



Centre of Excellence for Climate Change  
Woodland & Forest Health



# Managing South-West Western Australia's forests for their **health** and their **biodiversity** assets for future generations

*Presented By  
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UNIVERSITY

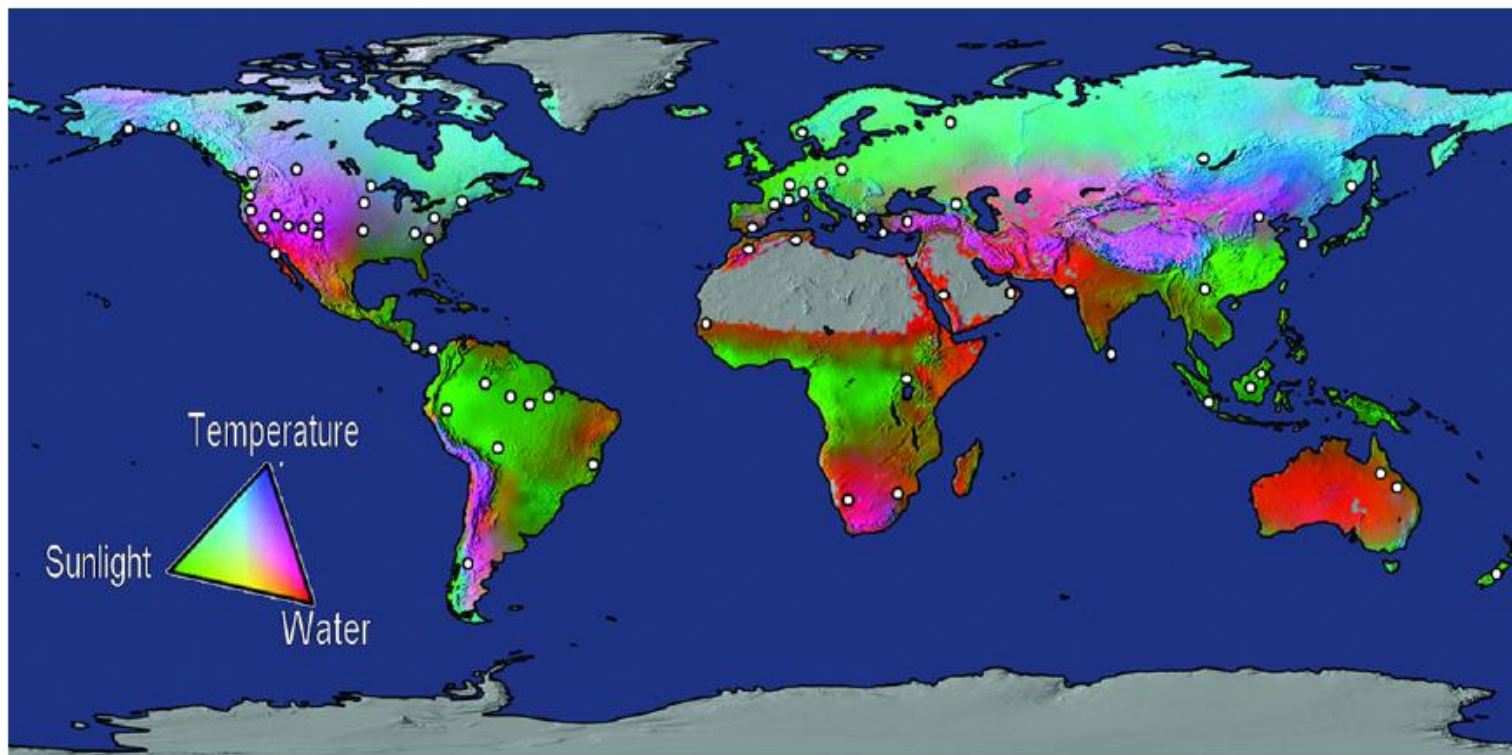


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**Fig. 1.** White dots indicate documented localities with forest mortality related to climatic stress from drought and high temperatures. Background map shows potential environmental limits to vegetation net primary production (Boisvenue and Running, 2006). Only the general areas documented in the tables are shown—many additional localities are mapped more precisely on the continental-scale maps. Drought and heat-driven forest mortality often is documented in relatively dry regions (~red/orange/pink), but also occurs outside these regions.



