Mistletoes:
Ecology and Management



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Outline of Presentation

- What are mistletoes?
- The parasitic habit and mistletoe life cycle
- Mistletoe 'problem' in agricultural districts
- Which mistletoes are pests?
- Short-term control options
- Ecological insights into over-abundance
- Longer term preventative management

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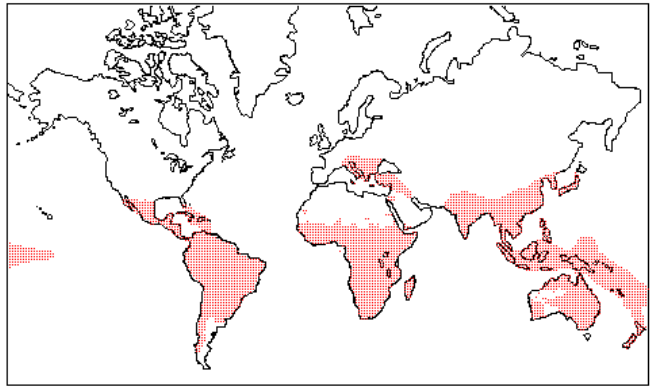
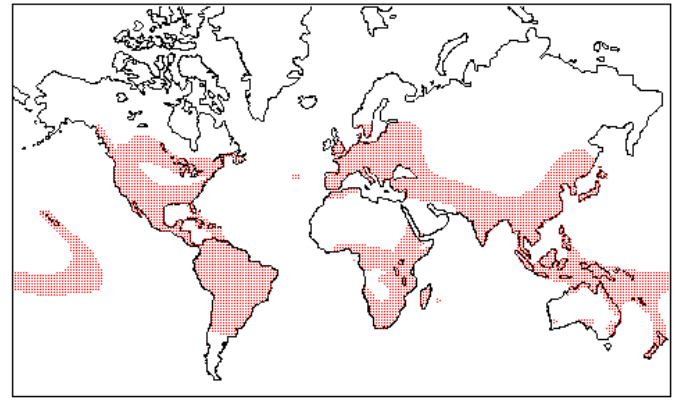
What are Mistletoes?

- Parasitic angiosperms (Loranthaceae, Viscaceae), 1500 spp world-wide
- Absorb water, mineral nutrients and organic compounds from host sapwood



← Loranthaceae

Viscaceae→



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Mistletoes in Australia

- Loranthaceae date back to the breakup of Gondwana (70+ MYA)
- Viscaceae more recent invaders (last 15 MY)
- 90 Native species on mainland, mainly loranths
- In most forest and shrubland ecosystems
- Most woodland and forest mistletoes are host-specific

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Mistletoes a Major Pest in North American Production Forests

Dwarf mistletoes (*Arceuthobium*, Viscaceae)

Holoparasites

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Mistletoes in North America

- Dwarf mistletoes (*Arceuthobium* spp) parasitise commercially important conifers
  - cause annual timber losses of:
    - 2.9 million m^3 in western Canada
    - 11.5 million m^3 in western US
  - equivalent to annual economic losses (volume loss × average price) of:
    - CDN $166 million
    - US $1 billion
  - also public liability in wildland recreation (day use, camping) areas

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Australian Mistletoes

… include the Western Australian Christmas Tree (*Nuytsia floribunda*, Loranthaceae), a root parasite

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But Most Australian Mistletoes are Aerial Parasites

They attach to host stem by means of a **haustorium** (a woody intrusive organ)

←Some are ball and socket like joins

Others ramify up and down stem→

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… with Striking Results

Haustorium can ramify inside or outside host stem

External ramifying haustoria are called ‘runners’ and look like roots

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Mistletoe Life Cycle

- Seeds are consumed and dispersed mainly by birds
- Viscid seeds stick to perch

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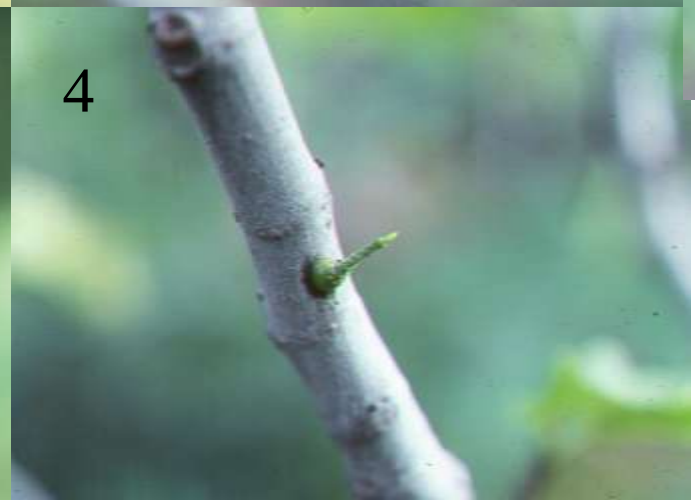
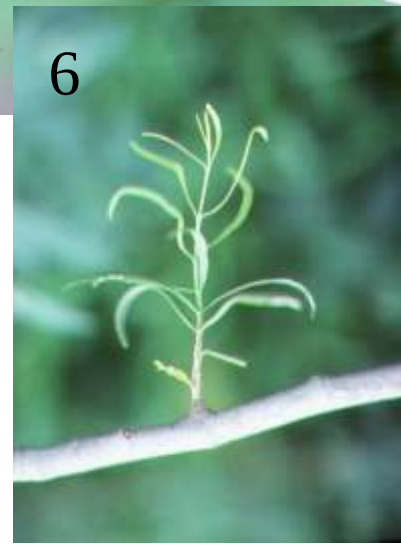
Brief Free-Living Phase Prior to Haustorial Development and Parasitism





