

***Corymbia calophylla* - *Kingia australis* woodlands on
heavy soil (Swan Coastal Plain Community type 3a -
Gibson *et al.* 1994)**

**INTERIM RECOVERY PLAN
2000-2003**

by

Val English and John Blyth

Photograph:

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Department of Conservation and Land Management
Western Australian Threatened Species and Communities Unit
PO Box 51, Wanneroo, WA 6946



FOREWORD

Interim Recovery Plans (IRPs) are developed within the framework laid down in Department of Conservation and Land Management (CALM) Policy Statements Nos 44 and 50.

IRPs outline the recovery actions that are required to urgently address those threatening processes most affecting the ongoing survival of threatened taxa or ecological communities, and begin the recovery process.

CALM is committed to ensuring that Critically Endangered ecological communities are conserved through the preparation and implementation of Recovery Plans or Interim Recovery Plans and by ensuring that conservation action commences as soon as possible and always within one year of endorsement of that rank by CALM's Director of Nature Conservation.

This Interim Recovery Plan will operate from 31 January 2000 but will remain in force until withdrawn or replaced. It is intended that, if the ecological community is still ranked Critically Endangered after three years, this IRP will be replaced by a full Recovery Plan.

The provision of funds identified in this Interim Recovery Plan is dependent on budgetary and other constraints affecting CALM, as well as the need to address other priorities.

Information in this IRP was accurate at January 2000.

SUMMARY

Name: *Corymbia calophylla* - *Kingia australis* woodlands on heavy soils

Description: Plant community located on heavy soils of the eastern side of the Swan Coastal Plain between Waroona and Forrestfield. Typical and common native taxa in the community are: *Corymbia calophylla*; the shrubs *Dryandra nivea*, *Eriostemon spicatus*, *Kingia australis* and *Xanthorrhoea preissii*; and the herbs, *Cyathochaeta avenacea*, *Dampiera linearis*, *Haemodorum laxum*, *Loxocarya fasciculata*, *Mesomelaena tetragona* and *Tetraria octandra*. The introduced grass *Briza maxima* is also common in the community.

CALM Region: Swan

CALM Districts: Perth, Dwellingup.

Shires: Armadale, Gosnells, Serpentine-Jarrahdale, Kalamunda, Murray and Waroona.

Recovery Team: To be established. The team will be chaired by a CALM Swan Region representative. The Recovery Team will report annually to CALM's Corporate Executive.

Current status: Assessed 21 November 1995 as Critically Endangered.

Habitat requirements: Marri (*Corymbia calophylla*) dominated plant communities were probably some of the most common on heavy soils on the eastern side of the Swan Coastal Plain. Gibson *et al.* (1994) recognised three distinct communities in this group. The floristic composition of these communities varies with rainfall, with the *Corymbia calophylla* - *Kingia australis* woodlands on heavy soils occurring on the wettest of the sites and being associated with the median species richness, and lowest level of weed invasion and disturbance.

IRP Objective: To maintain or improve the overall condition of this plant community in the known locations and reduce the level of threat, with the aim of reclassifying it from Critically Endangered to Endangered.

Criteria for success:

- An increase in the area of this community under conservation management.
- Maintenance in terms of diversity and basic composition of native species (as described by Gibson *et al.* 1994 and Department of Environmental Protection (1996)) as well as hydrological and biological processes, taking account of natural change of the community over time.
- Improvement in condition as measured by a reduction in numbers of exotic species and of other threatening processes as defined in this document.

Criteria for failure: Significant loss of area or further modification of occurrences of the threatened ecological community.

Summary of Recovery Actions

1. Establish Recovery Team	12. Develop Management Plans for occurrences
2. Liaise with landholders / management bodies / managers	13. Acquire unallocated Crown land
3. Disseminate information	14. Transfer care, control and management of Occurrence 7 to Serpentine-Jarrahdale Shire Council.
4. Clarify and monitor boundaries	15. Monitor flora
5. Install markers	16. Monitor weed populations
6. Develop Fire Management Strategy	17. Implement rehabilitation

7. Implement Fire Management Plans and dieback hygiene	18. Conduct research
8. Implement weed control	19. Survey for dieback
9. Fence Occurrence 8	20. Assess hydrological data
10. Fence Occurrence 9	21. Report on management strategies
11. Assess hydrological data	22. Transfer care, control and management to NPNCA / acquire occurrences as required

1. BACKGROUND

1.1 History, defining characteristics of ecological community, and conservation significance

A series of Marri (*Corymbia calophylla*) dominated plant communities occur on heavy soils between Waterloo (near Bunbury) and Bullsbrook. These communities are considered to have been some of the most extensive on the eastern side of the Swan Coastal Plain, but have suffered extensive clearing and are now regionally rare (Keighery and Trudgen 1992; Gibson *et al.* 1994; Department of Environmental Protection 1996). The dominant species in the overstorey vary between the three community types recognised by Gibson *et al.* (1994). The wettest sites are dominated by *Corymbia calophylla* and *Kingia australis* (this community); the intermediate group (type 3b) by *Corymbia calophylla* and *Eucalyptus marginata*; and the driest group (type 3c) is dominated by *Corymbia calophylla* and *Xanthorrhoea preissii*. The driest type is also critically endangered, and the community on sites of intermediate dryness is vulnerable (English and Blyth 1997).

Ten occurrences of this community (3a) have been located between Waroona and Forrestfield and recorded on the threatened ecological communities database. One reserve contains three occurrences that are separated by other vegetation types (Occurrences 4, 5 and 6; refer Table 1). The sites were located through extensive survey of the southern Swan Coastal Plain that involved compilation and analysis of data from over 1,500 plots (Keighery and Trudgen 1992; Gibson *et al.* 1994; State of Western Australia 1998).

All of the occurrences within the area considered under Perth's Bushplan that contain the community are included in the Perth's Bushplan document (State of Western Australia 1998). This document provides that any proposals likely to affect occurrences of threatened ecological communities will be dealt with through the Bushplan process, coordinated between the Department of Environmental Protection, Ministry for Planning, CALM and the Water and Rivers Commission. The aim of Bushplan is to protect sites listed within the Bushplan document (State of Western Australia 1998).

There are only approximately 83 hectares of the community remaining in the occurrences recorded on the database. Of this, about 51 hectares are on lands managed by Shire Councils, five hectares are in the care, control and management of state government agencies, 25 hectares are on private land, and about two hectares are in reserves without a management body.

Typical and common native plant taxa in the community are: *Corymbia calophylla*; the shrubs *Dryandra nivea*, *Eriostemon spicatus*, *Kingia australis* and *Xanthorrhoea preissii*; and the herbs, *Cyathochaeta avenacea*, *Dampiera linearis*, *Haemodorum laxum*, *Loxocarya fasciculata*, *Mesomelaena tetragona* and *Tetraria octandra* (Gibson *et al.* 1994). The introduced grass *Briza maxima* is also common in the community, although weed cover in most occurrences is currently quite low. A list of taxa that commonly occur in the community is at Appendix 1.

The most significant threat to the community is clearing, as there are no occurrences in a secure conservation reserve. Dieback, caused by *Phytophthora* species, is not recorded from occurrences of the community, but may be present.

Too frequent fire is another major threat to the community. Fires have occurred very recently in the occurrences at Brickwood Road (Brickwood reserve - Occurrences 3, 4 and 5: refer Table 1 and section 1.2 below), nearby or within the community on Mundijong Road (occurrence 7), and at Punrack Road (Occurrence 8).

Several occurrences (Occurrences 1 to 6, refer Table 1) are very close to or surrounded by highly urbanised areas. The frequency of fires, impact of recreational uses and incidence of illegal rubbish dumping are generally increased in urban areas. These factors can all lead to degradation of plant communities through increasing weed invasion and alteration of structure, species composition or loss of component taxa.

