



# Easter Bunnies and Ecological cascades

*Species interactions gone wild*



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Landcare Research  
Alexandra*



# Pests in a wider socio-political context

- **Two key requirements** for effective pest management
  - Understanding factors that drive pest abundance
  - Understanding full extent of impacts
- **Rabbits** are a good example of a pest that:
  - is influenced by a complex array of social and ecological factors
  - has both direct and indirect impacts (i.e. “ecological cascades”)
- **Indirect effects** less understood, less obvious and more complex, especially when multiple pest species involved
- Viewing pests in this **wider context** is critical for restoration of ecosystems



# Examples of indirect effects and ecological cascades

- Timber harvesting and agriculture

*Kinley & Apps 2001, Robinson et al. 2002, Wittmer et al. 2007, McLellan et al. 2009, Latham et al. 2011*

- More moose or white-tailed deer
- More wolf or cougar
- Fewer woodland caribou or mule deer

- Township development

*Hebblewhite et al. 2005*

- Fewer wolf
- More elk
- Fewer aspen & willow
- Fewer beaver & riparian birds



# Rabbit-prone grass/shrubland ecosystems

- 83% cleared
- 50% NZ's threatened flora
- 3% formally protected
- Most indigenous biodiversity on private land



# Two key features of these ecosystems

## 1. Highly modified

- Fertilised
- Heavily grazed
- Burnt
- Diverse suite of exotic species



## 2. Seral

- Increases in woody species and herbaceous swards with removal of pressures









# Plethora of weeds and pests







Coral broom



Carex decurtata



Galium sp.



Puccinella

# Cryptic plants



Lepidium



pincushion grass, *Agrostis muscosa*



*Atriplex buchanani*



Craspedia



# Diverse, but threatened, indigenous biodiversity











Top predators

Insectivores



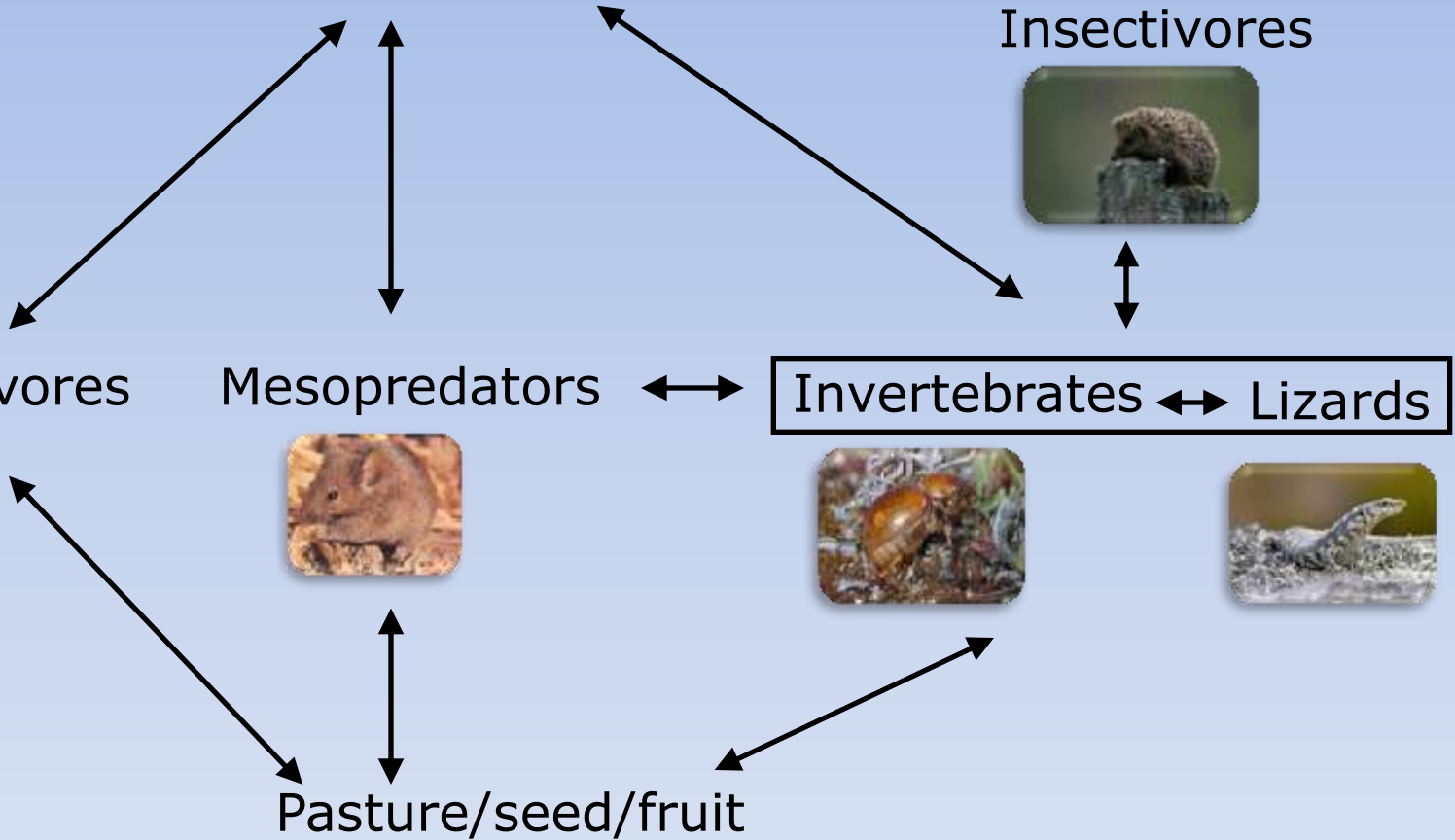
Herbivores

Mesopredators

Invertebrates ↔ Lizards



Pasture/seed/fruit





# Pasture development favours rabbits





# Indigenous grass/shrubland





# Indigenous tussock





# Open grassland





# Macraes Flat, Otago

## Landscape supplementation

Dunning, Danielson, Pulliam. 1992. Ecological processes that affect populations in complex landscapes. *Oikos* 65:169–175.

