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# Native Vegetation Handbook for the Shire of West Arthur

Shaun B. Grein

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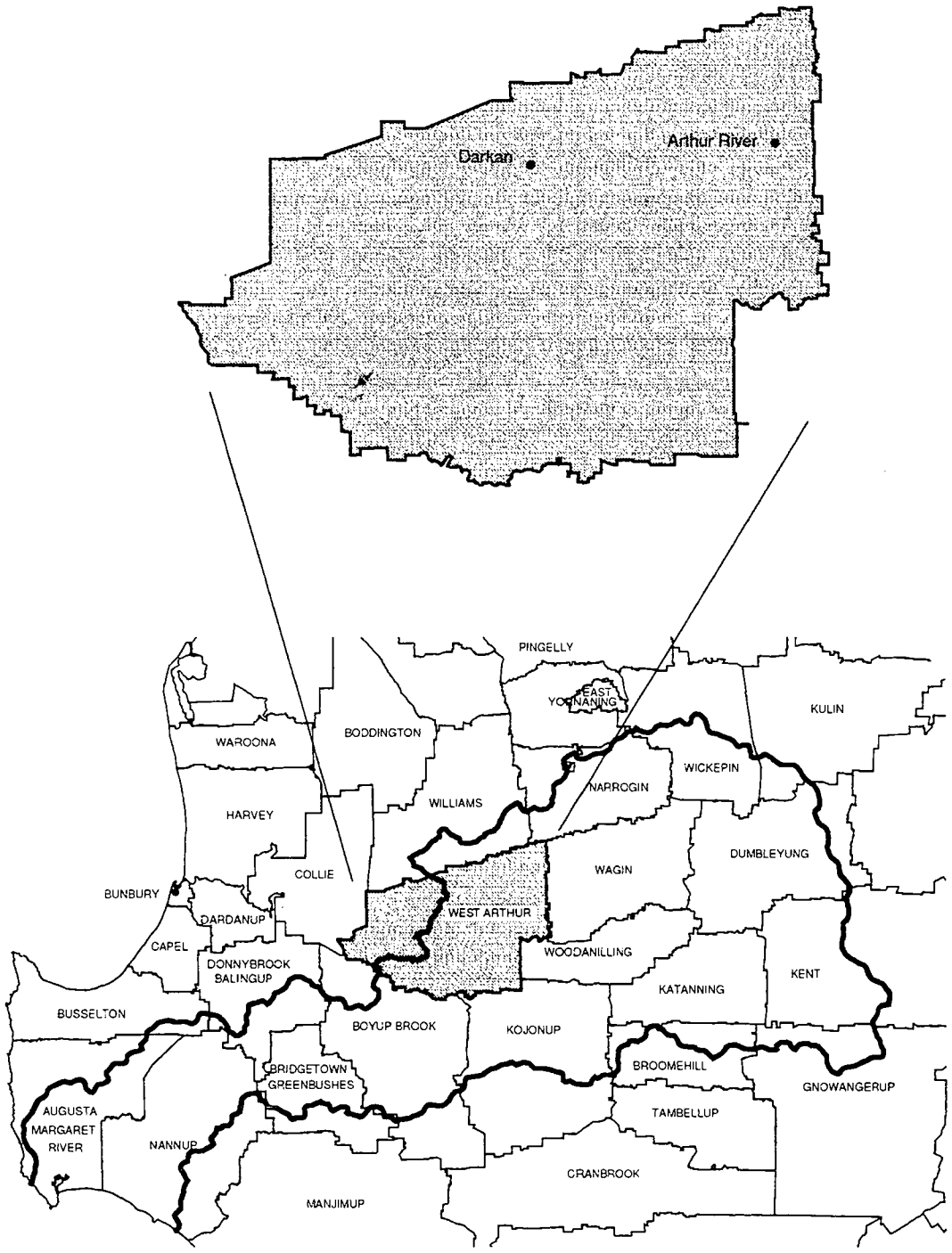


Agriculture
WESTERN AUSTRALIA

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Australian Nature Conservation Agency

## Acknowledgments

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All cartographic work carried out by Matthew Chafer.

Copies of the Native Vegetation Handbook for the Shire of West Arthur are available by contacting:

The Spatial Resources Information Group
Western Australian Department of Agriculture, South Perth
Phone: (09) 368 3732

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**Cover: The Shire of West Arthur in Relation to the Blackwood River Catchment (indicated by bold line).**

# NATIVE VEGETATION HANDBOOK

# FOR THE SHIRE OF WEST ARTHUR

Shaun B. Grein

Spatial Resources Information Group

Land Management Branch

Division of Regional Operations

Western Australian Department of Agriculture

Produced by the Western Australian Department of Agriculture and Greening Western Australia with the assistance from the Commonwealth Government through the Australian Nature Conservation Agency's Save the Bush Program.

November, 1994

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# The Shire of West Arthur

## Introduction

### Purpose of this Booklet

This project has arisen from the need to provide data to people in rural communities, land conservation districts (LCDs) and local government authorities who manage the remnant native vegetation within rural areas, whether on a regional, catchment or local basis.

This booklet is one of a series covering the agricultural region of Western Australia. The management of native vegetation and agricultural land is closely related. It is vital that both native vegetation and agricultural land issues are considered within the context of their ecological area of influence. Both have a wide range of effects on each other and as a consequence should be managed together. For example native vegetation has an effect on the hydrology of agricultural land, and nutrients can be transferred from farmland to remnants of native vegetation.

This booklet provides land managers with information relating to the natural resources of the Shire of West Arthur including the existing vegetation, drainage systems and soils. Some of the problems relating to the management of natural vegetation resources in the Shire of West Arthur and possible solutions to these problems are also discussed. By providing this information it is hoped this booklet will contribute to the long term viability of the agricultural landscape and the conservation of native vegetation within the Shire.

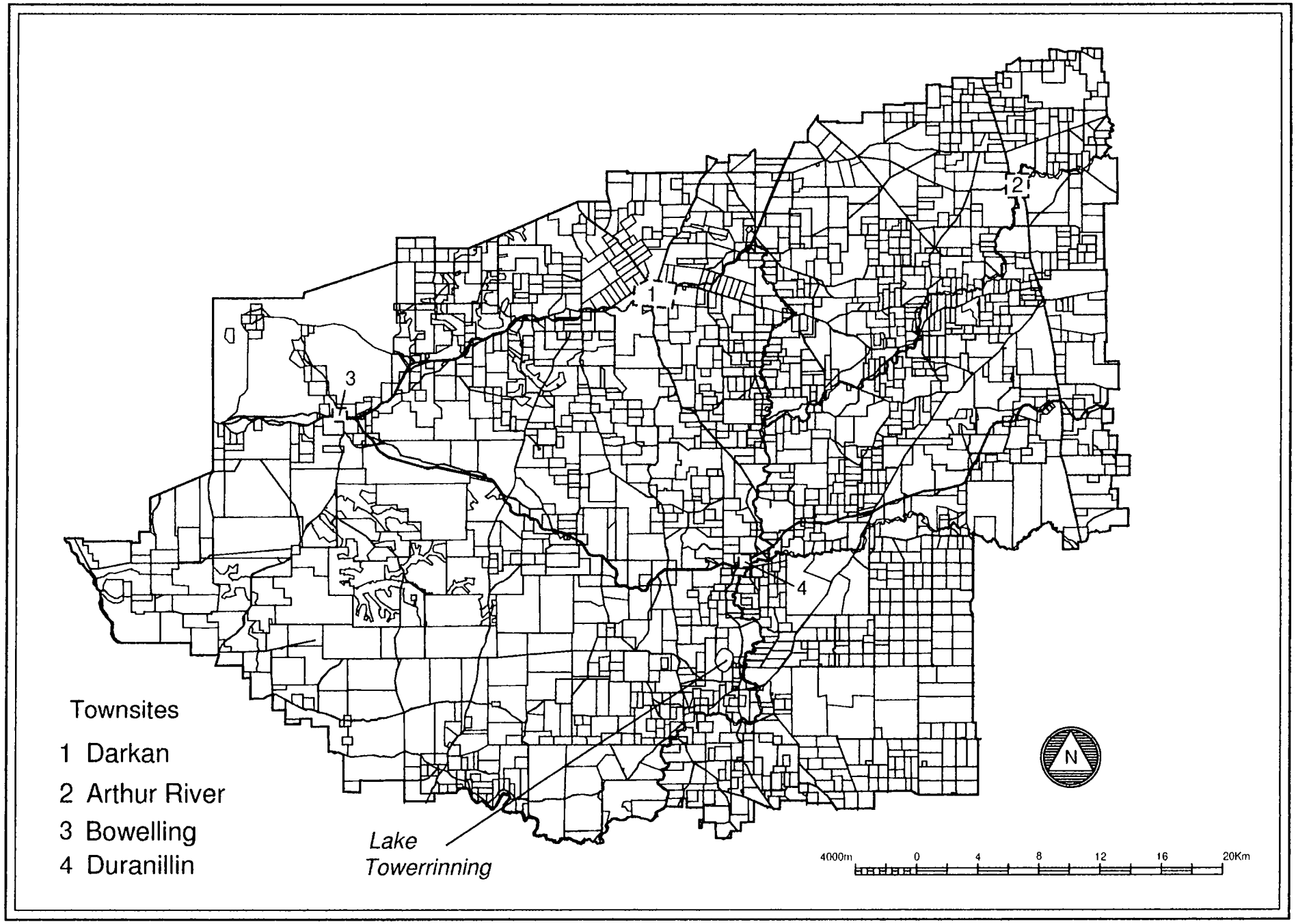


Figure 1 Cadastral Boundaries and townsites in the Shire of West Arthur.

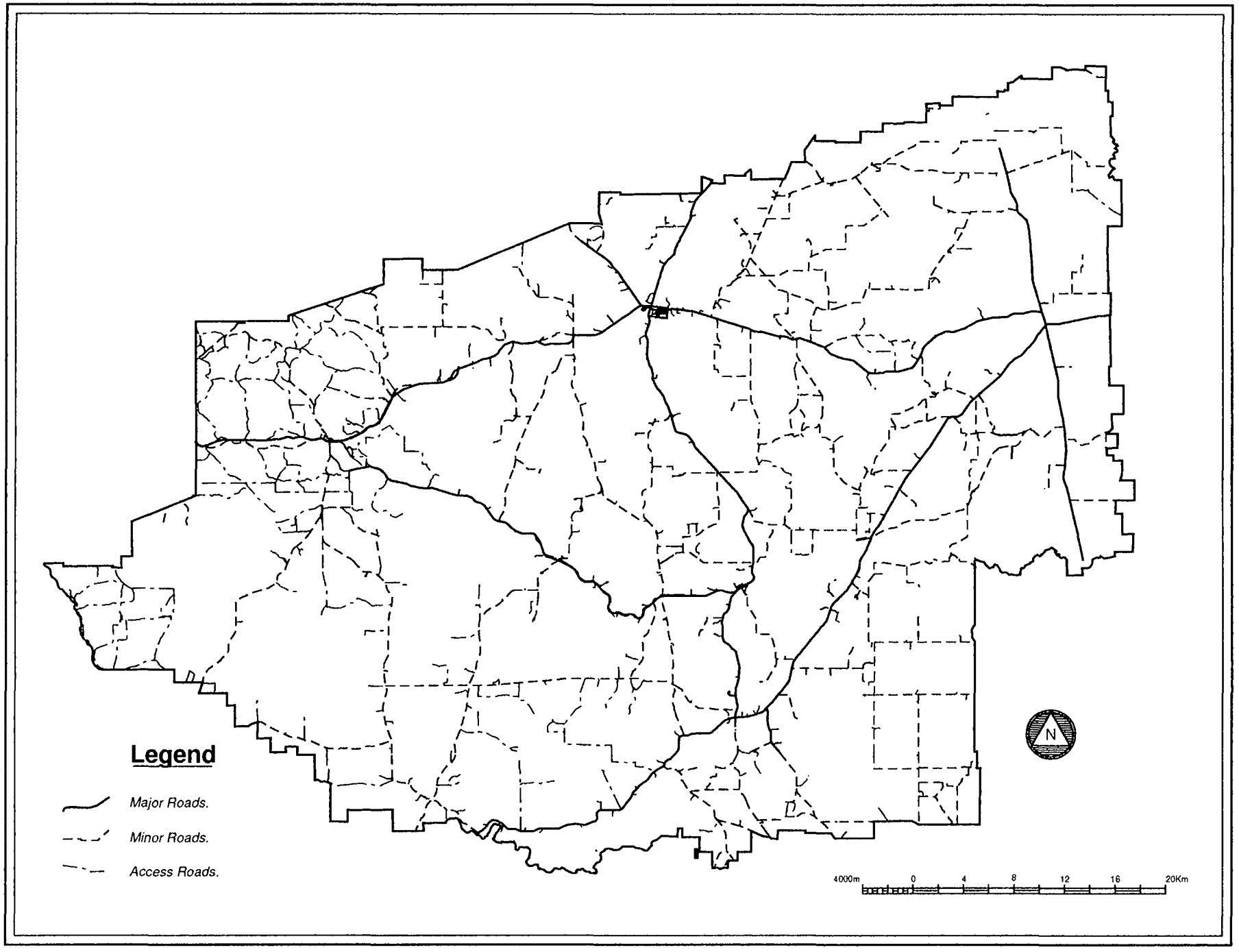


Figure 2 All major, minor and access roads in the Shire of West Arthur.

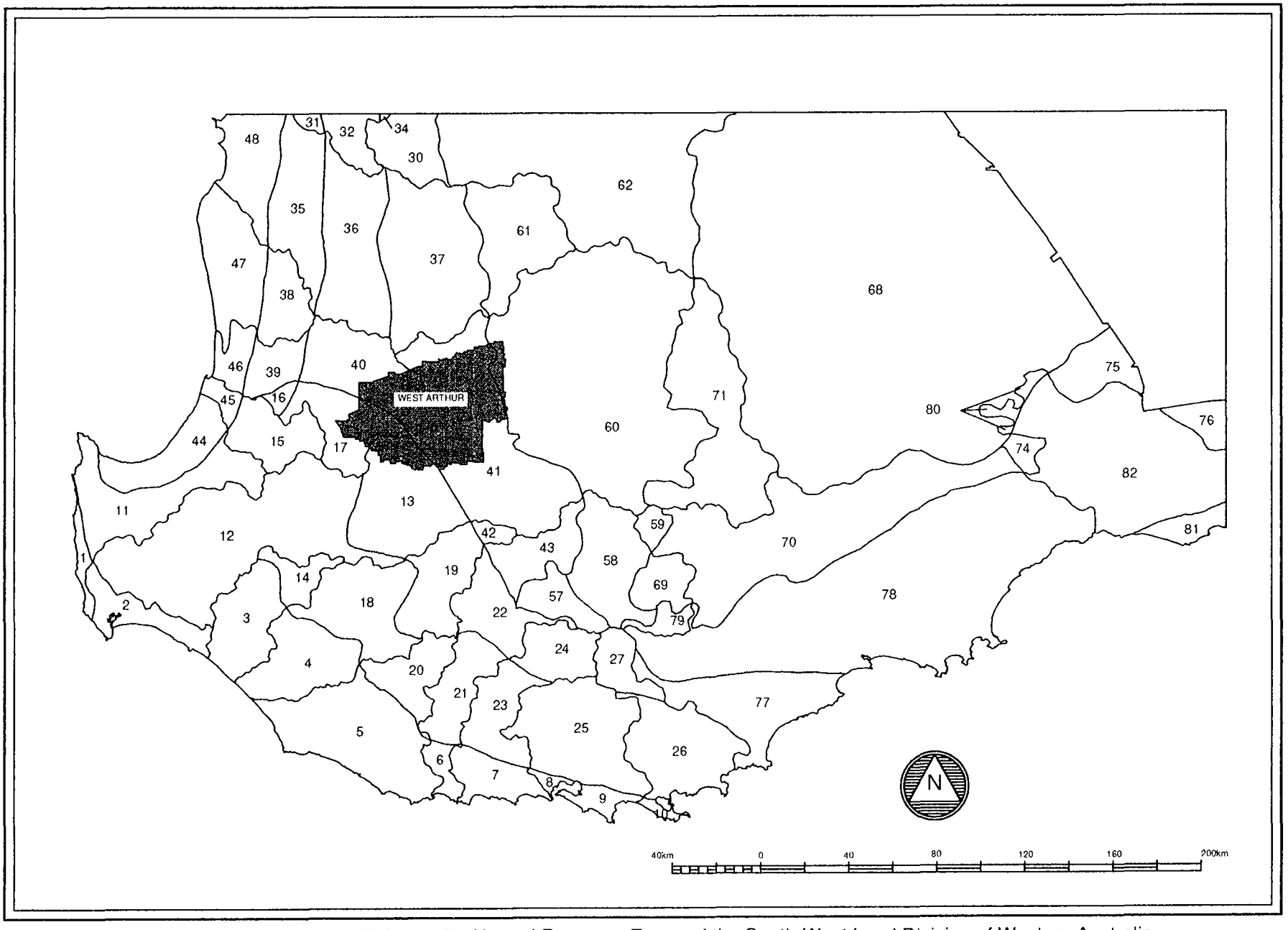


Figure 3: The Shire of West Arthur in relation to the Natural Resource Zones of the South-West Land Division of Western Australia (Allison, *et.al* 1993).

