Coordinated DNA capabilities for rodent management

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Overview

- Genetic sampling for rodents and other invasive species is a powerful tool for conservation management.
- It is particularly useful for identifying the source of reinvaders after an eradication attempt, and determining whether rats detected after the eradication are survivors or reinvaders.
- It is also useful before an eradication is attempted, for assessing reinvasion risk from nearby infested sources, and for general understanding of factors contributing to reinvasion risk, e.g. length of water crossing or presence of beach landings.

To make best use of this tool, we need **coordination** at a local or national level:

1. It's becoming common for local community groups to undertake eradications, such as the Motu Kaikoura Trust (Great Barrier Island). These groups don't have the resources to initiate their own genetic research programme or conduct their own lab work. No matter how small the project, it's important to be able to locate the source of reinvaders when they appear, so as to respond accordingly. Every failed eradication is an inconvenience to locals and can create a negative public attitude to future eradications.

2. A number of research groups around the country are undertaking rat genetic studies. This includes my group at the University of Auckland and groups at the University of Otago and Landcare. The start-up costs for a genetic study are among the most expensive part of the process. Sharing resources among groups (e.g. primer solutions and control samples) will minimise the start-up costs, increase the number of samples that can be processed, and allow comparability of results from all locations around the country.

3. Reinvaders to an eradicated island are unpredictable both in timing and in number. We need laboratory resources and technicians that can be called upon as and when reinvasions occur. This suggests we need to tap into an existing laboratory resource that can accommodate a small amount of extra processing on an unpredictable basis. Payment at commercial laboratory rates is unlikely to be possible for most conservation projects.

Meeting

I would like to propose a meeting of interested parties to discuss the potential for coordination across regions and research groups:

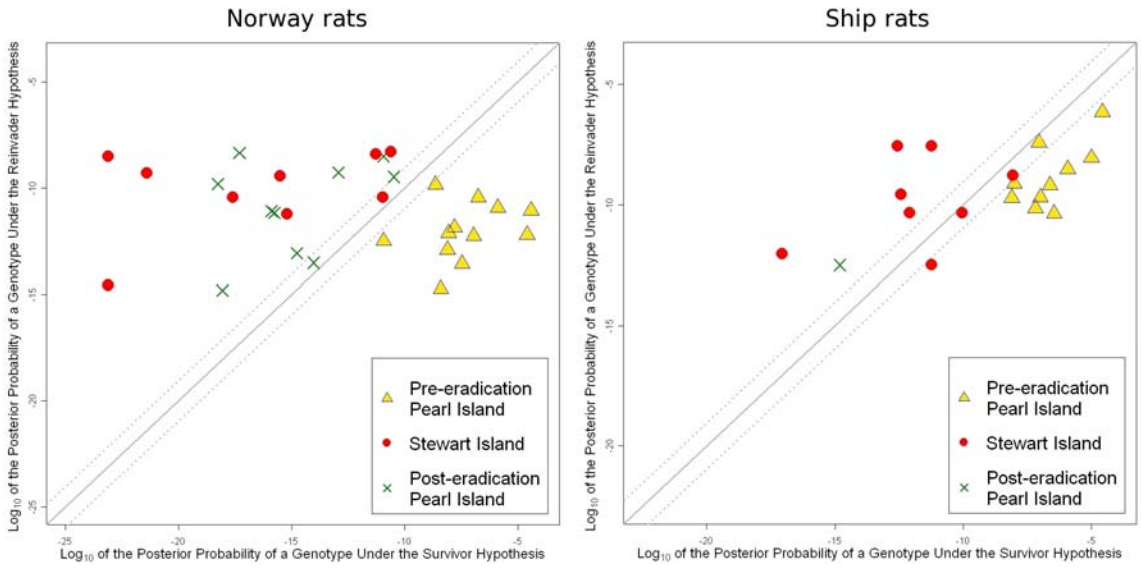
Tamaki Campus, University of Auckland, Room 721-231
8.45am – 10.15am
February 8th, 2010

The meeting is to take place just before the Island Invasives Conference begins, and the room is close to the conference rooms.

What can genetic studies achieve?

