
Where do we put money, sex and politics?
MARRIA
No. of children = √snoring - π x 2
socks on floor
3 x hair in sink + bad plumbing
< difficult in-laws
car trouble² = ironing x pets
flowe
x² √smelly feet
> xy
y x crabgrass ÷ unem
©Anne Gibbons

Suite of problems

Where to act?

- Large scale
- Local scale

How to act in an area?

- Manage types
- Manage/monitor

Large scale – designing reserve networks

Gazetting of reserves key conservation action

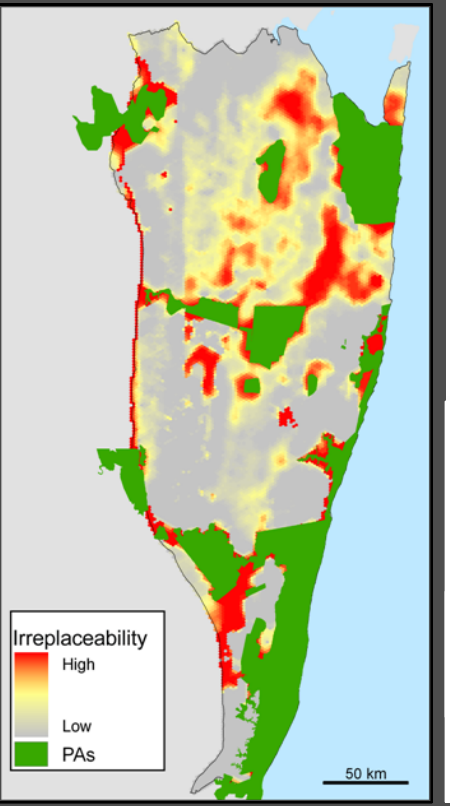
Historical places in areas of low value

Where should we place reserve to attain certain features?

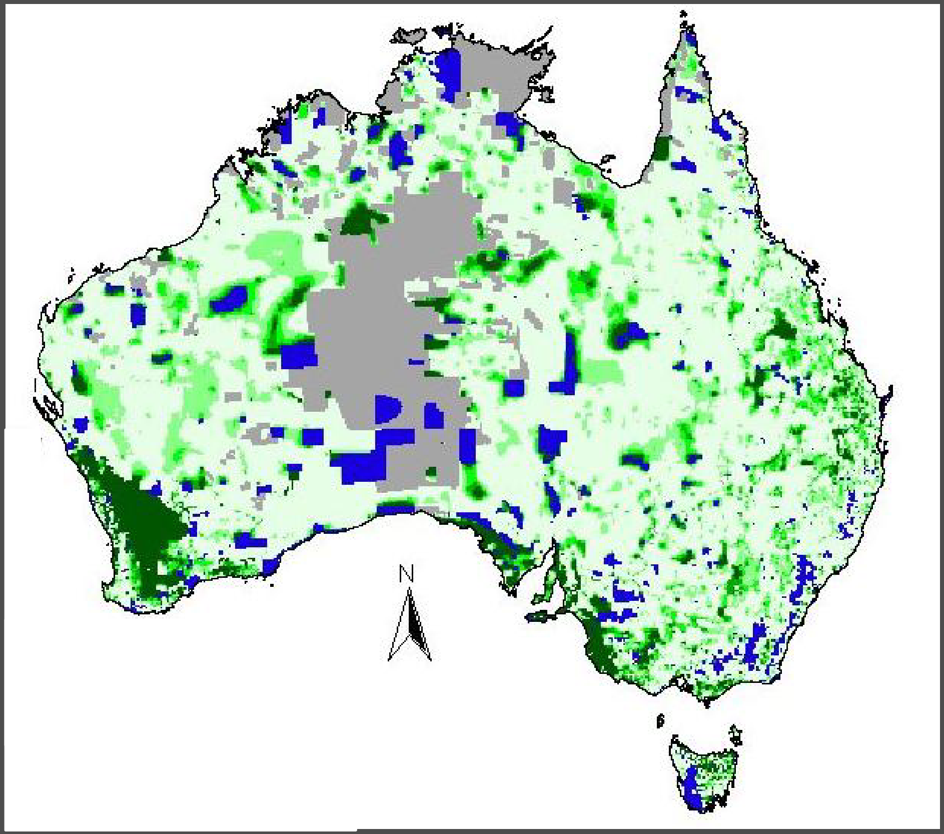
Knapsack problem – sim. annealing

A network that reaching targets for features for least cost.

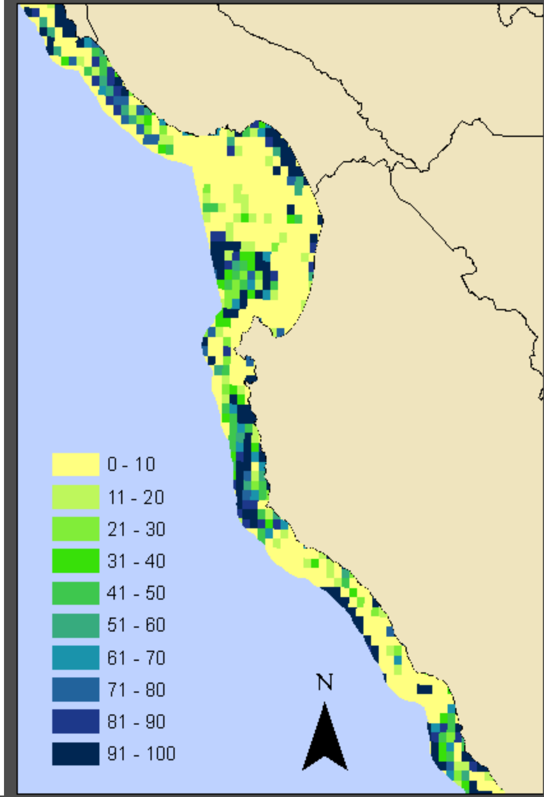
South Africa



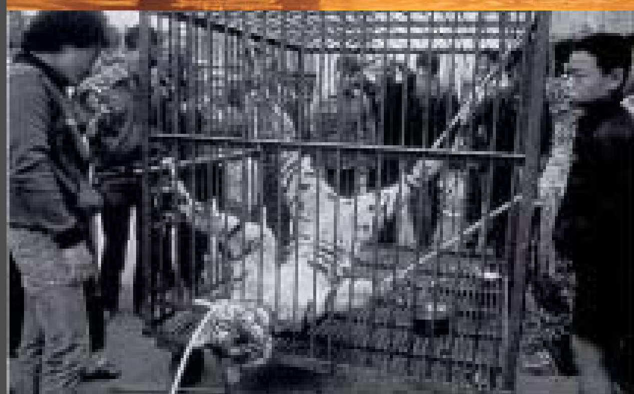
Obvious I hope

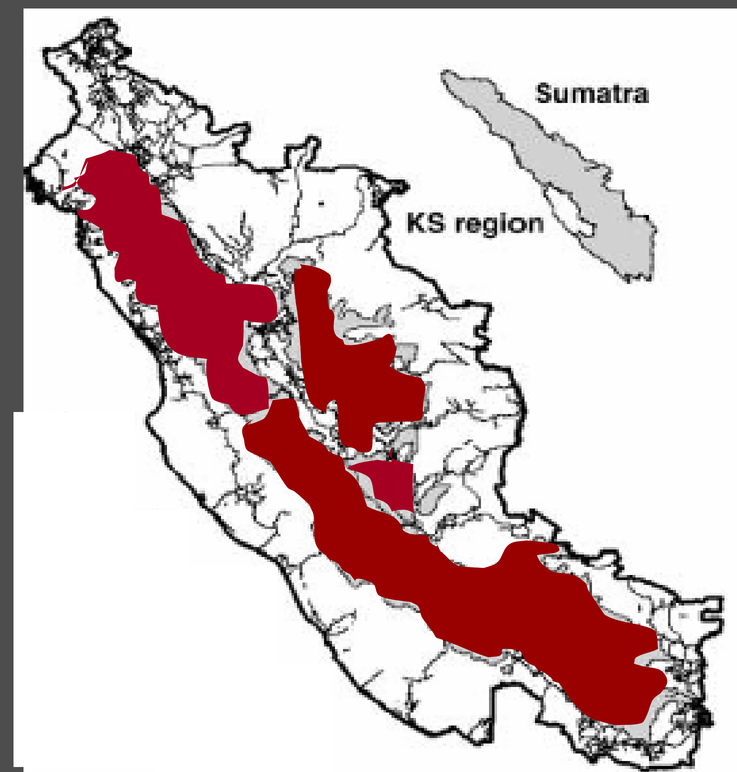


California



Local scale – managing th. species





McDonald-Madden *et al, (2008) Conservation Biology*

Where/when to manage th. species?

