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

Murdoch University

The University of Western Australia

Department of Environment and Conservation
Our environment, our future

Presented By
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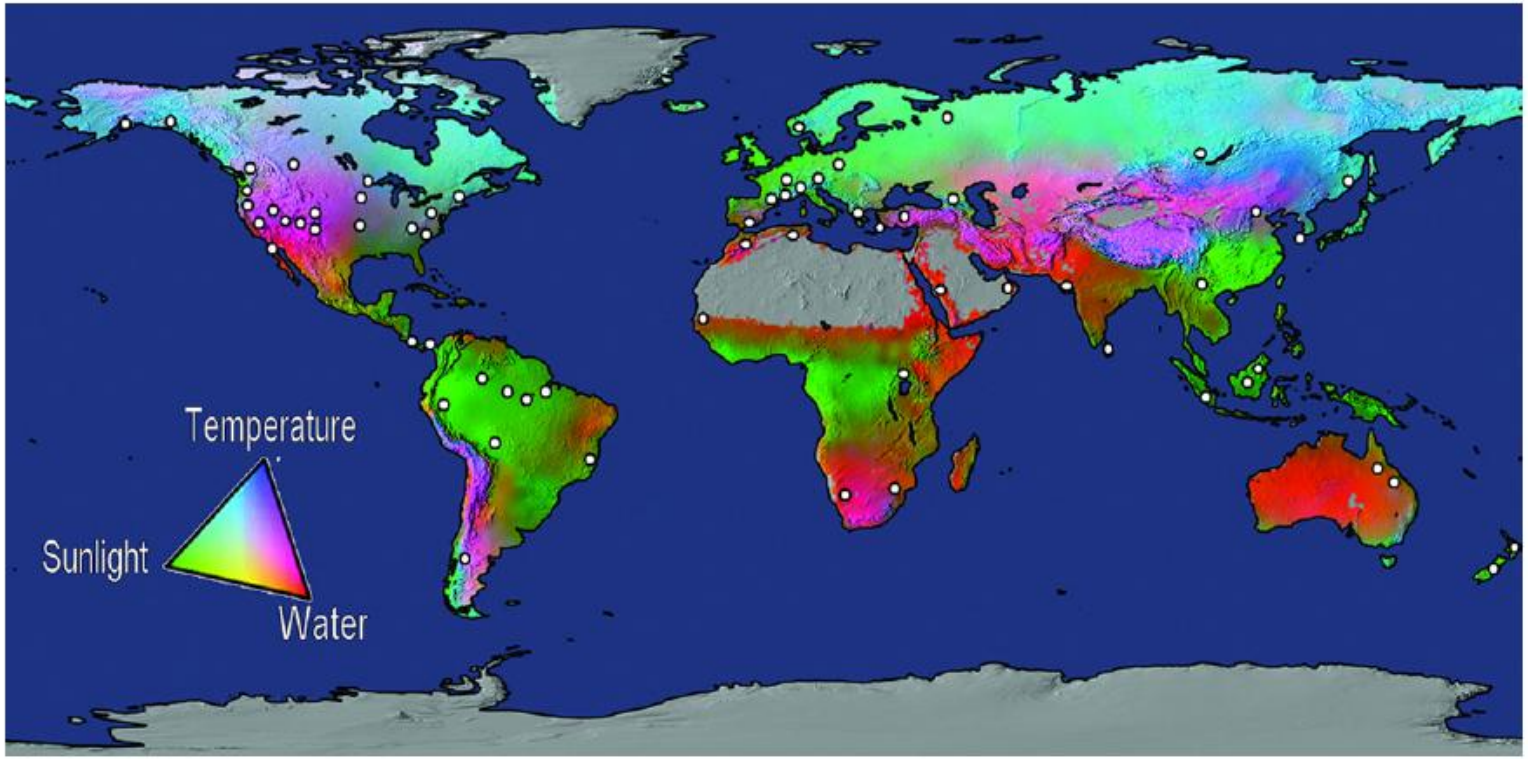


