Predictive models and new surveillance & treatment methods

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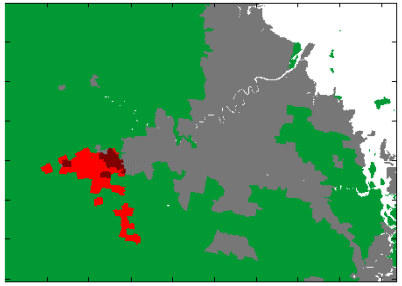
Terminology

Surveillance technology
- sensor, platform

Surveillance scheduling
- method for choosing where & when to search



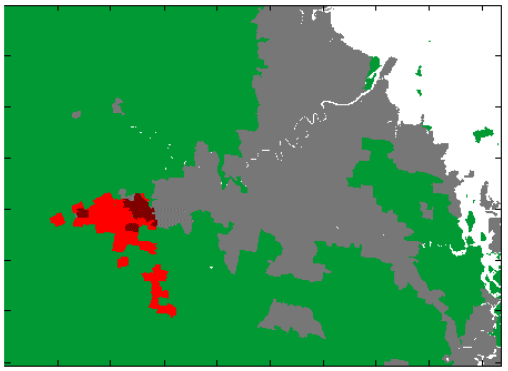
Map of Brisbane

Detectability of RIFA
- probability of finding colony/individual where present
- Depends on: sensor, colony attributes (size, no.), environ.

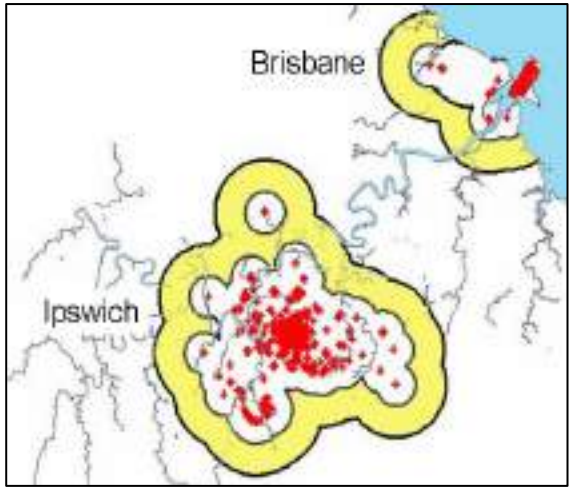
Surveillance coverage
- proportion of area of interest searched/yr

Surveillance Strategy

- Combination of technology & scheduling method
  - **EG 1:** remote sensing once/yr over entire AOI & sniffer dogs in places selected with remote sensing



- **EG 2:** Citizen monitoring continuously over entire AOI & sniffer dogs within specified buffer around nests



