GOVERNMENT OF WESTERN AUSTRALIA

DEPARTMENT OF Conservation AND LAND MANAGEMENT

Conserving the nature of WA

PHYTOPHTHORA CINNAMOMI

(Dieback)

Management Course

2006

Course Notes

Phytophthora cinnamomi Management Course

A course for practical management of *Phytophthora* root rot disease

Course Orientation

Phytophthora cinnamomi

Four Courses

- Detection, Diagnosis and Mapping
- Management course
- Field operators course
- Phosphite operations course

Management Course Objectives

To know and understand:-

- The basic biology of *Phytophthora cinnamomi*
- Disease caused by it *Phytophthora cinnamomi*
- The Department's policy on the management of *Phytophthora cinnamomi*

Management Course Objectives

To be able to:-

- Determine and map 'protectable' areas
- Prepare a *Phytophthora cinnamomi* Management Plan
- Use an Environmental Standards Checklist

Introduction

Why worry about

Phytophthora cinnamomi ?

What is Dieback?

A Case of Mistaken Identity

What is Dieback?

- Common name for disease in native plants caused by the pathogen *Phytophthora cinnamomi*
- The common name is misleading:
  - "sudden death" syndrome
  - catastrophic ecosystem change
- Phyto = plant, phthora = destroyer (biological bulldozer)

Definitions

Pathogen	– The agent causing harm.
Symptom	– Physical sign of infection.
Disease	– Harm inflicted in a plant.
Susceptible	– Influenced or harmed by an agent.
Resistant	– Not influence or harmed by the same agent.
Protectable area	– Worth keeping uninfested

Definitions

Epidemic	– rates of disease clearly in excess of normal.
Endemic	– Widespread or common within an area (disease). Also, restricted to an area (organism)
Infested	– Pathogen present.
Uninfested	– No pathogen present.
Risk	– The chance or probability.

History of the pathogen – *Phytophthora cinnamomi*

Background

- Occurs in many countries
- INTRODUCED by settlers into WA in root balls of orchard stock
- "FOUND" in 1921 in Java
- "Dieback" identified as *Phytophthora cinnamomi* in 1964
- 150 years of spread inc post WW1 use of machinery

Secondary Impacts

- Change in plant community
- Biomass reduced (resistant species may increase)
- Loss of other resistant species
- Loss of habitat for fauna:
  - cover
  - food

Biology of

Phytophthora cinnamomi

The Pathogen

Phytophthora cinnamomi

- Belong to Oomycetes (water moulds)
- Over 50 species worldwide
- *Phytophthora cinnamomi* most frequently isolated in WA
- Wide host range – kill and live on
- Dependent on plants (hosts) and moisture

The Pathogen

Phytophthora cinnamomi

The main body of the organism is the mycelium

The Pathogen

Phytophthora cinnamomi

The main body of the organism is the mycelium

- Grows on and through plant roots
- May be transported in tissue and soil
- "Moves" autonomously by growing from root to root

The Pathogen

Phytophthora cinnamomi

From the mycelium grow :-

- Spore sacs called sporangia which in turn produce and release zoospores

The Pathogen

Phytophthora cinnamomi

Zoospores

- Released from sporangia
- Motile in water (two flagella)
- Short lived and fragile
- Transported by above ground and subsurface water flow
- Initiate new infection by sending germ tube into plant cells

The Pathogen

Phytophthora cinnamomi

Chlamydospores

- Large, tough and long lived
- Produced under unfavourable conditions
- Resistant resting phase
- Transported in soil or roots
- Can produce mycelium and zoospores

Host-Pathogen Interaction

- Chemotactic attraction of zoospores to roots (chemotropism)
- Zoospores encyst and extend germ tubes into the root cell
- Mycelium grows from one root to another and invades the root cells

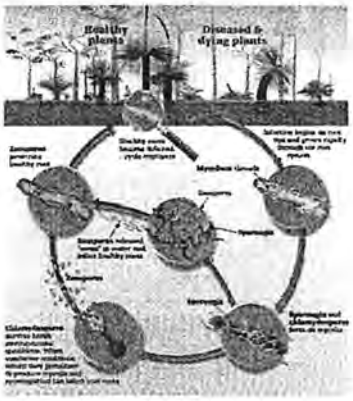
Host-Pathogen Interaction

The mycelium:

