

A photograph of a man standing in a dense forest. The man is wearing a light-colored short-sleeved shirt, dark trousers, and a cap. He is standing in the center-right of the frame. The forest is filled with many thin, vertical tree trunks and lush green foliage. The ground is covered with fallen leaves and small plants. The lighting is bright, suggesting a sunny day. The text is overlaid on the image in a semi-transparent white box.

# Increasing resilience when undertaking restoration

David Lamb  
University of Queensland  
Australia

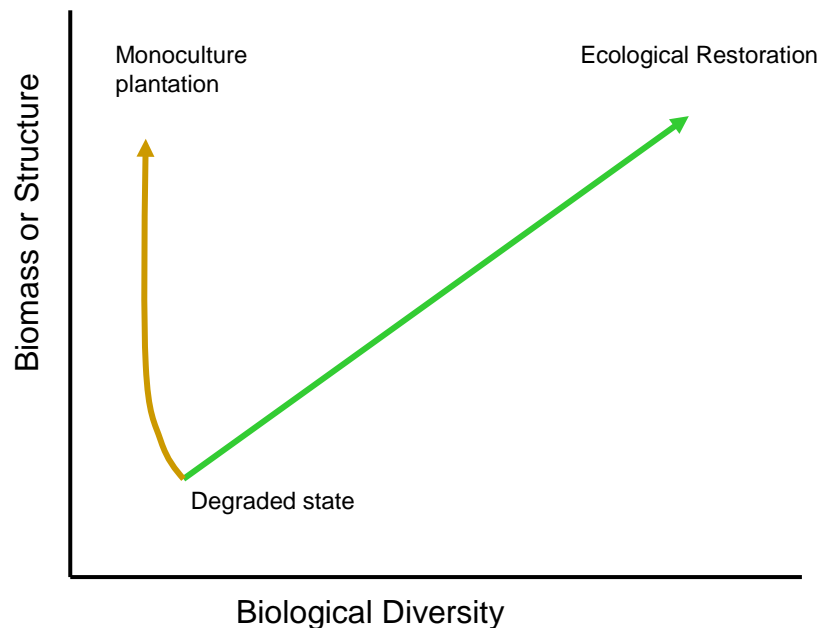
# Several approaches to reforesting degraded lands

## Monoculture plantations

- Use well-known species
- Simple to establish and manage
- Very productive
- Hence commercially attractive

## Ecological Restoration

- Natural regeneration or planting
- Restores biodiversity including rare and threatened species

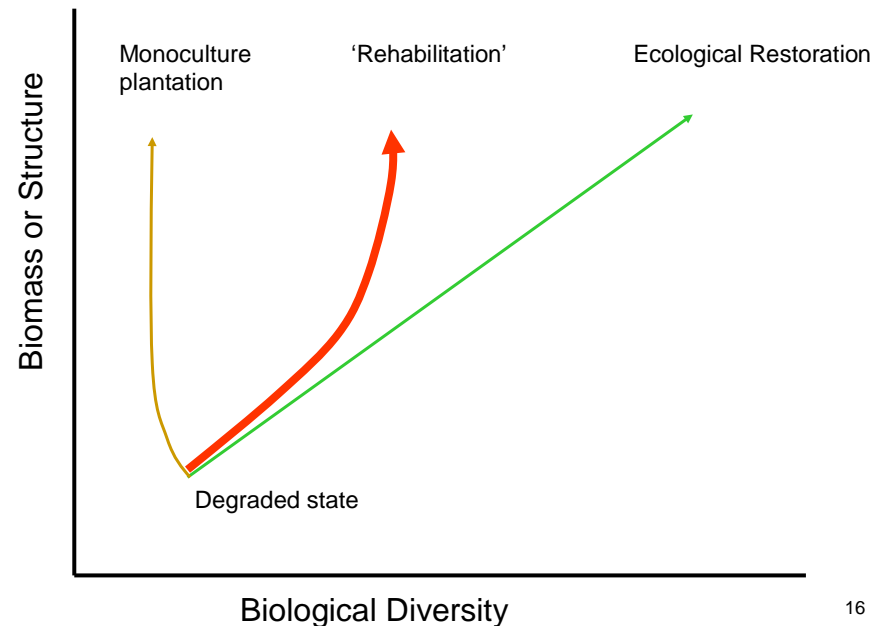


# Each has disadvantages

- Monocultures
  - Supplies limited only range of goods and services
  - Vulnerable to pests, diseases and market changes
- Ecological Restoration
  - Not always ecologically possible
  - Expensive if planted
  - Fewer financial benefits (to landholder) so less attractive

# Third approach

- Use some but not all original species
- Perhaps include exotics
- Provide financial plus some functional and conservation benefits
- BUT -
  - What are design rules?
  - Will they be attractive to landholders?
  - How resilient will these ecosystems be?



