Integrated Vegetation Management Plan for Fitzgerald Biosphere Reserve Zone of Cooperation

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Integrated Vegetation Management Plan for Fitzgerald Biosphere Reserve Zone of Cooperation

C.J. Robinson

Report to Environment Australia and Western Australian Department of Conservation and Land Management, Albany

March 1997

cover:
top: yate trees (*Eucalyptus occidentalis*) killed by salt accumulation along the upper Gairdner River

bottom: melaleuca tops being dried to release seed for revegetation by direct seeding

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Acknowledgments

This project was funded by Environment Australia and directed by Kelly Gillen of the Albany office of the West Australian Department of Conservation and Land Management

The following people gave valuable assistance over the course of the project:

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Carol Daniel - Landcare Coordinator, Jerramungup
Angas Hopkins - Plant Ecologist, CALM, Woodvale.
Suzanne Furby - CSIRO, Perth
Michael and Helen Palmer - farmers, Jerdacuttup
Ian Abbot - Scientist, CALM, Perth
Janet Farr- Scientist, CALM, Manjimup
Nathan McQuoid - former National Park ranger, FRNP
Rob and Ann Smart - farmers, Mallee Road
Gary and Marion Gilmore - farmers, Peniup
Nadine Brown - remnant vegetation surveyor, Jacup
Ross Williams - farmer, Bremer Bay
Rick Farrell - AgWA Adviser, Ravensthorpe
Mick and Penny Moir - farmers, Chillinup
Ernest Hodgkin - estuarine scientist, Perth
Rick Pepper - farmer, Ravensthorpe
Arjen Ryder - AgWA hydrology technician, Albany
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Abbreviations

FBR - Fitzgerald Biosphere Reserve
FRNP - Fitzgerald River National Park
FLIG - Fitzgerald Land Improvement Group
NPNCA - National parks and Nature Conservation Authority
NR - Nature Reserve
SAP - Western Australian Salinity Action Plan
CALM - Department of Conservation and Land Management
DEP - Department of Environmental Protection
VCL - vacant crown land
AgWA - Agriculture Western Australia

Executive Summary

Serious problems of land degradation were found to occur in most catchments of Fitzgerald Biosphere Reserve and priority action has been specified within each catchment and general principles espoused for landcare to be applied to all farmland in FBR. Fencing of remnants is still a high priority.

Although some vegetation types in FBR are considered to be more poorly conserved than others, all vegetation is considered valuable for protection of the land resource and biodiversity.

The catchment which is currently facing the greatest impact from salinity is the Gairdner River, and is currently the subject of a major revegetation project. Wind erosion is probably most prevalent in the Swamp Road and Bremer River area. Farming prospects appear most bleak in the Yallobup Creek catchment.

The most significant existing corridor which requires protective action is that which connects Lake Magenta Nature Reserve with Fitzgerald River National Park. This consists of a series of reserves and private remnants running up the main Fitzgerald River channel. Urgent action is required to protect this corridor from degradation due to salinity arising in the network of small tributaries, both east and west. The extensive corridor system that runs north from the coastal reserves around Beaufort Inlet and up the Corackerup and Peniup Creek systems does not have ultimate connectivity. The need has been identified to plan the best route to create an expansive and continuous corridor that could ultimately link the FRNP through coastal reserves to Lake Magenta NR via the Corackerup-Peniup system through the upper Gairdner catchment. Other opportunities to establish corridor links between catchments have also been identified.

The decline of remnant yate (*Eucalyptus occidentalis*) woodlands along drainage lines, through lerp induced defoliation, is a major environmental problem in the western half of FBR. This appears due to ecosystem breakdown caused by excessive clearing disturbing natural balances. Although more research is required to completely understand the cause of lerp outbreaks, it is suspected that revegetation around yates with a species diverse mix of local plants will stabilise rising watertables and foster a better balance between lerps and predators.

Scattered single yates in paddocks along the middle reaches of the Gairdner River are slowly dying and replacement vegetation should be planned.

Yate woodlands that occasionally are flooded to form yate swamps are increasingly rare in a pristine condition. In FBR most occur in the Swamp Road area and are now permanently inundated, often with salty or nutrient rich runoff. An excellent example of yate woodland protected by extensive vegetation has been identified in private land adjoining Aerodrome Road NR.

The Jerdacuttup River catchment has been recognised as being of high priority for revegetation and better land management to protect its coastal system. More survey work is required to identify the biodiversity values of the river itself.

Installation of piezometers to monitor rising water tables and the effects of revegetation (when planted) is required in most catchments in the eastern FBR.

To achieve the 90,000 hectares of revegetation that may be required to reach agricultural sustainability, direct seeding of locally collected species has been identified as the method most likely to be capable of covering such a large area. Planting of seedlings will supplement direct seeding.

Land clearing is still a major problem and a clearing exclusion zone is proposed within FBR.

1. Introduction

Fitzgerald Biosphere Reserve forms one of six sub regions of the South Coast Region, the geographic basis for the South Coast Regional Initiative which is a community based land and water care strategy prepared to ensure that Landcare funds are directed to priority issues and areas.

Fitzgerald Biosphere Reserve has long been recognised as an area of international biodiversity significance in its own right and as part of a world wide network of Biosphere reserves. It supports a static rural community of around 2,000 people, utilising 560,000 hectares of cleared farmland (in the Shires of Jerramungup and Ravensthorpe), producing about $80 million per year from cropping and grazing (draft South Coast Regional Land and Water Care Strategy). The area within FBR in which farming activities take place is called the zone of cooperation (see 2.2). Within this farmland, about 12% is already affected by salinity with the possibility that this may increase to 25% over the next 15 years unless action is taken to stabilise rising groundwaters (draft SCL&WCS). Waterlogging, wind and soil erosion also affect substantial percentages of farmland.

The extent of private remnant vegetation within the zone of cooperation is revealed in figure 1. and comprises only about 20% of the zone of cooperation, the balance being cleared farmland. Remnant vegetation is still being reduced through direct clearing and degradation due to grazing and salinity (figure 8). Much of the remnant vegetation is in small and often narrow, vulnerable parcels which are not fenced from stock.

Within FBR, land degradation occurring in the zone of cooperation poses a major threat to the viability of the rural community. In the medium term the biodiversity of the fragmented remnant vegetation is threatened, and a long term threat exists to the biodiversity of the core area of Fitzgerald River National Park.

The problems occurring in FBR are acknowledged as real by the community and it was recognised by South Coast Regional Initiative Planning team and CALM that within the zone of cooperation, a strategic overview was required to ensure that protection of remnant vegetation and revegetation is coordinated to provide the maximum benefit to both the rural community and biodiversity. This project aims to direct resources to priority areas through identification of:

- general principles of vegetation and land management that apply to all of FBR
- vegetation types that are of greater conservation significance due to rarity or lack of security
- specific areas within catchments that require immediate action
- opportunities for corridors within catchments, between catchments and from FBR to outside areas of biodiversity

During this project, GIS staff at the CSIRO Leeuwin Centre have been involved in producing a series of products based upon interpretation of a time series of Landsat TM imagery. The products will graphically demonstrate the gross (clearing) and subtle (condition) changes that have occurred to vegetation within FBR over the last 8 years. Ground truthing carried out by the project officer has supported that process. Salinity prediction maps are also being refined, and will be of great value in planning for revegetation and remnant management on individual properties within each catchment

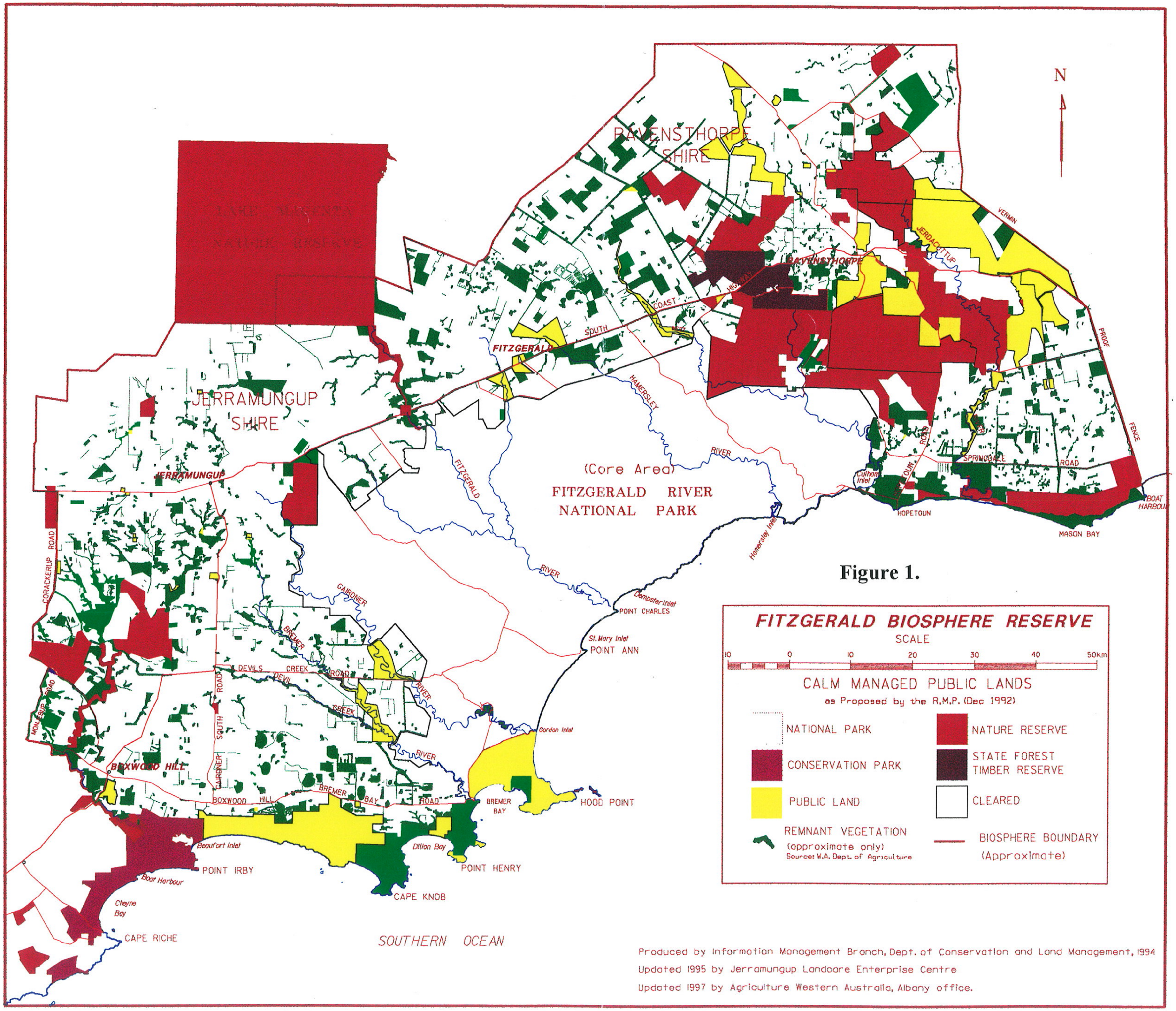
FITZGERALD BIOSPHERE RESERVE
SCALE
10 0 10 20 30 40 50km
CALM MANAGED PUBLIC LANDS
as Proposed by the R.M.P. (Dec 1992)
NATIONAL PARK
NATURE RESERVE
CONSERVATION PARK
STATE FOREST TIMBER RESERVE
PUBLIC LAND
CLEARED
REMNANT VEGETATION (approximate only)
Source: W.A. Dept. of Agriculture
BIOSPHERE BOUNDARY (Approximate)
N
RAVENSTHORPE SHIRE
JERRAMUNGUP SHIRE
(Core Area)
FITZGERALD RIVER NATIONAL PARK
SOUTHERN OCEAN
RAVENSTHORPE
FITZGERALD
JERRAMUNGUP
BOXWOOD HILL
HOPETOUN
MASON BAY
POINT CHARLES
POINT ANN
HOOD POINT
BREMER BAY
POINT HENRY
CAPE KNOB
POINT IRBY
CAPE RICHE
Produced by Information Management Branch, Dept. of Conservation and Land Management, 1994
Updated 1995 by Jerramungup Landcare Enterprise Centre
Updated 1997 by Agriculture Western Australia, Albany office.

Figure 1.

2. Biosphere Reserves

2.1 History and Concept

"Biosphere Reserves are areas of terrestrial or coastal ecosystems which are internationally recognised within UNESCO's Man and the Biosphere Program for promoting and demonstrating a balanced relationship between people and nature" (UNESCO 1996). Biosphere Reserves collectively form a world network to ensure a global system to conserve the diversity of all living organisms and their environments which constitute our biosphere, in a manner which is compatible with the material needs of a growing world population. Biosphere reserves are meant to be used as tools for promoting sustainable development.

In 1968, the UNESCO conference on the Conservation and Rational use of Resources of the Biosphere was convened to assess universal trends of population growth and rapidly increasing consumption of resources by an expanding global economy. The effects of development on the environment could not be dealt with by countries acting independently. Issues of cultural erosion, communications and inequities in technology were also addressed. The Man and the Biosphere (MAB) Program was subsequently formed by UNESCO to strike a balance between the apparently conflicting goals of conserving biodiversity and human development. The concept of Biosphere Reserves was developed in the early 1970's as the tool to test the reconciliation and integration of these land use conflicts.

Under the MAB concept, a Biosphere Reserve must fulfil three basic functions of conservation, development and logistics in a compatible manner known as *sustainable development*. The conservation function ensures the preservation of landscapes, ecosystems, species and genetic diversity. The development function promotes at the local level (within the Biosphere Reserve) development which is culturally, socially and ecologically sustainable. The logistic function provides support to research , monitoring and education from local to international network level to promote the benefits of a balanced relationship and to encourage universal adoption of Biosphere principles.

Human pressure has already drastically reduced the diversity of plants and animals on earth through the destruction or modification of a range of ecosystems and landscapes. Human welfare is inextricably linked with preservation of plants and animals as biodiversity is the source of potential for foods, fibres, medicines, renewable energy and raw materials for building and industry. Healthy ecosystems also purify the air we breath and our drinking water and protect the systems producing our food and many other products. Sociologically, preservation of natural landscapes and the creatures in them, has compassionate value that is good for humans to allow other species the right to exist. Societies at peace with their own surroundings are more likely to be at peace with the rest of the world. It is essential for human survival, therefore, that biological diversity be conserved. The Biosphere Reserve system is the UNESCO means to reserving the biological repositories of the world's major biogeographic regions and Biosphere Reserves should show the way to sustainable management of natural resources.

Working examples of Biosphere Reserves are needed to demonstrate to the global community that man can live on the *interest* without depleting the *capital* of nature into a sustainable future.

2.2 Fitzgerald Biosphere Reserve

Biosphere reserves are nominated by national governments and must meet the criteria of providing the conservation, development and logistic functions. They remain under jurisdiction of their own country and in many cases are protected under national law. The Fitzgerald Biosphere Reserve (FBR) was nominated by the Australian government to MAB in 1978 as one of 12 Australian Biosphere reserves.

Each Biosphere Reserve consists of a legally protected **core** area that is large enough to sustain genetically viable populations of its existing plants and animals. Human activity in the core is limited to research, minimal impact recreation or traditional activity of original inhabitants. In the case of the Fitzgerald Biosphere Reserve the core is the Fitzgerald River National Park, owned by the people of Western Australia and managed and protected through the Conservation and Land Management legislation. It covers about 342,000 hectares and includes 1748 species of plants (nearly 10% of Australia's flora) and 261 species of vertebrate fauna and includes many species considered to be rare (Chapman & Newbey, 1995). Activities are strictly limited to controlled tourism and biological research (CALM, 1991).

The core of a Biosphere Reserve is surrounded by or contiguous with a **buffer zone** in which human pursuits do not hinder the conservation objectives of the core and help to protect it. The buffer may accommodate activities such as forestry, fisheries, biological research and tourism. The buffer around the Fitzgerald River National Park core is composed of about 130,000 hectares of vegetated reserves and some privately owned remnant vegetation, forming a narrow envelope around most of the perimeter of the national park with extended corridors along the coast and up the adjoining river systems. Activities carried out in the buffer compatible with the national park core are seed collecting, woodcutting, wildflower picking, tourism and recreation and some small mining operations.

The last land component of a Biosphere Reserve is the outer transition area or **zone of cooperation** which extends outwards and may contain agricultural activities and concentrations of human settlement. The emphasis of land use in this area has moved away from primary nature conservation to a dominance of economic and social factors, with the natural resources utilised in a sustainable manner. In FBR, the zone of cooperation covers 895,000 hectares (almost all privately owned) and is the biggest component of the Biosphere Reserve. It includes mostly cleared farmland with substantial areas of remnant native vegetation and covers the upper catchments of all the river systems that pass through or around the core. The management of the zone of cooperation is the most critical for the sustainabiltiy of the whole Biosphere Reserve and due to the extent and manner of landuse carried out by a multitude of different landowner/managers presents the greatest challenge.

