Hawke's Bay Regional Council
Milestone Report

Project Title	Te Matau a Maui Hawkes Bay Project: research workstream	
Contractor	Landcare Research	
Research Leader	Grant Norbury	
Key researcher	Roger Pech	
Milestone 7.4	Determine the social, economic and biophysical thresholds that have highest priority for generating the outcomes required in the C2C footprint.	
Proposed Completion Date of Milestone: 30 June 2016		**Actual Completion Date of Milestone:** 16 June 2016

Background

The success of the Cape-to-City programme (C2C) depends on effective control of predators through an initial co-ordinated programme and the subsequent efforts of individual landholders and the wider community. C2C is expected to result in enhanced native biodiversity and flow-on benefits from ecosystem services. Experience and research have shown that it is likely there are minimum management thresholds that need to be met to achieve these goals (e.g. Glen et al. 2016). One approach to estimating critical thresholds is via a social-ecological model that represents the factors that motivate people to participate in pest control and the effects of management intervention to suppress predators and re-establish native avian, reptile and invertebrate communities. The aim is to use this model to predict the outcomes of varying the types and level of intervention in supporting landholder engagement in C2C and in conducting predator control and biodiversity monitoring.

Development of a social-ecological model for C2C will depend on the availability of the necessary social and biophysical data. Predator control has started in the C2C footprint, new control techniques are being evaluated (e.g. improved lures and wireless technology for networks of traps) and a monitoring network has been established to track changes in the abundance of predators and the responses of native and exotic prey species. These activities will generate a substantial ecological data base for C2C. Concurrently, a survey of rural landholders (Niemiec 2016; Niemiec et al. 2016) and a community survey (Brown 2016) have been completed to provide baseline data on people's attitudes to predator control and the potential benefits that might accrue from C2C. Some additional data are available from a 2015 national survey of more than 2300 commercial farm owners and farm managers about their attitudes and motivations with regard to pest control (Brown 2015). Economic data are yet to be compiled on the costs of predator control, how these costs might change with the use of new methods being tested, and the value of potential changes in prey species and flow-on effects to other species and ecosystem processes.

Progress towards modelling social, economic and ecological thresholds for C2C

Perhaps not surprisingly, the pest species targeted by the C2C programme are ranked as high priority species by farmers across all of New Zealand (Brown 2015; Figure 1), which implies that a social-ecological model for C2C will be of interest beyond Hawkes Bay. The survey data show differences between production sectors in farmers' motivation for controlling pests (Figure 2). These differences could be factored into the model to predict the effects on C2C of potential future changes in land-use. Also the data suggest that higher priority is placed on the need to protect native biodiversity by farmers in the Hawkes Bay Region than in most other regions (Figure 2). Regional differences will need to be taken into account if model predictions are extrapolated beyond C2C.

