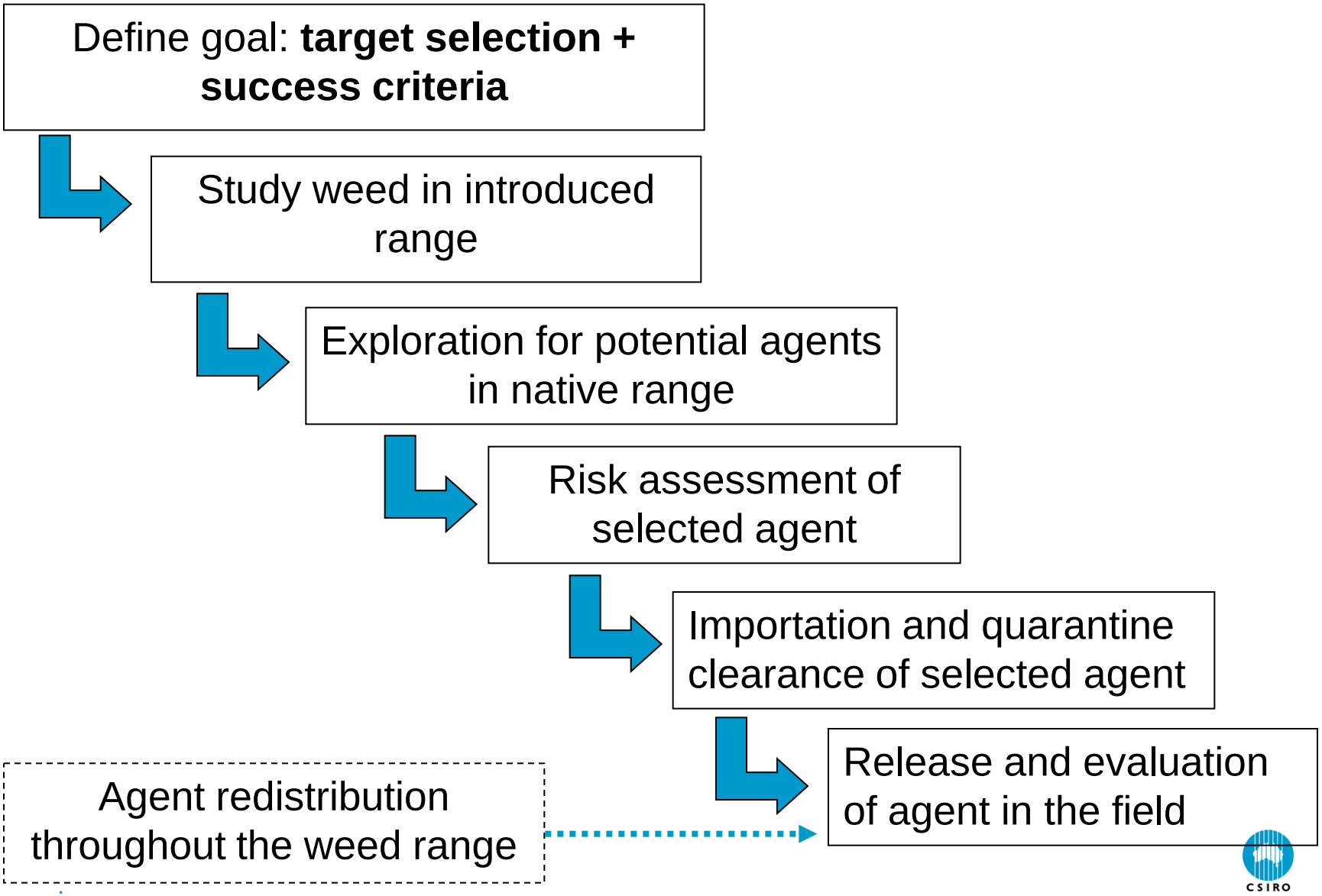
Picking the right fight: how target selection can determine success and failure of biocontrol

Rieks van Klinken

Target selection and the Biocontrol Lifecycle



Overview

1. Does the weed pose a serious threat in the first place?

2. Is biocontrol the right tool?

Invasion threats: First impressions can deceive!

