Knowing when, where & how much to act on pest incursions

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acera
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αεδα
Applied Environmental Decision Analysis
A Commonwealth Environment Research Facility
smart science for wise decisions

Limitations and tradeoffs in invasives control

- Money

    (want to be as effective as possible)

- Time

    (want to be effective as quickly as possible)

- Knowledge

    (can improve, given time and money!)

Want a good theoretical framework

to examine these trade-offs

How to find an invasive species

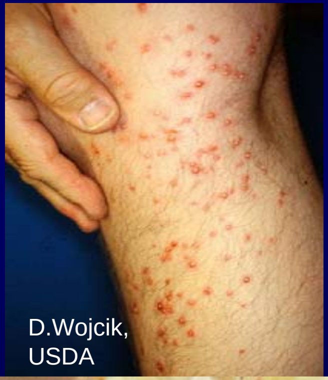
- Look in as many places as possible?

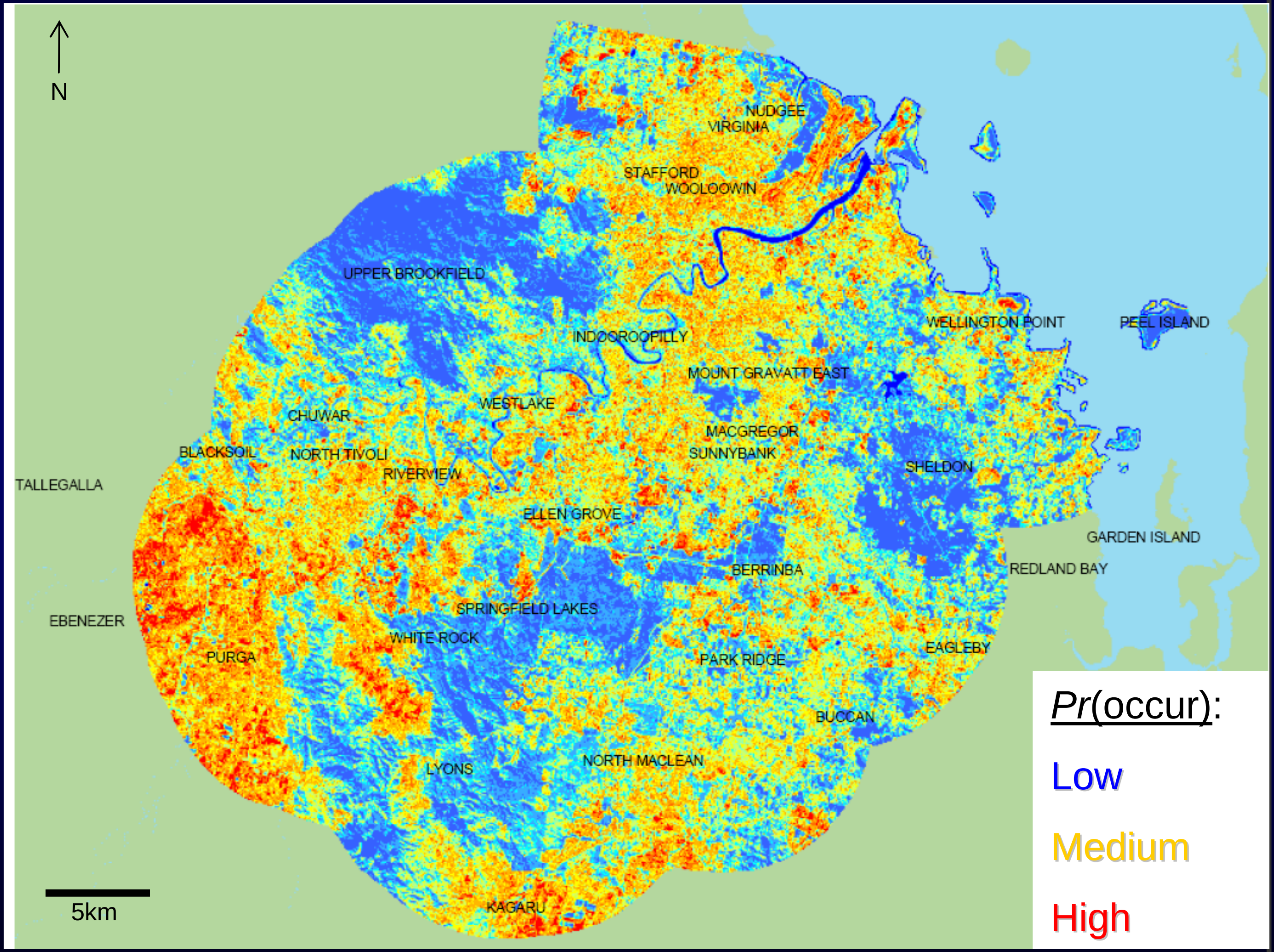
  (more places → less time per place)

- Predict the more likely places

  (e.g. habitat maps)

Where to search? Habitat Maps





George, R. 2004. *Modelling areas of suitable habitat for colonisation by* Solenopsis invicta *in south-east Queensland*. Fire Ant Control Centre, Qld.

Where to search? Habitat Maps

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From: Science Env Policy [sfep@uwe.ac.uk]
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26 February, 2009
Issue 142

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IN THIS ISSUE

Carbon capture and storage: climate impacts
One proposal for meeting targets for the reduction in emissions of greenhouse gases (GHGs) is to capture and store CO_2 that is emitted by fossil fuel burning power stations. In a recent study, researchers demonstrated that carbon capture and storage (CCS) could help mitigate against climate change, especially in the short term. (more...)

Choosing the best eco-design technique
Eco-design is increasingly viewed as an important approach to sustainable and improved product development. A recent study explores the adoption of eco-design techniques for a new product in a specific company. It identifies three key eco-design techniques and provides manufacturers with guidelines on how to choose the best eco-design approach for them.(more...)

Farmers: strategies for adapting to climate change
Climate change could have a significant influence on agriculture. However, the impacts will largely depend on how farms are managed to adapt to change. A recent study considers interactions between climate variability, farm management and the combined impact on productivity. It discusses how farms in different regions of Europe will have to change their farm management practices, such as fertiliser use and irrigation.(more...)

Predicting the spread of plant invasions across Europe
For the first time, a map has been produced that can be used to predict the level of invasion by alien plants across Europe, which could help policy makers design conservation policies suited to different habitats and landscapes. Areas dominated by farming and urban land are among those identified as particularly at risk.(more...)

Crop management to reduce biofuels' carbon debt
It is widely considered that using biofuels produces less greenhouse gas (GHG) emissions than using fossil fuels. However, there are concerns that the possible effects of land use change (LUC) may outweigh these benefits. New research looks at the effects of sustainable crop management as a means of reducing the negative impacts of LUC. (more...)

Past economic losses from flooding not due to climate change
Economic losses from flooding disasters can be the result of both social and climate factors. A recent investigation into floods in Europe from 1970 to 2006 revealed that an observed trend in economic losses was mostly driven by societal factors, such as increases in population and wealth, rather than climate factors.(more...)

Opinions expressed in this News Alert do not necessarily reflect those of the European Commission.

