Temporal Changes in the

Eucalyptus loxophleba (York Gum) - *Acacia acuminata* (Jam)

Communities on selected Reserves in

the Western Australian Wheatbelt, 1984 to 1995

Prepared by Mattiske Consulting Pty Ltd
for
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SUMMARY

Mattiske Consulting Pty Ltd was commissioned in 1995 to re-monitor a series of monitoring sites, established in 1984 by Jim Goodsell, in the woodlands of *Eucalyptus loxophleba - Acacia acuminata* on a series of Nature Reserves in the Wheatbelt of Western Australia. This project was funded through the Save the Bush programme under the National Conservation Programme.

The main objective of the project was to undertake measurements on the vegetation to assess the changes in structure and composition that have occurred during the last 10 years.

The results reflect that there were some limitations associated with the lack of data, with only two data sets available for comparison. Despite these limitations, temporal trends were observed in the *Eucalyptus loxophleba - Acacia acuminata* communities. In addition, there were local variations in the communities which reflected different rainfall zones and soil conditions, as well as relationships with the extent and location of nearby agricultural lands.

The temporal changes observed included:

- The number of plant species recorded increased in 1995. The latter result may in part reflect the different timing of the field studies.

- The *Eucalyptus loxophleba* populations in most reserves exhibited growth in intercept lengths, circumference at breast height (CBH) and height, however recruitment has been low between 1984 and 1995.

- The *Acacia acuminata* populations have also increased with regard to circumference at breast height, intercept length and height. *Acacia acuminata* also exhibited a greater recruitment rate than *Eucalyptus loxophleba*, especially in response to fire.

- Significant changes either in cover and or presence of other perennial species have occurred in most reserves.

Several broader issues arose from this project:

- There is a need to protect the remaining areas of *Eucalyptus loxophleba - Acacia acuminata* from further degradation, as the area of this woodland remaining in the Wheatbelt has been diminished substantially since European settlement and significant areas of the woodland have been invaded by introduced species.

- There is a need to review the importance of burning regimes in the *Eucalyptus loxophleba - Acacia acuminata* woodlands. In the results presented there were only two quadrats in one reserve that had been affected by fire over the past eleven years, and no line transect measurements were taken in 1984 or 1995 for one of these quadrats. This burn did affect new and increased recruitment of *Acacia acuminata* in

Quadrat (3) of Reserve 2023, and burning may be beneficial in reserves where the *Acacia acuminata* population seems to be stagnant in terms of recruitment. Burning has some undesirable effects such as the increase of weed species such as **Avena* ssp., as was observed in the burn area in Reserve 2023 in 1986 by Leon Sylvester. Reserve 2023 is also situated in an area of moderate precipitation, and was before the burn (as after) fairly disturbed. Many of the reserves in this study are located in the eastern Wheatbelt, and experience lower precipitation than Reserve 2023, and contain a different species composition. Burning may have a different impact on these reserves. Therefore, more data on the state of growth and recruitment of these populations in these reserves need to be collected before burns are proposed in an operational programme.

- There is a need to review the type of monitoring and the methods used in different plant communities throughout the Wheatbelt. This aspect is beyond the terms of this project, however issues related to monitoring should be addressed so that efforts expended return relevant information to management and operational issues.

- There is a need to possibly review several management options for these reserves, such as regular inspections for weeds and other signs of degradation, fencing (to assist in controlling grazing pressures) and fire regimes appropriate to conserving native vegetation particularly on smaller remnant areas.

Some aspects of the sampling design warrant concern, and are listed below:

The number of quadrats sampled per reserve.

The orientation of the line transect.

The measurement of distance crossed by individuals on the line transect, and position of the individuals on the transect.

The measurement of RFC values.

Time of year in which surveys are completed.

Time taken to complete the survey in comparison with the amount of useful information gained.

Inability to properly record recruitment rates of tree species.

Suggested improvements for use in future temporal monitoring programmes of this type are as follows:

The number of quadrats sampled per reserve needs to be increased from one to a minimum of three. This would result in greater statistical validity by giving a larger sample.

The orientation of the line transect at present forces the sampler to re-sample individuals, therefore decreasing the total number of individuals which are sampled. By orientating the line transect on a straight line, running 100m from one of the quadrat pegs whilst keeping the line transect within the community would result in a larger sample size of individuals, and prevent the re-sampling of individuals in the same time frame.

The measurement of the distance of the individuals across the line transect, and the position of the individuals upon the line transect may be aided by the use of a small mirror (e.g. densiometer) which is travelled along the line transect. The reflection of the beginning and end of the canopy of the individuals can be then accurately measured. It may also be advisable that individual trees either inside the quadrat and/or those that cross the line transect be tagged and numbered in some way, to enable individual trees which have been measured to be identified in a later sampling session with ease. This can make the identification of new individuals which indicate recruitment easier also. Metal wire with small metal tags can be used for this.

The method of measurement of RFC values is extremely subjective, and it is difficult to determine whether changes in RFC values of species between years can be attributed to actual growth changes or differences between personnel. Ideally the same person should repeat all measurements of this subjective nature, however in practise this is often difficult as temporal monitoring programmes are designed to run over the course of many years. Measurements of this sort should be avoided.

It is advisable that the surveys are completed at the same time of year, preferably in spring, for ease of identifying annual species.

The time taken to complete the surveys was large, however repeats of the species/area curve are unnecessary once the first survey has been undertaken, although it was repeated in this project. Total species listing and abundance measures, the distance crossed by individuals along the line transects and the heights and CBH measurements of individuals are all necessary, however RFC measurements and the height to the base of the canopy of individuals are not necessary and if time is limited these measurements can be removed. There is little technical difficulty with this method, excluding the identification of species, and properly motivated volunteers under the leadership of an experienced botanist for identifying species could complete studies of this type using these methods with little difficulty.

This study was not designed to properly measure recruitment of species, which is important to gauge the health of populations. Individuals which germinate in between sampling periods may not cross the line transect, and therefore be left unrecorded. False recordings of recruitment of young individuals can also be made when new individuals recorded on the line transect are actually mature individuals which have experienced growth. Methods such as a count of all individuals of a species (preferably tree species) within the quadrats can be made, and increases of this number in further surveys can be regarded as conclusive proof of recruitment of this species.

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"*Measurement of the trends in vegetation community structure and composition that have occurred during the last 10 years in an important remnant vegetation community (York Gum/Jam Woodland)*"

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1. INTRODUCTION

1.1 Background

Australian vegetation has at various times coped with and adapted to new, dominant and unpredictable changes which affect the composition and integrity of native vegetation. These changes have included new fire regimes introduced by the Aborigines, which favoured the selection of scleromorphic and fire-resistant vegetation (Adamson and Fox 1982), and global climatic changes on a scale of thousands of years. These changes differ from the smaller, regular and predictable localised events such as fires, droughts and floods, in which the vegetation over a small area is affected, but over the long term the vegetation appears to have moved around a steady state.

European land use on the Australian continent has had far-reaching and dramatic consequences on the native flora over the last two centuries (Saunders *et al.* 1990). The impact of the widespread use of European farming practises and associated clearing activities have probably had more of an effect on the Australian vegetation than either global climate change or the introduction of Aboriginal fire regimes because of it's very extent and severity. The agrarian and industrial revolutions which had slowly developed in England over a period of centuries were brought to and subjected on the Australian environment within an extremely short period of time, causing extensive change in the natural ecosystems, changes which are still occurring in the present day. Australian vegetation is more likely to have been affected by the introduction of European disturbances (such as extensive agriculture) than vegetation in Europe, because European vegetation had been subjected gradually to these disturbances over the past few thousand years, whereas these changes were suddenly and forcibly placed on an unprepared Australian flora (Hobbs and Hopkins 1990). Widespread clearing in the south-west of Western Australia has left small, fragmented remnants of (predominantly) native vegetation within a much wider area of agricultural land (Hobbs 1992).

In view of these latter changes, it is important to understand what changes have occurred in order to manage the remaining biota. Long-term monitoring programmes (temporal monitoring) can identify relationships and interactions between the biota and the biophysical environment, such as the effect of climate and land use on the distribution and occurrence of plants. These programmes can also describe life history attributes of the species such as reproduction, death and growth rates which are also important to understand the dynamics of the communities (Goodsell unpub. report). Thus, temporal monitoring can be used to describe long-term changes in ecosystems and to gather baseline information on relatively undisturbed ecosystems before such changes occur. The effect of practises such as clearing and intensive agriculture on nearby remnants of natural vegetation may not be obvious immediately, a short-term 'look and see' approach therefore may not be effective. Changes in factors such as community structure, species of plants present and age-classes may only be identified and described adequately using long-term monitoring techniques.

This study is a follow up of a monitoring programme established by Jim Goodsell in 1984. During this earlier work, Jim Goodsell set up a series of permanent quadrats in Nature Reserves over a rainfall gradient in the Wheatbelt Region of Western Australia. Nature Reserves are important for nature conservation, being areas set aside specifically for the conservation of native flora, vegetation and fauna, as well as conserving genetic diversity of native species, and as such are ideal areas for long-term monitoring and studies into natural processes. Long-term monitoring studies are needed to prepare adequate management programmes for such reserves, because whether or not these assemblages of vegetation can survive into the future in their present state under present conditions is unknown. Nature Reserves, being small remnants of the larger, original ecosystems or communities, suffer from the effects of fragmentation. The effects of the latter must be understood before the area can be managed in an effective manner. These effects may include a greater impact of local fires due to the fragmentation of the areas, the introduction of weeds from nearby land uses (and thus a gradual change in species composition), and possible local extinctions due to a decrease in genetic diversity.

Much land in the south-west has not only been cleared for agricultural purposes (93% of the original vegetation has been cleared [Hobbs 1992]), but the proportions of different types of vegetation left on nature reserves has also been altered. Woodlands in particular have been decimated, especially woodlands which utilize heavier soils which are preferred for agriculture.

The Woodlands of *Eucalyptus loxophleba - Acacia acuminata* (York Gum-Jam) were once widespread across the Wheatbelt, from beyond the Darling Scarp across the central and eastern Wheatbelt, on gentle slopes to valley flats (Hussey and Wallace 1993). Before clearing, *Eucalyptus loxophleba - Eucalyptus salmonophloia - Eucalyptus wandoo* Woodland covered an area of 41,125km^2 (13.27% of total area of the south-west botanical province), of which 97% has been cleared (Majer 1992). Much of this type of community vanished during this century, as the Wheatbelt was extensively cleared for agricultural purposes. Remnants of these woodlands remain on designated Reserves, and also on private property, where if not fenced from livestock can be subjected to severe degradation. Aboriginal burning practices may have also influenced the structure of the *Eucalyptus loxophleba - Acacia acuminata* Woodlands.

Early descriptions of these woodlands after European settlement indicate that the communities were more open. For example, Beard (1991) described the *Eucalyptus loxophleba* (York Gum) communities around the Avon Valley and Victoria Plains as grassy woodlands. In addition, this community was classified as savannah-forest by Diels when he visited the region in 1901 (Beard 1981). Records indicate that these woodlands in the inner Wheatbelt were probably burnt regularly, due to their position on lower slopes and river flats, near water, which encouraged herbage growth (which in turn attracted game). This burning encouraged a more open community, with a grassy, herbage understorey. Beard (1981) notes that in the few remaining uncleared stands of *Eucalyptus loxophleba* (York Gum), the trees are more closely spaced with a fairly sparse understorey than when Europeans first arrived, and that this could be

in response to the cessation of this type of burning.

There have been two main approaches to monitoring in the past, which can be basically described as the static and the dynamic approaches. In the former (also known as the Clementsian view), succession is described as the main driving force behind change, and that areas which are separated spatially will follow through with the same sequences of change through time after a disturbance. Each new stage in the succession changes the environment in such a way enabling a new assemblage of plants to succeed. This view is linked to the idea of the community being akin to an organism, developing in a routine manner (Miles 1979). The dynamic approach states that each site will develop individualistically, and that succession is only one of the factors which causes the vegetation to change. This is a more tenable approach, as vegetation does not behave like a single organism, as it is itself comprised of many organisms, all behaving more or less independently (Miles 1979). A set of principles can apply, and models can be extracted, however these are general and vegetation in different areas do not necessarily follow the same pathway after change.

This study utilises permanent quadrats in different areas to assess if there are any common threads affecting the temporal change in the vegetation (Goodsell unpub. report).

1.2 Objectives

This project has been designed to monitor changes in the *Eucalyptus loxophleba - Acacia acuminata* (York Gum-Jam) community structure in several selected Nature Reserves. The specific objectives were:

- To re-monitor the quadrats established in 1984.
- To search the Department of Conservation and Land Management files for any information relevant to the specific study areas.
- To analyse the two sets of data, using standard statistical techniques to determine trends.
- To determine changes in species composition, community structure and growth of species within *Eucalyptus loxophleba-Acacia acuminata* remnant communities located on Reserves.
- To determine appropriate management procedures to maintain or improve present community structure within these communities
- To improve the level of knowledge and experience of temporal monitoring, and as a possible type example for future monitoring in other remnant vegetation studies. There has been a considerable dearth in long-term monitoring studies

of this type in Western Australia, and this study may help contribute some knowledge into long term effects of how we currently manage the native vegetation on Reserves. It may also demonstrate the use and need for studies such as this in other aspects of conservation biology.

. To translate the information gained into management recommendations for this woodland community over its range.

. To prepare a report summarizing the findings of the re-monitoring.

By measuring some important parameters of remnant *Eucalyptus loxophleba - Acacia acuminata* (York Gum-Jam) Woodlands, and comparing this data with similar data gathered in the past we can determine the growth (either negative or positive) of the communities studied. We can attempt to relate known events (such as frequency of burning) which have occurred in the intervening time period in these reserves to these growth changes, and determine management policies which will best conserve the remaining native vegetation.

1.3 Hypotheses Tested

Several hypothesis have been tested on data relating to measurements of growth of species in the reserves between 1984 and 1995, using *t* tests. These are as below.

H_o : There is no significant difference in *Eucalyptus loxophleba* total intercept length in 12 quadrats between the years 1984 and 1995

H_a : There is a significant difference in *Eucalyptus loxophleba* total intercept length in 12 quadrats between the years 1984 and 1995.

H_o : There is no significant difference in mean *Eucalyptus loxophleba* CBH in 12 quadrats between the years 1984 and 1995

H_a : There is a significant difference in mean *Eucalyptus loxophleba* CBH in 12 quadrats between the years 1984 and 1995

H_o : There is no significant difference in mean *Eucalyptus loxophleba* height in 12 quadrats between the years 1984 and 1995

H_a : There is a significant difference in mean *Eucalyptus loxophleba* height in 12 quadrats between the years 1984 and 1995

H_o : There is no significant difference in mean *Eucalyptus loxophleba* canopy height in 12 quadrats between the years 1984 and 1995

H_a : There is a significant difference in mean *Eucalyptus loxophleba* canopy height in 12 quadrats between the years 1984 and 1995

H_o : There is no significant difference in *Acacia acuminata* total intercept length in 11 quadrats between the years 1984 and 1995

H_a : There is a significant difference in *Acacia acuminata* total intercept length in 11 quadrats between the years 1984 and 1995.

H_o : There is no significant difference in mean *Acacia acuminata* CBH in 11 quadrats between the years 1984 and 1995

H_a : There is a significant difference in mean *Acacia acuminata* CBH in 11 quadrats between the years 1984 and 1995

H_o : There is no significant difference in mean *Acacia acuminata* height in 11 quadrats between the years 1984 and 1995

H_a : There is a significant difference in mean *Acacia acuminata* height in 11 quadrats between the years 1984 and 1995

H_o : There is no significant difference in mean *Acacia acuminata* canopy height in 11 quadrats between the years 1984 and 1995

H_a : There is a significant difference in mean *Acacia acuminata* canopy height in 11 quadrats between the years 1984 - 1995

1.4 Description of the Reserves

Sixteen permanent quadrats were set up in 1984 by Jim Goodsell, in *Eucalyptus loxophleba - Acacia acuminata* (York Gum-Jam) communities throughout the Wheatbelt across a rainfall gradient. These quadrats extend in range from Wagin in the south to Dowerin in the north and Merredin in the east. All of these reserves occur in the South-West Botanical Province, either in the Avon or Roe districts, which occupy the drier parts of the South-west Province (Beard 1981). The natural vegetation of the Roe district is characterised by mallee-type vegetation, whereas the Avon district is dominated by woodlands. The area exhibits a Mediterranean climate, with cool, wet winters and hotter, dry summers. All sites occur in either the dry mediterranean (5-6 dry months/year) or extra-dry mediterranean areas (7-8 dry months/year). The original vegetation in both of these climatical areas included Eucalypt woodlands and mallee (Beard 1981).

The following description of the monitoring sites and Reserves was based on the previous studies by Goodsell (1984) and field observations. The descriptions of the reserves was based on file records, field observations and previous studies by Goodsell

(1984) and Muir (unpublished files and reports prepared in 1977). Detailed notes are provided on the location of the monitoring sites, as well as GPS readings for all quadrats (see mud-maps or sketches of the reserves in Appendix A).

Reserve 2023 (The Ovens, Mockerdungulling)

The Ovens is located 16.7 km west of Pingelly, and four quadrats are located in this reserve (one included only in the species list). The Reserve has an area of approximately 35 ha. This Reserve is located in a small area described by Beard (1981) as *Eucalyptus astringens - Eucalyptus accedens* Woodland, which is surrounded by a larger area of *Eucalyptus loxophleba - Eucalyptus wandoo* Woodland. Goodsell (unpub. report) described this area as *Eucalyptus loxophleba - Acacia acuminata* (York Gum - Jam) Woodland.

The average yearly precipitation of Pingelly is 455 mm, over a period of an average 89 rain-days. The Reserve itself has light-medium brown sandy-clay soils, although this was described as deep alluvial red loams by Goodsell (unpub. report).

Quadrat (4) is positioned near an old well, 175m north of Wickepin-Pingelly Road, from a point 150m from the junction of this road and the southern border of the reserve. Quadrat (3) is located approximately 190m north north-west from this point, near the main watercourse. Quadrat (1) is located approximately 350m east of a point which is 150m north along the track which runs north along the western edge of the reserve. Quadrat (2) is positioned approximately 70m south south-east from Quadrat (1), and to reach (2) from (1) a watercourse must be traversed. The positions of these quadrats are shown Appendix A. This Reserve has a high proportion of weeds, and some areas have been burnt since the quadrats were set up in 1984. This burnt area is shown in Appendix A. A high number of rabbit warrens were also observed, especially around Quadrat (1).

GPS : Quadrat (1) : S 32° 33' 48.9"
E 117° 15' 92.3"

Quadrat (2) : S 32° 33' 55.1"
E 117° 15' 93.5"

Quadrat (3): S 32° 33' 62.8"
E 117° 15' 70.9"

Quadrat (4): S 32° 33' 71.1"
E 117° 15' 77.3"

Reserve 23201 (Wyening)

This Reserve is located 9.5 km north-east of Bolgart, over an area of 81 ha and the general area is composed of *Eucalyptus loxophleba - Eucalyptus salmonophloia* (York Gum - Salmon Gum) Woodland (Beard, 1981). Muir (unpub. report) states that the majority of the Reserve is covered with woodland, with *Eucalyptus loxophleba* Low Forest A on the west side (although the quadrat is located on the east side). The York Gum Woodland is described as *Eucalyptus loxophleba* trees over *Borya nitida*, with scattered *Acacia acuminata*.

Nearby, Wongan Hills experiences a precipitation rate on average of 391 mm per year, falling over an average of 78 rain-days. The soil is recorded as being red sandy clay loam (Goodsell unpub. report).

The quadrat is approximately 280m along the eastern side of the Reserve, and then approximately 88m at 90° to the fence inside the Reserve. A samphire flat must be crossed along the fence. The quadrat is situated mid-slope (very slight), in an open area, understorey consisting mainly of grasses and exotic annuals. Some rabbit warrens were in evidence, and stump showing fire damage (scorching), however this fire scarring appeared to have occurred prior to 1984.

GPS : Quadrat (1) : S 31° 10' 44.2"
E 116° 32' 43.5"

Reserve 26664 (Lake Dumbleyung)

This Reserve covers most of Lake Dumbleyung and some of the surrounding landscape. The region is described by Beard (1981) as *Eucalyptus loxophleba - Eucalyptus salmonophloia - Eucalyptus wandoo* Woodland, and the area around the quadrat contains *Eucalyptus loxophleba - Acacia acuminata* Woodland. The nearest township that records meteorological data is Wagin, therefore precipitation statistics will be similar to those in Reserve 4458.

The quadrat is located south-east of the end of Bairstowe Scenic Drive, on the north side of the lake. A paddock fence approximately 50 m to the west is followed south, then east, then north and then 50m east. The quadrat is located approximately 100m south of this point. The quadrat is situated on a quite steep mid-slope with dark brown sandy-clay soil, and is very open with only a grassy (mainly exotic) understorey.

GPS : Quadrat (1) : S 32° 33' 71.1"
E 117° 15' 77.3"

Reserve 23164 (Camel Peaks)

Camel Peaks is located 17 km north of Hyden, and consists mainly of a large granite outcrop. Beard (1981) described the area as mallee with scattered woodland. The quadrat is situated on *Eucalyptus loxophleba* (York Gum) Mallee, on sandy loam near the edge of the granite. Wallace (unpub. report) described ten vegetation associations in this Reserve, including one relating to *Eucalyptus loxophleba* (York Gum) which is split into three sub-associations. The quadrat is located in *Eucalyptus loxophleba* (York Gum) Open Scrub Mallee over *Acacia acuminata* (Jam) Scrub with *Santalum spicatum*, over *Borya nitida* herbs.

The average yearly precipitation of Hyden is 336 mm falling over an average period of 76 rain-days.

The quadrat is located near the edge of a granite outcrop, near an *Allocasuarina* grove, which is located on the north-east side of the Reserve. A track along the north-west side of the Reserve is taken (starting by driving into a gravel pit), and this track travels along this side of the Reserve until the nearby paddocks are reached. The north-east side of the Reserve is walked, the shrubland becomes a thicket (as above), and this is penetrated until the edge of the rock is seen. The quadrat is then located alongside the edge of this granite, approximately 50 - 100m away. The quadrat is on a slight decline towards a small non-permanent stream. There was no evidence of past burns, and there were many fallen branches, leaves etc.

GPS : Quadrat (1) : S 32° 18' 13.6"
E 118° 49' 17.4"

Reserve 16714

Reserve 16714 covers an area of 27 ha, and is located 19 km south south-east of Corrigin, on the Brookton Highway. Beard (1981) described the area as being composed of Eucalypt mallee with patches of woodland. Goodsell (unpub. report) described the Reserve as *Eucalyptus loxophleba* (York Gum) Dense Forest, however in 1995 the area around the quadrat was composed of mainly *Acacia acuminata*. Muir (unpub. report) describes the Reserve as being composed of *Eucalyptus loxophleba* (York Gum) Dense Forest over *Acacia acuminata* (Jam) Open Low Woodland A, *Acacia acuminata* (Jam) Low Woodland A over Low Grass and Tamma Thicket. The quadrat is located on the boundary of the first two types of community.

Corrigin experiences an average yearly precipitation of 379 mm, spread over an average of 85 rain-days.

The quadrat is situated approximately 250m north from a Department of Conservation and Land Management reserve sign which is situated on the south end of the Reserve on Brookton Highway. The quadrat is situated on a mid-slope facing south-west, with

a medium-brown sandy-clay soil. There was no evidence of fire (such as scorched stumps), and much dead wood debris is scattered over the quadrat and surrounding area.

GPS : Quadrat (1) : S 32° 27' 51.7"
E 118° 0' 05.1"

Reserve 13594

Reserve 13594 is situated 26 km south south-east of Merredin, and covers an area of 40.5 ha. Beard (1981) describes the area as mallee with patches of woodland, the quadrat is composed of *Eucalyptus loxophleba* (mallee) - *Acacia acuminata* Woodland. Muir (unpub. report) describes the majority of the Reserve as being covered in woodland. This is described as Gimlet Woodland consisting of *Eucalyptus salubris* Low Woodland A over mixed Open Dwarf Scrub C with scattered *Eucalyptus loxophleba* around damsite and edges of association.

Merredin experiences an average annual precipitation of 327 mm over an average of 70 rain-days.

The Reserve is located 3.5 km from the beginning of Depot Dam Road (coming from the Merredin-Narembeen Road), on the left. On the right is a farmer's gate and fence, and the Dam is located 150m due south from a point which is 100m further along from the farmer's fence on the left. The quadrat is a further 100m south from the Dam. The soil is a medium brown-red sand, and the quadrat is situated on a negligible slope. There was no evidence of any fire activity, and many rabbit warrens were present.

GPS : Quadrat (1) : S 33° 40' 69.2"
E 118° 21' 25.0"

Reserve 9754 (Cairn Nature Reserve)

Reserve 9754 is situated 26 km east north-east of Cramphorn Siding, and covers an area of 688 ha. Two quadrats are present in this Reserve. The area is described by Beard (1981) as mallee with patches of woodland, the Reserve itself is situated mainly on a large granite outcrop, with light red poorly drained clay over shallow granite (Goodsell unpub. report). Several associations in this Reserve were described by Muir (unpub. report), including *Eucalyptus salmonophloia* (Salmon Gum) Woodland, *Acacia acuminata* (Jam) Woodland, *Eucalyptus loxophleba* (York Gum) Tree Mallee, *Allocasuarina corniculata* heath and Granite Outcrop. Both quadrats are representative of different vegetation associations. Quadrat (2) is located in *Eucalyptus loxophleba* (York Gum) Tree Mallee, which was described as mature to senescent, with an absent understorey except for *Borya nitida, Allocasuarina campestris, Santalum acuminatum, Spartochloa scirpoidea* and *Stipa elegantissima*. Quadrat (1) is located in *Acacia*

acuminata (Jam) Woodland, which is described as having no understorey except scattered *Lepidosperma gracile, Lomandra effusa, Santalum spicatum, Stipa elegantissima*. The nearest townsite with past meteorological data is Merredin, therefore precipitation rates are similar to that of Reserve 13594.

Quadrat (1) could not be re-located, a new quadrat was set up in 1995. Quadrat (2) is located on the section of Cox Road which bisects the Reserve, 15m inside the reserve on the south side of the road. The section of Cox Road is evidenced by a swampy drainage line, approximately half way down this section of the road. Quadrat (1) is now located on a granite outcrop. A track is located on Cox Road (see Appendix A), and this track crosses over a temporary stream, and then leads onto the granite. The site is located approximately 40m from the track.

GPS : Quadrat (1) : S 31° 50' 76.6'
E 118° 50' 81.0'

Quadrat (2) : S 31° 49' 96.5'
E 118° 50' 56.7'

Reserve 19138

This Reserve is situated 11 km south-east of Bruce Rock, and covers an area of approximately 81 ha. The vegetation is described as *Eucalyptus loxophleba* (York Gum) - *Eucalyptus salmonophloia* (Salmon Gum) - *Eucalyptus salubris* (Gimlet) Woodland (Beard 1981), and the vegetation of particular area around the quadrat consists of *Eucalyptus celastroides* mallee Woodland.

The average yearly precipitation of Narembeen (to the south-east of the Reserve) is 336 mm over an average of 70 rain-days.

The quadrat is located along a creek line which runs south from the north end of the Reserve, on the boundary between Reserves 19138 and 13057 (as per Appendix A). The quadrat is slightly south-west of the dam, however it is extremely close to the dam itself. The quadrat is situated on a slight slope, with medium-brown sand with some clay and gravel. The area is quite open, with a sparse shrub-layer, and an understorey consisting predominantly of annuals.

GPS : Quadrat (1) : S 31° 57' 43.2"
E 118° 12' 44.2"

Reserve 31211 (Mokine)

Mokine Reserve is located 20 km north-west of York, within an association described by Beard (1981) as *Eucalyptus loxophleba* Woodland.

The average yearly precipitation recorded in Northam is 433 mm, falling over an

average of 89 rain-days. Goodsell (unpub. report) recorded the soil as being shallow dark loam over granite at mid-slope.

The quadrat is located approximately 300m from the east edge of the Reserve along Leaver Road, and approximately 45 m due north. A track follows along Leaver Road just inside the Reserve, entering from Leaver Rd near the east edge of the Reserve. The quadrat is just north of this track. The quadrat is on a slight slope towards Leaver Rd, no rabbit warrens were sighted in 1995, and there were some young *Acacia acuminata*, *Eucalyptus loxophleba* and *Eucalyptus wandoo* individuals. Logging has occured sometime in the past in this area, and there was no evidence of burning.

GPS : Quadrat (1) : S 31° 47' 75.9"
E 116° 35' 512"

Reserve 4313

This Reserve occurs on a small region of *Eucalyptus loxophleba* Woodland (as described by Beard (1981), surrounded by a larger area of scrub heath on sandplain. It is located 14.7 km south south-west of Dowerin, and has an area of approximately 43.7 ha. Muir (unpub. report) notes that the reserve is covered by She-oak and York Gum Woodlands, and *Eucalyptus oleosa* mallee, *Melaleuc*a stands and Tamma Shrubland. The York Gum Woodland is described as *Eucalyptus loxophleba* trees with scattered *Eucalyptus wandoo* and *Acacia acuminata* with an understorey of *Loxocarya fasciculata* and *Harpiera lateriflora*.

The average yearly precipitation of nearby Goomalling is 367 mm falling over an average 80 rain-days.

The quadrat is located in the area of the reserve adjacent to Nambling South Rd, approximately 60 m due west. The quadrat is flat, with light brown sandy-clay soil. There was some log debris present, and evidence of an old fire on a fallen branch.

GPS : Quadrat (1) : S 31° 22' 38.9"
E 117° 0' 33.1"

Reserve 29313

Situated 22 km south-west of Narrogin and 570 ha in area, this Reserve is in an area described by Beard (1981) as *Eucalyptus loxophleba - Eucalyptus salmonophloia - Eucalyptus wandoo* Woodland, although this particular Reserve is dominated by a mixed *Eucalyptus calophylla - Acacia acuminata - Casuarina* Woodland.

The average annual precipitation of Narrogin is 506 mm, over an average of 98 rain-days.

As the original quadrat could not be located, a new quadrat was set up in 1995. This quadrat is located approximately 80m at 20° inside the Reserve from a CALM sign which has been erected on Sargent's Road, stating '*Euc. Wandoo* Plantings 1986'. This sign is located approximately 100m east from the farmer's gate and fence on Sargent's Road (see Appendix A). The new quadrat is situated on a slight slope rising east, on medium-brown sandy-clay soil. Few rabbit warrens were seen in 1995, and has an understorey of native shrubs.

GPS : Quadrat (1) : S 33° 5' 42.4"
E 117° 0' 66.9"

Reserve 4458 (Nallion Springs)

Reserve 4458 has an area of 97 ha, and is located 11 km north-east of Wagin. It is situated in an area comprised of *Eucalyptus loxphleba - Eucalyptus wandoo - Eucalyptus salmonophloia* Woodland (as described by Beard 1981), on dark-brown sandy clay mid-slope.

Wagin experiences an average yearly precipitation of 438 mm, falling over an average 92 rain-days.

As the original quadrat could not be located, in 1995 a new quadrat was pegged. The new quadrat is located approximately 250m north along the western boundary of the Reserve from a CALM sign erected in the south-west corner of the reserve. The quadrat is then located 130m due west of this point. To the north of the quadrat is a grove of *Allocasuarina* sp. The area of this Reserve around the quadrat has no shrub layer at all, and the herbaceous layer is infested with exotic annuals.

GPS : Quadrat (1) : S 33° 14' 271"
E 117° 25' 52.1"

2. METHODOLOGY

2.1 Introduction

The use of quadrats is one of the most widely used methods to quantitatively survey vegetation. The size and number of quadrats can be varied according to the type of vegetation that is being surveyed, the type of information which is being gathered or other factors such as economics. In this study, permanent quadrats were utilised as there was a need to assess change in growth of the plant communities over a period of time in exactly the same location (Kent and Coker 1992). The location of quadrats is also important, on one hand to disperse the quadrats randomly, and on the other to make sure that quadrats are not affected by factors such as edge-effects, which occur near the boundary of different communities, and between a community and any disturbances such as a road.

The size of the quadrats used is another factor which must be taken into consideration. The quadrat must be large enough to enable a representative sample of the species present in the community to be taken (Kershaw 1973). The size of the quadrat must also take into account economics, if the size is larger than is necessary, then extraneous information is gathered and thus time is wasted. A species-area curve was used to determine the appropriate size of the quadrat in 1984. A small quadrat will turn up a small number of species, and as this quadrat is expanded a greater number of species will be found. However, the number of new species discovered will decrease as the majority of species in the community is found. The minimal area of a viable quadrat is the size where the number of new species being included in the quadrat decreases (Kershaw 1973). 20m x 20m - 50m x 50m quadrats are a size applicable to communities with woodland canopies (Kent and Coker 1992).

Line intercept techniques can be used to measure frequency and cover of species within a quadrat or community. The length across which the individuals touch or cross the line transect is measured, and this can be used to give a measure of the coverage of the species (Kent and Coker 1992). The number of individuals encountered by the line transect gives a measure of frequency of the species in the quadrat/community.

2.2 Field Work

In 1984, Jim Goodsell established 16 permanent 20m x 20m quadrats in *Eucalyptus loxophleba - Acacia acuminata* (York Gum-Jam) Woodlands in the Wheatbelt Region of Western Australia, across a rainfall gradient. These quadrats were sited as to avoid vegetation boundaries, as the sites were to be representative of *Eucalyptus loxophleba - Acacia acuminata* (York Gum-Jam) Woodlands in terms of soils and species present. Sixteen sites in total were pegged out in 12 Wheatbelt Nature Reserves, using 4 foot 6 inch metal star pickets in a square formation, the sides being aligned north-south and east-west. Each stake was numbered in a clockwise fashion, the north-west corner being Corner 1.

