Survey of tree dieback on the Mornington Peninsula, Victoria

A consultancy undertaken
for the Mornington Peninsula Shire

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1. INTRODUCTION

Patches of dead and dying eucalypts have been recorded in Victoria for many years and may be caused by both biotic agents (fungi, insects etc) and/or abiotic agents (drought, water logging, fire, herbicides etc.).

BIOTIC

Root Disease

Phytophthora cinnamomi (Rands)

Phytophthora cinnamomi Rands (Cinnamon Fungus) is an introduced soil and water borne microscopic fungal-like pathogen that attacks and destroys both the fine feeder roots and the main roots and collars of many native and introduced plants (Marks and Smith 1991). It is one of the most serious potential agents causing dieback in Victoria. The loss of roots limits the ability of plants to absorb water and nutrients effectively and as such visible symptoms of infection resemble chronic drought stress, ranging from slight yellowing of foliage through to leaf wilt and massive leaf fall, dead branches and plant death. It is best known as the cause of eucalypt dieback and heathland deaths in Western Australia and Victoria (Figure 1). On the Mornington Peninsula dieback due to *Phytophthora cinnamomi* has been recorded from the Point Nepean National Park. While symptoms of the disease can indicate the presence of the pathogen, it can only positively be identified by undertaking laboratory tests.

Figure 1. (A) Eucalypt dieback and (B) *Xanthorrhoea* deaths in Victoria caused by *Phytophthora cinnamomi.*

Armillaria luteobubalina (Watling and Kile)

Armillaria root rot occurs naturally in many native forests of Victoria. This aggressive fungal pathogen has caused serious damage to many species of native trees and shrubs including eucalypts and wattles, and introduced trees and shrubs growing in parks and botanical and domestic gardens, particularly in the coastal sand-belt areas near Melbourne. It produces similar symptoms to *Phytophthora cinnamomi* and causes death through rot of major roots and collar of species affected. This pathogen moves between trees through root to root contact and can also cause a sapwood rot. Eucalypt dieback due to *Armillaria* has been recorded from Red Hill on the Mornington Peninsula. Armillaria species can best be identified through the presence of creamy white mycelial fans under the bark and mushrooms (May-June) that are Yellow-brown to Yellow-olive in colour, cap size of 4-15cm, stalks up to 25cm long with ring and gills attached and spores white (Figure 2)

Figure 2. (A) dying tree caused by *Armillaria luteobubalina* with (B) Creamy white mycelium under bark. (C) Fruiting bodies of *Armillaria* around the base of the trunk.

Defoliators

Bell Miner Associated Dieback

Defoliation caused by leaf eating and sap sucking insects, such as beetles and psyllids, also contribute to decline over time. In particular the interaction between psyllids and bell miners (BMAD) has been shown to cause dieback in eucalypts through exclusion of other birds and other insects that are better biological control agents of the psyllids (Loyn 1987, Stone 1996). However the death of the trees appears associated with root rot caused by secondary pathogens. Moisture stress is also believed to contribute to outbreaks of insects. BMAD dieback has previously been recorded from the Moorooduc Quarry and Baxter Park (Figure 3).

Figure 3. Defoliation and dieback of eucalypts associated with Bell miner/psyllid interaction in Baxter Park, .

Other insect defoliators

Chrysomelid leaf beetles, Gumleaf Skeletoniser (Uraba lugens), Cup Moth, Leafblister sawfly, Steelblue sawfly and Gumtree Scale are native insects that have the potential to cause isolated defoliation of native species on the Mornington Penninsula.

Mycospherella Leaf Disease

This disease, due to several *Mycosphaerella* species, can result in severe defoliation on some species of eucalypts. Infection of foliage, particularly in lower crowns, occurs during warm wet weather, after which there is usually a 1–2 month time lag for symptoms to appear. They generally produce irregular spots or blotches (lesions) on leaves (Figure 4). Extensive infections causes leaves to distort or crinkle.

Figure 4. Mycosphaerella Leaf disease on *Eucalyptus globulus*.

Vertebrates

Several vertebrates are known to cause significant defoliation, particularly where overpopulation occurs in remnant vegetation isolated from more extensive native forests. These include Possums and Koalas. As with insect and fungal associated impacts, repeated defoliation can result in a weakening of the tree such that secondary pathogens can kill the tree.

Bark and Wood Borers

Generally the presence of bark and wood borers in a tree reflects a decline in health caused by other primary biotic or abiotic stress factors, although some species of longicorn beetles can act as primary pests by invading healthy trees. Their infestations can be extensive and result in death of trees that may have survived the initial cause of decline in health. Most often this death is caused through ring-barking by larvae feeding in the inner bark and sapwood. Trees infested with wood borer larvae (e.g. longicorns), are sometimes also attacked by parrots that will rip the bark of the trees to reach the larvae (Figure 5A). *Paroplites australis* (Banksia logicorn) is possibly a primary agent on Banksia species (Figure 5B).

Figure 5. (A) Tree damaged by parrots in search of larvae of wood borers. (B) Banksia longicorn (*Paroplites australis*) (Image CSIRO http://www.ento.csiro.au/aicn/name_c/a_249.htm).

ABIOTIC

Mundulla Yellows

Mundulla Yellows (MY) is a progressive dieback 'disease' of eucalypts and other native species, first reported in the 1970s, in *Eucalyptus camaldulensis* near Mundulla, South Australia (SA) (Hanold *et al* 2002, Czernakowski *et al*. 2006). It has since been reported in all states of Australia. It is characterised by symptoms of interveinal chlorosis (yellowing, Figure 6), usually observed first in immature leaves on a single branch and then spreading to mature leaves throughout the tree canopy resulting in severe dieback, although it may take several years or decades. Trees displaying these symptoms predominantly occur in disturbed vegetation, particularly near roadsides and paths. While initially thought to be caused by a biotic agent, recent research suggests abiotic factors are involved (Luck *et al.* 2006,) and that a reversal of symptoms can be attained in some cases through the addition of iron (Czernakowski *et al*. 2006. Figure 7). While symptoms resemble lime chlorosis, the relatively recent development of the disease would suggest other underlying causes leading to symptom development (e.g. climate change processes). Mundulla yellows has been recorded at several locations from Point Nepean to Dromana (Figure 8).

Figure 6. Interveinal chlorosis of leaves associated with Mundulla Yellows.

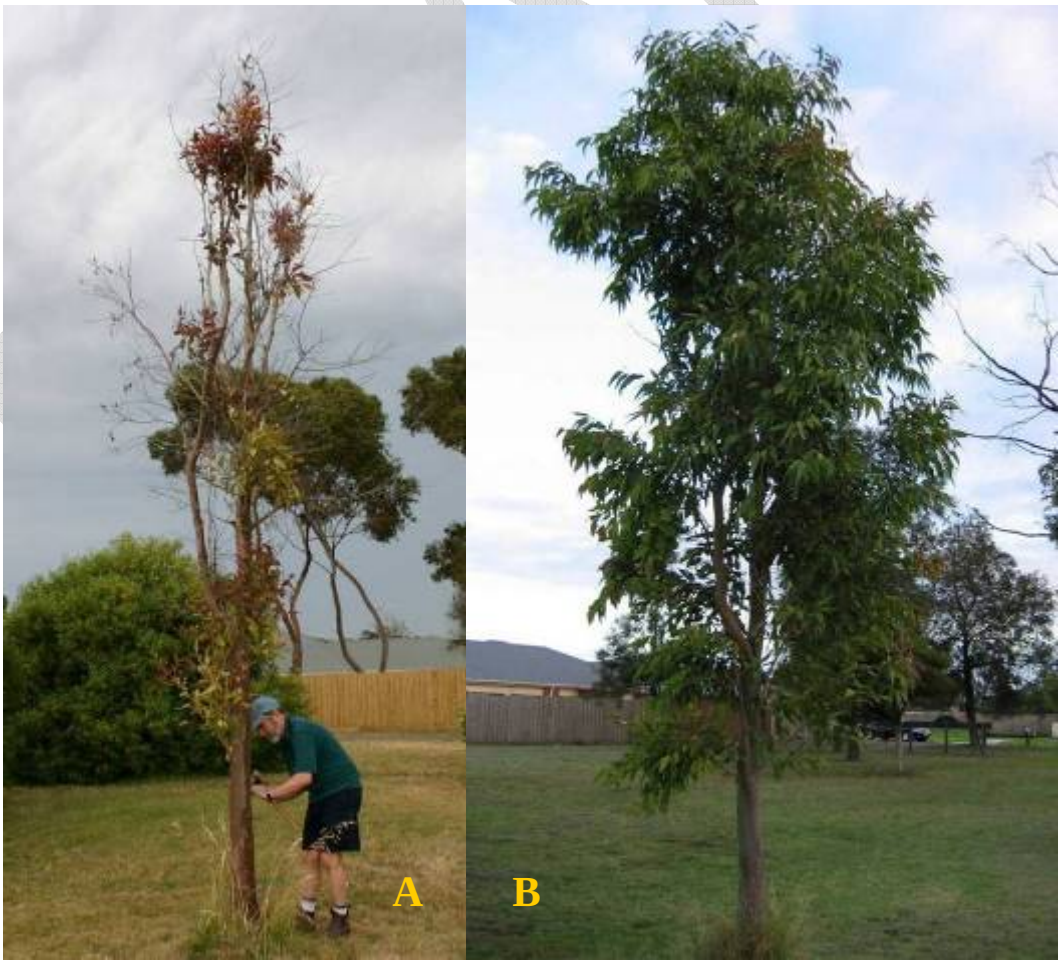

Figure 7. A) Mundulla Yellows affected eucalypt, B) Same tree 16 months after treatment with iron implant.

