The Cause-and-Effect Problem in Regulated Environmental Monitoring

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Audit of Environmental Management Effectiveness: *New South Wales Parks & Wildlife Service*

- **The audit concluded that "the *Service* has yet to:**
  - **Clarify what constitutes success in reserve management**
  - **Develop an adequate information base to measure success"**

NSW Auditor-General performance audit of the NSW Parks and Wildlife Service (NSW Audit Office, 2004).

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- **The audit concluded that "the *Service* has yet to:**
  - **Clarify what constitutes success in reserve management**
  - **Develop an adequate information base to measure success"**
- **"Consequently the Service cannot reliably determine how well it conserves and protects our natural heritage. This is a common situation for like agencies."**

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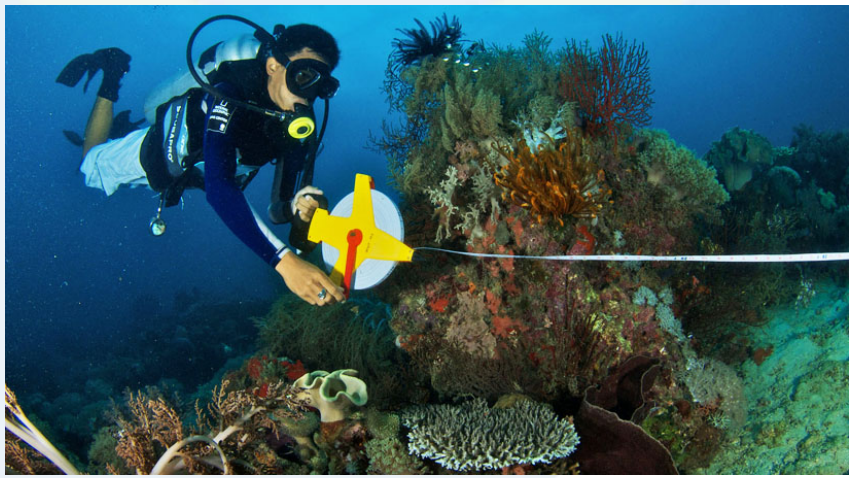
Summary

- Measuring environmental management effectiveness



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Summary

- Measuring environmental management effectiveness
- A framework for monitoring performance
  - IUCN ME Framework

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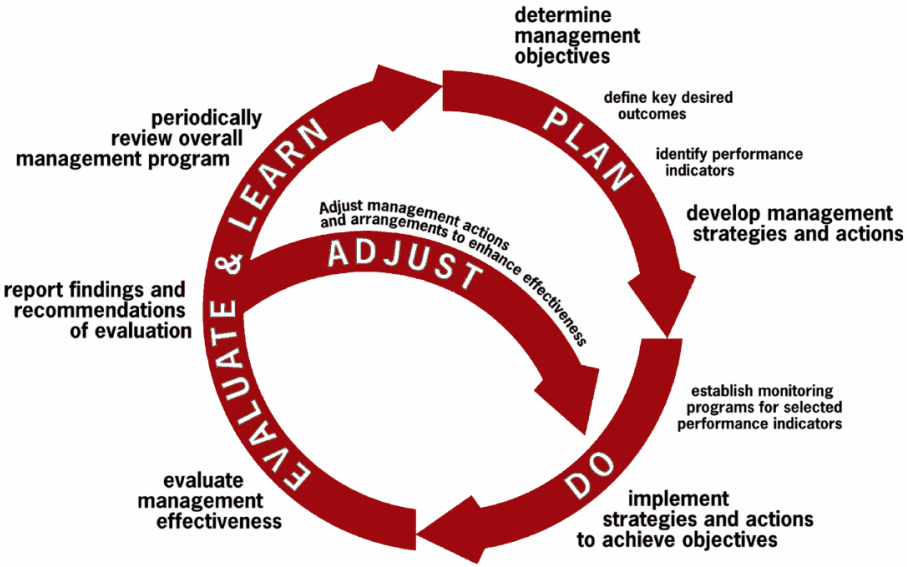
- Adaptive management
  - Policy drivers and continual improvement



