Rodent eradication on Lord Howe Island: challenges posed by people, livestock, and threatened endemics

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Abstract Like many oceanic islands, World Heritage listed Lord Howe Island (LHI), 760 km north-east of Sydney (Australia), has populations of invasive rodents. The house mouse (*Mus musculus*) probably arrived around 1860, and the ship rat (*Rattus rattus*) in 1918. Both species have significantly reduced the island's biodiversity. Rats are implicated in the extinction of at least 20 species (or subspecies) of birds, invertebrates and plants. Exotic rodents remain a threat to many endemic species, so much so that predation by ship rats on LHI is listed as a Key Threatening Process under New South Wales and Australian environmental legislation. A feasibility study in 2001 concluded that eradication of rats and mice was technically feasible. A cost-benefit study in 2003 demonstrated that costs of the eradication would be quickly offset by discontinuation of the current rat control programme and increased yields of commercial palm seed. A plan to eradicate exotic rodents on LHI was prepared in 2009. Technical challenges include: the presence of numerous threatened endemic species, several of which could be placed at risk during the eradication; a permanent human population of approximately 350, their pets and livestock; and a well-developed tourist industry. Several species of threatened fauna will be housed in captivity for the duration of the operation to mitigate the risk of primary and secondary poisoning. The presence of a large human settlement requires customary eradication strategies to be modified. Within uninhabited areas, bait will be aerially broadcast, whereas within the settlement, bait will be hand broadcast or placed in bait stations. Livestock will either be eliminated from the island before the eradication or aggregated into small enclosures. Community support is vital to the success of the operation, and extensive consultation is a major component of the eradication programme.

Keywords: Brodifacoum; eradication; house mouse; human inhabitants; island; mitigation; *Mus musculus*; *Rattus rattus*; ship rat; threatened endemic species.

INTRODUCTION

The Lord Howe Island Group (LHIG) is 760 km north east of Sydney, Australia. The group comprises Lord Howe Island (LHI; 1455 ha), Roach Island (15 ha), Mutton Bird Island (4.5 ha) and Blackburn Island (3 ha) plus smaller rocks and islets (Fig. 1). The first permanent settlement began on LHI in 1833. The resident population is now around 350 in approximately 150 households restricted to the central lowlands, which comprise about 15% of the island. Islanders hold perpetual leases on blocks of up to 2 ha for residential purposes, and short-term leases on larger tracts for agricultural and pastoral activities. Today, there are approximately 1000 buildings or structures on the island.

The outstanding natural beauty of the LHIG, together with its highly diverse and substantially unique flora and fauna assemblages, were recognised by its inscription as a natural World Heritage site in 1982 (DECC 2007). Tourism is one of two major sources of income, with about 16,000 visitors each year. Visitor numbers are regulated to a maximum of 400 on the island at any one time. Export of kentia palm (*Howea forsteriana*) seedlings is the other major source of income for islanders. The LHI Board (LHIB) operates a nursery that exports 2–3 million palm seedlings annually. The seed is harvested from plantations and from natural palm forests.

The first rodents to reach LHI were house mice (*Mus musculus*) in about 1860. Ship rats (*Rattus rattus*) arrived in 1918. Within two years, the rats were so widespread the Island Board of Control (a forerunner of the current LHI Board) instigated a bounty system as a means of control (Hindwood 1940). The environmental effects of the rats were immediately evident to A.R. McCulloch, who wrote that *'one can scarcely imagine a greater calamity in the bird world than this tragedy which has overtaken the avifauna of Lord Howe Island'* (McCulloch 1921).

