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Stochastic modelling of rat invasions among islands in the New Zealand archipelago

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A Norway rat on Okahu Island in the Bay of Islands, Northland, New Zealand.

Photographer: Stephen Cope.

Abstract

This project was formulated with the purpose of advancing knowledge of the invasion dynamics of rats within archipelagos in New Zealand. The concentration on islands reflected the conservation focus of this project - islands are the last refuges for many native New Zealand species that cannot survive in the wild on the mainland.

This project can be divided into four areas:

1. Data collection: There was no intent for innovation here, but a deeper understanding of the environments in which rats are born, breed, migrate, and die was developed.

2. Development of tools for data exploration:

   - A user-friendly point-and-click graphical interface for the R program was designed to allow any user to easily explore simple genetic characteristics of the data.

   - A novel method for exploring the genetic similarity between individuals was developed and showcased with real data, proving successful in cases of both high and low genetic differentiation, and in detecting likely individual migrants.

3. Improvement of a method for estimating migration:

- An attempt was made to improve the Markov chain Monte Carlo procedure underlying this method.
- The migration model used by the method was significantly improved, so that it could cope with any level of migration. Previously, results from situations where migration rates were high were invalid.

4. Investigated topics of ecological interest:

   - Field measurements of rats were used to show that Norway rats tend to have larger masses than ship rats, southern rats are generally larger than northern rats, but the effect on mass of living on an island as opposed to the mainland depends on the latitude. It was also shown that relative tail length is a good species discriminator.
   - Multiple paternity was confirmed for both Norway and ship rats. This breeding characteristic might form part of the explanation for why rats are such successful invaders.

During the project, case studies involving rats on Big South Cape Island, Great Barrier Island and in the Bay of Islands were used to highlight the methods developed, and provided some unexpected and fascinating results.

Dedication

I would like to dedicate this thesis to my family. Without their support and encouragement I would not be close to where I am today. Working on a PhD can be an all-consuming task at times, but I always knew I could rely on my family to help me through, and take the slack when I wasn't pulling my weight.

If I ever needed transport, a meal, or just a friendly word, I knew where I could find it.

Words cannot express how thankful I am to have them.

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