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Mature Loranthaceous Mistletoes are Bird-Pollinated

Keystone resources for nectar feeders in Australian woodlands and forests

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Mistletoes are also Important for Frugivorous Birds

Amyema quandang

- Spiny-cheeked honeyeaters and mistletoebirds feed mainly on grey mistletoe fruit for some or all of year in arid woodland

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Which Bird Disperses Seeds?

- Dispersal of seeds by mistletoebird and spiny-cheeked honeyeater quite different

Safe Sites for Mistletoe Seeds?

- Experiments to determine where *A. quandang* can establish on its host (*Acacia papyrocarpa*)

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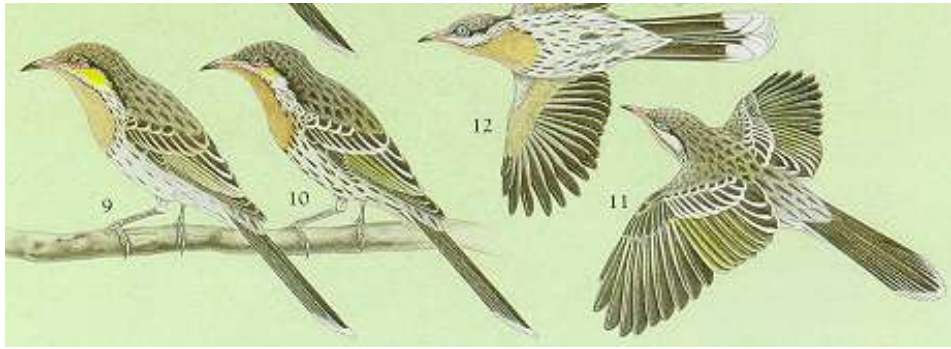
Both Birds Disperse *A. quandang* Seeds



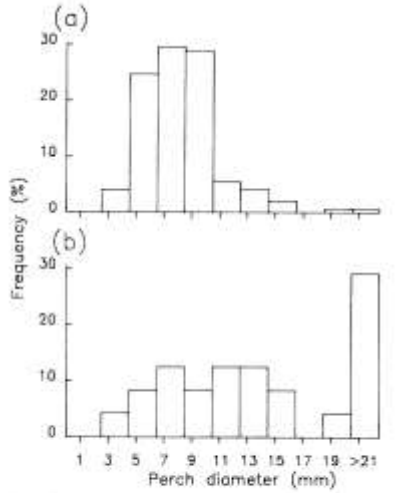
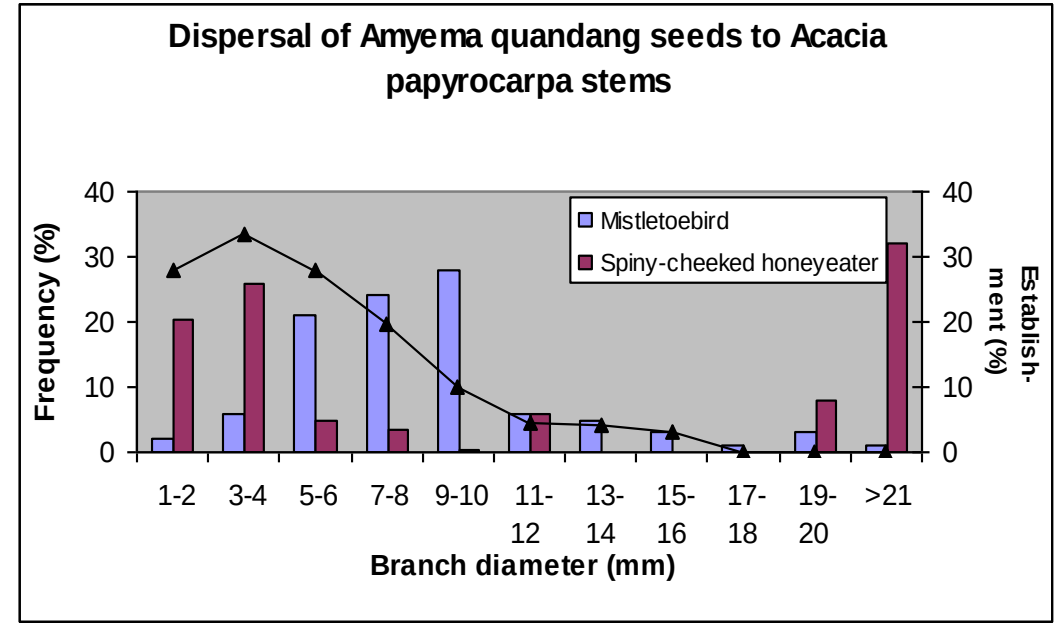


FIG. 2. Frequency distribution of perch size used by (a) *Dicaeum hirundinaceum* ($n = 146$) and (b) *Acanthagenys rufogularis* ($n = 24$) for defecation. The two distributions differ significantly (two-tailed Mann-Whitney *U*-test, $P < 0.001$).



