Online Planning Tools for Determining the Level of Control and Surveillance for Pest Management

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Pest Management in NZ

The Big ‘Three’

- Brushtail possum
- Rats (Norway and Ship)
- Mustelids (Stoats, Ferrets, Weasels)

Also:

- Goats, Hedgehogs, Mice…

Eradication

or

Suppression

Critical Rules For Eradication

1. Animals killed at rate faster than rate of increase
2. Prevent immigration
3. All reproductive animals put at risk

Mary Bomford & Peter O'Brien
(1995) Eradication or control for vertebrate pests
Wildlife Society Bulletin

Rules For Suppression

1. Animals killed at rate similar to rate of increase
2. Immigration is minimised
3. Most animals put at risk

Pest Management

Two main types of activity

1. Lethal control to kill pests

2. Surveillance to prove success

Landscape Scale Control

- How many traps??
- How long to set them for?
- How often should they be checked?

Computer models to simulate control

- Explore effect of different trap regimes:

RStudio

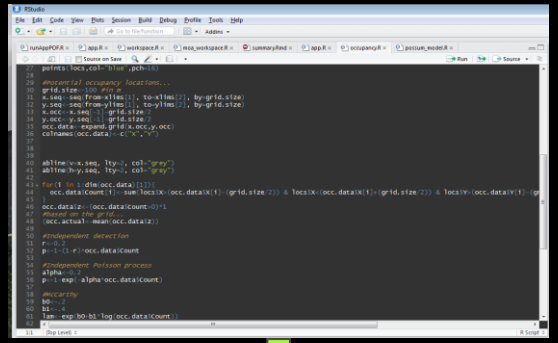
File Edit Code View Plots Session Build Debug Profile Tools Help

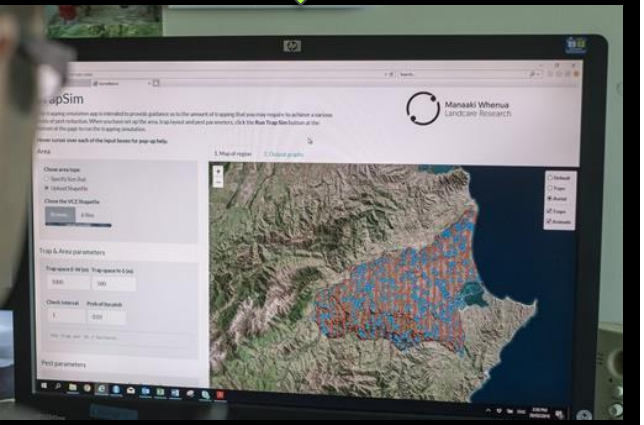
Go to file/function | Addins

runAppPOF.R | app.R | workspace.R | moa_workspace.R | summary.Rmd | app.R | occupancy.R

Source on Save

```
points(locs,col="blue",pch=16)

#Potential occupancy locations...
grid.size<-100 #in m
x.seq<-seq(from=xlims[1], to=xlims[2], by=grid.size)
y.seq<-seq(from=ylims[1], to=ylims[2], by=grid.size)
x.occ<-x.seq[-1]-grid.size/2
y.occ<-y.seq[-1]-grid.size/2
occ.data<-expand.grid(x.occ,y.occ)
colnames(occ.data)<-c("X","Y")



abline(v=x.seq, lty=2, col="grey")
abline(h=y.seq, lty=2, col="grey")

for(i in 1:dim(occ.data)[1]){
  occ.data$Count[i]<-sum(locs$x>(occ.data$X[i]-(grid.size/2)) & locs$X<(occ.data$X[i]+(gr
}
occ.data$z<-(occ.data$Count>0)*1
#based on the grid...
(occ.actual<-mean(occ.data$z))

#Independent detection
r<-0.2
p<-1-(1-r)^occ.data$Count

#Independent Poisson process
alpha<-0.2
p<-1-exp(-alpha*occ.data$Count)

#McCarthy
b0<-.2
b1<-.4
lam<-exp(b0+b1*log(occ.data$Count))
```



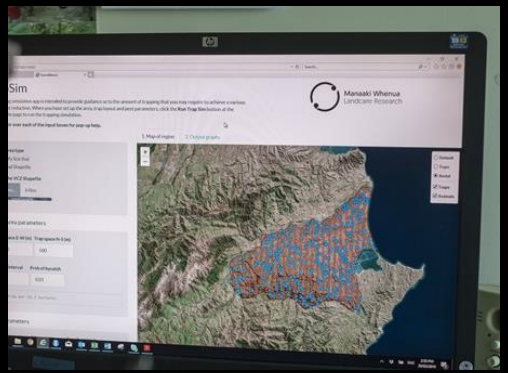


TrapSim

- Simulates the trapping process
- Decision support tool (Ready-reckoner)
- Developed for land managers
- Freely available online