# Building resilience

- Definition of resilience
  - Capacity to **tolerate/adapt** to disturbances and
  - remain in same state with same **structure**, **functioning** and **feedback** mechanisms
- Avoids a search for
  - (i) optimal productivity or
  - (ii) some unattainable former state
- But how to achieve this?

# Some attributes of resilient systems: they have

1. Diversity
2. Modularity (connectedness)
3. Tight feedbacks
4. Openness (inflows and outflows)
5. Reserves (e.g. seedbanks, social memories)
6. Overlapping institutions (polycentric governance)
7. Are adaptively managed

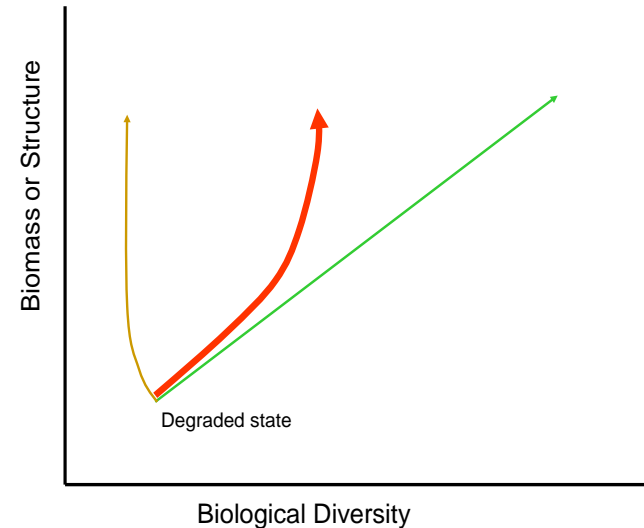
# In the case of restoration resilience has four components

- Ecological resilience
- Economic resilience
- Social resilience
- Institutional resilience

# 1. Ecological component

## In Theory

- Use more species
- Use diversity of functional types
- Work at local and landscape scales
- Protect residual forests (seed sources, etc.)



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## But in Practice

- How many species to get more resilience?
- What types of species (longevity, shade tolerance, fire tolerance, N-fixing?)
- Are landscape patterns more important than what happens at a particular site?

# 2. Economic component

## In Theory

- Use >1 species providing multiple goods
- Look for multiple markets
  - goods and services
  - Local, national and international
- Supportive local and national institutions  
(e.g. finances, market access, market knowledge)

## But in practice

- What are these species?
- How to foster new markets if not already present?
- How to trade off diversity vs production?
- Uncertain land tenure?

# 3. Social components

## In Theory

- Increase capacity to adapt to change by encouraging
  - learning networks
  - marketing networks

## But in Practice

- Many landholders lack capacity for adaption
  - don't have formal land tenure
  - are unaware of technology
  - are unaware of markets
- There are limited social memories about restoration

# 4. Institutional components

## In Theory

- Devolve authority - encourage local decision-making
- Avoid simple top-down prescriptions
  - foster experimentation by landholders - more technical self-sufficiency (generates social 'memory')
- Develop means of monitoring changes - seek feedback
- Practice adaptive management
- Financial and legal support

## But in Practice

- Government policies and institutions are often not supportive
- Prefer top-down control
- Conflicts between different levels of government
- Laws un-enforced
- Often limited institutional memories about restoration
- Limited financial support

# In short, resilience requires

- Multiple species (site and/or landscape)
- Avoiding reliance on single product or services (e.g. just timber)
- Avoiding dependence on single market
- Social networks and organisation
  - learning (silviculture, markets)
  - marketing
- Monitoring to promote
  - innovation
  - adaptive management
- Improving access to financial support in times of stress

# Case Study 1: Storm damage, China

- Severe ice storm (Hunan, latitude 27S)
- Anecdotal evidence that exotics and monocultures more affected



# Case Study 2: Minesites, Australia

- Post mining rehabilitation originally done with exotic monocultures but unstable
- Now use multi-species plantings of natives



# Importance of Context

- Production areas
  - Close to markets
  - Distant from markets
  - Smallholder or Corporate
- Protection areas
- Extent of degradation
  - severe
  - less-severe
- Short term risks vs long term risks

# Raises important questions

1. How to predict the ecological and economic risks at particular locations?  
how severe might they be?  
how long might they take to appear?
2. What is an appropriate balance between increasing resilience and increasing productivity?  
how many and which species?  
how far are they compatible and when do they diverge?  
Scale - sites vs landscapes
3. Are there trade-offs between ecological and economic or social resilience?  
are win-win solutions possible?  
building social capital?
4. Hence, how much (and what type of) resilience needed?  
what are the key stressors?  
what are they necessary institutional arrangements?