Predictive models

What they do

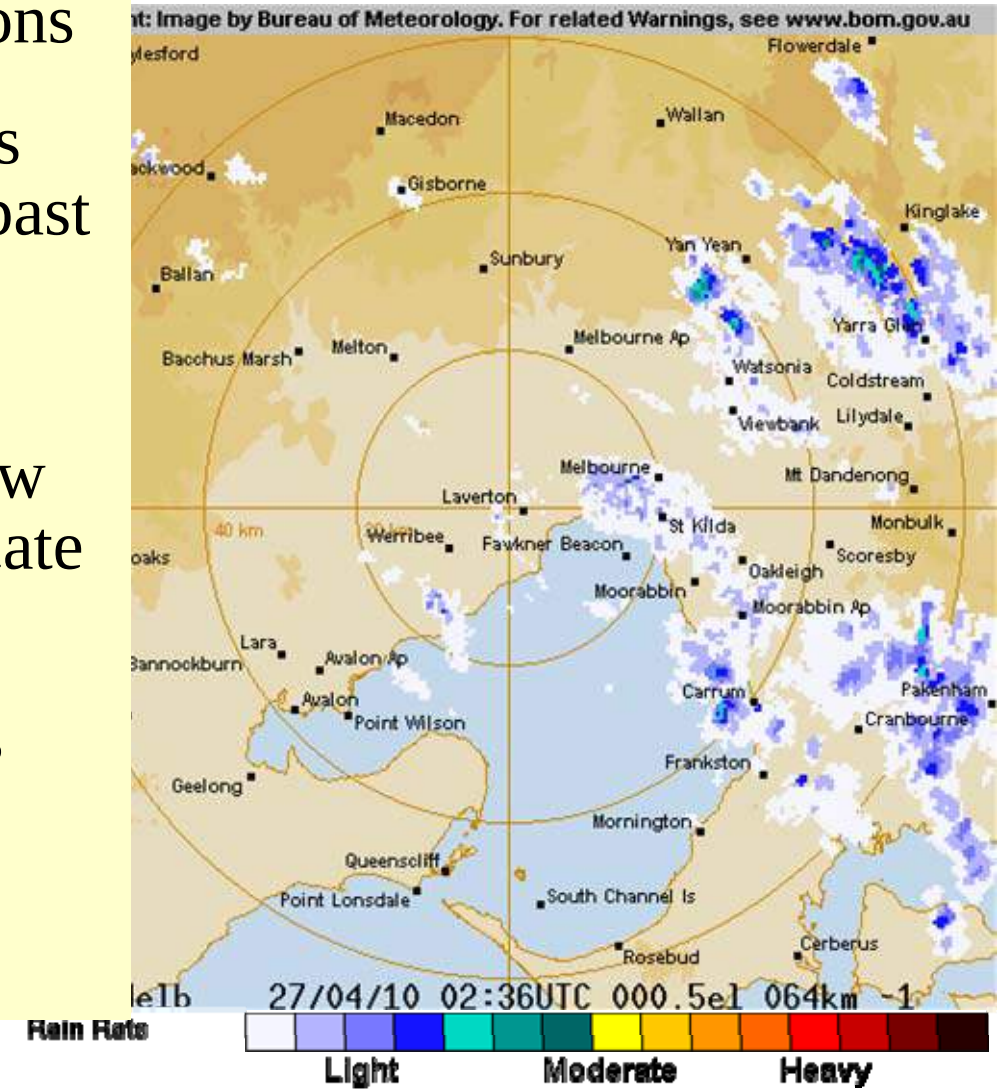
- Predict areas where individuals likely to be present

How they are used

- To help target search/treatment effort

Predictive Models - A Weather Analogy

- Identify current rain locations
- Predict future rain locations based on past locations & past movement
- RIFA colonies stay in one place for long time - if know recent locations, can eradicate
- But only some locations searched & not all colonies detectable
  - – so prediction useful



Predictive accuracy, search and treatment

- If perfectly predict all individuals, no need for:
  - High-tech surveillance technologies
  - Search scheduling
  - Broad-bait treatment
  - Just need nest injections (if 100% mortality)

- **Real world**: Cannot perfectly predict - can only predict areas where some individuals are present. How to find/remove remaining individuals?
  - Search/treat larger area than actually infested
  - How much larger?

Main Questions in Eradication Programs