Total species lists and species/area curves were compiled for each quadrat using a nested squares formation, in increments of 1m. The name of each species of plant present was recorded, as was the square in which it first occurred. The immediate area surrounding each quadrat was checked for species not occurring inside the quadrat. It was found that between 80-100% of the species in the quadrat and immediate area occurred within the quadrat, thus a quadrat size 20m x 20m was deemed large enough. Species lists were used to establish species presence in different quadrats, and in principle component analysis using species presence/absence. Individuals which lay on the boundary of the quadrat were considered to be inside the quadrat if they were rooted inside the quadrat, or in the case of tree species if over half the area of the trunk lay inside the quadrat.

No quantitative abundance values were recorded using quadrats, such as an estimated cover (using percentages or scales). Only data relating to species presence/absence was recorded, giving only qualitative data. Recording species presence/absence is the least time consuming, and also a measure of abundance was deemed unnecessary in ordination work (Goodsell unpub. report).

A line intercept technique was used to measure cover of perennial species. The line transect (using tape measures) ran across two sides and two diagonals of the quadrat, from Corner 1 to 3, to 2, to 4 and back to Corner 1, equalling a distance of 96.6m. The distance across which each perennial plant either touched, underlayed or overlayed the transect was measured using the tape measure and a vertical rod, to help measure the exact point. If any plant crossed the transect line more than once (eg. in case of a large tree with many branches), then each individual distance across the transect was recorded. Height to the top and base of crown in metres and presence of flowers or fruit on individuals intercepted were also recorded. Circumference at breast height (CBH) in metres were recorded, if the individual had more than one stem at breast height then the individual circumferences were recorded for each stem and then summed to give the total circumference at breast height of the individual.

Measuring the line transect intercept is fraught with errors due to variation between plant forms and the recorders. If the individual plant is small, and crosses the line transect near where the tape has been run, then measuring is fairly easy. However, when a tall tree intercepts the transect line at a large distance above the ground, the measurement where the tree actually intercepts the line has a fair amount of subjectivity incorporated into it. When the head is tilted, the eyes do not usually look 90^0 upward, as they must do to correctly gauge the position of the branch or leaf. Thus the measurement for the start of an intercept measurement for a tree is usually too far. As this also occurs when the end point of the intercept is being measured, the actual intercept length is not affected. However, the actual position measured is different, and this makes comparisons between data to identify the same individual through time difficult.

RFC (Relative Foliage Cover) was recorded for each individual encountered along the line transect, and this consists of a measurement by eye of the percentage of foliage

cover inside the canopy cover of an individual. The total canopy cover is the area on which if the canopy was dropped suddenly to the ground would occupy, and the foliage cover is the percentage of this area which the leaves actually occupy (deleting any spaces between the leaves).

The perennial species encountered along the line transect were also classified according to Raunkaier's life-form classification system, in which plants are classified according to the height above ground of the perennating buds from which growth occurs in the next favourable season (Raunkaier 1934, 1937). The three life-forms exhibited by species in this study were:

- Phanerophytes (P) : Perennating buds or shoot apices borne on aerial shoots.
- Chamaephytes (CH) : Perennating buds or shoot apices borne very close to the ground.
- Therophytes (T) : Annual species which complete a life history from seed to seed during the favourable season of the year (Kershaw 1973).

These same measurements and techniques were used by Mattiske Consulting in August-September 1995, 11 years after the quadrats were established. All pegs of 3 of the 16 quadrats were totally missing, most probably removed by people. These 3 quadrats were re-established in nearby locations, and the measurements as above taken; however as they are not in the exact location of the original quadrats these measurements cannot be used in comparison with the older data. These quadrats were located in Reserves 29313, 4458 and quadrat (1) in Reserve 9754. Other quadrats were also disturbed, with one or more pegs removed, however by using old data and photographs taken in 1984 it was feasible to replace the missing pegs.

Fifty metre measuring tapes were used to measure the line transect, and measuring sticks were held upward and straight to help judge exactly where vegetation crossed this line. Measuring tapes were also used to measure circumference at breast height measurements, and clinometres were used to record the height of the trees and to show the borders between the nested squares when compiling the species/area curve. Small metal tags with the numbers of the corners punched on one side were also attached using copper wire to the tops of the metal star pickets, so that in future missing pegs can be identified and replaced without fuss. Individual pickets have also been labelled using metal squares attached to the top of each picket, starting with the number of the quadrat first and then the number of the picket.

GPS (Global Positioning System) were used in 1995, to aid in finding the quadrats again in the future. These are detailed on the maps on Appendix A. Photos were also taken of each quadrat. In 1995 general notes were taken on the condition of the quadrats, including evidence of animal (in particular rabbit) activity, soil, slope,

evidence of burning or cutting, rubbish and occurrence of weeds.

Approximately one and a half quadrats were surveyed per day, using two people, including travelling time and time to set up entirely new quadrats. If future work is done on these permanent quadrats, it is recommended that it is more efficient for two people to work together. Jim Goodsell noted that it took one person one and a half days to complete a quadrat, including time for selecting the area for the quadrat and setting up the quadrat. To avoid this time factor in searching and re-establishment some of the quadrat pickets have been cemented in situ.

2.3 Data Analysis

Results pertaining to several reserves could not be analysed, due to the 3 quadrats that were missing and re-pegged in 1995. Only a species list was made for Quadrat (4) in Reserve 2023 in 1984, and as such no line transect data was collected in 1995. The quadrat in Reserve 19138 was placed by accident in a *Eucalyptus celastroides ssp. virella* Woodland, due to an identification error (*Eucalyptus celastroides* resembles the mallee form of *the former Eucalyptus loxophleba ssp.* 'smooth bark', now *Eucalyptus loxophleba ssp. lissocarpha*), however measurements such as line intercept length and height of *Eucalyptus celastroides ssp. virella* in this reserve have been included for analysis with those of *Eucalyptus loxophleba.*

Several species identifications have been changed in the 1984 data, due to updates in taxonomy and discrepancies with data collected in 1995, namely:

- *Lepidosperma viscidum* which was recorded in Reserve 13594 is now *Lepidosperma* sp. A2,
- *Stypandra imbricata* has been changed to *Stypandra glauca*,
- *Santalum spicatum* in Reserve 9754 (2) is now *Santalum acuminatum, and*
- *Eucalyptus loxophleba* in Reserve 19138 is now *Eucalyptus celastroides ssp. virella* (as above).

All raw data (1984 and 1995) was entered into Quattro Pro V6.0, and *t* tests were also conducted using this programme. The raw data was also transformed into Paradox format for use by the Department of Conservation and Land Management officers. All graphics were produced using Harvard Graphics 3.0.

Cover for perennial plants which did traverse the line intercept were calculated using the following method:

$$\% \text{ Cover (Sp. A)} = \text{Total Intercept Length of Sp. A} \times \frac{100}{\text{Tot. Length of Transect}}$$

This technique uses information gained by the use of the line transect (Kent and Coker 1992). It gives the percentage along the line transect which individuals of a species have traversed (the line transect is equal to 96.6m per quadrat in this study), and is a relative measurement and hence is not in m^2 values.

Projective Foliage Cover (PFC) has been calculated for both 1984 and 1995 data, for all perennial species which intercepted the line transect. This method takes into account the RFC value calculated in the field, which is a measure of the density of the foliage. PFC is calculated by :

PFC = RFC x Cover

RFC is estimated in the field, and Cover is calculated by

$$\text{Cover} = \frac{\text{Total Intercept Length of Sp. A}}{\text{Total Transect Length}}$$

The PFC for each individual plant was calculated, and then PFC of individuals of the same species were summed, to give a total PFC for the species. However, these results are somewhat subjective, as the RFC value is a measurement which is a personal estimation and therefore has some error. Both sets of measurements were done by different researchers, and therefore this error in the RFC value is likely to be high. Therefore, analysis is concentrated on changes in the Percent Cover values as described above.

Paired *t* tests were also used to compare changes in *Eucalyptus loxophleba* and *Acacia acuminata* intercept values, circumference at breast height, height and canopy height between years, using mean values measured in applicable reserves. This results in a broad statement regarding growth (positive or negative) in these two species in these reserves over the period 1984 - 1995, giving an indication whether as a whole *Eucalyptus loxophleba - Acacia acuminata* communities in Nature Reserves are dynamic, stagnant or in a state of decay

Originally the design of this study was to allow for the data to be subjected to analysis by Principle Component Analysis, however *t* tests (where the means of measurements of two samples are compared) are being used to analyse temporal differences between perennial species. Number of individuals or abundance of each species at each quadrat were not originally recorded, because they were unnecessary in generating useful ordination results, and thus were not recorded in 1995. However, this leaves us with no way to examine events such as the decline in cover (and hence importance) of one species with the increase in cover of another - only if a species is lost or added to the species list can changes be identified. Only perennial species which traversed the line transect have covers calculated in this study.

There are several different factors which can be measured to give an indication of the change in growth of perennial woody species. Measurements on several of these factors

(growth characteristics) have been collected and compared in this study, and the resulting differences and analysis are presented below. Growth characteristics which were measured are :

- Line Intercept Length - Cover
- Circumference at Breast Height (CBH)
- Height
- Canopy Height

By examining change in each of these characteristics we can achieve a better understanding of changes in growth rates than by examining one characteristic alone. The structure of the transect line includes as many individuals as possible which are present in and near the quadrat. However this results in a smaller number of sampled individuals, than for example a straight 96.6m transect, as it repeats measurements on some individuals (especially individuals which have a wide cover). The results as below are influenced by the low numbers of individuals which have been sampled along the transect line.

3. RESULTS

3.1 Introduction

The results are summarized in Figures 1 to 17, Tables 1 to 4, and Appendices A to E.

Appendix A provides a sketch map of the Reserves and the location of the quadrats (with GPS recordings for each quadrat (Q)). All values for *t* tests quoted below and corresponding data is given in Appendix B. The Projection Foliage Cover (PFC) is summarized in Appendix C. Details on the presence absence data for each species in the Reserves in 1984 and 1995 are presented in Appendix D. A photographic record of all sites is presented in Appendix E. All data for this report has also been sent in Paradox format to the Department of Conservation and Land Management.

3.2 Changes in Total Intercept Length of *Eucalyptus loxophleba* and *Acacia acuminata*

A summary of the mean intercept lengths of *Eucalyptus loxophleba* and *Acacia acuminata* in 12 and 11 quadrats respectively between the years 1984 and 1995 are set out in Figures 1 and 2.

The total *Eucalyptus loxophleba* line intercept length increased in 11 of the 12 quadrats tested. *t* test results show that change in *Eucalyptus loxophleba* intercept length in the reserves between the years 1984 - 1995 has been significant, thus the null hypothesis is rejected and the alternative hypothesis:

H_a : there is a significant difference in *Eucalyptus loxophleba* total intercept length in the quadrats between the years 1984 and 1995

at a probability level of $P = 0.05$ can be accepted. This indicates overall positive growth of *Eucalyptus loxophleba* in these nature reserves in the past eleven years. There was a decrease in *Eucalyptus loxophleba* intercept length in Reserve 16714. There have been no recorded fires or other such effects which have occurred in this reserve in the past 11 years which would have caused a decline in the total *Eucalyptus loxophleba* line intercept length. Table 1 gives the raw data of the line intercept length of *Eucalyptus loxophleba* trees in Reserve 16714 in 1984 and 1995, and individuals have been given arbitrary numbers for identification purposes. Since along this line transect there were relatively few *Eucalyptus loxophleba* individuals, this decline is probably due to natural death of portions of these trees which formerly crossed the transect line (Table 1).

In July 1989, officers from the Department of Conservation and Land Management planted *Eucalyptus loxophleba* seedlings in Reserve 16714, the planted area included the position of the permanent quadrat. However, no *Eucalyptus loxophleba* seedlings or young trees were encountered in the quadrat in 1995.

Figure 1: Summary of 1984 and 1995 Line Transect Intercept Lengths(m) of *Eucalyptus loxophleba* in 12 Quadrats

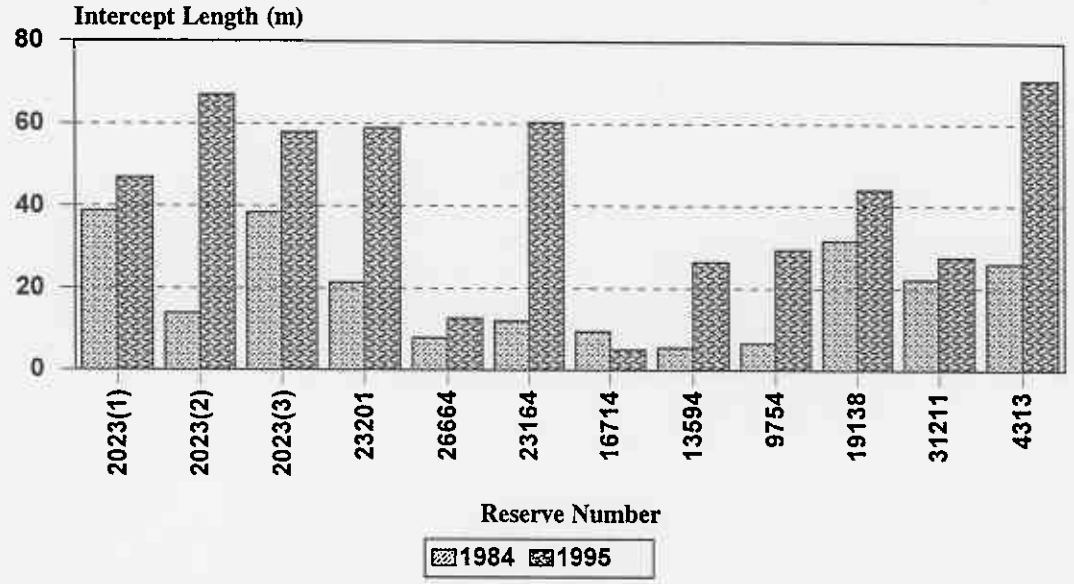


Figure 2: Summary of 1984 and 1995 Line Transect Intercept Lengths(m) of *Acacia acuminata* in 11 Quadrats

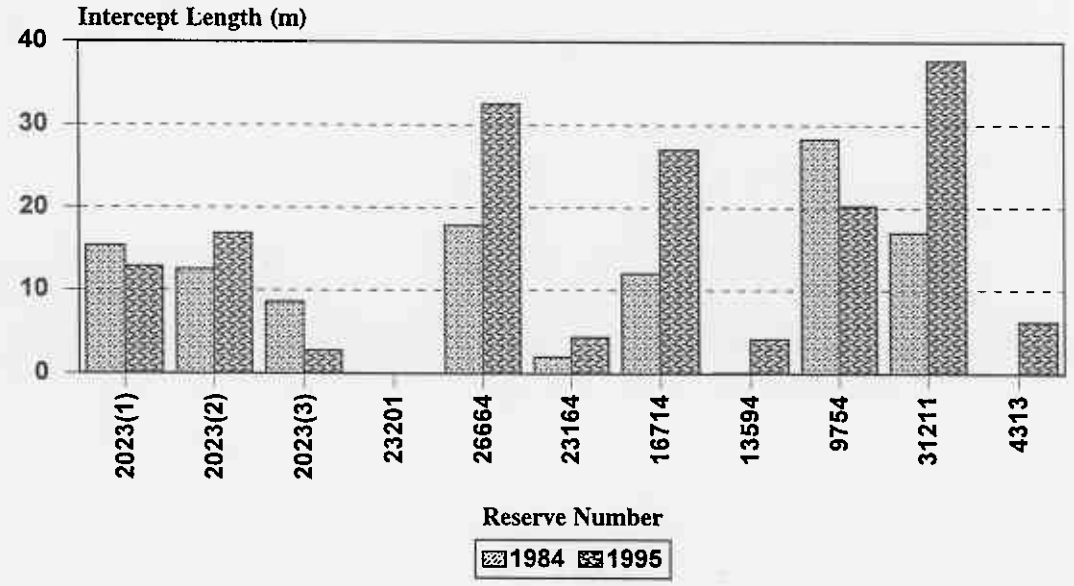


Table 1 : Raw Line Intercept Data from 1984 and 1995, giving a comparison of change in *Eucalyptus loxophleba* intercept lengths of individual trees in Reserve 16714

Date	Tree Number	Intercept	Length	Height
15/10/84	1	25.24-25.44	0.2	0.38
15/10/84	2	27.09-28.52	1.43	6.54
14/9/95	2	27.2-27.7	0.5	6.6
15/10/84	3	49.18-49.48	0.3	2.15
14/9/95	3	49.37-50.16	0.79	3.8
15/10/84	4	66.58-66.83	7.5	9.44
14/9/95	4	66.75-70.5	3.75	10.3

In 7 of the 11 quadrats (*Acacia acuminata* did not occur on the line transect in Reserve 19138) there was an increase in *Acacia acuminata* intercept length. However, results from a *t* test analysing *Acacia acuminata* intercept length data show that there is no significant difference between 1984 and 1995 total intercept lengths, thus the null hypothesis :

H_o : there is no significant difference in *A. acuminata* total intercept lengths in the quadrats between 1984 and 1995

at a probability level of $P = 0.05$ cannot be rejected.

Total interval length decreased in Reserve 2023 (1) and (3) and in Reserve 23201 and 9745 (2). A prescribed burn was put through the area marked on the map in Appendix A in Reserve 2023 on the 21 March 1985, affecting both Quadrats (3) and (4). *Acacia acuminata* is fire sensitive, and the original individuals in quadrat (3) were probably destroyed in the fire, resulting in a change in the *Acacia acuminata* intercept length. Regeneration of this species in quadrats (3) and (4) was in evidence in 1995. No records of fire affecting the area around Quadrat (1) have been found, and a decrease in intercept length could possibly be due to natural death of individuals on the transect line, with little recruitment.

Quadrat (2) in Reserve 9754 is located on a drainage line, where runoff from the nearby granite outcrop collects. The area is moister than when the quadrat was first placed (Goodsell, pers. comm.), and although *Acacia acuminata* prefers low-lying flats and lower slopes, a combination of increased moisture and competition from species such as *Spartochloa scirpoidea* may have caused a decline in growth of *Acacia acuminata*.

The decrease in *Acacia acuminata* intercept length in Reserve 23201 is minimal, the original individual not being re-recorded, either due to a change in direction of growth in the individual (which was only 1.23m in height in 1984) or death in the portion of the individual which originally covered the transect line.

3.3 Changes in Foliage Cover of Perennial Species

Of a total of 295 species which were recorded during the course of this study, 35 perennial species were recorded in line transect intercept data. Percentage Cover of these species in 1984 and 1995 are given in Table 2, and the Projection Foliage Cover values are summarized in Appendix C.

The majority of perennial species recorded in both years had only small intercept lengths in comparison with that of *Eucalyptus loxophleba* or *Acacia acuminata*. This is due to the larger size and greater numbers of these two species in comparison to the understorey species recorded in the majority of the quadrats. *Spartochloa scirpoidea* in Reserve 9754 (2) underwent a large cover increase during the past 11 years (Table 2), from 11.54% to 33.74%, due to an increase in moisture since the quadrat was pegged. Similarly *Melaleuca hamulosa* and *Melaleuca arenicola* also increased in cover in this quadrat during this time frame. *Lomandra effusa* in Reserve 23164 also increased in cover dramatically, from 0% to 20.31% in 1995. Reserve 23164 is fairly pristine, medium-sized reserve located on a granite outcrop in the far eastern Wheatbelt with little evidence of human usage (in the area around the quadrat) and the increase of *Lomandra effusa* may be also due to an increase in drainage from the granite outcrop on which it is located. Most of the other perennial species in the quadrats have also increased coverage in the past eleven years, although to a lesser degree than *Spartochloa scirpoidea* or *Lomandra effusa* as in the above examples (Table 2). These increases would be due to normal growth and recruitment, and generally not as responses to changes in environment.

Decrease of cover of some species in some reserves were not dramatic, due to the fact that they had little cover at the start of this study. Cover of species such as *Aristida contorta* and *Grevillea paniculata* in Reserve 13594 and *Dianella revoluta*, *Pittosporum phylliraeoides* and *Santalum spicatum* in Reserve 23164 decreased. Cover of *Dianella revoluta* (Reserve 23164) fell from 8.69% to 0%. *Acanthocarpus preissii* and *Santalum acuminatum* decreased in cover in Reserve 4313. These results are influenced by small sample sizes. Original cover values result from measurements of few or even single individuals, and occurrences such as natural deaths of these individuals, or deaths of even portions of their branches and leaves which once covered the line transect influence these results.

Some new species of plant were recorded on the line transect in 1995, particularly in Reserves 9754, 16714 and 23164. This is a positive occurrence on these Nature Reserves, where increased natural diversity is to be encouraged. Species appearing on

Table 2: Summary of Percentage Foliage Cover of All Perennial Species present on Transect Lines in 1984 and 1995

Perennial Species	2023 (1)		2023 (2)		2023 (3)		23201		26664		23164		16714		13594		9754 (2)		19138		31211		4313	
	1984	1995	1984	1995	1984	1995	1984	1995	1984	1995	1984	1995	1984	1995	1984	1995	1984	1995	1984	1995	1984	1995	1984	1995
Acacia acuminata	15.94	13.34	12.99	17.48	8.9	2.89	0.01	0	18.51	33.7	2.07	4.55	12.45	28.01	0.16	4.34	8.33	20.97			17.59	39.08	0	6.42
Acacia saligna							0.01	4.76																
Acacia sp. (CG477)											0	0.72												
Acanthocarpus preissii																							0.96	0
Allocasuarina huegeliana	0.26	7.16	3.31	10.51	0	3.42							0	0.1										
Aristida contorta															1.13	0								
Caesia parviflora																	0.35	0						
Calothamnus quadrifidus											0.83	2.07												
Dampiera lavandulacea													0	0.07									0	0.11
Dianella revoluta							0.12	0.54			8.69	0	0	1.79	0.16	0.21	0	0.93						
Enchylaena tomentosa																							0	1.16
Eucalyptus celastroides																			32.69	45.58				
Eucalyptus loxophleba	40.11	48.52	14.39	69.38	39.68	59.89	22.09	60.97	8.18	13.15	12.45	45.51	9.76	5.22	5.64	27.29	6.81	30.42			22.93	28.5	26.9	73.33
Eucalyptus salmonophloia																			6.8325	7.4525				
Eucalyptus wandoo																					0	22.1		
Glischrocaryon aureum															1.16	1.35								
Grevillea paniculata															4.36	0	0	1.41						
Hakea preissii									3.67	6.99														
Jacksonia sternbergiana							5.28	0																
Lepidosperma costale													0	0.39										
Lepdiosperma drummondii																	22.13	25.84						
Lepidosperma sp. A2															7.95	13.65								
Lomandra collina															0	0.1								
Lomandra effusa											0	20.31			0	1.35							0	0.16
Melaleuca arenicola											0	1.66					1.66	2.31						
Melaleuca hamulosa																	2.59	3.21						
Olearia revoluta											0	0.94			0	0.43								
Pittosporum phylliraeoides									0.1	0.26	0.88	0											0	0.31
Platysace maxwellii															1.88	2.08								
Rhagodia preissii											0.41	0.67												
Santalum acuminatum															0	0.25	2.38	4.22					4.64	0
Santalum spicatum											1.07	0												
Spartochloa scirpoidea															3.04	2.08	11.54	33.74						
Stypandra glauca																					0	1.38		
Trymalium ledifolium																				0	0	0.63		

the line transect in Reserve 9754 (2) in 1995 were *Dianella revoluta* and *Grevillea paniculata*, of which *Dianella revoluta* was not present in the species list in 1984. In Reserve 16714 *Allocasuarina huegeliana*, *Dampiera lavandulacea*, *Dianella revoluta* and *Lepidosperma costale* appeared on the line transect in 1995, all of which were present the species list of 1984. This gives an indication of positive growth in a range of species in this reserve. *Acacia* sp. (CG477), *Lomandra effusa*, *Melaleuca arenicola* and *Olearia revoluta* appeared on the line transect in Reserve 23164 in 1995, of which *Lomanda effusa* was not present in the species list in 1984.

3.4 Changes in Circumference at Breast Height of *Eucalyptus loxophleba* and *Acacia acuminata*

The mean *Eucalyptus loxophleba* circumference at breast height (CBH) of individuals sampled across the line transects increased over the period 1984 - 1995 in all quadrats, indicating an overall positive growth of this species in all reserves, see Figure 3. However, when a *t* test was applied to these results, the null hypothesis was rejected and the alternative hypothesis:

H_o = there was a significant difference in mean *Eucalyptus loxophleba* CBH values in the quadrats between the years 1984 and 1995

could be accepted at a probability level of $P = 0.05$, however not at $P = 0.025$. This is due to the large variability in circumference at breast height values in both data sets (Appendix B, Table C). This large variability results partly from the effect of single individuals on a small sample size. The measurement from a single large individual can dominate measurements of other individuals in the transect if the sample size is small. Reserves in the western portion of the Wheatbelt were more likely to have larger *Eucalyptus loxophleba* circumference at breast height values than their eastern counterparts. Quadrats in Reserves 23201, 26664 and quadrats (1) and (2) in Reserve 2023 all exhibited individuals with circumference at breast height values of over 2m, whereas quadrats in Reserves 23201, 13594 and 9754 seldom had *Eucalyptus loxophleba* circumference at breast height values of more than 0.5m. This is because of the occurrence of different sub-species. *Eucalyptus loxophleba* ssp. *loxophleba* is common in the Darling Range and Wheatbelt, and was commonly seen in the reserves in the western Wheatbelt. This sub-species forms a small to medium sized tree (Brooker and Kleinig 1990), and *Eucalyptus loxophleba ssp. lissocarpha*, which is common to the Wheatbelt and goldfields and was observed in reserves in the eastern Wheatbelt exhibits a mallee habit. Thus *Eucalyptus loxophleba* ssp. *loxophleba* commonly has a larger circumference at breast height than that of *Eucalyptus loxophleba ssp. lissocarpha*.

In 7 of the 11 quadrats *Acacia acuminata* circumference at breast height values increased, however in Reserves 23201, 2023 (3), 16714 and 13594 the circumference at breast height values decreased, see Figure 4.

Figure 3: Summary of 1984 and 1995 Mean Circumference at Breast Height (CBH) (m) of *Eucalyptus loxophleba* in 12 Quadrats

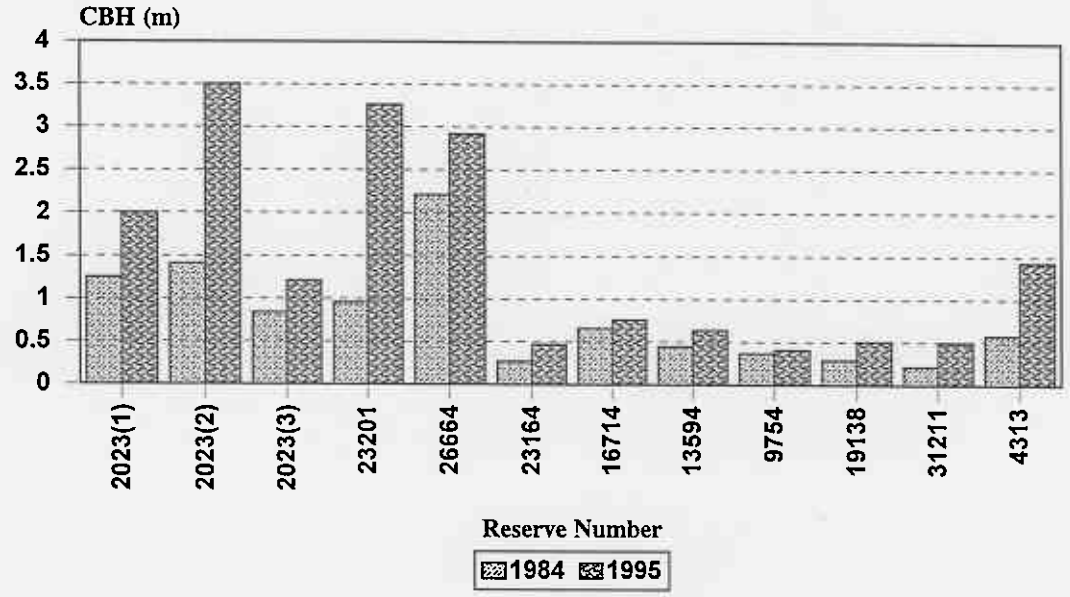
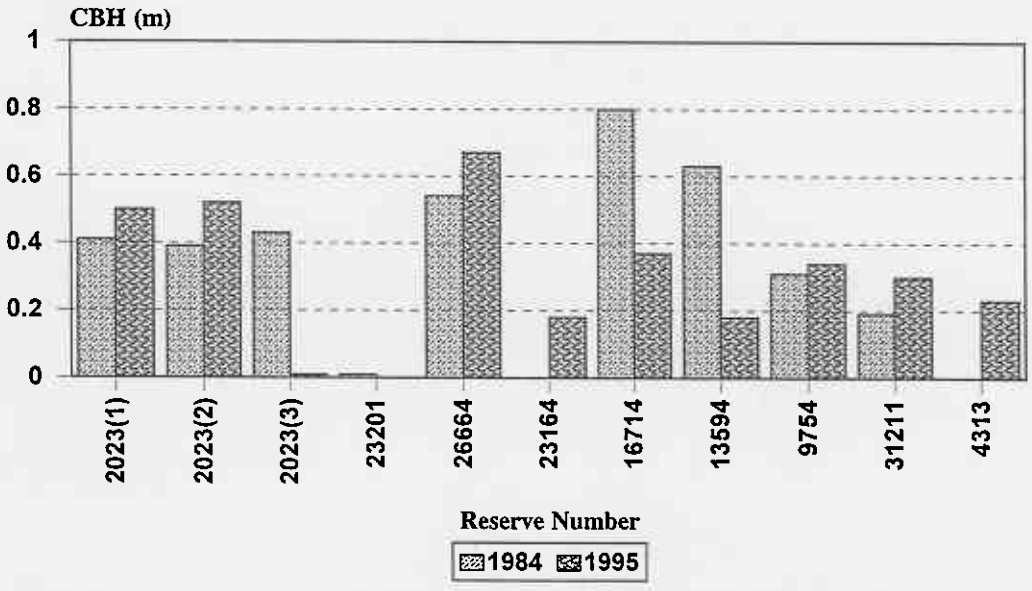


Figure 4: Summaryof 1984 and 1995 Mean Circumference at Breast Height (CBH) (m) of *Acacia acuminata* in 11 Quadrats



The *t* test performed indicates that we cannot reject the null hypothesis :

> H_o : there is no significant difference in mean *Acacia acuminata* CBH in the 11 reserves between the years 1984 and 1995

for either at P = 0.05. When the circumference at breast height values for the reserves above which decreased in 1995 are removed from the test, we still cannot reject the above null hypothesis. Thus any increases in *Acacia acuminata* circumference at breast height between 1984 and 1995 are judged not significant. The latter relates to the wide range of variability in the results.

Acacia acuminata circumference at breast height values decreased rapidly in quadrat (3) Reserve 2023 due to the prescribed burning in March 1989 that was undertaken in this reserve by the Department of Conservation and Land Management. The original individuals were killed, and although regeneration has taken place they have not reached the size of the original trees.

Decreases in circumference at breast height were evidence in *Acacia acuminata* on Reserves 16714 and 13594, both occurring in the mid - east Wheatbelt. In Reserve 16714, some of the 1995 *Acacia acuminata* individuals cannot be identified in the 1984 data - 5 individuals were recorded on the transect in 1984, compared to 10 in 1995. The circumference at breast height values in this reserve in 1984 were uniform, with no values corresponding to young *Acacia acuminata* trees. In 1995 several young *Acacia acuminata* trees crossed the line intercept, including 2 which had no recorded circumference at breast height values because they were too young. These individuals were included in the mean circumference at breast height value, and were given individual values of 0. There were also 3 other trees which had low circumference at breast height values, because of their age (as deduced from their small height). Thus the mean *Acacia acuminata* circumference at breast height value is lower in this reserve in 1995 due to the influx of new individuals rather than decline in older ones, showing recruitment and regeneration of this species. No factors have been found to explain why *Acacia acuminata* has experienced recruitment in this reserve, as no regenerative effects such as fire or sudden increases in summer precipitation have been recorded for this reserve in the intervening 11 years. Precipitation values are only slightly useful in these instances, however, as readings are taken in nearby towns, and isolated thunderstorms occurring over other areas can increase precipitation without being recorded. The lack of a suitable sample size (ie. repeated quadrats in each reserve) can also skew results, other quadrats located in the same community may have resulted in no recruitment.

Of the 2 *Acacia acuminata* on the line transect in Reserve 13594 in 1984, only one of them appeared in 1995. This loss could be due to death of the individual or death of the portion of the individual which once crossed the line transect. The circumference at breast height value of the original tree has seemed to decrease with age - probably due to death and falling off of branches during the past eleven years, although the individuals height is now greater. Two new, younger individuals have appeared on the

line transect in 1995, which as in Reserve 13594 has lowered the mean circumference at breast height value.

The original individual *Acacia acuminata* which was measured in 1984 in Reserve 23201 was unrecorded in 1995, either due to death or growth away from the line transect.

3.5 Changes in Height of *Eucalyptus loxophleba* and *Acacia acuminata*

Mean *Eucalyptus loxophleba* heights in metres of 12 reserves in 1984 and 1995 are illustrated in Figure 5. In two quadrats there was a decrease in the mean *Eucalyptus loxophleba* height from 1984 to 1995 : Quadrat (1) in Reserve 2023 , and in Reserve 2666. We cannot reject the null hypothesis:

> H_o : there is no significant difference in mean height of *Eucalyptus loxophleba* in the reserves between the years 1984 and 1995

at $P = 0.05$. When the mean heights of reserves which had a decrease in height over 1984 - 1995 are subtracted from the analysis, we still cannot reject the above null hypothesis. Thus there was no significant change in *Eucalyptus loxophleba* height in the 12 reserves over the period 1984 and 1995.

