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Rangitoto and Motutapu – A Starting Point for Future Vertebrate Pest Eradications on Inhabited Islands

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ABSTRACT: Conservation efforts in New Zealand have removed invasive mammals from more than 130 offshore and inshore islands. Of these islands, just 8 were permanently inhabited by someone other than a government employee. In contrast, many future eradication projects within New Zealand will be undertaken on islands with a resident human population. A recent project that removed 8 mammalian pests from Rangitoto and Motutapu islands (3,842 ha), two intensively visited islands with a small number of permanent inhabitants, provides a potential blueprint for developing invasive vertebrate eradication projects on inhabited islands. A number of lessons can be drawn from the Rangitoto and Motutapu project. A proactive consultation process resulted in strong support for the project, and a transparent approach to communications gained exposure for conservation issues. Efforts to engage the media and maintain transparency were beneficial in responding to public concerns about the project. The project also demonstrated that the human health and safety concerns associated with trapping, shooting, and the use of toxins could be effectively addressed.

KEY WORDS: anticoagulant, brodifacoum, human health, invasive species, New Zealand, poisoning, risk, rodenticide, rodents, safety, toxin

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INTRODUCTION

The earth faces an increasing rate of species loss as a result of biological invasions (Genovesi 2011). Caught up within this trend, islands represent those areas most acutely affected (Loehle and Eschenbach 2011) but also are locations where the greatest conservation gains can be made (Bellingham et al. 2010). Nowhere is this more evident than in New Zealand (NZ), which lost nearly half of its native vertebrate species following human colonization (Wilson 1997). More recently the tide has turned; NZ conservation efforts over the last 100 years have removed all non-native mammals from more than 130 inshore and offshore islands (<http://db.islandconservation.org/>, accessed 28 February 2012). These actions have provided measurable benefits to many threatened and endangered species and almost certainly saved a number of species from extinction (Bellingham et al. 2010).

As a consequence of its success, NZ island restoration efforts must now shift to larger islands, many of which have permanent human settlement (Ogden and Gilbert 2011). These islands often support endangered species and ecosystems (Merton et al. 2002, Brooke et al. 2007), but private land ownership and a resident human population add a further layer of complexity to eradication planning and implementation. The transition from uninhabited to inhabited islands provides an alternative explanation to the one suggested by Bellingham et al. (2010) for the recent slowdown in the rate of eradication operations being undertaken in NZ. Of the 137 NZ islands that have had invasive mammals removed (<http://db.islandconservation.org/>, accessed 28 February 2012), just 17 were permanently inhabited and if government employees are excluded, the number of permanently inhabited islands decreases to

9 (R. Griffiths, unpubl. data).

Selling the concept of invasive species eradication to the inhabitants of an island is a significant challenge (Ogden and Gilbert 2011, Varnham et al. 2011, Wilkinson and Priddle 2011). Techniques currently available for the removal of invasive vertebrates are perceived by many as unethical (Cowan and Warburton 2011) or posing an unacceptable risk to human health or the environment (Varnham et al. 2011). Unless these perceptions can be aligned with the actual risk, which may be low and acceptable to others within the same community, a project is unlikely to proceed.

The removal of 8 invasive vertebrate species from Rangitoto and Motutapu, two intensively visited islands near Auckland, NZ, was recently declared successful (<http://www.doc.govt.nz/conservation/threats-and-impacts/animal-pests/restoration-projects/rangitoto-and-motutapu-islands-restoration-project>). Although Rangitoto and Motutapu are publicly owned and administered by the Department of Conservation, most island residents are not employees of the Department, many individuals and organisations have a significant stake in the islands, and many dwellings on the islands are used privately (Griffiths 2008). Accordingly, the project confronted many of the issues that would be encountered on an island with private landowners and permanent residents. Resistance from any of the island's key stakeholders could have jeopardized project success.

The techniques used during the eradication operation included trapping, shooting, and the aerial application of rodent bait containing brodifacoum. No part of either island was excluded from aerial bait application. This paper outlines the methods used to gain and maintain the sup-

port of key stakeholders and the public. It outlines the mechanisms by which human health and safety was successfully protected, and lessons from the project that may be applicable to future projects on inhabited islands are discussed.