Figure 8. MY affected *Eucalyptus botryoides* in the Point Nepean National Park.

Salt

Chloride toxicity within coastal vegetation communities of Victoria has been observed on several occasions, despite the fact that species that habit these areas are generally considered to be salt tolerant. A study on the decline and death of Coast Tea-tree (*Letospermum laevigatum*) in the Barwon Heads area in the 1980's showed that surfactants entering salt spray through sewerage outfalls were contributing to this decline by causing the wax cuticle on the leaves of these trees to be eroded, resulting in chloride uptake by the plants. Chloride from salt spray also tends to be more damaging during times of drought due to lack of fresh water through rainfall washing the salt from leaves. Even areas inland from the coast during drought years have also been noted to have increased chloride levels in the foliage due to the increased concentration of salt in the soil as a result of low soil moisture (Figure 9).

Figure 9. Salt affected windbreaks within coastal areas of Victoria.

Drought

Drought alone can also result in serious dieback. Rainfall deficits over the last several years have been among the lowest on record and drought symptoms have been observed throughout both urban and rural landscapes in Victoria.

DISEASE MANAGEMENT IN PLANTATIONS

Tree diseases are the result of interactions between the responsible pathogen, their hosts and the forest environment and can be portrayed figuratively as a disease triangle, Figure 10). Disease prevention, reduction or their elimination are therefore based on a modification of one or more of these factors, or on exclusion of the pathogens and susceptible hosts.

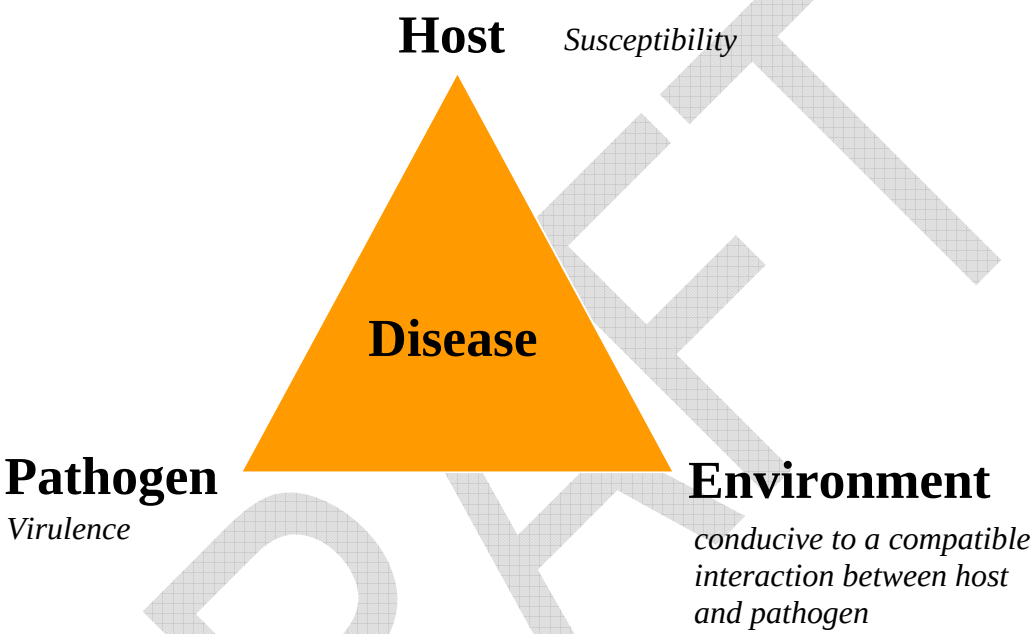

Figure 10. The disease triangle which describes the relationship between the host, the pathogen and the environment in the development of disease.

Non airborne pathogens may be excluded from an area through quarantine and good hygiene practices aimed at reducing the movement of infested soil and plant material into area. Moreover, containment measures such as the early culling of diseased or dying trees, fungal sprays, destruction of vectors or soil amendment can lower inoculum levels thus reducing the virulence of the pathogen and disease expression.

Susceptibility of hosts in an area can be lowered or eliminated by planting resistant species or provenances of species.

Site evaluation before planting, or appropriate silviculture including nutrient supply, as well as soil drainage are among practises which can improve tree health and capacity to resist disease. Disease management should be based upon regular monitoring of tree health.

2. BACKGROUND TO CONSULTANCY

Over the last several years, on-going tree death has been noted on the Mornington Peninsula. A large number of theories and ideas exist as to why this may be occurring. There are variations between regions of the Peninsula and between differing species.

A consultancy was requested by Sam Hand, on behalf of the Shire of Mornington Peninsula, to undertake a survey of dieback on selected sites throughout the Shire (Table 1, Figure 11). At each site the consultants have been requested to carry out tests to determine the cause of the dieback and give recommendations regarding management.

Table 1 Sites investigated for the survey of tree dieback on the Mornington Peninsula, Victoria (Figure 11).

Site No.	Site	Melways reference	GPS	Images
1	Lorikeet Reserve	Map 105 J2	38°11'14.68"S 145° 6'9.58"E	
2	Mt Eliza Regional Park	Map 105 K9	38°12'40.92"S 145° 6'19.65"E	
3	Mt Martha Foreshore @ Balcombe Creek	Map 144 J11	38°15'52.42"S 145° 0'57.26"E	
4	Mt Martha Public Park	Map 150 G8	38°17'42.59"S 145° 0'2.04"E	
5	Woods Reserve	Map 152 D5	38°17'10.46"S 145° 4'58.37"E	
6	Warringine Park	Map 164 D4	38°19'39.15"S 145°10'10.72" E	
7	Tyrone Reserve	Map 167 J4	38°22'16.56"S 144°47'29.90" E	

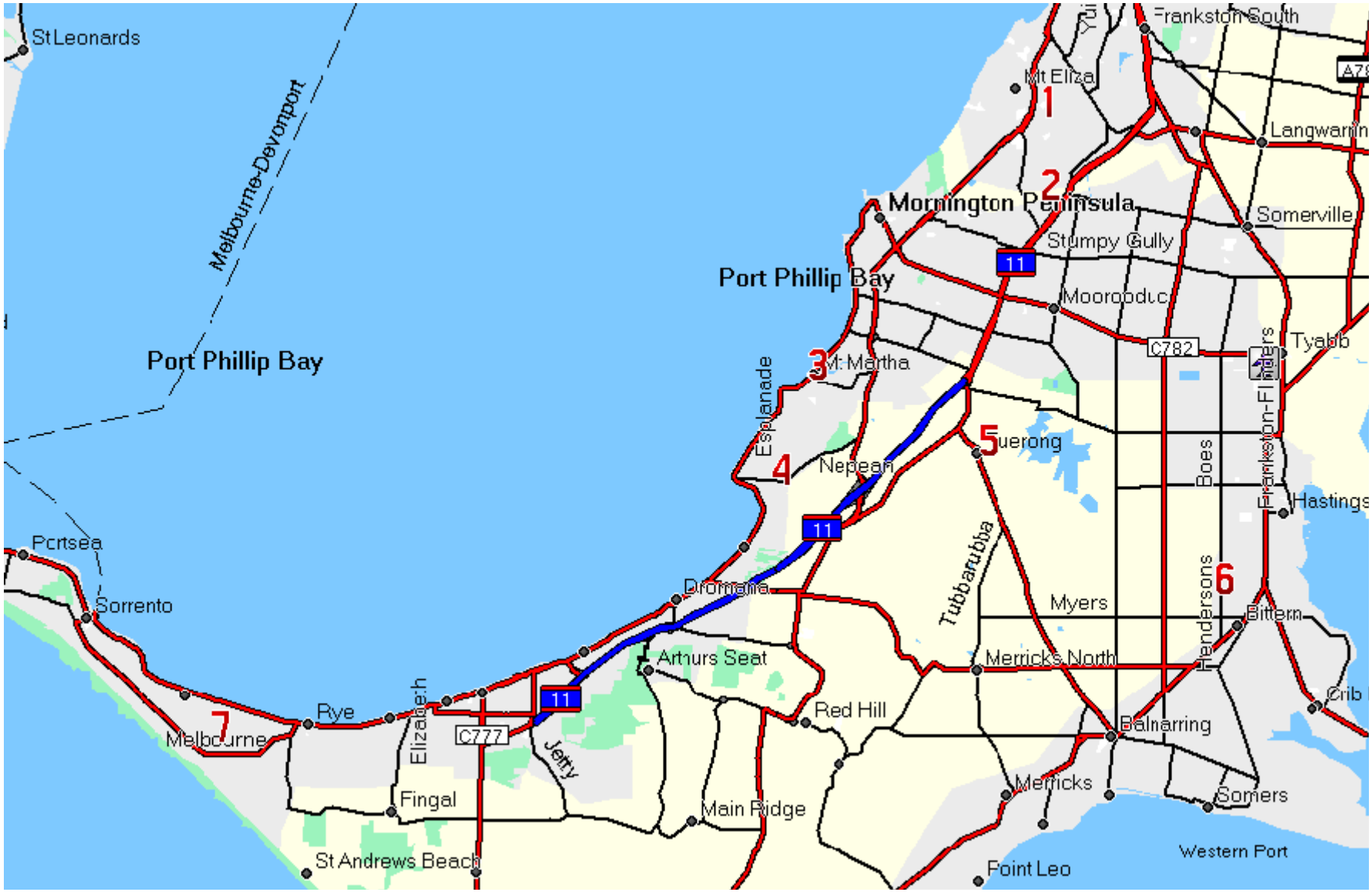

Figure 11. Location of sites 1 to 7 on the Mornington Peninsula to be surveyed for the cause of dieback (Table 1).

