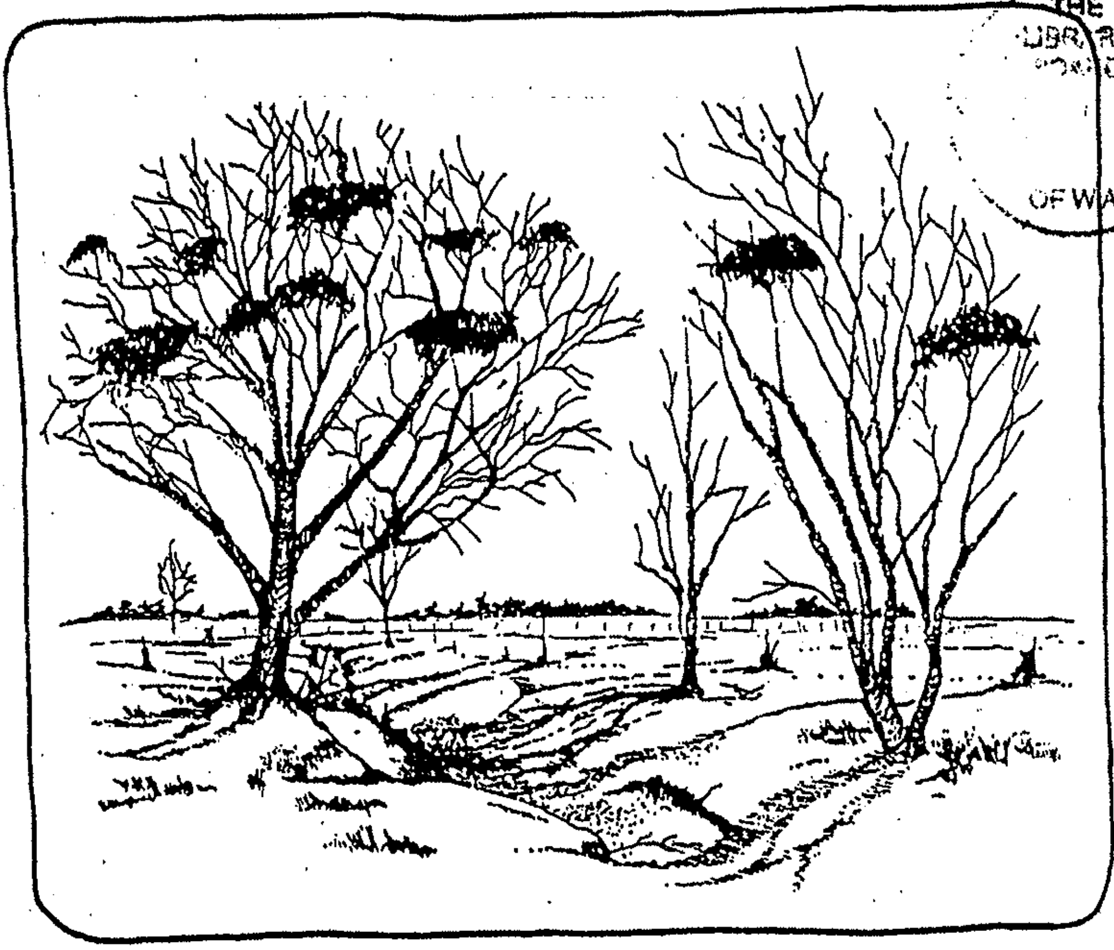
TREE HEALTH SURVEY



TAMMIN and WYALKATCHEM SHIRES: 1983

TREE HEALTH SURVEY - TAMMIN & WYALKATCHEM SHIRES

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SUMMARY:

A survey of tree death was conducted throughout the Shires of Tammin and Wyalkatchem. 1172 trees were assessed at 112 sample points, 45% of these trees showed symptoms of decline.

The decline appeared to be of recent origin, having started perhaps 10 to 15 years previously.

Introduced species and the native Eucalyptus sheatheana had markedly fewer decline symptoms than the seven other native eucalypt species assessed.

Tree decline showed a positive association with tree age, bitumen road verges, and heavy soils.

