

Conservation of Tasmanian Plant Species & Communities Threatened by *Phytophthora cinnamomi*

Strategic Regional Plan for Tasmania



Richard Schahinger, Tim Rudman and Tim Wardlaw

Nature Conservation Branch
Technical Report 03/03



DEPARTMENT of
PRIMARY INDUSTRIES,
WATER and ENVIRONMENT



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EXECUTIVE SUMMARY

The introduced soil-borne pathogen *Phytophthora cinnamomi* ('root-rot') is listed as a key threatening process in the Commonwealth's *Environment Protection and Biodiversity Conservation Act 1999*. The pathogen is recognised as being a very real and rapidly spreading threat to many of Tasmania's plant species and communities.

This report addresses *P. cinnamomi* management in Tasmania through the establishment of a suite of priority management areas that contain representative examples of those plant species and communities considered most at risk. Sixty-seven management areas have been selected on the basis of their suitability for management to protect against infection by *P. cinnamomi*, with a deliberate attempt at bioregional representation.

Priorities for management included the following plant species listed in the Commonwealth's *Environment Protection and Biodiversity Conservation Act 1999*: *Epacris apsleyensis*, *Epacris barbata*, *Epacris exserta*, *Epacris glabella*, *Epacris grandis*, *Epacris limbata*, *Epacris stuartii*, *Epacris virgata*, *Phebalium daviesii*, *Tetratheca gunnii*, *Xanthorrhoea arenaria* and *Xanthorrhoea bracteata*. Additional species listed under the Tasmanian *Threatened Species Protection Act 1995* were also targeted. Where achievable, each species was sought in at least three management areas.

Plant communities in Tasmania were rated for their known susceptibility to *P. cinnamomi*. Susceptibility mapping was based on 1:25000 scale vegetation maps (TASVEG) prepared by the vegetation mapping programme in the Department of Primary Industries, Water and Environment. Communities most at risk included coastal heaths, heathy woodlands and buttongrass moorlands, particularly in the lowland areas of the state. Again, each susceptible community was targeted for inclusion in the *P. cinnamomi* management scheme.

As far as possible areas have been sited within the existing reserve system or land managed by Forestry Tasmania, thus simplifying management requirements. Ongoing management of the *P. cinnamomi* areas will be implemented through mechanisms agreed to by the two principal land managers, the Tasmanian Parks and Wildlife Service and Forestry Tasmania. Processes have been established whereby any activity proposed for a management area is evaluated against the risk of introducing the pathogen and, where necessary, prescriptions implemented to mitigate that risk. Similarly, any mineral exploration activities proposed for the areas will be in line with procedures agreed to by Mineral Resources Tasmania.

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1. Introduction

Phytophthora cinnamomi is an introduced plant pathogen that has the capacity to kill a wide variety of native plant species. It is widely recognised as one of the most threatening of all disease epidemics to affect native plant communities anywhere on the globe. In consequence, 'Dieback caused by the root-rot fungus [sic] *Phytophthora cinnamomi*' has been listed as a key threatening process in Schedule 3 of the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*.

This report outlines the processes required to achieve objectives 1 and 2 of the national *Threat Abatement Plan for Dieback caused by the Root-rot Fungus Phytophthora cinnamomi* (Biodiversity Group, 2002) for the State of Tasmania, viz.,

- **Objective 1:** To promote the recovery of nationally listed threatened species and ecological communities that are known or perceived to be threatened by *Phytophthora cinnamomi*.
- **Objective 2:** To limit the spread of *Phytophthora cinnamomi* into areas where it may threaten threatened species and ecological communities or into areas where it may lead to further species or ecological communities becoming threatened.

In Tasmania *P. cinnamomi* is causing a substantial decline in the populations of many susceptible plant species and markedly modifying the structure and composition of plant communities. Most of the susceptible plant communities occur within the moorland, heathland and heathy dry sclerophyll vegetation types.

Phytophthora cinnamomi management in Tasmania to date has largely been applied as a set of generic prescriptions relating to activities that carry a high risk of spreading the pathogen. This management approach, which focuses on the pathogen, is failing due to:

- our inability to monitor the pathogen's complex and widespread distribution
- insufficient resources and inadequate processes to monitor and enforce management across industry and the public
- the potential high costs of compliance where management may not be warranted

Provision of advice and input into regional and local planning, such as catchment management plans, will continue to be problematic and often ignored for these reasons.

It is intended these problems be overcome by developing a management programme that focuses on the threatened biological assets – plant species and communities – rather than the pathogen. With a ceiling on the resources available to manage *P. cinnamomi* in Tasmania, it is proposed that a suite of strategic *Phytophthora* Management Areas be established to provide representative protection of the species and ecological communities that are most threatened by *P. cinnamomi*. These areas are to be selected on the basis of the greatest long-term chances of protection and management practicability.

The proposed management programme continues an innovative and successful Tasmanian approach to *Phytophthora* threat abatement. For each of the proposed areas, management agreements and community partnerships will be developed to implement threat abatement actions, with the integration of *P. cinnamomi* management prescriptions into regional and local management plans where appropriate.

Section 2 of this draft report contains an introduction to the biology and ecology of *P. cinnamomi*, its impact on Tasmania's vegetation, and the role of humans in its spread. Section 3 includes an outline of the methodology involved in the selection of management areas, and a profile of the plant species and vegetation types most at risk from *P. cinnamomi*. Section 4 details the implementation process for the proposed management areas, while descriptions of individual areas are given in Section 5, with management prescriptions in each case. Section 6 includes an overview of the representativeness of the management areas, while Sections 7 and 8 contain discussions of ongoing management concerns and proposed updates to the plan, respectively.

2. Ecology of *Phytophthora cinnamomi* in Tasmania

The ecology of *P. cinnamomi* has been well documented by Shearer and Tippett (1989) for the Jarrah forests of Southwestern Australia, and summarised at length for Tasmania's Southwest World Heritage Area (Parks & Wildlife Service, 1993). The following section has been extracted largely verbatim from the latter document; additional information may be obtained in the companion manual to this report (Tasmanian Government, 2003b).

Phytophthora cinnamomi is a soil-borne microscopic organism belonging to the Pythiaceae family, in the newly constructed kingdom Chromista (Hawksworth *et al.*, 1995, 8th edition) (Phylum: Oomycota, Order: Pythiales). It is in the evolutionary primitive group called the Oomycetes or 'water moulds'. The fungus is pathogenic, requiring plant tissue as a food source. As the name 'water mould' suggests, the life cycle of *P. cinnamomi* depends on moist conditions that favour survival, sporulation and dispersal.

Phytophthora cinnamomi attacks the feeder roots of both susceptible and resistant plant species but can only flourish in the tissues of susceptible species. The fungus also invades larger roots, root collars and stems; infection results in the death of many native species (Podger *et al.*, 1990b). Such infection is an integral part of *P. cinnamomi*'s life cycle.

2.1 Disease Dynamics

The life cycle of *P. cinnamomi* is dependent on warm, moist aerobic conditions that favour survival, spore production and spore dispersal. Hyphae, filaments that form the body or mycelium of the fungus, feed by rotting then absorbing the root tissue of host plants. When soil temperatures are greater than 12°C specialised hyphae produce sporangia or spore sacs. Mobile reproductive units, zoospores, are released from the sporangia to swim through the soil to the roots of plants. The life of the motile zoospore is short, in the order of hours; however, encysted zoospores may survive for weeks in the right soil and moisture conditions. Under favourable conditions the cycle from zoospore release to root infection and then to a second release of zoospores can occur within 24 hours of wetting and baiting a soil with *P. cinnamomi* inoculum.

Chlamydospores may also be produced by the mycelium under drier conditions. Thick spore walls give chlamydospores the ability to survive under harsh conditions. In very dry soils chlamydospores require the protection of host tissues to survive. It is therefore likely that chlamydospores are a significant component of inoculum spread along road systems and are capable of establishing new foci of infection following long distance/time dispersal. Once dispersed, chlamydospores may either germinate to produce sporangia and zoospores or hyphae.

Where soil moisture and temperature conditions are suitable for *P. cinnamomi* survival, there are complex soil and biotic interactions that affect the ultimate expression of disease. This variability in expression may occur in part as a result of the effect of antagonistic rhizosphere microflora that are associated with particular plant species and of other antagonistic soil microbes. Soil physical and chemical properties may also affect the expression of disease. Disease is seldom seen on alkaline soils (eg. heath communities on calcareous sands), while severe disease develops on acidic peats overlying quartzite. Soils having few or small pores, for example heavy textured soils, limit the amount of soil water movement available for spore dispersal. In Tasmania, disease expression is strongly suppressed on krasnozems derived from Tertiary basalts and heavy textured soils on ultramafics (Podger *et al.* 1990b). Survival of *P. cinnamomi* is favoured by low nutrient soils. Highly fertile soils favour the growth of antagonistic microflora that are inhibiting to *P. cinnamomi* growth (Shearer and Tippett, 1989).

2.2 Disease Spread

Phytophthora cinnamomi can spread by the following means: motile zoospores, hyphae growing through root systems, and by the physical movement of chlamydospores and zoospores within soil and water. It may be carried by groundwater, human activity, some animals such as wombats and possibly cockatoos. Human activity is the main long-distance dispersal agent, with groundwater further spreading the disease downslope and along watercourses.

Dispersal by digging animals has been suggested to explain some anomalous localised infection patterns (Podger *et al.*, 1990a; Rudman, pers. observation). There is also some evidence to suggest that *P. cinnamomi* can survive passage through an animal's digestive system, and hence some mammals (e.g., wombats, bettongs) may be

significant vectors of spread due to their browsing habits. If *P. cinnamomi* were solely dependent on zoospore motility and hyphal growth for its dispersal, then spread would be greatly reduced.

Phytophthora cinnamomi spores and infected root material can be transported in minute quantities of soil, with the risk of infection increasing the greater the quantity of soil moved. Machinery, especially earth-moving equipment, vehicles, infected planting stock and the movement of infected soil or gravel, produce the greatest risk of contamination.

3. Method for selecting *P. cinnamomi* Management Areas

The *Phytophthora cinnamomi* management areas were chosen with the following criteria in mind:

- the presence of viable areas of the target plant communities;
- the presence of viable numbers of the target plant species;
- manageability, *P. cinnamomi* status, capacity to control vectors of spread and commitment to long-term management.

The sixty management areas identified by Barker (1994) in targeting rare plants susceptible to *P. cinnamomi* were used as the basis for capturing listed target species and, where appropriate, target plant communities. The suitability of each of Barker's areas was reassessed in the light of advances in our understanding of individual species distributions and/or taxonomic validity, while the efficacy of the management prescriptions proposed by Barker was also assessed (in conjunction with personnel from Forestry Tasmania).

As intimated earlier, the ultimate goal of this project has been the establishment of a suite of management areas that contain replicates of each of the target plant species and communities at a bioregional level, ideally on land of secure tenure. This has been achieved wherever possible, though it should be noted that the options for management for some species and communities were extremely limited, due either to naturally restricted distributions or to existing high levels of *P. cinnamomi* infestation.

3.1 Target species & plant communities

3.1.1 Plant Species

A list of plant species considered to be susceptible to *P. cinnamomi* was compiled initially from the Tasmanian literature (Podger et al., 1990b; Barker, 1994; Kirkpatrick and Harris, 1999), and subsequently refined through discussions with experienced botanists and plant pathologists, and personal observations in the field during the course of this project (the final list of 101 species is given in Appendix 1).

The susceptible plant species fall into two categories depending on whether or not they are listed for protection under State or Commonwealth legislation. Thirty-two of the susceptible plant species are listed under the *Threatened Species Protection Act 1995* and/or the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999*. The listed species were specifically targeted for representation in at least three *P. cinnamomi* management areas. It is assumed that the unlisted species will be adequately conserved in the targeting of the range of highly susceptible plant communities (see section 3.1.2).

The Tasmanian Parks & Wildlife Service's GTSpot database was interrogated for all 101 susceptible species and their number plotted for each 1 by 1 km element throughout Tasmania. This provided an initial indication of concentrations of susceptible species and hence communities, and also highlighted gaps in the data. Those areas with a high number of susceptible species typically coincided with coastal heaths or heathy woodlands in established reserves (e.g., Freycinet, Mt William, Waterhouse, Asbestos Range, Rocky Cape), a consequence in part on the concentration of past botanical surveys in areas of known significance (e.g., Kirkpatrick, 1977).

3.1.2 Plant Communities

Tasmania has vegetation mapping available for much of the state at a scale of 1:25,000 (TASVEG; see Appendix 2). Each of the TASVEG mapping units has been categorised on the basis of its observed susceptibility to *P. cinnamomi*. Two clear categories have been employed, those mapped vegetation types that are reliably highly

susceptible to *P. cinnamomi* and those that are reliably not susceptible or have low susceptibility. Between these extremes a third category of variable susceptibility has been used.

The assessment of susceptibility was based either on records of field expression (e.g., Podger *et al.*, 1990a and b) or inferred using the proportion of susceptible species within the described communities or vegetation mapping units (e.g., Kirkpatrick, 1977; Duncan and Brown, 1985; Kirkpatrick and Harris, 1999; TASVEG website). The degree of susceptibility of each mapping unit has two components: (1) the number of susceptible plant species within the unit, and (2) the level of change occurring after infection of the unit by *P. cinnamomi*.

It is acknowledged that there will be considerable variability within a particular vegetation mapping unit, given that each unit may include a number of described plant communities. For example, the TASVEG mapping unit 'shrubby coastal heath' includes at least 10-12 floristic communities (Kirkpatrick and Harris, 1999), while the 'Coastal *Eucalyptus amygdalina* forest' unit may include facies on three or four substrates. In addition, the impact of *P. cinnamomi* within the eucalypt-dominated units in the 'variable' category may be quite localised. For these units the presence of reliable and highly susceptible indicator species such as *Xanthorrhoea australis* (Grass Tree) will help to determine the likely level of impact (Figure 1).

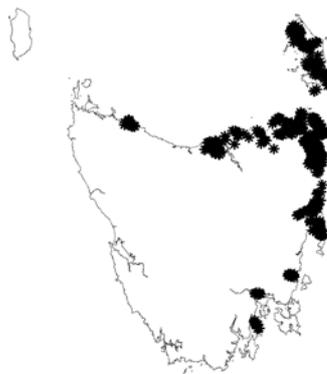


FIGURE 1. Grass tree distribution

3.1.3 Distribution and Climatic Envelope of *Phytophthora cinnamomi*

The distribution of *P. cinnamomi* within Tasmania (Figure 2) is based on soil sampling by Forestry Tasmania since 1972, and soil sampling and the mapping of positive symptoms by DPIWE. Additional sampling and mapping has been undertaken during this project.



FIGURE 2.



FIGURE 3.

FIGURE 2. Distribution of *Phytophthora cinnamomi* in Tasmania (as at February 2002); *P. cinnamomi* is also known to be widespread on Cape Barren Island in the Furneaux Group (with an isolated record from Clarke Island).

FIGURE 3. Climatic envelope for *Phytophthora cinnamomi* (Podger *et al.*, 1990a); hatched areas are considered unsuitable for *P. cinnamomi* expression (= mean annual air temperature < 7.5°C or mean annual rainfall < 600 mm).

Podger *et al.* (1990a) demonstrated that the impact of *P. cinnamomi* in Tasmania was largely confined to those areas with a mean annual air temperature greater than 7.5°C (equivalent to an altitude of c. 600 m) and a mean

annual rainfall greater than 600 mm (Figure 3). The pathogen may occur in localised microsites at higher altitudes (e.g., Mathinna Plains at 800 m) but its impact at such altitudes is minimal.

