How might the new Maungatautari mouse management regime affect the restoration project's vision and goals?

The value of the sub-enclosures (fenced and pest-eradicated in 2004)

- Initially installed to:
  - Demonstrate the practicality and effectiveness of the Xcluder fence.
  - Trial the pest eradication techniques.
  - Serve as a promotional/marketing/fundraising tool, for the planned whole-mountain project.
  - Reintroduce kiwi, takahe and tuatara asap, as iconic/charismatic species that could be contained in the enclosures – to help serve the above purpose.
- Post-2006 use (i.e. after the inclusion of the main mountain into the programme):
  - Can serve as the main visitor focus areas, where:
    - Any pests that come in with visitors can potentially be contained within the enclosure (by adding an internal hood), thereby preventing invasion onto the main mountain.
    - Wildlife experiences for visitors can be enhanced with e.g. feeding stations, and advocacy and interpretation programmes – while the main mountain remains 'wild'.
    - Visitor management and safety; they can't wander off-track far without encountering the fence, which will lead them back.
  - Can serve as secure sites if any pest species reinvades the main mountain.
  - Management of pests can be more intensive than is possible on the main mountain, e.g. mouse eradication.
  - Possibilities for reintroductions and survival of some missing (and even some still-existing but as-yet-undiscovered) native species, which might not do well on the main mountain with uncontrolled mice.
  - Research opportunities, with different ecological and management scenarios in the enclosures and on the main mountain.

Rodent history on Maungatautari

Rodent arrivals in NZ:

- Kiore arrived about 700-800 years ago.
- Norway rats arrived in the latter half of the 18th century.
- Mice arrived in the early 19th century.
- Ship rats arrived in the latter half of the 19th century.

Rodent 'suites' through time:

- Maungatautari had **nearly half a millennium** of **kiore-only** impact on the composition of plant species in the forest – and that is enough time to change a forest. Moa were of course the primary shapers of the forest structure and species composition, and they totally disappeared quite early on in this initial human plus kiore-impact period. So the primary agents of change during that period would have been the addition of kiore and the loss of moa (and many other species were lost as well of course).
- Another **half-century** of **Norway rat** plus kiore impact (if the 2 species co-existed on Maungatautari).
- Another **half-century** of **mouse** plus Norway rat plus kiore impact (but mice would probably have been suppressed on Maungatautari by the rats).
- Another **almost century-and-a-half** of **ship rat** plus mouse plus Norway rat impact – kiore probably disappeared from the mix in this period. Ship rats became the dominant rodent, with mice still probably mostly suppressed.
- We are now launching into a period of **mouse-only** impact – outcome unpredictable, it has never happened here before. Kiore had an opportunity over several centuries to change the composition of plant species in this forest, by e.g. selectively removing seed crops. The loss or reduction of some plant species might have had knock-on or even cascading ecosystem effects (compounded by the loss of moa influence).

  Will mice alone have different or additional ecosystem effects to those of kiore alone – or will the new mouse situation simply be a *déjà vu* moment for the mountain, who has seen it all before? Wikipedia says; "In popular [American] culture, the phrase 'Groundhog Day' has come to represent going through a phenomenon over and over [again], until one spiritually transcends it". So maybe mice will be just another groundhog – or perhaps it suggests that we might eventually beat them with something less tangible that poisons or traps.

Maungatautari had nearly half a millennium of 'just kiore'. 'Just mice' is likely to be different – but we can't predict either the degree or the nature of that difference.

Species that still survived immediately prior to restoration

Fungi:

John Innes and others have commented on the new abundance of fungi on the mountain following pest removal. That outcome was a surprise. Might uncontrolled mice again reduce the abundance of those fungi to the pre-restoration levels? Mouse-only effects might be different from mixed-mammal effects? Fungi are known to be important food for a variety of native animals. The mouse-free enclosures will of course provide refuge for some fungi that live at the lower altitudinal levels. There is some research interest in this aspect.