## SETTING THE SCENE

### The south-west is a very old landscape

- Long time since last ice-age
- Very poor soils
- Huge biodiversity
- Complex multi-partner symbiotic relationships
- Adapted to strong disturbances (fire and drought)
- Our eucalypt forests are **VERY** resilient to change  
**BUT** - we are seeing substantial tree declines
- Are we starting to see “**ECOSYSTEM TIPPING POINTS**”? **AND “WHY”**?

**These questions need to be considered in our overall management of our forests/woodlands**



# Our forests are **very** different to what they were 200 years plus ago

- **Extensively cut over**
  - Younger forest
  - Higher Leaf Area Index- use more water
  - More stems per hectare
  - Example would be the Wungong Catchment
- **Mined and rehabilitated extensively in certain regions**
- **Grazed**
- **Other land uses**
- **Fire history changed**
- **Diseases (*Phytophthora* ‘Dieback’ and other *Phytophthoras* and other pathogens (e.g. Marri canker)**
- **Loss of critical fauna (e.g. bioengineers and more)**
- **Huge areas of ‘unhealthy forest’ - our forests are SICK**
- **Shift to monoculture type stands (e.g. Karri forest coups).**
- **Jarrah forest – selection of superior trees (shift in genetics?)**



## Sustainable Forest Management

The General Assembly of the United Nations adopted in December 2007 the most widely, intergovernmentally agreed definition of *Sustainable Forest Management (SFM)*:

*Sustainable forest management as a **dynamic and evolving concept** aims to maintain and enhance the economic, social and environmental value of all types of forests, for the benefit of present and future generations. It is characterized by seven elements, including: (i) extent of forest resources; (ii) forest biological diversity; (iii) forest health and vitality; (iv) productive functions of forest resources; (v) protective functions of forest resources; (vi) socio-economic functions of forests; and (vii) legal, policy and institutional framework.*

*(Source: UN 2008, Resolution 62/98)*



## **Forest Management Plan - Vision Statement**

**The Government requires that the State's forests are managed so as to provide in perpetuity for biodiversity, freshwater, timber, recreation and tourism, heritage values and other products such as honey and wildflowers.**

**Can we effectively 'manage' when we know so little about how the forest is really functioning at a biodiversity level and its continued resilience to change?**



# Three principles guide ecologically sustainable forest management

- **maintain the ecological process within forests**
- **preserve their biological diversity**
- **obtain for the community the full range of environmental, economic and social benefits from all forest uses within ecological limits.**



## • Healthy Forests- definition

Two perspectives of forest health:-

1. *Utilitarian*
2. *Ecosystem*

*Base-line mortality* (e.g. Jarrah forest = 0.05% pa)

- **Disease**
  - Biotic – insect pests and pathogens
  - Abiotic – (e.g. drought, heat, frost, flood etc.)
- **Decline**





# Woodland decline in Western Australia

- Epidemics occurring in endemic species of eucalypt such as tuart, wandoo, flooded gum, marri, jarrah, and in banksia woodlands and heathlands
- Causes are often complex
- Need to understand the causes (biotic and abiotic) in order to manage and implement control methods



## Wandoo



- **Reduced rainfall**
- **Grazing**
- **Fertilisers**
- **Insect pests (foliar and wood borers)**

