Habitat Brisbane Citywide Meeting March 2013

Managing novel ecosystems: opportunities and dilemmas with non-native woody plants in forest restoration

Carla Catterall

Environmental Futures Centre

Griffith UNIVERSITY
School of Environment

Managing novel ecosystems: opportunities and dilemmas with non-native woody plants in forest restoration

1. background
2. what are novel ecosystems?
3. novel ecosystems case study – camphor laurel regrowth
4. other emerging novel ecosystems & associated dilemmas

Background

The challenge of reforestation

past over-clearing; losses – biodiversity, carbon storage, hydrological regulation, ++

→ Protecting the remaining forest is not enough

.... rapid restoration to avoid more time-lagged losses?

how possible is rapid restoration of biodiversity and ecosystem function?

Forest cover dynamics

Hectares of forest @ time 1 − (Hectares lost/ cleared + Hectares gained) = Hectares of forest @ time 2

Loss – Gain = Net change

Global statistics (FAO 2010 global forest resource assessment):

1990-2000:
Loss = 16 mill. ha; Gain = 7.7 mill. ha; Net change = - 8.3 mill. ha

2000-2010:
Loss = 13 mill. ha; Gain = 7.8 mill. ha; Net change = - 5.2 mill. ha

Reforestation

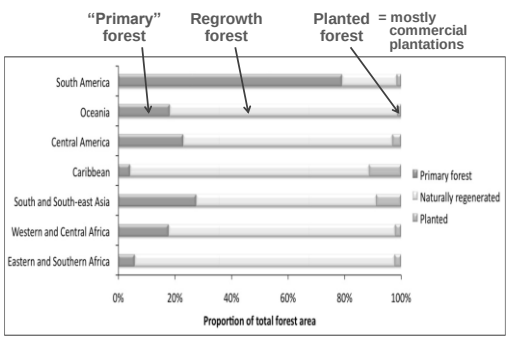
→ in 2010 only 36% of forests were considered "primary"
→64% is reforested land

What does "reforestation" consist of ?

Spontaneous (passive) regrowth
- establishes without assistance;
- low-cost
- can be slow

Active planting
- seedlings actively planted;
- done for various reasons;
- higher cost
- faster initial establishment.

Global area of forest & "reforestation" types:



Source: FAO 2010, Global Forest Resources Assessment

Brisbane region's forests

- about 80% of former forest cover now converted to suburb, pasture or cropland.
- remainder is in remnant patches surrounded by other land uses
- riparian forests and lowland rainforests were almost completely eliminated in the 1800s and early 1900s
- current remnant patches:
  - some are partly >50 year-old regrowth after early clearing and land use for pasture or cropland
  - others have also been affected by timber-getting (virtually all large trees cut and removed in 1800s-early 1900s), and livestock grazing (removes and simplifies the understorey)

→ *virtually all the current forest areas are ecologically different from their state at the time of European settlement*

Source: Catterall & Kingston 1993

What are novel ecosystems?

New forests and novel ecosystems

Deforestation continues to destroy large tracts of native forest, but there is increasing abandonment of agriculture over large areas.

& exotic species are often the earliest tree colonisers
- → novel mix of native & exotic species = "novel ecosystems"
- → dilemma for ecologists and land managers
  + large restoration potential

Defining characteristics of novel ecosystems:
- incorporation of new species, in new combinations
- driven directly or indirectly by human actions

e.g. Puerto Rico's "new forests"
- large proportion of original forests cleared
- widespread regrowth on abandoned cropland
- exotic trees dominant in early regrowth
  - eg *Spathodea campanulata* African tulip
- many native trees becoming more common in older regrowth

Novel ecosystems case study – camphor laurel regrowth

Location:
the "Big Scrub" in northern NSW
– originally 750 km² rainforest (c. 1800)

Changes in vegetation cover:

In 1958: less than 0.1 % remained uncleared

In 2004, 25% of the landscape was forest regrowth
- mostly dominated by camphor laurel, introduced from China

Camphor laurel *Cinnamomum camphora* - ecological properties

- fast grower,
- fleshy fruits widely dispersed by birds,
- tolerates drought/frost,
- not much browsed by wallabies,
- seeds short-lived,
- seedlings shade-intolerant