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Mistletoes since European Settlement

- Abundant in temperate and arid areas early in European settlement
- Repeated calls for mistletoe control since 1900

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Problem Mistletoes

1. Box mistletoe (*Amyema miquelii*) on eucalypts in southern Australia

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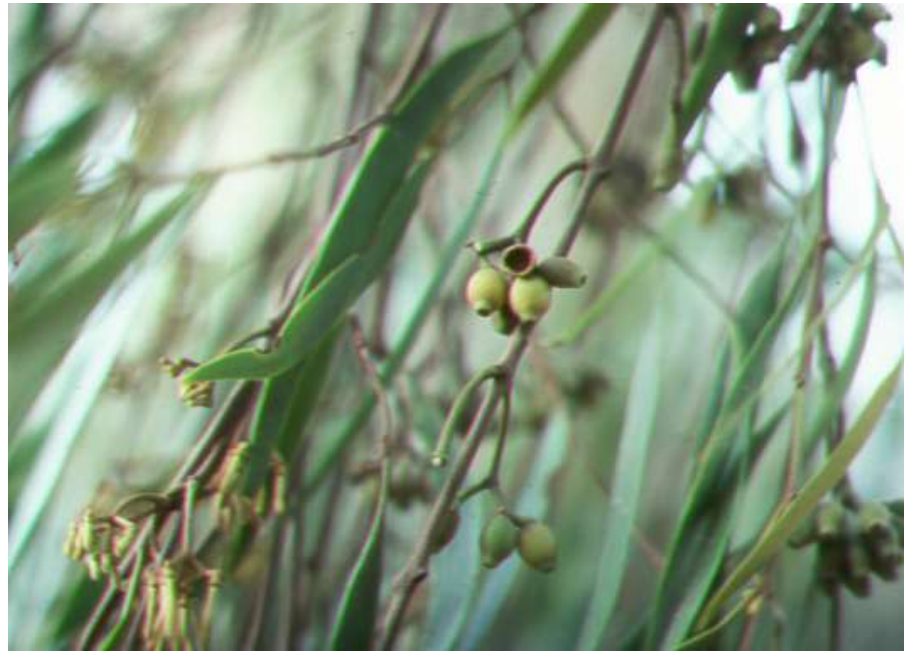
Problem Mistletoes, contd

2. Drooping mistletoe (*A. pendula*) on eucalypts in high rainfall zone of south-eastern Australia



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Problem Mistletoes, contd

3. Wire-leaf mistletoe (*A. preissii*) on acacias in wheatbelt of south-western Australia

Local Problem Mistletoes: Namoi Catchment

- Jointed mistletoe (*Korthalsella rubra* ssp. *geijericola*) on wilga ↓

- Long-flowered mistletoe (*Dendrophthoe glabrescens*) on kurrajong ↓↘

→

- Kurrajong mistletoe (*Notothixos corneifolius*) on kurrajong

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Impacts of Mistletoes

- Kill heavily infected trees
- Cause reductions in radial growth of infected trees

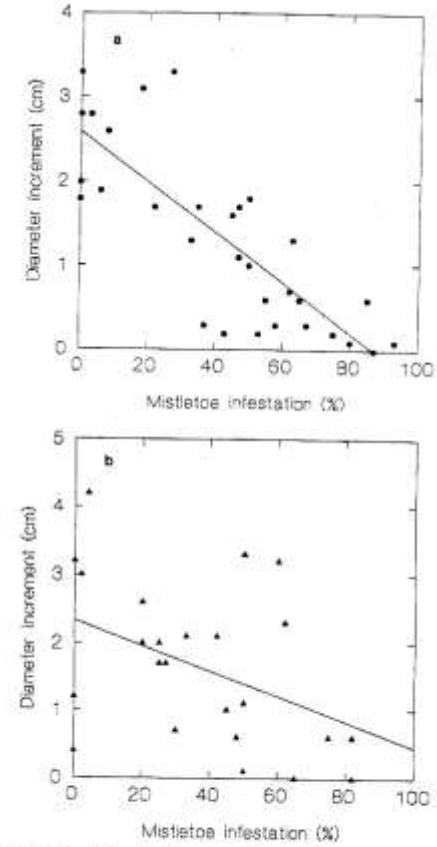
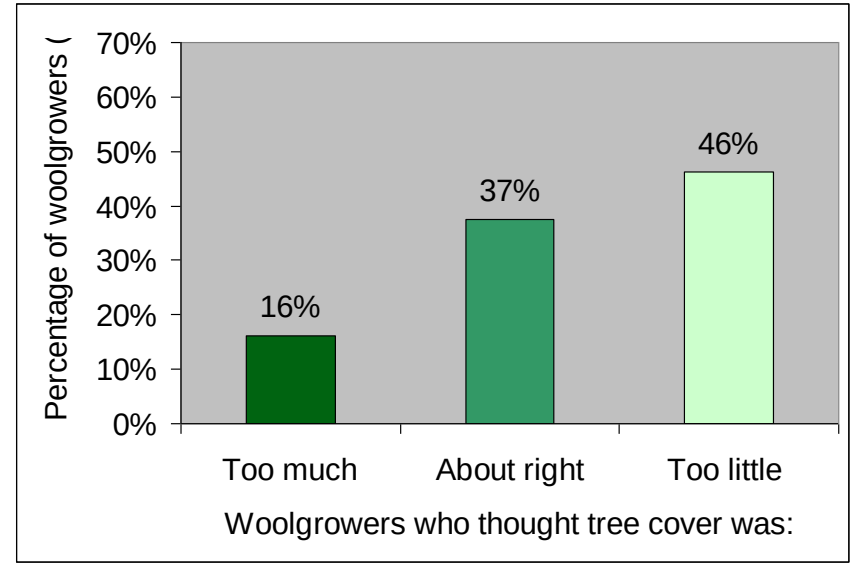
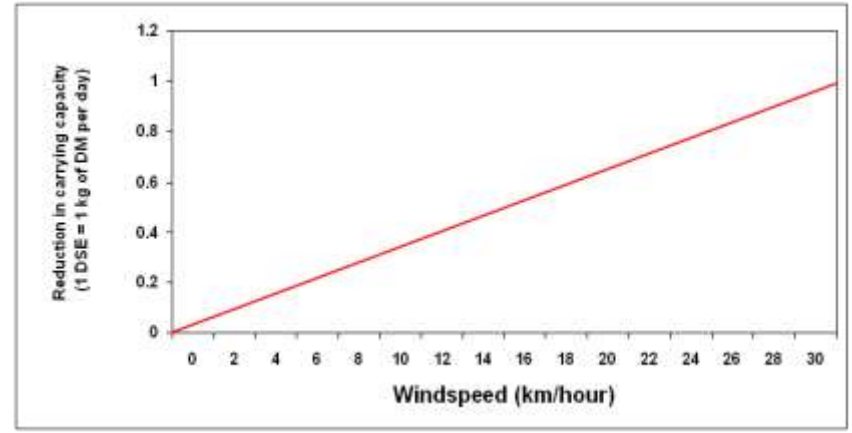