## *E. rudis* (swamp gum)

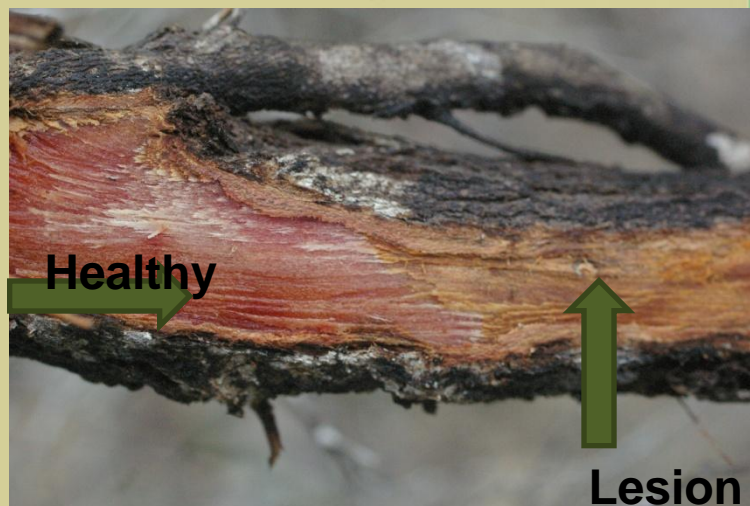
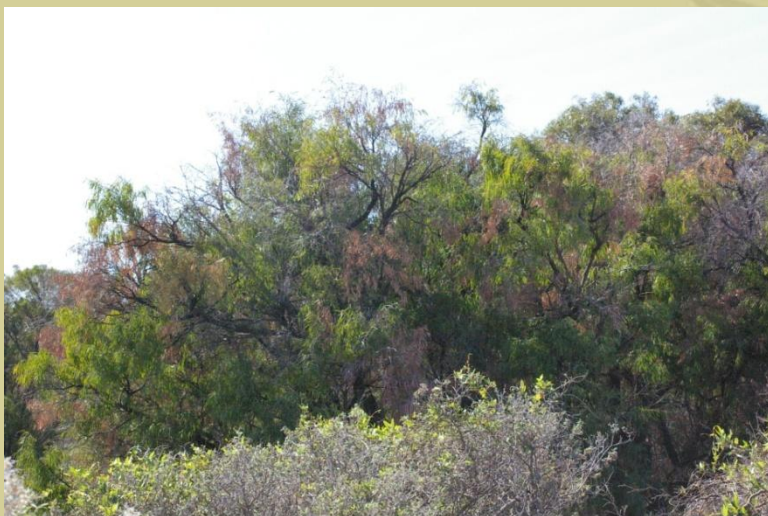


- **Armillaria butt rot**
- ***Phytophthora* root rots**
- **Clearing**
- **Salinity**
- **Loss of understorey plants**





# *Agonis flexuosa*- Peppermint decline



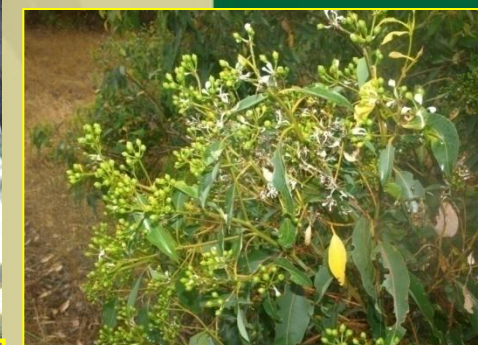


# MARRI DECLINE

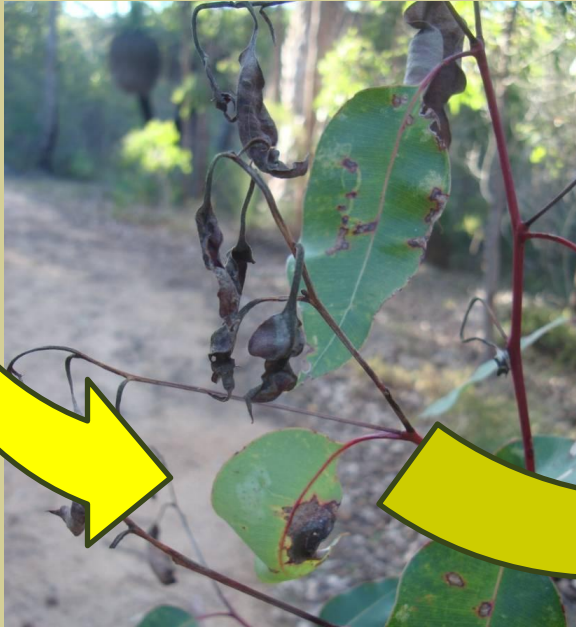
- Tree deaths increasing
- Reduction in flowering
- Reduction in seed set and hence recruitment
- Strong association with two fungal plant pathogens
- Abiotic drivers?
- Affect on bees/pollination?
- Fauna (e.g. cockatoos)?