1. Locating the source of post-eradication rats

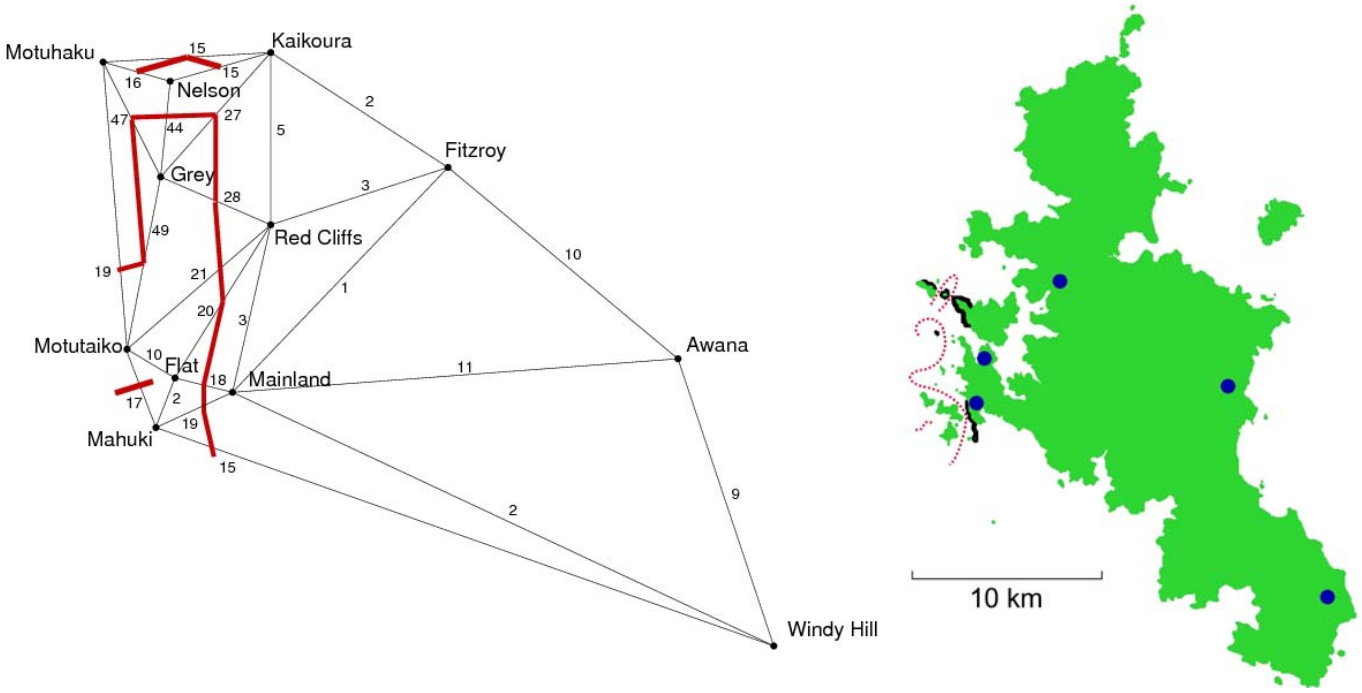
The figure below shows genetic results from Pearl Island, off Stewart Island. Norway rats, ship rats, and kiore were eradicated in July 2005, and new rats were first detected on the island in May 2006. By July 2006, 10 Norway rats and 1 ship rat had been caught on the island. A small number of DNA samples of both species were available from before the eradication. Due to the large number of rats found, it was assumed that the eradication had failed and the rats caught were survivors. However, the genetic evidence showed clearly that the new rats (green crosses) clustered with rats from nearby Stewart Island (red circles), not with the pre-eradication Pearl Island rats (yellow triangles). This presented strong evidence that the new rats were in fact swimmers from Stewart Island, not survivors as previously suspected. The results enabled management to focus their efforts on biosecurity rather than on eradication procedures.



Reference:
Russell, J. C., Miller, S. D., Harper, G. A., MacInnes, H. E., Wylie, M. J., and Fewster, R. M. (2010). Survivors or reinvaders? Genetic assignment of rats following eradication from Pearl Island, New Zealand. *Biological Invasions,* from www.springerlink.com/content/q35148r15h328303/fulltext.pdf

2. Identifying reinvasion risk and eradication units

The genetic relatedness of rats from different islands tells us about the level of mixing of the populations, which gives information about reinvasion risk if an eradication is attempted. Studying the genetic relatedness also tells us which geographical features are associated with genetic isolation, and which are associated with high genetic mixing. The figure below shows a genetic relatedness network for ship rats on islands off Aotea/Great Barrier Island. The numbers are genetic distances (100 x F_{ST}) with numbers from 0 to 5 representing very low distances (little



genetic separation), and numbers over 15 representing high distances (islands relatively isolated from each other). The thick red lines are **genetic boundaries** along which some sort of separation of islands occurs. The map on the right shows that these red boundaries are associated with two features. The first is a long water crossing of a kilometre or more, shown by the strong genetic boundary around the tiny Grey Group Islands on the centre left. The second feature is a cliff or otherwise inaccessible landing spot on one or both sides of the dividing channel, as marked by thick black lines on the map. By contrast, there are no genetic boundaries seen over water crossings of the same size when the landing spots are accessible, such as beaches, and there are no genetic boundaries found over large distances of unbroken land. Sampled locations on the main island are shown by blue circles on the map.