Fig. 4. The relationship between diameter increment after 33 months and initial mistletoe infestation level in surviving control trees of (a) Blakely's red gum and (b) yellow box. The equations of the linear regressions are: (a) $y=2.589-0.030x$, $r^2=0.65$, $P<0.001$; (b) $y=2.336-0.019x$, $r^2=0.15$, $P=0.053$.

Loss of Tree Cover a Problem

- About half southern New England farms have too little tree cover (2004 survey)
- Too little tree cover affects livestock and pasture production:
  - increases energetic cost of thermoregulation in stock
  - decreases pasture water-use efficiency





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Mistletoe Eradication?

- Neither possible nor desirable
- Mistletoes are native plants
- Keystone plant resources for many native animals, including endangered species
  - e.g. painted honeyeater, regent honeyeater

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Short-term Control vs Long-term Prevention

- Short-term controls
  - attacking symptoms
    - Pruning
    - Pollarding
    - Aerial application of selective herbicide
    - Stem-injection of selective herbicide
    - Myco-herbicides

Short-Term Control—Attacking the Symptoms

- Prune individual mistletoes
- Appropriate for treating high-value individual trees or heavily infested stands
- Pollard heavily infected trees (i.e. remove infected host canopy)

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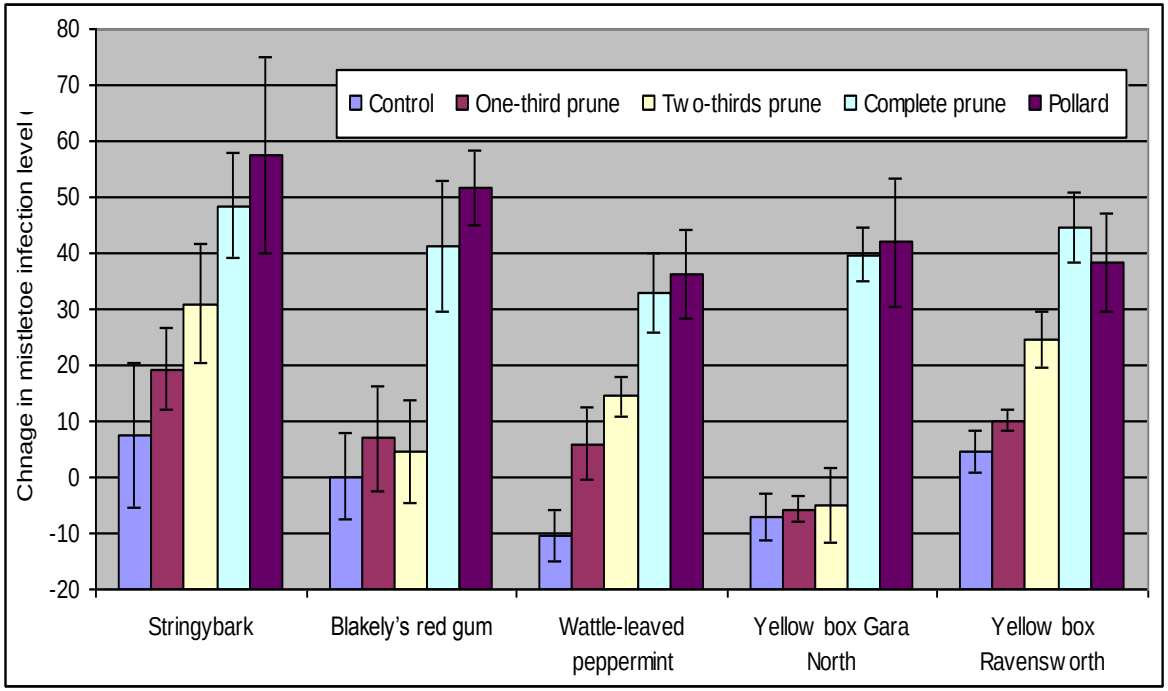
Host Tree Response to Pollarding

