INTERIM RECOVERY PLAN NO. 57

# SHRUBLAND AND WOODLANDS ON MUCHEA LIMESTONE
# INTERIM RECOVERY PLAN 2000-2003

by

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Photo: Emma Holland

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DEPARTMENT OF Conservation AND LAND MANAGEMENT
Conserving the nature of WA

Natural Heritage Trust
Helping Communities Helping Australia

## 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This Interim Recovery Plan will operate from 28 February 2000 but will remain in force until withdrawn or replaced. It is intended that, if the ecological community is still ranked Critically Endangered, this IRP will be replaced by a full Recovery Plan after three years.

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 February 1999.

## SUMMARY

**Name:** Shrublands and Woodlands on Muchea Limestone

**Description**: The community occurs on the heavy soils of the eastern side of the Swan Coastal Plain. Where the best developed limestone occurs, near Gingin, the plant community is located on shallow black clay or sandy clay soils on limestone. Typical and common native species (from Keighery and Keighery 1995) are the tree *Casuarina obesa,* the mallees *Eucalyptus decipiens* and *Eucalyptus foecunda* and the shrubs *Melaleuca huegelii*, *Alyogyne huegelii* var. *huegelii*, *Grevillea curviloba* ssp. *incurva, Grevillea curviloba* ssp. *curviloba, Grevillea evanescens, Melaleuca acerosa, Melaleuca huegelii,* and the herb *Thysanotus arenarius.* The following exotic species are also currently common*; Hypochaeris glabra*, *Sonchus asper*, *Briza maxima*, *Briza minor*, *Anagallis arvensis* and *Centaurium erythraea.*

**CALM Region(s)**: Swan

**CALM District(s)**: Perth

**Shire(s)**: Gingin, Chittering

**Recovery Team:** To be established as a joint team to deal with this community and the Perth to Gingin ironstone community. Proposed membership: landholder, CALM Perth District (chair), CALMScience, WATSCU, planning officer - Shire of Gingin, Fire and Rescue Service. The Recovery Team will report annually to CALM's Corporate Executive.

**Current status**: Assessed 21 November 1995 as Critically Endangered.

**Habitat requirements**: The plant community occurs on soils mapped as Muchea Limestone or Plain limestone deposits in the Urban Geology Map Series (Anon 1976 a and b, 1977, 1978; Gozzard, 1982 a and b, 1983 a and b, 1986). The soils are frequently mounded up above the surrounding area and are likely to reflect areas of spring activity in the past, where carbonates have precipitated out of solution (McArthur and Bettenay 1960).

The plant community that occurs on these soils reflects the unusual mixture of limestone, clay and sands. Many of the species are commonly associated with the limestone soils that occur on the coast, and do not generally occur further inland.

The Muchea Limestone soils have pH levels of between 7.8 to 8.3, which reflects the alkalinity of the limestone in the soil profile.

**Objective(s)**: To maintain or improve the overall condition of the plant community associated with the Muchea Limestone soils and reduce the level of threat towards downgrading 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 in Keighery and Keighery 1995; Department of Environmental Protection (DEP) 1996) as well as hydrological and biological processes, taking account of natural change of the community over time.
- Improvement in terms of reduction of numbers of exotic species (as described in DEP 1996) 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.

**Recovery actions**:

| | |
|---|---|
| 1.Establish Recovery Team | 10. Fence occurrences |
| 2. Clarify and monitor boundaries | 11. Access funding incentives for conservation |
| 3. Liaise with landholders, management bodies and managers | 12. Seek to acquire community and buffer |
| 4. Install markers | 13. Monitor flora |
| 5. Develop Fire Management Plans | 14. Monitor weed populations |
| 6. Implement Fire Management Plans, implement dieback hygiene | 15. Replant / rehabilitate |
| 7. Implement weed control | 16. Monitor for dieback |
| 8. Monitor depth and timing of inundation | 17. Conduct research |
| 9. Disseminate information | 18. Report on management strategies |

# 1 BACKGROUND

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

The plant community occurs on soils that are mapped as Muchea Limestone or Plain limestone deposits in the Urban Geology Map Series (Anon 1976 a and b, 1977; 1978; Gozzard 1982 a, 1982 b; 1983 a, 1983 b, 1986). The soil type extends from Muchea to Benger approximately parallel to the scarp, and may have been indicative of a fracture line associated with the Darling Scarp. The soils are frequently mounded up above the surrounding area and are likely to reflect areas of spring activity in the past, where carbonates have precipitated out of solution (McArthur and Bettenay 1960).

The plant community that occurs on these soils reflects the unusual mixture of limestone, clay and sands. Many of the species are commonly associated with the Tamala limestone soils that occur on the coast, and do not generally occur further inland. The communities that occur on these soils appear to vary as a result of differences in the relative amounts of the major three components - limestone, clay and sand; with the depth to limestone in the soil profile; and with the degree of inundation (Keighery and Keighery 1995 - refer Appendix 2). The remnants in best condition where the limestone is most developed in the soils are rises dominated by *Melaleuca huegelii* shrubland or *Eucalyptus decipiens* mallee (Keighery and Keighery 1995). Wetter areas on the soil type are dominated by *Casuarina obesa* woodland or *Melaleuca* shrublands (Keighery and Keighery 1995). Floristic analyses of occurrences on this soil type link to Spearwood communities - reflecting the limestone in the soil; or with plant communities on calcareous silts - reflecting both the clay and the limestone in the soils (Department of Environmental Protection (DEP) 1996).