FULL ARTICLES

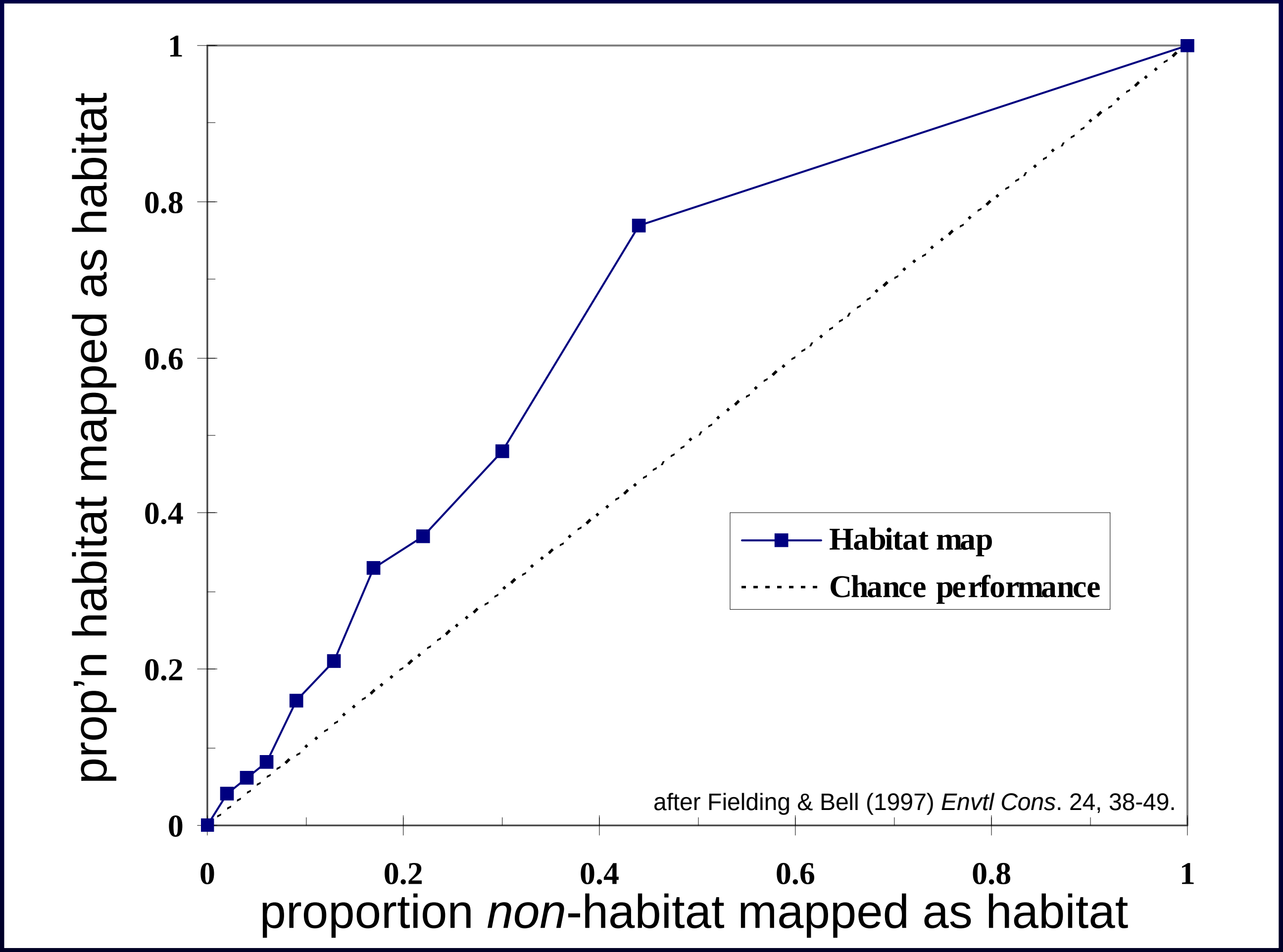
Carbon capture and storage: climate impacts

Predicting the spread of plant invasions across Europe

For the first time, a map has been produced that can be used to predict the level of invasion by alien plants across Europe, which could help policy makers design conservation policies suited to different habitats and landscapes.

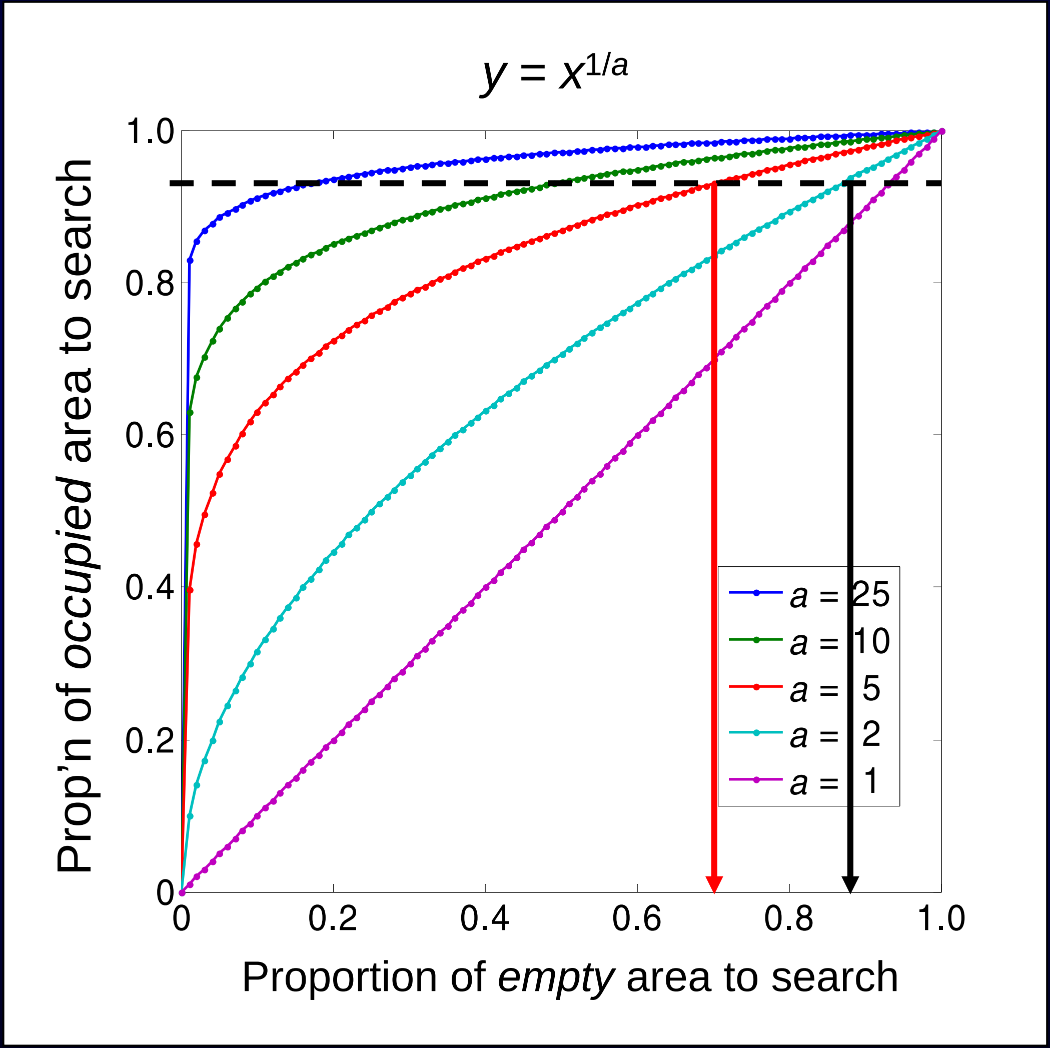
Chytry et al. (2009) European map of alien plant invasions based on the quantitative assessment across habitats. *Diversity & Distributions* 15:98-107

How good are habitat maps?