To assess the risk to each of the following species and groups, I have considered 4 basic questions:

- Do they persist elsewhere with uncontrolled rodents?
- Are their young especially vulnerable to mice?

- Might the new mouse management regime reduce their food resources?
- Are they likely to persist on Maungatautari with the new mouse management regime?

Invertebrate species assemblage:

- Do they persist elsewhere with uncontrolled rodents?
    - Yes for most, perhaps all (they survived on Maungatautari up to 2006 with uncontrolled pests).
- Are their young especially vulnerable to mice?
    - Probably no more so than adults, in most cases.
- Might the new mouse management regime reduce their food resources?
    - Some plant species might be especially vulnerable to a saturated mouse population, and some invertebrate species might depend on those plants.
- Are the currently-existing species likely to persist on Maungatautari with the new mouse management regime?
    - Unknown for many species, and general densities of (especially terrestrial) invertebrates are likely to be significantly reduced. Uncontrolled mice alone might have different effects than a mixed mammal pest suite which includes mice.

Long tailed bats:

- Do they persist elsewhere with uncontrolled rodents?
    - Yes.
- Are their young especially vulnerable to mice?
    - Most maternal roosts are likely to be beyond most mouse reach – and they survived on Maungatautari with ship rats as the dominant rodent.
    - Young are potentially vulnerable from December to February. Mice might not be especially food-limited at that time.
    - Adults in torpor might be vulnerable when mouse populations are high, but they did survive with ship rats as the dominant rodent.
- Might the new mouse management regime reduce their food resources?
    - Long tailed bats are obligate aerial insectivores. The larval forms especially of some of their prey might be affected by mice.
- Are they likely to persist on Maungatautari with the new mouse management regime?
    - Yes, but the effect on their density is unpredictable.

Lizards – 4 or 5 currently known species:

- Do they persist elsewhere with uncontrolled rodents?
    - Yes (but situation unclear for Duvaucel's gecko).
- Are their young especially vulnerable to mice?
    - All NZ gecko species are live-bearers, and they are mostly arboreal and probably mostly beyond the normal reach of mice – and at least 3 species survived on Maungatautari with ship rats as the dominant rodent.

    - Copper skinks are terrestrial, and give birth to live young in mid/late summer. Mice might not be especially food-limited at that time.
- Might the new mouse management regime reduce their food resources?
    - Geckos: Their arboreal invertebrate, fruit and nectar resources are unlikely to be affected significantly by mice in the short/medium term – and they did survive with ship rats as the dominant rodent.
    - Copper skinks: Yes, mice are likely to compete for invertebrate and fruit resources.
- Are they likely to persist on Maungatautari with the new mouse management regime?
    - Yes for geckos, but the likely effect on their density is unpredictable.
    - Unpredictable for copper skinks. Uncontrolled mice alone might have different effects than the previous mixed-mammal pest suite which included low densities of mice.
    - The mouse-free enclosures should provide refuges for viable populations.

Frogs – Hochstetter's are known to be present:

- Do Hochstetter's persist elsewhere with uncontrolled rodents?
    - Yes.
- Are their young especially vulnerable to mice?
    - Hochstetter's eggs have been observed at almost any time of year (but less laying has been recorded in winter). Eggs are laid in wet seepages, where vulnerability to mice is unknown. Larvae take about 3 months to metamorphose into small froglets, and are semi-aquatic during that time. Froglets are well within the size-range of mouse prey.
- Might the new mouse management regime reduce their food resources?
    - Yes, mice are likely to compete for terrestrial invertebrate food.
- Are they likely to persist on Maungatautari with the new mouse management regime?
    - Unpredictable – uncontrolled mice alone might have different effects than a mixed-mammal pest suite which includes mice.

Birds – 12 resident species known:

- Do they persist elsewhere with uncontrolled rodents?
    - Yes for all 12 species.
- Are their young especially vulnerable to mice?
    - All are likely to either nest out of normal reach of mice, or have adequate defensive behaviours.
- Might the new mouse management regime reduce their food resources?
    - Harrier; large home ranges will allow them to forage as normal over surrounding landscape. They also prey to some extent on forest birds, and the abundance of some of those species might be reduced.
    - Kereru; primarily forage for fruits and foliage in the forest canopy, where mice will have little effect in the short to medium term.