*Quambalaria*  
*coyrecup* - native



*Q. piterika*  
Introduced



**Shoot and flower blight**



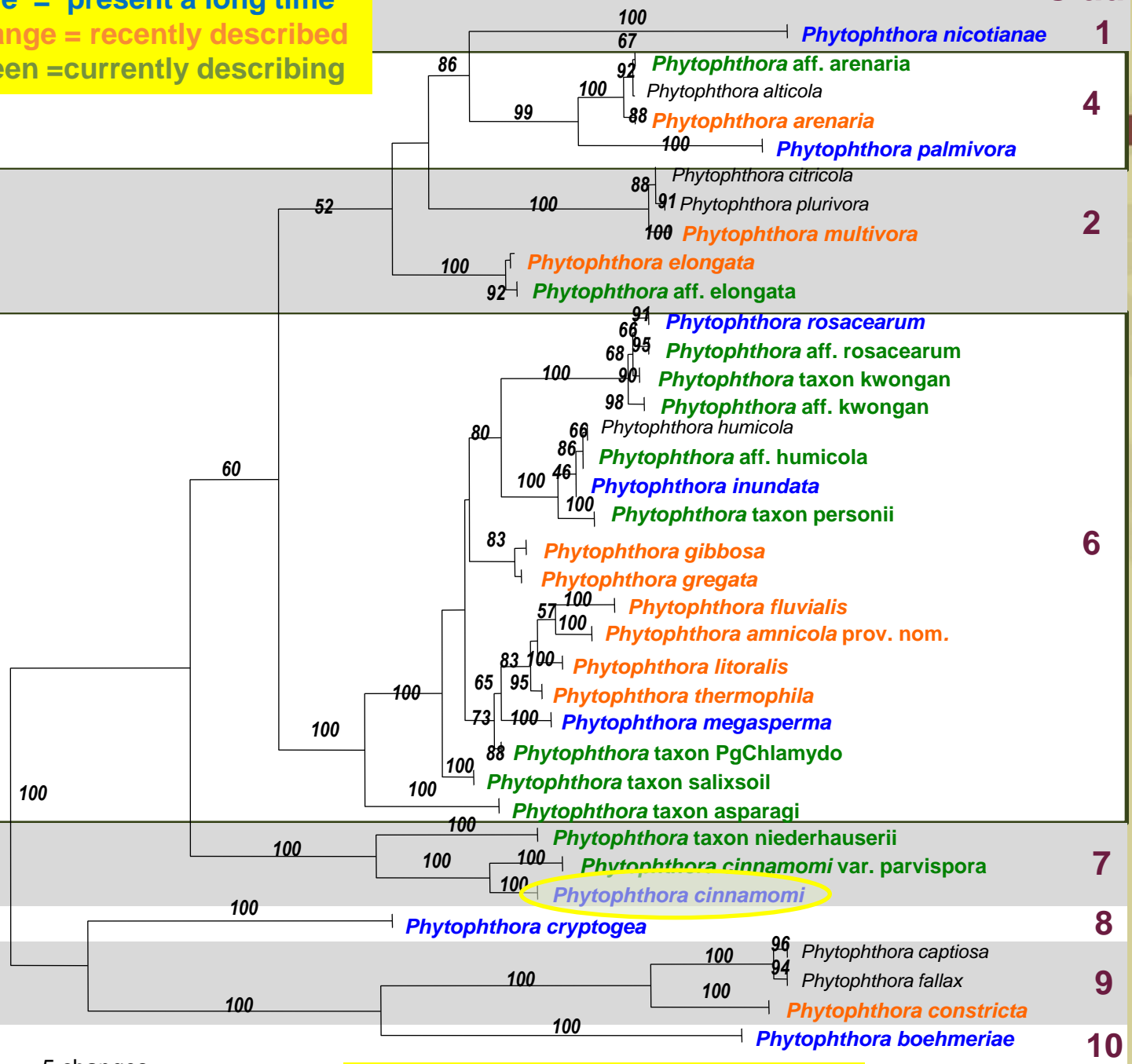
# *Phytophthora dieback*



***Phytophthora cinnamomi* is an introduced pathogen  
In WA alone kills over 41% of the 5710 described plant species  
Listed as a KEY THREATENING PROCESS to Australia's Biodiversity**

**MANY NEW *PHYTOPHTHORA* SPECIES BEING DESCRIBED**

Blue = present a long time  
 Orange = recently described  
 Green = currently describing