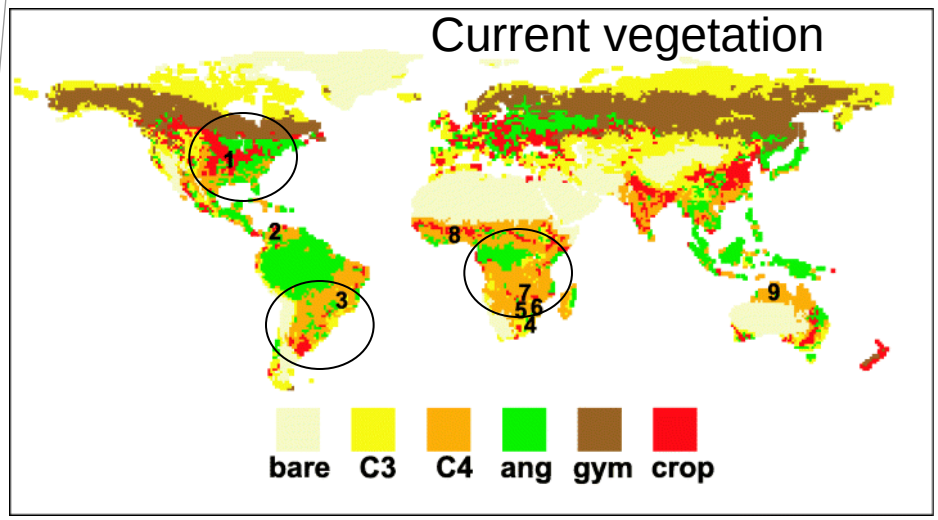
Impacts: putting invasions into context

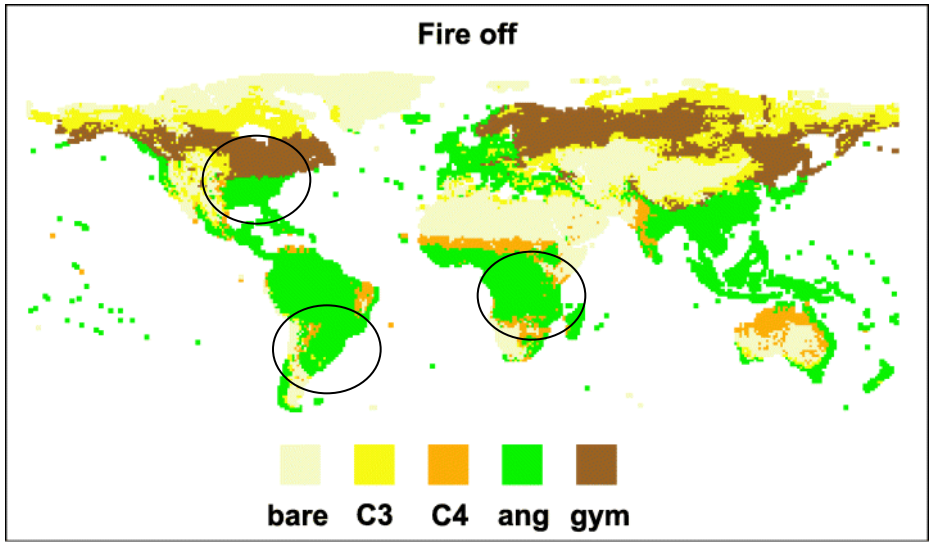
Weed invasions are happening in a broader context:

- climate change
- CO_2 increase
- change in fire management
- land use change

When are invaders important in their own right?

Impacts: putting invasions into context





Fire: the great herbivore

Dynamic Global Vegetation Models used to predict vegetation "**climate potential**"

Turn fire off and:

- vast areas of savannas and C4 grasslands in Africa and South America will become forests
- large-scale shifts in forest type in North America will occur

Bond et al. 2005 New Phytologist

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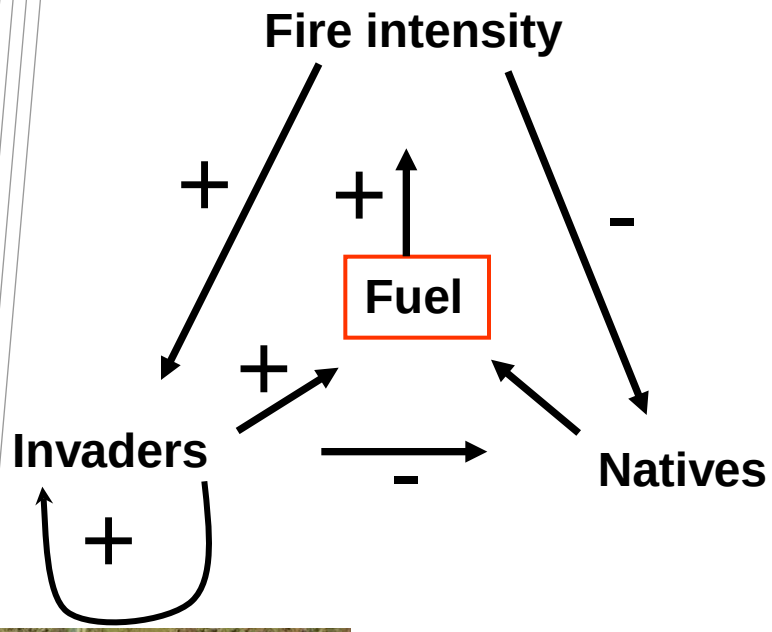
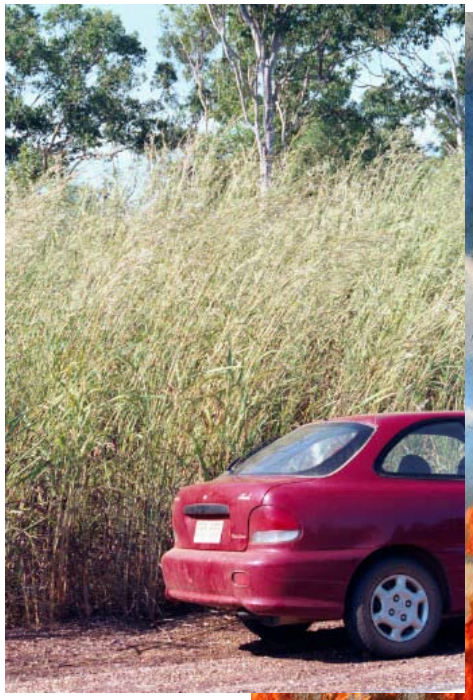
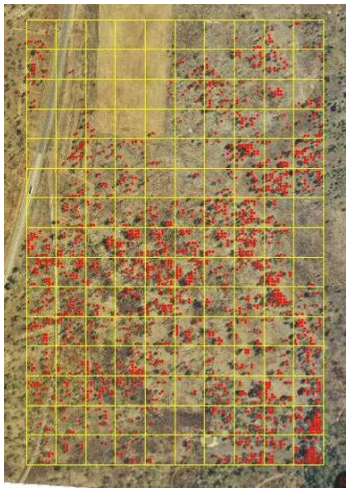
Invasions: causal or tag-a-longs?