3.71 km

Image © 2012 DigitalGlobe

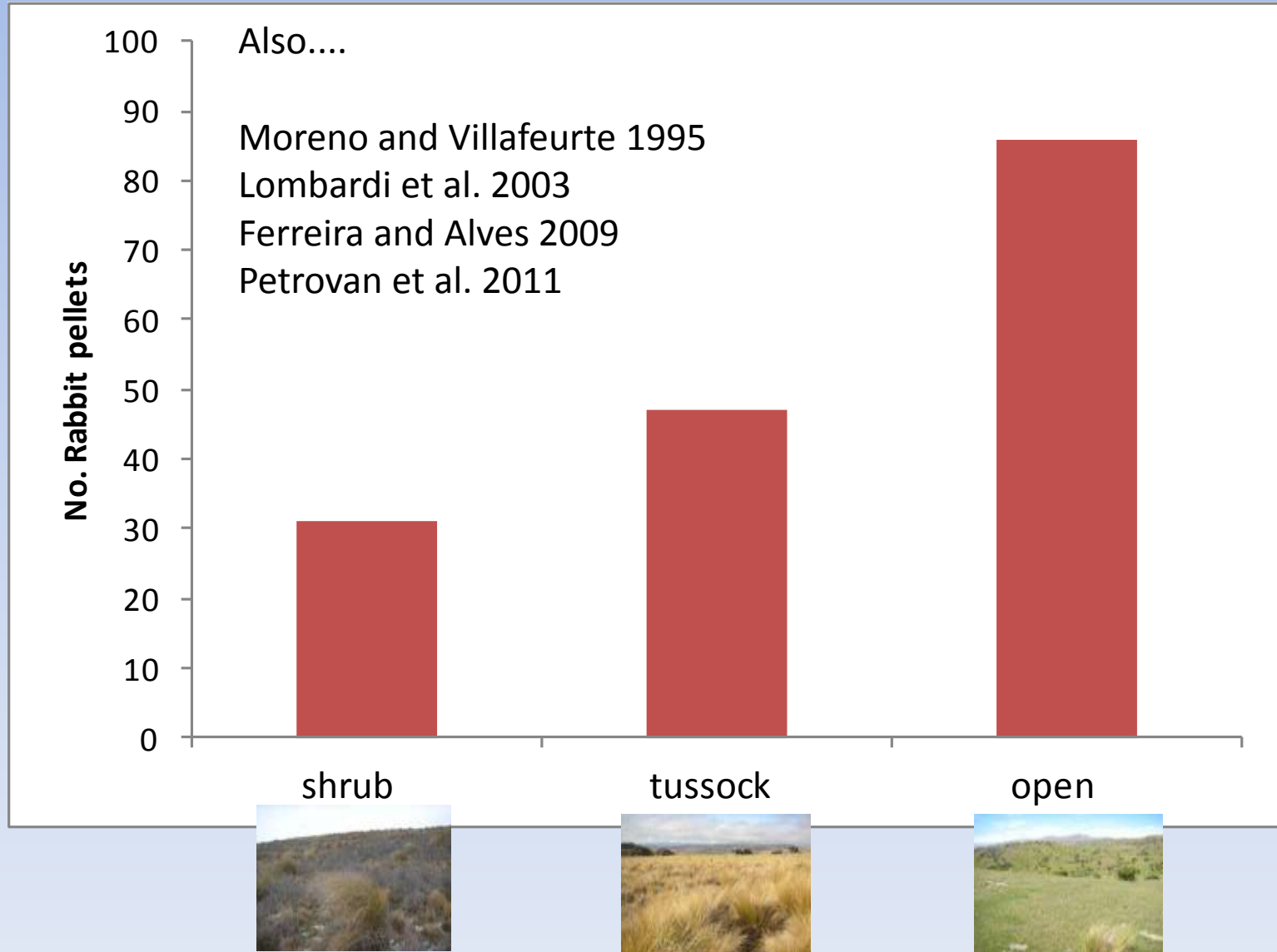
lat -45.465848° lon 170.418809° elev 544 m

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Eye alt



# Pasture development favours rabbits





# Two socio-political drivers

## 1. Resource management policy

Habitat modification continues under RMA, administered by local government

## 2. Human perceptions

Perceived as a production landscape

General lack of appreciation and endearment for dryland indigenous species





ALEXANDRA



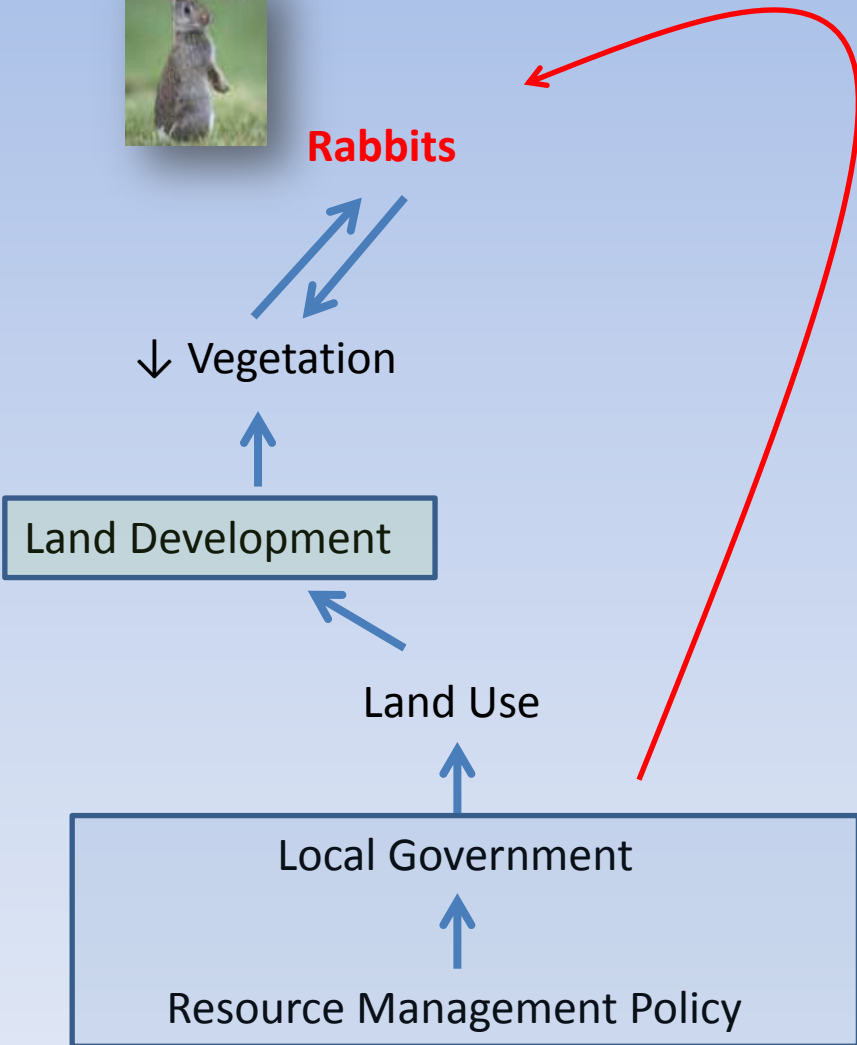
thyme  
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# Socio-ecological interaction web