The vegetation on these soils once extended from Gingin to Benger (McArthur and Bettenay, 1960). The largest areas of the soil type occurred north west of Gingin and the most westerly occurrences are along the Gingin Brook, in very heavy black clay soils (Keighery and Keighery 1995). Churchward and McArthur (1980) refer to the presence of marl in the Yanga, Mungala and Bootine landforms. The Mungala soils consists of black clays and are associated with the greatest development of limestone. In particular, a reserve on Bootine Road occurs on these very heavy soils, and a species list for plots in this site occurs at Appendix 3.

The Muchea Limestone soil type occurs on the eastern side of the Swan Coastal Plain, an area that is some 97% cleared (CALM 1990) as the heavy soils were useful for agricultural purposes. An additional impact on the community has been the mining of the limestone. At the time of release of the Gibson *et al.* (1994) report - "A floristic survey of the southern Swan Coastal Plain" no significant remnants of the community on the Muchea Limestone soils were known from public lands. Since then, vegetated occurrences from north of Gingin (31$^{o}$ 14'S, 115 $^{o}$ 46'E) to Passmore Street, Gosnells have been found. This occurred during the integrated process of updating the 'System 6' Conservation Through Reserves System Recommendations (DEP 1996) and the Ministry for Planning Urban Bushland Strategic Plan, resulting in Perth's Bushplan (State of Western Australia 1998). Most of these vegetated areas are extremely small or degraded, not all had been mapped as Muchea Limestone on the soils maps, and some of the less significant occurrences identified have yet to be added to CALM's threatened ecological communities database.

Some areas of the Muchea Limestone are seasonally inundated with fresh water. This inundation could be due to flows of surface water accumulating above the impermeable clay soils, but in some cases the surface may be in contact with the groundwater table.

Remaining vegetation on Muchea Limestone soils is mostly altered by grazing, mining or other disturbances. It is unknown to what extent fire has influenced the present structure or composition of the vegetation. The grazing would almost certainly have increased the invasion of exotic species in occurrences of the community.

There are 29 typical and common native species that are regularly associated with the soil type; one tree, eighteen shrubs, six herbs and two grasses (Keighery and Keighery 1995 - see Appendix one).

Two of the *Grevillea* taxa that occur in the community are Critically Endangered, (*Grevillea curviloba* subsp. *incurva* and *Grevillea curviloba* subsp. *Curviloba)*, while *Grevillea evanescens* is a Priority 1 taxon (refer to Appendix 1 for definitions). Another taxon, *Haloragis aculeolata* that commonly occurs in the community is a Priority 2 species. The major threats to the community are weed invasion, grazing, inappropriate fire regime, clearing, and possibly changes to hydrology such as salinisation and altered patterns of inundation. Dieback, as caused by *Phytophthora* species is not recorded from occurrences of the community, but may be present.

**Table 1: Extent and location of occurrences**

| Occurrence Number | Location | Estimated area |
|---|---|---|
| 1 | **Bootine Road, Gingin;**<br>Part 1 Nature Reserve (A45035) vested in the National Parks and Nature Conservation Authority (NPNCA)<br>Part 2 Owned freehold by State of WA, to be added to reserve A45035 | 6 ha<br><br>53 ha |
| 2 | Reserve C2336 Muchea (now vested in the NPNCA) | 0.06 ha |
| 3 | Vines Stage 5 (privately owned) | 28 ha |
| 4 | Private land, Beermullah West Road, Gingin | 3.8 ha |
| 5 | Yurine Swamp Nature Reserve A9676 | No intact remnants |

## 1.2 Description of Occurrences

Occurrence 1 is on Bootine Road, Gingin and contains the most significant area of the community type in good condition. The occurrence was located by staff of the Department of Environmental Protection and CALM, and has now been added to the conservation reserve system, with two purchases funded jointly by CALM and Environment Australia.

This occurrence is on very heavy clay soils in an area where the limestone is well developed. Vegetation on the site was flattened by rolling in 1985 by previous owners. The first lot acquired, in 1996 (Part 1 in Table 1), was of 6 ha and had been allowed to regenerate naturally. In the absence of subsequent disturbance such as grazing or cropping, that lot has regenerated well.

The second acquisition, a lot of 64.7 ha containing about 53 ha of the limestone community (Part 2 in Table 1), abuts Part 1. This later acquisition has been partly sewn down to introduced pasture species and sporadically grazed since rolling and there is significant weed invasion in some areas, although much natural regeneration is occurring.

Occurrence 2 is a very small area of the community in the old Townsite reserve in Muchea. The reserve was vested in the National Parks and Nature Conservation Authority in 1996. This reserve and Occurrence 5 in Yurine Swamp Nature Reserve appear to occur where the limestone is at greater depth in the soil profile (Keighery and Keighery 1995). Prior to the area becoming a Nature Reserve, limestone was mined from the Yurine Swamp site, leaving no intact remnants of the community (B. Keighery[1] personal communication). If left undisturbed, however, some degree of regeneration may occur.

Occurrence 4 on Beermullah West Road is on comparable soils and is inhabited by a similar suite of species to those at the Bootine Road reserve (Keighery and Keighery 1995). The plant communities on these soils differ in composition from those that occur on soils where the limestone appears to be at greater depth, contains more sand, is geographically isolated from other areas containing the community type, or where the degree of inundation differs (Keighery and Keighery 1995; see Appendix 2).