# 1. How to predict the ecological and economic risks at particular locations?

- how severe might they be?
- how long might they take to appear?

Land use history?

Ecological trends?

Institutional framework?

## 2. What is an appropriate balance between increasing resilience and increasing productivity?

- How many and what type of species?
- does context matter? ('close to' or 'distant from' markets?)
- how far do they go together and when do they diverge?
- Sites vs landscape scales

### 3. Are there trade-offs between ecological and economic or social resilience?

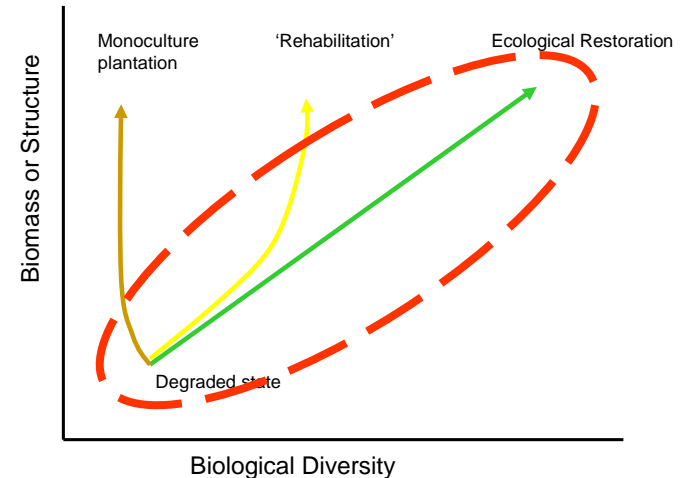
- Which species (for markets? For ecological functioning?)
- are win-win solutions possible?
- Nurturing markets as well as ecosystems?

## 4. How much (and what type of) resilience is needed

- what are the key stressors?
- how to build social capital?
- what are the necessary institutional arrangements?

# One approach - Ecological Restoration

- Ecological restoration
  - Re-establish native species
  - Seek to re-establish presumed original ecosystems
- Advantages
  - Variety of functional types
  - Buffered against change
- Disadvantage
  - Not always ecologically possible
  - In absence of PES not economically attractive to many landholders (high opportunity costs)
  - Hence often (though not always) used on small areas

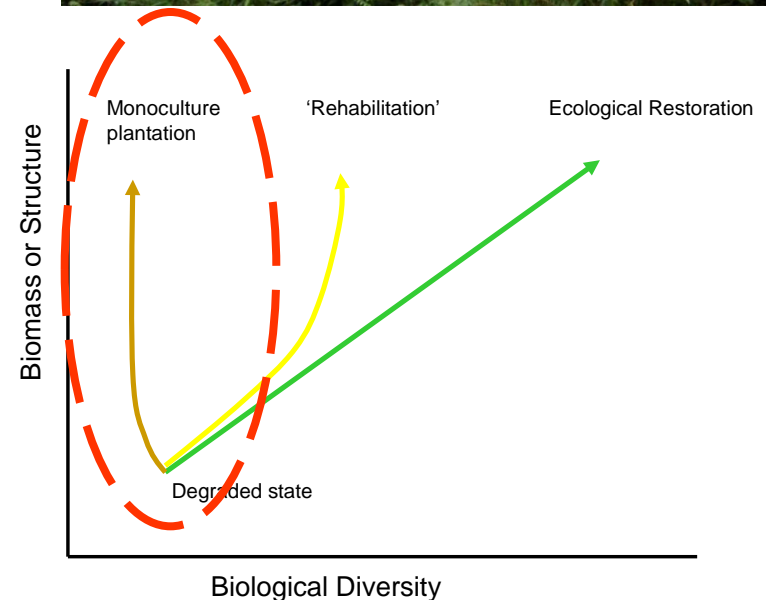


# A second approach - Mono-cultural plantings

Use single species  
that is:

- Productive
- Commercially valuable
- Has readily available seedlings
- Has a known silviculture

Seek to maximise  
productivity and efficiency



# Advantages and Disadvantages

## ADVANTAGES

- Can be financially profitable
- Hence attractive to landholders
  - Widely implemented (agriculture, forestry)

## DISADVANTAGES

- Monocultures risky over longer term
- Sensitive to changes in circumstances
  - Ecological (pests, disease, storms, etc)
  - Economic (market changes)
- i.e. Lacks **resilience**

# Difficult to restore degraded lands

- Ecological problems
  - Finding species able to tolerate changed conditions
  - Working out
    - how and sequencing of re-establishment,
    - the relative proportions of each species to use,
    - managing inter-actions, etc
- Economic and social problems
  - who pays for restoration?
  - Overcoming opportunity costs
  - Scaling up to cover ecologically significant areas