In 1984, Quadrat (1) in Reserve 2023 recorded an individual as having a height of 27.7m, which is by far larger than any individual recorded in 1995 in this quadrat (indeed, in the entire study). By matching data records, this individual tree was recorded as having a height of 14.2m in 1995. This discrepancy is either due to incorrect recording in the field, or factors such as lightning strike or death and eventual rotting and falling of part of or all of the tallest branch of the tree over the time 1984 to 1995. Two other individuals recorded in 1984 were not re-recorded in 1995, and one younger individual having a height of just over 5m was recorded in 1995. This tree was not recorded in 1984, having either not existed or existed as a seedling and not crossed the line transect when the quadrat was first surveyed.

Reserve 26664 covers almost the entire Lake Dumbleyung area, and the area is salt-affected. The quadrat in this reserve is very close to the lake itself, although it is situated on a rise. Only a single *Eucalyptus loxophleba* individual was found in both years along the line transect, and although it's line intercept length and circumference at breast height have both increased, it's height has decreased. This may be due to recording error or the individual experiencing situations such as lightning strikes or ageing. It may be impossible to tell from a single individual whether or not the *Eucalyptus loxophleba* population is suffering from problems such as increased salinity.

It can be noted that the main increase in *Eucalyptus loxophleba* height occurred in the reserves which are located in the eastern and northern Wheatbelt, as can be seen in Figure 5. Quadrat (1) in reserve 2023 and 2664, which had negative increase in height, and Quadrat (2) and (3) in 2023 and Reserve 23201 which had poor increase

Figure 5: Summary of 1984 and 1995 Mean Heights(m) of *Eucalyptus loxophleba* in 12 Quadrats

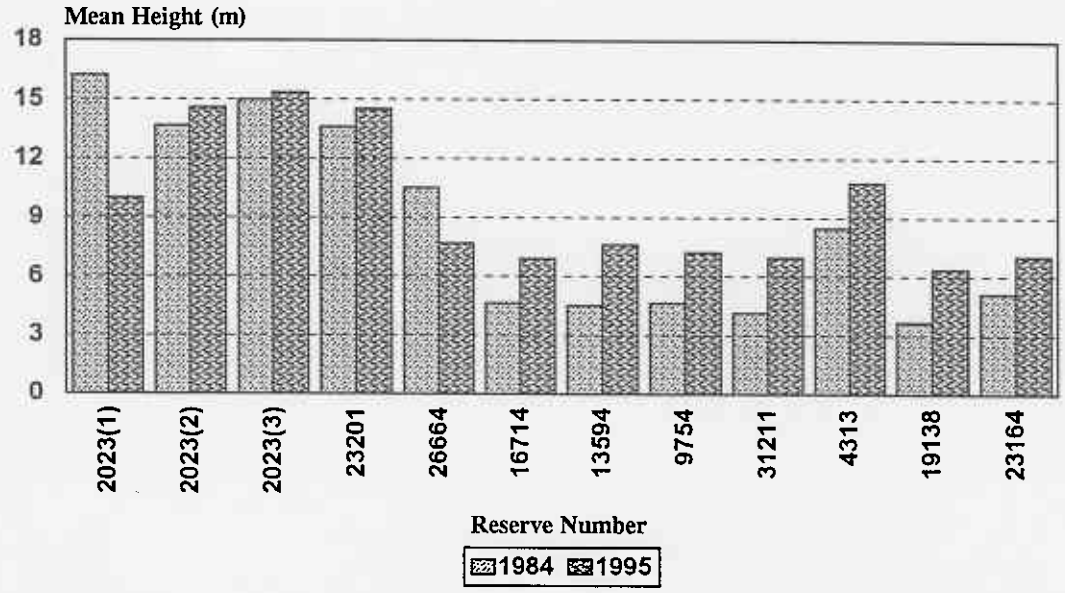
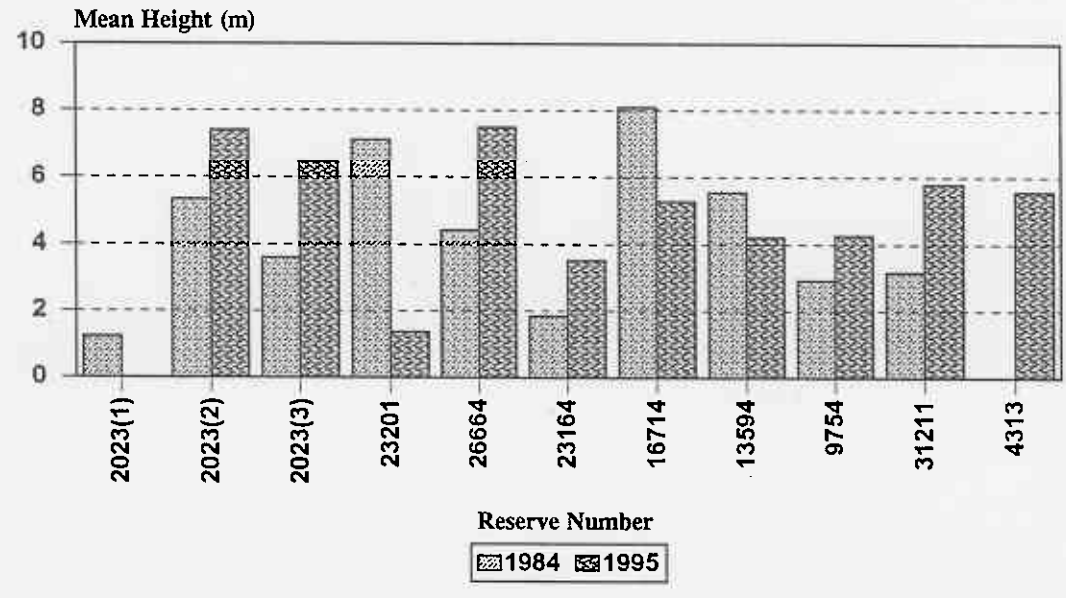


Figure 6: Summary of 1984 and 1995 Mean Height (m) of *Acacia acuminata* in 11 Quadrats



in height, may be affected by nearby farming practises to a greater extent than these species on other reserves.

The change in mean *Acacia acuminata* height over this period shows the same pattern as the change in circumference at breast height values. The height increased in 7 of the 11 quadrats, however quadrats in Reserves 23201, 2023 (3), 16714 and 13594 experienced a decrease in heigh, see summary of mean heights in Figure 6. The null hypothesis below could not be rejected :

H_o : there is no significant difference in mean *Acacia acuminata* height in the reserves between the years 1984 and 1995

at $P = 0.05$. This indicates that over the period 1984 - 1995 in these Reserves there was no overall significant change in *Acacia acuminata* height, and thus no growth in the populations. However, this result is influenced by the large internal variations in these data sets, and positive growth did occur in 7 of the 11 quadrats.

The reasons for decrease in *Acacia acuminata* mean height in Reserves 23201, 2023 (3), 16714 and 13594 are the same reasons for decrease in *Acacia acuminata* mean circumference at breast height in these reserves. The burn in Reserve 2023 killed the original trees, and the regeneration of young *Acacia acuminata* have not exceeded the original heights. An increased number of young *Acacia acuminata* individuals in 1995 also have decreased the mean height in Reserve 16714, and this same factor also skewed the mean height results in Reserve 13594. The original individual which was measured in Reserve 23201 in 1984 was also unrecorded in 1995.

3.6 Changes in Canopy Height of *Eucalyptus loxophleba* and *Acacia acuminata*

Canopy height is the distance between the top of the tree and the base of the canopy. This gives an indication of the biomass of the individuals, but not in absolute values. The canopy heights of *Eucalyptus loxophleba* and *Acacia acuminata* in 1984 and 1995 and their differences are shown in Figures 7 and 8 respectively.

We cannot reject the null hypothesis :

H_o : there is no significant change in *Eucalyptus loxophleba* canopy height in the reserves over the period 1984 - 1995

at $P = 0.05$. Three of the 12 quadrats recorded a decrease in canopy height, these quadrats were in Reserve 2023 (1) and (3) and 26664. This can be related to the decrease in *Eucalyptus loxophleba* mean height in these reserves, as this affects canopy height - the quadrats in Reserve 2023 (1) and 26664 recorded a decrease in height. The mean *Eucalyptus loxophleba* height in Quadrat (3) in Reserve 2023 increased, however the mean height of the base of the canopy increased proportionately higher than the mean height of the *Eucalyptus loxophleba* on the transect - thus the canopy height decreased. This may result from the prescribed burn which was put through this area in March, 1985.

Figure 7: Summary of 1984 and 1995 Mean Canopy Height (m) of *Eucalyptus loxophleba* in 12 Quadrats

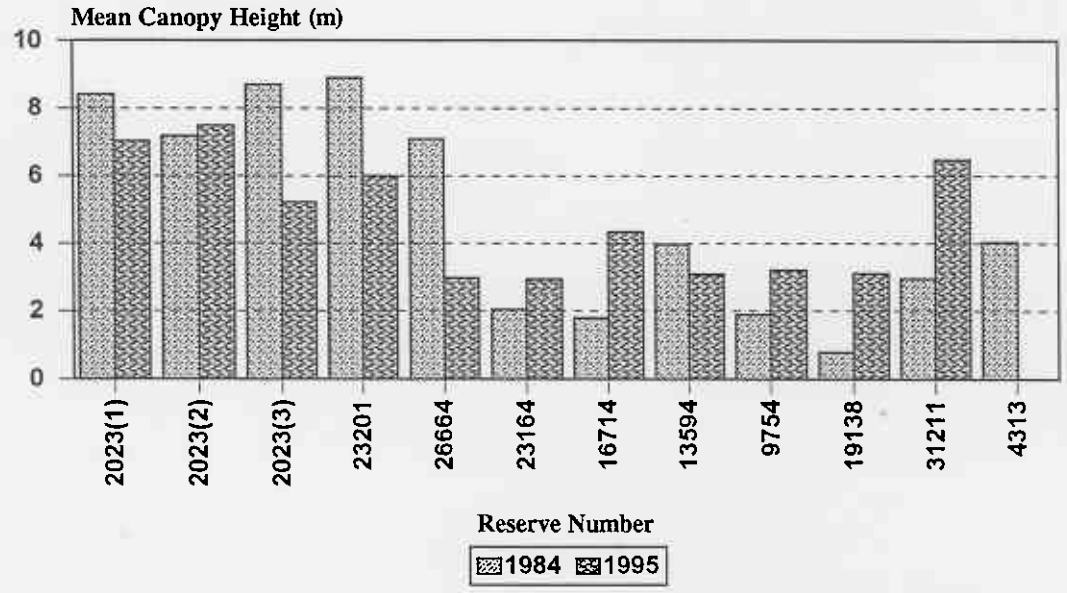
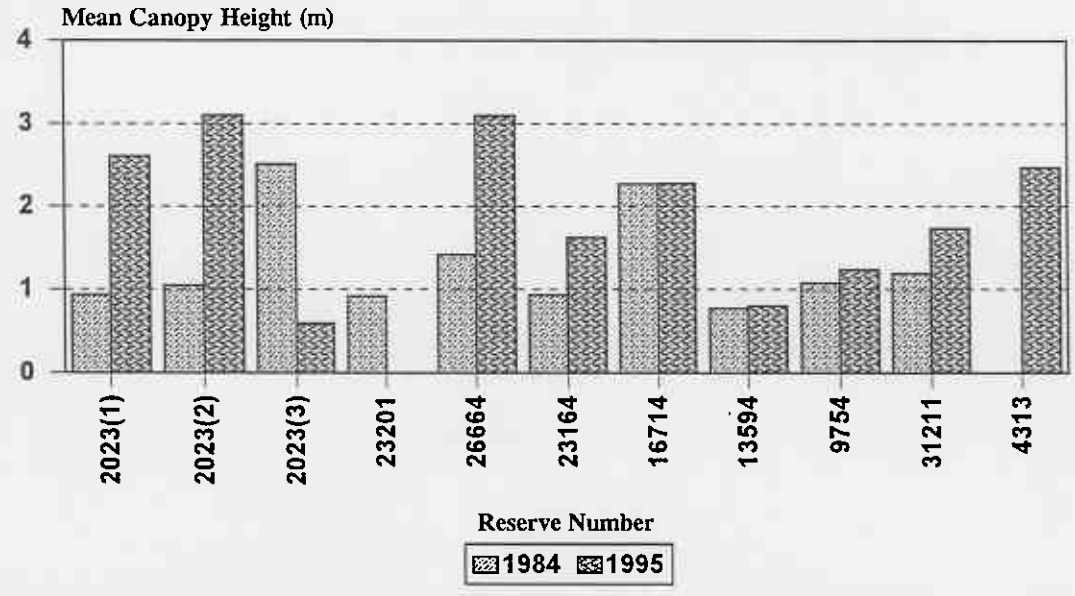


Figure 8: Summary of 1984 and 1995 Mean Canopy Height (m) of *Acacia acuminata in* 11 Quadrats



We cannot reject the null hypothesis (as below) for change in *Acacia acuminata* canopy height over the period 1984 -1995 in the 11 quadrats, although only 2 of these quadrats (in Reserve 23201 and Reserve 2023 (3)) showed a decrease in canopy height (P = 0.5).

H_o : there is no significant change in mean *Acacia acuminata* canopy height in the 11 reserves over the period 1984 - 1995

This is a result of high internal variance of the two data sets, rather than a true representation of the change in *Acacia acuminata* canopy height.

In Reserve 23201, only one *Acacia acuminata* individual intercepted the transect line in 1984, and this was not re-recorded in 1995. This individual was only 1.23m in height in 1984, and only crossed the transect line by 1cm. Thus this individual either died or the direction of growth since 1984 has moved away from the line. No other individuals were recorded on the transect in 1995.

In Reserve 2023 (3) the prescribed burn of 1985 killed all *Acacia acuminata* individuals (as stated above), and thus a comparison involving growth of the original trees is not possible. New individuals which have replaced the old have a much lower mean canopy height.

3.7 Recruitment of *Eucalyptus loxophleba* and *Acacia acuminata*

Recruitment was determined by the presence of young individuals of a species along a line transect in 1995, which were absent in 1984. Recruitment of *Acacia acuminata* was greater in general than that of *Eucalyptus loxophleba*. The only population of *Eucalyptus loxophleba* which experienced recruitment in this study was in Reserve 13594, whereas populations of *Acacia acuminata* experienced recruitment in Reserves 26664, 4313, 2023 (3), 16714, 13594 and 23164. This is due to the population structure of the two species - *Eucalyptus loxophleba* is a larger, longer-lived species which is not necessarily killed by fire, and therefore has a slower recruitment rate than *Acacia acuminata*. The majority of the reserves in which *Acacia acuminata* experienced an increase in recruitment occur in the eastern wheatbelt, however there is no factor (such as precipitation, fire) which unites these reserves to give a conclusive statement stating why recruitment occurred in these reserves and not in others. The sampling method used does not lend itself well to measuring recruitment of populations of these species, some young individuals of either species were observed in almost all quadrats in 1995 but were not recorded because they did not traverse the line transect. Recruitment will occur in every reserve naturally at some rate.

There are no statistics which compare the increase in recruitment of *Acacia acuminata* in Reserve 2023 (3) with recruitment in other reserves, however concluding from general observations there was a significant increase in recruitment of this species in this quadrat (and quadrat (4) in this same reserve) in comparison to all other quadrats.

As can be seen from the photographs in Appendix E, there was large number of young *Acacia acuminata* found in these quadrats in 1995, which was not observed in any other quadrat.

3.8 Changes in Growth Characteristics of Other Perennial Species

The majority of the quadrats had sparse understorey, and thus the number of individuals of other perennial species was low. Comparisons using *t* tests therefore have not been undertaken. Measurements of individuals of species such as *Allocasuarina huegeliana, Acacia saligna*, *Hakea preissii*, and *Santalum acuminatum* between both data sets can sometimes be identified, and changes in height and intercept examined, however changes in measurements such as height of species such as *Spartochloa scirpoidea* (which reaches a height of about 1 metre) are not significant.

In Reserve 23201, one individual of both *Acacia saligna* and *Dianella revoluta* were recorded on the line transect in 1984 and 1995. *Acacia saligna* was a young plant 0.23m high in 1984, and was recorded at 2.70m in 1995. Similarly the corresponding intercept length and circumference at breast height values also increased. *Dianella revoluta* also recorded an increase in line transect length, however the height decreased from 1.07m in 1984 to 0.5m in 1995. This could be due to the action of herbivores. Thus in general there has been an increase in growth of other perennial plants found within the quadrat in Reserve 23201.

Allocasuarina huegeliana was recorded on the line transect of Quadrat (1) in Reserve 2023 in 1984 and 1995, and the number of individuals recorded has increased from 1 in 1984 to 3 in 1995. The height of the original individual has increased from 6.15m to 9.5m, and the two new individuals have heights of 6.6m and 7.2m respectively. Thus there has been positive growth of *Allocasuarina huegeliana* in this quadrat.

Two *Allocasuarina huegeliana* trees were also found in Quadrat (2) in this reserve in 1984 and 1995, however by comparing the positions on the transect line in 1984 and 1995, these were not re-recorded. The two original trees were the same height (4.0m and 4.6m), and so had probably regenerated in response to an event such as a fire which had occurred before the quadrat had been pegged. The two individuals recorded in 1995 were taller, having heights of 8.8m and 6.8m. Although the data does not match trees, there has been a net increase in growth in this quadrat.

Only *Eucalyptus loxophleba* and *Acacia acuminata* were recorded on the line transect of Quadrat (3) in Reserve 2023 in 1984, however in 1995 three *Allocasuarina huegeliana* were also recorded, thus growth of *Allocasuarina huegeliana* has been experienced in this quadrat. This would be a response to the prescribed burning of this area in 1989. The heights of these individuals were 2.2m, 1.4m and 2.05m.

Hakea preissii and *Pittosporum phylliraeoides* were recorded at Reserve 26664 in both 1984 and 1995. The original *Pittosporum phylliraeoides* tree had a height in 1984 of

3.38m and was not re-recorded in 1995, instead a new plant with a height of 1.2m appeared on the transect. Thus re-generation of this species is apparent. The single *Hakea preissii* individual has grown from 3.69m to 7.4m, and a new individual with a height of 6.2m also appeared on the transect in 1995. The total line intercept of *Hakea preissii* grew from 3.55m to 6.75m in length. Although the single *Eucalyptus loxophleba* tree on the transect decreased in height, other perennial species have had positive growth and recruitment over this same time frame.

Perennial species such as *Dianella revoluta*, *Santalum spicatum* and *Calothamnus quadrifidus* were recorded on the transect in Reserve 23164. *Dianella revoluta* had a total line intercept length of 8.39m in 1984, however it was not present on the transect in 1995. Conversely, *Lomandra effusa* had a line intercept length of 19.62m in 1995, and was not present in 1984. This is due to either a change in species composition, or mis-identification. The original *Calothamnus quadrifidus* plant was re-recorded in 1995, and has experienced slight growth. The intercept length has expanded from 0.8m to 2m in length, and the height has risen from 1.69m to 1.95m. Overall, other perennial species underwent positive growth during the time frame.

Dianella revoluta, *Allocasuarina huegeliana*, *Lepidosperma costale* and *Dampiera lavandulacea* appeared on the line transect in Reserve 16714 in 1995, thus each of these species underwent a period of growth in the quadrat. *Dianella revoluta* had the greatest increase in number and cover of these species, with five individuals recorded on the line transect in 1995, compared to zero in 1984. This is in accordance with the increase in cover of *Acacia acuminata*, however it is also in contrast to the decrease in cover of *Eucalyptus loxophleba*.

Reserve 13594 contains a diverse assemblage of understorey perennial plants in comparison to most other reserves in this study, consisting of mainly small shrubs and sedge-like plants. *Santalum acuminatum* was not recorded on the transect in 1984, although it was found in 1995; *Platysace maxwellii* was recorded in both years, experiencing an increase in number and a decrease in height - possibly due to the action of herbivores. *Glischrocaryon aureum* is represented by a single individual which was recorded in both 1984 and 1995, and has experienced growth in both height and cover. As an overview, perennial understorey species experienced growth, excluding *Aristida contorta* and *Grevillea paniculata*, both of which were missing from the transect line data in 1995.

Melaleuca arenicola, *Melaleuca hamulosa* and *Santalum acuminatum* individuals were recorded in 1984 and 1995 at Reserve 9754 (2), and all 3 species experienced growth in height, circumference at breast height and line transect intercept length. The number of *Santalum acuminatum* individuals which crossed the transect decreased from 3 to 2, an individual measuring 2m in 1984 was not re-recorded in 1995. The average height of *Santalum acuminatum* rose from 2.18m to 3.55m, the average height of *Melaleuca hamulosa* rose from 2.12m to 4.15m, and the average height of *Melaleuca arenicola* rose from 2.37m to 3.7m. Other perennial species along the transect line included *Dianella revoluta* and *Lepidosperma drummondii*, covers of which increased also.

Overall, the understorey perennial species in this quadrat increased growth during the period 1984 - 1995.

In Reserve 31211, three perennial species crossed the transect line, none of which were recorded in 1984. These were *Eucalyptus wandoo*, *Trymalium ledifolium* and *Stypandra glauca*. Eight individual *Eucalyptus wandoo* trees were located on the transect in 1995, two of which were less than 2.5m tall. Five individual *Stypandra glauca* plants and 1 *Trymalium ledifolium* plant were also located. Growth in number and thus cover of these species, especially *Eucalyptus wandoo*, has been significant.

New species were discovered along the line transect in Reserve 4313 in 1995, including *Dampiera lavandulacea*, *Enchylaena tomentosa*, *Lomandra effusa* and *Pittosporum phylliraeoides*. Changes in growth indicators such as height cannot be examined because they were not recorded on the transect in 1984, except to say they have increased. The *Santalum acuminatum* individual recorded in 1984 was not re-recorded in 1995.

3.9 Changes in Species Composition of Individual Reserves

The species compositions of each quadrat have changed in the past eleven years, and these are described below. Species lists in the form of a presence absence tables are given for each reserve in Appendix D. The differing times of years in which the lists were compiled (the 1984 lists were compiled in October - November, the 1995 lists were compiled in August - September) may have affected the results somewhat, with species of the family Asteraceae being more prominent and therefore identifiable in September rather than in November. The apparent increase of these species in most of the species lists compiled in 1995 may be due to this fact. The majority of change occurred in each reserve within the families Poaceae and Asteraceae, due to the fact that many shorter-lived and annual species in each of these families were recorded.

Reserve 2023

Only one combined species list was given in 1984, so it is impossible to compare presence and absence in individual quadrats. Therefore, the species lists for the four quadrats in 1995 has been combined here for comparison.

The species richness of this reserve increased from 31 species recorded in 1984 to 51 recorded in 1995. The number of exotic species decreased by 1 between 1984 and 1995, and the number of native species increased by 11 species during this same time frame (Figure 9). The largest increases were in species from the families Asteraceae, Droseraceae and Orchidaceae. Four species from the family Asteraceae were recorded in 1984, and this increased to 13 in 1995. Three of the 4 species originally recorded were not re-recorded in 1995, and all of these were native. The common species was **Sonchus oleraceus*. Of the 12 new species recorded in 1995, 3 were exotic. Thus the total number of Asteraceae species increased, and the number of native and exotic species increased proportionately.

Figure 9: Summary of Changes in Number of Exotic and Native Species (Grouped into Perennial and Annual Habits) in Reserve 2023

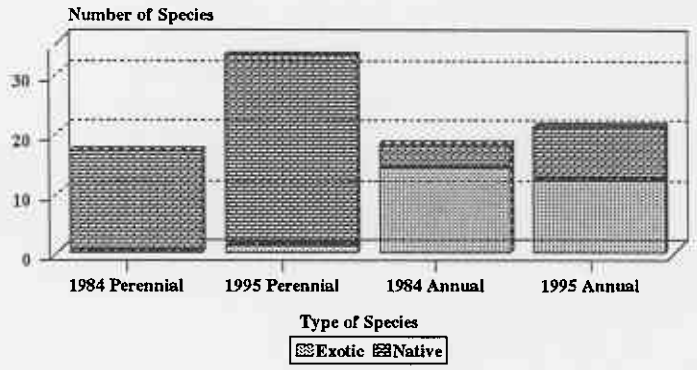


Figure 10: Summary of Changes in Number of Exotic and Native Species in Reserve 23201

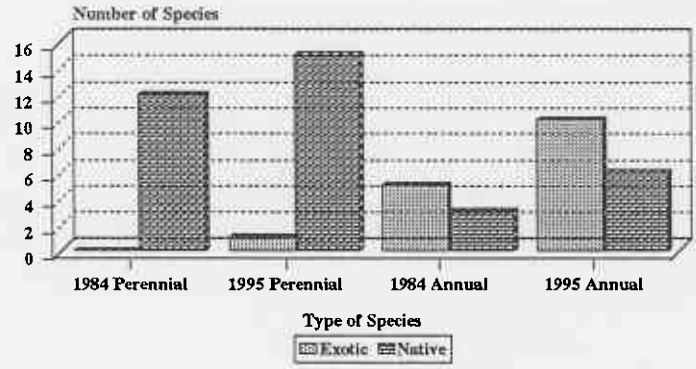
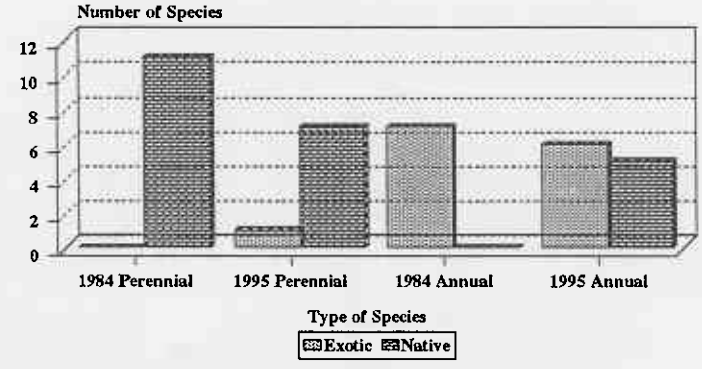


Figure 11: Summary of Changes in Number of Native and Exotic Species in Reserve 26664



Four species of the family Droseraceae were recorded in 1995, and none were recorded in 1984. This would be due to the time of year in which the surveying was done. Likewise, 5 species of Orchidaceae were recorded in 1995, and none were recorded in 1984. This is because these species would not be flowering and thus visible in November.

Seventeen species of grass were recorded in 1984, and only 7 were recorded in 1995, thus there was a decrease in species richness of the family Poaceae. Thirteen of the 17 recorded in 1984 were exotic, 3 of these exotic species were also recorded in 1995 - **Avellinia michelii, *Avena fatua* and **Briza maxima.* Native species recorded in 1984 were *Aristida contorta, Danthonia caespitosa, Neurachne alopecuroidea, Stipa elegantissima* and *Stipa tenuifolia.* The native species recorded in 1995 were *Danthonia caespitosa, Stipa elegantissima* and *Stipa trichophylla,* thus *Aristida contorta, Neurachne alopecuroidea* and *Stipa tenuifolia* were native grasses not present in 1995. The overall number of species of grass fell, however most of these species which disappeared were exotic grasses.

There were relatively few species of perennial understorey found in total inside the quadrats in this reserve. The majority of these species were present in both years, such as *Allocasuarina huegeliana and Acacia acuminata. Loxocarya flexuosa, Dichopogon preissii, Borya sphaerocephala* and *Caesia parviflora* all appeared in the quadrats for the first time in 1995.

Reserve 23201

There was a greater species richness in the quadrat in 1995, increasing from a total of 20 species in 1984 to 32 in 1995. The majority of the increase involved species from the family Asteraceae, and were mainly exotics such as **Ursinia anthemoides, *Arctotheca calendula* and **Anagallis arvensis.* One exotic grass, **Avena barbata* was recorded in 1995, however **Avena fatua* disappeared. Two native grasses recorded in 1984 were also not re-recorded : *Danthonia setacea* and *Stipa tenuifolia.* The number of both exotic and native species increased (Figure 10). New species recorded in 1984 also include members of the Anthericaceae and Portulaceae families. Excluding *Caesia parviflora,* no new perennial species were recorded in 1995. However, 3 perennial species were not recorded in 1995 : *Allocasuarina huegeliana, Jacksonia sternbergiana* and *Eucalyptus wandoo.*

Reserve 26664

The species richness of this reserve did not increase, in each year 18 species were recorded present in the quadrat. The relative numbers of exotic and native species also did not change (Figure 11). However, the composition did change; half the species recorded in 1984 belonged to the family Poaceae, whereas in 1995 only 3 species recorded belonged that family. The majority of the grass species recorded in 1984 were exotics, most of which were not re-recorded. Of the two native grass species recorded in 1984 (*Danthonia caespitosa* and *Stipa elegantissima*), only the latter was recorded

in 1995. Thus although many of the exotic grass species disappeared, only one native grass was still present in 1995. In this year the quadrat was noted as being extremely grassy. The difference in species is made up by numerous species from various families - the species which were recorded in 1995 belong to 13 different families, whereas in 1984 species recorded came from only 9 families. Of the five perennial species recorded in the quadrat in 1984, only *Rhagodia preissii* was missing from the species list in 1995, thus the change in species composition was limited to the fluctuating annual species.

Reserve 23164

The species composition in the quadrat in this reserve increased from 35 species recorded in 1984 to 52 species recorded in 1995. The majority of this increased occurred within the family Asteraceae, where 11 new species were discovered. All of these were native species, eg. *Podotheca angustifolia*, *Rhodanthe manglesii* and *Helipterum ramosum*. No exotic Asteraceae disappeared from the species list in 1995, however only 4 of the 19 species found in 1995 were exotics. Four new species of the family Poaceae were also recorded, 3 of these were exotic and the other, *Stipa elegantissima*, is a native species. In total, both the number of exotic and native species increased (Figure 12). Six perennial species were lost from the species list in 1995, these were : *Dianella revoluta*, *Allocasuarina campestris*, *Hakea scoparia*, *Santalum spicatum*, *Stackhousia monogyna* and *Glischrocaryon aureum*. Two new perennial species were recorded - *Pittosporum phylliraeoides* and *Dampiera lavandulacea*. Species such as *Calothamnus quadrifidus*, *Melaleuca arenicola*, *Acacia acuminata* and *Rhagodia. preissii* were recorded in both years.

Reserve 16714

Species richness increased between 1984 and 1995 in this quadrat, from 37 to 58 recorded species. This increase was spread over several families, such as the Asteraceae, Poaceae, Droseraceae and Orchidaceae. Six new species of Asteraceae were recorded in 1995, and 4 species were lost. All of the 6 species were native, and one exotic species, **Arctotheca calendula*, was not re-recorded. The number of exotic Asteraceae was low in this quadrat in comparison to other , with only 2 exotic species of the 10 species recorded in 1995. Five new Poaceae species were recorded in 1995, and three were not re-recorded. Three of the 5 new species are exotic, the two natives being *Stipa elegantissima* and *Stipa hirsuta*. Two of the 3 species which were not re-recorded were exotic. Thus there has been an increase in the number of native species found in this quadrat, however there has also been an increase in the number of exotic species (Figure 13). Three new orchids were also recorded (this is probably due to the time of year in which the surveying was done), and also 3 new *Drosera* species were discovered.

There has been an overall increase in the number of perennial species recorded within the quadrat, with species such as *Lomandra effusa*, *Borya sphaerocephala* and *Acacia acuminata* recorded for the first time in 1995. *Lepidosperma gracile*, *Borya nitida* and

Figure 12: Summary of Changes in Number of Exotic and Native Species in Reserve 23164

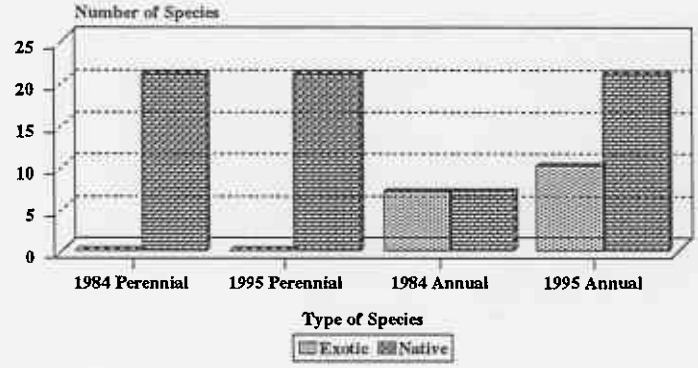


Figure 13: Summary of Changes in Number of Exotic and Native Species in Reserve 16714

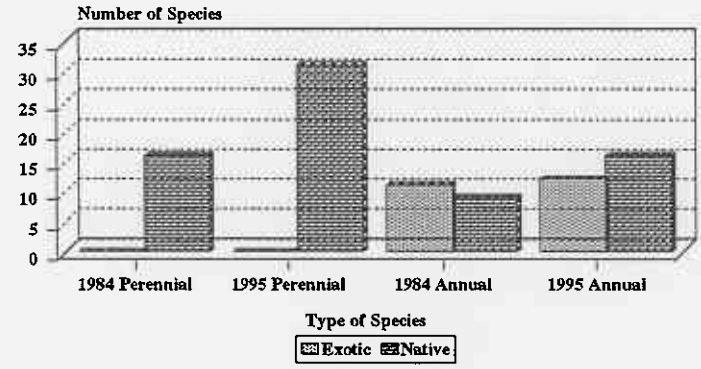
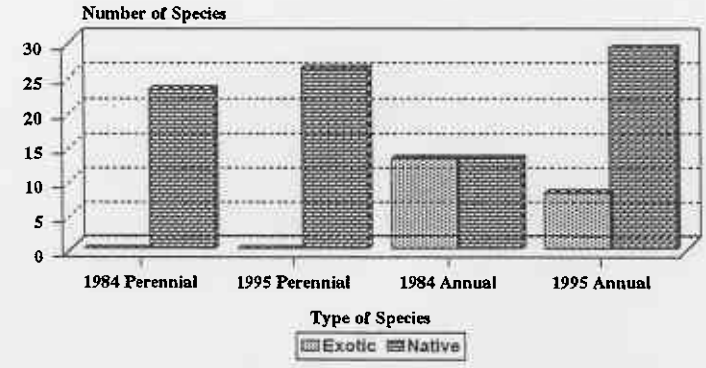


Figure 14: Summary of Changes in Number of Exotic and Native Species in Reserve 13594



Glischrocaryon aureum were not re-recorded. The majority of perennial species were recorded in both years, including *Allocasuarina huegeliana*, *Lepidosperma costale* and *Dianella revoluta*.

