Campbell Island – pushing the boundaries of rat eradications

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Abstract. Campbell Island (11,300 ha) is situated 700km south of New Zealand, making the project to eradicate Norway rats (*Rattus norvegicus*) the largest and one of the most isolated rodent eradications ever undertaken. The methodology for the project built on the techniques developed on a range of smaller island eradications closer to New Zealand. The size and isolation of Campbell Island meant that aspects such as the baiting rate and bait storage had to be significantly modified to make it financially and logistically feasible. The changes from the standard techniques were significant enough to require an extensive field trial in 1999 to test the probability of success. In 2001, the New Zealand Department of Conservation (DOC) used four helicopters to transport and spread 120 tonnes of bait containing 20ppm brodifacoum. While three months had been allowed to complete the project, the bait drop took just over four weeks due to unexpectedly good weather. The initial monitoring, using trained dogs, trapping and gnaw sticks was undertaken in 2003 and found no sign of rats. Continued opportunistic checks, along with outcome monitoring, has shown that the eradication has been successful. Several species of land and seabirds have recolonised Campbell Island since the eradication and some invertebrate populations have increased dramatically. This project has proved that increasingly larger and more isolated islands could be successfully cleared of rats providing there is sufficient funding; the required political and institutional support; a high level of planning to customise the methodology to the particular island; and a positive attitude from all those involved. It has already lead the way for other ground-breaking projects including: Rat Island, Aleutians (2008); Macquarie Island (planned for 2010); and South Georgia (planned to start in 2011), with hopefully more to come.

Keywords: Eradication, Norway rat, *Rattus norvegicus*, aerial

INTRODUCTION

Campbell Island (11,300ha) is located 700km south of New Zealand in the latitudes known as the furious fifties due to their consistently strong winds (Fig. 1). During the 19th century, the island was primarily a base for sealing and land based whaling. The island was also farmed from 1895 until 1931, after which the farm and its livestock were abandoned. The legacy of these activities included feral sheep (*Ovis aries*), feral cattle(*Bos taurus*), feral cats (*Felis catus*) and Norway rats (*Rattus norvegicus*). The island was subsequently designated as a Nature Reserve and is now administered by the Department of Conservation (DOC). Restoration of the island started in 1970 when sheep were removed from approximately half the island. Over the following 20 years, the remaining sheep and a small herd of feral cattle were removed (Brown 2002), leaving feral cats and Norway rats as the only introduced mammals.

This paper describes the methods used for what is still the largest successful rat eradication ever undertaken. I describe how existing methods for aerial spread of rat baits were tested and adapted for the island's remote location and difficult terrain, and outline the early responses to rat removal by native species.

Most people considered that it was not feasible to eradicate rats from Campbell Island because of its distance from the mainland, size and topography. Furthermore, since not all parts of the island could be safely accessed, a ground-based operation was impossible. The only solution was aerial spread of baits using helicopters. When the Campbell Island project was proposed, the largest previous aerial operation had been on 1,965ha Kapiti Island 5 km off the west coast of the North Island of New Zealand. Because baits could be ferried to Kapiti from the mainland, there were few logistic difficulties (Empson 1996; Empson and Miskelly 1999).

Initially, the Campbell project was for a joint rat and cat eradication (DOC 1998). However, given several years without any sign of cats, checks were carried out in 1999 using trained dogs. These confirmed that there were no cats present (Brown and Theobald 1999). It is not known why the cats died out, although it may be related to the previous removal of sheep. This was followed by increasingly dense vegetation cover (Meurk 1982) which either created difficulties when cats were hunting rats or, when wet, the vegetation was too inhospitable for cats. The absence of cats greatly simplified the eradication project.