Suspected causes of decline were, in decreasing order of importance, weedkillers, drought, salinity, physical damage, insect damage, old age and fire.

No cause for decline was apparent in 33% of the trees showing symptoms.

Some recommendations are made for the alleviation of tree decline in the area, and for further exploratory work on the causes of the decline.

1. INTRODUCTION

Tree decline in rural Australia is a subject of concern to both farmers and foresters. This concern is reflected in tree decline being the subject of two seminars in the Eastern States in 1980, and a 'Trees in the Rural Landscape' Conference in Western Australia in 1981. 'The Bulletin' took up the subject in its issue of 9th November 1982.

Rural tree decline in Western Australia, and in Queensland, appears to be of more recent origin than in Victoria and New South Wales.* This gives weight to the assertion that it is associated with clearing and farming activities. These activities have had a greater impact in the longer-settled and more populous states.

Although the gross association between man's rural activities and tree decline is obvious, the direct causes of decline are not so easily determined. The survey reported here is an attempt to find associations between tree decline and various natural and man-made factors, and to pin-point areas of interest where further investigation is warranted.

The Shires of Wyalkatchem and Tammin were selected for the survey as both Councils had expressed extreme concern at tree decline, and both Shires are representative of the Central Wheat Belt.

2. METHOD

2.1. The selection of sampling sites.

A route was selected from 1:40,000 black and white aerial photographs covering the full range of topographical features and vegetation types.

Sample points were selected from ground survey along this route.

2.2. The method of assessment.

After location of a sample point on the ground the 10 (range 9 - 15) trees nearest to it were assessed for their health, and various environmental and other factors were recorded. These attributes are listed in Appendix 1. Information was recorded individually for each tree.

A total of 1172 trees was assessed at 112 sample points during the period February 28 to March 4, 1983.

2.3. Recording and processing data.

Attributes of each tree and sample point were recorded directly onto computer sheets. The data was processed by computer using an SPSS* programme which indicated possible associations between the recorded attributes.

(* Statistical Package for the Social Sciences - developed by the Vogelback Computing Centre, Northwestern University U.S.A.).

3. RESULTS

3.1. Tree decline in the surveyed area.

3.1.1. Extent of decline.

Of the 1172 trees assessed in the survey, 528 (45%) showed symptoms of decline. These symptoms ranged from discoloured or dead leaves, through massive dieback in the crown, to dead trees which accounted for 2.8% of the total.

Apart from variations between land-use strata, which will be discussed later, declining trees appeared to be fairly evenly distributed over the area of the survey.

3.1.2. How far have the trees declined.

An assessment of the percentage of the crown affected on declining trees is shown in Table 2.

Table 2

Degree of Decline

(Healthy Trees excluded)

Degree of Decline	No. of Trees	Percentage
Up to ¼ crown affected	177	33.5
¼ to ½ " "	130	24.6
½ to 3/4 " "	102	19.3
Entire crown affected	86	16.3
Dead	33	6.3
TOTAL	528	100.0

If it can be assumed that the decline is a progressive process, the data in Table 2 suggests that is may be of relatively recent origin.

This aspect is pursued further in the following section.

3.1.3. Period Since the Decline Started.

Decline in the crown of a tree takes place in stages. Firstly the leaves die and are shed, followed by the death and shedding of twigs and progressively larger branches. The stage of decline reached was recorded for each tree, and related to the number of years which, in the assessors experience, it would take to reach that particular stage. A summary of the number of trees in various stages of decline is shown in Table 3.

Table 3

Stages of Decline and Estimated Period (Healthy Trees excluded)

Symptoms	Estimates Period of decline (Yrs)	Number of Trees	Percentage
Leaves discoloured or dead	current	114	21.6
Leaves shed, twigs green	1	147	27.8
Fine twigs shed	3	117	22.1
Branches up to 2cm diameter shed.	5	119	22.5
Branches of 5cm diameter and more shed.	10 - 15 +	31	6.0
TOTALS		528	100.0

The figures in Table 3 suggest that extensive tree decline is a relatively recent phenomenon, and that the majority of symptoms have appeared within the last 10 years to 15 years.