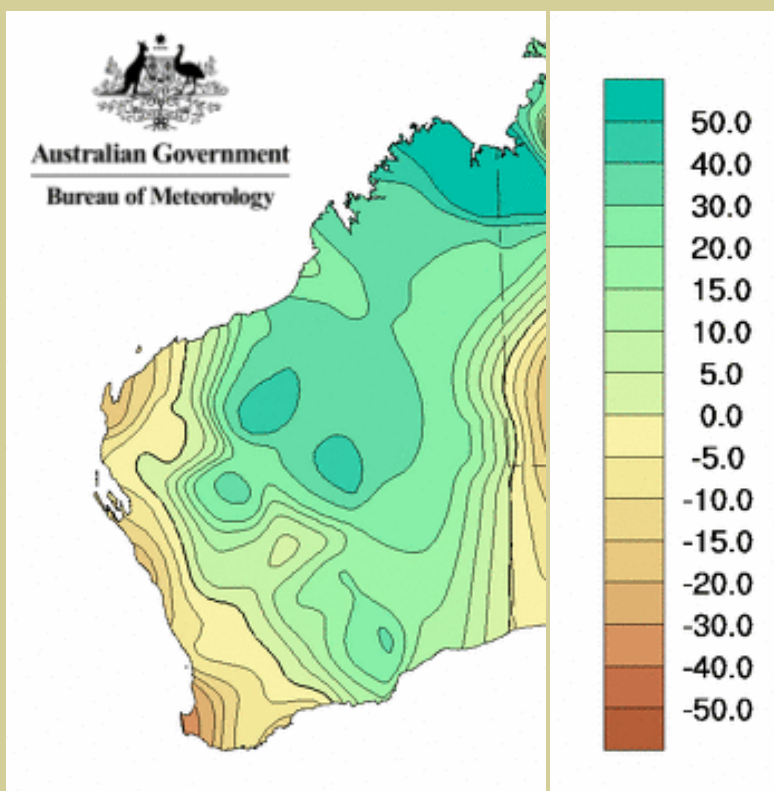


NEW *Phytophthora* species in Western Australia

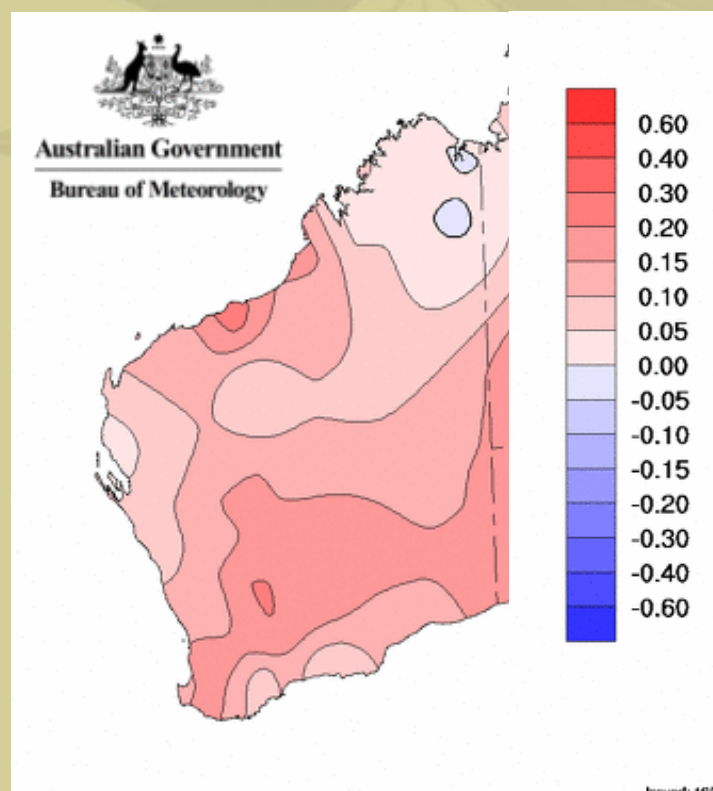




# Climate Change and south west of WA



Trend in Annual Total Rainfall  
(1910-2010) in mm per 10 years



Trend in mean temperature  
1950-2010 (°C/10 years)





## Predicted changes in the SW of WA

- By 2030, rainfall will decrease by between 2 to 20 percent;
- By 2070, rainfall will decrease by between 5 to 60 percent;
- By 2030, summer temperatures will increase by between 0.5 to 2.1 degrees C;
- By 2070, summer temperatures will increase by between 1.0 to 6.5 degrees C; and
- Potential evaporation is predicted to change by up to +10% by 2030 and by up to +30% by 2070





# Climate Change – drought and temperature

- **Climate-induced water stress may**
  - directly cause tree mortality through short-term acute effects (cavitation) or longer-term by carbon starvation.
  - indirectly by attack from insects and pathogens
    - Climate can change significantly the population dynamics of detrimental organisms