3. METHODS

3.1 Site inspection

At each site to be surveyed, 3-4 plots were established and the health of up to10 trees in each plot was assessed. The following measurements/samples were collected and tests undertaken within each plot/site.

1. Soil depth, pH and Ec.
2. Bulk sample (5 per plot) tested for the presence of *Phytophthora cinnamomi*.
3. Assessment for the presence of other agents known to cause decline in tree health (e.g. *Armillaria*).
4. Tree health status (e.g. dead, dieback, healthy, current foliage health).
5. Foliage sample (where present) for nutrient analysis. Foliage analysis was undertaken by the State Chemistry laboratory, Department of Primary Industries, Victoria, using standard techniques.
6. General site info.

3.2 *Phytophthora cinnamomi* testing

Sample analysis was undertaken using established techniques for identification of *Phytophthora cinnamomi* from soil and plant material. Soil baiting was carried out using the eucalypt cotyledon method (Marks and Kassaby 1974) and isolation from plant material via plating using selective agar media (Jeffers and Martin 1986).

4. RESULTS & RECOMMENDATIONS

Lorikeet Reserve

Three plots were established within the Lorikeet Reserve (Figure 12). Overall dieback within the reserve was patchy and confined primarily to the older trees present on the site (Tables 2 and 3, and Figure 13). Younger saplings of gum species appeared healthy although the presence of defoliators such as sawflies was noted (Figure 13 B). Soils were very dry and of a sandy clay and relatively shallow. *Phytophthora cinnamomi* was isolated from the soil sample taken from Plot 2.

Diagnosis: There appears to be a combination of factors affecting the site that has led to the observed dieback. While the current drought may be having a significant impact on the vegetation, the site appears to also be one that may have previously been affected by BMAD, and the presence of *Phytophthora cinnamomi* on the site may have significantly contributed to the dieback observed. While the soils were extremely dry, reflecting the current drought conditions, the shallow soils may make them subject to periodic waterlogging which may enhance activity of *P. cinnamomi*. The lack of regeneration of stringybark/ash eucalypts on the site which are more susceptible to *Phytophthora cinnamomi*, would also suggest an impact due to this pathogen.

Prognosis: The older trees on the site may continue to exhibit further dieback until the drought breaks.

Recommendations:

1. Undertake management of the site to promote natural seedling regeneration and thus selection for resistance amongst species susceptible to *P. cinnamomi.* This may be achieved through the implementation of a fire plan for the site that is more in balance with natural biological processes. However given the proximity to residential areas and a school, this may be difficult to achieve, although dividing the site into several smaller blocks may help. If planting, then use only species that are tolerant of the pathogen. Ensure good site preparation preferably using ripping to a depth of at least 50cm where possible, followed by disc plough or rotary hoe over the rip line to cultivate the site. Also ensure good weed control and following planting in winter, apply Pivott 800 fertilizer in October (375g/tree) applied in a ring out to 30 cm from the seedling. Tree guards to be erected around each seedling to prevent browsing damage.

2. When works are carried out on the site leading to soil adhering to vehicles and machinery, then hygiene arrangements (e.g. washdown), should be carried out prior to movement to another site so as to limit the spread of *P. cinnamomi* (see Appendix 1).

Figure 12. Location of health assessment plots within the Lorikeet Reserve, Mt Eliza.

Figure 13. Dieback within the Lorikeet reserve. A) View from gate, B) Sawfly larvae attacking regeneration. C) Plot 1, D) Plot 2, D) Plot 3 and D) Sapling regeneration within site appears healthy.

Table 2 Results of testing of soil and foliage for agents contributing to the dieback at Lorikeet Reserve Mt Eliza.

Plot	Tree Health	Foliage analysis												
		Total N g/kg	Total S g/kg	Total P g/kg	Total K g/kg	Total Ca g/kg	Total Mg g/kg	Total Na g/kg	Total Fe mg/kg	Total Mn mg/kg	Total Zn mg/kg	Total Cu mg/kg	Total B mg/kg	Total Al mg/kg
1	dieback	11.7	1.1	0.5	4.7	7.5	2.1	1.0	49.1	615.0	9.9	5.2	27.6	61.7
2	dieback	16.4	1.5	0.8	6.1	10.5	2.2	1.2	67.0	757.0	25.5	10.9	33.1	88.1
3	dieback	16.8	1.5	0.8	5.4	7.6	1.7	1.5	92.2	671.0	23.0	13.2	56.7	145.0

Plot	Foliage Chloride	Soil pH			EC			Pathogens / pests observed tested
		Surface	Subsoil		Surface	Subsoil		
		0-10cm	40-50cm	90-100cm	0-10	40-50cm	90-100cm	
1	4.1	5.2	5.7	6.0	40.6	19.9	31.9	*Perga* (Sawflies)
2	2.7	5.6	5.9	5.7	21.4	16.5	22.8	*Phytophthora cinnamomi*
3	3.5	5.4	5.6	na	20.6	33.5	na	Negative

Table 3 Assessment of tree health within the Lorikeet Reserve Mt Eliza.

Plot	Tree No.	Species	Age	Health	Comments
1	1	Eucalypt	Mature 60cm diameter	Dead >1Yr	
	2	Eucalypt	Mature 50cm diameter	Dieback	Canker on stem, unknown cause
	3	Eucalypt	Sapling	Discoloured leaves	Canker on branch, unknown cause
General Comments					Unburnt area, Wattle and grass understorey. Dieback patch. Sandy soils above impeded clay layer at 30cm.
2	1	Eucalypt	Large mature 100cm diameter	Dead > Yr	
	2	Eucalypt	Sapling	Some discolouration	Insect damage on leaves (Uraba lugens), Gum tree scale on lower branches.
	3	Eucalypt	Sapling	Some discolouration	Insect damage on leaves (Uraba lugens), Gum tree scale on lower branches.
General Comments					Unburnt area, Wattle and grass understorey. Dieback patch. Sandy soils above impeded clay layer at 30cm.
3	1	Eucalypt	Mature 50cm diameter	Dead >1Yr	
	2	Eucalypt	Mature 50cm diameter	Dead >1Yr	
	3	Eucalypt	Mature 50cm diameter	Dead >1Yr	
General Comments					Dieback, Wattle & dense understorey of tea tree, no eucalypt seedlings. Sandy soils above impeded clay layer at 40cm. Area may have been affected by BMAD in the past.

Mt Eliza Regional Park

Three plots were established within the Mt Eliza Regional Park (Figure 14). Again dieback within the reserve was patchy and in Plots 1 & 2 were confined primarily to the older trees present on the site (Tables 4 and 5, and Figure 15). Soils were very dry and of a sandy clay and relatively shallow. *Phytophthora cinnamomi* was isolated from the soil sample taken from Plot 1. The presence of the pathogen on the site is to be expected given the extensive fill brought into the area. Several weeds were present on the site including blackberry, pittosporum, and sallow wattle, with some evidence of previous herbicide application.

Diagnosis: The soils were again extremely dry, reflecting the current drought conditions and again the area is similar to that affected by past BMAD which has been recorded previously within the Moorrooduc Quarry reserve and Baxter Park to the north of the current sites. However scorching of leaves of saplings in Plot 2 suggest the current primary cause of the dieback in the area is drought (Figure 14 H). Younger planted trees in Plot 3 were also suffering from drought (Figure 14 C). The drought stress has led to attack by longicorn beetles resulting in ringbarking of the trunks of severely affected saplings (Figure 14 D). The reshooting of several stems below the ringbarking suggests root pathogens are not involved in the dieback of the saplings. The species of eucalypt saplings dying in plot 3 are also considered tolerant of the pathogen (E.?) again suggesting drought as the primary underlying cause. The shallow soils in plots 1 & 2 also make them subject to periodic waterlogging which may enhance activity of *P. cinnamomi* contributing to the dieback on these plots. However again, the presence of wood borers in both eucalypts and wattles on the site suggest drought as the underlying cause on these sites also.

Prognosis: The trees on the site may continue to exhibit further dieback until the drought breaks.

Recommendations:

1. The native vegetation sites again need to be managed to remove significant weeds and promote natural seedling regeneration. The implementation of a fire plan for the site that is more in balance with natural biological processes may provide the method for this to be achieved. Again the proximity of the site to residential areas may make this difficult to achieve. Where planting, use only species that are tolerant of drought and Phytophthora cinnamomi. Ensure good site preparation preferably using ripping to a depth of at least 50cm where possible, followed by disc

plough or rotary hoe over the rip line to cultivate the site. Also ensure good weed control and following planting in winter, apply Pivott 800 fertilizer in October (375g/tree) applied in a ring out to 30 cm from the seedling. Tree guards to be erected around each seedling to prevent browsing damage.

2. Due to the presence of *P.cinnamomi* in the area, works carried out on the site leading to soil adhering to vehicles and machinery, will require hygiene arrangements (e.g. washdown), to be implemented prior to movement to another site so as to limit the spread of the pathogen. (Appendix 1).

Figure 14. Location of health assessment plots within the Mt Eliza Regional Park.

Figure 15. Dieback within the Mt Eliza Regional Park. A) Plot 1, B) Plot 2 C0 Plot 3, D) Longicorn beetle damage, E) Acacia dieback with associated F) stem bleeding, G) Wood decay and H) Leaf scorch associated with moisture stress.