3.1.4. How Various Tree Species are Affected.

The survey covered a total of 22 species of tree, 20 of them being eucalypts.
Twelve species were represented in such low numbers (less than 30 individuals) that the information collected on them is unreliable. They accounted for a total of 49 trees. The amount of decline found in the remaining 11 species is listed in Table 4.

Table 4

Decline by Species

Species	Number Assessed	Number showing decline symptoms	Percentage showing decline
Eucalyptus camaldulensis	123	25	20.3
E. cladocalyx	30	9	30.0
E. erythronema	47	20	42.6
E. flockontiae	68	30	44.1
E. longicornis	52	31	59.6
E. loxophleba	261	121	46.4
E. salmonophloia	193	86	44.6
E. salubris	171	108	63.2
E. wandoo (inland)	105	68	64.8
E. sheatheana	73	20	27.4

The worst affected species were wandoo (*E. wandoo*) gimlet (*E. salubris*) and red morrel (*E. longicormis*) The least affected native species was ribbon gum (*E. sheatheana*).

Both river gum (*E. camaldulensis*) and sugar gum (*E. cladocalyx*) showed low levels of decline. Neither is native to the area and all the trees had been planted. Their resistance to decline should not be automatically assumed as, due to their origin, their average age is considerably less. than that of other species. The effect of tree age on decline is discussed in a later section.

3.1.5. Decline related to Tree Age

The size of each tree, relative to its size at maturity, was assessed and used as an index of its age class. The division into age classes was as follows:-

Sapling/pole	-	a young tree less than about 20 years old.
Immature	-	a tree of a height approaching that of a mature tree, but with an incomplete spread of the crown.
Mature	-	A wide-crowned tree with heavy branches.
Overmature	-	A tree of large size with evidence of lon standing deaths of large branches.

The relationship between tree decline and age is shown in Table 5.

Table 5

Decline Related to Tree Age

Age Class	Number of Trees Assessed	Number showing decline	Percentage with decline
Sapling/pole	159	29	18.2
Immature	227	76	33.5
Mature	708	384	54.2
Overmature	29	29	100.0

(Note - species represented by less than 30 individuals are excluded from this table).

A strong correlation appears between decline and tree age in Table 5. The increasing level of decline with increasing age can be explained from two aspects. Firstly it can be regarded as natural that old trees past their prime should enter a period of senescence during which their crowns will decline. Secondly, the older the tree, the less adaptable it is likely to be to changes in its environment.

3.1.6. Suspected Causes of the Decline.

Whenever a cause of decline in a tree was apparent, it was recorded. A list of suspected causes and the percentage of trees affected by them is given in Table 6.

Table 6

Suspected Causes of Tree Decline

Suspected Cause	Number of Trees	Percentage
Fire	10	1.9
Old Age	27	5.2
Insect damage	32	6.2
Physical damage by man	44	8.5
Salinity	46	8.9
Drought	77	14.9
Weedkillers	110	21.2
None apparent	172	33.2
TOTAL	518	100.0

The reliability of the suspected causes is variable. In some cases, for example drought, the decision that this factor caused the decline is somewhat subjective and based on circumstantial evidence. In other cases, for example fire, insect damage, and weedkillers, the symptoms are distinctive. In one third of the trees there was no cause apparent for their decline. This suggests a need for more detailed examination.

3.2. Associations between tree decline and land use.

3.2.1. Land use and Tree decline

Table 7 gives a broad review of the association of tree decline with land-use.

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Table 7

Land-use and Tree Decline

Land-Use	Number of Trees assessed	Number of trees showing decline	Percentage of trees showing decline
Woodland	261	114	43.7
Crop/Pasture	136	60	44.1
Railway verges	39	18	46.2
Bitumen Rd verges	160	99	61.9
Gravel Rd. verges	452	195	43.1
Water pipeline	27	10	37.0
Townsite	48	22	45.8

(Note - this table excludes species represented by less than 30 individuals).

The percentage of trees showing symptoms of decline is very similar in areas of various land-use with the exception of bitumen road verges. On this site tree decline is 50 percent greater than elsewhere. Probable reasons for this difference will be discussed in a later section.