**The Shire of West Arthur**

The Shire of West Arthur covers an area of 282614 hectares. Most of the Shire is located in the Blackwood River Catchment (see cover map) with a substantial portion of the western region of the Shire within the Wellington Dam Catchment. The Shire is drained by the Arthur, Hillman, Beaufort and Blackwood Rivers. Townsites in the Shire include Darkan, Duranillin, Moodiarrup, Bowelling and Arthur River (Figure 1).

The Shire's climate is regarded as Mediterranean, with dry, warm summers and cool winters. Darkan receives on average, 660 mm rainfall per annum. The average maximum temperature ranges from 31$^0$C in January to 16$^0$C in July, while the corresponding average minimum temperatures ranges from 14$^0$C in February to 4$^0$C in August. The population of the Shire was 1100 in 1992 (Municipal Directory, 1992). Agricultural land use in the Shire is predominantly wheat and sheep:- in 1991/92 a total of 299.8 hectares of the Shire was sown with wheat, 139229.4 hectares with sown pasture and grasses, 16731 hectares of native pastures, 350 hectares with hay and 767 hectares left fallow (ABS, 1992). The cadastral boundaries in the Shire are shown in Figure 1 and all 1032 kilometres of road network in the Shire is shown in Figure 2

The South-west of Western Australia has been divided into districts (called Natural Resource Zones) on the basis of their natural resources ie vegetation type, drainage/catchment system and rainfall (Allison *et al.*, 1993). The Shire of West Arthur contains parts of five Natural Resource Zones (No.13, 17, 40, 41 and No.60) (Figure 3) making it a mosaic of three vegetation regions (Menzies and Dale subdistricts and Avon District) and two drainage systems (Collie and Blackwood Rivers) within an area receiving less than 500 mm to 1100mm rainfall per annum.

The West Arthur Land Conservation District (LCD) is based on the Shire's boundaries.

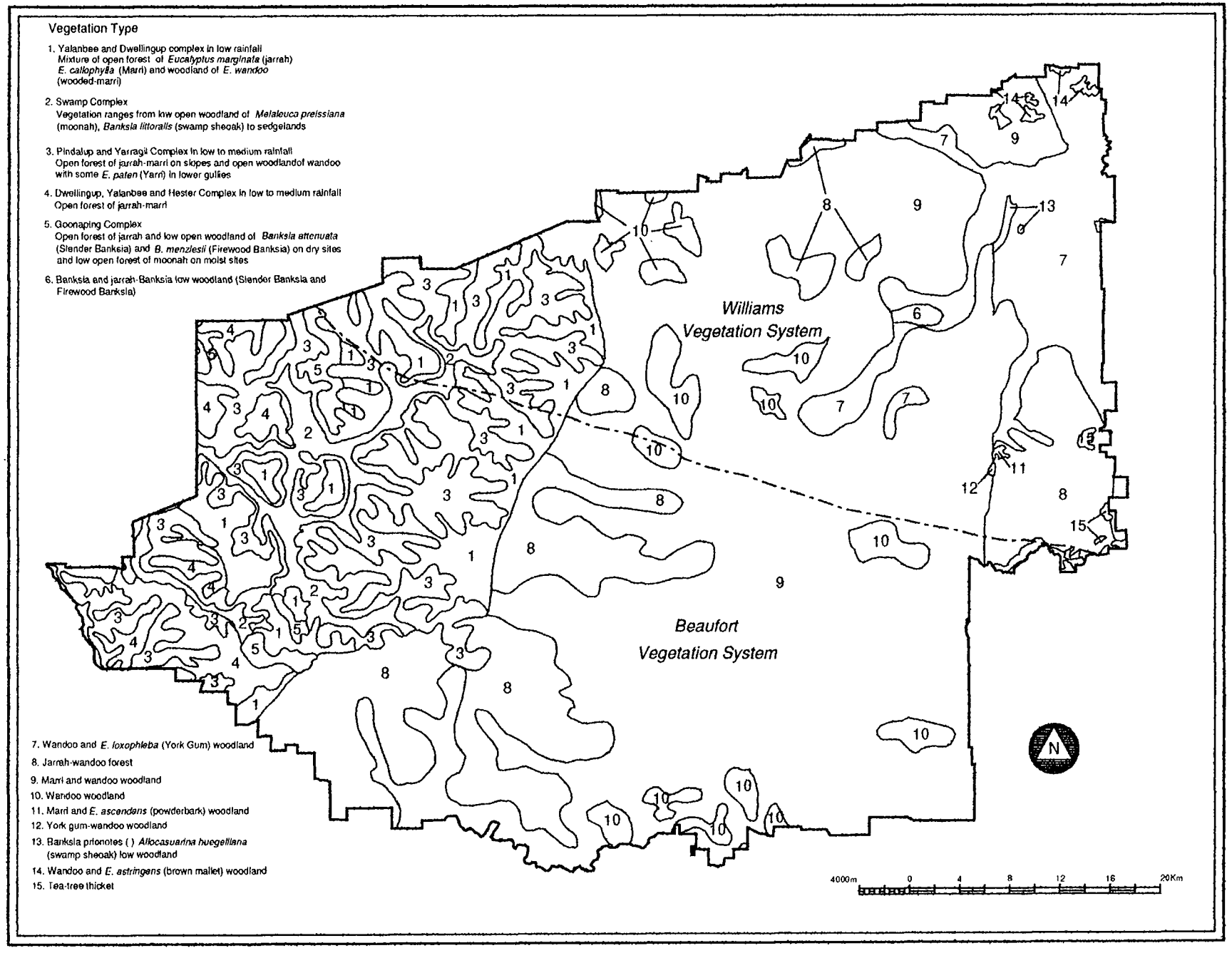


Figure 4: Vegetation systems (italics, dashed line) and major vegetation types (continuous lines) in the Shire of West Arthur (According to Beard, 1980b, 1981 and Heddle *et al* 1980).

## Vegetation of the Shire of West Arthur - Past And Present

Native vegetation has been degraded in a variety of ways as a consequence of the extensive clearing and agricultural practices. In the South-west of Western Australia, clearing for agricultural purposes has resulted in the removal of 85-95% of native vegetation. More than 80% of plant species now extinct were formerly found on land cleared for agriculture.

Physical factors such as soil and climate combine to produce natural ecological regions, within which the plant life essentially similar. Western Australia is divided into three Botanical Provinces (ie. natural ecological regions) - the South-Western, the Eremaean, and the Northern (Beard, 1980a). The Botanical Provinces are in turn divided into Botanical Districts and then into Vegetation Systems. The Shire of West Arthur lies within the Avon and the Darling Botanical Districts of the South-West Botanical Province. Each of these Vegetation Systems consists of a series of plant communities occurring in a mosaic pattern which are closely linked to topographic and soil features.

The western third of the shire is not covered by a Beard's 1:250,000 sheet and the detail of vegetation given in his 1:1,000,000 Swan sheet is too general to show on a shire basis. A small area of the eastern edge of the shire is captured in Beard's 1:250,000 series. It has therefore been necessary to also use a combination of the System 6 Collie vegetation sheet (Heddle *et al*, 1980), Beard's 1:250,000 Dumbleyung sheet (Beard, 1980b) and his 1:1,000,000 Swan sheet (Beard, 1981) to provide the most detailed vegetation description (Figure 4). As Beard's Vegetation Systems are closely linked to the soil type on which they grow, so too are plant communities described in the Collie Vegetation sheet.

### Brief Description of the Vegetation Systems and System 6 Vegetation Communities

This section is based on the plant distribution studies of J.S. Beard and the CALM (formerly the Department of Environment and Conservation). Further detail can be obtained from the following references - i) Heddle, E.M., Longeran, O.W. and Havel, J.J. (1980). *Atlas of Natural Resources, Darling Range System, Western Australia. Collie Vegetation Sheet.* Department of Environment and Conservation. ii) Beard, J.S., (1981). *Vegetation Survey of Western Australia: Swan 1:1,000,000 Vegetation Series with Explanatory Notes.* University of Western Australia Press, Perth. iii) Beard, J.S., (1980b). *The Vegetation of the Dumbleyung Area: Vegetation Map and Explanatory Memoir (1:250,000 series).* Vegmap Publications, Perth

### *Description of Vegetation Mapping Units in the Collie Vegetation Sheet*

The Collie Vegetation Sheet attempts to depict the original native vegetation that existed before European settlement. Although the Collie Sheet concentrates mainly on the vegetation of the Darling Plateau, a small area of the map to the east of the plateau covers the eastern third of the Shire of West Arthur. The Darling Plateau and adjoining areas have been subdivided into 28 vegetation complexes. The vegetation complexes are defined in relation to soil-landform units and, where relevant, to average annual rainfall readings, meaning the main determinants of the vegetation complexes are landform, soils and annual rainfall. There are 5 vegetation complexes covering the western third of the Shire of West Arthur and these are described in the following section.

**1. Yalanbee and Dwellingup Complex in Low Rainfall**

This complex consists of a mixture of open-forest of jarrah (*Eucalyptus marginata*)-marri (*Eucalyptus calophylla*) and a woodland of wandoo (*Eucalyptus wandoo*)-marri and is restricted to areas of low rainfall (600-850 mm). The dominant vegetation types are, the prickly bitterpea (*Daviesia decurrens*), jarrah, *Lepidosperma angustatum*, semaphore sedge (*Mesomelaena tetragona*), hairy flag (*Patersonia rudis*), common pinheath (*Styphelia tenuifolia*), wandoo, honey bush (*Hakea lissocarpha*), zamia (*Macozamia riedlei*), *Leucopogon capitellatus* and *Leucopogon propinquus*. Less dominant vegetation includes pincushions (*Borya sphaerocephala*), fuchsia grevillea (*Grevillea bipinnatifida*), oval-leaved hakea (*Hakea elliptica), Hakea undulata*, Darling Range ghost gum (*Eucalyptus laeliae*) and low open-forest of rock sheoak (*Allocasuarina huegeliana*) and herblands on shallow soils overlying granitic rocks.

**2. Swamp Complex**

This complex is associated with the swamp valley floors of the Yarragil and Pindalup complexes and small areas of the Goonaping complex. The vegetation is diverse and varied owing to the wide distribution of this complex from high rainfall areas in the west to low rainfall areas to the east of the Darling Plateau. Swamps are most developed in areas surrounding the upper reaches of the Darkan Swamp, the Bingham, Harris and Collie Rivers and Beraking Brook. The vegetation ranges from modong (*Melaleuca preissiana)*-swamp banksia (*Banksia littoralis*) to sedgelands on the wetter soils. Swamps are distinguished by the variety of teatree species which include *Melaleuca cymbifolia*, grey honeymyrtle (*Melaleuca incana*), *Melaleuca subtrigona*, broom bush (*Melaleuca uncinata*), mohan (*Melaleuca viminea*) and robin redbreast bush (*Melaleuca lateritia).* Other species include sandplain cypress (*Actinostrobus*

*pyramidalis*), variable-leaved hakea (*Hakea varia)* and several *Verticordia* species. The dominant vegetation of the Swamp complex is yarri (*Eucalyptus patens*).

**3. Pindalup and Yarragil Complex in Low to Medium Rainfall.**

This complex defines the distribution of the most westerly extension of wandoo woodland in the shallow upper valleys. Generally the vegetation complex is predominantly comprised of an open-woodland of wandoo with some marri, yarri and jarrah and an open-forest of jarrah-marri. As the majority of valleys covered with wandoo-yarri woodlands occupied more fertile soils, most have now been cleared to make way for agricultural production.

**4. Dwellingup, Yalanbee and Hester Complex in Low to Medium Rainfall**

This complex is similar to other complexes on the uplands in that it supports an open-forest of jarrah-marri. However the floristic composition of the understorey reflects the lower rainfall and warmer temperatures of the northern and eastern regions of the jarrah forest. This complex extends from Lower Chittering in the north, the full length of the eastern section of the Darling Plateau to the series of ridges just south of Boyup Brook. The dominant vegetation types are the prickly bitterpea, jarrah, Blueboy (*Stirlingia latifolia*), honeybush, *Leucopogon capitellatus, Leucopogon cordatus,* zamia, *Patersonia rudis,* and the common pinheath. Occurring less frequently are hairy glandflower (*Adenanthos barbigerus*), bull banksia (*Banksia grandis*), Wilson's grevillea (*Grevillea wilsonii*), holly-leaved hovea (*Hovea chorizemifolia*), false boronia (*Phyllanthus calycinus*) and karri hazel (*Trymalium floribundum*).

**5. Goonaping Complex**

This complex occurs on shallow depressions and consists of a variety of structural formations. In localised moist, low-lying areas there are similarities with the Swamp Complex. The vegetation ranges from the open-forest of jarrah-marri through to low open-woodland of slender banksia (*Banksia attenuata*)-firewood banksia (*B. menziesii*) to low open-forest of moonah-swamp banksia and low open-woodland of moonah-swamp banksia on the moister soils. The dominant vegetation types are jarrah, common smokebush (*Conospermum stoechadis*), prickly bitterpea, candle hakea (*Hakea ruscifolia*), *Hibbertia polystachya, Leptocarpus tenax,* semaphore sedge and blueboy.