Objective: maximise the number of extant population

Probability of extinction given investment (state transitions)

Stochastic dynamic programming for state-dep solution

What have we assumed?

What don't we know.....

system state

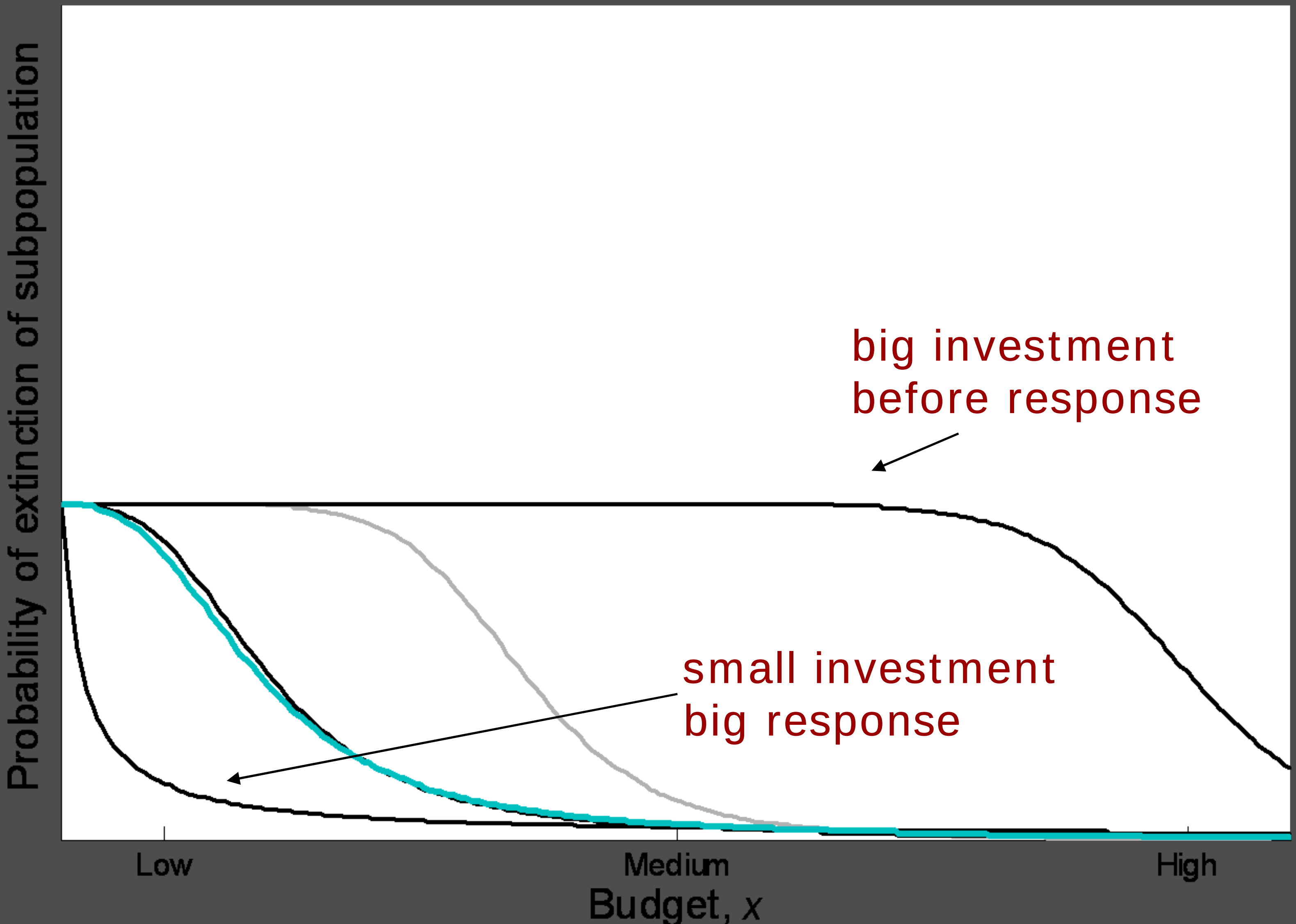
- what's in our reserve?
- is a species extant?