**Rabbits**





# Ecological cascades

More rabbits means more predators

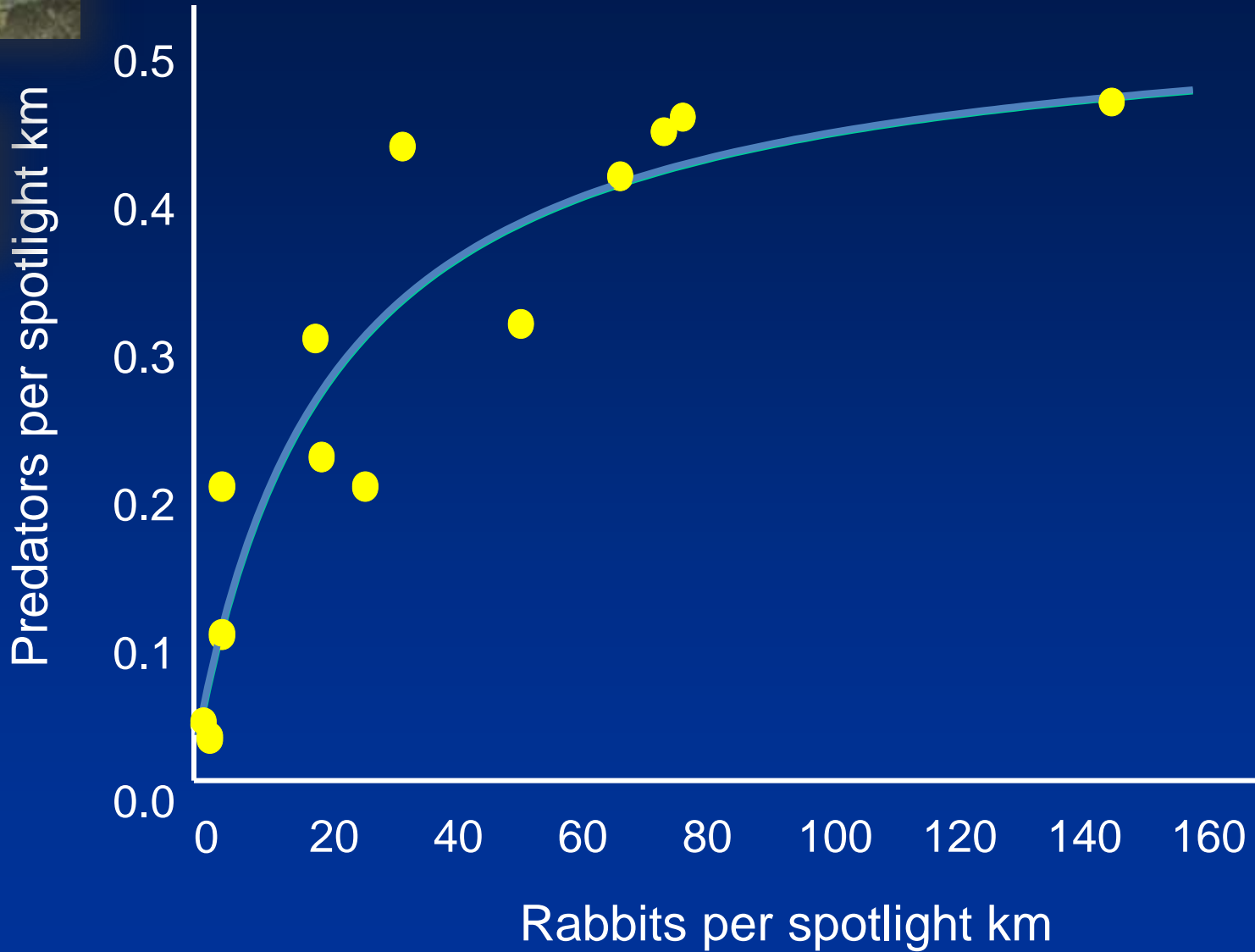




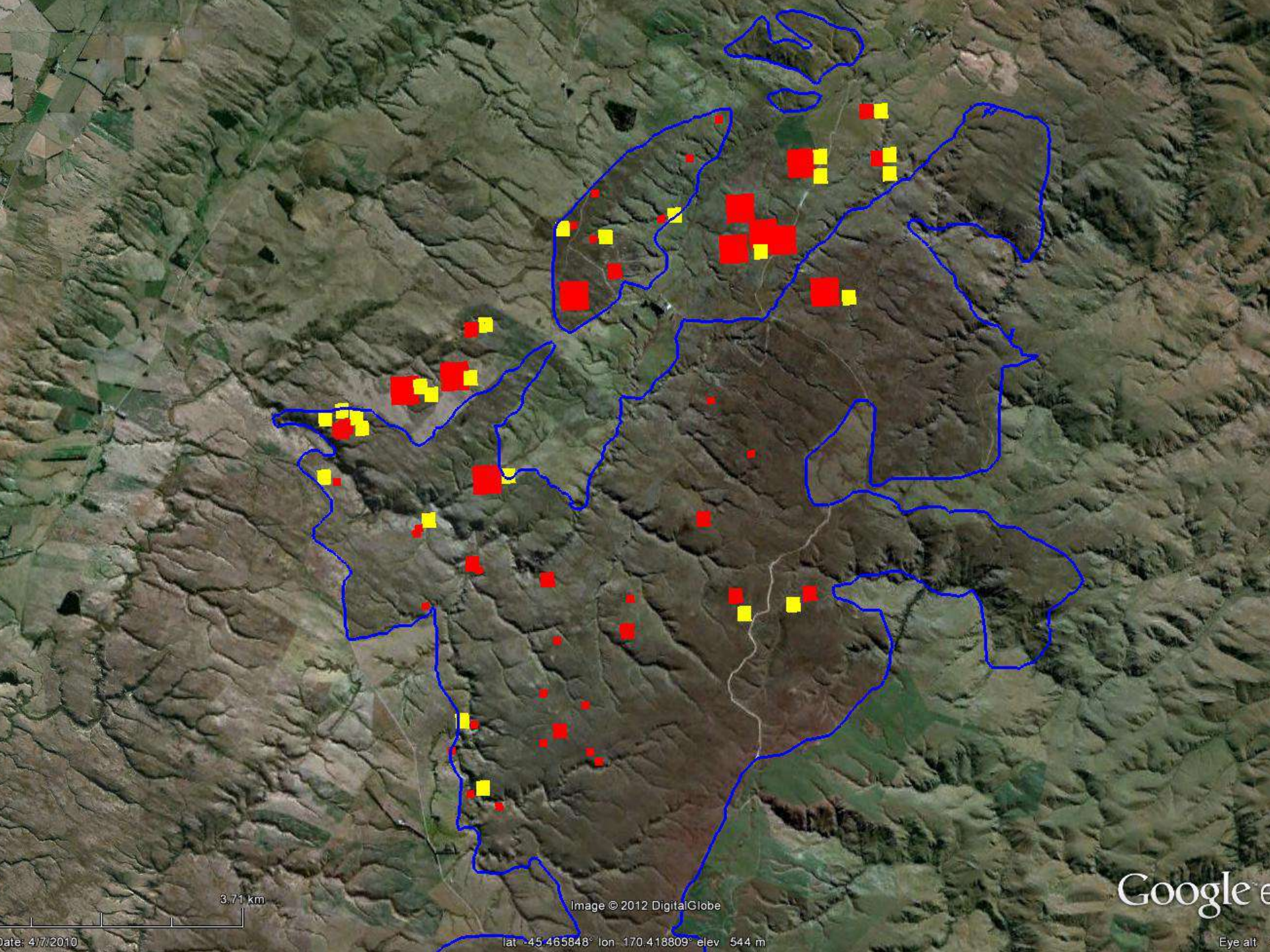




Norbury, Heyward & Parkes (2002)







3.71 km

Image © 2012 DigitalGlobe

Google e

Date: 4/7/2010

lat -45.465848° lon -170.418809° elev 544 m

Eye alt





**Predators are lizard hooverers**



# Predator impact research

- Norbury 2001 (lizards)