landcare.shinyapps.io/TrapSim

TrapSim



Area

Chose area type

- ○ Specify Size (ha)
- ◉ Upload Shapefile

Chose the VCZ Shapefile

Browse... 6 files

Upload complete

Trap parameters

Chose traps

- ◉ Simulate Traps
- ○ Upload Locations

Trap space E-W (m)	Trap space N-S (m)
100	200

Nights	Check interval	Prob of bycatch
50	1	0.01

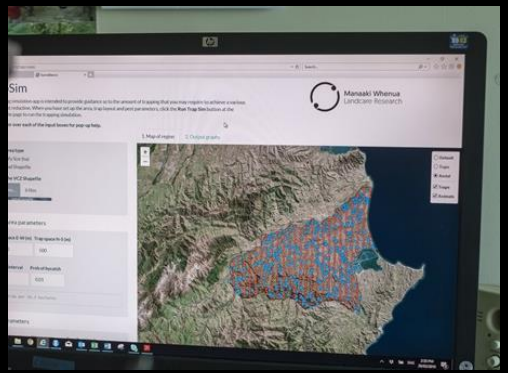
One trap per 21.7 hectares

1. Select Control Area

2. Set trap options:

- Trap layout
- Duration
- Checking interval

TrapSim



Area

Pest parameters

Trap probability (g0)

Mean	StdDev
0.13	0.2

Max SD: 0.34

Home range (sigma)

Mean	StdDev
90	0.2

Home range size: 15.27 ha

Specify animals

- (•) Density
- ( ) Number

Density (per ha)	Carrying capacity (per ha)
0.2	5

Rmax	Start day of reproductive period	Length of reproductive period (days)
0.4	100	60

