Clearing of native vegetation on Victoria Location 10598 Cockleshell Gully Road, Shire of Dandaragan - Reassessment under Section 43 of the Environmental Protection Act

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Mr Craig Underwood

Report and recommendations
of the Environmental Protection Authority

Environmental Protection Authority
Perth, Western Australia
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Summary and recommendations

The proponent, Mr Craig Underwood, proposes to clear 870 hectares of native vegetation on Victoria Location 10598 Cockleshell Gully Road, Shire of Dandaragan. The Environmental Protection Authority reported on the environmental acceptability of this proposal to the Minister for the Environment in November 1996 (Bulletin 832).

In May 1997, following consideration of a number of appeals lodged on the content of Bulletin 832, the Minister for the Environment referred the proposal back to EPA for reassessment of the following issues under the provisions of Section 43 of the Environmental Protection Act :

(a) impact on nature conservation in a regional context;

(b) adequacy of vegetation buffers;

(c) adequacy of studies related to the identification of declared rare flora and priority species; and

(d) impact on declared flora and priority species.

The EPA has sought further advice and reassessed the issues of concern raised by the Minister. This report provides the Environmental Protection Authority's (EPA's) advice and recommendations to the Minister for the Environment on the above issues.

Conclusion

The EPA has concluded that while the majority of the vegetation floristic groups on the property appear to be also represented in the Lesueur National Park, in view of the species richness and endemism of the vegetation in the region, of which the property is an integral part, it is appropriate from a biodiversity perspective to retain the vegetation on the property if this could be negotiated with the landowner.

The EPA also considers that it may be appropriate for the State Government to consider arrangements as to how best ensure long term protection of the vegetation on Mr Underwood's property in view of its biodiversity significance. This may include acquisition of the property.

This view is consistent with 'The National Strategy for the Conservation of Australia's Biological Diversity', signed by the Premier on behalf of the Western Australian Government.

Recommendations

The EPA submits the following recommendations to the Minister for the Environment:

1. That the Minister notes that this report is provided as a result of a request by the Minister under Section 43 of the Environmental Protection Act to provide additional information in relation to a proposal.

2. That the Minister considers the EPA's report on the matters referred by the Minister to the EPA in relation to the proposal by Mr Underwood to clear 870 hectares of native vegetation.

3. That the Minister notes that the EPA has concluded that its preferred position in relation to the proposal is that the native vegetation not be cleared because of its biodiversity value.

4. That the Minister notes that in coming to this conclusion the EPA has been mindful of:
   - the Remnant Vegetation Policy, adopted by the State Government in May 1995;
   - the National Strategy for the Conservation of Australia's Biological Diversity ; and
   - the Commonwealth's National Reserve System Program under the Natural Heritage Trust.

5. That the Minister endeavour to organise with the landowner, Mr Underwood, for there to be a negotiated arrangement which results in the retention of the native vegetation on Mr Underwood's property.

1. Introduction and background

The EPA advised the Minister for the Environment in November 1996 (Bulletin 832), that the proposal by Mr Craig Underwood to clear 870 hectares of native vegetation on Victoria Location 10598, Cockleshell Gully Road, Shire of Dandaragan could be managed to meet the environmental objectives established by the EPA, subject to the implementation of the commitments made by the proponent.

In May 1997, following consideration of the appeals lodged on the content of Bulletin 832, the Minister referred the proposal back to EPA for reassessment of the following issues under Section 43 of the Environmental Protection Act:

(a) impact on nature conservation in a regional context;

(b) adequacy of vegetation buffers;

(c) adequacy of studies related to the identification of declared rare flora and priority species; and

(d) impact on declared flora and priority species.

The EPA has sought further advice and reassessed the issues of concern raised by the Minister. Section 2 of this Report describes the proposal. Section 3 discusses environmental matters raised by the Minister with respect to this proposal. Section 4 presents the advice which has been provided to the EPA since the original assessment of the proposal was completed by the EPA in November 1996 (Bulletin 832). Section 5 presents the EPA's conclusion and Section 6 the EPA's recommendations.

2. The proposal

The proponent, Mr Craig Underwood, proposes to clear 870 hectares of native vegetation on Victoria Location 10598 Cockleshell Gully Road, Shire of Dandaragan. The property has a total area of 1705 hectares, of which 500 hectares is currently cleared. The location of the property is indicated in Figure 1.

The proponent proposes to plant a commercial fodder crop (tagasaste) on the cleared land. Some of the 500 hectares of land that is currently cleared is already planted with tagasaste.

Mr Underwood has proposed that the remaining 335 ha of native vegetation be retained to the satisfaction of the Department of Conservation and Land Management (CALM), Agriculture Western Australia (AgWA) and Department of Environmental Protection (DEP).

3. Environmental matters referred to the Environmental Protection Authority by the Minister for the Environment

Under the provisions of Section 43 of the Environmental Protection Act, the Minister for the Environment has requested the EPA to reassess the following issues:

(a) impact on nature conservation in a regional context;

(b) adequacy of vegetation buffers;

(c) adequacy of studies related to the identification of declared rare flora and priority species; and

(d) impact on declared flora and priority species.

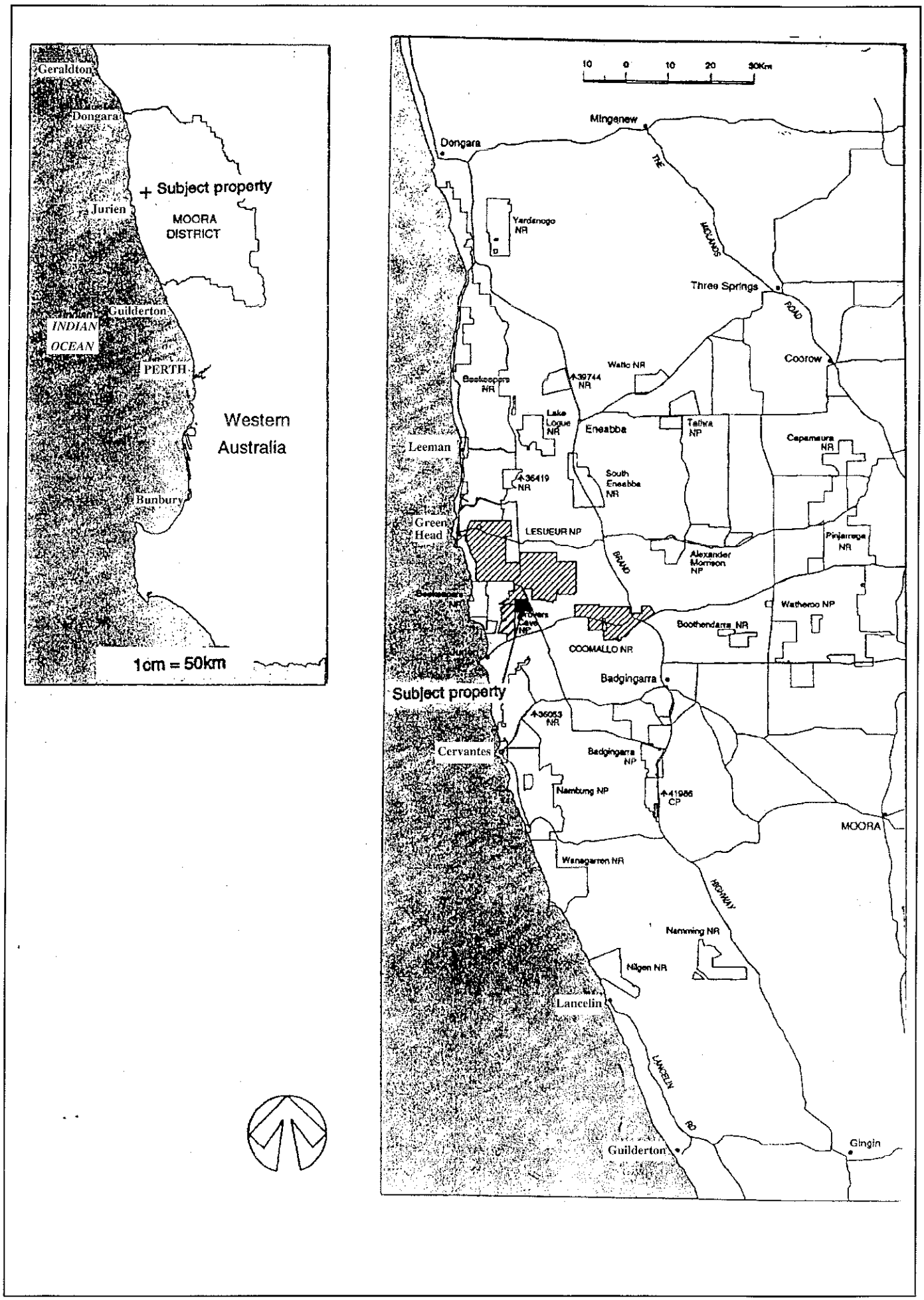

Figure 1. Locality of Victoria Location 10598 Cockleshell Gully Road, Shire of Dandaragan.

The EPA has sought further advice and reassessed the matters of concern raised by the Minister. To assist with the re-assessment, Dr Ray Hart, an Environmental Scientist of Hart, Simpson and Associates Pty Ltd, was appointed by the Department of Environmental Protection (DEP) to undertake additional surveys, research and investigation to provide advice on the issues of concern raised by the Minister. A copy of Hart et al's report entitled 'Clearing of Native Vegetation on Location 10598, Shire of Dandaragan' (November 1997) is attached to this report as Appendix 2. Information was also sought from Mr Ted Griffin, a botanist who has carried out extensive surveys and investigation of vegetation in the Dandaragan region previously. A copy of Mr Griffin's report, entitled 'Floristic Communities in the Underwood Property, a Regional Assessment' (April 1998), is included in Appendix 3.

In reviewing these matters, the EPA has taken into account some important recent Western Australian State Government initiatives in relation to the broad question of biodiversity, and its relationship to land clearing. These include:

• the *Remnant Vegetation Policy*, adopted by the State Government in May 1995. This Policy restricts clearing in agricultural areas if deep-rooted perennial vegetation would be reduced to less than 20% of the property area. Clearing is also discouraged where total remnant vegetation within a sub-catchment or local government authority area is less than 20% ;

• State Government endorsement of *The National Strategy for the Conservation of Australia's Biological Diversity (1996).* An objective of this strategy is to ensure that effective measures are in place to retain and manage native vegetation, including controls on clearing; and

• participation of the State Government in the Commonwealth's National Reserve System Program under the Natural Heritage Trust. This program has, as its primary goal, the establishment of a comprehensive, adequate and representative system of protected areas to conserve Australia's native biodiversity.

3.1 Impact on nature conservation in a regional context

Background

The Minister for the Environment requested the EPA to report on the impact on nature conservation in a regional context if the proposed clearing were to take place.

Information presented to the EPA by Hart et al and Mr Griffin was used by the EPA in the assessment of this matter. Comment was also sought from Dr Andrew Burbidge of the Department of Conservation and Land Management and Dr Steven Hopper of the Kings Park Board in view of their specialist knowledge of the Lesueur area and their involvement in the preparation of EPA Bulletin 424 'Nature, Conservation Landscape and Recreation Values of the Lesueur area' (1990).

Assessment

Hart et al concluded 'there are no high conservation values associated with the land to be cleared', and that the vegetation units proposed to be cleared appear to be common and well represented in the Lesueur and Drovers Cave National Parks.

The EPA reviewed this information, and noted that this advice is generally consistent with advice provided to the Minister in Bulletin 832.

However, the Minister's request was that the EPA consider the broader question of nature conservation. Accordingly, the EPA requested a report on the biodiversity of the vegetation in a regional context. Mr Ted Griffin was subsequently contracted by the DEP to review the regional significance of the vegetation based on site specific data including indicator species present.

The EPA considered the advice provided on nature conservation values under four headings. In doing so, the EPA has not only taken into account the current information provided by Hart et al and Mr Griffin, but has also reviewed relevant information presented in EPA Bulletin 424 published in 1990 as a report by the Department of Conservation and Land Management to the EPA, entitled 'Nature Conservation, Landscape and Recreation values of the Lesueur area'.

1. Regional representation of vegetation at the level of Beard's vegetation units.

Beard has mapped the vegetation of Western Australia based on an interpretation of vegetation structure and associations correlated against mapped geological surface types. From this basis, Beard has defined a series of vegetation units. Within the Dandaragan region, the mapping has been undertaken at a scale of 1 : 250,000. Each mapped unit therefore would normally include several vegetation types.

The vegetation on Mr Underwood's property is classified *as 'low woodlands; Banksia attenuata and B. menziesii'* and *'shrublands; scrub heath'* (Beard, 1979). Analysis by officers of the DEP of the remaining vegetation in the Dandaragan region has shown that 68% of the original *'low woodlands; Banksia attenuata and B. menziesii'* remains in the Shire, and 83% of the *'shrublands; scrub heath'* remains.

2. Representation of vegetation at the level of regional floristic groups.

In this discussion, the term 'floristic group' is used to mean a group of stands of vegetation which have a similar suite of plant species present. Floristic groups represent a method of defining plant communities objectively on the basis of floristic composition.

Mr Griffin has provided the following advice with respect to regional representation of native vegetation found on the Underwood property by comparison between floristic information from this property and regional floristic data from Griffin (1994) and analysed in Griffin (1998).

a.) The areas of Banksia woodland and sand heath on Mr Underwood's property belong to several floristic groups which are limited to the area from Cockleshell Gully Road to south of Cataby. The groups are represented in the Lesueur National Park (adjacent to Cockleshell Gully Road), portions of the Coomallo Nature Reserve and the Badgingarra National Park. However, Banksia woodlands in the core of Lesueur National Park belong to different floristic groups (upper catchment of Cockleshell Gully and Munbinea Creek).

b.) The Banksia woodlands on the Bassendean dunes north of the Moore River are poorly represented in conservation reserves. While the Banksia woodlands on the Underwood property are at the northern extent of the Bassendean dunes they appear to be more related to the scattered patches of woodlands within the above conservation reserves. They would, therefore, not contribute greatly to the improvement of the conservation of Banksia woodlands on the Bassendean dunes.

c.) The areas within the Underwood property which are of most regional significance are the winter damp areas and the surrounding vegetation. The areas of sheet laterite (bog-iron) and the adjacent *Banksia prionotes* are included in this grouping. These stands are floristic groups which are limited to the northern portion of the Bassendean dunes and are poorly represented in the conservation estate.

3. Species richness.

The reference for the information provided in this section is EPA Bulletin 424.

Chapter 12.4 describes the Lesueur National Park within a State-wide context.

> "The Lesueur Area (now Lesueur National Park) lies at the centre of one of three nodes of extraordinary species richness and endemism in the south-west of the State. The other two nodes are the Stirling Range National Park and the Fitzgerald River National Park, both of which are infected with *P. cinnamomi* as well as several other *Phytophthora* species." (p. 113, Bulletin 424).

Figure 2 includes isoflor maps for particular flora in the south-west of Western Australia illustrating the species richness in the regions of Stirling Range National Park, Fitzgerald River National Park and Lesueur National Park.

Chapters 5.4 and 5.6 of Bulletin 424 discuss the species richness of vascular flora of the Lesueur National Park. They document the fact that the kwongan sandplain in the vicinity of the Lesueur National Park is known to have a extraordinary high species richness, and that most vegetation types have over 80 species per 100 m^2 quadrat, which may increase by as many as 10 species just after a fire (p. 51, Bulletin 424). This fact is thought to be due to the wealth of habitats present, with varied topography and range of geological substrates. The richest areas have been found on sandstones and lateritic soils, both of which occur on the Underwood property.

4. Size of conservation area

The reference for the information provided in this section is also EPA Bulletin 424.

Chapter 12 refers to the significance of the Lesueur National Park and surrounds, which has been identified as an area of world, national, State and regional nature conservation significance (p. 111, Bulletin 424).

The report states that the major characteristics of the Lesueur National Park and surrounds include its uniqueness in terms of high numbers of endemic plants; biodiversity as it includes high numbers of vascular plants and vertebrate animals; high nature conservation value as it includes vegetation associations and species not protected within other reserves; and its size.

The report also states that Lesueur National Park and surrounds is not considered to be large for an important conservation reserve, and that 'desirably it should be larger'.

> "At 27 500 ha, the Lesueur National Park is not large for an important conservation reserve; desirably it should be larger. If a conservation reserve for the Lesueur Area was to be designed without any consideration for existing land tenure, it would include most of the area between Nambung National Park, Badgingarra National Park, Alexander Morrison National Park and South Eneabba Reserve. However, much of this area is now freehold and cleared for farming. This does not mean that the Lesueur National Park is not extremely valuable, it reinforces the need to retain as much as possible of this larger area in nature conservation reserves." (p. 111, Bulletin 424).

Finally, in relation to the three nodes of 'extraordinary species richness and endemism in the south-west of the State' (referred to in Point 3 above) i.e. Fitzgerald River National Park, Stirling Range National Park and Lesueur National Park, it is pertinent to compare the respective sizes of the parks. Fitzgerald River National Park covers an area of 242,800 ha, Stirling Range National Park 115,700 ha and Lesueur National Park 27,500 ha. Clearly the Lesueur National Park is significantly smaller.

Conclusion

The EPA has concluded that while the majority of the floristic groups on the property appear to be also represented in the Lesueur National Park, in view of the species richness and endemism of the vegetation in the region, of which the property is an integral part, it is appropriate from a biodiversity perspective to retain the vegetation on the property if this could be negotiated with the landowner.

The EPA also considers that it may be appropriate for the State Government to consider arrangements as to how best ensure long term protection of the vegetation on Mr Underwood's property in view of its biodiversity significance. This may include acquisition of the property.