Rats are implicated in the extinction of five species of endemic birds (Hindwood 1940), two species of plants and at least 13 species of invertebrates (Ponder 1997; LHIB

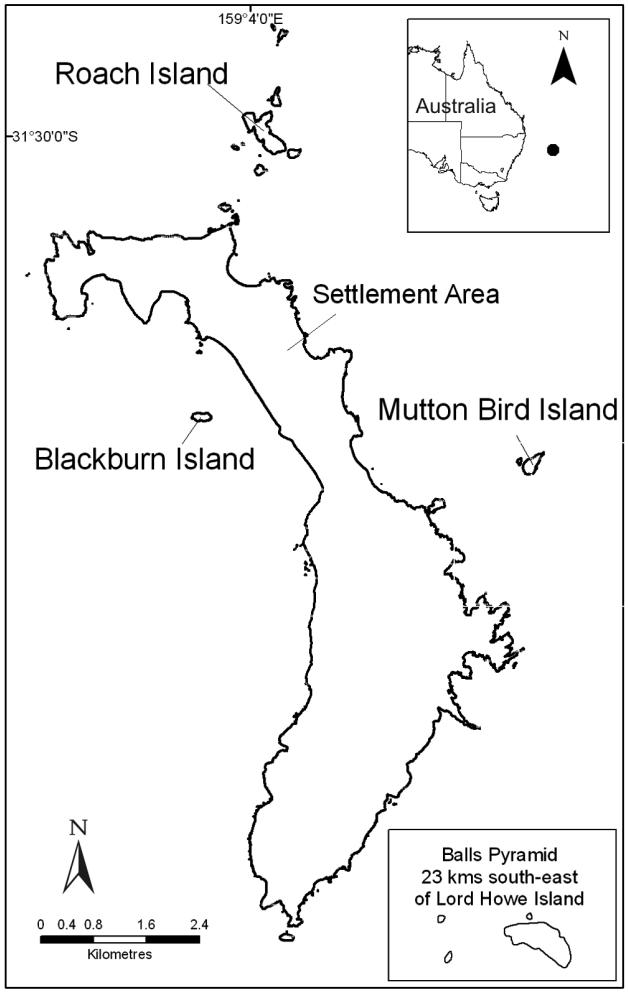

Fig. 1 Lord Howe Island Group.

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2009; C. Reid pers. comm.). Predation by rats suppresses animal populations and severely reduces recruitment of many species of plants (Moore 1966; Pickard 1982; Auld *et al.* 2010). The LHI phasmid or stick-insect (*Dryococelus australis*) disappeared from the main island; the only surviving population is on rat-free Balls Pyramid (Priddel *et al.* 2003). Likewise, the LHI wood-feeding cockroach (*Panesthia lata*), white-bellied storm-petrel (*Fregetta grallaria*) and Kermadec petrel (*Pterodroma neglecta*) are now restricted to rat-free outer islets (NSW SC 2004; DECC 2007).

The effects of house mice on the LHIG may not be as great or as well understood as those of ship rats, but are likely to be similar to those demonstrated on other islands (e.g., Newman 1994; Jones *et al.* 2003). These impacts can include direct predation on seabirds (Cuthbert and Hilton 2004), reptiles and their eggs (Towns and Broome 2003), invertebrates (Marris 2000) and seeds (Smith *et al.* 2002).

The two species of exotic rodents on LHI currently threaten at least 13 species of birds, two species of reptiles, 51 species of plants, plus 12 vegetation communities, and numerous species of threatened invertebrates (DECC 2007). Predation by ship rats on LHI is listed as a Key Threatening Process under both state and national environmental legislation. A threat abatement plan produced by the Australian Government identifies the eradication of exotic rodents from LHI as a high priority action (DEWHA 2009).

Exotic rodents also affect the social and economic wellbeing of the LHI community. The rodents host viruses, bacteria, internal parasites (such as intestinal worms) and external parasites (such as fleas, mites and lice), many of which can spread disease to humans (Henderson 2009). The island's residents continuously attempt to keep rodents out of dwellings, often through the use of poisons that pose a risk to small children and family pets requiring a level of vigilance that would be unnecessary if rodents were eradicated.

Rat predation on kentia palm seed severely reduces seed production (Pickard 1983; Billing 1999) and represents an economic loss to the island (Harden and Leary 1992). The impacts of rodents on biodiversity also have the potential to affect the island's tourism industry.