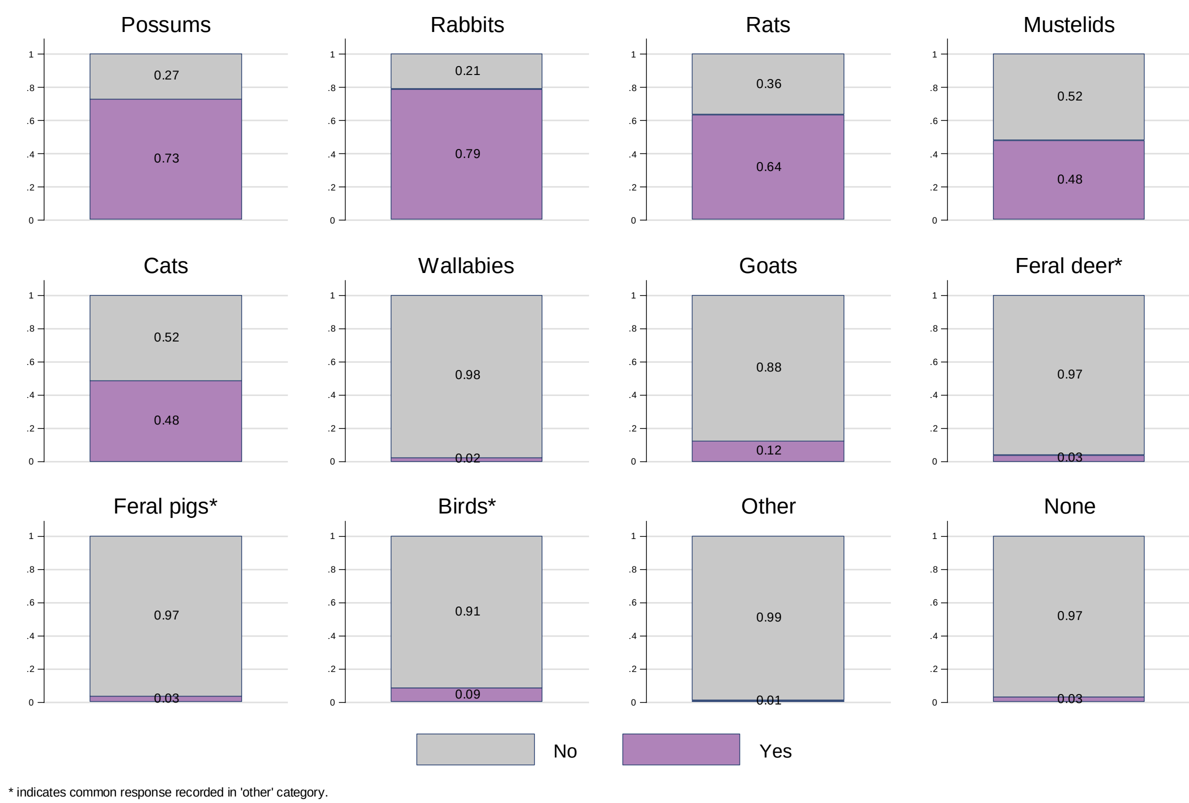

Figure 1. Animals considered by rural decision makers to be pests on farms across New Zealand (from Brown 2015).

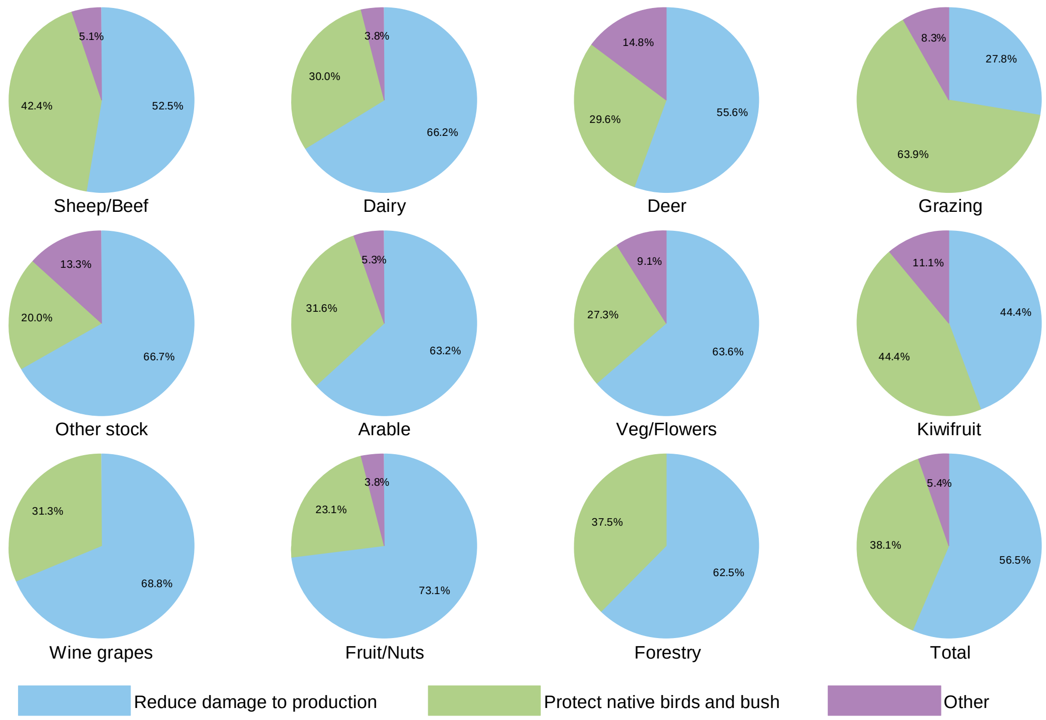

Figure 2. Primary reason for controlling pests on farms in different production sectors in New Zealand (from Brown 2015).