- Feed off sugars and starches of conductive tissue
- Form lesions (rot)

Plants:

- Either block lesions (resistant)
- Or fail and die (susceptible)



Pathogen Vectoring

Four ways :-

- Humans move infested material
- Animals move infested material
- Mycelium root to root growth
- Zoospores autonomous mobility - swim/washed

Environmental Factors

- Confined to the South West
- In South West Land Division

<u>≤400mm</u> - no occurrence

<u>400 - 600mm</u> - water gaining sites, severe disease may occur

<u>600 - 800mm</u> – widespread, not extensive

<u>800mm+</u> - widespread and extensive

Other Environmental Factors

- Temperature
  Optimum for growth 15° – 30°c
  Optimum for sporulation 25° – 30°c

Other Environmental Factors

- Soil.

  Ph 5 to 6 (acid) optimum
  - forested areas
  - higher rainfall areas more acid

  Calcareous sands on the coast and coastal plain are alkaline and generally not favourable for *P. cinnamomi* survival.

Other Environmental Factors

- Landform

  Water gaining sites are more susceptible to disease (Gullies streams and stream zones).

Epidemiology and Disease Syndromes

Reminder!

Disease?

Harm inflicted on a plant

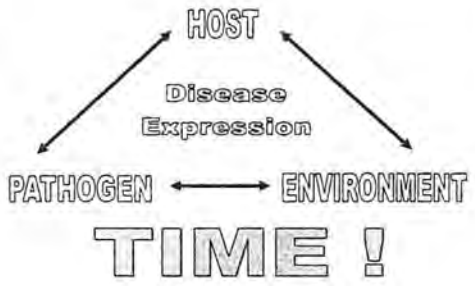
Epidemiology

- Epi = upon
- Demos = population

Epidemiological effects of disease are those that display within a population of susceptible organisms

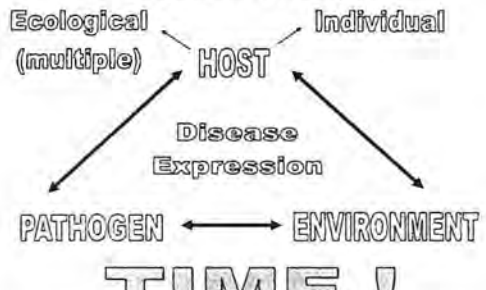
Ecological study looks for the relationship between factors or events and disease frequency based on entire populations

Disease Triangle



TIME !

Disease Triangle



TIME !

Disease

- Individual - pathogen acting within an organism to cause effect (harm)
- Ecological - multiple plants, other harm arising out of original infections. Eg ↓ host causes ↓ in fauna depending on host

Susceptible Hosts – Native Species

- Not consistent to or within a family(s), genus or species
- 1,500 – 2,000 species susceptible
- Thousands more act as hosts

Wide Host Range

Indigenous species most affected belong to four families:

- PROTEACEAE
- EPACRIDACEAE
- FABACEAE
- MYRTACEAE




Disease Syndromes

1. No apparent disease at all
2. A variable epidemic within the dominant jarrah tree component of the forest
3. An extremely destructive epidemic of root rot
4. An altered ecosystem commensurate with endemic disease presence

Legislation

Legislation

Commonwealth *EPBC ACT 1999*

- Listing of threatening processes
- Requires a *Threat Abatement Plan* to be prepared
- Significance to WA and CALM?
  - nation-wide problem recognised
  - funding via NHT & NRM process

Legislation

State Acts of Parliament

- Often include the power for the Governor to "regulate":
  - Make "rules"
  - Set penalties for breaking rules
  - Provide powers for enforcement
- Two key State Acts
  - Wildlife Conservation
  - Conservation & Land Management

Legislation

Wildlife Conservation Regulations1970

- Part 6 dealing with the management of nature reserves repealed in 2002
- No relevant *regulations* remain
- Rely on *Conservation and Land Management Act 1984*

