West Midlands Study

Project Status Report

22 May 2000

AJM Hopkins and MA Langley

The West Midlands is an area with very high nature conservation values, but the area lacks a well designed conservation reserve system to protect those values. There are some emerging land-use issues that have the potential to impact severely on the nature conservation values: collectively these issues create an urgent need to develop a nature conservation strategic plan for the area. The West Midlands Study is a response to that need.

The objectives set down for the West Midlands Study are summarised on Attachment 1. This Attachment also reviews the project on a milestone-by-milestone basis.

In simple terms, the West Midlands Study will provide a map of the study area that shows the distribution of nature conservation values across the landscape based on implicit data. This map will be intersected with the existing conservation reserve system to determine how well these nature conservation values are represented in that system and, by implication, what additional areas might need to be added to the system. A protocol for using the data when dealing with land-use proposals will be developed.

A draft of the map for the West Midlands Study is attached (Figure 1). The map is of floristically-defined catenas along the lines of the Vegetation Systems defined for the South West of Western Australia by J S Beard. We will refer to these map units as Sub-Systems. This map will be refined over the next two weeks.

Once the map is completed to our satisfaction, the conservation assessment and planning process will commence. It is anticipated that this process will take 4 weeks. A final report on the whole West Midlands Study, including proposals for improving the conservation reserve system and a protocol for land-use planning and environmental impact assessment.

Attachments:

Figure 1. Draft map of vegetation sub-systems of the West Midlands area.

Figure 2. Map of the remnant vegetation of the West Midlands area (data from the Land Monitor project, to be up-dated from Project DAW27).

Figure 3. Map of CALM estate within the West Midlands area (a sub-set of the remnant vegetation extent).

Figure 4. Map showing the type and extent of native vegetation in the West Midlands area according to the mapping at 1:250,000 scale by J S Beard.

Figure 5. Map of the soil landscape systems of the West Midlands area.

Figure 6. Map showing the distribution of rare and priority flora within the West Midlands area.

Figure 7. Map showing the location of the 2602 quadrats that have contributed floristic data to the West Midlands Study.

Attachment 1. Detailed status report for the West Midlands Study.

Attachment 2. Summary if information on Vegetation Sub-System No 5, as an example of the Sub-System concept.

Attachment 1

West Midlands Study
Project Status Report

1 May 2000

The Project Objectives

The objectives of this project are fourfold:

1. To design a network of protected areas that will adequately protect and conserve the landscape and nature conservation values throughout the study area.

In designing this network of protected areas, the project will address the following questions:

- how much of each different part of the landscape should be reserved; and
- how should the protected areas be distributed across the landscape as a whole to ensure long-term viability (which includes issues of connectivity).

The process will result in priorities for acquisition or other forms of conservation management being assigned to individual parcels of land and bioregions; this will include designing a comprehensive, adequate and representative (CAR) reserve system for the area.

2. To develop reliable models of the distribution of threatened and restricted plant and animal species which can be used in the reserve design procedures and in the environmental impact assessment process.
3. To develop a set of procedures and protocols for implementing the Memorandum of Understanding for the protection of remnant vegetation on private land in the Agricultural Region of Western Australia, which take account of the high biodiversity conservation values of the area.
4. To establish a framework by which proposals for major land-use change in the area might be considered.

It is probable that the procedures and protocols developed to fulfill Objective 3 above will be able to be used, with appropriate modification, in other areas within the South West Agricultural Region.

Officers of the Department of Environmental Protection have indicated the very strong interest of that Department in outcomes #3, #4 of this project, and a willingness to collaborate to extend these outcomes to other areas within the South West Agricultural Region.

Project Schedule

The study was designed in two phases, extending over a period of 18 months that included two Spring field seasons. Nineteen steps or scope items plus a final sign-off were detailed in the project proposal – there was some duplication with similar field work and analytical procedures being undertaken in years 1 and 2 . These 19 scope items have been concatenated into 16 milestones. A status report for each of these 16 milestones is given below:

1. Compile existing botanical survey data for the area.

Pre-existing floristic survey data were compiled into a coherent database, with up-to-date taxonomy and reliable geo-referencing.

2. Compile existing records of the distribution of plant taxa of special interest (ie threatened, priority, local endemics, and species with significant range extensions in the area) and of Threatened Ecological Communities (TECs).

Data on threatened, rare and priority flora have been compiled from various sources. The preliminary data set, maps provided by Ms Sue Patrick have been passed to DEP for databasing. Recently, the records from the West Midlands study quadrats have been extracted – these additional 2000 records will be passed on to DEP for inclusion in the project database. Data on local endemics and/or species at the limits of their range have been compiled, and will be passed on to DEP for databasing. There is only one TECs in the West Midlands Project study area at present (Heath dominated by one or more of *Regelia megacephala*, *Kunzea praestans*, *Dryandra sessilis* and *Allocasuarina campestris* on the upper slopes of the chert (quartzite) hills of the Coomberdale floristic region). Linework for this TEC is not yet available. Several possible additional ecological communities in the Lesueur- Coomallo area are under consideration.

3. Compile existing data on the distribution of vertebrate and invertebrate fauna.

Records of threatened vertebrate fauna have been downloaded from the WA Museum database and are available for GIS application. There is no equivalent database for invertebrates - compilation of invertebrate data in a suitable form is beyond the scope of this project. Dr Mike Bamford has offered to provide access to his extensive field records for the West Midlands area but this offer has not been taken up yet.

4. Compile relevant spatial data sets (vegetation, geology, soils and soil landscapes, landforms, catchments and drainage patterns, wetland types (Seminiuk classification), known biogeographic patterns, remnant vegetation, orthophotos, public land types, land subject to Agreements to Reserve (ATRs) or conservation covenants or identified under the Land for Wildlife Scheme, and other land-use and cadastral data).

The relevant spatial data sets have been compiled. Most of these data sets have been transferred to DEP (the up-to-date ATRs remain to be transferred). The Land for Wildlife data are not available digitally and use of the data requires permission of individual landowners, and to organise permission to use data through individual landowners – these data are not available as a consequence. There appear to be residual problems within DEP in loading data acquired from elsewhere.

5. Compile information on known threats to the biological values in the area, including *Phytophthora* spp, existing approvals to clear and applications to clear (NOIs), mineral tenements and other land-use proposals.

The relevant data sets have been compiled. Most of these data sets have been transferred to DEP (the up-to-date records of NOIs and approvals to clear remain to be transferred). A digital map coverage for potential threat to native vegetation from rising groundwater (and associated salinisation) is in preparation at Agriculture WA.