Salinisation and increased inundation as a consequence of clearing in the catchment may also represent threats to the community as it occurs in low lying sites in highly cleared areas, and most occurrences experience seasonal inundation.

Table 1: Extent and location of occurrences (from north to south)

Occurrence Number	Location	Land Tenure and Purpose	Estimated area
Occurrence 1	Reserves 37981 and 37260 adjacent to Roe Highway, Forrestfield	Reserve 37981 managed by Western Power for Depot site; Reserve 37260 managed by the Bush Fires Board for Fire Training Area	4 ha in reserve 37981; 0.6 ha in reserve 37260 4.6 ha (total)
Occurrence 2	Brixton Street reserve; Lot 37 of Canning Location 10, Kenwick	State Housing Commission	0.75 ha
Occurrence 3	Reserve 42044, Lambert Road, Wungong	Unmanaged	2 ha
Occurrence 4	Brickwood Recreation reserve 17490, Byford	Shire of Serpentine -Jarrahdale	28 ha
Occurrence 5	Brickwood Recreation reserve 17490, Byford	Shire of Serpentine -Jarrahdale	4.5 ha
Occurrence 6	Brickwood Recreation reserve 17490, Byford	Shire of Serpentine -Jarrahdale	4 ha
Occurrence 7	Reserve C23793; Mundijong Road reserve, Mundijong	Unmanaged; Government Requirements	1.2 ha (total)
Occurrence 8	Privately owned land and the adjacent road reserve in Serpentine Jarrahdale Shire	Road reserve is managed by the Shire of Serpentine -Jarrahdale.	2 ha on roadside remnant; 25 ha on private land. 27 ha (total)
Occurrence 9	Reserve 34033; Recreation reserve, Pinjarra	Shire of Murray	1.3 ha
Occurrence 10	Reserve 31437, Waroona	Shire of Waroona	10 ha

1.2 Description of Occurrences

Occurrence 1 is located in the Shire of Kalamunda on two separate reserves managed by Western Power and the Bush Fires Board. The whole remnant, of which this community occupies only a small proportion, is a Bushplan site (State of Western Australia 1998). Community 20a (Gibson *et al.* 1994) occurs to the south west of this occurrence within the same remnant. Community 20a has been assessed as endangered (English and Blyth 1997).

Roe Highway is to the south of Occurrence 1. Buildings and partly cleared storage area occupy the northern portion of reserve 37981 which is managed by Western Power. This community occupies most of the remainder of the reserve, and a minor creek line occurs in the south west corner of the reserve area. The adjacent Bush Fires Board reserve number 37260 also contains a small area of the community and this

reserve is surrounded by a wide fire-break and a high electric fence. The community is confined to the north-east corner of reserve 37260. The Western Power reserve number 37981 also has a fire-break around the perimeter. Two Priority flora taxa listed in CALM (1998) have been recorded in Occurrence 1 (DEP 1996). These are *Schoenus pennisetis* (Priority 1 - see Glossary for definitions) and *Lambertia multiflora* var. *darlingensis* (Priority 3).

Occurrence 2 occurs within a 19 hectare parcel of land that is commonly known as the Brixton Street wetlands and is under the care, control and management of the State Housing Commission. This lot and the contiguous remnant to the north, between this lot and the rail line, in Canning Location 47 are part of a Planning Control Area (Bushplan site no. 387) declared by the Ministry for Planning that extends from this remnant to Roe Highway. Significant remnants within this area are planned to be progressively acquired for conservation as they become available. The Brixton Street wetlands are bounded by Brixton Street to the north east, Alton Street and Wannaping Road to the south east and south, and a rail line to the west and north. There are remnants in good condition on private and public land on the opposite side (to the north east) of Brixton Street and these are also part of the Planning Control Area.

The Priority 3 flora *Haemodorum loratum*, *Stylidium mimeticum* and *Synaphea acutiloba* occur within the community in Occurrence 2. Only a very small area of the remnant defined by Brixton Street, the rail line, Alton St and Wannaping Road contains the community 'Corymbia calophylla - Kingia australis woodlands on heavy soils'. The remainder of the remnant is the type 8 'herb rich shrublands in clay pans' as described by Gibson *et al.* (1994). This community is classified as vulnerable (English and Blyth 1997) and contains additional threatened and priority flora. These are: *Aponogeton hexatepalus* (Declared Rare Flora (DRF)); *Eryngium pinnatifidum* subsp. *palustre* (Priority 2); *Triglochin stowardii* (Priority 2); *Rhodanthe pyrethrum* (Priority 3); and *Stylidium mimeticum* (Priority 3). The Brixton Street wetlands contains a total of 307 species of vascular plants, of which 17 are Priority or DRF taxa, over an area of only 19 hectares (Keighery and Keighery 1993b; Keighery 1995). This represents 17% of the known flora of the Perth Region, in less than 0.005% of the area (Keighery and Keighery 1993b).

The Wildflower Society and local Friends Group are involved in managing the Brixton Street reserve, and have received grants to develop a Management Plan for the reserve. Management Guidelines (Keighery 1995) were developed as a result of such grants. Funds have also been obtained to perform some management actions including weed control. The reserve has recently been fenced to ensure only operational and foot access.

Occurrence 3 occupies most of an unmanaged two hectare reserve in Armadale, that is to be transferred to vesting in the NPNCA as a nature reserve in 2000. The site has been used for illegal rubbish dumping in the past, and a major weed infestation has occurred where garden waste has been deposited. The remnant is also used for passive recreation. A rail line and gravel track lie to the east and Lambert Lane, a minor road, is to the south. There are houses to the west, north and south of the reserve. The Priority 3 taxon *Synaphea acutiloba* also occurs in this reserve.

Occurrences 4, 5 and 6 as mapped by Keighery and Keighery (1993a) are in the Brickwood reserve in Byford. Occurrence 4 occupies about 28 hectares - most of the north-western portion of the reserve. Occurrences 5 and 6, both around 4 hectares, are to the south of Turner Road that divides the reserve. Mead Street is to the north, Soldiers Road to the east, Warrington Street to the west, and private land to the south of the reserve. Houses also occur along a portion of the eastern and western boundaries. Altogether, the community covers approximately 36 hectares of a total of about 48 hectares occupied by the reserve. The remainder is occupied by 'dense shrublands on clay flats' and 'eastern *Banksia attenuata* and/or *Eucalyptus marginata* woodlands' (Gibson *et al.* 1994 community types 9 and 20b respectively). Community type 9 is vulnerable and type 20b is endangered (English and Blyth 1997). *Stylidium mimeticum*, a Priority 3 taxon, is also recorded in Occurrences 5 and 6. The Brickwood reserve is used for passive recreation.

Occurrence 7 occurs on a narrow roadside remnant on Mundijong Road, Mundijong. The remnant comprises road reserve and a Government Requirements reserve that is not placed with any management body.

However, the Shire of Serpentine-Jarrahdale manages the road reserve and the adjacent Government Requirements reserve that contain this community. Mundijong Road is to the north of the occurrence, a Racecourse reserve occurs to the south, and Webb Road is to the east. Cleared agricultural lands occur to the north and south, adjacent to the race track and Mundijong Road. The remnant vegetation along the road reserve that contains Occurrence 7 continues to the east and west with a track used by horse riders running through the middle. Weeds are invading along this track.

The DRF taxon *Caladenia huegelii* and the Priority 1 taxon *Verticordia plumosa* var. *pleibotrya* occur in Occurrence 7 (Gibson *et al.* 1994). The community 'herb rich shrublands in clay pans' (Gibson *et al.* 1994; community type 8) occurs to the west in the same remnant on the road verge. This community has been assessed as vulnerable (English and Blyth 1997). Portions of this roadside remnant have been burnt recently.