Legislation

CALM Act 1984

Section 62. Land may be classified

...(c) a limited access area;

...(f) such other class of area as the Minister, on the recommendation of the Conservation Commission,thinks necessary to give effect to the objects of this Act

Legislation

Conservation and Land Management Regulations 2002

- Regulation 42. Access to limited access areas

" A person must not, without lawful authority, enter otherwise than by foot or by vessel any and classified - ....." Penalty $2,000

Legislation

CALM Act 1984

- Part VII deals with: "*The Control and Eradication of Forest Diseases*"

  - provides strong powers, <u>but only on State Forest in relation to</u>:

Legislation

CALM Act 1984
Has sections that deal with:

- Identifying risk areas in which trees may be or may become infected with any forest disease [<u>DRA</u>]
- Identifying disease areas which are infected with any forest disease [DISEASE AREA]
- Controlling & eradicating such diseases

Legislation

CALM Act 1984

A Disease Risk Area (DRA) is:

" Any area of public land where the Executive Director considers that the earth, soil or trees *may be*, or *may become* infected with a forest disease"

Where are the DRA's? So what ?

Legislation

Forest Management Regulations 1993

- Require a written authority to take a potential carrier into a *DRA*
- Must have written authority with you
- Allow for conditions to be applied
- Require that conditions be met
- Penalties specified up to $2,000

Policy

What is "policy"?

Why have a "policy" statement?

Policy

1996 Government Review

Phytophthora cinnamomi

- Management options
- Research priorities

Policy

What can we do ?

Option 1 - Do nothing

Option 2 - Prohibit all access

Option 3 – Eradicate the pathogen

Option 4 – Stop the spread

Option 4 - Set obtainable & affordable objectives ✓

Policy

Policy Objectives
(Obtainable and affordable?)

1. Find 'protectable' areas

Policy

Protectable areas

Policy

Protectable areas

"…. protectable areas are those for which the values are significant and the benefits of hygiene are likely to be sustained for more than a few decades, prioritises them and concentrates available resources on rigorous application of hygiene for their protection."

Policy

Protectable areas

- values are significant.
- benefits of hygiene last more than a few decades.
- rigorous application of hygiene for their protection.

Policy

Protectable areas

- Label for the remaining higher value uninfested "jewels"
- Cost effective control of human vectoring is possible
- Includes areas where phosphite treatment can be used

Policy

Protectable areas

- > 600mm rainfall zone or water gaining sites in 400 – 600 mm zone
- Not a calcareous soil
- Free of the pathogen
- Will not be engulfed in a few decades e.g. > 4 ha with axis > 100m)

Policy

Policy Objectives
(Obtainable and affordable?)

1. Find 'protectable' areas
2. Manage values of infested areas (Recovery programs: germ-plasm conservation and translocation)
3. Protect DRF with phosphite
4. Interagency research and liaison
5. Encourage community interest and participation

Field Detection

Describe the process for identifying the presence of plant disease caused by *Phytophthora cinnamomi* using visible indicator species and disease symptoms expressed in them and their distribution over time and space.

Observable Factors

- Indicator species
- Chronology of deaths
- Pattern of deaths
- Site and climatic factors
- Other causes of death
- Sample

Other Impacts

- Wind Damage
- Senility
- Canker Fungi
- Fire
- Frost
- Lightning
- Insect Attack
- Chemical Spills
- Waterlogging
- Competition
- Salinity
- Mechanical Damage
- Other *PHYTO Sp*
- Herbicides
- Drought
- Armillaria

Soil and Tissue Sampling

Sample Results

POSITIVE RESULT

- Indicates presence of *Phytophthora cinnamomi*

NEGATIVE RESULT

- does not necessarily mean that *Phytophthora cinnamomi* is not present. Sampling may have "missed" the pathogen

TO IMPROVE CONFIDENCE IN RESULTS A NUMBER OF SAMPLES SHOULD BE TAKEN

Disease Boundary Demarcation

Demarcation Categories

- Infested areas
  Plant disease symptoms present
- Uninfested areas
  No plant disease symptoms consistent with presence of *Phytophthora cinnamomi*
- Uninterpretable areas
  Plant disease symptoms can't be evaluated

Demarcation

- Infested areas.
  "Day-glo orange" flagging tape.
- Uninterpretable.
  "Pink and black" diagonally striped tape in the Warren Region and "white" tape in the South West and Swan Regions.