3.1.4 Manageability

Areas identified as possible *P. cinnamomi* management areas through the above desktop study were assessed on the ground, wherever possible following discussions with experienced botanists with local knowledge. The following features were noted during fieldwork:

- the presence, area and condition of the target plant communities
- the presence, number and condition of listed target plant species
- *Phytophthora cinnamomi* status
- manageability

Criteria for manageability

1. the nature of the topography in each area: a steeply dissected landscape provides a greater opportunity for *P. cinnamomi* management than a relatively flat landscape
2. the presence of natural barriers to the spread of *P. cinnamomi* (e.g., rivers, dense wet forest, sharp ridgelines)
3. the total size of the management area
4. the tenure of the immediate and surrounding areas
5. the number of access points and the type and amount of roading in the area
6. past and 'likely' future use of the area, including commercial, recreational and a range of illegal activities (e.g., firewood cutting)

3.2 Management areas within the World Heritage Area

The process used for selection of management areas within the Tasmanian Wilderness World Heritage Area differed from the rest of the State. The lack of access, together with existing land management policy, suited an approach which focussed on managing all areas of blanket moorland not known to be infected by *P. cinnamomi* (PWS, 1993). This is contrary to the approach taken in the settled areas of the State. However, in keeping with the representative area methodology used in this strategy, the key catchments free of *P. cinnamomi* and naturally protected from incursion are identified for a higher level of management.

Diseased areas were defined by creating a 3 km buffer around recorded infestations. This buffer was modified to be consistent with expected *P. cinnamomi* spread, natural boundaries and catchment divides, the result being a zone boundary which is identifiable on the ground. Diseased area boundaries will be kept under constant review and modified within the Parks and Wildlife Service management system as required.

The disease-free catchments that are protected by natural boundaries have been identified and, where possible, grouped together to create *Phytophthora* management areas for prescriptive management and incursion monitoring. Individual areas are described in Section 4; the representation of Blanket moor communities in each *Phytophthora* management area was recorded and the capture of each community type tabulated.

Selection of target communities

Jarman et al (1988) described 47 different plant communities within moorland vegetation, with two major groupings, Blanket moor and Eastern moor. Eight of these communities (Table 1) were chosen for management under the present project, based on the presence of target *P. cinnamomi* susceptible species (Table 2) and the observed *P. cinnamomi* impact in the field. Six are blanket moor communities and two are eastern moor communities. Seven of the eight communities are classified by Jarman et al. (1988) as 'Graminoid heathlands', and the eighth – dry eastern heathy – as 'heathland' (i.e., where shrubs have greater prominence than sedges).

Epacris curtisiae is the only *P. cinnamomi* susceptible threatened species occurring in moorland communities that required consideration in the selection process. This shrub is restricted to the 'Northwestern dense' blanket moor (Jarman, 1988).

Montane blanket moor was excluded from the current analysis as *P. cinnamomi* fails to cause disease at the altitudes in question due to depressed soil temperatures. Copse communities have been excluded for similar reasons, though it is canopy cover rather than altitude that depresses soil temperatures below that suitable for *P. cinnamomi* expression (some edge effects may be apparent and disease expression post-fire is also a possibility). Copse communities are also highly likely to be well represented within the target graminoid heath communities.

TABLE 1. Moorland target communities & generalised distributions (after Jarman et al., 1988)

BLANKET MOOR		
B1. (a)	Standard Peat	Western Tasmania, widespread in SW, regional facies in northwest
B1. (b)	Standard Pebbles	Western Tasmania, widespread in SW (= degenerate facies of B1 (a) due to fire/erosion)
B2.	Wet Standard	Southwestern Tasmania, poorly drained areas in broad valleys at low altitudes.
B4.	Layered Blanket Moor	Western Tasmania, low to mid altitude
B8.	Clay Pans	Western Tasmanian lowlands, most common in northwest
B11.	Northwestern Dense	Northwestern Tasmania
EASTERN MOOR		
E1. (a)	Common Wet Eastern Heathy	Eastern Tasmania, northwest and west coast
E5.	Dry Eastern Heathy	Northwest Tasmania, Southport, Huon area

TABLE 2. Target species occurring in moorland plant communities

<i>Agastachys odorata</i>	<i>Dillwynia glaberrima</i>
<i>Allocasuarina monilifera</i>	<i>Epacris corymbiflora</i>
<i>Amperea xiphoclada</i>	<i>Epacris curtisiae</i>
<i>Aotus ericoides</i>	<i>Epacris impressa</i>
<i>Baeckea leptocaulis</i>	<i>Epacris lanuginosa</i>
<i>Banksia marginata</i>	<i>Hibbertia procumbens</i>
<i>Bauera rubioides</i>	<i>Isophysis tasmanica</i>
<i>Blandfordia punicea</i>	<i>Leptospermum glaucescens</i>
<i>Boronia citriodora</i>	<i>Melaleuca squamea</i>
<i>Boronia parviflora</i>	<i>Sprengelia incarnata</i>
<i>Boronia pilosa</i>	<i>Stylidium graminifolium</i>
<i>Cenarrhenes nitida</i>	

The distribution of moorland communities has not been mapped. However, broader moorland vegetation assemblages discernible by aerial photographic interpretation were in the process of being mapped at the time of preparation. Capture of target communities has been determined by reference to distributions in Jarman et al. (1988), expert opinion (J. Balmer and S. Corbett), species distribution records and WHA vegetation maps.

TABLE 3. Relationship between selected moorland communities and mapped moorland vegetation assemblages. (WHA mapping tags in bold refer to SW community mapping.)

Jarman et al. (1988)	WHA vegetation mapping tags (Corbett, unpublished)
B1. (a) Standard Peat	Bs, Bs/M; BS
B1. (b) Standard Pebbles	Bs, Bs/Ro; BF
B4. Layered Blanket Moor	L/M/B variants, Aws or Bws with Bs: BS, LS

The Blanket Moor communities are generally broadly distributed but also tend to occur in complex mosaics at a range of scales across the landscape. Changes in drainage, soil type and depth with changing slopes and aspects can have a major influence on community composition. Coexistence of a number of the target Blanket Moor communities within any one area is likely even though the mapped vegetation assemblage may vary.

4. Implementation of *P. cinnamomi* Management Areas

(1) Tasmanian Parks and Wildlife Service (PWS)

Phytophthora cinnamomi Management Areas on land managed by PWS will be implemented in the first instance through the adoption of the area-specific prescriptions outlined in this report; the prescriptions will be incorporated into specific reserve management plans and generic reserve-class management plans as they are developed, and in conservation management statements for specific reserves.

The *P. cinnamomi* Management Areas will be shown on the PWS GTSpot database and the Track Team Server (www.gisparks.tas.gov.au and www.geryon.tas.gov.au, respectively). Any planned development or activity within a *P. cinnamomi* Management Area will be undertaken in accordance with the process outlined in the (Draft) Reserve Management Code of Practice (Section 5.3, DPIWE & FT, 2001). A formal project proposal will be prepared according to the PWS Reserve Activity Assessment and Approval System (RAAAS, in prep.), and the endorsement of the Nature Conservation Branch (DPIWE) will be required for the development to proceed.

(2) Forestry Tasmania (FT)

Phytophthora cinnamomi Management Areas on State Forest will be implemented through the Management Decision Classification system (MDC) using Special Management Zones (SMZs). The Environmental Management System (EMS) and the Forest Practices System provide the standards for developing and implementing prescriptions.

- MDC system: *P. cinnamomi* management areas will be coded as special management zones (specifically for managing *P. cinnamomi*). Forest Practices Plans (FPPs) or other forest activities within areas identified as *P. cinnamomi* Management Area SMZs require the input of a forest pathologist to ensure prescriptions provide safeguards that minimise the risk of accidentally introducing or spreading *P. cinnamomi*. Such prescriptions are to be developed on a case-by-case basis for each FPP or activity depending upon the level of risk associated with the proposed operation.
- EMS: Forestry Tasmania's Environmental Management System requires that planning and implementation of prescriptions is done according to standard operating procedures. This process is subject to independent audit by an accredited third party.
- Forest Practices System: under the Forest Practices System, forest-harvest operations and associated roading and quarrying are required to have FPPs developed. This process involves the identification of special values, including threatened species and flora of conservation significance. *Phytophthora cinnamomi* issues are taken into account when developing management prescriptions for *P. cinnamomi* susceptible species and communities, or within *P. cinnamomi* Management Areas.

(3) Mineral Resources Tasmania (MRT)

A number of the proposed *P. cinnamomi* management areas occur on land available for mineral exploration. They include the following tenure categories: Conservation Area, Nature Recreation Area, Regional Reserve, Forest Reserve, State Forest and unallocated Crown Land.

In accordance with the Tasmanian *Mineral Exploration Code of Practice* (Bacon, 1999), any proposals for mineral exploration within *P. cinnamomi* Management Areas will be referred to the Mineral Exploration Working Group (MEWG) for consideration. The Code will guide MEWG to the level of prescription required, but individual prescriptions will be developed on a case-by-case basis depending on the level of risk associated with the proposed operation, with specialist advice to be provided by Nature Conservation Branch (DPIWE).

Personnel with Mineral Resources Tasmania and DPIWE will assess the level of compliance of prescribed activities at regular intervals to ensure that adequate hygiene measures are in place.

(4) Department of Primary Industries Water and Environment (DPIWE)

Many other stakeholders may impact on the success or otherwise of land managers achieving the objectives of this plan. DPIWE will promulgate the plan among other stakeholder agencies and groups to ensure management areas and prescriptions are included in relevant environmental management systems (eg Councils, DIER). DPIWE will also provide management advice and assist with identification of additional management areas.

5. Management Areas by Bioregion

Descriptions of each of the proposed *P. cinnamomi* management areas are given in the following section. The areas have been ordered clockwise by bioregion (IBRA Regions Version 5.0; Peters and Thackway, 1998), starting with the King bioregion, then Northern Slopes, Flinders, Ben Lomond, South East, Southern Ranges and West. Individual management areas are coded alphanumerically within each bioregion (as shown in Figure 4); maps of the individual areas are presented in Appendix 5 at a scale of 1:100,000 for those areas outside the WHA, and at a scale of 1:500,000 for those areas within the WHA. The agency responsible for each of the management areas is noted in Table 4.

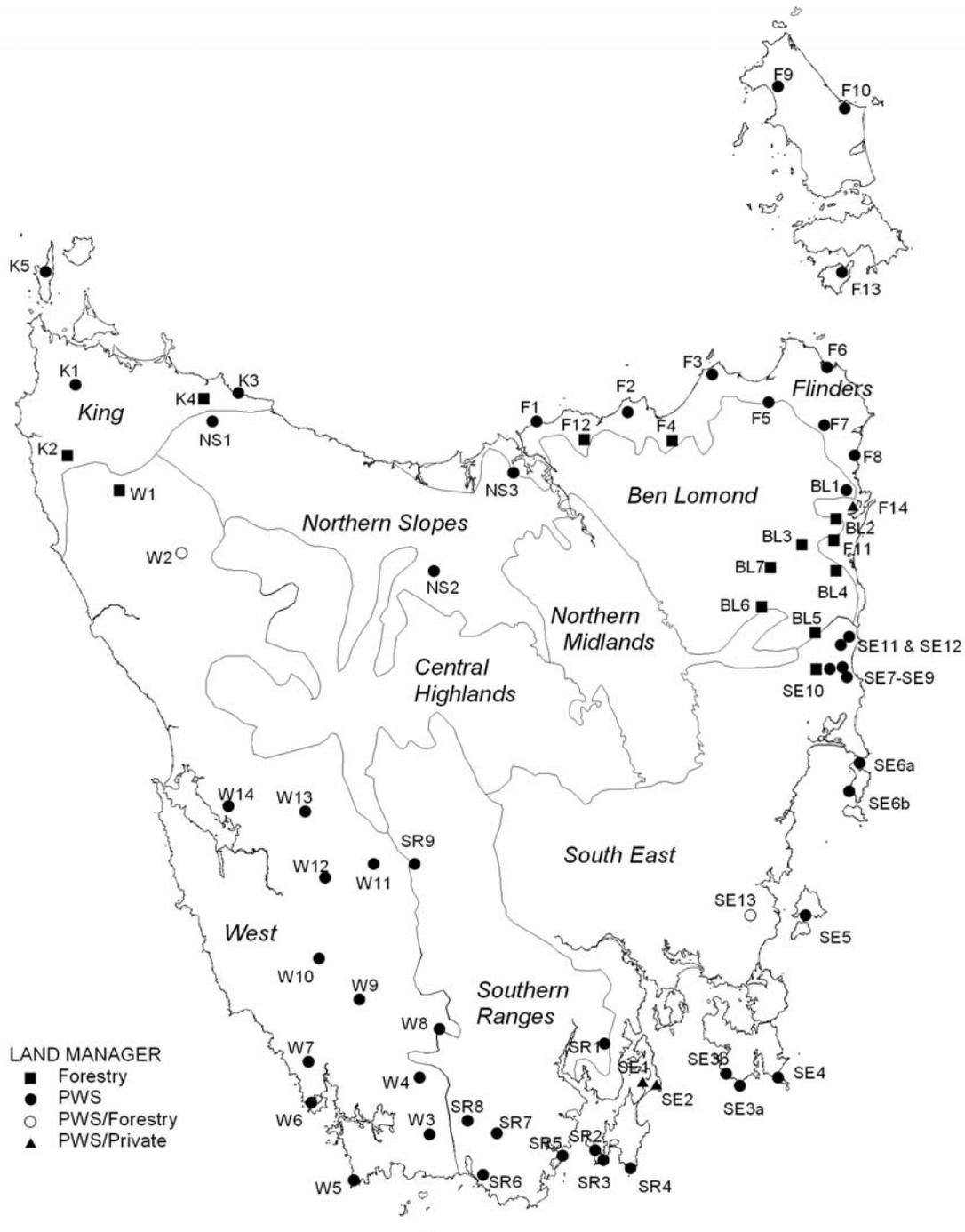


FIGURE 4. *Phytophthora cinnamomi* Management Areas by Tenure (overlain on the nine IBRA bioregions)

TABLE 4. Operational responsibility for the proposed *P. cinnamomi* management areas

Parks & Wildlife Service Management District	
North West	K1, K3, K5, NS1, W2 (jointly with FT)
Central North	NS2 & NS3, F1
North East	F2, F3, F5-F10, F13, FE14, BL1, SE6-SE9, SE11 & SE12
South	SE1 & SE2 (both with private land owners), SE3a, SE3b, SE4, SE5, SE13 (jointly with FT), SR1-SR8, W3, W5, W6
Central South	SR9, W4, W7-W12
Western	W13, W14
Forestry Tasmania District	
Murchison	K2, K4, W1, W2 (jointly with PWS)
Bass	F4, F11, F12, BL2, BL3, BL4, BL5, BL6, BL7
Derwent	SE10, SE13 (jointly with PWS)
Private	
North East	F14, SE1 & SE2 (all jointly with PWS)

A number of the management areas proposed in this study correspond to those nominated by Barker (1994) for the protection of rare species that are susceptible to *P. cinnamomi*, and as such have existing management recommendations (which may or may not have been adopted). Part of this study included a reassessment of Barker's areas and the efficacy of his proposed management prescriptions. The proposed areas that fall into this category are indicated in the summary of areas tabulated in Appendix 3.

Three of the proposed areas have detailed *P. cinnamomi* management prescriptions either in place or in development as part of specific recovery plans.

NS3	Dans Hill	<i>Tetratheca gunnii</i> and <i>Epacris virgata</i> Recovery Plans (Potts and Barker, 1999; Keith, 1998)
F14	Georges River	<i>Phebalium daviesii</i> Recovery Plan (Lynch and Appleby, 1996)
SR5	Southport	<i>Epacris stuartii</i> Recovery Plan (Keith and Ilowski, 1999)

In addition, a number of areas that occur within the existing reserve system are subject to generic *P. cinnamomi* hygiene prescriptions, with some additional specific actions recommended.