- Wilson et al. 2007 (lizards)
- Reardon et al. 2012 (lizards)
- Rebergen et al. (1998) (birds)
- Sanders & Maloney (2002) (birds)
- Starling-Windhof et al. 2011 (birds)



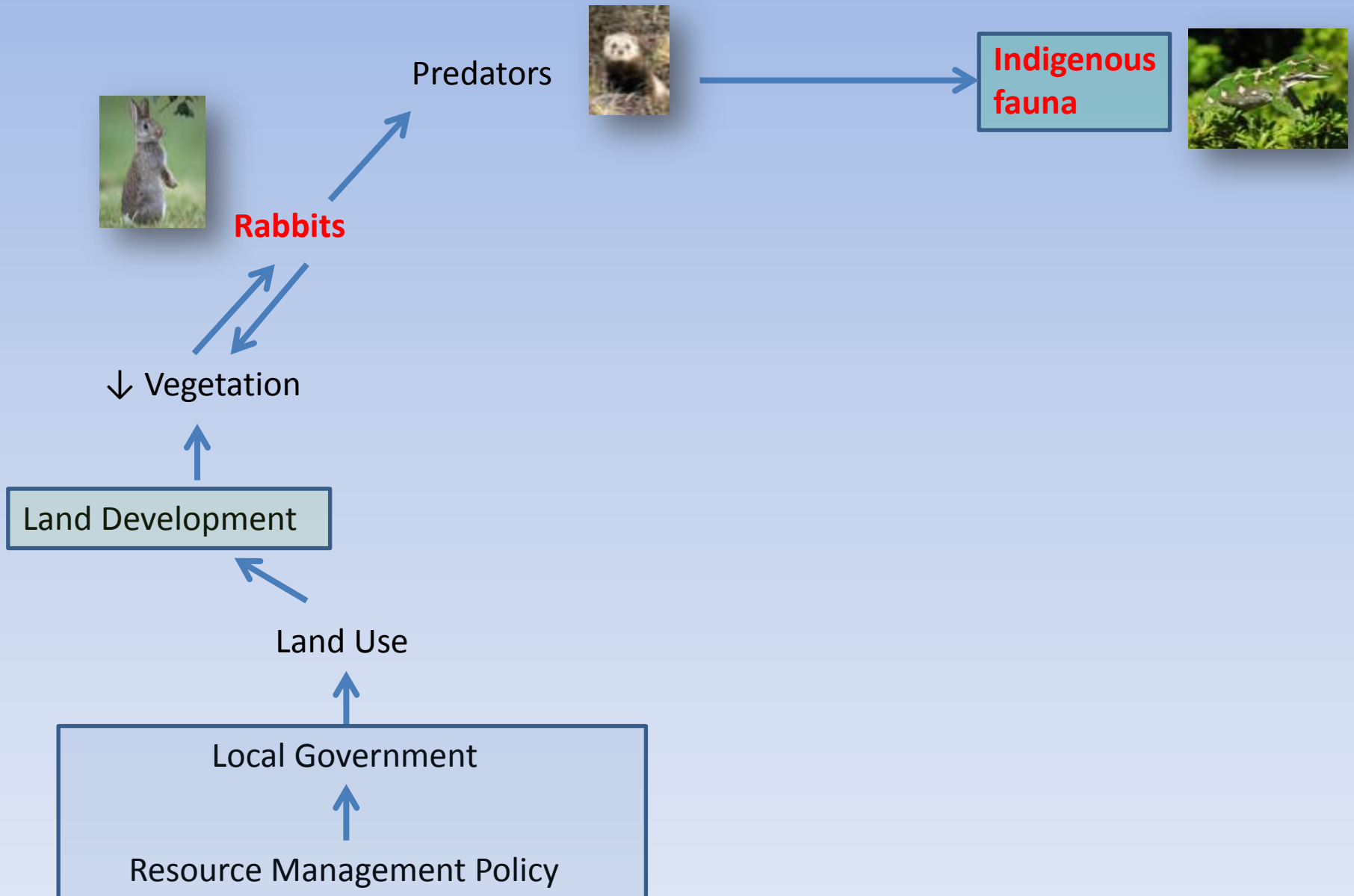


# Hyperpredation





# Socio-ecological interaction web





# Solutions to the rabbit problem

- Population control
- Protect intact ecosystems
- Reduce pressures on modified ecosystems
- *Judicious development*