6. Collect additional botanical survey data to cover priority data gaps.

Specific gaps in the floristic survey data set were identified and the process of gap filling was carried out sequentially over two field seasons. In October 1998, 43 quadrats were sampled. In October 1999, 37 quadrats were sampled. The data from these quadrats (a total of 2602) have been incorporated in the database.

7. Analyse comprehensively the botanical survey data-

- to identify discrete plant communities,
- to quantify the floristic diversity in a way that is relevant to designing a reserve system,
- to define and map biogeographic units (sub-systems) which can be used as the basis for planning a reserve system, bringing together data on plant communities, soil landscapes and vegetation, and

The site x species data matrix derived from the floristic survey has been analysed using an agglomerative polythetic classification procedure in PATN. The classification has been truncated at the 500 group level - this provides meaningful groups as a starting point for the project.

The floristic groups so defined have been grouped in terms of their geographic patterns, to reflect regional catenary sequences. Some 38 sets of floristic communities have been identified. These 38 sets have been mapped. Based on the mapped distribution of the sets, 29 regions have been defined. These 29 regions are based in part on the soil landscape map unit boundaries. **These 29 regions are to become the fine scale phytogeographic units or sub-systems that will be used for the conservation assessments in the project.**

8. Compare distribution patterns of selected plant taxa and other components of the biota to test the hypothesis that the proposed biogeographic units (sub-systems) are reliable surrogates for the biota as a whole.

Not yet done. A review of available fauna distribution data suggests that such a test will be meaningless. This component of the proposal will focus on plant species only.

9. Field validate the proposed sub-regions.

Not yet done

10. Finalise the bioregionalisation for the West Midlands study area, including proposals for adjustments to IBRA boundaries, and the identification of sub-regions.

Not yet done

11. Undertake a comprehensive spatial analysis, including a gap analysis, to identify nature conservation priorities for the area.

Not yet done

12. Define a series of options, or a preferred option for a protected area network in the area.

Not yet done

13. Prepare a draft report which includes the following:

- options or a preferred option for protected area network throughout the area,
- procedures and protocols for the implementation of the Memorandum of Understanding for the protection of remnant vegetation on private land in the Agricultural Region of Western Australia, which take account of the high biodiversity conservation values of the area., and
- a framework by which proposals for major land-use change in the area might be considered.

Commenced, not yet completed

14. Circulate the draft report for comment.

15. Prepare the final report.

16. Sign-off

Table 1. Status of scope items in the West Midlands Study, 1 May 2000

Milestone Item No	Item Description	Status	Action
1.	Compile existing botanical survey data	Completed	
2	Compile data on special floristic values	Rare, threatened & priority species data compiled, yet to be completely databased, Data on species with special distributions compiled, yet to be completely databased. Linework for TEC not yet available.	))Action #1)CALM & DEP) Action #2 CALM & DEP
3	Compile fauna data	Vertebrate data obtained, yet to be databased. Additional data from Bamford to be obtained. Invertebrate data (Buprestids, Camaeinids, ?Arachnids) yet to be obtained and databased.	Action #3 DEP, CALM Action #4 CALM & DEP
4	Compile spatial data sets	Available data sets obtained (to work on Land for Wildlife data capture when time permits). (Residual problems with loading Microstation files yet to be resolved)	Action #5 DEP, AgWA & CALM
5	Compile data on threats	Data on *Phytophthora* compiled, to be passed on to DEP. Other data sets with DEP. A data set on potential hydrological/ salinity risks in preparation.	Action #6 DEP (minor CALM, AgWA)
6	Botanical field work	Completed	
7	Analyse complete floristic data set to identify floristic communities and define bioregional units	Completed (minor fine-tuning of bioregional units)	(CALM)
8	Check bioregional units against	Not yet commenced	CALM & DEP

	other data sets		
9	Field validate the proposed bioregional units	Not yet commenced	CALM (some EAG)
10	Finalise bioregional units	Not yet done	CALM, EAG, some DEP involvement
11	Do comprehensive spatial analysis	Not yet commenced	CALM, DEP
12	Define option(s) for nature conservation	Not yet commenced	CALM, DEP
13	Prepare draft final Report	Commenced	CALM, DEP
14	Circulate draft final Report		CALM, DEP
15	Prepare Final Report		CALM, DEP
16	Sign-off		

Action items overdue as at 1 May 2000

1. Complete capture of threatened, rare and priority flora (DEP from maps). CALM to pass to DEP additional data on rare and priority species derived from study quadrats. CALM to pass to DEP the database of records of local endemic plant species, and species with significant range extensions or limits within study area. DEP to complete database.
2. CALM to provide data on TEC to DEP. DEP to database.
3. CALM to pass to DEP the database vertebrate fauna records. DEP to complete database. CALM to liaise with Dr Mike Bamford to obtain additional records (as time permits).
4. CALM to compile distribution and habitat data on selected invertebrate groups eg Buprestids, Camaenids, and Arachnids (as time permits). DEP to database (as time permits).
5. Complete databasing of listed spatial data sets. Action DEP with some assistance from AgWA and CALM. (CALM to arrange digital capture of Land for Wildlife data, and to organise permission to use data through individual landowners).
6. Complete spatial database of threats. CALM to pass to DEP *Phytophthora* data set. AgWA to provide up-to-date data on NOIs, approvals to clear etc. A data set on potential threats from rising groundwater +/- salinity is in preparation at AgWA. DEP to database these and all outstanding data sets.
7. Check bioregional units against other biological distribution data to ensure that units are reliable surrogates for the biota as a whole. Action CALM, DEP, (EAG)
8. Prepare draft report. Action CALM, DEP (EAG)

Attachment 2

West Midlands Study

Identifying Vegetation Sub-Systems in the West Midlands Study Area

Vegetation Sub-Systems are the largest-scale map unit that can be identified and mapped throughout the Study Area within the practical constraints of the Study. They are a sub-division of the Vegetation Systems already defined for the area by Beard (1976a,b, 1979a,b). Beard (1969) defined a Vegetation System as an area or group of areas throughout which there is a reoccurring pattern of vegetation types that may be associated with patterns of topography and or soils (ie catenas).

Some perspective on the Vegetation Systems identified in the present study area by J S Beard, the Sub-Systems identified in the present study, Beard's vegetation mapping, and the complexity of the patterns of plants distributions in the West Midlands study area can be seen in the following example. Within the West Midlands study area, some of the Vegetation Systems mapped by Beard contain only one or two vegetation mapping units. For example, almost 90% by area of the Tathra System is a fine-scale mosaic unit such as heath and scrub-heath mosaic on lateritic sandplain – *Dryandra* and blackboys on laterite and *Hakea obliqua* on sand. The remainder of the system is some very small patches of eucalypt woodland and small patches of heath on laterite. The present study defines five Sub-Systems within the Tathra System.