***Beards 1:250,000 Dumbleyung and 1:1,000,000 Swan Sheets***

The **Williams Vegetation System** occurs on an undulating plateau from which most of the lateritic sheet has been eroded and the hills are of basement rock. Some jarrah

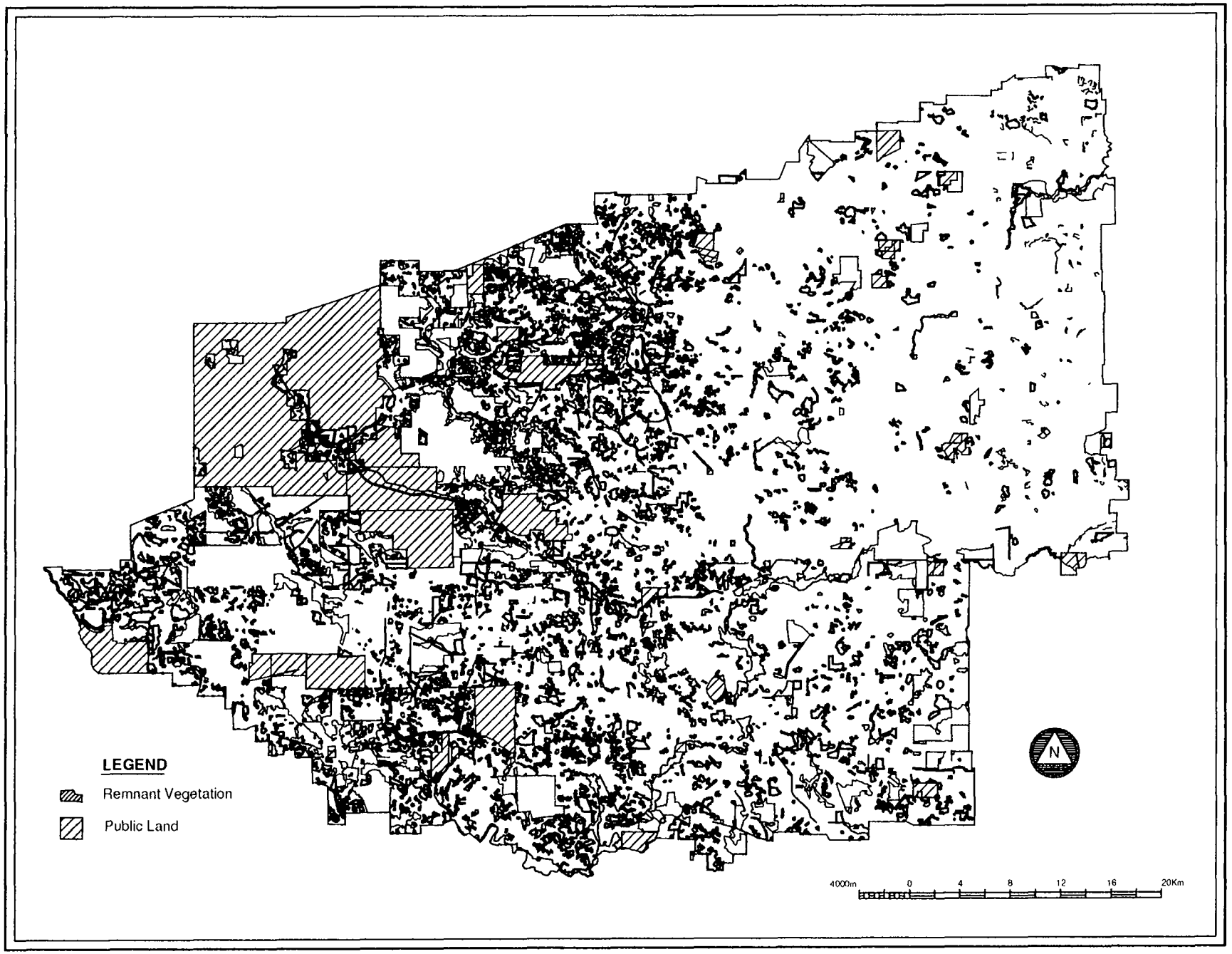


Figure 5: The Shire of West Arthur showing native vegetation cover. Twenty nine percent of the Shire remains covered by native vegetation, with nineteen percent on private land.

occurs where the soil is gravelly, but usually only as woodland which often merges with wandoo. On lateritic hill tops and breakaways brown mallet (*Eucalyptus astringens*) forms open forest, while on granitic hills and slopes marri and flooded gum (*Eucalyptus rudis*) form woodland. On lower slopes of hills and valleys York gum (*Eucalyptus loxophleba*) forms woodland with jam (*Acacia acuminata*) understorey.

The **Beaufort Vegetation System** covers the south-eastern corner of the Shire of Williams and occurs in similar country to the Williams System but lacks granite hills. The principle elements of this vegetation system landscape are woodland of wandoo on laterite residuals, woodlands of York gum and wandoo on undulating country and woodland of York gum and flat-topped yate (*Eucalyptus occidentalis*) on sand patches. Often there is a mosaic of different combinations of Eucalyptus spp. woodland on a variety of landscapes (Beard, 1980b)

**Current Extent of Native Vegetation**

The total area of native vegetation in the Shire of West Arthur has been reduced through broadscale clearing for agricultural, horticultural and forestry purposes. However, much of the native vegetation that remains in public reserves and on private land is similar in composition to that which existed previously, although the extent of cover has been significantly reduced. The Shire contains a significant number of reserves and areas of uncleared land carrying jarrah/marri forest and wandoo woodland.

Approximately 29% of the Shire of West Arthur remains covered by original native vegetation, 19% (54003 ha) of which is found on private land. This is more than any other shire in the Blackwood catchment. The remaining 10% (28627.9 ha) exists as public reserves, water reserves, crown land and gravel pits etc, not all of which has a cover of native vegetation.

In the Shire of West Arthur there are 4710 bush remnants, of which 70% or 3314 remnants are regarded as being "remnant vegetation", 27% or 1302 remnants regarded as being "scattered trees" and 3% or 94 remnants as being of "modified vegetation". More than 91% of all bush remnants in the Shire are less than 20 ha in area (Beeston *et al.*, unpub.) (Figure 5).

**Vegetation classed as "remnant vegetation" has one or more of the following characteristics (Beeston *et al.*, unpub.) :**

* Most closely reflects the natural state of vegetation for a given area.
* Has an intact understorey (if forest or woodland).
* Has minimal disturbance by agents of human activity.

**Vegetation classed as "modified vegetation" has one or more of the following characteristics:**

* Degraded understorey (i.e. reduction in the number of native species, includes weeds).
* Obvious human disturbance- clearing, mining, grazing, weeds.
* Affected by salt.
* Narrow corridors of vegetation (usually along roads and railway lines or windbreaks), which are more likely to be affected by edge effects.

**Vegetation classed as "scattered vegetation" have:**

* No understorey.
* Parkland cleared i.e. are scattered single trees
* No significant signs or chance of regeneration.

There are 10 nature reserves vested by the National Parks and Nature Conservation Authority, the Water Authority of W.A. and the W.A Wildlife Authority in the Shire of West Arthur. These range in size from 40 ha, for the Haddelton Springs Nature Reserve, to 1161 ha for Haddleton Nature Reserve, to 294 ha for the Wild Horse Swamp Nature Reserve. Other nature reserves in the shire include Hillman Nature Reserve, Beaufort Bridge Nature Reserve, Trigwell Nature Reserve, Towerinning Nature Reserve, Boolading Nature Reserve, Arthur River Nature Reserve and Dead Man's Swamp Nature Reserve.

In 1991 Frans Mollemans undertook a botanical survey of the Shire of West Arthur (Mollemans, unpub.)(N.B. Copies of the findings of this survey are available by contacting the Spatial Resource Information Group, WADA, 368 3732). A total of 525 bush remnants in the Shire were surveyed by Mollemans including two in detail. For all of Mollemans detailed surveys, each remnant was classified according to its plant communities (ie a,b,c ect).

**Remnant 85**

Location: 2 km ESE of Dardadine, 23.5 km south of Williams, 16 km NE of Darkan, and 21 km NW of Arthur River; 33^14'55"S, 116^52'00"E; c. 300 m.

a - jarrah - wandoo + marri woodland over *Dryandra* spp. shrubland.
b - marri + wandoo woodland over shrubland.
c - wandoo + marri woodland over shrubland.
d - sheoak + jam + wandoo woodland over shrubland and herbland.
e - wandoo woodland over dryandra scrub community.
f - Open wandoo woodland over grass - herb - shrub layer on sandy loam soil.
g - Mixed scrub community.

**Remnant 86**

Location: 10 km NNE of Arthur River, 27 km WNW of Wagin, and 27 km SW of Highbury; 33^14'55"S, 117^03'42"E; ca 275 m.

a1 - banksia + sheoak + *Dryandra sessilis* (3.5-5.5 m) tall shrubland over ca. 1.5 m open shrubland.
a2 - *Banksia* over *Eremaea pauciflora* ca. 1.5 m open to closed shrubland.
b - *Eremaea pauciflora* - mixed shrub scrub and heath to 80 cm - 1.2 m tall.
c - wandoo-sheoak woodland on ironstone + granite outcrop; sand soil non-wetting in character.

For complete flora list of Remnants 85 and 86 see Appendices 8 and 9.

**Wetlands**

Wetlands are defined by the Wetlands Advisory Committee as ".... areas of seasonally, intermittently or permanently waterlogged soils or inundated land whether natural or otherwise, fresh or saline, e.g. waterlogged soils, ponds, billabongs, lakes, swamps, tidal flats, estuaries, rivers and tributaries".

The rise of saline groundwater as a result of the clearing of native vegetation has been well documented throughout the agricultural region. The wetlands of the wheatbelt have suffered enormous changes as a result of these salinisation processes.

Most of the wetlands in the Blackwood River Catchment were fresh or near fresh until the 1940's. Prior to increases in salinity the wetlands were covered by sheoak, paperbark and teatree. Although the majority of the Shire of West Arthur is covered by

the Blackwood River Catchment, Arthur River is the principal water course that runs through it.

Environmental changes in the wetlands of the Blackwood Catchment began with the rise of the saline water table that followed the "opening up" of the wheatbelt in the early 1900's. The salinity changes in the Blackwood River catchment began to take effect in 1940, which was earlier than many other wheatbelt catchments as the region was settled and cleared earlier. These changes were quickly followed by the death of vegetation fringing lakes and wetlands in the catchment.

Many of the vertebrate animals (including water-rats (*Hydromys chrysogaster*), water birds, reptiles and frogs that were once common to wetlands and the surrounding areas have now disappeared. The water rat was noted as being present at Lake Towerinning and Arthur River, before disappearing around 1960. The Clamorous Reed-Warbler (*Acrocephalus stentoreus*) appears to have disappeared from Lake Towerinning. This could be because of increased wetland salinity or the decline of their prey or related to predation by introduced animals, habitat destruction or other factors. Other water birds appear to have colonised wetland areas since they have become saline. This includes the silver gull (*Larus novaehollandiae*) which first appeared at Lake Towerinning in the 1980s in groups of 20 or 30. It has also been noted that some species of birds appear after unusually wet seasons, including black-winged stilts (*Himsntopus himantopus*) and red-kneeded dotterels (*Erythogonys cinctus*) at Lake Towerinning in the early 1980's (Sanders, 1991).

The disappearance of reptiles such as the long-necked turtles (*Chelodina oblonga*) from Lake Towerinning in the early to mid 1970's appears to coincide with the loss of reed beds, although in recent years several have been sighted around the lake. Redfin perch (*Perca fluviatilis*), marron (*Cherax tenuimanus*) and mussels were caught in Arthur River up until the mid 1960s, 10 to 25 years after the onset of salinisation was first noticed (Sanders, 1991).

The Shire of West Arthur has two major wetland areas within its boundaries: Lake Towerinning and Wildhorse Swamp.

Lake Towerinning is a moderate-sized (179.5 ha with a vegetated area of 21.5 ha) (previously) brackish lake with several patches of *Baumea articulata* below the water mark and isolated and live *Melaleuca cuticularis* nearby, slightly higher on the shore.

There is a narrow fringe of *Eucalyptus rudis* above the water mark. *Schoenus* sp. grows sparsely beneath the *E. rudis* (Halse *et al.*, 1993).

Wildhorse Swamp is a small (4.2 ha with a vegetated area of 3.9 ha) brackish swamp containing dense stands of dead paperbark (*Melaleuca rhaphiophylla*) throughout the lake bed with occasional *Halosarcia lepidosperma* growing beneath them. Above the water mark is a closed woodland of paperbark trees with smaller *Melaleuca viminea* thickets. The sedge *Schoenus brevifolius* grows under paperbark. Beyond the zone of *Melaleuca* surrounding the swamp is a woodland of flooded gum.

The amount of salinized land in agricultural areas is still increasing (Schofield *et al.*, 1988), which means that wetlands will continue to become saline and that there will be resultant changes in wetland vegetation. Lake Towerinning was one such wetland where these changes took place. However the local catchment group has done some work to reverse this situation. Following the 1955 "February Flood", freshwater was diverted from Lake Towerinning. Since 1989 the Lake Towerinning Landcare Catchment Group has worked to have freshwater re-diverted back into the lake via a 12 km waterway and in an endeavour to reverse the situation, have removed more than 40,000 tonnes of salt which choked the lake. For these efforts the Landcare Catchment Group was awarded the 1993 Combined Rural Traders Community Landcare Group Award at National Landcare Awards.

**Fauna**

In the Shire of West Arthur animals commonly seen include the western grey kangaroo (*Macropus fuliginosus*) the western brush wallaby (*Macropus irma*) and the echidna (*Tachyglossus aculeatus*) and reptiles including the bobtail (*Tiliqua ragosa*), the blue tongue lizard (*Tiliqua occipitalis*), the dugite (*Pseudonaja affinif*), the mulga snake (*Notechis australis*) and a variety of geckos. Other animals which are considered to be the under threat of extinction and are being monitored include the tammar wallaby (*Macropus eugenii*), the brush wallaby (*Macropus irma*), the red-tailed phascogale (*Phascogale culara*), the red-tailed black-cockatoo (*Calyptorhynchus magnificus naso*) and Carnaby's cockatoo (*Calyptorhynchus funereus latirostris*). Most of these species are under threat because of introduced predators, loss of habitat and of their preferred food. No specific faunal surveys have been undertaken in the Shire, although general reconnaissance surveys have been regularly been carried out by wildlife officers from the Department of Conservation and Land Management's Katanning District Office. For a complete list of avifauna seen in the shire see Appendix 11

The clearing of large amounts of natural bushland for agriculture, the introduction of feral animals, alterations to fire regimes and other disturbances have caused the local extinction of 17 of the 43 species (40%) of mammals recorded from the Wheatbelt since European settlement. Only 12 of the 43 species are now considered to be moderately common to abundant (Kitchener *et al.*, 1980). A total of eight species of mammal have disappeared from the wheatbelt region: *Perameles bougainiville, Chaerpus ecaudatus, Macrotis lagotis, Bettongia lesueur, Lagorchestes hirsutus, Lagostrophus fasciatus, Onychogalea lunata and Leporillus* sp. Mammals in the wheatbelt region thought to be at high risk of becoming extinct include the red-tailed phascogale (although a small colony was recently discovered on the White's property, near Darkan) and the numbat (*Myrecobius fasciatus*) (Sanders and Holt, 1991). For a complete list of all mammals in the shire, see Appendix 10. For details of the reptile and frog species recorded in the shire, see Appendix 11.

Most of the original species of birds still occur in the wheatbelt, although several species have been lost from particular nature reserves (Kitchener *et al.*, 1982). Birds such as whistlers and fairy wrens have not coped well with the changes associated with clearing and are generally declining in numbers. They may well become locally extinct. Species such as Carnaby's cockatoo have undergone a significant reduction through loss of habitat (Saunders *et al.*, 1985).

In the south west of the state, 83% of the land birds are dependant on native vegetation for all or some of their annual requirements (Smith, 1987). Continued loss of these bird species can therefore be expected due to degradation of remnant vegetation and continued clearing. However some species such as galahs (*Cacatua roseicapilla*), ravens (*Corvus coronoides*), crested pigeons (*Ocyphaps lophotes*), magpies (*Gymnorhina dorsalis*), twenty eights (*Platycercus* zonarius) and wood-ducks (*Chenonetta jubata*) have benefited from increased agricultural development and are increasing in numbers.