All of the remaining occurrences are on private land. Occurrence 3 at 'The Vines' occurs on soils that are wetter and have a high component of sand (Keighery and Keighery 1995). This area appears to have been

[1] Bronwen Keighery, Department of Environmental Protection, 141 St Georges Terrace, Perth, 6000

grazed historically and has been invaded by weeds in some areas. Occurrence 4 on Beermullah Road West has also been grazed. The Vines occurrence contains the largest known population of the Critically Endangered *Grevillea curviloba* subsp. *curviloba* (DEP 1996).

## 1.3 Biological and ecological characteristics

Our understanding of variation in the floristics of the community with the different soil types, depth to limestone and moisture regimes is gleaned from sparse information about areas that are small and frequently degraded. The full variation in the community that existed prior to European settlement may never be known, as the full suite of variation may not be represented in the remaining occurrences. Some occurrences of the community are seasonally inundated (surface water in wetter months), in particular those on the heavier impermeable clays such as the reserve on Bootine Road (Occurrence 1) and the occurrence on private land on Beermullah Road West (Occurrence 4). Some of the plant taxa present are particularly adapted to such water regimes, for example *Casuarina obesa* and *Melaleuca viminea*.

Many of the plant species that frequently occur in the community are commonly associated with Tamala limestone on the coast and may be obligate calcicoles (species dependent on the presence of limestone); eg *Allocasuarina lehmaniana*, *Baeckea robusta*, *Comesperma integerrimum*, *Dodonaea aptera, Eucalyptus decipiens, Eucalyptus foecunda*, *Hibbertia spicata* ssp. *leptotheca*, *Lechenaultia linearioides*, *Melaleuca acerosa*, *Melaleuca huegelii*, and *Pimelea ferruginea* (Keighery and Keighery 1995). Some taxa appear to be restricted to the Muchea Limestone or similar soils, eg *Grevillea curviloba* ssp. *curviloba* and *Grevillea curviloba* ssp. *incurva* (Keighery and Keighery 1995). Removal of the limestone from the soils, as occurs when the limestone is mined, is likely to result in conditions being unsuitable for regeneration of such plants (eg. Occurrence 5).

Soil analysis undertaken on the reserve on Bootine Road indicates pH of between 7.8 to 8.3. The alkalinity results from the presence of the limestone in the soil profile. Another characteristic of the Muchea Limestone soils at Gingin is low nitrogen and phosphorus levels.

## 1.4 Hydrology

Hydrological data on the Muchea limestone community are from personal observations of those who identified the community, and from information on the hydrogeology of the Swan Coastal Plain in Davidson (1995). In the areas where inundation does occur, in particular, on the heavier soils (Occurrences 1 and 4), the Muchea limestone community contains limited surface water during the wetter months.

The typical occurrence on these soils is seasonally inundated in winter for a period of around three months. The heavy soils associated with some occurrences dry to cracking clays in summer.

A trend of falling water tables in the general area is evident since around 1976 (Greay 1993). As there is a corresponding decline in annual rainfall this general fall in the water table may be presumed to be a result of this decline. It is possible that drawdown of the superficial aquifer— the Gnangara Mound—could also have had an effect on occurrences south of Gingin Brook. Conversely, the area is characterised by much valued heavy soils, which were historically highly cleared for agriculture. Clearing is likely to have increased surface runoff and recharge of the groundwater in the local area. Altered surface flow and/or alteration of the height of the local watertable may change the length of the period or depth of ponding.

Saline soils were recorded from the reserve on Bootine Road (Occurrence 1) (Agro-nutritional Research Laboratory, unpublished report). This is probably a result of secondary salinisation and evaporation of ponded surface water coming from adjacent cleared land and perhaps carried by the creek adjacent to the community at this site. The observed salinity could also originate from saline groundwater.

Changes to the watertable could have further implications for salinisation, particularly where groundwater is close to the surface and contains saline water. Davidson (1995) indicates that groundwater is 0-3 metres below the surface in September - October at Occurrences 2 and 3. However, the levels of salinity in that groundwater are low - 250-500 milligrams per litre total dissolved solids (mg/L TDS) in the superficial aquifer that underlies Occurrence 2, and 500-1,000 mg/L TDS under Occurrence 3. This is quite fresh water.

Other occurrences were outside Davidson's study area. Areas overlying fresh groundwater on the Swan Coastal Plain are probably associated with low risk of salinisation (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, where the Muchea Limestone soils occur. About 97% of all vegetation in the area was cleared historically (CALM 1990), hence this type has suffered almost total destruction.

### Mining

Historically, the Muchea Limestone soils have been extensively mined for limestone. South of Gosnells, it appears that all occurrences have been mined (Keighery and Keighery 1995). Plants that are obligate calcicoles are unlikely to regenerate once the limestone is removed from the soil profile. In addition, regeneration techniques such as returning the topsoil and controlling weeds would not have been developed when much of this community was mined. Hence, regeneration is not likely to have returned the community to anything approaching its original state.

The occurrence in Yurine Swamp, which is now a Nature Reserve, has been highly altered by mining. As mentioned, no intact remnants of the community are located in this reserve (B. Keighery personal communication). However, with minimal additional disturbance and with weed control, some components of the original plant community may return.

### 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. Weeds are also likely to be favoured by increased nutrient levels from animal droppings, as local species are generally adapted to more impoverished soils.

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 those weeds that pose the greatest threat to the community in the early stages of invasion where possible; eg invasive perennial grasses, Watsonia.
4. Rehabilitating the vegetation through reintroduction of local native species where areas are no longer capable of regenerating following weed control.

### Grazing

Grazing of the community is likely to have caused alterations to the species composition by the selective grazing of edible species, the introduction of weeds and nutrients, trampling and general disturbance.