3.2.2. Causes of Decline and Land-Use.

Although the percentage of trees showing symptoms of decline is fairly uniform over the range of land uses identified in the survey (with the exception of a higher level on bitumen road verges), the causes of decline vary. (Table 8)

Table 8

Causes of Tree Decline and Land-use

(showing percentages of decline attributed to various causes)

ected e of ine	Land-Use						
	Wood-land	Crop/ pasture	Railway verge	Bitumen Rd. verge	Gravel Road Verge	Water Pipe-line	Townsite
Fire	8.8	0	0	0	0	0	0
Age Old Age	8.8	10.0	0	4.0	3.6	0	0
cts Insects	0	0	0	15.2	8.7	0	0
al e Physical Damage	4.4	16.7	16.7	15.2	5.1	0	4.5
nity Salinity	0	6.7	0	10.1	16.4	0	0
ght Drought	47.4	13.3	0	7.1	4.1	0	0
killers Weed Killers	0.9	21.7	72.2	11.4	16.4	90.0	91.0
None apparent	29.8	31.7	11.1	26.3	45.6	10.0	4.5
of Declined s	114	60	18	99	195	10	22

In woodlands, crop and pasture, and on road verges the cause of a significant proportion (average 36%) of tree decline was not apparent. Significant apparent causes for decline were, nevertheless, observed in all land-use categories and are summarised as follows:-

Woodland - a high proportion of tree decline was attributed to drought.

Crop and Pasture - drought accounted for 13 percent, physical damage and weedkillers together accounted for 40 percent of tree decline

Road verges (bitumen and gravel) - these sites appeared to confer a wider range of adverse effects on trees, leading to their decline, than any of the other land-uses. Salinity, although apparently more associated with roads than with other land uses, does not have more influence on roadside trees. The figures are inflated by the tendency of some roads to follow drainage lines where salinity is prevalent.

Prime agents of tree decline on road verges were identified as insects, physical damage (butt damage leading to rot, severed roots, and compaction) and weedkillers.

Railway verges, water pipeline and townsites - An average of 84 percent of tree decline on these sites was attributed to weedkillers.

3.2.3. Proximity to Crop or Pasture

This attribute was recorded to determine the relative impact on tree decline of the most widespread activity in the area, farming. The results are shown in Table 9.

Table 9

The Association of Tree Decline with Crop/Pasture Land

Proximity to Crop/Pasture	Number of Trees Assessed	Number showing decline	Percentage showing decline
Trees in crop/ pasture	178	80	44.9
1 - 50 metres away	752	330	39.9
50-100 "	129	71	55.0
More than 100 metres away	61	37	60.7

If agricultural practices had a relatively high impact on tree decline, one would expect the amount of decline to fall off with increasing distance from crop and pasture lands. The data in Table 9 suggests a tend in the opposite direction to this. We conclude that although the amount of tree decline on farms is serious, it is certainly no worse than on land used for other purposes in the same area.

3.3. Associations between Tree Decline and Natural Factors.

3.3.1. Soil Type

The association between tree decline and soil type is shown in Table 10.

Table 10

Tree decline and Soil Type

Soil Type	Number of Trees Assessed	Number showing decline symptoms	Percentage showing decline
Light	168	56	33.3
Medium	608	260	42.8
Heavy	347	202	58.2

A trend towards greater tree decline on heavier soils is apparent in Table 10. The reasons for this are not immediately obvious. However, the three tree species showing most decline (wandoo, gimlet, and red morrel - Table 4) all favour heavier soils. Whether these species have an inherent susceptibility to decline, or whether decline is directly associated with heavy soils could not be determined from this study.

3.3.2. Tree Decline and Position in the Landscape

The association between tree decline and position in the landscape is shown in Table 11

Table 11

Tree Decline and Position in the Landscape

Position in Landscape	No. of Trees assessed	No. of trees with decline	Percentage of Trees with decline
Ridge/Breakaway	65	39	60.0
Elevated valley	74	26	35.1
Upper Slope	295	107	36.3
Mid Slope	206	113	54.6
Lower slope/valley	483	233	48.2

The predominance of decline high in the landscape on ridge/break-away sites is attributable to their free-draining, and sometimes rocky character which predisposes trees to droughting. More tree decline was found on mid slopes and lower slopes/valleys than in elevated valleys and upper slopes. The reason for this difference is probably the preponderance of man's activity, and of salinity, in sites lower in the landscape.