"Receiver Operating Characteristic" (ROC) curves

Theoretical ROC curves



e.g.
Regional pest density = 0.06
1000 sites in region,
→ 60 infested, 940 pest-free

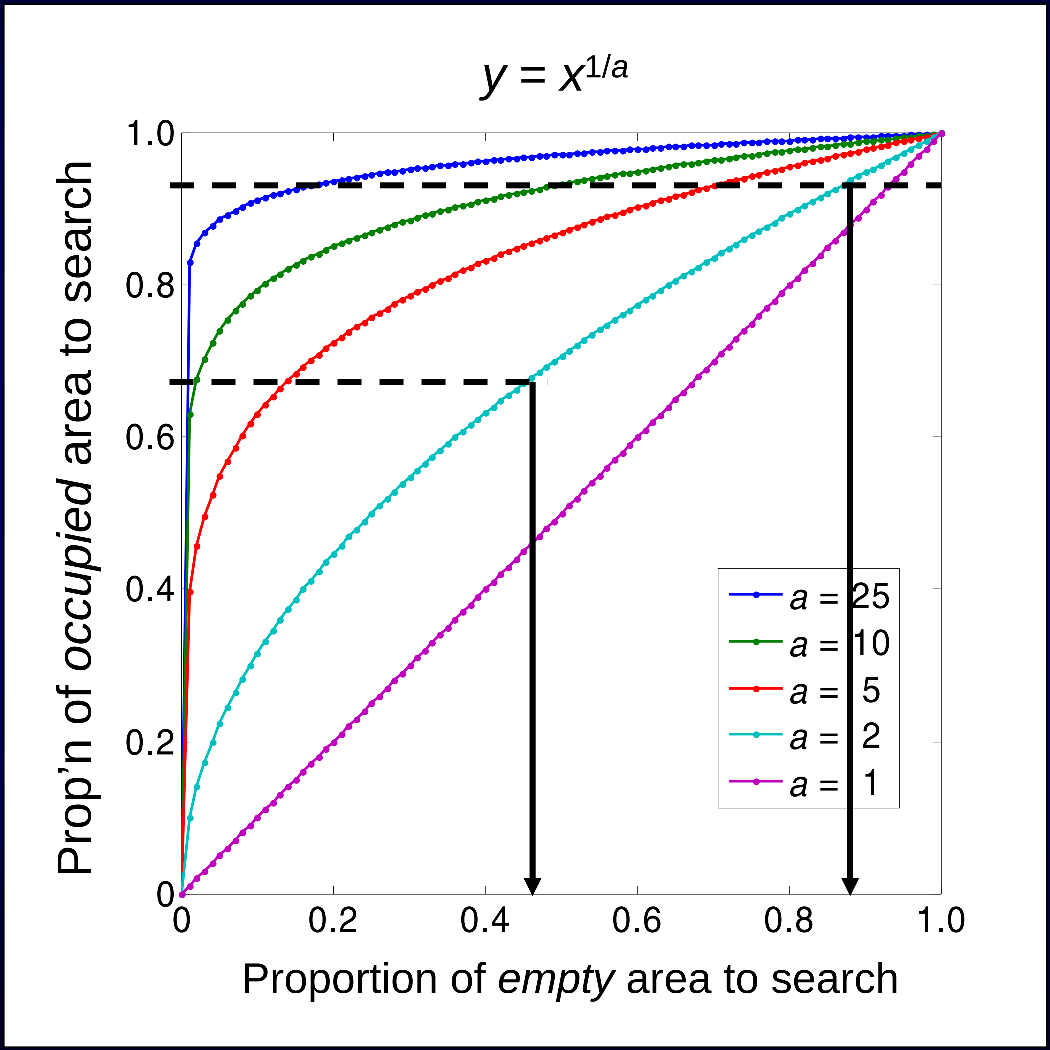
Target:
Find 57 (95%) occupied sites

→ 0.9 x 940 futile searches

Total search area required:
57+848 = 905

Better map? Just search
57+654 = 710

Theoretical ROC curves



e.g.
60 infested, 940 pest-free

Target I:
Find 95% occupied sites

Total search area required:
57+848 = 905

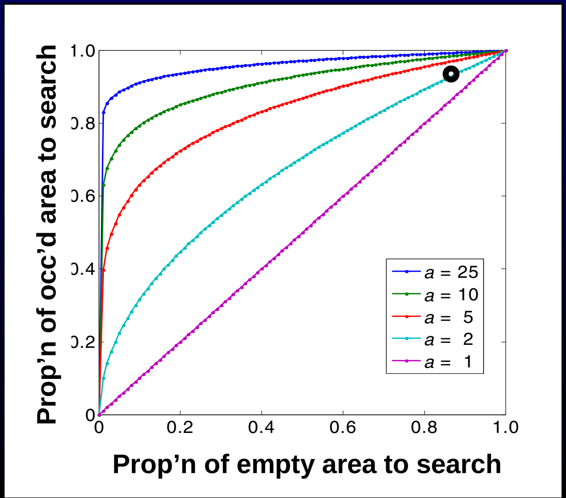
Target II:
Search 453 sites

→ 40 worthwhile searches
… and 413 futile

Management options

1. Broad-scale search

→ search effort spread thinly across many sites



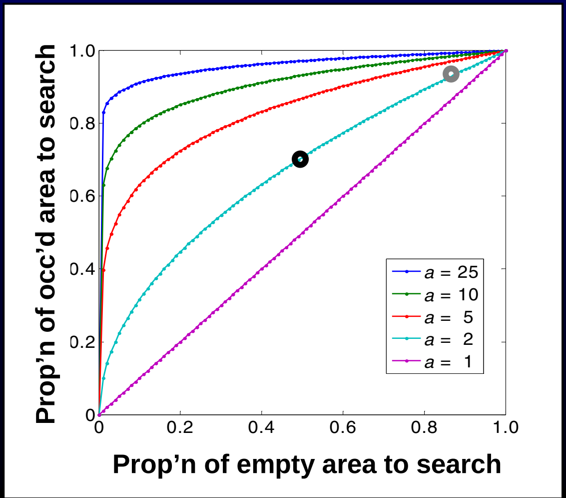
Management options

1. Broad-scale search

→ search effort spread thinly across many sites

2. Focussed search

→ fewer sites searched, but more successfully



Management options

1. Broad-scale search

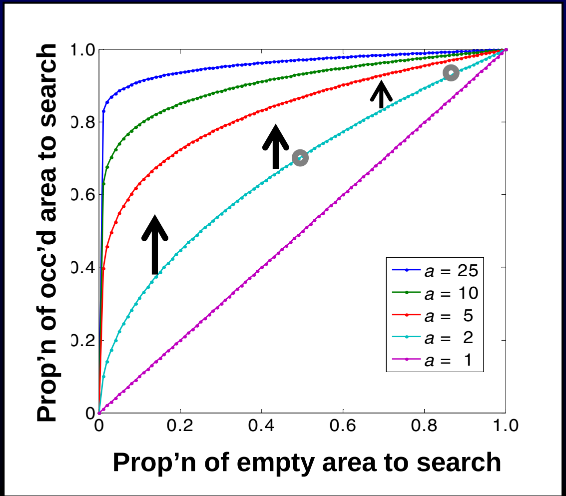
   → search effort spread thinly across many sites