Another critically endangered community (type 3c as described by Gibson *et al.* 1994) also occurs west of Occurrence 7 between Duck Pond Road and Mundijong Road. The native vegetation along Mundijong Road between the Duck Pond Road occurrence and Webb Road is extremely important as it represents one of only two remaining linear remnants that span the vegetation sequences on alluvial soils of the southern Swan Coastal Plain (Gibson *et al.* 1994). The other remnant of this type occurs along the Wonnerup-Tutenup Road near Busselton (Gibson *et al.* 1994).

Keighery (1996) provides a detailed treatment of the conservation values and management guidelines for roadside remnants on Mundijong Road.

Occurrence 8 is mainly located on private land, but also extends into remnant vegetation on an adjacent roadside managed by the Shire of Serpentine Jarrahdale (DEP 1996). Cleared agricultural lands occur to the south of the occurrence, but the roadside remnant continues on either side of the community along the south side of the road. A drain occurs within this roadside remnant and acts as a source of weeds. The invasive weed *Watsonia* is encroaching from the drain following a recent fire.

The privately owned lot covers a total of 61 hectares, of which about 25 hectares is occupied by this community. The owners are aware that their property contains significant vegetation, and that any development proposal would need to be assessed under the Bushplan process (State of Western Australia 1998).

Occurrence 9 occurs to the north west of the junction of Phillips and Moores Road in Pinjarra. Reserve 34033 for Recreation continues on the opposite side of Phillips Road, and covers a total of about 30 hectares. This community occupies only a small proportion of the reserve. The remnant within the reserve continues to the north, west and east of Occurrence 9, although these areas contain different plant communities. A light industrial area occurs adjacent to the northern end of this reserve.

The reserve in which occurrence 9 is located is used for four wheel driving and illegal rubbish dumping including disposal of car bodies. Some parts of the reserve have been highly disturbed, in particular through indiscriminate tracks being cleared within the area. Recently, an approximately 40 metre wide area was slashed around the southern and eastern extremities of this community, presumably as a fire-break. Despite these disturbances this occurrence of the community has quite a dense, diverse shrub layer and appears to be relatively resistant to weed invasion. The Priority 1 taxon *Tripterococcus paniculatus* ms, and the Priority 3 taxon *Synaphea acutiloba* were also recorded within this occurrence (DEP 1996).

Occurrence 10 occupies about ten hectares of a Parkland and Conservation reserve that covers a total of about 36 hectares. There are no DRF or Priority flora recorded within the occurrence. The South Western Highway is to the east of the community, and a rail line to the west. A pine plantation occurs to the south, and two other threatened communities occur adjacent to the southern end of the pines within the same reserve. These communities are 'shrublands on dry clay flats' and 'herb rich shrublands in clay pans' (community types 10a and 8 as described by Gibson *et al.* 1994) and are endangered and vulnerable respectively (English and Blyth 1997).

Data on all occurrences listed above of this community are recorded on the threatened ecological community database at CALM's Wildlife Research Centre, Woodvale.

Note. Some additional occurrences of several threatened ecological communities, including type 3a, have been identified recently. This has occurred during the integrated process of updating the 'System 6' Conservation Through Reserves System Recommendations and the Ministry for Planning Urban Bushland Strategic Plan, resulting in Perth's Bushplan (State of Western Australia 1998). Most of these newly found occurrences are small and/or degraded and additional information is required to enter them on the TEC database. All occurrences of threatened ecological communities are a focus for protection in Perth's Bushplan document (State of Western Australia 1998).

1.3 Biological and ecological characteristics

This community occurs on the wettest of the soils, and the highest rainfall sites of the group of Marri communities that occur on the heavy soils on the eastern side of the Swan Coastal Plain (Gibson *et al.* 1994).

Plant taxa that commonly occur in the community are listed at Appendix 1. The mean species richness for ten plots in the community surveyed by Gibson *et al.* (1994) was 58.9 species in 100 square metres. An average of 3.9 weed species were recorded per plot in the Gibson *et al.* 1994 study. This is lower than in the two other Marri dominated communities in the group, and is a relatively low level of weed invasion. This floristic information does not include data for Occurrences 1, 8, and 9, collected by the Department of Environmental Protection (DEP, 1996), that are yet to be entered on the threatened ecological communities database.

Occurrences 1 and 8 occur on the Southern River Geomorphological Unit of the group described as Aeolian Deposits by Churchward and McArthur (1980). Those authors describe this unit as 'sandplain with low dunes and many intervening swamps; iron and humus podzols, peats and clays'.

Occurrences 2, 7 and 10 occur on the Guildford Unit of the Fluvatile Deposit group as mapped by Churchward and McArthur (1980). The soils are otherwise known as the Guildford clays. The Unit is described as 'Flat Plain with medium textured deposits; yellow older duplex soils'.

Occurrence 3 is within the Forrestfield Unit of the Ridge Hill Shelf group as described by Churchward and McArthur (1980). They describe the Forrestfield Unit as 'laterised foothills of the Darling Scarp characterised by gravelly and sandy spurs'.

Occurrences 4, 5 and 6 occur on the junction of the Guildford and Forrestfield Units (Churchward and McArthur 1980).

Occurrence 9 is at the junction of the Guildford Unit described above, and the Bassendean Sand Unit of the group described as Aeolian Deposits (Churchward and McArthur 1980). They describe the Bassendean Unit as 'sand plains with low dunes and occasional swamps: iron or humus podzols; areas of complex steep dunes'.

This community occurs on a variety of land units and soil types. However, the soils in each occurrence would all contain an impervious clay layer that would act as a barrier to drainage of water through the soil. A number of plant taxa that occur in the community are typically associated with these seasonally inundated impervious clay soils. These include *Kingia australis*, *Mesomelaena tetragona*, *Pericalymma ellipticum*, and *Hakea ceratophylla*.

1.4 Hydrology

Occurrences may become inundated in the wetter months due to rainfall and surface flows because the community occurs mainly on soils that contain a clay layer that is quite impervious. In some areas

groundwater is very close to the surface. At Brixton Street (Occurrence 2) and at Occurrence 8 for example, groundwater is 0-3 metres below the surface at the end of spring (Davidson 1995). Surface waters may link to groundwater in the wetter months at such sites and may influence the quantity and quality of water on the surface of the sites at this time of the year. In other areas (eg, Occurrences 1, 3 and 4), the groundwater is generally more than about 12 metres below the surface at the end of spring (Davidson 1995) and it seems unlikely that surface water would be linked to the water table at any time of the year.

Salinity levels of around 250 to over 2,000 milligrams per litre total dissolved salts (mg/L TDS) have been recorded for the superficial aquifers where the community occurs (Davidson 1995). Levels of over 2,000 mg/L TDS were recorded for the shallow Leederville aquifer in the area of Occurrence 2 (Brixton Street reserve) and Occurrence 7 (Mundijong Road). In these areas, Guildford Clay soils inhibit the infiltration of rainfall and cause concentration of salts by evaporation (Davidson 1995).

1.5 Threatening processes

Clearing

Clearing for agriculture has been extensive on the heavy soils on the eastern side of the Swan Coastal Plain, with some 97% of all vegetation in the area cleared historically (Keighery and Trudgen 1992; CALM 1990). The marri dominated types on these heavy soils were probably some of the most common on this portion of the plain but are now very rare and are likely to be at least 90% cleared (Gibson *et al.* 1994). Future clearing is more likely to be associated with developments for road works, housing or industry. If proposed developments are likely to affect occurrences of threatened ecological communities they will require assessment under the Bushplan process (State of Western Australia 1998).