Table 4 Results of testing of soil and foliage for agents contributing to the dieback at Mt Eliza Regional Park.

Plot	Tree Health	Foliage analysis												
		Total N g/kg	Total S g/kg	Total P g/kg	Total K g/kg	Total Ca g/kg	Total Mg g/kg	Total Na g/kg	Total Fe mg/kg	Total Mn mg/kg	Total Zn mg/kg	Total Cu mg/kg	Total B mg/kg	Total Al mg/kg
1	dieback	13.5	1.5	0.8	5.0	14.0	1.2	2.6	99.6	894.0	49.3	2.5	36.7	124.0
2	dieback	16.6	1.5	0.9	5.3	8.4	2.2	1.5	86.3	456.0	19.4	4.7	33.8	124.0
3	dieback	18.1	1.5	1.3	5.0	7.5	2.3	1.6	90.0	85.5	31.0	3.6	45.1	98.0

Plot	Foliage Chloride	Soil pH			EC			Pathogens / pests observed tested
		Surface	Subsoil		Surface	Subsoil		
		0-10cm	40-50cm	90-100cm	0-10	40-50cm	90-100cm	
1	5.5	4.87	5.04	5.03	40.59	142.7	205.4	*Phytophthora cinnamomi, Gymnopilus sp.* Longicorn beetles, *Mycosphaerella sp.*
2	2.7	5.67	5.95	6.55	100	64.49	141	Longicorn beetles
3	2.7	5.67	5.95	6.55	100	64.49	141	Longicorn beetles

Table 5 Assessment of tree health within the Mt Eliza Regional Park.

Plot	Tree No.	Species	Age	Health	Comments
1	1	Eucalypt	Old	Dead > 2yrs	Understorey relatively healthy including weed species of blackberry, *Pittosporum*, Sallow wattle. Dead black wattle also present. Evidence of longicorn beetle attack of the tree. *Gymnopilus* fruiting bodies observed around base of tree suggesting wood decay present in trunk.
	2	Eucalypt	Sapling 30cm diameter	Healthy	Understorey as for 1 and including boneseed. Relatively healthy crown although with some insect attack. Surrounded by old dead and dying Black wattle.
	3	Eucalypt	Old	Dead top, with healthy shoots from base	Understorey as for 1. Main trunk with substantial evidence of longicorn beetle attack. Juvenile leaves of the new shoots attacked by *Mycosphaerella* leaf disease and insects.
	4	Eucalypt	Sapling 15cm diameter	Dead >2 yrs	Understorey as for 1. *Gymnopilus* fruiting bodies observed around base of tree suggesting decay in tree.
	5	Eucalypt	Sapling 25cm diameter	Healthy	Understorey as for 1. Some tip dieback and insect damage to leaves. Healthy Radiata Pine also near tree.
	6	Eucalypt	Old	Dead >2yrs	Understorey as for 1. Evidence of longicorn beetle attack of the tree. . Bracket fungi on trunk indicating wood decay. Young seedling next to tree healthy, with some *Mycosphaerella* leaf damage. Black wattle next to tree bleeding from trunk probably due to insect attack to the stem
	7	Eucalypt	Sapling 20cm diameter	Healthy	Some damage to leaves due to *Mycosphaerella* and insects.
	8	Black Wattle	Old	>2yrs	Understorey as for 1. Evidence of longicorn beetle attack on stem.
	9	Eucalypt	Seedling	Healthy	Grassland. Some insect damage to leaves.
	10	Eucalypt	Seedling	Healthy	Grassland. Some insect damage to leaves.
					Flat plot. Sandy soils above impeded clay layer at 40cm. Healthy *Pinus radiata* throughout area. Appears that I may have been subject to past BMAD.

Table 5 Assessment of tree health within the Mt Eliza Regional Park (Cont).

Plot	Tree No.	Species	Age	Health	Comments
2	1	Eucalypt	Mature	Dead >2 yrs	Understorey of *Melaleuca*, and weeds including bridal creeper, boneseed and some *Pittosporum*. Some evidence of past longicorn borer attack.
	2	Eucalypt	Mature	Dead >5 yrs	Past longicorn borer attack
	3	Eucalypt	Mature	Dead >5 yrs	Past longicorn borer attack
	4	Eucalypt	Mature	Dead >5 yrs	Past longicorn borer attack
	5	Eucalypt	Mature	Dead >5 yrs	Past longicorn borer attack
	6	Eucalypt	Mature	Healthy	Multiple stems, large tree, peppermint. Some insects on leaves.
	7	Eucalypt	Mature	Dead >5 yrs	Past longicorn borer attack
	8	Eucalypt	Mature	Healthy, Main trunk dead (>2yrs)	Understorey mainly grassland with some *Pittosporum*. Multiple stems from base, peppermint. Some insects on leaves. Past longicorn borer attack to main dead stem
	9	Eucalypt	Mature	Healthy, Main trunk dead (>2yrs)	Branches at base alive and healthy. Past longicorn borer attack to main dead stem.
	10	Eucalypt	Mature	Dead >5 yrs	Past longicorn borer attack
					Gentle slope to creek. *Melaleuca* thicket in gully. Sandy soils above impeded clay layer at 50cm. Appears that I may have been subject to past BMAD.

Table 5 Assessment of tree health within the Mt Eliza Regional Park (Cont).

Plot	Tree No.	Species	Age	Health	Comments
3	1	Eucalypt sp 1	Sapling	Recent death	Longicorn beetles ringbarking trunk
	2	Eucalypt sp 1	Sapling	Healthy	
	3	Eucalypt sp 1	Sapling	Dead 1 yr	Longicorn beetles ringbarking trunk
	4	Eucalypt sp 1	Sapling	2 stems, 1 dead 1 healthy	Longicorn beetles ringbarking trunk of dead stem.
	5	Eucalypt sp 1	Sapling	2 stems, 1 dead 1 healthy	Longicorn beetles ringbarking trunk of dead stem. Some insect and *Mycosphaerella* damage to leaves.
	6	Eucalypt sp 1	Sapling	Alive with dead top	Bleeding of main trunk. Possibly longicorn beetle attack.
	7	Eucalypt sp 1	Sapling	Dead main trunk re-sprouting from base.	Longicorn beetles ringbarking trunk of dead stem
	8	Eucalypt sp 2	Sapling	Healthy	Some dead branches with evidence of longicorn beetle attack.
	9	Eucalypt sp 1	Sapling	Healthy	
	10	Eucalypt sp 1	Sapling	Dead 1-2 yrs	
					Young plantings approx 10cm diameter on ridge site next to landscaped area. Grass understorey. Soil very shawl, loam overlying clay at 20cm. Possible landfill. Appears to be suffering from drought stress.

Mt Martha Foreshore @ Balcombe Creek (Banksia decline)

Four plots were established within the *Banksia integrifolia* woodland along the Mt Martha Foreshore at Balcombe Creek (Figure 16). Severe dieback of the mature Banksia was observed in three of the plots (Tables 6 and 7, and Figure 17). The deep sands on which the trees were growing was very dry.

Diagnosis: No pathogens were isolated from the sites of the dying banksias. Planted seedlings on the site were also showing signs of dieback (Figure 17B), the symptoms of which were generally consistent with drought. The presence of longicorn beetles was evident from the holes in the stem and in the presence of old galleries in the stump of a tree that had been removed (Figures 17 D & E). The presence of longicorn beetles often indicates the presence of a significant stress (e.g. drought). While no evidence of herbicide damage was observed, it cannot be discounted as Banksia deaths along the foreshore due to herbicide have been reported (Frankston City Council report http://www.frankston.vic.gov.au/library/scripts/objectifyMedia.aspx?file=pdf/72/73.pdf&siteID=3&str_title=Minutes%20-%20Ordinary%20Meeting%20-%20OM149%20-%2018%20September%202006.pdf).

Foliage and soil analysis indicated conditions that were not consistent with Mundulla Yellows, the probable cause of *Banksia integrifolia* decline at Wilson's Promontory (i.e. high pH and low levels of iron in the foliage). While foliage chloride levels were elevated they were similar to those found in healthier trees. It is probable that the cause of the decline is due to drought.

Prognosis: The older trees on the site may continue to exhibit further dieback until the drought breaks.

Recommendations:

1. Undertake management of the site to promote seedling regeneration and manage weeds. Where there is a lack of a seed source for sowing, seed may need to be sourced from other areas of healthy vegetation. Planting of the site is another possibility after the drought has broken, however again good site preparation is crucial for good growth of the seedlings and use of low P fertilisers for Banksia spp. may aid in their establishment.

Figure 16. Location of health assessment plots within Banksia decline on the Mt Martha Foreshore @ Balcombe Creek.

Figure 17. Dieback within the Mt Martha Foreshore @ Balcombe Creek. A) Plot 1, B) Dying planted seedling, C) Plot 2 and D & E) Borer damage, F) Plot 3 and G) Plot 4 Healthier Banksia.

Table 6 Results of testing of soil and foliage for agents contributing to the dieback at Mt Martha foreshore.