Given these effects, the LHIB embarked on eradication planning in 2006. If undertaken, LHI would be the largest, permanently inhabited island on which the eradication of ship rats and house mice has been attempted. The proposal is challenged by: 1) the complexities of targeting two pest species; 2) the existence of threatened endemic species that are susceptible to the poison; and 3) the presence of a large resident human population, a well-developed tourist industry, domestic animals and livestock.

Our paper details how the presence of threatened endemic species and human inhabitants has constrained planning and implementation of the eradication on LHI.

CONTROL OR ERADICATION?

There have been attempts to control rodents on LHI since about 1920 (Hindwood 1940). Current control is principally directed at: 1) protection of kentia palm seed over approximately 10% of the island, utilising about 1000 bait stations at 33 sites replenished five times annually with warfarin or coumatetralyl baits; 2) minimising impacts at the island's commercial palm nursery, using brodifacoum baits; and 3) reducing rodent activity in and around residences, using either warfarin or brodifacoum baits. This control effort currently costs the LHI Board around A$65,000 per annum. There have been few attempts to quantify the effectiveness of the programme, and there have been no assessments of whether there are benefits to biodiversity. Significantly, there is no control of mice beyond the settlement because this species has become resistant to warfarin (Billing 2000).

The increasing frequency and success of island eradication programmes (Towns and Broome 2003; Howald *et al.* 2007) and the increasing costs and limited success of control on LHI, led the LHIB to examine the feasibility of eradicating ship rats and house mice from the LHIG. Eradication was viewed as feasible, but the study recommended careful management of potential risks (see Saunders and Brown 2001).

In 2003, the LHIB reviewed the risks and constraints around eradicating ship rats and house mice, and to assess the various costs and benefits involved (see Parkes *et al.* 2003). This report demonstrated the financial benefits if rodents were eradicated particularly through increasing production of kentia palm seed. There were also acknowledged, but monetarily unquantified, biodiversity benefits. An eradication would thus provide overall benefits greater than can be achieved through current control programme.

A draft plan for the eradication of rodents on LHI was then developed in consultation with expert planners and practitioners from around the globe together with the LHI community (LHIB 2009). The plan recognises that: 1) eradication rather than ongoing control is the most effective long term option; 2) the impacts of rodents on the LHI environment are significant and ongoing; and 3) eradication is feasible using current techniques without unacceptable risk to non-target species and human residents.

The operation will utilise the cereal-based bait Pestoff® Rodent Bait 20R (Animal Control Products, Wanganui, New Zealand) containing brodifacoum at the concentration of 20 ppm. The primary method of bait application will be through two aerial broadcasts 10–14 days apart, with hand broadcasting or bait stations used in areas not suitable for aerial application, such as in the settlement area or where livestock are present.

MITIGATING POTENTIAL IMPACTS ON THREATENED SPECIES

Brodifacoum has been used effectively to eradicate rodents > 200 times (Howald *et al*. 2007). However, the toxin can affect some non-target species (Eason and Spurr 1995). If not mitigated, potential impacts may range from the loss of a few individuals to, on rare occasions, the loss of an entire population. Previous eradications have been accompanied by mitigation associated with the level of risk posed and the potential for population recovery (Empson and Miskelly 1999; Merton *et al.* 2002; Howald *et al.* 2005). In the latter case, any mortality associated with baiting can be far outweighed by increased survival in the absence of predation and competition from rodents. As a result, many species increase to numbers far greater than before the eradication (Empson and Miskelly 1999). On LHI, evaluation of the potential risk to non-target species, particularly to endemic species, has been a prime consideration.

Birds

Risks posed by brodifacoum to avifauna were assessed through literature reviews and non-toxic bait trials on LHI in 2007. Four endemic species of land birds survive on LHI: Lord Howe (LH) woodhen (*Gallirallus sylvestris*),

LHI pied currawong (*Strepera graculina crissalis*), LHI golden whistler (*Pachycephala pectoralis contempta*) and LHI silvereye (*Zosterops lateralis tephropleurus*). The woodhen and currawong populations, which are regularly monitored, each number about 220 individuals (DECC 2007). The whistlers and silvereyes have not been surveyed, but their populations are estimated to be between 100 and 1000 pairs (DECC 2007). Without appropriate mitigation, woodhens and currawongs would be placed at risk by a baiting programme targeting rodents. These two species are both listed as vulnerable under the Australian Government's *Environment Protection* and *Biodiversity Conservation Act 1999*, and endangered and vulnerable respectively under the New South Wales *Threatened Species Conservation Act 1995*.