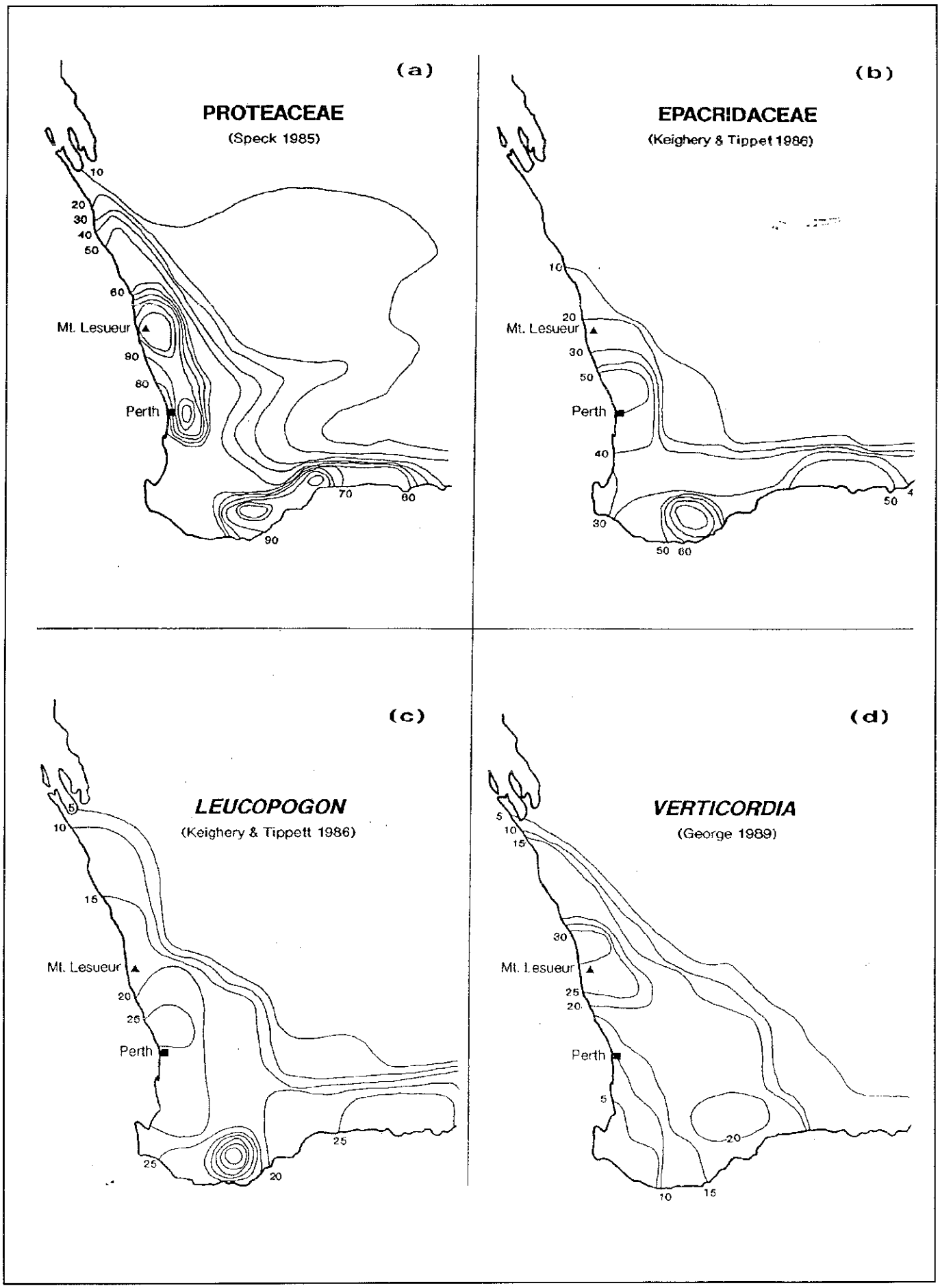

Figure 2. Isoflor maps South-west Western Australia. (After Burbidge et al (1990))

This view is consistent with 'The National Strategy for the Conservation of Australia's Biological Diversity', endorsed by the State Government. Objective 7.4 of this Strategy states :

'Ensure that the costs of biological diversity protection are equitably shared, such that they reflect contributions to degradation and benefits from protection or use'

3.2 Adequacy of vegetation buffers

Background

The Minister for the Environment requested the EPA to report on adequacy of vegetation buffers if the proposed clearing were to take place.

Information presented by Hart et al and Mr Griffin was used to reassess this matter. However, the assessment by the EPA needs to be considered within the context of conclusions reached in Section 3.1. The EPA holds the view that the area has high biodiversity values and that the vegetation should be retained.

Assessment

The study by Hart et al concluded that weed encroachment into the national parks does not appear to be a major problem and, on this basis, considers that the vegetation buffers between the proposed clearing and national parks are adequate to meet the intent of protecting the adjacent national parks. The national parks consist of good intact vegetation which is resistant to weed invasion except for a few species already able to grow there.

A recommendation has been made by Hart et al to increase the buffer around the wetlands on the property, mainly to increase their protection from nutrients and to bring the buffer out into the dry land vegetation.

Mr Griffin states within his report that the areas within the Underwood property which are of the most regional significance are the winter damp areas and the surrounding vegetation. The areas of sheet laterite (bog-iron) and the adjacent *Banksia prionotes* are included within this grouping. These stands are floristic types which are limited to the northern portion of the Bassendean dunes and are poorly represented within the conservation estate. Mr Griffin expressed the view that damp areas which include stands of *Banksia prionotes* should also be protected.

Conclusion

The EPA has considered the above advice, particularly in relation to the importance of the winter damp areas and *Banksia prionotes* species. The EPA has concluded that this is the minimum area of vegetation which should be retained on the property to meet biodiversity requirements and should be included within buffers associated with the wetland areas. This would mean that additional native vegetation would be protected. However, the EPA has concluded in Section 3.1 that no further clearing should take place.

3.3 Adequacy of studies related to the identification of declared rare flora and priority species

Background

The Minister for the Environment requested the EPA to report adequacy of studies related to the identification of declared rare flora and priority species if the proposed clearing were to take place.

Information presented by Hart et al was used to reassess this matter.

Assessment

Hart et al state that the surveys conducted by CALM were reasonable and accurate within the stated limitations. The study conducted by Hart et al relied on more detailed information and still reached the same conclusions.

Conclusion

The EPA notes that the report prepared by Hart et al has confirmed the conclusions reached by CALM in relation to the identification of declared rare flora and priority species. Accordingly, the EPA concludes that adequate studies have been undertaken in relation to the identification of declared rare flora and priority species on the area proposed to be cleared.

3.4 Impact on declared flora and priority species

Background

The Minister for the Environment requested the EPA to report on the impact on declared rare flora and priority species if the proposed clearing were to take place.

Information presented by Hart et al was used by the EPA to reassess this matter.

Assessment

The surveys undertaken by CALM found no Declared Rare Flora (DRF) species on Location 10598 and Hart et al concluded that it is highly unlikely that any are present. Few priority plant species were found and it is considered that none of these would be significantly affected by the proposed clearing.

Conclusion

Following consideration of the information presented by Hart et al the EPA has concluded that the proposal is unlikely to have a significant impact on declared rare flora and priority species if the proposed clearing were to take place.

4. Other advice

Hydrogeological

During the EPA's reassessment of this proposal, further advice was provided to it by both the Water and Rivers Commission (WRC) and Agriculture WA (AgWA) on potential hydrological and land salinisation impacts from the clearing.

The WRC advised that the regional groundwater table beneath the site is relatively deep. The property is in a groundwater recharge area and the groundwater aquifer beneath the property is fresh. The WRC found no evidence of land salinisation caused by upward groundwater discharge and concluded that clearing native vegetation to plant tagasaste will not lead to land salinisation.

The WRC recognised, however, that shallow perched water could be found in drainage lines and damplands on the property where there is sufficient clay. The salinity of the perched water is highly variable. The WRC advised that increasing recharge to the perched groundwater by changing the vegetation cover could marginally increase salt storage in some depressions by evaporation. AgWA also raised concerns regarding the salinity of water in the vicinity of the drainage line and damplands.

To manage potential impacts on salinity in the perched water, an adequate vegetation buffer would need to be maintained along the drainage line and around damplands. This matter is addressed in more detail in point 3.2 above.

Biodiversity approach in land clearing applications

Since the EPA's original assessment of the proposal to clear Victoria Location 10598 in November 1996, the EPA has been developing a basis for considering biodiversity issues where the proposal involves extensive clearing. This framework has been based in part on the principles and criteria for the assessment of the impact of land clearing on biodiversity (Safstrom & Craig 1996).

This allows for a preliminary analysis of a range of effects that clearing on remnant vegetation would have and has been incorporated as a formal part of the assessment of land clearing proposals under the 1997 Memorandum of Understanding between the Commissioner for Soil Conservation, Environmental Protection Authority, Department of Environmental Protection, Agriculture WA, Department of Conservation and Land Management and Water and Rivers Commission for the protection of remnant vegetation on private land in the agricultural region of Western Australia. Agricultural land clearing applications will be subject to this review process.

5. Conclusions

The EPA has sought further advice and reassessed the issues of concern raised by the Minister.

The EPA has concluded that while the majority of the vegetation floristic groups on the property appear to be also represented in the Lesueur National Park, in view of the species richness and endemism of the vegetation in the region, of which the property is an integral part, it is appropriate from a biodiversity perspective to retain the vegetation on the property if this could be negotiated with the landowner.

The EPA also considers that it may be appropriate for the State Government to consider arrangements as to how best ensure long term protection of the vegetation on Mr Underwood's property in view of its biodiversity significance. This may include acquisition of the property.

This view is consistent with 'The National Strategy for the Conservation of Australia's Biological Diversity', signed by the Premier on behalf of the Western Australian Government .

6. Recommendations

In response to the Minister for the Environment's request for the reassessment of four specific matters under Section 43 of the Environmental Protection Act, the EPA submits the following recommendations to the Minister for the Environment:

The EPA submits the following recommends to the Minister for the Environment:

1. That the Minister notes that this report is provided as a result of a request by the Minister under Section 43 of the Environmental Protection Act to provide additional information in relation to a proposal.

2. That the Minister considers the EPA's report on the matters referred by the Minister to the EPA in relation to the proposal by Mr Underwood to clear 870 hectares of native vegetation.

3. That the Minister notes that the EPA has concluded that its preferred position in relation to the proposal is that the native vegetation not be cleared because of its biodiversity value.

4. That the Minister notes that in coming to this conclusion the EPA has been mindful of:
   - the Remnant Vegetation Policy, adopted by the State Government in May 1995;
   - the National Strategy for the Conservation of Australia's Biological Diversity ; and

- the Commonwealth's National Reserve System Program under the Natural Heritage Trust.

5. That the Minister endeavour to organise with the landowner, Mr Underwood, for there to be a negotiated arrangement which results in the retention of the native vegetation on Mr Underwood's property.

Appendix 1

References

Beard, J. S. (1979) The vegetation of the Moora and Hill River area, Western Australia: Map and explanatory memoir. Vegetation Survey of Western Australia. Vegmap Publications, Perth.

Burbidge A.A., Hopper S. D. and van Leeuwen S. (Eds.) (1990) Nature Conservation, Landscape and Recreation values of the Lesueur area. A report to the Environmental Protection Authority from the Department of Conservation and Land Management, Bulletin 424.

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Safstrom R & Craig G F (1996) Environmental Evaluation of native Vegetation in the Wheatbelt of Western Australia: Principles and Criteria Used to Appraise Land Clearing Proposals.

Appendix 2

Hart Simpson and Associates Pty Ltd. Environmental Consultants
(1997)Clearing of native vegetation on Location 10588, Shire of Dandaragan

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CLEARING OF NATIVE VEGETATION ON LOCATION 10598, SHIRE OF DANDARAGAN.

Prepared by

Hart, Simpson and Associates Pty Ltd

for

Department of Environmental Protection

November 1997

1. SUMMARY.

An application to clear native vegetation on Victoria Location 10598 on Cockleshell Gully Road in the Shire of Dandaragan, which adjoins two National Parks, was referred to the Environmental Protection Authority and was assessed at the level of Consultative Environmental Review. The Environmental Protection Authority recommended that the proposal was environmentally acceptable subject to various conditions, but subsequently appeals were made to the Minister and some of these were upheld. The Minister referred four issues back to the Environmental Protection Authority for further assessment. Hart, Simpson and Associates was commissioned by the Department of Environmental Protection to provide this further information on:

1. Impact on nature conservation in a regional context.

2. Adequacy of vegetation buffers.

3. Adequacy of studies related to the identification of declared rare flora and priority species, and

4. Impact on declared rare flora and priority species.

The present study has found that there are no high conservation values associated with the land to be cleared, and its values would not prevent clearing of the land even under the more stringent restrictions which have been introduced since the assessment was made. No Declared Rare Flora species were found and it is highly unlikely that any are present, few Priority plant species were found and none would be affected significantly by the loss of this area, and there are no rare animals which would be affected significantly. The vegetation units to be cleared appear to be common and well conserved in the adjacent National Parks. The clearing of the land will have not have a significant impact on the adjacent National Parks or the conservation values in a regional context.

The buffers already agreed to by the proponent meet both the normal regulatory requirements and the intent of the buffers in protecting the adjacent National Parks and the remnant vegetation to be preserved on the farm. A recommendation is made to increase the buffer around the wetlands, mainly to increase their protection from nutrients and to bring the buffer out into dry land vegetation.

The previous survey has been found to be a reasonable and adequate study within its stated limitations. No substantially different conclusions have been made on the basis of the more detailed information collected in the present study.

3. METHODS.

Information on the history, nature and condition of the vegetation was obtained from aerial photographs, the owner of the land and a neighbour. The vegetation was assessed by the description of sites which appeared to be typical of the different vegetation units. These sites were approximately 0.25ha. Most attention was focussed on the vegetation to be cleared, with replication of the sites, and not on the units already agreed to be retained. The proponent had already undertaken to retain considerable areas of vegetation. The vegetation was not studied quantitatively because of the season and there is no comparable regional information available to make use of such results. The vegetation structure and soil were recorded, common species present at each site were listed, and the condition of the vegetation was assessed in terms of structural integrity, species diversity, physical disturbance, weed invasion, dieback, fire, history, and other factors. This allowed an assessment of condition according to the scale of Keighery (1994) which is a scale of 1 to 6:

1. Pristine or nearly so.

2. Vegetation structure intact, disturbance affecting individual species, and weeds are non-aggressive species.

3. Vegetation structure altered, obvious signs of disturbance.

4. Vegetation structure significantly altered by very obvious signs of multiple disturbance, retains basic vegetation structure or ability to regenerate it.

5. Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management.

6. The structure of the vegetation is no longer intact and the area is completely or almost without native species.

The vegetation was mapped from the site descriptions of the vegetation, aerial photograph interpretation and ground traverses by vehicle and on foot.

Much of the native flora was identified or collected for identification during the examination of the sites and opportunistically. Rare species which might be present were identified, and listed in terms of habitat. Opportunistic searches were carried out for these species during other work, as well as specific searches by vehicle and on foot. A watch was also kept for any other species of potential interest which might be present.

4. RESULTS.

4.1 VEGETATION.

Vegetation units.

The vegetation was divided into the following major units, parts of which are proposed to be cleared:

1. Banksia woodland structurally dominated by *Banksia attenuata, B. menziesii* and *Eucalyptus todtiana*, over diverse shrubs and sedges, on grey sand. Map unit A.

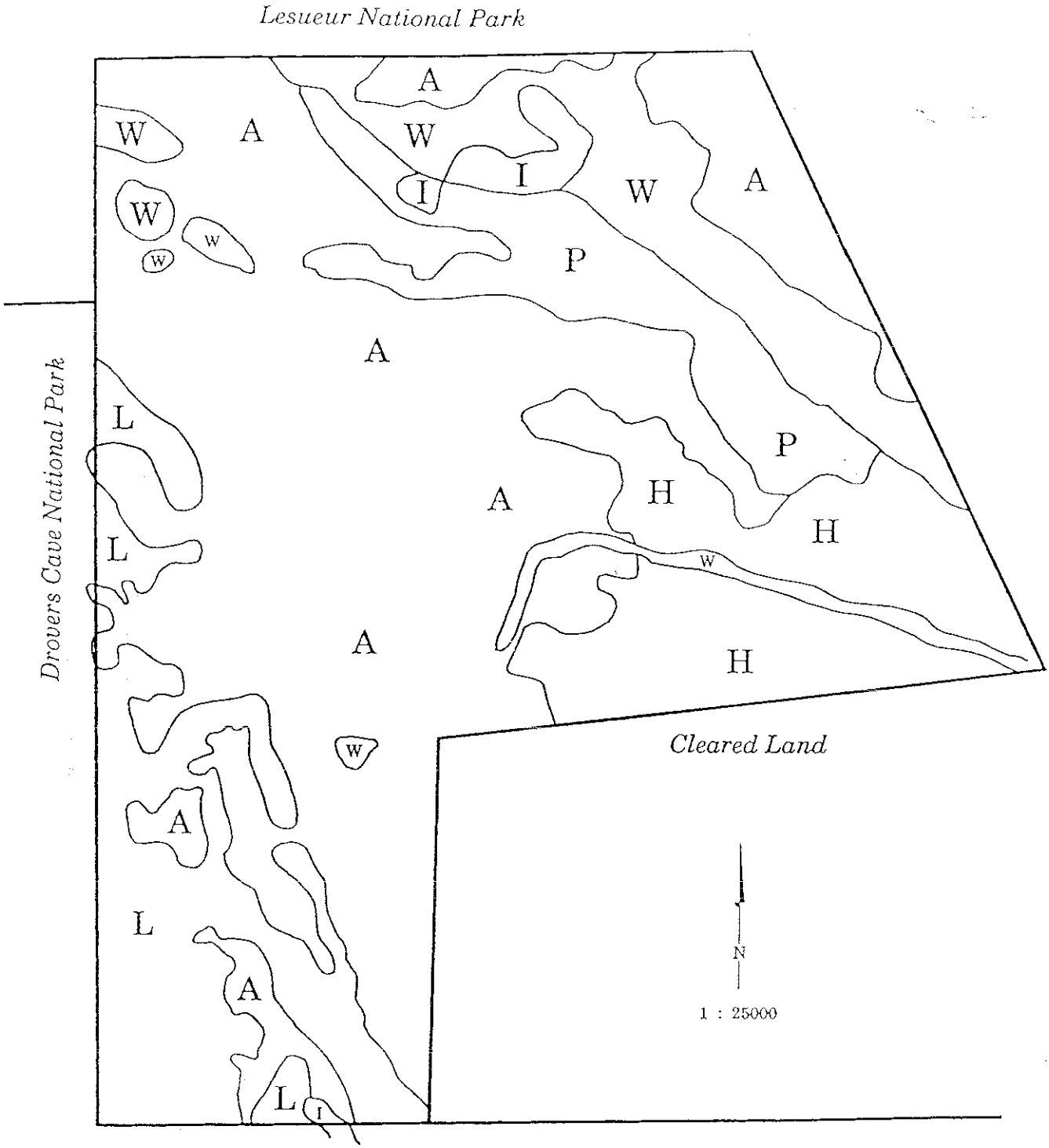
Banksia attenuata low woodland is structurally dominated by *Banksia attenuata* and, less consistently, by *Banksia menziesii* and *Eucalyptus todtiana*. The woodland varies in density from open woodland to open forest and merges with neighbouring sand heath and *Banksia prionotes* low woodlands. Species which are common in the understorey of *Banksia attenuata* low woodland and are more or less restricted to it include *Anigozanthos manglesii, Blancoa canescens* and *Bossiaea eriocarpa.*

Banksia attenuata low woodland is most common on slopes on deep white to grey sand in the central and northern parts of the property.

2. A heath of diverse shrubs with *Banksia candolleana* as the most conspicuous species, on grey sand. Map unit H.

Banksia candolleana heath has a mixture of structurally dominant species, but *Banksia candolleana* is the most conspicuous of them and is the sole dominant in some places. The heath ranges in height from 0.5m to 1m with a number of emergents. The emergents include *Gyrostemon ramulosus, Grevillea shuttleworthiana, Hakea ruscifolia* and *Jacksonia floribunda*. In one area *Eucalyptus todtiana* is such a common emergent it almost forms an open woodland over the heath, and in Alan Peggs Rural Pty Ltd (1995) this *Banksia candolleana* heath is referred to as *Eucalyptus todtiana* woodland.