Plot	Tree Health	Foliage analysis												
		Total N g/kg	Total S g/kg	Total P g/kg	Total K g/kg	Total Ca g/kg	Total Mg g/kg	Total Na g/kg	Total Fe mg/kg	Total Mn mg/kg	Total Zn mg/kg	Total Cu mg/kg	Total B mg/kg	Total Al mg/kg
1	dieback	7.6	1.1	0.4	1.2	4.0	2.7	3.6	376.0	215.0	9.8	2.3	23.3	902.0
2	dieback	8.9	1.7	0.4	2.4	6.8	2.5	5.2	784.0	119.0	16.4	3.4	25.4	1070.0
3	dieback	9.1	1.7	0.5	3.0	3.2	1.3	5.3	292.0	71.0	11.8	3.9	37.3	481.0
4	healthy	9.3	1.7	0.4	2.1	4.7	2.2	7.5	373.0	129.0	11.9	3.4	39.3	844.0

Plot	Foliage Chloride	Soil pH			EC			Pathogens / pests observed tested
		Surface	Subsoil		Surface	Subsoil		
		0-10cm	40-50cm	90-100cm	0-10	40-50cm	90-100cm	
1	3.0	6.57	6.62	6.48	87.2	32.65	36.13	Longicorn beetles
2	5.6	7.69	7.6	7.82	104	164.2	100.4	Longicorn beetles
3	3.3	6.28	6.56	6.6	59.84	37.36	23.82	Longicorn beetles
4	5.7	7.47	6.59	6.98	53.94	99.7	107.7	Negative

Mt Martha Park

Three plots were established within the Mt Martha Park (Figure 18). Overall dieback within the reserve was patchy although previous fires in the North Western section of the Park has resulted in significant understorey growth (Figure19 B, C & D). Tree crowns were sparse (Figure 19). The soil on which the trees were growing was dry, although the clay at depth was still moist in one plots. *Phytophthora cinnamomi* was not isolated from the soil samples taken.

Diagnosis: Regeneration of eucalypts within the burnt sites was low suggesting either poor seedling establishment due to the drought, or poor seed availability (Figure 20C & D). The sparse crowns of the trees in plots appear to be indicative of browsing damage. *Eucalyptus pauciflora* appeared to be the main species affected. The probable cause of browsing animals is supported by the banded trees in one area of the park, which show significant crown recovery following the installation of the bands (Figure 20A).

Prognosis: Continued unsustainable browsing will result in further defoliation and dieback and eventual death of trees in the Park.

Recommendations:

1. In the burnt areas, supplementary planting of trees may be required to increase the number of trees in the area. Again good site preparation and fertiliser addition will aid in the establishment of trees and tree guards erected to prevent browsing damage.
2. The native vegetation represented in the plots, again need to be managed to remove weeds and promote natural seedling regeneration. The significant browsing in the area may need to be managed by either further banding of trees or management of the populations of the browsing animals. This may require further study to investigate population dynamics of the browsing animals to determine carrying capacity of the remnant vegetation. .

Figure 18. Location of health assessment plots within Mt Martha Park.

Figure 19. Dieback within the Mt Martha Park. A) Plot 1, B) Defoliation Plot 1, C) Plot 2, D) Defoliation Plot 2, E) Plot 3, F) Defoliation Plot 3

Figure 20. Tree recovery within the Mt Martha Park. A) Banded tree B) Recovery after fire C) & D) Understorey regeneration after fire; lack of eucalypt regeneration.

Table 7 Results of testing of soil and foliage for agents contributing to the dieback at Mt Martha Park.

Plot	Tree Health	Foliage analysis												
		Total N g/kg	Total S g/kg	Total P g/kg	Total K g/kg	Total Ca g/kg	Total Mg g/kg	Total Na g/kg	Total Fe mg/kg	Total Mn mg/kg	Total Zn mg/kg	Total Cu mg/kg	Total B mg/kg	Total Al mg/kg
1	dieback	13.7	1.4	1.0	6.4	7.5	2.1	1.2	65.5	1150.0	12.6	5.5	40.0	91.3
2	dieback	13.0	1.3	0.6	4.5	13.3	3.6	0.5	60.6	1280.0	12.4	3.6	62.1	76.1
3	dieback	14.1	1.5	0.7	5.2	9.6	1.4	2.1	111.0	876.0	19.7	4.9	35.0	133.0

Plot	Foliage Chloride	Soil pH			EC			Pathogens / pests observed tested
		Surface	Subsoil		Surface	Subsoil		
		0-10cm	40-50cm	90-100cm	0-10	40-50cm	90-100cm	
1	5.5	4.74			37.11			Longicorn beetles
2	3.9	4.89	5.4		69.75	33.61		Longicorn beetles
3	1.6	4.77	6.14		129	29.71		Longicorn beetles

Table 8 Assessment of tree health within the Mt Martha Park.

Plot	Tree No.	Species	Age	Health	Comments
1	1	E.pauciflora	Mature	Healthy	
	2	E.pauciflora	Mature	Dead	
	3	E.pauciflora	Mature	Healthy	
	4	E.pauciflora	Mature	Dead	Evidence of large canker on stem.
	5	E.pauciflora	Mature	Healthy	
	6	E.pauciflora	Mature	Healthy	
	7	E.pauciflora	Mature	Dieback	Sparse crown, some leaves on tips indicative of browsing
	8	E.pauciflora	Mature	Dieback	Sparse crown, some leaves on tips indicative of browsing
	9	E.pauciflora	Mature	Dieback	Sparse crown, some leaves on tips indicative of browsing
	10	E.sp1	Mature	Healthy	
					Soil silty loam overlying clay@30cm. Soil very dry. Understorey of Blackwood & Casuarinas.

Table 8 Assessment of tree health within the Mt Martha Park (Cont).

Plot	Tree No.	Species	Age	Health	Comments
2	1	E.pauciflora	Mature	Dead top, lower crown only	Understorey of Bracken.
	2	E.pauciflora	Mature	Poor crown, recovering	Understorey of Bracken. Banded
	3	E.pauciflora	Mature	Poor crown, recovering	Understorey of Bracken. Banded
	4	E.pauciflora	Mature	Poor crown, recovering	Understorey of Bracken. Banded
	5	E.pauciflora	Mature	Poor crown, recovering	Understorey of Bracken. Banded
	6	E.pauciflora	Mature	Dead. >2yrs	Understorey of Bracken.
	7	E.pauciflora	Smaller tree	Dead top poor crown.	Understorey of grass.
	8	E.pauciflora	Mature	Dead. >2yrs	Understorey of grass
	9	Eucalypt	Mature	3 trunks, 2 dead, one poor crown.	Understorey of grass
	10	E.pauciflora	Mature	Dead. >2yrs	Understorey of grass
					Soil silty-loam overlying clay @30cm. Plot next to walking track.

Table 8 Assessment of tree health within the Mt Martha Park (Cont).

Plot	Tree No.	Species	Age	Health	Comments
3	1	E1	Mature	Dieback	Crown tips only remain.
	2	E1	Sapling	Poor crown	
	3	E.pauciflora	Sapling	Poor crown	
	4	E.pauciflora	Mature	Poor crown	
	5	E.pauciflora	Mature	Healthy	
	6	E.pauciflora	Mature	Healthy	
	7	E7	Mature	Dieback	
	8	E10	Mature	Poor crown	
	9	E10	Mature	Poor crown	
	10	E10	Mature	Healthy	
					Plot along road. Understorey of Black Wattle, Casuarina, some sallow wattle, sedges and bracken. Soil dry, 50 cm over clay. Clay moist. Crowns appear to have been browsed

Woods Reserve

Three plots were established within Woods Reserve (Figure 21). Overall dieback within the reserve was low with only a few patches observable (Tables 9 and 10, Figures 22). The soil on which the trees were growing was very dry. *Phytophthora cinnamomi* was not isolated from the soil samples taken.

Soils were dry and of silt overlying clay and again relatively shallow. The presence of Gahnia on some sites suggested possible waterlogging in some areas. The area is being invaded by *Pittosporum undulatum.*

Diagnosis: The general health of the site is relatively good. The concentrations of chloride in the foliage of trees in the areas showing dieback are at levels considered to be detrimental to the health of the trees (Table 9). The relatively low levels of EC in the soil would suggest that either chloride is accumulating in the foliage due to the drought or that the trees are accessing water at depth that is salty. Phytophthora was not isolated from the soil, however the species affected suggest that it may be present. It often difficult to detect the pathogen during drought.

The underlying factor associated with the dieback is probably drought.

Prognosis: With a return to normal rainfall patterns the salinity issues should subside. However of concern is the invasion of the site with Pittosporum. It will provide habitat into the future which could become a haven for Bellbirds and potential future BMAD.

Recommendations:

1. The native vegetation sites again need to be managed to remove significant weeds and promote natural seedling regeneration. The site was scheduled for burning (Figure 22F).
2. Simple hygiene measures (i.e. clean on entry) should be introduced to reduce the possibility of introduction of *Phytophthora*.
3. Further soil sampling of the dieback sites following a return to normal rainfall to confirm the absence of *Phytophthora*.