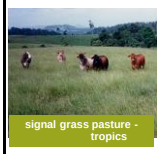



+ Establishes and grows well in pasture if not heavily grazed

Why pasture often limits forest regeneration

1. **Limited seed supply** of forest tree/shrub species
   (- short-lived seed → few spp with soil seed stores;
   - lack of disperser activity)

2. **Competition from grasses and herbs** of open habitats
   (often introduced pasture grasses with vigorous growth, aggressively competitive, can be fire-prone
   → resist the establishment of tree seedlings)


signal grass pasture - tropics


pasture 7+ years since destocking - tropics

The camphor dilemma:

- is camphor regrowth desirable reforestation or undesirable weed invasion?

→ need research to clarify its ecological role

→ survey of plants & frugivorous birds in 24 camphor patches >3 ha (survey sites 0.6 ha)

1. is camphor regrowth used by frugivorous birds?

→ Yes, 34 species;
10 high quality seed-dispersers
& regionally-threatened rose-crowned fruit-dove found at 92% of sites


Rose-crowned fruit-dove

Neilan et al. 2006 *Biol. Cons.*; Kanowski et al. 2008 *Ecol. Manag. Restn.*

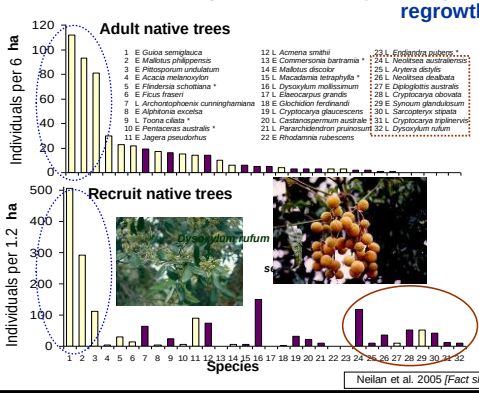
2. Does this catalyse native regeneration under the camphor canopy?

→ Yes,
native species are 25% of adult trees;
vs native species are 47% of recruits (< 25 mm dbh)

and
these recruits include
more later-successional species

Neilan et al. 2006 *Biol. Cons.*; Kanowski et al. 2008 *Ecol. Manag. Restn.*

Later successional tree species recruiting in camphor regrowth



Neilan et al. 2005 *[Fact sheet]*

3. How well does camphor regeneration promote recovery of soil properties?

Nine soil properties that differ in rainforest vs pasture:

	Camphor regrowth	Ecological restoration planting
Nitrate	P	I
Plant-available ammonium-N	RF	I
Plant-available nitrate-N	P	RF
Nitrification	RF	RF
Δ 13 Carbon	RF	I
Soil pH	O	RF
Bulk density	P	RF
Fine root biomass	P	P
Plant-available phosphate	RF	RF

4 of 9 soil properties in camphor regrowth aged 30-40 yr have recovered

5 of 9 soil properties in restoration plantings age 15-20 yr have recovered

P: similar to pasture; RF: similar to rainforest; I: intermediate; O: some other pattern

Paul et al. 2010 *Forest Ecology & Management.*

Conclusion from all this research:

- camphor regrowth does re-establish many ecological values and functions of native forest
- camphor regrowth can accelerate native tree recruitment

Further questions:

- what factors affect the amount of native recruitment?
- does the camphor canopy limit growth of native recruits?

→ if so, then killing the camphor trees after the regrowth is established will accelerate forest development

→ potential for working with camphor regrowth as a cost-effective restoration pathway?

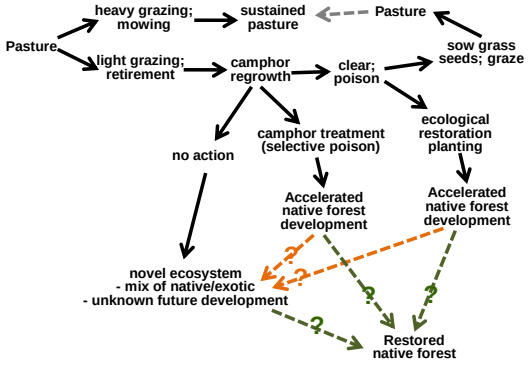
Options for camphor-based reforestation:

1. Do Nothing	Cheap	trajectory unknown, mix of exotic and native species
2. Clear and replant	$30-50000 (AUD)/ha	rapid establishment, does not make use of existing regeneration, inappropriate in some sites
3. Camphor conversion	$5-30000 (AUD) /ha	utilises existing regeneration, sites distant from remnants may require supplementary planting

- achieved by selectively poisoning the camphor adults and seedlings, over several years.;
- being conducted by a number of practitioners
- effective in accelerating recruitment and growth of native trees

See Kanowski & Catterall *2007 {Fact sheet}.*

Alternative universes: land use options & pathways:



Uncertain directions of floristic composition in restoration plantings

Research in progress in rainforest restoration plantings is showing that:

The seedlings of larger-seeded woody plants (and many of the frugivores that disperse them) are very slow to establish in ecological restoration plantings.

Most seedlings that are establishing are likely to be small-seeded and/or invasive species, that are dispersed by frugivores that don't depend on forest

Ecological benefits of camphor regrowth on former agricultural land

1 decreased diversity of introduced plants

2 increased diversity of native rainforest plants, especially seedlings

3 improved soil seed bank (rainforest species)

4 improved soil function – nitrification, plant-available ammonium, phosphate

5 improved soil stability (slopes and streambanks)

6 increased diversity of native fauna (eg fruit-dove; 92% of patches)

7 habitat linkages and stepping stones

8 buffer (shade, microclimate) for very small rainforest remnants

9 sequestered carbon.

10 increased rainforest regeneration potential over large areas (eg currently around 25% in former Big Scrub region).

Ecological impacts of clearfelling camphor regrowth & converting to pasture

1 increases in introduced plants

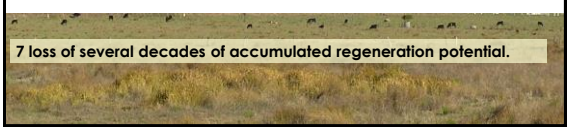
2 declines in native rainforest plants (& threatened spp) - due to loss of native plants within camphor patches

3 reduced soil function and soil stability

4 declines in native fauna - due to habitat loss & disruption of linkages

5 loss of buffer for very small rainforest remnants → further weed invasion, greater edge effects

6 less sequestered carbon



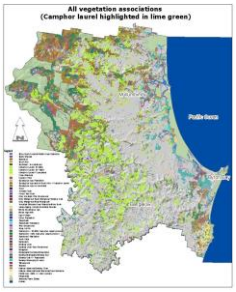
Initiatives favouring camphor felling and pasture re-establishment

- ❑ Noxious weed – commonly held view - a pest that should be removed
- ❑ Camphor chip enterprise – fuel source for co-generation plant to generate "green" energy from sugar cane waste

Initiatives favouring incorporating camphor within landscape-scale conservation planning

- eg Byron Shire Council – Local Environment Planning 2010

- Camphor-dominated regrowth comprises 25% of extant vegetation
- Landscape conservation network
  - Rainforest + up to 50% camphor is considered HCV
  - Camphor patches within mapped wildlife corridors
  - both considered priorities for restoration using selective poison
- Possibility of protecting these areas via zoning in Local Environmental Plan



The future of camphor regrowth in the Big Scrub?

Uncertain

NSW state government in 2013 is proposing to remove provisions for applying "environmental protection" zones to privately-owned rural and urban land (within Local Environmental Plans) .....

Are there situations where the ecological role of camphor regrowth is mostly negative?

- e.g., camphor can colonise in the understorey of eucalypt forests

..... is this also a fire management issue?

Other emerging novel ecosystems & associated dilemmas

- none are as well-studied as the camphor laurel case

Other potential novel ecosystems in this region

Native veg./*Lantana camara* mixes

Some similarities with the camphor case:
- bird-dispersed fruit, habitat for wildlife, shade-intolerant.

Removal of lantana from sclerophyll forest understoreys may reduce bird and mammal diversity & limit rainforest seedling recruitment

But in dry climates lantana carries fires which can destroy rainforest seedlings

Various other "weedy regrowth" mixes
- need a better understanding of their ecological roles and trajectories of development

Some flying-fox roost sites in Brisbane region

eg Enoggera; Hill End (Ipswich)
- emergent remnant sclerophyll trees over understorey of exotic shrubs (chinese elm, cocos palms, etc)

FFs both respond to and cause the shrubby layer

In general what creates novel forest ecosystems?