4. DISCUSSION

4.1. The role of Natural Factors in Tree Decline.

4.1.1. The age structure of the tree population.

The age structure of the trees sampled was as follows:

Saplings and Immature	-	386 trees	-	34.4%
Mature	-	708 "	-	63.0%
Overmature	-	29 "	-	2.6%

Overmature trees formed a surprisingly small part of the population, however the bulk of the trees sampled (63%) were mature. Based on the information in Table 5, which demonstrated a strong association of increasing decline with increasing age, it can be assumed that decline symptoms will continue to develop as the mature trees continue to age.

4.1.2. Drought

The cause of decline in 77 (14.6%) of the affected trees was attributed to drought. The majority of these trees were located in woodlands, a situation where there is likely to be intense competition for moisture.

Tree decline due to drought is a common occurrence in semi-arid areas; it is a natural attempt to reduce the competition for the limited amount of available soil moisture. Decline, and occasionally death, can be expected in woodlands in periods of below average rainfall.

4.2. The Role of Man's Activities in Tree Decline.

4.2.1. Salinity

The relationship between the clearing of native vegetation and the development of salinity in drainage lines has been well documented.

In this study salinity accounted for 8.9% of the trees showing symptoms of decline. It can be regarded as a minor cause and unlikely to increase very greatly The majority of farmland in the area has been cleared for many years and the resultant salination has possibly passed its peak of development.

4.2.2. Roads and Road Verges.

All the road verges surveyed were narrow. There was generally less than ten metres separating the roadside drain and the fence of the adjoining farming property. Trees on the verges of bitumen roads were by far the worst affected by symptoms of decline. The reasons are not hard to deduce. The trees which once had a root spread of many metres now have heavily compacted soil with a waterproof surface on one side (the road), and are subject to cultivation and sometimes deliberate root ripping on the other (the farm).

Trees can probably grow satisfactorily under these conditions provided they experience them right from the seedling stage. They will then develop their root system within the road verge. Many of the trees now showing decline were mature when the roads were made and were unable to adapt to the reduced area for root activity.

Road construction frequently alters local drainage patterns. There are numerous examples quoted in literature of tree decline associated with alterations in drainage caused by roads. Some of the roadside tree decline found in this survey may be attributable to this cause.

4.2.3. Weedkillers

21% of the decline observed in the survey was attributed to weedkillers. Weedkiller use is separated into two categories for the purpose of this discussion. The first is their use by the farmer for selective weed control in crops. The second is their use by public utilities for total, and often long-term, weed control.

21% of decline in trees standing in crop or pasture land was attributed to weedkillers. The likely source of this damage is spray drift, particularly of the 'hormone' type phenoxy compounds of which 2,4-D and dicamba are examples. It is often claimed that damage to trees from this source is temporary and they eventually recover. This may be so, and the damage (decline) recorded in the survey may have resulted from the previous seasons spraying with incomplete recovery. However, the long term effect of frequent, mild damage by weedkillers is not known.

The types of weedkiller favoured by public utilities are different to those used by the farmer. They are generally non-selective, have a residual effect, and are absorbed through plant roots. High levels of tree decline attributed to weedkillers were recorded on some public utilities.

Where these utilities run parallel and close to one another, as for example the main road, railway and goldfields water pipeline near the townsite of Tammin, the effects of the suspected weedkiller damage are dramatic.

4.3. Some possible causes of decline (where none were apparent)

4.3.1. Root cutting.

Ripping around the edges of blocks of trees to sever their roots, and so prevent their competing with crops is practised in the area by some farmers. It is not known how widespread the practice is, however it would certainly contribute to tree decline in the case of mature trees. Trees subject to this treatment from a young age would probably be less subject to decline. Further possible sources of root cutting are the installation of underground services such as water pipes and telephone cables.

4.3.2. Cultivation and Hardpan Formation

Sub-surface soil compaction or hard-pan formation can result from a history of cultivation in some wheatbelt soils. Such layers are less permeable to water than the original soil structure and they can inhibit infiltration. This in turn could lead to reduced water storage at depth in the soil and induce droughting in trees.