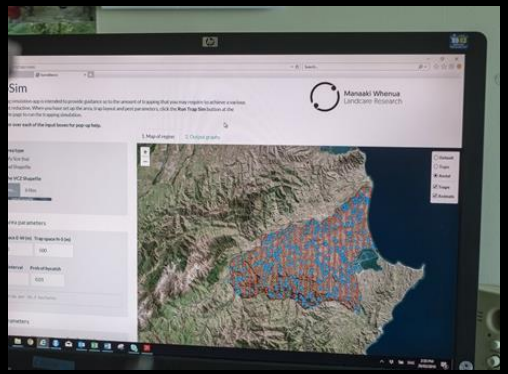
3. Species parameters

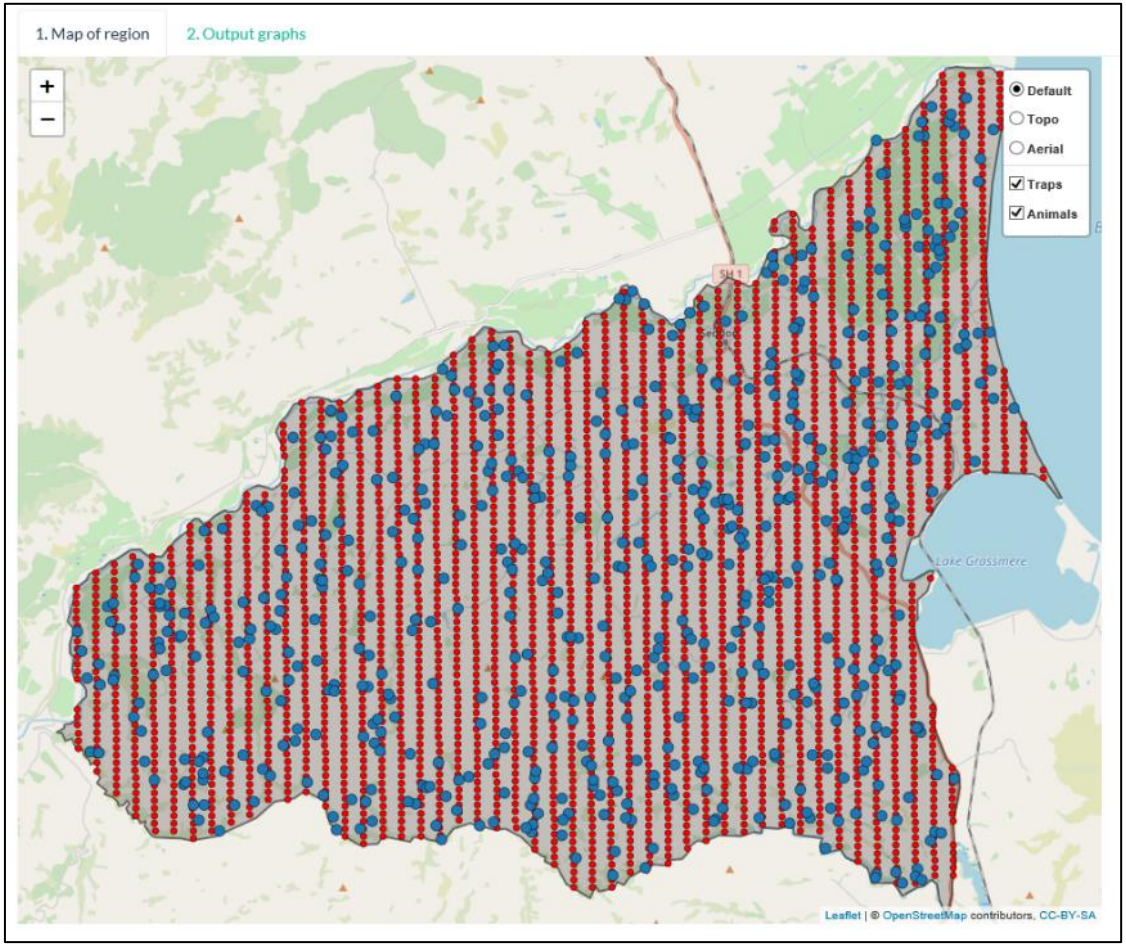
- Probability of capture
- Home range

4. Starting values

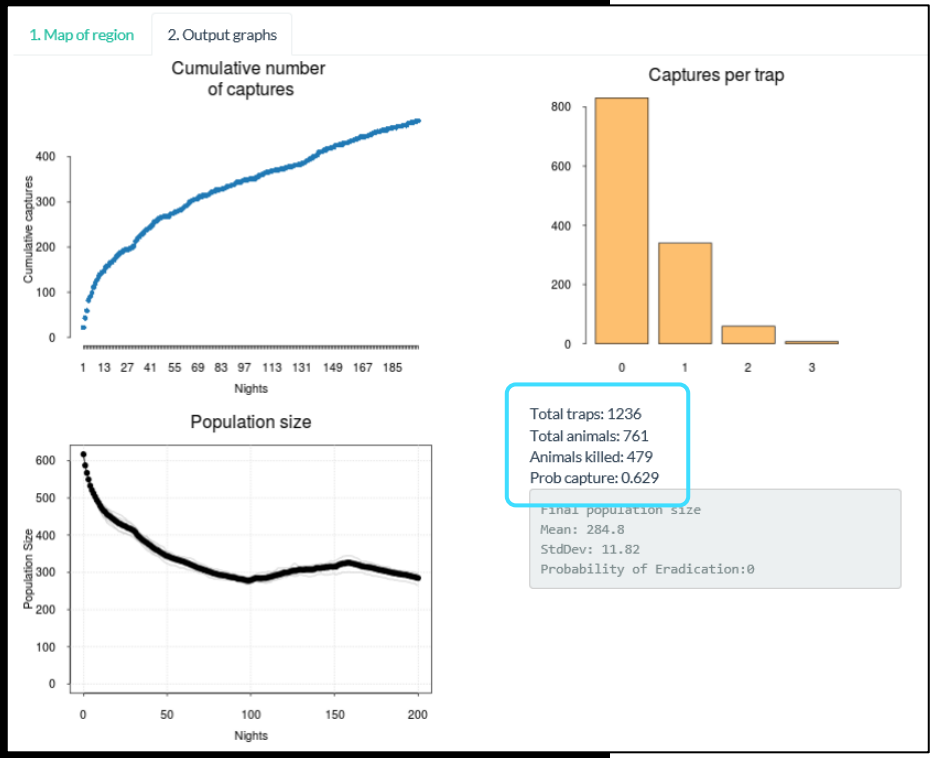
- Density of animals
- Carrying capacity
- Reproductive rate

TrapSim


Sim
Manaaki Whenua
Landcare Research


1. Map of region
2. Output graphs
Default
Topo
Aerial
Traps
Animals
SH 1
Lake Grassmere
Leaflet | © OpenStreetMap contributors, CC-BY-SA