The woodhen is congeneric with the New Zealand weka (*G. australis*). Eradications using brodifacoum have devastated populations of weka (Brown 1997a), so woodhen are likely to be similarly affected. Blue-coloured faeces from woodhen caught during annual surveys indicate that they already consume dyed rodenticide blocks used by residents (Harden 2001). In 2007, a non-toxic bait trial conducted on LHI confirmed their attractiveness to woodhen, thus demonstrating a high probability of brodifacoum toxicosis during an eradication operation. The endemic LHI pied currawong consumes rodents, and is therefore potentially susceptible to secondary poisoning. To minimise any potential impact, at least 85% of the woodhen population, and 50% of the pied currawong population will be placed into captivity for the duration of risk. The woodhen is iconic and any avoidable loss of individuals through poisoning is unacceptable to the LHI community. A greater number of individuals will be placed into captivity than would be required based on population genetics alone.

The LHI golden whistler is at low risk given their predominantly insectivorous diet. Trials conducted in 2007 found no evidence that this species consumed baits, and secondary poisoning of a significant proportion of the population appears unlikely. The chances of secondary poisoning are further reduced by the operation being carried out in winter when invertebrate activity is low (Craddock 2003). Nonetheless, as a precaution, approximately 20 golden whistlers will be held in captivity during the eradication.

The LHI silvereye is also at low risk given their diet mainly of insects and fruit. Trials in 2007 found no evidence that this species consumed baits. Notwithstanding, like silvereyes in some New Zealand operations (Brown 1997b) a few individuals may succumb to the effects of brodifacoum. Any losses are likely to be quickly offset by increased population sizes following the release of food resources from suppression by rodents. As with whistlers, approximately 20 birds will be held in captivity during the eradication as a precaution.

The emerald ground dove (*Chalcophaps indica*) although not endemic, is less wary than the same species on the mainland, and so is considered unique. The species did not consume bait in the trial, but as a precaution, approximately 20 birds will be held in captivity during the eradication.

Based on findings from previous eradications, other native birds on LHI likely to be at risk from aerial distribution of brodifacoum baits include buff-banded rail (*Gallirallus philippensis*) and purple swamphen (*Porphyrio porphyrio*). Neither species is endemic and in the remote event that they are extirpated each is likely to recolonise. Consequently, no action will be taken to mitigate the potential effects of baiting on these species.

Birds will be held in captivity from at least one month before baiting, and until risks of primary or secondary poisoning are no longer present. The release protocol for woodhen will follow that used for weka during the Kapiti Island eradication (C. Miskelly pers. comm.). When baits have completely disintegrated (condition 6; Craddock 2004), 20 woodhen fitted with radio transmitters will be released at their site of capture and monitored for one month. If there are no problems with these birds, the remaining woodhen will be released. Helicopter support will enable rapid transfer of captured birds from the field to the captive facility, as well as their return to the wild at the completion of captivity.

Captive management will require the construction of an enclosure for woodhen and aviaries for the other species. To ensure these facilities do not provide a refuge for rodents, they will be precision built to eliminate gaps larger than 6 mm (the size required to exclude mice), and the areas surrounding the aviaries will be baited using a combination of hand broadcasting and bait stations. A trial replicating the timing and duration of the eradication will be conducted well in advance of the eradication to test the captive facilities and evaluate the methods proposed. At the completion of the trial, some woodhen will be transported to zoos on the Australian mainland. This mainland population will provide an insurance population that can be returned to LHI in the unlikely event of an unforeseen catastrophe. Woodhen have already been held in captivity both on the island and on the mainland (Miller and Mullette 1985; Lourie-Fraser 1985) and a comprehensive husbandry manual can be prepared from these experiences as well as those with weka in New Zealand. Captive management will be conducted and overseen by experienced aviculturists and veterinarians.