The challenge to the community of the FBR is for activities to be conducted in a manner which will not deplete the current cleared land resource through over grazing, increasing salinity, waterlogging, acidity, wind and water erosion and the spread of agricultural pests. Ideally farming operations should become sustainable in the sense that land degradation has ceased, remnant vegetation is protected and revegetation is being carried out where appropriate. The core area will then be protected from excessive salinisation and nutrient enrichment of its rivers and invasion by pest species. Genetic diversity and viability of the species in the core will be further enhanced by protection of vegetated remnants and corridors which provide links to gene pools beyond the Biosphere.

Currently, however, there are serious problems of land degradation within the zone of cooperation of FBR (see FBR Catchment Review) and much restoration work needs to be planned and implemented before this area can be claimed to be truly sustainably managed.

Sustainability in the zone of cooperation will benefit local landholders in the protection of the basic resources of land and water resulting in a more stable economic and social environment for current and future generations, where employment is assured with the opportunity to maintain existing traditions and lifestyles. The growing landcare movement has objectives which closely parallel those of the Biosphere concept, where as Campbell (1994) has recognised that "after 200 years...Europeans in Australia are starting to live with the land, and not from it".

Scientists will benefit from the preservation of the core as an area of secure tenure for long term monitoring projects. For example, in the Fitzgerald River National Park responses of plant and animal populations to treatments such as phosphonate spraying to combat dieback and fox baiting to aid recovery of small marsupials need to be monitored over long periods to ensure that extinction trends do not go unnoticed. Large areas of uncleared land may also be used as reference points against which changes (eg. climate) occurring in modified landscapes can be compared.

Governments can benefit from Biosphere Reserves as working examples of how the sustainable management of natural resources can be achieved through cooperation of all interest groups within the community. Once the course of recovery through integrated vegetation management has commenced in Fitzgerald Biosphere Reserve , the opportunity will exist for FBR to be used widely as an example of how implementation of desirable landcare practice can achieve sustainable agriculture. Through extension, education and communication activities, the Fitzgerald Biosphere Reserve can demonstrate to the global public that there are ways to solve landuse conflicts and preserve biological diversity to the benefit of all people.

There is a tremendous opportunity for the Fitzgerald River Biosphere Reserve to cement its place as a world class example of a Biosphere Reserve managed for perpetuity.

3. Remnants and Biodiversity

3.1 The value of remnant vegetation to Sustainable Rural Development and biodiversity

The value of remnant vegetation to the achievement of sustainable agriculture in Western Australia has been clearly defined by Hussey & Wallace (1993) and Wallace (1994). The latter identifying the value of remnant vegetation to developing and maintaining sustainable agricultural practices through provision of the following:

- stock and crop shelter
- direct production of wood, honey, cutflowers etc.
- effect on hydrology and prevention of waterlogging, salinity and water erosion
- reduction of wind erosion
- source of new products for the future
- seed source for revegetation and commercial cultivation
- shelter for natural predators of agricultural pests
- recreation for humans
- sinks for nutrient runoff
- minimisation of dam evaporation
- historical insight to environment pre European settlement as a reminder to land capability
- human psychological well being
- beachheads for revegetation

It is the last of these attributes which can make even the smallest remnant or loosely associated group of trees valuable as a base or building block around and upon which revegetation can be established. Any of the 13 values outlined above could be used as a criteria for assessing the value of a private remnant and the importance of its preservation. The link between maintenance of vegetation for sustainability of agriculture and benefits to biodiversity is strong.

3.2 Criteria for identifying important remnants

Any piece of remnant vegetation of any size or condition, or even single trees can be considered valuable, depending upon the criteria used for evaluation. A viable population of invertebrates may only need a few square meters of vegetated ground whereas wheatbelt euros need at least 100 hectares (Arnold et al, 1993). A single tree in a paddock may briefly sustain a honeyeater on its way to a larger remnant or reserve. A remnant which is healthy now but may be in the path of rising salinity can provide interim refuge whilst better situated revegetation is being established.

Safstrom (1995) has provided an excellent review of criteria for evaluating remnants and the many different approaches that have been made to this subject. He cites the work of Saunders et al (1991) who found that larger remnants contained a greater diversity of habitat than small reserves, but a collection of smaller reserves may have greater diversity than a single big one. Similarly, Kitchener (1980) found that reserve size accounted for most faunal diversity. Safstrom's study identified a number of general principles for selecting reserves for nature conservation purposes, but found that there were no clear cut essential criteria. Ultimately he used the following criteria: area of greater than 30 ha., high priority conservation status of vegetation type (determined by subjective evaluation) and high viability or close proximity to a viable reserve of secure tenure. He added the presence of rare flora or fauna to extend the number of reserves selected. Safstrom' procedure was designed to select remnants suitable for vesting with the NPNCA. As a consequence he did not directly evaluate remnants for purposes other than nature conservation.

The critical factor to the establishment of sustainable farming practices and the flow-on benefits to conservation of biodiversity will be the universal acceptance of the value of remnant vegetation by the land managers (farmers). Wallace (1994) and Burbidge and Wallace (1995) have discussed how this acceptance can be achieved. Perhaps the most important factor will be for people to accept "that protection and management of remnant bush is in their own best interests" (Wallace 1994). This will require a shift in cultural and social values to where the rights of the individual to carry out business are seen as compatible with long term commitment to conservation of biodiversity. That commitment may be achieved by providing economic incentives, providing support (through education, research and technical advice), promoting leadership and recognition of achievement and finally by making it compulsory through legislation.

The value of remnant vegetation in private property in conserving biodiversity may also be enormous. It has been recognised (Burbidge and Wallace, 1995) that a considerable proportion of Western Australia's biodiversity can be conserved only on land allocated for primary purposes other than nature conservation. Only 29% of the state's rare flora populations occurred only within conservation reserves (Hopper et al 1990). Additionally, the maintenance of biodiversity within conservation reserves will be greatly enhanced if connectivity (and genetic exchange) between reserves is preserved by habitat extensions and corridors through protected areas of vegetation on private land linking them. In South Australia over 500,000 hectares of remnant vegetation in private land have been formally secured in off-park conservation of biodiversity to form a very significant adjunct to formal conservation reserves.

4. Vegetation Types in FBR

One factor in determining the relative value of remnants of native vegetation is the rarity of the species and vegetation association within the remnant. Conservation significance of vegetation type is directly related to the extent to which that type is adequately represented and secured in conservation land.

Vegetation types identified by Hopkins et al (1996) to be poorly represented in conservation reserves were used as a guide to attempt to prioritise the conservation value of remnant vegetation in FBR. Hopkins' group digitally captured the 1:250,000 vegetation maps of Beard (1973, 1976) for the whole of Western Australia and overlaid that on the digital cadastral data of CALM managed estate (from CALM's Tenure Information System). Vegetation maps for every nature conservation reserve were then generated. Those vegetation types which had less than 10% of their original areal extent (or a total of less than 2,000 ha.) currently protected in conservation reserves (VCL not included) were regarded as being inadequately conserved.

A summary of the conservation status of vegetation in the Esperance and Mallee Biogeographic Regions (see Thackway and Cresswell, 1995) was provided (for this FBR project) by Hopkins. Table 1, a list of poorly conserved vegetation types for the Fitzgerald Biosphere, was extracted from this data by deleting those types (identified by their dominants) considered to occur outside the biosphere boundary. This selection was based upon the extensive field experience of former Fitzgerald River National Park ranger Nathan McQuoid and the author.

Some poorly defined vegetation types used by Beard and identified by Hopkins et al to be poorly represented in conservation land (such as shrublands of acacia-scrub heath, scrub heath or mallee scrub) were eliminated from Table 1. due to lack of sufficient definition. As this work was based on such large scale mapping, the vegetation types recognised above can only be taken as a guide in assessing remnant value. In the light of recent advances in Eucalypt taxonomy, the nomenclature used by Beard is relatively imprecise and thus less meaningful. Beard's classification does, however, indicate that almost all vegetation types that were once common throughout the Esperance and Mallee biogeographic regions must now be considered poorly conserved. Almost all vegetation encountered in field survey for this project can be allocated into a vegetation type recorded in table 1. The notable exception would appear to be mallee scrub on sand characterised by *Eucalyptus tetragona* and proteaceous shrubs (eg. *Lambertia inermis*).

With less than 20% of original vegetation left in the zone of cooperation, and the current extent of land degradation, any remnant, irrespective of vegetation type or floristics must be important.

In the course of this project , further investigation was carried out to provide more specific description of rare vegetation assemblages within the zone of cooperation of FBR. Table 2, provided by Nathan McQuoid (unpublished data) is based upon his extensive experience in FBR as a former Ranger in FRNP. This list is not exhaustive and would be expanded with further survey and vegetation mapping. These rare or restricted vegetation types in FBR are based mostly upon one or more rare species forming association with other more common scrub or heath species. The high number of such associations is indicative of the extremely complex and ever changing nature of the flora and underlying soils/geology of FBR and further underlines the probability that almost any vegetation is likely to be important from a conservation perspective.

Table 1. Poorly conserved vegetation types in FBR derived from Hopkins (1996)

less than 2% in reserves:

medium woodland - E. wandoo, E. salmonophloia, E. salubris, E. myriadena (presumed ident.by Beard in FBR as E. melanoxylon), E. astringens, E. floctoniae/transcontientalis; as single dominant species or in association with any combination of the other species.

low or medium woodland - Allocasuaina huegeliana & E. loxophleba

low woodland - Allocasuarina huegeliana

low forest - E. platypus

shrubland /mosaic shrubland - Acacia & Allocasuarina campestris
Acacia acuminata & Allocasuarina acutivalvis
Acacia spp.
E. redunca, E. eremophila, E. nutans, E. floctoniae, E. wandoo, and E. occidentalis (singly or in association).

succulent steppe - open woodland of eucalypts and Casuarina obesa

between 2% and 5% in reserves:

medium woodland -E. loxophleba/E. salmonophloia, E. salmonophloia/E. myriadena/melanoxylon, E. occidentalis, E. salmonophloia/E. salubris.

shrubland/ mosaic shrublands - scrub heath/Allocasuarina campestris thicket
- Melaleuca thyoides/E. occidentalis

salt lakes

fresh lakes

between 5% and 10% in reserves:

succulent steppe - samphire

shrubland - mixed thicket
dryandra heath
teatree thicket
Acacia acuminata/Allocasuarina huegeliana thicket

rock outcrops

Table 2. Rare vegetation communities in Fitzgerald Biosphere Reserve according to McQuoid

1. *Banksia pilostylis* scrub heath - Mason's bay coastal sand surrounding sub-coastal swamp; this type is common further eastward and extends to near Esperance, but is rare in FBR

2. *Eucalyptus famelica* mallee shrubland - Starvation Boat Harbour and Lake Shaster NR; very localised association dominating L. Shaster NR and into FBR for about 1 km from vermin proof fence - highly tolerant of waterlogging and salinity and of significance for revegetation in saline areas.

3. *Eucalyptus" utilis"* (formerly *platypus var. heterophylla*) coastal woodland on sand occurring only on tertiary dunes and aeolian calcareous sands around coastal estuaries - some in FRNP but best FBR stands between East Mt Barren and Mason's Bay.

4. *Eucalyptus preissiana* ssp *lobata* - heath with E. *angulosa* on limestone outcrops from Mason's Bay east.

5. *Banksia blechnifolia/Adenanthos glabrescens* heath - Jerdacuttup school area

6. *Eucalyptus forrestiana* ssp. *stoatei* mallee heath - Jerdacuttup area on red/brown cracking clay that are possibly areas of ancient colluvial flow from the Ravensthorpe range and Bandalup Hill greenstones; a strong phyto -edaphic feature

7. Ravensthorpe Range mallet woodlands - *E. megacornuta*, *E. gardneri* ssp *ravensthorpensis*, *E. cernua*, *E. clivicola*, *E. eremophila* ssp *pterocarpa*

8. Ravensthorpe Range gravel heath and shrublands including *Dryandra foliosissima*, *Grevillea fulgens Isopogon* aff *polycephala* and *Beaufortia orbifolia*

9. *Eucalyptus desmondensis* shrubland - Mt Desmond, Elverdton, Sleepy Hollow, Track Eleven and was known from northern Ravensthorpe Range, off Carlingup Road but requires resurvey

10. *Eucalyptus dielsii / E. salubris/ E. annulata* over *Melaleuca cucullata* woodland north of Ravensthorpe Range on red-brown cracking clay only; only one restricted occurrence in FBR

11. *Eucalyptus cylindroidea* tall mallee woodland in restricted locations in lower slopes of Ravensthorpe Range just north of Ravensthorpe and junction of Phillips and West rivers on Moir Track.

12. *Eucalyptus salmonophloia* (Salmon Gum) woodland with understorey of *Acacia acuminata* (jam) and *Hakea preissii* (needlewood) on red loam with heavy layer of nodulated limestone; scattered salmon gums in Gairdner NR

13. *Acacia acuminata* woodland or in assoc with yates (E. occidentalis) along Gairdner River; in association with *H. preissi* and *Santalum spicatum* at Gairdner junction with Calyerup Creek; tiny patch in FRNP on Tammar Creek

14. *Acacia acuminata, H. preissii, Alyxia buxifolia, Santalum sp* under *E. salmonophloia* on central Phillips River west of Moir Track.

15. *Eucalyptus indurata* associations in Steere River system, Road 11 and Jones Rd; requires further survey.

16. *Eucalyptus aff. platypus* red moort over scattered heath Corackerup NR on heavy loam

17. *Eucalyptus dissimilata/ E. perangusta* mallee heath in upper Fitzgerald , south of Magenta NR

18. *Eucalyptus "decens"(aff incrassata)/ E. argyphea* (Silver mallet) scattered along the northern FBR east of Fitzgerald River.

19. *Eucalyptus brachycalyx* (Gilja) Ravensthorpe area east along highway and into Cocanarup timber reserve and at Hamersley Inlet

20. *Santalum spicatum* anywhere

21. *E. aff. transcontinentalis* on mica soils in band from Lake Magenta

22. *Eucalyptus occidentalis* - all yate woodland on high ground loam over granite once common around Jerramungup and now present only as largely degraded remnants; population opposite Jerramungup saleyards is probably the best "reserved" remnant - may be Noongar land

23. *Casuarina obesa* woodland along saline watercourses; present in FBR only along Corackerup/Pallinup system but at its limit in western FBR.

24. *Eucalyptus rudis* (River Gum) eastern edge of range on Pallinup/Corackerup River system

25. *Eucalyptus newbeyi* mallet woodland at Millars Point and east on alluviums in gullies to Bremer Bay

26. *Eucalyptus wandoo* and *E. loxophleba* (York Gum - mallee form) woodlands on south eastern edge of range at Pallinup-Boxwood Hills area

27. *Eucalyptus mesopoda* mallee shrubland Boxwood to Chillinup rocky sandy soils over clay

28. *Eucalyptus melanophitra* mallet woodland on red loams around Corackerup Creek on Borden Road

29. *Eucalyptus cornuta* woodland between Bremer Bay to Gordon Inlet

30. *Eucalyptus platypus* var *nutans* moort woodland in one only known small dense population on east side of Wellstead Estuary; type location of real "nutans"

31. *Eucalyptus goniantha* ssp. *notactites* and *E.* sp. aff. *calciola* on sandy limestone between Bremer Bay and Beaufort Estuary

32. Entire Doubtful island/Hood Point communities differ from elsewhere in FBR in "odd" species combinations

33. freshwater wetland comminutes around Bremer Bay/Gairdner areas

34. *Eucalyptus clivicola* mallet is scattered across FBR, restricted occurrence in conservation land and little known in FRNP

5. Corridors

5.1 Corridor Concepts

In the existing landscape, in which native vegetation has been fragmented by human activities, vegetated corridors offer the only means whereby fragments can be connected to permit movement of the less mobile and shy species of animals. Isolation of the smaller remnants by fragmentation will inevitably lead to local extinctions whereas isolation of larger remnants (eg. FRNP) may result in homogenisation and erosion of genetic biodiversity. In reduced and fragmented habitat, populations can disappear one by one simply through bad luck (such as a single catastrophic fire) until extinction eventually occurs (Possingham, 1996). An isolated large private remnant on Diagonal Road (north west of Jerramungup) was almost completely consumed by wildfire in January 1997 (Strahan[1] pers. comm.). The consequences of that fire may never be known as no data on fauna of the area was collected prefire or preclearing. A huge proportion of private remnants are in this predicament and the only way to avoid chance local extinctions is to effectively link habitat fragments with corridors to allow recolonisation.