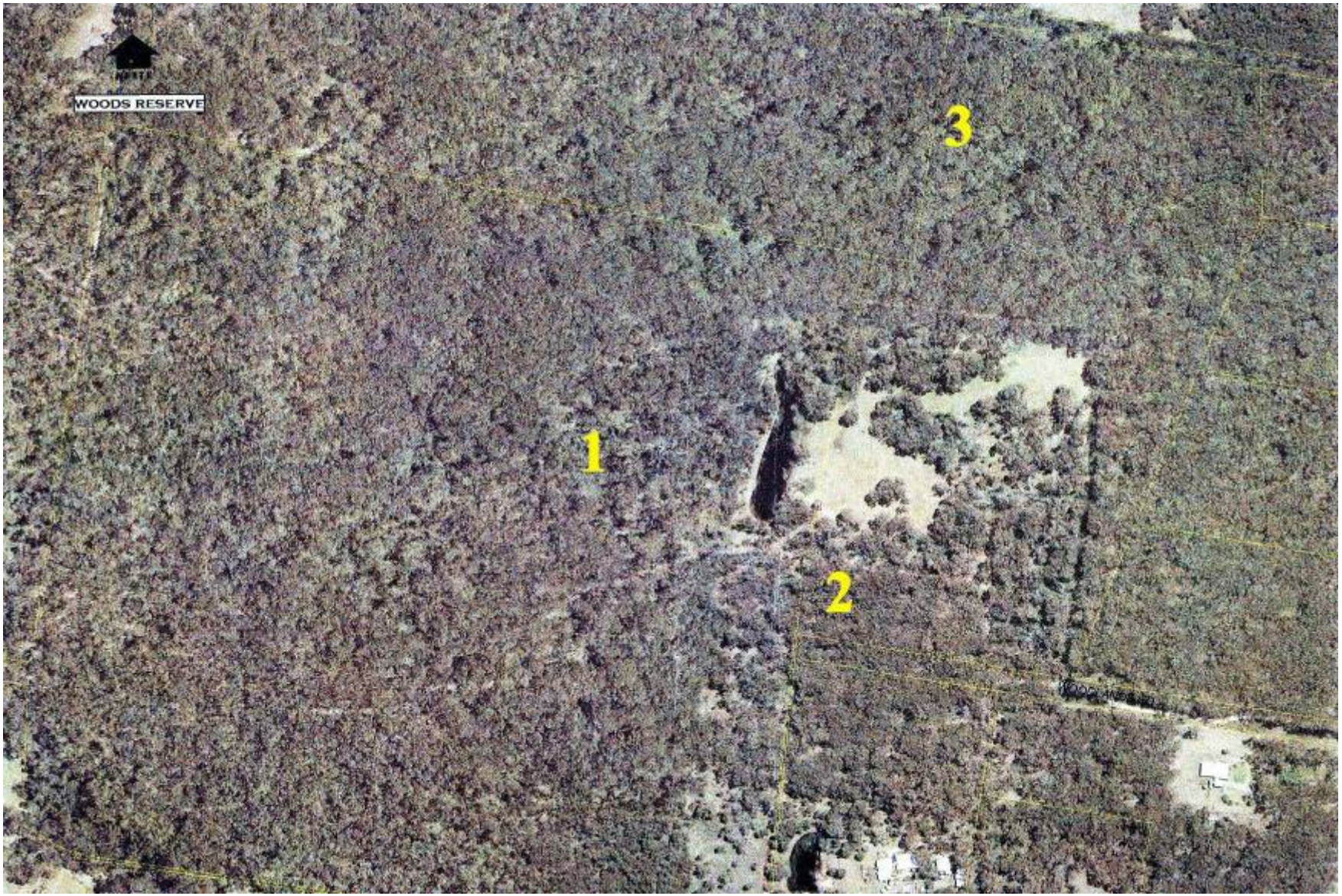

Figure 21. Location of health assessment plots within Woods Reserve.

Figure 22. Dieback within the Woods Reserve. A) Plot 1, B) Plot 2, C) Plot 3 D) Build up of Pittosporum understorey. E) Differences in understorey may reflect F) fire history.

Table 9 Results of testing of soil and foliage for agents contributing to the dieback at Woods Reserve.

Plot	Tree Health	Foliage analysis												
		Total N g/kg	Total S g/kg	Total P g/kg	Total K g/kg	Total Ca g/kg	Total Mg g/kg	Total Na g/kg	Total Fe mg/kg	Total Mn mg/kg	Total Zn mg/kg	Total Cu mg/kg	Total B mg/kg	Total Al mg/kg
1	dieback	13.9	1.4	0.6	4.6	7.2	2.6	2.5	75.8	564.0	16.9	5.7	33.9	103.0
2	dieback	12.2	1.3	0.7	5.1	5.6	3.0	2.5	65.6	679.0	13.0	4.9	30.8	89.2
3	dieback	9.6	1.2	0.6	7.5	8.6	3.4	4.2	49.7	452.0	17.3	6.7	24.5	58.6

Plot	Foliage Chloride	Soil pH			EC			Pathogens / pests observed tested
		Surface	Subsoil		Surface	Subsoil		
		0-10cm	40-50cm	90-100cm	0-10	40-50cm	90-100cm	
1	8.3	5.5	5.75	5.82	20.17	8.61	40.61	negative
2	6.5	4.96	5.4	5.22	88.1	45.31	53.48	negative
3	10.8	4.96	5.57		32.97	15.07		negative

Table 10 Assessment of tree health within Woods Reserve.

Plot	Tree No.	Species	Age	Health	Comments
1	1	E. (Peppermint?)		Dead	
	2	Smooth bark top sp1 Rough Bark			
	3	Smooth bark top sp2 Rough Bark Narrow leaf		Dying Top	
	4	Peppermint?		Dead	
	5	Smooth		Healthy	
	6	Peppermint		Dead >2yrs	
	7	E.O?		Dead >2yrs	
	8	E.O		Dead >2yrs	
	9	E.O		Dead >2yrs	
	10	E.O	Sapling	Healthy	
					Silt overlying clay @40cm impeding layer. Understorey Gahnia, Acacia armata, Bracken.

Table 10 Assessment of tree health within Woods Reserve. (Cont).

Plot	Tree No.	Species	Age	Health	Comments
2	1	EO?		Dead	
	2	Esp1		Healthy	
	3	EO?		Dead	
	4	EO?		Dead	
	5	EO?		Dead	
	6	EO?		Healthy	
	7	EO?		Dead	
	8	EO?		Healthy with some tip dieback	
	9	EO?		Dead	
	10	EO?		Dead	
					Soil, silty overlying clay 30cm. Clay moist. Large mistletoe in some trees. Lot young wattle growth. Fire in past?

Table 10 Assessment of tree health within Woods Reserve. (Cont).

Plot	Tree No.	Species	Age	Health	Comments
3	1	Peppermint		Healthy	
	2	Peppermint		Healthy	
	3	Messmate		Dieback in tips	
	4	Messmate		Dieback in tips	
	5	Peppermint		Suppressed	
	6	Messmate		Some dieback in tips	
	7	Messmate		Some dieback in tips	
	8	Messmate		Healthy	
	9	Messmate		Healthy	
	10	Peppermint		Healthy	
					Bracken understorey with some sedges. Edge shows Pittosporum invading site. Soil, silt overlying clay, shallow only 25 cm. Soil dry.

Warringine Park

Three plots were established within Warringine Park (Figure 23). Dieback within the reserve was patchy and confined primarily to the older trees present on the site (Tables 11 & 12 and Figure 24). Soils were very dry and of a sandy clay and relatively shallow. While some minor pests and leaf pathogens were noted, no root pathogens were isolated from the soil. Several weeds were present on the site including blackberry and gorse although evidence of herbicide spraying to control the weeds was noted. Soils were dry and of silt overlying clay and again relatively shallow suggesting possible waterlogging in some areas.

Diagnosis:

The general health of the site is relatively good. The concentrations of chloride in the foliage of trees in the areas showing dieback were again at levels considered to be detrimental to the health of the trees (Table 11). The relatively low levels of EC in the soil would suggest that either chloride is accumulating in the foliage due to the drought or that the trees are accessing water at depth that is salty. *Phytophthora* was not isolated from the soil and the presence of healthy saplings of species that are susceptible to the pathogen would confirm the absence of the pathogen. The underlying factor associated with the dieback is probably drought.

Prognosis:

With a return to normal rainfall patterns the salinity issues should subside.

Recommendations:

1. The native vegetation sites again need to be managed to remove significant weeds and promote natural seedling regeneration.
2. Simple hygiene measures (i.e. clean on entry) should be introduced to reduce the possibility of introduction of *Phytophthora*. .

Figure 23. Location of health assessment plots within Warringine Park.