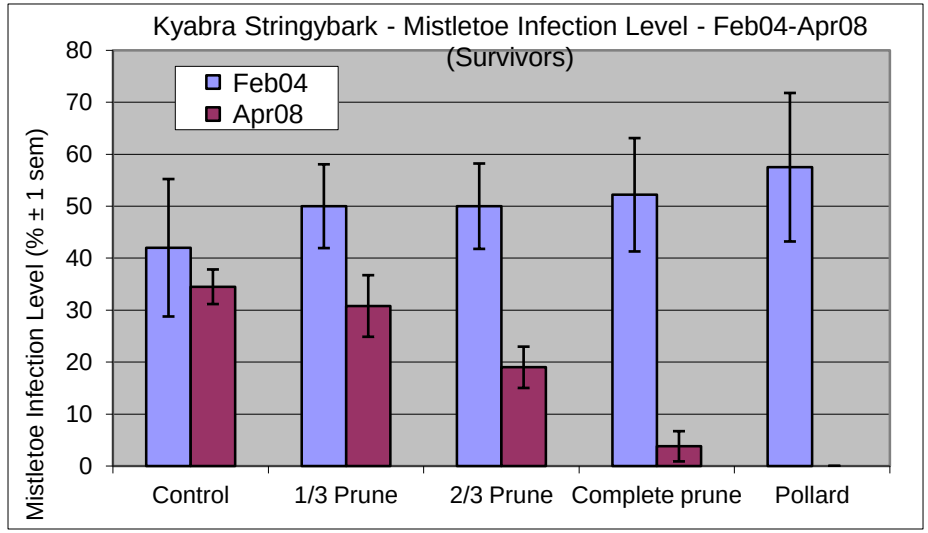
- Blakely's red gum, yellow box, wilga and kurrajong tolerate pollarding
- Otherwise exercise caution and adopt experimental approach to pollarding

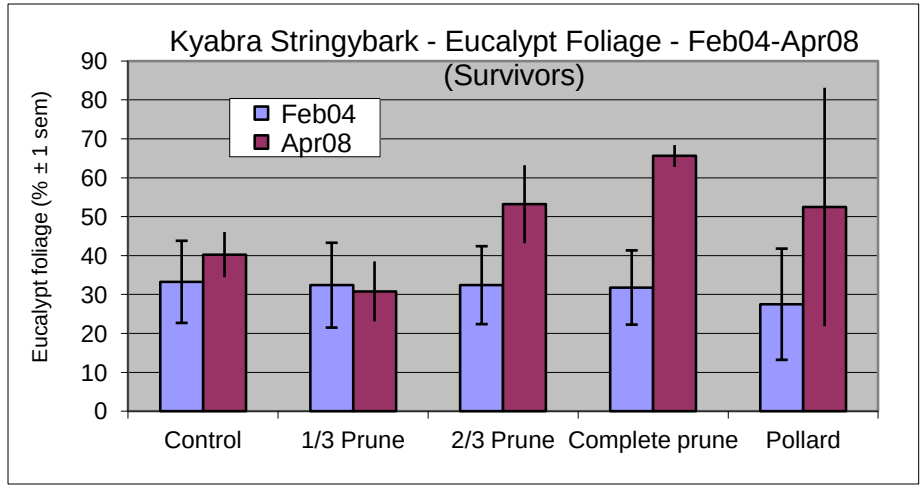



Pruning and Pollarding Trials

- Partial and complete pruning of local eucalypts effective in boosting tree health