Reserve 13594

Species richness increased inside the quadrat in Reserve 13594, from a total of 49 species to 57 species. The majority of this increase was seen in the family Asteraceae, and with representation of new families by one or two species. Seven new species of the family Asteraceae were recorded in 1995, all of which are native. Two species have also not been re-recorded in 1995, one of which (**Sonchus asper ssp. nymanii*) is exotic. Families such as Portulaceae, Brassicaceae, Droseraceae and Orchidaceae are represented in the species list of 1995 and not in 1984. Three species which were recorded in 1995 and not in 1984 are exotic species : **Crassula colorata*, **Erodium botrys* and **Anagallis arvensis*, however the majority are native species. In total, the number of native species increased in this quadrat, and the number of exotic species decreased (Figure 14).

The majority of the perennial species recorded in 1984 were present in 1995, such as *Lepidosperma sp. A2*, *Lomandra collina*, *Lomandra effusa*, *Grevillea paniculata*, *Santalum acuminatum*, *Rhagodia preissii*, *Acacia acuminata* and *Platysace maxwellii*. Several species disappeared from the list, including *Acacia hemiteles*, *Pimelea argentea*, *Eucalyptus salmonophloia* and *Dianella revoluta*, however these were fewer in number. *Enchylaena tomentosa* and *Acacia acuaria* were also recorded for the first time in 1995.

There was a decrease in the number of species of the family Poaceae in this quadrat, from 12 species to 8. Four of these missing 5 species were exotic, and one native (*Danthonia setacea*). Two new species were recorded in 1995, 1 exotic and 1 native (*Danthonia caespitosa*). Thus the number of exotic grasses has decreased, whereas the number of native grasses has stayed constant. *Stipa elegantissima* and *Stipa trichophylla* were present in both years.

Reserve 9754 (2)

The species richness in this quadrat has increased slightly, from 44 species recorded in 1984 to 50 in 1995. There was an increase in the number of species of the family Poaceae by 1 recorded between 1984 and 1995, and the number of species of the family Asteraceae which were recorded in 1995 increased by only 1 also. However, the species composition of these two families changed. The number of exotic species increased by 1, and the number of native species increased by 5 (Figure 15).

Only five species belonging to the family Asteraceae were common in both years, 2 of these (**Arctotheca calendula* and **Hypochaeris glabra*) are exotic, and 3 (*Podolepis lessonii*, *Podolepis gnaphaloides* and *Waitzia acuminata*) are native. Only 1 of the 6 new species recorded in 1995 was exotic (**Ursinia anthemoides*), and none of the

species which were not re-recorded in 1995 were exotic. Overall, 2 of the 10 Asteraceae species recorded in 1984 and 3 of the 11 species recorded in 1995 were exotic.

Four of the 5 species of the family Poaceae that were common in both years were native species, these being *Danthonia caespitosa*, *Neurachne alopecuroidea*, *Spartochloa scirpoidea* and *Stipa trichophylla*. **Pentaschistis airoides* was also common between the years. Three new species were recorded in 1995, two of which were native, *Stipa elegantissima* and *Stipa tenuifolia*. The two species which disappeared from the 1984 species list in 1995 were exotic, **Bromus rubens* and **Lolium perenne*. Overall, the number of exotic species of grass decreased, from 3 of 6 species in 1984 to 2 of 7 species in 1995.

The majority of the perennial species present in 1984 were also present in 1995, for example *Acacia acuminata*, *Melaleuca arenicola*, *Melaleuca hamulosa*, *Dampiera lavandulacea*, *Lepidosperma costale* and *Lepidosperma drummondii*, *Santalum acuminatum* and *Grevillea paniculata*. A noted addition to the species list in 1995 was *Dianella revoluta*.

Reserve 19138

There was a large increase in species richness within this quadrat between 1984 and 1995, from 26 recorded species in 1984 to 42 species. In total, the number of exotic species and native species increased in this quadrat between the years 1984 and 1995 (Figure 16). The main increases in the families Asteraceae and Apiaceae. Only 2 species of Asteraceae were recorded in 1984, both of which were native and one of which was recorded again in 1995, *Olearia muelleri*. Eleven species of Asteraceae were recorded in 1995, of which 2 were exotic species. Thus there has been a approximate five-fold increase in the number of species of Asteraceae, with two newly introduced exotics into this quadrat.

The number of species of the family Apiaceae increased from 1 to 4, and the 3 new species were all natives; *Daucus glochidiatus*, *Hydrocotyle callicarpa*, *Hydrocotyle rugulosa* and *Trachymene pilosa*.

No new species from the family Poaceae were recorded in 1995, and 4 species from the list compiled in 1984 are missing. These 4 species are all exotic. Seven of the original 10 species recorded in 1984 were exotic, now 3 of the 6 species recorded are exotic. The native species found in both years are *Danthonia caespitosa*, *Stipa elegantissima* and *Stipa trichophylla*.

Few perennial species were recorded in either year at this quadrat, and no new perennial species were added to the species list in 1995. Several species disappeared - *Acacia merrallii*, *Eucalyptus salmonophloia*, *Acacia acuminata* and *Maireana georgei* were not recorded in 1995. *Acacia erinacea*, *Eucalyptus celastroides ssp. virella*, *Enchylaena tomentosa* and *Rhagodia spinescens* all were present in both years.

Figure 15: Summary of Changes in Number of Exotic and Native Species in Reserve 9754 (2)

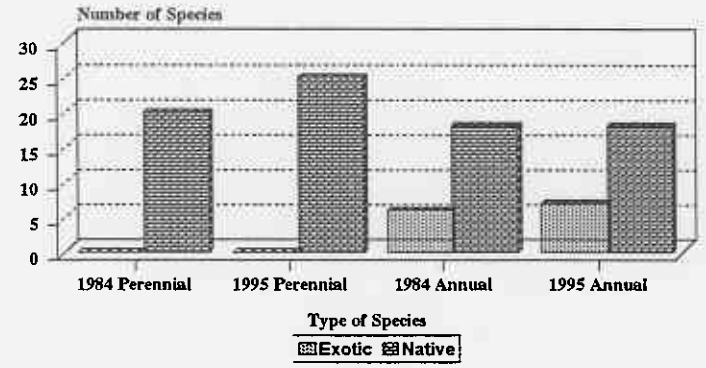


Figure 16: Summary of Changes in Number of Exotic and Native Species in Reserve 19138

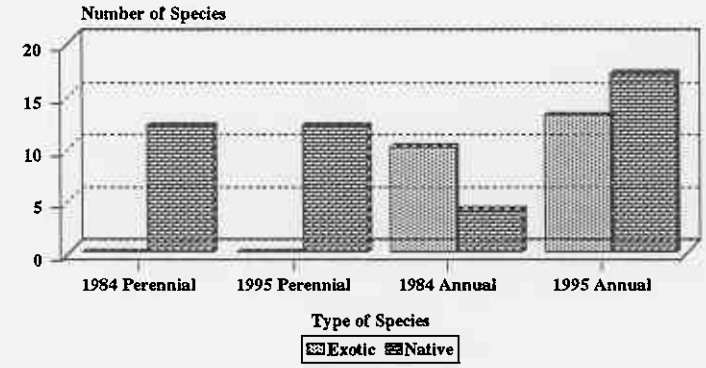
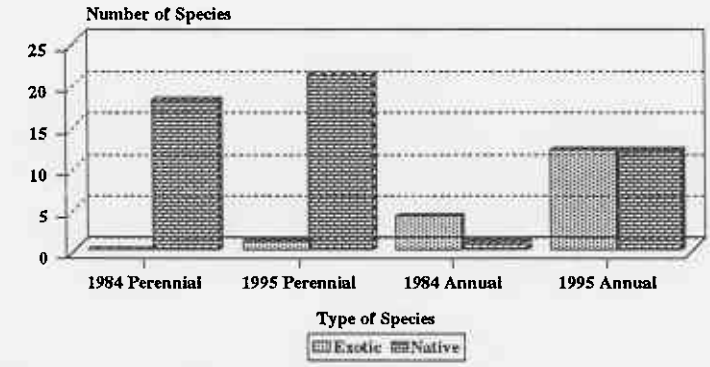


Figure 17: Summary of Changes in Number of Exotic and Native Species in Reserve 4313



Reserve 31211

There was a great increase in species richness in this reserve in 1995, with 37 species recorded in this year compared to 13 in 1984. This is probably due to an incomplete species list. Nine species belonging to the family Poaceae were recorded in 1984, including 5 which were exotic, and only 2 were recorded in 1995. These were **Briza maxima* and *Neurachne alopecuroidea* and were also recorded in 1984.

Reserve 4313

The species richness of this quadrat increased during the period 1984 - 1995, from a total of 23 species recorded to 46. The number of both exotic species and native species increased dramatically (Figure 17). The families where this increased the most were Poaceae and Asteraceae. The species recorded in 1984 numbered 5, including 2 exotic species, which increased to 9 with 4 exotic species in 1995. Three new exotic species in 1995 were **Avellinia michelii, *Briza maxima* and **Vulpia bromoides. *Avena fatua* was missing from the species list in 1995. *Stipa trichophylla* and *Danthonia caespitosa* were the 2 native species which were recorded for the first time in 1995. Thus there was an increase in the number of exotic grasses, which was larger than the increase in number of native grasses between 1984 and 1995 in this quadrat.

The species richness of the family Asteraceae also increased, from 2 species in 1984 to 10 species in 1995. Both original species recorded in 1984 were re-recorded in 1995, and consisted of one native and one exotic species. The eight new species recorded in 1995 consisted of 3 exotic and 5 native species, resulting in an overall increase of both native and exotic Asteraceae species, although the increase in native species was larger.

There was a small increase in the number of perennial species recorded in this quadrat between 1984 and 1995, including *Lepidosperma tenue* and *Lomandra collina*. Several species also disappeared from the species list, including *Loxocarya pubescens* and *Borya nitida*. Species such as *Lomandra effusa, Dianella revoluta, Enchylaena tomentosa, Pittosporum phylliraeoides* and *Acacia acuminata* were present in the quadrat in 1984 and 1995.

Reserves 29313 and 4458

No comparisons were made with previous data as new quadrats were established on these Reserves. In future the quadrats established will provide baseline data for these areas.

In summary, it can be seen from these results above and in the species presence absence lists in Appendix D that changes have occurred in the reserves, and that each reserve has a different assemblage of species. This is due to the wide range in which the reserves have been placed, and the differing environments in which these communities exist. Change in species of the family Asteraceae and Poaceae have been the most pronounced, because of the seasonality of their flowering seasons and thus the

ease in which they can be identified, and also because they are mainly annuals and are opportunistic. A change in species composition away from exotic species and toward native species is desirable, and indicates a robustness of the components of these communities against influences such as nearby agriculture. However, to maximize reliability of these species lists it is preferable that surveys are done during the same time of year, preferably spring, so that a maximum number of species which are present and identifiable in the quadrat at least some time during the year are recorded.

4. DISCUSSION

4.1 Review of Methodology

There are several points to consider before findings can be examined and inferences made about the changes which have occurred in these quadrats, in both species composition and growth of perennial species.

Foremost, is the limiting number of quadrats and the method of the line transect measurements. Relatively few quadrats were used, especially as data on three of the original sixteen quadrats (about one fifth) could not be used as it was not possible to re-locate the quadrats. The latter raises the issue of how to establish permanent sites which will not be interfered with during the long term monitoring programme. If there was an increased number of quadrats, there would be statistically validity. The reserves utilized are scattered across the Wheatbelt, which is useful in that growth in a wide variety of communities experiencing differing factors such as rainfall and nearby land use are measured. As there is no internal repetition of quadrats it has been made more difficult to compare changes within a reserve. The number of individuals which were measured in each quadrat (both *Eucalyptus loxophleba* and *A. acuminata* as well as other species) was also low, due to the orientation of the line transect which usually measured the same trees more than once. This gave in total an overall lower number of individuals on which data was collected, affecting results of changes which have occurred in individual reserves. However, if the number of quadrats increases, the time and effort involved in data collection also increases, so there must be a balance between time spent and amount of data collected.

As mentioned in the unpublished report by Goodsell on the original data of this study, a change in field recorders affects the data collection. Differing individual preferences in methods of collecting data, and also in estimation (such as in RFC values and line transect data) influence the results gained, and therefore ideally the same field recorders should do the measurements. However, in temporal monitoring this is generally not practical due to the long time frame of the study. Therefore, there may be some unavoidable error due to a change in personnel. This is minimized by measuring using the same methods.

4.2 Evidence of Temporal Change Within Reserves

Change within the respective reserves will be discussed individually, and then over the study as a whole. Each community is changing in various directions, due to community reactions to different local site conditions and influences such as burning regimes and rainfall.

Barry Muir examined several reserves in 1977, including some reserves which have been included in this study. He made notes on species composition and general description on the reserves, including evidence of fire and species of weed. These observations have been included where appropriate in the following summaries.

Reserve 2023 - Quadrat (1)

Change in the *Eucalyptus loxophleba* population in Quadrat (1) is shown by the increase in total intercept length and mean circumference at breast height, and the decrease in mean height and mean canopy height. There was no recruitment in this quadrat over the past eleven years, with the same individuals being recorded in both years, so the change in mean heights is probably due to a mis-recording or falling of the top of one tree in the intervening time period, rather than due to an increase in younger and therefore smaller individuals.

Changes in the *Acacia acuminata* population in this quadrat are shown in the decreased intercept length and increased mean circumference at breast height, mean height and mean canopy heights. Only one new individual was discovered on the transect line in 1995, showing little recruitment of this species over the intervening time period. The decrease in intercept length may be due to the death of branches of individuals which crossed the line, however no instances such as fire affecting this part of the reserve has been recorded.

Changes which have occurred in this quadrat during the period 1984 - 1995 are described by the growth in mean circumference at breast height and intercept length of the *Eucalyptus loxophleba* population, and the lack of recruitment by this population. The *Acacia acuminata* population of this quadrat has shown change by an increase in mean height and mean circumference at breast height, but a decrease in intercept length. Both populations have undergone little recruitment, and decreases in growth indicators are likely in the future if the population is not renewed.

Reserve 2023 - Quadrat (2)

Change in the *Eucalyptus loxophleba* population is shown by the large increase in intercept length in this area, and an increase in mean circumference at breast height, mean height and mean canopy height. The number of individuals recorded has not increased, therefore no recordable recruitment of this population has taken place in the past eleven years. These individuals have grown outwards more than upwards, resulting in a small change in height for a much larger change in intercept length.

All four growth indicators of the *Acacia acuminata* population increased over the period 1984 - 1995, indicating a growth in this population. No recruitment occurred in this quadrat in this time frame, and many of the original individuals in 1984 were of similar height, indicating that these individuals appeared after an event such as a fire. However, no burns have been recorded in this area of the reserve.

The increase of number and intercept length of *Allocasuarina huegeliana* in this quadrat also indicates positive change in this reserve. These individuals however were not recorded as being inside the quadrat itself.

Growth of these species has been observed in this quadrat, however the lack of recruitment in both *Eucalyptus loxophleba* and *Acacia acuminata* populations may be a cause for concern in the future.

Reserve 2023 - Quadrat (3)

Eucalyptus loxophleba population around this quadrat increased in intercept length, mean circumference at breast height and mean height over 1984 - 1995, indicating positive growth of this population. The canopy height probably decreased in response to the prescribed burn which affected the area around this quadrat in 1989. The burn has not had a detrimental affect on the growth of *Eucalyptus loxophleba* in this quadrat. There is an increase in the number of individuals which cross the transect line in 1995, however this is not due to recruitment because all are older trees (as seen from heights).

All four growth characteristics of the *Acacia acuminata* population decreased over the period 1984 - 1995, due to the prescribed burn as mentioned above. The original individuals were killed in the fire, and new individuals have resprouted. This was noted by Atkins in 1985, in a update on the reserve (Department of Conservation and Land Management file). This fire has encouraged recruitment of new individuals, which has not happened in Quadrats (1) and (2) above. These new individuals in quadrat (3) have not yet reached the size of the originals, and have a different spatial separation. The number of original *Acacia acuminata* individuals in 1984 in this quadrat is unknown, as such measurements were not originally made, and therefore whether recruitment has been sufficient to replace the number of original trees is also unknown. However, as the number of *Acacia acuminata* individuals recorded on the line transect increased, it can be assumed that recruitment has been sufficient to replace the original population.

The burn has probably also encouraged the growth of *Allocasuarina huegeliana* in the quadrat, which is evidenced by measurements on two small individuals which traversed the transect line in 1995.

Change in this quadrat is exhibited by the positive growth in size of individuals of the *Eucalyptus loxophleba* population, although recruitment was negligible. The *A. acuminata* population was affected by the prescribed burn, the original trees destroyed

and recruitment generated. The presence of *Allocasuarina huegeliana* has also been affected by the prescribed burn.

Reserve 2023 - Change in Species Composition

The change in species composition is noted by the large increase in native species in 1995 in comparison exotic species. The number of exotic species actually decreased from 1984 to 1995, which indicates a positive change away from a degraded reserve. However, in 1995 the reserve was still infested to a large extent with exotic weeds. The decrease in the number of exotic grasses is a positive change in this reserve, and the appearance of native Droseraceae and Orchidaceae is positive also, although this has more to do with the time of surveying than the introduction of native species into the reserve.

The perennial understorey was sparse in 1984 and this did not change in 1995, although the appearance of new perennial species in the 1995 species list is encouraging.

The prescribed burn did affect the species composition around Quadrats (3) and (4), as noted from several brief reports of the area in the relevant Department of Conservation and Land Management file. Atkins noted on 18 July 1985 that *Acacia acuminata* seedlings had regenerated, and that there was a good resprouting of several Liliaceous spp. and *Drosera* spp., and a decrease in **Avena* sp.. Conversely it was also mentioned that there was an increase in density of **Romulea rosea*. Leon Sylvester noted on June 8 1986 that a wild oat (**Avena* sp.) problem now existed. Many Liliaceous species were recorded in and around Quadrats (4) and (3) in 1995, as well as species of *Drosera*. Burning the area stimulated the recruitment of new *Acacia acuminata* seedlings, and possibly *Allocasuarina huegeliana* seedlings, and also increased the amount of Liliaceous spp and *Drosera* spp. However, burning also increases the abundance of exotic opportunistics into an area which is rich in nutrients and lacks competition between species.

This reserve has quite a high proportion of exotic species, due to the length of time of which the surrounding land has been put to agricultural use, and the small size of the reserve. It has a very disturbed understorey, and in the past was probably grazed, leading to it's degraded state. This reserve needs to be fenced, and access limited. Maintenance of fire breaks surrounding the reserve needs to be regularly seen to, to prevent bushfire from spreading to nearby agricultural land. The prescribed burn increased recruitment of the *Acacia acuminata* population, which seems to be stagnant in other areas of the reserve, and planning of future burns may improve this population. However, care must be taken to ensure that the reserve is not burnt too often, and that ample time is given for burnt areas to recover fully before burning is commenced. The problems associated with an influx of exotic species in the post-burn period must also be recognized, and steps taken to ensure that the spread of exotic weeds in this reserve does not increase.

Reserve 23201

Sampled *Eucalyptus loxophleba* individuals increased in total intercept length, mean circumference at breast height, mean height and mean canopy height in this reserve over the past eleven years, although the increase in mean height and mean canopy height were not large. This gives an indication of positive growth in this reserve with respect to the *Eucalyptus loxophleba* population. The increase in total intercept by this species has been especially large, nearly a threefold increase. The very small increase in height is due to either a mis-recording of heights (as mentioned in the text earlier, the highest individual recorded in 1984 was much higher than recorded in 1995), or damage to that particular tree causing a decline in height. Only one young tree was recorded on the transect in 1984 and none were recorded in 1995, although it was reported by Muir (Department of Conservation and Land Management files) that both senescent and young tree were common over the reserve. This indicates that recruitment amongst *Eucalyptus loxophleba* has been negligible in this area over the past eleven years, and the use a larger sample in the form of additional quadrats or straight line transect may have shown a different result. Overall, *Eucalyptus loxophleba* in this quadrat has exhibited positive growth in the past eleven years, and is consequently a changing population.

The growth of *Acacia acuminata* in this reserve is harder to judge, due to the fact that only one individual was recorded on the transect in 1984, and none were recorded in 1995. This species was present on the species list in both years, and obviously is fewer in number in this reserve when compared to *Eucalyptus loxophleba* or in comparison with other reserves. This species is less important in this reserve in comparison with other reserves as a growth and change indicator as it's cover has been much lower.

The species richness has also increased in this reserve, which is a positive change, however the increased number of exotic species indicates factors which favour these species. This influx of exotics on the 1995 species list may be due to the difference in time of year in which the surveys were completed. Muir in 1977 (unpub. report) reported that **Hypochaeris glabra, *Ursinia anthemoides* and **Arctotheca calendula* were all abundant in this reserve. Of these, only **Ursinia anthemoides* is present on the species list in 1984. Thus these exotic species have not been introduced into the reserve in the past eleven years, but have been present for some time. The precipitation in the months leading up to September in both 1984 and 1995 were also different, precipitation in June-July being more acceptable to growth than June-July in 1984. Muir (unpub. report) reported past extensive grazing by sheep, which explains the almost non-existence of understorey in this reserve. Three of the four native grass species noted inside the quadrat in 1984 were re-recorded in 1995. Although the number of species of exotics seem to have increased, the numbers of natives have also increased.

The disappearance of *Eucalyptus wandoo* and *Allocasuarina huegeliana* from the species list in 1995 is some cause for concern, however in 1984 they were not recorded on the line transect and thus probably were few in number. There have been no

recorded factors such as burns which may affect the presence of these species, and factors such as increased salinity are unlikely, due to the increased growth of *Eucalyptus loxophleba* over the same time period. Thus natural death of these individuals may explain why these species were not recorded in 1995.

Change in this reserve is mainly represented by the growth of *Eucalyptus loxophleba*, the loss of species such as *Eucalyptus wandoo* and *Allocasuarina huegeliana* from the species list and the addition of both native and exotic species to the species list. Overall there has been positive change in this quadrat - an increase in the growth of *Eucalyptus loxophleba* and although an increase in the number of exotic species, no significant decrease in the numbers of native species.

Management of this reserve should include fencing of the reserve to prevent access by people, and subsequent checks by CALM Wildlife Officers on the spread of exotic species. Once an exotic species has become established in an area it is very difficult to control, so prevention of these species from becoming a problem is the key to better management. This reserve is comprised of other communities as well as *Eucalyptus loxophleba - Acacia acuminata*, and so recommendations on prescribed burning of this reserve cannot be made. The samphire area present in this reserve in particular will react to burning in a different way than the York Gum - Jam community.

Reserve 26664

Positive growth was recorded in the *Eucalyptus loxophleba* population of this reserve, with increases in total intercept length and mean circumference at breast height from 1984 - 1995. The decrease in height and canopy height is probably due to either mis-recording or breakages of limbs, and the growth in intercept and circumference at breast height in this case is judged to be more important indicators of growth. However, it is impossible to make a total statement on the *Eucalyptus loxophleba* population in this reserve (or at least in this part of the reserve), on the growth of this sample, which was a single individual. Recruitment along the line transect did not occur over the past eleven years, which may be indicative of a stagnant population, however recruitment of this species may be slow.

Positive growth of the *Acacia acuminata* population is indicated by the increase in all four growth indicators of this species during the past eleven years. Positive growth of the population is also shown by the recruitment of new individuals along the transect line. The increase in *Hakea preissii* numbers and intercept length and recruitment of *Pittosporum phylliraeoides* also indicates favourable conditions for these species.

The area in and around the quadrat in Reserve 26664 is very disturbed, with a high proportion of exotic to native species. The lack of disturbances such as fire may have caused the shift in presence from a high number of species of the family Poaceae to just three species. The higher number of species of the family Asteraceae in 1995 is probably due to the time of year in which the survey was done.

Change in this quadrat is represented mainly by the positive growth of the perennial species and the change dominance of numbers of species of the family Poaceae. The large number of exotic species is due to the proximity of cleared land, land which was cleared extensively in a short period of time. The land adjoining the lake experiences both salinity and waterlogging problems due to this clearing (Department of Conservation and Land Management file). The growth of the *Eucalyptus loxophleba* population of this area cannot however be determined from the single individual which has been included in the line transect in both years.

This reserve is comprised mostly of Lake Dumbleyung and a small strip of surrounding land around the lake, which is used by people for recreation. The open woodland probably looks today a lot like when Europeans first settled the area, except for the influx of exotic species. This influx must be curbed, by the complete fencing of this area away from the nearby agricultural land and the education of visitors and locals of the effects of the introduction of exotic species into the reserve. Physical and chemical methods of control of these species could be a way of preventing the problem of increasing numbers of exotic species. Burning encourages the growth of exotic species, and it is preferable that burning only be undertaken when necessary, to prevent the build up of fuel loading. Steps have already been undertaken to prevent the spread of double-gees around the reserve. They occur to the west of the location of the quadrat, and management of the spread of this pest is currently controlled by signs warning people coming in and out of scenic drives in the area that they do occur, and that vehicle tyres should be checked for seeds when leaving the area. The York Gum community itself cannot adequately be examined by the quadrat, due to the extremely low sample of this species taken. More quadrats and study in this area are needed before recommendations on management of this population can be stated.

Reserve 23164

Total intercept length, mean circumference at breast height, mean height and mean canopy height all increased over the period 1984 - 1995, indicating positive growth in the *Eucalyptus loxophleba* population of this reserve. Intercept Length in particular increased, by a factor of five. This is a result of increased number of trees along the line transect, indicating recruitment of this species around the quadrat.

Total intercept length, mean circumference at breast height, mean height and mean canopy height of the *Acacia acuminata* population also all increased during this time period. This was not due to recruitment, but to growth of the individuals present on the line transect. Positive growth of the *Acacia acuminata* population has therefore occurred, however there has been no recruitment of this species on the transect line. Recruitment of this species may occur at a slower rate in this area than further west, and future investigation in this quadrat may discover new *Acacia acuminata* individuals. One young individual was noticed inside the quadrat in 1995, however it did not traverse the line intercept and therefore measurements were not taken.

The increase of the species richness of this quadrat, and the increased number of native

species discovered in 1995 in proportion to exotic species is a positive change in this quadrat, towards a less disturbed state. The influx of exotic grasses into the quadrat is an unwanted factor. In a brief summary Wallace (unpub. 1983) noted that the reserve was virtually undisturbed, and weeds were generally absent, except on small infestations on disturbed soil piles in the yellow sand heath area, away from the position of the quadrat. These weeds have spread since this time, as shown by the increase in number of exotic Poaceae species which were recorded in 1995. This influx in exotic species is probably originating from the agricultural land which surrounds this reserve entirely.

The impact of the loss of the six perennial species as listed in Chapter 3 cannot be determined. *Allocasuarina campestris* and *Santalum spicatum* were not present in the species list in 1995, however they were present near the quadrat. A grove of *Allocasuarina campestris* was located just metres away from the quadrat and a few *Santalum spicatum* individuals were located within a metre or so from the quadrat. As no cover or numbers of individuals were recorded in 1984, it is impossible to state whether only one or a few individuals were present inside the quadrat, or many. If only one or few individuals were present, factors such as simple old age and death can explain why these species are no longer located inside the quadrat. However, two individual *Santalum spicatum* in 1984 measured heights of 0.15m and 0.46m, and were very young. They may not have survived due to factors such as lack of suitable rainfall. The presence of some perennial species such as *Calothamnus quadrifidus* and *Rhagodia preissii* over these eleven years suggests that the community is fairly stable.

Change inside this quadrat is demonstrated by the large increase in measurements of all four growth indicators of *Eucalyptus loxophleba*, and recruitment, and the growth in intercept, mean circumference at breast height, mean height and canopy height of *Acacia acuminata* in this quadrat. This apparent lack of recruitment of *Acacia acuminata* could be indicative of a slow recruitment process of this species in this area. K. Wallace (unpub.) in September 1983 noted that there was no recent fire history in the area, and there was no evidence of past burns in 1995. This lack of burning may discourage *Acacia acuminata* recruitment. Wallace (unpub.) also noted that this reserve is relatively pristine and has little evidence of human activity. The positive change in the growth of the *Eucalyptus loxophleba* and *Acacia acuminata* populations and increase in species richness is indicative of this, however care in the surrounding land use and in what little human activity in this reserve there is must be taken to prevent this pristine reserve from becoming a disturbed area.

Reserve 23164 is a virtually pristine reserve, of which the *Eucalyptus loxophleba* - *Acacia acuminata* community is only a part. Although no recruitment was observed in the *Acacia acuminata* population over the past eleven years, recruitment in this reserve may occur at a slower rate than areas further west due to the lower precipitation experienced, or be triggered by infrequent factors such as a large amount of summer rain. Also, only one quadrat was examined on this large reserve, and the seeming lack of recruitment of this species may be a result of poor sampling. Burning is to be discouraged on this reserve, which is large and in a near-pristine state. It is surrounded

by agricultural land, and burning parts of the reserve may encourage an influx of exotic species which at present are not fully established in the reserve. The area is also fairly dry, and the reaction of the community to a prescribed burn may be very different to that of quadrat (3) in Reserve 2023. This reserve however should be fenced along the perimeter where it is not, and if possible fire breaks be constructed and maintained along the perimeter to prevent spread of fire either into or out of nearby agricultural land. Access by people should also be limited.

Reserve 16714

The total line intercept of *Eucalyptus loxophleba* in Reserve 16714 decreased between 1984 and 1995 and the mean circumference at breast height, height and canopy height all increased. These increases were small, however compared to the decrease in line intercept length. This is possibly due to death of branches, as there was a large number of fallen branches observed in and near the quadrat in 1995. Increase in growth of the *Eucalyptus loxophleba* population has not been as great in this reserve as in the preceding reserves. This may be due to the original individuals becoming senescent with little recruitment. Muir (unpub.) noticed that there were few young trees present, although one individual which was recorded on the line transect in 1984 and 1995 was younger, measuring a height of 2.15m in 1984.

The overall growth in the *Acacia acuminata* population was greater, the total intercept length more than doubling over the past eleven years. This is counter to the fact that the mean circumference at breast height and mean height decreased and the canopy height stayed approximately the same over the same time period. These decreases are due to the recruitment of new individuals along the transect line, rather than a decrease in growth however. These new individuals have probably recruited naturally, as no fires or other like factors have been recorded in this reserve, and the only evidence of fire which was seen in the quadrat in 1995 were slight burn marks on a fallen branch, although no burn marks were seen elsewhere. Change as positive growth in the *Acacia acuminata* population of this reserve is represented by the increase in intercept length and increase in number of individuals.

The increase in species richness in the quadrat also indicates positive growth in the Reserve, although some of the new species may have been recorded in 1995 and not in 1984 because of the differing times of year in which surveying was completed. The increase in the number of exotic grasses indicates an influx of these species from nearby clearing or from other areas in the reserve. A nearby drainage line was infested with **Ehrharta longiflora* in 1995. Muir (unpub.) noted abundant ephemeral weed species were present throughout the reserve in 1977. Interestingly two native grasses, *Stipa elegantissima* and *Stipa hirsuta* were newly recorded in 1995. This indicates colonization of these species into the quadrat, which is a positive change in the increase of native species present in the quadrat. This tallies with unsubstantiated observations of the increase of native grasses over introduced grasses when the nutrient input ceases (BMJ Hussey, pers. comm).

The quadrat inside Reserve 16714 has changed considerably in regard to species composition and growth of the major perennial species. The increase of native species in comparison to the stagnant nature of the number of exotic species exhibits change in species composition in this reserve back to a more naturalized state. The extensive coverage of **Ehrharta longiflora* which was observed in 1995 is still a problem, however. The increase of the *Acacia acuminata* population with regard to number of individuals and intercept length, and also the slight increase in circumference at breast height, mean height and canopy height of *Eucalyptus loxophleba* all indicate positive growth in this reserve, however the growth of *Acacia acuminata* and *Dianella revoluta* is by far greater than of *Eucalyptus loxophleba*. The population of *Eucalyptus loxophleba* may be entering a senescent stage, experiencing little recruitment.

This reserve is fairly degraded, with a large population of exotic species. It needs fencing to discourage access by people, and either the physical removal or chemical removal of large tracts of exotic species may help control the problem. Some planting of *Eucalyptus loxophleba* has been done in the south-east corner of the reserve by CALM, and future monitoring of these plants should be carried out by CALM Wildlife Officers. Future monitoring of the *Eucalyptus loxophleba - Acacia acuminata* community should be carried out also, and plantings of these species by CALM Wildlife Officers (or community groups) may help if recruitment in this community is not deemed significant. Burning may stimulate recruitment of the *Acacia acuminata* population, however care should be taken to prevent the increase and further spread of exotic species into this reserve.

Reserve 13594

Measurements of the four growth indicators of *Eucalyptus loxophleba* increased in 1995, indicating positive growth for the *Eucalyptus loxophleba* population over the past eleven years. The increase in the total line intercept increased approximately five-fold, due to growth of original individuals and the addition of new ones. Therefore, the population has also increased in number.

Change in the *Acacia acuminata* population in the quadrat is indicated by the increase in intercept length and the decrease in mean circumference at breast height and mean height and canopy height. This decrease was due to recruitment of new individuals, as a population increase has been experienced in the past eleven years. The increase in cover of the majority of the other perennial species such as *Lomandra effusa, Calothamnus quadrifidus* and *Rhagodia preissii* also indicate an overall increase in growth over the past eleven years in this reserve.