Reptiles and mammals

Two species of native reptiles are present on the island: LHI skink (*Oligosoma lichenigera*) and LHI gecko (*Christinus guentheri*). Both species also inhabit offshore islets around LHI and Norfolk Island, 900 km to the northeast of the LHIG. The insectivorous diet of these species (DECC 2007) exposes them to the risk of ingesting brodifacoum if they feed on invertebrates carrying brodifacoum from baits. However, the risk of secondary poisoning is low. Firstly, coagulation chemistry of reptilian blood is different to that found in mammals, and as such, the risk posed to reptiles from baiting programmes using brodifacoum is low (Merton 1987; Hoare and Hare 2006). Second, baiting will take place in winter when reptiles are less active (Craddock 2003). Third, there are no published reports of widespread deaths in reptile species following rodent eradications. In many instances the removal of rodents has resulted in substantial increases in the abundance of reptiles (Towns 1991). For example, the number of skinks on Korapuki Island increased 30-fold within five years of rats being removed (Towns 1994). Consequently, mitigation measures are not planned for reptiles on LHI.

The only extant native mammal on LHI is the large forest bat (*Vespadelus darlingtoni*) (DECC 2007), a species that is common throughout much of southern Australia (Hoye *et al.* 2008). It is insectivorous, and is therefore considered to be at low risk of poisoning.

Invertebrates

The LHIG is characterised by numerous endemic species of terrestrial invertebrates, and predation by rodents is regarded as a significant threat to many (DECC 2007). Arthropods and annelids are apparently unaffected by brodifacoum unless it is used in concentrations many orders of magnitude greater than that used in rodent eradication operations (Booth *et al.* 2001, 2003; Craddock 2003; Bowie and Ross 2006), and are not considered at risk in the LHI operation.

Although studies of molluscs indicate that they are generally unaffected by brodifacoum (Booth *et al.* 2003; Bowie and Ross 2006), one non-peer-reviewed study conducted in Mauritius reported mortality in two snail species after consuming brodifacoum baits (Gerlach and Florens 2000). Consequently, risks associated with the proposed operation were evaluated for the endemic Lord Howe flax snail (*Placostylus bivaricosus*). Results of trials indicated that *Placostylus* did not feed on bait when natural food was available. When deprived of natural food the snails consumed brodifacoum baits, but no snails died. Despite the negligible risk, *Placostylus* will be collected from locations across LHI and housed in captivity for the duration of the baiting programme. Husbandry guidelines for the care of *Placostylus* in captivity have already been established (Brescia *et al.* 2008).

In addition to *Placostylus*, four additional species of endemic land snails on LHI are critically endangered: Masters' charopid land snail (*Mystivagor mastersi*), Mount Lidgbird charopid land snail (*Pseudocharopa lidgbirdi*), Whitelegge's land snail (*Pseudocharopa whiteleggei*) and *Gudeoconcha sophiae magnifica*. Each species is so threatened by rat predation (DEWHA 2010) if rats are not removed they are likely to become extinct. The extreme rarity of these species precludes any testing of their susceptibility to brodifacoum. However, the threats to these species from not removing rodents are likely to exceed the potential risk associated with an eradication, so none of these species will be held in captivity during the operation.

EFFECTS OF HUMAN HABITATION ON ERADICATION DESIGN

A human population and their associated pets and livestock raise issues rarely encountered on other large islands where eradications have been undertaken (Towns and Broome 2003; Broome 2009). However, modifications made to ensure the safety of the community need not jeopardise the success of the operation.

Addressing livestock issues

Numbers of livestock on LHI fluctuate. Currently there are around 100 beef cattle and a herd of 14 cows provides milk for local consumption. There are also approximately 3 horses, 12 goats and 300 chickens on the island. Pigs are prohibited.