METHODS

Bait trials

In the late 1990s, the accepted method for aerial spread of baits against rats in New Zealand involved two bait drops of 8 and 4 kg/ha with a ten-day gap in between and a forecast of three fine nights following each bait drop. Initial planning for Campbell Island indicated that the amount of bait required for this conventional approach, and the costs of transporting and spreading it, were not affordable. Similarly, the number of hours of suitable weather required for spreading a total of 12 kg/ha of bait was unlikely within the time available. The baiting rate was thus reduced to a single drop of 6 kg/ha involving 3 kg/ha out of the bait spreader with a 50% overlap of bait swaths to minimise the risk of gaps. Although based partially on previous experience, the chosen rate was largely based

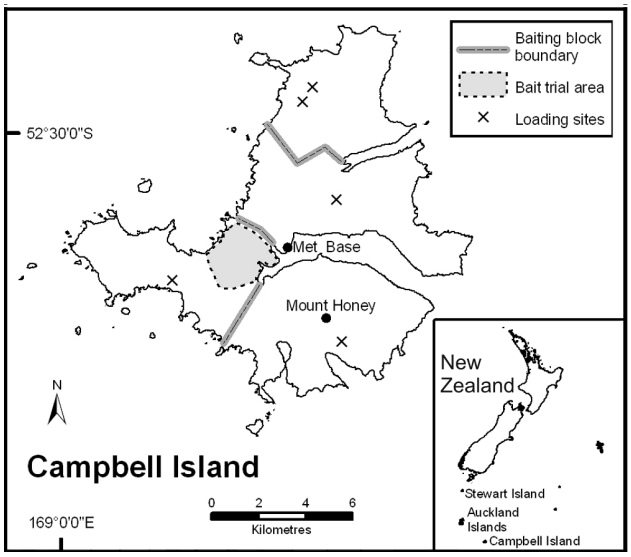

Fig. 1 Campbell Island.

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on the gut feelings of the advisory group and as such it needed testing for its efficacy on Campbell Island. In 1999, a trial was carried out with non-toxic 16mm Pestoff cereal pellet baits containing the biomarker Rhodomine spread at the proposed rate over approximately 600 ha containing most of the habitat types found on Campbell Island (Fig. 1, McClelland *et al*. 1999). Snap-traps were then set throughout the area. All of the rats caught, except two near the boundary of the test block, had eaten the bait. Since the latter two rats were likely to have moved into the area after resident rats had been removed during the trapping programme, bait uptake was considered sufficient to indicate the potential for 100% mortality.

Compared with islands elsewhere around New Zealand where rat eradications have been undertaken, the climate on Campbell is wetter and has a high probability of snow, at least for short periods. The type and size of baits thus needed testing for the conditions on Campbell Island (Brown 1999). "Pestoff 20R" 16 mm cereal pellets performed best in the cool wet climate. Brodifacoum, a second generation anticoagulant, was chosen as the preferred toxin as it can kill rats after a single feed. All previous rodent eradications using helicopters around New Zealand had used baits containing this toxin with minimal failures.

Non target species

Experience from previous bait drops against rats, and the feeding behaviour of potential non-target species, indicated that albatrosses, penguins, seals, and sea lions were at minimal or no risk of either primary or secondary poisoning. As no native land birds remained on the island, the only species believed to be at risk were Subantarctic skua (*Catharacta antarctica*), southern black-backed (*Larus dominicanus*) and red-billed (*L. novaehollandiae*) gulls, self-introduced mallard ducks (*Anas platyrhynchos*), a variety of self introduced passerines, and possibly northern giant petrel (*Macronectes halli*). Although giant petrels were of concern because their populations are in global decline, as scavengers they were at low risk of either primary or secondary poisoning. Furthermore, no feasible precautions could be taken to protect them.

Timing

Timing of the operation was based on the standard assumptions used for most previous New Zealand rat eradications: that bait should be spread in winter when 1) natural food sources were minimal; 2) rat numbers are lowest thus requiring less bait to give all rats access to a lethal dose; and 3) there is least chance of rats breeding with the associated risk of young rats emerging from their nest after all bait had been consumed or decomposed.