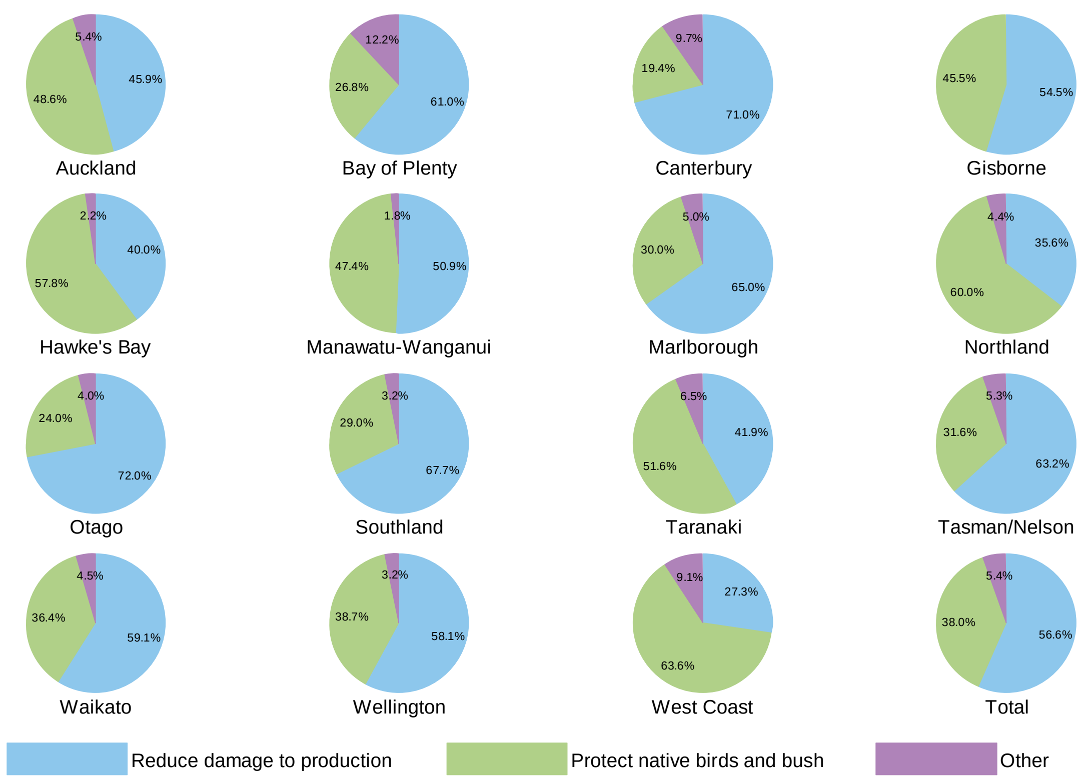

Figure 3. Primary reason for controlling pests on farms across regions of New Zealand (from Brown 2015).

Glen et al. (2016) modelled the effect of landholder participation rates on the outcomes of trapping to remove feral cats, ferrets and stoats in the C2C footprint. Some of the key findings are that non-participation by owners of small 'lifestyle' blocks are likely to have very little impact on the effectiveness of predator control, and that non-participation by owners of large farms could be offset by moving traps to nearby participating properties. However the model does not assess the effects of landowner participation changing over time, which could easily happen for example through peer pressure, education programmes, and perceptions of success (or failure) in achieving the overall C2C objectives. Furthermore, the scenarios modelled by Glen et al. (2016) could be re-configured taking into account the data collected by Niemiec (2016). For example, the social survey data indicate (a) baseline levels of participation could be 87% in the initial knockdown of predators and 50% for follow-up maintenance control, (b) participation in maintenance control could change if contractors are used because "almost half of the survey participants felt that predator control was best done by trained contractors", and (c) in the absence of a C2C programme, the participation rate in follow-up predator control could decline to 26%. The potential for low participation in control of pests other than rabbits and possums is supported by data from the community survey by Brown (2016): current involvement in control of mustelids both inside and outside the C2C footprint is not statistically distinguishable from zero.

The survey of rural landholders (Niemiec 2016; Niemiec et al, 2016) found that most respondents recognised that stoats, ferrets and feral cats pose a significant threat to native birds and other animals (Figure 4(a)). However several factors could affect landholder participation in predator control and how this might change during the course of the C2C programme. For example, the data suggest that landowners take into account the (a) the level of contribution by non-landowners who are benefiting from collective control efforts; (b) the potential for the programme to upset the local "ecological balance", leading to increases in other pests such as rabbits (Figure 4(b)); and (c) the probability for the programme to be successful given the likelihood of others participating (Figures 4(c), (d)) and characteristics of the local environment.