2. Focussed search

   → fewer sites searched, but more successfully

3. Improve habitat map

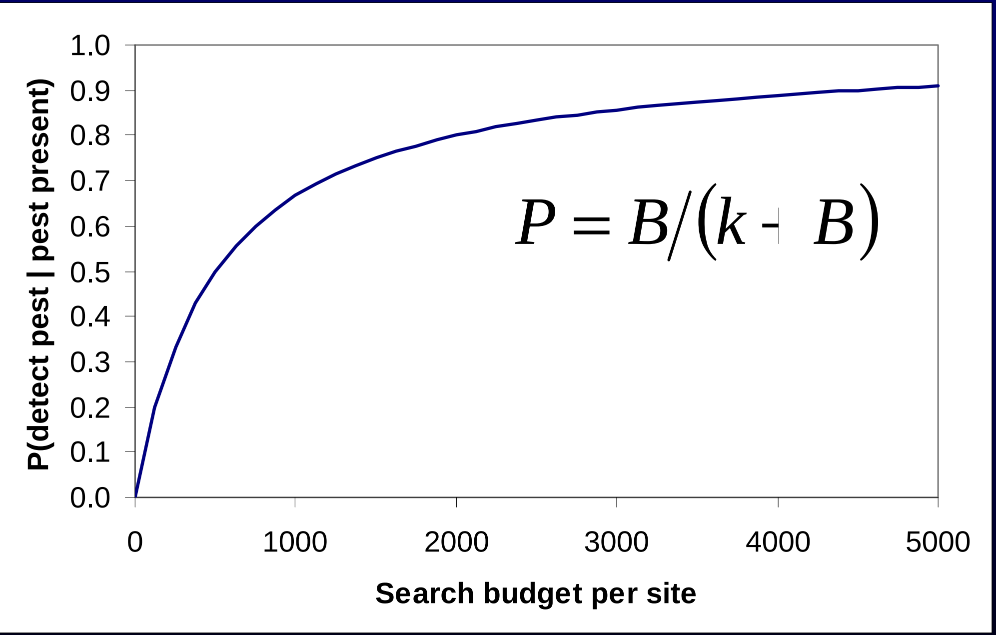
   → don't search, pest spreads, but better future searches



Consequences of search decision

1. P(detection)

Probability of detecting a pest, which is present in a site, by searching the site with a budget *B*:



Consequences of search decision

2. Invasion dynamics

Spread of invasion depends on <u>missed</u> and <u>found</u> colonies:

$$\phi_{t+1} = \phi_t\left(\overbrace{(1-d)\lambda(\phi_t)}^{1-d} + \overbrace{d\left(\sqrt{\lambda(\phi_t)}-1\right)}^{d}\right)$$

$\lambda(\phi_t)$ ~ logistic spread of an uncontrolled invasion,

doubling time of 24 months.

Scanlan & Vanderwoude (2006). *Aus.J.Ent.* 45: 1-9.

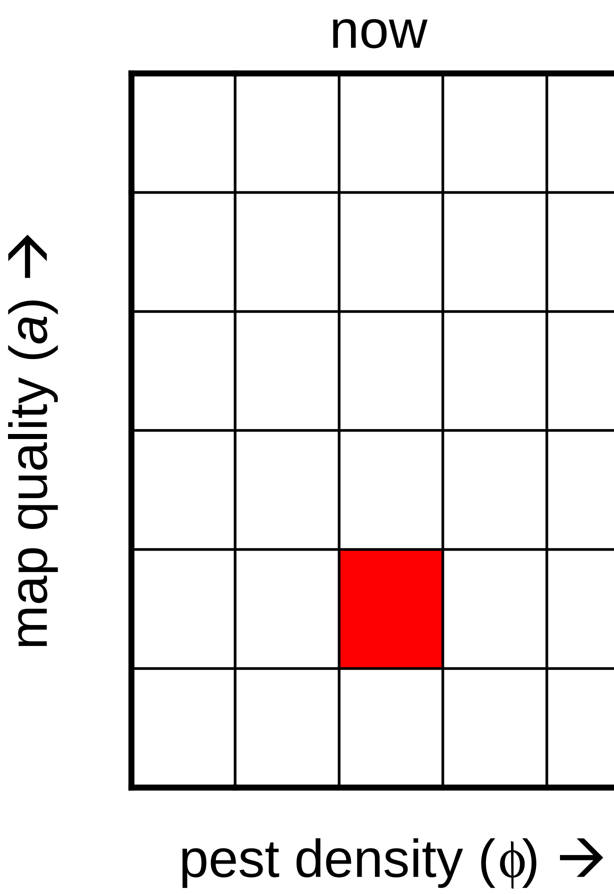
Optimising trade-offs

Stochastic dynamic programming

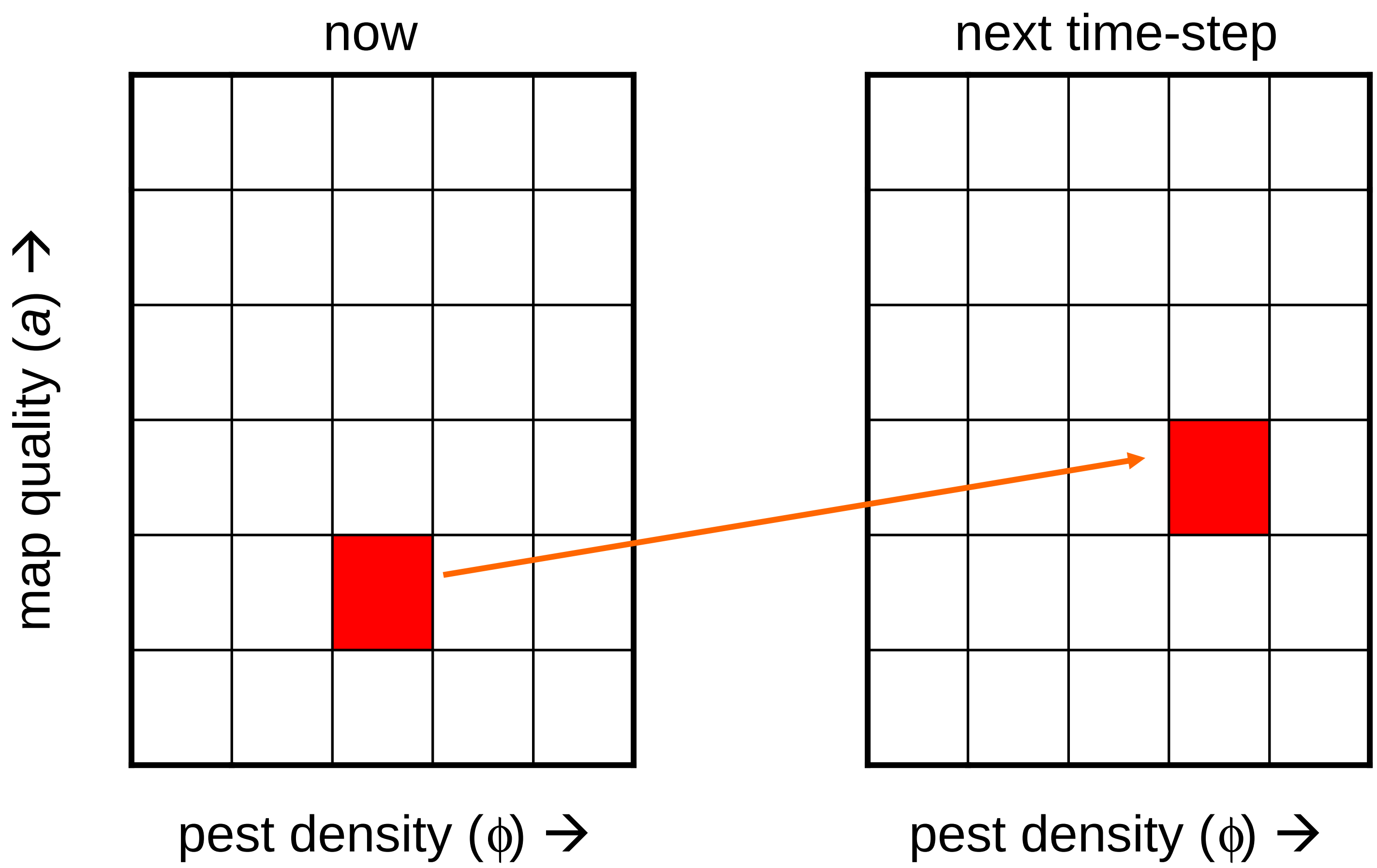
→ optimal decisions which depend on:

- current "state" of system
  - map quality, regional pest density
- value of being in each state
  - from management objective (eradicate, or low density)
- constraint on taking some action
- probability an action takes us to another state

Optimisation (stochastic dynamic programming)



Optimisation (stochastic dynamic programming)