system model

- benefit | investment

the list goes on…

Uncertainty in functional form

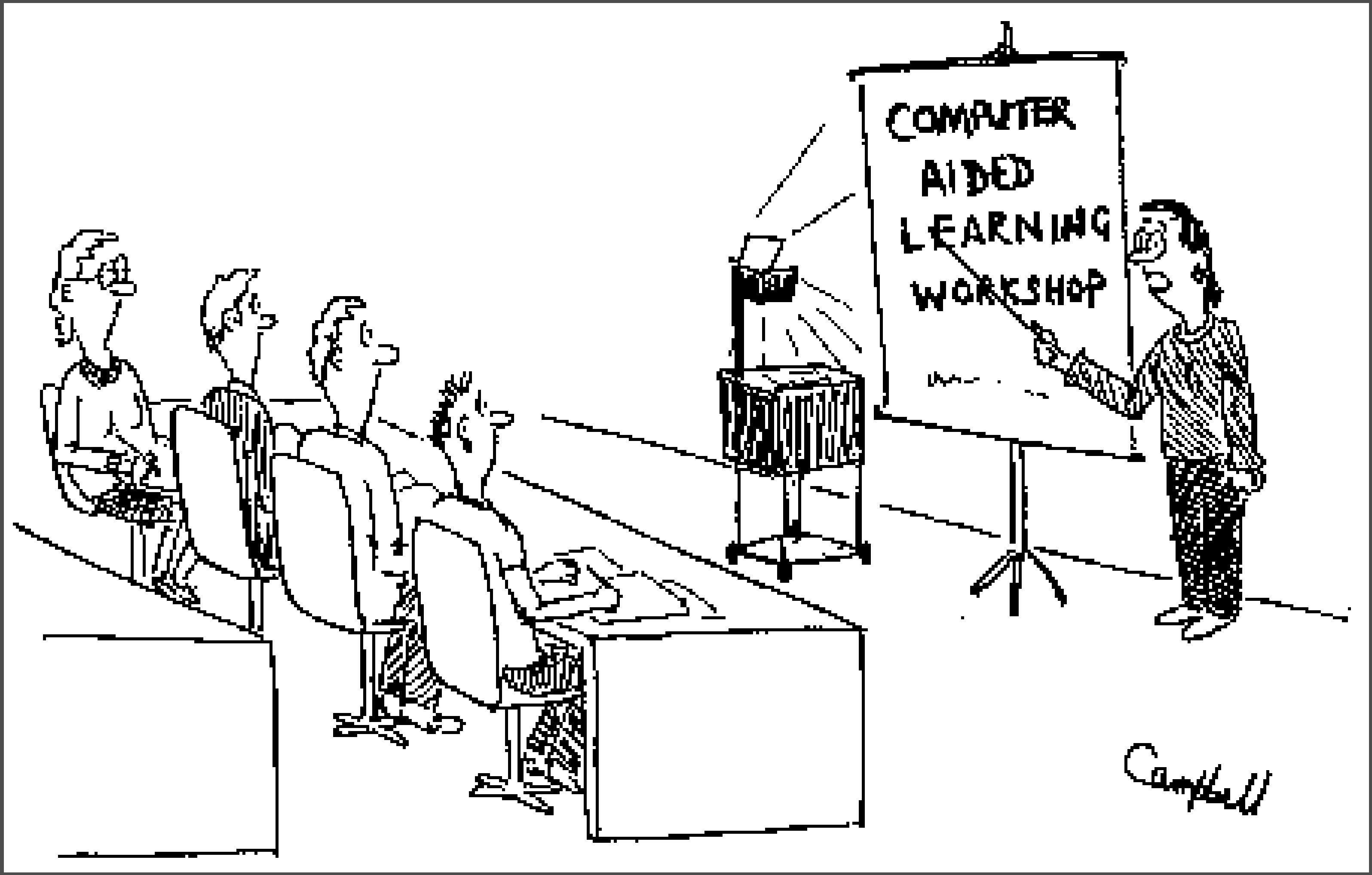


Decisions in the face of uncertainty

Uncertainty Analysis

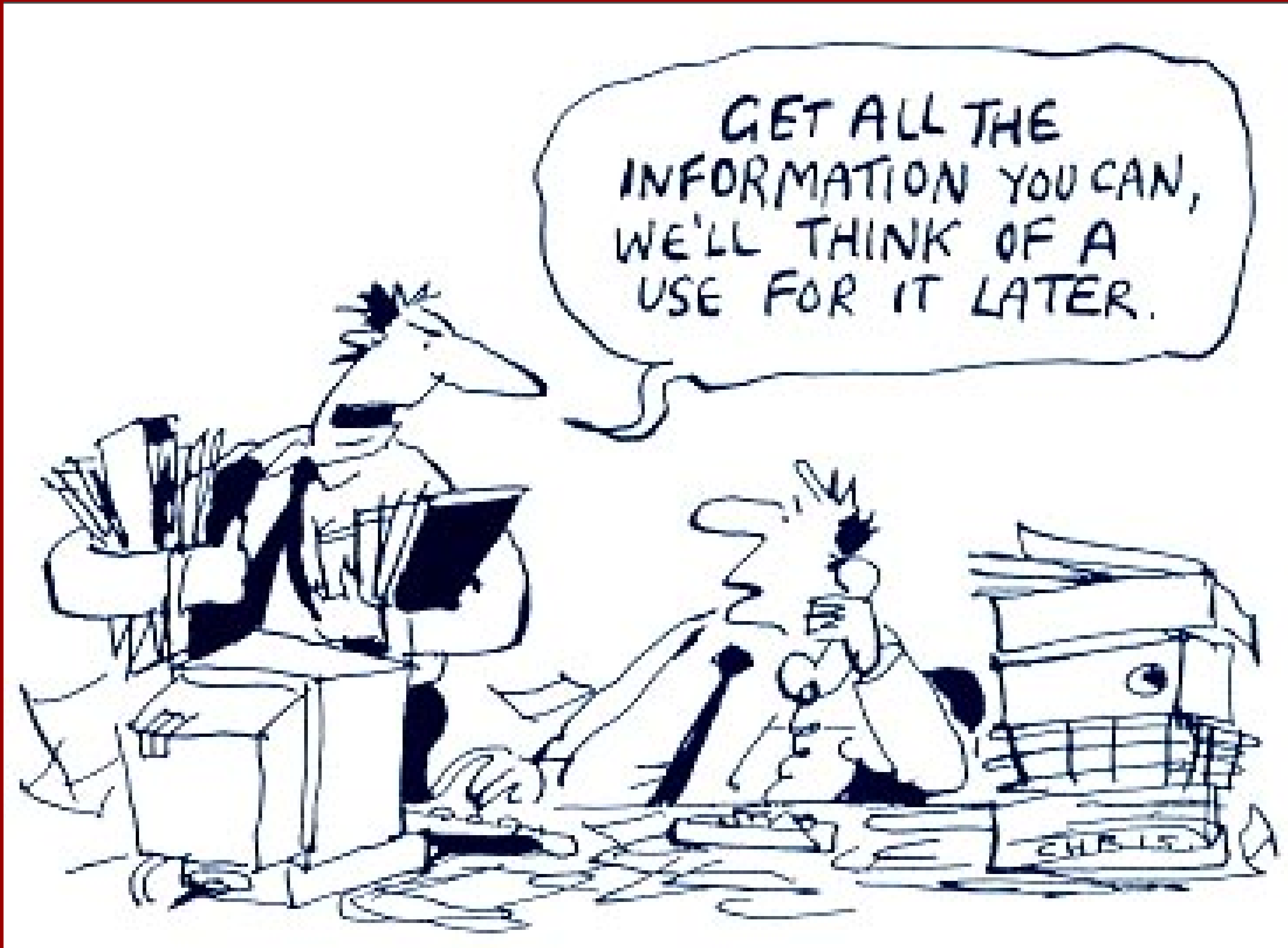
- Sensitivity
- Maximin Theory
- Information Gap Theory

From accept'ism to reductionism



Why monitor in conservation?

- Information gathering*
- Adaptive management
    - learning system state*
    - learning system model*


GET ALL THE INFORMATION YOU CAN, WE'LL THINK OF A USE FOR IT LATER.

Why monitor in conservation?