Livestock and poultry can present risks to the success of the eradication through: 1) potential human health issues associated with the consumption of contaminated beef, milk, and poultry (Fisher and Fairweather 2010); 2) stock feed, which provides an ideal harbour and food source for rodents, who may then not consume toxic bait; and 3) poultry sheds as food and shelter from which rodents may not leave. Consequently, the aim is to de-stock the island as much as possible before bait is distributed.

Livestock on LHI use approximately 75 hectares of pasture outside the settlement within which rodents must have access to bait. Australian food safety standards require that no brodifacoum is detectable in food. Consequently planning for the LHI eradication intends to eliminate the risk of brodifacoum entering the food chain.

Beef cattle on LHI will be de-stocked through slaughter during the two years leading up to the eradication. Owners will be either compensated financially or given replacement stock brought to the island when the breakdown of bait is complete. Most owners of stock have indicated their willingness to co-operate in this process.

The dairy herd will remain on the island throughout the operation, with animals confined to a small paddock connected to the existing milking shed by a narrow race. Confinement will extend until baits disintegrate. No aerial baiting using a spreader bucket will be conducted within 30 m of the holding paddocks. Instead, either aerial baiting using a trickle bucket (with a swathe width of a few metres only) or hand broadcasting will be used to distribute bait within this buffer zone. Baiting within the holding paddock will use cattle-proof bait stations. Similar arrangements will be made for goats and horses confined during the period of risk. All confined livestock will be fed with fresh cut grass from unused paddocks, alleviating the need to store food that may otherwise provide alternative food for rodents.

Brodifacoum is unlikely to contaminate milk (O'Connor *et al*. 2001). However, milk testing will be conducted after each bait drop and continue if any samples register positive for brodifacoum. Owners will be compensated for any lost milk production.

All poultry will be eliminated from the island at least one month before the eradication. Disease-free day-old chicks will be brought to the island to replace those birds removed. Although it would be more convenient to import adult chickens, quarantine measures within the LHI Act prohibits this. Poultry owners will be compensated for lost egg production.

Managing impacts on domestic dogs

There are approximately 48 domestic dogs on LHI. Cats are prohibited. Dogs are potentially vulnerable to primary and secondary poisoning. Owners will need to be vigilant to prevent animals from eating baits or consuming dead or dying rodents. To assess the risk to each dog, owners will be provided with a sample of non-toxic bait well in advance of the eradication. Any dogs that have a propensity to eat baits will need to be protected or restrained. Given the current widespread use of anticoagulant poison in the settlement area, most dog owners should be familiar with the threats posed. Nevertheless, an education programme will be implemented to advise residents of the potential risks to pet dogs and how to avoid them. The option of removing dogs from the island and housing them in boarding kennels on the mainland for the duration of risk will be available to concerned residents, at no cost. Any cases of poisoning will be treated by a course of vitamin K injections administered by the veterinarian employed for the operation.

Modifying baiting strategies to minimise risk to the community

The proposed operation on LHI will utilise a combination of aerial, hand broadcast and bait station/tray techniques in order to deal with issues associated with human habitation, public concern about aerial bating in a residential area, and to protect potable water storages. No aerial baiting will be conducted within the settlement area.

To facilitate appropriate distribution of baits around residences, the LHIB will negotiate a 'property action plan'

with each leaseholder. These plans will be agreements with the LHIB about effective and safe actions on each property. These plans will detail: 1) how and where the bait will be distributed on each property (including residences, outbuildings and gardens); 2) methods to control rodents in the lead up to the eradication; 3) management of pets; 4) procedures to ensure the health and safety of all family members; and 5) procedures to dispose of compost and food waste before and during the eradication.

During the baiting period, island residents will be asked to help monitor rodent activity. Tasks include checking for evidence of bait take from bait trays and bait stations, cleaning up all rodent droppings so that any fresh droppings will be easily detected, regularly checking for signs of rodent activity, and reporting any such findings to the project team.