The increase in species richness between 1984 and 1995, the dominance of number of native species over exotic species in both years and the increase in number of native species over the eleven years with a corresponding decrease in exotic species all indicate positive changes in this quadrat towards a more natural environment. Muir (unpub. report) regarded this reserve in 1977 as in excellent condition, with little disturbance, which is probably due to it's position in the east of the Wheatbelt. Muir

(unpub. report) also reported no evidence of fire in the past 20 - 30 years, and no fire evidence was observed in 1995. Thus without this factor, the species composition in the quadrat is changing as there has been recruitment in the *Acacia acuminata* population, which was not observed in the quadrat in Reserve 23164.

This reserve is in a more degraded state than either 9754 or 23164, however it is still in good condition and a useful reserve with a high species richness. The greater number of weed species could be due to the smaller size of this reserve, and the proximity of agricultural land. This reserve needs to be fenced completely, and physical/chemical removal of exotic species may alleviate degradation. The reserve is in good condition compared to reserves further west, and prevention of any increase in the amount of exotic species in this reserve is necessary. The decrease in number of exotic species in comparison to native species and an increase in *Acacia acuminata* recruitment over the past eleven years is a sign that current management of the reserve is effective. It is advisable that small parts of this reserve only are burnt at any one time, due to the small size of this reserve, and the current good condition. As burning generally stimulates the influx of exotic species into an area, and the *Acacia acuminata* population is showing recruitment, burning would be inadvisable for this reserve. However, if prescribed burns are deemed necessary, only small pockets should be burnt at any one time, and care to control exotic species post-burning should be undertaken. Fire breaks should be maintained around the perimeter of this reserve by CALM Officers.

Reserve 9754 - Quadrat (2)

All measurements of the growth indicators of *Eucalyptus loxophleba* increased over the eleven years, showing a positive change in this population. The increase in the intercept length was related to the increase in the number of individuals recorded in 1995, however this does not infer a higher rate of recruitment, because the majority of these new individuals were not juveniles. The higher amount of moisture in this area has allowed this population to increase in growth considerably. Muir (unpub.) in 1977 noted that the York Gum Tree-Mallee population was mature to senescent, and this has stayed constant.

The total intercept length of the *Acacia acuminata* individuals sampled decreased, whereas the other growth indicators increased, although only marginally. There has also been no recruitment of this species over the past eleven years. This population is not stagnant, as there has been a reasonable increase in the mean height of the population, however the decrease in intercept length and lack of recruitment indicates that this population is responding poorly to the changing surrounding conditions, and may be related to the increase in soil moisture.

The increase in soil moisture in the area which surrounds the quadrat has affected the coverage of species such as *Spartochloa scirpoidea*, which seems to prefer wetter environments. The increase in growth of *Melaleuca* ssp. has also been encouraged by the increase in the soil moisture of the area.

The species richness increased slightly over the past eleven years, and the increase in the number of native species was higher than the increase in number of exotic species. This shows a trend in this quadrat towards a more natural species composition. This area to begin with was fairly pristine, with little exotic species present. Muir (unpub. report) in 1977 recorded the areas of high run-off to have a high number of weeds, including **Hypochaeris glabra, *Ursinia anthemoides* and **Anagallis arvensis*, all of which were recorded in both years (excepting **Ursinia anthemoides* in 1984). **Chenopodium pumilio, *Inula graveolens, *Solanum hystrix* and **Solanum nigrum* were also listed as present in these areas by Muir, however they were not recorded in 1984 or 1995 in this study. The number of exotic species was found to be low in this study.

Change in this quadrat in this Reserve is characterised by the increase in growth indicators of *Eucalyptus loxophleba*, although recruitment is low to non-existent, and thus this population will eventually decline unless this trend reverses. The *Acacia acuminata* population has also little recruitment, and the decrease in intercept length means a possible decline in this population. This is balanced by the increase in *Spartochloa scirpoidea* and *Melaleuca ssp., Lepidosperma drummondii, Grevillea paniculata* and *Santalum acuminatum* increases in cover and number, which reflects the increase in soil moisture. The larger increase in native species in comparison to exotic species over the past eleven years is also a positive change in this community.

This reserve is in near-pristine condition, and is composed of a variety of different communities. This quadrat is located in a small drainage line, and is thus not representative of the reserve as a whole. Any recommendations which can be brought out from information from this quadrat may not be applicable to the entire reserve. The *Acacia acuminata* population on the granite itself (quadrat (1)) has not been measured itself due to the removal of the quadrat sometime in the last 11 years. The reserve needs fencing around the perimeter, and already access into the reserve has been limited by the placement of large drums on the track which leads into the reserve from the west side. This is good in preventing public access into the reserve, which has inevitably helped the invasion of exotic species into the reserve from surrounding agricultural land. Tracks made by people bringing four-wheel drive cars and motorcycles into the reserve are also in evidence. However, access must be left for CALM personnel to monitor the reserve, noting general increase in exotic species through time.

Burning should be discouraged in this reserve, at present it is in near-pristine condition and prescribed burns would encourage the influx of exotic species, which once established are difficult to control. The dry conditions may also present a problem with controlling the fire. Much of the reserve is situated on granite rock, and therefore supports limited upperstorey and mainly a grass-like understorey, and a build up of fuel enough to support a large naturally sparked bushfire is unlikely in these areas. Fire breaks must be constructed and maintained around the perimeter of the reserve, however.

Reserve 19138

The *Eucalyptus celastroides* population in this reserve exhibited an increase in all four growth factors over the past eleven years in this quadrat, and there was a small increase in the number of individuals which were recorded on the line transect. The recruitment of *Eucalyptus celastroides* has not been very significant, with few individuals in 1995 exhibiting a smaller height than individuals in 1984. However, growth in this population has occurred with intercept length, circumference at breast height, height and canopy height all increasing.

Few other perennial species were present in this quadrat, this area having no shrub layer and a very sparse understorey of herbaceous plants and species from the families Asteraceae and Poaceae. *Eucalyptus salmonophloia* was not recorded inside the quadrat in 1995, although a very large tree was located just several metres from the boundary of the quadrat. *Acacia merrallii, Acacia acuminata* and *Maireana georgei* were all missing from the species list also in 1995. These species may have been represented by a single individual, and consequent death by natural causes may have been the reason for these species not recorded in the quadrat in 1995. However, as we have no cover values for 1984, an estimate of abundance of these species is impossible.

There was a high proportion of exotic species to native species in 1984, and the higher increase of native species to exotic species in 1995 indicates the shift in species composition in this reserve to a more natural state. This is a positive change in the quadrat (and area around the quadrat), although this has been influenced by a greater number of native species of the family Asteraceae in 1995, species of which may not have been recorded in 1984 due to the time of year in which the survey was undertaken.

Change in this quadrat is represented by the increase in growth of the *Eucalyptus celastroides* population, although recruitment of new individuals is very low. The loss of the above perennial species is a negative change, although the overall species richness increased and the number of new native species increased at a much higher proportion than the number of new exotic species over 1984 - 1995.

The area around the quadrat is quite degraded, with little understorey other than annual plants. The *Eucalyptus celastroides* population underwent little recruitment, however this could be due to the slow rate of recruitment that long-lived species are expected to exhibit. This community covers only part of the entire reserve, and the area towards the south and west of the quadrat on casual inspection was in better condition. Exotic grasses were more abundant towards the east (Reserve 13057), where this reserve narrowed between two farms and the main road. Care would be needed in burning this area, due to the high abundance of grasses and dead logs which are present in that reserve. Burning also would stimulate the growth of exotic species in this area, which would further degrade this area. Firebreaks need to be built and maintained along the perimeter of the reserve, to help control fires in this area. Physical and chemical control of exotic species, especially grass species, needs to be undertaken in this

reserve, to prevent further degradation.

Reserve 31211

All four growth indicators of *Eucalyptus loxophleba* increased over the period 1984 - 1995, although the number of individuals of this species decreased. *Eucalyptus wandoo* individuals were also recorded on the line transect and species list in 1995, and was not in 1984. In the Department of Conservation and Land Management file relevant to this reserve, the vegetation was described as a common Woodland of York and Wandoo. The *Eucalyptus wandoo* individuals which were recorded on the line transect in 1995 ranged from young to mature individuals, which would have been present in the area in 1984 but did not cross the transect line. Thus the recruitment in the *Eucalyptus loxophleba* population has been non-existent, whereas it has been significant in the *Eucalyptus wandoo* population in the past eleven years. No burns have been recorded as occurring in this reserve over the past eleven years, however a slow prescribed burn was put through part of this reserve in 1983. It is unknown whether the area around the quadrat was burnt.

The *Acacia acuminata* population experienced increases in these four growth indicators over the past eleven years also, especially an increase in line transect length. There was an increase in the number of individuals of this species along the transect length, which indicates slight recruitment rate of this species in this reserve. It was reported in the relevant Department of Conservation and Land Management file that several fires had been lit in this reserve in 1991, however the number, range and intensity of these fires were not recorded, so it is impossible to say if any of these affected the area around the quadrat. The recruitment rate and increase in growth of the *Acacia acuminata* population is a positive change within the quadrat during the period 1984 - 1995.

The large increase in the species richness of this site is probably due to an incomplete species list in 1984.

Change within this quadrat is evidenced by the increase in growth of *Eucalyptus loxophleba*, and the decrease in numbers of individuals of this species which were present on the transect line. The increase in numbers of individuals of *Eucalyptus wandoo* is also a positive change in this quadrat between years. The presence of *Stypandra glauca* and *Trymalium ledifolium* on the line transect in 1995 are also evidence of positive changes ingrowth of perennial species in this quadrat.

This reserve needs to be fenced around the perimeter, and firebreaks to be maintained around this fencing to prevent the spread of bushfire. Access by people into the reserve needs to be restricted as hunting of kangaroos and rabbits by people using vehicles and shotguns has been noted by CALM Wildlife Officers in CALM files, which degrades the reserve and helps spread exotic species. Recruitment by the *Eucalyptus wandoo* and *Acacia acuminata* (although small) populations indicates that these populations are healthy, and although the *Eucalyptus loxophleba* population showed no recruitment,

this population is not in decay either. Burning is not necessary in this part of the reserve to stimulate recruitment in the *Acacia acuminata* population, and burning may instead encourage further growth of exotic species which are already widely present in the reserve. More study is needed over the entire reserve (not just where the quadrat is located) to monitor the communities found in it, to make an assessment on whether prescribed burning would be beneficial to this reserve. The area around the quadrat is quite damp, indicated by the large amount of Liliaceous species which were found in and around the quadrat, and is not representative of the entire reserve. Many exotic species are already established in this reserve, and although total removal of these is impossible, partial removal is possible and should be undertaken, using physical or chemical methods.

Reserve 4313

Positive change in the *Eucalyptus loxophleba* population in this quadrat is evidenced by increase in all four growth characteristics between 1984 - 1995. There was also a greater number of *Eucalyptus loxophleba* individuals intercepting the transect line in 1995 than in 1984, which indicates recruitment in this population, however none of these individuals are juveniles, thus assumed recruitment is false. Muir (unpub.) noted that many nestholes were present in the *Eucalyptus loxophleba* and *Eucalyptus wandoo* Woodlands, and that very few young trees were present. This trend has obviously continued in the area in and around the position of the quadrat.

An increase in the four growth indicators is noted for the *Acacia acuminata* population also. *Acacia acuminata* was not recorded on the transect in 1984, and this is an indication of recruitment of the *Acacia acuminata* population, which is a positive change in this quadrat.

Changes in this quadrat are also evidenced by changes in the presence of other perennial species in this quadrat over the past eleven years, with different species located on the transect line in both years. *Santalum acuminatum* and *Acanthocarpus preissii* were present on the transect in 1984, whereas these have been replaced with *Pittosporum phylliraeoides, Acacia acuminata, Dampiera lavandulacea* and *Enchylaena tomentosa* in 1995. These latter four species are present in the species list in 1984, and thus have increased their respective covers. Neither *Acanthocarpus preissii* or *Santalum acuminatum* are present on the species list in 1995.

The species richness of this quadrat increased over the past eleven years, indicating a positive change, however as the number of exotic species increased at the same rate as the number of native species (and in fact the number of new exotic grass species increased more than the number of new native grass species), this change can be seen as a move away from a quasi-natural state to an even more disturbed one. According to Muir (unpub report.), in 1977 this reserve was disturbed, with a large exotic grass population present throughout the reserve. The change in species composition indicates a move towards a more degraded reserve. This is a small reserve, surrounded by farmland, and is unfenced. Exotic species have been observed in this reserve for a long

period of time, and once established they are difficult if not impossible to eradicate. Programmes of physical or chemical removal of exotic species may be of some use in this reserve, to prevent further degradation occurring. The only way to prevent this trend occurring in other reserves is to stop exotic species from becoming established in these reserves, by limiting or preventing access by people, fencing and physical and chemical control of exotic species.

The main evidence of change which has occurred in this reserve between 1984 and 1995 is in the growth of the *Eucalyptus loxophleba* population, the lack of recruitment of this species, the change in perennial species along the line transect and the change in species composition, with the increase in both exotic and native species of plants. The *Eucalyptus loxophleba* population has undergone growth but as little recruitment has occurred, this growth cannot continue indefinitely. This community should be continued to be monitored, and if recruitment does not occur at a rate to replace deaths, plantings may be an option to address the imbalance. The increase in cover of several perennial species is offset by the disappearance of others, and the change in species composition with the inclusion of a greater number of exotic species indicates a move towards a degraded state.

Reserves 29313 and 4458

In view of the need to establish new quadrats on these two reserves, no comparisons were feasible in 1995.

4.3 Effects of Fire on These Communities

Only one quadrat of the twelve experienced burning over the past eleven years, and therefore it is impossible to make a broad statement concluding the effects of fire on *Eucalyptus loxophleba - Acacia acuminata* communities across the wheatbelt, because of this low number. Every reserve has a different annual precipitation, history and amount of exotic species (and hence degradation), and the noted affects of fire on this one quadrat may not occur in quadrats of other reserves. It has been seen that burning can be beneficial for species such as *Acacia acuminata* which regenerate well after fire, as seen in quadrats (3) and (4) in Reserve 2023. The original individuals died in the fire, however the number of young plants, although not counted, was significant in 1995 and far exceeded the number of plants in other quadrats, including those quadrats which were in the same reserve and were left unburnt. Eventually the number of individuals in these quadrats will decrease, as competition from these individuals for nutrients and light builds, and the population will decrease. Burning can stimulate recruitment in *Acacia acuminata* populations, and may be effective when recruitment of these populations is not enough to replace naturally dying individuals. However, *Acacia acuminata* populations *do not necessarily need fire* to stimulate recruitment, as seen in quadrats which have experienced positive recruitment of this species without fire, such as in Reserves 26664, 4313, 16714, 13594 and 23164.

Either a positive or negative effect of burning on *Eucalyptus loxophleba* populations is impossible to state from this project, as recruitment of this population in the quadrat which was burnt was negligible, but nor did any individuals die in the fire. Fire is not a factor which controls the recruitment of this species as it does *Acacia acuminata*. The natural recruitment of *Eucalyptus loxophleba* is far slower than *Acacia acuminata*, due to the size and the longevity of the species. This study has not concluded any factors which stimulate recruitment of *Eucalyptus loxophleba*, and further study either using these plots after another 5 - 10 years or controlled plots of this community type where (for example) some are purposefully burnt, left unburnt or inundated with water during summer months may be necessary to give conclusive answers to this. The prescribed burn had no negative effect on the CBH and height of the *Eucalyptus loxophleba* population in this quadrat, which both increased over the past eleven years, and therefore had no detrimental effects on this population.

Recruitment of *Allocasuarina huegeliana* also increased in quadrat (3) in Reserve 2023, with two new individuals being recorded on the line transect. Burning appeared to have a positive effect on recruitment.

As the one plot which was burnt was located in the west, the effects of burning will probably be different in reserves located in the east, due to the differing species composition and lower precipitation. As the burning may have a different impact on these reserves, it may not be the best option for increasing recruitment of species such as *Acacia acuminata*. It cannot be concluded from this study which reserves to burn or what the eventual outcome will be, either positive or negative from the point of view of degradation due to increase of exotic species, effect on other species of native plants and the effect on recruitment of species such as *Eucalyptus loxophleba*. However it is advised that a no burn option is taken out on Reserves 23164 and 9754, due to the pristine nature of these granite-based reserves.

The Australian vegetation has slowly adapted to fire, due to the widespread use of fire by the original Aboriginal population, and naturally lit fires (such as lightning strikes), and should recover after burning. However, more data on the state of growth and recruitment of these populations in these reserves need to be collected before burns are devised for these reserves. The affects of frequency and extent of burning cannot be stated from results of this study, and these factors need to be controlled as burning too frequently may discourage the survival of some species, which need to set seed before another fire devastates the area. The influx of exotic species after a fire (such as the increase in **Avena* spp. which was noted by Leon Sylvester in the burnt area of Reserve 2023 in 1986) also needs to be controlled if reserves are burnt to prevent further degradation, especially those which are already degraded to some extent. It is advisable that firebreaks are constructed and/or maintained around the perimeter of each reserve, to prevent fires originating in reserves from reaching agricultural land, and vice versa.

4.4 Review of Changes in Growth and Recruitment in Relation to Regional Rainfall Data

Changes of all four growth characteristics have been compared between reserves across a rainfall gradient, to determine whether there is a relationship between precipitation experienced by the communities and increases or decreases in these characteristics. It was found that there is no relationship between average amount of precipitation and growth of *Eucalyptus loxophleba* or *Acacia acuminata*, with the exception of changes in CBH and Canopy Height for *Eucalyptus loxophleba* across the rainfall gradient. The trend of a decrease occurring in both of these characteristics down the gradient is shown in Figures 18 and 20.

It is likely that these trends are due to the sampling of different sub-species, rather than a result of a direct link between growth and amount of precipitation. However, the amount of precipitation may be indirectly related to growth, as it probably has been a factor in the development of these different sub-species which occur in different parts of the wheatbelt. *Eucalyptus loxophleba* ssp. *loxophleba*, which occurs in the wetter communities of the western wheatbelt has a tree habit, with a relatively large CBH when mature, and branches which either grow straight upwards, or bend downwards. *Eucalyptus loxophleba* ssp. *lissophloia*, which occurs in the generally drier eastern wheatbelt exhibits a mallee habit, which naturally has smaller CBH measurements than *Eucalyptus loxophleba* ssp. *loxophleba*. The branches of *Eucalyptus loxophleba* ssp. *lissophloia* do not tend to loop downwards, and the foliage occurs within a relatively small area at the very tops of the individuals, thus this species exhibits smaller Canopy Height measurements. For comparison, Figures 19 and 21 show the changes of CBH and Canopy Height measurements for *Acacia acuminata*, ranked in order according to the average rainfall received. It can be seen that there are no trends evident from these figures, further concluding that changes in CBH and Canopy Height values have not been influenced by the rainfall gradient on which these reserves have been placed.

Evidence of *Eucalyptus loxophleba* recruitment was seen in only one quadrat in 1995, and as such no statement on trends between recruitment and precipitation can be made. *Acacia acuminata* recruitment was evidenced in a wider array of quadrats, as was listed in Section 3.7. The quadrats in which recruitment of this species was evidenced are found in reserves which are scattered across the wheatbelt, from Reserve 2023 (the reserve experiencing the highest average annual precipitation of 455mm) to Reserve 13594 (the reserve which experiences the second lowest annual precipitation of 327mm). Recruitment occurs at some rate naturally in all communities, and it is beyond the scope of this study to make further statements regarding the affect of precipitation on recruitment of these species.

Figure 18: Summary of 1984 and 1995 Mean Circumference at Breast Height (CBH) (m) of *Eucalyptus loxophleba*, ranked in descending order according to rainfall

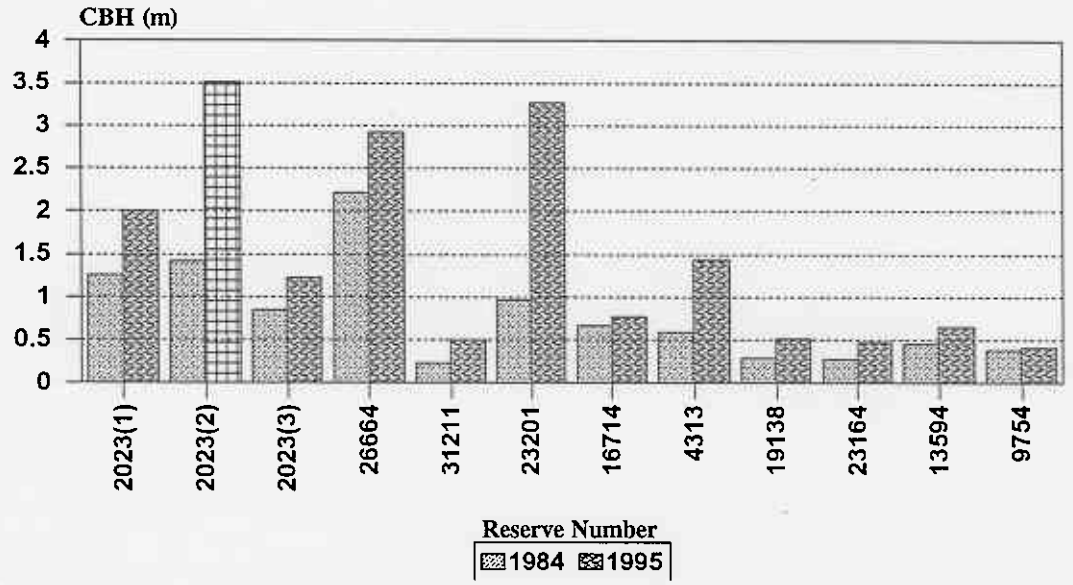


Figure 19: Summaryof 1984 and 1995 Mean Circumference at Breast Height (CBH) (m) of *Acacia acuminata*, ranked in order according to rainfall

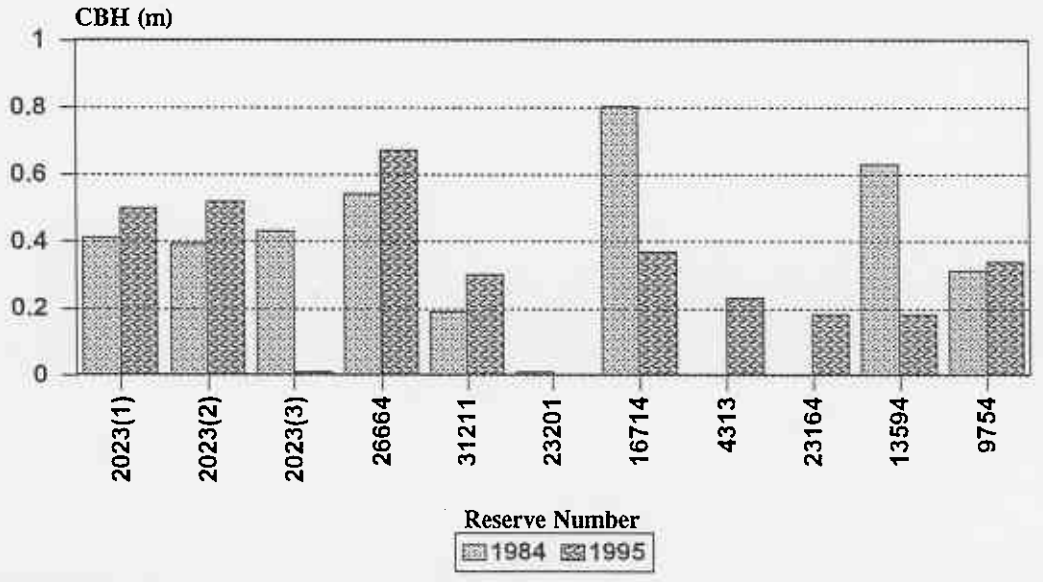


Figure 20: Summary of 1984 and 1995 Mean Canopy Height (m) of *Eucalyptus loxophleba,* ranked in descending order according to rainfall

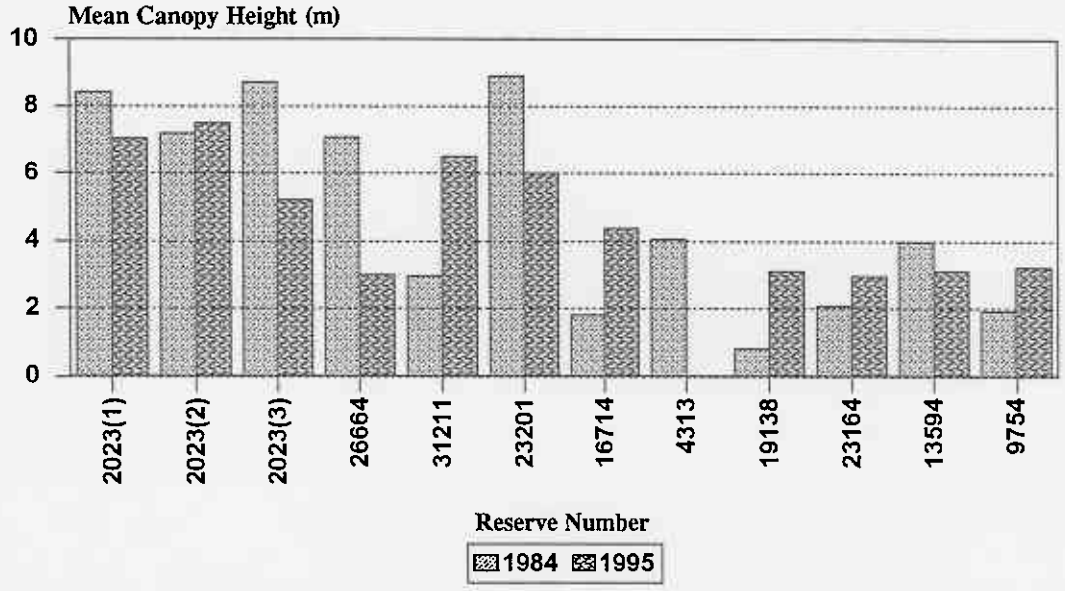
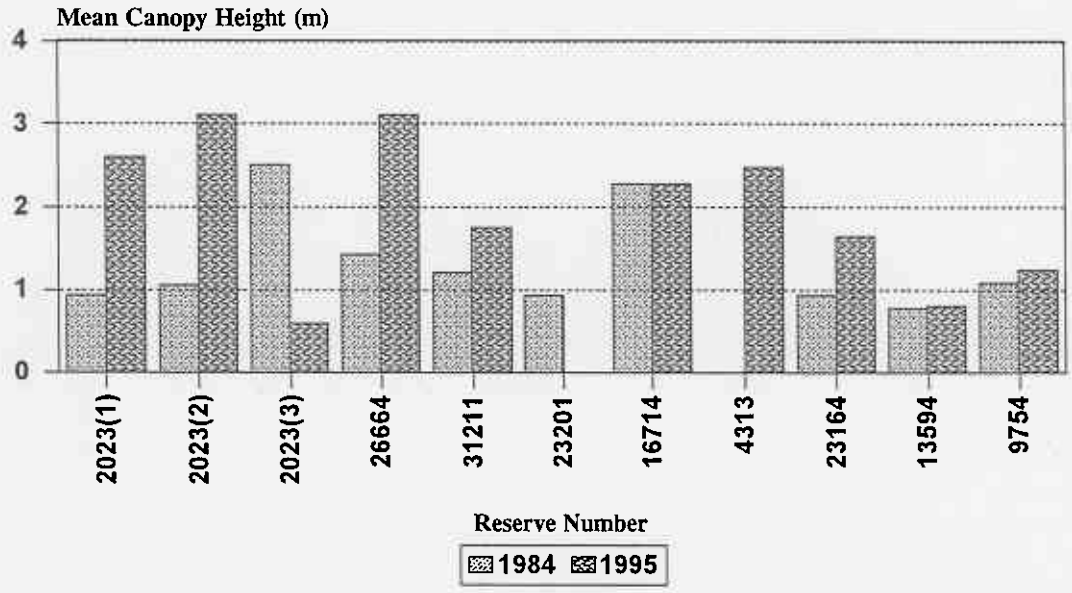


Figure 21: Summary of 1984 and 1995 Mean Canopy Height (m) of *Acacia acuminata,* ranked in descending order according to rainfall



5. CONCLUSIONS

Different changes in *Eucalyptus loxophleba - Acacia acuminata* communities have been examined in the time frame between 1984 and 1995. Each quadrat in each reserve has a different species composition, due to factors such as differing rainfall and soils, and also as a reaction to the extent and length of nearby agricultural land use. This is because the quadrats were originally pegged across a wide range of environments.

Tables 3 and 4 summarise the change in growth and recruitment of *Eucalyptus loxophleba* and *Acacia acuminata*, as well as other perennial species and the change in species composition in terms of species richness and increase or decrease in numbers of exotic and native species. The majority of reserves have responded in a positive way to their individual environments over the past eleven years, with increases in growth of *Eucalyptus loxophleba*, *Acacia acuminata* and other perennial species, and the increase in species richness and numbers of native species. These reserves are also usually passively monitored by the local Department of Conservation and Land Management, with little prescribed burning, although weed and rabbit control is practised in some reserves, such as in Reserves 26664 and 2023 where Soursob (**Oxalis* sp.) and Cape Tulip (**Homeria* sp.) have been discovered.

Significant change either in the growth and recruitment of the individual *Eucalyptus loxophleba* or *Acacia acuminata* populations, or in cover and presence of other perennial species and changes in species composition have occurred in all reserves. None of these quadrats have resulted in a stagnant community, however future data is needed to be able to describe and explain continuing changes in these communities. It is suggested that in a similar time frame, for example ten years, that these quadrats are monitored again, to describe further changes which will occur. All quadrats will be present (due to cementing of pickets), so changes which may occur in the communities in Reserves 4458, 29313 and around Quadrat (1) in 9754 can also be examined. It will be especially important to investigate further changes in Quadrat (3) in Reserve 2023, to describe growth of the new *Acacia acuminata* individuals in this area, and any changes in the *Eucalyptus loxophleba* population. Any increases in number and amount of exotic species in reserves such as 9754 and 23164, being fairly pristine environments in the eastern Wheatbelt, are also important, as they would indicate degradation of these environments. Increases in recruitment of *Eucalyptus loxophleba* in any of these quadrats in the future are also important to note, as populations of these long-lived perennial species probably recruit at a slower rate than do species such as *Acacia acuminata*.

On the basis of observations on these reserves, it is recommended that the Department of Conservation and Land Management monitor these reserves by inspecting the areas regularly (checking weeds, tracks, fencing, degradation, rapid changes in plant condition) and by maintaining the long-term vegetation monitoring programme. The studies undertaken on these selected reserves should be extended to other reserves, however prior to this there is a need to rationalize the monitoring approach so that the time and cost commitment can assist longer term reserve management issues (e.g. weed

control, delineation of burning regimes - including the no burn option and burning regimes in different communities).

Table 3: Summary of Increases and Decreases in Selected Criteria on Reserves between 1984 and 1995

Selected Criteria	23201	26664	31211	4313	2023(1)	2023(2)	2023(3)	2023
El Intercept	+	+	+	+	+	+	+	
El CBH	+	+	+	+	+	+	+	
El Height	+	--	+	+	--	+	+	
El Recruitment	=	=	=	=	=	=	=	
Aa Intercept	--	+	+	+	--	+	--	
Aa CBH	--	+	+	+	+	+	--	
Aa Height	--	+	+	+	+	+	--	
Aa Recruitment	=	+	=	+	=	=	+	
Perennial Cover	+	+	+	+	+	+	+	
Species Richness	+	=		+				+
# Exotic Species	+	=		+				--
# Native Species	+	=		+				+
Exotic vs Native	--	=		--				+

Note: El = *Eucalyptus loxophleba* (*Eucalyptus celastroides* in Reserve 19138); Aa = *Acacia acuminata;* Perennial Cover refers to total cover of species other than *Eucalyptus loxophleba, Eucalyptus celastroides* and *Acacia acuminata*; Exotic vs Native refers to the relative increases of exotic to native species; + refers to increase in that characteristic in that reserve between 1984 and 1995; -- refers to decrease in that characteristic in that reserve between 1984 and 1995; = refers to no change in that characteristic in that reserve between 1984 and 1995; np refers to the lack of species on the transect line; a blank space means lack of information

Table 4: Summary of Increases and Decreases in Selected Criteria on Reserves between 1984 and 1995

Selected Criteria	16714	13594	9754	23164	19138
El Intercept	--	+	+	+	+
El CBH	+	+	+	+	+
El Height	+	+	+	+	+
El Recruitment	=	+	=	=	+
Aa Intercept	+	+	--	+	np
Aa CBH	--	--	+	+	np
Aa Height	--	--	+	+	np
Aa Recruitment	+	+	=	+	np
Perennial Cover	+	+	+	+	+
Species Richness	+	+	+	+	+
# Exotic Species	=	--	+	+	+
# Native Species	+	+	+	+	+
Exotic vs Native	--	--	--	+	--

Note: El = *Eucalyptus loxophleba* (*Eucalyptus celastroides* in Reserve 19138);

Aa = *Acacia acuminata;*

Perennial Cover refers to total cover of species other than *Eucalyptus loxophleba, Eucalyptus celastroides* and *Acacia acuminata*;

Exotic vs Native refers to the relative increases of exotic to native species;

+ refers to increase in that characteristic in that reserve between 1984 and 1995;

-- refers to decrease in that characteristic in that reserve between 1984 and 1995;

= refers to no change in that characteristic in that reserve between 1984 and 1995;

np - plant species was not present on the transect line

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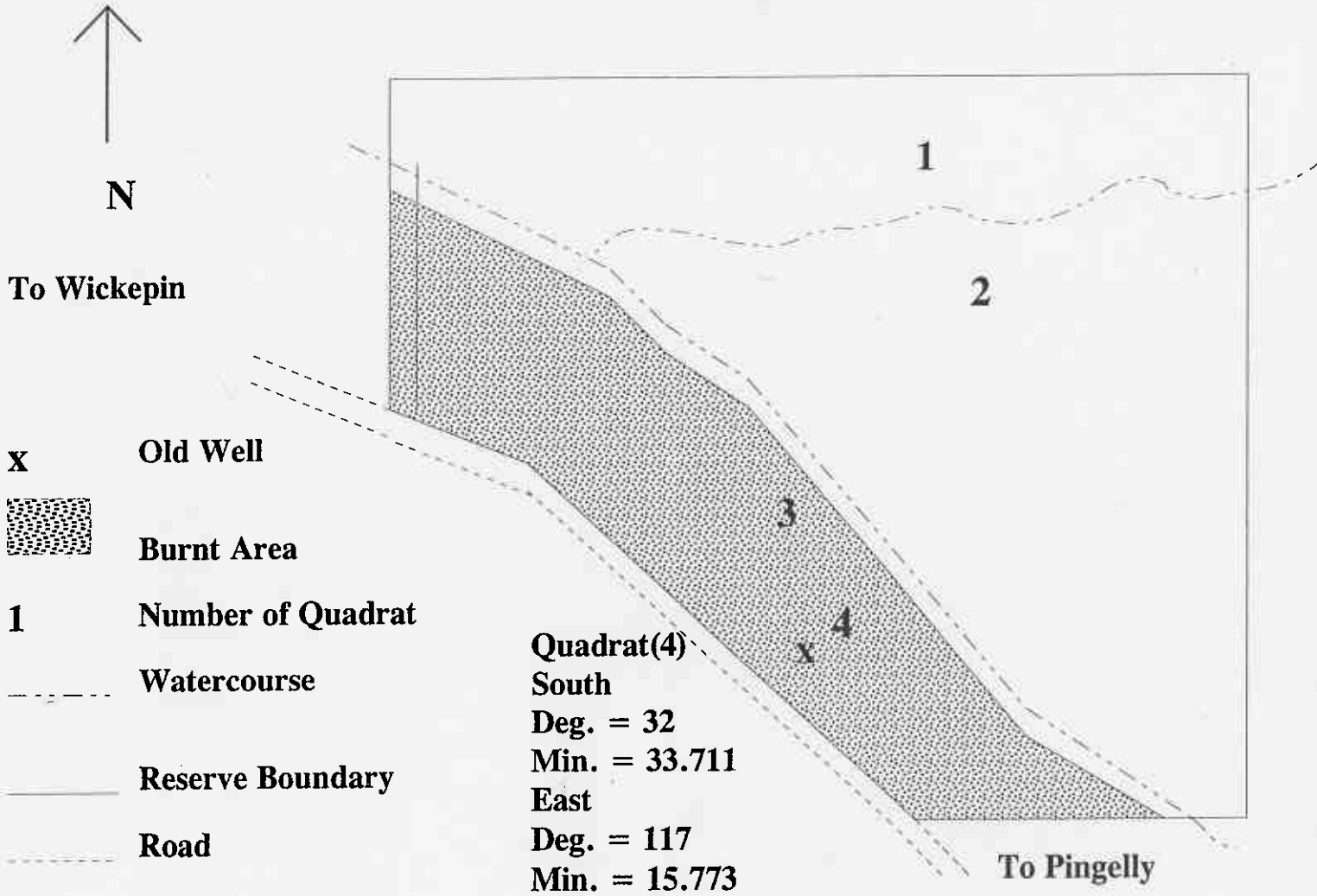
Extracts from an unpublished report of 1977, giving a vegetation description of several Wheatbelt Nature Reserves, from Department of Conservation and Land Management files.