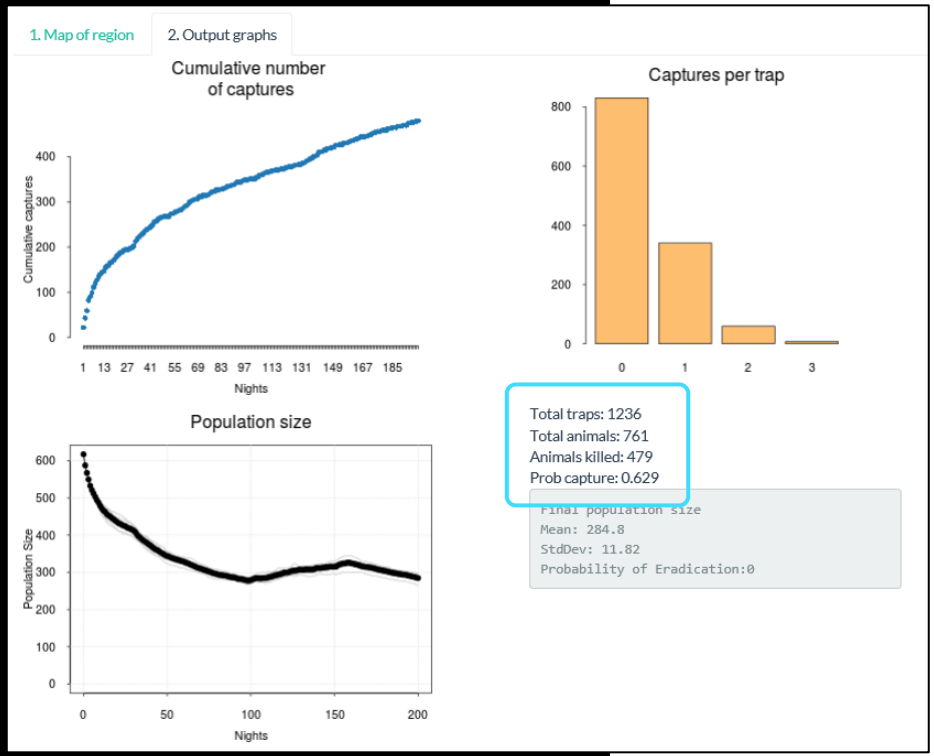
TrapSim

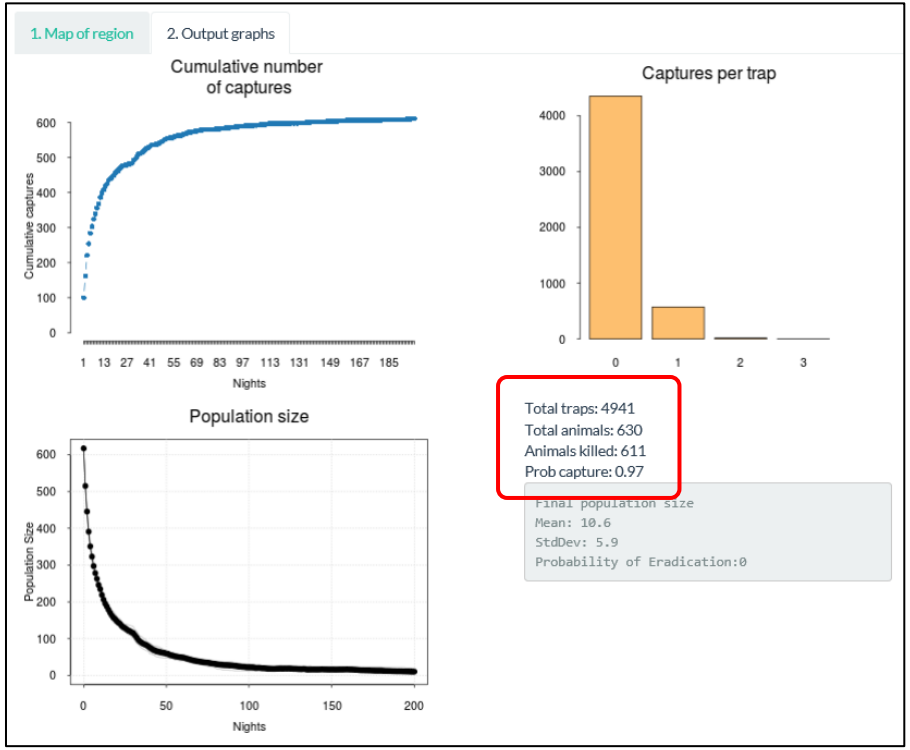


Trap layout not enough for eradication

Therefore re-run with more traps!

TrapSim


1. Map of region
2. Output graphs
Cumulative number of captures
Cumulative captures
Nights
Captures per trap
Population size
Population Size
Nights
Total traps: 1236
Total animals: 761
Animals killed: 479
Prob capture: 0.629
Final population size
Mean: 284.8
StdDev: 11.82
Probability of Eradication:0


1. Map of region
2. Output graphs
Cumulative number of captures
Cumulative captures
Nights
Captures per trap
Population size
Population Size
Nights
Total traps: 4941
Total animals: 630
Animals killed: 611
Prob capture: 0.97
Final population size
Mean: 10.6
StdDev: 5.9
Probability of Eradication:0

TrapSim

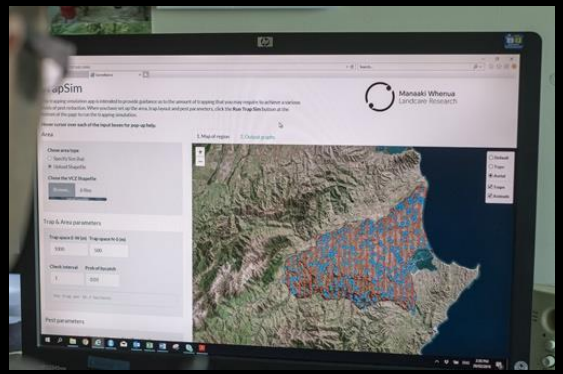
- Free, and online

  landcare.shinyapps.io/TrapSim

- Can provide valuable insights

- A simplification of reality

- Current work to include:
  - Immigration/Emigration
  - Habitat differences
  - Seasonal effects
  - Costs of control
  - Improve computational efficiency