1. Human actions cause long-term environmental changes:

- legacies of past land use (eg abandoned pasture, crops)
- legacies of forest uses (eg grazing, thinning, fragmentation, altered fire regimes)
- changes in physical conditions (eg water availability, fertility)
- changes in climate (eg rainfall, temperature, extreme events)

2. Human actions remove some species and adds new ones:

- removal of large species (often apex predators / keystones)
- introduction of new species

→3. New biological communities and ecosystems emerge:

- Removal of some original species
- Limited dispersal by some original species
- Active addition of new species
- New environments unsuitable for some original species
- New environments suitable for some new species
- Altered interactions between species

Altered species interactions are important in creating novel ecosystems

- eg seed dispersal interactions

Rainforest fragmentation

→ decline of large frugivorous birds in fragments

→ large-seeded fruits no longer transported in their guts

→ reduced dispersal & regeneration of these plants

(→?? feedback effects for frugivores?)

Isolated rainforest fragment

Rose-crowned fruit-dove eating *Ficus* (fig) fruit

+ smaller frugivorous birds remain & they disperse the seeds of both native and exotic plants

Cryptocaria glaucescens (a large-seeded native laurel)

Rainforest seedling regeneration

Managing novel forest ecosystems in general:

Novel ecosystems have assembled new webs of interaction

→ attempted management by removing particular species is likely to have unintended consequences

- sometimes negative consequences for conservation

→ in the Anthropocene era, simply being native vs exotic is not a good surrogate for conservation or management action

→ a more realistic approach:

- consider species' ecological relationships, and outcomes of alternative actions
- adopt an evidence-based approach to management
- keep an open mind

****

Author's note

This is a modified version of the slides accompanying my talk at the Habitat Brisbane Citywide Meeting, March 2013

For most specific information source shown at the bottom of slides, the full citation details are given in the reference list in the next slide.

In other cases, information herein should be used as a general guide to knowledge and ideas in this field; this presentation is not intended for use as a supporting reference in any written document.

Carla Catterall

Acknowledgements:

- Wendy Neilan
- John Kanowski
- Stephen McKenna
- Cath Moran
- Miriam Paul
- and many others

For research contributions:

& many landholders for access

& several government funding agencies

Downloadable fact sheets for non-specialists
(type the fact sheet name into Google to locate pdf of fact sheet):

Kanowski J. and Catterall C. P. 2007 *Converting stands of camphor laurel to rainforest: What are the costs and outcomes of different control methods?* Environmental Futures Centre, Griffith University

Neilan, W., Catterall, C. P. and Kanowski, J. 2005 *A New Role for Weeds in Rainforest Restoration?* Rainforest CRC Issues Series No. 4.

Roberts, B., Kanowski, J. & Catterall, C. P. 2006 *Ecology and Management of Flying Fox Camps in an Urbanising Region* Rainforest CRC Issues Series No. 5.

Moran, C. 2011. *The Important Role of Birds and Bats in Rainforest Regeneration*. Environmental Futures Centre, Griffith University.

References to key research publications

Catterall, C.P & Kingston, M. 1993. *Remnant Bushland of South East Queensland in the 1990's: its Distribution, Loss, Ecological Consequences and Future Prospects*. Institute of Applied Environmental Research, Griffith University & Brisbane City Council.

Neilan W., Catterall C.P., Kanowski J. & McKenna, S. 2006. Do frugivorous birds assist rainforest succession in weed dominated oldfield regrowth of subtropical Australia? *Biological Conservation* 129: 393-407.

Kanowski, J., Catterall, C.P. and Neilan, W. 2008. The potential value of weedy regrowth for rainforest restoration: the case of Camphor Laurel in north-east New South Wales. *Ecological Management and Restoration* 9: 88-99.

Paul, M., Catterall, C.P., Pollard, P.C, and Kanowski, J. 2010. Recovery of soil properties and functions in different rainforest restoration pathways. *Forest Ecology and Management* 259: 2083–2092..