A wildlife corridor is generally accepted as a linear, vegetated landscape element which connects other areas of wildlife habitat that were once contiguous, prior to clearing. Most animals need the opportunity to move "on a daily, seasonal or intermittent basis to seek food, shelter or breeding sites" (Hussey et al, 1991); that opportunity for less mobile animals and plants in a fragmented landscape can only be provided by corridor links.

In south western Australia most animal species will use corridors primarily as habitat in its own right and secondarily for long term dispersal of population expansion. Use of corridors by animals for short term "commuting" is rare in the Australian context. Corridors also serve as a means of extending genetic interaction of plant species through cross pollination and seed dispersal.

Lynch and Saunders (1991) investigated the use of sparsely vegetated road verge corridors by wheatbelt birds. Species that can feed in paddocks were more common in road verges than species which were more reliant upon dense natural vegetation. The latter species were generally smaller creatures such as thornbills, whistlers, robins and shrike thrushes and require dense cover and are more common in the interior of larger reserves. Sanders[2] (pers. comm.) includes the shy heath wren, white browed babbler, southern scrub robin and the rare western whipbird into this group within the FBR. The numbers of these smaller species that are dependent upon native vegetation have dramatically declined as more land has been cleared. Bigger, mobile species such as ducks, ringneck parrots, crested pigeons, wagtails, miners, magpies and galahs use the bigger roadside trees for nesting and roosting, as habitat in its own right and not primarily for protective cover of movement. Some of these species such as the crested pigeon have moved into areas previously occupied by other species before clearing.

Sanders[2] (per. comm.) has observed a restless flycatcher moving quickly and directly through a vegetated road reserve of unsuitable feeding habitat, from one area of suitable habitat presumably to another. Large flocks of honey eaters will move rapidly through vegetated corridors, however they will only do so if flowering plants are providing a target food source.

Use of vegetated corridors by native mammals has not been well researched. Arnold et al (1991) showed that for the relatively large kangaroo, use of road verge vegetation as corridor linkage between remnants is limited. Corridors were mostly used as an extension of the remnant habitat, particularly where they provided dense cover and shade to rest during the day. Small mammals such as dunnarts, bush rats, western mice, echidnas, pygmy and honey possums have been recorded in the corridors of FBR (Sanders, 1996). These species use corridors only where they are big enough to provide habitat and are often recaptured in the same area. Larger mammals like brush wallabies and tammars need dense vegetation

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[1] Ross Strahan, Ongerup farmer

[2] Angela Sanders, CALM biologist, Ravensthorpe

cover and will not stray far from it. Most reptiles such as geckos and skinks (with the exception of large goannas, bobtails, bluetongues, tiger snakes and dugites) will not move beyond native vegetation through open paddocks. A few small mammals such as the brush tailed Phascogale and Chuditch are known to cross open farmland to reach shelter or food. A dispersing juvenile Phascogale has been recorded to move 6 km in six weeks (Sanders pers. comm.).

Some small native mammals will move considerable distances through dense vegetation in a short period. Baczocha[1] (pers comm) has recorded movement of a dibbler over 600 m in 20 minutes. This movement is considered by her to be within a home range and not nomadism. However, there has been little data gathered on the size of dibbler range and of the density of individuals within that range. Baczocha has recorded 15 individuals within an area of approximately 600 m by 600 m over one year, but cannot say whether individuals remain within that area. The dibbler, which has recently been recorded within FRNP, is typical of many of the small native mammals in that very little is known of specific habitat requirements.

A theoretical analysis by Soule and Gilpin (1991) has determined that corridor capability must account for many aspects of ecology, biogeography, behaviour and genetics of the candidate species. Current lack of extensive knowledge of particular animal species and the animal species composition of individual remnants precludes the formulation of corridor design for any sole species in the FBR. Given that most species in the Fitzgerald Biosphere zone of cooperation will use corridors primarily as habitat and for long term dispersal, corridor design must attempt to satisfy as many of aspects of habitat requirement as possible.

Corridors may become death traps or demographic "sinks" if they are too long relative to width. This configuration may expose travellers to a higher risk of predation or is marginal habitat because it requires excessive energy expenditure to search for food or mates or for territorial defence. The problems of long , thin corridors may be overcome by periodic bulges or habitat expansions.

Densely vegetated corridors that contain sections of open woodland may act as a wildlife filter. Sanders (1996) found that only 52 species of birds (totalled over 60 survey visits) used an area of Salmon gum woodland which constituted a "bottle neck" in an otherwise broad and densely vegetated corridor. Only 2 surveys in a nearby woodland reserve which also included mallee heath vegetation totalled 72 species, including small birds such as robins, fairy wrens and shy heath wrens which require dense cover. These small birds would not move through or use the open woodland.

There are a number of strategic corridors currently existing within FBR such as the link between FRNP and Magenta NR, through crown land and remnants along the upper Fitzgerald River. This corridor and several others will only be useful tools for conserving biodiversity within FBR if they are protected and possibly expanded to ensure that they retain their connectivity. Many other opportunities to connect remnants with revegetation have also been recognised (see FBR Catchment Review below).

5.2 Prescription for revegetation and corridors in FBR zone of cooperation

FBR Catchment Review (below) has identified that extensive revegetation is required to halt current land degradation and to achieve an equilibrium of sustainable agriculture. The Western Australian Salinity Action Plan (1996) has recognised that 3 million hectares of revegetation are required within the south west's agricultural region (18 million ha cleared). The zone of cooperation within FBR includes about 560,000 ha cleared which may require 90,000 ha of revegetation over 30 years on a pro rata basis (from SAP). Much of that FBR revegetation should be designed to provide direct benefits to biodiversity and may constitute part of a corridor network. The techniques for vegetation protection and revegetation (see

[1] Natasha Baczocha, CALM Dibbler researcher

Lefroy, 1991 and Hussey & Wallace 1993) are being rapidly developed and the challenge now is to implement them on a broad and strategic scale.

5.2.1 Plant Species

As corridors in the FBR cannot or will not be designed for single species in the foreseeable future, then the prescription must be general and potentially applicable to a greater number of animal species. Fauna survey by Sanders (1996) has shown that in FBR the greatest diversity of species occurs in the ecotone margins between dense mallee heath adjacent to tall open woodland (eg. salmon gums). Consequently the most practical species mix will be one of **great species and structural diversity** that provides reasonable **density**. The greater number of species used will provide a greater chance of providing food resources through nectar, seeds and insects year round. Mercer[1] (pers. comm.) recommends that at least 80 species be included in direct seeding revegetation "shotgun" mixes for the north Stirlings area. Any species not suited to subtle changes in the soils or topography will not thrive where others may have an advantage. Through this process of localised selection a corridor of appropriate habitat should result.

5.2.2 Dimension

As the corridor will be functioning primarily as an extension of habitat rather than as a thoroughfare, corridors should be as **wide as possible**, especially when there is no single candidate fauna species.. Inevitably, in a fragmented landscape dominated by human activities, human constraints (of farming) will strongly influence the corridor dimensions. Harris and Sheck (1991) have suggested that corridors which are to function over decades for an entire assemblage of species, should be measured in kilometres, not metres wide. On a local and perhaps more achievable level, Mercer (pers. comm.) believes that a minimum of 150 metres width revegetation is acceptable.

5.2.3 Method

The scale of revegetation (ca. 90,00 ha) that is required within FBR is such that it cannot be achieved by planting seedlings. Direct seeding of an appropriate species mix (supplemented by seedling planting) will allow the coverage of a greater area, and is more cost effective. Some information on direct seeding is available in various publications by Hussey and Wallace (1993), Baxter (1996) and Lefroy et al (1991) and from Jerramungup LCDC office. Although there have been many successful attempts within FBR to establish revegetation from direct seeding, the concept is still not widely understood or accepted. To promote the wider implementation of direct seeding, more effort is required to document success and failures and to demonstrate the collection, extraction and sowing of seed from appropriate species.

5.2.4 Location

The selection of sites for revegetation and the establishment of corridors on individual farm properties must be complementary to an overall plan for the catchment. This will ensure planting is to the maximum benefit in preventing or repairing land degradation, and is also maximising the benefit of local and regional biodiversity. Catchment plans should aim to site revegetation to join remnants with wide corridors that may become part of a system which crosses over catchment boundaries to form strategic long distance corridors.

Revegetation should be concentrated primarily higher in the landscape to prevent recharge of groundwater tables. Planting along fencelines and along midslope contours (below banks) is ideal. Planting may be useful in broad bands around discharge sites, but should not be established in areas where salinity predictions indicate that it will be affected by rising saline groundwaters. The even distribution of vegetation over the broader landscape is especially desirable in the gently undulating landforms of high salinity hazard. Other land management strategies such as the use of deep rooted perennial pastures and minimum tillage should also be taken into consideration when planning revegetation.

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[1] Jack Mercer, revegetation researcher, Albany

6. FITZGERALD BIOSPHERE RESERVE CATCHMENT REVIEW

For the purpose of this study, FBR was divided into 13 catchments or AREAS (Figure 2.) which broadly encompass all the river systems which flow through or immediately around (and may impact on) the FBR core, which is FRNP. It is not necessarily intended that the boundaries delineated should geographically define catchment groups which are often formed through social alliances which may extend over geographic features. Each AREA was assessed to determine current land degradation problems, status and extent of remnant vegetation, special features and ACTION required to address immediate problems.

More detailed examination and planning of each catchment is required to define, on a farm to farm basis exactly what is required and should be implemented in accordance with salinity predictions when available from CSIRO. Priorities listed in each area are those which were apparent in this study only and are not suggested as the only immediate action required.

It is assumed that broad principles of planning to control land degradation within all catchments will be **automatically** applied to all land managed for farming across FBR to achieve the status of sustainable farming . These broad principles are:

- fencing of all remnant vegetation
- broad scale replanting of recharge zones to halt rise of regional water table
- revegetation of discharge areas to rehabilitate or prevent salt scald areas developing
- use of local species of structural and species diversity for revegetation with biodiversity value
- use of phase cropping to increase water use
- use of lucerne and other deep rooted perennial pasture
- use of minimum tillage to prevent soil erosion and increase water penetration/availability
- reduced stocking rates to prevent runoff from hardpanning
- use of tall wheat grass in creek lines that must be grazed
- broad bands of vegetation along contours banks and along fence lines
- strategic placement of appropriate earthworks to control surface water movement
- promotion of direct seeding techniques for revegetation

As planning for revegetation within catchments was investigated, the opportunity to plan coordinated revegetation between catchments to create new corridors or enhance and protect existing corridors was taken. When revegetation is planned to protect the basic farming resource (the land) from rising water tables, salinity and erosion it should also be planned to benefit biodiversity wherever possible. A perspective much greater than the single farm is required to identify the opportunities to enhance biodiversity on a broad scale within FBR. The corridor opportunities identified in the catchments are graphically presented in figure 2. They are concentrated in the western part of FBR which is a direct reflection of the extent of clearing in that area.

The time scale over which the general principles listed above and specific action outlined below must be implemented is variable, depending on each situation. In some cases Ferdowsian's (1994) salinity hazard predictions (figure 3.) have already been realised, and in others there may 20 or 50 years before full expression will occur (Ferdowsian[1] pers. comm.). Many farmers are daunted by the realisation of the size of the task at hand and may baulk at taking it on. However, it is essential that farmers are encouraged to begin the recovery process in the understanding that they may implement and fund their program over at least 20 years. The sooner it is begun, however, the better.

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[1] Ruhi Ferdowsian, hydrologist, AgWA, Albany

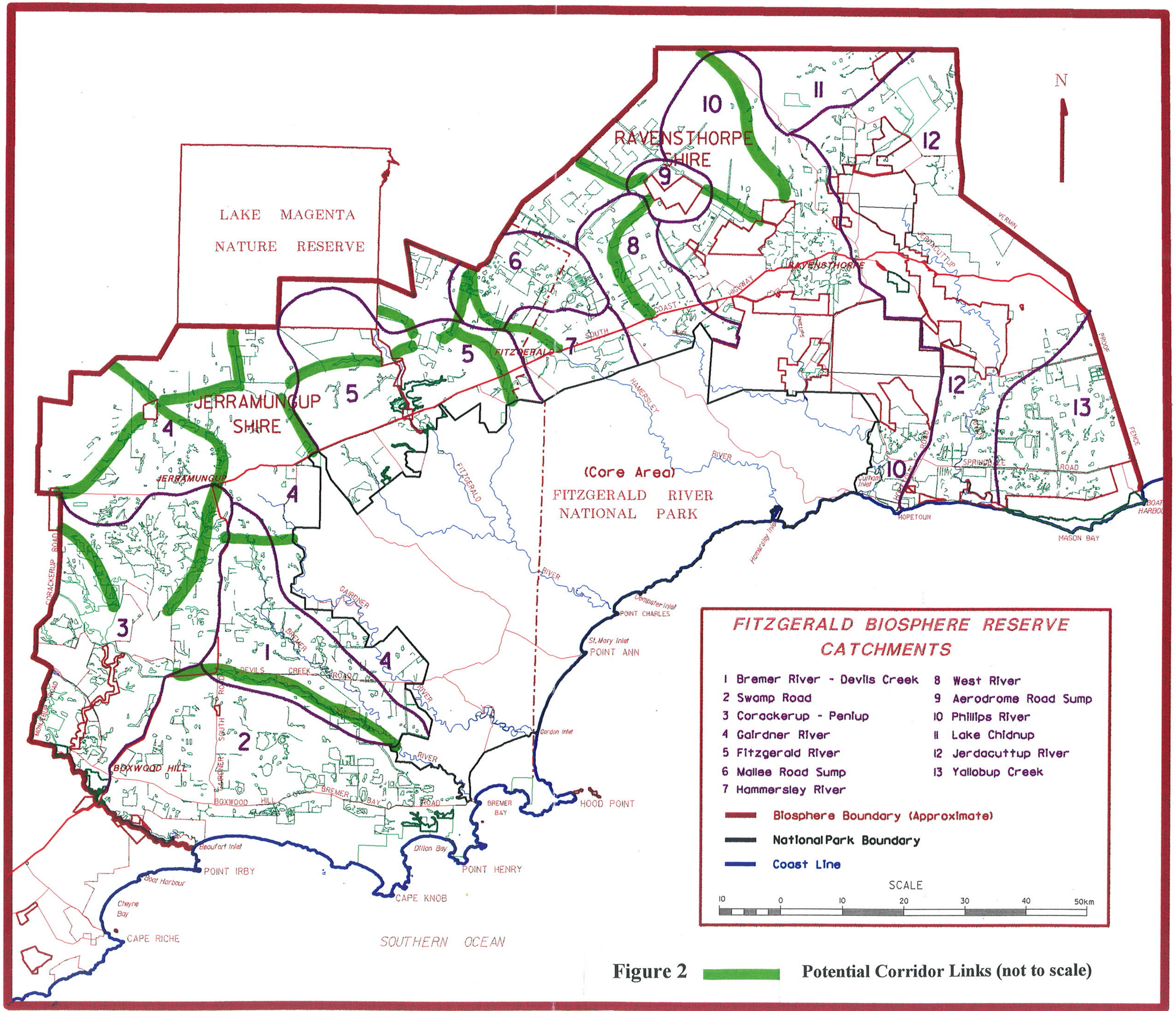
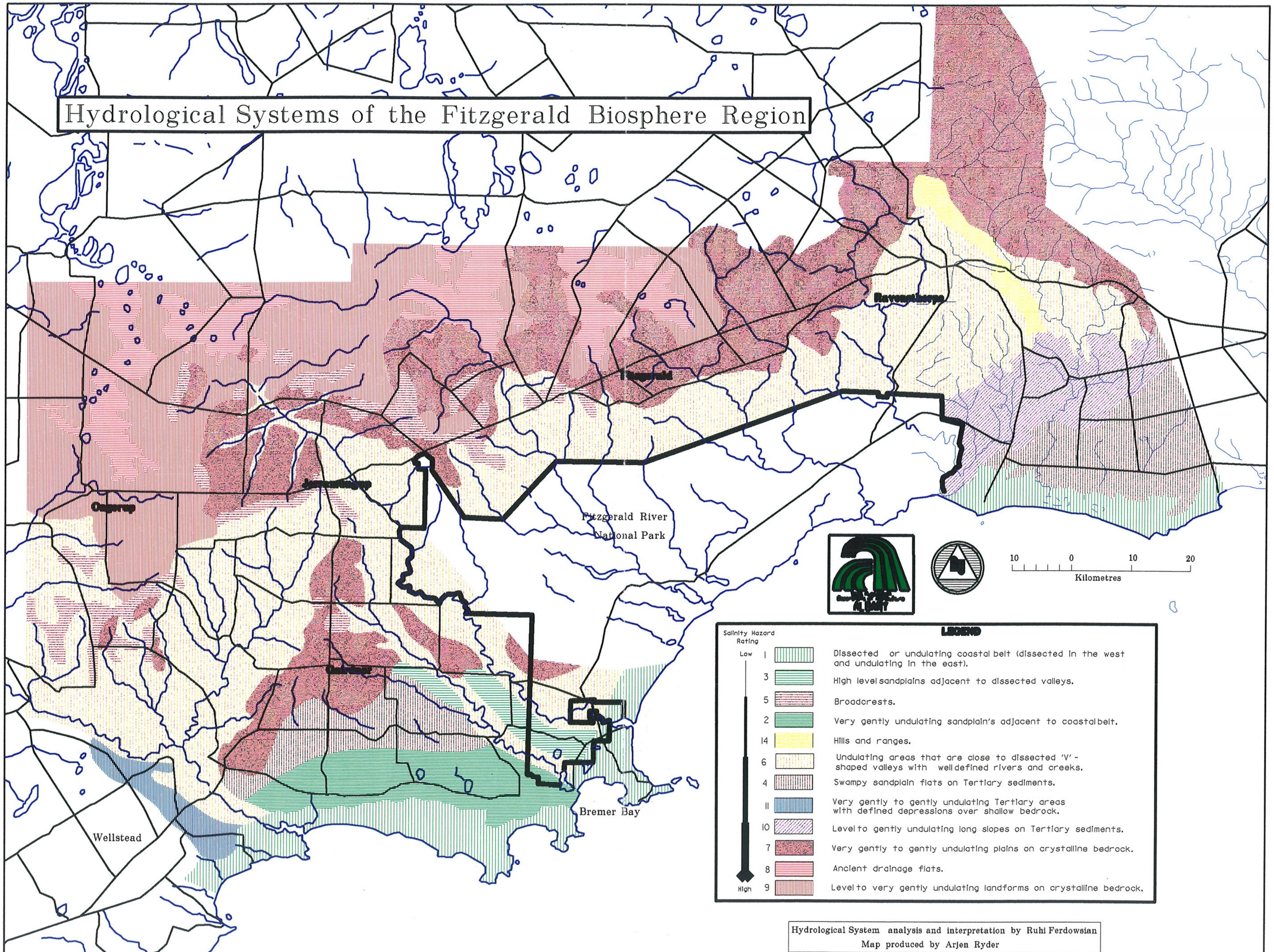