F3	Waterhouse	PWS Management Plan (PWS, 2000a)
F9	Wingaroo	PWS Management Plan (PWS, 2000b)
SE3	Cape Raoul	PWS Management Plan (PWS, 2001)
SE4	Cape Pillar	PWS Management Plan (PWS, 2001)
SE5	Maria Island	PWS Management Plan (PWS, 1998b)
SE8	Blindburn Creek	Douglas-Apsley Fire Management Plan (PWS, 1998a)
SE9	Doug-Apsley	Douglas-Apsley Fire Management Plan (PWS, 1998a)
SE11	Nichols Cap	Douglas-Apsley Fire Management Plan (PWS, 1998a)

5.1 Management Areas outside the World Heritage Area

(1) King Bioregion (K)

K1: Seventeen Mile Plain. This area was purchased by the RFA Private Land Reserve Programme in late 2000, the principal target community being *Eucalyptus brookeriana* forest. Extensive areas of moorland, heathy moorland and dry *E. nitida* woodland occur in the southern parts of the reserve. Access to the reserve is gained via Buckbys Road through private property owned by Gunns Limited, with a lockable boom gate close to the settlement of West Montagu. An unknown *Phytophthora* species was isolated from a number of soil samples taken from the area in November 2000 and July 2001. The impact on the vegetation appeared to be minimal, with *Sprengelia incarnata* the only species obviously affected.

Land Manager: PWS

Tenure: (proposed) Nature Reserve

Manageability: high

PC Status: uncertain symptoms at several points in the southern and central areas of the reserve

Recommendations: An additional boom gate should be placed at the boundary of the reserve to safeguard the area's considerable values. Monitoring by Nature Conservation Branch (DPIWE).

K2: Arthur-Frankland 'wedge'. This area of State Forest has excellent natural protection in the form of the Arthur and Frankland Rivers, with the southern boundary being buffered from disturbing activities by wet forest. The area supports extensive areas of heathy moorland ('Northwestern Dense' with *Epacris curtisiae*, *Philothea virgata* and *Monotoca submutica*) and dry *E. nitida* forest. *Phytophthora cinnamomi* was recorded from the old access track to the south of the proposed management area, but does not appear to have spread to the heart of the area.

Land Manager: Forestry Tasmania

Tenure: State Forest

Manageability: high

PC Status: no field symptoms within proposed area, positive isolation to south along access track

Recommendations: The risk of introducing *P. cinnamomi* in developing access to commercial forests in the Management Area needs to be considered.

K3: Rocky Cape (Two Sisters). The eastern end of the Rocky Cape National Park supports extensive areas of *Banksia serrata* woodland and dry *E. nitida* forest. A number of PC infestations are known from the area, though the northeastern section is in relatively good condition compared to the ravaged western part of the park. A popular walking track traverses the area from Irbys Flats in the northwest to Irbys Road in the southeast.

Land Manager: PWS

Tenure: National Park

Manageability: low

PC Status: positive isolations from several points

Recommendations: It is recommended that interpretative signs be placed at either end of the walking track, and that *P. cinnamomi* pamphlets be circulated to the local community. The local community should be encouraged to monitor the PC status of the area through Wildcare's 'Adopt-a-Track' program.

K4: Shakespeare Hills. Part of the Shakespeare Hills Forest Reserve, this area supports important stands of *Banksia serrata* woodland (with grass trees prominent), with heathy moorland and dry *E. nitida* forest. The area is heavily tracked, with an ongoing high recreational vehicle use. *Phytophthora cinnamomi* infestations are known at a number of points along tracks in the north, with some particularly dramatic examples of the down-slope spread of PC. However, the steeply dissected nature of the landscape means that some uninfested areas remote from existing tracks do have a chance of remaining so into the medium term, providing recreational vehicles stay on the formed tracks.

Land Manager: Forestry Tasmania

Tenure: Forest Reserve

Manageability: low-moderate

PC Status: positive symptoms in north

Recommendations: Review access tracks, recreational vehicle use and fire management prescriptions.

K5: Hunter Island. Extensive areas of coastal heath are known from the eastern side of Hunter Island, comprising almost 40% of the island (Kirkpatrick, 1977; Harris and Lazarus, 2002). The island is currently a Conservation Area, though a grazing lease does apply to the greater proportion of the island (indeed, grazing of the island began in the 1850s). The first positive *P. cinnamomi* soil isolation was recorded from Hunter Island in June 2002. The age of the first infection on Hunter Island has considerable implications for future *P. cinnamomi* management: an early introduction would suggest that *P. cinnamomi* has had ample time to be spread through the susceptible heath communities, whereas a more recent introduction provides a greater opportunity for management. More extensive *P. cinnamomi* surveys are required to address this issue. It is anticipated that a management plan for the Fleurieu Group of islands (Hunter/Three Hummock/Walker/Robbins/Perkins) will be developed along the same lines as that for the 'Small Bass Strait Island Reserves' (Parks and Wildlife Service 2000c; McCuiag, pers. comm.). Management prescriptions for Hunter Island need to be developed in close consultation with the current lessee, with prescriptions in place to adequately manage the key issues of cattle grazing, fire management and *P. cinnamomi*.

Land Manager: PWS

Tenure: Conservation Area (with grazing lease over the greater proportion of the island)

Manageability: low-moderate

PC Status: infestation in central east of island – scattered infestations likely elsewhere

Recommendations: specific hygiene prescriptions for Hunter Island should be developed as part of a wider management plan for the Fleurieu Group of islands. The lease conditions for Hunter Island should be modified through consultation with the present lessee; if the grazing lease should be renewed it is recommended that cattle be restricted to the exotic grasslands occupying the central western part of the island. Additional surveys for *P. cinnamomi* are required.

(2) Northern Slopes Bioregion (NS)

NS1: Dip Range. Part of the Dip Range Conservation Area, the proposed area supports moorland, heathy moorland and dry *E. nitida* forest, with outlying occurrences of the highly susceptible *Agastachys odorata*. Parts of the area appear to have suffered from infection in the past but there are still extensive areas of diverse susceptible vegetation. There is vehicular access to the area from Newhaven Road in the northwest – this track traverses the low-lying western section of the proposed management area.

Land Manager: PWS

Tenure: Conservation Area

Manageability: low-moderate

PC Status: positive isolation to immediate north, probable scattered old infestations through range

Recommendations: A sign warning of the PC risk should be installed on the track leading into the area from the northwest; recreational vehicle users should be advised to remain on formed tracks.

NS2: Gog Range. Partly within the Alum Cliffs State Reserve and partly within the Gog Range Regional Reserve, this proposed management area supports an unusual suite of communities, including damp heaths dominated by *Melaleuca squamea*, Coastal Amygdalina on Ordovician sediments (up to an altitude of 700 m), patches of almost pure buttongrass along the main ridgeline, and a large population of the endangered *Epacris exserta*. The Mersey River and the rugged nature of the Gog Range provide excellent natural protection for the area, the southeastern sector in particular being rarely visited. At present, access to the ridgeline can be gained via a Forestry 4WD track in the northwest just off the Union Bridge Road – the track continues eastwards along the Gog Range ridgeline past Granta Ponds to at least 450000E, with a flagged route continuing along the ridgeline. There has been some recent mineral exploration at the western end of the range, including the western end of the proposed management area.

Land Manager: PWS

Tenure: State Reserve & Regional Reserve

Manageability: moderate-high

PC Status: free of field symptoms (positive isolation along Gog Road to the north of the ridgeline)

Recommendations: There should be no further track development along the ridgeline. A gate should be placed at the western end of the track at c. 447000E to prevent unhindered access by 4WD vehicles.

NS3: Dans Hill. This area coincides with Phil Barker's M6 S1 management area, and is notable for the presence of two endemic species that are restricted to serpentinite substrates, viz., *Tetratheca gunnii* and *Epacris virgata*. The area supports two facies of the mappable unit Coastal E. Amygdalina forest, *E. amygdalina* on Quaternary alluvium and *E. amygdalina* on serpentinite, the latter being of extremely high state significance. *Phytophthora cinnamomi* has been isolated from the area, though its expression on serpentinite appears to be muted (with positive isolations from areas free of visible symptoms). The status of the area has been the subject of recent negotiations between PWS and Forestry Tasmania, with the ongoing development of management prescriptions by personnel from the Threatened Species Unit (Black, 2002).

Land Manager: PWS

Tenure: Conservation Area (proposed)

Manageability: low

PC Status: positive isolations and symptoms from several points

Recommendations: The detailed management prescriptions being developed for the area by the Threatened Species Unit should be adopted.

(3) Flinders Bioregion (F)

F1: Five Mile Bluff. This area is presently unallocated crown land, with 'landfalls' for Duke Energy and Basslink anticipated in the near future to the immediate east and west. The area supports a diverse – albeit small – patch of wind-pruned coastal heath, buffered in the main from disturbances on adjoining private properties by

dense coastal scrub. Characteristic species include *Pultenaea tenuifolia*, *Acacia verticillata* var. *ovoidea* and *Pomaderris apetala* var. *maritima*, while grass trees are also present. Cattle have had recent access to the heath from the property to the west, while a semi-permanent open 'shack' has been set up in the lee of the Bluff.

Land Manager: PWS

Tenure: Unallocated Crown Land

Manageability: moderate

PC Status: free of field symptoms; positive isolations from private property to south

Recommendations: It is recommended that the area become a Nature Reserve to better reflect the values present. Negotiations with the landowner to the west should address the issue of wandering livestock; fencing of the boundary to the coastline should also be considered.

F2: Single Tree Plain (Bridport). Unallocated crown land, again deserving a higher 'status' in recognition of its flora values. Susceptible communities in the eastern part of the proposed area include Coastal E. Amygdalina forest and coastal heath. The symptoms of *P. cinnamomi* are widespread on private property to the east (Bridwood), with isolated occurrences within the proposed management area. The topography is not particularly helpful in terms of *P. cinnamomi* management, being relatively low and undulating (similar to the Waterhouse Conservation Area). However, the area does support reasonable patches of uninfested vegetation, and as such has significance at the regional level. The western sector is characterised by large active sand dunes, a seeming magnet for 'recreational' drivers; access is gained from either the southwest across private property, from private property to the east, or via the beach (via Bridport).

Land Manager: PWS

Tenure: Unallocated Crown Land

Manageability: low

PC Status: scattered positive symptoms

Recommendations: It is recommended that the area become a Conservation Area to better reflect the values present. Negotiations with adjoining landowners should address the question of access.

F3: Waterhouse. Barker's M16 S2 management area, part of the Waterhouse Conservation Area. Kirkpatrick (1977) identified the Waterhouse Point area as being the most highly urgent reservation priority for heathlands in Tasmania, and asserted that '*Phytophthora cinnamomi* is not known from the area'. Unfortunately, reservation does not equate to protection in terms of *P. cinnamomi*, and numerous roadside infestations were observed at the time of Barker's survey in 1994. Surveys during the present project have revealed that the poorly drained southeastern sector is also heavily infested. As noted by Barker (1994), the gently undulating nature of the terrain is unlikely to inhibit the further spread of *P. cinnamomi*. However, the area still supports excellent examples of coastal heath, wet heath and Coastal E. Amygdalina forest, including five listed species (*Hibbertia virgata*, *Pultenaea paleacea* var. *sericea*, *Styliidium perpusillum*, *Xanthorrhoea arenaria* and *Xanthorrhoea bracteata*). Despite its low manageability the area has been selected because of its high regional significance.

Land Manager: PWS

Tenure: Conservation Area

Manageability: very low

PC Status: positive isolations and symptoms from numerous points

Recommendations: The recommendations for *P. cinnamomi* management outlined in the draft Waterhouse Conservation Area Management plan (PWS, May 2000a) should be adopted, with some adjustments to the recommended zoning. That area to the west of Homestead Road (between Croppies Rd and South Croppies Rd) should be classified as a 'natural zone' rather than a 'recreational zone' in recognition of the area's high flora and fauna values.

F4: Badger Hill. Barker's M9 S2 management area, State Forest to the east of the Bridport Road. Classified as a Forest Health Special Management Zone, this area supports Coastal E. Amygdalina forest forest/woodland with *Xanthorrhoea bracteata* locally prominent. The area is heavily tracked and is now infested with *P. cinnamomi*.

Land Manager: Forestry Tasmania

Tenure: State Forest

Manageability: low

PC Status: positive symptoms in centre of area

Recommendations: Review access for recreational and management purposes. Develop actions to minimise illegal firewood cutting.

F5: Little Boobyalla (also partly within the Ben Lomond bioregion). Barker's M16 S1 management area, now the Little Boobyalla Conservation Area. No field symptoms were recorded in 1994; surveys in 2000-2001 revealed a number of old infestations within the reserve, along with positive symptoms at several points to the south along the Old Port Road. However, the area still supports good examples of Coastal E. Amygdalina forest, wet heath, and small patches of heathy moorland (with *Xanthorrhoea bracteata*). Firewood cutting and recreational driving represent the greatest dangers to the integrity of the management area, though access to the southeastern sector is (at present) restricted due to the condition of the bridge across the Little Boobyalla River. Access from the west across the Boobyalla River from the Banca Road is still possible to the more adventurous 4WD'er.

Land Manager: PWS

Tenure: Conservation Area

Manageability: low

PC Status: scattered positive isolations and symptoms

Recommendations: Vehicle movements in the area should be restricted to dry conditions only; there should be no further tracks developed, and access from the west should be curtailed if possible.

F6: Musselroe Bay. Part of the Musselroe Bay Conservation Area, this area contains extensive areas of coastal heath, with small patches of heath on granite, heathy moorland and sedgey heath (with *Xanthorrhoea bracteata/arenaria* prominent). The area has a long history of disturbance and is heavily tracked to the south of Musselroe Lagoon. *Phytophthora cinnamomi* symptoms were noted at several points in the proposed management area.

Land Manager: PWS

Tenure: Conservation Area

Manageability: very low

PC Status: scattered positive isolations and symptoms

Recommendations: Further track development should be avoided. The area provides a good opportunity to monitor the development of *P. cinnamomi* in coastal heath (Nature Conservation Branch, DPIWE).

F7: Mt William extension (also Ben Lomond bioregion). This area was added to the Mt William National Park in 1998. It supports extensive areas of Coastal E. Amygdalina forest, with patches of wet heath, (heathy) moorland, dry Obliqua and sedgey heath. Symptoms of *P. cinnamomi* were recorded from several points along the 4WD tracks in the area, and frequent firing of the Eucalypt-dominated communities has simplified the composition of the heathy understorey in most areas. Pockets of susceptible vegetation do remain, however, and at a regional scale the area remains significant. Again, firewood cutting and recreational vehicles are ongoing management issues. Access to the area has been effectively controlled at two points (Boggy Creek and the Musselroe River), but a boom gate installed by Forestry Tasmania in the south has failed to stem the flow of 4WD vehicles.

Land Manager: PWS

Tenure: Conservation Area

Manageability: low

PC Status: scattered positive isolations and symptoms

Recommendations: Users of the area should be encouraged to collect firewood from other areas; there should be no further track development into the heart of the proposed management area.

F8: The Gardens. Part of the Bay of Fires Conservation Area, this area supports coastal heath, wet heath and Coastal E. Amygdalina forest (forest and woodland). The vulnerable *Conospermum hookeri* occurs in the area. The area is buffered from disturbance by private property to the north and south, and generally dense scrub to the west (though recent forestry activities to the west have reduced the scrub/forest buffer). A well-formed 4WD track runs through the area from south to north, which is currently used by neighbouring landowners to move stock through the area.

Land Manager: PWS

Tenure: Conservation Area

Manageability: moderate

PC Status: scattered positive isolations and symptoms

Recommendations: Public vehicular access to this area should continue to be restricted and permission to move stock through the area should be reviewed

F9: Wingaroo. This area corresponds to the southerly 'Special Flora Management Area' identified in the Wingaroo Nature Reserve Management Plan (PWS, 2000b), specifically for the protection of the threatened species *Banksia serrata* and *Isopogon ceratophyllus*. The area supports coastal heath, Flinders Island scrub,

Furneaux *E. nitida* forest, and the only *Banksia serrata* woodland in the Furneaux Group. Fieldwork in December 2000 confirmed the 'clean' status of the area, though infestations are known from earlier sampling in the west, north and east.