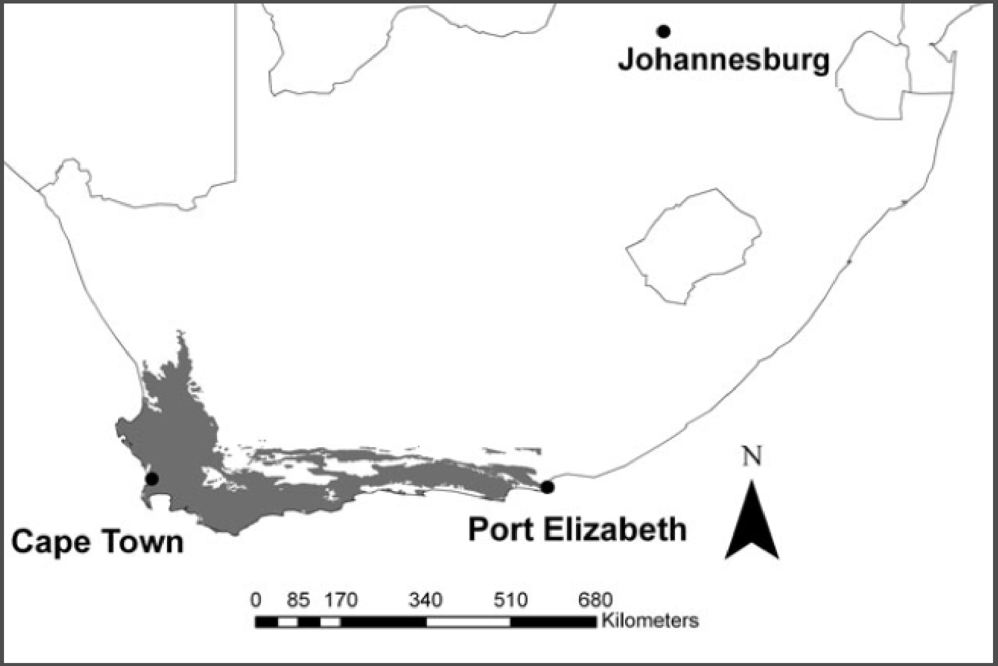
Simulation

- **Information gathering***

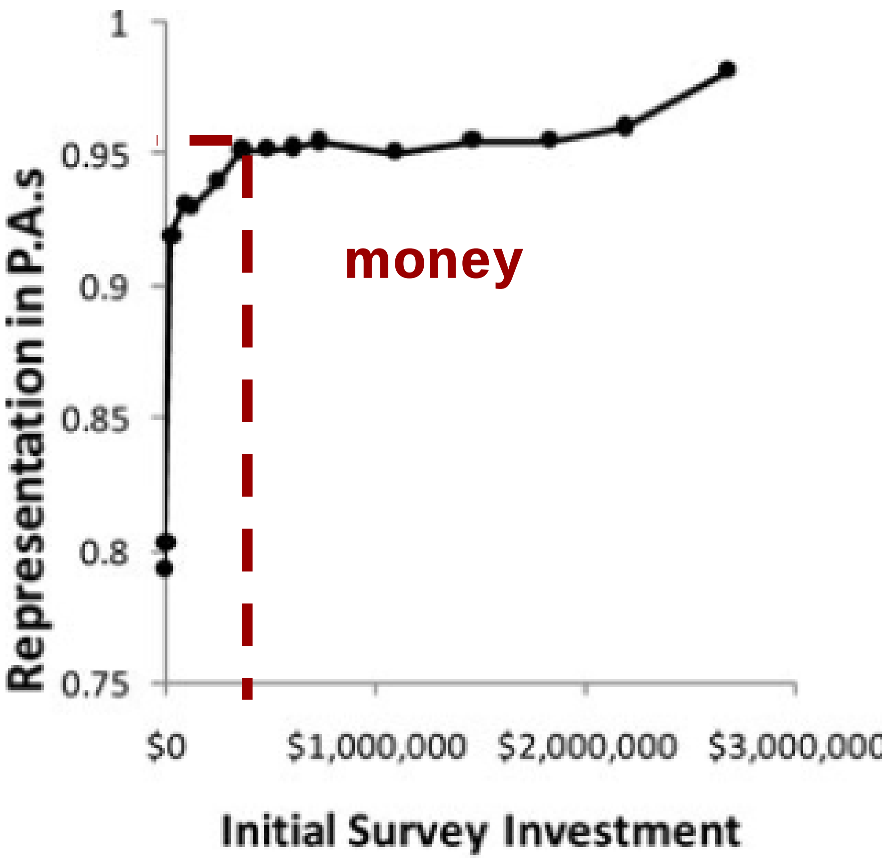
Optimal stopping - RL/MDP

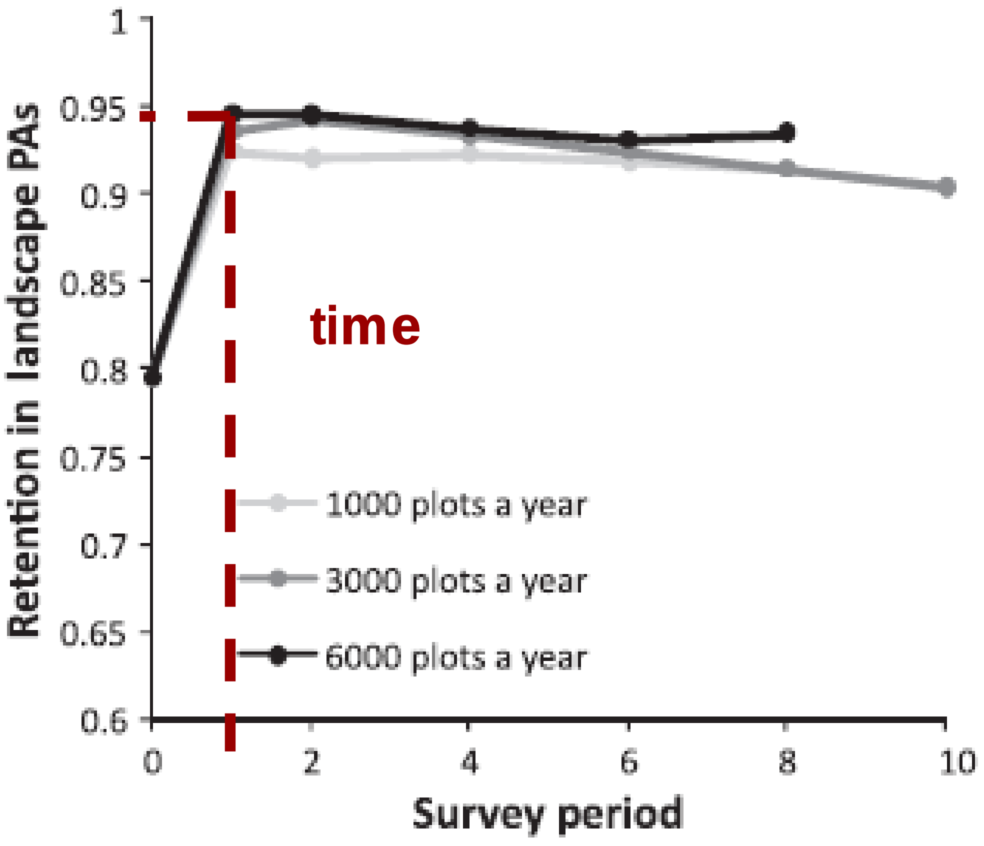
- Adaptive management
  - learning system state*
  - learning system model*

How much to learn before designing a reserve for proteas?



Simulation of reserve representation with more/less info.

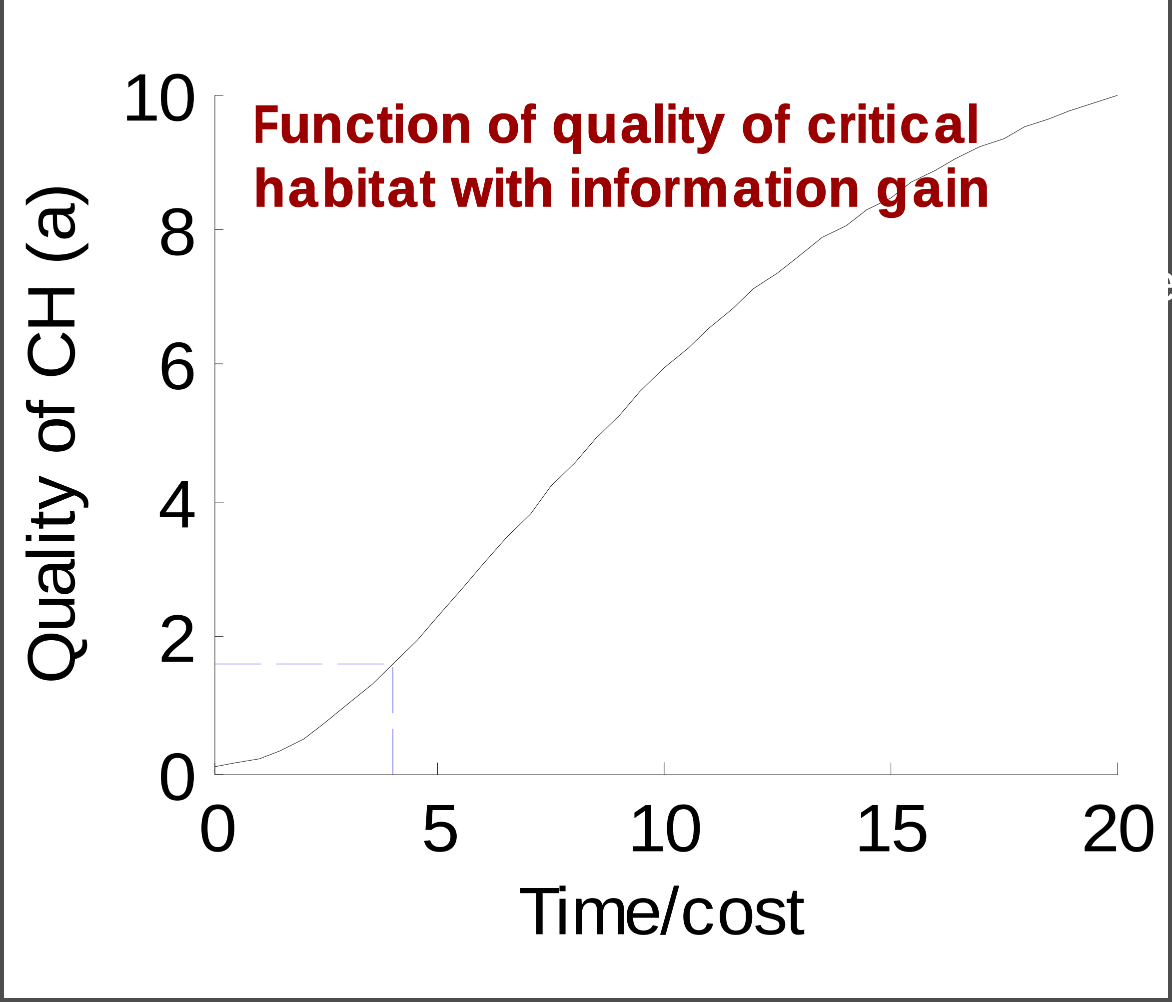


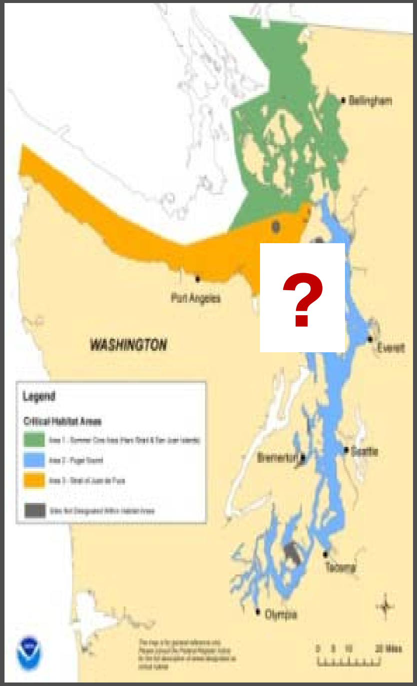


Grantham et al. (2008)Conservation Letters

Grantham et al. (2009) Ecology Letters

Designating critical habitat





Martin et al 2009

What should we do?