# Canopy Tree Mortality In The Jarrah Forest

Jarrah is the primary canopy tree observed collapsing throughout the forest. However, in the most severely affected areas marri has also failed. This observation is contrary to traditional thinking.



# What we know about the scale of the damage

In a recent aerial survey of 8.8% of the Northern jarrah forest, approximately 17,000 ha were determined to be severely affected. Additionally, an estimated 5% was showing severe crown chlorosis and discolouration.



## Key

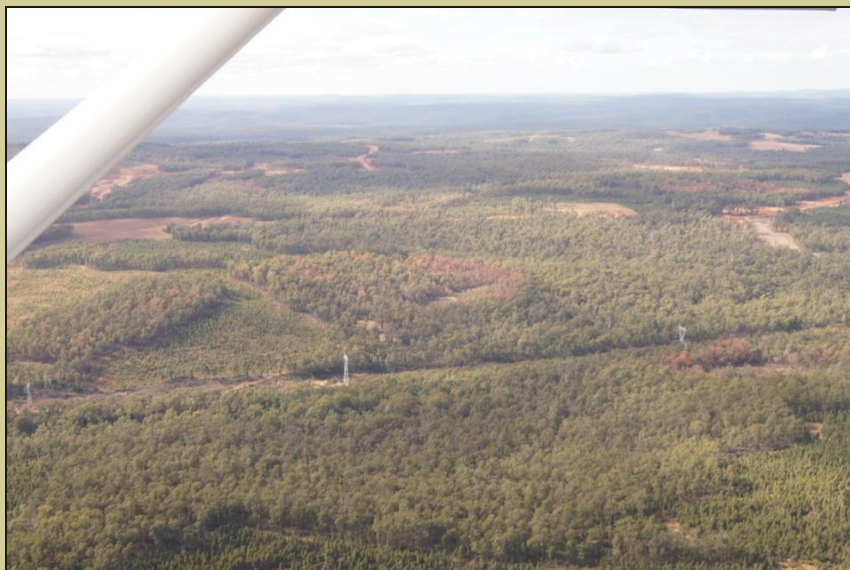
Blue Line = Flight Path

White Shading = sample area

Red Polygons = severely damaged areas



# What we know about the scale of the damage



# What we know about the scale of the damage



Most damaged areas are closely associated with a shallow soil structure but many are not

The increased fuel will likely have dramatic consequences on fire intensity, which has the potential to have many secondary effects.