Land Manager: PWS

Tenure: Nature Reserve

Manageability: moderate

PC Status: positive symptoms in the east and northwest

Recommendations: The policies and actions recommended in the Wingaroo NR Management Plan should be adopted, viz.,

- public access within this area to be restricted.
- scientific research in the area to be subject to strict quarantine procedures to prevent the introduction of *P. cinnamomi* into the area.
- no new vehicle or walking tracks to be constructed in the area.
- existing tracks within the area to be closed, except for those required for management purposes.

F10: Northern Patriarchs. This area occurs within a proposed Conservation Area and is centred on the massive Northern Patriarchs granite tor, with Holocene sediments on the slopes below. Plant communities include Flinders Island scrub, Furneaux *E. nitida* forest, heath on granite and coastal heath. The upper slopes support good stands of the vulnerable *Isopogon ceratophyllus*. *Phytophthora cinnamomi* is known from the 4WD tracks to the north and west. The area is at risk of *P. cinnamomi* being spread to 'clean' areas by bushwalkers and feral pigs, though the thick dry scrubs on the middle slopes would tend to deter the former.

Land Manager: PWS

Tenure: Conservation Area (proposed)

Manageability: low-moderate

PC Status: scattered positive symptoms to the north and south

Recommendations: There should be no new track development in the area. Eco-tour operators should be advised of the importance of the area in terms of *P. cinnamomi* management, and should be provided with *P. cinnamomi* educational material for distribution. PC pamphlets should also be made available at Whitemark airport, the local council offices and the Service Tasmania outlet.

F11: Loila Tier. This section of State Forest corresponds to Phil Barker's M19 S4 management area, designed to provide protection for the vulnerable *Hibbertia calycina* (Hopkins, 1995). The area contains extensive tracts of *E. sieberi* on Mathinna sediments. Barker (1994) indicated that a more remote management area would be desirable given the extent of roading and proposed logging coupes. However, Loila Tier was recognised by Hopkins (1995) as one of three outstanding meta-populations in Tasmania's northeast (along with German Town and Mt Echo).

Land Manager: Forestry Tasmania

Tenure: State Forest

Manageability: low-moderate

PC Status: no field symptoms within the proposed area, but positive isolations are known from the eastern Creek Rd to the northeast and southeast, and Wolfram Creek Rd to the northwest.

Recommendations: Review access control in the Management Area. The risk of introducing *P. cinnamomi* needs to be taken into consideration in planning any new roading and harvesting.

F12: Lefroy. Part of the Lefroy Forest Reserve, this area corresponds to Phil Barker's M9 S5 management area, designed to provide protection for the vulnerable *Pultenaea hibbertioides*. The area supports Coastal E. Amygdalina forest (forest and woodland on Ordovician sediments) and dry *E. obliqua* forest. Barker (1996) established two long-term monitoring plots in the centre of the area in 1995, noting that the site was infected with *P. cinnamomi*, though also noting that 'the activity of the pathogen appears to be very low with only occasional and scattered symptoms.' The area is heavily tracked and continues to suffer from unchecked firewood cutting, with unhindered access along the area's western boundary (= Back Creek Rd).

Land Manager: Forestry Tasmania

Tenure: Forest Reserve

Manageability: low-moderate

PC Status: positive isolation from centre of area

Recommendations: Review public vehicle access. Review conditions of access for management.

F13: Clarke Island. The area proposed for management corresponds to the Clarke Island Nature Reserve, and has long been recognised for its high nature conservation values (Kirkpatrick, 1977; Harris and Reimer, 1994). The area supports an array of heath communities (Kirkpatrick, 1977), with the following susceptible listed

species: *Hakea ulicina*, *Isopogon ceratophyllus* and *Leucopogon esquamatus*. The island has a long history of burning and cattle grazing, but symptoms consistent with *P. cinnamomi* were not observed until 1994 (Harris and Reimer, 1994). The present extent of *P. cinnamomi* within the nature reserve is unknown.

Land Manager: PWS

Tenure: Nature Reserve

Manageability: low-moderate

PC Status: positive symptoms recorded in January 1994

Recommendations: management recommendations are dependent on the results of more comprehensive *P. cinnamomi* surveys. Some track rationalisation is likely.

F14: Georges River. This area corresponds with the management area M19 S1 (Barker, 1996). It contains all but two plants of the total population of the nationally endangered *Phebalium daviesii* as well as *ex-situ* plantings of this species. The management area also contains a population of *Hovea corrickiae*. The management area is among the highest priority plant conservation sites in the State. Though there is little capacity to manage the threat of *P. cinnamomi* introduction from upstream, the absence of disease to date suggests this risk is not high.

Land Manager: private land and PWS

Tenure: Private land and river reserve

Manageability: low-moderate

PC Status: no symptoms present in 2002

Recommendations: Landholder agreements are in place for the majority of the area to prevent the direct introduction of *P. cinnamomi* and these need to be maintained and expanded to cover the rest of the immediate catchment. Management actions include avoiding high-risk activities, applying hygiene to any machinery accessing the area and monitoring annually for disease.

(4) Ben Lomond Bioregion (BL)

BL1: Mt Pearson (also partly within the Flinders bioregion). This area lies within the recently proclaimed Mt Pearson State Reserve. Susceptible communities include Coastal E. Amygdalina forest, *Sieberi* on sediments (Mathinna), *Sieberi* on granite, wet heath and heathy moorland (western sector). The *E. sieberi* forests in much of the northeast have been the subject of repeated firing (Neyland and Askey-Doran, 1996), the result being a sparse depauperate understorey that favours further disturbance caused by recreational vehicles and illegal wood cutting. The Mt Pearson region is no exception, with the areas east of Mt Pearson in particular the subject of heavy past and ongoing disturbance (firewood cutting & trail-bike riding). Infestations of *P. cinnamomi* are known from a number of points. Recreational activities such as orienteering and horse riding also pose a threat to uninfected areas of the reserve.

Land Manager: PWS

Tenure: State Reserve

Manageability: low-moderate

PC Status: positive symptoms and isolations from the eastern sector of the reserve.

Recommendations: Recreational users should be encouraged to confine their activities to the eastern part of the reserve. Tracks leading into the western part of the reserve need to be rationalised, while access along the southern boundary needs to be tightened.

BL2: Mt Echo (also partly within the Flinders bioregion). This area of State Forest corresponds to Phil Barker's M19 S3 management area, designed to provide protection for the vulnerable *Hibbertia calycina*. The area contains a good example of *E. sieberi* on Mathinna sediments (with *Xanthorrhoea australis* prominent). *Phytophthora cinnamomi* has been known for some time from the east of the area below the *H. calycina* population. Indeed, Barker (1994) recommended that the road to the summit of Mt Echo be closed. This has yet to be done – as at March 2001 – and remains a priority action. Firewood cutting and trail-bike riding are ongoing issues in the region, with users apparently being directed to this area since the proclamation of the Mt Pearson area as a State Reserve. Unfortunately, the open nature of the vegetation makes the enforcement of any vehicular restrictions extremely difficult, a factor common to many of the proposed management areas in the northeast of the state.

Land Manager: Forestry Tasmania

Tenure: State Forest

Manageability: low

PC Status: isolations and symptoms from eastern part of management zone.

Recommendations: Review public access to manage illegal firewood cutting and recreational vehicle use. Review conditions of access for management.

BL3: Avenue River. Part of the Avenue River Forest Reserve, the proposed management area supports Coastal *E. Amygdalina* forest and *Sieberi* on sediments (both on Mathinna). The understorey in these forests tends to be relatively species-poor, with a sparse medium shrub layer (*Acacia terminalis/Banksia marginata*) over a small shrub layer typically dominated by bracken (with occasional *Pultenaea gunnii*, *Leptospermum scoparium*, *Aotus ericoides*, *Epacris impressa* and *Hibbertia procumbens*). A 4WD track runs through the western part of the reserve – countering this is the relative remoteness of the area.

Land Manager: Forestry Tasmania

Tenure: Forest Reserve

Manageability: moderate

PC Status: no symptoms

Recommendations: Review public access to manage illegal firewood cutting and recreational vehicle use. Review conditions of access for management.

BL4: German Town (also partly within the Flinders bioregion). This area encompasses Phil Barker's M18 S18 management area, targeting *Hovea corrickiae* and *Prostanthera rotundifolia* (a resistant host). The area also supports a good-sized population of the vulnerable *Hibbertia calycina* (Hopkins, 1995), and is now largely within the recently proclaimed German Town Forest Reserve. Plant communities include *E. sieberi* on Mathinna sediments.

Land Manager: Forestry Tasmania

Tenure: Forest Reserve and State Forest

Manageability: moderate

PC Status: no symptoms

Recommendation: Control public access to fire trails. Review conditions of access for management.

BL5: Dukes Marsh. Phil Barker's M18 S1 management area, targeting *Epacris exserta* and *Boronia pilosa* var. *laricifolia* (and the endangered but resistant *Pultenaea selaginoides*). The area supports predominantly dry *E. delegatensis* forest with only small areas of susceptible wet heath and *E. amygdalina* forest on dolerite. The altitude of the 'marshes' is c. 500 m, which may serve to limit the impact of *P. cinnamomi*.

Land Manager: Forestry Tasmania

Tenure: State Forest

Manageability: low

PC Status: no symptoms

Recommendations: Review boundaries of MDC Protection Zones. Ensure appropriate hygiene prescriptions are used with any harvesting operations. Review road drainage into the management area.

BL6: Pepper Hill (Mangana). Phil Barker's M14 S9 management area, targeting the rare *Bossiaea obcordata*. The northern part of the area supports dry *E. sieberi* forest on Mathinna sediments, with patches of *Bossiaea obcordata* occurring on steep upper slopes with a northwesterly aspect. The *E. sieberi* forests are generally depauperate at ground level, though there are a few patches with a relatively diverse heathy understorey (with species like *Aotus ericoides*, *Leucopogon ericoides*, *Epacris impressa*, *Tetratheca labillardierei*, *Oxylobium ellipticum* and *Acacia terminalis*). A track off the Rossarden Rd gives unhindered access to the more southerly parts of the reserve, though the position of the *Bossiaea obcordata* populations high in the landscape provides some natural protection from the spread of *P. cinnamomi*.

Land Manager: Forestry Tasmania

Tenure: Forest Reserve

Manageability: moderate

PC Status: no symptoms

Recommendations: Review potential to control 4WD access from the Rossarden Rd and illegal firewood cutting.

BL7: Golden Gate Rd (Mathinna). Phil Barker's M14 S7 management area, targeting the largest known population of *Bossiaea obcordata* in Tasmania (Lynch, 1993). The area supports dry *E. sieberi* forest on Mathinna sediments, with a largely depauperate understorey resulting from a frequent fire regime. The *Bossiaea* population occurs on steep slopes with a northwesterly aspect. As noted by Barker (1994), a gravel road passes above part of the *Bossiaea* population. Drainage from this road was identified as being a risk to the population. Firewood cutting is a continuing issue, with uninhibited access from Tower Hill Rd.

Land Manager: Forestry Tasmania

Tenure: State Forest

Manageability: low

PC Status: no symptoms

Recommendations: Ensure any harvesting operations within the management area are done using appropriate hygiene prescriptions. Review options for managing firewood cutting and recreational vehicle use. Review options for diverting road drainage away from *B. obcordata* populations.

(5) South East Bioregion (SE)

SE1: Chuckle Head (Bruny Island). This management area contains good examples of Coastal E. Amygdalina forest (forest and woodland) and Inland Tenuiramis. The boundaries of the area were selected to encompass the entire Chuckle Head catchment, and necessarily include private property to the immediate southeast of the Chuckle Head Conservation Area. The integrity of the area depends heavily on the willingness of the property owner to monitor the movement of machinery and animals from the Bruny Main Rd (especially during wet conditions). Negotiations between the PWS and the landowner are imperative.

Land Manager: PWS & private landowner

Tenure: Conservation Area & private

Manageability: moderate

PC Status: no symptoms in management area

Recommendations: PWS to develop a voluntary management agreement with the owner of the land abutting the Chuckle Head Conservation Area, stressing the importance of vehicle hygiene.

SE2: Church Hill (Bruny Island). The bulk of the proposed area is within the Bruny Neck Game Reserve, with a small section in the north on private property. The area supports excellent examples of the following communities: Coastal E. Amygdalina forest, Inland Tenuiramis, coastal heath, wet heath, Obliqua woodland and small patches of heathy moorland. The core of the area is a large basin, with north-south aligned mudstone ridges to the east and west. The siting of 4WD tracks along the ridges above the most susceptible communities poses a considerable threat to their integrity. The Rookery Track has traditionally provided access to the rookeries on the western side of Cape Queen Elizabeth; a gate is sited close to the boundary with private property to the north.

Land Manager: PWS & private landowner

Tenure: Game Reserve & private

Manageability: low

PC Status: infestations of *P. cinnamomi* occur just to the north of Church Hill and along the walking track to the immediate west of the proposed area.

Recommendations: management prescriptions should be developed in conjunction with the landowner and the traditional users of the area. Recommendations might include the following: (1) gating of the Church Hill track at the boundary with private property to the north; (2) installation of a PC interpretation panel at the start of the Cape Queen Elizabeth at the Bruny Island Main Road warning of the spread of *P. cinnamomi* to other areas on the island; (3) restrictions on vehicle use in wet conditions; (4) PWS monitoring.

SE3a: Cape Raoul – Shipstern Bluff. This area is within the Tasman National Park and supports coastal heath, Coastal E. Amygdalina forest, and *E. tenuiramis* on dolerite. As noted by Barker (1994) the area has a high level of use by bushwalkers and the installation of interpretative signs was recommended. Unfortunately, inappropriate walking track developments in the Tunnel Bay - Curio Bay area have compromised the western section of the management area, with *P. cinnamomi* established in at least two points in the Tunnel Bay area. In consequence, Barker's original management area has been divided into eastern and western sections: the core uninfested area centred on Cape Raoul and Shipstern Bluff, and an infested area to the west of Tunnel Bay (see SE3b).

Land Manager: PWS

Tenure: National Park

Manageability: medium

PC Status: positive isolations in the Tunnel Bay area

Recommendations: There should be no new track development in the proposed management area. The walking track in the vicinity of the *P. cinnamomi* infestation at Tunnel Bay should be hardened to reduce the risk of *P. cinnamomi* being spread to the sensitive Shipstern Bluff heaths. In addition, a washdown station should be installed close to the junction of the Cape Raoul and Shipstern Bluff walking tracks, with an associated warning sign to potential users. DPIWE personnel should continue annual inspections of all walking tracks.

SE3b: Tunnel Bay – Curio Bay. This area abuts the proposed SE3a management area, lying to its immediate west. Susceptible communities include coastal heath and *E. tenuiramis* on dolerite.

Land Manager: PWS

Tenure: National Park

Manageability: low

PC Status: positive isolations in the Tunnel Bay area

Recommendations: There should be no new track development in the proposed management area. The walking track on the infested southeasterly slopes to the immediate west of Tunnel Bay should be rerouted, with hardening of tracks in vulnerable areas.

SE4: Cape Pillar & Tasman Island. This section of the Tasman National Park supports coastal heath, wet heath, *E. tenuiramis* on dolerite, and heathy moorland. The highly susceptible heathy moorlands are limited to poorly drained areas to the north of Tornado Ridge. *Phytophthora cinnamomi* is known from the Cape Pillar, Cape Haug and Arthurs Peak (Budget Head) walking tracks, and also occurs extensively in the heathy moorlands at Tunah Plains (Tim Rudman, pers. comm.). A washdown station at Lunchtime Creek was established in the mid 1990s to protect the susceptible endemics *Allocasuarina crassa*, *Epacris marginata* and *Epacris myrtifolia* (Barker, 1994; Schahinger, 2002). Despite suspicions of *P. cinnamomi* in the Hurricane Heath area, extensive soil sampling during this project has returned only negative results.