1. Is eradication feasible?

2. What search-treatment technologies & scheduling method gives greatest probability of eradication?

3. What uncertain parameters affect 1 & 2 most?
    - Helps to guide research efforts

Monash Models

Model 1: Schmidt, Spring et al. ***(in press, Ecol Apps)***

Model 2: Report to BQCC

Models Used To Assist Biosecurity Queensland Control Center

1. Estimated eradication feasibility

2. Identified improved search-treatment strategies

3. Identified uncertain biological parameters that has biggest effect on eradication feasibility and best eradication strategy

Approach

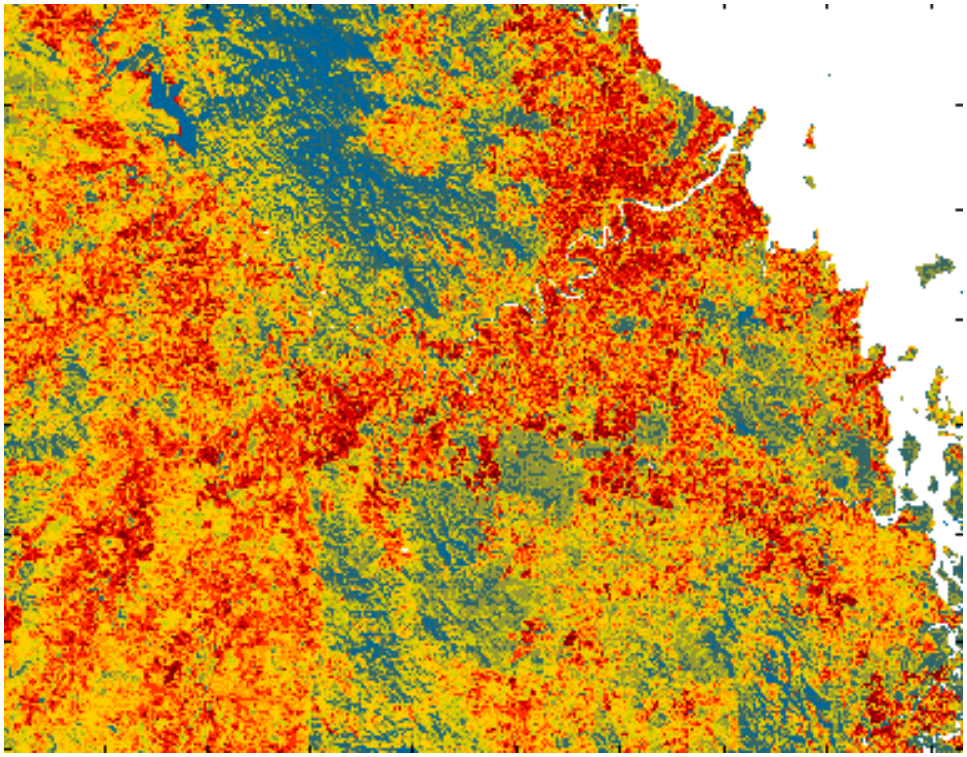
1. Estimated RIFA reproduction & dispersal
   - Used statistical model in absence of direct observations of movement
   - Made assumptions about biological parameters
     - Eg: colony clusters originate from single queen
     - Inbreeding occurs so only 1 nest for invasion spread
2. Simulated reproduction & dispersal under different search and removal strategies