Banksia candolleana heath occurs on flat and gently sloping areas in the eastern and central part of the property, on white to grey sand and merges into the neighbouring Banksia woodlands.



A. Banksia attenuata woodland on grey sand.
H. Heath on grey sand.
L. Heath or woodland on limestone.
P. Banksia prionotes woodland on yellow sand.
W. Wet areas.
I. Laterite.

MAP 1. VEGETATION.

c. The main valley complex of plant communities in the north which varies from separate forests of *Eucalyptus rudis*, *Melaleuca rhaphiophylla*, *Melaleuca preissiana* and *Corymbia calophylla*, with a variety of understoreys, to dense and open shrublands of several species of *Melaleuca*, to heaths of *Banksia ?grossa* and other shrubs, to moist open ground which supports a variety of sedges, sedge-like plants and other herbaceous plants, including several species of spider orchids.

The distribution of these two units is also shown in Map 1, and the species recorded are listed in Appendix 1 but little time was spent on the general flora of these units because they will not be cleared.

Vegetation condition.

The areas of native vegetation on the property are mainly intact native vegetation with no loss of structure or species. Small areas of the native vegetation have been cleared for tracks and firebreaks, and these have little native vegetation. Several small areas have been partly cleared in the past. These appear to have been chained down but not actually cleared of vegetation, and are now regenerating to normal native vegetation. There are several dams within the areas of native vegetation and these have caused disturbance to small areas. In particular there is an old dam in the low-lying area in the centre of the property where there has been severe physical disturbance and weed invasion, but this took place at least some decades ago.

Weed invasion within the intact areas of native vegetation was found to be very limited. There was limited invasion for short distances along some edges but within the main part of the vegetation weed species were rare or absent. The only species found within undisturbed vegetation were the two small herbs *Ursinia anthemoides* and *Hypochaeris glabra*, and these were generally small and stunted. These two species are widespread in native vegetation over much of the south-west.

The property has probably seen a change in fire regime since European settlement which may have affected the vegetation and flora, but there is no evidence that the impact on this property is any different to other areas including the adjacent National Parks. The property had not been burnt recently except for small patches.

Rabbits are present and may be having a significant impact on the flora.

4.2. FLORA

The plant species identified on the property are listed in Appendix 1, with their major occurrences in the vegetation units.

One hundred and sixty three species of vascular plants were recorded on the property, including seven weed species. Other weeds found only in pasture or adjacent on firebreaks are not listed. This is not a complete flora list because of the way the survey was carried out and it was restricted to a single visit. Other species were found adjacent in the Lesueur National Park and are likely to be found on the property. Most of the species listed in Appendix 1 are common or widespread. No Declared Rare Flora species were found on the property or nearby, but the following Priority species are listed in Appendix 1:

Hakea spathulata (Priority 3), which was found on the largest ridge of laterite, next to and part of the main valley complex in the north. This species is known from the Mt Lesueur-Dandaragan area.

Guichenotia alba (Priority 3), which was found as single plants in two sites in *Banksia prionotes* low woodland on sand. This species is known from the Eneabba-Three Springs-Cataby area.

Darwinia sanguinea (Priority 4), which was found at several locations, mainly in the laterite heaths and in *Banksia attenuata* low woodland on the whitest sand. This species is known from the Eneabba-Gairdner Range area.

In addition, *Hypocalymma xanthopetalum* var. *linearifolium* (Priority 2) was found adjacent in the Lesueur National Park and may well occur on the property considered here.

These Priority species categories are defined as (CALM 1996):

"Priority Two - Poorly known Taxa. Taxa which are known from one or a few (generally <5) populations, at least some of which are not believed to be under immediate threat(i.e. not currently endangered). Such taxa are under consideration for declaration as 'rare flora' but are in urgent need of further survey.

Priority Three - Poorly known Taxa. Taxa which are known from several populations, at least some of which are not believed to be under immediate threat (i.e. not currently endangered). Such taxa are under consideration for declaration as 'rare flora' but are in need of further survey.

TABLE 1. Rare Plants of the Lesueur Area

CONSERVATION CODE
C Current (1997)
P Previous

HABITATS

SOILS
C Clay
G Gravel
L Loam
S Sand
B Brown
G Grey
S Shallow
W White
Y Yellow

TERRAIN
I Ironstone/Laterite
L Limestone
S Sandstone
W Wetland
T Topography
B Breakaway
D Drainage line
F Flat
H Hill
M Mesas
P Plain
S Slope
T Hill/Ridge top
U Upland
V Valley

VEGETATION
E Eucalypt woodland
M Marri
P Powder bark wandoo
V Various: *C. chlorolampra, E. haematoxylon, E. marginata, E. lateritica, E. accedens, C. calophylla, suberosa* and *E. gittinsii*, at base of scarp
E. drummondii, at top of scarp
W Wandoo
Y York Gum
B Banksia woodland
A *Banksia attenuata*
P *Banksia prionotes*
H Heath (& shrubland)
C *Banksia candolleana*
D Dryandra
E *Eucalyptus todtiana*
L Lateritic
O Other
W Woodland

Taxon	Cons Code		Nearest locality	Habitats													Flower Time
				Soils				Terrain					Vegetation				
	C	P		S	C	L	G	I	L	W	S	T	E	B	H	O	
Daviesia chapmanii PAPI	4		N of Mt Lesueur	G		B	x	x				B			x		Apr-Aug
Daviesia debilior subsp. *debilior* PAPI	2		NW of Mt Lesueur	S G				x				U			x		Aug
Daviesia epiphyllum PAPI	3		SW of Mt Lesueur	G W			x					H S			T		Apr-Aug
Daviesia pteroclada PAPI	1		NW of Mt Lesueur		x	x	x	x			x	S	W		x		Jul-Jan
Desmocladus elongatus MS REST	3		Breakaway Farm					x				B			x		Aug-Nov
Desmocladus gigas MS REST	3		Breakaway Farm	G				x				H			x		Jun-Sep
Diuris recurva ORCH	4		Coorow-Grnhead Rd		x	x		x		x		H	W				July (-Aug)
Drosera marchantii subsp. *prophylla* DROS	1		Breakaway Farm					x				B					Jun-Sep
Dryandra kippistiana var. *paenepeccata* PROT	1		W of Mt Peron	x				x				U B			x		Sep-Nov
Dryandra sclerophylla PROT	4		Mt Lesueur	S G				x				B			x		Jul-Oct
Dryandra stricta PROT	1		BlackArrow/ Jur. Bay Rds	O		x	x	x			x	S R			x	W	Aug-Oct
Dryandra tortifolia PROT	3		Cockleshell Gully	W Y				x				U T			x		Oct
Eleocharis keigheryi CYPE	3		E of Mt Peron	G	B	x				x		D	W				Sep-Oct
Eucalyptus abdita MYRT	2		S of Mt Peron	Y B	x		x	x				B S	V		x		Mar, Aug
Eucalyptus angularis MYRT	2		NE of Mt Lesueur					x				B			x		
Eucalyptus argutifolia MYRT	R		S of Jurien	x					x			R			x		Jan-Apr
Eucalyptus crispata MYRT	R		Lesueur area?	x	x	x		x				B	E				Apr, Nov
Eucalyptus exilis MYRT	4		NE of Mt Lesueur	G				x				S B			x		Dec-Apr
Eucalyptus johnsoniana MYRT	R		Lesueur NP	x				x				M P			C		Nov-May Aug
Eucalyptus lateritica MYRT	R		Mt Lesueur Canyon					x				U B			x		Apr-Sep
Eucalyptus leprophloia MYRT	R		Mt Benia			x	x	x				B S	P		x		Nov
Eucalyptus macrocarpa subsp. *elachantha* MYRT	4		SW of Mt Lesueur	x								P			x		Apr-Sep
Eucalyptus pendens MYRT	4		Mt Benia					x				H S			x		Jul-Aug
Eucalyptus suberea MYRT	R		Mt Lesueur Canyon					x				U B			x		Dec-Mar
Gastrolobium callistachys PAPI	4		Gnunmarra Rd		x	x	x	x				S	W Y				Sep
Gompholobium sp. Gairdner Range (EA Griffin 2306) PAPI	2		W of Mt Lesueur	W	x		L				x				x		Sep-Nov
Goodenia xanthotricha GOOD	1		Mt Lesueur	S x								V S			x		Oct, Jan-Feb
Grevillea batrachioides PROT	R		Mt Lesueur	S x		x											late spring

Taxon	Cons Code		Nearest locality	Habitats													Flower Time
				Soils				Terrain					Vegetation				
	C	P		S	C	L	G	I	L	W	S	T	E	B	H	O	
Persoonia filiformis PROT	2		NW of Mt Lesueur	x			x	x				S			x		Nov
Persoonia rudis PROT	3		Cockleshell Gully	S			x	x							x		Sep-Nov
Petrophile biternata PROT	3		'Jurien'	S			x										Sep
Phlebocarya pilosissima subsp. *pilosissima* HAEM	3		Lesueur area	W			x	x							x		Aug-Sep
Phlebocarya pilosissima subsp. *teretifolia* HAEM	1		Cockleshell Gully	G B			x	x				S V		A	x		Jul-Oct
Restio stenandra MS REST	1		SE of Mt Lesueur	Y								D			x		Sep
Schoenus sp. Warradarge (EA Griffin 3842) CYPE	-	2	Near Break-away Farm	W G				x							x		Apr
Stachystemon axillaris EUPH	4		Mt Lesueur					x				H			x		Jul-Oct
Stenanthemum limitatum RHAM	2		W of Mt Lesueur	W			x	x			x	S R	x		x		Oct-Nov
Stenanthemum reissekii RHAM	3		Mt Lesueur	W				x				S			x		Aug-Oct
Stylidium aeonioides STYL	2		Jurien Bay Rd	G			x	x				U			x		Sep-Nov
Stylidium diuroides subsp. *paucifoliatum* STYL	2		Cockleshell Gully	W				x			x				C		Sep-Nov
Stylidium inversiflorum STYL	4		Cockleshell Gully Rd	G								U			x		Sep-Nov
Stylidium nonscandens STYL	2		N of Mt Michaud	x	x							U S			x		Sep-Nov
Synaphea endothrix PROT	2		Mt Lesueur	G		x	x	x							x		Aug-Sep
Synaphea lesueurensis PROT	2		Cockleshell Gully Rd			x	x	x			x	H			x		Jul-Oct
Tetratheca remota TREM	1		Mt Lesueur	x			x					U S	W		x		Aug-Sep
Thelymitra apiculata ORCH	4		SW of Mt Lesueur				x	x				T H					Jun-Jul
Thelymitra stellata ORCH	R		Mt Lesueur					x				T R			x		Oct-Dec
Thysanotus anceps ANTH	3		NW of Mt Lesueur	W Y			x				x	S B			x		Nov-Dec
Thysanotus glaucus ANTH	4		N of Mt Peron	S G				x				U			x		Oct-Feb
Thysanotus sp. Badgingarra (EA Griffin 2511) ANTH	2		Cockleshell Gully	G		x	x	x				H			x		Nov-Dec
Thysanotus vernalis ANTH	1		W of Mt Lesueur	x								P			x		Sep-Oct
Tricoryne robusta MS ANTH	2		Cockleshell Gully Rd	W G			x	x		x		U		A	x		Sep-Dec
Verticordia amphigia MYRT	3		Cockleshell Gully Rd	x	x							S V			x		Oct-Nov
Verticordia argentea MYRT	1		Mt Lesueur														Jan
Verticordia blepharophylla MYRT	2		Cockleshell Gully Rd	G B	x					x				x	x		Nov-Dec
Verticordia fragrans MYRT	1		S of Eneabba														Oct

4.3 FAUNA

The fauna habitats present on the land were divided into two groups:

1. Those on the area proposed to be cleared, which are Banksia woodland, sand heath, heath or *Banksia prionotes* woodland on limestone, and *Banksia prionotes* woodland on yellow sand.

2. Those on the areas not proposed to be cleared, which are parts of all of the above plus small areas of laterite, and the various low-lying areas and drainage lines.

All vertebrate species which might occur in these two groups are listed in Appendix 2.

The following species listed in Appendix 2 have some classified conservation status.

Schedule 1 species (gazetted under Schedule 1 of the Wildlife Act as "Rare or likely to become extinct").

Calyptorhynchus latirostris (Short-billed Black-Cockatoo). This species breeds primarily in the northern and eastern parts of its range and tends to move to the coastal belt when not breeding where it feeds on native shrubs and trees (particularly proteaceous species) as well as pine trees. It is threatened primarily by loss of tree hollows used for breeding, particularly in the wheatbelt. This species breeds nearby and may breed in the few large trees on the property. It would certainly feed in the woodland and heath on the property.

Cacatua pastinator (Western Corella). This species occurs locally and breeds in large trees. It may breed in the few large trees on the property. It feeds largely on introduced plants. There is a southern population which is threatened but the northern population is expanding its range.

Schedule 4 species (gazetted under Schedule 4 of the Wildlife Act as "In need of special protection".

Morelia spilota imbricata (Carpet Python). This species is widespread in the South West of Western Australia, where it occurs in a variety of habitats. It is usually found under logs or rocks and may even be found around human settlements. It has been recorded locally and would be present in the site considered here. This species is not endangered in total and is mainly gazetted to protect it from illegal killing and capture, particularly where it is mistaken for large venomous species.

Priority 3 and 4 species are defined as:

Priority 3 "Taxa with several, poorly known populations, some on conservation lands. Taxa which are known from few specimens or sight records from several localities, some of which are on lands not under immediate threat of habitat destruction or degradation. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna."

Priority 4 "Taxa in need of monitoring. Taxa which are considered to have been adequately surveyed, or for which sufficient knowledge is available, and which are considered not currently threatened or in need of special protection, but could be if present circumstances change. These taxa are usually represented on conservation lands. Taxa which are declining significantly, but are not yet threatened."

Feral animals are restricted to a single bird and a suite of mammals (Appendix 2). The birds is the Kookaburra which is a predator of native birds but is common and widespread. The mammals are the ubiquitous mice, cats, foxes and rabbits which are found throughout the South-west, and although they may have an impact on native species this impact occurs on all lands.

4.4 VEGETATION IN ADJACENT AREAS.

The heath and *Banksia prionotes* woodland on limestone or sand are the edge or outliers of the large adjacent areas which run along the coastal strip. Large areas of this vegetation occur within the adjacent Drovers Cave National Park. These adjacent areas were not studied because the impact of clearing the small areas on the farm considered here was clearly very small, and no further description or analysis was necessary.

The Banksia woodland on grey sand and the sand heath have not been studied or mapped locally, and required further examination.

Banksia woodland.

Two sites of Banksia woodland were described within the farm and three sites were described in the adjacent Lesueur National Park, as well as one more distant site near Mt Lesueur. The two sites within the farm were compared with the two most separated sites in the adjacent part of the National Park. The four sites occupied very similar topographic positions of slopes, and had the same grey sand at least on the surface.

Conospermum canaliculatum
Conospermum crassinervium
Conostephium ?pendulum
Eremaea asterocarpa subsp. histoclada
Eremaea asterocarpa subsp. ?octoclada
Eriostemon spicatus
Eucalyptus todtiana
Hibbertia hypericoides
Jacksonia floribunda
Leucopogon polymorphus
Melaleuca acerosa
Mesomelaena pseudostygia
Patersonia occidentalis
Petrophile linearis
Petrophile macrostachya
Scholtzia involucrata
Stirlingia latifolia

These are all common and widespread species. The species not in common between the plots are mainly much less common species such as *Nuytsia floribunda*, *Calectasia cyanea*, orchids, *Anigozanthos manglesii*, some triggerplants, and some *Drosera*. Some of these are also very patchy in their distribution.

These results are best interpreted as showing that there is a core of common species and a pool of less common species which may occur in any one site. This description is consistent with the high species diversity of the total vegetation (Griffin 1994).

The more distant site examined in the National Park was clearly less similar, with at least a small suite of common species not recorded in the other sites. This result suggests that further study may allow the apparently similar structural unit of Banksia woodland to be broken up, but at this stage there is no useful information.

To find whether the common species or these less common species define different vegetation types would require a sophisticated floristic analysis of more sites over larger areas. This is discussed further below.

It was not possible to map the extent of the apparently similar Banksia woodland in the adjacent National Park from aerial photographs, but it was clear that there are substantial areas to the north, and it was easy to find sites apparently similar to those seen in the farm despite limited access. There are more remote areas in the National Park which may have similar vegetation, but this has not been studied sufficiently.

Dryandra shuttleworthiana
Ecdeiocolea georgei
Eremaea violacea
Eucalyptus todtiana
Hakea prostrata
Hibbertia hypericoides
Jacksonia floribunda
Lepidobolus chaetocephalus
Lysinema ciliatum
Melaleuca acerosa
Mesomelaena pseudostygia
Petrophile macrostachya
Scaevola ?canescens
Scholtzia sp.

These are common or widespread species, and many occur in other types of vegetation as well. Again, many of the species not in common between most of the sites are the less common species such as *Nemcia reticulata*, *Hovea stricta*, *Synaphea spinulosa*, *Acacia sphacelata*, and several unidentified *Verticordia*. There is also a significant suite of less common species which are more common in the Banksia woodland, such as *Adenanthos cygnorum*, *Stirlingia latifolia*, *Eremaea asterocarpa*, *Blancoa canescens*, *Patersonia occidentalis*, and some triggerplants and *Drosera*.

There is a considerable overlap in species between the heath and Banksia woodland on sand, and these two units merge into each other.

The more distant site examined in the National Park was less similar, with a high overlap but also a small suite of species not recorded in the other sites. Again, this result suggests that further study may allow the apparently similar structural unit of heath to be broken up, but at this stage there is no useful information available and this could only be resolved by a more extensive study of a large number of sites over a bigger area.

As for the Banksia woodland it was not possible to map the extent of the apparently similar heath in the adjacent National Park from aerial photographs, but it was clear that there are substantial areas to the north, and it was easy to find sites apparently similar to those seen in the farm. There are more remote areas in the National Park which may have similar vegetation, but this has not been studied sufficiently.

The *Banksia prionotes* on sand unit does not occur nearby in the adjacent National Parks, unless it is regarded as a variant of the Spearwood unit in which case it is common.

According to the owner of this second property, where there are numerous vegetation remnants and a long common boundary with the Lesueur National Park, the most important damaging influence on remnant vegetation is fertiliser because this causes weeds to grow (Ward pers. comm.). All observations made in the present study support this conclusion, with few weeds observed in intact vegetation.

Other rare animal species are present or potentially present but none would be affected significantly by the loss of the small area of habitat represented by this site.

The conservation status of the vegetation units to be cleared is less clear.