The process of identifying and mapping the Vegetation Sub-Systems had the following steps:

1. Identify floristic communities using numerical analysis techniques on data on floristic composition within all the quadrats sampled.
2. Identify groupings of floristic communities or sets of communities based on coincidence of geographic distribution of floristic communities.
3. Map distribution of the individual sets.
4. Develop a map based on all the known sets of communities and which separates geographic areas where only one set occurs from areas where sets overlap, identifying each separate area as a Sub-System.

The rationale for this approach is based on the observation that floristic groups representing different parts of the landscape tend to be grouped geographically (eg Beard, JS. 1969. Griffin, EA. 1994). In other words, floristic groups associated with different parts of the landscape within a Sub-System tend to have a closer affinity with each other than they do with floristic groups associated with the same landscape unit throughout the study area. There are identifiable geographic patterns of species that may be associated with physical environmental factors such as soils and landforms +/- climate – a correlation that is yet to be tested.
The following is an example of one of the Vegetation Sub-Systems - Vegetation Sub-System 5 (VS5) which has been determined by the combination of geographic patterning and relationship with mapped vegetation patterns and soil landscapes.

Geographic Patterning

Different floristic communities that have a strongly coincident geographic distribution (or a subset of that distribution) have been combined to form Floristic Communities Sets. In this case, Floristic Communities Set9 includes 13 Floristic Communities (at the 500 group level in the numerical

analyses) which include a total of 78 quadrats. These Floristic Communities include vegetation types recognised in general as *Banksia attenuata* woodlands, heaths on sandy plains, heaths on heavy soils or pediment slopes and shrublands on non-saline wet soils.

Figure 8 shows the distribution of Floristic Communities Set 5 (in olive dots) together with Set 6 (light blue dots), Set 23 (magenta dots), Set 24 (purple dots), Set 10 (terracotta dots), Set 17 (green dots), Set 12 (olive dots in the south). Floristic Communities Set 5 could be enclosed within a boundary that excluded the majority of these adjacent Floristic Communities Sets (this version of the linework includes 13 quadrats from Set 17 (green dots); however, it would be possible to develop linework that does exclude those quadrats).

Relationship with mapped vegetation patterns and soil landscapes.

Figure 8 shows the polygon enclosing Floristic Communities Set 9 with the vegetation mapping linework from JS Beard's 1:250,000 in the background. The northern portion of the Floristic Communities Set polygon occupies almost all of a vegetation mapping polygon labelled scrub heath x_5SZc (≡ Beard's Erindoon System). The southern portion of the Floristic Communities Set polygon crosses over a straight line which represents a transition (labelled No Precise Boundary) into a vegetation mapping polygon labelled heath and scrub heath mosaic on lateritic sandplain dZc/ hSZc (≡ the north western part of Beard's Le Seur System).

Figure 9 shows the polygon enclosing Floristic Communities Set 9 overlaid on the soil landscape systems mapping. The northern portion of the Floristic Communities Set polygon overlaps two soil landscape systems: 221Cy (dark grey = Correy System) and 221En (light brown = Eneabba Plain System). In the south, the Floristic Communities Set polygon occupies in the main a portion of soil landscape system 224Ye (dark green = Yerramullah System).

These figures are indicative of the relationships of the Floristic Communities Set polygon with the mapped vegetation and soil landscapes. There is also an implied inter-relationship between these two data sets. These relationships will be explored further in the course of the West Midlands Study.

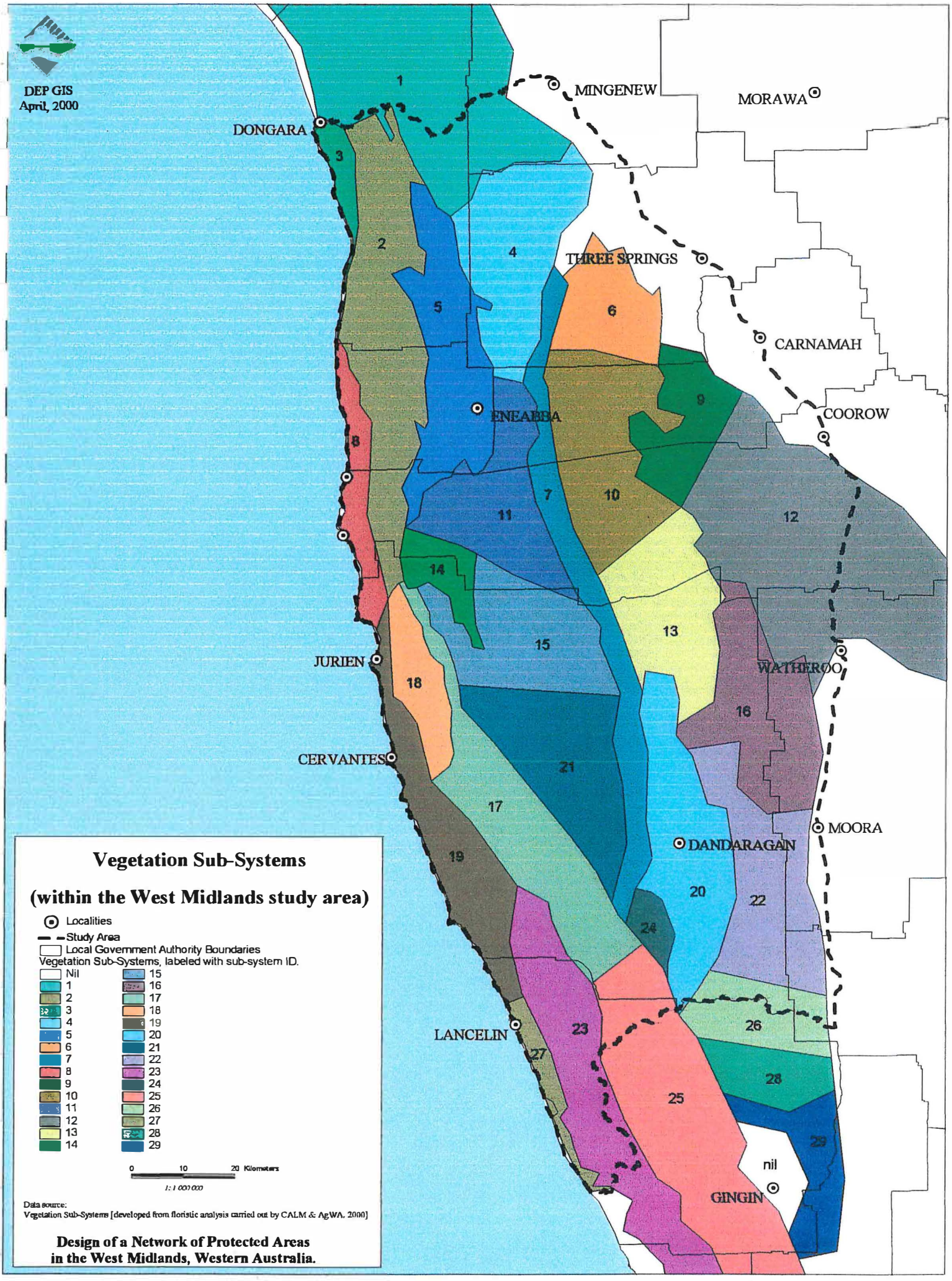
Development of the Vegetation Sub-Systems map.