1998

2003

Brooks et al. 2004: invasive plant-fire regime cycle

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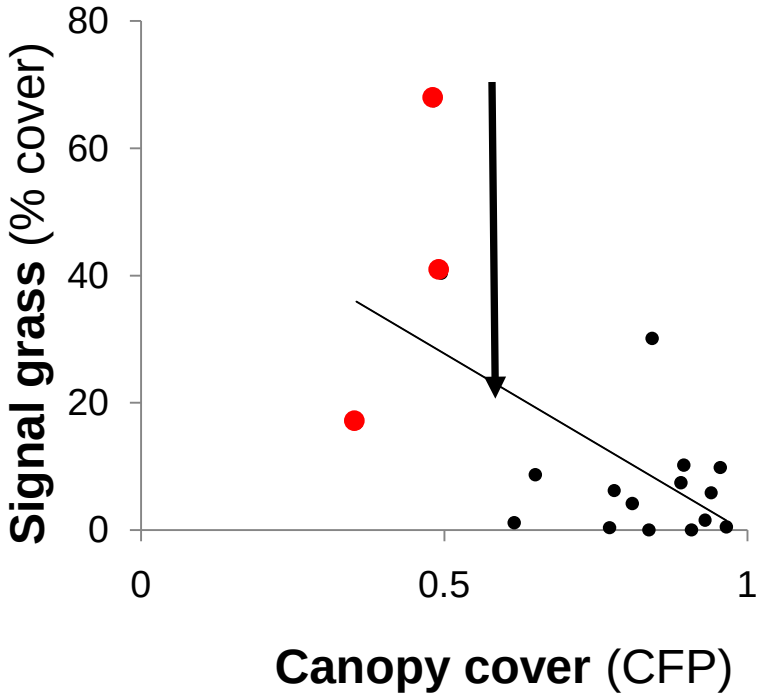
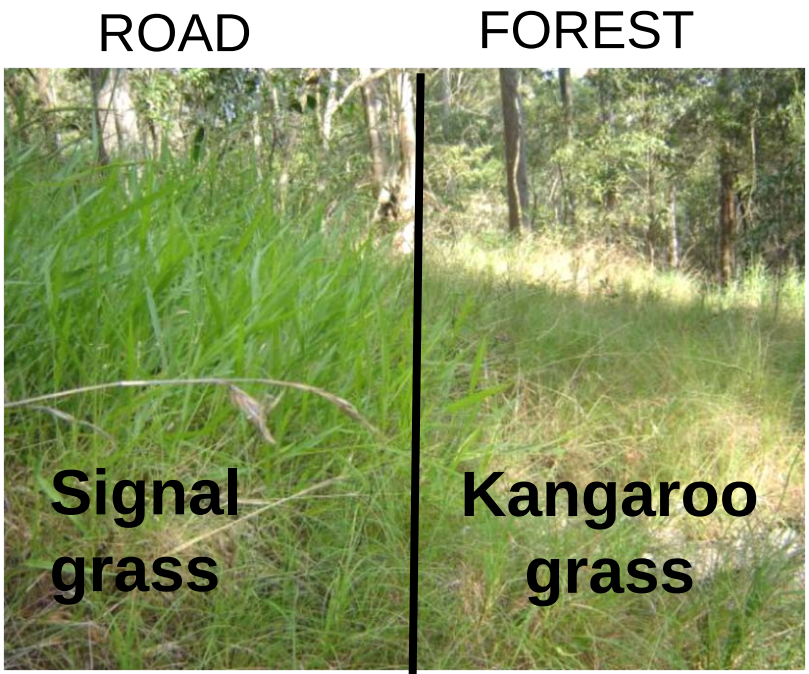
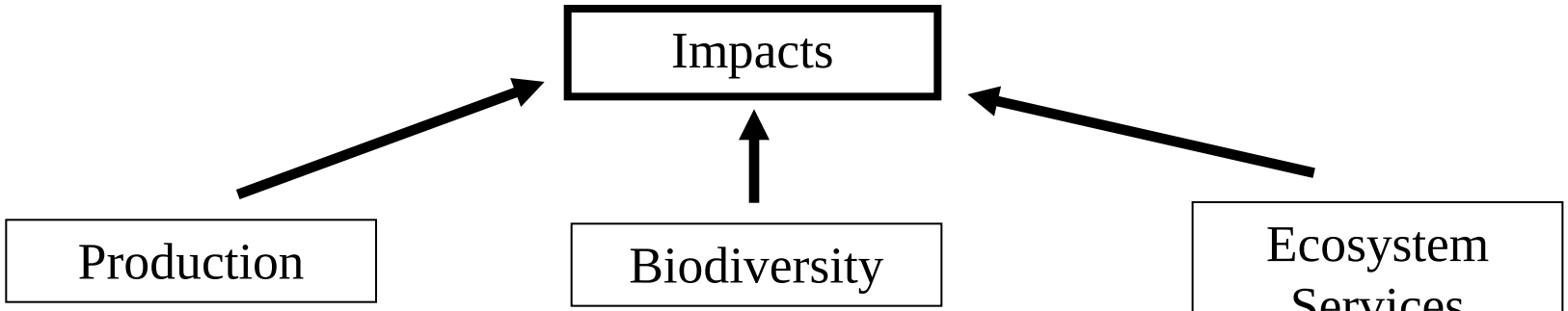
Invasions: causal or tag-a-longs?