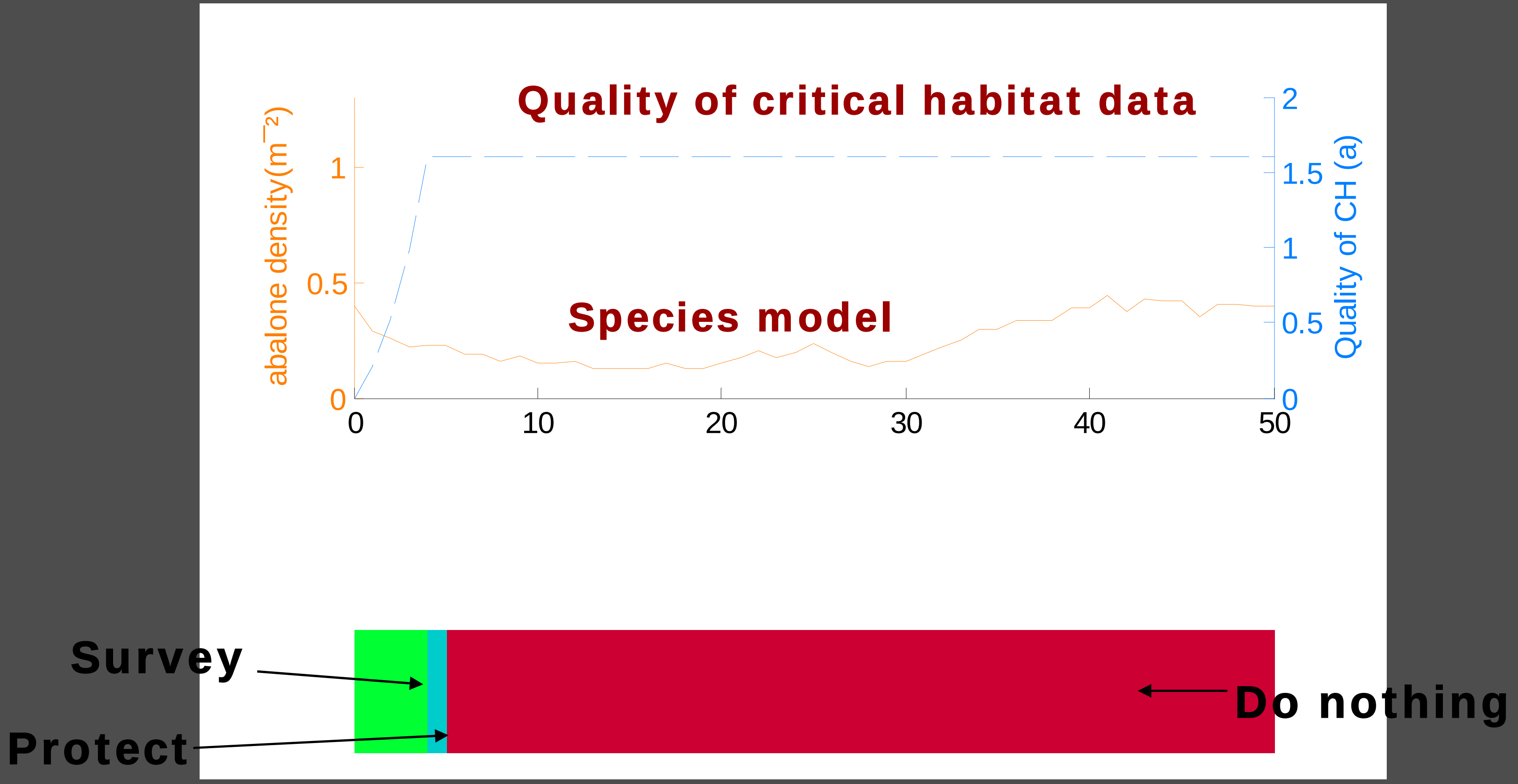
Do nothing

Survey and learn about
the critical habitat

Stop surveying & protect
what we think is CH

Optimal strategy given information & species models

Reinforcement Learning.



Why monitor in conservation?

- Information gathering*
- Adaptive management
    - **learning system state*** → POMDP
    - learning system model*

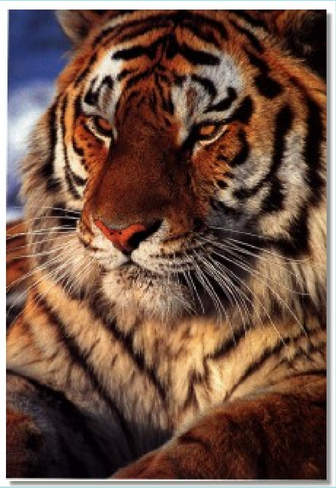
Acting based on belief.

If decision to patrol is based on state of system

- tigers extant or extinct

Uncertain about state

Save/Survey/Surrender question



80% sure?

Chades *et al (2008) PNAS*

POMDP

- Find best decision given our belief in 'real state'

"where I think I am"

s_1 extant $\quad b(s_1) = 0.75$

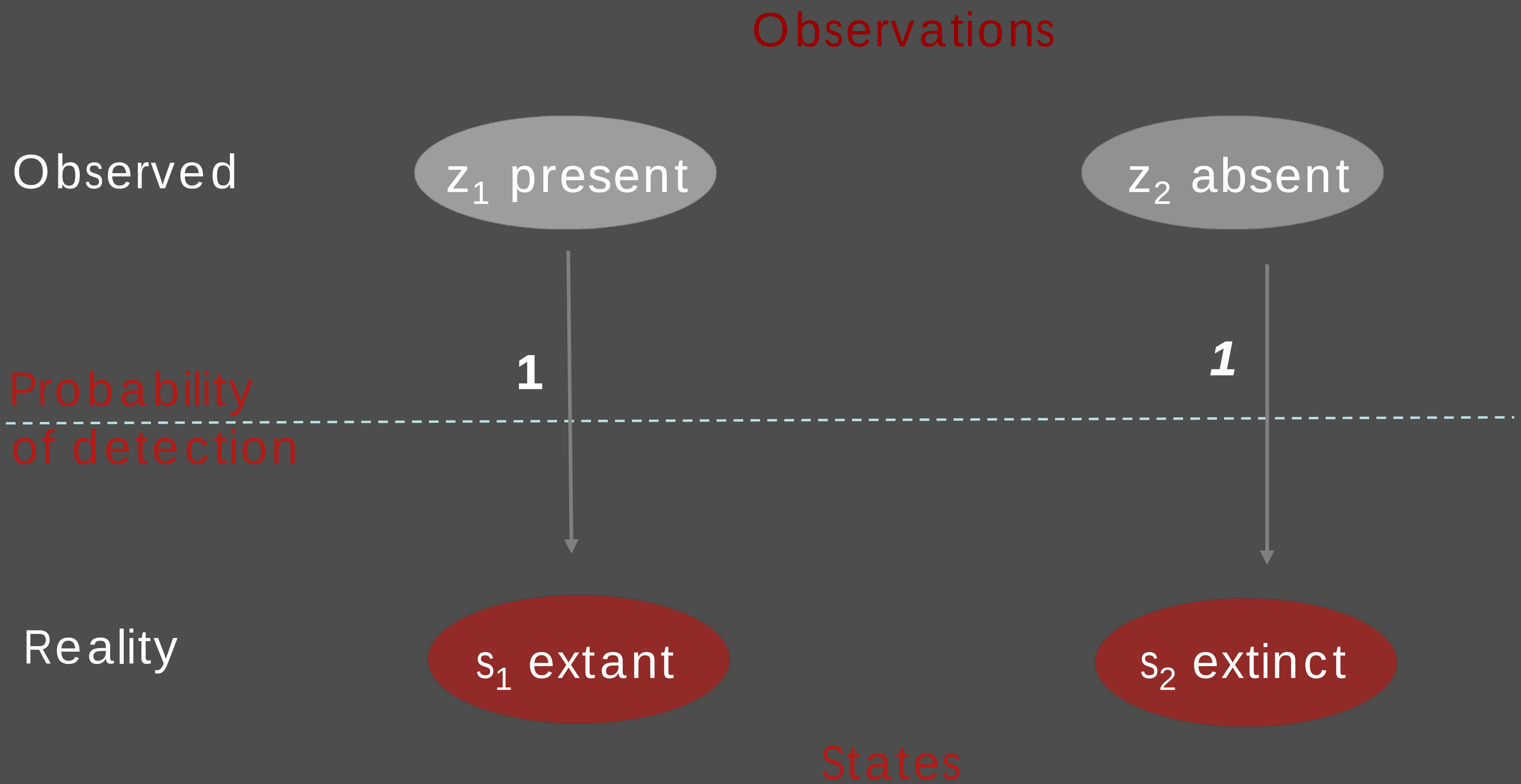
s_2 extinct $\quad b(s_2) = 1 - b(s_1) = 0.25$

Incorporating surveying - detection

How many frogs can you find?