**Rare and Endangered Flora**

There are approximately 238 plant taxa declared endangered (Hopper *et. al,* 1990) in Western Australia. Many of these can be found within remnants of native vegetation on private land in the Wheatbelt region. There are six Rare and Endangered species of flora found in the Shire of West Arthur.

1. ***Calectasia arnoldii* ms** - Very erect growing plant to 30 cm with stiff, shiny, 6-petalled star-shaped flowers and numerous stilt roots. Some project from upper branches. Found between Corrigin and Dumbleyung.

2. ***Caladenia bryceana* subsp. *bryceana*** (Dwarf Orchid) - Rarely exceeding 9 cm in height, flowers green to apricot in colour with an unusually large leaf. Found between Boyup Brook and Boxwood Hills. Flowering Period - August to October.

3. ***Conostylis drummondii*** (Drummond's Conostylis) - A tufted herb with erect finely hairy subterate leaves to 30 cm long by 0.5-1.5 mm wide, characterised by having stamens at two levels in the flower. Occurs in sandy soil in low woodland and heath between Arthur River and Wagin. Flowering Period - October to November.

4. ***Drakea confluens*** (Late Hammer Orchid) - Uniformly green leaf covered with short dense hairs and distinctive two-coloured labellum. Occurs between Boyup Brook and Stirling Ranges.

5 ***Grevillea cirsiifolia*** (Varied-leaf Grevillea) - A prostrate shrub with erect, narrow leaves to 20 cm long and numerous pale yellow, sweetly scented flowers arranged along erect leafless stalks. Found in gravelly soil, associated with thick shrub under wandoo between Darkan, Boddington and Tenterden. Flowering Period - September to December

6. ***Thelymitra stellata*** (Star Sun Orchid) - A small perennial herb to 30 cm high with a single ovate leaf to 9 cm long and from 1-10 golden brown-striped flowers 2.5-3 cm in diameter. Uncommon and scattered in lateritic soils in soils or heath between Perth, Three Springs and Dumbleyung. Flowering Period - October to December.

There are compelling reasons for focussing conservation efforts on endangered species. From an asthetic perspective, it is clear that there lies an opportunity to appreciate and study the biological diversity and attractiveness of many of these endangered flora. Equally compelling is the fact the extinction of a species constitutes an irreplaceable lost opportunity for plant utilisation by humans. Some of the worlds rare species have proven to be of outstanding economic value. Also as so little is known of the biochemistry of many of these species, there lies the possibility of discovering cures to major human diseases. For example it has recently been publicised that smokebush (*Conospermum* spp.) may possibly provide a potential cure for AIDS.

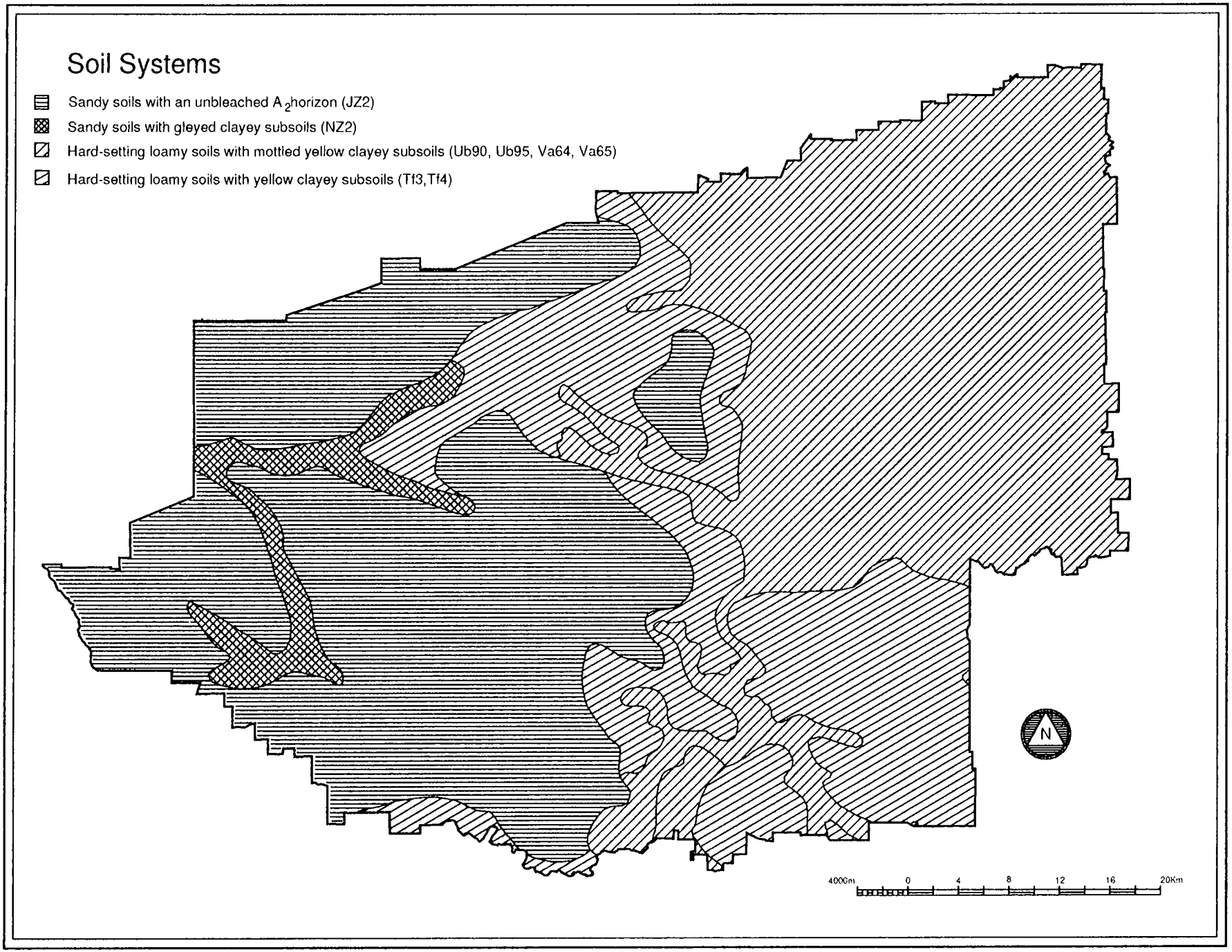


Figure 6: The four main soil systems of the Shire of West Arthur, each of which is a mosaic of different soil types.

## Land Resources

### Geology

The Shire of West Arthur is comprised of both strongly and weakly dissected Tertiary alluvial flats along the Hillman and Arthur Rivers, salt lakes and ancient drainage flats, and granite domes and flat outcrops exposed by erosion of the sandplain. A large body of Darkan Quartz Monzonite is centred 8 km south of Darkan and occupies an area of about 150 km$^2$. Six smaller outcrops to the south and the south-east occupy areas of around 100 km$^2$ (Chin and Brakel, 1986; Wilde and Walker, 1982). Several dolerite dykes occur in a north-south and an east-west direction.

### Soils

The distribution of the two soil landscape systems for the Shire of West Arthur is shown on Figure 6 (Northcote *et al.*, 1967). Within some of these are sub-systems known as soil types. The nine types within the four soil landscape systems differ mainly in their position within the topographic profile and form a mosaic of soil landscapes.

To the east of the Shire, the sandplain soils of the ancient plateau are extensively preserved. To the west, greater stripping of the landscape has produced shallow duplex soils formed on the lateritic profile, and resulted in the surface drainage system being better defined than that to the east. A key to understanding the nine soil types which occur in the Shire follows:

1) ***Hard-setting loamy soils with yellow clayey subsoils***

i) **Ta 8** - Incised valley side slopes of moderate to very steep relief. Chief soils are hard acidic, and also neutral, yellow mottled soils with hard neutral yellow mottled soils containing ironstone gravels.

ii) **Tf 3** - Low hilly terrain comprised of valleys that are frequently narrow and have short fairly steep slopes, along with breakaways, mesas and occasional granite tors. Chief soils are hard acidic yellow mottled soils along with sandy acidic yellow mottled soils all of which contain moderate to large amounts of ironstone gravel.

iii) **Tf 4** - On low hilly portions of dissected lateritic plateau with gently undulating ridged crests and narrow incised valleys: Chief soils are hard acidic yellow mottled soils, containing moderate to large amounts of ironstone gravel.

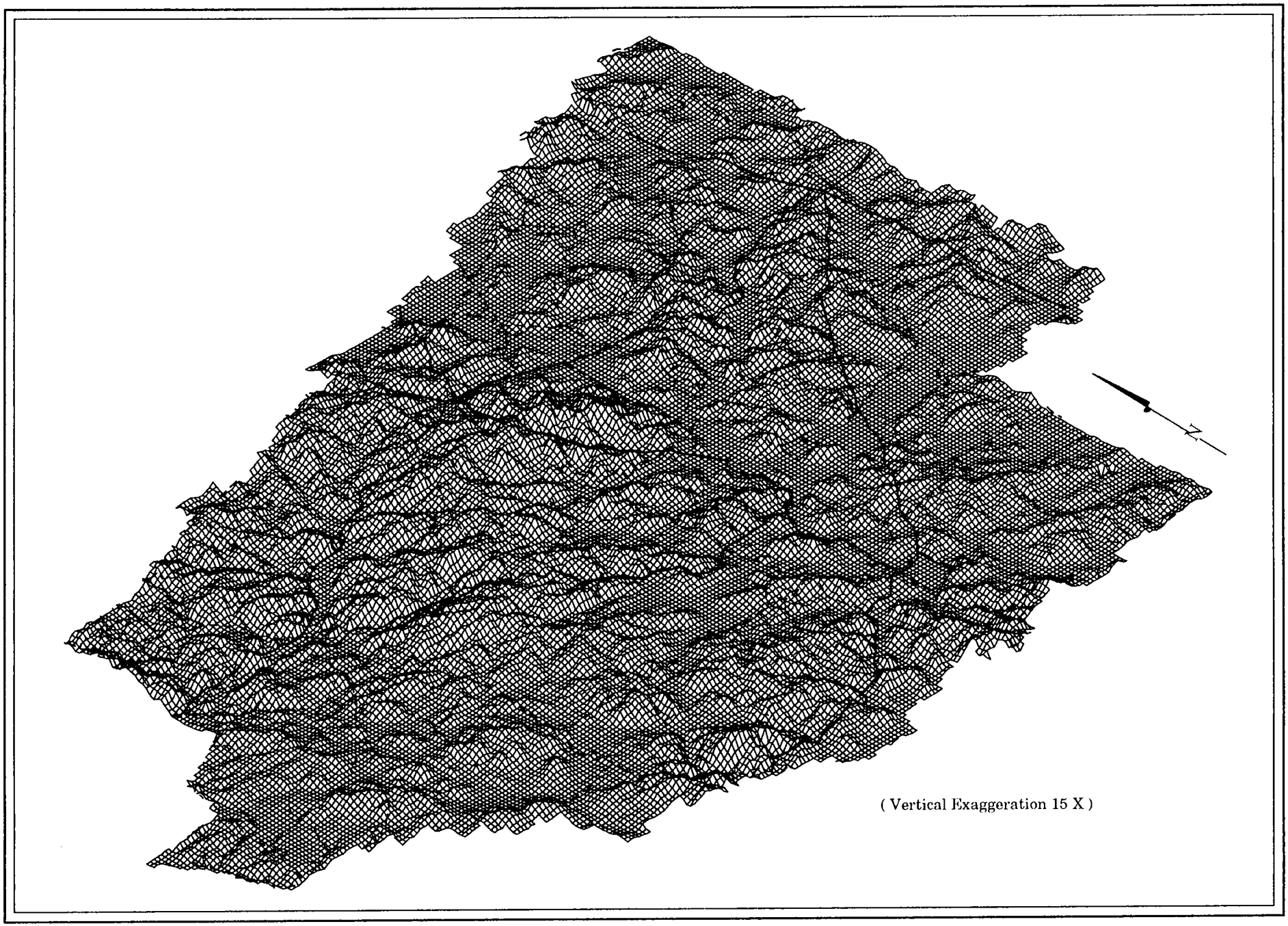


Figure 7: Topographical view of the Shire of West Arthur.

2) *Hard-setting loamy soils with mottled yellow clayey subsoils ($Dy_3$)*

i) **Ub 90** - Generally rolling to hilly country with tors; alteration mesas and buttes on some areas. Chief soils are hard neutral and acidic yellow mottled soils, sometimes containing ironstone gravels.

ii) **Ub 95** - Valley plains with some sandhills, lateritic gravel areas and swamps. Chief soils are hard neutral and sandy neutral mottled soils.

iii) **Ub 96** - Valley plains in which some salinity is present. Chief soils are hard neutral, and also alkaline, yellow mottled soils.

iv) **Va 64** - Plains are shallow and flat-bottomed. In valley plains, hard alkaline and some salinity is evident. Chief soils are hard alkaline and neutral mottled soils.

3) *Sandy soils with an unbleached $A_2$ horizon*

i) **JZ 2** - Dissected plateau with gentle undulations with broad swampy drainage-ways and basins. It is characterised by lateritic gravels and block laterite.

4) *Sandy soils with gleyed clayey subsoils*

i) **NZ 2** - Shallow swampy flat valley floors at moderately high elevation. Chief soils are sandy acidic gley soils and hard acidic gley soils

**Topography**

The eastern region of the Shire of West Arthur can be described as being a terraced or flat to broad alluvial plain, typical of many central wheatbelt shires. Some of the more prominent topographical features of the shire include Mt Fisher (379 m), the Hillman and Arthur Rivers and Lake Towerinning. Figure 7 gives a topographic view of the Shire, showing vertical exaggeration.

**Land Management and Land Degradation Issues of the Shire**

Since settlement in the south west of Western Australia and the subsequent clearing and replacement of native vegetation with crops and pastures, problems have arisen for both agricultural production and native vegetation conservation. Some of the most obvious problems are associated with changes in hydrology e.g rising water table with associated salinity and waterlogging. Water erosion and wind erosion are a problem on unprotected soils.

There are several forms of land degradation that occur within the Shire of West Arthur: salinity, waterlogging, wind and water erosion, soil acidification and subsoil compaction. An integrated approach to tackling these problems uses farm planning to: reorientate paddock boundaries; revegetate and fence drainage lines; protect and connect existing vegetation and establish windbreaks and replant on both recharge and degraded areas. In addition altering management practices to minimum and zero tillage will benefit both agricultural production and wildlife conservation.

Most farmers now recognise that replanting the trees and shrubs that existed prior to clearing is one of the most effective means of reversing the current trend towards land degradation. One of the main problems has been a lack of information about how to go about revegetation and what, when and where to plant. The "Revegetation Guide to the Central Wheatbelt" (Lefroy *et al.*, 1991) is an excellent resource book which attempts to address these problems by providing lists of local species grouped according to the specific soil types of a particular area, although it has only limited reference value in West Arthur.

*Clearing*

The Shire of West Arthur has been less extensively cleared than many other older shires and has more original native remaining on private land than any other shire in the Blackwood River Catchment (20%).

Current clearing guidelines recommend that for an area receiving 500 mm/annum rainfall or less (e.g. Shire of West Arthur), the minimum proportion of native vegetation considered necessary to be left to use sufficient groundwater to ensure water tables remain stable in that subcatchment is 25% or 1000 ha/catchment. (Clark, 1992; Holm, 1994). Currently the shire has almost 30% remnant native vegetation cover.