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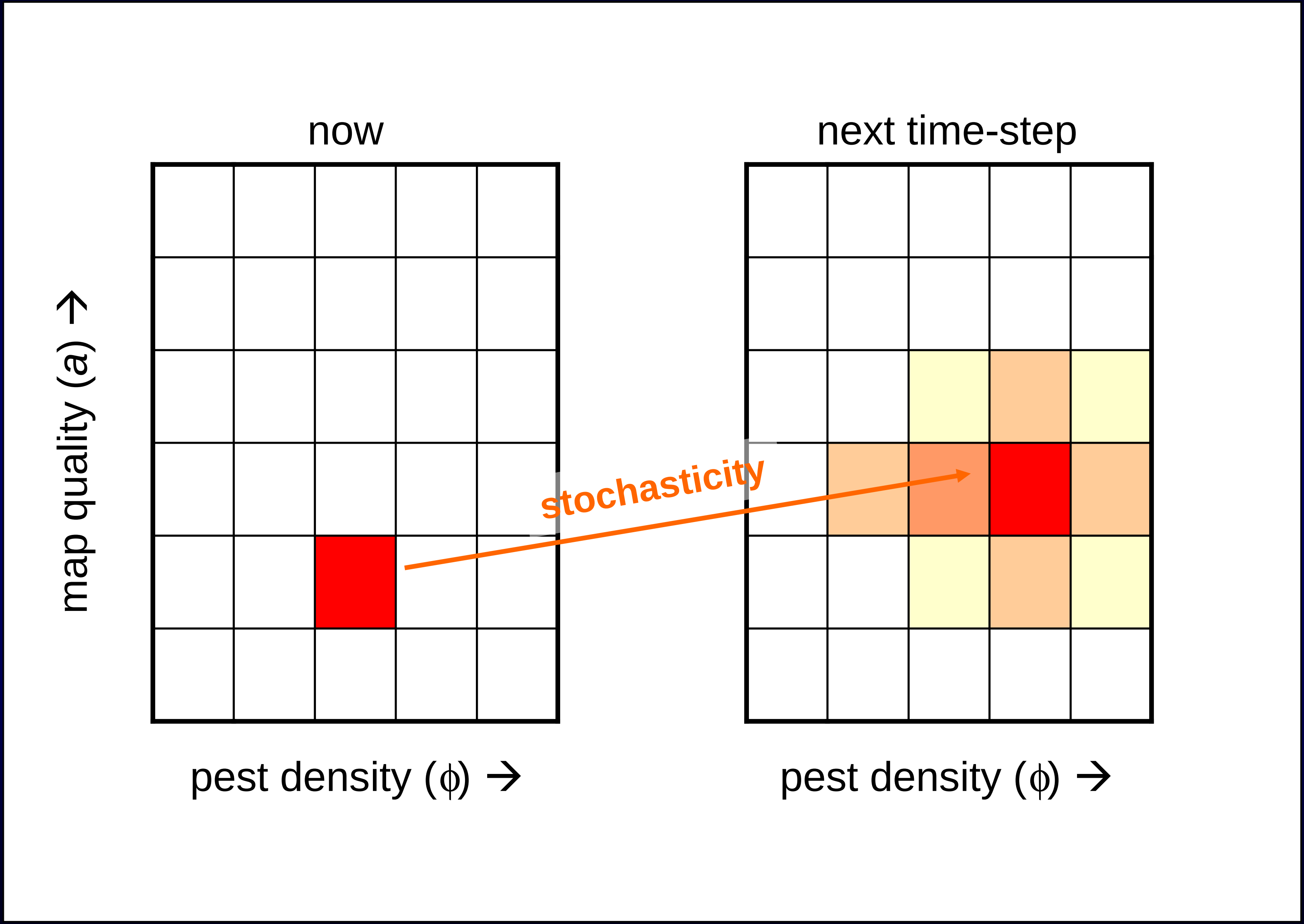
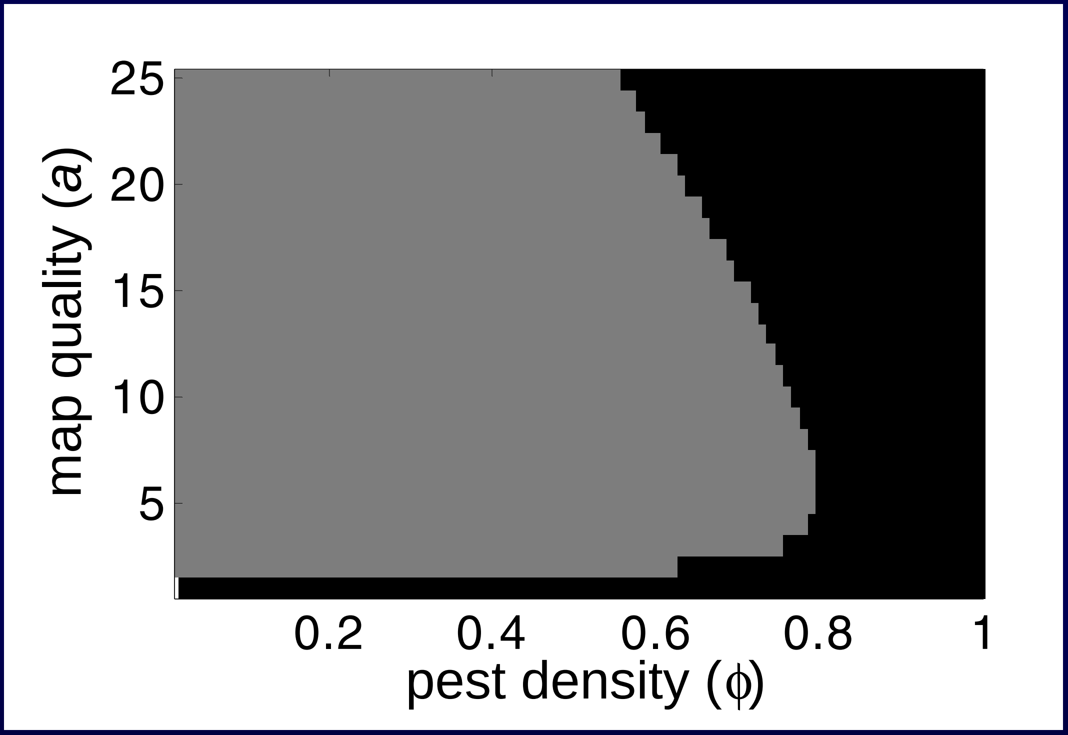


Optimisation results

1-year management timeframe



Black:

Broad search

Grey:

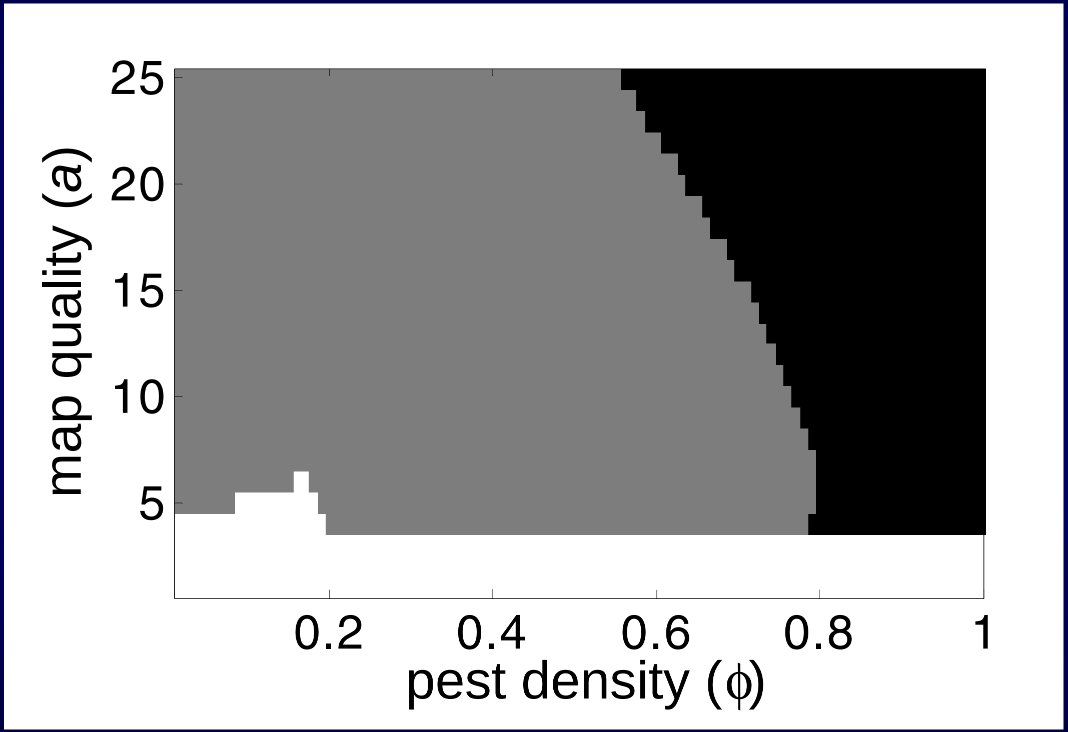
Focussed search

White:

Improve map

Optimisation results

8-year management timeframe



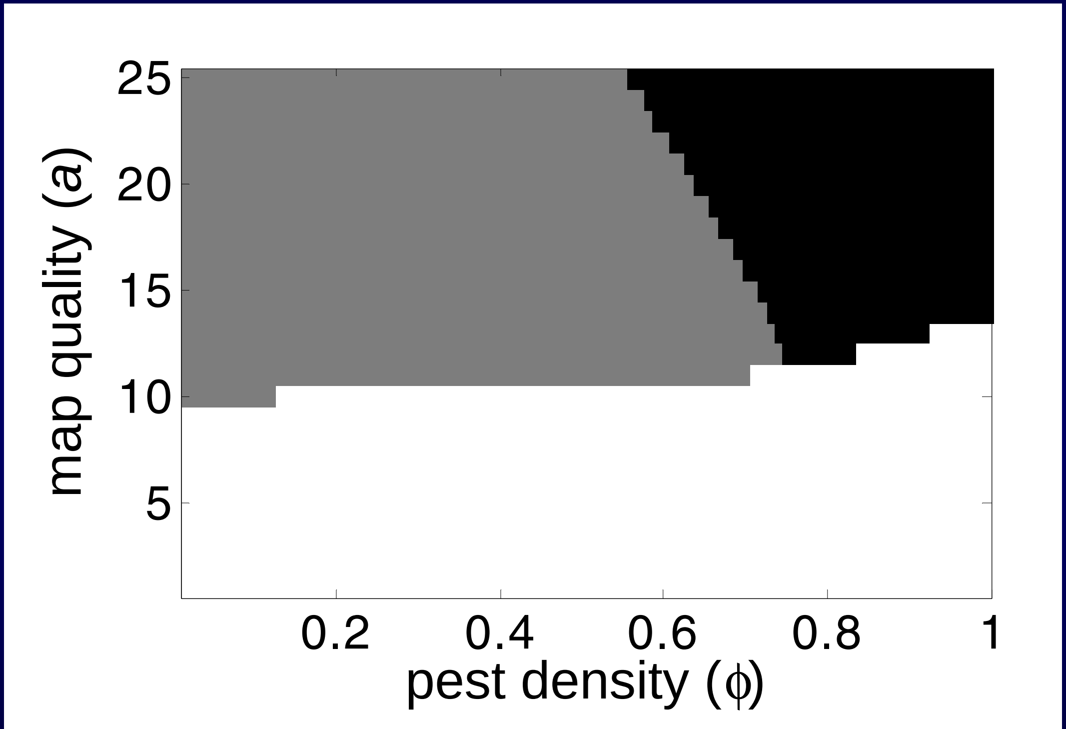
Black:
Broad search

Grey:
Focussed search

White:
Improve map

Optimisation results

14-year management timeframe



Black:

Broad search

Grey:

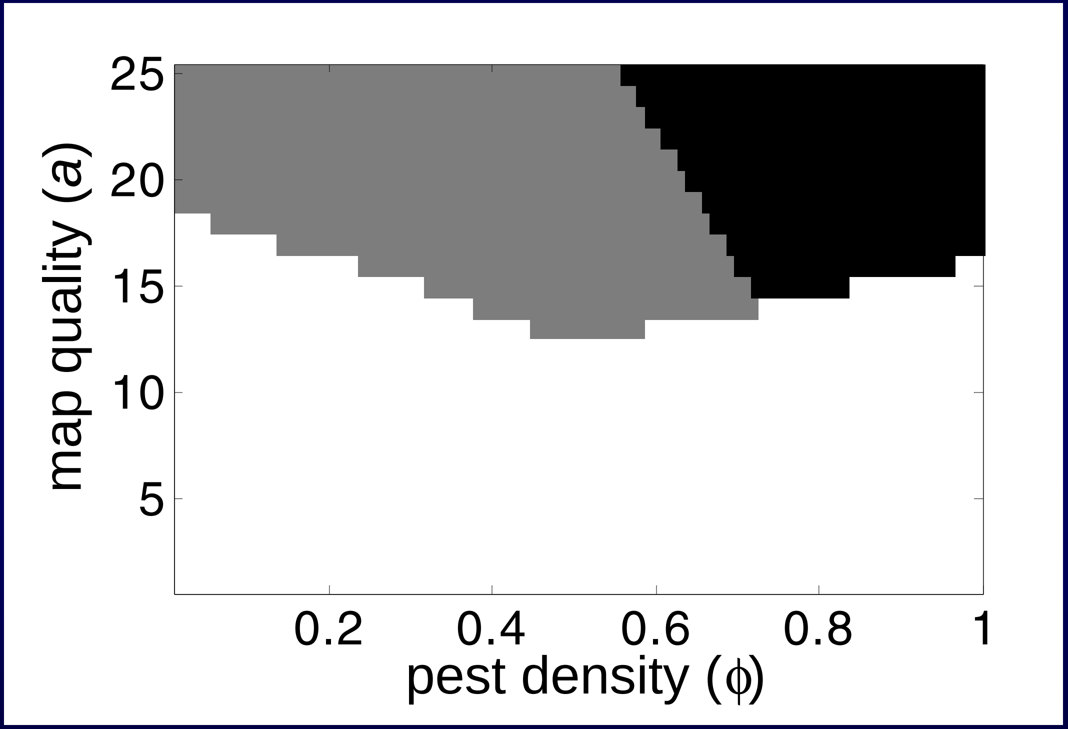
Focussed search

White:

Improve map

Optimisation results

20-year management timeframe



Black:
Broad search

Grey:
Focussed search

White:
Improve map

How does the optimal solution perform?