Land Manager: PWS

Tenure: National Park

Manageability: medium

PC Status: scattered infestations along existing walking tracks in the area's north

Recommendations: There should be no new tracks in the area, while any bedding material for existing tracks should be from certifiably 'clean' sources. The washdown station at Lunchtime Creek should be maintained. Walkers should be advised at the registration booth on the Cape Pillar walking track to stay on the tracks to ensure the heathy moorlands between Crescent Mount and Tornado Ridge remain free of the pathogen. The area beyond Lunchtime Creek should continue to be monitored annually for signs of *P. cinnamomi* by personnel from the Nature Conservation Branch of DPIWE.

SE5: Maria Island. Fieldwork in October 2000 confirmed the 'clean' status of the island. Communities include coastal heath, heath on granite, wet heath, Coastal *E. amygdalina* and heathy *E. obliqua* woodland/forest. The granite-based heaths on the Island's east coast proved to be disappointingly depauperate, with fewer than a dozen species in total. The island does, however, support populations of the susceptible endemics *Epacris marginata* and *Epacris myrtifolia*.

Land Manager: PWS

Tenure: National Park

Manageability: high

PC Status: no symptoms

Recommendations: The current management conditions relating to *P. cinnamomi* hygiene outlined in the Maria Island Management Plan (PWS, 1998b) should be maintained. Monitoring by PWS. An ecological burning programme should be developed and implemented to ensure the perpetuation of the heath communities.



SE6a: Eastern Hazards (Freycinet National Park). This spectacular area supports the following plant communities: heath on granite, *E. tenuiramis* on granite, Coastal *E. amygdalina* and small pockets of heathy moorland. A walking route traversing the Hazards starts at Sleepy Bay. Surveys in August and November 2001 revealed scattered *P. cinnamomi* infestations in the western part of the Hazards (around Mt Mayson), with isolated infestations in the east atop both Mt Dove and Mt Baudin (as well as the southeastern flanks of Mt Amos). The slabby nature of the Hazards gives at least medium-term protection to species under more

immediate pressure from *P. cinnamomi* in other parts of the park, in particular the nationally endangered *Epacris barbata*.

Land Manager: PWS

Tenure: National Park

Manageability: low-moderate

PC Status: isolated infestations

Recommendations: Potential walkers, school groups for example, should be informed of the risk of spreading *P. cinnamomi*. It is recommended that a 'dry' washdown station be installed at the Sleepy Bay end of the traverse, together with an explanatory sign. Monitoring by PWS. [A *P. cinnamomi* interpretation panel is to be installed along the Fisheries Track to the immediate west of the main Freycinet trackhead.]

SE6b: Cooks – Bryan Beaches (Freycinet National Park). This management area lies to the west of the popular walking track that links Cooks Beach and Bryan Beach at the southwestern extremity of the Freycinet Peninsula. The area supports heathy *E. amygdalina* woodland/forest (on wind-blown sands over dolerite; = Coastal *E. Amygdalina* forest), with extensive patches of the rare shrub *Thryptomene micrantha*. Walker incursions to this area are thought to be low, and the buffering effect of the beaches to the area's north and south afford the area some protection from infection by *P. cinnamomi*. Natural topographic protection is provided by the low ridgeline to the immediate west of the walking track.

Land Manager: PWS

Tenure: National Park

Manageability: moderate

PC Status: free of symptoms

Recommendations: The area should be incorporated within the Freycinet National Park Management Plan as a special management zone. Appropriate hygiene precautions should be taken before entering the area. There should be no further track development in the area, while any bedding material required for the Cooks Beach – Bryans Beach walking track should be from sources free of *P. cinnamomi*. Eco-tour operators should be advised of the importance of the area and provided with appropriate educational material.

SE7: Apslawn. Phil Barker's M18 S6 management area, designed to protect the largest known population of the nationally endangered shrub *Epacris apsleyensis*. The area is part of the newly proclaimed Apslawn Conservation Area and supports the following plant communities: *Amygdalina* on dolerite (with *Xanthorrhoea australis*) and heathy *Ovata* woodland.

Land Manager: PWS

Tenure: Conservation Area

Manageability: low

PC Status: positive isolations from the central western sector of the area

Recommendations: Further survey work is required to determine the extent of *P. cinnamomi* in the area and the appropriate management requirements. Monitoring by Threatened Species Unit personnel.

SE8: Blindburn Creek. Barker (1994) described this management area located in the southeastern corner of the Douglas-Apsley national Park as 'one of the most important in the State' (his M18 S4 area). It supports several nationally listed species (*Epacris apsleyensis*, *Epacris grandis*, *Pultenaea selaginoides*), as well as a number of endemics characteristic of Tasmania's central east coast (Kirkpatrick et al., 1980). Susceptible plant communities include *E. sieberi* and *E. amygdalina* on dolerite. The area has excellent natural protection and was thought to be free of *Phytophthora* in 1994. Unfortunately, surveys in 1998 and 2002 have shown that *P. cinnamomi* is well established in a number of areas in the north of the management zone, although the only casualty noted was *Xanthorrhoea australis* (Tim Rudman, pers. comm., pers. obs.).

Land Manager: PWS

Tenure: National Park

Manageability: low-moderate

PC Status: scattered positive symptoms

Recommendations: The area should be retained as a management zone, with monitoring of the endangered *Epacris grandis* populations by personnel from the Threatened Species Unit. The present PWS management approach should be maintained, with additional prescriptions as per the Douglas-Apsley National Park Fire Management Plan (PWS, 1998a), viz., earthmoving equipment and other machinery must not enter the area under any circumstances.

SE9: Douglas-Apsley (southwest). This corresponds to the M18 S3 management area of Barker (1994), with the endangered *Epacris limbata* the target species. The area supports wet heath (with *E. ovata*), *E. amygdalina* on dolerite, *E. tenuiramis* on dolerite, and isolated patches of *E. barberi*. Barker noted one small area infested

with *P. cinnamomi*, and survey work in February 2001 revealed several additional infestations in the immediate area. *Xanthorrhoea australis* is a significant if patchy component of a generally heathy understorey, and appeared to be the only casualty in infested areas. The *Epacris limbata* population does not appear to have been affected to date. The infestations are relatively low in the catchment, hence the decision to retain this area for management.

Land Manager: PWS

Tenure: National Park

Manageability: moderate

PC Status: scattered positive symptoms

Recommendations: The area should be retained as a management zone, with monitoring of the endangered *Epacris limbata* by Threatened Species Unit personnel. The present PWS management approach should be maintained, with additional prescriptions as per the Douglas-Apsley National Park Fire Management Plan (PWS, 1998a), viz., earthmoving equipment and other machinery must not enter the area under any circumstances.

SE10: Hardings Falls. Phil Barker's M18 S2 management area, targetting a number of nationally listed species (*Pultenaea selaginoides*, *Epacris grandis* and *E. limbata*), is part of the Hardings Falls Forest Reserve. The following susceptible communities dominate the area: *E. amygdalina* forest on dolerite, *E. tenuiramis* forest & woodland on dolerite, and wet heath. *P. cinnamomi* is known from the southeastern sector of the management zone (Barker, 1994), while a long-term monitoring site is in place to gauge the effect of phosphonate treatment on diseased *E. limbata* (Barker, 1997).

Land Manager: Forestry Tasmania

Tenure: Forest Reserve and State Forest

Manageability: low

PC Status: isolated symptoms from the area's southeast

Recommendations: Maintain and measure long-term monitoring plots.

SE11: Nichols Cap. Another of Phil Barker's management areas (M18 S5), again within the Douglas-Apsley National Park, and again targetting the nationally endangered *Epacris apsleyensis* and *Epacris grandis*. Susceptible communities include *E. amygdalina* on dolerite, *E. sieberi* on sediments and dry *E. obliqua* forest. *Phytophthora* was known from the main walking track to the north of the Douglas River in 1994, with walkers encouraged to travel north to south to avoid spreading the infection any further north. Since 1994 *Phytophthora* has been recorded from the lower reaches of the 4WD track in the central east of the management zone. The dissected nature of the landscape should ensure the infection-free status of at least some of the areas supporting susceptible plant communities.

Land Manager: PWS

Tenure: National Park

Manageability: moderate

PC Status: positive symptoms from close to old tracks in east of area

Recommendations: The present passive PWS management approach should be maintained, with additional prescriptions as per the Douglas-Apsley National Park Fire Management Plan (PWS, 1998a), viz., earthmoving equipment and other machinery must not enter the area under any circumstances. PWS monitoring.

SE12: Douglas-Apsley (northeast). The northeastern sector of the Douglas-Apsley NP supports areas of Coastal E. *Amygdalina* forest, *Sieberi* on sediments and *Sieberi* on dolerite (principally on the lower flanks).

Land Manager: PWS

Tenure: National Park

Manageability: moderate

PC Status: no symptoms

Recommendations: There should be no track development in this area, while earthmoving equipment and other machinery should not enter the area under any circumstances. The Douglas-Apsley National Park Fire Management Plan (PWS, 1998a) should be updated to include this area in zones classified as 'No Earth Moving Equipment'.

SE13: Weilangta. Phil Barker's M11 S1 management area, targetting the endemic shrub *Epacris marginata*. The following marginally susceptible communities dominate the area: *E. pulchella* woodland/forest and dry *E. obliqua* forest. *Epacris marginata* tends to occur on slabby dolerite outcrops in this area and in consequence has good natural protection from infection by *P. cinnamomi*; the greatest threat to the *E. marginata* populations would appear to be over-frequent firing.

Land Manager: PWS and Forestry Tasmania

Tenure: Three Thumbs State Reserve and State Forest

Manageability: moderate - high

PC Status: no field symptoms

Recommendations: Keep route of any new roading to already formed tracks through the Management Area.

(6) Southern Ranges Bioregion (SR)

SR1: Snug Tiers. The proposed management area lies within the Snug Tiers Nature Recreation Area and supports moorland and heathy moorland. The apparent absence of *P. cinnamomi* from the area appears to be in large part due to suboptimal temperatures, with the altitude range of 550-650 m at the upper limits of *P. cinnamomi*'s climatic envelope. Snug Tiers is an important eastern refugium for a range of rainforest and alpine species (viz., *Prionotes cerinthoides* and *Anodopetalum biglandulosum* along the upper reaches of the Snug River, *Eucryphia lucida* to the north of Morrison Hill, and *Schizacme montana* and *Herpolirion novae-zelandiae* in some of the central heathy moorlands). The most significant vegetation in terms of PC-susceptibility is in the southeast of the reserve to the east of Morrison Hill, with heathy moorlands that contain a number of species more characteristic of Tasmania's southwest (e.g., *Agastachys odorata*, *Monotoca submutica*). The area is characterised by shallow peaty soils on a quartzitic sandstone base. Much of Snug Tiers has been heavily disturbed in the past through logging activities, with numerous 4WD tracks dissecting the region; there is ample evidence of ongoing use by 'recreational' drivers. A small area of heathy moorland to the north of the Snug River appears to have escaped tracking, being buffered by dense vegetation to its north and east and by Snug River to its south.

Land Manager: PWS

Tenure: Nature Recreation Area

Manageability: low-moderate

PC Status: no symptoms

Recommendations: There should be no new tracks in this area, with vehicular access restricted solely to management purposes (ideally in dry conditions). A gate should be placed on the access track leading to the east of the reserve at 516000E, 5228500N (upi 3821); PWS to negotiate with landowner re gate placement. Entry points to the area's northwest within the reserve should be closed by the judicious placement of large boulders or logs. The area should be identified within the fire management plan being prepared for the Snug Tiers NRA (Marsden-Smedley, pers. comm.), with prescriptions in place to control the movement of earthmoving equipment or other machinery into the area.

SR2: Cape Labillardiere Peninsula & Partridge Island. This management area supports a diverse range of susceptible communities, viz., coastal heath, wet heath, Coastal E. Amygdalina forest, and dry heathy *E. obliqua* and *E. tenuiramis* forests, with the highly susceptible lily *Blandfordia punicea* a ubiquitous and distinctive presence. A popular walking track traverses the peninsula, that on the western side being negotiable by 4WD vehicles. The southern part of Partridge Island supports good examples of coastal heath and heathy *E. amygdalina* woodland.

Land Manager: PWS

Tenure: National Park

Manageability: moderate

PC Status: no symptoms in management area; positive isolations from the Lighthouse Road.

Recommendations: Wash-down stations should be established at the start of the Cape Labillardiere walking track at the existing camping site, with the installation of a *P. cinnamomi* interpretation panel. Vehicle use in the area should be confined to dry conditions. There should be no new tracks in the area. A sign should be erected on the Partridge Island jetty advising visitors to ensure all gear is clean of soil before landing (scrubbing brushes should be provided).



SR3: West Cloudy Head. This area supports a range of wet and dry heath communities, variously dominated by *Melaleuca squarrosa*, *Melaleuca squamea*, *Allocasuarina monilifera*, *Banksia marginata* and *Leptospermum scoparium*. A number of dolerite rock-plate communities are also present, with *Ozothamnus scutellifolius* and *Epacris myrtifolia* prominent. The area has good natural protection, being buffered to the north by wet forest, and to the west by dense scrub (though a recent fire has ‘opened’ up the area somewhat). The scouring sands of the Lighthouse Bay Beach provide an excellent hygienic safeguard for any walkers approaching the management area from the southwest.

Land Manager: PWS

Tenure: National Park

Manageability: high

PC Status: no symptoms in management area

Recommendations: There should be no track development in this area; a sign should be erected at the northern end of the Lighthouse Bay Beach alerting walkers to the significance of the area.

SR4: Tasman Head. This section of the South Bruny National Park supports a similar range of plant communities to those at West Cloudy Head, though with an abundance of *Blandfordia punicea* on the ridges above Pine Log Bight. Species diversity is relatively low, but a large proportion of those are considered to be susceptible to *P. cinnamomi*. A walking track runs from the Cloudy Bay camping area to the rookery at Pine Log Bight, with *P. cinnamomi* infestations known from a number of points (*Sprengelia incarnata* being the principal casualty).

Land Manager: PWS

Tenure: National Park

Manageability: moderate

PC Status: positive isolations and symptoms along the walking track to Pine Log Bight

Recommendations: The walking track should be maintained only as far as East Cloudy Head, with a note to walkers at the registration booth to the south of the Cloudy Bay camping site warning of the dangers of spreading *P. cinnamomi* to other areas of Bruny Island. Walkers should be advised to scrub their boots on the Cloudy Bay beach before leaving the area.

SR5: Southport Bluff. Phil Barker’s M5 S1 management area, designed to protect the only known population of the critically endangered *Epacris stuartii*. The area supports coastal heath, heathy moorland and Coastal Amygdalina. The management zone has been expanded to include Southport Island, the site of a recent *ex situ* planting of *Epacris stuartii*.

Land Manager: PWS

Tenure: Conservation Area

Manageability: moderate

PC Status: no symptoms

Recommendations: management of the area should be in accordance with the *Epacris stuartii* Recovery Plan (Keith and Ilowski, 1999).

SR6-SR9: these areas lie within the World Heritage Area. Management prescriptions are outlined in Sect. 5.2.

(7) West Bioregion (W)

W1: Dempster Plains. This extensive area of State Forest contains good examples of heathy moorland (eastern & northwestern blanket) and dry *E. nitida* forest. Sumac Road to the northwest, Horton Road bound the area to the east, and the Horton River to the south and west. *Phytophthora cinnamomi* is known from the western part of the area, but the central part of the management zone is considered to have reasonable long-term security due to the buffering presence of dense creekline vegetation.

Land Manager: Forestry Tasmania

Tenure: State Forest (production)

Manageability: moderate

PC Status: positive *P. cinnamomi* isolations and symptoms along Sumac Road.

Recommendations: Ensure all harvesting operations use appropriate hygiene prescriptions. Maintain the integrity of the dense creekline vegetation in the central part of the management area. Ensure the construction of any new roads has prescriptions for mitigating the risk of further spreading the pathogen within the management area.