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- Case studies of monitoring effectiveness
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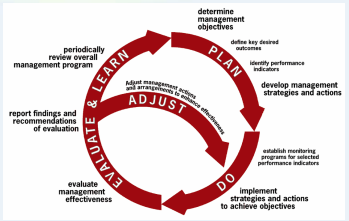
- Information needs - Ecoinformatics
- From policy to implementation
  - policy as a blunt instrument



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A framework for transparency: IUCN Monitoring and Evaluation

- IUCN ME Framework used in evaluating management effectiveness of protected areas.
  - The Western Australian DEC: Biodiversity Conservation Appraisal System

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A framework for transparency: IUCN Monitoring and Evaluation

- IUCN ME Framework used in evaluating management effectiveness of protected areas.
  - The Western Australian DEC: Biodiversity Conservation Appraisal System
- Direct biodiversity investment through an auditable process of:
  - Identifying key biodiversity values across the state that must be protected.
  - Identify the threat (pressure) degrading these values
  - Provide mechanism to introduce Adaptive Management to address these threats.
  - Monitor and evaluate management effectiveness

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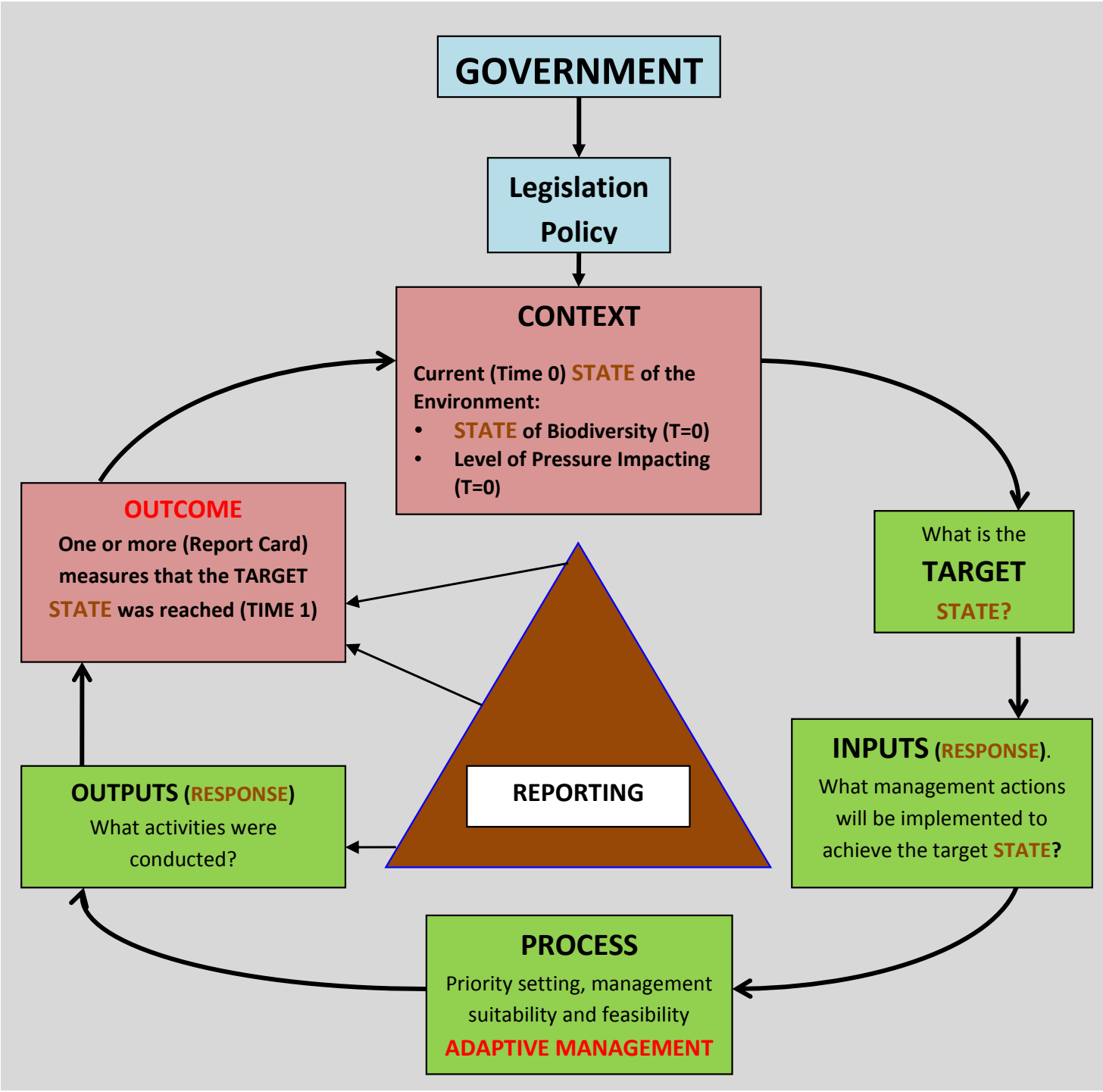
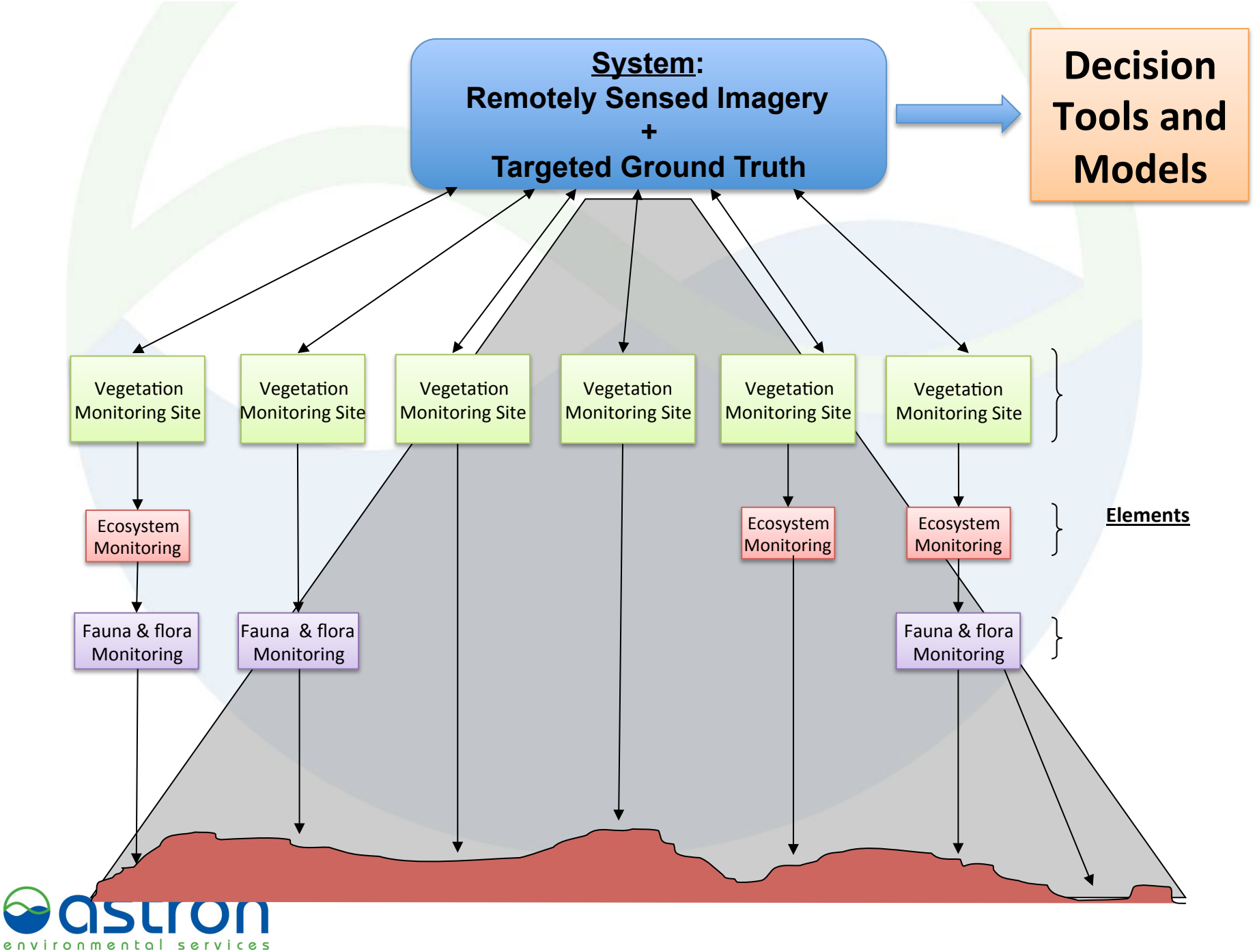

