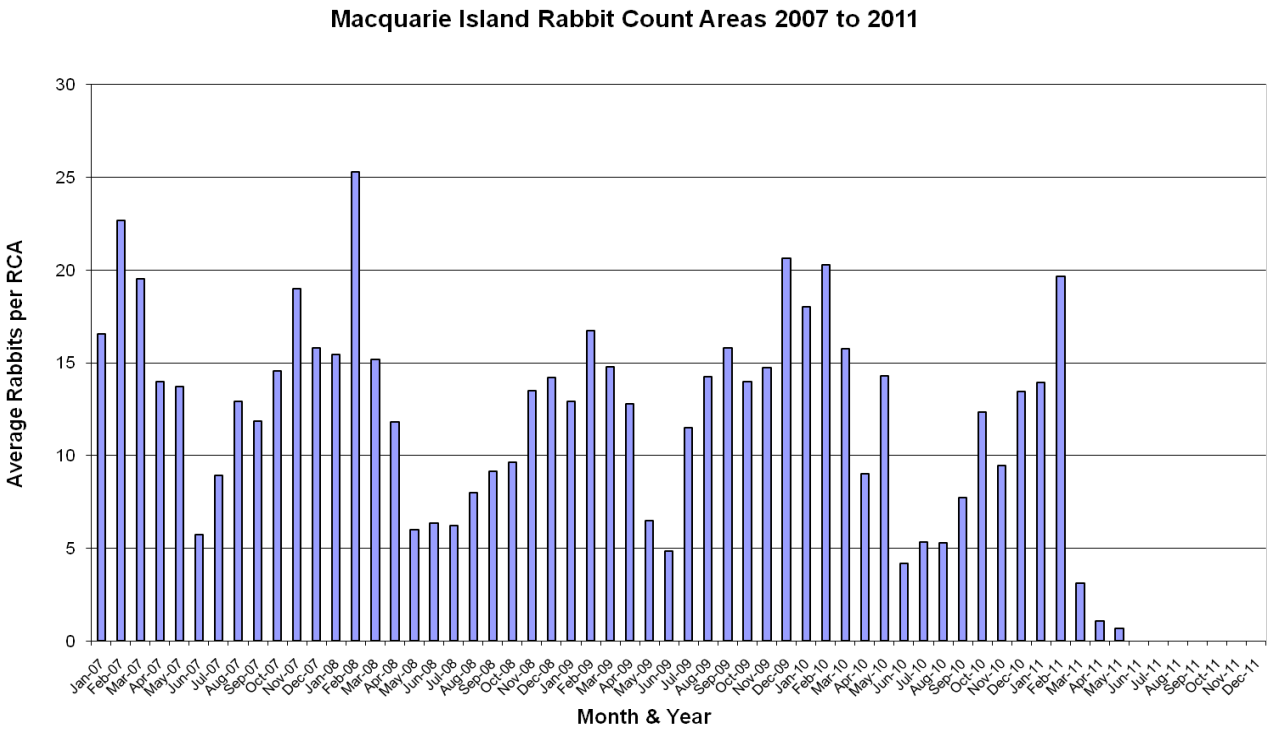
not however reduce the extent of primary poisoning which was expected to affect kelp gulls and black ducks. After it was released in February 2011, the virus spread rapidly through the population and effectively reduced the rabbit population from an estimated >150,000 by about 80-90% (figure 2). Two other primary non-target mitigation measures utilised were the earlier arrival at the island allowing baiting to be completed well before the return of migratory birds in the spring; and deployment of search teams to remove carcasses containing poison residues. Helicopter over-flights of king penguin colonies were again monitored by an observer who filmed flights and relayed penguin behaviour or disturbance to the pilot. Wandering albatross nests had bait removed from a five metre radius, with bait placed in a series of bait stations within the five metre circumference. Following the 2011 baiting, search teams during and after the baiting recovered 1468 dead birds, most of which could be attributed to primary or secondary brodifacoum poisoning. The six species affected by baiting were the six species assessed in the Environmental Impact Statement as being likely to be affected. No other species was impacted by toxin consumption.