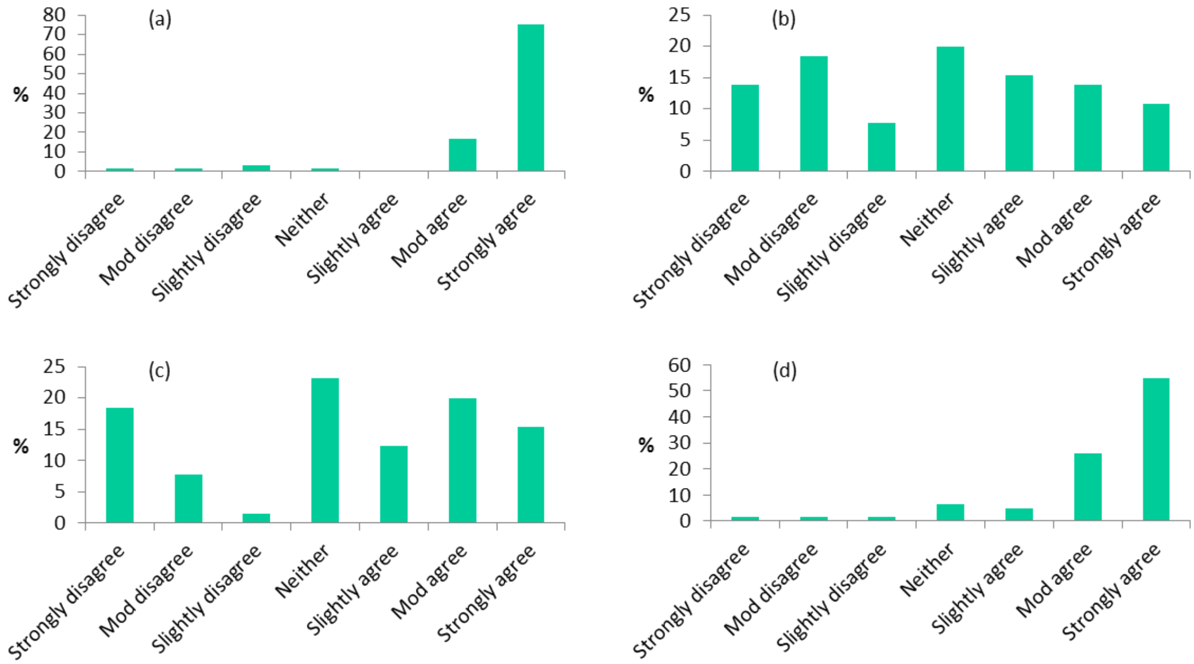

Figure 4. Percent of survey respondents who agreed or disagreed with the following statements about invasive mammalian predators: (a) stoats, ferrets, and feral cats in the region pose a significant threat to native birds and other animals; (b) removal of predators will allow rabbits to flourish; (c) people I know care about whether I do predator control on my property: and (d) together landowners could bring back native birds and native animals (from Niemiec (2016) and Niemiec et al. (2016)).

Further analysis is required to quantify the importance of the first of these factors: survey respondents who were concerned about less than full participation "often discussed the lack of control in "town" or other more populated areas" (Niemiec (2016). With regard to the concerns about upsetting the "ecological balance", an earlier review by Norbury and Jones (2015) concluded that the abundance of rabbits is unlikely to be affected significantly by removal of predators, i.e. changes in rabbit populations are determined primarily by food availability and, depending on locality, the impact of rabbit haemorrhagic disease. Rabbit monitoring inside and outside C2C will provide more information on this issue, and interactions between predators and major prey species such as rabbits and rodents could be included in the ecological component of a social-ecological model (see, for example, the multispecies models in Arthur 2005, Tompkins and Veltman 2006, Tompkins et al. 2013). The model could be used to predict likely changes in the abundance of non-target pests and, hence, potential changes in the attitudes of landowners towards C2C.