Beard (1979) mapped the vegetation at a scale of 1:250,000 and shows the vegetation of the property as being *Banksia attenuata - Banksia menziesii* low woodland on the eastern part of the property and as *Dryandra - Calothamnus* scrub-heath on the western part. Beard's map shows the Banksia woodland as extending from a point about 1 km south of Cockleshell Gully southward across the property in a 2-4 m wide band which begins to widen some 10 km south of Jurien Bay Road. The map shows the woodland as being on National Park land north and north-west of the property but not east of it.

Beard shows the *Dryandra - Calothamnus* scrub-heath as occurring on limestone from Nambung River northwards off the map beyond the Coorow-Greenhead Road. Large areas of this vegetation occur adjacent in the Drovers Cave National Park as well as in other conservation areas.

Beard also shows a mosaic of heath and scrub vegetation across Cockleshell Gully Road from the property. A principal component of this mosaic is *Hakea obliqua* scrub-heath (unit hSZc), which according to the map is the dominant vegetation type on sandplains north, east and south of Mt Lesueur. One of the characteristic species of this scrub-heath is *Banksia candolleana*, and the sandplain heath on the property considered here is apparently a widespread form of this *Hakea obliqua* scrub-heath.

Griffin and Keighery (1989) studied the sandplains between the Moore River and Cockleshell Gully and produced some broad categories from floristic analysis.

Griffin (1994) carried out a much larger analysis and examined the vegetation of the sandplains and associated landscapes between Perth and Geraldton using floristic community survey techniques. The survey was based on analysis of comprehensive species lists for a large number of releves and quadrats which ranged in size from $4m^2$ to $100m^2$. Griffin expressed the results as a series of groupings of finer divisions, identified by the number of groups at that level.

The *Banksia attenuata* low woodland on the property seems to best match Griffin's Group 20-12, although it may also be close to Group 20-11. According to Griffin's Group 20 distribution maps, Group 20-12 ranges from north of Perth to somewhere a short distance south of the Coorow-Greenhead Road and Group 20-11 ranges from north of Perth to south of Dongara.

The property also has conservation values due to its common boundary with two National Parks (Map 1). The issues which need to be addressed are:

- Does the property have any values which are not present in the National Parks?

No values have been identified here which are not present in the National Parks.

- Does the property contribute to the integrity of the National Parks?

The two National Parks have a wide area of contact, over approximately 2km (see Figure 2 in EPA 1996). The Drovers Cave National Park is dominated by heath and woodland on limestone while the adjacent part of the Lesueur National Park is dominated by Banksia woodland and heaths on grey sand, although there is considerable mixing of these two units and they merge into each other. Preservation of the vegetation on the property proposed to be cleared would further increase the degree of contact but in isolation this cannot be regarded as a significant reason not to clear the property.

The only specific value identified is the feeding habitat for the Short-billed Black-Cockatoo, but this will not threaten the survival of the population.

- Will the proposed clearing impact on the National Parks?

The clearing could increase the exposure of the National Parks to the edge effects of cleared farmland. This can be largely managed by the retention of buffers and the proponent has already made commitments to retain such buffers. These are discussed further below.

Subsequent to the original study and review of the proposed clearing which is discussed here, formal restrictions have been placed on clearing of agricultural land (Anon. 1997). These are far more restrictive than previous practices. It would not be appropriate to judge the current proposal by these standards because they did not apply at the time. The major elements of these new restrictions are that:

- The proposal must not impact on water levels or quality
- The proposal must not impact on wetlands of significance.
- The proposal must not cause land degradation, such as by salinisation.
- The proposal must not impact on endangered species or threatened communities.

The adequacy of buffers around wet areas has been examined widely and was addressed in EPA (1996). A review has been carried out (Davies and Lane 1995) to look at buffers around wetlands on the Swan Coastal Plain. This report produced a series of recommended buffers for different purposes. It also included the wetland affected vegetation as part of the wetland rather than just the wet area. The most relevant criteria here was nutrient flows into wetlands, for which a buffer of 100-200m was recommended with the 200m for sandy soils with high nutrient loadings. The Davies and Lane report has not been disseminated and has no regulatory standing. It is difficult to apply this recommendation at face value because the distances are partly arbitrary and it is not clear if the situation is a high nutrient loading, given that Tagasaste is proposed to be given relatively low levels of nutrients (Alan Peggs Rural 1995). The figure of 200m was derived from a high nutrient situation in the USA and doubled to be conservative and allow for local sandy conditions.

The use of buffers to maintain the integrity of adjacent native vegetation has been poorly studied. Observations in this study suggest that native vegetation has been able to persist in reasonable condition despite free access by grazing stock for 25 years, with remarkably little weed invasion. The vegetation has certainly been damaged, and clearly in the long term this vegetation will continue to be thinned and degraded. The most damaging influence appears to be the addition of fertiliser which allows weeds to grow.

If the remnants in the proposal considered here are fenced off it can be expected that they will survive very well except for a small edge effect due to fertilisers and minor weed invasion. The depth of direct fertiliser penetration can be controlled by good farm management, and with modern practices and better machinery the use of fertilisers and other chemicals can be more easily controlled. The buffers do not need to be wide because the depth of direct impact should not change over time. Buffers of 20m should easily meet the objective of protecting the adjacent vegetation, and the buffers already agreed to by the proponent clearly meet both the regulatory requirements and the intent of the buffers.

The issue of protection of the wetlands from nutrient run-off is more difficult. A distance of 100m from the edge of the wetland affected vegetation is recommended. This greatly exceeds the usual minimum of 50m from the wetlands themselves. In the southern drainage line this makes little difference, but in the northern part of the property this will considerably extend the area to be preserved (see Map 1, and EPA 1996). This distance includes the commitments already made in the CER and will also exceed the further commitments made during its assessment.

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APPENDIX I. List of the plant species identified on the property. Introduced species are identified by an asterisk (*).

The species except weeds are listed as
D Dominant
x Represented in at least 50% of the sites
+ Represented in fewer than 50% of the sites

They are listed in the following habitats:

A *Banksia attenuata* low woodland
P *Banksia prionotes* low woodland
S on sand plain
L on sand over limestone
H Heath
S on sand plain
L on limestone
I on laterite/ironstone
W Wetland communities

Species are also listed as

Col:
Collected in the field and subsequently identified

Notes:
W Weed
P Priority flora

Taxon	Vegetation Types							Col	Notes
	A	P		H			W		
		S	L	S	L	I			
Calytrix sapphirina	+							x	
Calytrix sp.	x		?						
Chamaescilla ?corymbosa						x	x		
Clematis linearifolia							x		
Conospermum canaliculatum subsp. canaliculatum	+	x		x				x	
Conospermum crassinervium	x							x	
Conostephium ?pendulum	x								
Conostylis ?aculeata	?								
Conostylis ?candicans	?								
Conostylis spp.	x								
Corymbia calophylla							x		
Cryptandra pungens			x					x	
Cyanicula deformis MS							x		
Darwinia sanguinea	+			+		x		x	P4
Dasypogon obliquifolius	+	x		+				x	
Daviesia angulata				+				x	
Daviesia divaricata	+							x	
Daviesia podophylla	+			x				x	
Daviesia triflora				x				x	
Dianella revoluta						+			
Diplolaena obovata MS					x			x	
Diuris sp.				+					
Drosera gigantea							x		
Drosera ?macrantha subs. macrantha				x					
Drosera ?parvula	x	+		+					
Drosera stolonifera	+	+	+						
Drosera sp.	x			+					
Dryandra armata var. armata						D		x	
Dryandra 'nivea'				+					
Dryandra sessilis					D	D			
Dryandra shuttleworthiana				x				x	
Ecdeiocolea georgei MS	+	+		x				x	
Ecdeiocolea monostachya	x							x	
Eremaea asterocarpa subsp. histoclada	x			x				x	
Eremaea asterocarpa subsp. ?octoclada	x			+				x	
Eremaea beaufortioides sens lat.	+		x	x				x	
Eremaea beaufortioides x violacea	+		x	x				x	

Taxon	Vegetation Types							Col	Notes
	A	P		H			W		
		S	L	S	L	I			
Leptospermum spinescens	+						+	x	
Leucopogon polymorphus	x			+				x	
Lomandra sp.	+								
Lysinema ciliatum				+				x	
Macarthuria australis	+								
Macrozamia riedlei	x		+						
Melaleuca acerosa	x	x		x	x			x	
Melaleuca cf. bracteosa	+							x	
Melaleuca lateriflora subsp. acutifolia MS							x	x	
Melaleuca lateritia							x	x	
Melaleuca preissiana							x		
Melaleuca rhaphiophylla							x	x	
Mesomelaena pseudostygia	x	x	x					x	
Mirbelia floribunda						+		x	
Mirbelia spinosa	+							x	
Muehlenbeckia adpressa							x		
Myoporum caprarioides							x	x	
Nemcia reticulata				+				x	
Nuytsia floribunda	+						+		
Orthrosanthus laxus			+						
Patersonia occidentalis	x								
Pelargonium capitatum									W
Petrophile brevifolia		x		x				x	
Petrophile linearis	x	x							
Petrophile macrostachya	x		x	x				x	
Petrophile serruriae					+			x	
Phlebocarya ? filifolia							x	x	
Pityrodia bartlingii		+							
Pterostylis sp	+								
Restio sinuosus MS	+							x	
Ricinocarpos glaucus						+			
Rumex sp.									W
Scaevola ?canescens				+					
Scholtzia involucrata	x							x	
Scholtzia laxiflora							x	x	
Scholtzia sp.	+	x	x	+				x	
Senecio lautus	+								

APPENDIX 2. List of the vertebrate fauna species which may occur on the property, in the two groups of habitats:

A. Those on the area proposed to be cleared, which are Banksia woodland, sand heath, heath or woodland on limestone, and *Banksia prionotes* woodland on yellow sand.

B. Those on the areas not proposed to be cleared, which are parts of all of the above plus small areas of laterite, and the various low-lying areas and drainage lines.

Introduced species are identified by an asterisk (*).

	A	B
SCINCIDAE		
Cryptoblepharus plagiocephalus Common Crypto	X	X
Ctenotus fallens West-coast Ctenotus	X	X
Ctenotus impar Eleven-striped Ctenotus	X	X
Ctenotus p. pantherinus Western Leopard Ctenotus		X
Egernia kingii King's Skink		X
Egernia multiscutata bos Southern Sand Skink	X	X
Egernia napoleonis Southern Crevice Skink	X	X
Hemiergis quadrilineata Two-toed Earless Skink	X	X
Lerista christinae Christine's Four-toed Lerista	X	X
Lerista distinguenda Southwestern Four-toed Lerista	X	X
Menetia greyii Grey's Menetia	X	X
Morethia lineoocellata Ocellated Morethia	X	X
Morethia obscura Dark Morethia	X	X
Tiliqua occipitalis Western Bluetongue	X	X
Tiliqua r. rugosa Western Bobtail	X	X
VARANIDAE		
Varanus gouldii Gould's Monitor	X	X
Varanus tristis Black-tailed Monitor	X	X
TYPHLOPIDAE		
Ramphotyphlops australis Southern Blind Snake	X	X
Ramphotyphlops waitii Waite's Blind Snake	X	X
BOIDAE		
Antaresia s. stimsoni Stimson's Python		X
Morelia spilota variegata Western Carpet Python	X	X
ELAPIDAE		
Demansia psammophis reticulata Grey-headed Whip Snake	X	X
Echiopsis curta Bardick	X	X
Neelaps bimaculatus Black-naped Snake	X	X
Neelaps calonotus Black-striped Snake	X	X
Notechis scutatus occidentalis Western Tiger Snake	X	X
Pseudechis australis Mulga Snake	X	X
Pseudonaja nuchalis Gwarder	X	X
Simoselaps bertholdi Jan's Banded Snake	X	X
Simoselaps f. fasciolatus Narrow-banded Snake	X	X
Simoselaps s. semifasciatus Southern Shovel-nosed Snake	X	X

	A	B
TURNICIDAE		
Turnix velox Little Button-quail	X	X
Turnix varia Painted Button-quail	X	X
SCOLOPACIDAE		
Tringa nebularia Common Greenshank		X
Tringa glareola Wood Sandpiper		X
Actitis hypoleucos Common Sandpiper		X
RECURVIROSTRIDAE		
Himantopus himantopus Black-winged Stilt		X
CHARADRIIDAE		
Elseyornis melanops Black-fronted Dotterel		X
Erythrogonys cinctus Red-kneed Dotterel		X
Vanellus tricolor Banded Lapwing		X
COLUMBIDAE		
Phaps chalcoptera Common Bronzewing	X	X
Phaps elegans Brush Bronzewing	X	X
Ocyphaps lophotes Crested Pigeon	X	X
CACATUIDAE		
Calyptorhynchus banksii Red-tailed Black-Cockatoo		X
Calyptorhynchus latirostris Short-billed Black-Cockatoo	X	X
Cacatua roseicapilla Galah	X	X
Cacatua sanguinea Little Corella		X
Cacatua pastinator Western Corella		X
PSITTACIDAE		
Glossopsitta porphyrocephala Purple-crowned Lorikeet		X
Polytelis anthopeplus Regent Parrot		X
Platycercus icterotis Western Rosella	X	X
Barnardius zonarius Australian Ringneck	X	X
Purpureicephalus spurius Red-capped Parrot		X
Neophema elegans Elegant Parrot	X	X
CUCULIDAE		
Cuculus pallidus Pallid Cuckoo	X	X
Cacomantis flabelliformis Fan-tailed Cuckoo	X	X
Chrysococcyx basalis Horsfield's Bronze-Cuckoo	X	X
Chrysococcyx lucidus Shining Bronze-Cuckoo	X	X
STRIGIDAE		
Ninox novaeseelandiae Southern Boobook	X	X

	A	B
MELIPHAGIDAE		
Anthochaera carunculata Red Wattlebird	X	X
Anthochaera chrysoptera Little Wattlebird	X	X
Acanthagenys rufogularis Spiny-cheeked Honeyeater	X	X
Manorina flavigula Yellow-throated Miner	X	X
Lichenostomus virescens Singing Honeyeater	X	X
Lichenostomus ornatus Yellow-plumed Honeyeater		X
Melithreptus brevirostris Brown-headed Honeyeater	X	X
Melithreptus lunatus White-naped Honeyeater	X	X
Lichmera indistincta Brown Honeyeater	X	X
Phylidonyris novaehollandiae New Holland Honeyeater	X	X
Phylidonyris nigra White-checked Honeyeater	X	X
Phylidonyris melanops Tawny-crowned Honeyeater	X	X
Acanthorhynchus superciliosus Western Spinebill	X	X
Ephthianura albifrons White-fronted Chat	X	X
PETROICIDAE		
Microeca fascinans Jacky Winter		X
Petroica multicolor Scarlet Robin	X	X
Petroica goodenovii Red-capped Robin	X	X
Melanodryas cucullata Hooded Robin	X	X
Eopsaltria griseogularis Western Yellow Robin	X	X
Drymodes brunneopygia Southern Scrub-robin	X	X
POMATOSTOMIDAE		
Pomatostomus superciliosus White-browed Babbler	X	X
NEOSITTIDAE		
Daphoenositta chrysoptera Varied Sittella		X
PACHYCEPHALIDAE		
Oreoica gutturalis Crested Bellbird	X	X
Pachycephala pectoralis Golden Whistler	X	X
Pachycephala rufiventris Rufous Whistler	X	X
Colluricincla harmonica Grey Shrike-thrush	X	X
DICRURIDAE		
Myiagra inquieta Restless Flycatcher		X
Grallina cyanoleuca Magpie-lark		X
Rhipidura fuliginosa Grey Fantail	X	X
Rhipidura leucophrys Willie Wagtail	X	X
CAMPEPHAGIDAE		
Coracina novaehollandiae Black-faced Cuckoo-shrike	X	X
Lalage sueurii White-winged Triller		X

	A	B
TARSIPEDIDAE		
Tarsipes rostratus Honey-possum	X	X
PHALANGERIDAE		
Trichosurus v. vulpecula Common Brushtail Possum		X
MACROPODIDAE		
Macropus fuliginosus Western Grey Kangaroo	X	X
Macropus irma Western Brush Wallaby	X	X
MOLOSSIDAE		
Mormopterus planiceps Southern Freetail-bat	X	X
Nyctinomus australis White-striped Freetail-bat	X	X
VESPERTILIONIDAE		
Nyctophilus geoffroyi Lesser Long-eared Bat	X	X
Nyctophilus timoriensis Greater Long-eared Bat	X	X
Chalinolobus gouldii Gould's Wattled Bat	X	X
Chalinolobus morio Chocolate Wattled Bat	X	X
Scotorepens balstoni Inland Broad-nosed Bat	X	X
MURIDAE		
Pseudomys albocinereus Ashy-grey Mouse	X	X
* Mus musculus House Mouse	X	X
Rattus fuscipes Bush Rat	X	X
CANIDAE		
* Vulpes vulpes Fox	X	X
FELIDAE		
* Felis catus Feral Cat	X	X
LEPORIDAE		
* Oryctolagus cuniculus Rabbit	X	X

Appendix 3

Griffin E A (1998) Floristic Communities in the Underwood Property, A Regional Assessment

Floristic Communities in the Underwood Property, a Regional Assessment

prepared for

Department of Environmental Protection

by

AGWEST Land Management

E. A. Griffin

APRIL 1, 1998

to be quoted as

E.A. Griffin (1998) Floristic Communities in the Underwood Property, a Regional Assessment. AGWEST Land Management Job 9857.

Introduction

The environmental significance of an application to clear native vegetation on Victoria Location 10598 (the Underwood Property) (Figure 1) has been assessed (EPA 1996). However, after appeal to the Minister for the Environment a number of points required assessment or clarification. Hart et al (1997) addressed most of these but there still remained an adequate assessment of the regional significance of the areas which are proposed to be cleared.

Ag West Land Management were engaged to use the data from Griffin (1994) to provide a detailed assessment of the likely regional significance of vegetation on the property. Any compatible data collected by Hart would be used in this assessment.

The focus of the assessment is the *Banksia* woodlands and heath on sandplain. These are the vegetation types which are for clearing.

The property is in the area known as the West Midlands or the Northern Sandplains. It is at the northern extent of mapped area of the Bassendean Dunes, and area dominated by pale deep sands. It includes small areas of the Arrowsmith Region which is a partially stripped lateritic upland. The Spearwood Dunes, yellow sand over limestone, flank the property on the west. These areas have been mapped as surface geology units (Lowry) and soil-landscape units (Schoknecht in prep).

Variation in the floristic composition of vegetation in the northern sandplains is related to a number of factors. At the coarse levels of distinction, these relate to different combinations of substrate and geomorphology. Distinct substrates are for example limestone, sand over limestone, yellow deep sand, sand over gravel or clay, and damplands. Geomorphic units include such as the Spearwood dunes, the Bassendean Dunes and the Arrowsmith Region. At finer levels of distinction there are relatively clear regional patterns in the variation in floristic composition which are not obviously related to substrate. Frequently these patterns are similar for different substrate types.

Methods

The investigation had two foci.

1. Analysing the distribution patterns of the groups from Griffin 1994 to determine the probable extent of floristic communities in the vicinity of the Underwood property.