There are several actions being undertaken by the State Government and Local Government authorities to address the clearing of native vegetation. Clearing of vegetation on private land is currently under the control of the Soil and Land Conservation Act which requires all landowners to give notice to the Commissioner of Soil Conservation of their intent to clear land. The guidelines for assessing notices of intent to clear land are directed at preventing further land degradation problems (Select Committee into Land Conservation, 1992). In addition many local government authorities have implemented planning schemes which may give them scope to effectively control the clearing of land.

Continued clearing of vegetation is obviously not compatible with the desire for native vegetation to persist. Much of the south west was cleared during major agricultural developments following World War II, and little thought was given to nature conservation requirements.

A great deal of the native vegetation that remains was set aside by the government as crown reserves for townsites, water catchments and sites of gravel extraction etc. Many of these small patches of native vegetation were designated by the government as conservation reserves in the 1960s and 1970s. However their conservation value varies because most of the patches of vegetation that are now nature or conservation reserves are fragmented and represent only a very small percentage of the region's vegetative cover.

***Rising Water Tables and Salinity***

The principle cause for increased soil surface salinisation in much of the Wheatbelt has been the removal of native vegetation. Native vegetation uses more water than pasture species as native plants posses extensive root systems and transpire all year, whereas crops and pastures have shorter roots and transpire for only 6 months of the year. The replacement of native vegetation with crops and pastures has resulted in changes to the water balance of the soil, bringing rising water tables and soluble salts to the surface.

There are two main effects of vegetation clearance in salt-prone areas: firstly, deep-rooted plants no longer draw groundwater for transpiration so water accumulates instead of being discharged in the atmosphere; and secondly, there is a decrease in the infiltration of rainwater because there is no vegetation to intercept it and as a consequence of this lack of water use the water table rises and dissolves the accumulated salts. Quite often the effects of salinity are not seen for 15-20 years following native vegetation removal.

Trees affected by salt display a reduction in growth and stunting compared to those that survive. Further salination among intolerant species results in the death of the lower leaves and branches proceeding from the base upwards followed by wilting, death of growing tip and eventual tree death.

The Shire of West Arthur had 5,775 ha (3.34% of arable land) affected by severe salinity in 1989 (George, 1990). This represents an increase of almost 50% over the previous saltland survey taken in 1979.

Biological solutions to salinity problems can emulate more expensive engineering methods because perennial vegetation can be used to pump out more water from aquifers that have become saline or are in danger of doing so than can annual crops and pastures. Obviously salt tolerant species are required for salt affected sites, not only to control the salt levels but also as a measure to prevent and manage erosion. Recharge and discharge areas should be replanted with trees or shrubs to reduce the amount of water entering or leaving the system. Some of the more commonly planted salt tolerant species include saltbush (*Atriplex* spp.), wandoo and various samphire species. Planting swamp sheoak, orange wattle (*Acacia saligna*) and a number of *Melaleuca* species will aid in reversing the problems associated with waterlogged and salt affected areas. Planting trees such as salt river gum (*Eucalyptus sargentii*), flat-topped yate, river gum (*Eucalyptus camaldulensis*), moort (*Eucalyptus platypus*) and coastal moort (*Eucalyptus platypus* var *heterophylla*) will lower the watertable in most salt affected areas. Around salt lakes where soils are often waterlogged as well as saline, the soil will need to be mounded before planting. It may be more viable for farmers to plant salt tolerant shrubs in salt affected areas. Although these species may be less palatable to sheep than many herbaceous pasture species, they are grazed heavily when the herbaceous species are absent (Runciman and Malcolm, 1991).

It has been suggested (Lefroy *et al.*, 1991) that for the soils indigenous to the Shire of West Arthur, York gum, jam, rock sheoak and manna (*Acacia microbotrya*) could be planted. On the soils following drainage lines and around the fringes of salt lake, it is suggested that planting salt river gum (*Eucalyptus sargentii*) and swamp sheoak will help to reverse both salinity and waterlogging problems.

Alley farming systems are beginning to gain acceptance amongst farmers, and provides a cost effective method of combating the problem of salinity. This has been due in part to the death of bluegum (*Eucalyptus globulus*) plantations as a result of poor site selection, too high densities and the effects of salinity.

It is also worth noting that planting deep-rooted crops such as lupins in saline susceptible areas can emulate the task of perennial native species and prevent saline water from rising to the surface. The benefits of planting such a crop are manyfold. Not only can lupins control salinity, and provide feed for stock, but it also leaves residual nitrogen in the soil, reducing the need for applying expensive nitrogen-based fertilisers.

*Wind Erosion*

Wind erosion is the action of the wind removing and redepositing soil. It can result in the loss of vegetation through sand blasting and smothering, and it reduces plant growth because of the loss of soil structure and fertility. The predominantly sandy-surfaced soils of Western Australia are naturally prone to wind erosion when vegetation is insufficient to protect the soil surface and at least 90% of the wheatbelt is vulnerable to wind erosion if soils are mismanaged (Carter *et. al.*, 1992). The most susceptible areas are those which are prone to sustained droughts extended over several growing seasons. The extent and severity of wind erosion depends on seasonal conditions.

The Shire of West Arthur, being largely comprised of leached and weathered soils is considered to be moderately susceptible to wind erosion (State of the Environment Report, 1992).

No-till methods of cropping, direct seeding of crops into stubble and the establishment of windbreaks for shelter will help in ameliorating the effect of wind erosion. Ideally windbreaks should be several rows wide and should include a mix of trees and shrubs.

*Water Erosion*

Water erosion is the loss of topsoil due to runoff from the soil surface. Water erosion occurs in three forms of increasing severity: sheet, rill and gully erosion.

Western Australian soils are particularly susceptible to water erosion because they are inherently infertile and have a sandy, loose texture. Their susceptibly is further increased by cultivation, overgrazing and stock trampling. An estimated 0.7 million hectares of the 6 million hectares of land cropped annually in the wheatbelt is affected by water erosion.

In the Shire of West Arthur water erosion can be expected to occur on all soil types particularly on slopes steeper than 1%. Clayey soils tend to be more prone to water erosion. (State of the Environment Report, 1992). Figure 8 shows some of the areas of the Shire which may be susceptible to water erosion.

Contour banks can reduce the speed of runoff water flow. They do this by restricting all cultivation to the contour, by diverting any runoff to a well grassed waterway, or by storing excess water in the channel above the bank. Vegetation can also reduce the possibility of water erosion by reducing the impact of raindrops.

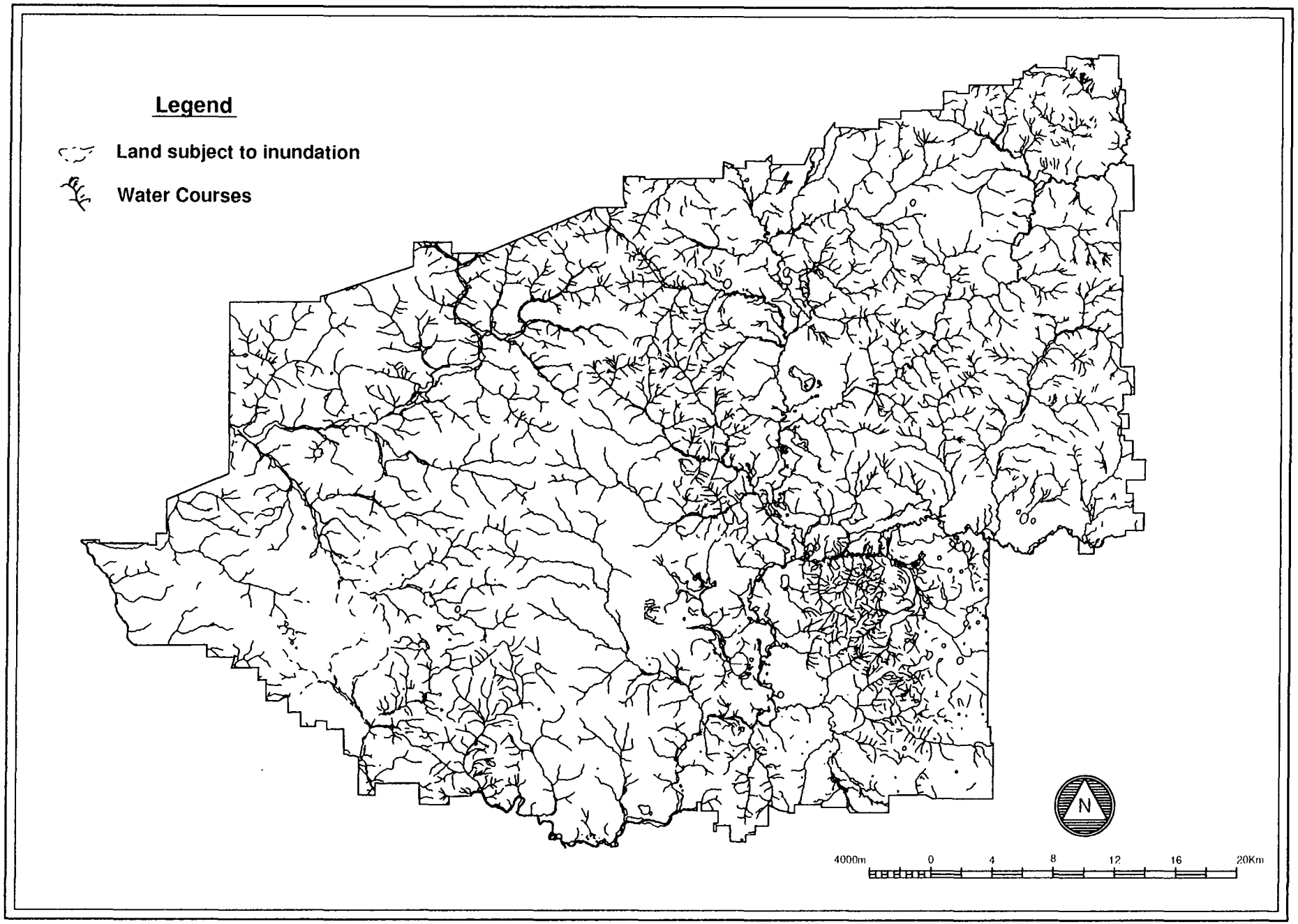


Figure 8: Major Drainage systems of the Shire of West Arthur showing areas subject to inundation and major water courses.

*Acidity*

The acidification of topsoils and subsoils can inhibit the growth of plant roots of both native and pasture species. Although some soils are predisposed to acidic conditions, agricultural practices are a major cause for the acceleration of the acidification process. This happens through using ammonium based fertilisers and growing clover pastures. Acidic soils tend to be more susceptible to degradation by wind and water erosion (State of the Environment Report, 1992) as soil particles do not bind together effectively under conditions of low pH.

In the Shire of West Arthur, most of the soils are regarded as being of moderate to high risk of developing subsurface soil acidification at depths of greater than one metre (State of the Environment Report, 1992). Solutions to ameliorating soil acidity include the rotation of legume-based pastures with non-legume based pastures, reduction in the use of chemical fertilisers and increased liming and gypsum applications.

*Soil Compaction*

Soil compaction by stock and heavy farm machinery is a major degradation problem experienced by many Wheatbelt Shires including West Arthur. Stock and heavy machinery compact the soil and prevent infiltration of both water and air. This inevitably results in reduced plant growth and an increase in wind and water erosion. The problem can be rectified by using lighter farm machinery and restricting machinery traffic on the land through using minimum or zero tillage to establish crops. Fencing remnant vegetation will prevent stock causing soil compaction within the bush.

*Waterlogging*

Waterlogging is the temporary or permanent saturation of the soil by rainfall or runoff and is usually a result of poor drainage. It inhibits germination, can damage the roots of young seedlings and increases the uptake of salt uptake into the shoots, which kills the plant. The problem is often exacerbated by excessive or inappropriate clearing of deep-rooted native vegetation and soil compaction by livestock and heavy machinery. The principal cause of waterlogging is a combination of excess rainfall, poor external drainage (runoff), poor internal drainage (water movement in the soil profile) and the inability of the soil to store much water. Waterlogged soils in Western Australia are also often salt-affected (Barrett-Lennard *et al.*, 1990).

Waterlogging is most prevalent in the 400-500mm rainfall area of the Wheatbelt and the problem is usually seasonal, although areas with soils of low permeability in valleys

downslope of areas which shed water will be prone to waterlogging in years of high rainfall. There are a number of indicators of waterlogging:

* The presence of weeds such as canary grass (*Phalaris* sp.) that tolerate waterlogging.
* The absence of waterlogging-sensitive species such as clovers.
* The presence of red, yellow or grey mottles in the soil profile (Cox and McFarlane, 1990).

**Managing Existing Vegetation**

Protecting existing vegetation is often easier than replanting. However, the survival of existing vegetation is affected by a number of factors including: grazing by stock of unfenced bush (passive clearing); changes in hydrology; increased exposure to the elements; increased fertiliser regimes; pests, herbicide drift and weed invasion. Native plants are often choked or covered by fast growing introduced plants that become weeds when they escape from pastures. Weeds compete with native plants for water and nutrients, increase the risk of fire and often do not provide the food and shelter that wildlife need.

Specific recommendations on how to manage existing bush are provided in "Managing your Bushland: A Guide for Western Australian Landowners" (Hussey and Wallace, 1993).

The long term solution to the problems of land degradation and the loss of local plant and animal species lies in taking a catchment approach to the management of natural resources within the Shire of West Arthur.

## Bringing It All Together

**Integrated Management for Land and Nature Conservation in the Shire**

The Wheatbelt of Western Australia today has severe nature conservation and agricultural problems resulting from the excessive clearing of native vegetation. The problems associated with land degradation and the maintenance of native vegetation are problems which cannot be halted by onsite management alone. An integrated catchment/land conservation district/farm-based approach is needed to effectively manage the land and native vegetation resources and ensure long term agricultural production, optimal water use and the maintenance of the diversity of flora and fauna. Retention of remnant vegetation, rehabilitation of degraded areas and strategic revegetation are essential components of this approach. Ownership of the problems and solutions at a local scale is the key to success.

As so much of the conservation resource lies under the control of private landowners and the local government authorities, the responsibility for the co-ordination of the conservation and management of natural resources must ultimately stem from these locally based groups. The Shire of West Arthur has a number of different organisations working towards land and nature conservation in the Shire.

The West Arthur Land Conservation District has been a prime mover in this field.

**Projects in the Shire**

A combination of measures and solutions aimed at protecting remnant vegetation, strategically revegetating areas degraded or void of native vegetation, and combating land degradation problems in the Shire of West Arthur have proven to be an effective method of achieving positive results.

The Remnant Vegetation Protection Scheme (RVPS) was developed by the State Government in 1988 to enhance soil and nature conservation by protecting native vegetation on farm land. It has been an effective scheme in the Shire of West Arthur. Since 1988/89, the Shire has received 11 RVPS grants to assist in the fencing of 397 hectares of native vegetation on farm land (Figure 9). Many of the fenced remnants which were previously in poor to average condition are now showing obvious signs of regeneration. However about half of all remnants on private land in the Shire are either unfenced or inadequately fenced or in many cases fences are present but are falling into disrepair (Mollemans, unpub.).