- Invasion limited if tree cover > 70%
  - High fire frequency will open tree canopy, facilitate invasion and commence fire:invasion cycle
  - Signal grass invasion an effect of fire regime





Consequences of Invasions

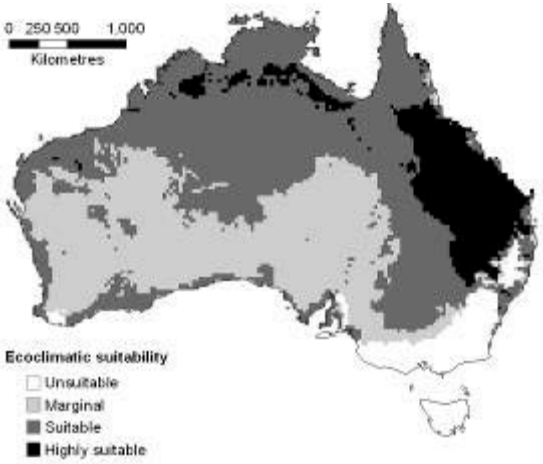


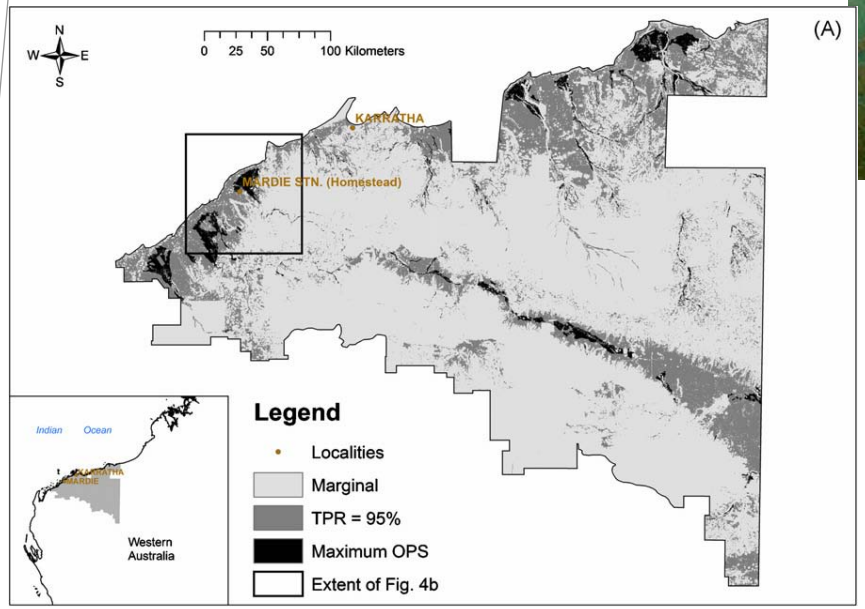
E.g.
- decreased land values
- reduced carrying capacity
- increased management
- reduced flexibility in enterprise management

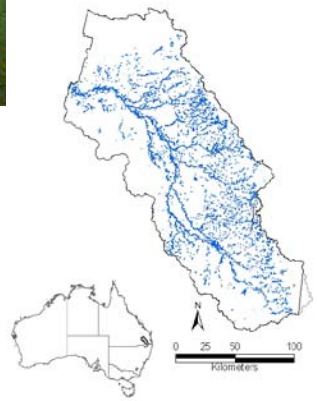
E.g.
- populations
- species
- communities
- vegetation types

E.g.
- erosion control
- water quality
- visual amenity
- nutrient dynamics

Impacts: where is it a problem?