Continued grazing would probably result in continuing modification of the species composition and community processes.

**Altered fire regimes**

Fires are likely to have a significant affect on the vegetation composition in Mediterranean ecosystems (Gill *et al.* 1981). It is also likely that the fire regime in the community has been extensively modified since European settlement to more frequent fires, especially hot ones. Most Mediterranean ecosystems are likely to be adapted to fire and indeed may require a particular fire frequency to assist regeneration. If this level 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 senesce and be unable to regenerate. Therefore, fires must occur at appropriate intervals to maintain the composition of plant communities. As this community is not well studied, little is known of the community's requirements in terms of fire regime to maintain species composition.

All disturbance in remnant vegetation is likely to result in increasing weed invasion, particularly where remnants are small. Therefore, fire frequency should be minimised unless research indicates the need to increase fire frequency. In addition, the risk of fire is increased by the presence of grassy weeds in the understorey, as they are likely to be more flammable than original native species in the herb layer.

**Hydrological changes**

Increased clearing would be expected to result in increased runoff and an increase in recharge to the groundwater table, while on the other hand uncontrolled extraction from irrigation bores may lower groundwater levels, especially in summer. This would be significant in occurrences of the community where surface water and groundwater are in contact. In these sites, altered periods or depths of ponding may affect the timing of growth of herbs in the understorey, and may also affect the species composition of the community by favouring different plant species.

Pollution of the surface waters with animal droppings or fertilisers would increase nutrient levels and hence favour weed invasion.

**Salinisation**

Salinisation may increase as a result of evaporation of surface water, especially at those occurrences north of the Gingin Brook and not influenced by the fresh groundwater of the Gnangara Mound. If increased ponding occurs in the community due to clearing or urbanisation 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, like those at the more northern occurrences, which inhibit rainfall infiltration and result in high evaporation rates and concentration of salts (Davidson 1995).

The levels of salinity in the community should be monitored to determine if salinisation poses a major threat to the community, especially at occurrences north of Gingin Brook. Remedial actions such as replanting with deep rooted vegetation in strategic parts of the catchment may be necessary if monitoring indicates secondary salinisation is a problem.

**Disease introduction**

It is not known if the community type is susceptible to dieback from *Phytophthora* species, or other diseases. Risk of introduction of disease should therefore be minimised wherever the community occurs by ensuring good hygiene procedures. This would involve washdown of any equipment used adjacent to the community.

**Erosion by wind and water**

Erosion by wind and water may also occur following removal of vegetation by grazing, clearing, mining, or fire, especially where the community is located on lighter soils, such as Occurrence 3.

## 1.6 Conservation status

This community met the following criterion for Critically Endangered (CR) ecological communities on 21/11/95 (from English and Blyth 1997):

B ii) 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 AIM AND CRITERIA

**To maintain or improve the overall condition of the Muchea Limestone community and reduce the level of threat with the aim of reclassifying it from Critically Endangered to Endangered.**

## 2.1 Criteria for success

An increase in the area and number of occurrences of this community under conservation management.

Maintenance in terms of diversity and basic composition of native species (as described in Keighery and Keighery 1995; DEP 1996) as well as hydrological and biological processes, taking account of natural change of the community over time.

Improvement in terms of reduction of numbers of exotic species (as described in DEP 1996) and of other threatening processes as defined above.

## 2.2 Criteria for failure

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

# 3. GENERAL MANAGEMENT ACTIONS REQUIRED

Note: 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, in cooperation with the Western Australian Threatened Species and Communities Unit (WATSCU) and the Recovery Team has the primary responsibility for securing funds for recovery actions.

## 3.1 Establish a Recovery Team

To be established as a joint team to deal with this community and the Perth to Gingin ironstone community. Proposed membership: landholder, CALM Perth District (chair), CALMScience, WATSCU, planning officer - Shire of Gingin, Fire and Rescue Service. The Recovery Team will report annually to CALM's Corporate Executive.

**Responsibility**: CALM (WATSCU)
**Cost**: Nil
**Completion date**: Year 1

## 3.2 Clarify and continue to monitor the extent and boundaries of the community

Occurrences should be monitored every two years. Boundaries can be determined from current aerial photographs and minimal 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 recommend the establishment of a Geographic Information System database for information on threatened ecological communities. When this is available, boundary information for occurrences of the community should be included.

The community is considered to have been well searched for (DEP 1996; Gibson *et al.* 1994). The boundaries of most occurrences have been mapped (from plot data and inference from current aerial photographs by V. English - unpublished data),

The discovery of additional uncleared areas of the community seems unlikely as it is considered to have been well searched for in likely areas during the System 6 Update survey (DEP 1996; State of Western Australia 1998); and the survey undertaken for the Gibson *et al.*, (1994) study. However, those new occurrences found during the System 6 Update survey (DEP 1996) still remain to be entered on the threatened communities database.

**Responsibility**: CALM (Perth District, WATSCU)
**Cost**: $300 every second year
**Completion date**: Completed for Occurrence 1. Others ongoing

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

Some of the occurrences of the community are privately owned. The involvement of land managers, landholders, local community groups and industry in the recovery of the community wherever possible and practical is therefore essential to the recovery process.

Stakeholders include owners of private land on which the community occurs and CALM's Perth District which manages the community on reserves vested in the National Parks and Nature Conservation Authority (NPNCA).

**Responsibility**: CALM (Perth District; WATSCU)
**Cost**: $2,500 for all liaison (not including vehicle costs)
**Completion date**: Ongoing

## 3.4 Install markers to indicate the location of the community

CALM mark, or encourage the appropriate authorities to mark the occurrences which occur alongside tracks, roads and firebreaks 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) and will be included in a future policy on Threatened Ecological Communities being prepared by CALM.