Altered fire regimes

Fires are likely to have a significant effect on the vegetation composition in Mediterranean ecosystems (Gill *et al.* 1981). It is also likely that the burning regime in the remnants containing the community has been modified to one of more frequent fires, especially hot burns, since European settlement.

Mediterranean ecosystems are usually well adapted to fire and indeed may require a particular fire regime to assist regeneration. If an appropriate frequency of fires is exceeded, however, species that are obligate seeders may not have sufficient time to flower and produce seed. If the time between fires is too long, obligate seeders may become senescent and unable to regenerate. Therefore, fires must occur at appropriate intervals and possibly at the appropriate season and intensity to maintain the integrity of plant communities.

The risk of fire is generally increased by the presence of grassy weeds in the understorey, as they are likely to be more flammable than many of the original native species in the herb layer.

Weed invasion

Disturbances such as fires and grazing can predispose areas to weed invasion if weed propagules are present. All of the occurrences of this community are close to weed sources such as urban or agricultural areas and would be vulnerable to weed invasion following any disturbance. However, even small remnants often exhibit surprising resistance to weed invasion particularly if left undisturbed (Keighery 1996). In this community, such resistance relates to the density of cover, seasonal inundation and the hardness of the soils in summer, and alteration of any of these factors reduces the ability to resist weed invasion (Keighery 1996).

There are tracks through most occurrences of the community. Weeds have invaded to varying extents along these tracks and such areas should be considered priority areas for weed control. In particular, piles of soil scraped from tracks generally contain high concentrations of weeds and act as a source of weed invasion. Such piles should be avoided when tracks are cleared, or be removed where they already exist.

A weed control program would be necessary to maintain or improve the current condition of occurrences of the community in the long term. Panetta and Hopkins (1991) state that the aims of weed control are to maintain the pre-invasion condition of the habitat (prevention); control or arrest ongoing weed invasion (intervention); and reverse the degraded condition of the habitat where applicable (rehabilitation). A weed control program would involve the following steps (adapted from Panetta and Hopkins 1991):

1. Accurately mapping the boundaries of weed populations
2. Selecting an appropriate herbicide or other method of weed control after determining which weeds are present
3. Controlling weeds that pose the greatest threat to the community in the early stages of invasion where possible, eg, invasive perennial grasses
4. Rehabilitation through reintroduction of local native species where areas are no longer capable of regenerating following weed control.

Hydrological changes

The hydrology of specific areas of the eastern side of the Swan Coastal Plain has been altered through the construction of drains to lower the water-table (Keighery and Trudgen 1992). The area is characterised by much valued heavy soils, which were historically highly cleared for agriculture. Despite a likely increase in runoff and recharge of the groundwater resulting from this clearing, drainage has probably brought about an overall lowering of the watertable in localised areas (B. Keighery¹ personal communication). Altered surface flow and/or alteration of the height of the local watertable may change the length of the period or the depth of any ponding.

Salinisation

Salinity levels of 250 - 2,000 mg/L TDS have been recorded where the community occurs (Davidson 1995).

Salinisation may increase as a result of evaporation of surface water, especially where saline superficial aquifers are in contact with the surface. If increased ponding occurs in the community due to urbanisation or clearing in the catchment, evaporation of a greater volume of water may result in larger amounts of residual salt. This is especially true for clay soils, which inhibit rainfall infiltration and result in high evaporation rates and concentration of salts (Davidson 1995). Occurrence 2 in particular may be under threat from salinisation, but other occurrences may also be under threat in future if water-tables rise as a result of urbanisation or other causes. The salinity and depth to groundwater in the vicinity of Occurrences 9 and 10 are not known.

The levels of salinity in the community should be monitored to determine if salinisation poses a major threat to the community. Remedial actions such as replanting with deep rooted vegetation in strategic parts of the catchment may be necessary if monitoring indicates salinisation is a problem. However, implementing such a strategy may prove difficult in areas that are surrounded by urban development, such as Brixton Street (Occurrence 2).

Grazing

Grazing of plant communities causes alterations to the species composition by the selective grazing of edible species and the introduction and encouragement of weeds by the addition of dung, trampling and general disturbance. It is not known if occurrences of the community have been grazed historically, but areas such as the portion of Occurrence 8 on private land may have been grazed at some stage. The significance of the impact of grazing is not known.

Introduction of Disease

¹ Bronwen Keighery, Department of Environmental Protection, Perth.

Dieback caused by *Phytophthora* species has the potential to impact the community, although it is not known if this type is susceptible to the disease. Plant communities that occur on heavy soils such as this one, especially in relatively flat areas, are generally not highly susceptible to *Phytophthora* (Helyar 1994). Occurrences have not been tested for presence of dieback and risk of introduction of disease should therefore be minimised by ensuring good hygiene procedures. This would involve washdown of any equipment used on or adjacent the community, and restricting access by vehicles and machinery to dry soil conditions.

1.6 Conservation status

The community meets criterion B (ii) as follows, for Critically Endangered (from English and Blyth 1997):

Current distribution is limited and there are very few occurrences, each of which is small and/or isolated and extremely vulnerable to known threatening processes.

1.7 Strategy for recovery

To identify, and influence the management of, the areas in which the community occurs, so maintaining natural biological and non biological attributes of the sites and the current area covered by the community.

To conduct appropriate research into the ecological characteristics of the community to develop further understanding about the management actions required to maintain or improve its condition.

2. RECOVERY OBJECTIVE AND CRITERIA

2.1 Objective

To maintain or improve the overall condition of the *Corymbia calophylla* - *Kingia australis* woodlands on heavy soils and reduce the level of threat with the aim of reclassifying it from Critically Endangered to Endangered.

2.2.1 Criteria for success

1. An increase in the area, and number of occurrences, of this community under conservation management.
2. Maintenance in terms of diversity and basic composition of native species (as described in Gibson *et al.* 1994 and DEP 1996) as well as hydrological and biological processes, taking account of natural change of the community over time.
3. Improvement in terms of reduction of numbers of exotic species and of other threatening processes as defined above.

2.2.2 Criterion for failure

Significant loss of area or further modification of occurrences of the threatened ecological community.

3. RECOVERY ACTIONS

Note 1. : The responsible authority is frequently listed as the relevant CALM District. This refers largely to initiating and guiding actions. However, in general the relevant CALM District, the Western Australian Threatened Species and Communities Unit (WATSCU) and the Recovery Team share the primary responsibility for identifying funding sources and securing funds for recovery actions.

Note 2. These actions are listed in the approximate order in which their implementation will begin.

Note 3. Where appropriate, the completion date for actions is given as year 1, year 2 or year 3, meaning the years for which this IRP operates.

3.1 Establish a Recovery Team

Responsibility: Western Australian Threatened Species and Communities Unit (WATSCU)
Cost: \$0 (the small costs of attending meetings should be met by Recovery Team members)
Completion date: Year 1

3.2 Enter all occurrences of community 3a onto the TEC database

Additional occurrences, including those referred to in the Bushplan document (State of Western Australia 1998) require survey for boundaries, condition and threatening processes, and entry of all data onto the database.

Responsibility: WATSCU
Cost: \$2 500
Completion date: Year 2

3.3 Liaise with current management bodies, owners, land managers and other interested groups to implement recommendations held in this IRP

All but one of the occurrences of the community are managed by authorities other than CALM, are unmanaged, or privately owned. The involvement of land managers, local community groups and industry in the recovery of the community wherever possible and practical is therefore essential to the recovery process.