# Woodborer Activity: Preliminary observations

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Photo © M.Hoskovec

## Marri Tree Dissections

- **\*Minimal and inadequate sampling**
- 6 tree boles (15-20 cm) to 10 meters in height

7, 26, 35, 36, 45, 108 living larvae m<sup>2</sup> surface area



**FROST DAMAGE JUNE/JULY 2012-**

**Northern Jarrah Forest Monadnocks Conservation Reserve**

**Similar events in 2006 and 2010**





## FROST DAMAGE ON JARRAH AND MARRI JUNE/JULY 2012

### Questions:

- Impact on stem and stand structure?
- Impact on flowering and seed set?
- Impact on recruitment?

- Impact on fauna?
- Impact on below-ground biodiversity
- **MANY MORE UNKNOWN**



Yr. 1 FROST EVENT



Crown dieback



Yr. 2. Epicormic shoots



Yr. 3. FROST EVENT



Crown dieback



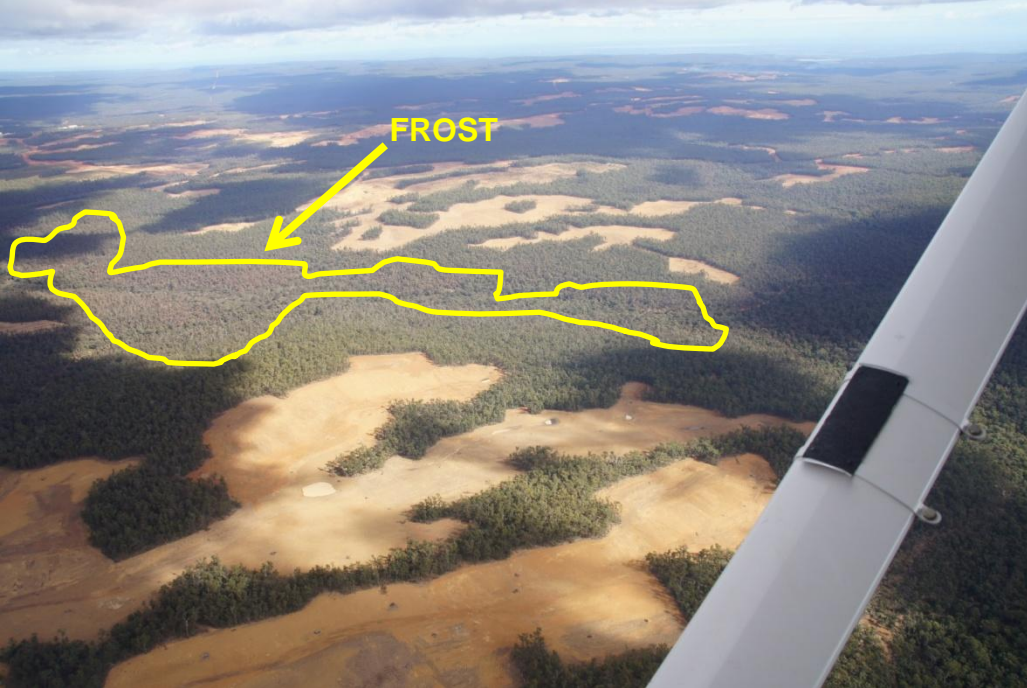
Yr. 4 Epicormic shoots



CARBON STARVATION



DEATH?



## MINING =

Mosaic of

- single aged stands
- **predominantly 2-3 species**
- very high stem densities
- **Lease to 2046**
- ~ 600 ha/yr = 20,400 ha total
- 



Questions for the future:-

- What is the trajectory of rehab forest to a jarrah forest pre-mining?
- **Impact of climate change?**
- How to manage stand density whilst maintaining biodiversity?
- **Impact on adjacent forest (all biodiversity values)?**





## Some Key Questions About, Logging, Drought and Frost and Mining

- Increased susceptibility and reduced resilience of the forest due to highly fragmented mosaic of activities, large edge effects, fragmentation etc.?
- Timing and intensity of future collapses?
- Impact on pests and pathogens (opportunists)?
- Impact on fauna? (we know many are adversely impacted upon)
- Consequences of monocultures
- Impact on beneficial microorganisms?
- Impact on soil health and structure?
- Impact on fire and fire severity?
- Impact on understorey plant species?
- Impact on soil water?
- Is forest resilience now compromised?