Protect intact ecosystems  
*(indigenous shrubland)*





# Retire modified ecosystems





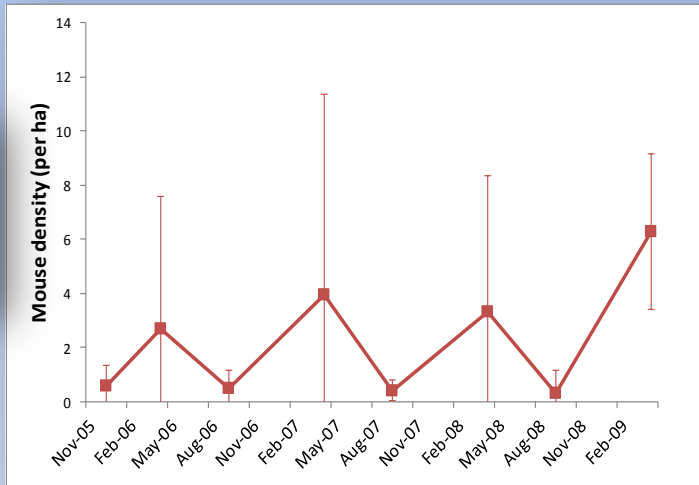
Retired ecosystems produce masses of seed: a windfall for mice!!



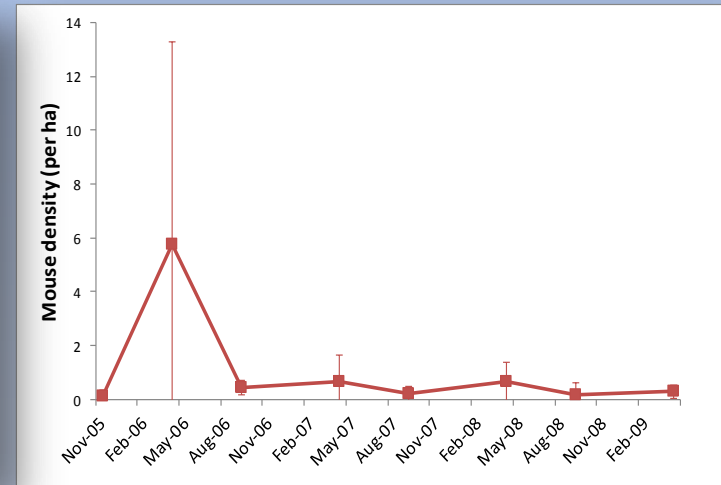


# Mice and pasture seed

## Alexandra

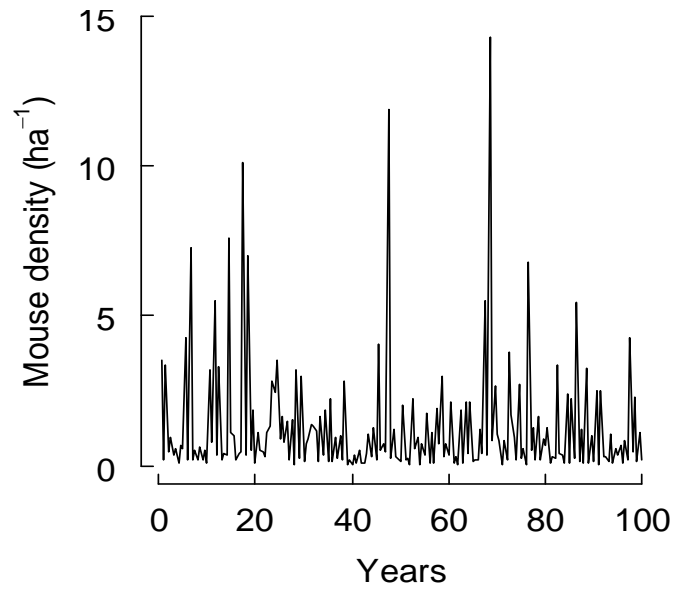


## Macraes

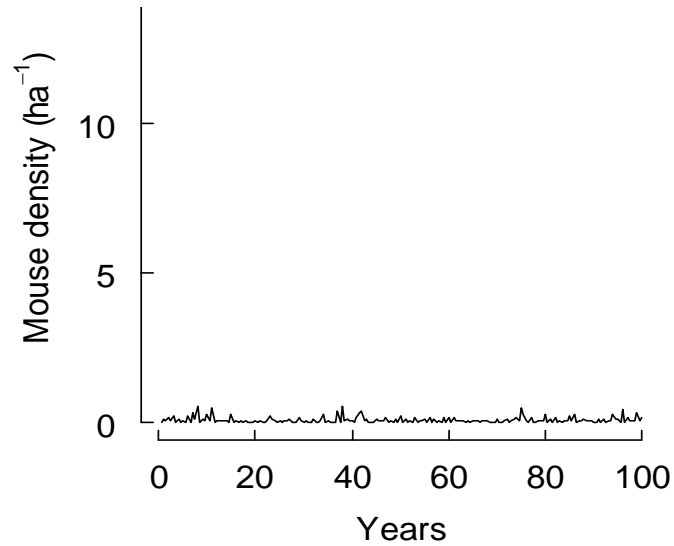




## High seed



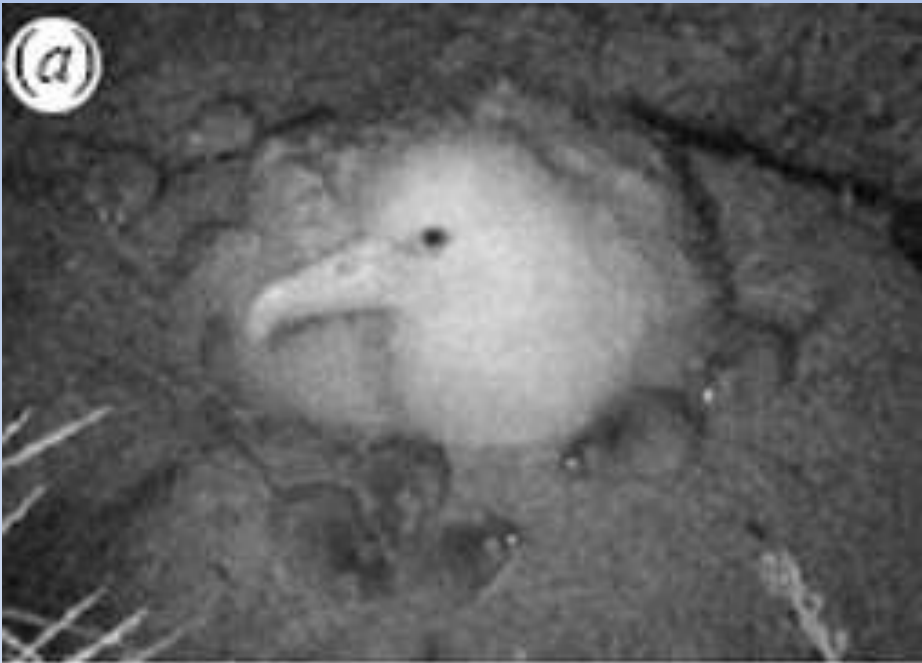
## Low seed





Do we need to worry about  
mice?