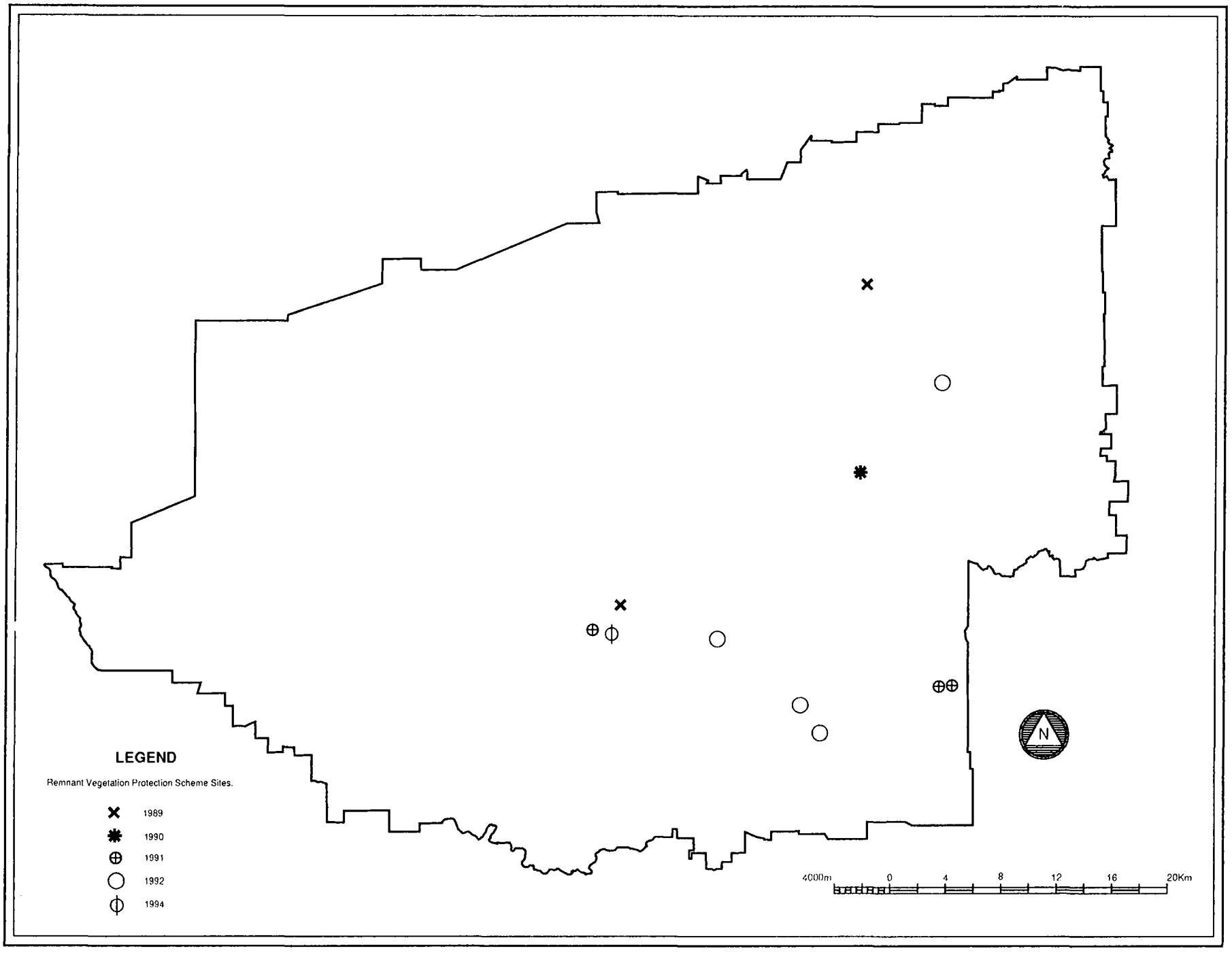


Figure 9: Remnant Vegetation Protection Scheme sites in the Shire of West Arthur.

There are several examples of projects with the aim of strategically revegetating sparsely vegetated areas currently underway in the Shire of West Arthur.

Road verges in the Shire of West Arthur were surveyed for their vegetation conservation status with the assistance of the Roadside Conservation Committee (RCC). The surveys were undertaken by community volunteers using the method developed by the RCC. In the Shire of West Arthur, approximately 800 km of the 880 km (91%) of roads have been surveyed by volunteers (Lamont, 1993).

The West Arthur Conservation District Committee has endeavoured to reverse land degradation problems with assistance from several programs. The National Landcare Program (NLP) was responsible for contributing $6,960 to the West Arthur saltland and water quality monitoring project in 1992/93. The aim of this project was to train catchment group members to select monitoring sites for the installation of groundwater observation bores, to collate results from catchment to detect trends and to relate changes in water quality and water table depth to land management techniques and promote those changes that lead to favourable results. There have also been several State Landcare funded projects in the Shire of West Arthur since 1989/90, many of which have involved cooperation with neighbouring shires. Details of each of these projects are outlined in detail in Appendix 14.

The Shire of West Arthur has not received any funding from the Save the Bush Program (STB) or the One Billion Trees Program (OBT) since their inception in 1989 (see Appendix 12 for further information). However the West Arthur townscape committee received 210 trees from the Plants for Conservation Program in 1993/94 to establish a corridor along local railway reserves (see Appendix 13).

**Reducing the cost of conservation**

It is now widely recognised that planting native trees and shrubs can be used to remedy land degradation problems. However the cost of revegetation is a relatively expensive practice. However there are methods of protecting remnant vegetation and planting native trees and shrubs in a cost-effective way. Initial costs are offset by long-term increases in productivity and decreases in land degradation.

To reduce the establishment costs for vegetation projects, a landholder could consider:

* cheaper fencing - (electric or re-cycled)

* collecting native plant seed from nearby sources instead of buying it (N.B. if the seed collector does not own the land, a licence will be needed. Check with CALM for details.)
* growing their own seedlings instead of buying in.
* direct seeding instead of planting seedlings.
* include deep-rooted perennial fodder species for multiple use of revegetation areas.

Developing new products and industries from planted trees has the potential to provide farmers with an additional source of income. Some possibilities for the development of tree-farm products include eucalypt and tea tree oils; tannins from acacia and eucalypt species; cut wildflowers and wildflower seeds; and value-added wood products such as tool handles, craftwood and laminated wood products for furniture manufacture. Contact CALM Katanning for advice (098) 211296.

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## Local Contacts

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2. Shire of West Arthur Offices-Phone: (097) 36 1003

3. Department of Conservation and Land Management Wheatbelt Regional Headquarters (Narrogin) Phone: (098) 811 444.

4. Department of Conservation and Land Management Katanning District Office. Phone: (098) 211 296

5. Western Australia Department of Agriculture (Narrogin) - Phone: (098) 810022

6. Western Australia Department of Agriculture (Katanning) - Phone: (098) 21333

7. National Landcare Program Project Officer, Jenny Crisp - Department of Agriculture (Narrogin) - Phone: (098) 810022

8. Western Australia Department of Agriculture - Catchment Planner - Jenny Gardner (Katanning District Office) - Phone: (098) 21333

9. Blackwood Catchment Co-ordinating Group Centre, Co-ordinator - Sue Masterson. P.O. Box 27, Boyup Brook, 6244. Phone: (097) 651401

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## Appendix 1.

**Plant Species List of the Yalanbee and Dwellingup Complex in Low Rainfall (Heddle et al 1980)**

| Botanical Name | Common name (if known) |
|---|---|
| *Acacia extensa* | Wiry Wattle |
| *Allocasuarina huegeliana* | Rock Sheoak |
| *Baeckea camphorosmae* | Camphor Wattle |
| *Borya sphaerocephala* | Pincushions |
| *Daviesia pectinata* | Prickly Bitterpea |
| *Dillwynia cinerascens* | Grey Parrot-Pea |
| *Eucalyptus calophylla* | Marri |
| *Eucalyptus laeliae* | Darling Range Ghost Gum |
| *Eucalyptus marginata* | Jarrah |
| *Eucalyptus patens* | Yarri |
| *Eucalyptus wandoo* | Wandoo |
| *Grevillea diversicolor* | Variable-leaved Grevillea |
| *Grevillea bipinnatifida* | Fuchsia Grevillea |
| *Hakea cyclocarpa* | Ramshorn |
| *Hakea elliptica* | Oval-leaf Hakea |
| *Hakea lissocarpha* | Honey Bush |
| *Hakea ruscifolia* | Candle Hakea |
| *Hakea undulata* | Wavy-leaved Hakea |
| *Hypocalymma angustifolium* | White Myrtle |
| *Isopogon dubius* | Pinecushion Coneflower |
| *Lasiopetalum floribundum* | Free Flowering Lasiopetalum |
| *Lepidosperma angustatum* | |
| *Leptomeria cunninghamii* | |
| *Leucopogon capitellatus* | |
| *Leucopogon propinquus* | |
| *Macrozamia riedlei* | Zamia |
| *Mesomelaena tetragona* | Semaphore Sedge |
| *Patersonia rudis* | Hairy Flag |
| *Phyllanthus calycinus* | False Boronia |
| *Sphaerolobium medium* | |
| *Stirlingia latifolia* | Blueboy |
| *Styphelia tenuiflora* | Common Pinheath |
| *Synaphea petiolaris* | Synaphea |
| *Trymalium ledifolium* | |

## Appendix 2.

**Plant Species List of Swamp Complex (Heddle et al 1980)**

| Botanical Name | Common name (if known) |
|---|---|
| *Actinostrobus pyramidalis* | Swamp Cypress |
| *Adenanthos obovatus* | Basket Flower |
| *Astartea fascicularis* | |
| *Banksia littoralis* | Swamp Banksia |
| *Dasypogon bromeliaefolius* | Pineapple Bush |
| *Eucalyptus calophylla* | Marri |
| *Eucalyptus patens* | Yarri |
| *Hakea ceratophylla* | Horned leaf Hakea |
| *Hakea varia* | Variable-leaved Hakea |
| *Hypocalymma angustifolium* | White Myrtle |
| *Lepidosperma angustatum* | |
| *Leptocarpus scariosus* | |
| *Leptospermum ellipticum* | Swamp Teatree |
| *Melaleuca preissiana* | Moonah |
| *Melaleuca cymbifolia* | |
| *Melaleuca incana* | Grey Honeymyrtle |
| *Melaleuca subtrigona* | |
| *Melaleuca uncinata* | Broom Bush |
| *Melaleuca viminea* | Mohan |
| *Melaleuca lateritia* | Robin Redbreast Bush |
| *Mesomelaena tetragona* | Semaphore Sedge |
| *Synaphea petiolaris* | Synaphea |
| *Verticordia acerosa* | |
| *Verticordia densiflora* | Compacted Featherflower |
| *Verticordia grandiflora* | Claw Featherflower |

## Appendix 3.

**Plant Species List of Pindalup and Yarragil Complex in Low to Medium Rainfall (Heddle et al 1980)**

| Botanical Name | Common name (if known) |
|---|---|
| *Acacia extensa* | Wiry Wattle |
| *Adenanthos obovatus* | Basket Flower |
| *Allocasuarina huegeliana* | Rock Sheoak |
| *Astartea fascicularis* | |
| *Baeckea camphorosmae* | Camphor Wattle |
| *Borya sphaerocephala* | Pincushions |
| *Caustis dioica* | Chinese Puzzle |
| *Dampiera alata* | Winged-stem Dampiera |
| *Dasypogon bromeliaefolius* | Pineapple Dasypogon |
| *Daviesia decurrens* | Prickly Bitterpea |
| *Dillwynia* sp. | Grey Parrot-Pea |
| *Diplolaena drummondii* | |
| *Eucalyptus calophylla* | Marri |
| *Eucalyptus laeliae* | Darling Range Ghost Gum |
| *Eucalyptus marginata* | Jarrah |
| *Eucalyptus patens* | Yarri |
| *Eucalyptus wandoo* | Wandoo |
| *Grevillea diversicolor* | Variable-leaved Grevillea |
| *Grevillea bipinnatifida* | Fuchsia Grevillea |
| *Hakea ceratophylla* | Horn Leak Hakea |
| *Hakea cyclocarpa* | Ramshorn |
| *Hakea elliptica* | Oval-leaf Hakea |
| *Hakea lissocarpha* | Honey Bush |
| *Hakea ruscifolia* | Candle Hakea |
| *Hakea undulata* | Wavy-leaved Hakea |
| *Hibbertia lineata* | |
| *Hibbertia polystachya* | |
| *Hypocalymma angustifolium* | White Myrtle |
| *Isopogon dubius* | Pinecushion Coneflower |
| *Kingia australis* | Black Gin |
| *Lasiopetalum floribundum* | Free Flowering Lasiopetalum |
| *Lepidosperma angustatum* | |
| *Leptospermum ellipticum* | Swamp Teatree |
| *Leptocarpus scariosus* | |
| *Leptomeria cunninghamii* | |
| *Leucopogon capitellatus* | |
| *Leucopogon cordatus* | |
| *Leucopogon propinquus* | |
| *Macrozamia riedlei* | Zamia |
| *Melaleuca preissiana* | Moonah |
| *Mesomelaena tetragona* | Semaphore Sedge |
| *Patersonia occidentalis* | Purple Flag |
| *Patersonia rudis* | Hairy Flag |
| *Phyllanthus calycinus* | False Boronia |
| *Sphaerolobium medium* | |
| *Stirlingia latifolia* | Blueboy |
| *Styphelia tenuiflora* | Common Pinheath |
| *Synaphea petiolaris* | Synaphea |
| *Trymalium ledifolium* | |

## Appendix 4.

**Plant Species List of Dwellinup, Yalanbee and Hester Complex in Low to Medium Rainfall (Heddle et al 1980)**

| Botanical Name | Common name (if known) |
|---|---|
| *Adenanthos barbigerus* | Hairy Glandflower |
| *Banksia grandis* | Bull Banksia |
| *Daviesia decurrens* | Prickly Bitterpea |
| *Eucalyptus marginata* | Jarrah |
| *Grevillea wilsonii* | Wilson's Grevillea |
| *Hakea lissocarpha* | |
| *Hovea chorizemifolia* | |
| *Leucopogon capitellatus* | |
| *Leucopogon cordatus* | |
| *Macrozamia riedlei* | Zamia |
| *Patersonia rudis* | Hairy rudis |
| *Phyllanthus calycinus* | False Boronia |
| *Styphelia tenuiflora* | Common Pinheath |
| *Trymalium florabundum* | Karri Hazel |

## Appendix 5.

**Plant Species List of the Goonaping Complex (Heddle et al 1980)**

| Botanical Name | Common name (if known) |
|---|---|
| *Adenanthos barbigerus* | Hairy Glandflower |
| *Adenanthos obovatus* | Basket Flower |
| *Allocasuarina fraseriana* | Sheoak |
| *Astartea fascicularis* | |
| *Baeckea camphorosmae* | Camphor Myrtle |
| *Banksia littoralis* | Swamp Banksia |
| *Caustis dioica* | Chinese Puzzle |
| *Conospermum stoechadis* | Common Smokebush |
| *Dasypogon bromeliaefolius* | Pineapple Bush |
| *Daviesia pectinata* | Prickly Bitterpea |
| *Eucalyptus calophylla* | Marri |
| *Eucalyptus marginata* | Jarrah |
| *Eucalyptus patens* | Yarri |
| *Grevillea wilsonii* | Wilsons Grevillea |
| *Hakea ceratophylla* | Horned leaf Hakea |
| *Hakea cyclocarpa* | Ramshorn |
| *Hakea ruscifolia* | Candle Hakea |
| *Hakea varia* | Variable-leaved Hakea |
| *Hibbertia polystachya* | |
| *Hypocalymma angustifolium* | White Myrtle |
| *Isopogon dubius* | Pincushion Coneflower |
| *Lepidosperma angustatum* | |
| *Leptocarpus scariosus* | |
| *Pericalymma ellipticum* | Swamp Teatree |
| *Leucopogon cordatus* | |
| *Leptocarpus tenax* | Slender Twine Rush |
| *Melaleuca preissiana* | Moonah |
| *Mesomelaena tetragona* | Semaphore Sedge |
| *Nuytsia floribunda* | Christmas Tree |
| *Patersonia occidentalis* | Purple Flag |
| *Patersonia rudis* | Hairy Flag |
| *Sphaerolobium medium* | |
| *Stirlingia latifolia* | Blueboy |
| *Styphelia tenuiflora* | Common Pinheath |