Figure 2 — Potential Corridor Links (not to scale)



Hydrological Systems of the Fitzgerald Biosphere Region
Fitzgerald River National Park
Bremer Bay
Wellstead
10 0 10 20
Kilometres
Salinity Hazard Rating
Low
High
1 Dissected or undulating coastal belt (dissected in the west and undulating in the east).
3 High level sandplains adjacent to dissected valleys.
5 Broadcrests.
2 Very gently undulating sandplain's adjacent to coastal belt.
14 Hills and ranges.
6 Undulating areas that are close to dissected 'V'-shaped valleys with well defined rivers and creeks.
4 Swampy sandplain flats on Tertiary sediments.
11 Very gently to gently undulating Tertiary areas with defined depressions over shallow bedrock.
10 Level to gently undulating long slopes on Tertiary sediments.
7 Very gently to gently undulating plains on crystalline bedrock.
8 Ancient drainage flats.
9 Level to very gently undulating landforms on crystalline bedrock.
Hydrological System analysis and interpretation by Ruhi Ferdowsian
Map produced by Arjen Ryder

Figure 3.

6.1 AREA 1 Bremer River-Devils Creek

This area covers the catchments for Bremer River and its major tributary, Devil's Creek, draining into Wellstead Inlet.

The catchment has been extensively cleared with only a narrow strip (frequently unfenced and degraded) left along most of the upper river corridor. The lower half of the Bremer River has a substantial and naturally vegetated corridor contiguous with FRNP, which if is excluded from the catchment leaves only 7% of the private land in the catchment vegetated (Hellar[2] pers. comm.).

The lower Bremer River catchment group has to date concentrated mostly upon developing farm plans, and numerous farmers have begun fencing their remnant vegetation and some replanting has been carried out. By 1992, 150 km of fencing had been funded by the Remnant Vegetation Scheme, 236 ha of saltbush and 35,000 trees planted and 108 km of drainage earthworks completed (Williams, R., 1993). The catchment group is not currently active. The headwaters of the Bremer River catchment is covered by the Carlawillup Landcare group which has developed a 10 year plan to fence and revegetate the river system. By 1990, 111 km of creeklines were fenced off and 20,000 trees planted (Houston, 1993). Unsuccessful applications for funding of further planting has since dampened enthusiasm.

Wind erosion is a major problem; in 1996 some crops were sown three times as each successive planting was blown away. Sand blown from paddocks to the west formed dunes across Murray Road during 1996 (photo 1.). Salinisation and/or waterlogging of most yate swamps is apparent. In some areas salt scalds are visible but are generally not as extensive or common as north of Jerramungup. The salt storage and concentration in the soil above bedrock is less in this area of higher rainfall and silty sediments than the heavier clay soils more common in other catchments of lower rainfall. The average water table depth over the catchment is 6.6m (range: 0.5m-17 m) and is rising at between 5 and 15 cm per year (Ryder[3] pers. comm.). Salinity of ground water is about 2,500 mS/m. Ferdowsian et al (1994) predicted that the majority of this area has a salinity hazard rating of between 15% and 25%. At the current rate of watertable rise, expression of this hazard will become severe over the next 50 years or so unless steps are taken now to reduce or minimise recharge of the watertable.

A detailed catchment study (honours thesis) on the impact of land degradation on runoff water quality was carried out in 1996 by Martin Heller (Edith Cowan University), monitoring the salinity, phosphorous and sediment content of runoff. Excessive sedimentation of Wellstead Estuary and possible eutrification is suspected and Hellar has identified the primary source as the area cleared for farming. Hodgkin and Clark (1987) support this view. Higher losses of salt in runoff coming from the cleared land was identified as a problem associated with rising watertables resultant from clearing. Nadine Brown (Jacup) has assisted Heller's project through assessment of individual vegetated remnants (classified for condition and vegetation type) on private land within the catchment.

An opportunity is identified here to create a strategic corridor connection between FRNP and the large remnants of Peniup and Corackerup Nature Reserves. This could be achieved through revegetation along Devils Creek and Cowalellup Road with broad planting which is structurally and species diverse. Similarly the top end of the Peniup corridor system can be joined to FRNP via Carlawillup Road.

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[2] Martin Hellar, post graduate Environmental Management student, Edith Cowan University

[3] Arjen Ryder, hydrology technician, AgWA, Albany

Priority ACTION for AREA 1.

1. protection and expansion of revegetation of major drainage lines especially Devils Creek and the middle upper Bremer River
3. stabilisation of sand blow areas and the encouragement of extended windbreaks and alley farming to prevent crop blasting and road closures (especially along Murray Road)
2. establish corridor/habitat link from Devils Creek to Peniup Nature Reserve possibly via enhancement of Cowalellup road reserve

6.2 AREA 2 Swamp Road

This area covers an internally draining catchment covered by the three catchment groups of Gairdner, Devils Swamp and the Swamp Road.

Gairdner

The Gairdner group was formed in 1983 as a result of salinity problems in creeklines that were beginning to become apparent. It covers the entire catchment for one large lake of 400 hectares (photo 2.) and is a cooperative of ten landholders to take coordinated action over the whole catchment. By 1992 a network of piezometers had been established, nearly 50,000 trees and 51 ha of saltbush and perennials planted, 64 km of fencing erected around remnant vegetation and 28 km of drainage earthworks built. Almost all of this has been funded by the group. Salinity in the lake in early 1996 was 900 mS/m. The potential for salinity problems in this area was well known to administrators of the War Service Land Settlement scheme before the land was released (Peacock, 1993).

Currently the group is continuing to work quietly, still with an emphasis on a whole catchment approach.

Swamp Road

Lisson (1994) has completed a detailed study of this catchment. Problems of salinity, waterlogging and erosion have been identified. Much of the catchment is comprised of flats of sandy, acidic yellow mottled soils containing ironstone gravel with minor areas of poorly drained clay flats, scattered dunes and associated swamps. Water tables are rising quickly (between 1 and 2 metres per year over the last eight years in some areas) indicating that expression of salinity will become severe over the next 10 to 15 years. Ferdowsian et al (1994) mapped this area as having a salinity hazard rating of between 20% and 25% in the upper areas and much lower on the gently undulating sandplains adjacent to the coast. Lisson recommended that revegetation of at least 25% of the upper catchment with associated drainage manipulation is required to prevent salinisation of freshwater swamps in the area. Prior to broad scale land clearing most of these "swamps" would have been yate woodlands that were only occasionally shallowly inundated for short periods. Many of these yate depressions are now inundated permanently with the water quality being determined by water usage in their local catchment. Salinity readings varied in 1994 from 35 mS/m (small basin catchment on sand) to 1180 mS/m (large catchment connected to extensive drainage from heavier soils). Eutrophication is also a problem with deaths of native birds and animals at Yendinnup Swamp through blue-green algal toxins. Underlying ground water tables (with salinities mostly between 2000 and 5000 mS/m) have not yet begun to influence most yate swamps, but if recharge is not controlled, they will reach and destroy the biota of these features.

The catchment group has been relatively active and construction of ground works (drainage) had already commenced in an uncoordinated manner during the period of Lisson's survey. Lisson provided detailed recommendations for revegetation and other measures required on 9 priority locations. In 1994/5 $53,000

Photo 1. Sand drifts blown over Murray Road

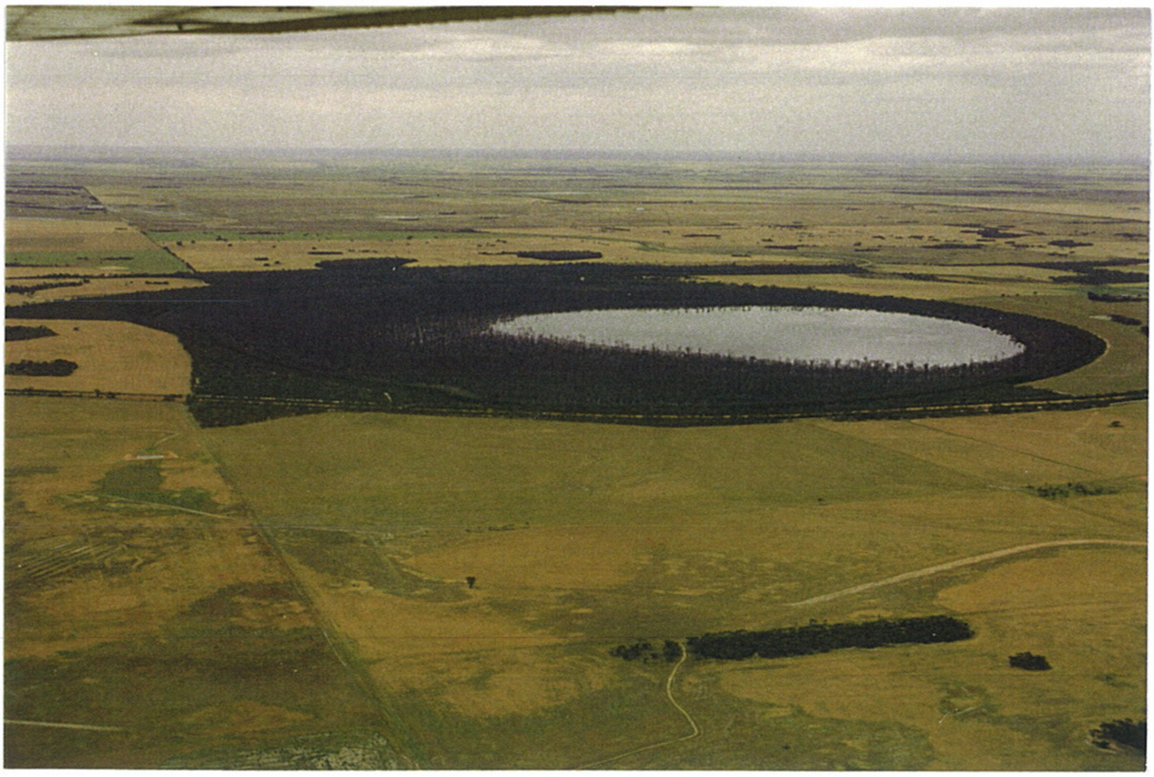

Photo 2. Permanently inundated yate swamp in Gairdner catchment area showing extensive tree deaths

was granted for fencing and revegetation to link wetlands. Seed collecting fields days have recently (November 1996) been held to provide material for direct seeding revegetation projects.

In the course of this project serious sand blows smothering road side vegetation were identified on Swamp Road, west of Gairdner Road South.

Devils Swamp

The main focus of landholders in this area is to keep the yate swamp known as Devil's Swamp (photo 3.) at the bottom of the catchment in a fresh condition. Overclearing and insufficient water use in the catchment has left this swamp permanently inundated. The water is still quite fresh, although some of the trees in the centre have died due to the excessive period of inundation. Devil's Swamp is situated in a fenced remnant of about 200 ha. To attempt this preservation, an active group has formed to replant and fence vegetation, initially to control runoff. An ANCA grant of $58,000 has been gained to erect 37.3 km of fencing and to plant 98,000 tree seedlings over 122.8 ha in 1996 (or when conditions permit), concentrated along the drainage lines at the head of the catchment where a large salt scalded area is apparent (photo 4.). The upper catchment is in a higher salinity risk area of heavier, shallower, more salt laden soils than the lower end which enters a zone of deeper sands.

The short term goal of reducing surface runoff to preserve Devil's Swamp must be supported by much broader revegetation to keep ground water tables stable within the catchment. Currently the watertable below the swamp is at 23 m and slowly rising at 15 cm per year (Smith[4] pers. comm.) and would be much closer to the surface in the upper catchment. If this rise is not halted, saline water could eventually discharge into the lake from below.

In the most southerly portion of this catchment area (as defined by the group) there is another yate and paperbark "swamp" (photo 5.) which is a local sump not connected to a drainage line which is better described as a woodland. It is not permanently inundated and on inspection (November 1996) was only slightly muddy at its centre and all trees were healthy with no tree deaths at all. Prior to clearing, most of the swamps in all of AREA 2 would have been woodlands like this. This woodland is protected from becoming a permanent swamp by a naturally vegetated area (120 ha) of shrubby mallee heath on deep sand immediately to the east. Sand areas such as this, which originate from material blown out of the swamp basin, will form a major source of fresh recharge to the swamp if they are cleared (Ferdowsian pers. comm.). Therefore, it would be ideal practice to revegetate these sandy zones where cleared, east of yate swamps, to help protect the vegetation from over inundation. As most of the remnant vegetation in AREA 2 is comprised of yate swamps and a narrow woodland fringe, the representation of the other habitat will be expanded with reestablishment of the mallee heath that occurred on the sand. Revegetating these areas will also help alleviate the common problem of wind erosion of sandy areas.

No significant opportunities for corridor connections have been identified in AREA 2.

Priority ACTION for AREA 2.

1. identification of important yate swamps that can be saved from excessive inundation, salination and eutrophication. Note: CALM research scientists are seeking funding to complete an inventory of freshwater wetlands in the wheatbelt (Lane[5] pers. comm.)
2. protection of important yate swamp woodland by revegetation to reduce runoff and trap nutrients in catchments and by planting local recharge areas on sand to the east of swamps
3. stabilisation of sand blow areas and the encouragement of extended windbreaks and alley farming to prevent crop blasting and road closures (especially along parts of Swamp Road).

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[4] Peter Smith, farmer, Swamp Road

[5] Jim Lane, research scientist, CALM, Busselton

Photo 3. Devil's Swamp permanently inundated with fresh water

Photo 4. Replanting of seedlings on slopes above saline scald in upper Devil's Swamp catchment

Photo 5. Yate and paperbark woodland protected from inundation by vegetated sand ridge to east

Photo 6. Extreme wind erosion east of Boxwood-Ongerup Road

6.3 AREA 3 Corackerup - Peniup

This is a relatively large catchment from Jerramungup through to the junction of Corackerup Creek and the Pallinup River, containing extensive remnant vegetation in private land and large reserves which together form a very significant, largely continuous corridor network. Ferdowsian et al (1994) identified this area as having a moderate risk of salinity (15%) owing to its undulating, dissected, terrain, with well defined creeks.

Currently, there are few broad areas of extensive salt scalds, but saline hillside seepages and salt encroachment from creeklines has occurred and have become a major concern over the last ten years. A broad salt scald does exist at the head of Chingarrup Brook, which eventually joins Corackerup Creek near the Pallinup River. This scald, clearly visible from Hassell Highway, is in an area of greater salinity hazard. It flows through a gently undulating broad valley on crystalline bedrock, where the water table is frequently close to the surface. Some revegetation has been established around the margins of the salt discharge. More revegetation should be established on the broader recharge area.