    - Small insectivorous species; all forage mostly above the ground, where the effect of mice will generally be less (but larval stages of invertebrates might be preyed on by mice).
    - Moreporks and kingfishers; prey mainly on large invertebrates and small vertebrates, including mice. The abundance of the native prey might be decreased.
- Are they likely to persist on Maungatautari with the new mouse management regime?
    - Yes, but there might be density effects for some species.
    - The mouse-free enclosures will provide safe breeding habitat for most, which might help to boost populations on the main mountain.

Species whose reintroduction programmes have already started

Kiwi:

- Do they persist elsewhere with uncontrolled rodents?
    - Yes.
- Are their young especially vulnerable to mice?
    - Eggs are mouse-proof – and young are unlikely to be very vulnerable – although they are somewhat helpless for the first few days while absorbing their very large yolk sac (initially under the skin and external from the body cavity), and they can be left unguarded for several hours each night. The first chicks of the season can hatch in September, when mice might be hungry – but most hatch from October to December or January.
- Might the new mouse management regime reduce their food resources?
    - Research on the Coromandel has shown that kiwi chicks in rat-controlled sites grow significantly faster than where rats are uncontrolled, probably due to food competition.
- Are they likely to persist on Maungatautari with the new mouse management regime?
    - Yes, but the growth rates of young are likely to be reduced. The effect on kiwi density is unpredictable.

Takahe:

- Do they persist elsewhere with uncontrolled rodents?
    - Yes, but in alpine areas where rodents are unlikely to be common for climate reasons (except perhaps during beech or tussock masts).
- Are their young especially vulnerable to mice?
    - Unlikely – young are precocial, with good parental care.
- Might the new mouse management regime reduce their food resources?
    - Invertebrate food for chicks is likely to be less abundant.
- Are they likely to persist on Maungatautari with the new mouse management regime?

- Yes. But on the main mountain they are likely to live mainly around the edge, including in the mouse-controlled fence-line zone – where they will potentially be exposed to some secondary poisoning, with adults perhaps eating toxin-laden mice and chicks perhaps eating toxin-laden invertebrates.

Kaka:

- Do they persist elsewhere with uncontrolled rodents?
  - Yes.
- Are their young especially vulnerable to mice?
  - Unlikely.
- Might the new mouse management regime reduce their food resources?
  - Unlikely in the short to medium term.
- Are they likely to persist on Maungatautari with the new mouse management regime?
  - Yes.

Hihi:

- Do they persist elsewhere with uncontrolled rodents?
  - Yes.
- Are their young especially vulnerable to mice?
  - Unlikely.
- Might the new mouse management regime reduce their food resources?
  - Unlikely in the short to medium term.
- Are they likely to persist on Maungatautari with the new mouse management regime?
  - Yes.

Whitehead:

- Do they persist elsewhere with uncontrolled rodents?
  - Yes.
- Are their young especially vulnerable to mice?
  - Unlikely.
- Might the new mouse management regime reduce their food resources?
  - Unlikely to be significant.
- Are they likely to persist on Maungatautari with the new mouse management regime?
  - Yes.

Yellow crowned kakariki:

- Do they persist elsewhere with uncontrolled rodents?
  - Yes.
- Are their young especially vulnerable to mice?
  - Unlikely.
- Might the new mouse management regime reduce their food resources?
  - Unlikely in the short to medium term.

- Are they likely to persist on Maungatautari with the new mouse management regime?
    - Yes.

Robin:

- Do they persist elsewhere with uncontrolled rodents?
    - Yes.
- Are their young especially vulnerable to mice?
    - Unlikely to be significant.
- Might the new mouse management regime reduce their food resources?
    - Probably, as they are primarily forest-floor insectivores.
- Are they likely to persist on Maungatautari with the new mouse management regime?
    - Yes, but perhaps at reduced density.