  Tapes are placed around trees at a visible height with knots facing the category to which they apply.

Buffers

- Account for "Cryptic" disease
- Upslope - 15m minimum
- Across slope - variable greater than 15m
- Downslope - minimum 25m. Interpreters discretion. Could be as much as 100m

Maps and Cell Reports

Phytophthora cinnamomi Occurrence Map

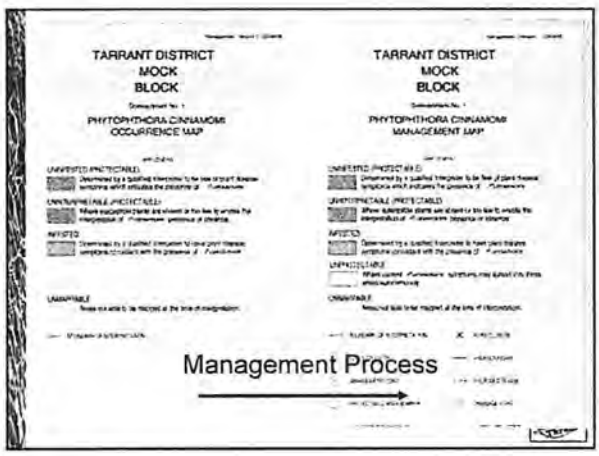
- Main product produced by Interpreters
- Shows infested, uninfested and uninterpretable areas
- Is the basis for the *Phytophthora cinnamomi* Management Plan

Protectable Areas Map

- Interim planning product.
- Shows interpreter recommendations of unprotectable areas.
- Not uniformly used as a step towards the Management map. Some managers will bypass.

Phytophthora cinnamomi Management Map

- Prepared as part of the 'protectable' area management planning process
- Records location and details of planned management actions
- Is placed in Proponent and FMB records systems



Cell Report

- Brings all of the results together
- Discusses the basis of decisions made
- Recommends Pc management strategies

Best Practice Management

Infested Areas

Infested Areas

Recovery Plans - Apply Phosphite to DRF

Phosphite

TRADE NAME	FOS-JECT 200, FOLI-R-FOS 400, FOS ACID 200, FOS-ACID, FOS-4-PINE.
ACTIVE INGREDIENT	200 or 400 g/l phosphonic acid
APPEARANCE	Water clear liquid
CLASSIFICATION	Fungicide exempt poison schedule
STABILITY	Non-flammable, non-corrosive, non-explosive, stable under all normal environmental conditions. Stable in original containers for at least two years
USE	Control of Phytophthora

Phosphite - Mode of Action

- Acts directly on the pathogen to either kill it or halt it's growth.
- Mobilises the plant's natural defence mechanism to ward off invasions of its root system.

Phosphite - Benefit and Cost

- Triggers short term resistance in same susceptible plants
- Protection only while phosphite is present
- Folia spray repeat every 2 to 3 years ($300/ha ground - $450/ ha aerial)
- Stem injection repeat every 7 years ($3.00 per tree)

Infested areas

Recovery Plans – *Ex Situ* Germplasm Conservation

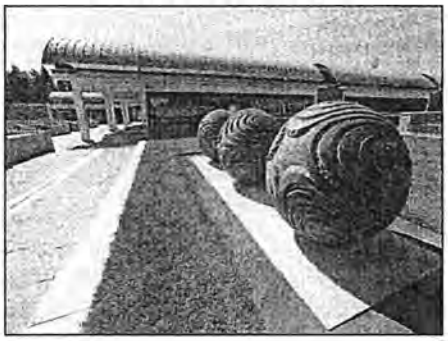
Germplasm Conservation

Ex situ - off site or conservation of organisms away from their natural habitat

Opposite of *in situ* (on site) conservation.