W2: Burgess Hill. Barker's M2 S1 management area, specifically for the nationally endangered *Epacris glabella*, a species restricted to serpentinite outcrops. Communities include buttongrass moorland, sedgey *E. nitida* low woodland/scrub and heathy *E. nitida* woodland on serpentinite, the latter two communities being equivalent to the TASVEG mapping unit *E. nitida* dry forest. As noted by Barker (1994), the area is heavily tracked, with past disturbance associated with mineral exploration. Keith (1997) noted disease symptoms in the area at two of his *Epacris glabella* sites. Sporadic positive symptoms were noted in October 2001, though the expression of *P. cinnamomi* was muted (consistent with the serpentinite experience at Beaconsfield).

Land Manager: PWS & Forestry Tasmania

Tenure: Savage River Regional Reserve and State Forest

Manageability: low-moderate

PC Status: scattered field symptoms, positive isolation from upper slopes of Brassey Hill

Recommendations: Barker (1994) recommended that an access track from the Waratah Road be gated (viz., immediately west of the bridge over the Heazlewood River). As at October 2001 the track in question had been 'closed', with an old timber bridge over Roaring Mag Creek impassable; however, 4WD vehicles can still cross the ford next to the bridge. It is recommended that large boulders be positioned on the Waratah Road side of the ford to prevent unauthorised access. Personnel from the Threatened Species Unit (DPIWE) should continue to monitor the health of the *Epacris glabella* populations.

W14: Farm Cove. Braddon & Clark River area. The proposed area abuts State forest to the northwest (Teepokana Plateau), with the Coal Head Track forming one boundary. The area has low visitation. Plant communities present include BS or a west coast variant.

Tenure: West Coast Regional Reserve and Macquarie Harbour Historic Site.

Manageability: moderate

PC status: no records within area; adjacent *Phytophthora* with uncertain boundaries.

Recommendations: Survey required to determine community composition and *P. cinnamomi* status.

W3-W13: these areas lie within the World Heritage Area. Management prescriptions are outlined in the next section.

5.2 Management Areas within the World Heritage Area (SR6-SR9 and W3–W13)

These areas are expected to remain free of disease for the medium to long term. Application of controls to minimise the risk of introducing *P. cinnamomi* is expected to be effective.

PRESCRIPTIONS

- Management activities should be kept to a minimum where these may increase the risk of *P. cinnamomi* incursion. This includes mechanised access and the development of further walking tracks which link directly with infected areas.
- A *Phytophthora* risk assessment shall be undertaken for new developments. Contact the Vegetation Management Section, Nature Conservation Branch.
- Where both the *Phytophthora* Infected zone and the *Phytophthora* free zone are entered in an activity the *Phytophthora* free zone must be entered first.
- *Phytophthora* infected areas should be indicated on maps at track-head booths with advice on any public actions required to prevent the spread of *P. cinnamomi*.
- Any potential *P. cinnamomi* infection should be reported promptly to the Vegetation Management Section, Nature Conservation Branch.
- Disease status of identified *P. cinnamomi* free catchments shall be monitored and reported.

A number of the walking tracks in the World Heritage Area were surveyed for *P. cinnamomi* early in 2002, along with a number of recommendations as to the placement of new washdown stations (Johnson and Bonwick, 2002).

SR6: South East Coast. Cockle Creek to New River Lagoon.

Target communities are largely limited to the New Harbour-Osmoridium Beach area.

PC status: no records.

Communities: Bb, Bm, Sn, N

SR7: Upper Picton. Picton River upstream of Farmhouse Creek.

PC status: no records. Forest barriers, extremely low visitation.

Communities: Bb, Bm, Sn, N

SR8: New River. New River to the coast.

PC status: no records (infestations to immediate east of New River lagoon at Deadmans Bay. Forest barriers throughout and surrounding area; visitation regular along coast, extremely low inland.

Communities: Bb, Bm, Sn, N

SR9: Vale of Rasselas.

PC Status: no records. Moderate visitation.

Communities: this area is notable for the 'juxtaposition of blanket moor and eastern moor at medium to high altitudes' (Jarman et al., 1988); Bb, Bm, Sn, N

W3: Old River (south)

PC status: no records. Very limited public use; higher use in the past - may need further mapping to confirm *Phytophthora* status; distance and topographic buffers.

Communities: Bb, Bm, Sn, N

W4: Old River (north)

PC status: no records. Very limited public use; higher use in the past - may need further mapping to confirm *Phytophthora* status; distance and topographic buffers.

Communities: Bb, Bm, Sn, N

W5: South West Cape. Window Pane Bay to Telopea Point.

PC status: no records. Under threat from adjacent walking track infestation, regular public use.

Communities: Bb, Bm, Sn, N

W6: Davey Head. Davey Head only.

PC status: no records, adjacent infections, distance only barrier, very limited public use.

Communities: Bb, Bm, Sn, N

W7: North Port Davey. Lower Davey River, Giblin River south and the Dewitt River area.

PC status: no records. Adjacent infestations, distance buffers, few barriers to spread.

Communities: Bb, Bm, Sn, N

W8: Gallagher Plateau & Mt Anne.

PC Status: no records. Infestations along Scotts Peak Rd at start of northeast ridge walking track. Moderate visitation.

Communities: Bb, Bm, Sn, N

W9: Greater Lake Pedder. Upper Davey River, Frankland River, Albert River, the western shoreline of Lake Pedder (& Mt Solitary), and the southern side of the Sentinel Range.

PC status: no records. Adjacent infestation with forest barrier in lower Hardwood and distance buffers to adjacent *Phytophthora* at Red Knoll and Mt. Sprent. Good internal buffers to spread. Some visitation, past activity in area could give rise to other lakeside infestations. Sentinel Range: past high visitation, needs further *Phytophthora* investigation. Distance buffers and good topographical barriers to spread of *Phytophthora* from adjacent areas.

Communities: Bb, Bm, Sn, N

W10: Orange River. Orange and Albert Rivers

PC status: no records. Effective forest barriers.

Communities: Bb, Bm, Sn, N

W11: North Gordon. Denison, Holley, Gell, Pokana and the upper Gordon Rivers.

PC status: no records. Low visitation, good forest and topographical barriers to spread, plus good internal barriers and distance buffers.

Communities: Bb, Bm, Sn, N

W12: Maxwell. Maxwell Valley

PC status: no records. Extremely low visitation, good forest and topographical barriers to spread. *Phytophthora* survey of access points undertaken in the late 1990s.
Communities: Bb, Bm, Sn, N

W13: Frenchmans. West of the Franklin River from Acheron River north to the Raglan Ranges infected area and east to the Loddon plains (plus the Jane River Valley etc, and the area to the south of Frenchman’s Cap).
PC status: no records. Variable visitation across area, good forest and topographical barriers to spread.
Communities: Bb, Bm, Sn, N

6. Extent of current *P. cinnamomi* impacts on target vegetation types

The expression of disease is dependent on three key elements, often portrayed as the ‘disease triangle’ of pathogen, host and environment. The susceptibility of plant communities to *P. cinnamomi* will thus depend on the number of susceptible plant species within a community, the structure of that community, and a suite of inter-related physical, biological and climatic parameters (viz., soil temperature, structure, pH and fertility, antagonistic microbes, rainfall, fire, etc.). Variation in these environmental factors over both space and time will affect the potential for disease to develop in a plant community.

The following tables contain a prioritised list of those TASVEG mapping units identified as being either highly or moderately susceptible to *P. cinnamomi* (Appendix 2). The nature of the mapping units means that a single unit may encompass a number of plant communities that differ greatly in their structure, dominant species and understorey floristics, and indeed, may occur on a variety of geologies (e.g., the Coastal E. Amygdalina forest mapping unit includes facies on recent sands, granite and Mathinna sediments). Thus a degree of internal variability is to be expected in a mapping unit’s vulnerability to *P. cinnamomi* (as discussed further in the next section). The prioritisation in Table 5 incorporates the *hazard rating* for a particular mapping unit – that is, the recognition of vulnerable sites – as well as an assessment of the *risk* of introduction and spread of *P. cinnamomi*. As defined by Shearer and Tippett (1989): ‘Hazard is determined by the influence of climatic, site and management factors on disease expression. Risk is the probability of spread and infection determined by disease proximity and the type of operation planned for an area’. The assessment of hazard and risk also takes into account the current and past extent and distribution of the mapping unit, biophysical naturalness, terrain, tenure and the level of past (and likely future) disturbance.

The assessments of *P. cinnamomi* impact in Tasmania are based on the past experience of Tasmanian researchers and personal observations during June 2000 - August 2001, a period characterised by perhaps the most severe drought in 20 years. Active symptoms in northern and eastern parts of Tasmania appear to have been particularly subdued compared to past ‘events’, with disease expression confined to just a few of the known susceptible plant species. In the settled areas of the state’s north and east the most reliable ‘indicator’ species was undoubtedly *Xanthorrhoea australis* (Grass Tree or Yacca Gum), while in the southeast *Sprengelia incarnata* was a frequent – if not always reliable – indicator species.

TABLE 5. Highly susceptible TASVEG mapping units - prioritised

Mapping Unit	Description	Bioregion
Hsw	Wingaroo complex (Flinders Island)	F
BS	<i>Banksia serrata</i> woodland	F, K
HSf	Flinders Island heath-scrub complex	F
Hr	heath on granite	F, SE
NF	Furneaux <i>Eucalyptus nitida</i> forest	F
Hc	shrubby coastal heath	K, F, BL, SE, SR
Hh	lowland and intermediate heath	K, F, BL, SE, SR
N	<i>Eucalyptus nitida</i> dry forest	CH, K, NS, SR, W
Eac	<i>Eucalyptus amygdalina</i> woodland (AC)	NS, F, BL, SE (SR)
AC	Coastal <i>Eucalyptus amygdalina</i> forest	NS, F, BL, SE (SR)
Bm	<i>Melaleuca squamea</i> with/without Bb on slopes	W (NS & SR?)
Hw	wet heath	K, NS, F, BL, SE, SR, CH
HSc	Coastal heath/scrub over-category	F, SE, SR

TABLE 6. Moderately or ‘variably’ susceptible TASVEG mapping units

Mapping Unit	Description	Bioregion
Bb	buttongrass moorland	W, K, NS, F, BL, SE, SR
Sf	Flinders Island scrub	F
HSk	King Island sedgeland-heath-scrub mosaic	K
AD (Ead)	<i>Eucalyptus amygdalina</i> forest on dolerite	BL, NM, NS, SE, SR
AS (Eas)	<i>Eucalyptus amygdalina</i> forest on sandstone	NM, NS, SE, SR, BL
G (Ev)	<i>Eucalyptus viminalis</i> and/or <i>E. globulus</i> coastal shrubby forest	SE (W, F, K)
O (El)	<i>Eucalyptus obliqua</i> dry forest	K, NS, F, BL, SE, SR, W
P (Em)	<i>Eucalyptus pulchella</i> - <i>E. globulus</i> - <i>E. viminalis</i> grassy shrubby dry forest	SE, SR
RO (Er)	<i>Eucalyptus rodwayi</i> forest	CH, NM, NS, SE, SR, BL
SG (Esg)	<i>Eucalyptus sieberi</i> forest on granite	SE, BL, F
SO (Eso)	<i>Eucalyptus sieberi</i> forest on other substrates	SE, BL, F
TG (Etg)	<i>Eucalyptus tenuiramis</i> on granite	SE
TD (Etd)	<i>Eucalyptus tenuiramis</i> forest on dolerite	SE, SR
TI (Eti)	Inland <i>Eucalyptus tenuiramis</i> forest	SE, SR
Ee	<i>E. barberi</i> woodland	SE
Eh	<i>E. ovata</i> heathy woodland (OV)	BL, NS, SE
Eq	<i>E. perriniana</i> woodland	SE
Ro	Boulder fields (viz., Hazards, Strzelecki Peaks)	SE, F
Hg	Lowland/coastal sedgey heath	K, NS, F, BL, SE, SR, W, CH
Sc	Coastal scrub	K, F, SE, SR, W
Sn	Western wet scrub with <i>E. nitida</i>	K, NS, SR, W

The following section contains a précis of the variability within some of the mapping units for which *P. cinnamomi* is considered to be a significant issue (as listed in Tables 5 and 6).

HIGHLY SUSCEPTIBLE

BS *Banksia serrata* woodland: this distinctive community is restricted to the Sisters Beach – Shakespeare Hills – Dip Range area of northwestern Tasmania, with a very localised occurrence on Flinders Island within the Wingaroo Nature Reserve. The Tasmanian mainland occurrences are all infested with *P. cinnamomi* to varying degrees, though the steeply dissected nature of the Shakespeare Hills area provides at least some natural protection to pathogen spread. The community appears to be least affected on the insulated rocky slopes of the Two Sisters above Irbys Flats, though even here patchy infestations may be found in the immediate area. Occurrences on private property in the Sisters Hills area are also heavily infested with *P. cinnamomi*, although the impact on young *Banksia serrata* does appear to be somewhat variable, with healthy young specimens observed in areas with a high recent mortality of grass trees. [The susceptibility of Tasmanian stands of *Banksia serrata* to *P. cinnamomi* appears to vary with substrate, with higher susceptibility on the peatier soils of the Shakespeare Hills (Richard Barnes, pers. comm.). The susceptibility of *Banksia serrata* to *P. cinnamomi* has been well documented by Weste (1998) for Wilsons Promontory in Victoria, with initial mortalities in stands of 60-80%.]

AC Coastal *Eucalyptus amygdalina* forest: this community occupies c. 200,000 ha on infertile siliceous soils in the coastal and subcoastal areas of northern and eastern Tasmania (occurrences mapped in the Fingal Valley are generally on Mathinna sediments and are better subsumed into a facies of the Inland Amygdalina mapping unit (North, 1998; Duncan, 2001). Unfortunately, this community has suffered a disproportionately high level of disturbance since European settlement, with agriculture, mining, logging and over-firing.

N *Eucalyptus nitida* dry forest: a community of northwestern Tasmania that has suffered badly from the impact of *P. cinnamomi*, as well as wholesale clearance in the past 30 years (Duncan and Brown, 1985). Heath species affected in this community include *Xanthorrhoea australis* (Rocky Cape and Dip Range area), *Dillwynia glaberrima*, *Leucopogon* spp., *Amperea xiphoclada*, *Blandfordia punicea* and *Hibbertia* spp.

Buttongrass moorland communities (see Table 1): Extensive areas of *P. cinnamomi* infested buttongrass moorland are present in Tasmania. Indeed, moorland is likely to have the largest total diseased area of any vegetation type in Tasmania. Though the actual extent of diseased areas can only be guessed at, surveyed transects in the area south of Melaleuca suggests that there is likely to be well in excess of 2,500 ha of infection in that area alone. Similar extensive occurrences of disease in moorland are observed in the Arthur-Pieman, south of Macquarie Harbour and northeast of Port Davey, to name but a few examples.

Though there are undoubtedly large areas of diseased moorland, the proportion of buttongrass moorland vegetation that is infected by *P. cinnamomi* in Tasmania is likely to be substantially less than that of heathland vegetation. Many large remote moorlands are expected to remain free from *P. cinnamomi* in the long term.

Species most at risk from *P. cinnamomi* in buttongrass moorland include *Banksia marginata*, *Agastachys odorata* and *Blandfordia punicea*, each of which shows very little resistance to *P. cinnamomi*. Twenty years of monitoring these species pre- and post-fire in diseased areas has indicated the potential for their elimination from infected moorlands (F. Podger, pers. comm.). Dramatic population declines are observed in a number of other species across disease fronts, including *Sprengelia incarnata*, *Baeckea leptocaulis*, *Epacris curtisiae*, *Isophysis tasmanica* and *Stylidium graminifolium* (Podger pers. comm.; Balmer & Rudman, unpublished data).