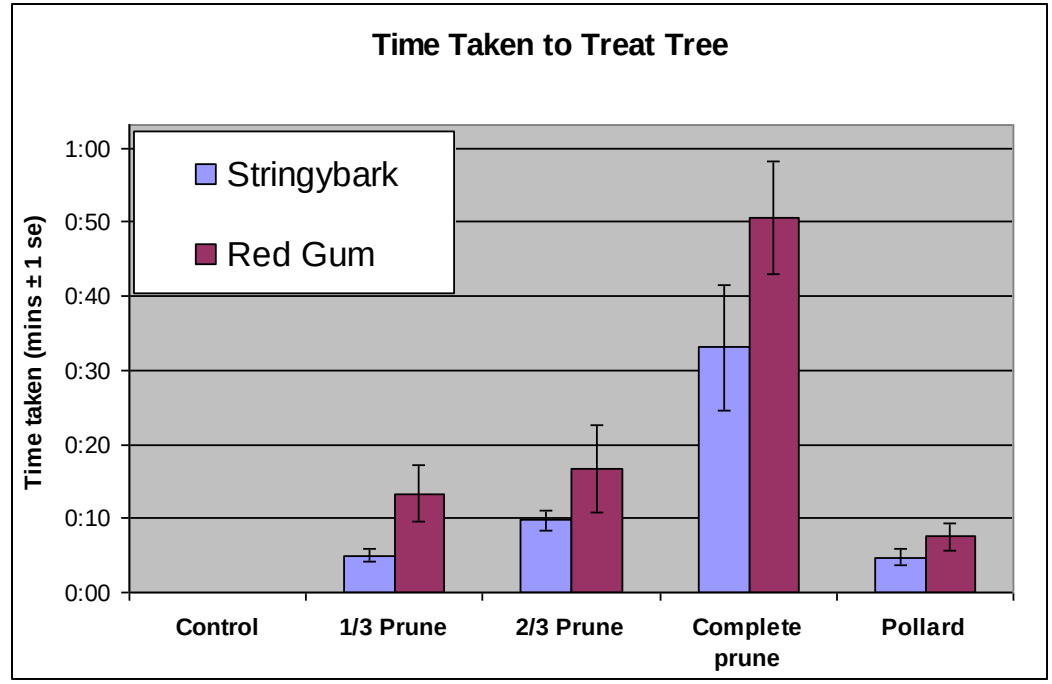


Pollarding Can Kill Some Trees

- Pollarding of large (50–70 cm DBH) trees killed or nearly killed half trees:
  - 2/5 red gums
  - 3/5 stringybarks
- Tree survival probably related to drought, season and age
  - large trees pollarded in autumn
  - subsequent drought
  - young trees pollarded in summer drought survived well

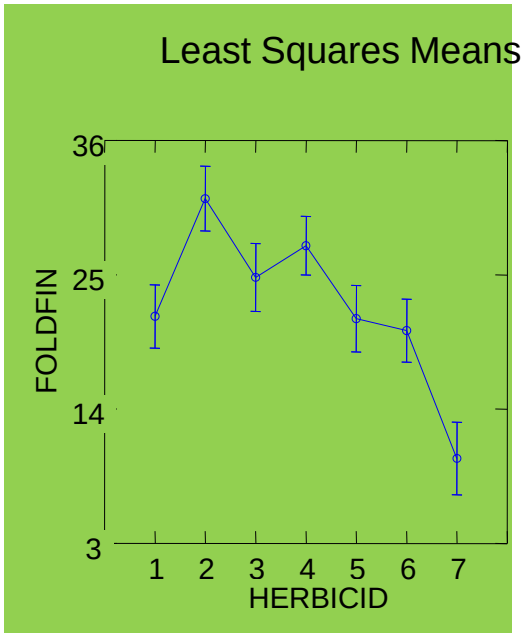
Pruning and Pollarding Costs

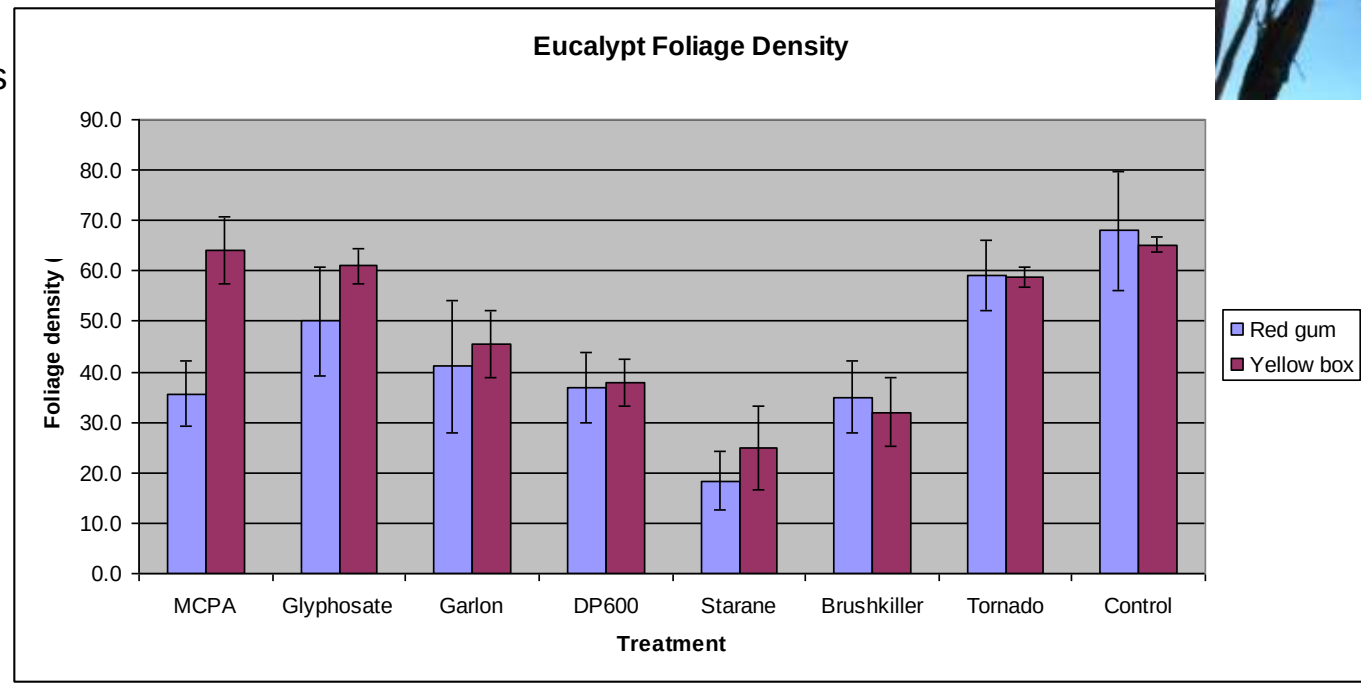
- Pollarding is much quicker than pruning
- Final third of mistletoes is disproportionately expensive
- Stringy: $4.72/min red gum: $2.82/min ($1,250 for 20 trees)



Herbicidal Control on Isolated Trees?