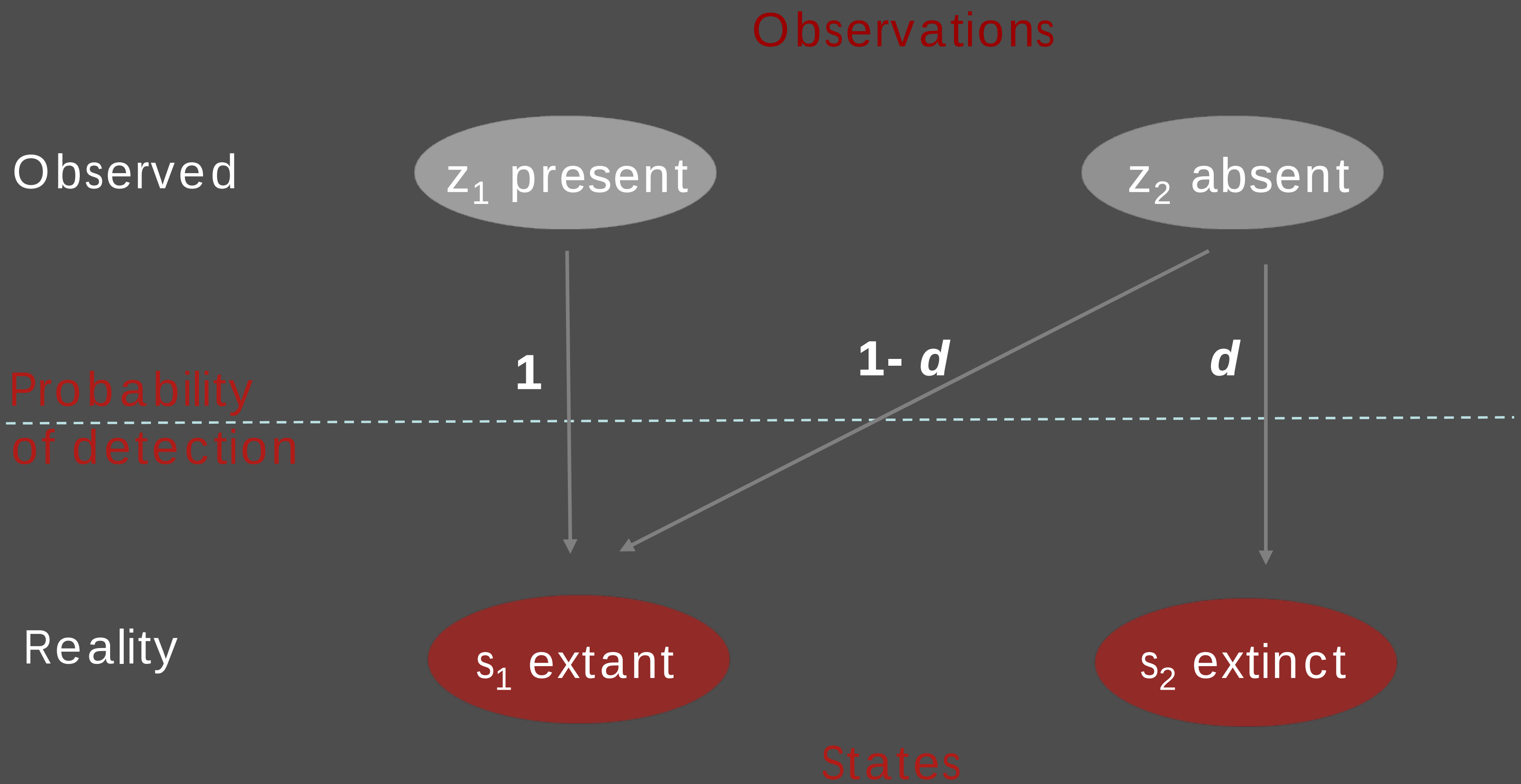
Relationship between states and observations

MDP



Relationship between states and observations

POMDP



changing belief | decisions & observations

“where i think i was”

changing belief | decisions & observations

“where i think i was”

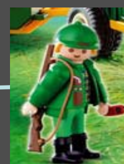
$$

$

0

changing belief | decisions & observations

“where i think i was”



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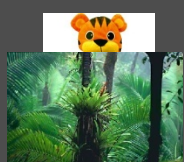
$

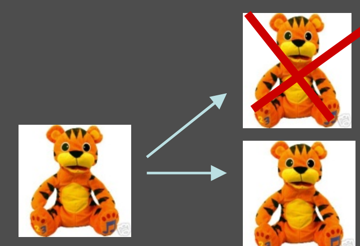
0



detection probabilities:

$d_m = 0.01$

$d_s = 0.78$

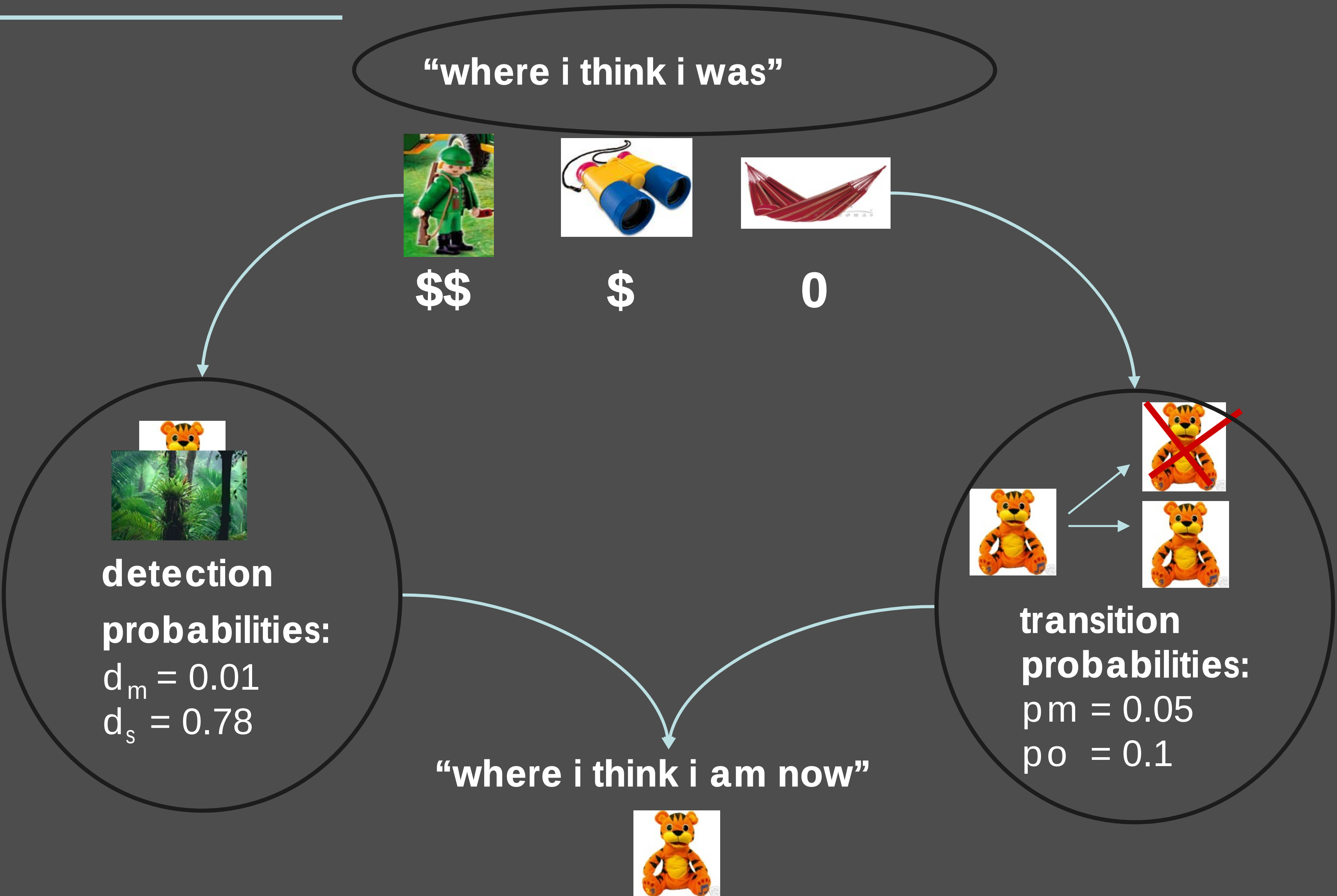


transition probabilities:

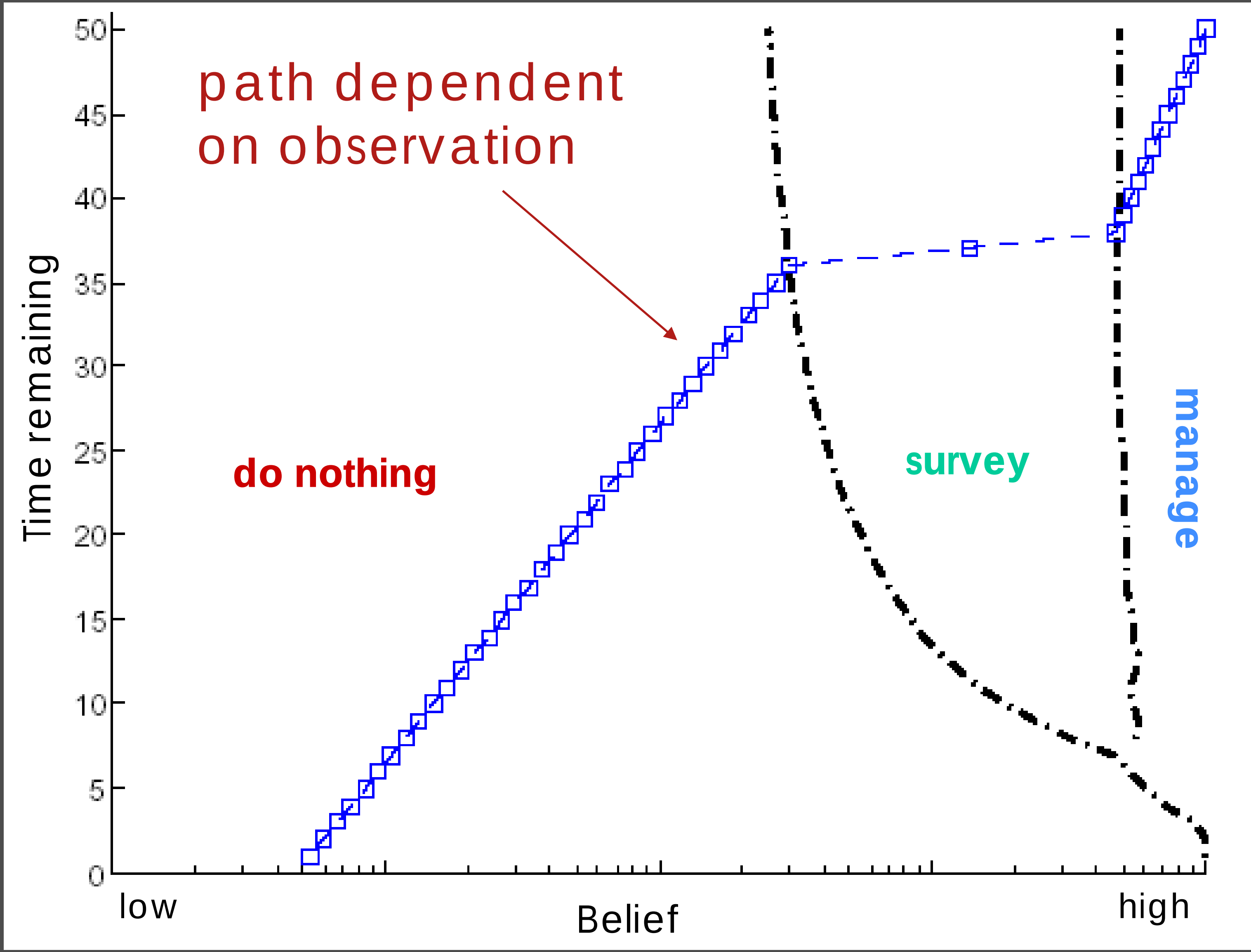
$p_m = 0.05$

$p_o = 0.1$

changing belief | decisions & observations



Acting based on belief in presence



Why monitor in conservation?

- Information gathering*
- Adaptive management
  - learning system state*
  - **learning system model*** → Belief MDP

Adaptive management

Systematic approach to improving management via learning

Understood but mathematically difficult to assess

Passive versus Active

WARNING: the following slides show images that may be disturbing to some people!

how can we actively learn system function?

- a devilishly difficult dilemma

Dramatic decline

Facial tumour disease

Urgent & expensive management

Disease behaviour unclear?

how can we actively learn system function?

- a devilishly difficult dilemma

Objective : Maximise pop growth

Decrease prevalence

Removal of individuals

2 sites for feasible learning

McDonald-Madden *et al (2009)*

A devilishly difficult dilemma - actions

Many facets unclear

Latency affects removal

Short – remove diseased

Long – remove all

Removal affects reproduction and prevalence

Models and Action

		model 1	model 2	model 3
		Disease will not progress	short latency	long latency
action 1	No treatment	1.20	0.9	0.9
action 2	Cull all diseased	1.05	1.15	0.95
action 3	Cull all adults	1.01	1.01	1.01