MODERATELY SUSCEPTIBLE

P *Eucalyptus pulchella* - *E. globulus* - *E. viminalis* grassy shrubby dry forest: a community of doleritic substrates in southeastern Tasmania, the impact of *P. cinnamomi* is restricted to those small areas that contain *Xanthorrhoea australis* in the understorey. On this basis, it is estimated that 3-4 % of the total area mapped as *E. pulchella* forest is considered to be susceptible to damage by *P. cinnamomi*, translating to c. 5,000 ha. Examples occur at Cherry Tree Hill, North Bruny Island and areas to the immediate west and south of Orford, with very small occurrences on private property on Hobart's eastern shore (Gunners Quoin, Craigow Hill and Dulcot). All but the eastern shore occurrences are infested with *P. cinnamomi*.

SO *Eucalyptus sieberi* forest on other substrates: extensive areas of this community occur on Mathinna sediments, with localised patches on dolerite. *Phytophthora cinnamomi* expression on the infertile fine-grained Mathinna beds is generally weak, though this is in part a reflection of past frequent firing which has led to a generally depauperate understorey (Neyland and Askey-Doran, 1996). Grass trees, where they occur, tend to be the most visible casualty in this dramatically stark community.

TI Inland *Eucalyptus tenuiramis* forest: a community occurring on Permian and Tertiary sediments in the southeast of the state, generally in areas climatically 'marginal' to *P. cinnamomi* expression. Records of the impact of *P. cinnamomi* in this community are restricted to facies containing *Xanthorrhoea australis* in the understorey; these facies have an extremely restricted distribution, with the only known occurrences infested with *P. cinnamomi* to varying degrees (viz., Grass Tree Hill near Risdon (Hogg and Kirkpatrick, 1973), Markes Point on Bruny Island).

7. Discussion

Each of the proposed *P. cinnamomi* management areas are highly significant for the target plant communities and/or threatened plant species in Tasmania that remain free of, or are least disturbed by *P. cinnamomi*. The long-term management of these areas will require two major issues to be addressed:

1. the perpetuation of the communities and species to be conserved
2. the prevention of the introduction and/or spread of *P. cinnamomi*

Perpetuation of the target plant communities and/or threatened species will require the maintenance of natural ecological processes by actions to:

- manage the fire regime
- manage disturbance to soil and hydrology
- control vegetation clearance

Prevention of the introduction and/or further spread of *P. cinnamomi* by human activity will require actions to:

- control the introduction of soil and plant material
- maintain natural barriers to *P. cinnamomi* spread such as wet forest and scrub
- minimise the level of human activity in management areas
- control the introduction of water from outside the immediate catchment

The next phase of this project will involve the development of specific fire plans for a number of the proposed management areas. As mentioned in section 3.1, management areas were selected with security of tenure in mind. That is not to say that reservation automatically translates to adequate conservation; the long-term success of the current project demands a proactive approach to *P. cinnamomi* management in the proposed areas.

The basis for the present project has been the acceptance that *P. cinnamomi* is widespread in the lowland areas of Tasmania, albeit in a mosaic of infested and uninfested areas. It was anticipated that the dissected nature of the Tasmanian landscape would provide sufficient opportunities for management of those plant communities at the greatest risk of transformation upon infection by *P. cinnamomi*. However, the extensive fieldwork conducted during the 2000-2001 period has shown that the opportunities for successful exclusion of *P. cinnamomi* in northern and eastern Tasmania are in fact few.

For many of our most susceptible heath and heathy woodland communities it is considered that the *P. cinnamomi* horse has well and truly bolted! In consequence, a number of the proposed management areas are considered to have relatively low manageability. That is not to say that we should do nothing. The view of Shearer and Tippett (1989) in relation to *P. cinnamomi* management in the Jarrah forests of Western Australia bears repeating:

‘Effective disease management balances the extremes between pessimism and over-optimism. ‘Gloom and doom’ lead to self-fulfilling prophecies; the failure to employ control measures and the actions undertaken because of a pessimistic outlook will lead to spread and intensification of disease. Over-optimism leads to a false sense of security and an underestimation of the consequences of disease.’

The ultimate aim of the present project is quite simple, to limit the spread of *P. cinnamomi* into uninfested areas supporting highly susceptible plant species and communities. Just how successful we will be depends on two factors: (1) the recognition by land managers and the wider community of the real threat that *P. cinnamomi* poses to the integrity of Tasmania’s biodiversity, and (2) the willingness of all stakeholders to embrace the management prescriptions proposed in this and accompanying reports (Tasmanian Government, 2003a and 2003b).

8. Plan Update

This plan establishes the optimal management areas for the selected species and plant communities in accordance with the current state of knowledge. However, it is desirable that the protection of many of the susceptible species and communities be improved as new opportunities for management are identified. It is envisaged that private land will play an increasingly important role in improving the protection of many *Phytophthora cinnamomi* susceptible plant communities. The principles used in this strategy are being applied in the Private Forest Reserves Program and Protected Areas on Private Land Program to further enhance *P. cinnamomi* management under this strategy.

Due to either taxonomic changes or a lack of knowledge of *P. cinnamomi* susceptibility, a number of taxa require further investigation and assessment of their conservation requirements. These include:

- *Epacris* aff. *virgata* ‘graniticola’
- *Philothea freyciana*
- *Zieria veronicea*
- *Hibbertia obtusifolia*

The present plan will be reviewed following any review of the Commonwealth *Threat Abatement Plan for Dieback caused by the Root-rot Fungus Phytophthora cinnamomi* or in 5 years.

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APPENDIX 1. Tasmanian plant species susceptible to *P. cinnamomi*

<u><i>Acacia axillaris?</i></u>	<u><i>Epacris barbata</i></u>	<i>Monotoca glauca</i>
<u><i>Acacia pataczeki?</i></u>	<i>Epacris corymbiflora</i>	<i>Monotoca linifolia</i> ssp. <i>linifolia</i>
<u><i>Acacia retinodes?</i></u>	<u><i>Epacris curtisiae</i></u>	<i>Monotoca submutica</i>
<u><i>Acacia siculiformis?</i></u>	<u><i>Epacris exserta</i></u>	<i>Oxylobium</i> spp.
<u><i>Acrotriche cordata?</i></u>	<u><i>Epacris glabella</i></u>	<i>Patersonia fragilis</i>
<i>Agastachys odorata</i>	<u><i>Epacris grandis</i></u>	<i>Persoonia muelleri</i> var. <i>densifolia</i>
<u><i>Allocasuarina crassa?</i></u>	<i>Epacris impressa</i>	<u><i>Phebalium daviesii</i></u>
<u><i>Allocasuarina duncanii?</i></u>	<i>Epacris lanuginosa</i>	<i>Phebalium squameum</i>
<i>Allocasuarina monilifera</i>	<u><i>Epacris limbata</i></u>	<i>Phyllocladus aspleniifolius</i>
<i>Amperea xiphoclada</i>	<i>Epacris marginata</i>	<i>Phyllota diffusa</i>
<i>Anopterus glandulosus</i>	<i>Epacris myrtifolia</i>	<i>Platylobium obtusangulum</i>
<i>Aotus ericoides</i>	<i>Epacris paludosa</i>	<i>Pultenaea daphnoides</i>
<i>Astroloma humifusum</i>	<u><i>Epacris stuartii</i></u>	<i>Pultenaea gunnii</i>
<i>Astroloma pinifolium</i>	<u><i>Epacris virgata</i></u>	<u><i>Pultenaea hibbertioides</i></u>
<i>Baeckea leptocaulis</i>	<i>Gaultheria hispida</i>	<i>Pultenaea juniperina</i>
<i>Banksia marginata</i>	<i>Gompholobium huegelii</i>	<u><i>Pultenaea paleacea</i> var. <i>sericea</i></u>
<u><i>Banksia serrata</i></u>	<i>Gonocarpus tetragynus</i>	<i>Pultenaea pedunculata</i>
<i>Bauera rubioides</i>	<i>Gonocarpus teucroides</i>	<u><i>Pultenaea prostrata?</i></u>
<i>Blandfordia punicea</i>	<u><i>Hakea ulicina</i></u>	<i>Pultenaea stricta</i>
<i>Boronia citriodora</i>	<i>Hibbertia acicularis</i>	<i>Richea dracophylla</i>
<i>Boronia parviflora</i>	<u><i>Hibbertia calycina</i></u>	<i>Richea milliganii</i>
<i>Boronia pilosa</i>	<i>Hibbertia empetrifolia</i>	<i>Richea pandanifolia</i>
<i>Bossiaea cinerea</i>	<i>Hibbertia procumbens</i>	<i>Sprengelia incarnata</i>
<u><i>Bossiaea obcordata</i></u>	<i>Hibbertia prostrata</i>	<i>Stylidium graminifolium</i>
<i>Calytrix tetragona</i>	<i>Hibbertia riparia</i>	<i>Styphelia adscendens</i>
<i>Cenarrhenes nitida</i>	<i>Hibbertia sericea</i>	<i>Tasmannia lanceolata</i>
<u><i>Conospermum hookeri</i></u>	<u><i>Hibbertia virgata</i></u>	<u><i>Tetratheca ciliata</i></u>
<i>Cyathodes glauca</i>	<u><i>Hovea corrickiae</i></u>	<u><i>Tetratheca gunnii</i></u>
<i>Cyathodes juniperina</i>	<i>Isophysis tasmanica</i>	<i>Tetratheca labillardierei</i>
<i>Cyathodes pendulosa</i>	<u><i>Isopogon ceratophyllus</i></u>	<i>Tetratheca pilosa</i>
<i>Daviesia latifolia</i>	<i>Leptospermum glaucescens</i>	<i>Tetratheca procumbens</i>
<i>Daviesia ulicifolia</i>	<i>Leucopogon collinus</i>	<u><i>Thryptomene micrantha</i></u>
<i>Dianella longifolia?</i>	<i>Leucopogon ericoides</i>	<u><i>Xanthorrhoea arenaria</i></u>
<i>Dillwynia glaberrima</i>	<u><i>Leucopogon esquamatus</i></u>	<i>Xanthorrhoea australis</i>
<i>Dillwynia sericea</i>	<u><i>Lomatia tasmanica?</i></u>	<u><i>Xanthorrhoea bracteata</i></u>
<u><i>Epacris acuminata</i></u>	<i>Melaleuca squamea</i>	
<u><i>Epacris apslayensis</i></u>	<i>Monotoca elliptica</i>	

Those species in bold are listed in the schedules of the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*, while those species underlined are listed in the schedules of the Tasmanian *Threatened Species Protection Act 1995*.

Species with a question mark have been demonstrated to be susceptible to *P. cinnamomi* in laboratory conditions (Barker, 1994); their susceptibility in the field remains open to question. The status of the nationally endangered *Lomatia tasmanica* is also uncertain.

APPENDIX 2. Susceptibility of Vegetation Mapping Units to *P. cinnamomi*

A. TASVEG Mapping

Tasmania is the first state in Australia to have a statewide vegetation map of a scale and accuracy useful to individual land managers. Called TASVEG, the mapping is being produced at 1:25,000 scale by a team of vegetation scientists and geographic information system technicians. The team is focusing on Tasmania's non-forest native vegetation, covering over 100 different vegetation community types, including scrub, heathland, wetland, riparian and grassland, as well as forested remnants not mapped during the Regional Forest Agreement.' (www.gisparks.tas.gov.au/TASVEG2000/TVMS.html, 2001).

The TASVEG vegetation mapping units have been categorised on the basis of their perceived susceptibility to *P. cinnamomi*. Two clear categories are identified, those mapped vegetation types that are reliably **highly susceptible**, and those that are reliably **not susceptible** or have low vulnerability. Between these extremes a third category of **variable susceptibility** is identified. This category indicates the need for site assessment to consider *P. cinnamomi* impacts.

Susceptibility indicates the level of susceptible species in the mapping unit and the level of change occurring on infection by *P. cinnamomi*. The assessment of vulnerability was based upon the documented composition of the units or their components (e.g., Duncan and Brown, 1985; Kirkpatrick, 1977; Kirkpatrick and Harris, 1999; TASVEG website), and past *P. cinnamomi* studies in Tasmania (e.g., Podger et al, 1990a and b). There will be considerable variability within a mapping unit, given that each may include a number of described plant communities (e.g., 10-12 communities within the 'shrubby coastal heath' unit). Note also that the impact within the eucalypt-dominated units in the 'variable susceptibility category' may be quite localised. For these units the presence of reliable indicator species like *Xanthorrhoea australis* (Grass Tree) will help to determine an area's susceptibility.

Bear in mind also that sites lying above about 600 metres or below the 600 mm mean annual rainfall isohyet are considered to be climatically unsuited to the development of *P. cinnamomi* (Figure 3).

The three categories are intended to support management planning and to help districts identify where *P. cinnamomi* may be an issue in their operations. They should be used in conjunction with *P. cinnamomi* distribution maps (accessible over the web on www.gisparks.tas.gov.au).

1. Highly susceptible to *Phytophthora cinnamomi* (hygiene precautions required)

Hc	shrubby coastal heath
Hh	lowland and intermediate heath
Hr	heath on granite
Hw	wet heath
Hsw	Wingaroo complex (Flinders Island)
HSc	Coastal heath/scrub over-category
HSf	Flinders Island heath-scrub complex
HSk	King Island sedgeland-heath-scrub mosaic
Bm	<i>Melaleuca squamea</i> with/without Bb on slopes
AC	Coastal <i>Eucalyptus amygdalina</i> forest
Eac	<i>Eucalyptus amygdalina</i> woodland (AC)
BS	<i>Banksia serrata</i> woodland
N	<i>Eucalyptus nitida</i> dry forest
NF	Furneaux <i>Eucalyptus nitida</i> forest
BEA	Eastern moorland
BSW	Southwest Blanket Moorland
BG	Sparse Buttongrass

2. Variable or moderate susceptibility (site assessment required)

AD	<i>Eucalyptus amygdalina</i> forest on dolerite
AS	<i>Eucalyptus amygdalina</i> forest on sandstone
Bb	buttongrass moorland

G	<i>Eucalyptus viminalis</i> and/or <i>E. globulus</i> coastal shrubby forest
O	<i>Eucalyptus obliqua</i> dry forest
P	<i>Eucalyptus pulchella</i> - <i>E. globulus</i> - <i>E. viminalis</i> grassy shrubby dry forest
RO	<i>Eucalyptus rodwayi</i> forest
SG	<i>Eucalyptus sieberi</i> forest on granite
SO	<i>Eucalyptus sieberi</i> forest on other substrates
TG	<i>Eucalyptus tenuiramis</i> on granite
TD	<i>Eucalyptus tenuiramis</i> forest on dolerite
TI	Inland <i>Eucalyptus tenuiramis</i> forest
Ea	<i>E. amygdalina</i> woodland
Ead	<i>E. amygdalina</i> woodland (AD)
Eas	<i>E. amygdalina</i> woodland (AS)
Ee	<i>E. barberi</i> woodland
Eh	<i>E. ovata</i> heathy woodland (OV)
El	<i>E. obliqua</i> woodland (O)
Em	<i>E. pulchella</i> woodland (P)
Eq	<i>E. perriniana</i> woodland
Er	<i>E. rodwayi</i> woodland (RO)
Esg	<i>E. sieberi</i> woodland (SG)
Eso	<i>E. sieberi</i> woodland (SO)
Etd	<i>E. tenuiramis</i> woodland (TD)
Etg	<i>E. tenuiramis</i> woodland (TG)
Eti	<i>E. tenuiramis</i> woodland (TI)
Ev	<i>E. viminalis</i> heathy woodland (G)
Ro	Boulder fields (viz., The Hazards at Freycinet)
Hg	Lowland/coastal sedgey heath
Sc	Coastal scrub
Sf	Flinders Island scrub
Sn	Western wet scrub with <i>E. nitida</i>

3. Low or no susceptibility

Includes wet forests, rainforests, high-altitude vegetation, grasslands, wetlands, saltmarshes and sphagnum bogs. Also miscellaneous units that correspond to improved pasture, areas of bracken, exotic plants, sand & water, and developed areas (urban and rural).