2. Numerical analysis of the data from Hart with a subset from Griffin 1994 to determine what floristic types are on Underwood's property in relation to the Lesueur National Park or other conservation areas.

The Numerical analysis used the PATN package used by Griffin (1994) and Gibson et al (1994). The modules used included ASO, FUSE, DEND, GDF, MST and SST.

Results and Discussion

Floristic types of Griffin (1994)

Hart (1997) attempted to place the vegetation of Underwood's property into some of the floristic groups of Griffin (1994). The groups nominated are shown in Table 1. The distribution of these are shown in Appendix 1.

Table 1 Hart estimation of floristic groups of Griffin (1994)

	gp20		gp100	
Banksia attenuata woodlands	12	Bassendean Dunes, some Arrowsmith Region		
	11	Assowsmith Region, Bassendean Dunes, Dandaragan Plateau		
Banksia prionotes woodland	1	Arrowsmith region	2	Spearwood E margin
	10	Spearwood Dunes North	66	Spearwood E margin, N of Green Head Rd
	11	Assowsmith Region, Bassendean Dunes, Dandaragan Plateau	71	Dandaragan Plateau, S of Green Head Rd
Limestone	10	Spearwood Dunes North		
Banksia candolleana heath	11	Assowsmith Region, Bassendean Dunes, Dandaragan Plateau	67	Eneabba Plain, some Arrowsmith Region

This was not entirely useful. Firstly none of Griffin's sites from two groups (100-67 and 100-71) occurred in the Cockleshell Gully area. Secondly, most of the groups identified are widespread. These are heterogeneous and not appropriate for use for describing regional patterns at the scale required.

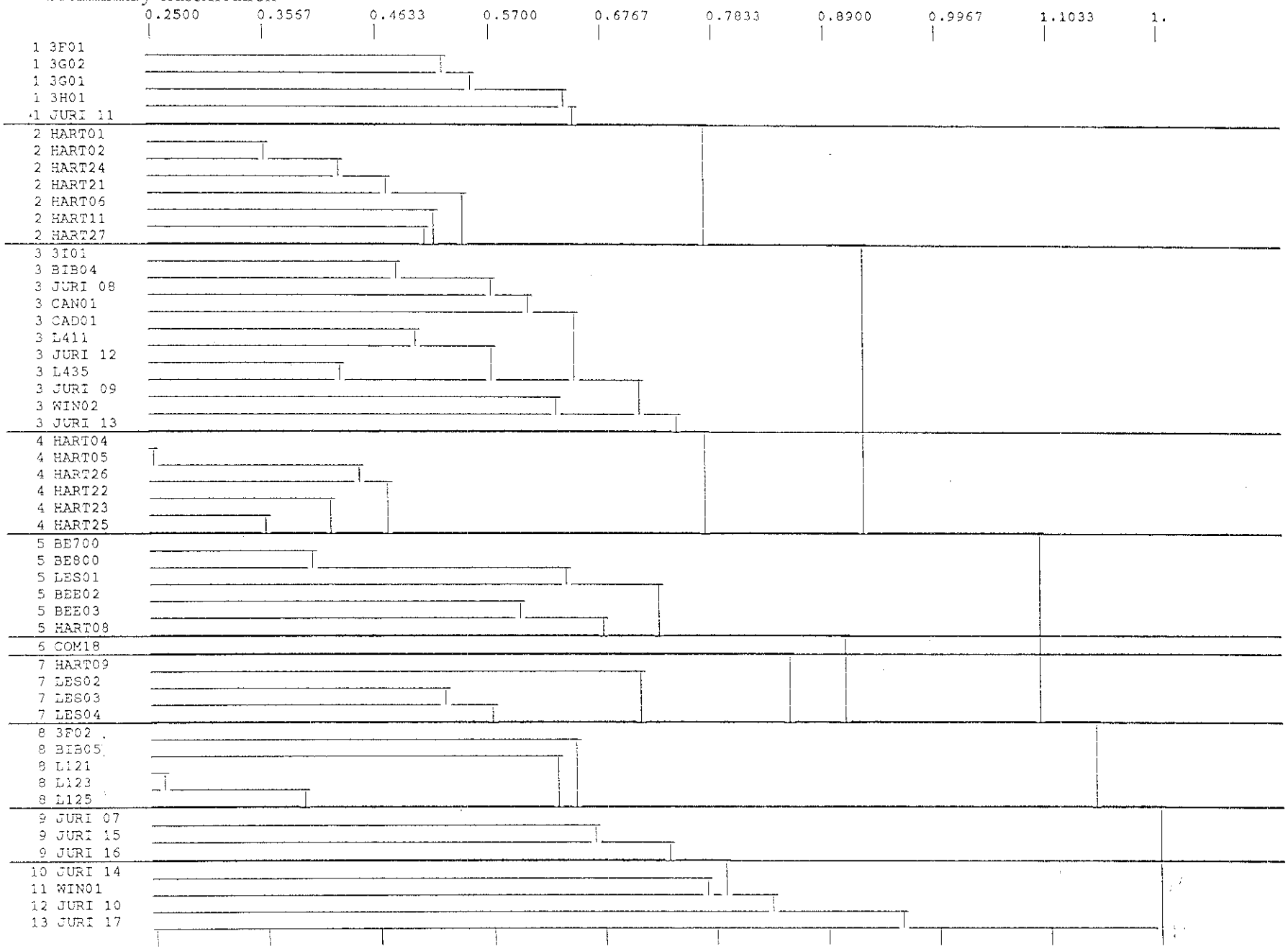
The 500 group level from Griffin (1994) is more appropriate as these are more homogeneous. The distribution of twenty-one cluster groups (at the 500 group level, Griffin 1994) of sites in the vicinity of the Underwood property or in comparable landscapes are presented in Appendix 1. These show a number of significant distribution patterns. Table 2 is a summary of these. From these distribution patterns, thirteen of these groups are inferred to be present on the Underwood property.

The *Banksia prionotes* woodlands of the Spearwood Dunes are probably from groups 9 and 11. The heath on limestone are probably from group 358. The damplands are probably from groups 277, 282, 299 and 393. Sand Heath are probably from groups 371, 372 and 374. *Banksia attenuata* woodlands are probably from groups 412, 413 and 414.

U	20	100	500	#	Ho	Dominant spp	Constant spp	landform	Geomorphic unit	location
Y	11	69	371	23	0.41	*Banksia attenuata, Adenanthos cygnorum* ssp. *cygnorum*	*Mesomelaena pseudostygia, B. attenuata*	pediment or plain, grey sand / yellow sand, v well drained	Arrowsmith Region, rare E Bassendean Dunes	Green Head Rd - Moore River
Y	11	69	372	19	0.23	*Allocasuarina humilis*	*Hibbertia hypericoides, Dryandra shuttleworthiana*	pediment or +, grey sand / lateritic gravel, v well drained	Arrowsmith Region	Cockleshell Gully and south, Arrowsmith Region
	11	69	373	30	0.35	*Allocasuarina humilis*	*A. humilis, Hypocalymma xanthopetalum*	pediment, grey sand, v well drained	Arrowsmith Region	Lesueur NP (core area)
Y	11	70	374	22	0.37	sandy spp	*Mesomelaena pseudostygia, Allocasuarina humilis*	pediment or plain, grey sand / yellow sand, v well drained	Arrowsmith Region	Badgingarra - Moore River, mainly east of Brand Hwy
Y	11	72	393	2	0.28	*Banksia telmatiaea*	*Eremaea beaufortioides, Verticordia densiflora*	valley flat, sand / ?, well drained, winter damp	E margin Bassendean Dunes	Cockleshell Gully - Wongonderra
?	12	75	412	2	0.32	*Melaleuca scabra*	*Banksia attenuata, M. scabra*	plain or dune, grey sand / yellow sand, v well drained	W margin of Bassendean Dunes	Munbinea Rd
?	12	75	413	14	0.32	*Banksia attenuata, B. menziesii*	*B. attenuata, Hypocalymma xanthopetalum*	flat or pediment, grey sand / yellow sand, v well drained	Bassendean Dunes, rare Arrowsmith region	Jurien to S of Cataby
Y	12	75	414	17	0.46	*Banksia attenuata, B. menziesii*	*B. attenuata, Blancoa canescens*	pediment or flat, grey sand, v well drained	Arrowsmith Region, minor Bassendean Dunes,	Cockleshell Gully - S of Cataby, W of Brand Hwy
	13	77	428	30	0.39	laterite spp	*Lambertia multiflora* ssp. Northern, *Hibbertia hypericoides*	upland plain or pediment, lateritic grey gravelly sand, v well drained	Arrowsmith Region	Green Head Rd - Cataby
	13	78	437	59	0.56	laterite spp	*Hypocalymma xanthopetalum, Calothamnus sanguineus*	upland plain or scarp, lateritic grey sandy gravel, v well drained	Arrowsmith Region	Lesueur (core)

Column Notes: U - present in Underwood property (Y or ?) Ho - homotoneity measure (see Griffin 1994).

Figure 2 Preliminary classification



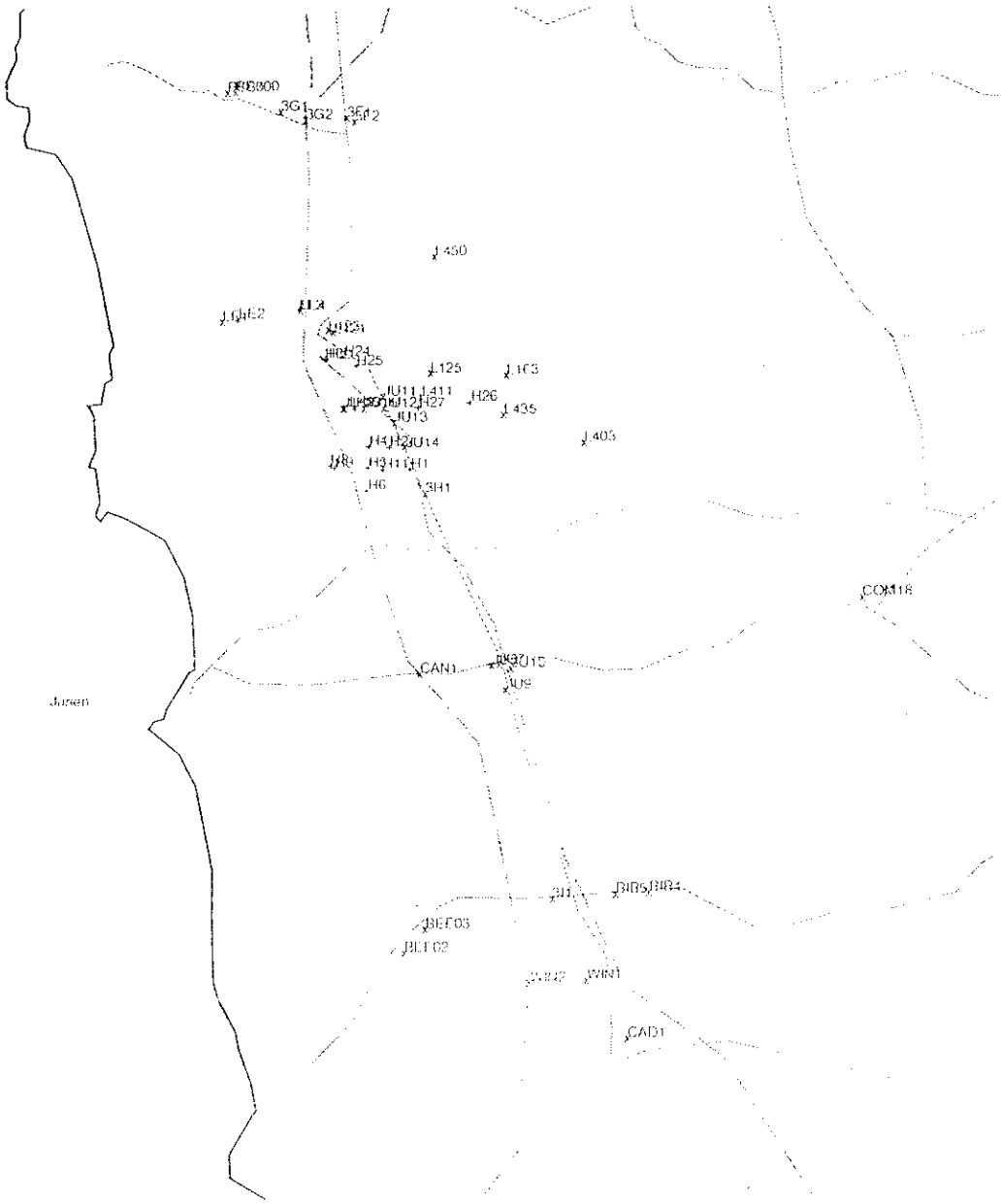


Figure 3:

Site numbers for sites used in clustering

Damplands

A wide range of floristic types occur in the damplands, both on the property and in the region. These appear to be mostly confined to within the Bassendean Dunes and some of the drainage lines of the Arrowsmith region. Most occurrence are quite small.

The floristic types of the damplands of the Underwood property is poorly represented in the conservation estate. This is because of two factors; most of the Bassendean Dunes north of Cataby are poorly represented in the conservation estate and there are few comparable damplands in the Badgingarra and Lesueur National Parks and Coomallo Nature reserve.

Heath on Laterite/Ironstone

The small areas identified as laterite adjacent to the damplands are different from typical lateritic uplands. This conclusion comes from two aspects; the species provided in the list of Hart, and the atypical landscape position. It is probable that these areas are bog iron formed in damp situations.

The vegetation of bog iron deposits are poorly represented in the conservation estate. Gibson et al (1994) identified these areas as being of high conservation significance in areas of the southern Swan Coastal Plain. Similar areas are being investigated for considered inclusion as a threatened plant community.

Figure 5:

Group numbers form clustering

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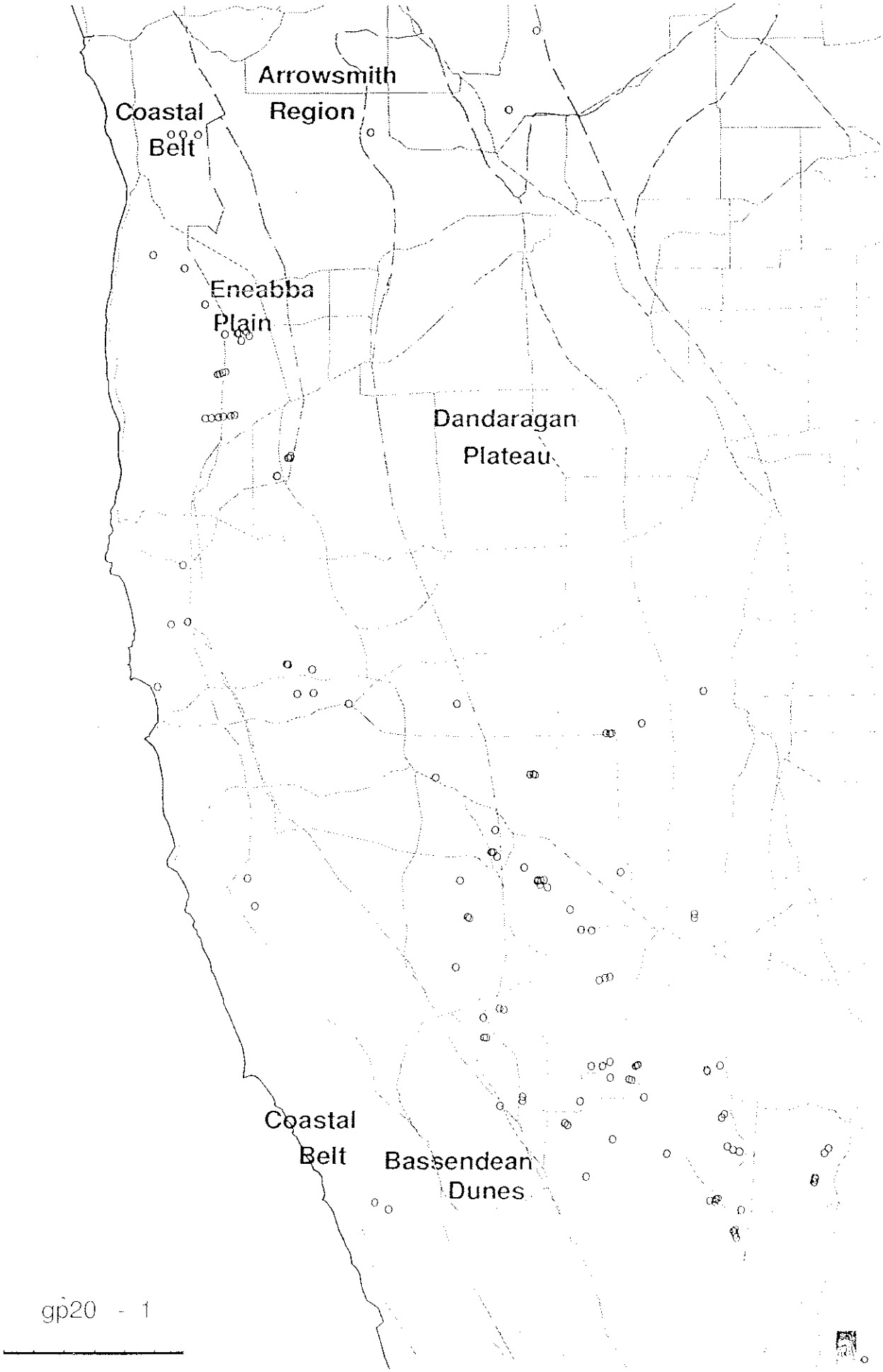
Acknowledgments