Current climate

Dry climate

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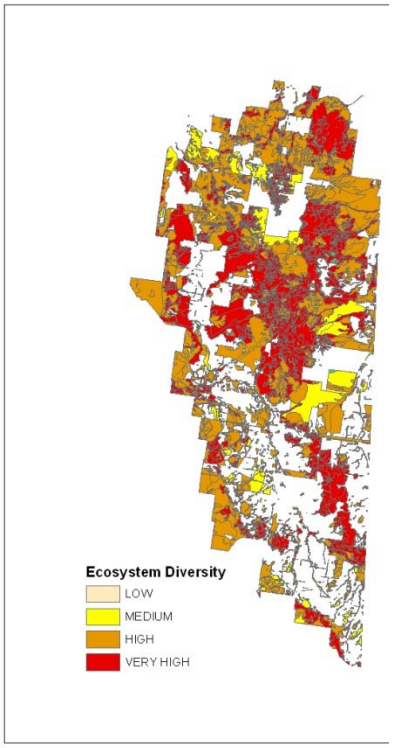
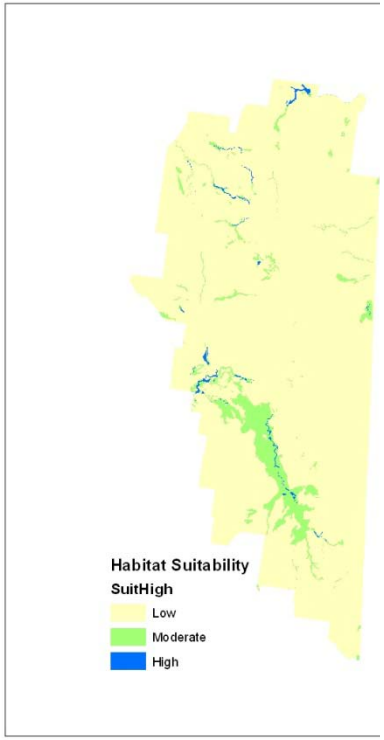
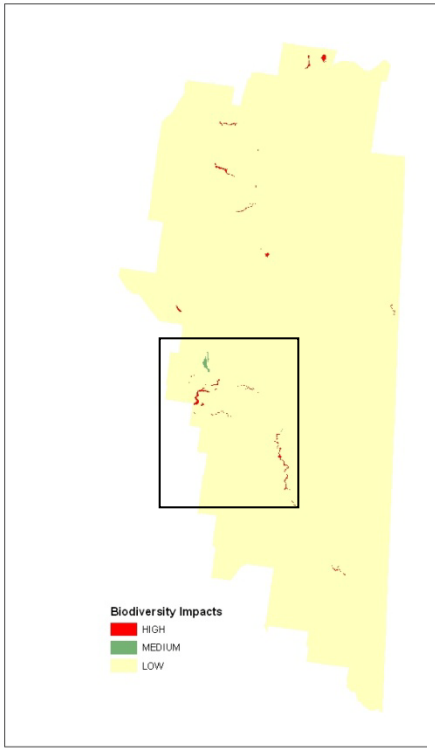
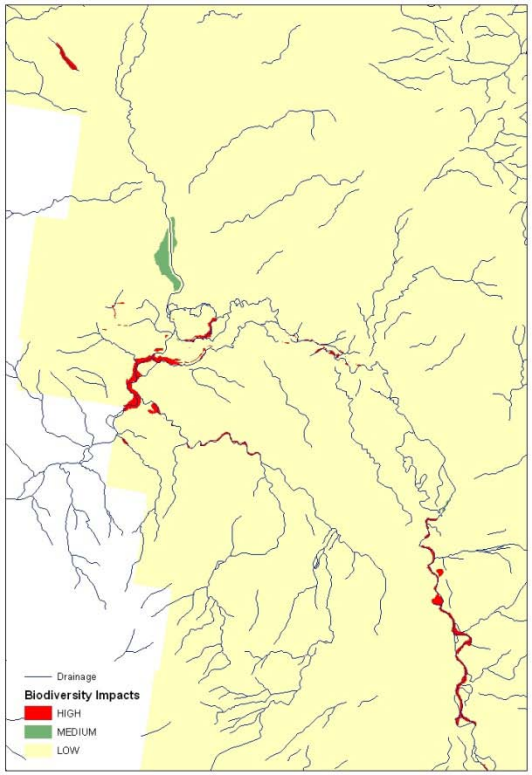
Impact: where is it a problem?