Kokopu – banded and giant:

- Do they persist elsewhere with uncontrolled rodents?
    - Yes.
- Are their young especially vulnerable to mice?
    - Eggs are laid at the water's edge where they might be exposed. Mice are known to prey on galaxid eggs in tidal vegetation in estuaries.
- Might the new mouse management regime reduce their food resources?
    - Kokopu are generalist insectivores (but large giant kokopu might also eat swimming mice).
- Are they likely to persist on Maungatautari with the new mouse management regime?
    - Kokopu have so far only been released into mouse-free enclosures. They might not breed in our inland situation, and their migrations paths to lowland waters are now blocked. If kokopu fail to establish breeding populations here, mice are unlikely to be the prime cause for that.

Species still to be potentially reintroduced

Petrels – black and Cook's:

- Do they persist elsewhere with uncontrolled rodents?
    - Blacks persist on Great Barrier with ship rats, which are not known to seriously affect them. But cats are also present there, which might suppress the rat population.
    - Cook's were removed from the mainland by kiore (which ate the helpless undefended chicks) several centuries ago. This was also happening on Little Barrier (where kiore arrived later than on the mainland), but the arrival of cats on LBI in the late 19th century temporarily suppressed that effect. But the eradication of cats from LBI in the 1970s allowed the kiore effect to re-

emerge, until kiore were also eradicated in 2004. If left unmanaged, kiore would have ultimately caused the extinction of Cook's petrels on LBI.

- Are their young especially vulnerable to mice?
    - General: there is good evidence that in some relatively simple island ecosystems, where mice are not suppressed by predation from other introduced mammals, they can have drastic effects on nesting seabirds. This includes killing albatross chicks up to 8 kgs in weight – and it threatens those seabird species with extinction at those sites. This extreme behaviour occurs mainly in winter, when other food sources are limited – but it has been recorded on islands in the same temperate latitudes as NZ.
    - Black petrel: chicks hatch in Jan/Feb, and after a few days they are not attended much by the parents except for feeding visits, and they are pretty small and helpless at this stage. They fledge in May. One might think that mice might not be especially food-limited at that time – but look at the kiore/Cook's scenario.
    - Cook's petrel: As for blacks (except chicks hatch Dec/Jan, and fledge in March/April). Similar or greater potential threat from mice (Cook's chicks are smaller than blacks)
- Might the new mouse management regime reduce their food resources?
    - No.
- Are they likely to establish and persist on Maungatautari with the new mouse management regime?
    - Unknown. If not, then localised mouse control can perhaps be undertaken around colony areas.

Brown teal (also perhaps blue duck):

- Do they persist elsewhere with uncontrolled rodents?
    - Yes.
- Are their young especially vulnerable to mice?
    - No. Young are precocial with good parental care.
- Might the new mouse management regime reduce their food resources?
    - Yes, mice are likely to compete for food.
- Are they likely to establish and persist on Maungatautari with the new mouse management regime?
    - Yes, but there might be density effects.

Snipe species:

- Do they persist elsewhere with uncontrolled rodents?
    - Yes (with mice on Antipodes), but at less-than-expected density. Ship rats removed them from Big South Cape Island. Kiore removed them from mainland NZ. They were discovered on LBI in 1870, apparently in the final stages of disappearing (and that indeed proved to be the case) – and it is

unclear if that final extinction was primarily due to kiore or to cats (the latter were introduced at about that time), or to human collectors.

- Are their young especially vulnerable to mice?
    - Probably not. Young are precocial, with parental care. Hatch on Chathams in October-February, and young are independent after 6 weeks.
- Might the new mouse management regime reduce their food resources?
    - Yes. Competition for terrestrial invertebrates is probably significant on the Antipodes.
- Are they likely to establish and persist on Maungatautari with the new mouse management regime?
    - Probably, but at reduced density.