The Vegetation Sub-Systems map shown as Figure 1 attaching to the main report, has been developed through the process of mapping the 38 individual Floristic Communities (described above), and then mapping them all simultaneously. This has allowed us to identify geographic areas where only one set occurs as well as areas where sets overlap. These separate areas provide the basis for defining the Vegetation Sub-Systems.

Some work remains to be done to refine the Vegetation Sub-Systems shown on Figure 1 and this is in progress.

Attachment 2. Table 1. Floristic Communities that are combined into Floristic Communities Set 9 and that ultimately contribute to Vegetation Sub-System 5.

Floristic community Gp500 designation	Vegetation type	Landform	Soil Surface Colour	Soil surface texture	Subsurface soil colour	Subsurface soil texture	Number of occurrences in VS5
1	Sand heath	flat	pale grey	sand	yellow to pale yellow	sand	3
2	Sand heath	plain	orange	Sand or loamy sand	red	Loamy gravel or gravel	2
3	Sand heath	plain	cream or grey	sand	yellow	sand	2
4	Sand heath	valley flat	grey	sand	-	clay	1
5	*Banksia attenuata* woodland	pediments	Grey	Sand	?yellow	yellow sand	2
6	Medium - Heavy soils heaths	Plain	Grey	Sand	(yellow-brown)	lateritic gravel	1
7	Sand heath	depression	pale yellow	sand	grey	loamy sand	1
57	Non saline wet shrublands	open depression	grey	sand			1
296	Sand heath	dune slope or plain or valley flat	pale grey or pale yellow	sand	pale yellow or yellow	sand or gravel	15
297	Banksia attenuata woodland	dune crest or plain	grey or pale yellow	sand	pale yellow or yellow	Sand or occasionally gravel	11
299	Sand heath	dune crest or plain	grey or yellow or pale yellow	sand	yellow	Sand or sandy loam	6
379	Banksia attenuata or Sand heath	plain	grey	sand	yellow	sand	4
418	Sand heath	valley flat	grey	sand	yellow	loamy sand or gravelly sandy clay or gravel	6


DEP GIS
April, 2000
DONGARA
MINGENEW
MORAWA
THREE SPRINGS
CARNAMAH
ENEABBA
COOROW
JURIEN
WATHEROO
CERVANTES
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LANCELIN
GINGIN
nil
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27
28
29
Vegetation Sub-Systems
(within the West Midlands study area)
Localities
Study Area
Local Government Authority Boundaries
Vegetation Sub-Systems, labeled with sub-system ID.
Nil
0 10 20 Kilometers
1: 1 000 000
Data source:
Vegetation Sub-Systems [developed from floristic analysis carried out by CALM & AgWA, 2000]
Design of a Network of Protected Areas
in the West Midlands, Western Australia.

(F)