Appendix A: Map of Reserve 2023, showing Quadrats (1) - (4), and area burnt in March 1989



x Old Well

Burnt Area

1 Number of Quadrat

Watercourse

Reserve Boundary

Road

GPS

Quadrat(1)

South
Deg. = 32
Min. = 33'48.9"
East
Deg. = 117
Min. = 15'92.3"

Quadrat(2)
South
Deg. = 32
Min. = 33'55.1"
East
Deg. = 117
Min. = 15'93.5"

Quadrat(3)
South
Deg. = 32
Min. = 33'62.8"
East
Deg. = 117
Min. = 15'70.9"

Quadrat(4)
South
Deg. = 32
Min. = 33.711
East
Deg. = 117
Min. = 15.773

Appendix A: Map of Reserve 23201, showing Quadrat (1) and Samphire Area

Small fence

Watercourse

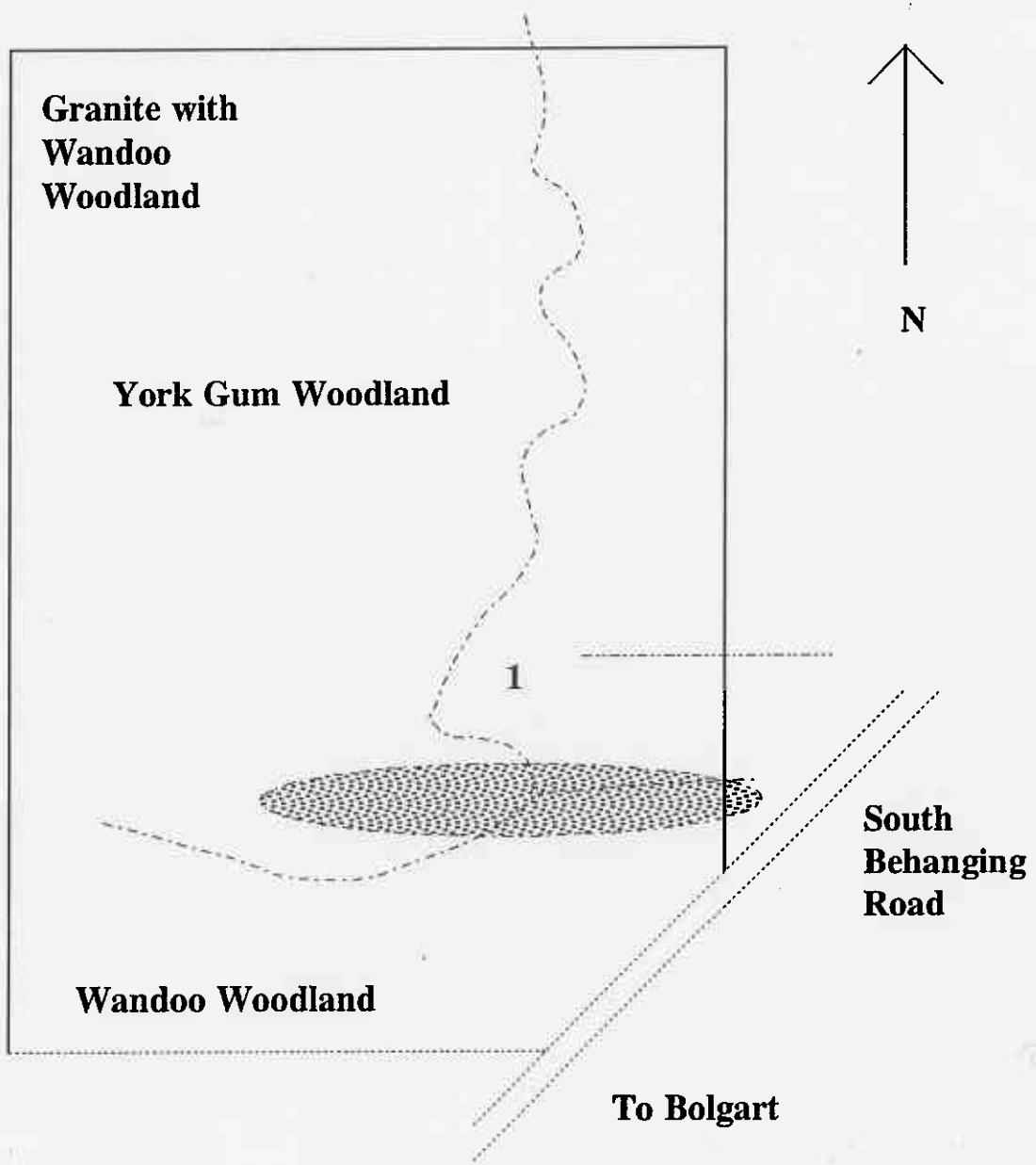
Road

Approximate Samphire Area

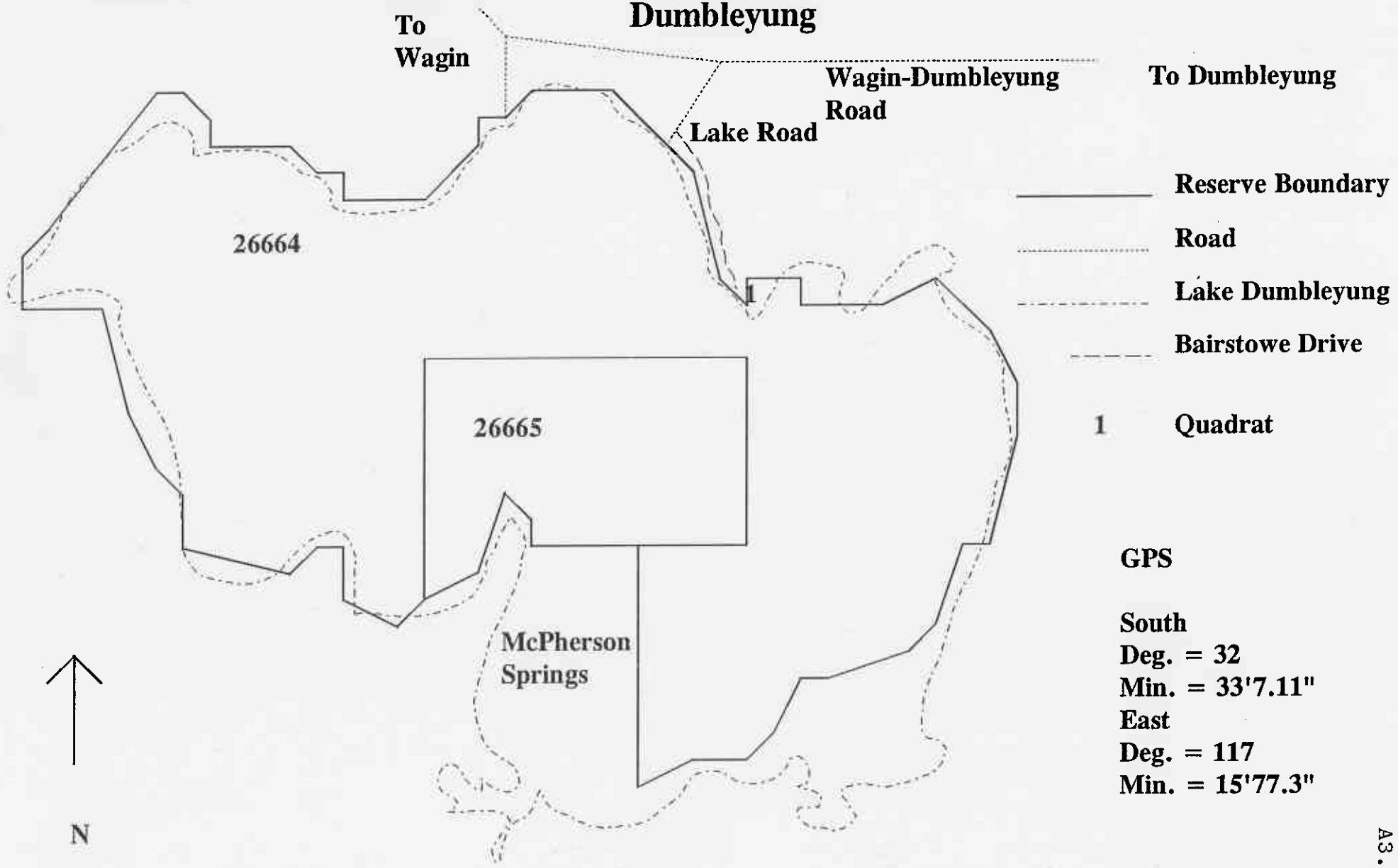
1 Quadrat

GPS

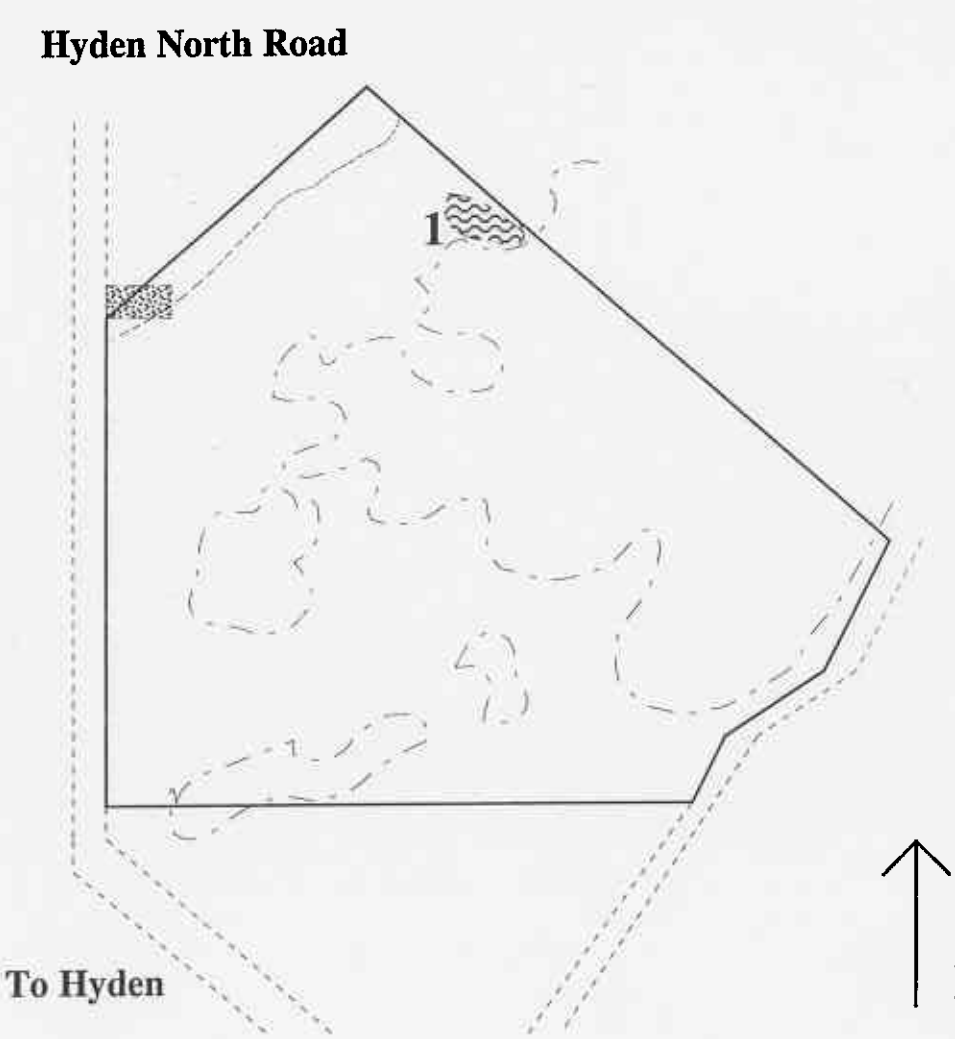
South
Deg. = 31
Min. = 10'44.2"
East
Deg. = 116
MIn. = 32"43.5"



Appendix A: Map of Reserve 26664, showing position of Quadrat (1) in relation to Lake Dumbleyung



Appendix A: Map of Reserve 23164, showing Quadrat (1)



Reserve Boundary

Road

Track

Granite Outcrop

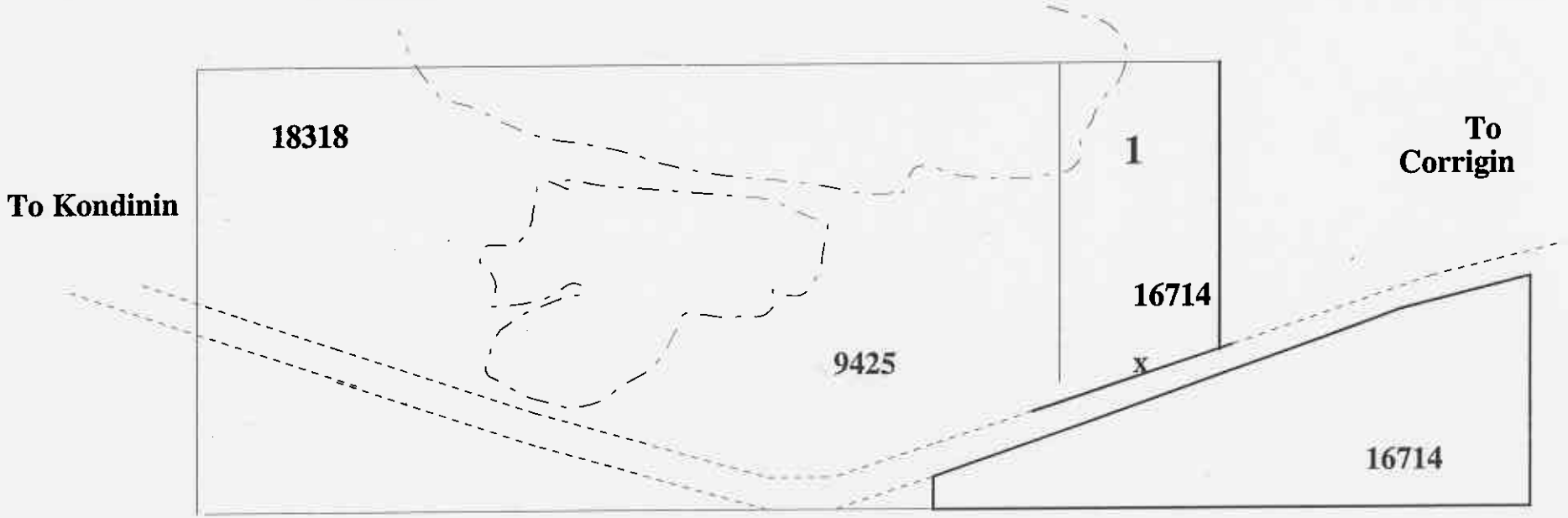
Gravel Pit

Allocasuarina grove

1 Quadrat

GPS
South
Deg. = 32
Min. = 18'13.6"
East
Deg. = 118
Min. = 49'17.4"

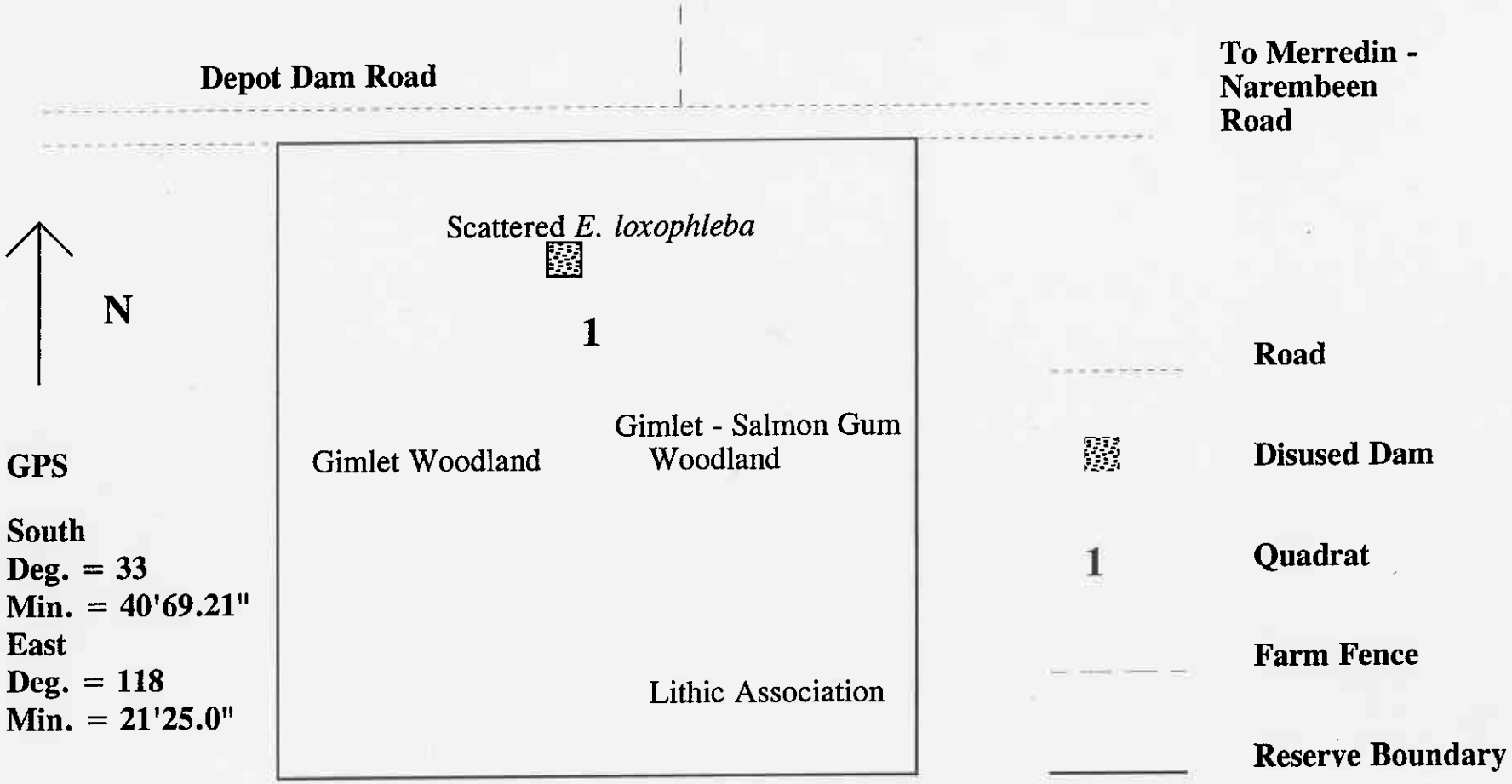
Appendix A: Map of Reserve 16714, showing Quadrat (1)



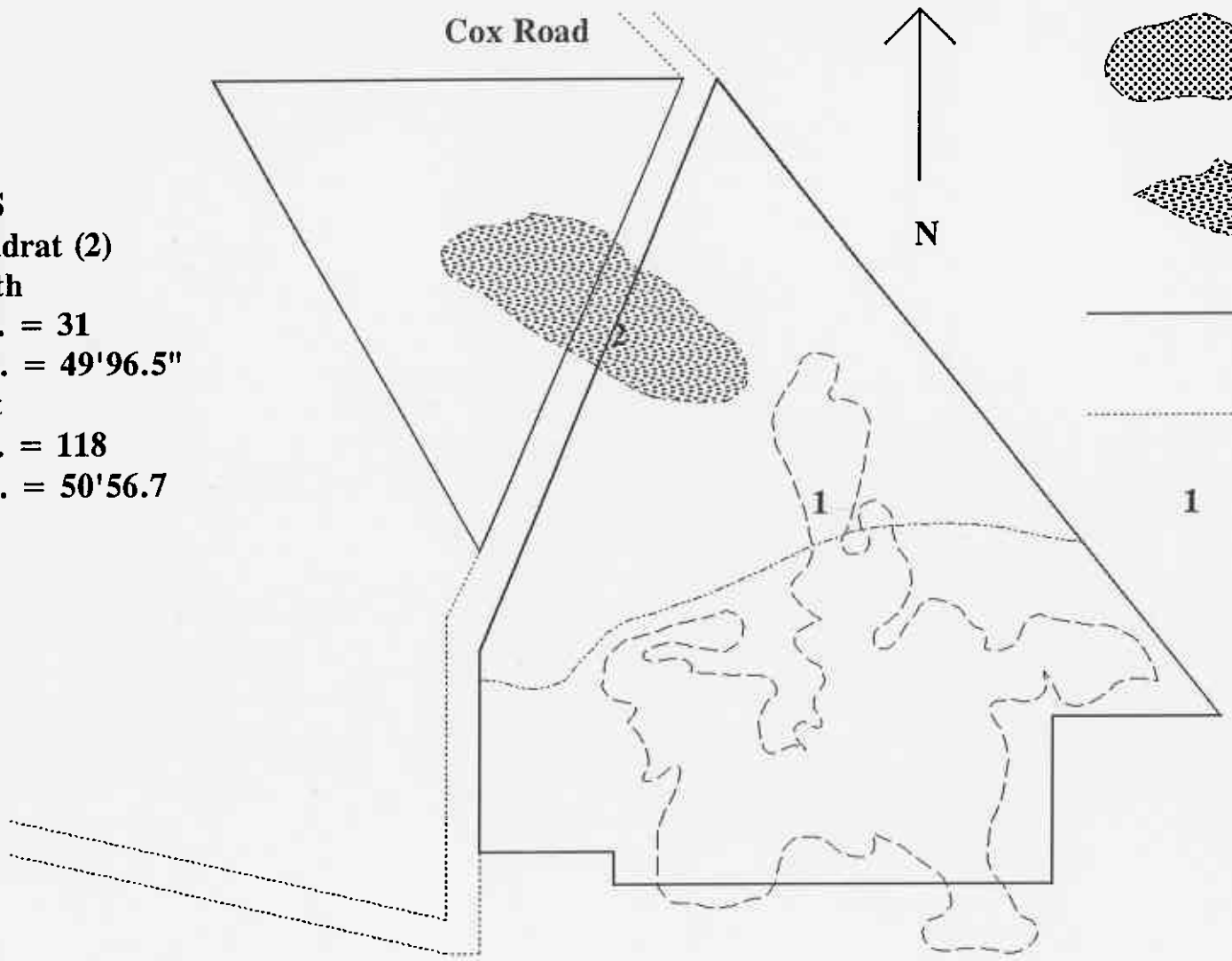
x	CALM sign	GPS
1	Number of Quadrat	South Deg. = 32 Min. = 27'51.7"
———	Reserve Boundaries	East Deg. = 118 Min. = 0'05.1"
— · — · —	Granite Outcrops	
- - - - -	Brookton Hwy	

N

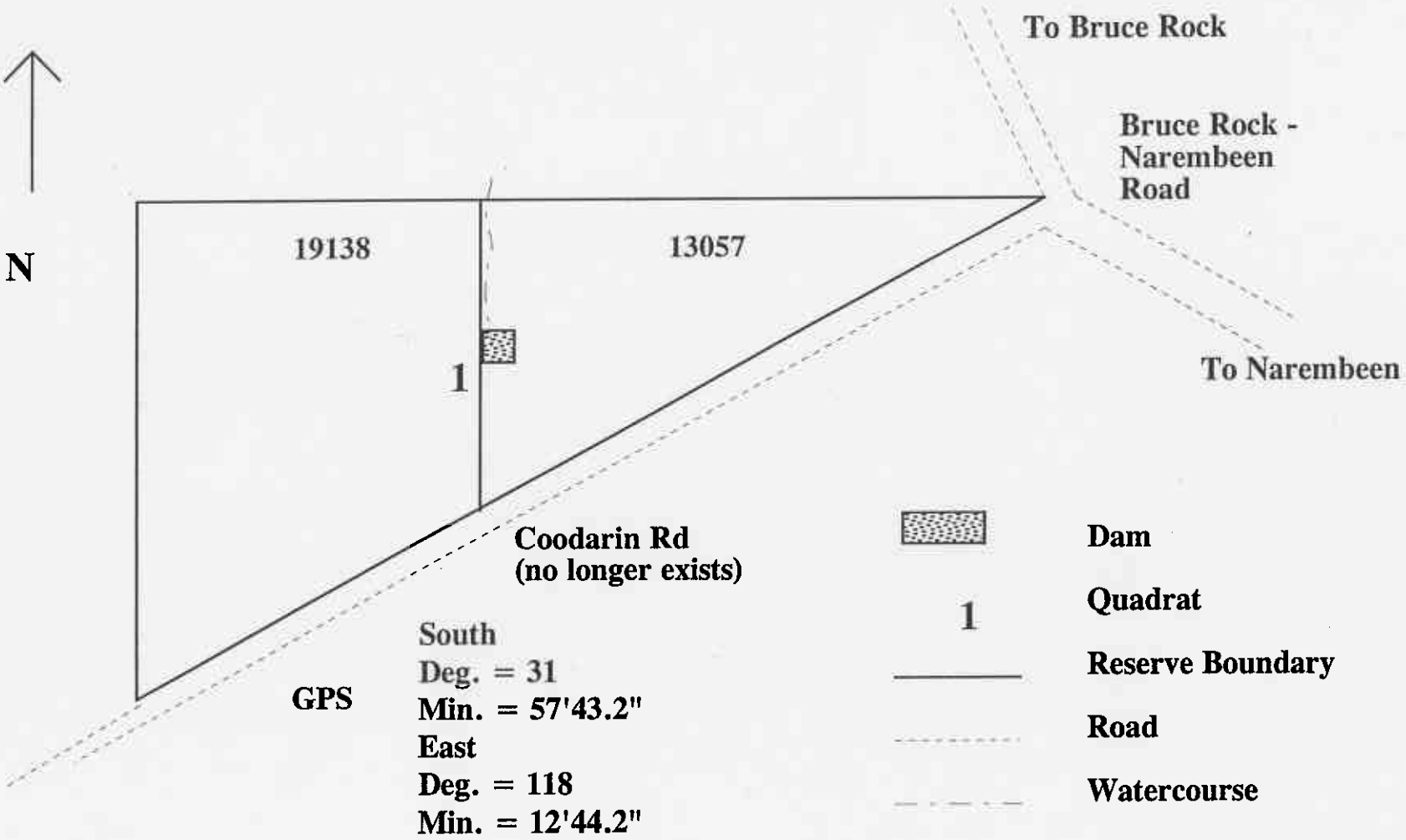
Appendix A: Map of Reserve 13594, showing Quadrat (1) and Position of Dam



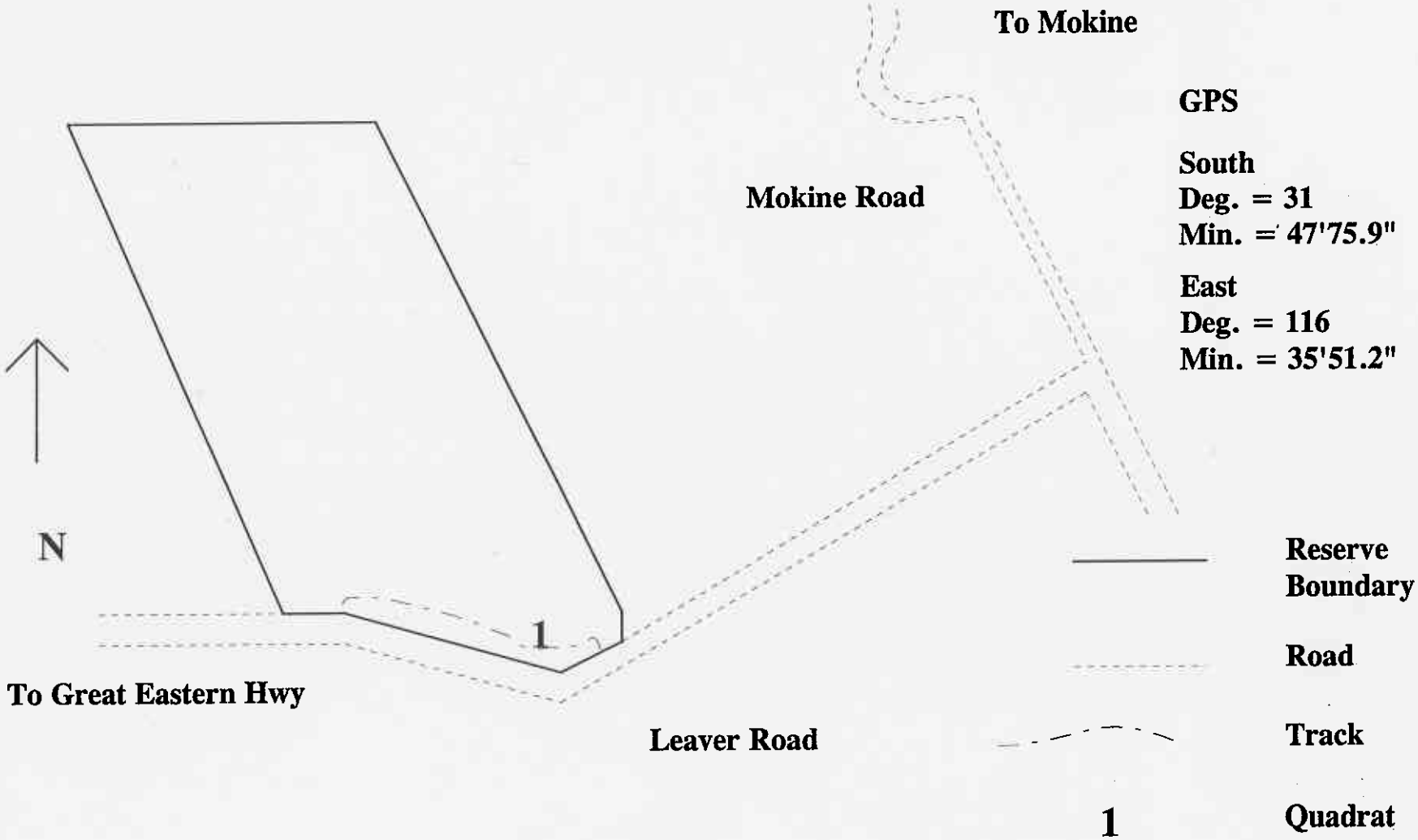
Appendix A: Map of Reserve 9754, showing Quadrats (1) and (2) and Moist Area