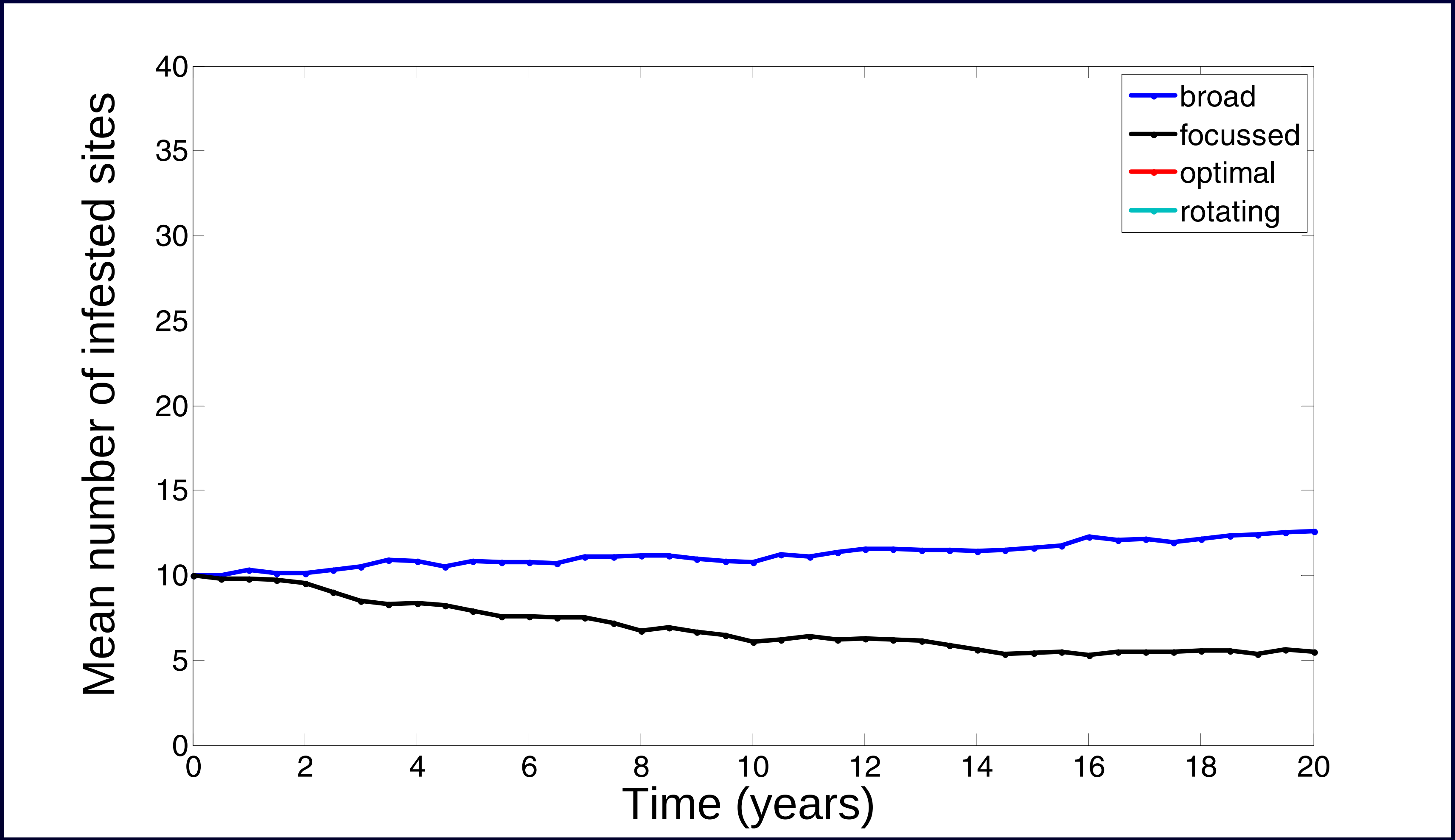
Simulated invasion and control over 20 years:

10 incursion sites (of 1000 total); initial map quality $a=2$

Four strategies compared:

1. always search, broad and quick
2. always search, focussed and intense
3. use the optimisation results
4. rotate: *broad* ... *improve map* ... *focussed* ... *broad* ...

How does the optimal solution perform?



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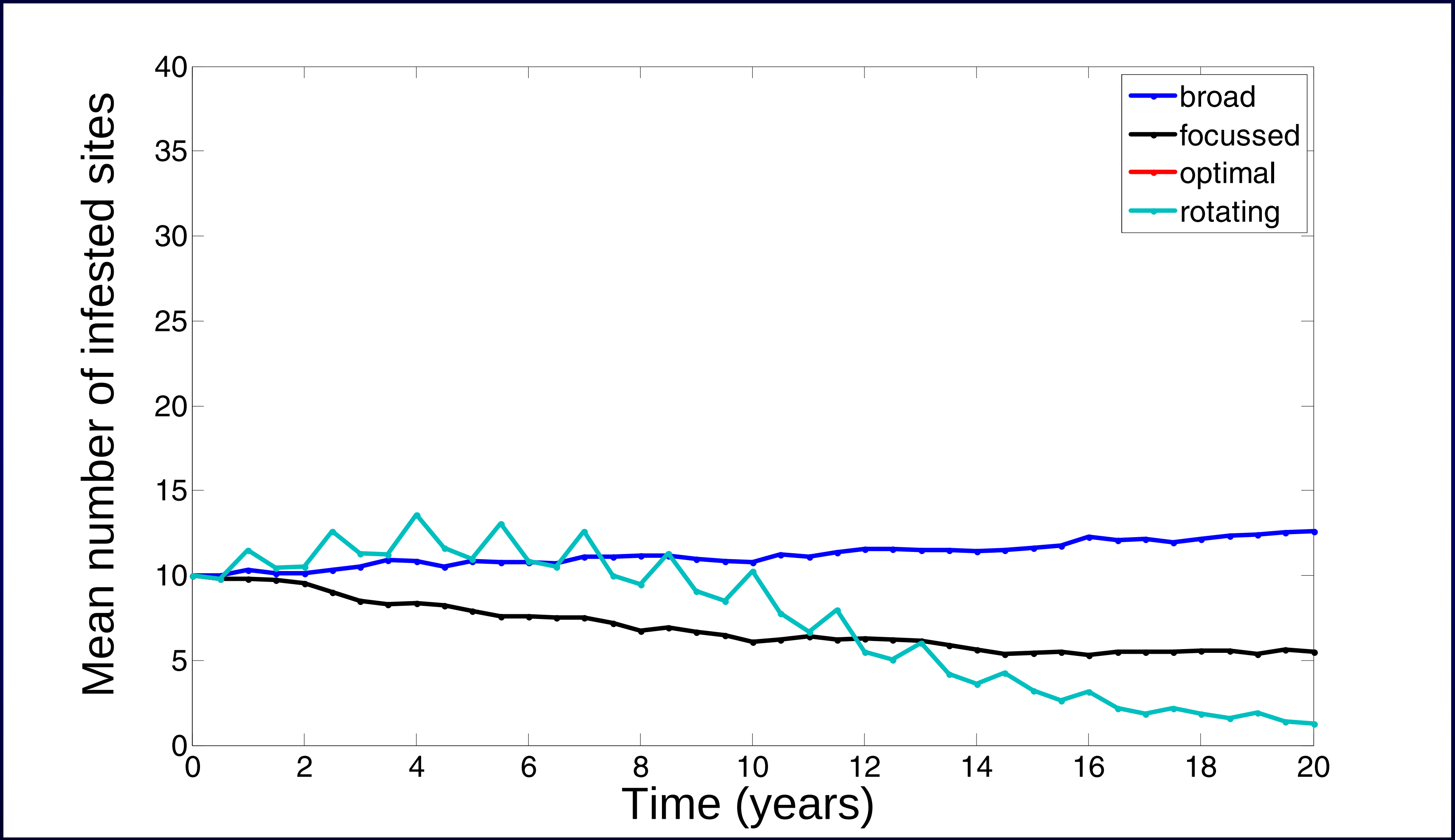