## Appendix 6.

**Plant List-Dominant Species of the Williams Vegetation System (Beard, 1980)**

| Botanical Name | Common name (if known) |
|---|---|
| **Trees** | |
| *Acacia acuminata* | Jam |
| *Allocasuarina huegeliana* | Rock Sheoak |
| *Eucalyptus calophylla* | Marri |
| *Eucalyptus wandoo* | Wandoo |
| *Eucalyptus astringens* | Brown Mallet |
| *Eucalyptus marginata* | Jarrah |
| *Eucalyptus rudis* | Flooded Gum |
| *Eucalyptus loxophleba* | York Gum |

## Appendix 7.

**Beaufort Vegetation System Dominant Species Plant List (Beard, 1980b)**

| Botanical Name | Common Name (if known) |
|---|---|
| **Shrubs** | |
| *Acacia saligna* | Black Wattle |
| *Adenanthos cygnorum* | Common Woollybush |
| *Allocasuarina corniculata* | Grey Tamma |
| *Allocasuarina humilis* | Scrub Sheoak |
| *Baeckea preissiana* | |
| *Calothamnus quadrifidus* | Common One-sided Bottlebrush |
| *Calothamnus planifolius* | |
| *Daviesia polycephala* | |
| *Eremaea paucifolia* | |
| *Hakea incrassata* | Marble Hakea |
| *Hakea trifurcata* | Two-leaf Hakea |
| *Hibbertia acerosa* | Needle Leaved Guinea Flower |
| *Isopogon* aff. *latifolius* | |
| *Kunzea recurva* | Mountain Kunzea |
| *Leptospermum erubescens* | Roadside Teatree |
| *Leschenaultia biloba* | Blue Leschenaultia |
| *Petrophile squamata* | |
| *Verticordia habrantha* | Hidden Featherflower |
| *Xanthorrhoea preissii* | Common Blackboy |
| **Herbaceous** | |
| *Anigozanthus humilis* | Catspaw |
| *Patersonia* sp. | |
| *Podolepis canescens* | Bright Podolepis |

## Appendix 8.

**Remnant 85 Plant List - based on initial herbarium identifications (Mollemans, unpub.)**

| Botanical Name | Common Name (if known) |
|---|---|
| *Angianthus tenellus* | Delicate Angianthus |
| *Billardiera sp.* | |
| *Boronia ramosa* | |
| *Chorizema aciculare* | Needle-leaved Chorizema |
| *Comesperma acerosum* | |
| *Comesperma volubile* | Love Creeper |
| *Conospermum stoechadis* | Common Smokebush |
| *Conostylis aculeata* | Prickly Conostylis |
| *Craspedia sp.* | Billy-buttons |
| *Danthonia caespitosa* | Common Wallaby Grass |
| *Drosera pycnoblasta* | Pearly Sundew |
| *Drosera gigantea* | Giant Sundew |
| *Dryandra bipinatifida* | |
| *Goodenia pulchella* | |
| *Grevillea bipinatifida* | Fuschia Grevillea |
| *Haemodorum simplex* | Mene |
| *Hakea sp.* | |
| *Helichrysum leucosidium* | |
| *Hibbertia sp.* | |
| *Hibbertia microphylla* | |
| *Hydrocotyle sp.* | |
| *Hylosperma zacchaeus* | |
| *Hylosperma cotula* | |
| *Jacksonia sternbergiana* | Stinkwood |
| *Kunzea preissiana* | |
| *Laxmania grandiflora* | |
| *Lepidosperma tenue* | |
| *Leucopogon sp.* | |
| *Lobelia rhytidosperma* | Wrinkle-seeded Lobelia |
| *Loxocarya flexuosa* | |
| *Melaleuca scabra* | Rough Honeymyrtle |
| *Mirbelia floribunda* | Purple Mirbelia |
| *Parentucella latifolia* | Common Bartsia |
| *Persoonia saundersii* | |
| *Persoonia sulcata* | |
| *Petrophile striata* | |
| *Pithocarpa pulchella* | Beautiful Pithocarpa |
| *Podolepis canescens* | Bright Podolepis |
| *Ptilotus sp.* | |
| *Rinzia tenuifolia* | |
| *Schoenus sp.* | |
| *Stylidium hirsutum* | Hairy Triggerplant |
| *Stylidium glaucum* | Grey Triggerplant |
| *Tetratheca virgata* | |
| *Thomasia foliosa* | |
| *Verticordia densiflora* | Compacted Featherflower |
| *Verticordia huegelii* | Variegated Featherflower |
| *Wahlenbergia gracilenta* | Annual Bluebell |
| *Waitzia aurea* | Golden Waitzia |

## Appendix 9.

**Remnant 86 Plant List - based on initial herbarium identifications (Mollemans, unpub.).**

| Botanical Name | Common Name (if known) |
|---|---|
| *Acacia sp.* | |
| *Acacia biflora* | |
| *Adenanthos sericeus* | Woolly Bush |
| *Amphipogon amphipogonoides* | |
| *Andersonia aff. brevifolia* | |
| *Andersonia carinata* | |
| *Aotus* sp. | |
| *Astroloma sp.* | |
| *Astroloma pallidum* | Kick Bush |
| *Billardiera rarifolia* | |
| *Calothamnus preissii* | |
| *Cassytha* sp. | |
| *Caustis* sp. | |
| *Conospermum amoenum* | Blue Smokebush |
| *Conospermum distichum* | |
| *Conospermum stoechadis* | Common Smokebush |
| *Conostylis aculeata* | Prickly Conostylis |
| *Dampiera sacculata* | Pouched Dampiera |
| *Danthonia setacea* | Smallflower Wallaby Grass |
| *Daviesia aphylla* | |
| *Gahnia aff. lanigera* | |
| *Gompholobium aristatum* | |
| *Hakea ruscifolia* | Candle Hakea |
| *Helichrysum leucopsideum* | |
| *Hemiandra pungens* | Snakebush |
| *Hibbertia acerosa* | Needle Leaved Guinea Flower |
| *Hovea trisperma* | Common Hovea |
| *Isopogon aff. heterophyllus* | |
| *Isopogon dubius* | Pincushion Coneflower |
| *Jacksonia furcellata* | Grey Stinkwood |
| *Jacksonia serecia* | Waldjumi |
| *Kunzea* sp. | |
| *Kunzea preissiana* | |
| *Lasiopetalum floribundum* | Free Flowering Lasiopetalum |
| *Lechenaultia tubiflora* | Heath Leschenaultia |
| *Lepidosperma gracile* | Slender Sword Sedge |
| *Lepidosperma tenue* | |
| *Leucopogon* sp. | |
| *Leucopogon gracillimus* | |
| *Levenhookia stipitata* | Common Stylewort |
| *Lyginia barbata* | |
| *Melaleuca scabra* | Rough Honeymyrtle |
| *Mesomelaena tetragona* | Semaphore Sedge |
| *Mesomelaena stygia* | |
| *Microcorys lenticularis* | |
| *Patersonia juncea* | Rush Leaved Patersonia |
| *Patersonia occidentalis* | Purple Flag |
| *Petrophile longifolia* | Long Leaved Cone Bush |
| *Petrophile serruriae* | |
| *Petrophile striata* | |
| *Pimelea preissii* | |

| | |
|---|---|
| *Pithocarpa corymbosa* | Corybose Pithocarpa |
| *Poa* sp. | |
| *Rinzia crassifolia* | |
| *Scaevola caliptera* | |
| *Schoenus* sp. | |
| *Schoenus curvifolius* | |
| *Schoenus subbulbosa* | |
| *Stipa semibarbata* | Bearded Speargrass |
| *Tetratheca virgata* | |
| *Tricoryne elatior* | Yellow Autumn Lily |

## Appendix 10

## Native Mammals of the Katanning CALM District (Sanders and Holt, 1991)

| Taxa | Common Name | Conservation Status |
|---|---|---|
| *Tachyglossus aculeatus* | Echidna | |
| *Dasyurus geoffroii* | Chudditch | G1, AR |
| *Phascogale calura* | Red-tailed Phascogale | G1,AR, RP |
| *Phascogale tapoatafa* | | |
| *Anthechinus flaviceps* | Mardo | NR |
| *Sminthopsis gilberti* | Common dunnart | |
| *Sminthopsis griseoventer* | Common dunnart | PO, NR |
| *Sminthopsis crassicaudata* | Fat-tailed dunnart | |
| *Sminthopsis granulipes* | White-tailed dunnart | |
| *Antichinomys laniger* | Kultarr | NR |
| *Myrmecobius fasciatus* | Numbat | G1, AR, |
| *Isooden obsesulus fusciventer* | Brown Bandicoot | G1, AR |
| *Perameles bougainville* | Barred Bandicoot | ER, G1 |
| *Macrotis lagotis* | Bilby | ER, G1 |
| *Peudocheirus peregrinus occidentalis* | Common Ringtail | G1, AR,NR |
| *Trichosurus vulpecula* | Brush-tailed possum | |
| *Cercartetus concinnus* | South-west pygmy possum | |
| *Tarsipes rostratus* | Honey Possum | |
| *Bettongia penicillata* | Woylie | G1, AR |
| *Bettongia lesueur* | Burrowing rat-kangaroo | ER, G1 |
| *Onychogalea lunata* | Cresent nail-tailed wallaby | ER, G1 |
| *Macropus eugenii* | Tammar wallaby | G1, AR |
| *Macropus irma* | Western brush wallaby | |
| *Macropus fuliginosus* | Western grey kangaroo | |
| *Tadarida australis* | White-striped Bat | |
| *Mormopterus planiceps* | Little Mastiff-Bat | NR |
| *Nyctophilus major* | Greater Long-eared Bat | |
| *Nyctophilus gouldi* | Gould's Long-eared Bat | NR |
| *Nyctophilus geoffroyi* | Lesser long-eared bat | |
| *Chalinologus morio* | Chocolate Bat | |
| *Scotorepens balstoni* | Western Broad-nosed Bat | NR |
| *Falsistrellus mackenziei* | | |
| *Eptesicus finlaysoni* | | |
| *Hydromys chysogaster* | Water rat | |
| *Pseudomys shortridgei* | Blunt-faced mouse | G1, AR |
| *Pseudomys albocinereus* | Ash-grey mouse | |
| *Pseudomys occidentalis* | Western mouse | G1, AR, RP |
| *Notomys mitchellii* | Mitchell's hopping mouse | |
| *Notomys alexis* | Brown hopping-mouse | |
| *Canis familiaris* | Dingo | |

**Status Key**

AR - At risk within the region
ER - Extinct within the region
G1 - Gazetted as Schedule 1 under Wildlife Conservation Act 1950
NR - Not recorded in the region since 1980
PO - Possibly occurring in the region but not yet recorded
RP - Have population mainly within the region

## Appendix 11

## Reptiles and Amphibians of the Katanning District (Sanders and Holt, 1991)

| Taxa | Conservation Status |
|---|---|
| | **Amphibians** |
| ***Leptodactyldae*** | |
| *Crinia georgiana* | NK;AR |
| *Crinia pseudinsignifera* | NK;AR |
| *Heleioporus albopunctatus* | AR |
| *Heleioporus eyrei* | AR |
| *Heleioporus inornatus* | AR |
| *Heleioporus psammophilus* | NR;AR |
| *Limnodynastes dorsalis* | AR |
| *Myobatrachus gouldii* | AR |
| *Neobatrachus albipes* | RP;AR |
| *Neobatrachus kunapalari* | AR |
| *Neobatrachus pelobatoides* | AR |
| *Neobatrachus sutor* | NR;AR |
| *Pseudophryne guentheri* | AR |
| *Pseudophryne occidentalis* | NK;AR |
| ***Hylidae*** | |
| *Litoria adelaidensis* | AR |
| *Litoria cyclorhynchus* | AR |
| *Litoria moorei* | AR |
| | |
| | **Reptiles** |
| **Chelidae** | |
| *Chelodina oblonga* | |
| **Gekkonidae** | |
| *Crenadactylus ocellatus ocellatus* | |
| *Diplodactylus granariensis* | |
| *Diplodactylus polyophthalmus* | |
| *Diplodactylus pulcher* | |
| *Diplodactylus spinigerus inornatus* | |
| *Gehyra variegata* | |
| *Oedura reticulata* | |
| *Phyllodactylus marmoratus marmoratus* | |
| *Underwoodisaurus milii* | |
| **Pygopodidae** | |

| | |
|---|---|
| *Aprasia pulchella* | |
| *Aprasia repens* | |
| *Delma australis* | |
| *Delma fraseri* | |
| *Delma greyii* | NR |
| *Lialis burtonis* | |
| *Pygopus lepidopodus lepidopodus* | NK |
| **Agamidae** | |
| *Ctenophorus cristatus* | |
| *Ctenophorus maculatus griseus* | |
| *Ctenophorus ornatus* | |
| *Ctenophorus salinarum* | |
| *Moloch horridus* | |
| *Pogona minor minor* | |
| *Tymanocryptis adelaidensis* | NR |
| **Scincidae** | |
| *Bassiana trilineata* | |
| *Cryptoblepharus plagiocephalus* | |
| *Ctenotus catenifer* | NK |
| *Ctenotus gemmula* | NR |
| *Ctentus impar* | |
| *Ctenotus labillardieri* | NR |
| *Ctentus schomburgkii* | |
| *Egernia kingii* | NR |
| *Egernia multiscutata bos* | |
| *Egernia napoleonis* | |
| *Egernia richardi* | |
| *Hemiergis peronii* | |
| *Lerista microtis* | |
| *Menetia greyii* | |
| *Morethia butleri* | NR |
| *Morethia lineoocellata* | NR |
| *Morethia obscura* | |
| *Tiliqua occipitalis* | |
| *Tiliqua rugosa rugosa* | |
| **Varanidae** | |
| *Varanus gouldii* | |
| *Varanus tristis tristis* | NK |
| *Varanus rosenburgi* | |
| **Typhlopidae** | |
| *Ramphotyphlops australis* | |
| *Ramphotyphlops pinguis* | NK |
| *Ramphotyphlops waitii* | |

| | |
|---|---|
| **Boidae** | |
| *Morelia spilota imbricata* | G2;AR |
| *Morelia stimsoni stimsoni* | PO(K);NK |
| **Elapidae** | |
| *Acanthophis antarcticus* | PO(K);NK |
| *Notechis coronatus* | PO(K);NK |
| *Notechis curtus* | |
| *Notechis scutatus occidentalis* | NR |
| *Pseudonaja australis* | NR |
| *Pseudonaja affinis affinis* | |
| *Pseudonaja modesta* | NK |
| *Pseudonaja nuchalis* | |
| *Rhinoplocephalus bicolor* | NK |
| *Rhinoplocephalus gouldii* | |
| *Rhinoplocephalus nigriceps* | |
| *Vermicella bertholdi* | |
| *Vermicella bimaculata* | PO(K);NK |
| *Vermicella semifasciata semifasciata* | |

**Status Key**
AR - At risk within the region
G2 - Gazetted as Schedule 2 under Wildlife Conservation Act 1950
NR - Not recorded in the region since 1980
PO - Possibly occurring in the region but not yet recorded (district shown in brackets)
NK - Date of last record not known
RP - Have population mainly within region