Figure 1

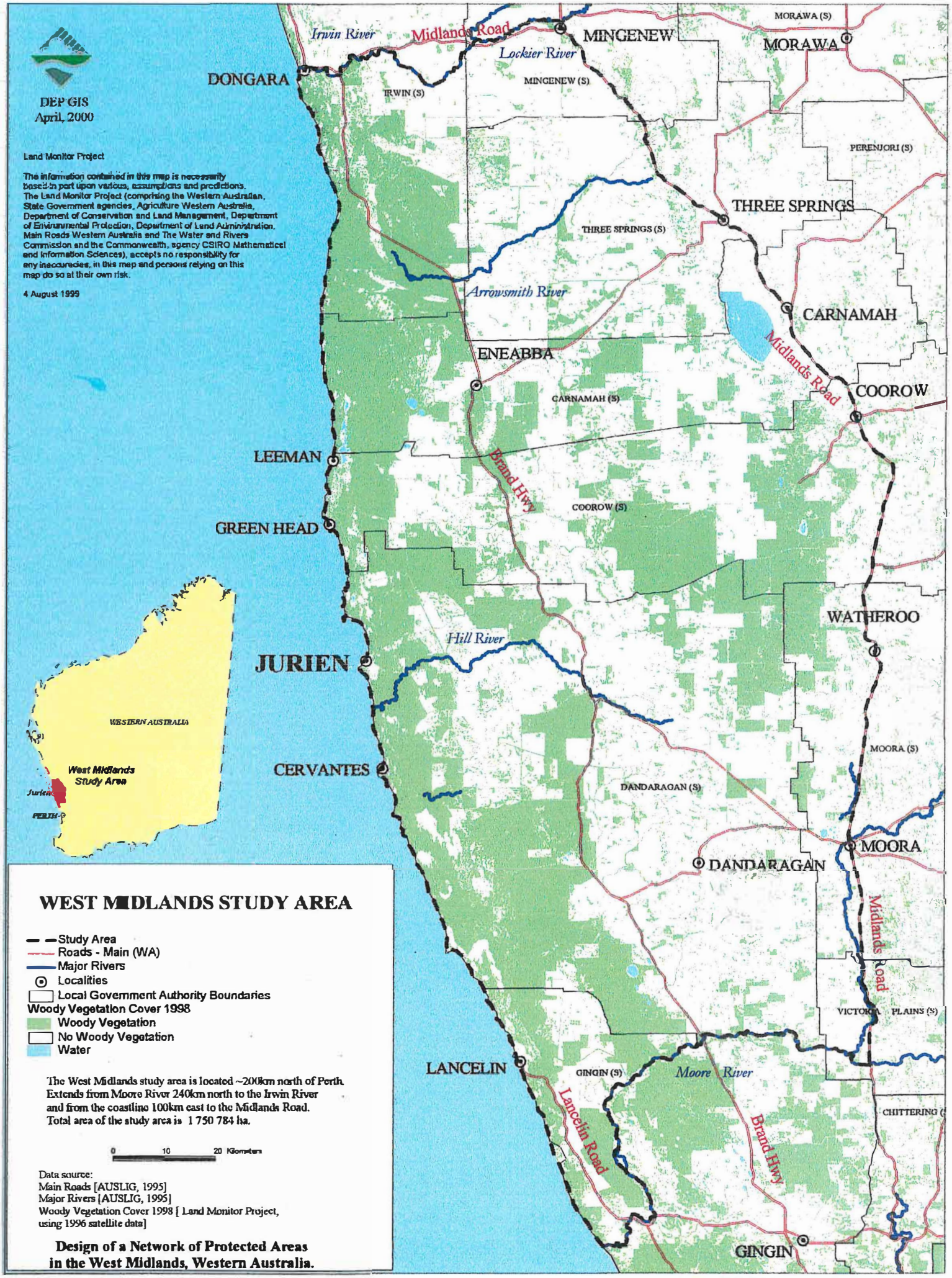

DEP GIS
April, 2000
Land Monitor Project
The information contained in this map is necessarily based in part upon various, assumptions and predictions. The Land Monitor Project (comprising the Western Australian, State Government agencies, Agriculture Western Australia, Department of Conservation and Land Management, Department of Environmental Protection, Department of Land Administration, Main Roads Western Australia and The Water and Rivers Commission and the Commonwealth, agency CSIRO Mathematical and Information Sciences), accepts no responsibility for any inaccuracies, in this map and persons relying on this map do so at their own risk.
4 August 1999
Irwin River
Midlands Road
Lockier River
MINGENEW
MORAWA (S)
MORAWA
DONGARA
IRWIN (S)
MINGENEW (S)
PERENJORI (S)
THREE SPRINGS
THREE SPRINGS (S)
Arrowsmith River
CARNAMAH
ENEABBA
Midlands Road
COOROW
CARNAMAH (S)
LEEMAN
Brand Hwy
COOROW (S)
GREEN HEAD
WATHEROO
Hill River
JURIEN
WESTERN AUSTRALIA
West Midlands Study Area
Jurien
PERTH
CERVANTES
MOORA (S)
DANDARAGAN (S)
MOORA
DANDARAGAN
Midlands Road
VICTORIA PLAINS (S)
LANCELIN
GINGIN (S)
Moore River
Lancelin Road
Brand Hwy
CHITTERING
GINGIN
WEST MIDLANDS STUDY AREA
Study Area
Roads - Main (WA)
Major Rivers
Localities
Local Government Authority Boundaries
Woody Vegetation Cover 1998
Woody Vegetation
No Woody Vegetation
Water
The West Midlands study area is located ~200km north of Perth. Extends from Moore River 240km north to the Irwin River and from the coastline 100km east to the Midlands Road. Total area of the study area is 1 750 784 ha.
0 10 20 Kilometers
Data source:
Main Roads [AUSLIG, 1995]
Major Rivers [AUSLIG, 1995]
Woody Vegetation Cover 1998 [Land Monitor Project, using 1996 satellite data]
Design of a Network of Protected Areas in the West Midlands, Western Australia.

Figure 2

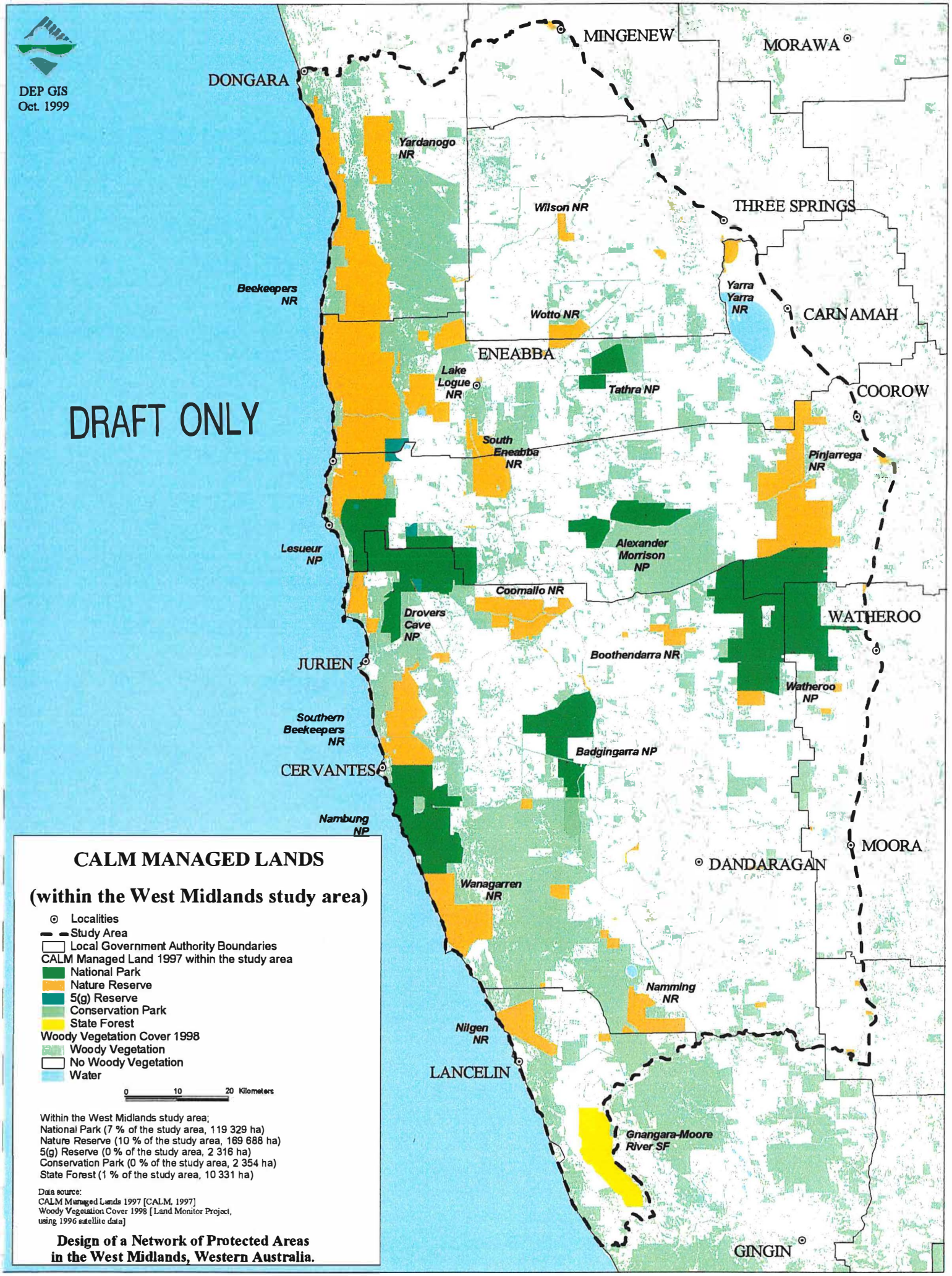
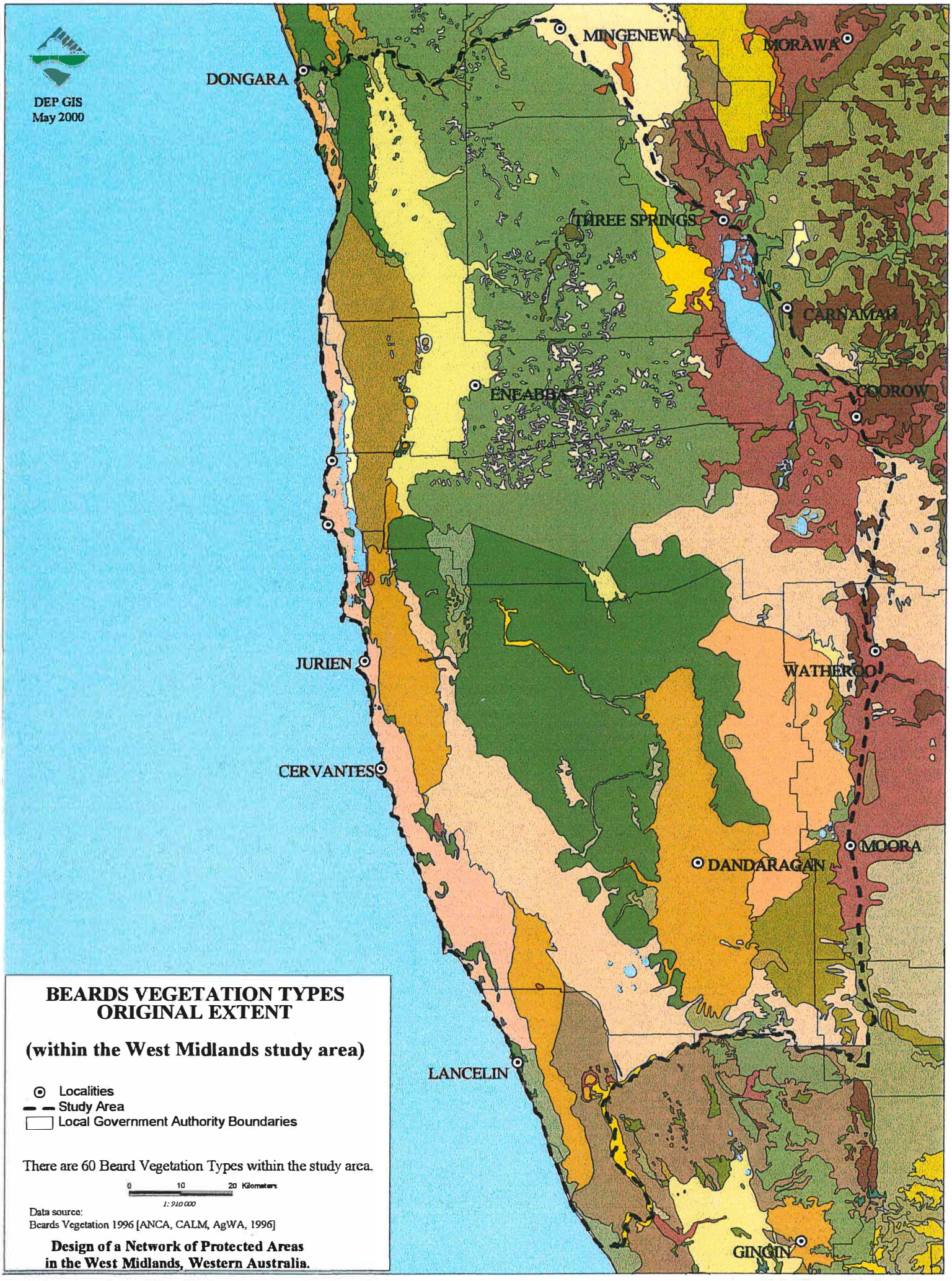