Fig. 1. White dots indicate documented localities with forest mortality related to climatic stress from drought and high temperatures. Background map shows potential environmental limits to vegetation net primary production (Boisvenue and Running, 2006). Only the general areas documented in the tables 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.**

Regional Forest Agreement - Australia

• Healthy Forests- definition

Two perspectives of forest health:-

1. Utilitarian

2. Ecosystem

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

- Disease

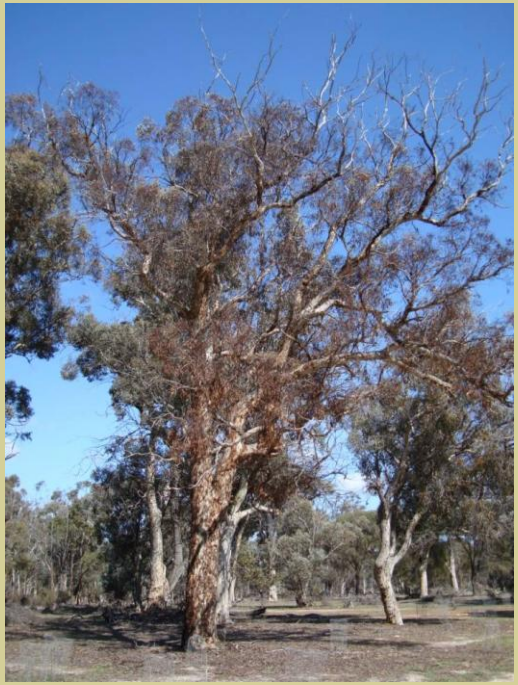
- **Biotic – insect pests and pathogens**
- **Abiotic – (e.g. drought, heat, frost, flood etc.)**

- 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

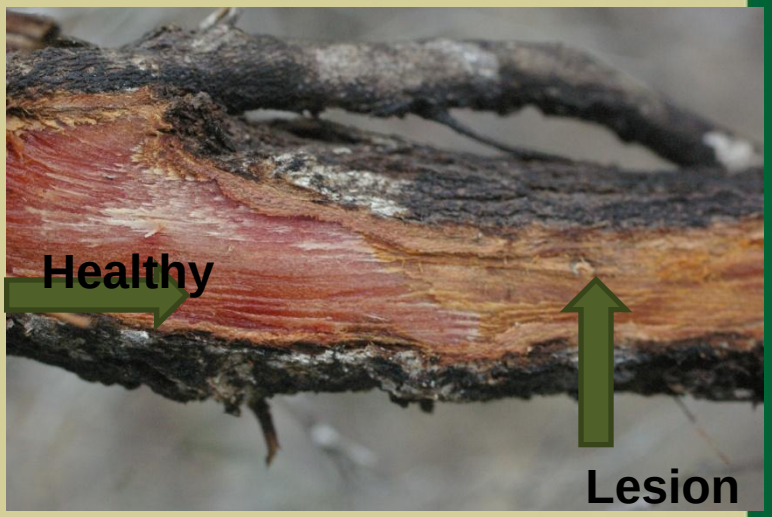


- Reduced rainfall
- Grazing
- Fertilisers
- Insect pests (foliar and wood borers)