Dr A.S. Weston provided, on behalf of Hart, Simpson & associates, the data from sites described on the Underwood property. This is gratefully acknowledged.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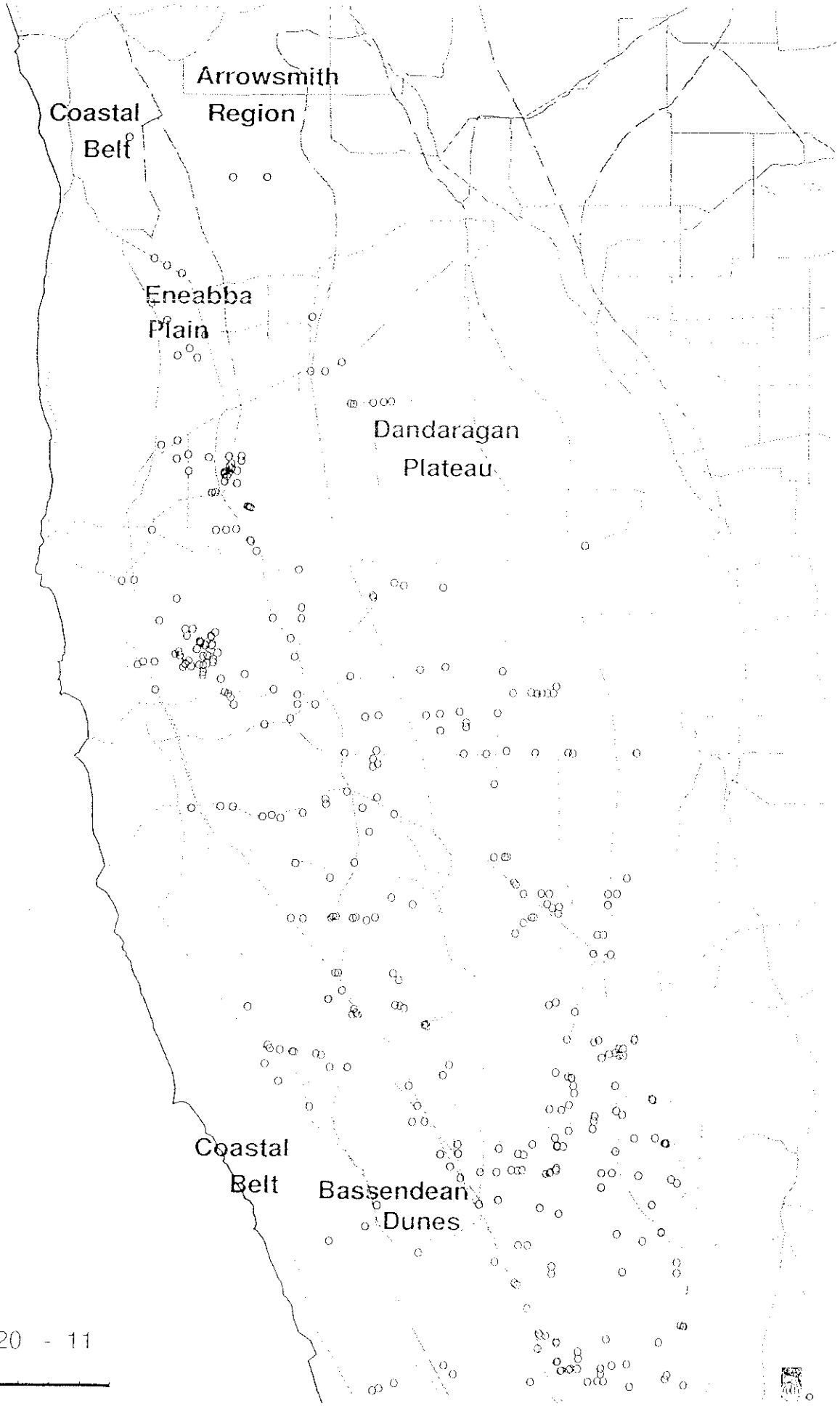
Belt
Eneabba
Plain
Dandaragan
Plateau
Coastal
Belt
Bassendean
Dunes

gp20 - 1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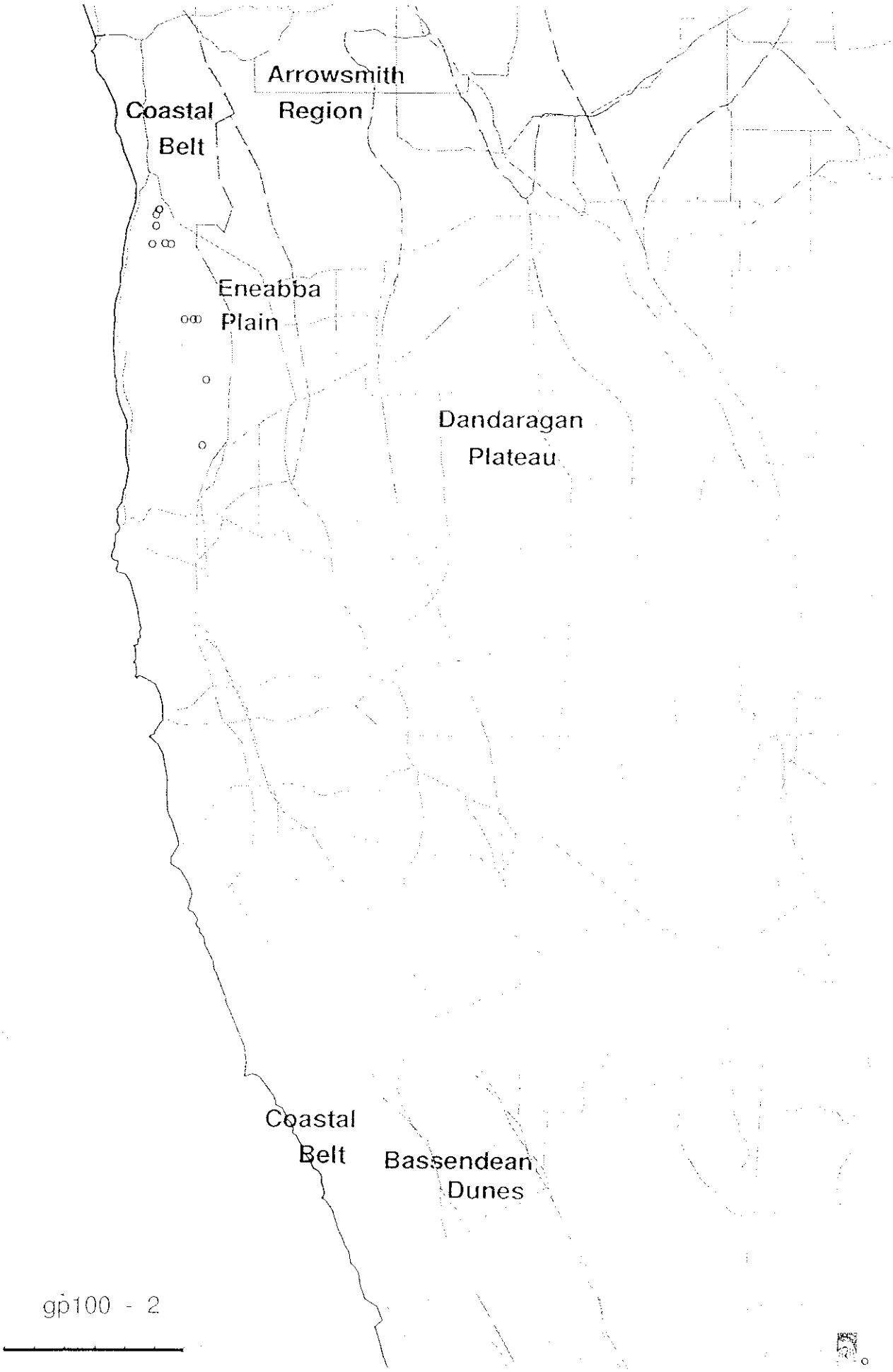
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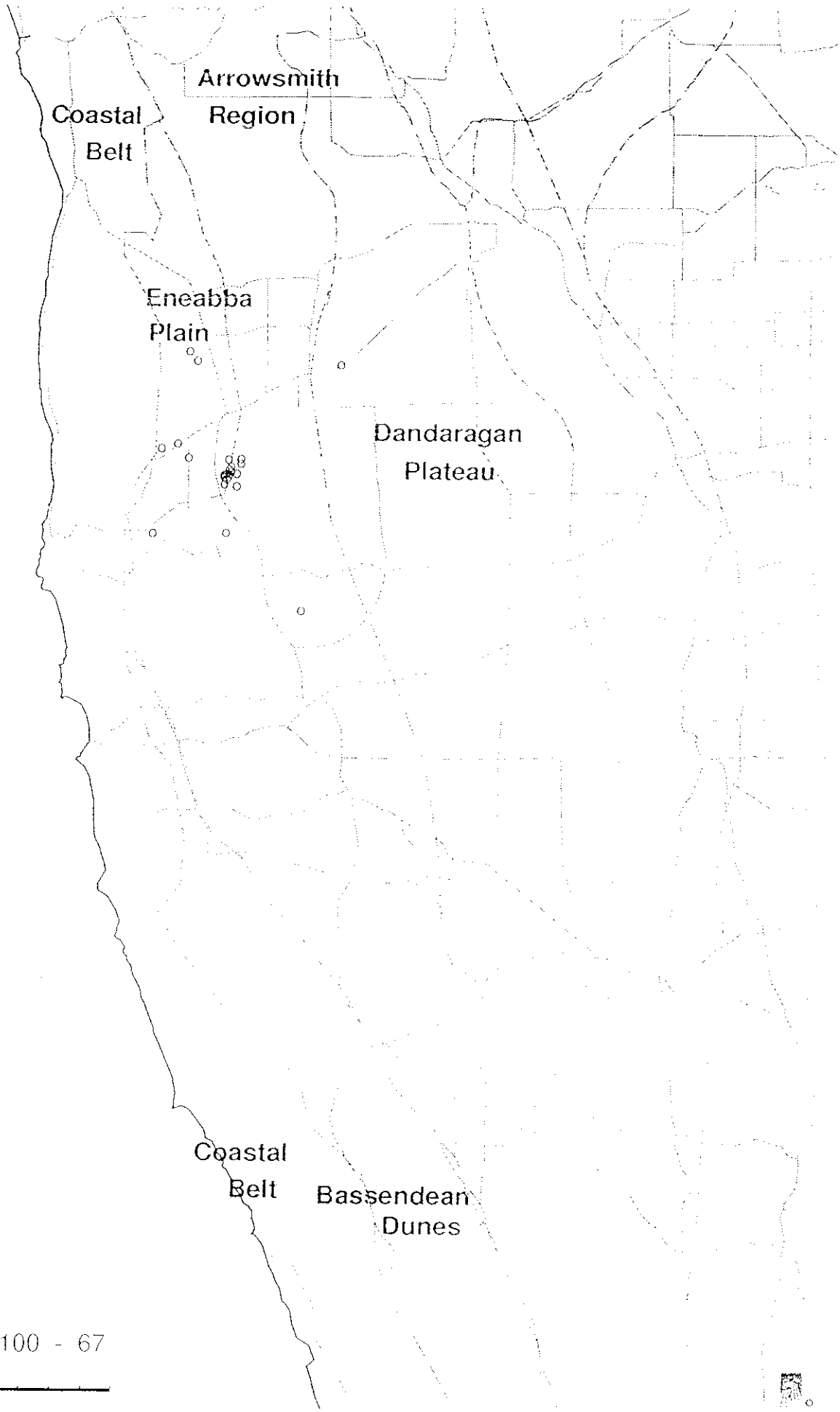
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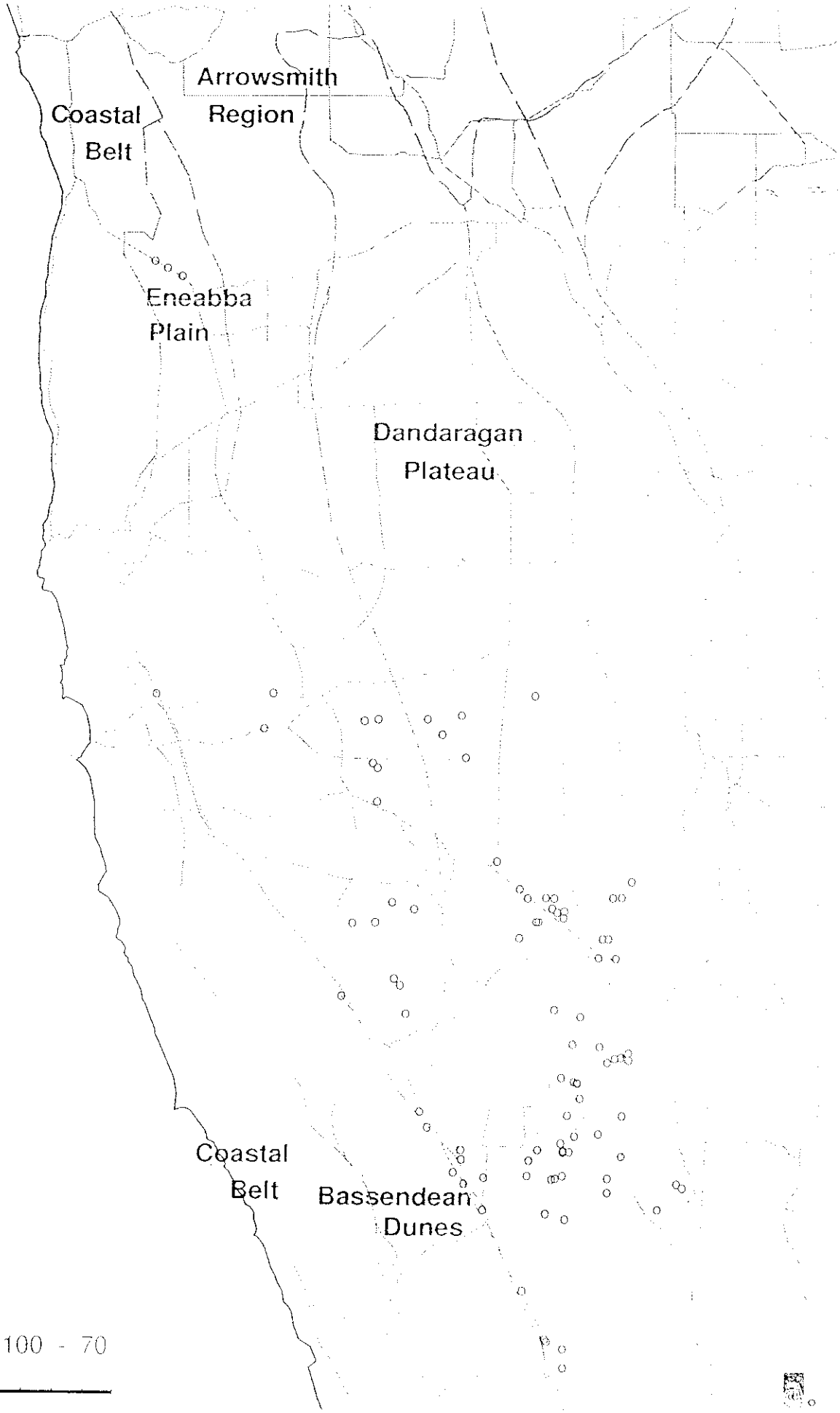
Dunes