Pest Management

Two main types of activity

1. Lethal control to kill pests

2. Surveillance to prove success

Outcomes

Surveillance for Eradication

1. Find the pest
   - Not eradicated!

   - Do more control

Outcomes

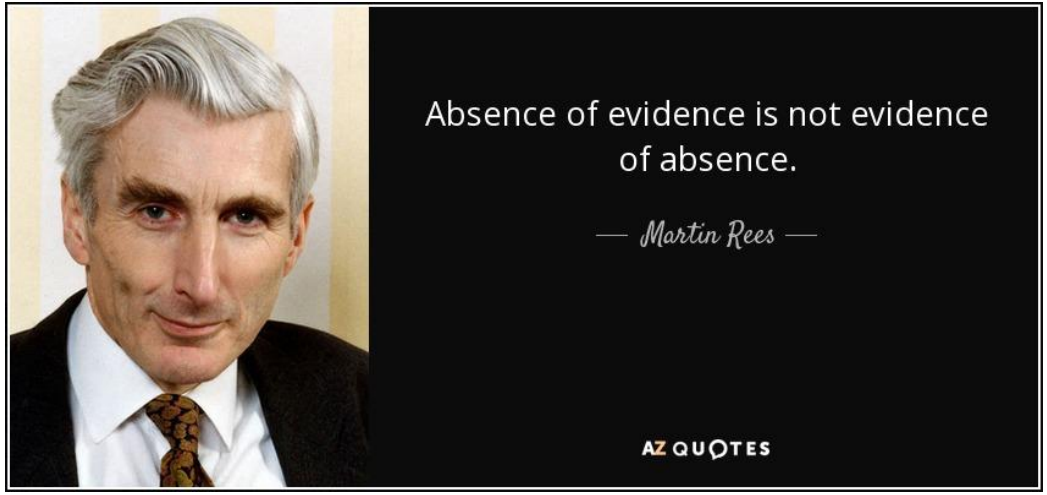
2. Do not detect it

- Eradicated ?

Or

- We didn't look hard enough ?

Surveillance for Eradication



Surveillance Outcomes

Our conclusion depends on:

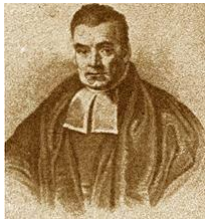
1. How sure are we that we have eradicated?

2. How hard did we look?

3. How confident do we want to be?

Bayes' Theorem

$$PoA = \frac{Prior}{1 - SSe \times (1 - Prior)}$$



Thomas Bayes
1701-1761

1. **Prior:** probability species was eradicated before we looked (Starting value)

2. **SSe:** (System-level sensitivity)
   Chance of finding species if it is still present

3. **PoA**: Probability of Absence (Stopping value)

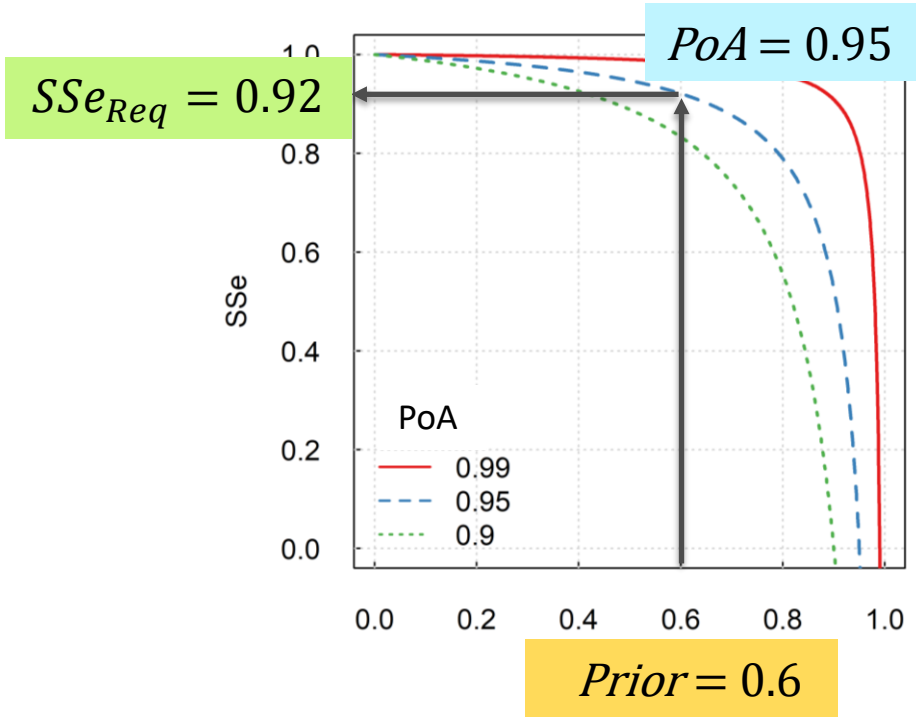
How much surveillance to we need to do?

If we can specify the :

Prior – starting value

PoA – stopping value

Then we can calculate required surveillance



How much surveillance to we need to do?

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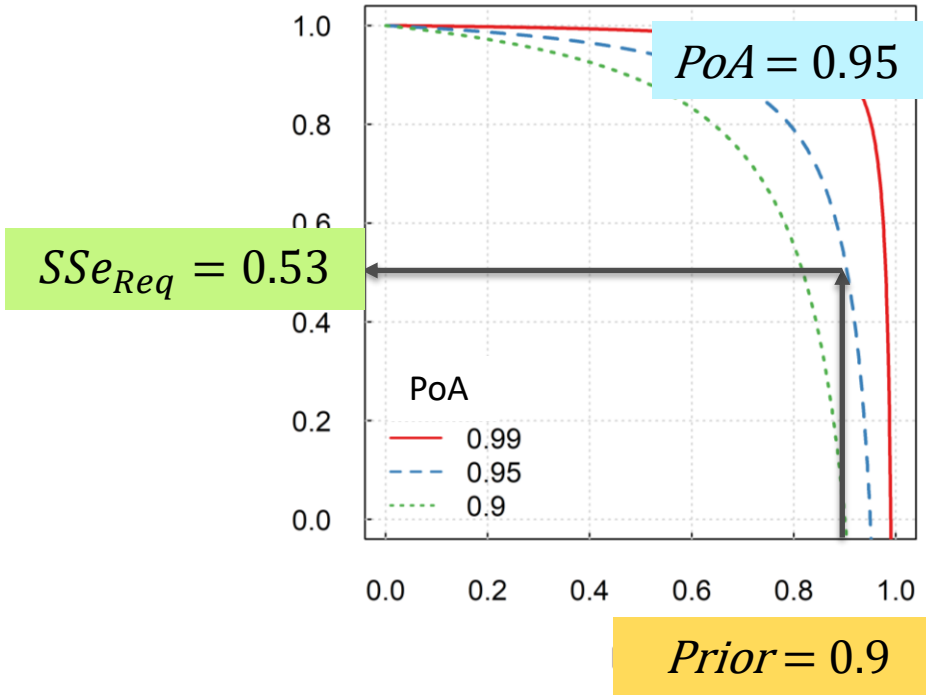