E. rudis (swamp gum)

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

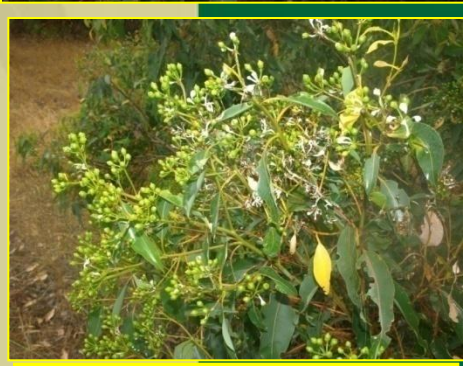
Agonis flexuosa- Peppermint decline



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

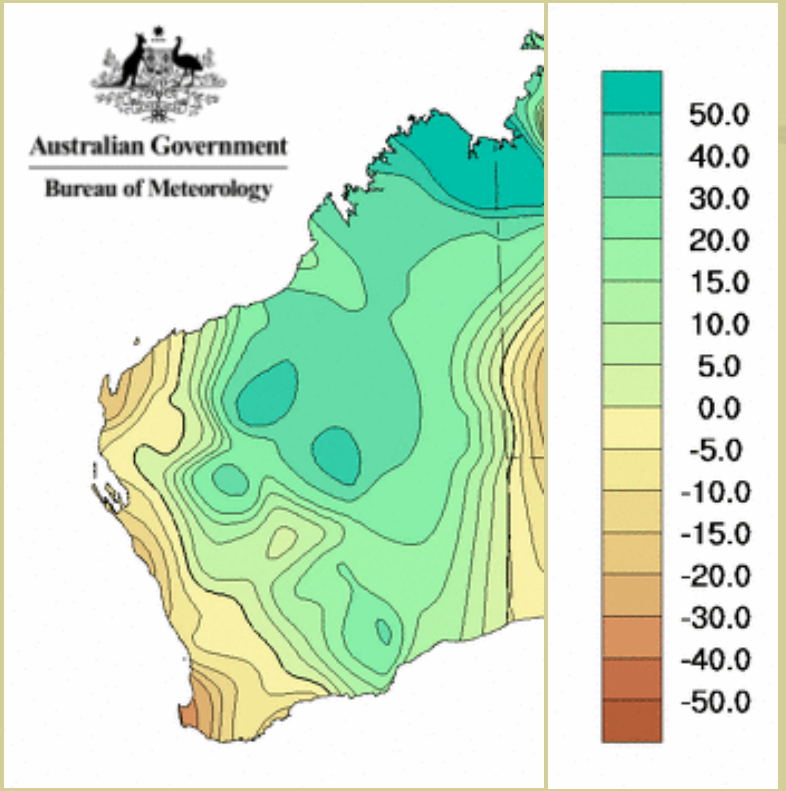
Clade

Phytophthora nicotianae — 1
Phytophthora aff. arenaria
Phytophthora alticola
Phytophthora arenaria
Phytophthora palmivora — 4
Phytophthora citricola
Phytophthora plurivora
Phytophthora multivora — 2
Phytophthora elongata
Phytophthora aff. elongata
Phytophthora rosacearum
Phytophthora aff. rosacearum
Phytophthora taxon kwongan
Phytophthora aff. kwongan
Phytophthora humicola
Phytophthora aff. humicola
Phytophthora inundata
Phytophthora taxon personii
Phytophthora gibbosa
Phytophthora gregata
Phytophthora fluvialis
Phytophthora amnicola prov. nom.
Phytophthora litoralis
Phytophthora thermophila
Phytophthora megasperma
Phytophthora taxon PgChlamydo
Phytophthora taxon salixsoil
Phytophthora taxon asparagi — 6
Phytophthora taxon niederhauserii
Phytophthora cinnamomi var. parvispora — 7
Phytophthora cinnamomi
Phytophthora cryptogea — 8
Phytophthora captiosa
Phytophthora fallax
Phytophthora constricta — 9
Phytophthora boehmeriae — 10