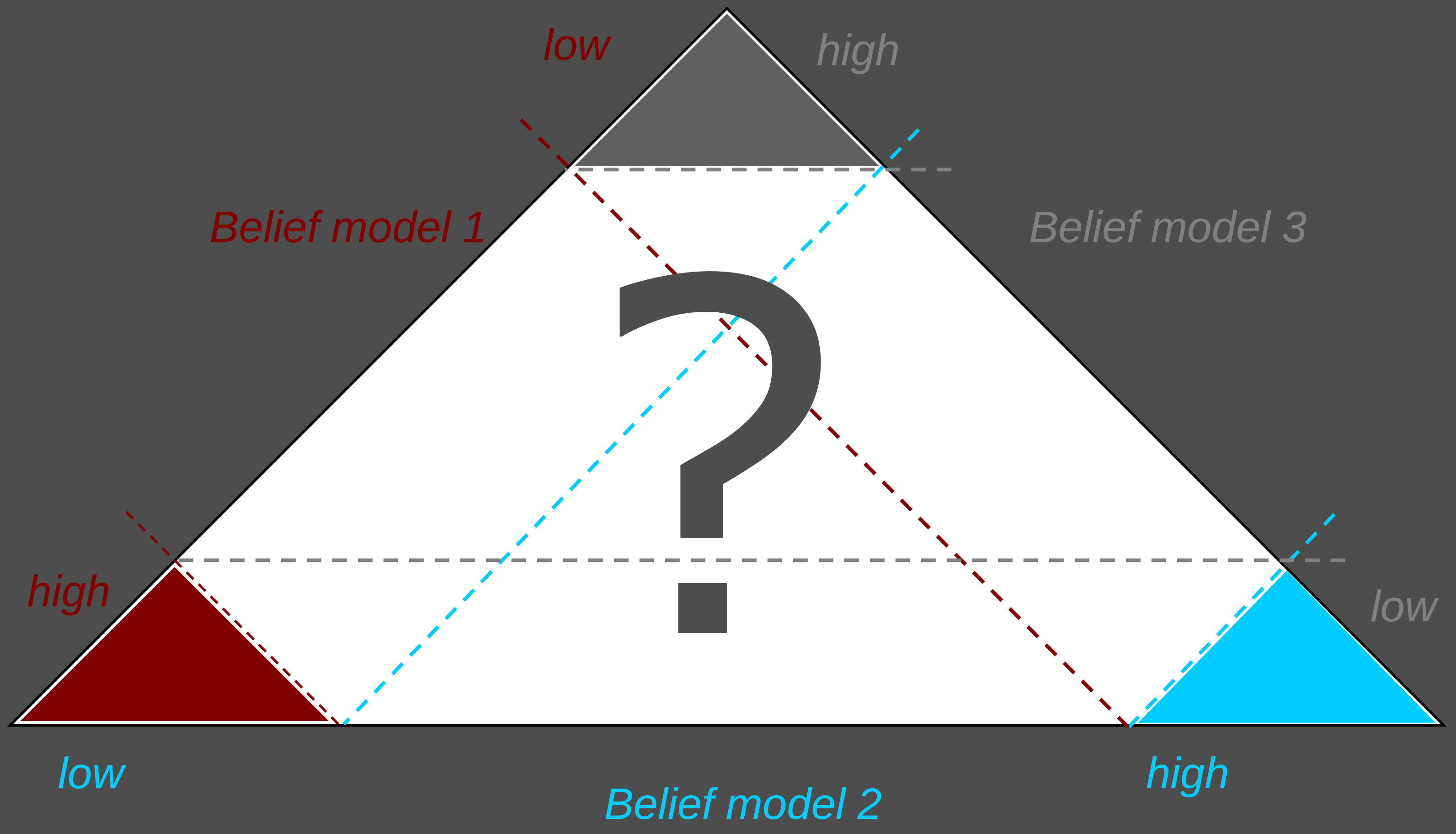
Monitoring

Information state for each model – belief that it is true

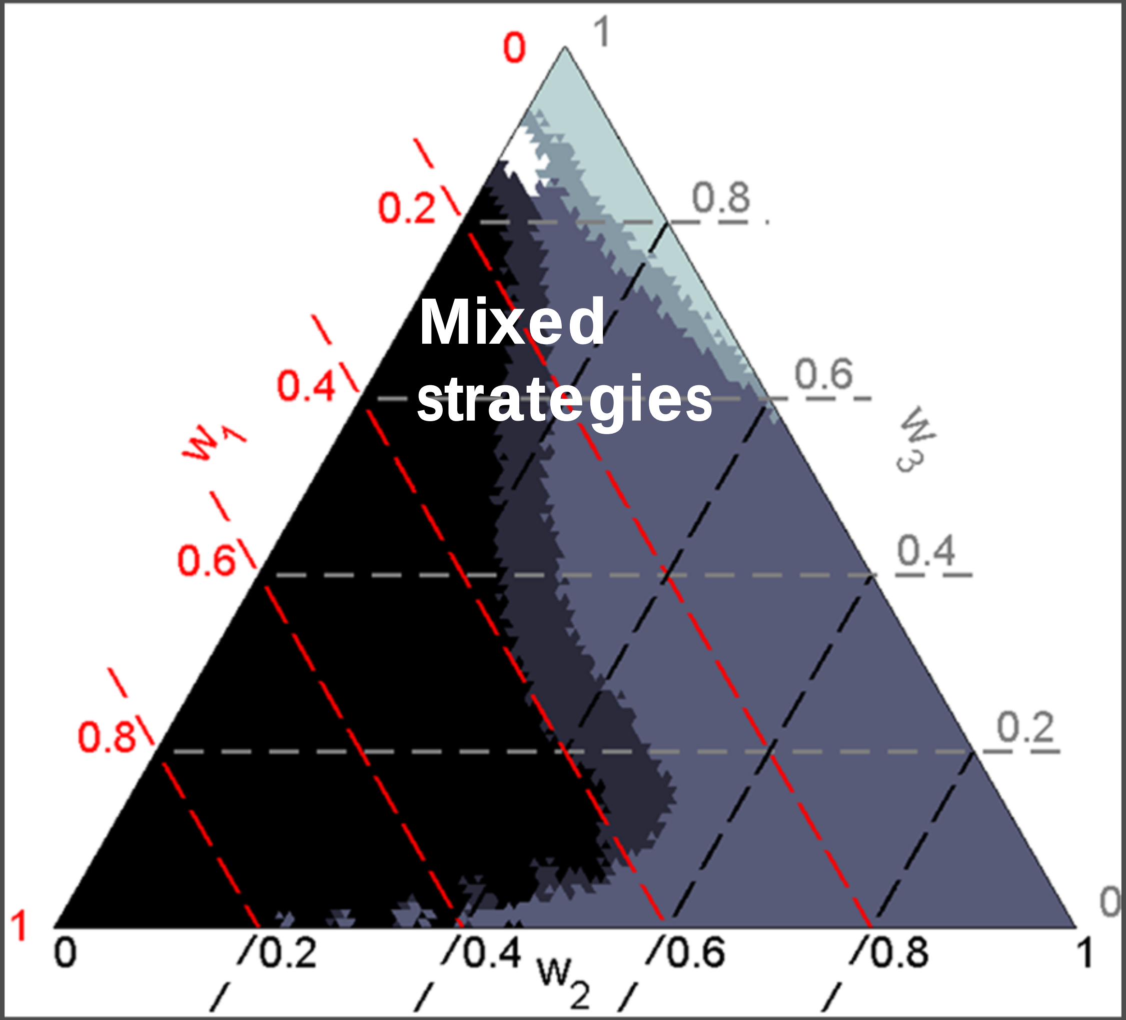
Outcomes assessed by monitoring λ^{s}_{ijt}

Reassess belief by Bayesian updating

High belief clear



Benefit based on learning and return



What we have to do....

Allocate money b/w areas

Allocate money b/w species

Allocate money b/w actions

Allocate money b/w info and management

Where to from here – more reality

"In the computer simulation he said he admired my candor and gave me a raise."

Where to from here……

Getting around the curse of dimensionality

- dynamic reserve design

- species allocation on more complex system state

Where to from here……

More model complexity

- spatial dispersal, multiple species and their interactions

- transitions unclear

Where to from here……

Dealing with multiple competing objectives (multi-agent)

- social and biological (fisheries and reef conservation)

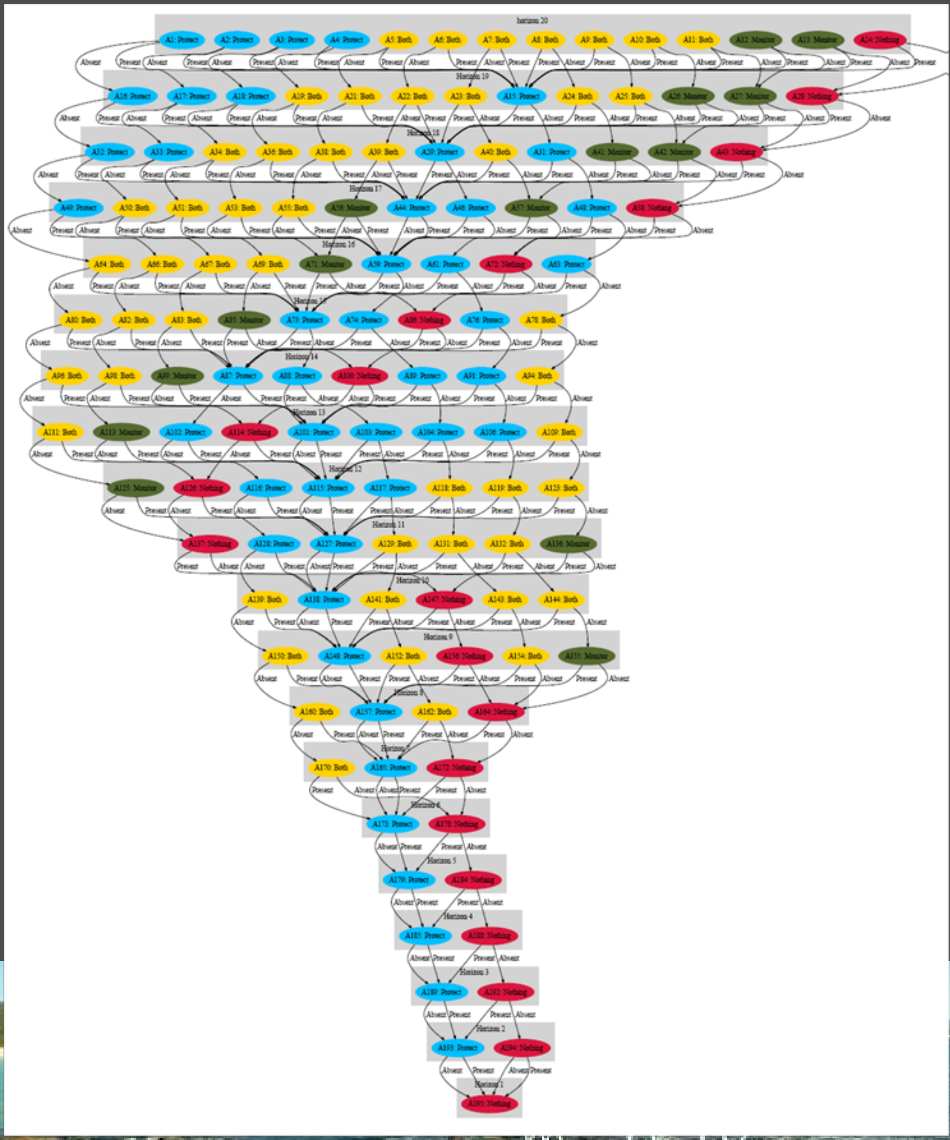
Where to from here……

Even if we can optimize

- How to present

- How to use

- Rules of thumb




questions...