Kakapo:

- Do they persist elsewhere with uncontrolled rodents?
    - Yes, with kiore on the mainland for about 600 years. But protection measures against kiore around nests were instigated on Codfish and LBI (and kiore have since been eradicated from both those islands), so there was obviously some concern about potential kiore predation.
- Are their young especially vulnerable to mice?
    - Probably, in some circumstances. The helpless young are unguarded in the ground-level burrow at night soon after hatching. See for petrels. Hatch Feb/April, last chicks fledge in June. One might think that mice might not be especially food-limited at that time – but look at the LBI/kiore/Cook's scenario.
    - But, kakapo are likely to only breed on Maungatautari in years of abundant rimu mast-fruiting (or perhaps other mast-fruiting species). So there is likely to be abundant fallen fruit on the ground for mice, in years when kakapo breed.
- Might the new mouse management regime reduce their food resources?
    - Unknown, but perhaps unlikely to be significant in the short to medium term. Kakapo have a notoriously slow metabolism, and can survive well with low nutrition. But they need to fatten in preparation for a (infrequent) breeding season – but they will have access to fruit higher in trees than mice normally do. When kakapo are feeding chicks, the females will be foraging for fruit high in rimu trees, while the mice will be mostly feeding on the fallen fruit at ground level (as they do with beech mast).
- Are they likely to persist on Maungatautari with the new mouse management regime?
    - Probably – but nests might need to be protected from mice.

Red crowned kakariki:

- As for yellow crowned, except that reds take more seeds close to ground level (e.g. grass and flax seed), and might compete with mice for that resource.

Rifleman:

- Do they persist elsewhere with uncontrolled rodents?
    - Yes.
- Are their young especially vulnerable to mice?
    - Unknown in a mouse-only pest-mammal situation – even adult riflemen are considerably smaller than an adult mouse, and often nest low down. Their normal nest sites could well be attractive to mice as refuges, and even weta have been suspected of evicting riflemen from their nests. Young hatch October-January, and the last chicks fledge in February – and mice might not be especially food-limited at that time.
- Might the new mouse management regime reduce their food resources?
    - Riflemen are primarily 'gleaners' of invertebrates from tree trunks and branches, and that food source might not be affected much by mice.
- Are they likely to persist on Maungatautari with the new mouse management regime?
    - Yes probably. The mouse-free enclosures will provide safe breeding habitat that might help to boost the population on the main mountain.

Rock wren:

- Do they persist elsewhere with uncontrolled rodents?
    - Yes, but in SI alpine areas where rodents are unlikely to be common for climate reasons (except perhaps following beech or tussock masts).
- Are their young especially vulnerable to mice?
    - Unknown. They nest at ground level – and their helpless young are much smaller than mice, and will be undefended while both parents are collecting food. Adult rock wren are about the same size as an adult mouse. Young are initially brooded by an adult for >50% of daytime, and <50% of daytime closer to fledging. Nests will be attractive refuges for mice. Hatch in November-January, last fledging in February – and mice might not be especially food-limited at that time.
- Might the new mouse management regime reduce their food resources?
    - Mice will compete for their ground and low-level invertebrate food.
- Are they likely to persist on Maungatautari with the new mouse management regime?
    - Unknown.

Kokako:

- Do they persist elsewhere with uncontrolled rodents?
    - Yes.
- Are their young especially vulnerable to mice?
    - No.
- Might the new mouse management regime reduce their food resources?
    - Not in the short to medium term.
- Are they likely to persist on Maungatautari with the new mouse management regime?

- Yes.

Saddleback:

- Do they persist elsewhere with uncontrolled rodents?
  - Yes (with kiore).
- Are their young especially vulnerable to mice?
  - Nests are often in cavities close to the ground. A reintroduction to Kapiti Island did not initially succeed well – thought to be due to the presence of Norway rats, even though they aren't considered to be proficient climbers. Both parents collect food for the chicks, from soon after hatch – and the helpless young will be vulnerable while they're away. Hatch August to April, last fledging in May – and mice might not be especially food-limited at that time.
- Might the new mouse management regime reduce their food resources?
  - Saddleback forage for medium-large invertebrates from ground level to the canopy, and are particularly adept at extracting prey from refuges (e.g. under leaf litter, and in tree holes and under bark). Mice will compete for many of those invertebrates at the lower levels.
- Are they likely to persist on Maungatautari with the new mouse management regime?
  - Yes probably, but perhaps at reduced density. The mouse-free enclosures will provide safe breeding habitat that might help to boost the population on the main mountain.