**Responsibility**: CALM (Perth District; WATSCU); in consultation with owners of land containing the community
**Cost**: $600
**Completion date**: Year 1

## 3.5 Design and implement a program for monitoring flora of the shrublands and woodlands on Muchea Limestone

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

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

Two floristic plots occur in the Bootine Road reserve (but none in the recently acquired area intended to be added to the reserve), and there is one plot in each of Occurrences 2, 3 and 4 (DEP 1996). Permanent plots should be put into Occurrence 5, and the recently acquired portion of Occurrence 1. All native and weed species have been recorded for all plots, but density or cover values for each species were not included in these data. This additional information would be essential for determining changes over time (eg as a result of too frequent fire or the success of a rehabilitation strategy). 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 (DEP 1996).

Data should be entered on a database program such as that used by Gibson *et al.* (1994) and unknown plant species should be collected (except identified Declared Rare Flora). Following the second monitoring period, data should be analysed and compared, and incorporated into a full Recovery Plan if developed.

**Responsibility**: CALM (Perth District; WATSCU)
**Cost**: $4,000 every second year for monitoring the six plots currently in the community, and two additional plots in the portion of Occurrence 1 still to be added to the nature reserve and in Occurrence 5
**Completion date**: Ongoing

## 3.6 Develop and Implement a Fire Management Strategy

### 3.6.1 Develop and implement fire management plans that encompass the following (3.6.1-3.6.4) and include an annual fire monitoring and reporting schedule

There is a need for research into recovery of the community from wild fire (to be completed under Action 3.5 - flora monitoring), and to determine the implications of findings for management. This would also include developing a fire history map of the occurrences, which is 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 it is necessary and urgent.

A Fire Management Plan has been developed for Talbot Road reserve 23953 in Stratton. 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 weed monitoring, and maintenance of fire breaks. It also records the location of significant areas such as locations of Declared Rare Flora (DRF) and Priority taxa, and threatened ecological communities. A similar plan should be developed for all occurrences of this community, using the plan for Talbot Road reserve 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. Close liaison with all stakeholders is required to develop Fire Management Plans.

**Responsibility**: CALM (Perth District; WATSCU); in liaison with all stakeholders
**Cost**: $4,250 for preparation of guidelines
**Completion date**: Year 2

### 3.6.2 Ensure maintenance of strategic firebreaks to help prevent fire spreading to the community

Maintenance of existing firebreaks is appropriate where firebreaks are already constructed, unless maintenance is likely to cause spread or intensification of dieback or otherwise degrade the community. Careful use of herbicides should be considered as an alternative method of maintenance of firebreaks to minimise soil movement and risk of dieback spread. No new fire breaks should be constructed or existing breaks upgraded around occurrences of this community on CALM-managed lands without the approval of the Director of Nature Conservation. No new fire breaks should be constructed within this community.

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

**Responsibility**: CALM (Perth District)
**Cost**: Cost of firebreaks $1,800 pa; costs of liaison included in 3.3
**Completion date**: Ongoing.

### 3.6.3 Liaise with surrounding landholders 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 this community should be avoided.

**Responsibility**: CALM (Perth District) in liaison with owners of land containing, or adjacent to, the community
**Cost**: Costs of liaison included in 3.3
**Completion date**: Ongoing

### 3.6.4 Ensure fire suppression strategy does 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. Further, chemicals that may be toxic to the community should not be used. Guidelines for appropriate fire suppression actions similar to those developed for Talbot Road reserve (refer 3.6.1) should be developed for areas that contain this community

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

**Responsibility**: CALM (Perth District) responsible for implementing this Action for Occurrences 1, 2 and 5. Landowners responsible for action in occurrences on private land; CALM (Perth District) responsible for liaison with local Bush Fire Brigades and Fire and Rescue Service
**Cost**: Costs of preparation of guidelines and liaison included in 3.6.1; additional funds for CALM District staff to attend fires in the community - $300 pa
**Completion date**: Ongoing

## 3.7 Assess and monitor weed populations

Floristic data held in DEP (1996) may help determine weeds that pose the greatest threat as all weed species that occur in plots have been recorded. Some significant weeds in occurrences also may not occur in plots, however. DEP (1996) data included detailed species lists, but cover or density information were not reported for weeds. Populations of weeds that are a high priority for control should be accurately mapped for all occurrences and appropriate herbicides or other method of weed control determined.

**Responsibility**: CALM (Perth District)
**Cost**: Weed monitoring incorporated into Action 3.5; $1,500 every second year for mapping of the boundaries of weeds species
**Completion date**: Ongoing

## 3.8 Implement weed control, and replanting where necessary

Initial stages of rehabilitation should involve control of perennial weeds, 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 DEP (1996) and from the results of Action 3.5.

The highest priority should be controlling weeds that pose the greatest threat to the community in the early stages of invasion where possible (eg invasive perennial grasses and *Watsonia)*. Rehabilitation through reintroduction of local native species may be necessary if areas are no longer capable of regenerating following weed control.

Only seed from the same occurrence should be used for rehabilitation. No seed from other areas should be introduced into occurrences.

**Responsibility**: CALM (Perth District)
**Cost**: $3,000 pa for weed control; costs of replanting and rehabilitation to be determined
**Completion date**: Ongoing

## 3.9 Monitor salinity and groundwater levels, and depth and timing of inundation

Occurrences of the community may be at risk from salinisation due to rising groundwater and increased ponding as a result of clearing of the catchment. Monitoring salinity and ponding in occurrences would indicate if remedial action was necessary in the catchment. This might include strategic planting of deep rooted vegetation to increase water usage.