DEP GIS
Oct. 1999
DRAFT ONLY
DONGARA
MINGENEW
MORAWA
THREE SPRINGS
CARNAMAH
COOROW
ENEABBA
WATHEROO
JURIEN
CERVANTES
DANDARAGAN
MOORA
LANCELIN
GINGIN
Yardanogo NR
Wilson NR
Beekeepers NR
Yarra Yarra NR
Wotto NR
Lake Logue NR
Tathra NP
South Eneabba NR
Pinjarrega NR
Lesueur NP
Alexander Morrison NP
Coomallo NR
Drovers Cave NP
Boothendarra NR
Watheroo NP
Southern Beekeepers NR
Badgingarra NP
Nambung NP
Wanagarren NR
Namming NR
Nilgen NR
Gnangara-Moore River SF
CALM MANAGED LANDS
(within the West Midlands study area)
Localities
Study Area
Local Government Authority Boundaries
CALM Managed Land 1997 within the study area
National Park
Nature Reserve
5(g) Reserve
Conservation Park
State Forest
Woody Vegetation Cover 1998
Woody Vegetation
No Woody Vegetation
Water
0 10 20 Kilometers
Within the West Midlands study area;
National Park (7 % of the study area, 119 329 ha)
Nature Reserve (10 % of the study area, 169 688 ha)
5(g) Reserve (0 % of the study area, 2 316 ha)
Conservation Park (0 % of the study area, 2 354 ha)
State Forest (1 % of the study area, 10 331 ha)
Data source:
CALM Managed Lands 1997 [CALM, 1997]
Woody Vegetation Cover 1998 [Land Monitor Project, using 1996 satellite data]
Design of a Network of Protected Areas in the West Midlands, Western Australia.

Figure 3


DEP GIS
May 2000
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MINGENEW
MORAWA
THREE SPRINGS
CARNAMAH
ENEABBA
COOROW
JURIEN
WATHEROO
CERVANTES
MOORA
DANDARAGAN
LANCELIN
GINGIN
BEARDS VEGETATION TYPES
ORIGINAL EXTENT
(within the West Midlands study area)
Localities
Study Area
Local Government Authority Boundaries
There are 60 Beard Vegetation Types within the study area.
0 10 20 Kilometers
1: 910 000
Data source:
Beards Vegetation 1996 [ANCA, CALM, AgWA, 1996]
Design of a Network of Protected Areas
in the West Midlands, Western Australia.