Colonies of grey-headed (*Diomedea chrysostoma*) and Campbell (*Diomedea impavida*) albatross and rockhopper penguins (*Eudyptes chrysocome*) on the island were potentially at risk of disturbance by the helicopters, and the albatrosses could pose a risk of air strike. It was decided that the project should be carried out during the winter absence of these species from the island. Furthermore, a winter operation would remove the risk of primary and secondary poisoning of skua, which are also absent from the island at this time.

The combination of maximum effects on rats and minimum risk to other species narrowed the period to three months in which to complete the bait drop.

Logistics

Once the baiting regimes were decided, and given that there were minimal non-target issues, the main planning tasks involved the following numerous inter-locking logistical issues.

Helicopters. Three helicopters were used to spread the bait in order to maximise the chances of completing the drop within the three month period available, ie to allow for anticipated poor weather, and to provide cover in the event of a breakdown of a machine or illness of a pilot. Bell Jet Ranger 206s were selected because: 1) they were the most readily available model of helicopter already equipped for bait sowing, 2) most of the experienced bait sowing pilots were familiar with these machines, and 3) they were proven for their reliability and relatively easy maintenance. The last two criteria were especially important given the conditions expected on Campbell and the limited maintenance facilities available.

A spare bait spreading bucket and GPS base station as well as a range of spare parts for the helicopters and buckets were taken to the island, but were not required.

The bait pods (see below) weighed 850kg, which is beyond the lifting capacity of a Jet Ranger, so an Aerospatiale B2 Squirrel was used to move them and transport personnel around the island. A second Squirrel was taken to the island to ensure that the ship was unloaded within one day to reduce ship charter costs. The second Squirrel then returned to New Zealand. The extra cost of two Squirrels paid for itself because after unloading was completed as planned, the following three days were unsuitable for flying.

Pilots. The selection of pilots is a crucial part of any aerial eradication, especially when operating in a harsh and remote environment like Campbell. The lead pilot (Peter Garden) was selected for his constructive attitude, experience with three previous eradication bait drops and numerous control operations on the mainland, and expertise in the use and downloading of the GIS information. Peter assisted with planning and in turn selected the other two Jet Ranger pilots (Brian Beck and Don Sanders) based on their experience, skills and attitude. The squirrel pilot Richard (Hannibal) Hayes was recognised as one of the best in New Zealand for the long-line work required to unload the ship and move the pods to the loading sites. He was also very experienced at mountain and poor weather flying. The four pilots all worked for different helicopter companies. Because agricultural helicopters are often set up by each company differently for doing the same job, each company provided the specific helicopter with which the pilot was most familiar. This reduced the risk of unforeseen problems.

Infrastructure. The New Zealand Meteorological Service built a weather station and associated accommodation on Campbell Island in the 1950s. The station was automated and destaffed in 1995 but the buildings were still in good condition, although stripped of chattels. An advance team set up the base, including electricity, heating, hot water, and gas cooking prior to the arrival of the main party, helicopters, and the bait. A warm, dry environment to return to each day meant that the team was comfortable and able to work harder longer and in worse conditions than might otherwise have been the case. It also meant that bait spreading teams would be ready to make the most of any suitable weather from the day they arrived.

Transport. Options for shipping the bait to the island were limited. The vessel used was the coastal freighter, "Jenka" with large holds and wide hatch covers to facilitate unloading of the bait by helicopter. The bait pods and other materials were stored in the hold of the vessel while the helicopter fuel was stored on deck to reduce the risk of bait contamination.

Shipping the helicopters to Campbell would have required a larger and more expensive ship and the pilots decided that it was safer to fly the machines to the island,

thereby avoiding the need to remove blades or the risk of damage in transit. The helicopters were all fitted with long range fuel tanks which allowed them to make the flight utilising two fuel depots which had been set up the previous summer on islands on the way.