Groundwater levels and salinity are routinely monitored by the Water and Rivers Commission (WRC) in specific areas and data for areas close to the community should be analysed. The local Landcare District Committees (LCDCs) and Agriculture Western Australia may also have data on groundwater levels and quality for areas near the community.

The depth and timing of inundation for occurrences that experience seasonal inundation should be measured by checking against a depth gauge at specific intervals (say weekly during winter, and monthly thereafter). This would only be possible where surface water accumulates in occurrences (Occurrences 1, 4 and 5).

**Responsibility**: CALM (Perth District); liaison with the WRC, Agriculture Western Australia and LCDCs
**Cost**: $1,500 pa for measuring depth and timing of inundation (Occurrences 1, 4 and 5)
**Completion date**: Ongoing

### 3.10 Ensure dieback hygiene

Occurrences have not been tested for presence of dieback. 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 on existing tracks through the community, and restricting access by vehicles and machinery to dry soil conditions.

Standard practice should therefore be that all vehicles entering tracks through remnants that contain the community be free of soil and plant-propagules. No vehicles should be permitted onto undisturbed bushland where the community occurs.

**Responsibility**: All personnel using machinery in the occurrences; liaison to be undertaken by CALM (Perth District)
**Cost**: Costs of liaison included in 3.3; other costs to be underwritten by user of machinery
**Completion date**: Ongoing

### 3.11 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 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 should ensure regular liaison with owners of land containing the community to ensure threatened ecological community information is up to date.

A publicity campaign utilising signs on site, local media and poster displays in prominent areas should be undertaken to encourage awareness about this threatened ecological community. Information on the community was included in an issue of Landscope (English *et al.* 1996) and reprints of this article were reprinted and widely distributed.

**Responsibility**: CALM (Corporate Relations Division Perth; Perth District; WATSCU)
**Cost**: $2,000
**Completion date**: Ongoing

### 3.12 Determine if dieback represents a threat to the community, and if so, determine priority areas for treatment

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 using CALM's Dieback Protocol (K. Vear[2] personal communication). 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 been recorded in this community, but may be present. If dieback is detected, any dieback front should be monitored at least every two years in summer and flagging marking the front replaced regularly. Floristic plot information (refer 3.5) would provide useful monitoring data.

**Responsibility**: CALM (Perth District)

[2] Kevin Vear, Dieback Coordinator, CALM, Hayman Road, Como, 6152.

**Cost**: $5,000
**Completion date**: Year 1

### 3.13 Design and conduct research

Research should be designed to increase the understanding of the biological and ecological characteristics of the community to assist future management decisions. Such research could include:

1. The impact of weeds on the community.

2. The role of disturbance in regeneration of the community.

3. The development of a monitoring system. Protocols will be developed based on recommendations held in English and Blyth (1997).

4. Significant biological processes in the community such as pollination biology, germination requirements, longevity and time taken to reach maturity of important plant taxa in the community.

5. Monitoring of water depth, timing and depth of inundation, and water quality in the community

**Responsibility**: CALM (CALMScience); Perth District; 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**: To be determined

### 3.14 Report on success of management strategies for the community

Reporting will be part of annual reports prepared by Recovery Teams for CALM's Corporate Executive. The final report will 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 District; WATSCU)
**Cost**: Nil
**Completion date**: End of Year 3

**Specific conservation management actions required - reserve on Bootine Road, Reserve 2336 Muchea, and Yurine Swamp Nature Reserve Number 9676 - Occurrences 1, 2 and 5.**

### 3.15 Upgrade fencing on reserves where necessary

The perimeter fencing on reserves that contain the community should be upgraded where necessary, to ensure stock are excluded and vehicle access can be limited to management purposes only.

**Responsibility**: CALM (Perth District)
**Cost**: Fencing for Bootine Road reserve (Occurrence 1) - $4,000; gate and upgrade of fencing for Muchea Townsite reserve (Occurrence 2) - $1,000
**Completion date**: Year 1

**Specific management actions - Occurrence 4 - private farmland, Beermullah Road, Gingin.**

### 3.16 Encourage and assist landowner to access available incentives and mechanisms for conserving the Muchea Limestone community

Access incentives for protection, including the Remnant Vegetation Protection Scheme and other sources, to ensure long term protection of the community.

**Responsibility**: CALM (Perth District; WATSCU); liaison with landholders
**Cost**: Costs of liaison included as part of 3.3
**Completion date**: Ongoing

### 3.17 Seek to acquire occurrences if the community is not being successfully managed for conservation, or if they become available

If management for conservation seems unlikely under recommendations in this IRP, or if land that contains the community becomes available, CALM seek funds and seek to negotiate purchase of the occurrence and an adequate buffer area if required and declare the area Class A reserve for the purpose of 'Conservation of Flora and Fauna' vested in the National Parks and Nature Conservation Authority (NPNCA). Boundaries of areas to be acquired should be determined from Action 3.2.

**Responsibility**: CALM (Land Administration Section; Perth District; WATSCU); Environment Australia
**Cost**: Market price of land at time of purchase
**Completion date**: Completed for what will be a 70.7 ha Nature Reserve on Bootine Road. Other acquisitions if and when necessary

### 3.18 Fence community to ensure stock are excluded and vehicle access can be limited to management purposes only

Occurrence 4 is likely to require about 1.2 kilometres of fencing. Fencing requirements should be accurately determined following survey under Action 3.2.