Figure 4

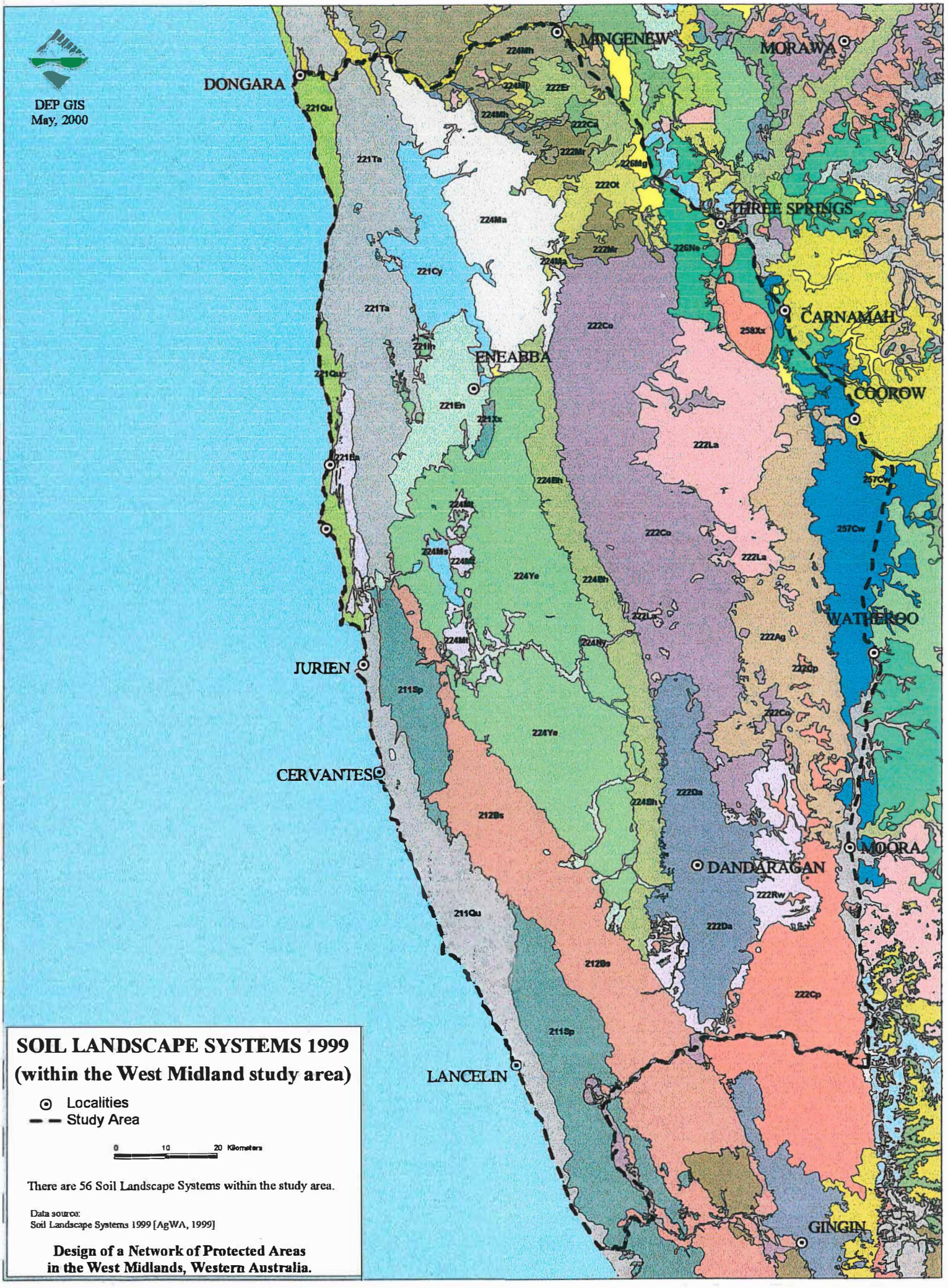
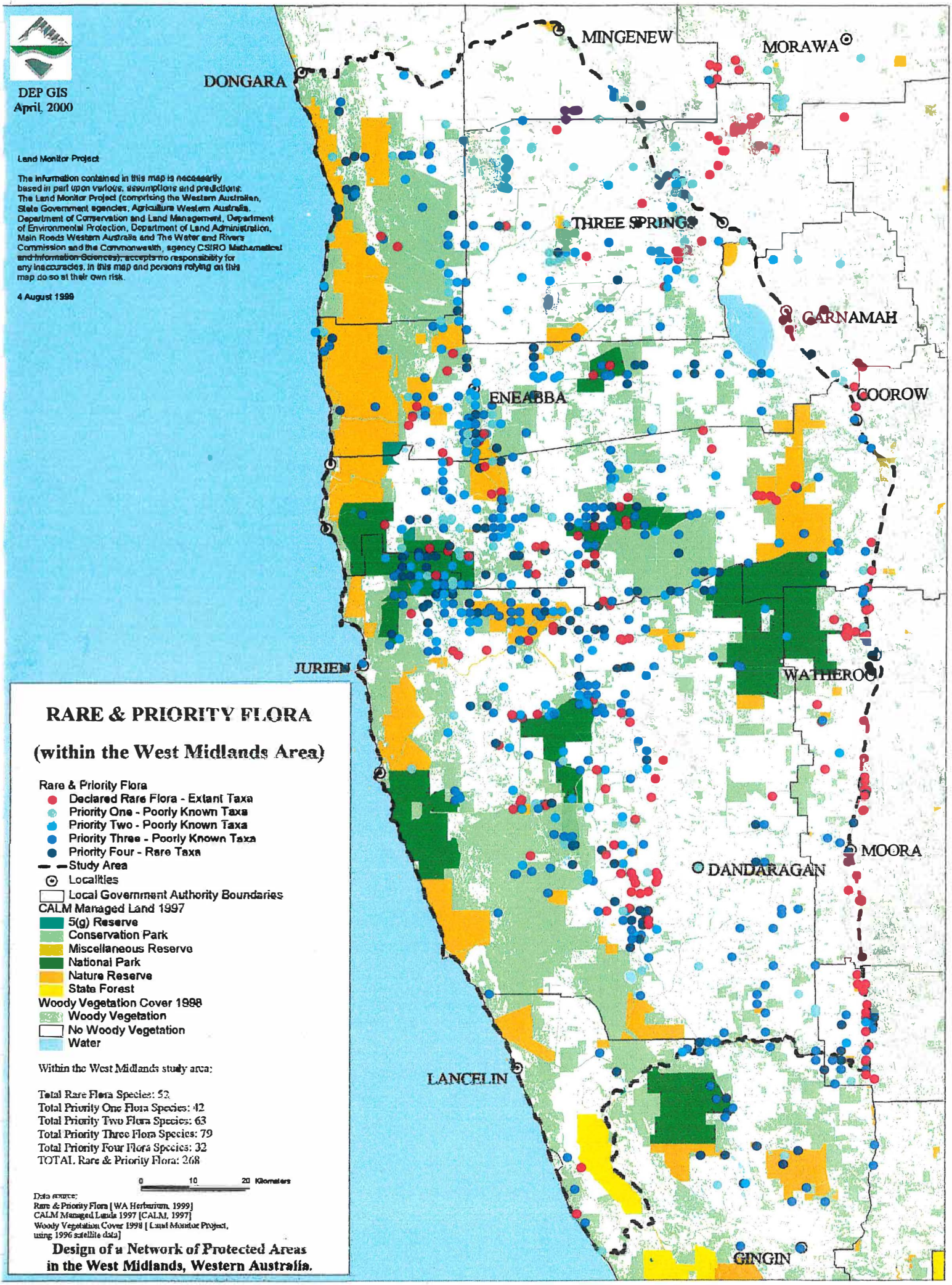