**MANY MORE QUESTIONS TO BE ASKED**



## National Forest Policy Statement

Harvesting from native forests must be done sustainably -  
Wood production is only one aspect of this assessment.

- The **BACI (Before After Control Impact)** principle must be applied when assessing whether an impact such as forestry is having a beneficial or deleterious effect on other biota

**WE NEED TO CONSIDER BACI in relation to:**

- Forestry, mining, **proposed thinning for water harvesting**, controlled fire management, and **CLIMATE CHANGE** (drought, frost, increased temperatures) etc.

**WE ARE NOT DOING THIS IN A SCIENTIFICALLY  
ROBUST AND REPLICATED MANNER**



## Assessment of change caused by forestry, or other interferences is complex

- It is not enough to simply assess an area cut for timber, thinning for water harvesting, mining etc. and to compare with a 'pristine' area
- need to assess multiple sites (replication)
- before and after impact
- need control sites to be assessed over time also
- need several times of assessment not just one if the assessment of the impact is to be true/correct
- Need to assess all biodiversity assets

**WE DO NOT YET HAVE ENOUGH/SUFFICIENT OF THE ABOVE TO ADEQUATELY INFORM POLICY MAKERS INTO THE FUTURE**



## How to provide robust datasets for the future

- Whole of community ownership of research and adaptive management trials- transparent datasets and dataset sharing
- Independent Advisory Committee (from across the community).
- Establish key questions relating to forest management
- Must consider biodiversity, and ecosystem function and services in the mix
- Adequate size and replication throughout the forests
  - Need adequate data collection before treatments imposed
  - To allow for adaptive management
- To involve all disciplines including the social sciences
- Adequate infrastructure at start (remote sensing, weather stations, soil water monitoring, tree towers, etc.)

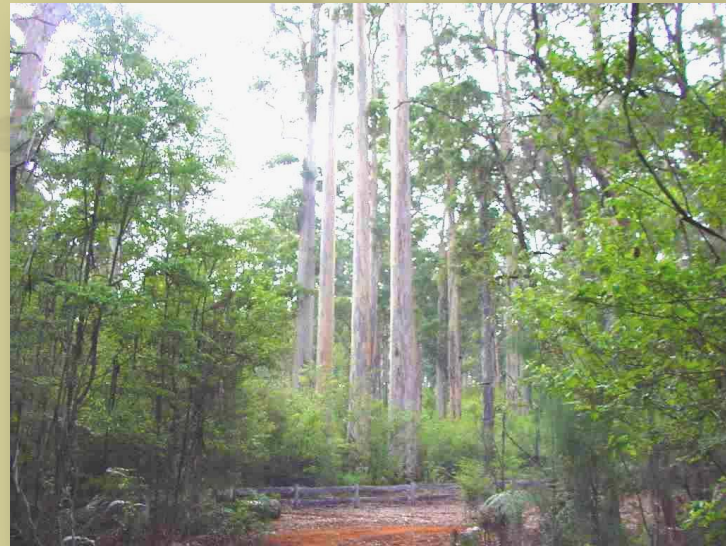


- We have the tools, the knowledge and expertise to provide scientifically (and socially) robust datasets to policy makers and the wider community on how to manage our forests
- A series of trial research plots need to be put in place across our forests ASAP.
- These need to relate to Climate Change, Fire, Clearing/thinning for water, Mining etc. with **BIODIVERSITY and ECOSYSTEM SERVICES AND FUNCTIONS** at the top of the list.
- Adequate resources to DEC and others required



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# WHEN LOOKING AT A FOREST - SEE MORE THAN THE WOOD FROM THE TREES!



Thank you



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