Short tailed bat (likely to be reintroduced if surveys indicate they're not already present):

- Do they persist elsewhere with uncontrolled rodents?
  - Yes.
- Are their young especially vulnerable to mice?
  - Most maternal roosts are likely to be beyond most mouse reach – and they survive where ship rats are the dominant rodent.
  - Young are potentially vulnerable in mid/late summer. Mice might not be especially food-limited at that time.
  - Adults in torpor might be vulnerable when mouse populations are high, but they survive where ship rats are the dominant rodent.
- Might the new mouse management regime reduce their food resources?
  - Short tailed bats are aerial insectivores; as well as terrestrial and arboreal insectivores, frugivores, and nectivores (when foraging they often walk/scurry and climb rather than fly). Terrestrial invertebrate abundance will be affected by mice.
- Are they likely to persist on Maungatautari with the new mouse management regime?
  - Probably, but perhaps at reduced density.

Tuatara:

- Do they persist elsewhere with uncontrolled rodents?
    - No.
- Are their young especially vulnerable to mice?
    - Unknown. There is a record of a captive adult being attacked and injured by mice. Kiore eradicated tuatara from the mainland, and from many islands – most likely mainly by eating eggs and young. Tuatara are entirely terrestrial. They bury their eggs in the ground in summer, and they hatch about a year later. The young weigh about 6 grams, and grow relatively slowly. So tuatara eggs and young will be vulnerable to mouse predation at the most dangerous times of year, i.e. winter/spring, when mice are likely to be hungry. Being cold-blooded, tuatara are likely to be more vulnerable to predation when lethargic in winter.
- Might the new mouse management regime reduce their food resources?
    - Mice will compete directly for terrestrial invertebrates and perhaps small vertebrates, which are the tuatara's sole food. Slow or sick or silly mice will potentially be eaten by tuatara.
- Are they likely to persist on Maungatautari with the new mouse management regime?
    - Unknown. But the mouse-free enclosures will be available for tuatara, and perhaps the mouse-control fence-line zone might be habitable (although secondary poisoning from eating toxin-laden mice and invertebrates might be an issue).

<u>Lizard species</u> – e.g. large *Cyclodina* skink species:

- Do they persist elsewhere with uncontrolled rodents?
    - No, in the case of the large *Cyclodina* species. Other potential species are yet to be investigated.
- Are their young especially vulnerable to mice?
    - Unknown. Normally give birth to live young in late summer/autumn. All these skinks are terrestrial. Some get up to 60 grams in weight – but being cold-blooded, they are likely to be more vulnerable to predation when lethargic in winter. Young-of-the-year will still be small in winter/spring, when mice are hungry.
- Might the new mouse management regime reduce their food resources?
    - Mice will directly compete for all of their food, which comprises terrestrial and low-level invertebrates and fruits.
- Are they likely to persist on Maungatautari with the new mouse management regime?
    - Unpredictable. But the mouse-free enclosures will be available for them, and perhaps the mouse-control fence-line zone might be habitable (although secondary poisoning from eating toxin-laden invertebrates might be an issue).

<u>Frog species</u> – 2 additional species are potentials for reintroduction:

- Do they persist elsewhere with uncontrolled rodents?

    - Yes for Archey's (but they are largely confined to higher-altitude cloud-forest, where rodents might be less abundant).
    - No for the Cook Strait species.
- Are their young especially vulnerable to mice?
    - Unknown.
- Might the new mouse management regime reduce their food resources?
    - Yes, mice will compete for terrestrial invertebrate food.
- Are they likely to persist on Maungatautari with the new mouse management regime?
    - Unknown. Some sites in the enclosures might be suitable – yet to be investigated.