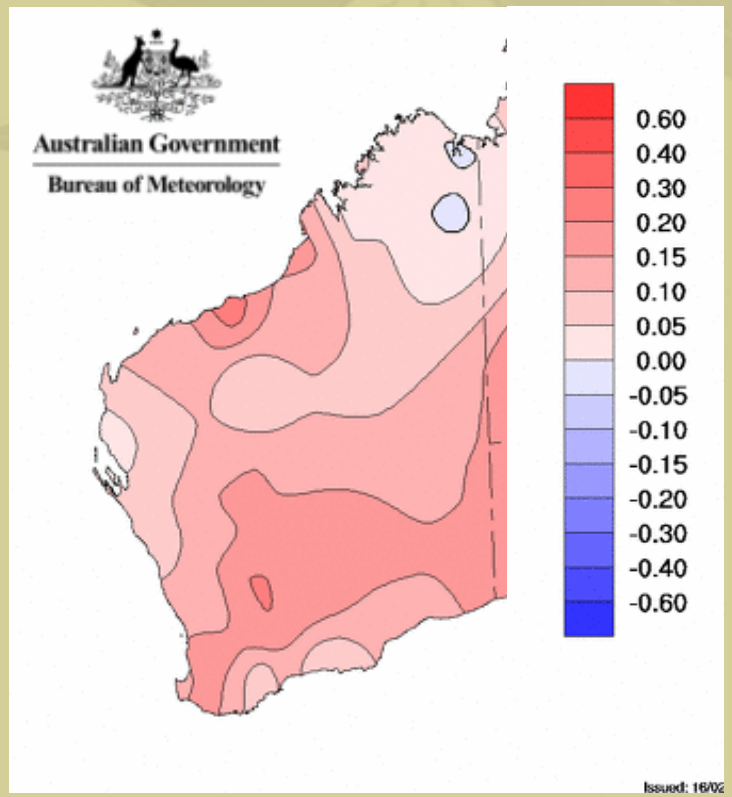
— 5 changes

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 (ºC/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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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^2 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 UNKNOWNS

Yr. 1 FROST EVENT

▼

Crown dieback

▼

Yr. 2. Epicormic shoots

▼

Yr. 3. FROST EVENT

▼

Crown dieback

▼

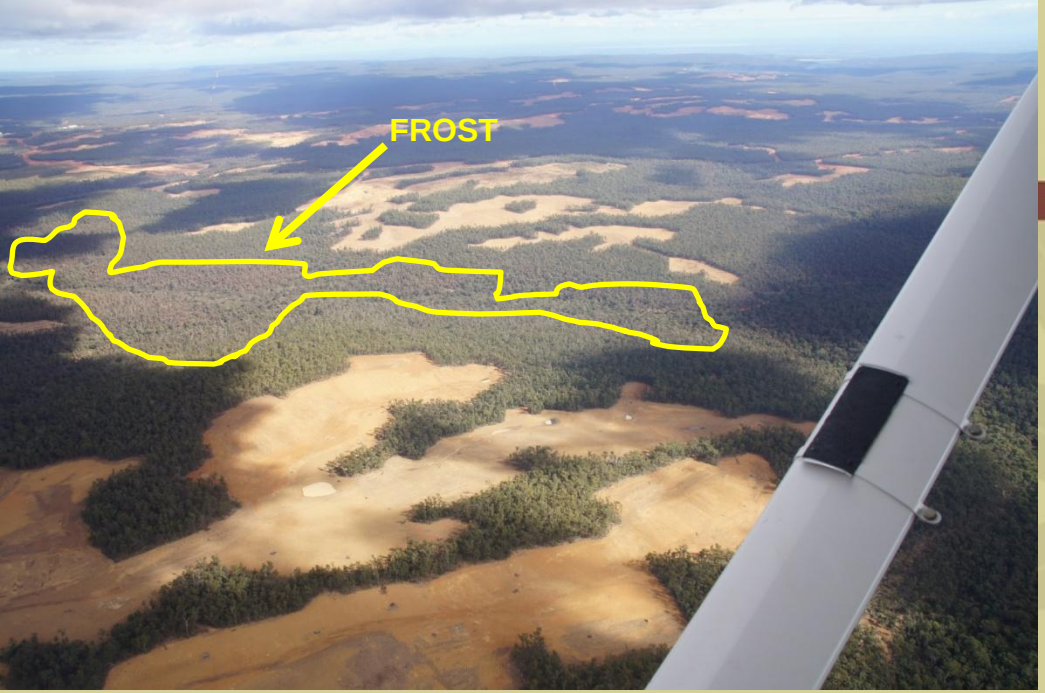
Yr. 4 Epicormic shoots

▼

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 out 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**

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

Thank you