Bait transport and storage

None of the existing buildings on the island were suitable for storing the required 120 tonnes of bait. The storage needed to be waterproof, strong enough to hold more than half a tonne of bait, moveable by forklift, and able to be slung under a helicopter. The chosen option was a purpose-built 1.2 m^3 plywood box, termed a "pod" to avoid confusion with other containers and boxes used for the project. The pods weighed only 100 kg and could hold 750 kg of bait (25 x 30 kg bags); were easy to fly under a helicopter; enabled minimal bait handling because bait in filled pods wasn't touched until it was loaded into the spreader bucket; and they were comparatively cheap.

The pods had the added advantage that four could be formed into a loading platform of ideal height for loading the bait buckets. If bait spreading was stopped for any reason the bags of bait were returned to a pod, which was then resealed. When empty, the pods could be rapidly dismantled and flown back to base.

Baiting the blocks. Campbell Island is roughly triangular in shape so the island was divided into four blocks based around major geographical features: the three main ridges and the highest hill on the island (Fig. 1). This allowed for the most efficient management of the loading sites. Baits were sown within the blocks sequentially from the north so that areas around albatross colonies were covered before the birds returned to breed.

Monitoring the spread of baits. The spreading of baits was guided by differential GPS with a base station set on a high point to receive satellite signals. Differential GPS was found to reduce the risk of inconsistencies with the flight lines. The GPS units allowed each block to be divided up into numbered 40 m parallel swaths. These were then allocated among the three helicopters to ensure no swaths were missed or flown twice. Every evening after bait had been spread flight lines from the three helicopters were downloaded, printed and checked for gaps. Actual or potential gaps became priority work for the next day.

Loading sites. Multiple loading sites were established in order to minimise ferrying time for the bait-spreading helicopters and maximise the time they spent spreading baits. Six loading sites, five remote and one at the base, were used during the project. With loading teams working at two of them at any one time. Where the sites had soft peat soils, a working base of timber and dismantled pods was laid out prior to putting the four pods in place to make the loading platform.

When operating at the north end of the island, a second refuelling site was also set up. All other refuelling was done at the base.

Bait pods and fuel were ferried by the Squirrel helicopter from storage at the base to the loading sites being used at the time. Dismantled pods were stacked in cargo nets and back loaded to the base where they were packed for return to New Zealand.

Safety

Safety was a major concern for this project because of isolation, extreme weather, and the presence of four helicopters working simultaneously over the island. While helicopters were the greatest hazard, they also provided some reassurance that rapid evacuation of anyone injured was possible. Safety was stressed at every briefing and while there was an assigned safety officer, everybody was made responsible for both individual and team safety.

Field team selection

The project manager had full control over selecting the field team and ensuring compatibility within the group. A list of the required skills and experience was drawn up and the best people then targeted for those roles. The skills required included mechanical, electrical, cooking, medical, as well as experience with eradications and the Campbell Island environment.

Island Eradication Advisory Group

DOC's Island Eradication Advisory Group (IEAG), set up to advise multi-island eradication programmes (K. Broome pers. comm.), was involved in all planning phases for the Campbell Island operation (Broome *et al*. 1999). The IEAG ensured that the lessons learnt from previous eradications around New Zealand were considered during the planning for Campbell and that the lessons learnt from Campbell have been considered in subsequent projects.

RESULTS

Bait coverage

There were no gaps in the bait coverage due to the combined benefits of compatible GPS systems in all helicopters, careful checks of all flight lines after each day's bait spread, and the 50% overlap of flight lines. After the baits had been spread, a second check of the flight lines revealed several relatively small (50m x 200m) areas where bait had been applied at rates lower than expected. Apparently the 50% overlap had not been complete leaving bait at only 3 kg/ha in some patches. Ground checks showed that bait cover was still sufficient so no further action was undertaken.