The social-ecological model could be designed to include dependence of landholder participation on the attitudes and actions of others. Niemiec's (2016) report noted that the "benefit of knowing that others were also participating may have contributed to a higher sense of personal and collective efficacy, whereby respondents were more likely to think their actions to control possums on their property would be worthwhile given that control was also happening elsewhere". This would lead to positive feedback in a model: the higher the participation rate, the more likely another landholder will join in. Alternatively, any level of participation <100% could reduce the probability of participation by a particular landholder: "Those who did mention a negative aspect most often wrote about the lack of enforcement to ensure 100% participation", and "everyone has to do it or it's pointless ….. it has to include everyone and they have to enforce it" (Niemiec 2016). As an example of the potential influence of the local environment on potential landholder participation in C2C, several of the survey respondents spoke about how they believed people with trees on their property, or who were near DOC reserves, would be more likely to see birds come back and appreciate the benefits of the C2C program. Proximity to reserves or patches of bush, and other attributes such as rabbit-proneness, could be built into a spatial social-ecological model.

Next step

Development of a social-ecological model for C2C will require a full-time scientist. A proposal for a post-doctoral fellowship was prepared by staff from the University of Canterbury (Alex James, Mike Plank, Simon Kingham and Melanie Tomintz) and Landcare Research, with 'in principle' support from Campbell Leckie at Hawkes Bay Regional Council. In February 2016 this proposal was submitted to Te Pūnaha Matatini, which is a Centre of Research Excellence hosted by the University of Auckland. Te Pūnaha Matatini gave top raking to this proposal in March and the final step is sign-off by the University of Canterbury (which is pending), with a projected starting date in January 2017. The aim of the post-doctoral project is to develop a model that can help to quantify social, economic or biophysical thresholds for regional control of invasive predators (Appendix 1). The fellowship will be fully funded by Te Pūnaha Matatini but will rely on access to data from C2C in order to provide model predictions for C2C. Also the aim is to help evaluate how C2C could become a template for predator control across the lower part of the North Island.

References

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Tompkins, D.M. and Veltman, C.J. (2006) Unexpected consequences of vertebrate pest control: predictions from a four-species community model. *Ecological Applications* 16: 1050–1061.

Appendix 1. Post-doctoral fellowship proposal submitted to Te Pūnaha Matatini in February 2016.

TE PŪNAHA MATATINI POST-DOCTORAL FELLOWSHIP PROPOSAL

A. ABSTRACT OF RESEARCH PROPOSAL

Very large-scale conservation: pan-regional control of invasive predators

Problem: Pests are everywhere (including gardens in Cashmere) but agreeing how to control them is not always straightforward.

One third of New Zealand's land area is classed as protected, the highest proportion of OECD countries, but this still leaves a huge area unprotected. Further losses of remaining native species are inevitable unless the extent of pest control increases markedly, especially outside currently protected areas where the conservation effort has a relatively low priority. This unprotected land may be urban, peri-urban or production but it still makes a welcoming home for many predators and leaving it without pest control is causing problems for many species of reptiles, invertebrates and birds, including some of our most iconic species such as kiwi.

Much of this unprotected area is in the hands of private individuals who have a range of views on pest control so land management decisions have to be carefully negotiated and agreed to by a range of different stakeholders from cat-lovers to rabbit-haters. Experience has shown there are minimum landholder participation thresholds that need to be met to maintain ecosystem health and provide ecosystem services at the levels expected by society. For example, a co-ordinated effort is required so that pest reinvasion from a few untreated properties does not compromise pest control achieved by others. Also a landscape perspective is needed to mesh pest control with land use so that connectivity ('safe passage') can be established for native species dispersing between fragments of suitable habitat. Because this biological connectivity necessarily crosses landowner boundaries, large scale pest control is inherently a spatial issue with social, environmental and economic components. Without a well thought out strategy, native biodiversity will continue to decline at local, regional and national scales.

Background

In New Zealand, control of invasive mammals is mostly restricted to large uninhabited areas, such as national parks, forests and near-shore islands. The first major exception is the current Cape-to-City project, 'large-scale' predator control covering 26,000 ha of agricultural land in Hawkes Bay. This is just a start for a much more ambitious project proposed by four regional councils for the southern part of the North Island. In addition, initiatives like 'Predator-free New Zealand' have a national-scale vision for pest eradication. A major challenge is to make this work in production, peri-urban and urban areas where participation and buy-in from private individuals will be essential. The potential impact of successful large-scale predator control is manifold and includes:

- Biodiversity: Invasive mammals have already caused massive loss of New Zealand's unique native biodiversity via a combination of herbivory on native flora and predation of native fauna. Many of our native bird species are now largely confined to predator-free islands. Other fauna such as lizards and snails are also hard-hit by predators, although often less well reported.
- Economic productivity: The economic costs of a continuing decline in New Zealand's native biodiversity are difficult to quantify. There is currently a substantial research effort directed to evaluating ecosystem services provided by native species, especially for agriculture. Agriculture is also threatened by the pest species themselves in several ways, for example by consumption of pasture by herbivorous pest species such as rabbits and goats, invasion of production weeds such as Nasella tussock, and transmission of bovine tuberculosis by possums. Biodiversity loss is also detrimental for the tourist industry, which is increasingly marketing tours that showcase our native biodiversity.
- Matauranga Māori: For iwi, the very essence of the Māori world view is relationships - not only amongst people but also between the spiritual world and the natural world. Relationships extend from the deities to whānau, to hapū, to iwi, to fauna and to flora. There is a strong belief in the inter-relationship of all living things to each other. As a result, Maori wellbeing is directly linked to the health of the environment. None of this world view can operate successfully in an environment of impoverished biodiversity. However, bringing Maori back into connection with a healthy environment will have significant social and economic benefits. Most New Zealanders, Māori included, have little regular contact or experience with our native natural heritage. This is true for those living in urban or peri-urban environments, as well as rural areas where many native species are uncommon at best. This in itself is a huge loss but, is also a huge practical impediment to biodiversity restoration. People protect what they care about; and it is difficult to care for something you know little or nothing about.
- Human health: Some predators carry diseases that are a risk to human health, for example toxoplasmosis and bovine tuberculosis.

In the long-term, successful conservation programmes in New Zealand will require community engagement and buy-in from a variety of stakeholders including private landowners, iwi, business operators and government. Promoting interactions and cooperation among these sometimes disparate groups is therefore a priority for maximising the impact of limited public conservation funding.

The aim of our study is to use socio-ecological models to assess the feasibility of scaling-up management of invasive mammals outside traditional conservation areas.

This project fits well with Te Pūnaha Matatini's biosphere theme, in particular with its predator-free New Zealand projects. It will strengthen our links with Landcare Research and the Biological Heritage National Science Challenge, whilst providing useful information and outcomes to Regional Councils, initially in the lower North Island, and subsequently at a national level. It will help us build useful connections with the newly formed Geospatial Research Institute at UC (co-founded by Board member Wendy Lawson). It will align well with the Government's Geospatial Research Strategy which aims to significantly improve the value of geospatial data and deliver stronger economic, social and environmental outcomes for New Zealand, for example by "developing innovative and holistic systems thinking approaches to sustainable land management". Significant blocks of the area under study are owned by local iwi and hapū so this work has the potential to make a major contribution to Māori and the Māori economy (e.g. He Kai Aku Ringa).

Approach

Mathematical models of pest control usually confine themselves to pest population dynamics and non-spatial models. This project will lift these models to a new level in two ways: by using a geospatial approach from the outset and by linking pest control and landholder participation in environmental management in a dynamic, spatially explicit socio-ecological model.

Start - 12 months: Develop a geospatial model of pest spread in the lower North Island.

Starting with geographical data of land boundaries, ownership and usage, habitat types and probable pest abundance, we will develop models of pest population dynamics and control across the lower North Island. This will be based on combining individual-based models of pest species (for example Landcare Research has a national-scale individual-based simulation model for possums) with geospatial data. This null model will predict hot-spots of pest activity that would occur in an uncontrolled landscape. The model will be designed so that a spatial management 'layer' can be incorporated in the second stage of the project. This will add a dynamic social component by modelling changes over time in the distribution of landholder participation in pest control programs

12 – 18 months: Extract data on attitudes to pest control and incorporate likely pest management levels given current attitudes.

Surveys of attitudes to pest management have been completed for rural landholders and urban residents in the Hawkes Bay Region. These surveys will be repeated over the next 3-5 years. Quantitative data will be extracted on the attributes of landholders willing to participate in pest control programmes (e.g. age, ethnicity, education, occupation) and the types of incentives (e.g. involvement of neighbours; increases in local biodiversity; improved productivity) that can increase and propagate participation rates throughout a region. In addition, the latest national Survey of Rural Decision Makers includes spatial data on involvement of landholders in pest control, providing the potential to broaden the scope beyond the southern part of the North Island. Other potential data sources to fill in knowledge gaps include land-use data (e.g. sheep-farming, lifestyle blocks) and soil maps (e.g. to quantify how prone an area is to supporting rabbit populations as farmers with rabbit problems are less likely to allow control of predators).