Germplasm is living tissue - seed, pollen, vegetative propagules, tissue or cell culture, living plants or DNA.

Seedbanking



Use of Seed Collections

- Long term storage (insurance policy)
- Recovery and restoration
- Research - Disease susceptibility
  - Seed biology
  - Genetic
- Display and Education
  - Botanic Gardens
  - Schools

Infested Areas

Recovery Plans -

Translocation of
Critically Endangered Flora

What is a Translocation?

"The deliberate transfer of plant material from one area to another for conservation purposes".

(from the "Guidelines for the Translocation of Threatened Plants in Australia" by the Australian Network for Plant Conservation).

Translocation - Categories

- Re-stocking: increase size of an existing population.
- Re-introduction: establish a population where it formerly occurred.
- Introduction: establish a population where it is not known to have occurred, within the known range and habitat.
- Conservation Introduction: establish a population in an area that is outside the known range, which has appropriate habitat.

Translocation - Aims

1. Increase the number of individuals and populations of threatened plant taxa.
2. Investigate techniques to enhance establishment and survival

Best Practice Management

Uninfested Areas

Uninfested Areas

Survey, map and demarcate 'protectable' areas

- System and standards in place
- Uses qualified specialists

Reminder!

Vectoring?

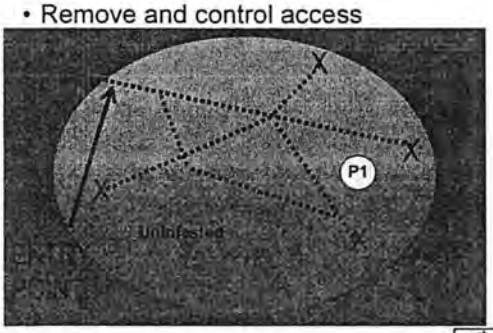
Uninfested Areas

Four ways of vectoring :-

- Humans move infested material
- Animals move infested material
- Mycelium grows from root to root
- Zoospores swim or washed

Uninfested Areas

- Remove and control access



Uninfested Areas

- Entry point signs

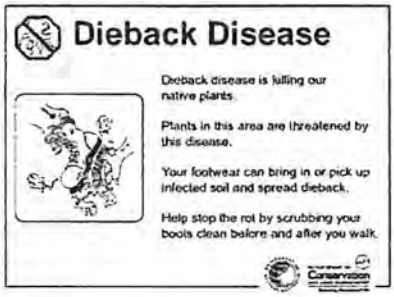
Uninfested Areas

- Be clean on entry into uninfested areas
  - ✓ No clods of soil or plant material
  - ✓ No slurry of soil, plant tissue and water

  Dust and grime adhering to the sides of the vehicles need not be removed!

Uninfested Areas

- Clean on entry



Uninfested Areas

- Clean on entry

Control and Eradication of Forest Diseases
Forest Management Regulations

CLEANDOWN POINT

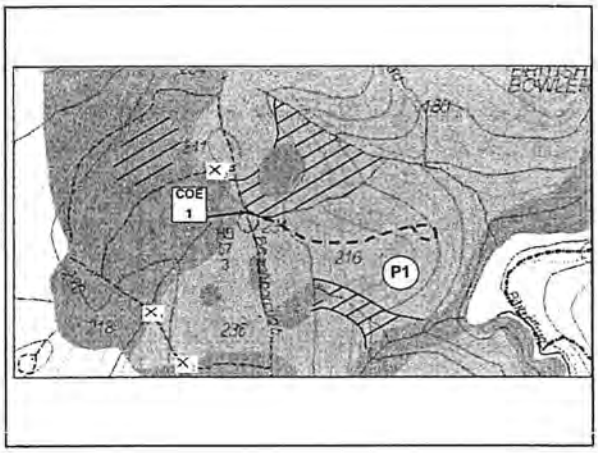
Uninfested Areas

Cleandown point

- ✓ Separates the machine from the effluent and infested soil and plants
- ✓ Machines can enter uninfested areas without becoming re-infested
- ✓ Effluent falls directly onto infested soil or is contained
- ✓ Easy and safe access and use