<u>Invertebrate species</u> – e.g. Mahoenui giant weta:

- Do they persist elsewhere with uncontrolled rodents?
    - Special circumstances apply for MGW at their remaining 'natural' mainland site. Other potential candidates for invertebrate reintroductions have not yet been investigated in depth.
- Are their young especially vulnerable to mice?
    - Large terrestrial or low-level species might be. MGW lay their eggs in the ground, where they might be vulnerable.
- Might the new mouse management regime reduce their food resources?
    - Not in the short to medium term.
- Are they likely to persist on Maungatautari with the new mouse management regime?
    - Unknown. Females MGW come down to ground level to lay in about late summer, when mice might not be especially food-limited – otherwise they're likely to be largely arboreal. Can be released initially into the enclosures. Potential for invertebrate reintroductions to Maungatautari has not yet been fully investigated.

<u>Plants</u>:

***Dactylanthus taylorii* (wood-rose)**

- Do they persist elsewhere with uncontrolled rodents?
    - Yes.
- Are they likely to persist on Maungatautari with the new mouse management regime?
    - Mice are not known to affect them, other than perhaps helping with pollination (which is normally performed by short tailed bats if present). Potential for plant reintroductions to Maungatautari has not yet been fully investigated.

Bird species that might self-reintroduce

<u>Falcon</u> (recent evidence suggests they might already be starting to breed on the mountain):

- Do they persist elsewhere with uncontrolled rodents?
    - Yes.
- Are their young especially vulnerable to mice?
    - Probably not. Nests can be out of reach in e.g. arboreal epiphyte clumps, but can also be at ground level. Even quite young chicks have quite good defensive behaviours.
- Might the new mouse management regime reduce their food resources?
    - Probably not significantly, in the short to medium term.
- Are they likely to persist on Maungatautari with the new mouse management regime?
    - Yes probably.

Long tailed cuckoo:

- Do they persist elsewhere with uncontrolled rodents?
    - Yes.
- Are their young especially vulnerable to mice?
    - As for whiteheads (the NI host for this nest parasite).
- Might the new mouse management regime reduce their food resources?
    - Perhaps – large invertebrates and small vertebrates are their prey.
- Are they likely to persist on Maungatautari with the new mouse management regime?
    - Yes.

Small rail species – banded rail and spotless crake:

- Do they persist elsewhere with uncontrolled rodents?
    - Yes, but not in forest habitats.
- Are their young especially vulnerable to mice?
    - Probably not (precocial with good parental care), but unknown in this habitat.
- Might the new mouse management regime reduce their food resources?
    - Yes, mice will compete for terrestrial invertebrates.
- Are they likely to persist on Maungatautari with the new mouse management regime?
    - Both species are known to live in quite open forest on some pest-free offshore islands. Whether they can or will do that on Maungatautari, whether mice are present or not, is entirely unknown. They certainly do have the dispersal ability to reach Maungatautari from potential source populations. Might establish primarily in the enclosures, if vulnerable to mice.

Fernbird:

- Do they persist elsewhere with uncontrolled rodents?
    - Yes, but not in forest habitats.
- Are their young especially vulnerable to mice?
    - Probably, as they nest on or close to the ground and have helpless young.
- Might the new mouse management regime reduce their food resources?
    - Yes, mice will compete for terrestrial and low-level invertebrates.

- Are they likely to persist on Maungatautari with the new mouse management regime?
    - Fernbirds are known to live in quite open forest on some pest-free offshore islands. Whether they can or will do that on Maungatautari, whether mice are present or not, is entirely unknown. They might well have the dispersal ability to reach Maungatautari from potential source populations, but those events might be rare. Might establish primarily in the enclosures, if vulnerable to mice.

As-yet-undiscovered surviving species

At the time the project started, there might have been very low numbers of some undiscovered native species on the mountain, which hadn't quite yet been eradicated by introduced pests. The project might have started just in time to save them – and the Duvaucel's gecko might be an example of that. Hochstetter's frogs might also be an example.