GOVERNMENT
Legislation
Policy
CONTEXT
Current (Time 0) STATE of the Environment:
• STATE of Biodiversity (T=0)
• Level of Pressure Impacting (T=0)
What is the TARGET STATE?
INPUTS (RESPONSE).
What management actions will be implemented to achieve the target STATE?
PROCESS
Priority setting, management suitability and feasibility
ADAPTIVE MANAGEMENT
OUTPUTS (RESPONSE)
What activities were conducted?
OUTCOME
One or more (Report Card) measures that the TARGET STATE was reached (TIME 1)
REPORTING



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Population Monitoring:
Risk of Weed Spread

- Buffel Grass (*Cenchrus ciliaris*)
  - ubiquitous environmental weed in northern Australia
- Management Goal: complete eradication
  - pre-impact state in 1960s
- Where to invest in control:
  1. Quarantine
  2. Contain vectors of dispersal
  3. Eradication (life stage? timing?)

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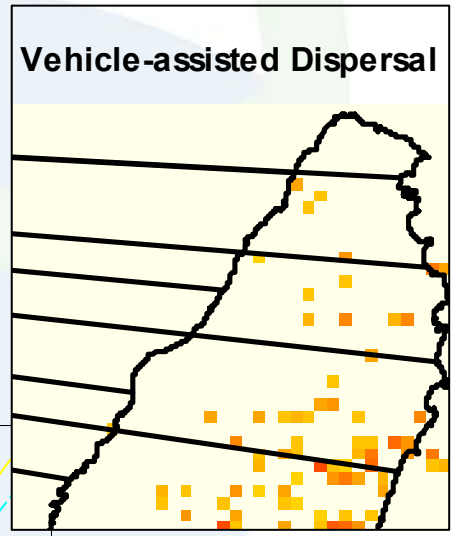
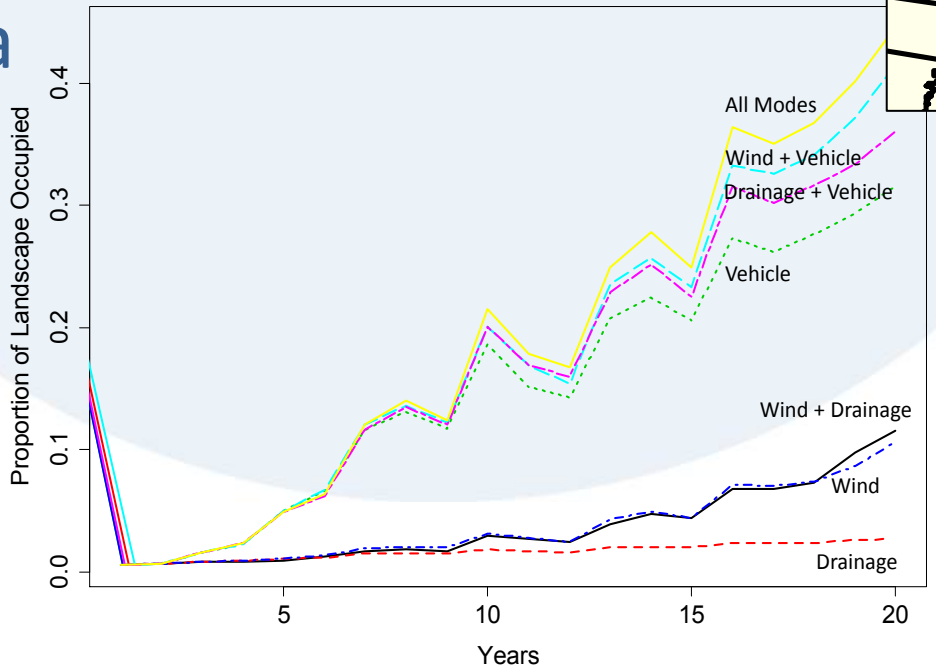
Population Monitoring:
Risk of Weed Spread