Follow-up hunting

Following completion of the baiting programme, hunters commenced work immediately, although the full hunting team didn't arrive on the island for a further month after baiting concluded. Anticipating a >99% kill, up to 200 rabbits could have been expected to survive. However in the period from July 2011 to March 2012, 13 rabbits were killed, with only nine of these being adults (i.e. survivors of the baiting). All were located in the first five months following baiting, and comprised seven males and two females. A litter of four newly weaned kittens was located in November 2011, shortly after a lactating doe was taken nearby. The comprehensive extent of hunting coverage gives confidence that any significant rabbit activity would be detected across all accessible parts of the island. While no sign has been detected since December 2011, some previous evidence of rabbits has not been accounted for, therefore the assumption must be made that a very small number survive, probably fewer than five.

Hunting effort is organised into six hunting blocks. Two hunters are rostered into a block for a month before rotating. One hunter in each block has two dogs. All hunters use GPS units (Garmin CSX60) to record their daily hunting coverage. The main hunting technique is searching for sign, such as evidence of grazing, digging, scats or footprints. When this was found efforts intensified to target the individual rabbit. Methods for killing rabbits once found included fumigating burrows, firearms, leg-hold traps or cervical dislocation. The dogs proved invaluable, and were involved in locating the majority of rabbits to allow handlers to use other methods to dispatch them.

Figure 2. Rabbit counts 2007 - 2011



Environmental recovery

One austral summer has passed since completion of baiting. While neither rodent nor rabbit eradication is yet confirmed, anecdotal and survey evidence provides initial impressions of a changing environment.

Most visually, vegetation recovery across the island is very evident. Palatable species previously targeted by rabbits and subjected to wide scale overgrazing are all growing healthy stands, including tussock (*Poa foliosa*) and the two native mega-herb species Macquarie Island cabbage (*Stilbocarpa polaris*) silver-leaf daisy (*Pleurophyllum hookeri*). Other native plants including *Agrostis magellanica*, *Ranunculus crassipes* and the prickly shield fern *Polystichum vestitum* are all showing regeneration, as are introduced species such as *Poa annua* and *Cerastium fontanum.*

Some bird species are showing a noticeable change in behaviour and/or breeding success in the absence of rat predation. Grey petrels (*Procellaria cinerea*) have only been confirmed breeding on the island since 2000 after a century of absence due to cat predation. The population has been monitored since 2000 and the 2011 breeding season showed a significant increase in both breeding success and number of chicks fledged over previous years. Blue petrels (*Halobaena cærulea*) have likewise been absent from the main island due to rat predation, with breeding restricted to offshore stacks. In the summer after aerial baiting, over a hundred active blue petrel burrows were observed on the island, mostly on North Head, which had been baited in 2010 as well as 2011. An Antarctic Tern (*Sterna vittata bethunei*) census late in 2011/early 2012 recorded 51% of nests on cobblestone

beaches or attached stacks on the main island (compared with 9% in the 2009/10 census) and 49% on off-shore stacks (91% in 2009/10) (bird data from PWS unpublished reports).

Anecdotal observations have also noted a significant increase in invertebrate activity, especially spiders, which had formed a significant diet component of mice. Several months after baiting, cobweb development in grass has been observed at levels never before recorded on Macquarie Island.

Conclusion

The combination of RHDV and aerial baiting appeared to reduce rabbit numbers from >150,000 to <20 individuals and successfully eradicated rodents, although it is too early for confirmation of this. Surviving rabbits were expected and hunting planned to account for survivors. This strategy has been used successfully with 13 rabbits killed post baiting and no confirmed sign seen since December 2011.

The eradication of invasive vertebrates was a measure designed to allow recovery of natural ecosystems on the island and progress towards this goal is evident. In less than a year since removal of the vast majority of pest individuals, recovery of vegetation, birdlife and invertebrates is being observed. Biosecurity practices need further improvement to ensure that the efforts to date are not reversed as a result of re-invasion of pests.

Acknowledgements

The Macquarie Island Pest Eradication Project would not have made such significant achievements without the assistance and support of staff from the Tasmania Parks and Wildlife Service, Australian Antarctic Division and New Zealand Department of Conservation. Their individual and collective efforts are acknowledged and appreciated. Keith Broome, Ian Wilkinson and Tony Martin made useful contributions in reviewing the text.

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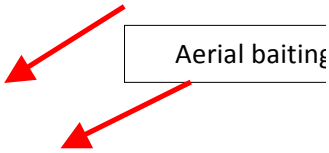
Aerial baiting