Beaufort Inlet, which is fed directly by Pallinup River and indirectly by the Corackerup/Peniup system suffers from serious eutrophication (from nutrient rich runoff) and sedimentation (Hodgkin and Clark 1988) due to clearing in its catchment. A complete cessation of clearing and broad revegetation coupled with minimum tillage type farming practices are required in the catchment if this estuary is to survive.

The most obvious problem in this catchment, especially in the northern half, is the almost universal decline of flat topped yate trees (*Eucalyptus occidentalis*). In this area, yate woodlands occur commonly high in the landscape in loamy soils and in the dissected valleys, as well as in water gaining basins. There are narrow but extensive networks (mostly unfenced) of mature yates left in strips up many creeklines and in patches on hill tops. They also frequently occur as scattered, single trees in open paddocks. Most of the decline is due to defoliation by the sap sucking psyllid *Cardiospina jerramungae*. They produce a dome shaped covering, called a *lerp* which is the name often also applied to the insects. Psyllid numbers and lerp attack have frequently reached epidemic proportions around Jerramungup since 1982. Previously, psyllids existed in relatively low numbers in their natural habitat, but now demonstrate an ability to rapidly build up great numbers followed by rapid decline in frequent cycles in the modified landscape.

Janet Farr (1992), a CALM entomologist has studied the lerp outbreaks. She found that the psyllids attack mostly mature foliage, and are most active after periods of tree stress such as prolonged inundation or drought. Apparently the leaves of stressed trees are more palatable to lerps. It is also speculated that trees stressed by salinity in rising watertables are more prone to lerp attack, however that hypothesis has not been tested (by piezometer installation). Jack Mercer[6] (pers. comm.) has shown that leaves of stressed native trees tend to hydrolise nitrogen from the breakdown of proteins which provides a ready source of food for sap suckers. *Cardiospina jerramungae* produces a waxy (proteinaceous) lerp. Farr found that in pristine bushland of FRNP lerp attack was far less severe than in remnants. One possible explanation for this is that in this bushland, rising salinity is not a problem and the trees are not stressed. The lack of psyllid predators in remnant vegetation composed mostly of yates is another significant factor. Farr found that a wasp which parasitises psyllids was not present in yate remnants, whereas she recorded 15% parasitism of psyllids in FRNP yate swamps. The adult wasps feed on nectar and therefore rely on flowering heathland shrubs which are not present in cleared farmland or yate remnants. There appears to be a strong link therefore between the occurrence of lerps and lack of understorey shrubs but the exact implications have yet to be revealed. Farr believes that prior to clearing lerp numbers were much lower and that clearing has dramatically changed the population threshold, although it may take up to 30 yrs after clearing for population explosions to occur. The lag phase may be linked to the time for rising salinity to affect the yates.

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[6] Jack Mercer, revegetation researcher, Albany

Some bird species such as pardalotes prey upon psyllids and can quickly control lerp outbreaks if in sufficient numbers. However, lerp outbreaks are cyclical and bird predator numbers are unlikely to be able respond quickly enough to the short term explosion of this food resource.

Research in eastern Australia on the aggressive noisy miner (Low, 1994) has shown that fragmentation of woodlands and removal of understorey favours this "edge" species. It drives out and even kills other smaller species such as pardalotes, robins, fantails, whistlers, treecreepers, thornbills and small honeyeaters. Noisy miners prefer narrow corridors of taller plants or trees with little or no understorey. Chapman[7] (pers. comm..) believes that the FBR miner species, the yellow throated miner, may impact on smaller bird species in a similar manner and is also favoured by clearing for agriculture (and artificial water supplies). Sanders[8] (pers. comm.) only recorded yellow throated miners in degraded remnants or narrow corridors where they aggressively chase off other birds. Several studies of avifauna in narrow, degraded road verge remnants around Kellerberrin found that yellow throated miners and singing honeyeaters were the most common passerines (Lynch and Saunders, 1991). Farmers around Ongerup in FBR refer to yellow throated miners as "rats with wings" due to their aggression and their occurrence in degraded "graveyard areas" areas. Smaller birds, driven off by miners are more likely to prey upon psyllids than miners: in a psyllid infested forest near Melbourne, flocks of small birds moved in to devour the infestation when scientists removed the resident bell miners (Low, 1994). It is therefore highly probable that yate stands may be protected and preserved by structurally diverse peripheral revegetation of a range of local flowering shrub and tree species. This will control rising ground water and provide a more balanced population of insects and their natural predators.

The need for more understanding and action on the problems of lerp attack was identified by the community in the South Coast Regional Initiative. The lerp problem is most clearly a direct result of a decline in biodiversity and ecosystem failure within the FBR. The biology of all psyllid predators urgently needs more research.

Selection of lerp resistant yates to provide seed for revegetation may be one way of ensuring the continued presence of yates in this landscape in the presence of periodic lerp outbreaks. Similar to jarrah trees with leaf miner resistance (25%), some yate trees with apparent resistance to lerps have been seen in the field (Abbott[9] pers. comm.). No selection has been attempted to date.

Uncontrolled wind erosion from paddocks causing sand to smother remnant vegetation in road verges is a problem. One location (Carney Road north of Maringarup Rd) where roadside vegetation has been burnt, has failed to recover after being buried by sand. In other locations where the road verge is relatively narrow, sand is creeping into the scrub heath. Windbreaks planted within the open sandy paddocks are essential to ensure protection of road reserve vegetation and will protect crops and stock. An extreme case of wind erosion was encountered adjacent to the lower Boxwood - Ongerup Road where three paddocks were completely bare, trees drowned in sand and at least one dam filled with sand (photo 6.). The property appeared unmanaged and is likely to be ideal country for *Pinus pinaster* establishment.

Water erosion has also been identified as a problem in the more deeply dissected country immediately north of Corackerup Nature Reserve (Williams, D., 1993).

As detailed in AREA 1, a possible expansion of the corridor link from Peniup NR, east via Cowelallup Rd and Devils Creek, through to FRNP has been identified. Another opportunity exists to link the upper Chittowurup Creek corridor with northern FRNP via Carlawillup Road through expanded corridors of revegetation. Sanders (1996) surveyed the large private remnant (Powell's block) on the Chittowurup Creek which contained extensive mallee heath, moort and yate woodland and described it as "significant remnant with a relatively fresh creek". Sanders recorded 106 vertebrates, the fourth highest number from

[7] Andy Chapman, biologist, Ravensthorpe
[8] Angela Sanders, CALM biologist, Ravensthorpe
[9] Ian Abbott, CALM scientist, Perth

8 sites surveyed in FBR. This block would provide an ideal springboard for a connection back to FRNP. Some sections of the corridor along Chittowurup creek which exist now as a narrow band of yate trees must be expanded with a more complex species mix to avoid the effect of a wildlife filter. The upper Chittowurup Creek is quite degraded in sections just south of Jerramungup and should be the focus of revegetation.

The extensive Corackerup/Peniup corridor system does not at present have strong links with the remnants north of the highway. Further survey is required to determine the best routes to make this critical connection which could ultimately provide a continuous corridor from the coastal reserves in the western FBR with Lake Magenta NR. Gairdner NR is a prime corridor target and a link from Chittowurup Creek, through Jerramungup townsite and across to remnants on the Gairdner River may make an ideal connection. Gairdner NR could also be linked back to the upper Corackerup corridor via a large private remnant on Diagonal Road and Nature Reserve no. 26792 on Corackerup Road.

During the course of this project it was apparent that a large block (ca 1000 ha) of mallee heath which had previously formed a very significant part of the Peniup Creek corridor, was being cleared. This clearing has created a narrow bottle neck at a point where the Peniup corridor crosses Maringarup road. Ironically, this property is adjacent to another, smaller holding whose owners have just received an award for direct seeded revegetation to provide shelter and prevent land degradation (photo 7.). The permit to clear the large block had been given in 1988 and the process is legal. However, this situation does highlight an ongoing problem within FBR where desire to clear often conflicts greatly with already serious problems of land degradation.

Priority ACTION for AREA 3

1. restoration of vegetation of upper Chittowurup Creek
2. strategic revegetation and improved land management practices to prevent wind erosion and to protect existing vegetation from sand encroachment, especially on the Boxwood-Ongerup Road and Carney Road
3. survey to identify corridor weak links and selection of a corridor route north from this system toward Lake Magenta
4. revegetation around yate woodlands using a diverse species mix to restore ecological balance to control lerp attack
5. further research into the predators of lerps
6. selection of lerp resistant yates
7. resolution of opportunity for clearing to compound existing land degradation and weaken corridor links

6.4 AREA 4 Gairdner River

The 130 km long Gairdner River arises north west of Jerramungup and flows for the northern half of its length through cleared farmland, and eventually drains into the Gordon Inlet on the edge of FRNP.

This catchment is currently suffering the greatest impact of salinity in the FBR, especially in the upper reaches of little topographical relief where Ferdowsian et al (1994) has predicted a salinity hazard rating of between 25% and 40%. A preliminary salinity map of the upper catchment has been prepared by C.S.I.R.O Leeuwin Centre (figure 4.). Water tables are rising at between 0.20 m and 0.35 m per year (Jerramungup LCDC office). Field observation of Gordon Inlet indicates that it is suffering from siltation and possible eutrophication, a view supported by Hodgkin (1988) who describes Gordon Inlet as a "graveyard" estuary due to clearing in its catchment. In some areas wind erosion is also a problem, resulting in sand blows across roadside vegetation as on the southern end of Bowra Rd and east of Gairdner NR on Rabbit Proof Fence Road.

Photo 7. John Tonkin tree planting award winning property in foreground and 700 ha being cleared on adjoining property in background

Photo 8. Revegetation project on North Needilup Road in upper Gairdner River catchment

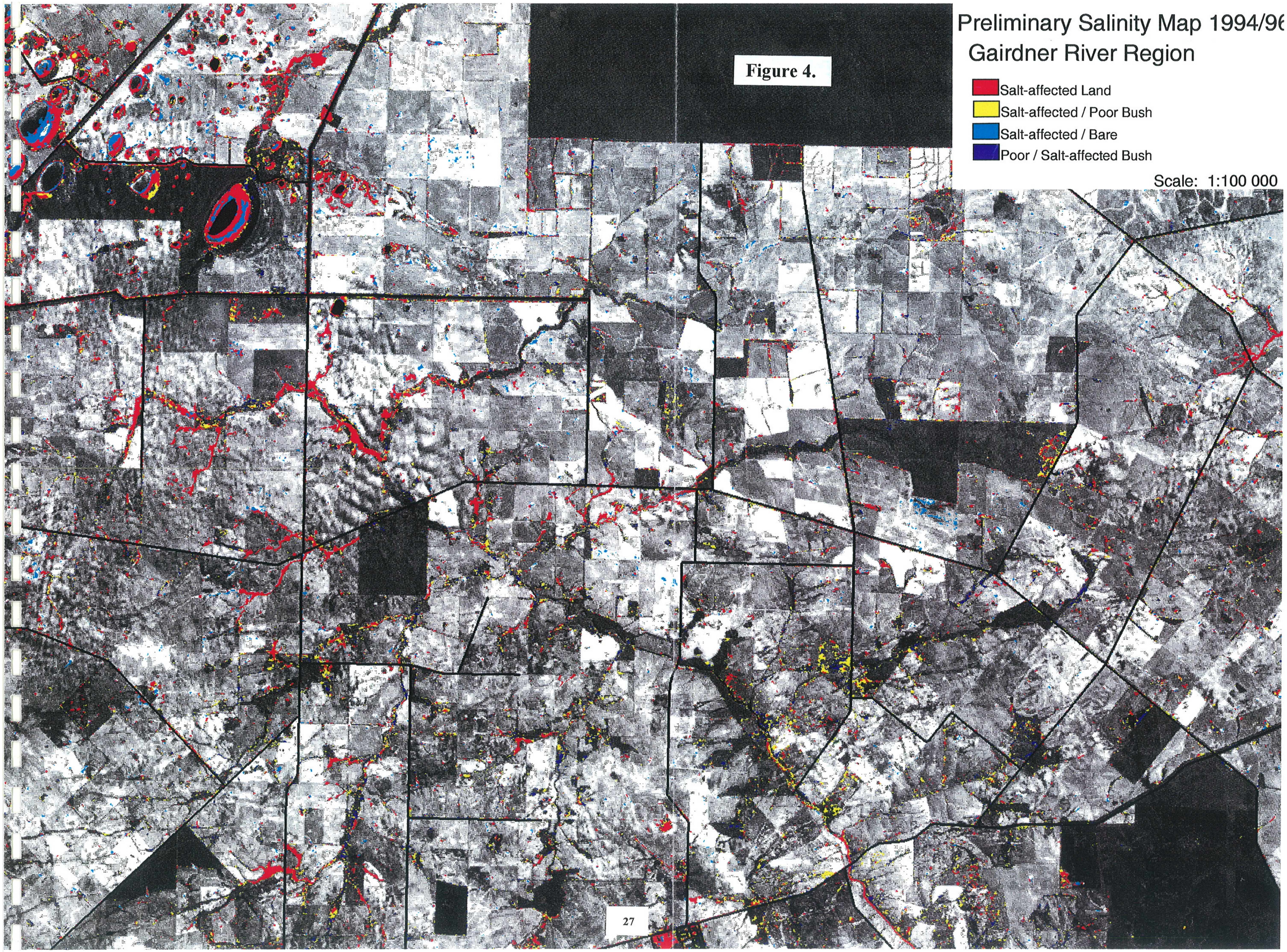
Preliminary Salinity Map 1994/96
Gairdner River Region
Salt-affected Land
Salt-affected / Poor Bush
Salt-affected / Bare
Poor / Salt-affected Bush
Scale: 1:100 000

Figure 4.

Through the Jerramungup LCDC, a major strategy has been designed (and funded by NLP) to tackle the problem of salinity in this catchment. Revegetation of 655 ha with 100,000 seedlings and 100 kg of locally collected native seed (cover photo), 214 km of fencing, and extensive drainage will be carried out in 1996/7, followed by similar efforts over the ensuing two years. The landholders within this catchment have given unprecedented cooperation and support to the project. Many landholders have already begun revegetation and fencing of remnants, largely self funded. A significant planting of saltbush and *Acacia saligna* has been established on Needilup North Rd (photo 8.) and is typical of what is required on a much broader scale. Gairdner River (Needilup) NR is immediately down stream from this planting and there is already serious decline of vegetation due to salt accumulation along drainage lines that run through the NR (photo 9.). The catchment above Gairdner NR needs special attention with emphasis on broad revegetation of recharge areas (higher in the profile) as well as around drainage lines. This should be addressed by *strategic* revegetation in the major LCDC project.

Lower in the catchment, south of the highway, relatively large numbers of isolated mature yates were left in paddocks (photo 10.). These individuals, which may have provided up to 10% canopy cover are in decline. There are already many standing dead trees and most have some degree of canopy defoliation. Eventually all these trees will die and grazing pressure will ensure that there will be no recruits to replace them. As they die, saline water tables will rise even faster. They must be replaced before they die, with strategically placed and fenced belts of vegetation which include a mix of species that may include yates and a wide range of flowering shrubs.

In combination with the LCDC project, an opportunity exists to link Gairdner NR with the wide road reserve of Bowra Rd which also connects through to Cairlocup NR. A wide revegetated corridor based around the broad salt affected creek running north west from Gairdner NR could be joined with a healthy remnant at the south west junction of Bowra and Needilup North Roads. Development of bulges or lateral vegetated expansions of the Bowra Road reserve could also be incorporated into farm plans and provide expanded habitat to enhance the corridor's capacity to sustain greater biodiversity.

The creekline which runs north east from Gairdner NR already has substantial remnant vegetation and connects with a vegetated road reserve (undeveloped) running due north to Lake Magenta NR. If both these elements are protected and expanded they would constitute a significant wildlife corridor to Magenta NR.

A large and healthy remnant between White and Exchange Roads, on the eastern edge of the Gairdner catchment may also be considered for linking back to Gairdner NR through wide revegetation of the drainage line. However, the priority for this remnant is as a major stepping stone between FRNP at Jacup and Lake Magenta NR. Expansion of habitat along Rabbit Proof Fence, Exchange and White Roads will join three large remnants to form a corridor from Jacup (FRNP) to Magenta NR. The eastern end of the largest remnant is also strategically placed to be connected with remnants on Cameron Creek to form a corridor to the Fitzgerald River. This connection would require extensive revegetation between Exchange and Brook Roads.

Possible links south to the Corackerup/Peniup corridor are discussed in AREA 3, above.