- Spatially explicit population model
- Intra-vehicular monitoring system
- Parameters assumed.
- Little data





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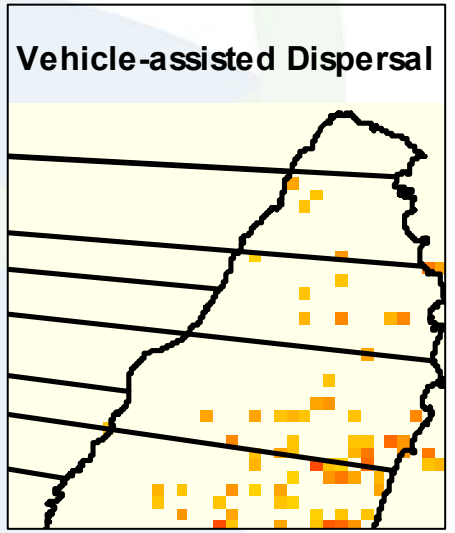
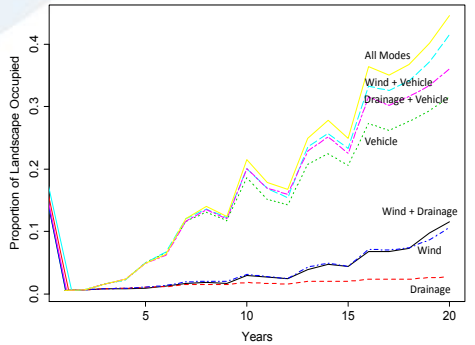


- Identified critical factors in weed success



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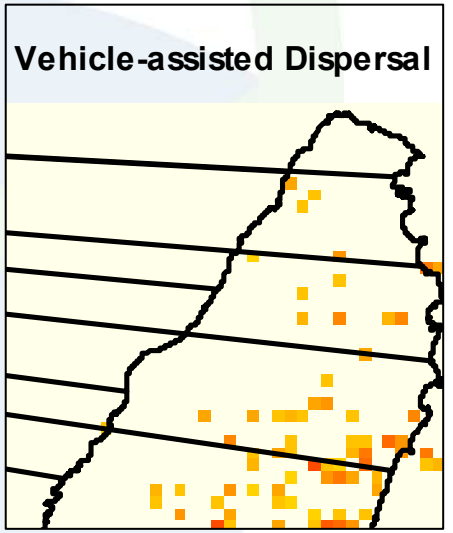
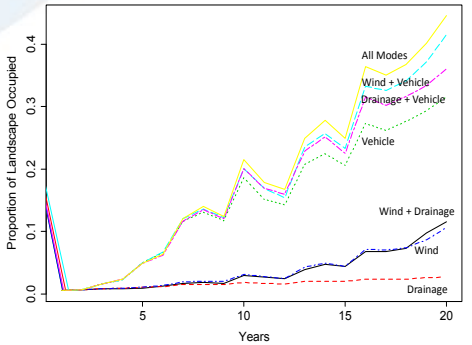


- Identified critical factors in weed success
- Future: responsive to cyclones



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Population Monitoring:
Infrastructure Impacts on Marsupial Populations

- Island site containing marsupial populations
  - Road kill during construction is reported
  - Wallabies (mobile)
  - Bandicoots (non-mobile)

- Management Goal
  - Robust population during construction phase
- How much road kill is tolerable?
  - Population parameter uncertainty