# Predation of Atlantic Petrel chicks by house mice on Gough Island



Wanless et al. 2012. Predation of Atlantic Petrel chicks by house mice on Gough Island. *Animal Conservation* 15:472-479.



[http://www.youtube.com/watch?feature=player\\_detailpage&v=ATXFCryzvgU](http://www.youtube.com/watch?feature=player_detailpage&v=ATXFCryzvgU)



# Mouse effects on NZ biodiversity





Norbury G, van den Munckhof M, Neitzel S, Hutcheon A, Reardon J, Ludwig K. (in press). Impacts of invasive house mice on post-release survival of translocated lizards. *New Zealand Journal of Ecology* 38.



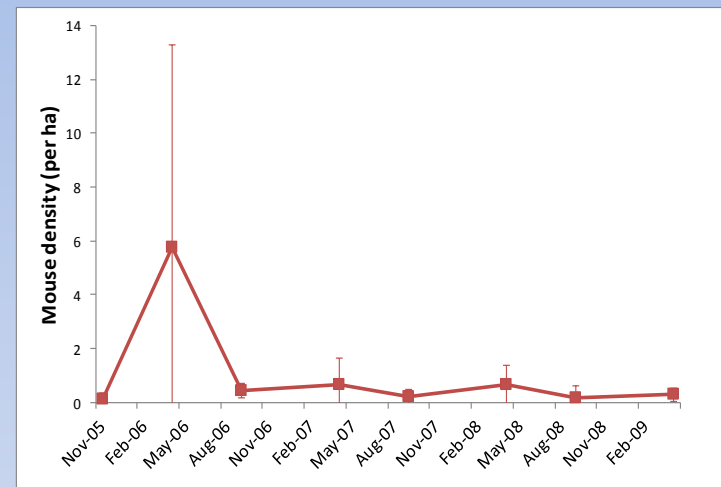
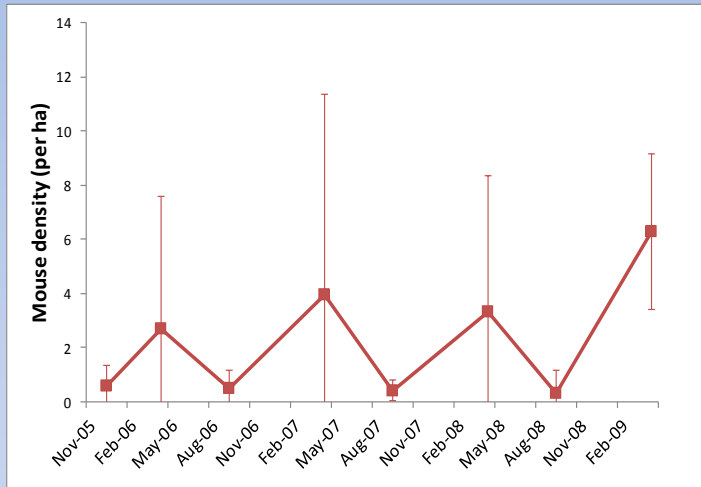


# Mouse impacts on lizards

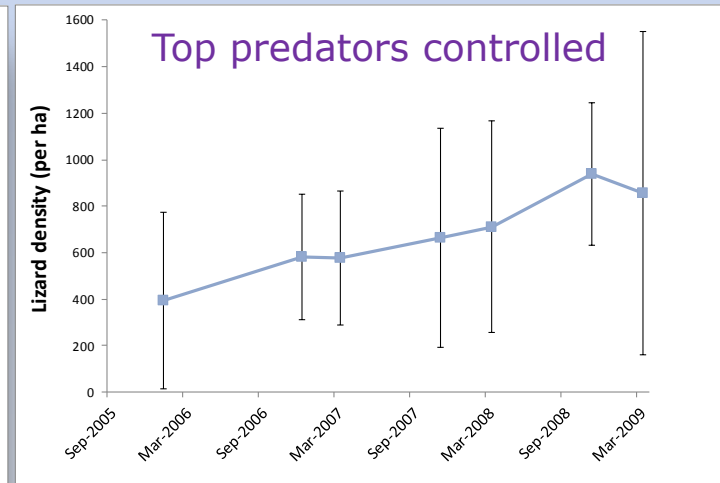
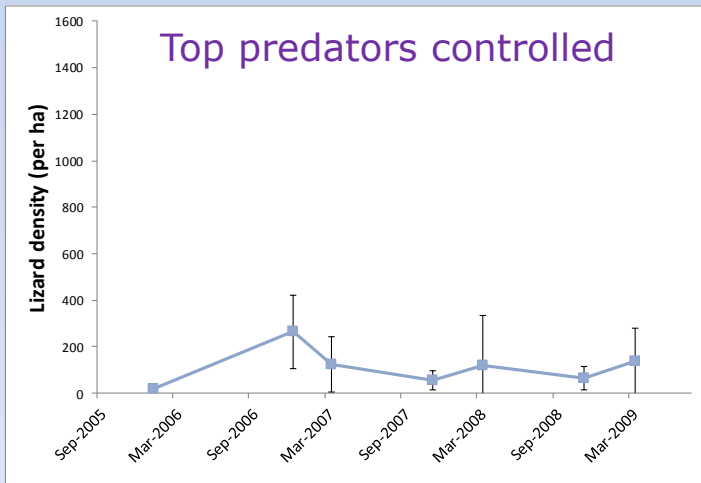
## Alexandra