Uninfested Areas

- Demarcate categories in the field
- ✓ Infested areas - pathogen present
- ✓ Uninfested areas - no pathogen
- ✓ Uninterpretable areas - cannot tell



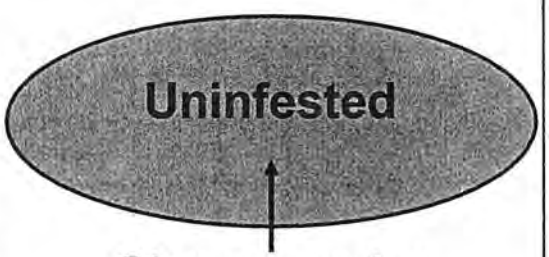
Hygiene Guidelines For 'Protectable' Areas

Hygiene Guidelines

No hygiene required

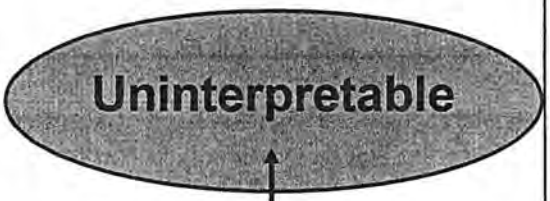
Infested

Hygiene Guidelines



Clean on entry

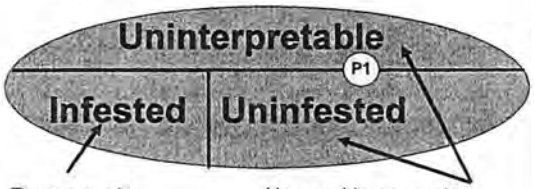
Hygiene Guidelines



Clean on entry

Hygiene Guidelines

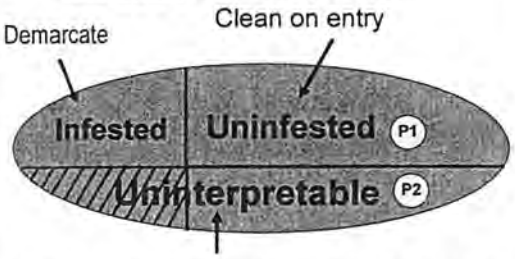
Where *Phytophthora cinnamomi* is <u>DOWNSLOPE</u> of uninterpretable:-



Demarcate

No need to separate – clean on entry

Where *Phytophthora cinnamomi* is UPSLOPE of uninterpretable:-



Separate uninterpretable – clean on entry AND for snigging only no soil movement

Hygiene Guidelines

Road Construction and Maintenance

Use only uninfested basic raw materials in 'protectable' areas

Management of areas when no information is available

- Treat area as protectable
- Assess soil movement risk (next section)
- Is the risk acceptable for a protectable area? – No/Yes DM decision

Risk

Definitions

- **Hazard** – a source of potential harm
- **Risk** – the chance of something happening that will have an impact upon our objectives

  [Measured – likelihood and consequences]
- **Likelihood** – the probability or frequency
- **Consequence**(s) – the outcome(s) of an event being a loss, injury or disadvantage

Likelihood Level

Likelihood Level	*Description*
Almost certain	Almost inevitable outcome, known consequences are the expected result in almost every occurrence of the event.
Likely	Not a certain outcome, there is a good chance the known consequences will be the expected result of the occurrence of the event.
Possible	Known consequences could be the result of the event.
Unlikely	Known consequences not expected to be the result of the event without the failure of systems/controls.
Very Rare	Little chance of known consequences resulting from every occurrence of the event without multiple failures of systems/control.

Consequence

Consequence Level	Environmental Harm
Catastrophic	Irreparable/long term damage, widespread environmental effects may include disturbance/death to threatened species and ecological communities, unauthorized damage to significant cultural or heritage sites. Occurrences may result in significant regulatory intervention
Major	Serious damage to the environment, medium-long term impact, rehabilitation at considerable expense. Possible legal non-compliance and/or damage to corporate reputation. Note: - no threatened species at risk
Moderate	Localised, short term damage. Disturbance to the environment (requiring relatively short term remedial action).
Minor	Noticeable impact on the natural environment/corporate reputation requiring little or no remedial action.
Insignificant	Negligible impact on the environment which is difficult to notice and does not require remedial action.