Converting SSe to a Surveillance Network

- How many devices is that?
- How long should they be deployed for?

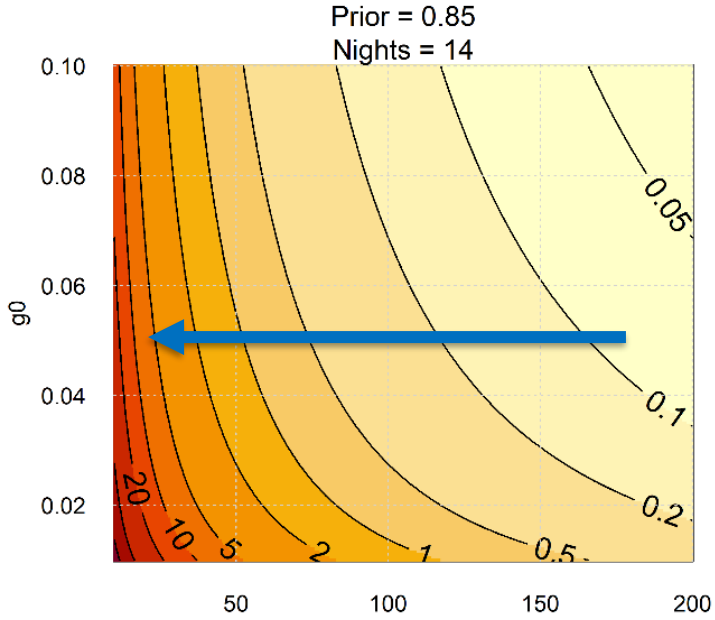
$$SSe_{Req} = 0.53$$

Traps per Hectare

We need to know:

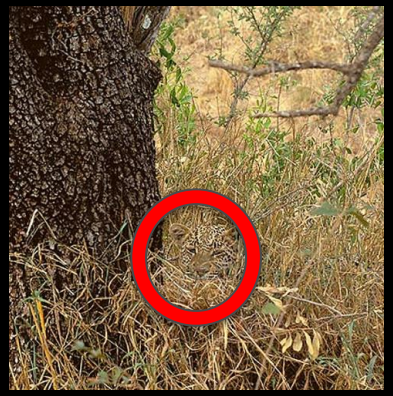
1. Home range

Smaller home range requires more surveillance



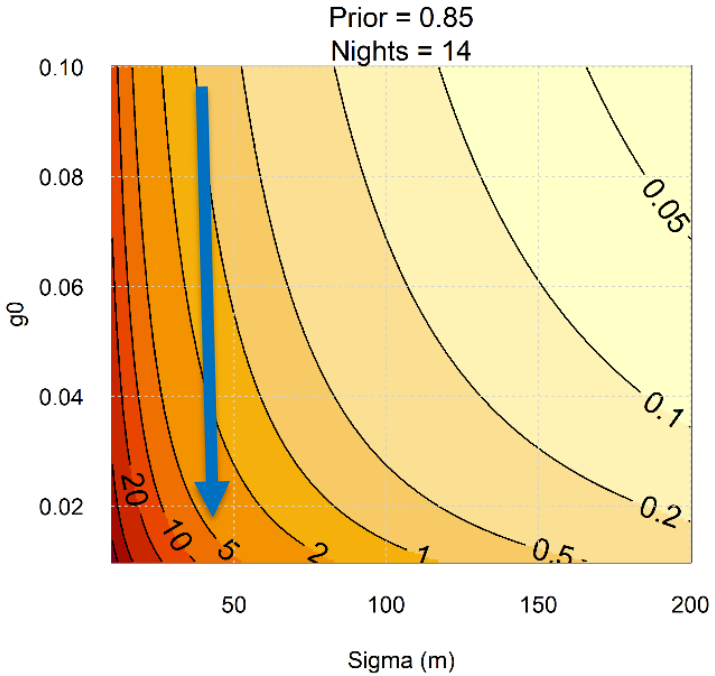
We need to know:

2. Probability of capture/detection



Traps per Hectare

Lower detectability requires more surveillance

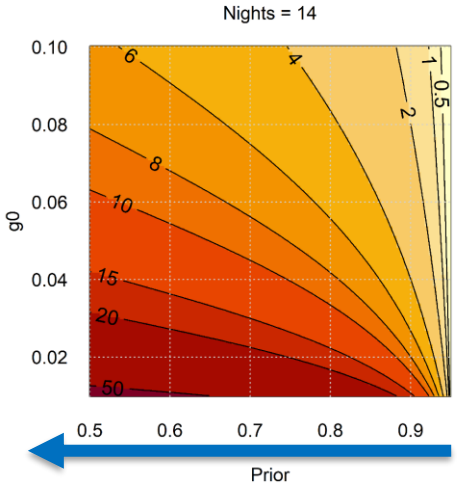


Amount of Surveillance Depends on

Prior probability

- Lower prior requires more surveillance

Traps per Home range



Amount of Surveillance Depends on

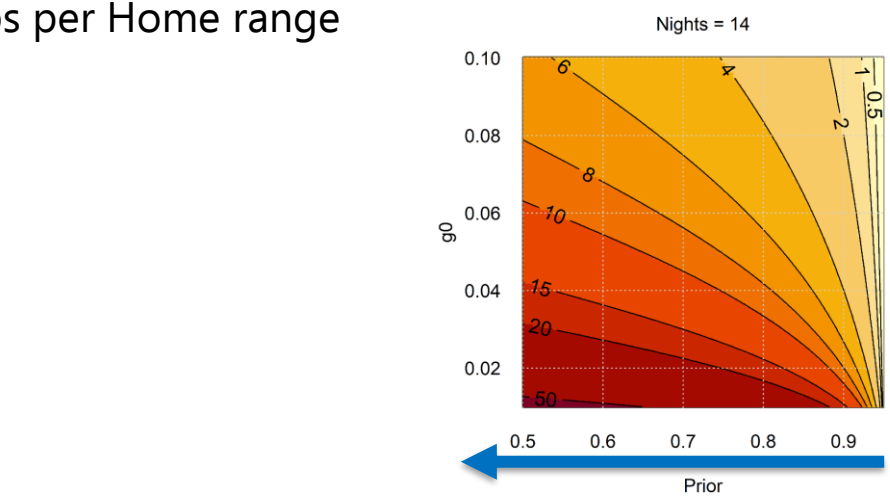
Prior probability

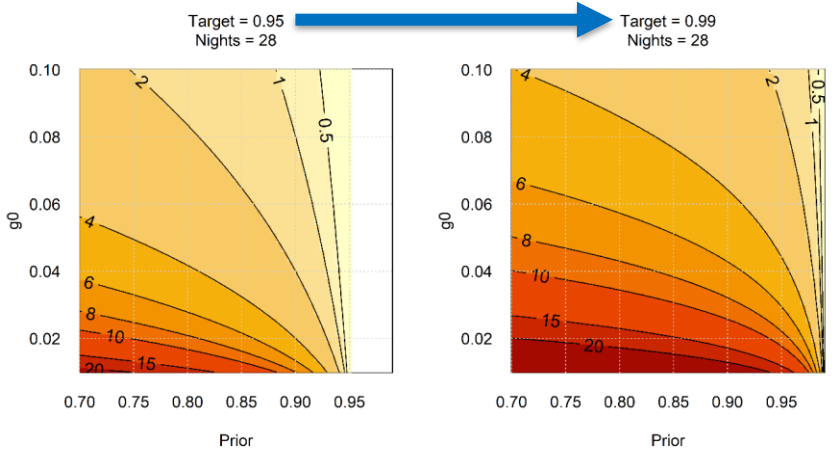
- Lower prior requires more surveillance

Stopping Target

- Higher stopping target requires more surveillance

Traps per Home range

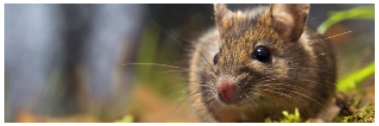




Tools for Planning Surveillance

JESS For Pests

Just Enough Surveillance Sensitivity: Planning tool for proving species absence



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☐ Show background information

Step 1: Estimate the minimum amount of surveillance needed to achieve the required system-level sensitivity to achieve the target PoA.

Decision Parameters

Prior Probability of Absence (PoA)

Prior	Target
0.8	0.95

SSe required = 0.789

Design prev.

1

Device Parameters

g0	Nights
0.13	12

Sigma (m)

90

Minimum Surveillance

Approximate number of devices to get from the prior to the target PoA.

180 devices
0.2/ha

Treatment Area

Area

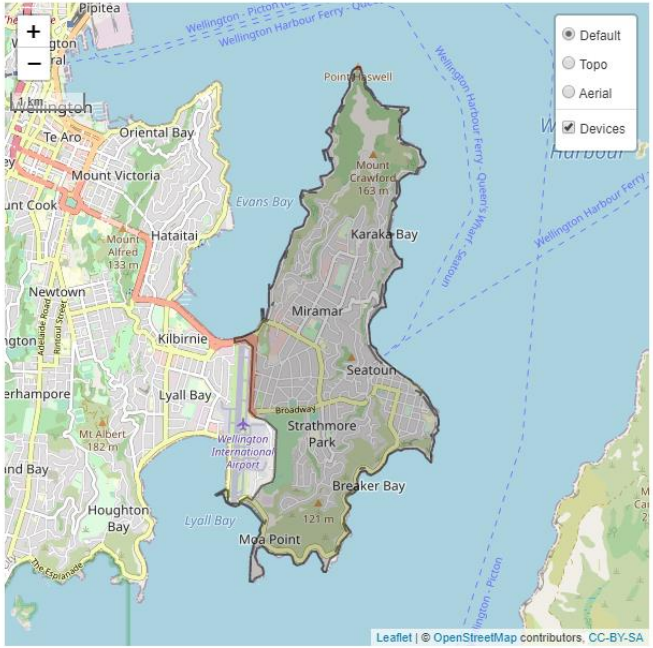
- ○ Specify Size (ha)
- ◉ Upload Shapefile

Chose the VCZ Shapefile

BROWSE... 6 files

Upload complete

Area = 916 ha



landcare.shinyapps.io/JESS4Pests

Step 2: Plan surveillance by changing the device layout to match the required SSe.