The Wildflower Society and local Friends Group are involved in managing the Brixton Street reserve (Occurrence 2) and the City of Armadale is likely to be involved in the management of Occurrence 3 although it is to be a nature reserve vested in the NPNCA. The unallocated remnant on Mundijong Road is managed by the Shire of Serpentine-Jarrahdale in association with the Roadside Care Volunteers and Serpentine-Jarrahdale Landcare Group. The groups have a Bushcare grant to implement management. Other stakeholders should be consulted on management of the community as they are identified.

Responsibility: CALM (Perth and Dwellingup Districts; WATSCU)
Cost: \$5,000 for all liaison (not including vehicle costs)
Completion date: Ongoing

3.4 Disseminate information about the community

To prevent accidental destruction of the community, and gain public support for its conservation it is recommended that information about the community be provided by local CALM staff to all stakeholders including management bodies, landholders, and managers of land containing the community. This would include information from the threatened ecological community database, and maps indicating the location of the community. Information about private land should only be provided to the landholder, unless permission is granted by the landholder to allow wider dissemination of the data. This action is recommended in English and Blyth (1997).

Local CALM staff will ensure regular liaison with landowners and management bodies of land containing the community to ensure threatened ecological community information is up to date.

A publicity campaign utilising local media and poster displays in prominent areas will be undertaken to encourage awareness about this threatened ecological community.

Responsibility: CALM (Corporate Relations Division; Perth and Dwellingup Districts; WATSCU)
Cost: \$3,000

Completion date: Ongoing

3.5 Clarify and continue to monitor extent and boundaries

Occurrences should be monitored every two years. Boundaries and extent can be determined from current aerial photographs and limited on-site checking. This information should be added to the threatened ecological community database as recommended in English and Blyth (1997). English and Blyth (1997) also recommended the establishment of a Geographic Information System database for information on threatened ecological communities. When this is available, boundary information should be included.

The boundaries of some occurrences have not been accurately mapped (Occurrences 2, 4, 5 and 6 and 10 in particular, and those identified in Bushplan (State of Western Australia 1998). The community is considered to have been well searched for (Keighery and Trudgen 1992; Gibson *et al.* 1994; DEP 1996).

Responsibility: CALM, (Perth and Dwellingup Districts; WATSCU) in consultation with landowners and management bodies
Cost: \$1,000 every second year
Completion date: Ongoing

3.6 Install markers to indicate the locations of occurrences of the community alongside tracks, fire-breaks and roads

CALM will mark, or encourage the appropriate authorities to mark roadside occurrences, and occurrences of threatened ecological communities located on tracks or fire-breaks with the same pegs as used to mark threatened flora, to reduce the likelihood of accidental destruction. This action is recommended in English and Blyth (1997).

This action cannot be undertaken for several occurrences (Occurrences 2, 4, 5, 6 and 10 and newly identified occurrences in particular) until action 3.5 is completed.

Responsibility: CALM (Perth and Dwellingup Districts; WATSCU)
Cost: \$1,700
Completion date: Year 2

3.7 Design and implement a program for monitoring flora

Data collected should include weed levels, plant species diversity and species composition of flora.

Occurrences should be monitored two-yearly to provide information on condition. This information should be added to the threatened ecological community database as recommended in English and Blyth (1997).

Floristic plots occur in all occurrences (total of 17 plots - Gibson *et al.* 1994; DEP, 1996). All native and weed species were recorded, but density or cover values for each species were not included in these data and would be essential for determining changes over time (eg as a result of too frequent fire). Line intercept and photographic methods as described in Hopkins *et al.* (1987) could be utilised to monitor these parameters, using permanent plots already in place from other surveys (Gibson *et al.* 1994; DEP 1996).

Responsibility: CALM (Perth and Dwellingup Districts; WATSCU)
Cost: \$5,000 every second year (to monitor 10 of the 17 plots in the community - one plot per occurrence) for field survey, specimen identification, and databasing
Completion date: Ongoing

3.8 Develop a Fire Management Strategy

3.8.1 Develop and implement Fire Management Plans that encompass the following (3.8.1-3.8.4) and include an annual fire monitoring and reporting schedule

There is a need for research into recovery of the community from fire (to be completed under Action 3.7 - flora monitoring), and to determine the implications of findings for management. This would also include developing a fire history map of the occurrences, which should be updated annually. As little is known of the response of the community to fire, no planned burn should be implemented for the life of this IRP, unless results of future studies suggest this is necessary and urgent. The occurrences are generally small and frequently burnt by arsonists. Therefore, even in the absence of planned burns, fires will be quite frequent in most occurrences.

A Fire Management Plan has been developed for Talbot Road bushland by WA Fire and Rescue Service, Shire of Swan and CALM. It specifies no planned burns without consultation with CALM, no construction of new fire-breaks, a fire-fighting strategy, implementation of dieback hygiene for all vehicles, routine fuel and weed monitoring, and maintenance of fire-breaks. A similar plan should be developed for all occurrences of this community, using the plan for Talbot Road bushland as a guide. CALM's Perth and Mundaring Districts are developing Fire Management Plans for all remnants in their districts that contain occurrences of threatened ecological communities in close liaison with all stakeholders.

Responsibility: CALM (Perth and Dwellup Districts); in consultation with landowners and management bodies and all stakeholders including Fire and Rescue Service and Bush Fire Brigades

Cost: \$6,800

Completion date: Plans to be completed in year 1

3.8.2 Ensure maintenance of strategic fire-breaks to help prevent fire spreading to community

Maintenance of existing fire-breaks is appropriate where fire-breaks are already constructed, unless maintenance is likely to cause spread or intensification of dieback or otherwise degrade the community. Fire-break maintenance should be carried out with a minimum of soil disturbance, using herbicides or mowing wherever possible. Local CALM staff should be involved in planning of fire-break construction and maintenance for all occurrences of the community.

Local CALM staff should be involved in planning of fire-break construction and maintenance for all occurrences of the community.

Responsibility: CALM (Perth and Dwellup Districts); liaison with surrounding landholders

Cost: Cost of fire-breaks \$2,400 pa; costs of liaison included in 3.3

Completion date: Ongoing

3.8.3 Liaise with owners of land adjacent to the community to ensure strategies for fuel reduction on their lands do not impact the community

For example, burning at inappropriate times when fires are likely to spread to adjacent lands should be avoided.

Responsibility: CALM (Perth and Dwellup Districts); liaison with surrounding landholders

Cost: Costs of liaison included in 3.3

Completion date: Ongoing

3.8.4 Ensure fire suppression actions do not impact the community

Ensure fire-fighting authorities recognise the importance of not constructing new tracks during their operations, including during wildfires. The use of heavy machinery to create new fire-breaks within the community should be avoided as additional disturbance would encourage further weed invasion, and chemicals that may be toxic to the community should not be used. Guidelines for appropriate fire suppression actions should be developed.

A local CALM staff member should be present during wildfires and controlled burns in remnants that contain occurrences of the community, to advise on protecting the conservation values of the community.

Responsibility: CALM (Perth and Dwellup Districts); in consultation with landowners, management bodies, local Bush Fire Brigades and Fire and Rescue Service
Cost: Costs of preparation of guidelines and liaison included in 3.8.1; additional funds for CALM district staff to attend fires in the community (\$500 pa)
Completion date: Ongoing

3.9 Assess and monitor weed populations

Floristic data from Keighery and Trudgen (1992), Gibson *et al.* (1994), DEP (1996) and other reports on individual areas may help determine weeds that pose the greatest threat to each occurrence as all weed species that occur in plots have been recorded. Some significant weeds in occurrences may not occur in plots, however. Weed populations should be accurately mapped and appropriate herbicides or other method of weed control determined.

Weed monitoring can be included in Action 3.7.