**Responsibility**: CALM (Perth District)
**Cost**: Approximately $4,800
**Completion date**: Year 1

**Specific actions requires - Vines Stage 5 development area - Occurrence 3.**

### 3.19 Reserve Occurrence 3

Negotiate with landholder to have Muchea Limestone occurrence, and a suitable buffer area if necessary, declared Class A reserve for Conservation of Flora and Fauna vested in the National Parks and Nature Conservation Authority (NPNCA).

**Responsibility**: Department of Environmental Protection (DEP), Ministry for Planning, Shire of Swan, CALM (Perth District; Land Administration Section); liaison with landholder
**Cost**: Costs of liaison included in 3.3
**Completion date**: To be determined

### 3.20 Determine appropriate location of fences for Occurrence 3

Ensure fences protect the community (and suitable buffer area if required) and ensure that vehicle access to the Muchea Limestone community can be limited to management purposes only.

**Responsibility**: CALM (Perth District) in liaison with landholder, Department of Environmental Protection (DEP), Ministry for Planning (MFP), Shire of Swan
**Cost**: Costs of liaison included in 3.3; costs of fencing to be determined

**Completion date**: To be determined

**Table 2: Summary of recovery actions**

| Recovery Action | Occurrences | Responsibility | Completion date |
|---|---|---|---|
| Establish Recovery Team | All | CALM (WATSCU) | Year 1 |
| Clarify and monitor boundaries | All | CALM (Perth District, WATSCU) | Ongoing |
| Liaise with landholders, management bodies and managers | All | CALM (Perth District, WATSCU) | Ongoing |
| Install markers | All | CALM (Perth District, WATSCU) | Year 1 |
| Develop Fire Management Plans | All | CALM (Perth, District, WATSCU) in consultation with all stakeholders | Development of Fire Management Plans has begun. To be completed in Year 1. |
| Implement Fire Management Plans, implement dieback hygiene | All | CALM (Perth District), landowners | Ongoing |
| Implement weed control | All | CALM (Perth District) | Ongoing |
| Disseminate information | All | CALM (Corporate Relations Division, Perth District, WATSCU) | Ongoing |
| Fence occurrences | 1, 2, 3, 4 | CALM (Perth District) | Year 1 for Occurrences 1, 2, 4. Timing to be determined for Occurrence 3. |
| Access funding incentives for conservation | 4 | CALM (Perth District; WATSCU) | Ongoing |
| Seek to acquire community and buffer | 3, 4 | CALM (Perth District, Land Administration Section; WATSCU); Environment Australia | Year 1 |
| Monitor flora | All | CALM (Perth District, WATSCU) | Ongoing |
| Monitor weed populations | All | CALM (Perth, District) | Ongoing |
| Replant / rehabilitate | Costs to be determined | CALM (Perth District) | Ongoing |
| Monitor depth and timing of inundation | 1, 4, 5 | CALM (Perth District); liaison with WRC, LCDCs and Agriculture Western Australia | Ongoing |
| Monitor for dieback | All | CALM (Perth District) | Year 1 |
| Conduct research | All | CALM (CALMScience, Perth District, WATSCU) | No date set |
| Report on management strategies | All | CALM (Perth District; WATSCU) | Year 3 |

**Table 3: Summary of costs for each recovery action**

| Recovery Action | 1998 | 1999 | 2000 |
|---|---|---|---|
| Establish Recovery Team | | | |
| Clarify and monitor boundaries | 300 | | 300 |
| Liaise with landholders, management bodies and managers | 1,000 | 1,000 | 500 |
| Install markers | 600 | | |
| Develop Fire Management Plans | 2,250 | 2,000 | |
| Implement Fire Management Plans, implement dieback hygiene | 2,100 | 2,100 | 2,100 |
| Implement weed control | 3,000 | 3,000 | 3,000 |
| Disseminate information | 500 | 1,500 | |
| Fence Occurrence 1 | $4,000 | | |
| Fence Occurrences 2 and 4 | ~5,800 | | |
| Fence Occurrence 3 | To be determined | | |
| Access funding incentives for conservation | - | | |
| Seek to acquire Occurrences 3 and 4 | To be determined | | |
| Monitor flora | 4,000 | | 4,000 |
| Monitor boundaries of weed populations | 1,500 | | 1,500 |
| Inspect for dieback | 5,000 | | |
| Replant / rehabilitate | To be determined | | |
| Monitor depth and timing of inundation | 1,500 | 1,500 | 1,500 |
| Conduct research | To be determined | | |
| Report on management strategies | - | | |
| **Total** | **45,150** | **11,100** | **12,900** |

Summary of costs over three years
Total $69,150 (costs excluded shown above)