SITE

Rangitoto and Motutapu are the most readily accessible of the island reserves close to Auckland and are serviced by a regular ferry service. Inextricably linked by a causeway and an extensive area of sand flats exposed at low tide, the two islands are a popular recreation destination receiving upward of 120,000 visitors per year (Griffiths 2008). The majority of island visitors travel to Rangitoto and Motutapu by way of a commercial ferry but, because the islands offer a number of safe anchorages and accessible beaches for landing, the islands are also a popular boating destination. The surrounding waters are intensively used for shipping, fishing, and recreational boating (Behrens and Constantine 2008), although the intensity of the two latter activities varies seasonally.

In addition to the ferry service, a number of other commercial enterprises (concessionaires) operate to or on the islands. These include a cattle and sheep farm, an outdoor education camp that receives more than 8,000 children a year, guided tours, cellular communication facilities, kayaking, and a bee-keeping operation (Griffiths 2008). A small number of private holiday homes (baches) exist on Rangitoto. These dwellings are used seasonally and are maintained under occupational licenses granted by the government. Between 10 and 15 people live permanently on Motutapu. Just two to three are employees of the Department of Conservation, the rest being staff of the concessionaires that operate there. A remote campsite, used by more than 4,000 people a year, is located on Motutapu (Anonymous 2005).

METHODS

Consultation

A proactive approach to consultation with affected parties was undertaken from the project's inception in June 2006, and this continued until the project concluded in August 2011. Key stakeholders were defined as any party likely to have been affected (either positively or negatively) by the project but also included individuals and organizations known to have an active interest in the islands, the project, or the methods proposed. Key stakeholders included local Maori tribes (iwi), concessionaires, community organizations, non-governmental organizations, and local and national government agencies. These groups were identified early on and approached to discuss the basic outline of the project and assess its social acceptability as part of a broader feasibility assessment (Griffiths 2008). Once initial contact had been made, regular contact was maintained throughout the project by mail, phone, or in-person meetings.

Consultation for the project was led by the project manager with support from communications and cultural liaison staff from the Department of Conservation and the Auckland Regional Council. Except for meetings with some community organizations, engagements with stakeholders were conducted on a one-on-one basis. Public

meetings were avoided because of the authors' prior experience and the known pitfalls associated with this method of consultation (McComas and Scherer 1998, Varnham et al. 2011). The general public was kept informed through the media, organizational websites, and regular and occasional publications produced by both the Department of Conservation and the Auckland Regional Council.

Consultation was also required as part of the publicly notified compliance process to gain consents for the discharge of contaminants, in this case the rodenticide brodifacoum, to terrestrial and coastal marine areas. Prior to submitting consent applications, follow-up meetings with stakeholders were undertaken to resolve issues that had been raised. In all engagements with stakeholders, the long-term benefits of the project were promoted, but all aspects of the project were discussed including the biosecurity standards necessary to prevent reinvasion, the techniques proposed for use, the temporary restrictions on access required, the anticipated environmental impacts, and the human health and safety considerations.

Although no controlled pesticides were used as part of the project and permission from the public health service was not required, consultation with public health representatives was undertaken throughout the project. A number of measures to protect human health recommended by the public health service were adopted.

Communications

Because of the high-profile nature of Rangitoto and Motutapu and the scale of planned activities, it was recognized that the project would receive intense public scrutiny. This attention was recognized as increasing the consequences if something were to go wrong but was also seen as an opportunity to increase awareness of conservation issues amongst the general public. To manage the risks and benefits, a communications plan was prepared. Communication objectives included keeping the public informed of project progress, building support for both the project and the Department's work in general, and promoting the threats posed by invasive species and the benefits of their removal. The plan established roles and responsibilities for communications and provided key messaging that was regularly updated to match project developments.

Efforts were made to engage the media both before and during the implementation of the project. Newspaper and TV crews were encouraged to visit the island and cover preparations for the project and were invited to attend the first aerial application of rodent bait and subsequent project developments. Resources were produced to support project communications including fact sheets, website updates, and a documentary film.

Mechanisms Utilized to Protect Human Health

Pathways for exposure to the hazards posed by the use of toxins, traps, and firearms were considered in the development of mechanisms for protecting people from harm. To preclude direct exposure, all staff and volunteers involved in the project wore protective equipment and received task-specific briefings on risk management. Staff involved in the project were selected for their skills and experience, with only specialist staff utilized for the

project's higher risk tasks.