Areas with cliffs, some of which were over 400m high, were baited with swaths flown parallel to the cliffs at intervals of approximately 100 vertical metres. The extent of coverage could not be confirmed in these areas so the helicopter pilots determined visually whether sufficient bait was landing on the ledges. A sideways deflector, which is a shield allowing bait to go out on only one side of the bucket, was trialled but not used due to mechanical problems.

Non target species

Searches for non-target mortality after the bait drop was opportunistic while doing other work. The only confirmed casualties were one mallard duck, 10 red-billed and black-backed gulls and 10 introduced passerines, most of which were redpolls (*Carduelis flammea*). There were no recorded effects on giant petrels.

Results monitoring

The first monitoring of the effects of baits on the rats was carried out over the 2003/2004 austral summer using snap traps, gnaw sticks and a trained rodent detection dog (King 2003). No sign of rats was detected. While too early to be sure of success, this gave sufficient confidence for the reintroduction of Campbell Island teal (*Anas nesiotis*) in 2004 (Gummer 2004). Additional low level monitoring using gnaw sticks and searching for sign in 2004 and 2005 failed to reveal any sign of rats. On the basis of these results, the eradication was declared successful in 2006. While the standard period before declaring success for an eradication is two years, this was extended for Campbell due to the size of the island and relative low intensity of the monitoring.

Outcome monitoring

Since the eradication of rats, the abundance of a flightless invertebrate, the weta (*Notoplectron campbellensis*), has increased dramatically (pers. obs.). In addition, Campbell Island pipits (*Anthus novaeseelandiae*) and Campbell Island snipe (*Coenocorypha aucklandica*) have recolonised Campbell from smaller rat-free islets offshore (Barker *et al*. 2005, Thompson *et al*. 2005). Grey-backed storm petrels (*Oceanites nereis*) (T Shaw pers. comm.) and white-chinned petrels (*Procellaria aequinoctialis*) (M Rutherford pers. comm.) have also both been recorded as breeding on the island for the first time.

DISCUSSION

There has been some suggestion that success of the Campbell Island project could be put down to the lucky break of "relatively" good weather. This enabled completion of the spread of baits in one month rather than the three months anticipated from previous weather records. Another view is that: Luck is when opportunity meets good planning. The Campbell Island project succeeded within the compressed time frame because of attention to detail when planning and the willingness and ability of the team, especially the pilots, to make the most of suitable weather. A conventional approach to spreading baits would have used a forecast of three nights with no precipitation and relatively calm weather. Under this regime, it is unlikely that the project would have been completed. Instead, every opportunity to spread bait was taken; any suitable weather window of two hours or more was regarded as sufficient to begin operations. This rapid response to local conditions also kept the baiting front progressing, which reduced the risk of rats reinvading areas where baits had already been consumed. Above all else, the successful aerial spread of baits reflected the skills and experience of the pilots and the precision with which they used GPS.

The Campbell Island project required a rethink of accepted aerial eradication methodology. Subsequent to the Campbell project, DOC has retained the well tested method of spreading bait at 8 kg and then 4 kg/ha. This approach avoids the potential risk of failure from reducing the baiting rate for rat populations that are likely to be at relatively high density. The Campbell eradication built on many years of knowledge developed over an extensive eradication programme around New Zealand. Other countries that have multiple islands, should look at treating their eradications as a programme to develop their techniques rather than simply tackling them one by one.

Removing rats from Campbell Island was a major achievement. It was built on many years of knowledge developed over an extensive eradication programme around New Zealand where each project was seen as an opportunity to refine techniques. As a result, the Campbell Island project demonstrated that it is possible to eradicate rats from increasingly larger and more isolated islands. Prerequisites for success were political and institutional support, adequate funding and a positive attitude. This success has not been lost on the international community. The eradication of rats from Campbell has already stimulated the eradication of rats from Rat Island over 2000km along the Aleutian chain (Bucklew *et al*. 2011). Planning is now underway for even larger islands such as Macquarie (Springer 2011), South Georgia and Gough Islands (Poncet *et al*. 2011).

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