Responsibility: CALM (Perth and Dwellup Districts) in consultation with landowners, land managers and management bodies
Cost: Mapping of the boundaries of weeds species that are high priority for control - \$2,000 every two years. Weed monitoring to be incorporated into Action 3.7
Completion date: Ongoing

3.10 Implement weed control, and replanting where necessary

Initial stages of rehabilitation should involve control of perennial weeds (mainly in Occurrences 3, 7, 9 and 10) and their replacement with local species, where appropriate. High priority actions may also include the removal of piles of soil scraped from tracks that contain high concentrations of weeds and act as a source of weed invasion.

Local species suitable for replanting should be identified from plot data for each occurrence held in Gibson *et al.* (1994) and DEP (1996) and from the results of Action 3.7.

Rehabilitation through reintroduction of local native species may be necessary if areas are no longer capable of regenerating following weed control (refer 3.7). Piles of weed-contaminated soil in Occurrence 3 should be removed and the area replanted. Tracks in Occurrence 9 should be left to revegetate naturally. Only seed from the same occurrence should be used for rehabilitation. No seed from other areas should be introduced into occurrences.

Responsibility: CALM (Perth and Dwellup Districts) in consultation with landholders, management bodies and land managers
Cost: \$4,000 pa for weed control all occurrences; \$2,000 pa for rehabilitation works for Occurrence 3 (includes preparation of a rehabilitation plan); rehabilitation needs of other occurrences need to be determined

Completion date: Ongoing

3.11 Fence remnants that contain the community, where necessary

Fencing may be necessary to prevent degradation where occurrences are in high usage areas, or to prevent grazing. The occurrence on private land (part Occurrence 8) may be grazed and require fencing to prevent degradation by stock. Occurrences 7 and 9 are suffering degradation from the impact of horse riders and indiscriminate clearing for tracks, but as Occurrence 7 is on a roadside, fencing would be difficult. Occurrence 9 should be fenced to prevent further degradation from uncontrolled vehicle access. Occurrences 1 and 2 are already fenced, and there is no evidence of broad-scale degradation of other occurrences as a result of uncontrolled access.

Responsibility: CALM (Perth and Dwellingup Districts), landowners and management bodies
Cost: Occurrence 8 - \$8,000; Occurrence 9 - \$5,000
Completion date: Year 1

3.12 Ensure hygiene conditions

Occurrences have not been tested for presence of dieback, and the susceptibility of the community to the disease is not known. Risk of introduction of disease should therefore be minimised by ensuring good hygiene procedures. This would involve washdown of any equipment used adjacent to the community, and restricting access by vehicles and machinery to dry soil conditions. No vehicle access should be allowed onto bushland areas in the community.

Responsibility: All personnel using machinery in the occurrences
Cost: Costs of all liaison to be undertaken by CALM (Perth and Dwellingup Districts), is included in 3.3; other costs to be underwritten by user of machinery
Completion date: Ongoing

3.13 Design and conduct research

Research should be designed to increase the understanding of the characteristics of the community to assist future management decisions. Research topics could include:

1. The hydrogeology of occurrences of the community.
2. The impact of weeds on the community.
3. The role of disturbance in regeneration of the community.
4. The development of a monitoring system. Protocols will be developed based on recommendations held in English and Blyth (1997).
5. Significant biological processes in the community eg pollination biology, germination requirements, longevity and time taken to reach maturity of important plant taxa in the community.
6. Monitoring of water depth, timing and depth of inundation, and water quality in occurrences of the community.

Responsibility: CALM (Science and Information Division (SID); Perth and Dwellingup Districts; WATSCU)
Cost: Recovery Team to determine costs and likely funds available through other sources and to recommend a research program and sources of funds to CALM
Completion date: No date set

3.14 Survey for dieback

Survey for dieback in the community. Undertake baseline and ongoing monitoring of the extent, impact and boundaries of dieback in all occurrences of the community and determine if there are priority areas for dieback treatment.

Priority areas for dieback treatment in the community should be determined from the Dieback Protocol that is currently being prepared by CALM. Data on dieback presence and impact, and future biodiversity implications (eg loss or decline of DRF or Priority taxa, structurally or functionally important taxa) are likely to be important determinants of the priority of treatment of individual occurrences.

Dieback has not yet been recorded in this community. If dieback is detected, the dieback front should be monitored at least every five years in summer and flagging marking the front replaced regularly. Additional plot information (refer 3.7) would provide useful monitoring data.

Responsibility: CALM (Perth and Dwellingup Districts)
Cost: \$8,000
Completion date: Year 1

3.15 Assess hydrological data

Occurrences of the community may be at risk from increased inundation or salinisation due to rising groundwater and increased ponding as a result of clearing of the catchments.

Groundwater levels and quality are routinely monitored by the Water and Rivers Commission (and in specific areas by Agriculture Western Australia and local Landcare District Committees (LCDCs)). Data in Davidson (1995) suggests Occurrence 2, in particular, may be at risk from hydrological changes. Information for areas close to this community should be assessed annually as it may indicate that remedial measures should be undertaken.

Responsibility: CALM (Perth and Dwellingup Districts); liaison with WRC, Agriculture Western Australia and LCDCs
Cost: \$500 pa for Occurrence 2; \$1,000 pa for all other occurrences
Completion date: Ongoing

3.16 Report on success of management strategies for the occurrences

Reporting should be part of annual reports prepared by the Recovery Team for CALM's Corporate Executive. A final report would be presented as part of or complementary to the full recovery plan for the community, if a full recovery plan is necessary.

Responsibility: CALM (Perth and Dwellingup Districts; WATSCU)
Cost: \$0
Completion date: Year 2

3.17 Investigate transferring the vesting of areas that contain the community to the NPNCA if conservation management seems unlikely, or if the areas become available

If effective management for conservation seems unlikely to result from recommendations held in this IRP, or if areas that contain the community become available, CALM will negotiate to have the remnants that contain the community, and adequate buffer areas where required, declared Class A reserves for the purpose of 'Conservation of Flora and Fauna' vested in the National Parks and Nature Conservation Authority.

Areas to which this recommendation applies comprise occurrences of the community, and include buffers in some cases. Suggested management boundaries as listed below follow logical borders such as those of existing reserves or remnants and may be selected to include other known threatened ecological communities.

This recommendation applies to the following areas:

- i) Areas of remnant native vegetation remaining in reserves 37981 and 37260 (Occurrence 1);
- ii) Lot 37 of Canning Location 10 and Canning Location 48 (Brixton Street wetlands - Occurrence 2);
- iii) Areas of remnant native vegetation remaining in reserve 17490 (Brickwood reserve - Occurrences 4, 5 and 6);
- vii) Part Peel Estate Lot 101/3, and areas of remnant native vegetation remaining in Reserve 23793 and the Mundijong Road reserve between Webb Road and the western edge of the remnant at Duck Pond Road (Occurrence 7);
- iv) The community on Peel Estate Lot 834, and on the adjacent roadside remnant on the south side of Karnup Road and Punrack Road, between Rapids Road and about 400 m south west of the junction of Punrack Road and Karnup Road (Occurrence 8);
- v) Reserve 34033 (Occurrence 9); and
- vi) Reserve 31437 (Occurrence 10).

Responsibility: CALM, Land Administration Section; Perth and Dwellingup Districts); Department of Land Administration (DOLA)

Cost: Costs of liaison included as part of 3.3

Completion date: To be determined

SPECIFIC MANAGEMENT ACTIONS; OCCURRENCES 1, 2, 3, 4, 5, 6, 9, 10 AND ROADSIDE REMNANT PORTION OF OCCURRENCE 8

3.18 Develop management plans

If site-based management plans that would conserve the threatened ecological community are not being prepared or implemented, CALM seek involvement in the cooperative preparation of plans for occurrences that include management considerations as listed in this IRP.