## Macraes

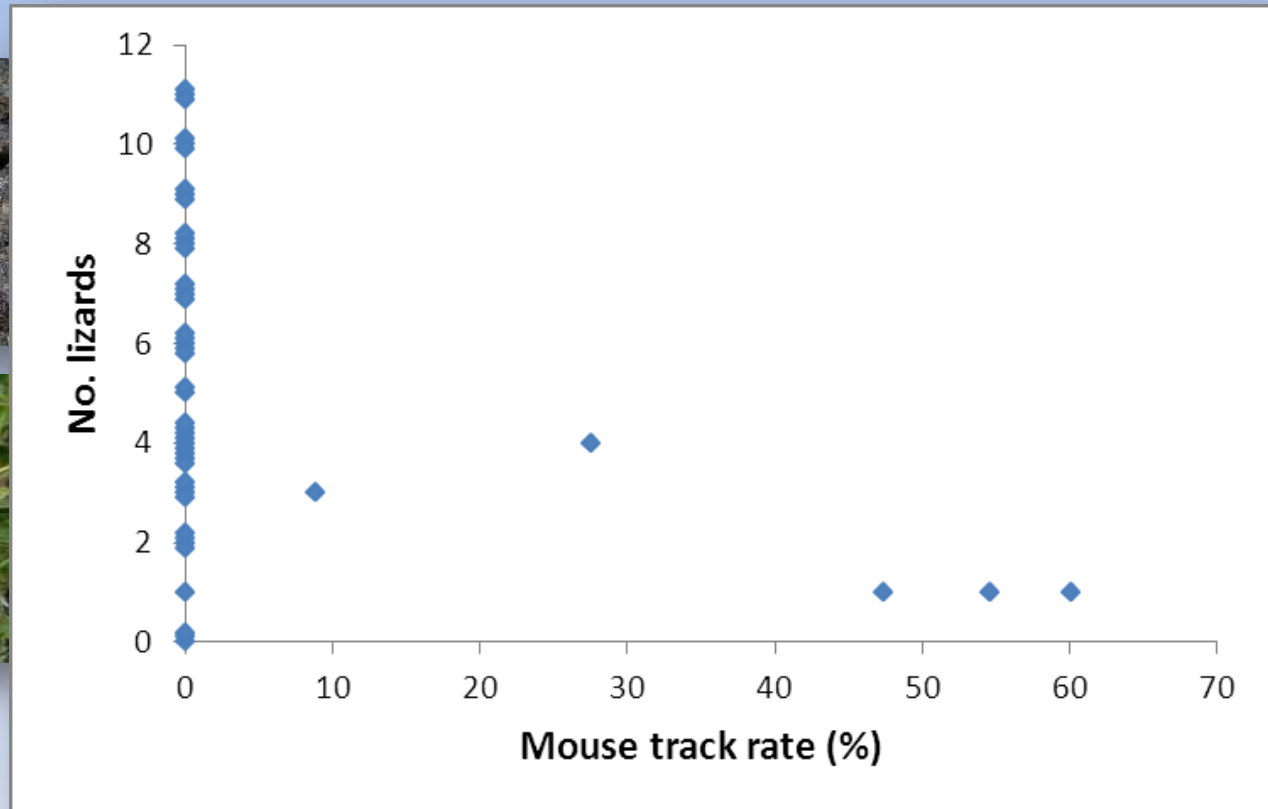
Mice



Lizards

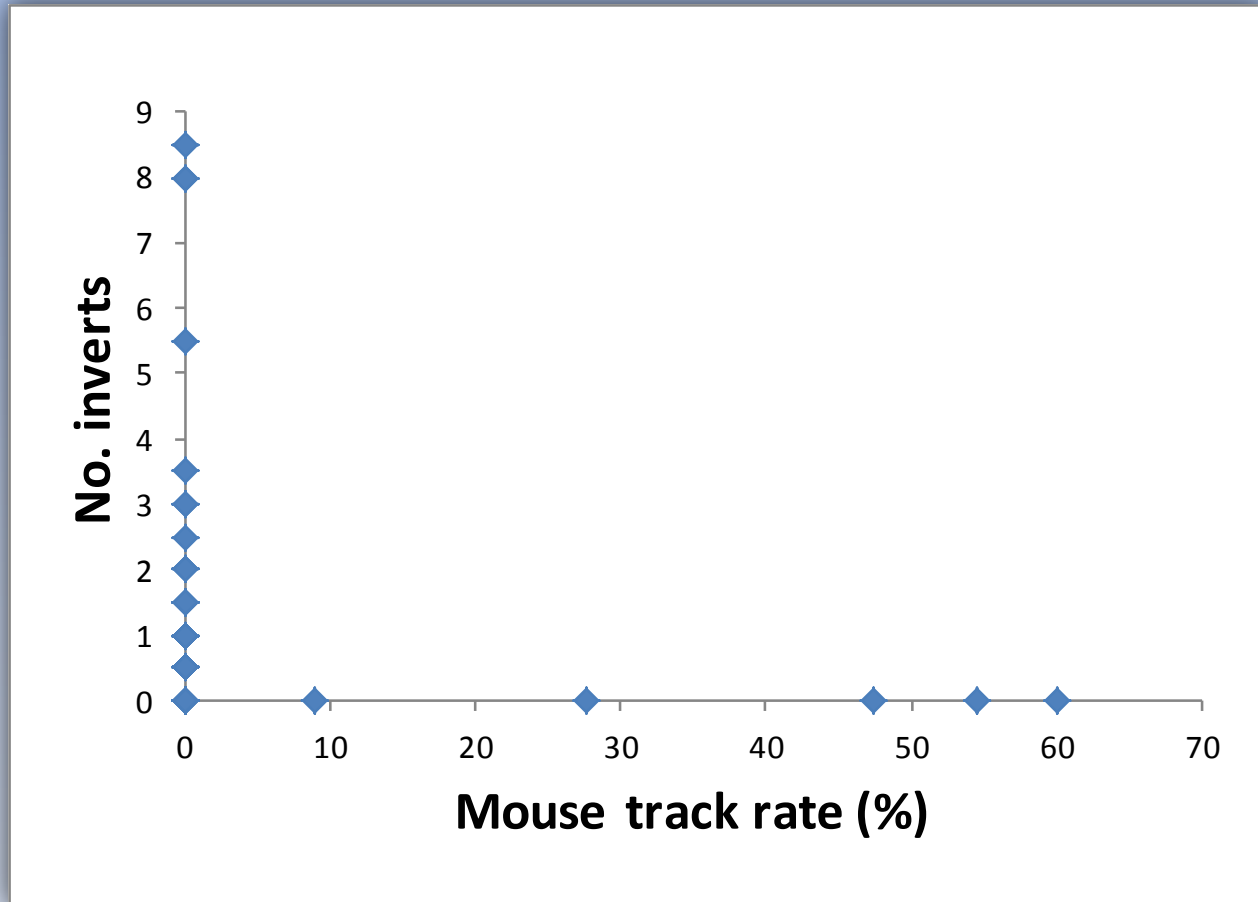


# Mouse impacts on lizards

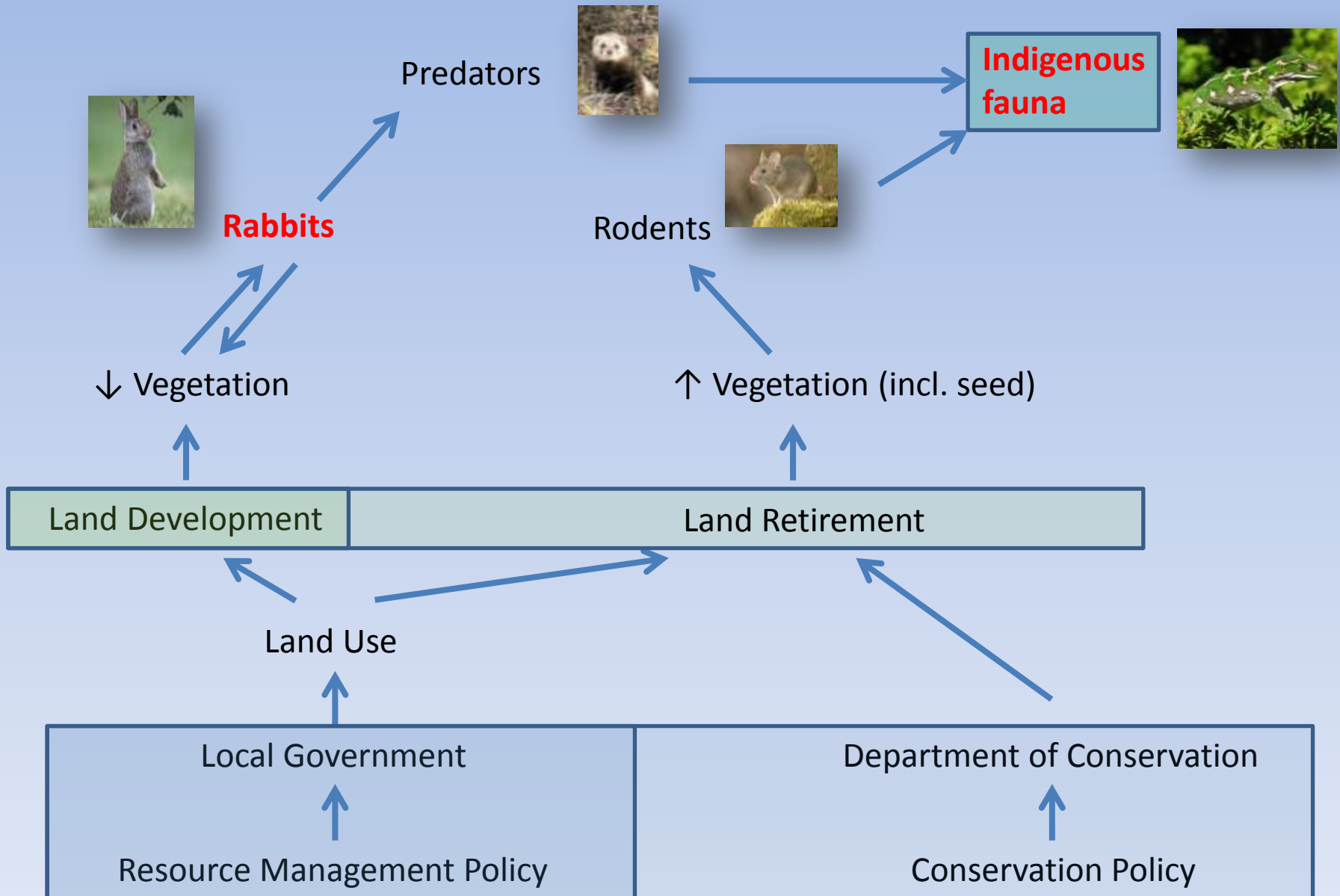




# Mouse impacts on invertebrates



# Socio-ecological interaction web





# Retirement of modified land is generally good

- More perennial vegetation and general increases in species richness at landscape scale

*Walker et al. 2009*

- Thick complex vegetation disadvantages rabbits and top predators

## **The not so good**

- Dense pasture swards and shrubs favour mice
- **Mice are an unmanaged, yet potentially important, player in the recovery of indigenous fauna in grass/shrubland ecosystems**

# 1. Prevent ecosystem destruction

- **Hold onto intact ecosystems**

  - *Up-skill local councils*

  - *Greater awareness of biodiversity values*

  - *Notions of integrating production with conservation are risky in rabbit-prone ecosystems*

# 2. Mitigate effects of land development

- **Landscape-scale control of rabbits**

- **Landscape-scale control of top predators**

# 3. Mitigate effects of land retirement

- **Light grazing using herbivores that don't support top predators**

- **Mouse control in certain situations**



Long-term solutions



- Predictive models
- Resource Management Act
- Judicious grazing
- Judicious grazing



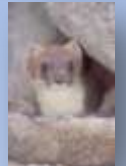
Masting of native trees and tussock



Rodents



Stoats



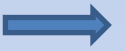
Intensification of land use



Rabbits



Cats & ferrets



Retirement of modified land



Seed



Mice



Retirement of modified land



Shrubs



Possums



Medium-term solutions



Short-term solutions



# General principles

- Restoring biodiversity in modified ecosystems is often constrained by unintended outcomes caused by complex species interactions  
*(Simberloff 2010, Ruscoe et al. 2011)*
- Winners and losers with any management intervention, sometimes involving managed coexistence of indigenous and non-indigenous species in perpetuity  
*(Carroll 2011)*
- Pest management most effective when it employs a long-term, ecosystem-wide strategy rather than a tactical approach focused on individual species  
*(Mack et al. 2000, Zavaleta et al. 2001)*





# Thanks to:

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- **Funders (MoBIE)**
- **DOC and private landholders**