- Principle: use selective herbicide that kills or suppresses mistletoe but doesn't harm host
- Aerial application or stem injection





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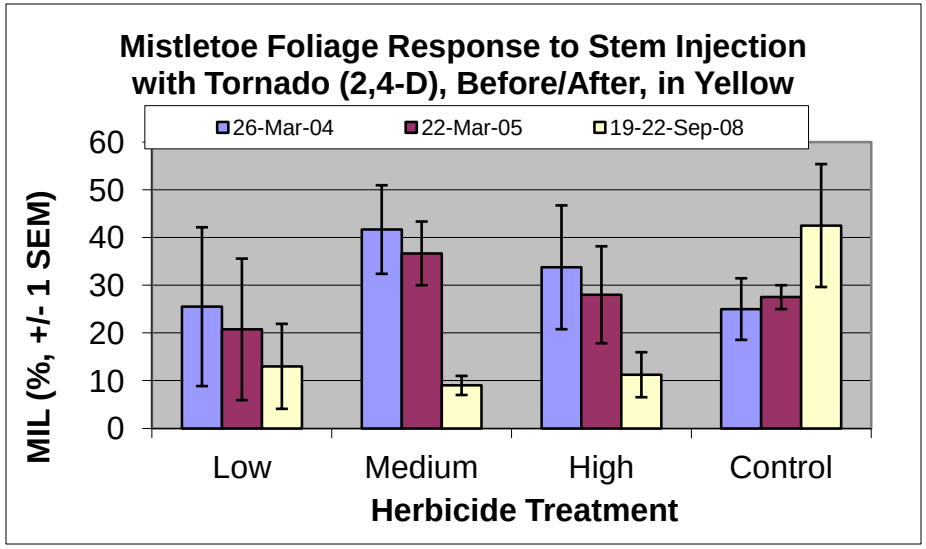
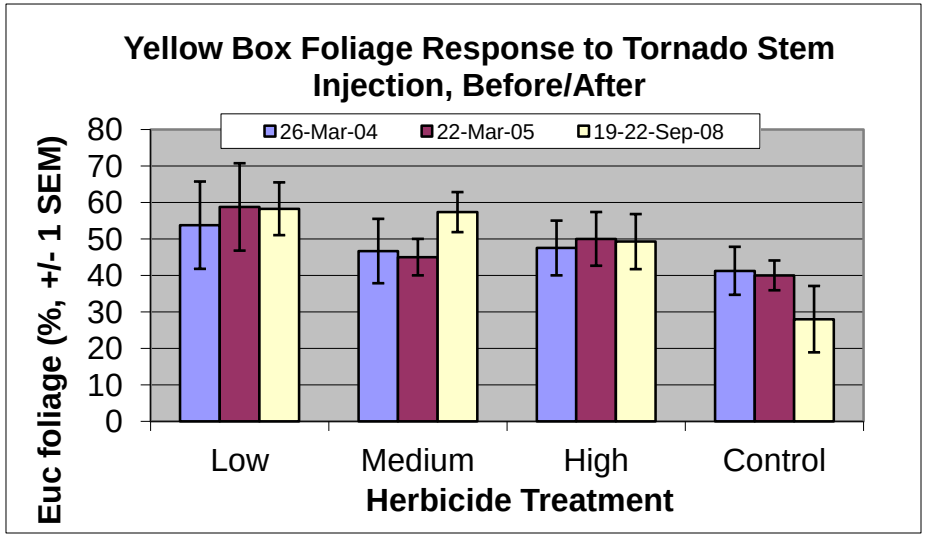
Stem-injection with 2,4-D (Tornado®)

- Three treatments and control (4-6 reps):
  - low dose (7.5% solution of 2,4-D)
  - medium dose (10%)
  - high dose (15%)
  - no stem injection
- Tornado® is sodium salt of 2,4-D
- After 4.5 years, on red gum and yellow box:
  - good control of box mistletoe