gp100 - 67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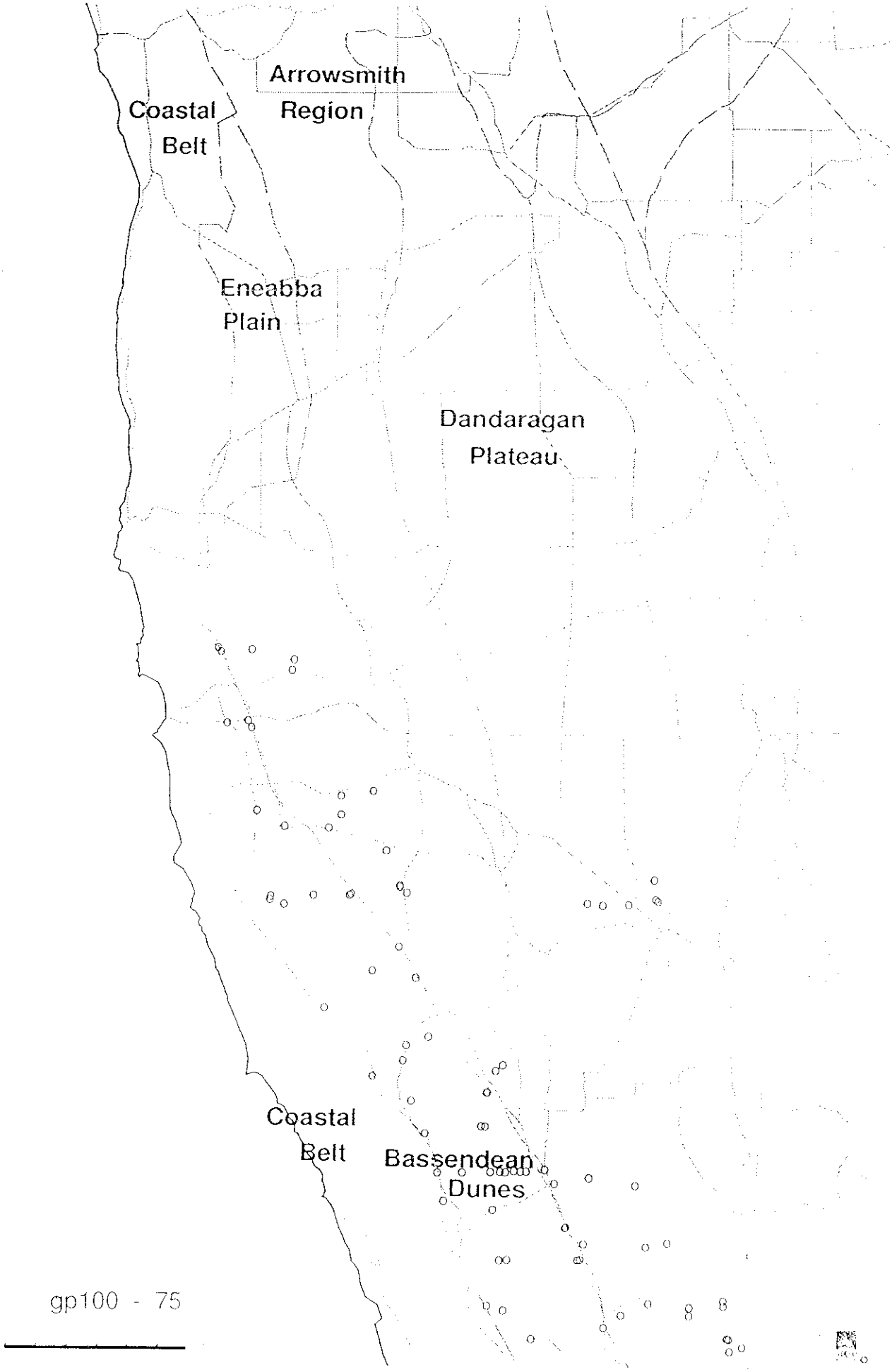
gp100 - 70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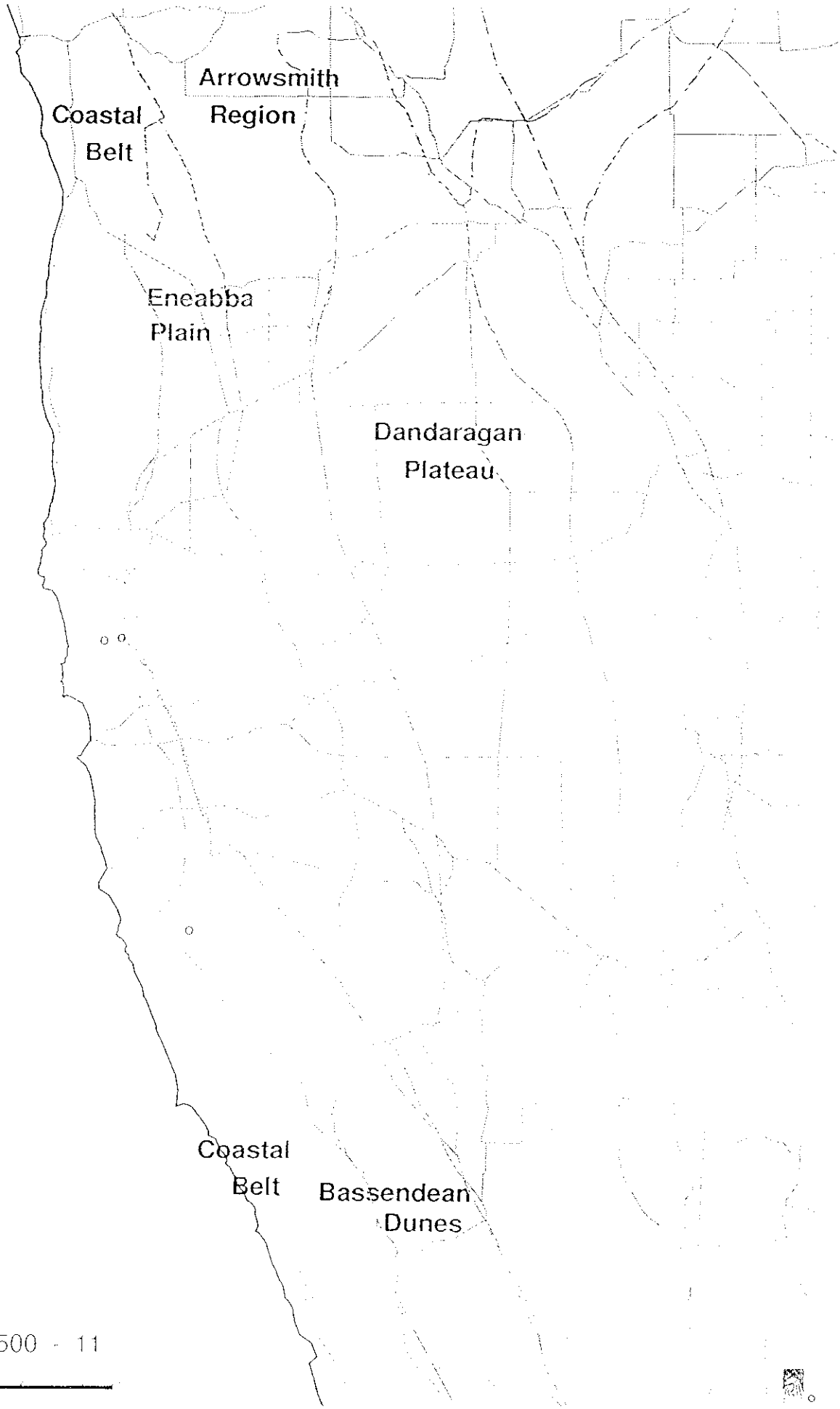
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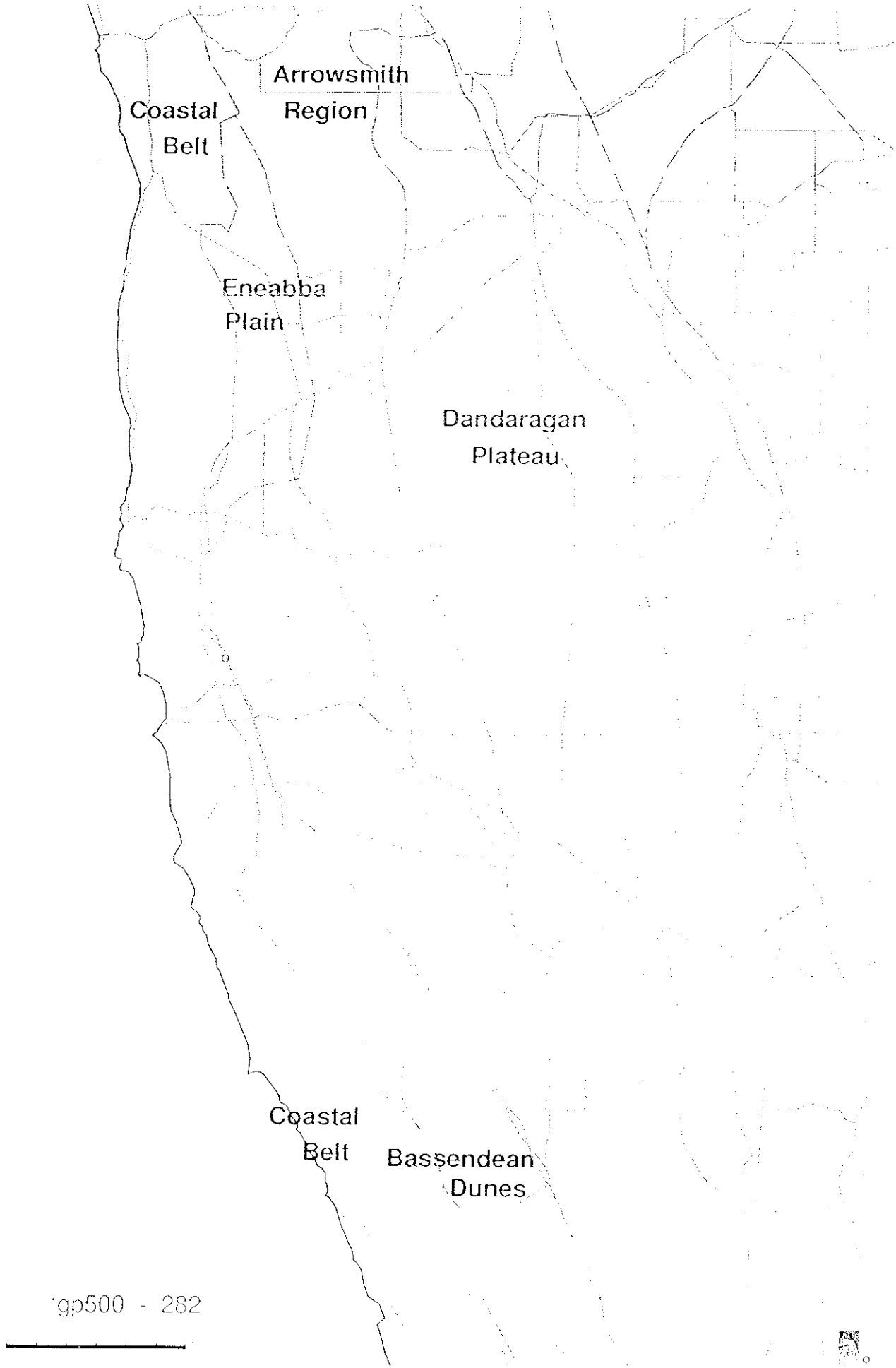
Dunes