Managing human health issues

Brodifacoum can be harmful to humans (Fisher and Fairweather 2010) through four pathways: 1) direct ingestion of baits; 2) ingestion of contaminated food; 3) inhalation of brodifacoum-laden dust; and 4) absorption of brodifacoum through the skin. On LHI, the only pathway that poses a significant health risk is the direct ingestion of brodifacoum baits by small children. However, the low application rate (nominally 2 g of bait per m^2), the inconspicuousness of the green pellets, and the relatively large amount of bait needed to pose a serious health risk given the low concentration of brodifacoum, combine to make accidental poisoning unlikely. Furthermore, the slow-acting nature of the poison and the availability of an effective antidote, mean that baiting poses negligible risk to the community. Notwithstanding, a comprehensive human health risk assessment is currently being conducted, and will be made available to all residents.

Brodifacoum baits are already widely used within the settlement, and large quantities of warfarin bait are used at bait stations. Many of these stations are readily accessible, and currently pose an unmitigated risk to humans, particularly children. As such, residents are already familiar with the risks of consuming and handling rodenticides, and there would be little additional risk posed by the proposed eradication operation. Nonetheless, detailed information outlining the hazards associated with brodifacoum will be provided to residents before the operation. Children at the island's school will be informed about the operation and how they should behave around the toxic bait. Residents will be informed of the date of baiting well in advance, and will be issued with reminders closer to the time. Residents will also be kept informed of progress and will be notified when baits have disintegrated and there is no further risk of poisoning. A successful eradication will end the current use of rodenticides, thereby removing the risks to human health posed by the presence of rodenticides and rodents.

In the extremely unlikely event that anybody ingests bait, medical advice and aid will be provided on the island. There is a hospital on LHI and diagnostic and treatment procedures, including the provision of the antidote, vitamin K, will be discussed with the island medical doctor as part of the operational planning process.

Potential threats to tourism

Global evidence demonstrates that invasive rodents have negative impacts on native fauna and flora (Towns *et al*. 2006; DECC 2007). Such effects can diminish the natural experience offered to visitors. In some locations, the impact of invasive rodents on tourism has provided the impetus for rodent eradication. For example, in the Seychelles Islands, which are a global biodiversity hotspot, the importance of rat eradication to tourism is well recognised, and resort owners acknowledge that 'exclusive five-star tourism and rats don't mix' (Nevill 2004).

Since tourism is the primary revenue earner on LHI, and the island's unique biodiversity underpins its World Heritage status, one might expect that improving experiences with biodiversity would be extremely important to the community. Surprisingly, some tourism operators view rodents as having little or no impact on biodiversity. Furthermore, there is some concern that publicly announcing the intent to eradicate rodents will irrevocably damage business opportunities. This view contrasts with experiences in the Seychelles, where tour operators embraced eradications as a means of enhancing their tourism experience (Nevill 2004). Further engagement with the tourism industry is needed to explore potential opportunities and ensure that there is no downturn in tourism arising from the eradication operation on LHI.

Transport to and from the Island and its implications for biosecurity

Natural reinvasion of LHI by rodents is impossible due to the island's approximately 500 km distance from the Australian mainland. However, the island is serviced by fortnightly cargo ships from the mainland, as well as daily commercial freight and passenger flights. There are also irregular visits from yachts and private or military aircraft. Commercial schedules, combined with a requirement of visiting boats and aircraft to notify the local authorities of their proposed arrival, ensures that the timing and potential source of invasive species arriving on the island are known.

A biosecurity strategy (Landos 2003) currently operates on LHI. Additional measures needed to ensure that rodents are not reintroduced once they have been eradicated include: 1) improved checks of cargo before departure from the mainland; 2) in-transit checks of sea freight; 3) pre-landing inspections of the cargo vessel and private yachts; and 4) arrival inspections of all aircraft and passengers using trained detector dogs. These measures are to be introduced before the eradication begins, but should also help prevent other unwelcome flora and fauna from reaching the island. The introduction of exotic pests has been identified as an ongoing threat to the biodiversity of the LHIG and prevention is a high priority (DECC 2007).