Surveillance Planning

Target = 180 devices.

Device data

(•) Simulate ( ) Csv file

X-spacing (m) Y-spacing (m)

500 500

Buffer (m)

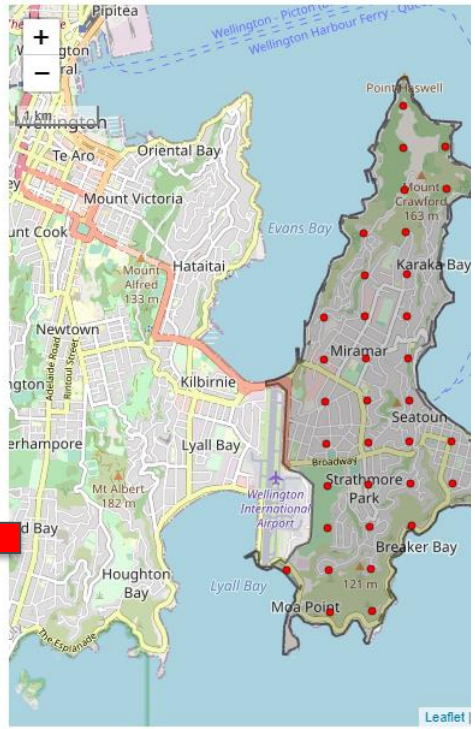
5

Results

34 devices, (0.037/ha)
SSe = 0.204
PoA = 0.834

Map display

( ) Static (•) Zoomable



Step 2: Plan surveillance by changing the device layout to match the required SSe.

Surveillance Planning

Target = 180 devices.

Device data

(•) Simulate ( ) Csv file

X-spacing (m) Y-spacing (m)

200 200

Buffer (m)

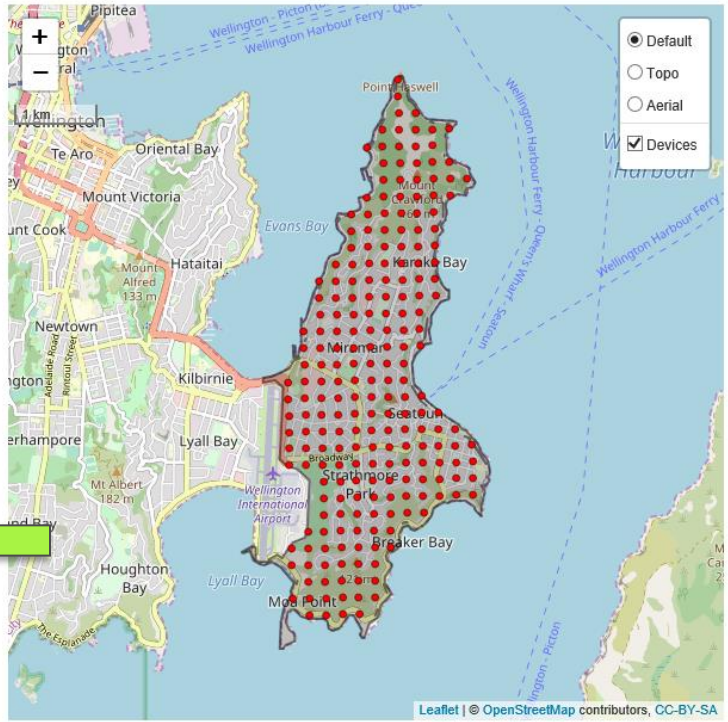
5

Results

225 devices, (0.246/ha)
SSe = 0.828
PoA = 0.959

Map display

( ) Static (•) Zoomable



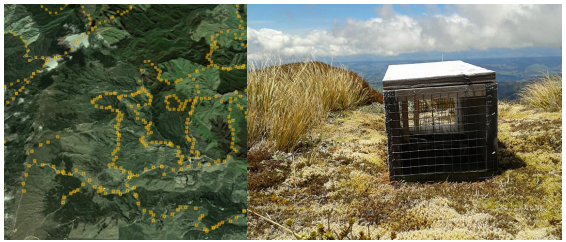
Online Decision Tools

landcare.shinyapps.io

- Simplifications of reality
- More sophisticated methods are available but require researchers to run them
- A useful first step for planning control and/or surveillance activities

TrapSim

- Simulate pest control at landscape scale
- Can help determine level of control



JESS4Pests

- Can help plan level of surveillance needed to confirm eradication

Acknowledgements

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- Dean Anderson, Audrey Lustig, Simon Howard, Bruce Warburton, Cecilia Latham, Rachelle Binny, Chris Jones (MWLR)
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