gp500 - 11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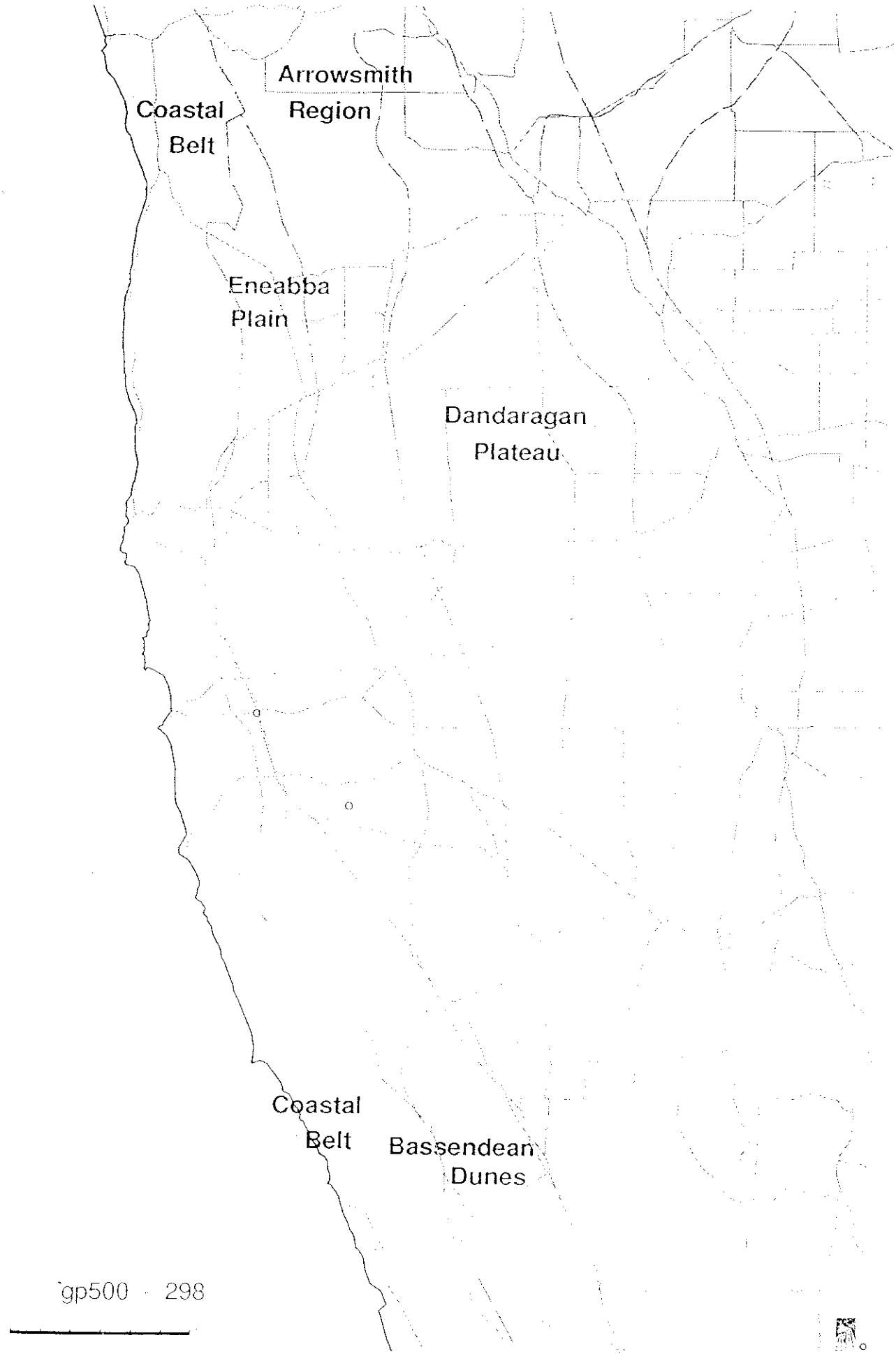
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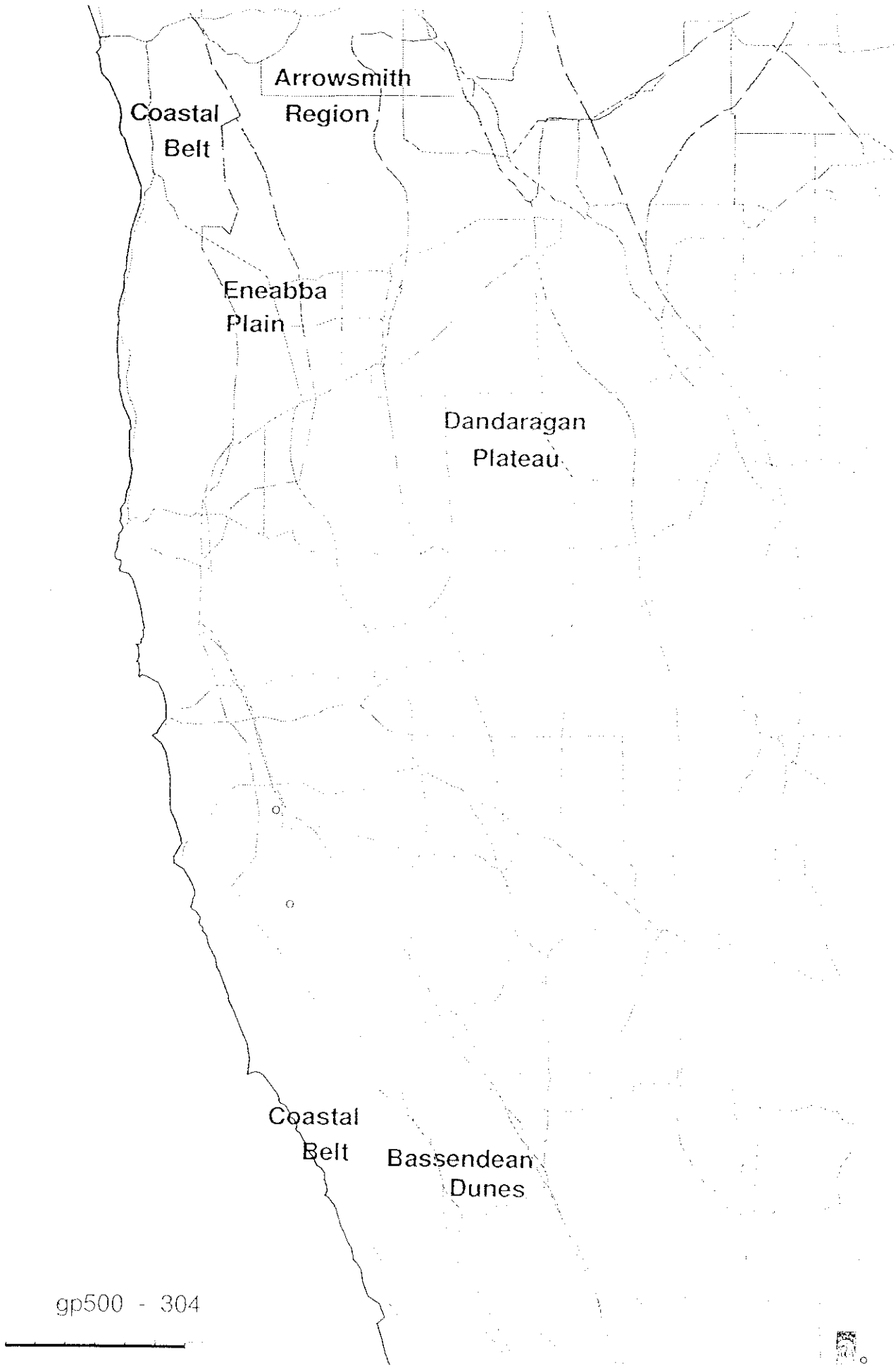
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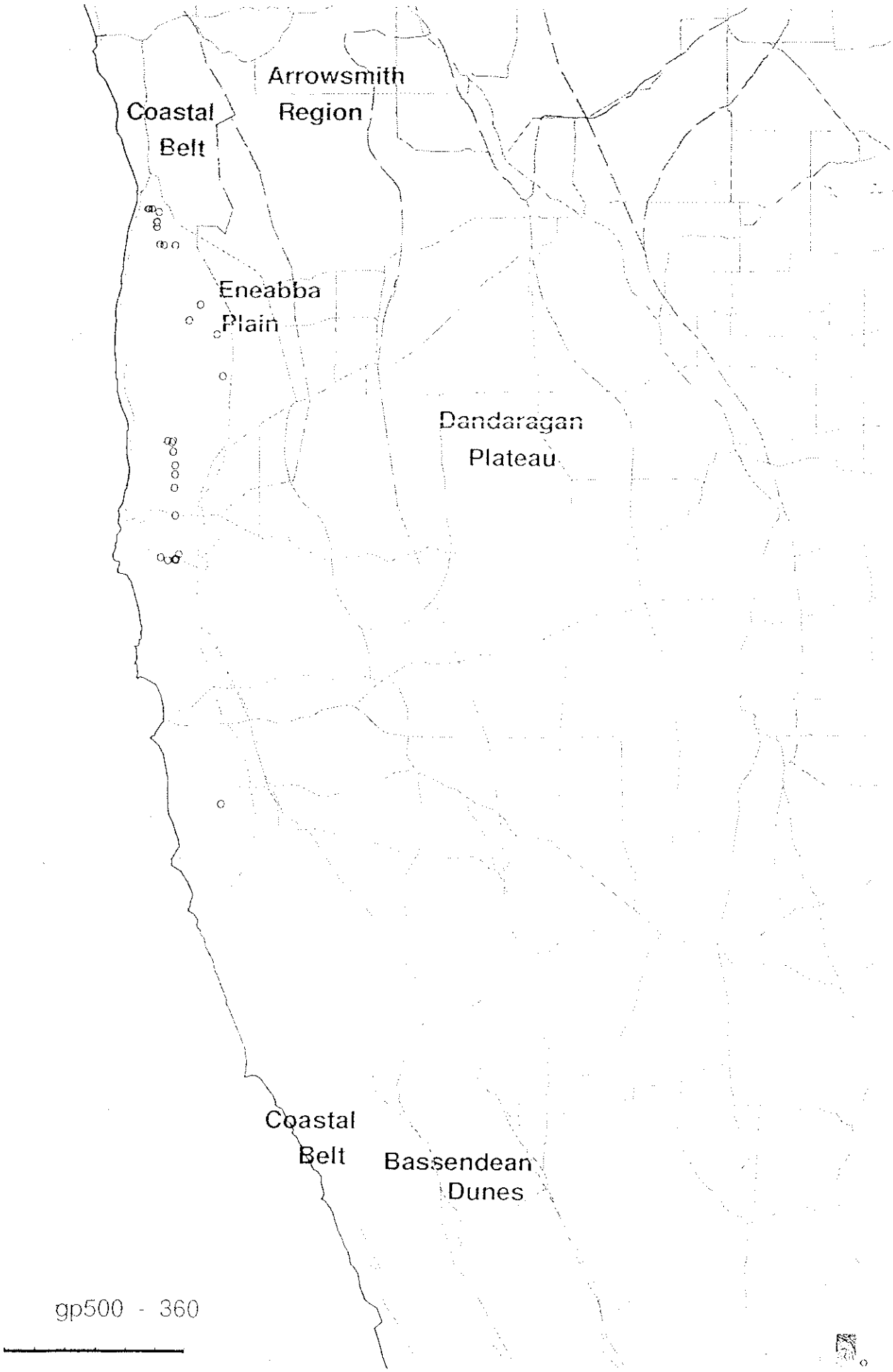
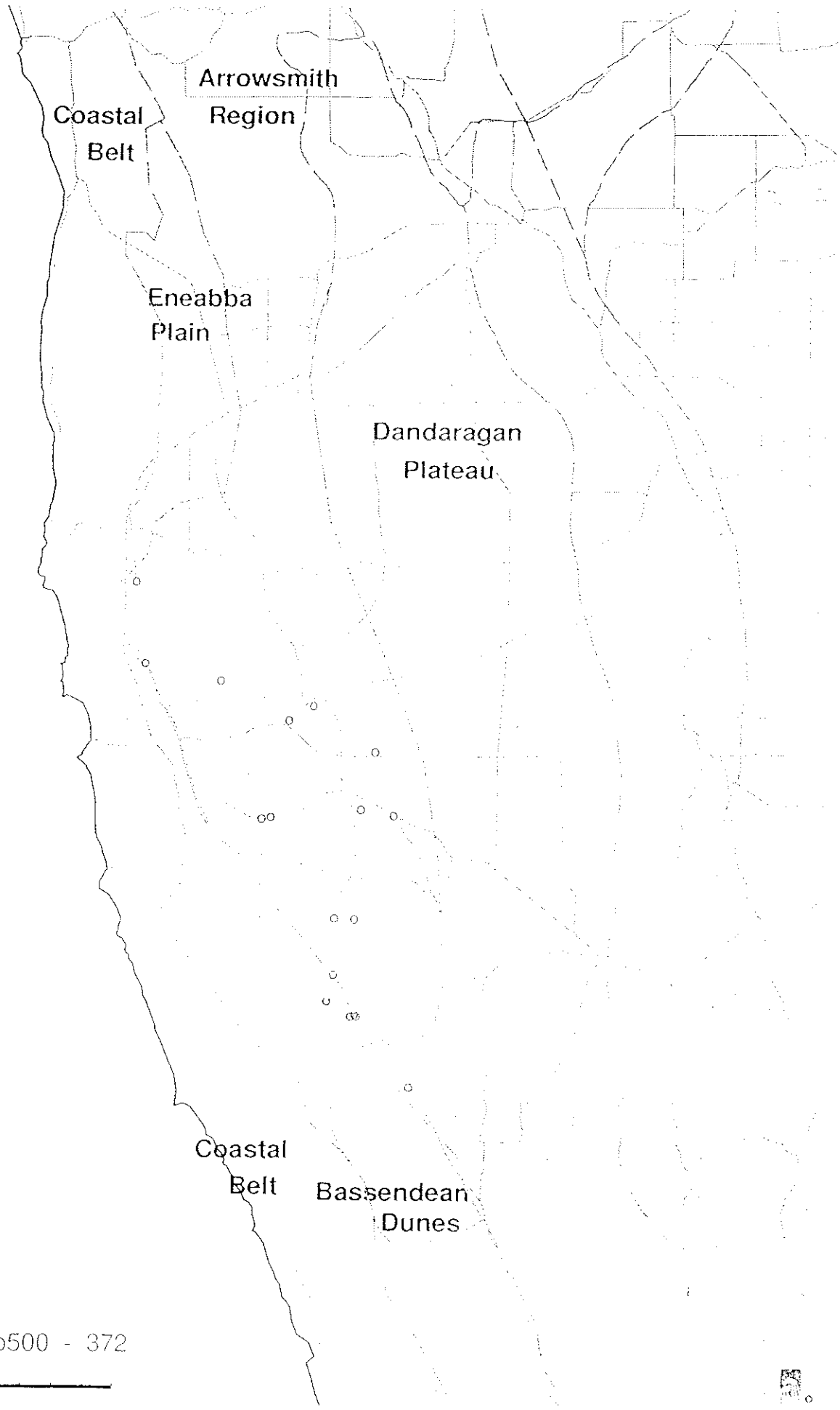
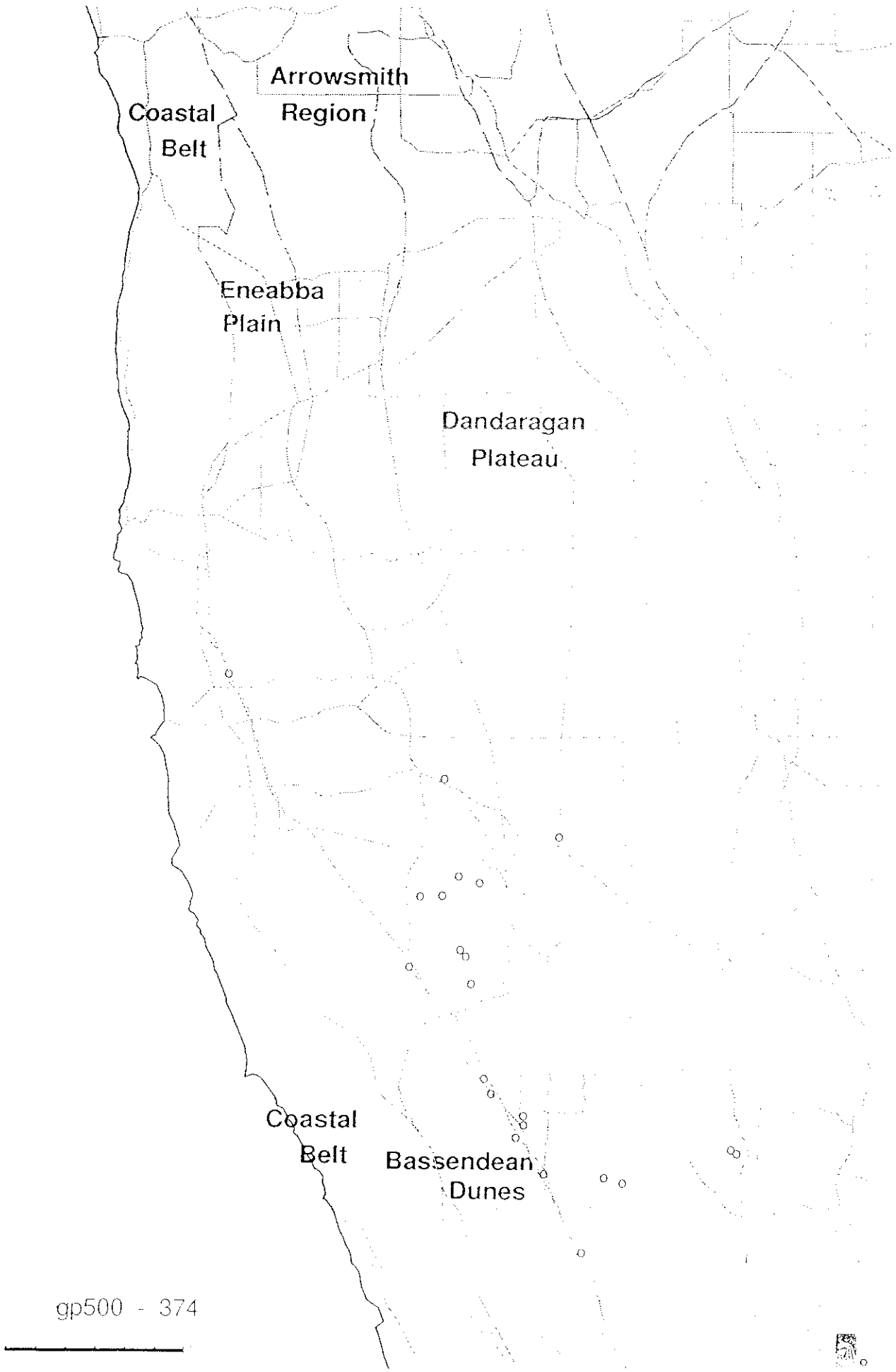
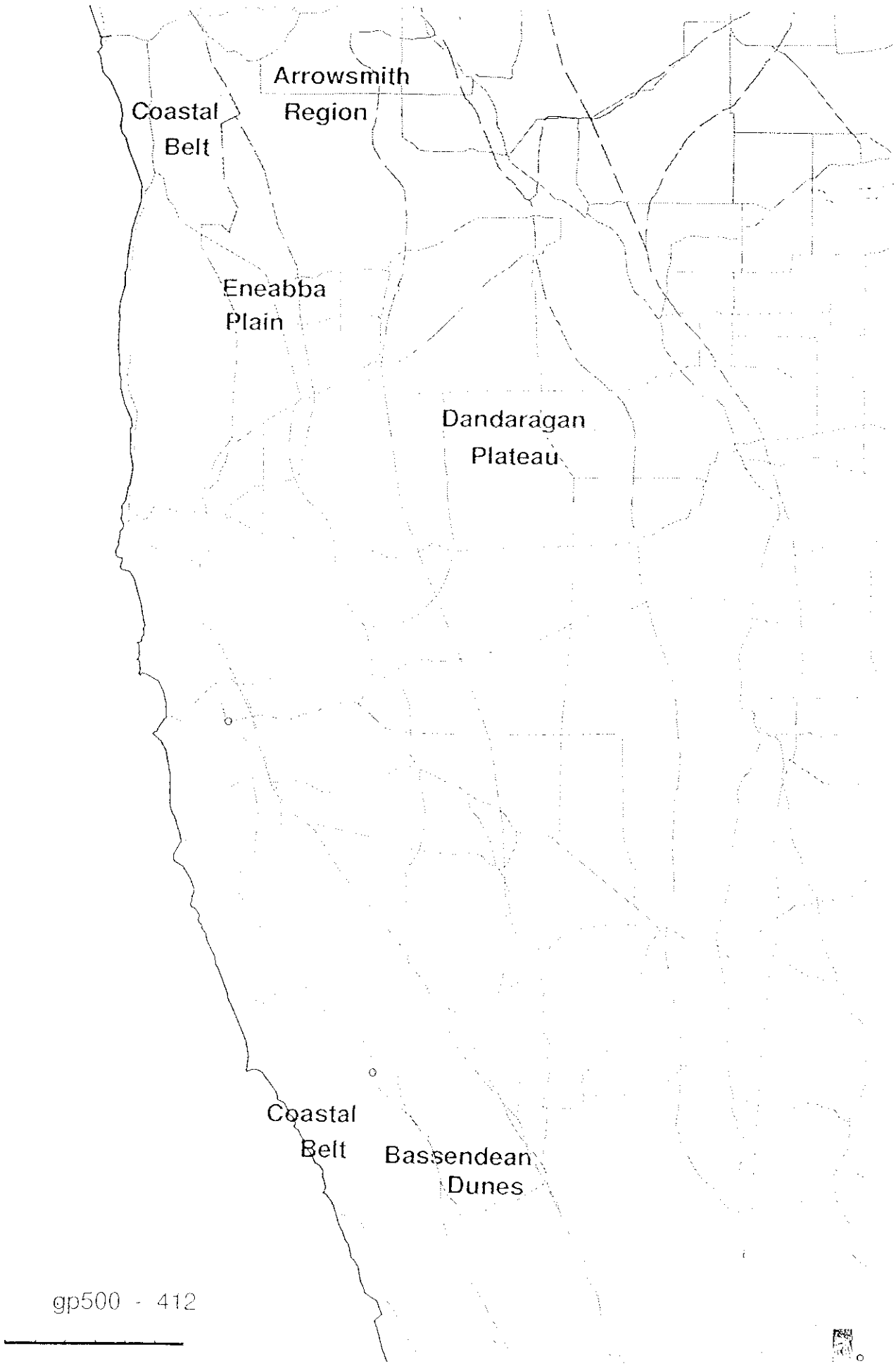
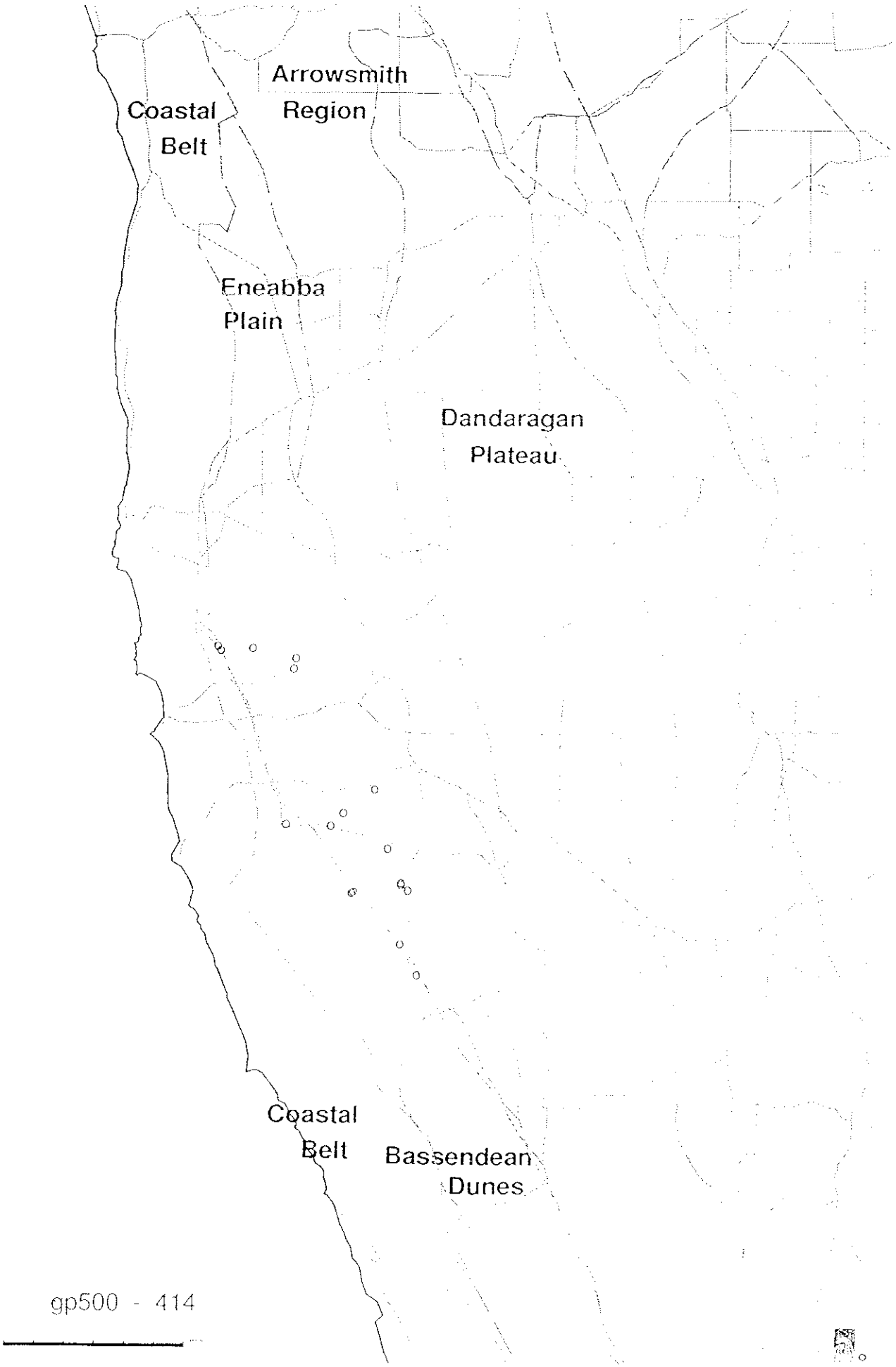
Coastal
Belt
Bassendean
Dunes
gp500 - 304

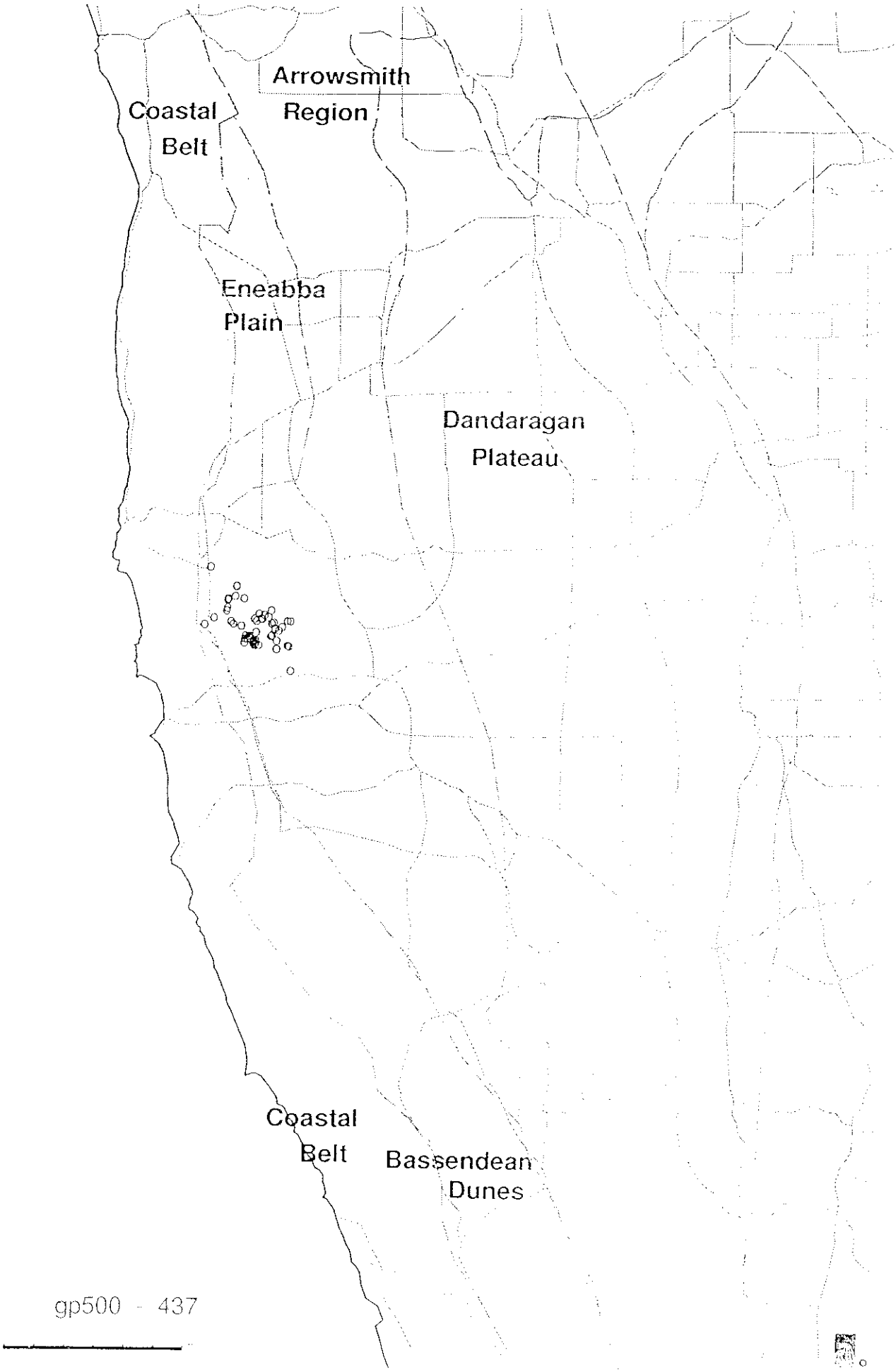

Arrowsmith
Region
Coastal
Belt
Eneabba
Plain
Dandaragan
Plateau
Coastal
Belt
Bassendean
Dunes
gp500 - 360


Arrowsmith
Region
Coastal
Belt
Eneabba
Plain
Dandaragan
Plateau
Coastal
Belt
Bassendean
Dunes
gp500 - 372


Arrowsmith
Region
Coastal
Belt
Eneabba
Plain
Dandaragan
Plateau
Coastal
Belt
Bassendean
Dunes
gp500 - 374


Arrowsmith
Region
Coastal
Belt
Eneabba
Plain
Dandaragan
Plateau
Coastal
Belt
Bassendean
Dunes
gp500 - 412


Arrowsmith
Region
Coastal
Belt
Eneabba
Plain
Dandaragan
Plateau
Coastal
Belt
Bassendean
Dunes
gp500 - 414


Arrowsmith
Region
Coastal
Belt
Eneabba
Plain
Dandaragan
Plateau
Coastal
Belt
Bassendean
Dunes
gp500 - 437