B. WHA Vegetation Mapping Units with a high susceptibility to *P. cinnamomi*

Southwest community mapping units

BE	Eastern buttongrass moorland
BS	Southwest buttongrass moorland
BF	Sparse buttongrass on slopes

Synusia based mapping (eastern WHA)

Bs	Southwest buttongrass with variants (M - Melaleuca/ L - Leptospermum etc)
L/M/B	Leptospermum/Melaleuca/Buttongrass sequence on ridges with scrubby inclusions (copses)

APPENDIX 3. Proposed *Phytophthora cinnamomi* Management Areas (refer to Figure 4).

Site Code	Barker	Location	Bioregion	Easting	Northing	Tenure	Area (ha)	Manager	Susceptible Vegetation
K1		Seventeen Mile Plain	King	321000	5472000	CA	2033	PWS	Bb (N, Sn)
K2		Arthur-Frankland 'wedge'	King	318000	5446000	SF	2716	Forestry	Bb, Bm, N, Sn
K3		Rocky Cape (Two Sisters)	King	380500	5469000	NP	290	PWS	BS, N
K4		Shakespeare Hills	King	368000	5467000	FR	1200	Forestry	Bb, BS (N, Sn)
K5		Hunter Island	King	310000	5514000	CA	7055	PWS	Hc
NS1		Dip Range	Northern Slopes	371000	5458500	CA	1850	PWS	Bb, Hw, N, Sn
NS2	M4 S1	Gog Range	Northern Slopes	452000	5403000	RR/SR	3029	PWS	Bb, AC (Ro)
NS3	M6 S1	Dans Hill	Northern Slopes	481000	5439500	CA	451	PWS	Bb, Hw, AC (serpentinite)
F1		Five-mile Bluff	Flinders	489500	5458500	UC	198	PWS	Hc
F2		Single Tree Plain	Flinders	523000	5462000	UC	1216	PWS	HC, AC, Eac
F3	M16 S2	Waterhouse	Flinders	554000	5476000	CA	3852	PWS	Hc, Hw, HSc, AC, Eac (Hg, Sc)
F4	M9 S2	Badger Hill	Flinders	539250	5451500	SF	392	Forestry	AC
F5	M16 S1	Little Boobyalla	Flinders	574500	5465500	CA	462	PWS	Hw, Bb, AC (Hg)
F6		Musselroe Bay	Flinders	596000	5478500	CA	930	PWS	Hc, Hr, Bb (Hg)
F7		Mt William (western extension)	Flinders	595000	5457000	NP	2655	PWS	Hw, Bb, AC (Hg, O)
F8		The Gardens	Flinders	606000	5446000	CA	496	PWS	Hc, AC
F9		Wingaroo (south)	Flinders	578000	5582500	NR	977	PWS	Hc, Hw, Sf, BS, NF
F10		Northern Patriarchs	Flinders	602500	5574500	UC	482	PWS	Hc, Hr, Sf, NF
F11	M19 S4	Loila Tier	Flinders	598650	5414700	SF	912	Forestry	SO
F12	M19 S5	Lefroy	Flinders	507150	5451900	FR	175	Forestry	AC, O
F13		Clarke Island	Flinders	601500	5513800	NR	3376	PWS	Hc, Hw, Hr
F14	M19 S1	Georges River	Flinders	605350	5427300	PP/rr	129	PWS/Private	SG, AC
BL1		Mt Pearson	Ben Lomond	603000	5433000	SR	4594	PWS	Hw, Bb, AC (O, SG)
BL2	M19 S3	Mt Echo	Ben Lomond	599500	5422500	SF	366	Forestry	SO
BL3		Avenue River	Ben Lomond	586900	5413000	FR	1291	Forestry	AC, Hw (SG)
BL4	M18 S7	German Town	Ben Lomond	599500	5403300	FR	727	Forestry	SO
BL5	M18 S1	Dukes Marsh	Ben Lomond	591800	5380600	SF	1088	Forestry	Hw, AD
BL6	M14 S9	Pepper Hill (Mangana)	Ben Lomond	572200	5390200	FR	432	Forestry	SO
BL7	M14 S7	Golden Gate Rd (Mathinna)	Ben Lomond	575250	5404500	SF	125	Forestry	SO
SE1		Chuckle Head	South East	528500	5214500	CA/Private	203	PWS/private	AC, Eac (TI)
SE2		Church Hill	South East	533500	5213500	GR/Private	753	PWS/private	Hc, Hw, Bb, Ac, Eac, TI (O)
SE3a	M10 S2	Cape Raoul/Shipstern Bluff	South East	564000	5213000	NP	870	PWS	Hc, HSc, TD
SE3b	M10 S2	Tunnel Bay/Curio Bay	South East	559000	5217500	NP	995	PWS	Hc, HSc, TD

SE4	M10 S3	Cape Pillar	South East	578000	5216000	NP	1995	PWS	Hc, HSc, Hw, Bb
SE5	M12 S1	Maria Island	South East	588000	5276000	NP	10218	PWS	Hc, Hr, Hw, HSc (O)
SE6a		Hazards	South East	608000	5332500	NP	444	PWS	Hr, Bb, AC (TG, Ro)
SE6b		Cooks-Bryans	South East	604000	5322000	NP	414	PWS	AC
SE7	M18 S6	Apsley	South East	603200	5364000	CA	173	PWS	AD, Eh (Ee)
SE8	M18 S4	Blindburn Creek	South East	601700	5367650	NP	357	PWS	AD, SO, O, P (Ee)
SE9	M18 S3	Douglas-Apsley (southwest)	South East	597000	5367000	NP	1165	PWS	Hw, Ad, TD (Eh, Ee)
SE10	M18 S2	Hardings Falls	South East	592200	5367000	FR	1336	Forestry	Hw, TD, AD
SE11	M18 S5	Nichols Cap	South East	601000	5376000	NP	939	PWS	AD, SO, O
SE12		Douglas-Apsley (northeast)	South East	604000	5379000	NP	623	PWS	AD, SO
SE13	M11 S1	Weilangta Hill	South East	568100	5276300	SR/SF	347	PWS/Forestry	O, P
SR1	M7 S1	Snug Tiers	Southern Ranges	514500	5228500	NRA	1216	PWS	Bb
SR2		Cape Labillardiere Peninsula	Southern Ranges	511000	5189000	NP	1555	PWS	Hc, Hw, HSc, AC (O, TI, Bb, EI)
SR3		West Cloudy Head	Southern Ranges	514000	5185500	NP	271	PWS	Hc, HSc, Hw (EI)
SR4		Tasman Head	Southern Ranges	524000	5182500	NP/SF	1358	PWS	Hc, HSc, Hw (EI)
SR5	M5 S1	Southport Bluff	Southern Ranges	499000	5187000	CA/HS	380	PWS	Hc, AC
SR6		Southeast (WHA)	Southern Ranges	470000	5180000	NP	16880	PWS	Bb, Bm, Sn, N
SR7		Upper Picton (WHA)	Southern Ranges	475000	5195400	NP	38660	PWS	Bb, Bm, Sn, N
SR8		New River (WHA)	Southern Ranges	464300	5200000	NP	16796	PWS	Bb, Bm, Sn, N
SR9		Vale of Rasselas (WHA)	Southern Ranges	445000	5295000	NP	44346	PWS	Bb, Bm, Sn, N
W1		Dempster Plains	West	337000	5433000	SF	7139	Forestry	Bb, N, Sn
W2	M2 S1	Burgess Hill	West	360000	5410000	SF/RR	3141	PWS/Forestry	Bb, N, Sn (serpentinite)
W3		Old River (south)	West	450350	5195000	NP	24224	PWS	Bb, Bm, Sn, N
W4		Old River (north)	West	447000	5216000	NP	8819	PWS	Bb, Bm, Sn, N
W5		South West Cape	West	422800	5178000	NP	2987	PWS	Bb, Bm, Sn, N
W6		Davey Head	West	407200	5206600	NP	4229	PWS	Bb, Bm, Sn, N
W7		North Port Davey	West	406200	5221800	NP	7022	PWS	Bb, Bm, Sn, N
W8		Gallagher Plateau	West	454000	5234000	NP	18562	PWS	Bb, Bm, Sn, N
W9		Greater Lake Pedder	West	424900	5245000	NP	47257	PWS	Bb, Bm, Sn, N
W10		Albert & Orange Rivers	West	410000	5260000	NP	11886	PWS	Bb, Bm, Sn, N
W11		Gordon north	West	430200	5295000	NP	88360	PWS	Bb, Bm, Sn, N
W12		Maxwell	West	412400	5290000	NP	22850	PWS	Bb, Bm, Sn, N
W13		Frenchmans	West	405000	5314500	NP	41011	PWS	Bb, Bm, Sn, N
W14		Farm Cove	West	376900	5316500	RR/HS	7682	PWS	Bb, Bm, Sn, N

Tenure: CA, Conservation Area; FR, Forest Reserve; GR, Game Reserve; HS, Historic Site, NP, National Park; NR, Nature Reserve; NRA, Nature Recreation Area; RR, Regional Reserve; SF, State Forest; UC, Unallocated Crown Land; rr, river reserve. **Barker:** proposed area an existing *Phytophthora cinnamomi* management area (as per Barker, 1994).

APPENDIX 4. Management Areas & Reserves containing Target Threatened Plant Species

Species	State	National	PC Management Area	Reserve (codes overleaf)
<i>Allocasuarina crassa</i>	r	-	SE4	TA
<i>Banksia serrata</i>	r	-	K3, K4, F9	DI, RO, SH, WI
<i>Bossiaea obcordata</i>	r	-	BL6, BL7	CC, PH, RM, SR
<i>Conospermum hookeri</i>	v	-	SE6a?, F8, F12?	BF, CB, FR
<i>Epacris</i> aff. <i>virgata</i> 'graniticola'	-	-	-	CA, MS
<i>Epacris apseyensis</i>	e	EN	SE7, SE8, SE11	AP, DA, HF
<i>Epacris barbata</i>	e	CR	SE6a	CB, FR, ML
<i>Epacris curtisiae</i>	r	-	K2, W1	AR, DO, ME
<i>Epacris exserta</i> s.str.	v	EN	NS2, BL4	AL, DH, MU, MR, PR, SR, TR, WA, ZZ
<i>Epacris glabella</i>	e	EN	W2	SA
<i>Epacris grandis</i>	v	EN	SE8, SE10, SE11	DA, HF
<i>Epacris limbata</i>	e	CR	SE9, SE10	AP, DA, HF
<i>Epacris marginata</i>	-	-	SE3a&b, SE4, SE5, SE13	MA, TA, TT
<i>Epacris myrtifolia</i>	-	-	SE3a&b, SE4, SE5, SR3, SR4	MA, SB, TA
<i>Epacris stuartii</i>	e	CR	SR5	GE
<i>Epacris virgata</i> s.str.	v	EN	NS3	AN
<i>Hakea ulicina</i>	v	-	F9?, F13	CL, DG, WI
<i>Hibbertia calycina</i>	v	-	BL2, BL4, BL6	GT, SC
<i>Hibbertia virgata</i>	r	-	F2?, F3, F6?, F8?	HU, MW, WC
<i>Hovea corrickiae</i>	r	-	BL2, BL5	CC, GT, LM, SF
<i>Isopogon ceratophyllus</i>	v	-	F9, F10	BR, CL, DG, SZ, WI
<i>Leucopogon esquamatus</i>	r	-	F9, F10	DG, WI
<i>Phebalium daviesii</i>	e	CR	F14	-
<i>Pultenaea hibbertioides</i>	v	-	F4, F12	DR, LE
<i>Pultenaea paleacea</i> var. <i>sericea</i>	v	-	F3	WC, Crown Reserve
<i>Tetratheca ciliata</i>	r	-	K3	RO
<i>Tetratheca gunnii</i>	e	CR	NS3	AN
<i>Thryptomene micrantha</i>	r	-	SE6b	CB, FR
<i>Xanthorrhoea arenaria</i>	v	VU	F3	CB, FR, HS, MW, WC
<i>Xanthorrhoea bracteata</i>	v	EN	F3, F4, F5, F6	CA, LB, MW, WC

Plant species addressed by Barker (1994) and excluded due to known field resistance or low probability of disease in field populations.

<i>Acacia axillaris</i>	v	VU	Undisturbed habitat not conducive to disease
<i>Acacia pataczekii</i>	r	-	Habitat not conducive to disease
<i>Acacia retinodes</i>	r	-	Habitat not conducive to disease
<i>Acacia siculiformis</i>	r	-	Habitat not conducive to disease
<i>Acrotriche cordata</i>	r	-	Habitat not conducive to disease
<i>Allocasuarina duncanii</i>	r	-	Habitat not conducive to disease
<i>Dianella longifolia</i>	r	-	Habitat not conducive to disease
<i>Epacris acuminata</i>	r	EN	Habitat not conducive to disease
<i>Epacris paludosa</i>	-	-	Observed to be resistant in the field
<i>Lomatia tasmanica</i>	e	CR	Undisturbed habitat not conducive to disease
<i>Pultenaea prostrata</i>	v	-	Habitat not conducive to disease

Significance Codes

State: r, v, e = rare, vulnerable, endangered in the schedules of the Tasmanian *Threatened Species Protection Act 1995*

National: VU, EN, CR = vulnerable, endangered, critically endangered in the schedules of the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*

RESERVE CODES

Apsley Conservation Area	AC	Snug Tiers Nature Recreation Area	SN
Alum Cliffs State Reserve	AL	St Patricks Head State Reserve	SP
Andersons Creek Forest Reserve	AN	St Pauls Regional Reserve	ST
Apslawn Forest Reserve	AP	South Bruny National Park	SB
Arthur-Pieman Conservation Area	AR	Southwest National Park	SO
Avenue River Forest Reserve	AV	Swan River Forest Reserve	SW
Bouchers Creek Conservation Area	BC	Strzelecki National Park	SZ
Bay Of Fires Conservation Area	BF	Tasman National Park	TA
Ben Lomond National Park	BL	Trevallyn State Reserve	TR
Brougham Sugarloaf Conservation Area	BR	Three Thumbs State Reserve	TT
Big Sassy Creek Forest Reserve	BS	Warrawee Forest Reserve	WA
Cameron Regional Reserve	CA	Waterhouse Conservation Area	WC
Coles Bay Conservation Area	CB	Wellington Park	WE
Castle Cary Regional Reserve	CC	Wingaroo Nature Reserve	WI
Clarke Island Nature Reserve	CL	Wye River State Reserve	WY
Douglas-Apsley National Park	DA	Zig Zag Reserve	ZZ
Darling Range Conservation Area	DG		
Dogs Head Hill Forest Reserve	DH		
Dip Range Regional Reserve	DI		
Den Ranges Forest Reserve	DR		
Donaldson River Nature Recreation Area	DO		
Freycinet National Park	FR		
Gleadow Creek Forest Reserve	GC		
George III Monument Historic Site	GE		
German Town Forest Reserve	GT		
Gravelly Ridge Forest Reserve	GR		
Hardings Falls Forest Reserve	HF		
Humbug Point Nature Recreation Area	HU		
Little Boobyalla River Conservation Area	LB		
Lower Marsh Creek Forest Reserve	LC		
Lefroy Forest Reserve	LE		
Long Marsh Water Reserve	LM		
Maria Island National Park	MA		
Meredith Range Regional Reserve	ME		
Moulting Lagoon Game Reserve	ML		
Montagu River Forest Reserve	MO		
Mount Barrow State Reserve	MB		
Mount Foster Forest Reserve	MF		
Mount Midway Forest Reserve	MM		
Mount Pearson State Reserve	MP		
Mount Roland Regional Reserve	MR		
Mount Stronach Forest Reserve	MS		
Mount Puzzler Forest Reserve	MU		
Mount William National Park	MW		
Pepper Hill Forest Reserve	PH		
Pipers River Forest Reserve	PR		
Reedy Marsh Forest Reserve	RM		
Rocky Cape National Park	RO		
Savage River Regional Reserve	SA		
Sawpit Ridge Forest Reserve	SR		
Scamander Forest Reserve	SC		
St Columba Falls State Reserve	SF		
Shakespeare Hills Forest Reserve	SH		