## Appendix 12.

**Bird Species seen in the Shire of West Arthur (Barratt *et al*, 1994; Garstone, 1970)**

| Common Name | Scientific Name |
|---|---|
| Emu | *Dromaius novaehollandiae* |
| Great Crested Grebe | *Podiceps cristatus* |
| Australasian Grebe | *Podiceps novaehollandiae* |
| Hoary-headed Grebe | *Podiceps poliocephalus* |
| Little Pied Cormorant | *Phalacrocorax melanoleucos* |
| Pelican | *Pelecanus conspicillataus* |
| Darter | *Anhinga melenogaster* |
| Great Cormorant | *Phalacrocorax carbo* |
| Little Black Cormorant | *Phalacrocorax sulcirostris* |
| Pacific Heron | *Ardea pacifica* |
| White-faced Heron | *Ardea noveahollandiae* |
| Great Egret | *Egretta alba* |
| Rufous Night Heron | *Nycticorax caledonicus* |
| Australasian Bittern | *Botaurus stellaris* |
| Straw-necked Ibis | *Threskiornis spinicollis* |
| Yellow-billed Spoonbill | *Platalea flaviceps* |
| Black Swan | *Cygnus atratus* |
| Freckled Duck | *Stictonetta naevosa* |
| Australian Shelduck | *Tadorna tadornoides* |
| Pacific Black Duck | *Anas superciliosa* |
| Grey Teal | *Anas gibberifrons* |
| Chestnut Teal | *Anans castanea* |
| Australian Shoveler | *Anas rhynchotis* |
| Pink-eared Duck | *Malacorhynchus membrananceus* |
| Hardhead | *Aythya australis* |
| Wood Duck | *Chenonetta jubata* |
| Blue-billed Duck | *Oxyura australis* |
| Musk Duck | *Biziura lobata* |
| Black-shouldered Kite | *Elanus caeruleus* |
| Square-tailed Kite | *Lophoictinia isura* |
| Whistling Kite | *Haliastur sphenurus* |
| Brown Goshawk | *Accipiter fasciatus* |
| Collared Sparrowhawk | *Accipiter cirrocephalus* |
| Wedge-Tailed Eagle | *Aquila audax* |
| Spotted Harrier | *Circus assimilis* |
| March Harrier | *Circus aeruginosus* |
| Peregrine Falcon | *Falco peregrinus* |
| Australian Hobby | *Falco longipennis* |
| Brown Falcon | *Falco berigora* |
| Australian Kestral | *Falco cenchroides* |
| Malleefowl | *Leipoa ocellata* |
| Stubble Quail | *Coturnix novaezelandiae* |
| Painted Button-quail | *Turnix varia* |
| Little Button-quail | *Turnix velox* |
| Baillon's Crake | *Porzana pusilla* |
| Spotless Crake | *Porzana tabuensis* |
| Black-tailed Native-hen | *Gallinula ventralis* |
| Purple Swamphen | *Porphyrio porphyrio* |
| Eurasian Coot | *Fulica atra* |
| Australasian Bustard | *Otis australis* |
| Bush Thick-knee | *Burhinus grallarius* |

| | |
|---|---|
| Banded Lapwing | *Vanellus tricolor* |
| Hooded Plover | *Charadrius cucullatus* |
| Red-capped Plover | *Charadrius dubius* |
| Black-fronted Plover | *Charadrius melanops* |
| Inland Dotteral | *Peltohyas australis* |
| Red-Capped Dotterell | *Charadrius alexandrinus* |
| Black-Fronted Dotterell | *Charadrius melanops* |
| Black-winged Stilt | *Himantopus himantopus* |
| Banded Stilt | *Cladorhynchus leucocephalus* |
| Red-necked Avocet | *Recurvirostra novaehollandiae* |
| Common Sandpiper | *Tringa hypoleucos* |
| Greenshank | *Tringa nebularia* |
| Marsh Sandpiper | *Tringa stagnatilis* |
| Black-tailed Godwit | *Limosa limosa* |
| Sharp-tailed Sandpiper | *Calidris acuminata* |
| Curlew Sandpiper | *Calidris ferruginea* |
| Silver Gull | *Larus novaehollandiae* |
| Whiskered Tern | *Sterna hydrida* |
| Common Bronzewing | *Phaps chalcoptera* |
| Brush Bronzewing | *Phaps elegans* |
| Crested Pigeon | *Ocyphaps lophotes* |
| Red-tailed Black-Cockatoo | *Calyptorhynchus magnificus* |
| Carnaby's Cockatoo | *Calyptorhynchus latirohynchus* |
| Baudin's Black Cockatoo | *Calyptorhynchus baudinii* |
| Galah | *Cacatua roseicapilla* |
| Long-billed Corella | *Cacatua tenuirostris* |
| Purple-crowned Lorikeet | *Glossopsitta porphyrocephala* |
| Regent Parrot | *Polytelis anthopeplus* |
| Budgerigar | *Melopsittacus undulatus* |
| Red-Capped Parrot | *Platycercus spurius* |
| Western Rosella | *Platycercus icterotis* |
| Port Lincoln Parrot | *Barnardius zonarius* |
| Mulga Parrot | *Psephotus varius* |
| Elegant Parrot | *Neophema elegans* |
| Pallid Cuckoo | *Cuculus pallidus* |
| Fan-tailed Cuckoo | *Cuculus flabelliformis* |
| Black-eared Cuckoo | *Chrysococcyx osculans* |
| Horsefield's Bronze Cuckoo | *Chrysococcyx basalis* |
| Shining Bronze-Cuckoo | *Chrysococcyx lucidus* |
| Southern Boobook | *Ninox novaeseelandiae* |
| Barking Owl | *Ninox connivens* |
| Tawny Frogmouth | *Podargus strigoides* |
| Owlet-Nightjar | *Aegotheles cristatus* |
| Spotted Nightjar | *Eurostopodus guttatus* |
| Laughing Kookaburra | *Dacelo gigas* |
| Sacred Kingfisher | *Halycon sancta* |
| Rainbow Bee-eater | *Merops ornatus* |
| Welcome Swallow | *Hirundo neoxena* |
| Tree-Martin | *Hirundo nigricans* |
| Fairy Martin | *Hirundo aeriel* |
| Richard's Pippit | *Anthus novaeseelandiae* |
| Black-faced Cuckoo Shrike | *Corocina novaehollandiae* |
| White-winged Triller | *Lalage leucomela* |
| Southern Scrub-robin | *Drymodes brunneopygius* |
| Scarlet Robin | *Petroica multicolor* |
| Red-Capped Robin | *Petroica goodenovii* |
| Hooded Robin | *Petroica cucullata* |
| Western Yellow Robin | *Eopsaltria georgiana* |

| | |
|---|---|
| Jacky Winter | *Microeca leucophaea* |
| Crested Shrike-Tit | *Falcunculus frontatus* |
| Golden Whistler | *Pachycephala pectoralis* |
| Rufous Whistler | *Pachycephala rufiventris* |
| Grey Shrike-thrush | *Colluricincla harmonica* |
| Crested Bellbird | *Oreoica gutturalis* |
| Grey Fantail | *Rhipidura fuliginosa* |
| Willy Wagtail | *Rhipidura leucophrys* |
| Western Whipbird | *Psophodes nigrogularis* |
| Chestnut Quail-thrush | *Cinclosoma castanotum* |
| White-Browed Babbler | *Pomatostomus superciliosus* |
| Clamorous Reed-Warbler | *Acrocephalus stentoreus* |
| Little Grassbird | *Megalurus gramineus* |
| Restless Songlark | *Cincloramphus mathewsi* |
| Brown Songlark | *Cincloramphus cruralis* |
| Blue-breasted Fairy Wren | *Malurus pulcherrimus* |
| Southern Emu-wren | *Stipiturus malachurus* |
| White-browed Scrubwren | *Sericornis frontalis* |
| Shy Hylacola | *Sericornis cautus* |
| Redthroat | *Pyrrholaemus brunneus* |
| Calamanthus | *Sericornis fuliginosus* |
| Weebill | *Smicrornis brevirostris* |
| Western Gerygone | *Gerygone fusca* |
| Inland Thornbill | *Acanthiza apicalis* |
| Chestnut-rumped Thornbill | *Acanthiza chrysorrhoa* |
| Western Thornbill | *Acanthiza inornata* |
| Yellow-tailed Thornbill | *Acanthiza chrysorrhoa* |
| Varied Sittella | *Daphoenositta chrysoptera* |
| Rufous Tree-Creeper | *Climacteris rufa* |
| Red Wattlebird | *Anthochaera carunculata* |
| Little Wattlebird | *Anthochaera chrysoptera* |
| Spiny-cheeked Honeyeater | *Acanthagenys rufogularis* |
| Purple-gaped Honeyeater | *Meliphaga cratitia* |
| Brown-headed Honeyeater | *Helithreptus brevirostris* |
| White-naped Honeyeater | *Helithreptus lunatus* |
| Brown Honeyeater | *Lichmera indistincta* |
| New Holland Honeyeater | *Phylidonyris novaehollandiae* |
| Tawny-crowned Honeyeater | *Philidonyris melanops* |
| White-cheeked Honeyeater | *Philidonyris nigra* |
| Western Spinebill | *Acanthorhynchus superciliosus* |
| Black Honeyeater | *Certhionyx niger* |
| Crimson Chat | *Epithianura tricolor* |
| White-fronted Chat | *Ephthianura albifrons* |
| Mistletoebird | *Dicaeum hirundinaceum* |
| Spotted Pardalote | *Pardalotus punctatus* |
| Yellow-rumped Pardalote | *Pardalotus xanthopygus* |
| Striated Pardalote | *Pardalotus striatus* |
| Western Silvereye | *Zosterops gouldi* |
| Zebra Finch | *Poephila guttata* |
| Australian Magpie lark | *Grallina cyanoleuca* |
| Masked Woodswallow | *Artamus personatus* |
| Black-faced Woodswallow | *Artamus cinereus* |
| Dusky Woodswallow | *Artamus cyanopterus* |
| Grey Butcherbird | *Cracticus torquatus* |
| Pied Butcherbird | *Cracticus nigrogularis* |
| Australian Magpie | *Gymnorhina tibicen* |
| Grey Currawong | *Strepera versicolor* |
| Australian Raven | *Corvus coronoides* |

## Appendix 13.

# Sources of funding for projects aimed at land and nature conservation

## Remnant Vegetation Protection Scheme

The Remnant Vegetation Protection Scheme (RVPS) was developed by the State Government in 1988 to enhance soil and nature conservation by protecting native vegetation on farm land. The Scheme (which is jointly administered by CALM and Western Australian Department of Agriculture (WADA), with WADA as the lead agency) provides a fifty percent subsidy towards to cost of protective fencing of native vegetation on farms. Landowners give an undertaking that the fenced vegetation will be managed for nature conservation for a period of at least thirty years.

To be granted a subsidy, the area of vegetation to be fenced must be five hectares or more, and must be in good condition or able to be rehabilitated to good condition.

## National Landcare Program

The National Soil Conservation Program (NSCP) was established by the Federal Government in 1983 with the aim of developing and implementing a national strategy for the rehabilitation and sustainable use of the nation's soil and land resources. The program has provided funds to government, education and research institutions and landcare and other community groups for soil conservation projects, with particular emphasis given to fostering co-operation and co-ordination amongst government agencies and those in the local community working on land degradation problems.

In 1992/93, the Community grants section of the National Soil Conservation Program (NSCP), the One Billion Trees Program (OBT), the Save the Bush Program (STB) and the Federal Water Resources Assistance Program were integrated into a one-stop-shop for community grants under the National Landcare Program. The aim of the NLP is to encourage community groups to responsibly manage and conserve land, water and biological diversity in their area.

### One Billion Trees

The One Billion Trees (OBT) Program was initiated in 1989 by the Federal Government with the aim of catalysing revegetation projects aimed at land and nature conservation. It is administered in Western Australia by Greening Western Australia. The program provides grants for revegetation projects through the one-stop-shop for community groups under the National Landcare Program.

**Save the Bush**

The Save the Bush Program (STB) was established by the Federal Government in 1989 to assist with the preservation of biological diversity by the protection and management of remnant vegetation. It is administered by the Australian Nature Conservation Agency (ANCA) and by CALM in Western Australia. Grants from this scheme encourage, facilitate and support programs, action and activities associated with the protection, management and investigation of remnant bush.

## Ribbons of Green

Ribbons of Green is a community based Greening Western Australia Project which started in 1989 with the aim of replanting and regenerating cleared strips of land with native plants and trees. The "Ribbons" are corridors along roads or rail reserves, along waterways or linking patches of bush. These 'Ribbons' may only contribute slightly to overall land conservation, but they are important for the conservation of wildlife by providing bush corridors. The details of what to plant, where and when to plant, are developed by the local community in consultation with Greening Western Australia, government departments (WADA, CALM and MRD), local government authorities, consultants and community groups.

## Plants for Conservation

The aim of Plants for Conservation (PFC) is to support groups and individuals undertaking revegetation projects aimed at land and nature conservation.

The Plants for Conservation program provides more than 300,000 seedlings each year for revegetation projects aimed at land and nature conservation. It is managed by Greening Western Australia and sponsored by ALCOA of Australia and by the Hamel Nursery. With the sponsors support, Greening Western Australia provides the seedlings. Participating groups and individuals contribute additional seedlings, materials and labour towards the projects.

## Gordon Reid Foundation for Conservation

The Gordon Reid Foundation for Conservation aims to provide funds or other support for the purposes of enhancing community involvement in conservation within Western Australia. Funds are provided for:

* the conservation of the Western Australian environment with emphasis on native flora and fauna;
* the identification and conservation of critical habitats and ecosystems;
* the conservation of rare, threatened and endangered species in WA;

* public education and awareness of environmental issues within WA;
* and research or other studies into other matters related to any of the above.

## State Landcare Program

The State Government introduced the State Landcare Program in the 1987 to support Land Conservation District Committees and catchment groups in combating land degradation problems in rural areas. Financial support is provided to LCDCs to undertake projects in catchment planning, demonstrate conservation practices and for communications and training.

## Appendix 14

Projects in the Shire of West Arthur which have been successful in receiving financial support through the State Landcare Program include:

**1). (1990/91)** **Project Title:** Hillside seepage reclamation demostration

**Project Location:** West Arthur

**Project Description:** The Lake Towerinning Landcare Group is a catchment group that fomed in 1988 to reverse the deterioration in Lake Towerinning and to address land degradation in the catchment. The Group decided to establish a demonstration of hillside seepage control using both vegetative and mechanical reclamation techniques. A seepage beside a road near Moodiarup was selected. Reverese bank interceptors were constructed above the seepage, and eight hectares of land surrounding the seepage were planted with trees.

**State Assistance Provided:** $1,300

**Contact Person**: Mr K. O'Connor
West Arthur Shire Council
DARKAN WA 6392

**2). (1990/91)** **Project Title**: Perennial Pasture Demonstration

**Project Location:** West Arthur

**Project Description:** The aim of this project was to establish a 10 hectare demonstration of perennial grass pasture that could be grazed under commercial conditions on the Hillman River flats

**State Assistance Provided**- $1,700

**Contact Person:** Mr K. O'Connor
West Arthur Shire Council
DARKAN WA 6392

**3).(1990/91)** **Project Title:** To demonstrate the feasability of a combination of a combination of drainage and agroforestry to combat increasing waterlogging and salinity.

**Project Location:** Dailup Creek Catchment

**Project Description:** The demonstration consisted of a shallow drainage system to reduce waterlogging and tree planting to reduce salinity. Over three to four years this is expected to entail 14 kilometres of fencing.

**State Assistance Provided:** $4,800

**Contact Person:** Mr K. O'Connor
West Arthur Shire Council

DARKAN WA 6392