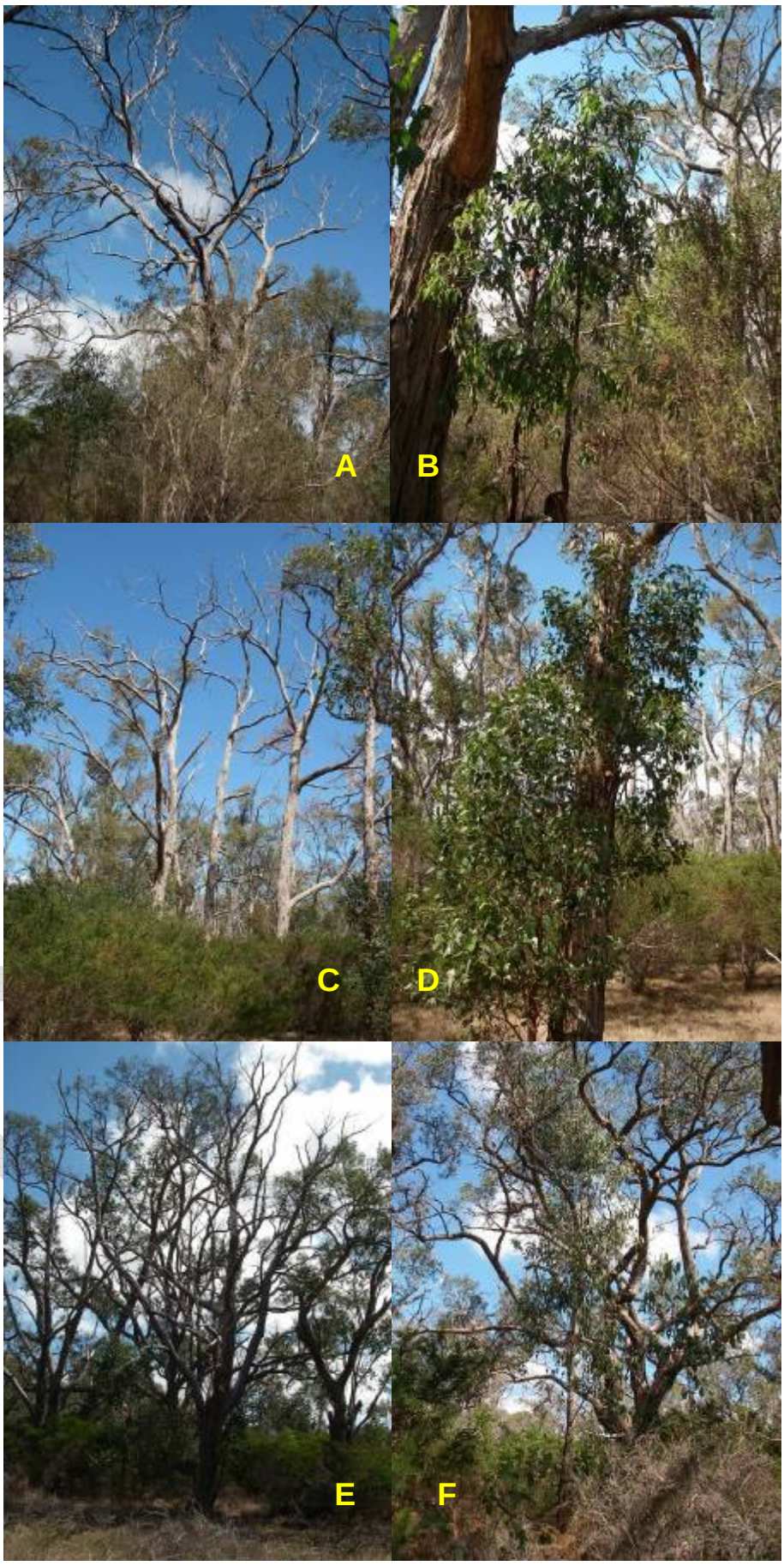

Figure 24. Dieback within Warringine Park. A) Plot 1, C) Plot 2, E) Plot 3, B), D) F) Sapling regeneration.

Table 11 Results of testing of soil and foliage for agents contributing to the dieback at Warringine Park.

Plot	Tree Health	Foliage analysis												
		Total N g/kg	Total S g/kg	Total P g/kg	Total K g/kg	Total Ca g/kg	Total Mg g/kg	Total Na g/kg	Total Fe mg/kg	Total Mn mg/kg	Total Zn mg/kg	Total Cu mg/kg	Total B mg/kg	Total Al mg/kg
1	dieback	13.7	1.3	0.6	3.4	5.5	3.0	1.6	63.2	440.0	14.2	3.2	18.5	81.7
2	dieback	15.9	1.4	0.7	3.9	5.5	3.2	1.2	77.8	461.0	12.9	3.7	27.6	99.4
3	dieback	12.5	1.2	0.5	3.7	4.3	1.9	3.5	92.1	294.0	10.8	2.2	18.2	122.0

Plot	Foliage Chloride	Soil pH			EC			Pathogens / pests observed tested
		Surface	Subsoil		Surface	Subsoil		
		0-10cm	40-50cm	90-100cm	0-10	40-50cm	90-100cm	
1	5.5	5.6	6	6.13	57.97	30.7	56.56	negative
2	4.3	5.5	6	6.14	47.83	25.56	22.68	negative
3	6.2	5.55	5.67	5.6	47.5	58.87	73.63	negative

Table 12 Assessment of tree health within Warangine Park.

Plot	Tree No.	Species	Age	Health	Comments
1	1	Messmate	Mature >100cm diameter	Dead >2yrs	2 young healthy messmate and one healthy peppermint seedlings growing beside trunk. Some Mycosphaerella on leaves. Understorey of dogwood and *Acacia armata*. Dead blackberry indicating past spraying?
	2	Messmate	Mature	Dead > 2yrs	Surrounding Messmate seedlings healthy.
	3	Messmate	Mature	Dying back	Large tree
	4	Messmate	Mature	2 stems, 1 dead some dieback in 2nd.	
	5	Peppermint	Mature	Healthy 2 stems, one with some dieback	Large tree
	6	Euc sp 3	Mature	Multiple stems. 1 dead top	
	7	Messmate	Mature	Some dieback	
	8	Messmate	Mid size	Dead	Edge of grassland (exposed)
	9	Peppermint	Seedlings	Several healthy regeneration	Some bleeding on some seedlings but relatively healthy
	10	Messmate	Mature	Dieback, 2 stems light crown	
					Soils, silty loam overlying clay@30cm. Flat site possibly experiencing periodic waterlogging.

Table 12 Assessment of tree health within Warangine Park. (Cont).

Plot	Tree No.	Species	Age	Health	Comments
2	1	Messmate	Mature	Dead > 2yrs	Understorey of grassland and *Acacia armata.*
	2	Messmate	Mature	Dead > 2yrs	
	3	Messmate	Mature	Dying, dieback	Some bleeding trunk possibly indicating longicorn beetle attack.
	4	Messmate	Mature	Some dieback	Epicormic shoots.
	5	Messmate	Mature	Light Crown, dieback	Fire scar.
	6	Peppermint	Mature	2 stems, Healthy	Some insect attack
	7	Messmate	Mature	Some dieback	Mycosphaerella Leaf Disease present.
	8	Messmate	Mature	Dead <1yr	
	9	Messmate	Mature	Dead <1yr	
	10	Messmate	Mature	Thin crown with dieback	
					All with some insect attack and Mycosphaerella leaf disease. Shallow soil sandy loam with clay @20 cm, periodic waterlogging?. Understorey of grassland and *Acacia armata.* Blackberries all dead due to spraying?

Table 12 Assessment of tree health within Warangine Park. (Cont).

Plot	Tree No.	Species	Age	Health	Comments
3	1	Messmate	Mature	Dead	Edge of grassland, understorey grassland, tea tree, blackberry (dead), acacia armata. Healthy eucalypt seedlings next to tree.
	2	Messmate	Mature	Some dieback	Large tree
	3	Messmate	Mature	Some dieback	Tree multiple stems
	4	Messmate	Mature	Light crown	Possible insect damage to leaves. Gorse understorey. Healthy Messmate seedlings.
	5	Messmate	Mature	Healthy	Good crown with some tip dieback
	6	Messmate	Mature	Dead	Next to grasslands
	7	Messmate	Mature	Mainly dead with 1 branch still alive.	
	8	Messmate	Mature	Light crown, some dieback	One branch still alive.
	9	Messmate	Mature	Healthy some dieback	
	10	Peppermint	Mature	Healthy	
					Soil shallow, sandy loam @ 20cm. Blackberries and Gorse sprayed? Several healthy messmate seedlings.

Tyrone Reserve

Three plots were established within Tyrone Reserve (Figure 25). Overall dieback of *Leptospermum laevigatum* within the reserve was extensive with no living individuals of either old or young plants observed within the centre of the reserve. Plants on the edge of the reserve are showing signs of interveinal chlorosis. Other species (e.g. Moonah, *Melaleuca lanceolata*) are also beginning to show symptoms of decline within the reserve (Tables 13 & 14 and Figure 26). The soil on which the trees were growing was very dry and had a high pH in both the sick (Figure 26) and healthy areas (Figure 27). Chloride levels in the sick plots was higher than the healthy. No pathogens were isolated from the soil samples taken. No regeneration of Leptospermum was observed.

Diagnosis: No pathogens were isolated from the sites of the dead and dying Leptospermum. The symptoms resemble that of Mundulla Yellows of eucalypts the causes of which are yet to be elucidated, but appear to be associated with soils that have high pH and salinity. The time frame for the appearance of the symptoms (i.e. over the last 10years) is similar to that observed for Mundulla Yellows. It is probable that the drought is playing a significant role in the development of the symptoms.

Prognosis: Mortality of the surviving trees will continue until the drought breaks. The dieback may also extend to include the Moonah trees on the site.

Recommendations:

1. Undertake management of the site to promote seedling regeneration through ecological burning. However the high fuel loads on the site will need to be managed carefully due to the close proximity to residential housing. Where there is a lack of a seed source for sowing, seed may need to be sourced from other areas of healthy vegetation. If planting of the site is preferred, then good site preparation is essential to get good seedling establishment. Fertilisers used for establishment will need to include iron chelates to help to reduce the impact of Mundulla Yellows on the growth and survival of the seedlings.

Figure 25. Location of health assessment plots within Tyrone Reserve.

Figure 26. Dieback within Tyrone Reserve. A) Plot 1, B) Plot 1 Sparse foliage, C) Plot 2 D) Plot 3, E) Dying Moonah, F) Interveinal chlorosis of *Leptospermum* foliage.

Figure 27. Healthy *Leptospermum* in park opposite cnr Fern Gv. and Milton Rd. 500 m east of Tyrone Reserve.

Table 13 Results of testing of soil and foliage for agents contributing to the dieback at Tyrone Reserve.