The Wildflower Society has developed Management Guidelines for Brixton Street reserve (Occurrence 2; Keighery 1995). Management plans would be required for each separate area of remnant vegetation containing the community, not for each individual occurrence (ie. one plan only for Occurrences 4, 5 and 6 within Brickwood reserve).

The Roadside Care Volunteers and the Serpentine-Jarrahdale Landcare Group are involved in the management of the roadside remnants that contain Occurrence 7. Keighery (1996) provides a detailed account of the conservation values and management recommendations for the remnant.

Responsibility: CALM (Perth District; WATSCU), management bodies and land managers

Cost: Costs of liaison included as part of 3.3; cost of plan development \$40,000

Completion date: Year 2

SPECIFIC MANAGEMENT ACTIONS; OCCURRENCE 3

3.19 Acquire unmanaged land that contains the community and vest the area in the National Parks and Nature Conservation Authority

CALM negotiate with land managers to seek vesting of Reserve 42044 (Occurrence 3) - unmanaged land, with the NPNCA.

Responsibility: CALM, (Land Administration Section; Perth District; WATSCU); DOLA
Cost: Costs of liaison included as part of 3.2
Completion date: 2000

SPECIFIC MANAGEMENT ACTIONS; OCCURRENCE 7

3.20 Negotiate to have the unallocated remnant on Mundijong Road placed in the care, control and management of the Shire of Serpentine-Jarrahdale as Class A reserve for Conservation and Passive Recreation

The linear remnant on Mundijong Road is very significant as it represents one of only two remaining cross sections of native vegetation that span the alluvial soils of the southern Swan Coastal Plain. The western end of this remnant contains another critically endangered community (type 3c as described by Gibson *et al.* 1994) and the central portion contains a vulnerable community (type 8 as described by Gibson *et al.* 1994).

Negotiate to seek transfer of unmanaged land, as follows, to the Shire of Serpentine-Jarrahdale as Class A reserve for 'Conservation and Passive Recreation';

i) Part Peel Estate Lot 101/3, and the remnant portion of Reserve 23793 (Occurrence 7) and the Mundijong Road reserve between Webb Road and the western edge of the remnant at Duck Pond Road

Note 1: reserve 23793 is managed by the Shire and local community groups although it is unvested.

Note 2: Occurrence 7 of this community occupies only a portion of the described area, but this recommendation is worded to be consistent with recommendations held in Interim Recovery Plans for other threatened ecological communities that occur along Mundijong Road and Duck Pond Road, Mundijong (*Corymbia calophylla* - *Xanthorrhoea preissii* woodlands and shrublands - Gibson *et al.* (1994) type 3c).

Responsibility: CALM (Land Administration Section; Perth District); Shire of Serpentine-Jarrahdale; DOLA
Cost: Costs of liaison included as part of 3.2
Completion date: Year 2

Table 2: Summary of recovery actions

Recovery Action	Occurrences	Responsibility	Completion date
Establish Recovery Team	All	CALM (WATSCU)	Year 1
Enter additional occurrences on database	All recently identified	CALM (WATSCU)	Year 2
Liaison with landholders / management bodies / managers	All	CALM (Perth and Dwellingup Districts, WATSCU)	Ongoing
Disseminate information	All	CALM (Corporate Relations Division, Perth and Dwellingup Districts, WATSCU)	Ongoing
Clarify and Monitor boundaries	All	CALM (Perth and Dwellingup Districts, WATSCU)	Ongoing
Install markers	All	CALM (Perth and Dwellingup Districts, WATSCU)	Year 2
Develop Fire Management Strategy	All (except	CALM (Perth and Dwellingup	Development of Fire

	possibly 2)	Districts, WATSCU) in consultation with all stakeholders	Management Plans has begun. To be completed Year 2.
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Table 2: cont.

Recovery Action	Occurrences	Responsibility	Completion date
Implement Fire Management Plans, implement dieback hygiene	All	CALM (Perth and Dwellingup Districts), Fire and Rescue Service, Bush Fire Brigades	Ongoing
Implement weed control	All - but mainly Occurrences 3, 7, 9, 10	CALM (Perth and Dwellingup Districts)	Ongoing
Fence Occurrence 8	8	CALM (Perth District), landowners, Management bodies	Year 1
Fence Occurrence 9	9	CALM (Dwellingup District), Management bodies	Year 2
Assess hydrological data	2	CALM (Perth District) liaison with WRC, LCDCs and Agriculture WA	Ongoing
Develop Management Plans for occurrences	1, 3, 4, 5, 6, 7, 8, 9, 10	CALM (Perth and Dwellingup Districts), Management bodies, land managers	March 2001
Vest reserve 42044 in NPNCA	3	CALM (Perth District, Land Administration Section, WATSCU), DOLA	Early 2000
Place management of Occurrence 7 with Shire of Serpentine- Jarrahdale	7	CALM (Land Administration Section; Perth District); Shire of Serpentine-Jarrahdale; DOLA	June 2000
Monitor flora	All	CALM (Perth and Dwellingup Districts, WATSCU)	Ongoing
Monitor weed populations	All	CALM (Perth and Dwellingup Districts)	Ongoing
Implement rehabilitation	3	CALM (Perth District)	March 2001
Conduct research (cost to be determined)	All	CALM (SID, Perth and Dwellingup Districts, WATSCU)	No date set
Survey for dieback	All	CALM (Perth and Dwellingup Districts)	December 2000
Assess hydrological data	1, 3, 4, 5, 6, 7, 8, 9, 10	CALM (Perth and Dwellingup Districts); liaison with WRC, LCDCs and Agriculture WA	Ongoing
Report on management strategies	All	CALM (Perth and Dwellingup Districts, WATSCU), Recovery Team	March 2001
Place management of threatened occurrences with NPNCA	To be determined	CALM (Land Administration Section, Perth and Dwellingup Districts), DOLA	Timing to be determined

Table 3: Summary of costs for each recovery action

Recovery Action	Year 1	Year 2	Year 3
Establish Recovery Team			
Add additional occurrences to database	1500	1000	
Liaison with landholders / vestees (three quarters of costs attributed to Perth District; one quarter to Dwellingup District)	2,000	2,000	1,000
Disseminate information (Costs equally attributed to all responsible groups)	1,500	1,000	500
Monitor boundaries (Three quarters of costs attributed to Perth District; one quarter to Dwellingup District)	1,000		1,000
Install markers (Three quarters of costs attributed to Perth District; one quarter to Dwellingup District)	1,700		

Table 3: cont

Recovery Action	Year 1	Year 2	Year 3
Develop Fire Management Plans (Three quarters of costs attributed to Perth District; one quarter to Dwellingup District)	3,400	3,400	
Implement Fire Management Plans, implement dieback hygiene (Three quarters of costs attributed to Perth District; one quarter to Dwellingup District)	2,900	2,900	2,900
Implement weed control (mainly occurrences 3, 7, 9, 10) (Three quarters of costs attributed to Perth District; one quarter to Dwellingup District)	4,000	4,000	4,000
Fence Occurrence 8 (All costs attributed to Perth District)	8,000		
Fence Occurrence 9 (All costs attributed to Dwellingup District)	5,000		
Assess hydrological data (Occurrence 2) (All costs attributed to Perth District)	500	500	500
Develop Management Plans		20,000 (All attributed to Perth District)	20,000 (Half to Perth, half to Dwellingup District)
Acquire Occurrence 3	-		
Place management of Occurrence 7 in Shire of Serpentine-Jarrahdale	-		
Monitor flora (Three quarters of costs attributed to Perth District; one quarter to Dwellingup District)	5,000		5,000
Monitor weed populations (Three quarters of costs attributed to Perth District; one quarter to Dwellingup District)	2,000		2,000
Implement rehabilitation (Occurrence 3) (All costs attributed to Perth District)	2,000 (Costs for other occurrences to be determined)	2,000	2,000
Conduct research	To be determined		
Survey for dieback (Three quarters of costs attributed to Perth District; one quarter to Dwellingup District)	8,000		
Assess hydrological data (Occurrences 1, 3, 4, 5, 6, 7, 8, 9,10) (Three quarters of costs attributed to Perth District; one quarter to Dwellingup District)	1,000	1,000	1,000
Report on management strategies (Three quarters of costs attributed to Perth District; one quarter to Dwellingup District)	-		
Have care, control & management placed in NPNCA or acquire occurrences (areas yet to be determined)	To be determined		
Total	49,500	37,800	39,900

