Are land management activities such as grazing of woodland and rangeland impacting on vegetation cover?

Josh Dorrough, Arthur Rylah Institute, DSE, Victoria & CSIRO Sustainable Ecosystems, Canberra
We have a fair idea of the impacts of overgrazing......
Livestock grazing and associated management

- Impacts on vegetation cover/dynamics and existing research challenges
- How might climate change modify interactions between livestock management and vegetation cover and dynamics?
  - Effects of CC on spatial and temporal patterns of land use
Major Structural groups – climate models and grazing response

• **Woody versus herbaceous** (tree - grass dynamics)
  • carbon storage, climate, habitat and production implications, C3 v C4 in tropics

• **Perennial vs Annual**
  • a global response to grazing (Diaz et al 2007), varying climate risk, C4/C3 v C3 in temperate Australia
Australia-wide woody plant responses

39 published papers, 52 responses

Response to Grazing
Neutral  🟦
Negative  🟥
Woody Plant Responses to Grazing

*Temperate incorporates mediterranean landscapes*
Tree and Shrub Encroachment or Decline

- Within and among region variation
  - climate, soils, topography
  - interaction with fire
  - livestock utilisation & other management
- Regional models of the “problem” (eg. Hodgkinson, 1991)
- National synthesis required, in many cases data is poor
  - Episodic responses – spatial and temporal replication required
Tree decline in the temperate zone

Eucalypt decline estimated at 0.5% to 2.5% annum\(^{-1}\)

Total loss of mature trees in 150-250 years under current management

Eucalypt regeneration in low fertility native pasture

Adapted from: Dorrough and Moxham 2005 Biol. Cons. 123:55-66
Eucalypt regeneration in grassy woodlands

Low phosphorus, native groundlayer

High phosphorus, exotic groundlayer

Adapted from: Dorrough and Moxham 2005 Biol. Cons. 123:55-66
Soil enrichment and native perennial groundlayer in grazed woodlands

Plants in temperate woodlands: Response to Phosphorus and Grazing

Dorrough and Scroggie, submitted
Reconstructing temperate woodlands

- Mineral nutrient enrichment – tree mortality, regeneration failure and highly modified understorey vegetation
- Evidence for nutrient/disturbance driven stable annual vegetation states (eg. Yates, Prober et al)
- Recruitment of groundlayer and overstorey – nutrient run-down, grazing strategies, spatial variability
- Year to year variation large (can overwhelm management interventions) - recruitment events rare and data poor
- Can significant change occur at broad scales and over what timescales?
Pasture Introductions

• Pasture/forage introductions
  – nitrogen fixers  eg. *Leucaena*
  – Pasture grass  eg. *Andropogon gayanus, Cenchrus*

• Large impacts on veg dynamics (eg. grass-fire cycles, nutrient cycling, acidification, competition) BUT
  – Data often scarce, predictions of long-term impacts may be difficult

• A massive research and management challenge to reverse impacts
Rotational grazing systems are being increasingly adopted throughout grazing lands. Regimes variable, ecological outcomes possibly also perennials and palatable woody vegetation? Much anecdotal information, little data to support claims.
Interactions: Climate change, grazing management and vegetation

• Complex interactions
  – $\text{CO}_2$, temp, moisture
  – Differential plant responses
  – Interactions with grazing: selection, tolerance, competitive response and effect

• Likely to influence Tree-grass dynamics, understorey structure and composition

• Spatial replication and scale limited
Changes in frequency and duration of rare events

- Recruitment and mortality episodic in response to extreme rain/drought events
  - \( \Rightarrow \) rapid long-term vegetation shifts
  - \( \uparrow \) Variation under CC, \( \downarrow \) predictability
- Current management systems often fail to manage existing variability - will this be exacerbated?
- CC will alter the likelihood and predictability of rapid vegetation change
- Models needed BUT data not good
  - few replicated extreme events
Interactions with changing land management

• Changing land use a primary driver of vegetation
  – play out over varying times-scales
  – difficult to distinguish CC impacts

• Intensification → Abandonment
  – Varying ability to predict outcomes

• Shifts in enterprise mix
  – dramatic eg. livestock to bluegums/pine
  – subtle but significant implications eg. sheep to goats or wool to meat

• How will climate change influence these land use changes?
Research Priorities - A rough summary

- Australia-wide synthesis of tree-grass dynamics - compilation of existing data and new data if required
- Better models and data of recruitment/mortality in response to extreme events and impacts of grazing on subsequent outcomes
- Reconstruction of perennial woodland systems in temperate zone
- Impact of introduced pasture/forage on vegetation dynamics and strategies to reverse trends
- LUC and CC interactions
Acknowledgements

Ideas here owe a lot to:
Andrew Ash, Steve Crimp, Michael Dunlop, Russell Fairfax, Ken Hodgkinson, Ian Lunt, Sue McIntyre, Pete Vesk and others

Errors, misinterpretation and shortcomings I claim as mine