The rodent eradication was timed for winter, but undertaking the operation at this time of year also meant less human activity on and around the islands. Island residents were allowed to remain during the project but were included in all operational and safety briefings. The islands were closed and the public excluded during, and for the 7 days following, each of the 3 applications of rodent bait. Key stakeholders were informed and extensive efforts were made to notify the public and boat owners of the island closures, timing of bait application, and the hazards posed by the activity. Public notices, media coverage (newspaper, TV and radio), information posted on websites, and messages on marine radio were all employed to ensure a broad level of awareness. "No landing" signs were temporarily erected at all potential landing sites around the islands, and boat patrols were undertaken on a regular basis throughout the closure period.

Five days after bait application and before the islands were reopened to the public, rodent bait was cleared from the island's walkways and areas of high public use to reduce the risk of exposure. All island visitors were kept informed of the risks posed by the presence of rodent bait and the hunting and trapping programme through ticketing (ferry passengers), signage on passenger ferries, and at entry points around the islands and messaging on marine radio. These measures remained in place until monitoring of bait breakdown confirmed the absence of any further risk of exposure.

Public safety risks associated with trapping and shooting were mitigated through signage, well-thought-out and discrete placement of traps, and cautious hunting techniques. Some tracks were closed for short periods for trapping, and stoat and hedgehog traps were placed within tamper-proof housing. Hunting for rabbits was generally carried out at night when the public were not present, and the campground and education camp were avoided by hunters while it was in use.

To prevent indirect exposure to the hazards associated with the techniques employed, a number of measures were implemented. All water collection systems vulnerable to contamination from rodent bait were disconnected prior to bait application. Bores and closed wells were not considered at risk because of brodifacoum's low mobility in soil (World Health Organisation 1995), but all surface rainwater collection systems, open springs, and stock water troughs were secured. A GPS waypoint for each site was recorded, and all sites were visited again prior to bait application to ensure they had been disconnected. A checklist of sites was kept to ensure no sites were missed. Following completion of bait application, a reverse process was undertaken with each site being visited, cleaned, and reconnected. Water samples were also taken and submitted for toxicology testing to confirm that island water supplies had not been contaminated. All samples sent for assay were tested to the minimum level of detection of 0.001 ppm.

The low solubility of brodifacoum in water (World Health Organisation 1995) and evidence from studies such as Primus et al. (2005) indicated a negligible risk of brodifacoum absorption by plants. Nevertheless, as a precautionary measure, all plants were removed from vegetable gardens prior to the application of rodent bait and gardens

covered during bait application. Livestock were removed from the island and excluded until all bait in open pasture habitat had reached a 'condition score of five' (Craddock 2003), as stipulated by a Code of Practice (Anonymous 2006). The only domestic animals remaining on the islands during the rodent eradication were working dogs associated with the project or the farm. These animals were confined to kennels and exercised under close supervision until bait had broken down. Following the return of stock to the island, liver samples from the first 5 sheep and cattle sent for slaughter were submitted for toxicological testing.

Six sites across both islands, representing the range of habitats accessible to people or livestock, were used to monitor bait breakdown. Bait pellet condition was assessed as per Craddock (2003). Monitoring of toxin breakdown within bait was considered unnecessary, as previous experience had shown that if any bait exists toxin will be present.

A differential global positioning system capable of tracking helicopter movements to within 5 m was used to spread rodent bait as accurately as possible. To minimize the extent of bait drift into the marine environment as a result of wind and pilot error, a maximum wind speed of 20 kts was set for operations, and helicopter pilots were instructed to spread bait only up to mean high water spring (MHWS). This boundary was flown and checked before any bait was spread. Nevertheless, some bait drift into the marine environment was foreseen and accounted for in an environmental impact assessment and consent for this discharge was sought. Samples of shellfish, 10 mussel (*Mytilus edulis*), and 10 pipi (*Paphies australis*) samples were collected from Rangitoto and Motutapu following bait application and assayed to reassure island residents and the public that the food chain had not been contaminated.

RESULTS

Consultation

Resources equivalent to one fully dedicated person for a year were utilized for project communications and consultation over the 4-year lifetime of the project. This level of resource investment resulted in strong support for the project. Eight of the 9 different organizations representing the various iwi of the region endorsed the project, and these iwi visited the islands prior to implementation to bless the islands and acknowledge the project. One iwi, which had had a negative experience with a past pest control operation, remained opposed to the project throughout, despite extensive dialogue.