Types of data used

- Spatial data
- Other data
  - Treatment mortality
    - Broadbait – aerial, ground, ATV
    - Nest injection
  - Search sensitivity
  - Search & treatment costs/ha

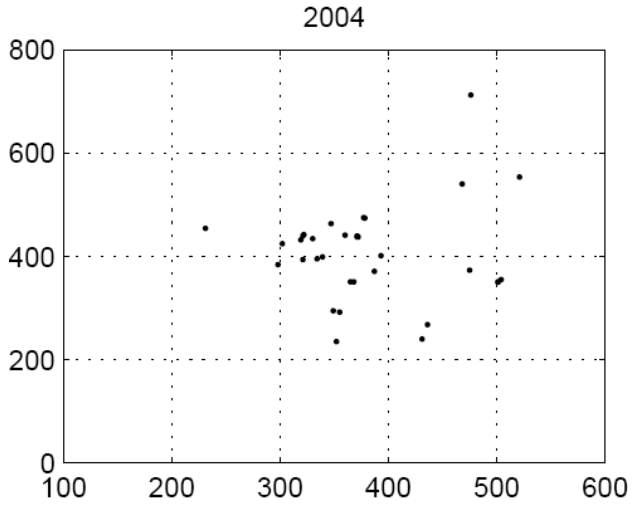
Spatial Data

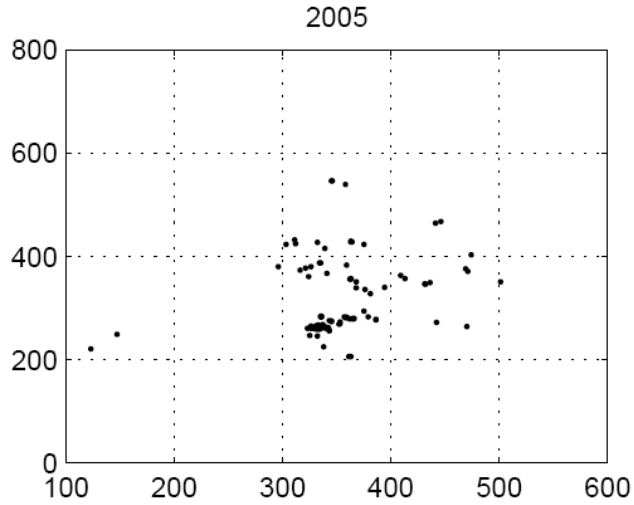
Habitat Suitability

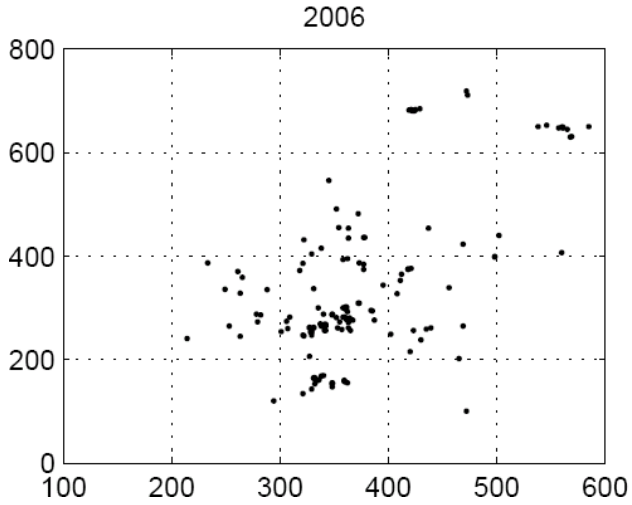


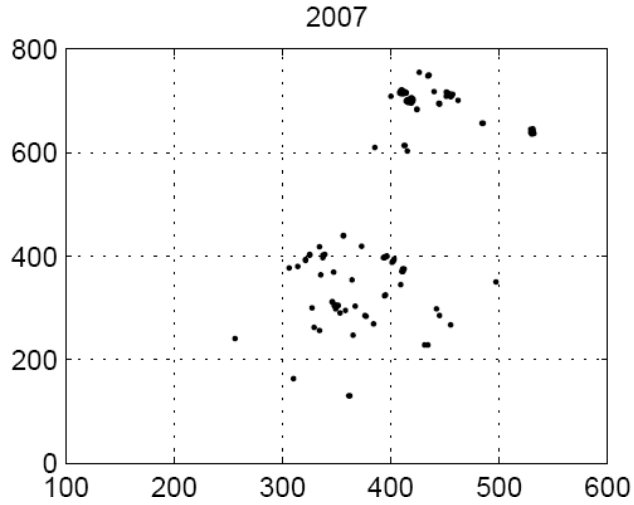
- red represents highest suitability for fire ants, estimated by R. George