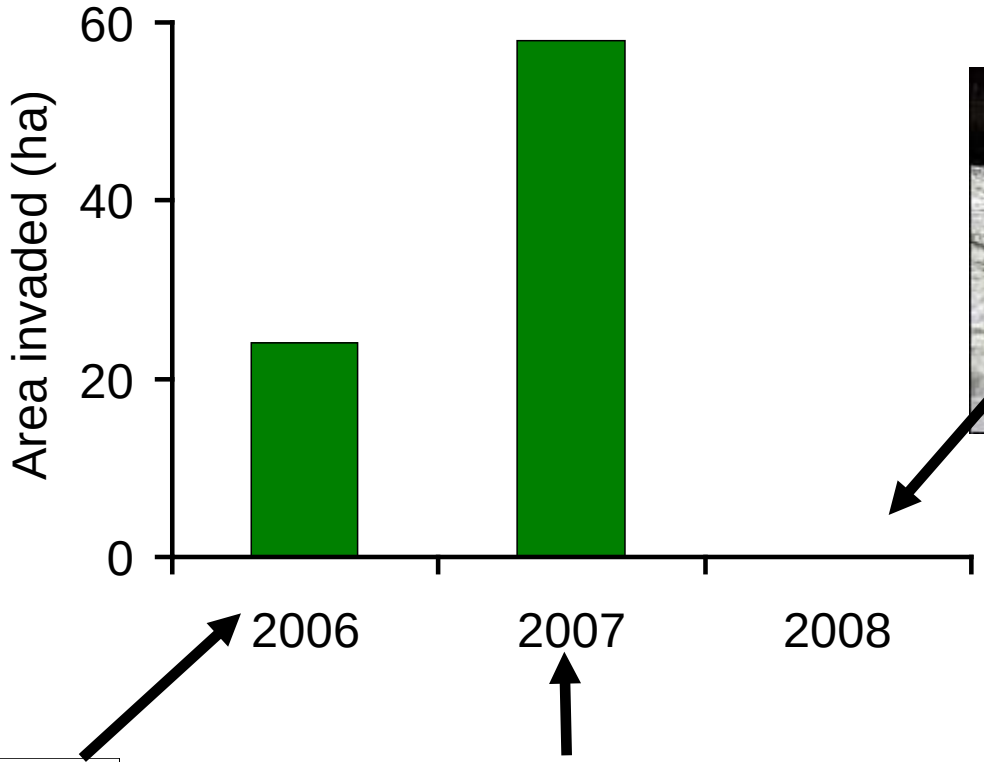


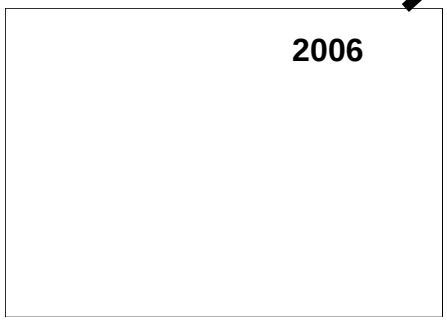




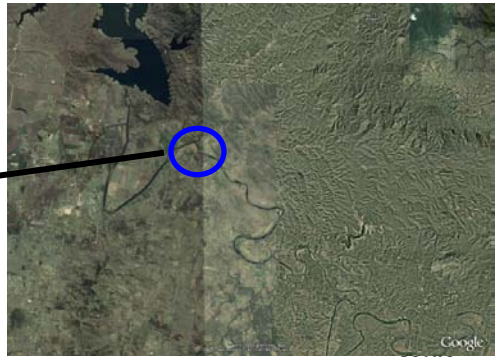


Impacts: when is it a problem?