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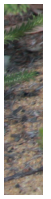
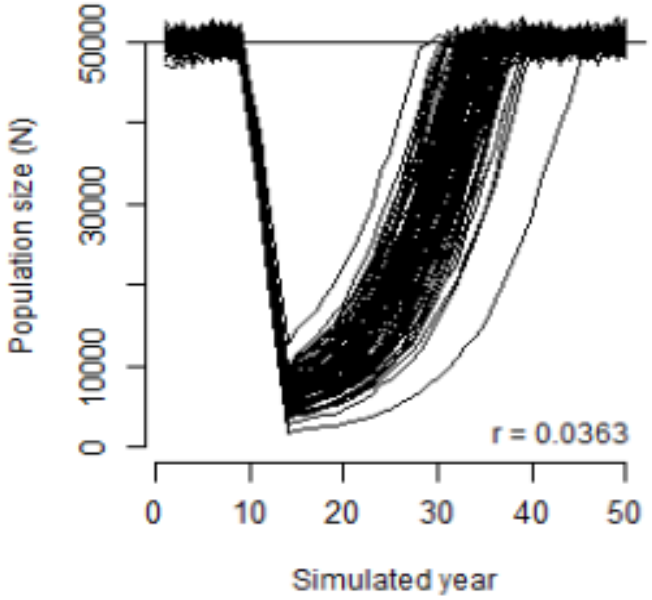
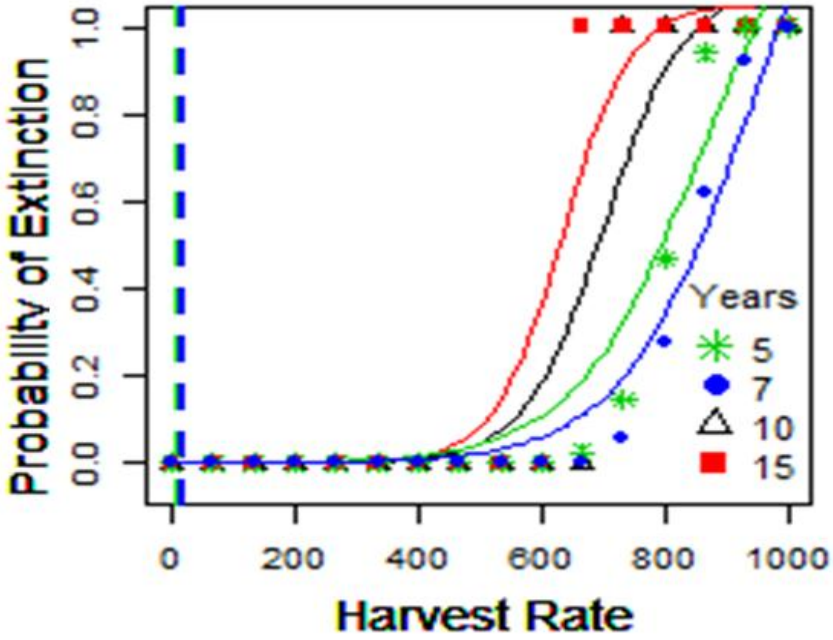


Population Monitoring:
Infrastructure Impacts on Marsupial Populations

- Mobile, slow reproducing populations at risk.
- Static, fast reproducing populations were not.
- But wider dispersing populations are genetically more robust!!





New Technologies: Ecoinformatics

- Camera traps
  - Sensor arrays
  - Automated id

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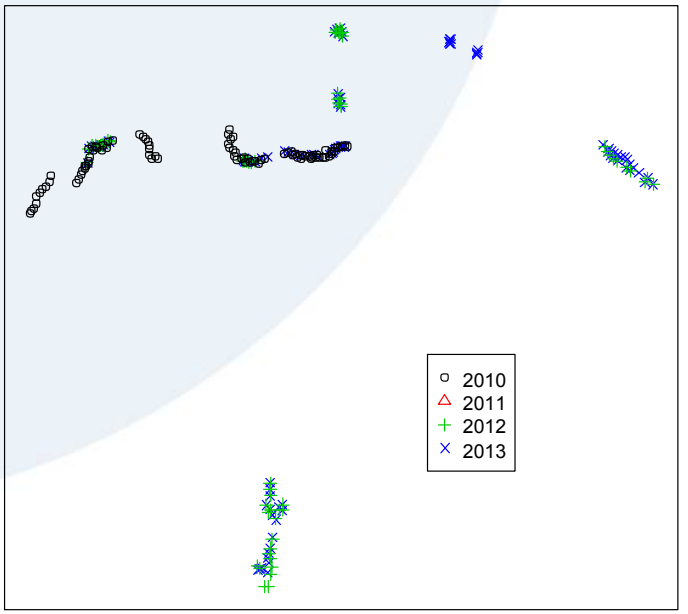
New Technologies: Ecoinformatics