Risk Rating

Likelihood consequences will result should an event occur	Consequences				
	Insignificant	Minor	Moderate	Major	Catastrophic
Almost certain	Significant	Significant			
Likely	Moderate	Significant	Significant		
Possible	Low	Moderate	Significant		
Unlikely	Low	Low	Moderate	Significant	
Rare	Low	Low	Moderate	Significant	Significant

Risk Action

Rating	Action Guideline
High	Immediate action required, involving detailed research, management planning and decision making at senior levels
Significant	Senior management attention needed
Moderate	Management responsibility for action and reporting must be specified
Low	Local management responsible for developing and deploying standard procedures

Risk Treatment

- Accept the risk
- Avoid the risk
- Reduce the likelihood
- Reduce the consequences
- Transfer the risk

Risk in Context

Risk - "the chance of being harmed by an agent" described in terms of:

- What can happen
- How it can happen
- Why it can happen AND
- The consequences

Risk in Context

Threat that serious or irreversible environmental damage may occur

Where?

SW Land Division > 400 mm rainfall with susceptoble vegetation

Risk in Context

Will the *Threat* be realised?

For areas that can be harmed by *Phytophthora cinnamomi* what is the *risk* that:

- People will introduce the pathogen

AND

- A new centre of infestation will result

Risk in Context

Risk taking varies between people:

- Managers when imposing and monitoring operating conditions?
- Proponents when implementing conditions

Risk in Context

For areas threatened by *Phytophthora cinnamomi*:

- The consequences are high
- Likelihood of introduction and establishment – variable

Risk in Context

Is the *Threat* that serious or irreversible environmental damage may occur real?

Where?

SW Land Division > 400 mm rainfall with susceptible vegetation

Risk in Context

If we are <u>not</u> clean on entry

- Road building – nearly 100%
- Snigging - < 100% but still high
- Hauling – high but less snigging
- Light vehicles – moderate to low ← illegal entry
- Boots – there a risk
- Native animals – there is a risk

Risk in Context

Chance of a hygiene failure is increased if;

- Multiple entry points to manage
- Area traversed by permanent roads
- Need to enter an area more than once
- Need to enter an area with large machines and trucks
- Trying to be clean on entry in winter *vs* summer

Field Trip

End Day One approx 4:30

PPE & Comfort requirements for field

- **Sturdy Boots**
- **Sun Protection**
- **Personal water**
- **Fly net**

CALM Planning Tools

Prompts for Pc management action

Proponents are prompted by various means.

- Inherent awareness - All know Pc must be managed.
- Standard Procedure – It is written that Pc must be managed.
- Internal checklists – Your manager knows that Pc must be managed and is trying to get you to do it too.
- High values of project area – All hell will break loose if Pc is not managed correctly.

CALM Planning Tools

"KISS"

CALM Planning Tools

"KISS" – a simple 5 step management process

1. Map *Phytophthora cinnamomi* Occurrence
2. Find the 'protectable' areas & boundaries
3. Control access – road closures
4. Be clean on entry
5. Conduct regular checks and reviews

CALM Planning Tools

Three simple tools:

- *Phytophthora cinnamomi* occurrence map
- *Phytophthora cinnamomi* management plan (includes a map)
- *Phytophthora cinnamomi* environmental standards checklist

CALM Planning Tools

Phytophthora cinnamomi Occurrence Map

- Map prepared by specialists for YOU

CALM Planning Tools

Phytophthora cinnamomi Management Plan

- A document *with* a map attached
- Prepared by YOU as the manager
- Usually in in a meeting with the activity proponent and the Disease Interpreter

CALM Planning Tools

Phytophthora cinnamomi Management Plan

- Separates:

  - Land management steps

  from

  - Activity management steps

CALM Planning Tools

Phytophthora cinnamomi Environmental Standards Checklist

- Field checks completed by YOU