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**APPENDIX 1**

**Typical and common native species regularly associated with Muchea Limestone soils (from Keighery and Keighery 1995).**

| Taxon | Status |
|---|---|
| **Trees** | |
| *Casuarina obesa* | |
| **Mallees** | |
| *Eucalyptus decipiens* | |
| *Eucalyptus foecunda* | |
| **Shrubs** | |
| *Acacia leptospermoides* ssp. *leptospermoides* | |
| *Allocasuarina lehmaniana* | |
| *Alogyne huegelii* var. *huegelii* | |
| *Baeckea robusta* | |
| *Comesperma integerrimum* | |
| *Darwinia* sp *"Muchea"* | |
| *Diplopeltis huegelii* | |
| *Dodonaea aptera* | |
| *Exocarpus sparteus* | |
| *Grevillea curviloba* ssp. *curviloba* | CR |
| *Grevillea curviloba* ssp. *incurva* | CR |
| *Grevillea evanescens* | P1 |
| *Hibbertia spicata* ssp. *spicata* | |
| *Lechenaultia linearioides* | |
| *Melaleuca acerosa* | |
| *Melaleuca huegelii* | |
| *Pimelea ferruginea* | |
| *Stylobasium australe* | |
| **Herbs** | |
| *Apium annum* | |
| *Conostylis candicans* | |
| *Haloragis aculeolata* | P2 |
| *Senecio lautus* ssp. *dissectifolius* | |
| *Thysanotus arenarius* | |
| *Wilsonia humilis* | |
| **Grasses** | |
| *Stipa flavescens* | |
| *Poa ?porphyroclados* | |

P1 = Priority one taxon (CALM 1998)
P2 = Priority two taxon (CALM 1998)

## APPENDIX 2

### Major structural formations of the Muchea Limestone plant community varying with depth to limestone; the overlying soil type; and under different water regimes (from Keighery and Keighery 1995)

**Where the Muchea Limestone is best developed**

**On rises with outcropping limestone:**
*Eucalyptus decipiens* mallee over heath often dominated by *Melaleuca huegelii.*
*Melaleuca huegelii* heath or shrubland over *Grevillea evanesens* and *Xanthorrhoea preissii.*

**On wet flats:**
Scattered *Casuarina obesa* over *Melaleuca lateriflora*, *Grevillea evanescens* and *Melaleuca viminea* shrubland and herbs.
*Melaleuca huegelii*, *Grevillea evanescens* and *Melaleuca* species shrubland and herbs.
*Casuarina obesa* open woodland over *Poa* grassland and herbs.

**Creekline:**
*Eucalyptus rudis* open forest over *Melaleuca rhaphiophylla* open low forest over shrubland over tall sedgeland and grassland.

Areas: Bootine Road, Beermullah West Road

**Where the limestone appears to be at greater depth, is more remote or the limestone area is geographically isolated from other limestone areas:**

**On sand dunes (often yellow or orange):**

*Banksia* woodlands over heath
*Acacia saligna* shrubland over herbs
*Eucalyptus decipiens* mallee

**On damper sands over limestone:**

Open Marri woodland over mixed shrublands usually containing *Melaleuca huegelii*, *Acacia saligna, Grevillea curviloba* and *Regelia ciliata*.

Areas: Yurine Swamp Nature Reserve, Bambun Road, Muchea, Vines and Gosnells

**APPENDIX 3**

Species list - reserve on Bootine Road Gingin (from DEP 1996)

| | **Taxon** | **Status** |
|---|---|---|
| | *Acacia pulchella* | |
| | *Acacia saligna* | |
| * | *Acacia* sp. | |
| | *Agrostis* sp. | |
| * | *Anagallis arvensis* | |
| | *Allogyne huegelii* | |
| | *Apium annuum* | |
| * | *Aster subulatus* | |
| * | *Avena fatua* | |
| * | *Bellardia trixago* | |
| | *Baumea juncea* | |
| * | *Briza maxima* | |
| * | *Briza minor* | |
| | *Cassytha ?glabella* | |
| | *Casuarina obesa* | |
| | *Centaurium erythraea* | |
| | *Centrolepis aristata* | |
| | *Cryptandra* sp. | |
| | *Dampiera alata* | |
| | *Danthonia* sp. | |
| | *Daviesia physodes* | |
| | *Dichopogon preissii* | |
| | *Dodonaea aptera* | |
| * | *Ehrharta calycina* | |
| | *Eryngium pinnatifidum* | |
| | *Eucalyptus decipiens* | |
| * | *Eucalyptus gomphocephala* | |
| * | *Eucalyptus platypus* | |
| | *Grevillea evanescens* | P1 |
| | *Gahnia trifida* | |
| | *Goodenia micrantha* | |
| * | *Hainardia cylindrica* | |
| | *Haloragis aculeolata* | P2 |
| | *Hakea varia* | |
| * | *Hypochaeris glabra* | |
| | *Isolepis cernua* | |
| | *Juncus bufonis* | |
| | *Kunzea recurva* | |
| | *Lepidosperma longitudinale* | |
| | *Melaleuca huegelii* | |
| | *Melaleuca lateriflora* | |
| | *Melaleuca teretifolia* | |
| | *Melaleuca viminea* | |
| | *Mitrasacme paradoxa* | |
| | *Opercularia vaginata* | |
| | *Pimelea ferruginea* | |
| | *Plantago* sp. | |
| | *Pogonolepis stricta* | |
| | *Pogonolepis* sp. | |
| | *Ptilotus ?manglesii* | |
| | *Scaevola ?holosericea* | |
| | *Scaevola lanceolata* | |
| * | *Schinus molle* | |

APPENDIX 3 .....cont

| | | |
|---|---|---|
| | *Schoenus* sp. *2* | |

| | |
|---|---|
| | *Senecio lautus* subsp. *dissectiflora* |
| | *Stylobasium australe* |
| | *Thysanotus arenarius* |
| | *Thysanotus patersonii/ manglesianus* complex |
| | *Tricoryne elatior* |
| | *Triglochin mucronata* |
| | *Viminaria juncea* |
| * | *Vulpia* sp. |
| | *Wilsonia humilis* |

## GLOSSARY

**Status of flora taxa (from CALM 1998)**

| | |
|---|---|
| **Declared Rare Flora (DRF)** | '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.' |