Some community members are concerned that increased biosecurity measures would impose additional inconvenience on visitors and residents, and increase the already high cost of living. On the other hand, the social and environmental costs of invasive species can be immense, as is the cost of controlling or eradicating them. Community education will further emphasise the importance of enhanced biosecurity to protect the environment, and links with LHI's World Heritage status and tourism industry.

Socio-political issues and eradication planning

Support for a rodent eradication from residents of an inhabited island is most likely if the threats posed by rodents are understood, the eradication seems possible, and the benefits that will accrue are appreciated. Support is likely to be strongest if the eradication will demonstrably provide benefits to the island's biodiversity and its inhabitants.

Several community meetings and focus groups have been held on LHI to inform the community about the need for an eradication, how it would be undertaken and when it was likely. The meetings outlined environmental benefits of rodent eradication, along with the potential flow-on effects

for tourism. We explained that planning for the operation utilised best-practice procedures and drew on a wealth of previous experience gained in successfully eradicating rodents from islands. We identified the potential risks to the community and to the environment, and outlined the contingencies built into the planning process to ensure that these risks were mitigated. We also explained the ongoing risks to children, non-target species, livestock and pets associated with the continued use of rodenticides should the proposed eradication not be undertaken.

A survey on LHI in mid 2009 , approximately 15 months after the commencement of consultation, indicated that a minority of residents believed exotic rodents to be either a benign addition to LHI, or in some kind of "equilibrium" with other species. However, most people (96% of 126 respondents) agreed with the need to eradicate rodents from the island, although understandably some questioned its feasibility. Most residents were generally supportive of the methods proposed, although many expressed concerns, particularly in relation to public safety. The fact that LHI will be the largest permanently inhabited island on which a rodent eradication has been undertaken has led some to believe that the operation is an experiment in which they are "guinea pigs".

The issue of incidental non-target mortality highlighted differences between the values of resource managers and those held by some members of the community. Planning includes mitigation measures for those species where a population level risk is likely and the species is of conservation concern. In the case of susceptible introduced species, such as blackbirds (*Turdus merula*), no mitigation is planned. Some residents view the death of any birds by baiting as unacceptable, making no distinction between endemic, native, and introduced species, nor acknowledging the current predation of LHI birds by rats and mice. Conflicting value judgements by resource managers and local communities are not uncommon (Parkes *et al.* 2002; Howald *et al.* 2005).

A few respondents to the 2009 survey suggested that the current control programme should be either continued or expanded, apparently failing to appreciate the difference between control and eradication. This is not surprising given that natural resource managers sometimes also fail to comprehend the difference (Thomas and Taylor 2002). Notwithstanding, because rodent eradication is achievable on islands, it seems illogical to elect for ongoing control that has little biodiversity benefit, which would perpetually place toxins in the environment, and to which rodents are developing immunity.

Many concerns raised by the community can be addressed through appropriate information. Fact sheets dealing with different aspects of the eradication have now been produced and distributed. Topics include: 1) impacts of rodents on islands; 2) the benefits of rodent removal; 3) the impacts of baiting on non-target species; 4) the choice of poison; 5) the methods of bait dispersal; 6) human health risks; and 7) risks to the marine environment. Some concerns from the community have required amendments to the original eradication plan. The challenge is to incorporate such modifications without jeopardising the success of the operation.

Freely available, detailed, and summarised information should in theory allay most concerns within the community. Unfortunately, incorrect information distributed by a few vocal detractors has created confusion and engendered some unjustified fear in the community. The detractors even alleged corrupt activities, which after investigation by Australian authorities were dismissed as baseless. The incident does highlight the extent to which some residents will attempt to discredit the planned operation.

In summary, there is ample evidence that the eradication of exotic rodents on LHI is achievable and potential threats to non-target endemic species can be overcome. The biggest remaining challenge involves reversing misconceptions and fully engaging the local community. If this can be achieved, the removal of exotic rodents from this World Heritage site will be arguably one of the most significant management actions undertaken for threatened species conservation in Australia.

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