Total of all costs over three years: \$127,200

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David Mitchell	CALM's Swan Region
Lyndon Mutter	CALM's Perth District

REFERENCES

- Churchward, H.M. and McArthur, W.M. (1980). Landforms and Soils of the Darling System. In: *Atlas of Natural Resources, Darling System, Western Australia*. Perth, Pinjarra and Collie Sheets. Department of Conservation and Environment, Western Australia.
- Davidson, W.A. (1995). *Hydrogeology and Groundwater Resources of the Perth Region, Western Australia*. Geological Survey of Western Australia. Bulletin 142.
- Department of Conservation and Environment (1985). *Conservation reserves for Western Australia; as recommended by the Environmental Protection Authority - 1983. The Darling System - System 6*. Report 13, DCE, Perth.
- Department of Conservation and Land Management (1990). *Data on the Conservation of Vegetation Associations on the Swan Coastal Plain*. Unpublished Report.
- Department of Conservation and Land Management (1998). *Declared Rare and Priority List for Western Australia*. Department of Conservation and Land Management, Perth.
- Department of Environmental Protection (1994) GIS. *Threatened or Poorly Reserved Plant Communities Requiring Interim Protection*. Environmental Protection Authority, Perth, Western Australia.
- .
- Department of Environmental Protection (1996). *System 6 update program unpublished site and area records and analysis*. Environmental Protection Authority, Perth, Western Australia.
- English, V. and Blyth, J. (1997). *Identifying and Conserving Threatened Ecological Communities in the South West Botanical Province*. Project N702, Final Report to Environment Australia. Department of Conservation and Land Management. Perth, Western Australia.
- Gibson, N., Keighery, B., Keighery, G., Burbidge, A and Lyons, M. (1994). *A floristic survey of the Southern Swan Coastal Plain*. Unpublished report for the Australian Heritage Commission prepared by the Department of Conservation and Land Management and the Conservation Council of Western Australia (Inc.).
- Gill, A.M., Groves, R.H. and Noble, I.R. (eds) (1981). *Fire and the Australian Biota*. Australian Academy of Science. Canberra, ACT.

- Helyar, K. (1994). *Dieback Interpreters Procedural Manual*. Department of Conservation and Land Management. Perth.
- Hopkins, A.J.M., Brown, J.M. and Goodsell, J.T. (1987). A Monitoring System for Use in the Management of Natural Areas in Western Australia. Pp 337-339 in *Nature Conservation: the Role of Remnants of Native Vegetation* ed. by D.A. Saunders, G.W. Arnold, A.A. Burbidge, and A.J.M. Hopkins. Surrey Beatty and Sons Pty Limited. Chipping Norton, NSW.
- Keighery, B. (1995). *Knowing and Managing the Brixton Street Wetlands*. Report compiled for the Friends of Brixton Steet Wetlands and the Perth Branch of the Wildflower Society of Western Australia (Inc.), in cooperation with the Department of Conservation and Land Management.
- Keighery, B. (1996). *Flora Information for Roadside Bush Protection Plans in the Shire of Serpentine - Jarrahdale*. Report prepared for the Roadside Care Volunteers. Perth, Western Australia.
- Keighery, B.J., Keighery, G.J., and Gibson, N. (1997). *Floristics of Reserves and Bushland areas of the Perth Region (System 6) Parts XI - XV*. Wildflower Society of Western Australia (Inc.), Nedlands.
- Keighery, B. and Trudgen, M (1992). *Remnant Vegetation on the Alluvial Soils of the Eastern Side of the Swan Coastal Plain*. Unpublished report for Department of Conservation and Land Management, Australian Heritage Commission and Heritage Council of WA.
- Keighery, G.J. and Keighery, B.J. (1993a). *Floristics of Reserves and Bushland Areas of the Perth Region (System 6). Parts V - IX*. Wildflower Society of Western Australia (Inc.), Nedlands.
- Keighery, G.J. and Keighery, B.J. (1993b). *Floristics of Reserves and Bushland Areas of the Perth Region (System 6). Parts II- IV*. Wildflower Society of Western Australia (Inc.), Nedlands.
- Panetta, F.D and Hopkins, A.J.M. (1991). Weeds in Corridors: Invasion and Management. Pp 341-351 in *Nature Conservation 2 the Role of Corridors* ed by D.A. Saunders, and R.J Hobbs. Surrey Beatty & Sons Pty Limited, Chipping Norton, NSW.
- State of Western Australia 1998. *Perth's Bushplan*. Western Australian Planning Commission, Perth.

APPENDIX 1

Vascular Plants recorded from at least 50% of plots in occurrences (From Gibson *et al.*, 1994)

Note: Data from DEP (1996) has not been incorporated into this table. Information is based on plots in Occurrences 2, 3, 4, 5, 6, 7, and 10 only. Occurrences 1, 8 and 9 were recorded in DEP (1996).

	Taxon
	<i>Borya scirpoidea</i>
*	<i>Briza maxima</i>
	<i>Cassytha glabella</i>
	<i>Conostylis setigera</i>
	<i>Cyathochaeta avenacea</i>
	<i>Dampiera linearis</i>
	<i>Drosera menziesii</i> subsp. <i>menziesii</i>
	<i>Dryandra nivea</i>
	<i>Eriostemon spicatus</i>
	<i>Corymbia calophylla</i>
	<i>Goodenia caerulea</i>
	<i>Haemodorum laxum</i>
	<i>Hakea ceratophylla</i>
*	<i>Hypochaeris glabra</i>
	<i>Hypolaena exsulca</i>
	<i>Kingia australis</i>
	<i>Loxocarya fasciculata</i>
	<i>Mesomelaena tetragona</i>
	<i>Neurachne alopecuroidea</i>
	<i>Patersonia occidentalis</i>
	<i>Pericalymma ellipticum</i>
	<i>Synaphea petiolaris</i>
	<i>Tetraria octandra</i>
	<i>Thysanotus manglesianus/patersonii</i> complex
	<i>Tricoryne elatior</i>
	<i>Xanthorrhoea preissii</i>
	<i>Xanthosia huegelii</i>

* Introduced

GLOSSARY

Aeolian - deposited or formed by the wind

Fluviatile - found in or near rivers

Podzols - an acidic forest soil, with an upper layer that is greyish white or ash coloured and depleted of colloids and iron and aluminium compounds and a lower layer, brownish in colour in which these have accumulated.

STATUS OF FLORA TAXA (FROM CALM, 1998)

Declared Rare Flora	‘taxa which have been adequately searched for and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection and have been gazetted as such.’
Priority 1	‘taxa which are known from one or a few populations which are under threat.’
Priority 2	‘taxa which are known from one or a few populations, at least some of which are not believed to be under immediate threat.’
Priority 3	‘taxa which are known from several populations, at least some of which are not believed to be under immediate threat.’