[1]*18 – 30 months: Test a series of feasible management scenarios.*

To be workable, management needs to incorporate social as well as geographical factors affecting viewpoints. Research aims include:

- Identifying properties with strategically critical locations for effective regional-scale pest control. This will be based on a combination of geospatial and social factors. For example, a key property might be one that acts as a geographical bottleneck for the spread of pest species, is a potential source of re-invasion for adjacent high-value conservation land, and has a landowner who is supportive of conservation efforts.
- Identifying features likely to affect logistics of pest control, e.g. flood-prone areas, road networks for trap access, cell phone coverage for wireless trapping technology, topography where ground-

[1] Co-funding has been obtained from UC that will allow us to extend the tenure of the fellowship from 2 to 3 years.

based control is unfeasible.
- Determining the optimum way to allocate conservation effort across properties as a function of their geospatial location, likely attitudes of their landowners, and their position with respect to neighbouring land areas.

24 – 36 months: Investigate factors affecting the economic feasibility of a pan-regional predator control project.
This phase will be developed in more detail as the project proceeds. In general terms, it will require sourcing the necessary data sets and configuring geospatial models to extend project outputs to very large spatial scales. For example, economic data on the costs and benefits of predator control will be used to estimate the value of 'economies of scale' for pan-regional implementation of the current *Cape to City* initiative in Hawkes Bay.

Resources
The fellow will be based in the College of Science at UC. We have obtained written confirmation from the College that they are able to offer co-funding to the project by way of a reduced overhead rate. This will allow us to extend the tenure of the fellowship from 2 years to 3 with no increased cost to Te Pūnaha Matatini.

Datasets
- Survey of Rural decision makers: 2013 data from 1500 respondents is available at: http://www.landcareresearch.co.nz/science/portfolios/enhancing-policy-effectiveness/srdm.
  The 2015 dataset, which had >3000 respondents, is about to be released. It includes questions about attitudes and activities on pest control as well as social networks used by individuals for information about pest control. Publicly available outputs necessarily have low spatial resolution (i.e. data are shown for Territorial Authorities to protect confidentiality), which will require use of these 'emergent' attributes to validate underlying models of social interactions.
- The following geospatial datasets will be utilised as appropriate:
  - Soils
  - Flood-prone areas
  - Land-use
  - Topography and habitat data to map inaccessible areas
  - Cell phone coverage
  - Road network
  - Socio-demographics
- The following datasets are available through Landcare Research
  - Possum abundance
  - Habitat suitability for major pest species
  - Current pest management by agencies (DOC, TBfree NZ, regional councils, community groups), stratified by pest control 'regime'(e.g. trapping, ground baits, aerial baiting)
  - Efficiency and costs of pest control regimes
  - Predicted biodiversity gains from pest control, stratified by habitat and land-use

Investigators
- Te Pūnaha Matatini: Alex James, Mike Plank, Rachelle Binny.
- Landcare Research: Roger Pech.
- Geospatial Research Institute: Simon Kingham, Melanie Tomintz

We will also utilise Te Pūnaha Matatini's expertise in data analytics and soil science.

Other support

This project has the ‘in principle’ support of the Pan Regional Predator Control project being developed across the Hawkes Bay, Greater Wellington, Horizons and Taranaki Regional Councils as an extension of the current *Cape-to-City* Project. *Cape-to-City* is a partnership between the Hawkes Bay Regional Council, Department of Conservation, Cape Sanctuary, Manaaki Whenua - Landcare Research and various landowners and businesses. The *Cape-to-City* project has also secured $2.3m funding from the Aotearoa Foundation, a philanthropic trust of Julian Robertson.

B. INFORMATION ABOUT THE CANDIDATE (IF KNOWN)

The ideal candidate will have a geospatial background as researchers in this area tend to have good quantitative skills and, with the appropriate support, will manage the mathematical and statistical aspects of the problem. This strategy also has the advantage of significantly increasing the candidate pool for the position. For example the last similar position advertised by the GeoHealth Laboratory (a research group related to the Geospatial Research Institute) received 24 applications.