4.3.3. Pathogens

Tippett (personal communication*) has investigated crown dieback in wandoo in the Narrogin area. She has isolated two species of pathogenic fungi consistently associated with crown dieback. They are Endothia havenensis and Cytospora eucalypticol It is possible that some of the decline found in this survey could have been caused by these organisms.

4.4. The History of Tree Decline.

Evidence collected in this survey (Table 3) strongly suggests that extensive tree decline in the two Shires is of relatively recent origin, perhaps extending back no more than 10 to 15 years.

A review of changes that have taken place in human activities over this period would possibly yield some further reasons for tree decline.

Climatic change, particularly rainfall shortages, can induce decline in trees. The southwest of W.A. was subject to a number of years of well below average rainfall in the decade 1969 - 1978. In particular 1969 was a year of exceptionally low rainfall with resultant tree deaths on shallow soils in the forest of the southwest. This year of low rainfall coincides neatly with the 10 to 15 year time span suggested for the origin of tree decline. The 1969 rainfall recorded at Tammin was similarly low - 186mm compared to an average of 341mm. However,

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* Dr. Joanna Tippett, Research Branch, Forests Department, Hayman Road, Como, 6152.

Tammin rainfall for the rest of that decade ranged from 285 to 485mm a year giving a ten year average of 345mm, close to the long term average and rather weakening the argument that the start of the decline was drought induced.

5. RECOMMENDATIONS

This survey amounts to no more than a preliminary study of the distribution, severity, and the probable causes of tree decline in the two Shires. Measures for alleviating the decline can be recommended for some situations. However the main recommendations are for further investigation of the problem.

5.1. Recommended measures to alleviate decline.

i) The weedkillers used for the long term control of vegetation need review. It should be possible to achieve satisfactory weed control with chemicals that do not affect trees.

ii) Salt tolerant tree species can be sown or planted on saline areas where some tree cover is desired. It is emphasized that tree establishment should venture no further into a salt area than the zone normally occupied by barley grass.

iii) Although little can be done to alleviate the decline of mature trees on narrow road verges, a regime of regeneration to replace the mature trees would ensure the perpetuation of a tree cover on these verges.

5.2. Recommended further investigations.

i) The long-term effect of agricultural weed-killers on trees needs to be determined.

ii) The involvement of fungal pathogens and insects in tree decline should be investigated.

iii) The implications of relatively recent drought in tree decline is worth investigating. Periods of drought have been recorded over the last century or more which would allow a dendrochronological type of study.

APPENDIX 1

Attributes recorded in the Survey

Attribute	Levels Recorded
A. Tree Characteristics	
1. Species	
2. Origin	i) Natural ii) Planted
3. Age of the tree	i) Sapling or small pole ii) Immature iii) Mature iv) Overmature
4. Degree of decline	i) None (=healthy) ii) ¼ crown affected iii) ½ crown affected iv) 3/4 crown affected v) Total crown affected vi) Dead
5. Period since decline started	i) Current - leaves discoloured or dead. ii) Recent - leaves, shed, twigs still green. iii) 3 Years - fine twigs shed iv) 5 years - branches up to 2cm diameter shed. v) 10 years + - branches of 5cm diameter and over shed.
6. Suspected cause of decline	i) Old age. ii) Salinity iii) Drought iv) Weedkiller v) Insect damage vi) Physical damage by man vii) Fire viii) No apparent cause.
B. Site Characteristics	
1. Site identification	Each site numbered serially
2. Land-use	i) Woodland ii) Crop or pasture iii) Bitumen road verge iv) Gravel road verge. v) Railway verge vi) Alongside water pipeline vii) Townsite.

3.	Soil type	i)	Light
		ii)	Medium
		iii)	Heavy
4.	Position in landscape	i)	Rocky ridge/Breakaway
		ii)	Elevated valley
		iii)	Upper Slope
		iv)	Mid Slope
		v)	Lower Slope/Valley
5.	Evidence of Salinity		Recorded as absent or presen
6.	Proximity to Crop/Pasture	i)	Trees in crop/pasture
		ii)	1 - 50 metres away
		iii)	50 - 100 metres away.