Priority ACTION for AREA 4

1. implementation of the Jerramungup LCDC Gairdner River Catchment Strategy with particular emphasis on strategic placement of revegetation on recharge areas and other areas not predicted to inevitably become saline and revegetation to prevent wind erosion.
2. revegetation to replace predicted loss of single yates in paddocks
3. development of corridor connections particularly through Gairdner NR

6.5 AREA 5 Fitzgerald River

The central corridor in this catchment joining Lake Magenta Nature Reserve and Fitzgerald River National Park is relatively short (ca. 19 km), moderately wide (0.5 km to 2.0 km) and is the only continuous corridor in western FBR. It has been recognised as having important conservation value in its own right and as a link between Lake Magenta NR and FRNP (Leighton and Watson, 1992; Sanders 1996). Leighton and Watson identified cleared land in the upper catchment as contributing to greater levels of runoff and sediment deposition in Fitzgerald Inlet, and Hodgkin and Clark (1990) commented that sediment transport from the Fitzgerald catchment can be reduced by tree planting and protection of native vegetation along margins of streams. Whilst aerial and ground survey reveal the Fitzgerald River corridor currently to be in reasonable condition (photo 11.) some decline has been observed in recent years as a consequence of waterlogging, invasion by weeds and feral animals and stock grazing (Sanders, 1996). Sections of the upper tributaries catchments (both east and west) flowing into the Fitzgerald River are showing severe degradation (photo 12.) due to accumulated salt (figure 5.). Hydrological predictions (Ferdowsian et al, 1994) for the majority of the area is that 25%-40% of the land (gently undulating plains) will be salt affected if current trends continue. It is essential that catchment management is modified to prevent further waterlogging, salination and invasion by weeds and feral animals to prevent decline of this vital link contributing to the maintenance of FBR biodiversity. Fencing and revegetation of broad areas in a reticulate pattern along the upper catchment tributaries is essential to eliminate or reduce the eventual impact on the main corridor. In many sections the river corridor only extends east of the river and must be increased to the west to improve the buffer effect.

Sanders (1996) established a fauna trapping site at the northern end of the corridor and reported that this area was subject to runoff from adjacent paddocks to the west causing waterlogging. The farming property (photo 13.) contributing to this impact was cleared extensively with almost no remnant vegetation. Piezometer records show that the ground water table under this property is rising rapidly at 0.38 metres per year (figure 6.). Aerial survey revealed vegetation decline in Lake Magenta NR due to salt accumulation in a small creek running north from this cleared farmland. This farm is a high priority for revegetation which should be integrated into the agricultural management. It would provide an ideal trial site to monitor the benefits of revegetation. A private remnant of over 300 ha which lies at the junction of Lake Magenta NR and the Fitzgerald River corridor should be added to the corridor as conservation land.

Suzetta River arises in the relatively small triangle defined by Mallee Road, Lake/Fitzgerald Road and the South Coast Highway, which contains less than 20% of the total length of the river. The bulk of this upper catchment has been cleared, whereas below the highway the river flows through pristine bushland, and joins the Fitzgerald River in the western heart of FRNP. Within the cleared part of the Suzetta catchment, expression of salinity is severe (eastern side of figure 5), with the major drainage lines showing as broad saline scalds, apparent even on small scale satellite imagery. The extent of clearing and subsequent lack of water use in this landscape, which has very little relief, has lead to rapid expression of the salinity. The current situation is that unless water use is significantly increased by establishing vegetation on recharge areas and by other farm management practices, the prediction (Ferdowsian et al, 1994) of up to 40% of this area becoming salt affected, will be realised.

The farmers within the upper Suzetta River catchment have formed a catchment group and are aware of the problems that confront them and have begun action to combat the spread of salinity. Approximately one third of the major drainage lines in this part of the catchment have been fenced and the balance will be fenced over time as funds become available (Daniel[10] pers. comm.). Broad scale revegetation has not yet commenced; when it does it must be established strategically to control as much recharge as possible. Revegetation of discharge sites close to the drainage lines will be of limited use if ground waters continue to rise due to hydrological forces originating from recharge areas, slightly higher in the landscape.

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[10] Carol Daniel, landcare coordinator, Jerramungup

Photo 9. Salt accumulation affecting vegetation in Gairdner Nature Reserve

Photo 10. Isolated yates in paddocks along Gairdner River

Photo 11. Fitzgerald River corridor viewed from crossing on central east-west road

Photo 12. Salt affected tributary draining west to Fitzgerald River

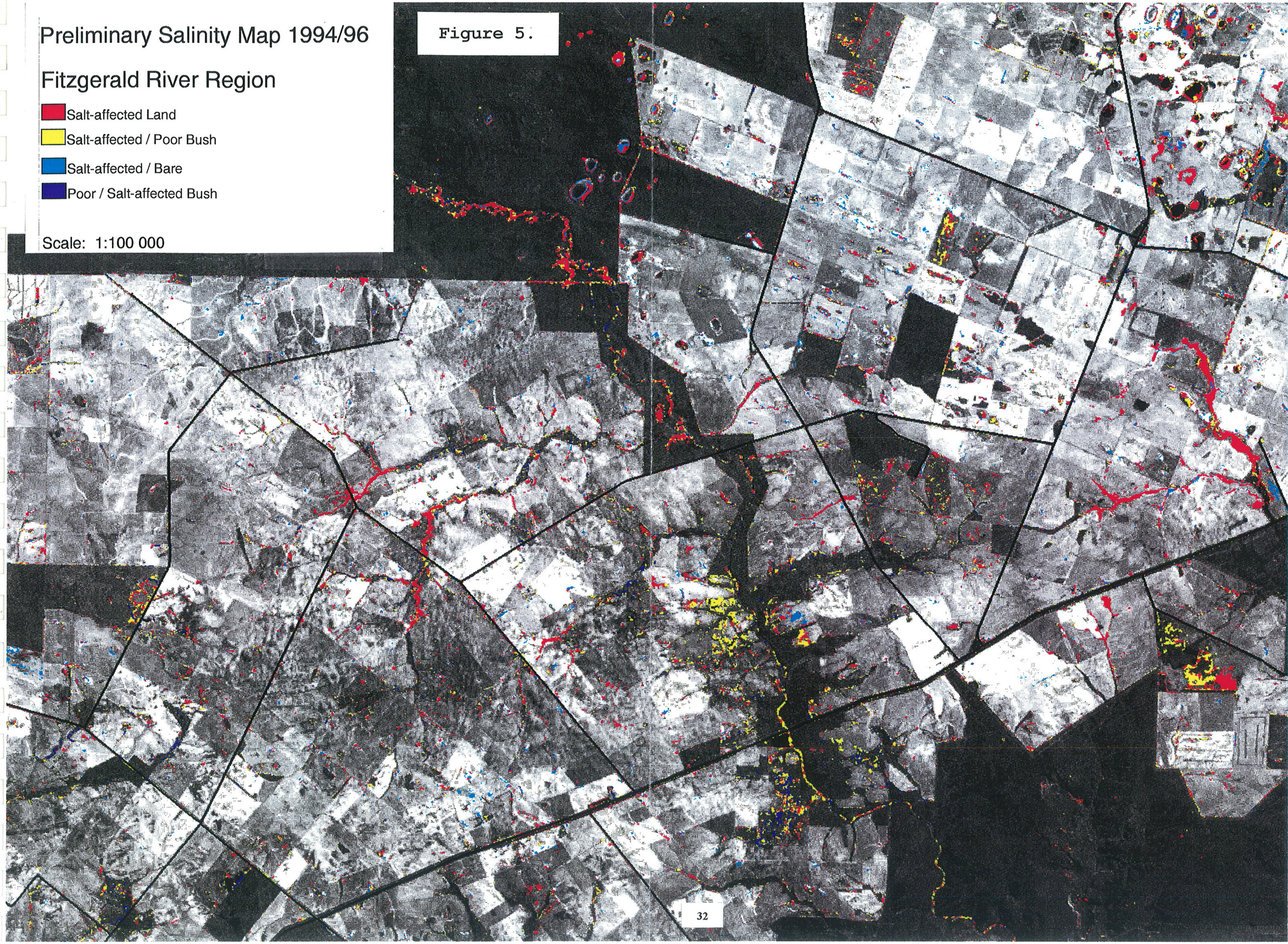

Preliminary Salinity Map 1994/96
Fitzgerald River Region
Salt-affected Land
Salt-affected / Poor Bush
Salt-affected / Bare
Poor / Salt-affected Bush
Scale: 1:100 000

Figure 5.

Photo 13. Extensively cleared farmland contributing to waterlogging in Fitzgerald river corridor

Photo 14. Severe sand blow across Fitzgerald Road

Figure 6. Piezometer records for farmland west of upper Fitzgerald River

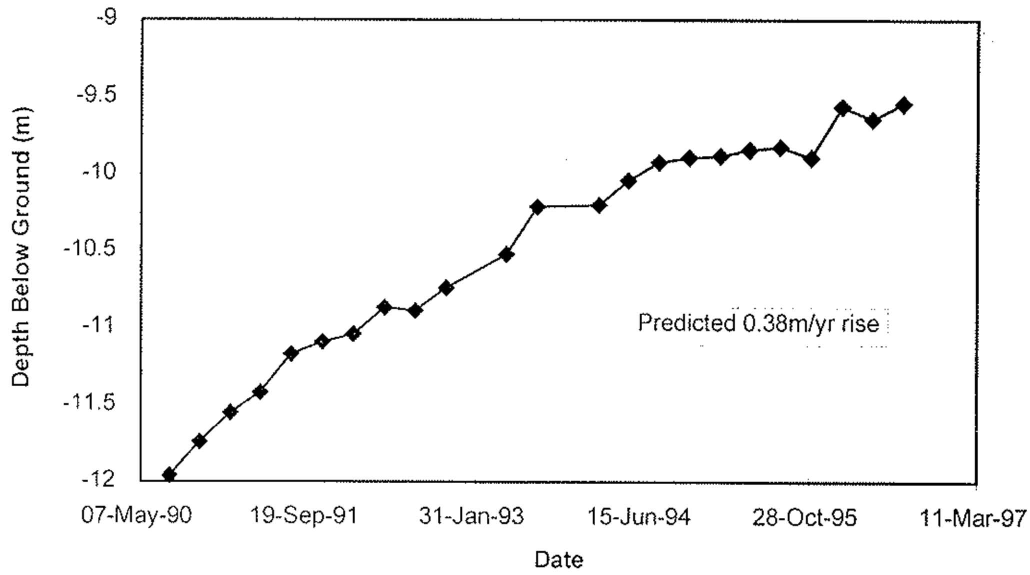
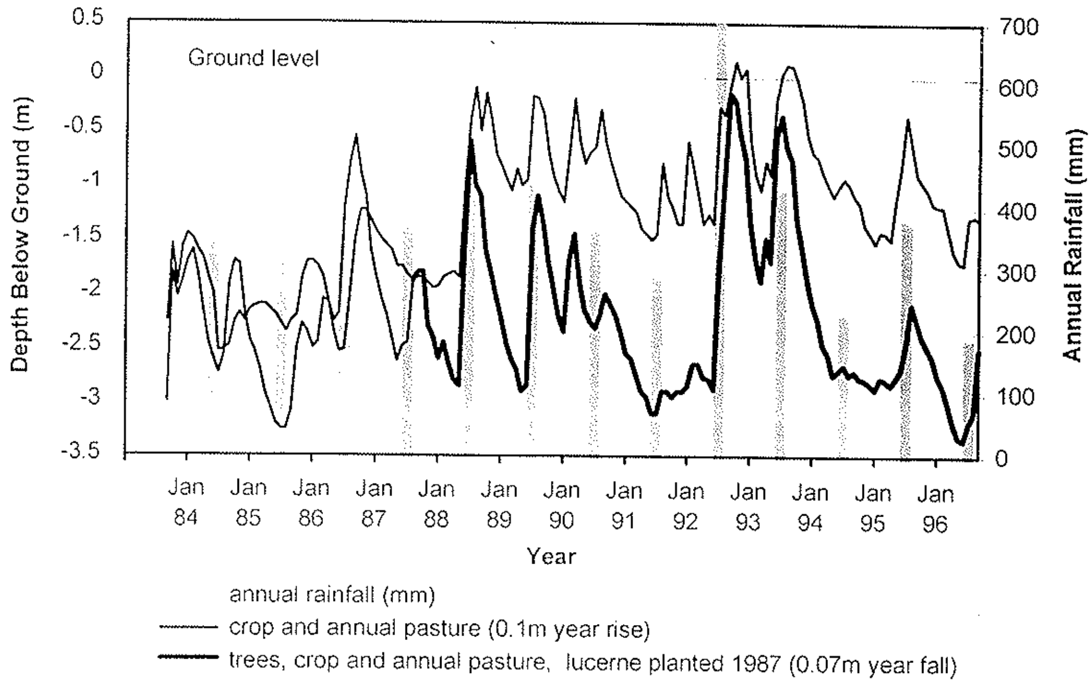


Figure 7. Piezometer records for sustainably farmed land in Mallee Road Sump



A severe sand blow across Fitzgerald Road (photo 14.) is indicative of the lack of protective vegetation in this catchment.

There is little remnant vegetation present in this triangle and it is not in a strategic location for preservation or establishment of a wildlife corridor. Revegetation will primarily be for the purpose of controlling ground water and the benefits that this will provide for the water quality in the lower reaches of the river system, rather than for immediate local biodiversity. However, a project designed in 1996 (see AREA 6 below) by the Fitzgerald Land Improvement Group may provide corridor connections.

Frequent deliberate burning of a large block of yate woodland adjoining the Fitzgerald River, south of the highway, has contributed to removal of understorey and accelerated yate decline.

Apart from revegetation to protect and expand the main corridor on Fitzgerald River (outlined above), an opportunity has been identified (in AREA 4) to link this corridor west to a large remnant between White and Exchange Roads and from there either west to Gairdner NR or north to Magenta NR. In the eastern catchment essential revegetation of tributary catchments could be designed to link the long eastern arm with three larger remnants. Through the expansion of Lake Magenta Road reserve this area could also have a secondary corridor connection with Magenta NR.

Priority ACTION for AREA 5

1. revegetation in of both recharge and discharge sites in the upper tributaries
2. revegetation to increase buffer width of immediate river corridor
3. purchase large private remnant for inclusion as nature reserve
4. revegetation in upper Suzetta River catchment
5. prevent frequent burning in lower corridor
6. development of corridor links east and west

6.6 AREA 6 Mallee Road Sump

This catchment is an internally draining system and is typified by terrain of little relief with scattered salt lakes and a few shallow yate-paperbark depressions that may occasionally flood with fresh water. Problems associated with an apparent lack of drainage from the area were recognised in the early 1970s (Smart, 1993). Ferdowsian et al (1994) have predicted that up to 40% of the agricultural land in this area will become affected by salinity if nothing is done to prevent the water table rising. Problems of waterlogging have already been experienced, especially in wetter seasons and have been followed by expression of salinity approaching Ferdowsian's predictions in some areas. Wind erosion is a major problem, especially prevalent on sandy paddocks with little vegetative protection (photo 15.).

An active community based group, Fitzgerald Land Improvement (FLIG) was established in 1983 within the Mallee Road Sump area and has fenced remnants on waterways, lakes and shelter belts, planted over 50,000 locally grown seedlings and constructed water control banks. This has been achieved using farmers own funds supported by grants from One Billion Trees and Remnant Vegetation Scheme with the additional aim of creating natural corridors to link existing remnants. To date most of these plantings are not of sufficient width and diversity to be ideal for habitat expansion (corridors) but have contributed significantly to protection of existing habitat. It is recognised by the group that what has been achieved to date is only a fraction of what needs to be done to preserve the farming resource and local biodiversity.

Siewert and Abbott (1991) carried out a detailed study of this sump, describing the area as a 30,000 hectare internally drained catchment with high salt storage and a saline water table rising on average at 0.2m per year since clearing. Water table rises of up to 0.58 m per year were recorded nearer the sump floor. Their investigations found the whole catchment acts as a recharge zone in winter, discharging and evaporating through the sump floor salt lakes during summer. Siewert and Abbott identified a need to reduce recharge of groundwaters by vegetative means as the lakes and swamps were not sufficiently deeply incised to be able to contain increased discharge due to clearing.