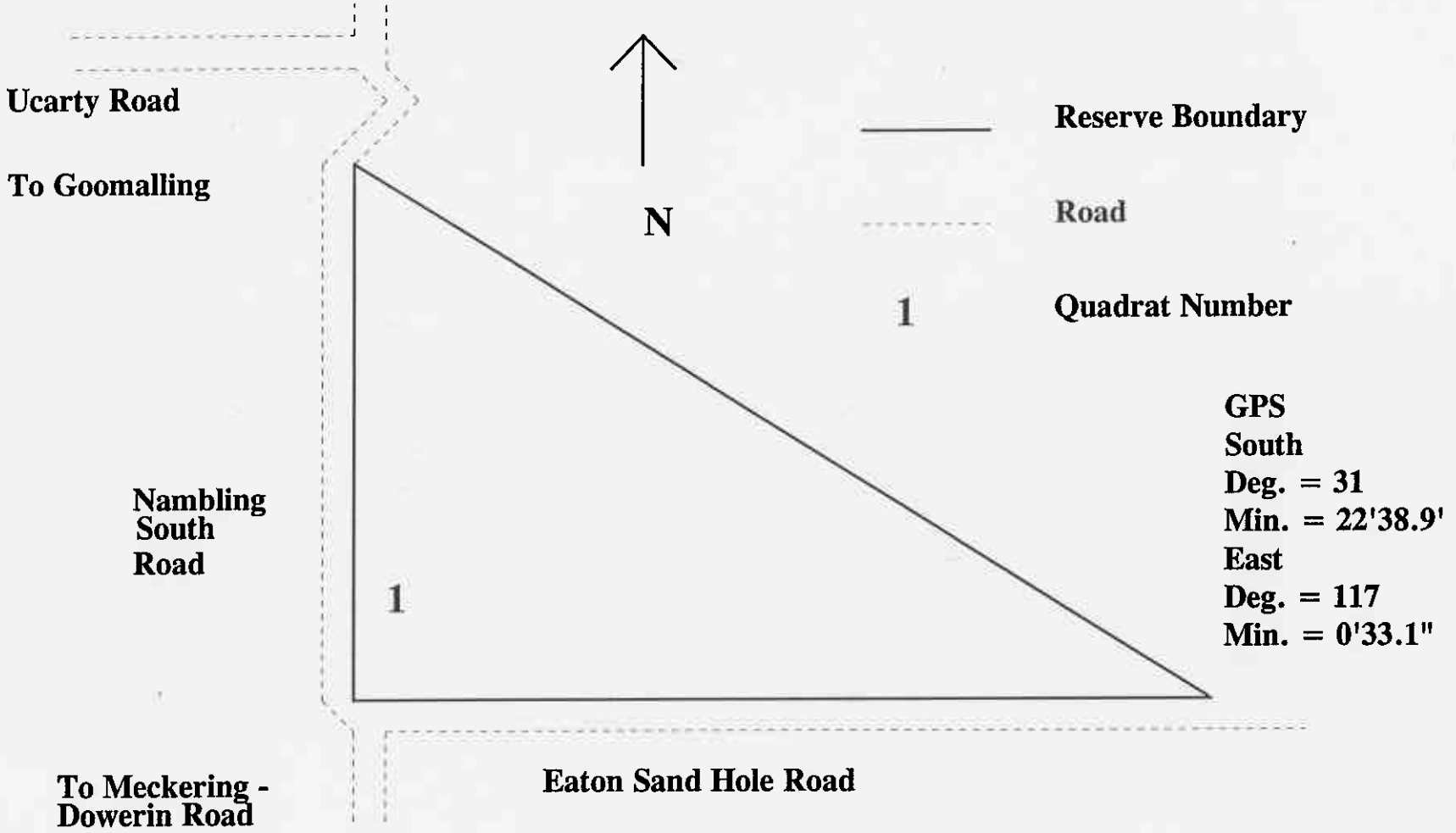
Appendix A: Map of Reserve 19138, showing Quadrat (1) and Position of Dam



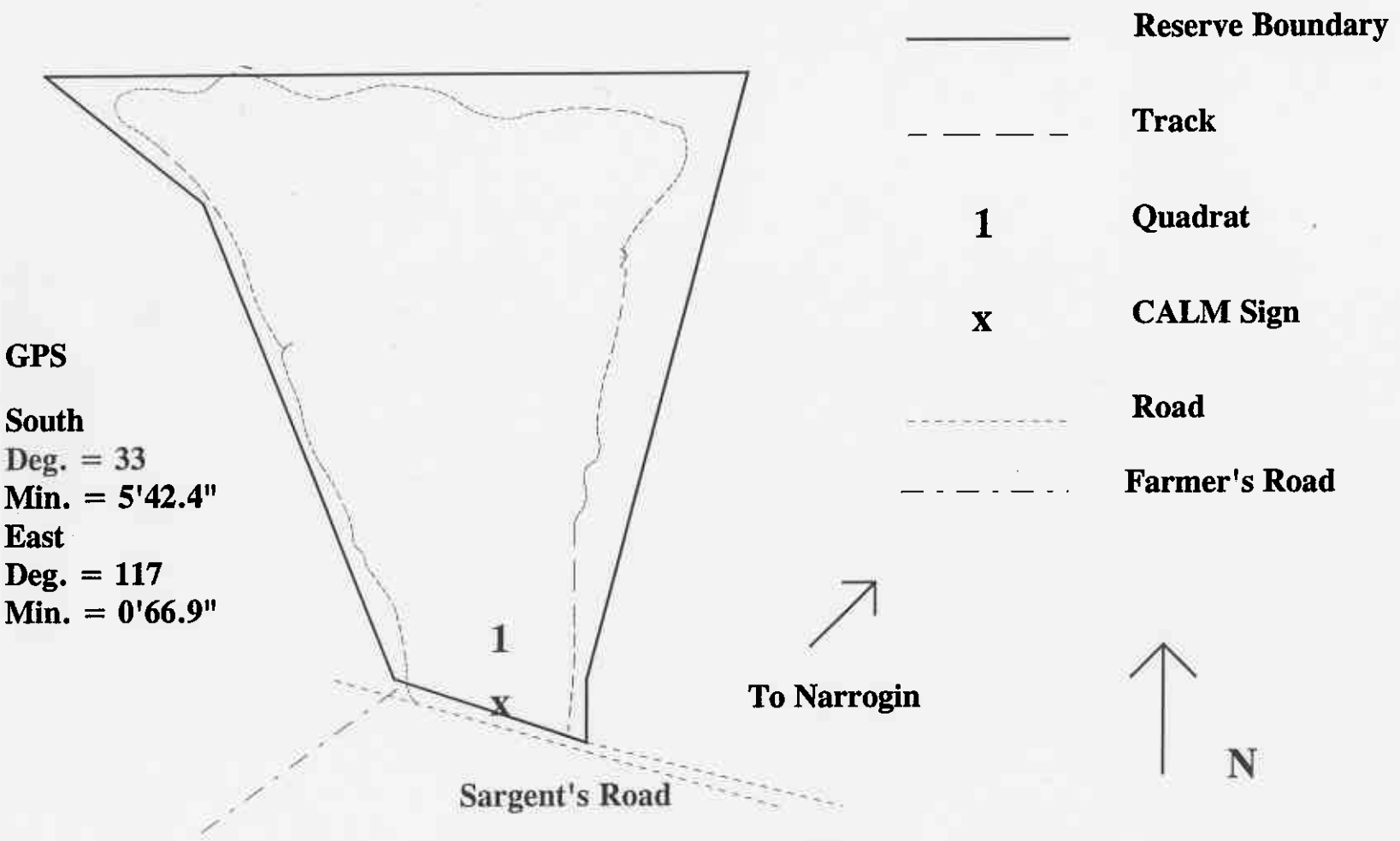
Appendix A: Map of Reserve 31211, showing Quadrat (1)



Appendix A: Map of Reserve 4313, showing Quadrat (1)



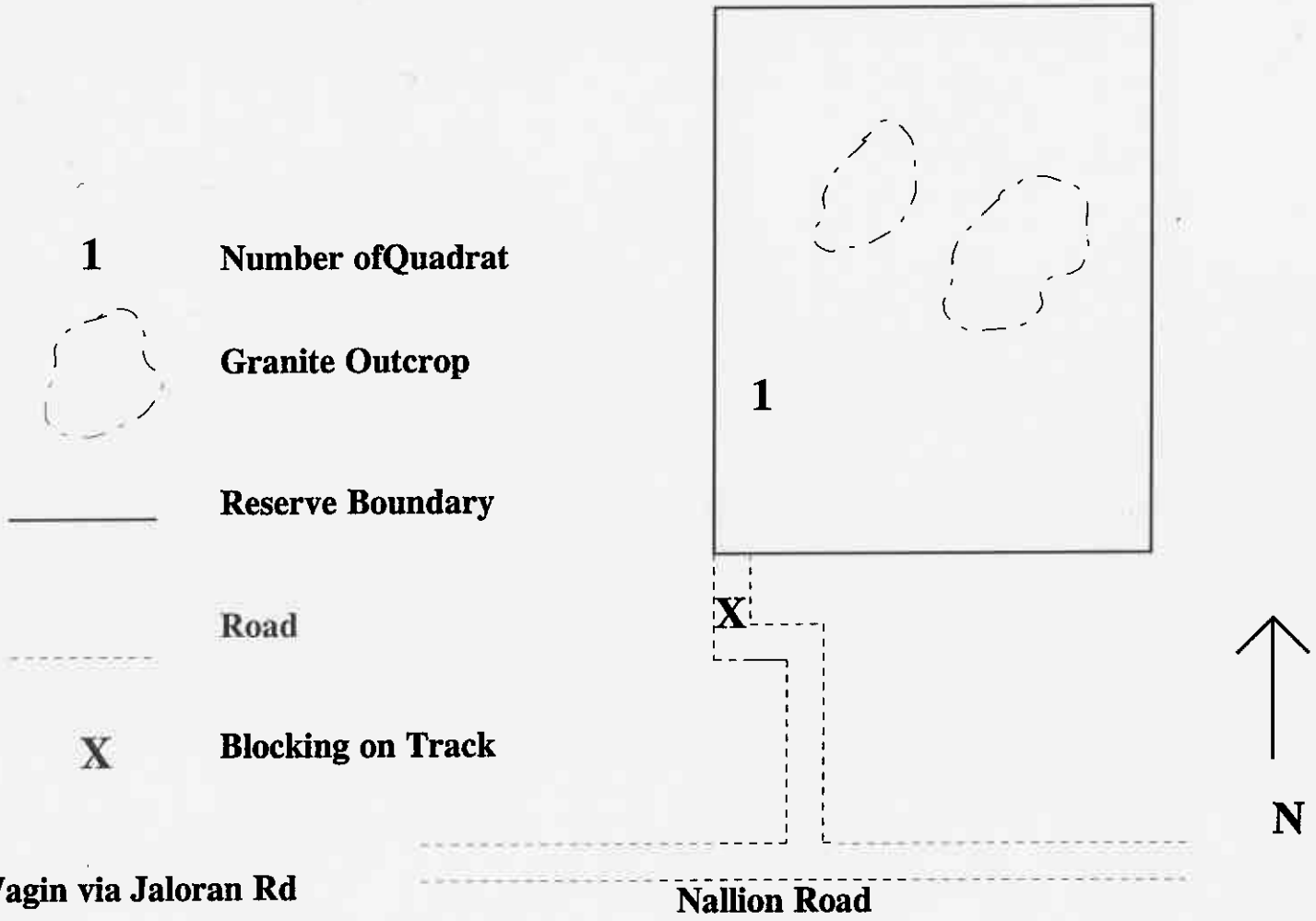
Appendix A: Map of Reserve 29313, showing Quadrat (1)



Appendix A: Map of Reserve 4458, showing Quadrat (1)

GPS

South
Deg. = 33
Min. = 14'27.1"
East
Deg. = 117
Min. = 25'52.1"



Appendix B: Total Line Transect Intercept Lengths (m) of *Eucalytpus loxophleba* in 12 Quadrats in 1984 and 1995 and Resultant *t* Test Values

Quadrat	Intercept - 1984	Intercept - 1995	Difference
2023 (1)	38.75	46.87	8.12
2023 (2)	13.9	67.02	53.12
2023 (3)	38.33	57.85	18.97
23201	21.34	58.9	37.56
26664	7.9	12.7	4.8
23164	12.03	60.4	48.37
16714	9.43	5.04	-4.39
13594	5.45	26.36	20.91
9754 (2)	6.58	29.39	22.81
19138	31.58	44.03	12.45
31211	22.15	27.53	5.38
4313	25.99	70.83	44.84
t	-3.17		
P (one-tail)	0.00		
t Critical	1.74		
P (two-tail)	0.01		
t Critical	2.11		

Appendix B: Total Line Transect Intercept Lengths (m) of *Acacia acuminata* in 11 Quadrats in 1984 and 1995 and Resultant *t* Test Values

Quadrat	Intercept - 1984	Intercept - 1995	Difference
2023 (1)	15.4	12.89	-2.51
2023 (2)	12.55	16.89	-4.34
2023 (3)	8.6	2.79	-5.81
23201	0.01	0	-0.01
26664	17.88	32.55	14.67
23164	2	4.4	2.4
16714	12.03	27.06	15.03
13594	0.15	4.19	4.04
9754 (2)	28.15	20.26	-8.05
31211	16.99	37.75	20.76
4313	0	6.2	6.2
t	-0.97		
P (one-tail)	0.17		
t Critical	1.73		
P (two-tail)	0.35		
t Critical	2.1		

Appendix B: Mean Circumference at Breast Height (CBH) (m) of *Eucalyptus loxophleba* in 12 Quadrats in 1984 and 1995 and Resultant *t* Test Values

Quadrat	CBH - 1984	CBH - 1995	Difference
2023 (1)	1.25	2	0.75
2023 (2)	1.41	3.5	2.09
2023 (3)	0.84	1.21	0.37
23201	0.96	3.26	2.3
26664	2.21	2.92	0.71
23164	0.27	0.47	0.2
16714	0.66	0.76	0.1
13594	0.45	0.64	0.19
9754 (2)	0.37	0.41	0.04
19138	0.29	0.51	0.22
31211	0.22	0.5	0.28
4313	0.58	1.43	0.85
t	-1.79		
P (one-tail)	0.05		
t Critical	1.75		
P (two-tail)	0.09		
t Critical	2.12		

Appendix B: Mean Circumference at Breast Height (CBH) (m) of *Acacia acuminata* in 11 Quadrats in 1984 and 1995 and Resultant *t* Test Values

Quadrat	CBH - 1984	CBH - 1995	Difference
2023 (1)	0.41	0.5	0.09
2023 (2)	0.39	0.52	0.13
2023 (3)	0.43	0.01	-0.42
23201	0.01	0	-0.01
26664	0.54	0.67	0.13
23164	0	0.18	0.18
16714	0.8	0.37	-0.43
13594	0.63	0.18	-0.45
9754 (2)	0.31	0.34	0.03
31211	0.19	0.3	0.11
4313	0	0.23	0.23
t	0.36		
P (one-tail)	0.36		
t Critical	1.73		
P (two-tail)	0.72		
t Critical	2.09		

Appendix B: Mean Heights (m) of *Eucalyptus loxophleba* in 12 Quadrats in 1984 and 1995 and Resultant *t* Test Values

Quadrat	Height - 1984	Height - 1995	Difference
2023 (1)	16.21	9.98	-6.23
2023 (2)	13.67	14.57	0.9
2023 (3)	14.98	15.34	0.36
23201	13.61	14.5	0.89
26664	10.5	7.7	-2.8
23164	5.13	7.04	1.91
16714	4.64	6.9	1.36
13594	4.5	7.61	3.11
9754 (2)	4.64	7.23	2.59
19138	3.69	6.38	2.69
31211	4.14	6.98	2.84
4313	8.49	10.76	2.27
t	-0.38		
P (one-tail)	0.353		
t Critical	1.728		
P (two-tail)	0.706		
t Critical	2.09		

Appendix B: Mean Heights (m) of *Acacia acuminata* in 11 Quadrats in 1984 and 1995 and Resultant *t* Test Values

Quadrat	Height - 1984	Height - 1995	Difference
2023 (1)	5.33	7.4	2.07
2023 (2)	3.59	6.47	2.88
2023 (3)	7.12	1.37	-5.75
23201	1.23	0	-1.23
26664	4.42	7.5	3.08
23164	1.84	3.52	1.68
16714	8.1	5.29	-2.81
13594	5.54	4.2	-1.34
9754 (2)	2.92	4.27	1.35
31211	3.17	5.79	2.62
4313	0	5.57	5.57
t	-0.72		
P (one-tail)	0.24		
t Critical	1.72		
P (two-tail)	0.48		
t Critical	2.09		

Appendix B: Mean Canopy Height (m) of *Eucalyptus loxophleba* in 12 Quadrats in 1984 and 1995 and Resultant *t* Test Values

Quadrat	Canopy Ht - 1984	Canopy Ht - 1995	Difference
2023 (1)	8.41	7.03	-1.38
2023 (2)	7.18	7.48	0.3
2023 (3)	8.7	5.21	-3.49
23201	8.91	9	0.09
26664	7.08	6	-1.08
23164	2.05	2.98	0.93
16714	1.79	2.93	1.14
13594	3.96	4.34	0.38
9754 (2)	1.9	3.08	1.18
19138	0.79	3.21	2.42
31211	2.96	3.1	0.14
4313	4.04	6.48	2.44
t	-0.24		
P (one-tail)	0.41		
t Critical	1.72		
P (two-tail)	0.81		
t Critical	2.09		

Appendix B: Mean Canopy Height (m) of *Acacia acuminata* in 11 Quadrats in 1984 and 1995 and Resultant *t* Test Values

Quadrat	Canopy Ht - 1984	Canopy Ht - 1995	Difference
2023 (1)	0.93	2.6	1.67
2023 (2)	1.05	3.1	2.05
2023 (3)	2.51	0.59	-1.92
23201	0.92	0	-0.92
26664	1.42	3.1	1.68
23164	0.93	1.63	0.7
16714	2.27	2.28	0.01
13594	0.77	0.8	0.03
9754 (2)	1.08	1.24	0.16
31211	1.2	1.74	0.54
4313	0	2.47	2.47
t	-1.48		
P (one-tail)	0.09		
t Critical	1.81		
P (two-tail)	0.17		
t Critical	2.23		

Appendix C : Summary of Projection Foliage Cover (PFC) of All Perennial Species present on Transect Lines in 1984 and 1995

Perennial Species	2023 (1)		2023 (2)		2023 (3)		23201		26664		23164		16714		13594		9754 (2)		19138		31211		4313	
	1984	1995	1984	1995	1984	1995	1984	1995	1984	1995	1984	1995	1984	1995	1984	1995	1984	1995	1984	1995	1984	1995	1984	1995
Acacia acuminata	6.93	5.71	0.56	4.87	0.318	0.37	0.01	0	9.01	1.321	1.05	1.88	0.52	11.87	0	1.17	0.24	4.32			7.99	15.6	0	1.81
Acacia saligna							0.01	0.95																
Acacia sp. (CG477)											0	0.36												
Acanthocarpus preissii																							0.96	0
Allocasuarina huegeliana	0.26	3.48	1.26	5.87	0	0.41							0	0.07										
Aristida contorta															0.29	0								
Caesia parviflora																	0	0						
Calothamnus quadrifidus											0.17	1.24												
Dampiera lavandulacea													0	0.07									0	0.03
Dianella revoluta							0.01	0.43			1.91	0	0	1.04	0	0.02	0	0.09						
Enchylaena tomentosa																							0	1.1
Eucalyptus celastroides																			1.5	17.24				
Eucalyptus loxophleba	2.37	29.24	1.08	41.36	9.87	22.72	0.5	2.5	0.409	3.27	5.33	28.8	0.4	1.11	0.19	8.02	0.31	7.4			7.99	16.5	1.25	34.03
Eucalyptus salmonophloia																			1.71	3.73				
Eucalyptus wandoo																					0	0.09		
Glischrocaryon aureum															0.01	0.94								
Grevillea paniculata															0.43	0	0	0.59						
Hakea preissii									0.37	3.15														
Jacksonia sternbergiana							0.11	0																
Lepidosperma costale													0	0.08										
Lepidosperma drummondii																	9.71	22.19						
Lepidosperma sp. A2															3.24	5.3								
Lomandra collina															0	0.21								
Lomandra effusa											0	9.61			0	0.97							0	0.03
Melaleuca arenicola											0	1.57					0.08	2						
Melaleuca hamulosa																	0.04	1						
Olearia revoluta											0	0.56			0	0.13								
Pittosporum phylliraeoides									0.1	0	0	0.62											0	0.12
Platysace maxwellii															0.35	1.43								
Rhagodia preissii											0.02	0.13												
Santalum acuminatum															0	0.01	0.12	1.06					0.08	0
Santalum spicatum											0.16	0												
Spartochloa scirpoidea															0.56	1.33	2.93	18.74						
Stypandra glauca																					0	0.88		
Trymalium ledifolium																					0	0.03		

Appendix D: Reserve 2023 Quadrats (1) and (2) Species Presence Absence (Combined List Given Only in 1984, Separate Lists for 1995)

Family	Species	(1)1984	(1)1995	(2)1984	(2)1995
Adiantaceae	*Cheilanthes austrotenuifolia*		+		+
Poaceae	* *Aira caryophyllea*	+		+	
	Aristida contorta	+		+	
	* *Avellinia michelii*				+
	* *Avena fatua*	+	+	+	+
	* *Briza maxima*	+	+	+	+
	* *Bromus diandrus*	+		+	
	* *Bromus hordeaceus*	+		+	
	* *Bromus rubens*	+		+	
	Danthonia caespitosa	+		+	+
	* *Ehrharta longiflora*	+		+	
	* *Hordeum glaucum*	+		+	
	* *Lolium perenne*	+		+	
	Neurachne alopecuroidea	+		+	
	* *Pentaschistis airoides*	+		+	
	* *Polypogon mospeliensis*	+		+	
	Stipa elegantissima	+	+	+	+
	Stipa tenuifolia	+		+	
	Stipa trichophylla				+
	* *Vulpia myuros*	+		+	
	* *Vulpia sp. (CG007)*				+
Restionaceae	*Loxocarya flexuosa*		+		
Phormiaceae	*Stypandra glauca*	+		+	
Anthericaceae	*Dichopogon capillipes*	+		+	
	Dichopogon preissii		+		+

Family	Species	(1)1984	(1)1995	(2)1984	(2)1995
Anthericaceae	*Borya nitida*	+		+	
	Borya sphaerocephala				+
	Caesia parviflora				+
	Chamaescilla corymbosa		+		
	Thysanotus patersonii		+		+
	Tricoryne elatior	+		+	
Colchicaceae	*Wurmbea drummondii*				+
Iridaceae	* *Romulea rosea var. australis*		+		+
Orchidaceae	*Caladenia sp. (CG028)*		+		
	Cyanicula deformis				+
	Pterostylis sp. (CG038)		+		+
	Pterostylis sp. (CG055)				+
Casuarinaceae	*Allocasuarina huegeliana*	+	+	+	
Polygonaceae	*Muehlenbeckia adpressa*	+		+	
Amaranthaceae	*Ptilotus declinatus*				+
	Ptilotus manglesii	+		+	+
Portulaceae	*Calandrinia calyptrata*		+		+
Droseraceae	*Drosera bulbosa*		+		+
	Drosera macrantha				+
	Drosera sp. climbing				+
Crassulaceae	*Crassula sp. (CG050)*		+		
Mimosaceae	*Acacia acuminata*	+	+	+	+
Papilionaceae	* *Trifolium sp. (CG011)*		+		+
	* *Erodium botrys*		+		+
Oxalidaceae	*Oxalis corniculata*	+		+	
Stackhousiaceae	*Stackhousia monogyna*	+		+	
Myrtaceae	*Eucalyptus loxophleba ssp. loxophleba*	+	+	+	+

Family	Species	(1)1984	(1)1995	(2)1984	(2)1995
Apiaceae	*Hydrocotyle sp. (CG031)*		+		+
Primulaceae	* *Anagallis arvensis*	+		+	
Rubiaceae	* *Galium murale*		+		+
Asteraceae	* *Arctotheca calendula*		+		+
	Blennospora drummondii		+		+
	Cotula coronopifolia	+		+	
	Gnaphalium sp. (CG009)				+
	* *Hypochaeris glabra*		+		+
	Lagenifera huegelii				+
	Millotia tenuifolia var. tenuifolia				+
	Podolepis canescens	+		+	
	Rhodanthe manglesii				+
	Rhodanthe rubella				+
	Siloxerus glossus		+		+
	* *Sonchus oleraceus*	+	+	+	
	* *Ursinia anthemoides*		+		+
	Waitzia citrina	+		+	
	Asteraceae sp. (CG047)		+		+

Appendix D: Reserve 2023 Quadrats (3) and (4) Species Presence Absence

Family	Species	(3)1984	(4)1995	(3)1984	(4)1995
Adiantaceae	*Cheilanthes austrotenuifolia*		+		
Poaceae	* *Aira caryophyllea*	+		+	
	Aristida contorta	+		+	
	* *Avena fatua*	+	+	+	
	* *Briza maxima*	+	+	+	+
	* *Bromus diandrus*	+		+	
	* *Bromus hordeaceus*	+		+	
	* *Bromus rubens*	+		+	
	* *Ehrharta longiflora*	+		+	
	* *Hordeum glaucum*	+		+	
	* *Lolium perenne*	+		+	
	Neurachne alopecuroidea	+		+	
	* *Pentaschistis airoides*	+		+	
	* *Polypogon mospeliensis*	+		+	
	Stipa elegantissima	+	+	+	+
	Stipa tenuifolia	+		+	
	Stipa trichophylla		+		
	* *Vulpia myuros*	+		+	
	* *Vulpia sp. (CG007)*		+		+
Restionaceae	*Loxocarya flexuosa*		+		
Phormiaceae	*Stypandra glauca*	+	+	+	
Anthericaceae	*Dichopogon capillipes*	+		+	
	Dichopogon preissii		+		+
	Borya nitida	+		+	
	Thysanotus patersonii		+		
	Tricoryne elatior	+		+	

Family	Species	(3)1984	(4)1995	(3)1984	(4)1995
Colchicaceae	*Wurmbea drummondii*		+		+
Iridaceae	* *Romulea rosea var australis*		+		
Orchidaceae	*Caladenia sp. (CG028)*		+		
	Cyanicula deformis		+		
	Pterostylis sanguinea		+		
	Pterostylis sp. (CG038)		+		
Casuarinaceae	*Allocasuarina huegeliana*	+	+	+	
Polygonaceae	*Muehlenbeckia adpressa*	+		+	
Amaranthaceae	*Ptilotus declinatus*		+		
	Ptilotus manglesii	+	+	+	
Droseraceae	*Drosera bulbosa*		+		+
	Drosera glanduligera		+		+
	Drosera sp. climbing		+		
Mimosaceae	*Acacia acuminata*	+	+	+	+
Papilionaceae	* *Trifolium sp. (CG011)*		+		+
	* *Erodium botrys*		+		
Oxalidaceae	*Oxalis corniculata*	+		+	
Stackhousiaceae	*Stackhousia monogyna*	+		+	
Myrtaceae	*Eucalyptus loxophleba ssp. loxophleba*	+	+	+	+
Apiaceae	*Trachymene pilosa*		+		+
Primulaceae	* *Anagallis arvensis*	+		+	
Asteraceae	* *Arctotheca calendula*		+		+
	Blennospora drummondii		+		
	Cotula coronopifolia	+		+	
	Gnaphalium sp. (CG009)		+		+
	* *Hypochaeris glabra*		+		+
	Lagenifera huegelii		+		

Family	Species	(3)1984	(4)1995	(3)1984	(4)1995
Asteraceae	*Podolepis canescens*	+		+	
	Podolepis lessonii		+		
	Rhodanthe manglesii		+		
	* *Sonchus oleraceus*	+		+	
	* *Ursinia anthemoides*		+		+
	Waitzia citrina	+		+	

Appendix D: Reserve 23201 Species Presence Absence

Family	Species	1984	1995
Adiantaceae	*Cheilanthes austrotenuifolia*		+
Poaceae	* *Avena barbata*		+
	* *Avena fatua*	+	
	* *Briza maxima*	+	+
	Danthonia setacea	+	
	* *Ehrharta longiflora*	+	+
	Neurachne alopecuroidea	+	+
	Stipa elegantissima	+	+
	Stipa tenuifolia	+	
	Stipa trichophylla	+	+
Phormiaceae	*Dianella revoluta*	+	+
Anthericaceae	*Caesia parviflora*		+
	Chamaescilla corymbosa		+
	Sowerbaea laxiflora		+
Hypoxidaceae	*Hypoxis occidentalis*		+
Iridaceae	* *Romulea rosea var australis*		+
Casuarinaceae	*Allocasuarina huegeliana*	+	
Amaranthaceae	*Ptilotus polystachyus*	+	+
Portulaceae	*Calandrinia brevipedata*		+
	Calandrinia calyptrata		+
Caryophyllaceae	* *Petrorhagia velutina*	+	
Droseraceae	*Drosera macrantha*		+
Crassulaceae	*Crassula colorata*		+
Mimosaceae	*Acacia acuminata*	+	+
	Acacia saligna	+	+
Papilionaceae	*Isotropis cuneifolia*		+

Family	Species	1984	1995
Papilionaceae	*Jacksonia sternbergiana*	+	
Geraniaceae	* *Erodium botrys*		+
Myrtaceae	*Eucalyptus loxophleba ssp. loxophleba*	+	+
	Eucalyptus wandoo	+	
Apiaceae	*Trachymene pilosa*		+
Primulaceae	* *Anagallis arvensis*		+
Scrophulariaceae	* *Zaluzianskya divaricata*		+
Asteraceae	* *Arctotheca calendula*		+
	Blennospora drummondii		+
	* *Hypochaeris glabra*		+
	Podolepis canescens	+	
	Podotheca gnaphalioides	+	+
	* *Sonchus oleraceus*		+
	* *Ursinia anthemoides*	+	+

Appendix D: Reserve 26664 Species Presence Absence

Family	Species	1984	1995
Adiantaceae	*Cheilanthes austrotenuifolia*	+	+
Poaceae	* *Aira caryophyllea*	+	
	* *Avena fatua*	+	
	* *Bromus diandrus*	+	
	* *Bromus rubens*		+
	Danthonia caespitosa	+	
	* *Ehrharta longiflora*	+	+
	* *Lolium perenne*	+	
	* *Pentaschistis airoides*	+	
	Stipa elegantissima	+	+
	* *Vulpia bromoides*	+	
Anthericaceae	*Chamaescilla corymbosa*		+
Hypoxidaceae	*Hypoxis occidentalis*	+	
Iridaceae	* *Romulea rosea var australis*		+
Proteaceae	*Hakea preissii*	+	+
Chenopodiaceae	*Rhagodia preissii*	+	
Amaranthaceae	*Ptilotus humilis*	+	
	Ptilotus polystachyus	+	
Crassulaceae	*Crassula colorata*		+
Pittosporaceae	*Pittosporum phylliraeoides*	+	+
Mimosaceae	*Acacia acuminata*	+	+
Geraniaceae	* *Erodium botrys*		+
Oxalidaceae	*Oxalis corniculata*		+
Myrtaceae	*Eucalyptus loxophleba ssp. loxophleba*	+	+
Rubiaceae	* *Galium murale*		+

Family	Species	1984	1995
Asteraceae	* *Arctotheca calendula*		+
	* *Hypochaeris glabra*		+
	Rhodanthe manglesii		+
	Asteraceae sp. (CG047)		+

Appendix D: Reserve 23164 Species Presence Absence

Family	Species	1984	1995
Adiantaceae	*Cheilanthes austrotenuifolia*	+	+
Poaceae	* *Avellinia michelii*		+
	* *Briza maxima*		+
	* *Bromus rubens*	+	+
	Danthonia caespitosa	+	+
	Neurachne alopecuroidea	+	+
	* *Pentaschistis airoides*		+
	Stipa elegantissima		+
	Stipa trichophylla	+	+
	* *Vulpia myuros*	+	+
Cyperaceae	*Lepidosperma drummondii*	+	+
Dasypogonaceae	*Lomandra effusa*	+	+
Phormiaceae	*Dianella revoluta*	+	
Anthericaceae	*Borya nitida*	+	
	Borya sphaerocephala		+
	Chamaescilla corymbosa	+	
	Thysanotus patersonii		+
Orchidaceae	*Caladenia microchila*		+
Casuarinaceae	*Allocasuarina campestris*	+	
Proteaceae	*Hakea scoparia*	+	
Santalaceae	*Santalum spicatum*	+	
Chenopodiaceae	*Rhagodia preissii*	+	+
Portulaceae	*Calandrinia calyptrata*		+
Droseraceae	*Drosera macrantha*		+
	Drosera subhirtella	+	
Crassulaceae	*Crassula colorata*		+

Family	Species	1984	1995
Pittosporaceae	*Pittosporum phylliraeoides*		+
Mimosaceae	*Acacia acuminata*	+	+
	Acacia sp. (CG477)		+
Oxalidaceae	*Oxalis corniculata*		+
Stackhousiaceae	*Stackhousia monogyna*	+	
Myrtaceae	*Calothamnus quadrifidus*	+	+
	Eucalyptus loxophleba ssp. (smooth bark)	+	+
	Melaleuca arenicola	+	+
Haloragaceae	*Glischrocaryon aureum*	+	
	Haloragis sp. (CG470)		+
Apiaceae	*Hydrocotyle callicarpa*		+
	Trachymene ornata	+	+
	Trachymene pilosa		+
Primulaceae	* *Anagallis arvensis*	+	
Loganiaceae	*Mitrasacme paradoxa*		+
Scrophulariaceae	* *Parentucellia latifolia*	+	
	* *Zaluzianskya divaricata*		+
Goodeniaceae	*Dampiera lavandulacea*		+
Stylidiaceae	*Stylidium calcaratum*	+	
Asteraceae	*Actinobole uliginosum*		+
	* *Arctotheca calendula*	+	+
	Brachyscome bellidioides	+	
	Brachyscome perpusilla		+
	Calotis hispidula		+
	Ceratogyne obionoides		+
	Helipterum laeve		+
	Helipterum ramosum		+

Family	Species	1984	1995
Asteraceae	* *Hypochaeris glabra*		+
	Millotia tenuifolia var. tenuifolia		+
	Olearia revoluta	+	+
	Podolepis capillaris	+	+
	Podolepis lessonii	+	+
	Podotheca angustifolia		+
	Podotheca gnaphalioides	+	+
	Rhodanthe manglesii		+
	Siloxerus humifusus		+
	* *Sonchus oleraceus*	+	+
	* *Ursinia anthemoides*	+	+
	Waitzia acuminata	+	+