Concessionaires were considered the most affected by the project because of restrictions on access during bait application and implementation of biosecurity, but all eventually supported the project. The project impacted a number of commercial activities, but compensation was provided to just two concessionaires for the loss of revenue. Motutapu Outdoor Education Camp (MOEC) suspended operations for a 6-month period and Motutapu Farms Ltd (MFL) removed all livestock from the island for an equivalent period of time.

The Motutapu Restoration Trust (MRT) and the Rangitoto Island Historic Conservation Trust (RIHCT) were

affected by loss of access to the islands during the operation. However, both groups are invested in the long-term conservation of the island's resources and were strong advocates for the project throughout. The project affected the Rangitoto bach community through temporary loss of access to the island, the temporary disconnection of water supplies, and the necessity to place bait inside dwellings. Despite these impacts, strong support from this stakeholder group was received. To ameliorate concerns about accessing personal property, 4 representatives from the bach community, MOEC and MFL staff, and a volunteer from the MRT were invited to assist Departmental staff to place rodent bait inside dwellings during the operation. The physical involvement of stakeholders generated increased cooperation and a greater level of buy-in for the project.

Consent applications were lodged with the Auckland Regional Council and the Auckland City Council in September 2007. Both applications were publicly notified and publicized in local and national newspapers. In total 63 submissions were received (56 in support, 1 conditionally supportive, and 6 opposed). A pre hearing was conducted to clarify and respond to concerns raised by opposing submitters and a hearing was held in April 2008. Aside from the Department's submission, just 4 supporting and 2 opposing submissions were presented during the hearing. All necessary consents were granted in June 2008, and the conditions applied to these consents did not place the project's likely success at risk. An appeal to the Environment Court, lodged by a member of the public, was struck out by the court because of irregularities in its submission, and this decision was not appealed.

Communications

The resources dedicated to communication were sufficient to achieve the project's communication objectives. The benefits of invasive vertebrate eradication were promoted to a wide audience and a general awareness of the project was gained as evidenced by consultation with recreational boat owners before and after completion of the operation (pers. observ.). Engagement of the media proved challenging but did lead to interest in the project and helped realize communication objectives. Coverage of key stages of the project in the media was extensive, and footage of the first application of rodent bait and subsequent work aired on two national TV channels, allowing key messages to be disseminated.

Significant public concern arose during the project when a series of coincidental but natural events in the marine environment and the death of several dogs on adjacent mainland beaches coincided with the aerial application of rodent bait. Both necropsy and toxicological data demonstrated that the events were unrelated; the dogs died as a result of ingesting tetrodotoxin, a potent marine neurotoxin, from the grey side-gilled sea slug (*Pleurobranchaea maculata*) (McNabb et al. 2010), and the marine species as a result of natural or unknown causes (Fisher et al. 2011). This information was used to allay fears, but by the time results were available, a large amount of misinformation had begun to circulate in the media. Negating the misinformation and false assertions arising in the media was facilitated by the good relationship that had been developed with the media and the project's transparent approach to

communications. However, the event undermined much of the public goodwill that had been generated. Strong support from stakeholders was maintained throughout the period of controversy, but suspicion amongst some members of the public remained (pers. observ.).

Mechanisms Utilized to Protect Human Health

No instances of ingestion, absorption, or inhalation of rodent bait were reported during the project, and no incidents were noted by island residents or Departmental staff who were exposed to the greatest risk. The level of risk reduction gained through the closure of the islands, the subsequent removal of bait from public areas, and resources invested in public notification and signage is unknown, but these measures are presumed to have reduced what is considered to have been a low likelihood of exposure. No issues were reported by those members of the public who chose to ignore the closed status of the islands. Public health representatives visited the island at the conclusion of the rodent eradication and assessed data from toxicological assays before providing a statement that no further risk to human health existed.

Although interference with traps was encountered on an occasional basis throughout the project, no injuries were reported or complaints received from the public or island residents over the course of the operation. The only injuries were sustained by project staff who incurred some scrapes and bruises in the course of the trapping and hunting operation.

Measures employed to protect drinking water successfully excluded rodent bait from water sources, and tests carried out on domestic and stock water supplies found no traces of brodifacoum (Fisher et al. 2011). The first livestock to be returned to the island were shipped to Motutapu 75 days following the last application of bait, well after bait had fully degraded from pasture habitat, and no traces of brodifacoum were detected in liver samples from the first 5 sheep and cattle sent for slaughter. Bait degraded quickly on Motutapu, disappearing completely from all sites within 2 months after its application. However, on the bare lava of Rangitoto, bait persisted, albeit in a much degraded form, for up to 10 months.