One property in particular in the Mallee Road Sump (photo 16.), has implemented a number of strategies to halt the rising water table and is approaching the status of being sustainably farmed. Crop yield and wool production have also been significantly improved. Piezometers installed in one paddock in 1983, 12 months after clearing, have shown that after an initial period of rapid rise, the water table is back to around original levels (figure 7.), and are considerably lower than water tables in traditionally farmed land. Strategies used from 1987 to achieve this equilibrium are:

- retention of fenced remnant bush in a strategic pattern around paddocks
- establishment of tree belts
- use of perennial lucerene to control recharge in paddocks not being cropped (5 yrs lucerene/2 yrs crop) and to use summer rainfall
- construction of contour drains to prevent down slope waterlogging on sloped paddocks
- minimum tillage techniques which achieve greater germination and water usage by crops
- de-stocking to prevent excessive soil compaction and wind erosion

The indications of water use as provided by the piezometer measurements on this property can be regarded as typically achievable for the entire sump (Ferdowsian pers comm). This property provides a role model for sustainable agriculture in FBR and beyond. An interesting observation made by the farmers is that the incidence of fly strike on sheep is significantly lower than on an adjoining property which has little remnant vegetation and no established revegetation. Although unsubstantiated, this phenomenon may be explained by the presence of insect eating birds in remnant vegetation. This is an excellent example of how maintaining biodiversity within the zone of cooperation can provide direct economic benefits.

In early 1996 a landcare project was designed by FLIG to continue efforts already begun to control ground water tables and reduce wind erosion. This project proposed establishment of revegetation using local species, within part of Mallee Road Sump and along some tributaries of Fitzgerald River and the upper Suzetta River. Funding for the project that was to continue for three years, was not approved. A substantial corridor network was planned that, with some additions could have linked Magenta NR with FRNP through the Suzetta River system. If the wide revegetation is established with a mix of plants that is species and structurally diverse, it would constitute an important extension of wildlife habitat.

It is understood that most landholders within the Mallee Road Sump accept the need for revegetation to control waterlogging, salinity and erosion.

Priority ACTION for AREA 6.

1. continued broad scale revegetation to control water tables and wind erosion
2. continued broad scale establishment of perennial pastures
3. seek funding for the FLIG Mallee Road and Suzetta River catchment project.
4. development of corridor links to Fitzgerald River corridor, Lake Magenta NR, Suzetta and Hamersley Rivers.

Photo 15. Wind eroded sand being halted by native vegetation in upper Mallee Road Sump

Photo 16. Well vegetated property in Mallee Road Sump where water tables are currently stable

6.7 AREA 7 Hamersley River

The Hamersley River arises about 15 km north of FRNP and runs the next 50 km through FRNP to Hamersley Inlet on the coast. The main river channel of the headwaters is surrounded by extensive remnant vegetation so that for almost its entire length the river is surrounded and well protected by vegetation. However, clearing in and around the upper tributaries has caused rapid expression of salinity, no more apparent than where a drainage line crosses the highway east of the main river (photo 17.). The vegetation at this site has declined rapidly over the last 6 years (Gillen[1] pers. comm.) and may be due to poor management by an absentee owner. It is apparent that those areas of the catchment that have been cleared have little remnant vegetation and water use is insufficient to prevent excessive recharge. Ferdowsian et al (1994) predicted that this gently undulating area will become about 25% salt affected if groundwater recharge is not controlled.

Although there is no catchment group formed in the area, some farmers are active in land conservation and have retained vegetated strips and are establishing revegetation of pine belts and eucalypt trees immediately east of the river reserve. This effort, however, has still not been sufficient to prevent some salt accumulation impacting upon vegetation around minor tributaries in the reserve.

An opportunity exists to connect the Hamersley River Corridor through to Magenta NR, via expansion of Lake Road reserve and revegetation initiatives in the Mallee Road Sump.

Priority action for AREA 7

1. revegetation is required urgently to arrest severe salt scald evident from highway crossing east of river both north and south of the highway

2. establish corridor connections to Lake Magenta NR

6.8 AREA 8 West River

The West River is a major tributary of the Phillips River which drains into Culham Inlet. This inlet has been subjected to more frequent flooding since catchment clearing has taken place (Hodgkin, in prep.). Increased water use and control of runoff in the West River catchment is critically linked to the protection of Culham Inlet.

Compared to the western part of the biosphere this catchment is reasonably well vegetated with much broader vegetated road reserves and more remnant bush in paddocks with fewer obvious expressions of land decline through erosion or salinity. It is also very apparent that from around this area, east through the rest of FBR, that yate trees (*E. occidentalis*) are healthy with no sign of excessive lerp outbreak. The main corridor of West River is vegetated for almost all its length above FRNP but narrows significantly in several places. Vegetation is especially scant in uppermost tributaries. Planning of revegetation will be necessary to capitalise on the existing vegetation to protect the main corridor. Extension of vegetated belts along and around the minor tributary system (which could readily become saline like many of the minor tributaries of the Fitzgerald River) is required.

Preliminary survey in the course of this study has revealed that little remnant vegetation is fenced.

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[1] Kelly Gillen, CALM, Albany District Manager

A catchment group is currently active with approved projects of $100,00 fencing and trees (over 2 years through Corridors of Green) and $20,000 (NLP) to install piezometers and complete a catchment study (Farrell[2] pers. comm.).

A strong opportunity exists to create a corridor link from Aerodrome Road NR, back through a large private remnant to the west and down through the West River reserves to FRNP.

Priority ACTION for AREA 8

1. fence all remnant vegetation
2. revegetate upper tributaries to control runoff and recharge
3. revegetate to expand weak points in main river corridor
4. develop corridor links to Aerodrome road NR

6.9 AREA 9 Aerodrome Road Sump

The area surrounding Aerodrome Road NR is an inwardly draining sump, similar to Mallee Road Sump, and typified by very gently undulating terrain, with shallow lakes flanked on their eastern side by vegetated sand hills. Approximately 50% of the sump area is comprised of the NR which is contiguous with substantial tracts of private remnant vegetation. Survey by Sandiford (1988; unpublished CALM data) revealed that the diverse vegetation (8 associations) in the NR is in excellent condition and was representative of pre clearing local vegetation associations. Sandiford recorded the rare Western Whipbird and Sanders (1996) recorded another 78 vertebrate species from limited survey, including Western Mouse (Specially Protected Fauna species). The NR contains a large salt lake which is fed by two creeklines which both arise in cleared farmland. Currently the vegetation fringing this lake is in good condition, however if ground water recharge is not controlled in its catchment, excessive runoff and salt accumulation could result in vegetation decline around the lake. The lake seasonally supports many species of waterbirds.

Possibly the most significant feature of the area is a large and healthy yate-paperbark woodland depression (photo 18.) in private remnant on the central southern side of the NR. As this woodland is surrounded by extensive vegetation, it is rarely flooded, but in high rainfall years (1992) it fills with fresh water to 2 metres depth which slowly recedes over up to 2 years, and provides extensive waterbird habitat (A. Sanders, pers comm). There remains few (if any) originally fresh lakes within FBR (outside FRNP) of this size which are still fresh and contain healthy yates not decimated by lerps, prolonged inundation or salt accumulation. Consequently this is a most significant lake in an area of great biodiversity significance.

Aerodrome Road NR is connected to both FRNP via the Phillips River corridor and Dunn Rock NR (outside FBR) by the vegetation in the broad road reserve of Aerodrome Road. Strategically located revegetation, established west to a large private remnant, could also connect Aerodrome Rd NR with the West River system. Corridor values of the road reserve could be enhanced by revegetating to create periodic bulges or radiating belts of suitable local species. In some cases this is already in place through bush retained at clearing, however much is still unfenced.

Priority ACTION for AREA 9

1. strategic revegetation in creek catchment to protect the large salt lake
2. fencing of remnant containing large fresh water woodland
3. consideration of acquisition of freshwater woodland (as in 2 above).
4. fencing all remnants

[2] Rick Farrell, AgWA landcare adviser, Ravensthorpe

6.10 AREA 10 Phillips River

The main channel of the Phillips River is protected for the majority of its length (outside FRNP) by a relatively substantial and healthy corridor of naturally vegetated reserves. The vegetation around the river is healthy and shows little sign of degradation due to excessive salination (photo 19.). It is important that farming practices are managed and monitored to ensure that the current status of the river reserves is maintained. Currently there is no catchment group and no piezometers installed to monitor water tables, and as a consequence, problems confronting landholders farming around the tributaries may not be identified or well understood.

Ferdowsian et al (1994) has mapped this area as having a salinity hazard rating of 25% or over. Problems are beginning to emerge throughout much of the catchment (Farrell, pers. comm.), especially around the minor tributaries where waterlogging and subsequent expression of salinity has occurred. This is evident in the area around Belli and Dam roads and at the very top of the catchment north of Fitzgerald Road, where there is little vegetation in a flat landscape.

The Phillips (and Steere) rivers flow into Culham Inlet, closed from the sea by a high sand bar, just west of Hopetoun. Flooding of farmland and native vegetation around the inlet and closure of access from Hopetoun to FRNP have become frequent in recent years (1989, 1990 and 1992). Concerns were growing that an uncontrolled breach of the bar may occur due to increasing water levels in the inlet. A controversial attempt was made in May 1993 to achieve a controlled release of inlet water to the ocean via a hastily constructed opening. This resulted in a 150 metre wide gap being torn in the sand dune and destruction of 250 metres of road (Hodgkin, in prep.). In 1996 an engineered structure to release future flood waters in a more controlled manner was completed. Previously, the bar had only been known to have opened naturally twice (1849 and possibly 1870s) and artificially in 1920. An increase in clearing in the catchment from about 10% in 1968 to 50% by 1988 has lead to much greater runoff and increased watertables resulting in increased river flow (at least doubled) and unusually high water levels (Hodgkin, in prep.). Increased water use by revegetation and modified farming practices in the upper catchment may provide a more permanent solution to flooding problems in Culham Inlet than the current engineering solution. It is better to effect treatment of the cause (lack of vegetation) than the symptom (flooding).

An opportunity exists to connect FRNP with Dunn Rock NR via the Phillips River corridor by creating a revegetated corridor to join the top end of the Phillips River reserve system with a large remnant on Millstead Road, just outside FBR.

Table 1. identified that most of the woodlands types which occur in FBR are poorly conserved in conservation reserves. These woodlands are more prevalent in the eastern part of FBR and the Phillips River catchment in particular. Tall salmon gums (photo 20.), for example, are scattered throughout cleared farmland around Ravensthorpe and are mostly unfenced from stock. Although , the immediate health of the trees does not appear to be suffering, they should be fenced to allow recruitment of seedlings in time.

There is some speculation that Stennett's Lake catchment to the north and outside current FBR boundary will drain to the Phillips River catchment in very wet years. It has not done so since clearing, although there is a palaeogeological channel link (John Platt, pers comm).

Priority ACTION for AREA 10

1. formation of catchment group(s) to identify problems and plan solutions (revegetation)
2. installation of piezometers
3. develop corridor links to Dunn Rock NR
4. fencing of stands of woodland such as salmon gums and mallets

Photo 17. Severe vegetation decline visible from highway in tributary of Hamersley River

Photo 18. Healthy yate-paperbark woodland protected by remnant vegetation adjacent to Aerodrome Rd Nature Reserve

Photo 19. Main channel of Phillips River viewed from Aerodrome Road

Photo 20. Salmon gums in private property in Phillips River catchment

Note: Just north of the Phillips River catchment, on the boundary of FBR is the Magdhaba Downs property which has been cleared with a high proportion of remnant vegetation left in strips. This property represents an excellent opportunity to monitor the benefits of this pattern of remnant vegetation in controlling recharge and preventing accumulation of salt. Installation of well monitored piezometers here would provide interesting data.

6.11 AREA 11 Lake Chidnup

This catchment is internally draining into Lake Chidnup in the north eastern section of FBR. The terrain is moderately undulating and expression of salinity is unlikely to be as severe as other more gently undulating parts of FBR. There is a catchment group operating in this area, which although not currently active, has been in the past and has completed some revegetation and fencing of remnants (Farrell pers. comm.). It is apparent from field survey that there are reasonable amounts of remnant vegetation and that land degradation problems are currently not severe. Many remnants, however, still require fencing and a salt affected tributary leading to a salt lake (flooded by excess runoff) was observed on Beatty Road.

Lake Chidnup itself appeared to be in good condition with relatively intact vegetation around its salt pan.

Priority ACTION for AREA 11

1. a catchment plan is required to preserve the landscape in its current state and address measures to prevent possible waterlogging and salinisation.

6.12 AREA 12 Jerdacuttup River

The Jerdacuttup River drains into the Jerdacuttup Lakes system reserves which form the central part of the important eastern coastal buffer zone of FBR. The Jerdacuttup Lakes "provide, at times, a very significant refuge and breeding area for water birds" (Lane pers. comm.). Twenty six species totalling thousands of individuals were recorded by Jaensch et al (1988). The lakes are subject to periodic episodes of inundation and waterlogging. The water is naturally saline, but it is likely that the quantity of salt and volume of water entering into the lakes has increased greatly since clearing for agriculture.

To protect the high conservation values of the lakes and the associated nature reserve, the catchment of the Jerdacuttup River must be managed to eliminate excessive runoff, siltation and salinity. Excessive inundation and salt accumulation will kill the vegetation surrounding the lake system, which then eliminates or reduces available nesting sites and cover for waterbirds.

Currently there is no catchment group for the Jerdacuttup River, except for the Moolyall-Woodenup Creek group covering the headwaters north of the Ravensthorpe Range. This group is organising the preparation of a catchment planning study to be completed by John Platt (Esperance based farm planner).

The river catchment is still about fifty percent uncleared. The largest tracts of uncleared land are in the northern half of the catchment, complemented by significant areas of remnant vegetation along the lower reaches. However, the southern section of the river corridor is not uniformly wide, with the western bank frequently being protected by less than 50 metres of vegetation. Revegetation planning should concentrate on improving this buffer width.

There are a number of relatively fresh pools fed by springs or seepages along the river course (Sanders pers. comm.), notably at Jerdacuttup Springs and on a tributary to the Woodenup creek. Fauna survey in the river, the fresh pools and Jerdacuttup lakes, and study of the interdependence of these areas has been minimal. Further work is urgently required to assess biodiversity values.

The farming community around the Jerdacuttup River, south of North Jerdacuttup Road is believed to be sympathetic to protection of the river (Sanders pers. comm.). It is imperative therefore to harness this sympathy (through catchment groups), to ensure that farm practices do not contribute to decline in river health. Some wind erosion problems have been experienced in the cleared section along the main highway and water erosion has occurred on slopes above the mid reaches of the river. The latter problem can be solved by using minimum till techniques or by eliminating cropping on problem slopes. Dense tree belts can be successfully established by direct seeding as achieved on Palmers property between Tamarine Road and the river. Such revegetation projects will serve to protect biodiversity in the river corridor and the Jerdacuttup lakes and should be planned to take into account local hydrology, particularly where it affects the fresh seepages. Sanders (1996) has highlighted the importance of appropriate planning in the development of ground water resources in the area to protect the local biodiversity and nature conservation values.

A critically weak point in the corridor joining the southern and northern sections of the Ravensthorpe Range has been identified by Sanders (1996) on Carlingup Road. It falls within the upper catchment of the Jerdacuttup River. The formation of an active catchment group to support fencing of remnant vegetation and the possible establishment of belts of revegetation (mallee heath species) may improve and consolidate the value of this link which joins the Fitzgerald Biosphere Reserve with the Southern Goldfields region.

Protection of unfenced salmon gums south of Ravensthorpe is required.

Priority ACTION for AREA 12

1. formation of catchment group(s) and catchment plans to protect the river and lakes
2. survey of river fauna
3. revegetation to control erosion on heavy red soils below Highway 1
4. revegetation to eliminate corridor weak links on Carlingup Road
5. protection of salmon gums in upper catchment

6.13 AREA 13 Yallobup Creek

This catchment in the south east corner of FBR is typified by flat terrain of shallow sandy soils over clay with poorly defined drainage, which eventually reaches the Jerdacuttup Lakes system. It was described by Ferdowsian et al (1994) as swampy sandplain flats on tertiary sediments with a salinity hazard rating of 20%, with salinity confined to open depressions, sumps and stagnant flats. The middle part of the creek frequently floods in a delta fashion (Platt[3] pers. comm.) and salinity is already major problem. As it is generally not suitable for cropping, and current returns from stock are poor, this area has probably the greatest challenge and worst outlook for farming in FBR. Difficulties for farming were already apparent in 1969 with a saline water table at 3m making it difficult to find dam sites and flooding occurring (Pepper[4] pers. comm.). The original vegetation, typified by broad areas of winter waterlogged, low, salt tolerant melaleucas could have been seen as an indicator of problems to come before clearing took place. Algal blooms have occurred in the flooded areas of slow moving or stagnant nutrient rich water (Pepper, pers. comm.), indicating that nutrient runoff is occurring. The health of the waters and wildlife of the coastal lakes may also be in jeopardy.