Appendix D: Reserve 16714 Species Presence Absence

Family	Species	1984	1995
Adiantaceae	*Cheilanthes austrotenuifolia*	+	+
Poaceae	* *Aira caryophyllea*	+	
	Amphipogon strictus	+	
	* *Avellinia michelii*		+
	* *Avena fatua*	+	+
	* *Briza maxima*	+	+
	* *Bromus rubens*		+
	Danthonia caespitosa	+	+
	* *Ehrharta longiflora*		+
	Neurachne alopecuroidea	+	+
	* *Pentaschistis airoidea*	+	+
	Stipa elegantissima		+
	Stipa hirsuta		+
	Stipa trichophylla	+	+
	* *Vulpia bromoides*		+
	* *Vulpia myuros*	+	
Cyperaceae	*Lepidosperma costale*	+	+
	Lepidosperma gracile	+	
	Schoenus humilis		+
Dasypogonaceae	*Lomandra effusa*		+
Phormiaceae	*Dianella revoluta*	+	+
	Stypandra glauca	+	+
Anthericaceae	*Dichopogon capillipes*		+
	Borya nitida	+	
	Borya sphaerocephala		+
	Thysanotus patersonii		+

Family	Species	1984	1995
Anthericaceae	*Thysanotus tenellus*	+	+
Orchidaceae	*Caladenia hirta ssp. hirta*		+
	Caladenia roei		+
	Diuris porrifolia		+
Casuarinaceae	*Allocasuarina huegeliana*	+	+
Amaranthaceae	*Ptilotus polystachyus*	+	
Portulaceae	*Calandrinia calyptrata*		+
	Calandrinia sp. (CG485)		+
Caryophyllaceae	* *Silene gallica*	+	
Brassicaceae	* *Brassica tournefortii*	+	+
Droseraceae	*Drosera erythrorhiza*		+
	Drosera glanduligera		+
	Drosera macrantha		+
Crassulaceae	*Crassula colorata*	+	+
Mimosaceae	*Acacia acuminata*		+
Geraniaceae	* *Erodium botrys*		+
Stackhousiaceae	*Stackhousia monogyna*	+	+
Myrtaceae	*Eucalyptus loxophleba ssp. loxophleba*	+	+
Haloragaceae	*Glischrocaryon aureum*	+	
	Gonocarpus nodulosus		+
Apiaceae	*Hydrocotyle callicarpa*		+
	Trachymene cyanopetala	+	
	Trachymene ornata		+
	Trachymene pilosa		+
Primulaceae	* *Anagallis arvensis*	+	+
Loganiaceae	*Mitrasacme paradoxa*		+
Asclepiadaceae	*Rhyncharrhena linearis*		+

Family	Species	1984	1995
Rubiaceae	*Opercularia vaginata*		+
Goodeniaceae	*Brunonia australis*	+	
	Dampiera lavandulacea	+	+
	Goodenia berardiana		+
	Velleia cycnopotamica	+	+
Stylidiaceae	*Levenhookia dubia*		+
Asteraceae	* *Arctotheca calendula*	+	
	Brachyscome bellidiodes	+	
	Brachyscome iberidifolia	+	
	Gilruthia osbornei		+
	Gnephosis sp. (CG500)		+
	Helichrysum lindleyi		+
	Helipterum manglesii	+	
	* *Hypochaeris glabra*	+	+
	Millotia tenuifolia var. tenuifolia		+
	Podolepis lessonii	+	+
	Podotheca gnaphalioides		+
	Rhodanthe manglesii		+
	* *Ursinia anthemoides*	+	+
	Waitzia acuminata	+	+

Appendix D: Reserve 13594 Species Presence Absence

Family	Species	1984	1995
Juncaginaceae	*Triglochin calcitrapa*		+
Poaceae	*Aristida contorta*	+	
	* *Avena fatua*	+	
	* *Briza maxima*	+	+
	* *Bromus rubens*	+	
	Danthonia caespitosa		+
	Danthonia setacea	+	
	* *Ehrharta longiflora*		+
	* *Lolium perenne*	+	
	* *Pentaschistis airoides*	+	+
	Spartochloa scirpoidea	+	+
	Stipa elegantissima	+	+
	Stipa trichophylla	+	+
	* *Vulpia bromoides*	+	+
	* *Vulpia myuros*	+	
Cyperaceae	*Lepidosperma sp. A2*	+	+
	Schoenus nanus		+
Dasypogonaceae	*Lomandra collina*	+	+
	Lomandra effusa	+	+
Phormiaceae	*Dianella revoluta*	+	
Anthericaceae	*Thysanotus patersonii*		+
Orchidaceae	*Caladenia roei*		+
Proteaceae	*Grevillea paniculata*	+	+
Santalaceae	*Santalum acuminatum*	+	+
Chenopodiaceae	*Enchylaena tomentosa*		+
	Rhagodia preissii	+	+

Family	Species	1984	1995
Amaranthaceae	*Ptilotus gaudichaudii*	+	
	Ptilotus humilis	+	+
	Ptilotus polystachyus	+	+
Portulaceae	*Calandrinia calyptrata*		+
Caryophyllaceae	*Stellaria filiformis*		+
Brassicaceae	*Lepidium oxytrichum*		+
Droseraceae	*Drosera microphylla*		+
Crassulaceae	*Crassula colorata*		+
Mimosaceae	*Acacia acuaria*		+
	Acacia acuminata	+	+
	Acacia hemiteles	+	
Papilionaceae	* *Medicago truncatula*	+	
	Oxylobium parviflorum	+	
Geraniaceae	* *Erodium botrys*		+
Dilleniaceae	*Hibbertia rupicola*	+	+
Thymelaeaceae	*Pimelea argentea*	+	
Myrtaceae	*Eucalyptus loxophleba ssp. loxophleba*	+	+
	Eucalyptus salmonophloia	+	
Haloragaceae	*Glischrocaryon aureum*	+	+
Apiaceae	*Daucus glochidiatus*		+
	Hydrocotyle rugulosa		+
	Platysace maxwellii	+	+
	Trachymene cyanopetala	+	
	Trachymene pilosa	+	+
Primulaceae	* *Anagallis arvensis*	+	
Loganiaceae	*Mitrasacme paradoxa*		+
Lamiaceae	*Hemigenia westringioides*	+	

Family	Species	1984	1995
Solanaceae	*Nicotiana rotundifolia*	+	+
Myoporaceae	*Eremophila drummondii*	+	
Rubiaceae	*Plantago varia*		+
Campanulaceae	*Wahlenbergia gracilenta*		+
Goodeniaceae	*Brunonia australis*		+
	Dampiera wellsiana	+	
	Goodenia berardiana		+
	Velleia cycnopotamica		+
Stylidiaceae	*Levenhookia dubia*		+
Asteraceae	*Actinobole uliginosum*	+	
	* *Arctotheca calendula*	+	+
	Brachyscome bellidioides	+	
	Helichrysum lindleyi	+	
	* *Hypochaeris glabra*	+	+
	Millotia tenuifolia var. tenuifolia		+
	Olearia muelleri		+
	Podolepis canescens		+
	Podolepis capillaris		+
	Podolepis lessonii	+	+
	Podotheca gnaphalioides	+	+
	Rhodanthe manglesii		+
	Rhodanthe rubella		+
	Rhodanthe spicata		+
	* *Sonchus asper ssp. nymanii*	+	
	* *Ursinia anthemoides*	+	+
	Waitzia acuminata	+	+

Appendix D: Reserve 9754 Quadrats (1) and (2) Species Presence Absence

Family	Species	(1)1984	(1)1995	(2)1984	(2)1995
Lycopodiaceae	*Phylloglossum drummondii*		+		+
Adiantaceae	*Cheilanthes austrotenuifolia*	+			
Poaceae	* *Bromus diandrus*	+			
	* *Bromus rubens*	+	+	+	
	Danthonia caespitosa	+	+	+	+
	* *Lolium perenne*			+	
	Neurachne alopecuroidea			+	+
	* *Pentaschistis airoides*		+	+	+
	* *Polypogon monspeliensis*	+			
	Spartochloa scirpoidea			+	+
	Stipa elegantissima		+		+
	Stipa tenuifolia				+
	Stipa trichophylla	+	+	+	+
	* *Vulpia bromoides*	+	+		+
	* *Vulpia myuros*	+	+		
Cyperaceae	*Lepidosperma costale*			+	+
	Lepidosperma drummondii			+	+
	Schoenus humilis		+	+	+
	Schoenus nanus			+	
Centrolepidaceae	*Aphelia brizula*			+	
	Centrolepis aristata			+	+
Phormiaceae	*Dianella revoluta*				+
Anthericaceae	*Dichopogon capillipes*				+
	Borya sphaerocephala				+
	Caesia parviflora			+	

Family	Species	(1)1984	(1)1995	(2)1984	(2)1995
	Thysanotus patersonii			+	+
Asphodelaceae	*Bulbine semibarbata*		+		
Colchicaceae	*Wurmbea tenella*				+
Orchidaceae	*Caladenia roei*			+	+
	Microtis unifolia		+		
	Thelymitra crinita			+	
Urticaceae	*Parietaria debilis*		+		+
Proteaceae	*Grevillea paniculata*		+	+	+
Santalaceae	*Santalum acuminatum*	+	+	+	+
Polygonaceae	*Muehlenbeckia adepressa*	+			
Amaranthaceae	*Ptilotus holosericeus var rosea*				+
	Ptilotus humilis		+		
	Ptilotus villosiflorus	+			
Portulaceae	*Calandrinia calyptrata*		+		
Caryophyllaceae	* *Silene gallica*	+			
Brassicaceae	* *Brassica tournefortii*	+			
	Brassicaceae sp. (CG399)				+
Droseraceae	*Drosera erythrorhiza*				+
	Drosera glanduligera		+	+	+
	Drosera macrantha		+		
Crassulaceae	*Crassula colorata*		+		
Pittosporaceae	*Pittosporum phylliraeoides*	+			
Mimosaceae	*Acacia acuminata*	+	+	+	+
	Acacia hemiteles			+	
	Acacia sp. (CG405)				+
Geraniaceae	* *Erodium botrys*	+	+		+
	* *Erodium cicutarium*		+		

Family	Species	(1)1984	(1)1995	(2)1984	(2)1995
Euphorbiaceae	*Poranthera microphylla*			+	
Myrtaceae	*Eucalyptus loxophleba ssp. lissophloia*			+	+
Myrtaceae	*Melaleuca arenicola*			+	+
	Melaleuca hamulosa			+	+
Haloragaceae	*Gonocarpus nodulosus*			+	
Apiaceae	*Daucus glochidiatus*				+
	Hydrocotyle callicarpa				+
	Hydrocotyle rugulosa				+
	Trachymene cyanopetala			+	
	Trachymene ornata			+	
	Trachymene pilosa			+	+
Primulaceae	* *Anagallis arvensis*			+	+
Gentianaceae	*Sebaea ovata*			+	
Solanaceae	*Nicotiana rotundifolia*	+	+		
	* *Solanum nigrum*	+			
Scrophulariaceae	* *Partentucellia latifolia*	+	+		
	* *Zaluzianskya divaricata*		+		
Plantaginaceae	*Plantago varia*		+		
Campanulaceae	*Wahlenbergia gracilenta*		+	+	
Goodeniaceae	*Dampiera lavandulacea*			+	+
	Velleia cycnopotamica		+		+
Stylidiaceae	*Levenhookia dubia*		+		
Asteraceae	*Actinobole uliginosum*		+		
	Angianthus tomentosus	+			
	* *Arctotheca calendula*	+	+	+	+
	Blennospora drummondii				+
	Brachyscome bellidioides	+	+	+	

Family	Species	(1)1984	(1)1995	(2)1984	(2)1995
Asteraceae	* *Centaurea melitensis*	+			
	Ceratogyne obionoides		+		
	Chrysocoryne drummondii	+			
	Chthonocephalus pseudevax		+		
	Cotula cotuloides		+		
	Gilruthia osbornei		+		
	Helipterum demissum				+
	Hyalosperma demissum		+		
	* *Hypochaeris glabra*	+	+	+	+
	Millotia tenuifolia var tenuifolia				+
	Podolepis capillaris	+	+		
	Podolepis lessonii	+	+	+	+
	Podotheca angustifolia			+	
	Podotheca gnaphaloides	+	+	+	+
	Podotheca sp. (CG361)				+
	Quinetia urvillei		+		
	Rhodanthe laevis			+	+
	Rhodanthe manglesii		+		
	* *Ursinia anthemoides*		+		+
	Waitzia acuminata	+	+	+	+
	Waitzia aurea			+	
	Waitzia citrina			+	

Appendix D: Reserve 19138 Species Presence Absence

Family	Species	1984	1995
Poaceae	* *Avena fatua*	+	
	* *Bromus rubens*	+	+
	Danthonia caespitosa	+	+
	* *Ehrharta longiflora*	+	
	* *Lolium perenne*	+	
	* *Pentaschistis airoides*	+	+
	Stipa elegantissima	+	+
	Stipa trichophylla	+	+
	* *Vulpia bromoides*	+	
	* *Vulpia myuros*	+	+
Anthericaceae	*Dichopogon capillipes*		+
Asphodelaceae	*Bulbine semibarbata*		+
Orchidaceae	*Pterostylis nana*		+
Chenopodiaceae	*Enchylaena tomentosa*	+	+
	Maireana georgei	+	
	Rhagodia spinescens	+	+
Amaranthaceae	*Ptilotus holosericeus var. rosea*		+
	Ptilotus humilis	+	
Aizoaceae	* *Mesembryanthemum crystallinum*		+
	* *Mesembryanthemum nodiflorum*	+	+
Portulaceae	*Calandrinia calyptrata*		+
Caryophyllaceae	* *Spergula arvensis*	+	
	* *Spergula diandra*		+
	Stellaria filiformis		+
Brassiaceae	* *Brassica tournefortii*	+	+
Crassulaceae	*Crassula colorata*		+
Mimosaceae	*Acacia acuminata*	+	

Family	Species	1984	1995
	Acacia erinacea	+	+
	Acacia merrallii	+	
Papilionaceae	* *Medicago minima*		+
	Templetonia sulcata	+	
Geraniaceae	* *Erodium botrys*		+
Myrtaceae	*Eucalyptus celastroides ssp. virella*	+	+
	Eucalyptus salmonophloia	+	
Apiaceae	*Daucus glochidiatus*		+
	Hydrocotyle callicarpa		+
	Hydrocotyle rugulosa		+
	Trachymene cyanopetala	+	
	Trachymene pilosa		+
Convolvulaceae	*Wilsonia humilis*		+
Scrophulariaceae	* *Parentucellia latifoia*		+
	* *Zaluzianskya divaricata*		+
Plantaginaceae	*Plantago hispida*		+
Asteraceae	*Actinobole uliginosum*		+
	* *Arctotheca calendula*		+
	Calotis hispidula		+
	Chthonocephalus pseudevax		+
	Hyalosperma demissum		+
	* *Hypochaeris glabra*		+
	Isoetopsis graminifolia		+
	Olearia muelleri	+	+
	Podolepis lessonii		+
	Pogonolepis muelleriana		+
	Pogonolepis stricta	+	

Family	Species	1984	1995
Asteraceae	*Senecio glossanthus*		+

Appendix D: Reserve 31211 Species Presence Absence

Family	Species	1984	1995
Adiantaceae	*Cheilanthes austrotenuifolia*	+	+
Poaceae	* *Aira caryophyllea*	+	
	* *Avena fatua*	+	
	* *Briza maxima*	+	+
	* *Briza minor*	+	
	Danthonia caespitosa	+	
	Neurachne alopecuroidea	+	+
	* *Pentaschistis airoides*	+	
	Stipa pycnostachya	+	
	Stipa tenuifolia	+	
Cyperaceae	*Lepidosperma angustatum*	+	
Restionaceae	*Loxocarya flexuosa*		+
Dasypogonaceae	*Lomandra collina*		+
Phormiaceae	*Stypandra glauca*	+	+
Anthericaceae	*Caesia parviflora*		+
	Chamaescilla corymbosa		+
	Sowerbaea laxiflora		+
Colchicaceae	*Wurmbea dioica ssp. alba*		+
Liliaceae	*Liliaceae sp. (CG237)*		+
Hypoxidaceae	*Hypoxis occidentalis*		+
Iridaceae	* *Romulea rosea var. australis*	+	+
Orchidaceae	*Diuris longifolia*		+
	Pterostylis sanguinea		+
	Pterostylis sp. (CG221)		+
Amaranthaceae	*Ptilotus declinatus*		+
	Ptilotus manglesii		+
Droseraceae	*Drosera glanduligera*		+

Family	Species	1984	1995
	Drosera macrantha		+
Mimosaceae	*Acacia acuminata*		+
Papilionaceae	* *Lupinus albus*		+
Geraniaceae	* *Erodium botrys*		+
Stackhousiaceae	*Stackhousia monogyna*		+
Rhamnaceae	*Trymalium ledifolium*		+
Dilleniaceae	*Hibbertia commutata*		+
Myrtaceae	*Eucalyptus loxophleba ssp. loxophleba*		+
	Eucalyptus wandoo		+
Apiaceae	*Hydrocotyle sp. (CG031)*		+
	* *Trachymene pilosa*		+
Primulaceae	* *Anagallis arvensis*		+
Scrophulariaceae	* *Parentucellia latifolia*		+
Asteraceae	* *Hypochaeris glabra*		+
	* *Lagenifera huegelii*		+
	Quinetia urvillei		+
	Rhodanthe macrantha		+
	* *Ursinia anthemoides*		+

Appendix D: Reserve 4313 Species Presence Absence

Family	Species	1984	1995
Poaceae	* *Avellinia michelii*		+
	* *Avena fatua*	+	
	* *Briza maxima*		+
	* *Bromus rubens*	+	+
	Danthonia caespitosa		+
	* *Ehrharta longiflora*		+
	Neurachne alopecuroidea	+	+
	Stipa elegantissima	+	+
	Stipa tenuifolia	+	
	Stipa trichophylla		+
	* *Vulpia bromoides*		+
Cyperaceae	*Lepidosperma tenue*		+
Restionaceae	*Ecdeicolea monostachya*		+
	Loxocarya flexuosa		+
	Loxocarya pubescens	+	
Dasypogonaceae	*Acanthocarpus preissii*	+	
	Lomandra collina		+
	Lomandra effusa	+	+
Phormiaceae	*Dianella revoluta*	+	+
Anthericaceae	*Borya nitida*	+	
	Caesia parviflora		+
	Thysanotus patersonii		+
Asphodelaceae	*Bulbine semibarbata*		+
Orchidaceae	*Caladenia sp. (CG210a)*		+
Urticaceae	*Parietaria debilis*		+
Santalaceae	*Santalum acuminatum*	+	
Chenopodiaceae	*Enchylaena tomentosa*	+	+

Family	Species	1984	1995
Aizoaceae	* *Carpobrotus aequilaterus*		+
Portulaceae	*Calandrinia calyptrata*		+
Brassicaceae	* *Brassica tournefortii*	+	+
	Lepidium hyssopifolium		+
Crassulaceae	*Crassula colorata*		+
Pittosporaceae	*Pittosporum phylliraeoides*	+	+
Surianaceae	*Stylobasium australe*	+	+
Mimosaceae	*Acacia acuminata*	+	+
Geraniaceae	* *Erodium botrys*		+
	Pelargonium havlasae		+
Zygophyllaceae	*Zygophyllum ?iodocarpum*		+
Polygalaceae	*Comesperma volubile*	+	
Sterculiaceae	*Guichenotia macrantha*	+	
Myrtaceae	*Eucalyptus loxophleba ssp. loxophleba*	+	+
Apiaceae	*Trachymene pilosa*		+
Primulaceae	**Anagallis arvensis*		+
Goodeniaceae	*Dampiera lavandulacea*	+	+
	Dampiera preissii	+	
Asteraceae	* *Arctotheca calendula*		+
	Blennospora drummondii		+
	Brachyscome bellidiodes		+
	* *Hypochaeris glabra*		+
	Podotheca angustifolia		+
	Podotheca gnaphalioides		+
	Senecio quadridentatus		+
	* *Sonchus oleraceus*		+
	* *Ursinia anthemoides*	+	+

Family	Species	1984	1995
Asteraceae	*Waitzia acuminata*	+	+

Appendix D: Reserve 29313 Species Presence Absence

Family	Species	1984	1995
Poaceae	* *Briza maxima*	+	
	* *Briza minor*	+	
	Danthonia caespitosa	+	+
	Neurachne alopecuroidea	+	+
	Stipa elegantissima	+	
	* *Vulpia sp. (CG007)*		+
Cyperaceae	*Lepidosperma gracile*	+	
	Schoenus sp. (CG095)		+
Restionaceae	*Loxocarya fasciculata*		+
	Loxocarya pubescens	+	
Dasypogonaceae	*Lomandra sp. (CG082)*		+
	Lomandra sp. (CG088)		+
Phormiaceae	*Dianella revoluta*	+	
Anthericaceae	*Dichopogon capillipes*		+
	Borya nitida	+	
	Borya sphaerocephala		+
	Caesia parviflora	+	
	Chamaescilla corymbosa		+
	Sowerbaea laxiflora	+	+
	Thysanotus patersonii	+	+
Liliaceae	*Liliaceae sp. (CG099)*		+
	Liliaceae sp. (CG135)		+
	Liliaceae sp. (CG237)		+
Haemodoraceae	*Conostylis setigera*	+	
Hypoxidaceae	*Hypoxis occidentalis*		+
Iridaceae	*Orthrosanthus laxus*		+
Orchidaceae	*Caladenia flava*	+	+

Family	Species	1984	1995
	Cyanicula gemmata		+
	Diuris laxiflora		+
	Pterostylis sanguinea		+
	Pterostylis sp. (CG055)		+
Casuarinaceae	*Allocasuarina huegeliana*	+	+
Proteaceae	*Dryandra armata*		+
	Dryandra nivea		+
	Hakea lissocarpha		+
Amaranthaceae	*Ptilotus manglesii*		+
Droseraceae	*Drosera bulbosa*		+
	Drosera macrantha		+
Mimosaceae	*Acacia acuminata*	+	
	Acacia pulchella		+
Papilionaceae	*Gastrolobium calycium*	+	
	Gastrolobium parvifolium		+
	Gastrolobium villosum		+
	Gompholobium marginatum		+
Tremandraceae	*Tetratheca virgata*		+
Stackhousiaceae	*Stackhousia monogyna*	+	
Dilleniaceae	*Hibbertia commutata*	+	+
Myrtaceae	*Eucalyptus calophylla*	+	
	Eucalyptus wandoo	+	+
	Hypocalymma angustifolium		+
	Melaleuca sp. (CG119)		+
	Verticordia sp. (CG098)		+
Haloragaceae	*Glischrocaryon aureum*	+	+
Apiaceae	*Trachymene pilosa*	+	
	Xanthosia huegelii		+

Family	Species	1984	1995
Epacridaceae	*Astroloma drummondii*	+	+
	Astroloma pallidum		+
	Leucopogon fimbriatus		+
Primulaceae	* *Anagallis arvensis*	+	
Scrophulariaceae	* *Parentucellia latifolia*	+	
Rubiaceae	*Opercularia vaginata*		+
Goodeniaceae	*Dampiera lavandulacea*	+	
	Dampiera succulata		+
Stylidiaceae	*Stylidium calcaratum*	+	
	Stylidium ?caricifolium ssp. caricifolium		+
	Stylidium piliferum		+
	Stylidium repens		+
	Stylidium uniflorum	+	
	Stylidium sp. (CG112)		+
	Hyalosperma demissum		+
	* *Hypochaeris glabra*	+	+
	Lagenifera huegelii	+	+
	Rhodanthe laevis		+
	Rhodanthe manglesii	+	
	* *Ursinia anthemoides*	+	
	Waitzia citrina	+	
	Waitzia suaveolens	+	

Appendix D: Reserve 4458 Species Presence Absence

Family	Species	1984	1995
Adiantaceae	*Cheilanthes austrotenuifolia*	+	+
Poaceae	* *Avena fatua*	+	
	* *Briza maxima*	+	+
	* *Bromus rubens*	+	
	Danthonia caespitosa		+
	* *Ehrharta longiflora*	+	
	Neurachne alopecuroidea	+	+
	* *Pentaschistis airoides*	+	
	Stipa elegantissima	+	+
	Stipa tenuifolia	+	
	* *Vulpia sp. (CG007)*		+
Restionaceae	*Loxocarya flexuosa*		+
Dasypogonaceae	*Lomandra effusa*		+
Anthericaceae	*Dichopogon capillipes*		+
	Borya nitida	+	
	Thysanotus patersonii		+
Colchicaceae	*Wurmbea dioica ssp. alba*		+
Liliaceae	*Liliaceae sp. (CG135)*		+
Hypoxidaceae	*Hypoxis occidentalis*		+
Iridaceae	* *Romulea rosea var. australis*		+
Orchidaceae	*Cyanicula deformis*		+
Casuarinaceae	*Allocasuarina huegeliana*	+	
Urticaceae	*Parietaria debilis*		+
Amaranthaceae	*Ptilotus declinatus*		+
	Ptilotus manglesii	+	+
	Ptilotus polystachyus	+	

Family	Species	1984	1995
Portulaceae	*Calandrinia calyptrata*		+
Brassicaceae	*Lepidium hyssopifolium*		+
Crassulaceae	*Crassula colorata*		+
Mimosaceae	*Acacia acuminata*	+	+
	Acacia erinacea		+
Papilionaceae	* *Trifolium cernuum*	+	
Geraniaceae	* *Erodium botrys*		+
Oxalidaceae	*Oxalis corniculata*		+
Myrtaceae	*Eucalyptus loxophleba ssp. loxophleba*	+	+
	Eucalyptus wandoo	+	
Apiaceae	*Hydrocotyle sp. (CG031)*		+
Epacridaceae	*Astroloma drummondii*		+
Primulaceae	* *Anagallis arvensis*	+	+
Asteraceae	*Actinobole uliginosum*		+
	* *Arctotheca calendula*		+
	Blennospora drummondii		+
	* *Hypochaeris glabra*		+
	Lagenifera huegelii	+	+
	Olearia paucidentata		+
	Podolepis lessonii		+
	Rhodanthe laevis	+	
	Rhodanthe pygmaea		+
	* *Ursinia anthemoides*	+	+
	Waitzia acuminata	+	

Appendix E: Photographic Records for the *Eucalyptus loxophleba - Acacia acuminata* Communities in the Wheatbelt, 1995

Photograph 1: Reserve 2023. View of Quadrat (1) facing east from Peg 1.
Note: extensive amount of old dead branches.

Photograph 2: Reserve 2023. View of Quadrat (1), facing east from Peg 4.
Note: sparse understorey typical of this Reserve.

Appendix E: Photographic Records for the *Eucalyptus loxophleba* - *Acacia acuminata* Communities in the Wheatbelt, 1995

Photograph 3: Reserve 2023. View of Quadrat (2), facing east from Peg 4.
Note: sparse understorey and presence of *Allocasuarina huegeliana*.

Photograph 4: Reserve 2023. View of Quadrat (2), facing east from midway between Pegs 1 and 4.
Note: fallen and dead branches of *Eucalytpus loxophleba*.

Appendix E: Photographic Records for the *Eucalyptus loxophleba* - *Acacia acuminata* Communities in the Wheatbelt, 1995

Photograph 5: Reserve 2023. View of Quadrat (3) facing south-east from Peg 1. Note: some *Eucalyptus loxophleba* deaths but fewer dead branches on ground

Photograph 6: Reserve 2023. View of Quadrat (3) facing north-east from Peg 4. Note: greater amount of young *Acacia acuminata* in comparison to above quadrats.

Appendix E: Photographic Records for the *Eucalyptus loxophleba* - *Acacia acuminata* Communities in the Wheatbelt, 1995

Photograph 7: Reserve 2023. View of Quadrat (4) facing east from Peg 1, depicting open area burnt in 1985.

Photograph 8: Reserve 2023. View of Quadrat (4) facing east from Peg 4.
Note: abundance of young *Acacia acuminata* in this area.

Appendix E: Photographic Records for the *Eucalyptus loxophleba* - *Acacia acuminata* Communities in the Wheatbelt, 1995

Photograph 9: Reserve 23201. View of Quadrat (1) facing east from Peg 1 of Open *Eucalyptus loxophleba* - *Acacia acuminata* Woodland.

Photograph 10: Reserve 23201. View of Quadrat (1), facing east from Peg 4. Note: sparseness of understorey.

Appendix E: Photographic Records for the *Eucalyptus loxophleba* - *Acacia acuminata* Communities in the Wheatbelt, 1995

Photograph 11: Reserve 26664. View of Quadrat (1) facing east from Peg 1. Note: largely grassy understorey of low species diversity.

Photograph 12: Reserve 26664. View of Quadrat (1) facing north-west from Peg 3, showing an Open Woodland dominated by *Acacia acuminata*.

Appendix E: Photographic Records for the *Eucalyptus loxophleba* - *Acacia acuminata* Communities in the Wheatbelt, 1995

Photograph 13: View of edge of Lake Dumbleyung (Reserve 26664) which is degraded by high salinity, at the end of Bairstowe Scenic Drive.

Photograph 14: Reserve 23164. View of Quadrat (1) facing north from a nearby granite outcrop.

Appendix E: Photographic Records for the *Eucalyptus loxophleba - Acacia acuminata* Communities in the Wheatbelt, 1995

Photograph 15: Reserve 23164. Quadrat (1) facing south-east from Peg 1. View of *Eucalyptus loxophleba* ssp. *lissophloia* Mallee Woodland.

Photograph 16: Reserve 23164. View of Quadrat (1) facing north-east from Peg 4 showing understorey containing *Calothamnus quadrifidus*.

Appendix E: Photographic Records for the *Eucalyptus loxophleba - Acacia acuminata* Communities in the Wheatbelt, 1995

Photograph 17: Reserve 16714. Quadrat (1) facing south-east from Peg 1.
Note: large number of fallen branches.

Photograph 18: Reserve 16714. View of Quadrat (1) facing north-east from Peg 4.
Note: the grassy nature of the understorey in this quadrat.

Appendix E: Photographic Records for the *Eucalyptus loxophleba - Acacia acuminata* Communities in the Wheatbelt, 1995

Photograph 19: Reserve 13594. View of disused Dam north of Quadrat (1). There is an abundance of *Eucalytus loxophleba* around the edges of the Dam.

Photograph 20: Reserve 13594. Quadrat (1) facing east from Peg 1.
Note: the increased amount of shrubs in the understorey in comparison to above reserves.

Appendix E: Photographic Records for the *Eucalyptus loxophleba* - *Acacia acuminata* Communities in the Wheatbelt, 1995

Photograph 21: Reserve 13594. Quadrat (1) facing east midway between Pegs 1 and 4, showing resprouting *Eucalyptus loxophleba* and abundant annuals.

Photograph 22: Reserve 9754. View of Quadrat (1) facing south-east from Peg 1. View of *Acacia acuminata* Open Woodland over annual species on granite.

Appendix E: Photographic Records for the *Eucalyptus loxophleba* - *Acacia acuminata* Communities in the Wheatbelt, 1995

Photograph 23: Reserve 9754. View of Quadrat (1) facing north-east from Peg 4.
Note: the total absence of shrubs from the understorey on the granite.

Photograph 24: Reserve 9754. View of Quadrat (2), facing north-east from Peg 4.
Note: thick sedge-like understorey of *Spartochloa scirpoidea*.

Appendix E: Photographic Records for the *Eucalyptus loxophleba* - *Acacia acuminata* Communities in the Wheatbelt, 1995

Photograph 25: Reserve 9754. View of Quadrat (2) facing east midway between Pegs 1 and 4.

Photograph 26: Reserve 19138. View of Quadrat (1) facing south-east from Pegs 1 to 3, showing *Eucalyptus celastroides* Mallee Woodland.

Appendix E: Photographic Records for the *Eucalyptus loxophleba - Acacia acuminata* Communities in the Wheatbelt, 1995

Photograph 27: Reserve 19138. View of Quadrat (1) north-east from Pegs 4 to 2. Note the extremely sparse understorey in and around this quadrat.

Photograph 28: Reserve 31211. View of Quadrat (1) facing south-east from Peg 1, showing open *Eucalyptus wandoo - Eucalyptus loxophleba - Acacia acuminata* Woodland.

Appendix E: Photographic Records for the *Eucalyptus loxophleba - Acacia acuminata* Communities in the Wheatbelt, 1995

Photograph 29: Reserve 31211. View of Quadrat (1) facing north-east from Peg 4. Note: the abundance of **Romulea rosea* var *australis* in this quadrat.

Photograph 30: Reserve 4313. View of Quadrat (1) facing south-east from Peg 1 depicting Open *Eucalyptus loxophleba - Acacia acuminata* Woodland.

Appendix E: Photographic Records for the *Eucalyptus loxophleba* - *Acacia acuminata* Communities in the Wheatbelt, 1995

Photograph 31: Reserve 4313. View of Quadrat (1) facing north-east from Peg 4, showing young *Pittosporum phylliraeoides* individuals near peg.

Photograph 32: Reserve 29313. View of Quadrat (1) facing north-east from Peg 4, showing *Eucalytpus wandoo* Woodland.

Appendix E: Photographic Records for the *Eucalyptus loxophleba* - *Acacia acuminata* Communities in the Wheatbelt, 1995

Photograph 33: Reserve 29313. View of Quadrat (1) facing east from midway between Pegs 1 and 4. Note: abundant leaf litter and increased shrub layer.

Photograph 34: Reserve 4458. View of Quadrat (1) facing south-east from Peg 1, showing Mature Open *Eucalyptus loxophleba* Woodland.

Appendix E: Photographic Records for the *Eucalyptus loxophleba* - *Acacia acuminata* Communities in the Wheatbelt, 1995

Photograph 35: Reserve 4458. View of Quadrat (1) facing north-east from Peg 4. Note: the absence of a shrub layer in and around this quadrat.