The 'unfettering' of mice over most of mountain, might now cause the resumption of that decline-to-extinction for some as-yet-undiscovered species. And the rate of decline might be different in a mouse-only situation, which the mountain has never experienced before. The enclosures might still allow some such species to recover to some extent – and one or more additional lizard species are indeed likely to emerge (e.g. the striped skink).

Other invasive exotic species

There are many other exotic species that are uncontrolled and common to varying degrees, over much or all of the mountain – including eastern rosellas and several other bird species, the orange pore fungus, several species of introduced predatory wasps, European honeybees, and other invertebrate species. The impacts of most of these species can only be guessed at, but research has shown that introduced European wasps for instance can have very significant impacts on forest ecosystems in the Waikato. We will have to live with these species, just as we might have to with mice for a while longer.

What state are we really 'restoring' the mountain to?

When the first humans arrived here they called the land 'Aotearoa', and the forest ecosystem and biota that existed at the time of their arrival has perhaps been viewed as MEIT's broad restoration goal (minus the species that have since gone extinct). By the time Europeans arrived and called it 'New Zealand', many native species had already been mostly or completely removed from the mainland by Maori influence – so the first Europeans saw something that was significantly different to what the first Polynesians saw. And then the Europeans (with their camp followers) went on to cause another wave of retrenchments and extinctions.

The current reality is:

- We can reintroduce some of the species that were lost from Maungatautari in Maori times – so it will be a partial restoration to NZ as it was when Maori first found it (and those people and kiore then caused the retrenchment of some species to offshore islands and other refugia).
- We can also reintroduce some of the species that were lost from Maungatautari in European times – so it will also be a partial restoration to NZ as it was when Europeans first found it (and those people and their camp followers then caused the retrenchment of additional species to offshore islands and other refugia).
- But:
    - Some of the now-totally-extinct species were absolutely keystone-species and ecosystem-drivers. E.g. moa – their forest ecosystem-shaping effect by heavy selective browsing (for which NZ plant species were adapted) is now lost, so the forest can never look like that again.
    - The very structure of the forest was changed over many centuries by kiore (influencing forest turn-over & regeneration by selective seed predation). Trees that are sparse now, might then have been dominant, and *vice versa* – and the direct kiore effects would have caused other ecosystem effects (knock-on or even cascade effects).
    - The forest now also contains many invasive exotic species that we'll be living with in the short/medium term at least – which do have ecological effects.
    - All of those 3 strong influences will have had compounding and cascading effects – resulting in the forest that we see now, which is very different to how it would have looked in 1300 AD.
- So the answer is; we aren't really restoring the mountain to some previous state – we are 'rebuilding' it to a state that includes as many of its earlier component species as possible, but it will be very different to any previous state because:
    - Very important keystone forest-shaping species are now extinct (mainly moa).
    - Kiore changed the composition and nature of the forest over many centuries.
    - The Maungatautari ecosystem now includes a significant number of exotic species that are beyond our resources or ability to remove or control – and for the meantime, that includes mice.

So we shouldn't really use the word 'restoration' at all, we should use the word 'reconstruction' or 'rebuilding'. In Christchurch, the rebuilding won't be a faithful replica of what was there pre-quake – and our project will be similar in that respect.

Finally, what might uncontrolled mice on the main mountain mean, in terms of the project's vision and goals?

- Maungatautari is still likely to have more than 30 species of native forest birds – more than any other NZ mainland site, and probably any offshore island as well.
- Maungatautari is still likely to provide a home for maybe 40 rare and endangered wildlife species, including plants and animals.
- Those species will (in the main) still be part of a reconstructed 'naturally-functioning' ecosystem.

- Such a reconstruction to this level – and on this scale – will still be absolutely unprecedented.
- It will still become one of the best wildlife-experience destinations in the world – and it will be both readily accessible, and in a spectacular natural setting.

Chris Smuts-Kennedy
Biodiversity Manager
7.11.2011