Ted Lefroy (AgWA, revegetation researcher) completed a study (unpublished) in 1989 based on land management units (Platt pers. comm.) which suggested strategies to increase water use and decrease

[3] John Platt, farm planner, Esperance

[4] Rick Pepper, farmer, Ravensthorpe

salinity by planting perennial pastures and revegetation. Around 1990 there was great interest within the catchment group in the use of earthworks and drainage to remove the excess water and John Platt was commissioned to carry out a study into the volume and movement of water. However, due to the social complexity of a multiple landholders and the local road network a complete network of drains has not been possible. Down stream landholders are particularly sensitive to plans to drain the headwaters above them. John Platt (pers. comm.) found that stream volumes dropped considerably when confronted by road culverts causing the water to divert into saline flats or existing small lakes. If a catchment drainage system had been developed it would have resulted in diverting the problem into the coastal lakes. Control of recharge higher in the catchment would be far more effective than drainage.

A catchment group does exist, although it does not have compliance of all Yallobup landholders. The current trend in the catchment is to concentrate more on increasing water usage and less on controversial drainage. Some grants ($20,000) have been obtained for revegetation.

McQuoid (see table 2.) has identified the vegetation of the low salt flats (*Eucalyptus famelica* association) as having great value for rehabilitation of saline areas.

Priority ACTION for AREA 13

1. complete catchment plan
2. revegetate to use water where it falls on recharge areas
3. revegetate discharge areas to use excess water where it accumulates
4. collection of seed for salt land rehabilitation
5. establish trials of *Eucalyptus famelica* for salt land rehabilitation

7. Land Clearing and Fitzgerald Biosphere Reserve

Land clearing remains an emotional and vexatious issue within FBR. Figure 8. shows the extent of vegetation clearing since 1990, in a selected area between Corackerup and Jerramungup. The big blocks of red (up to 700 ha) have been cleared mechanically in a short time space, whereas the smaller red dots, particularly along salt affected and stock damaged creeklines have declined slowly over many years since initial clearing. The latter could be described as remnant vegetation cleared by stealth. Within FBR, there are numerous landholders who wish to mechanically clear and many have submitted notices of intent. Whilst the process to apply for clearing approval remains in place, farmers **will** continue to have an expectation that they may be permitted to clear and may even feel obligated to their families to do so. After all, this is why they acquired the land and were originally expected to clear it.

However, given the serious problems of salinity, erosion and nutrient runoff caused largely by overclearing, and the decline of remnant vegetation and world wide decline in biodiversity (Possingham, 1996), a **complete clearing exclusion zone should be invoked for FBR**. Such a ban would be totally complementary to the State Government's commitment under the State Salinity Action Plan to ensure that 3 million ha are revegetated within the agricultural area of WA. It is also in line with the Commonwealth's pledge to invest $1.25 billion into landcare through the Natural Heritage Trust over the next 5 years. In the face of the extent of the official recognition of the problems already existing and growing annually, it would be folly to allow the possibility of further clearing in FBR. This is an internationally recognised area of significant biodiversity, and fits exactly within the criteria for a "recovery" catchment within the state Salinity Action Plan (Government of Western Australia, 1996). A total clearing ban in both "focus" and "recovery" catchments in WA should be automatic and could be achieved through legislation. Burbidge and Wallace (1995) state that while empowerment and education are crucial components of achieving landcare goals, legislation is also an important tool for assisting social change and compliance.

Because FBR is such a special area it could be used as a pilot-model in Western Australia to demonstrate how such a **clearing exclusion zone** can be implemented and accepted.

Currently in Western Australia the clearing of native vegetation is controlled under the Country Areas Water Supply Act (1978) and the Soil and Land Conservation Act (1986). Compensation to landholders is available under the former Act for areas above 10% of their holding for which permission to clear has been refused. Fencing of remnants is not required in these controlled catchments.

Under the Soil and Land Conservation Act the Commissioner has established guidelines where clearing is prevented if :

- it will cause soil or water degradation
- only 20% or less of whole shire is still vegetated
- only 20% or less of separate holding is vegetated
- the DEP or CALM has objection after referral

There is no provision for compensation under this Act for refusal for permission to clear.

Nominally, clearing applications (Notices of Intent) are referred by Agriculture WA to the DEP or CALM if the area is greater than 200 ha in less than 500 mm rainfall area or greater than 100 ha in areas over 500 mm rainfall. The acts that empower these authorities then may take effect in determining whether clearing may proceed. The DEP is in the process of investigating the formalisation of criteria for assessment of land clearing proposals (Safstrom & Craig, 1996). Currently, under the CALM Act only declared rare flora have legal protection from clearing. Although it is apparent that criteria for assessment of clearing applications are under review and are likely to become more stringent they are not yet well defined, especially in the area of conserving biodiversity.

The guidelines (above) which currently apply to clearing assessment in WA are poorly defined and ineffective from a bio-conservation perspective (20% remnant vegetation requirement has been plucked out of mid air with no scientific basis). The current situation results in much emotional input and frequent disappointment from the farmers and a considerable diversion of effort of government agencies into assessment of a sensitive issue which can be extremely stressful. Both parties would benefit greatly by a clear cut position on this issue.

In South Australia, following a protracted and painful process (see Dendy & Murray 1996) the situation of clearing of remnant vegetation as defined under the Native Vegetation Act 1991 is now well understood and accepted. From initial outrage at the introduction of clearing controls in 1983, SA farmers soon accepted that the era of broad acre clearing had finished and are now the custodians of extensive bushland conservation. South Australia is now recognised as a world leader in off park conservation of biodiversity.

Schedule 1 of the SA Native Vegetation Act states that native vegetation should not be cleared where:

- it compromises a high level of diversity of plant species
- it has significance as wildlife habitat
- it includes rare, vulnerable or endangered species
- the vegetation comprises a rare or endangered plant community
- it is a significant remnant in an area which has been extensively cleared
- it is in association with a wetland environment
- it has significant amenity value
- the clearance of vegetation will contribute to soil erosion, salinity or flooding
- the clearance of vegetation will cause deterioration to quality of surface or ground water
- the purpose to which the land will be put after clearing cannot be sustained under the Soil and Land Care Act 1989

Under the Native Vegetation Act and its immediate predecessor over 500,000 ha of private remnant vegetation is now protected and $70 million has been paid in adjustment to landholders. Clearance controls in South Australia are now viewed as a necessity, not a luxury (Possingham, 1996).

A Lake Grace farmer stated the following: "why don't we come down hard on those who are the culprits and get them to revegetate?" (ABC regional radio News 7.30 am 21/11/96). This farmer had carefully cleared his property and retained large amounts of remnant vegetation. He now wanted "to help his sons" but he could not now get approval to clear. There was no compensation available to him and he felt he was being forced to carry the burden of the consequences of his neighbours' overclearing. Similar sentiment is frequently expressed in FBR. Some farmers believe they should have a "right to clear".

Two issues are raised here. One of compensation and the other of the desire to provide more farm land for growing families. Firstly, landholders should not be financially disadvantaged from a clearing ban and monetary adjustment may be necessary were undue hardship results. Government is prepared to spend huge sums to revegetate and it would be far more cost effective to provide financial incentives to retain and protect vegetation than to replace it. In SA, farmers only began to accept that broad acre clearing had finished when incentives provided by compensation were introduced in 1986. Biologically, original bush is far more valuable than revegetation which is unlikely to have much of the original diversity. The issue of growing rural families cannot be solved by providing more land. This resource is finite and has already been over utilised as demonstrated by current land degradation. It is far better to preserve the existing resource of cleared land and make it more productive through landcare initiatives than to clear more land. Further land clearance will only hasten the decline of that land already cleared. If we clear more land now, the next generation will be left with an unproductive desert.

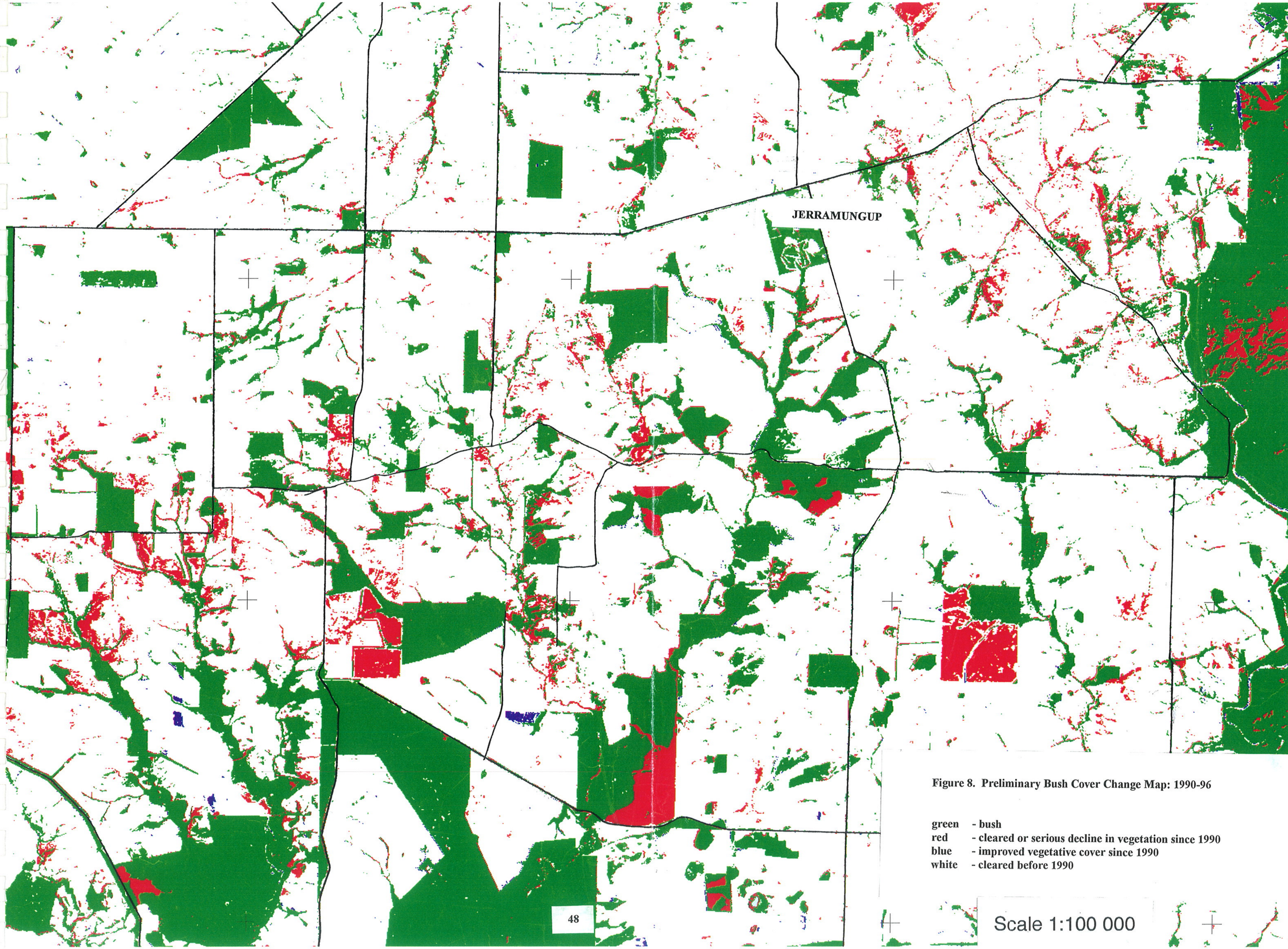

Figure 8. Preliminary Bush Cover Change Map: 1990-96

green - bush
red - cleared or serious decline in vegetation since 1990
blue - improved vegetative cover since 1990
white - cleared before 1990

8. Salinity Prediction and Vegetation Change Mapping

The CSIRO Leeuwin Centre is producing a number of products based on GIS interpretation of Landsat TM (Thematic Mapper) images which will be essential support to detailed planning of revegetation.

Figures 4. and 5. show the extent of salinity already apparent within the landscape. Such preliminary images are available for the whole of FBR. Further work is being carried out to produce a salinity change map for 1990 to 1996 which will clearly indicate the rate of spread of salinity in different parts of the landscape. This product will be further developed using digital elevation models to produce a salinity hazard or prediction image which will be invaluable in determining the location of revegetation and remnant vegetation worth saving. It is vital that effort is not expended on replanting or protecting areas that will inevitably be affected by salt accumulation due to irrevocable trends already under way.

Figure 8., an example of what is available for the whole of FBR, shows the gross change in vegetation over the last six years, revealing primarily the surprisingly large extent of recent clearing and the more subtle vegetation decline due to effects of salt and grazing. Refinement (supported by ground truthing) is being carried out on these products to eliminate some minor misinterpretations of the earlier Landsat TMs. There are a few areas which show an improvement in vegetative cover since 1990, due almost entirely to regeneration of areas of bush that had previously been chained, possibly burnt and then left. This product will provide a graphic record of the progress of revegetation over the next 30 years, which coupled with salinity maps, will hopefully show the control of land degradation and the benefits to biodiversity through corridor protection and expansion.

Figure 9. is a further refinement of the gross changes apparent in figure 8. and shows the rate of change of vegetation, expressed as condition change. This process is designed to detect the subtle changes that occur over time when, for example, stock are permitted access to remnant vegetation which will degrade regressively from the point of access.

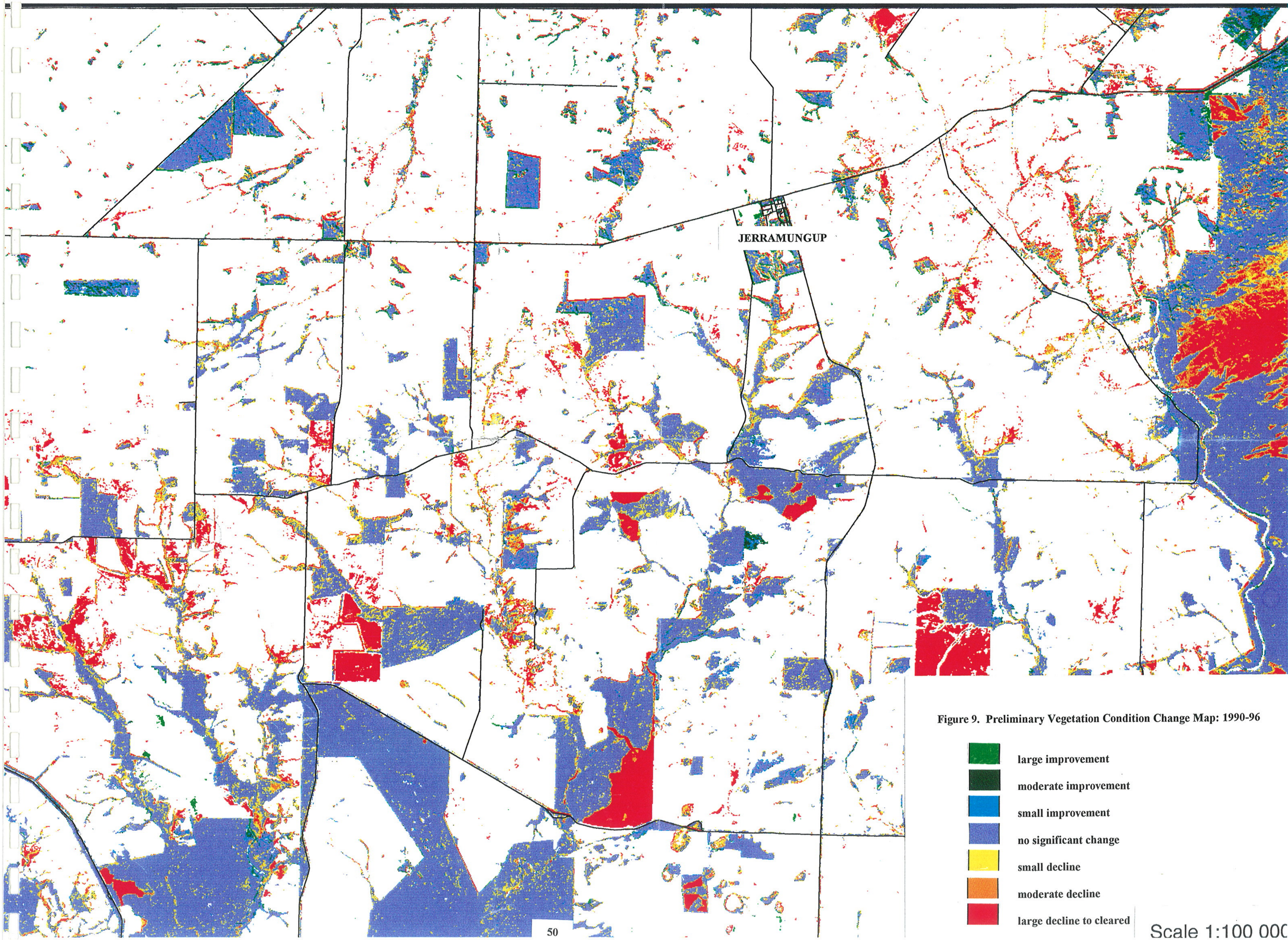

Figure 9. Preliminary Vegetation Condition Change Map: 1990-96

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