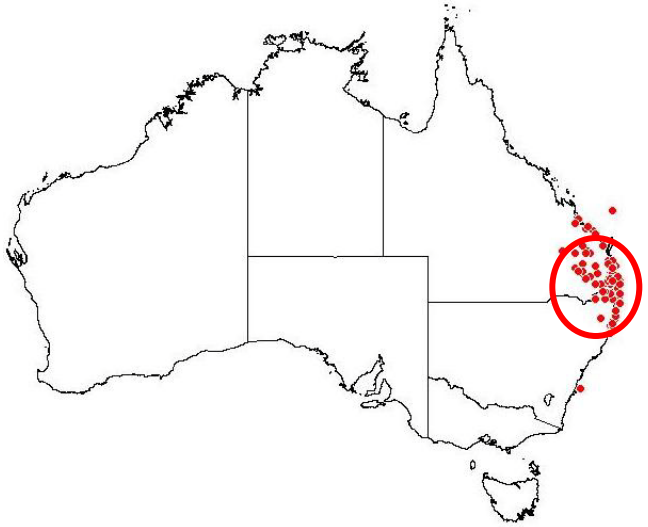


2007

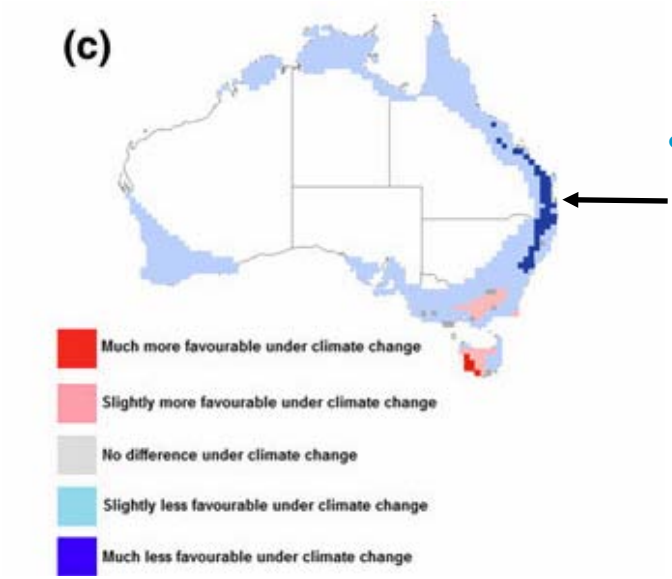


Dr Michael Schmidt (DERM: Michael.Schmidt@derm.qld.gov.au)

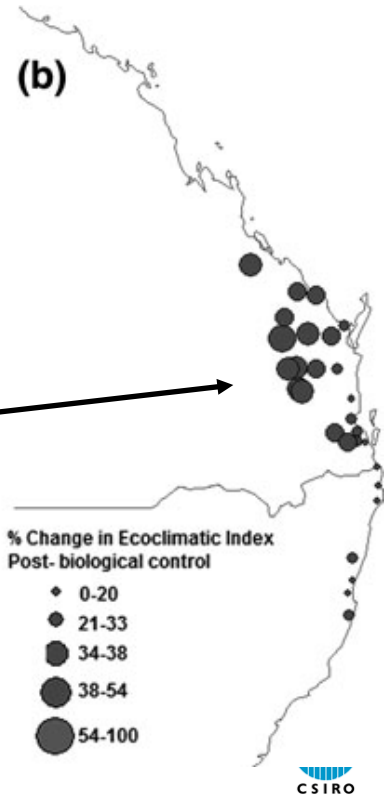
Impacts: will it remain a problem?



Biocontrol target 1963-88 (14 insects released), $50mill. Weed is no longer viewed as a serious problem



- Weed reduction through biocontrol climate change or land management changes



Sims-Chilton et al. 2010 Biol. Inv

Impacts: do invaders have a half-life?

Are impacts long term though?

Cane toads: Plague proportions on the invasion front with serious impacts on some predators

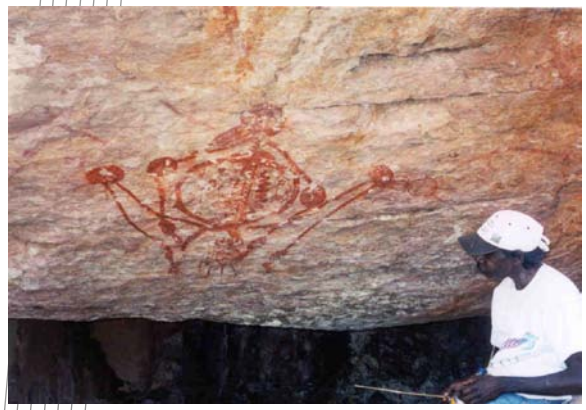
Impacts: succession

1973: heavily overgrazed, exclosures erected

1978: Calotropis became dense

1999: dense perennial pastures and shrubs

Transformers - few but fierce: Savannas



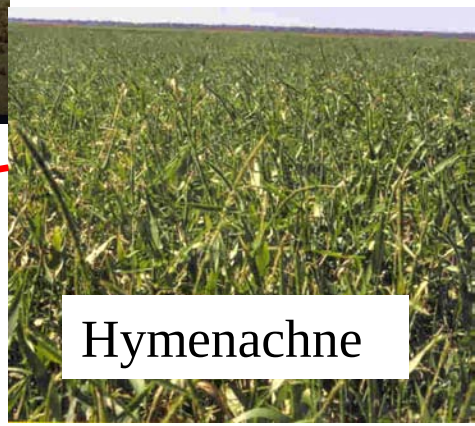
Mission grass

Gamba grass

Chromolaena

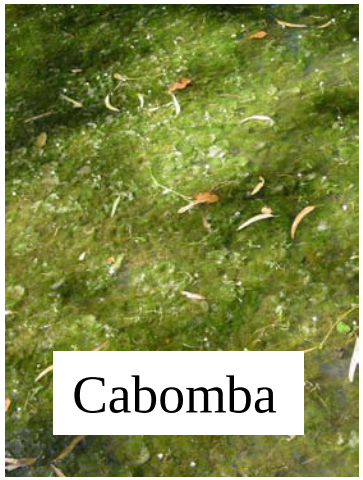
Transformers - few but fierce: Wetlands

Mimosa pigra



Hymenachne

Water hyacinth



Cabomba

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Transformers - few but fierce: arid/semi-arid

Buffel grass

Mesquite

Tamarix

Is biocontrol the right tool?