Search & Detection Maps 2001 - 2009







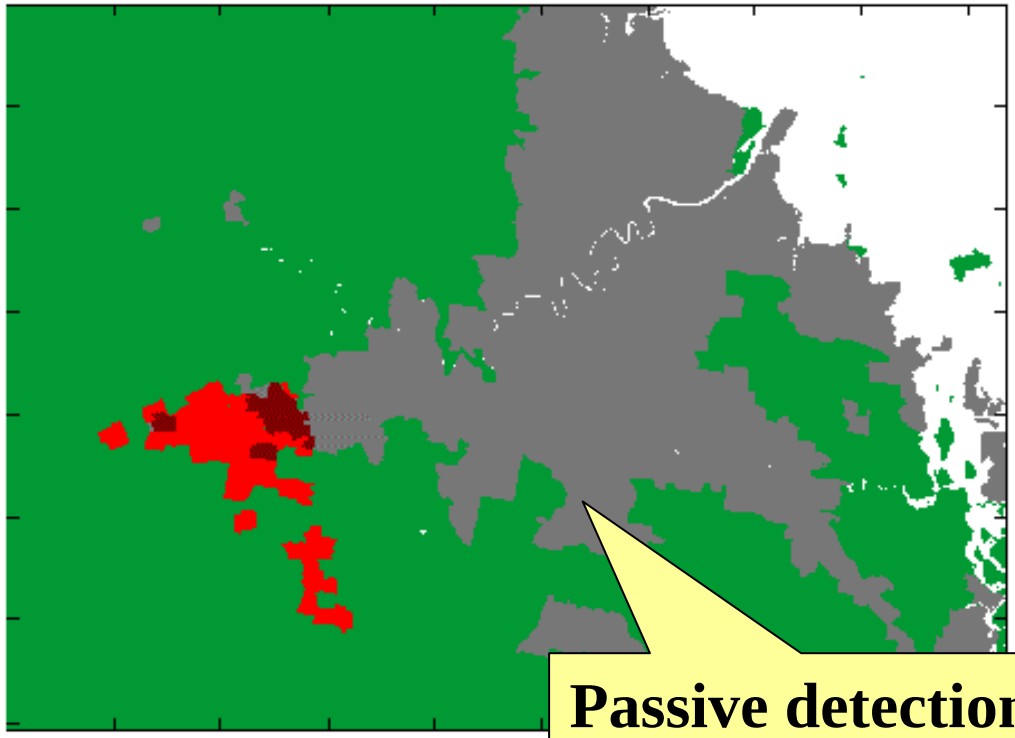


Urban-rural map

Rural

Urban

Amberley

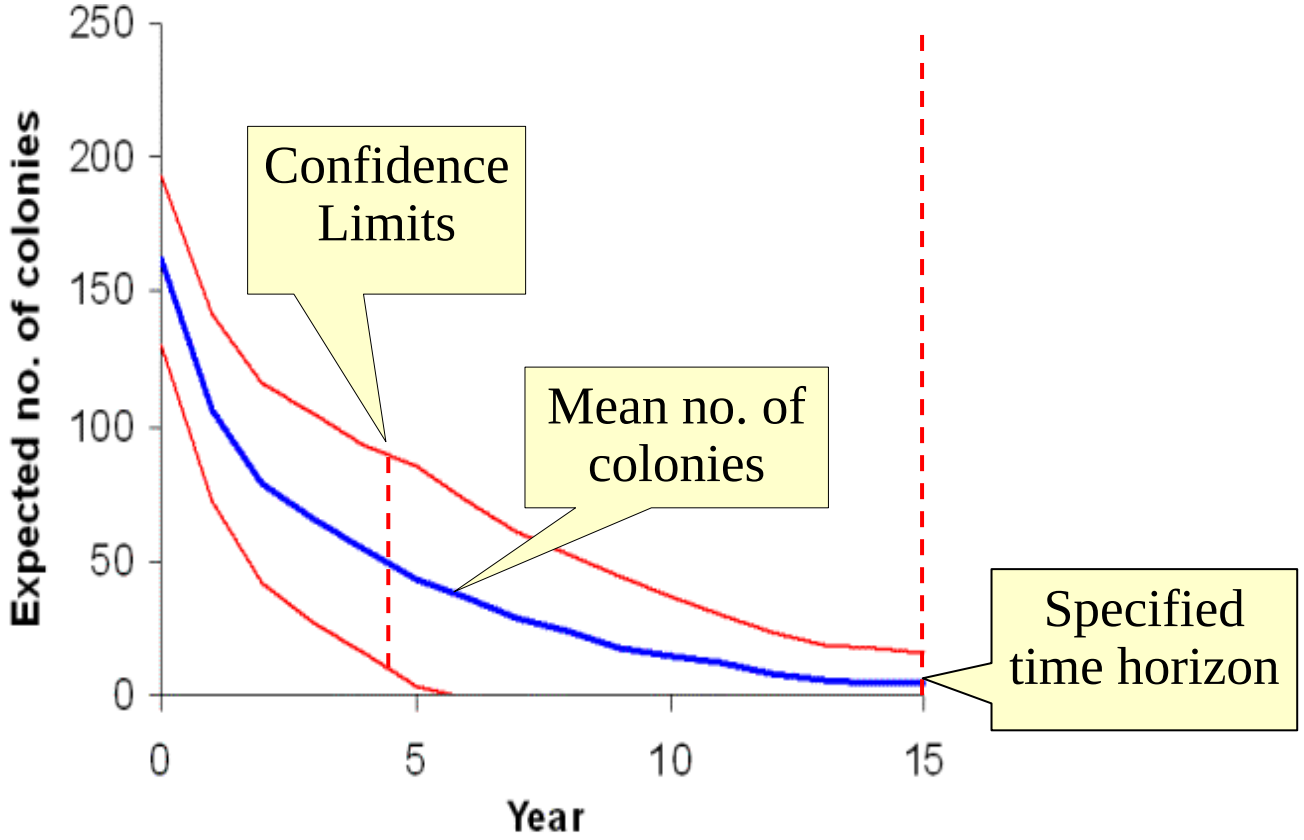


Passive detections more likely to occur in urban areas

Prediction

Biology + management effectiveness → spread prediction

(growth, dispersal) + (search/treatment effect.) → spread

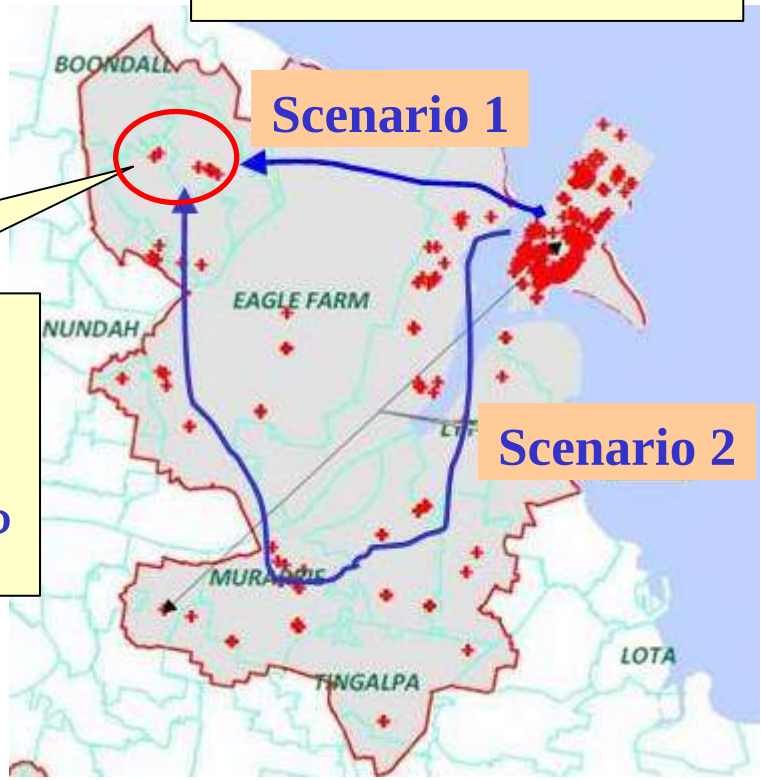


Inferring spread process from data is difficult

Eg: Estimating frequency of long jumps

blue arrows - two possible spread scenarios

Port of Brisbane



Source of colonies at top left:

- one long jump (Scenario 1)?
- many small jumps (Scenario 2)?

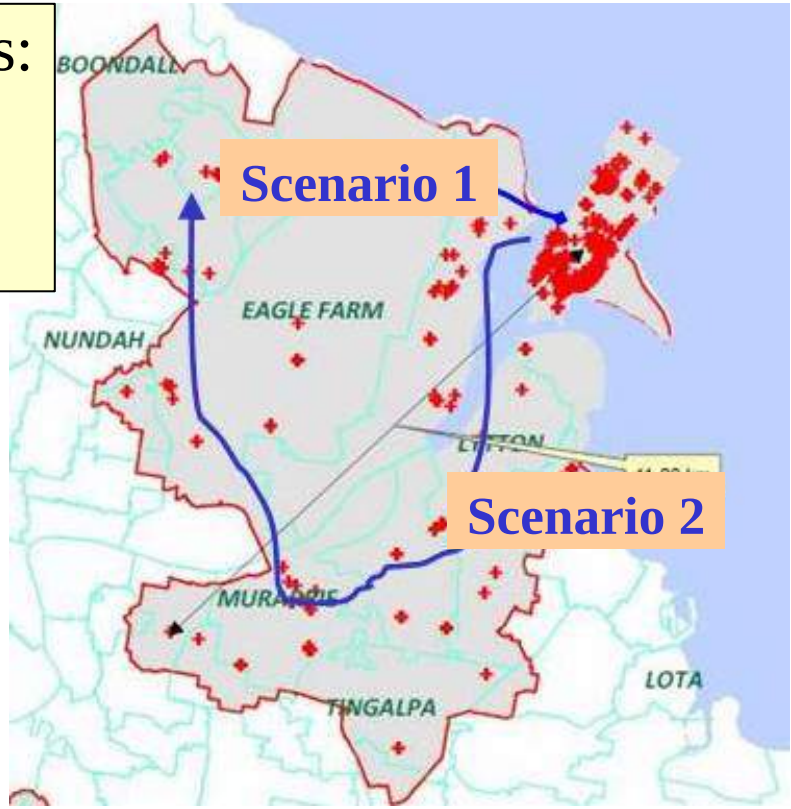
Multiple uncertainties

Large distance between 2 nests implies:

- one big jump?
- smaller jumps from missed nests?

Depends on search sensitivity:

- if high, jumps more likely



Assumptions to simplify inference

Need input from RIFA scientists

Future spread similar to past spread

1. Is this true?
2. A bigger proportion of monogyne nests now?

Younger nests come from older nests

- How to estimate colony age?
- Are bigger clusters older???
  - Depends on whether come from 1 or >1 queen?
- Important because older colonies produced propagules for longer
- Influences allocation of search/treatment resources

Main Findings

Eradication Feasibility Depends Mainly On

Area searched & sensitivity of search

- Must search a large area to find “jumpers”
  - Remote sensing important

Treatment cost and mortality

- Large-scale broad-baiting cost-effective if low cost and high mortality (>0.90/round)

Biological Factors

- Propagule “escape” rate
- Extinction threshold
- Frequency of “jumps”

Relative importance for eradication

Biggest gains, in order:

1. Introduce remote sensing
2. Reduce radius of follow-up surveillance use resource savings to increase treatment
3. Use probability search instead of standard protocol
4. Increase sensitivity of follow-up search
   - –Eg introduce “sniffer dogs”