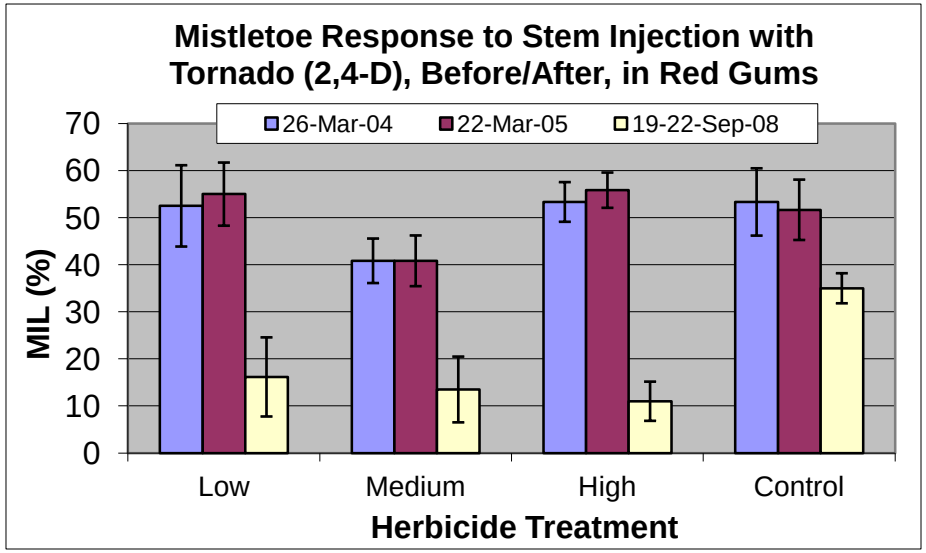
Stem-injection of Yellow Box

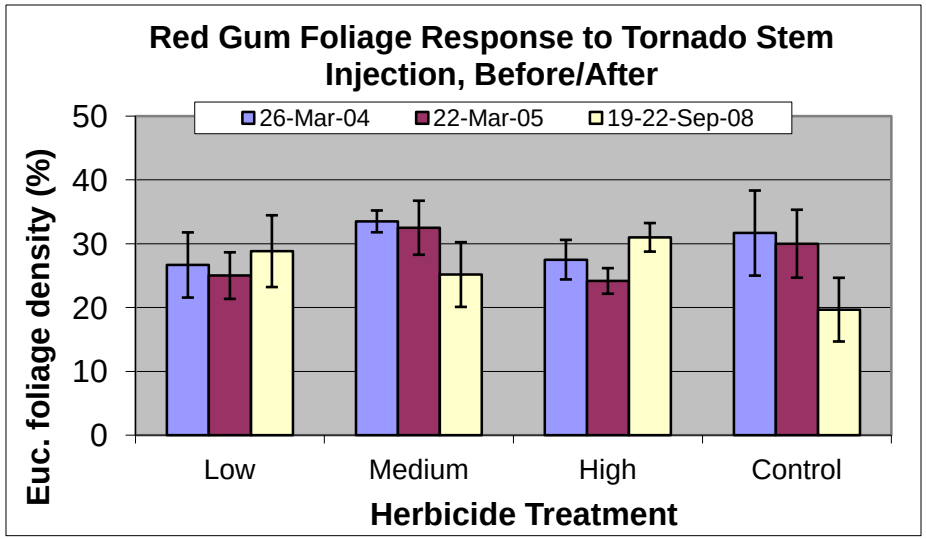




1 death in 16 yellow box (80% mistletoe, 5% euc. foliage)

Red Gum Stem-injection Results





0 deaths in 24 Blakely's red gum

Development of Myco-Herbicidal Control in Canada

- Many fungal parasites of varying host specificity attack dwarf mistletoe
- Most promising biological controls are:
  - *Colletotrichum gloeosporioides*, aerial shoot fungus
    - attacks any time after shoot emergence
    - disrupts shoot growth and reproduction
    - broad application window
  - *Neonectria neomacrospora*, canker fungus
    - selective for mistletoe-infected host tissue
    - proven pathogenicity
- Mass production and delivery systems

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Long-term Prevention

- Attacking causes rather than symptoms of mistletoe over-abundance
- *Ecology*:
  - key to understanding mistletoe over-abundance in rural areas

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1. Fire Suppression in Agricultural Districts

- Box and drooping mistletoe are fire-sensitive

2. Demise of Possums, Gliders and Koalas

- Hunting, habitat loss, fox predation and accidental poisoning
  - several mistletoes are preferred browse for possums

3. Forest and Woodland Thinning, Road Development and Pasture Improvement

- Remaining trees have enhanced nutritional and water status
- Develop woodland tree habitat
  - lower branches persist longer
- Predispose remaining trees to increased infection

4. Ecosystem Simplification

- Habitat clearing, ring-barking, selective tree removal, understorey modification
  - reduced abundance of mistletoe natural enemies:
    - broad-tailed parrots
    - herbivorous moths
    - butterflies

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Long-Term Strategies for Managing Mistletoes

1. Plan rural environment in which natural control agents prosper
   - retention or restoration of tree cover for wildlife at property and catchment scale

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Long-Term Strategies for Managing Mistletoes

2. Manage natural regeneration of farm trees
   - trees for on-farm purposes (shelter, posts, fuelwood, honey ecosystem function, amenity etc.)
   - enough trees to afford loss of a few to mistletoe

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Long-Term Strategies for Managing Mistletoes

3. Use fire to manage mistletoes

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Long-Term Strategies for Managing Mistletoes

4. Use mistletoe-resistant local tree species or genotypes in revegetation

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Conclusions

- Australian mistletoes are native plants
- Important keystone resources for fauna
- A few species contribute to rural tree decline
- Economics dictate mistletoe management strategies:
  - biological control strategies are elegant, but very expensive
  - time-honoured pruning and pollarding are effective for individual trees (but expensive)
  - stem injection with 2,4-D in eucalypts has promise

- Longer-term preventative strategies difficult to test
- Range of short-term control options yet to be developed:
  - bonfires, paint-ball herbicide, ultra-light surgical equipment, military-style flame throwers, myco-herbicides etc.