- Camera traps
  - Sensor arrays
  - Automated id
- Spatially explicit surveys
  - capture probabilities
  - dispersal rates
  - statistical inference
  - impact and resource effects



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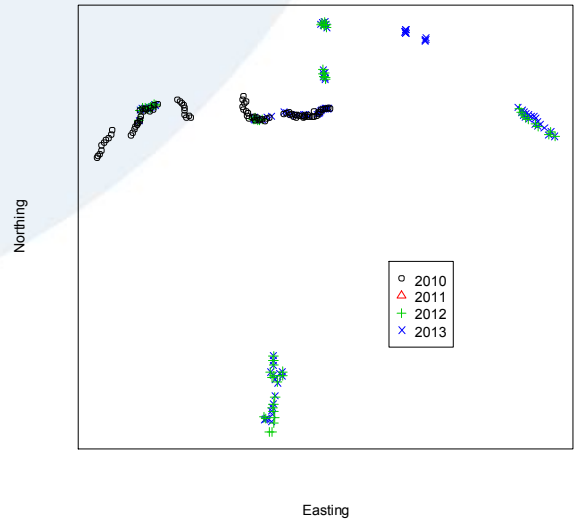
New Technologies: Ecoinformatics

- Camera traps: sensor arrays and automated ID
- Spatially explicit surveys
- Relative risk of capture probabilities
  - mixtures of different trap types and arrays
  - optimal survey design
- Digital chipping and tagging (e.g., Argos): animal movement
- Field based ring-buffer servers, rugged notepads, GNSS systems



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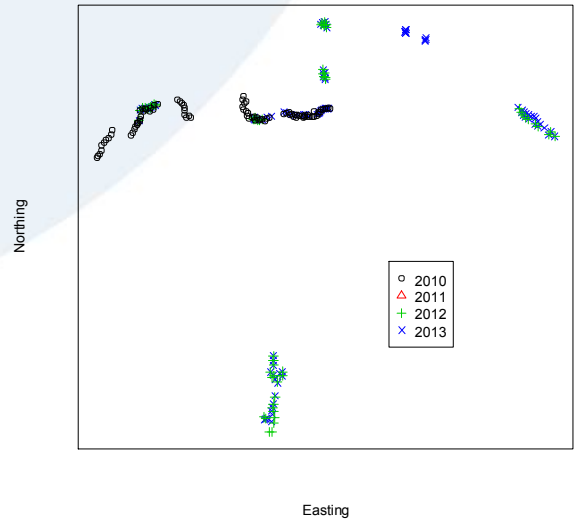
- Field based ring-buffer servers, rugged notepads, GNSS systems
- Analytical products
  - Scenario and regional models: cumulative impacts
  - Spatio-temporal analysis: BACI framework
  - Decision tools: optimal management and policy
  - Dashboard reporting and report carding
- Information platform (web based databases)



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Implications for Policy

- Policy now has a huge influence on how ecological monitoring to demonstrate complicance is undertaken
- IUCN framework + technology
  - stimulates more rigorous and sophisticated monitoring products
- Implications of key knowledge uncertainties need to be understood for policy design
- Well intentioned policy still carries risk of mis-specification in the absence of knowledge

General Science-Policy Papers

- Gove A.D., **Sadler, R.J.**, Matsuki M., Archibald, R., Pearse, S., Garkaklis, M. 2013. Control charts for improved decisions in environmental management: a case study of catchment water supply in south-west Western Australia. *Ecological Management & Restoration*, 14, 127-134.
- Florec, V., **Sadler, R.J.**, White, B., Dominiak, B.C. 2013. Economic analysis of the design of area–wide management schemes for Queensland Fruit Fly in Australia. *Food Policy*, 38, 203-213.
- White, B., **Sadler, R.J.** 2012. Optimal conservation investment for a biodiversity-rich agricultural landscape. *Australian Journal of Agricultural and Resource Economics*, 56, 1-21.
- Boer, M.M., **Sadler, R.J.**, Wittkuhn, R.S., McCaw, L., Grierson, P.F. 2009. Long-term impacts of prescribed burning on regional extent and incidence of wildfires—Evidence from 50 years of active fire management in SW Australian forests." *Forest Ecology and Management,* 259, 132–142.

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[Thanks to Wikipedia for some cute pictures]