These results suggest that cliffs may be a significant feature in determining reinvasion risk or frequency. The results are presented in our paper submitted to the Islands Invasives conference:

Fewster, R. M., Miller, S. D., and Ritchie, J. (2010). DNA fingerprinting – a management tool for rat eradication. *Island Invasives Conference Proceedings, Submitted.*

Suggestions for coordination of DNA work

There are several levels at which a coordinated scheme could operate, depending on the availability of funding and interest in participation from management authorities. Some ideas for consideration and discussion are below.

1. **Storage, publicity, and sharing resources.**
    - A central cold store for all rat samples, with availability of storage bottles and ethanol for preservation. Storage just needs 2cm of tail from each rat in a small individual sample bottle.
    - Publicity among conservation managers so that groups embarking on eradications are aware of the facility and (crucially) take DNA samples **before the eradication.** Samples can

be stored in the central facility and only need to be retrieved for lab processing in the event of a reinvasion.
- Groups embarking on their own genetic labwork should borrow 'control' samples from the store, and use the same genetic loci as existing work. This allows results from different labs to be compared.
- Ideally, a central repository of genetic primer solution should be available for sharing among groups, to reduce the expensive start-up costs and ensure that the same genetic loci are being used.
- Computer database where completed genetic profiles of rats are stored. This would need a database programmer, and there are intellectual property rights to consider.

2. **Trapping gear**
   - A repository for gear needed for taking DNA samples from source populations before the eradication takes place. This includes kiwi-safe trap covers, traps, sample bottles, and ethanol. Traps and covers can be borrowed for a project then returned.
   - Further items available for borrowing – e.g. a GPS unit for sample locations, and safety beacon / marine radio for fieldworkers collecting samples on islands.
3. **Collecting samples specifically for the DNA database for future use**
   - This would require funding for fieldworkers (or volunteers) to go out specifically to collect DNA samples from rats around the region so they can be compared with rats turning up on sanctuary islands from unknown sources.
   - Target boat marinas, popular holiday spots where boaties might pick up rats, and areas of coast within swimming distance of sanctuary islands.
   - Emphasis on Norway rats for swimming, both species for boat transport.
   - Particularly relevant in Auckland region after recent incursions by Norway rats on Hauraki Gulf sanctuary islands where the source of the rat has never been discovered: e.g. Motuora, Motuihe. Finding and removing a single rat can cost thousands of dollars and several days of full-time work for dog trackers and trappers.
   - The dream scenario is that we catch a rat on Motuora, send it to the lab, press a button and hey presto – we know where it came from. This is ambitious but not completely unattainable. Requires funding for fieldworkers and for laboratory processing of the samples.
4. **Provision of lab facilities**
   - Ideally we need a long-term lab resource that can accommodate occasional and unpredictable work below commercial prices.
   - Funding (from whom?) and buy-in from prospective laboratory managers is required.
   - Without this, each group planning an eradication would need to find and negotiate their own lab facilities – potentially a prohibitive obstacle to getting started.
   - Reasonable for the lab and technician costs to be paid by the individual eradication group, but perhaps subsidised by the central project? Commercial lab rates are likely to be prohibitive. There needs to be some incentive for the lab providers: e.g. payment, research papers, ... other?
5. **User-friendly statistical analysis package with maps and assignment**
   - With software development support, we could create a manager-friendly package so that graphics and analyses like those above are produced on demand.
   - Press a button for a map of the area, with catch locations.
   - Press another button and the genetic results are analysed and plotted into graphics like those above: genetic boundary graph or survivor/reinvader graph produced quickly and easily, plus other outputs or tests.
   - This would require funding for a specialist software developer, perhaps for 6 months work. Alternatively it might be suitable for a university Masters/PhD project, e.g. in Computer Science: needs consultation with relevant academics.