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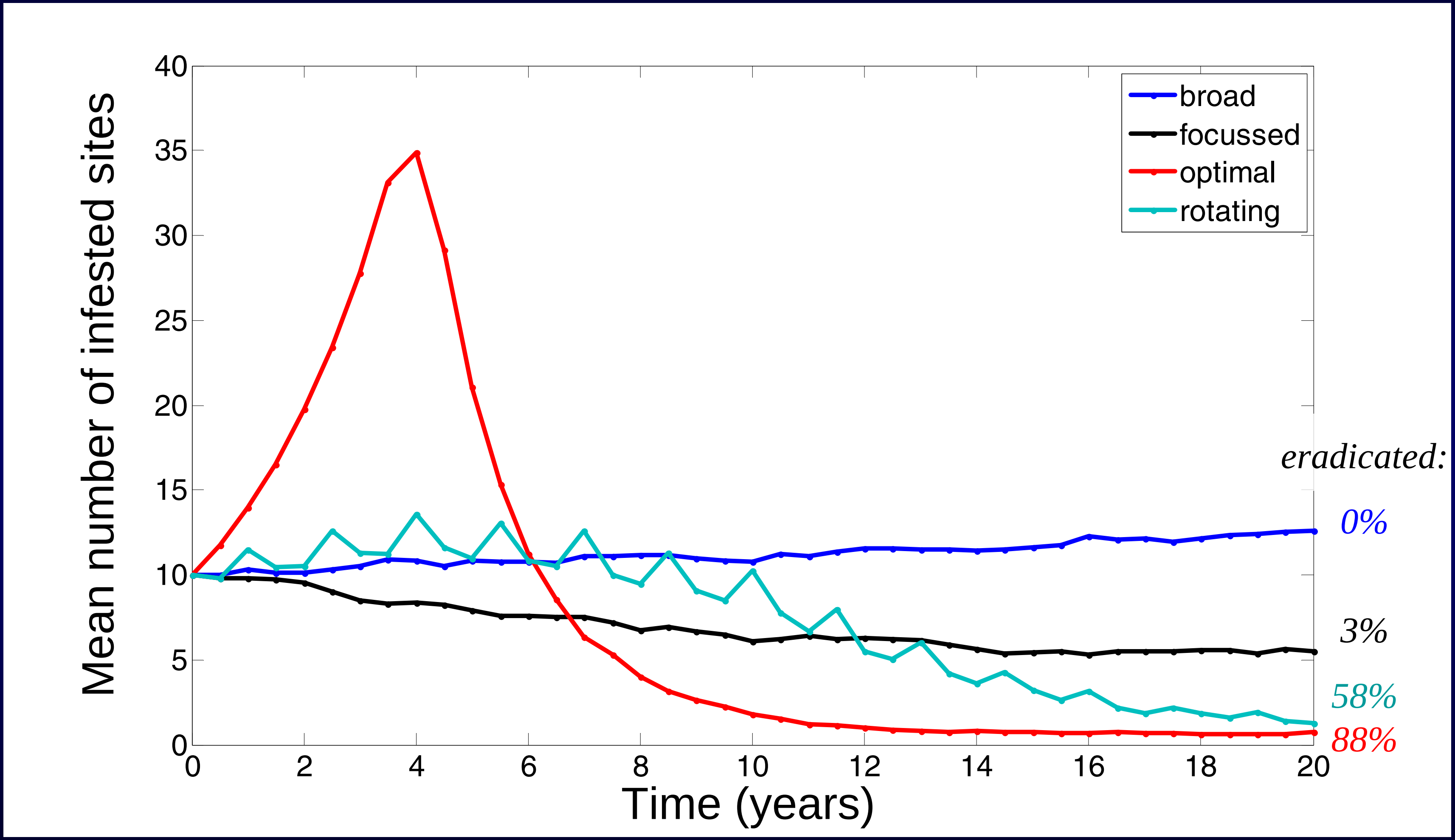

Conclusions

The best way to manage an incursion:

don't "do" anything, just employ a modeller [!?]

- Trade-offs of time, money and knowledge
- Tackling these together → optimal performance
    - lots of time: improve knowledge
    - lower pest density: focussed search
- When do we know enough to just act?
- Caveats of simplified model

Acknowledgements

- Mark Burgman, Cindy Hauser, Mick McCarthy, Dane Panetta & Spatial Ecology Lab

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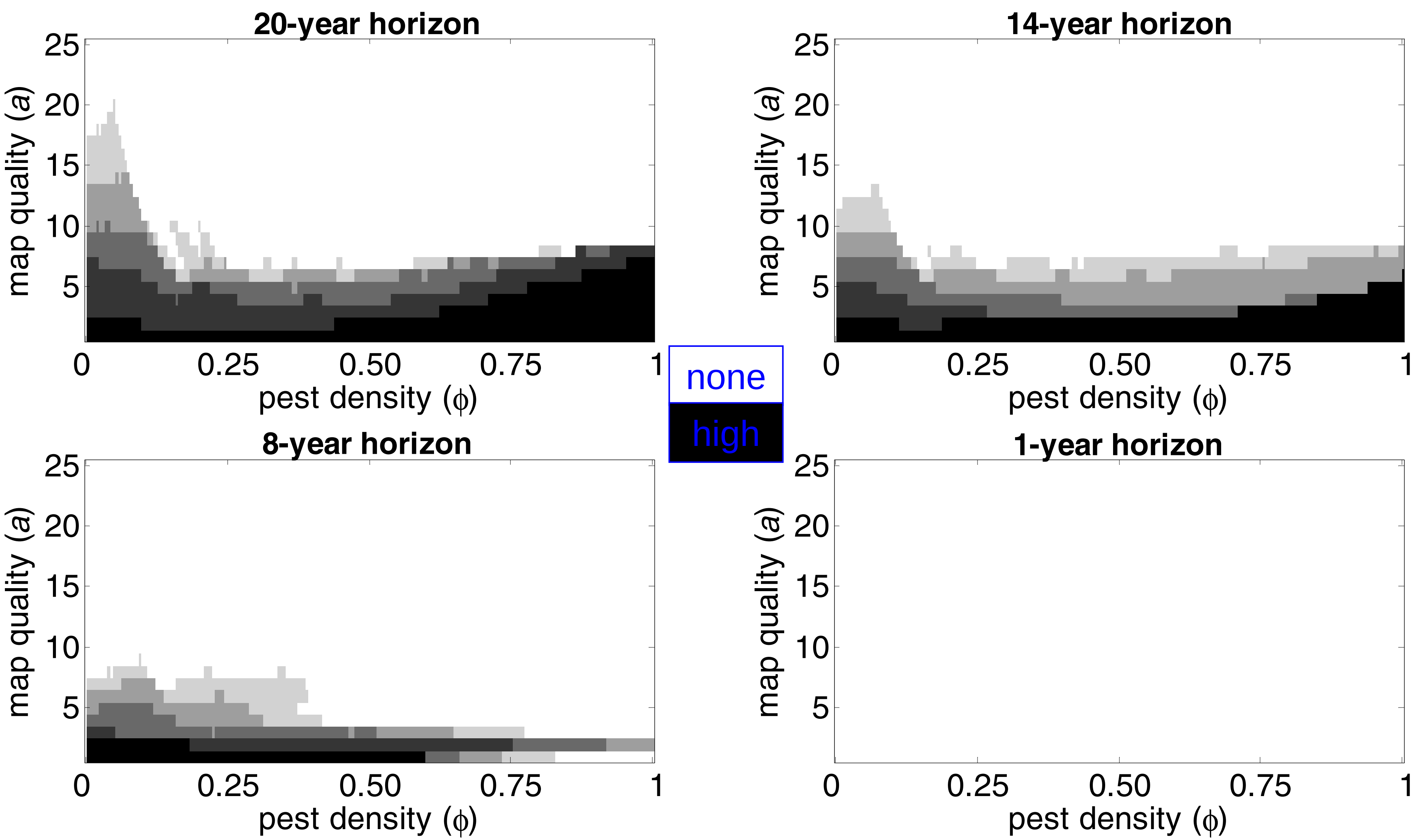
spatial ecology

(a couple of spare slides)

Finer-grained decisions: knowledge investment



Finer-grained decisions: search intensity