The best way to save effort and money is not to start a programme in the first place!

What are we trying to achieve?: defining success

Context	Examples of weed's impact	Examples of desired effects of biocontrol agent
(1) Ecological Hierarchy		
(a) Individual	Vines that smother upper-story trees	Reduce climbing ability
(b) Population	Become dominant	Reduce population growth rates
(c) Community	Alter patterns in species diversity through competitive interactions	Allow community restoration
(2) Ecological Processes	Disrupt hydrological flows	Restore desirable levels of hydrological flows

(& is biocontrol the best option?)

van Klinken and Raghu 2006. Aust J. Entomol.

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Developing success criteria: parkinsonia

Performance criteria	Pastoral	Environmental
Ecological objective		
Reduce patch size and density	Limit patches with 30% cover to < 0.1 ha in size	Prevent dominance in key habitats
Geographic objective		
Effective in most vulnerable regions	Central Qld, Barkly Tablelands	Pilbara, Central Qld, Barkly Tablelands
Management objective		
Reduce cost of control	Reduce regrowth and recruitment by 50%, increase time to reproduction by one year	

van Klinken 2006 Aust. J. Entomol.

Do targets need to have been released from enemies?

- No!
  - little evidence that bc agents suppresses mesquite in its native-range, but bc is effective in Australia.

Biocontrol can work even if release from natural enemies wasn't the reason for invasiveness

van Klinken et al. 2003

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Does biocontrol need to address the cause?

Not necessarily

Sida acuta

- benefits from overgrazing

- effectively managed nonetheless: no longer a production problem

- clearly hasn't addressed overgrazing problem

Appropriateness of biocontrol depends on what the success criteria are

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Biocontrol and the fate of weed-shaped holes

Does investment lead to recovery of natural ecosystems?

Morin surveyed land managers of 86 weed management projects where post-evaluation of non-weeds were done (mostly not BC)

Vegetation response following WoNS management	**% of replies**
none (bare ground)	7
WoNS recolonised site	2
WoNS replaced by native plants only	33
WoNS replaced by native and invasive plants	52

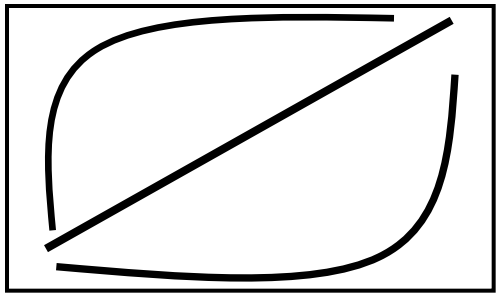
Louise Morin, pers. comm.

Biocontrol and the fate of weed-shaped holes

- An important question when success criteria = “community restoration”
  - Biocontrol “takes out” a single weed at a time
  - Multiple weed species can therefore be a problem
  - Biocontrol impact is “successional”? (often slow and through reduced competitiveness)

Are some target better than others?

Damage: Response relationship



Unpalatable pasture replacers

Allergens

Fire-invasion species

Some curves more amenable for BC

Trading off impact, feasibility and cost

Feasibility and cost-effectiveness

Impact of weed

	Unfeasible	Low	Mod	High
Negligible				
Low				
Mod				
High				

Local weeds but tech-transfer is possible

Conflict species

Serious high biomass grasses

Local problem, good agents likely

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Conclusions

- BC is a broad-scale, long-term tool which should address big, intractable, long-term problems
- Target selection should be science-driven not stakeholder-driven
  - Impact assessments needs to be hypothesis-based
  - Consider scale and context of problem
  - Define success criteria a priori
  - Take a broad, long-term, large-scale view
  - Avoid “making up” problems
- The price of getting it wrong
  - Wasted $$s
  - Unnecessary risks of non-target effects
  - Failure to “succeed”
  - Reputational
- Our aim is to do this systematically for Australian weeds

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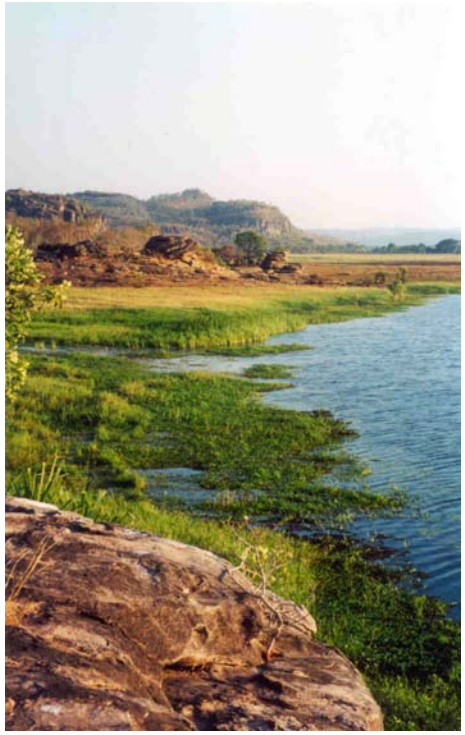

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