Although satellite navigation (DGPS) was used to spread bait as accurately as possible and wind speeds during the operation were less than the limits set, some bait did enter the marine environment. Based on GPS data collected during the operation, it is estimated that up to 1% of helicopter flight paths extended beyond MHWS corresponding to a maximum of 1,470 kg of cereal bait (29 g of brodifacoum) that could have entered the sea. Bait that entered the sea was patchily spread along the 56 km of coastline around the islands, with the areas most affected being convoluted sections of coastline.

Testing of shellfish following the application of rodent bait found no traces of brodifacoum (Fisher et al. 2011). Toxicological assays of dead pilchards and dolphins, undertaken in response to public concerns, were also negative (Fisher et al. 2011). Low level residues of brodifacoum were detected in 3 of 9 penguins found washed up on beaches around the Hauraki Gulf, but necropsy and toxicological data indicated that this was not the cause of death (Fisher et al. 2011).

DISCUSSION

Consultation with island stakeholders was successful in gaining support for the removal of invasive mammals from Rangitoto and Motutapu and in doing so created the conditions necessary for the project to succeed. Similar to conclusions reached by Morrison et al. (2011), undertaking consultation early on during the project's lifecycle, an open and direct communication strategy, and taking the time to meet with project stakeholders on an individual basis were all credited as key factors facilitating project success. Involvement of stakeholders in certain aspects of the eradication operation created further goodwill and cooperation. The independent assessment provided by the public health service offered additional reassurance to stakeholders, something particularly important for MOEC prior to reopening its facilities to school groups.

The feedback received during the publicly notified compliance process indicated that the project was generally acceptable to the public, and follow-up consultation generally succeeded at changing the perspectives of individuals who expressed reservations about the project. However, some parties remained unconvinced that the project's benefits outweighed the risks. Despite extensive dialogue, several members of the public, an NGO, and one iwi remained opposed to the use of toxins, without which the project could not have been completed. These opposing views were based on perceived and not actual risks to both people and the environment. With reference to future projects, we consider it doubtful that these parties would have supported the use of a more species specific toxin or a genetic technique to achieve the same outcome. In this respect, the project was fortunate; if these dissenting voices had been landowners, then it is likely that the project would have failed or delayed, and further avenues would have had to be explored. One option planned but not utilized was to provide the opportunity to witness a pest management operation or visit an island where the same techniques have been used previously. These methods have been used with success elsewhere (Ogden and Gilbert 2009).

Rather than eschew the media, as has been the case for many other pest management operations undertaken in NZ, the opportunity afforded by the Rangitoto and Motutapu project was utilized to engage the public. The significant effort that this entailed is considered to have paid off. Project communications successfully raised awareness about the project and promoted the benefits of conservation to a wide audience. Responding to public concerns generated by the coincidental but unrelated mortality of dogs and marine species was also simplified by the transparency the project had maintained.

Nevertheless, the level of public concern generated, the amount of misinformation circulated, and the fact that many members of the public were not reassured by the fact that the techniques have been widely used within NZ without negative impacts on the marine environment, highlights the need for more public education. Even in NZ, with its small population of less than 4.5 million people and relatively high level of awareness of conservation issues (Craig et al. 2000), there is a general lack of understanding of vertebrate pesticides, how they are used, and the risks they pose. To generate greater awareness, we strongly recommend that future pest control or eradication

projects adopt a similarly open approach to communications. Large pest management operations generate significant media attention, and exploiting this interest for the purposes of education should be seen as a priority.

Most importantly, the provisions put in place for the Rangitoto and Motutapu project to protect the health and safety of the public, staff, and island residents successfully prevented direct and indirect exposure to the risks posed by toxins, traps, and hunting. Other vertebrate pest eradications undertaken on permanently inhabited islands such as Kapiti (Empson and Miskelly 1999) and Urupukapuka (A. Walker, pers. comm.) also achieved this result. In this regard, these projects demonstrated that current techniques for vertebrate pest eradication including the aerial application of rodent bait, if used in accordance with current NZ best practice, can be used in areas where people are resident and in areas frequented by the public with minimal risks to water supplies, the human food chain, and ultimately human health.

Engaging communities and preserving their well-being will be the key challenge for future vertebrate pest management projects undertaken on inhabited islands. The Rangitoto and Motutapu project, along with other work completed in NZ, suggests that this is possible.

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