Plot	Tree Health	Foliage analysis												
		Total N g/kg	Total S g/kg	Total P g/kg	Total K g/kg	Total Ca g/kg	Total Mg g/kg	Total Na g/kg	Total Fe mg/kg	Total Mn mg/kg	Total Zn mg/kg	Total Cu mg/kg	Total B mg/kg	Total Al mg/kg
1	dieback	8.6	1.3	0.6	4.3	6.5	1.2	2.5	55.6	27.6	18.2	2.0	36.6	38.5
2	dead													
3	dieback	13.8	2.0	0.7	4.5	8.6	3.2	4.0	105.0	25.6	27.3	2.0	49.6	110.0
4	healthy	9.5	1.3	0.7	3.7	5.3	1.9	1.8	57.4	24.9	14.5	1.5	43.8	51.4

Plot	Foliage Chloride	Soil pH			EC			Pathogens / pests observed tested
		Surface	Subsoil		Surface	Subsoil		
		0-10cm	40-50cm	90-100cm	0-10	40-50cm	90-100cm	
1	3.3	8.28	8.83	9.05	125.9	74.45	69.86	negative
2	NA	8.46	8.61	8.86	95.7	72.74	68.84	negative
3	5.2	8.21	8.71	8.9	101	68.35	63.085	negative
4	2.2	8.18	8.67	8.8	242.9	191.1	237.3	negative

Table 14 Assessment of tree health within the Lorikeet Reserve Mt Eliza.

Plot	Tree No.	Species	Age	Health	Comments
1	1	Leptospermum laevigatum	Mature	Leaf Interveinal chlorosis	
	2	Leptospermum laevigatum	Mature	Leaf Interveinal chlorosis	
	3	Leptospermum laevigatum	Mature	Leaf Interveinal chlorosis	
General Comments					On north edge of reserve by road. Deep sands
2	1	Leptospermum laevigatum	Mature	Dead > 1 Yr	
	2	Leptospermum laevigatum	Sapling	Dead > 1 Yr	
	3	Leptospermum laevigatum	Sapling	Dead > 1 Yr	.
General Comments					In Middle of reserve all trees dead. Many fallen. A lot of fuel on ground. No tea tree seedlings observed. Moonah also showing some interveinal chlorosis. Deep sands
3	1	Leptospermum laevigatum	Mature	Leaf Interveinal chlorosis	
	2	Leptospermum laevigatum	Mature	Dead > 1yr	
	3	Leptospermum laevigatum	Mature	Leaf Interveinal chlorosis	
General Comments					On south edge of reserve. Deep sands
4	1	Leptospermum laevigatum	Mature	Healthy	Other sick tea tree nearby.
General Comments					In park opposite cnr Fern Gv. and Milton Rd. 500 m east of Tyrone Reserve. Deep sands

6. COMPILED RECOMMENDATIONS

Lorikeet Reserve

1. Undertake management of the site to promote natural seedling regeneration and thus selection for resistance amongst species susceptible to *P. cinnamomi.* This may be achieved through the implementation of a fire plan for the site that is more in balance with natural biological processes. However given the proximity to residential areas and a school, this may be difficult to achieve, although dividing the site into several smaller blocks may help. If planting, then use only species that are tolerant of the pathogen. Ensure good site preparation preferably using ripping to a depth of at least 50cm where possible, followed by disc plough or rotary hoe over the rip line to cultivate the site. Also ensure good weed control and following planting in winter, apply Pivott 800 fertilizer in October (375g/tree) applied in a ring out to 30 cm from the seedling. Tree guards to be erected around each seedling to prevent browsing damage.
2. When works are carried out on the site leading to soil adhering to vehicles and machinery, then hygiene arrangements (e.g. washdown), should be carried out prior to movement to another site so as to limit the spread of *P. cinnamomi* (see Appendix 1).

Mt Eliza Regional Park

1. The native vegetation sites again need to be managed to remove significant weeds and promote natural seedling regeneration. The implementation of a fire plan for the site that is more in balance with natural biological processes may provide the method for this to be achieved. Again the proximity of the site to residential areas may make this difficult to achieve. Where planting, use only species that are tolerant of drought and Phytophthora cinnamomi. Ensure good site preparation preferably using ripping to a depth of at least 50cm where possible, followed by disc plough or rotary hoe over the rip line to cultivate the site. Also ensure good weed control and following planting in winter, apply Pivott 800 fertilizer in October (375g/tree) applied in a ring out to 30 cm from the seedling. Tree guards to be erected around each seedling to prevent browsing damage.
2. Due to the presence of *P.cinnamomi* in the area, works carried out on the site leading to soil adhering to vehicles and machinery, will require hygiene arrangements (e.g. washdown), to be implemented prior to movement to another site so as to limit the spread of the pathogen. (Appendix 1).

Mt Martha Foreshore @ Balcombe Creek (Banksia decline)

1. Undertake management of the site to promote seedling regeneration and manage weeds. Where there is a lack of a seed source for sowing, seed may need to be sourced from other areas of healthy vegetation. Planting of the site is another possibility after the drought has broken, however again good site preparation is crucial for good growth of the seedlings and use of low P fertilisers for Banksia spp. may aid in their establishment.

Mt Martha Park

1. In the burnt areas, supplementary planting of trees may be required to increase the number of trees in the area. Again good site preparation and fertiliser addition will aid in the establishment of trees and tree guards erected to prevent browsing damage.
2. The native vegetation represented in the plots, again need to be managed to remove weeds and promote natural seedling regeneration. The significant browsing in the area may need to be managed by either further banding of trees or management of the populations of the browsing animals. This may require further study to investigate population dynamics of the browsing animals to determine carrying capacity of the remnant vegetation. .

Woods Reserve

1. The native vegetation sites again need to be managed to remove significant weeds and promote natural seedling regeneration. The site was scheduled for burning.
2. Simple hygiene measures (i.e. clean on entry) should be introduced to reduce the possibility of introduction of *Phytophthora*.
3. Further soil sampling of the dieback sites following a return to normal rainfall to confirm the absence of *Phytophthora*.

Warringine Park

1. The native vegetation sites again need to be managed to remove significant weeds and promote natural seedling regeneration.
2. Simple hygiene measures (i.e. clean on entry) should be introduced to reduce the possibility of introduction of *Phytophthora*. .

Tyrone Reserve

1. Undertake management of the site to promote seedling regeneration through ecological burning. However the high fuel loads on the site will need to be managed carefully due to the close proximity to residential housing. Where there is a lack of a seed source for sowing, seed may need to be sourced from other areas of healthy vegetation. If planting of the site is preferred, then good site preparation is essential to get good seedling establishment. Fertilisers used for establishment will need to include iron chelates to help to reduce the impact of Mundulla Yellows on the growth and survival of the seedlings.

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APPENDIX 1: PROCEDURES FOR COLLECTING SOIL SAMPLES FOR TESTING FOR *PHYTOPHTHORA CINNAMOMI*

Soil and Plant Testing for *Phytophthora cinnamomi*

SENDERS NAME:

SENDERS ADDRESS:

DATE DESPATCHED: **YOUR REF:**

ORDER NUMBER: **OUR REF:**

INSTRUCTIONS:

1. Collecting soil samples: at each location to be tested, 5 sub-samples containing approximately 200 grams each (a handful) should be excavated from the top 15 cm (6") of soil from beneath diseased vegetation. The 5 sub-samples should be pooled together in a plastic bag which has been labelled clearly with a non-water soluble marking pen. To enhance detection of the pathogen, samples should be moist and include small root pieces. For gravel pits collect sub-samples from around the edge of the gravel pile to be used, and at least one sample from the lowest point in the pit and from any surrounding diseased vegetation where drainage into the pit may occur.
2. Collecting plant samples: at each location to be tested, include in a plastic bag some of the fine roots, main root and a portion of any dark stained wood at the base of the stem of plants that have recently died. Label clearly as for soil samples.
3. Precautions:

   (a) avoid collecting samples when average soil temperatures are less than 10^{o} or when the soil or gravel is completely dry. The temperature of the samples should be kept between 10^{o} and 25^{o} C. Thus in summer, samples should be transported in an insulated container.

   (b) to avoid contamination, the trowel or spade used for collecting the samples should be thoroughly cleaned after each collection is made. Use of a quat disinfectant (e.g. 2 % Phytoclean, www.phytoclean.com.au) is recommended. Rinse spade in water after disinfecting.

   (c) transport samples to testing laboratory as soon as possible.
4. Description of environment (if available): to assist in interpreting the results, please include the following information in the table. Use the following ratings to fill in the table.

	RATING			
PARAMETER	1	2	3	4
(a) Plant health.	Healthy.	Dying.	Dead.	Soil/gravel only.
(b) Soil texture.	Sand.	Clay.	Silt.	Loam.
(c) Soil colour.	Grey.	Brown.	Red.	Yellow.
(d) Surface drainage.	Permanently waterlogged	Occasionally waterlogged	Well drained.	Irrigated.
(e) Topography.	Flat.	Gully.	Slope.	Ridge.
(f) Sample condition when collected	Dry.	Moist.	Wet.	

Sample Number	Date Collected	Location/* GPS	Dominant Plant Species Overstorey	Dominant Plant Species Understorey	Plant Health	Soil Texture	Soil Colour	Surface Drainage	Topography	Sample Condition	Result

Comments:

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* GPS reading if available.

Containers carrying the samples should be marked ***Phytophthora* Test** and sent to:

Forest Pathology Laboratory
School of Forest and Ecosystem Science
University of Melbourne, C/o DSE
123 Brown St
Heidelberg 3084, (03) 9450 8647

Tested by:_____ Date:_____

NOTE: **There are charges per sample.**
(Check current rates before sending)