DEP GIS
May, 2000
DONGARA
MINGENEW
MORAWA
THREE SPRINGS
CARNAMAH
ENEABBA
COOROW
WATHEROO
JURIEN
CERVANTES
MOORA
DANDARAGAN
GINGIN
LANCELIN
SOIL LANDSCAPE SYSTEMS 1999
(within the West Midland study area)
Localities
Study Area
0 10 20 Kilometers
There are 56 Soil Landscape Systems within the study area.
Data source:
Soil Landscape Systems 1999 [AgWA, 1999]
Design of a Network of Protected Areas
in the West Midlands, Western Australia.

Figure 5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4 August 1999
DONGARA
MINGENEW
MORAWA
THREE SPRINGS
CARNAMAH
ENEABBA
COOROW
JURIEN
WATHEROO
MOORA
DANDARAGAN
LANCELIN
GINGIN
RARE & PRIORITY FLORA
(within the West Midlands Area)
Rare & Priority Flora
Declared Rare Flora - Extant Taxa
Priority One - Poorly Known Taxa
Priority Two - Poorly Known Taxa
Priority Three - Poorly Known Taxa
Priority Four - Rare Taxa
Study Area
Localities
Local Government Authority Boundaries
CALM Managed Land 1997
5(g) Reserve
Conservation Park
Miscellaneous Reserve
National Park
Nature Reserve
State Forest
Woody Vegetation Cover 1998
Woody Vegetation
No Woody Vegetation
Water
Within the West Midlands study area:
Total Rare Flora Species: 52
Total Priority One Flora Species: 42
Total Priority Two Flora Species: 63
Total Priority Three Flora Species: 79
Total Priority Four Flora Species: 32
TOTAL Rare & Priority Flora: 268
0 10 20 Kilometers
Data source:
Rare & Priority Flora [WA Herbarium, 1999]
CALM Managed Lands 1997 [CALM, 1997]
Woody Vegetation Cover 1998 [Land Monitor Project, using 1996 satellite data]
Design of a Network of Protected Areas in the West Midlands, Western Australia.

Figure 6

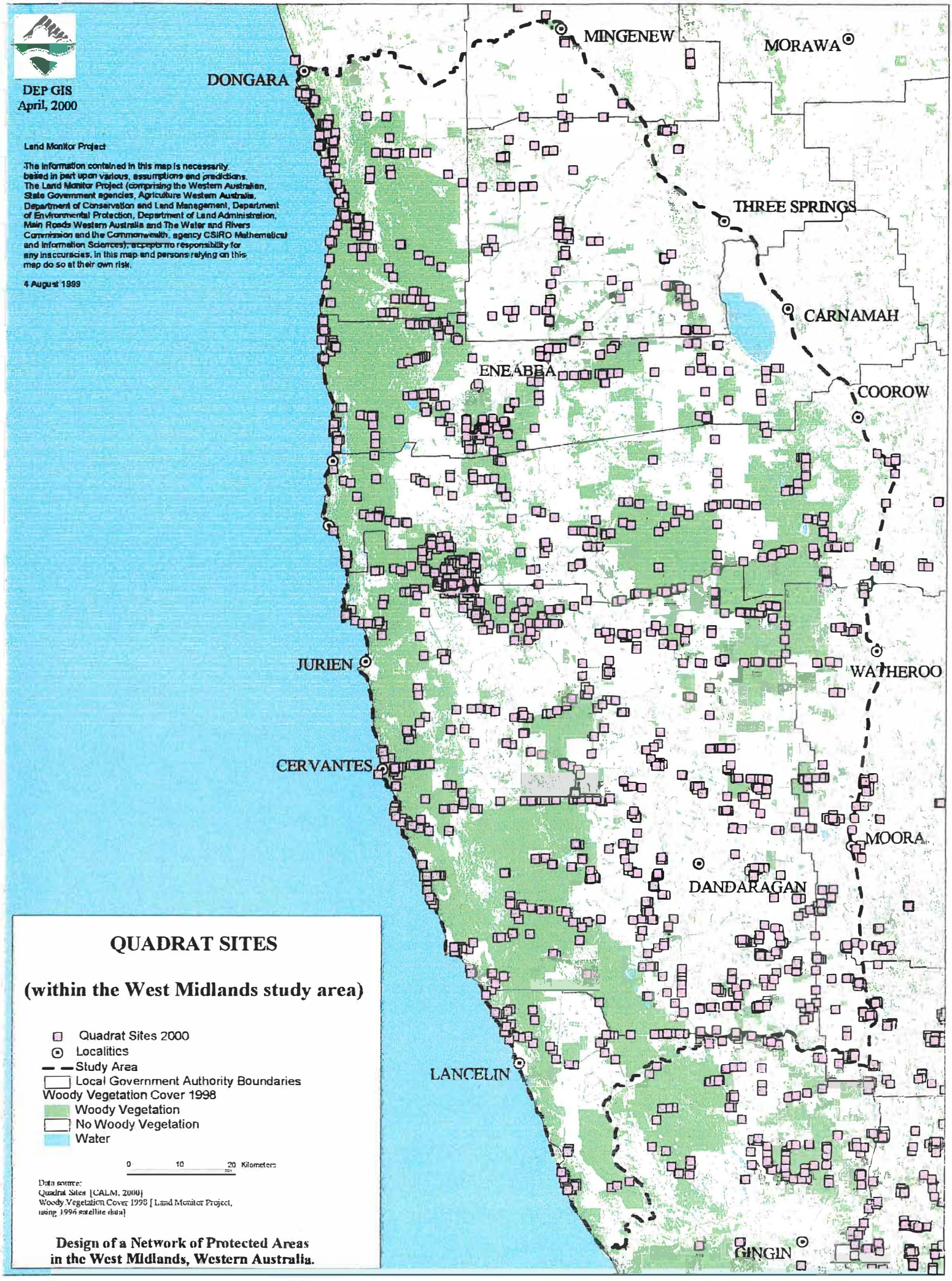

DEP GIS
April, 2000
Land Monitor Project
The information contained in this map is necessarily based in part upon various, assumptions and predictions. The Land Monitor Project (comprising the Western Australian, State Government agencies, Agriculture Western Australia, Department of Conservation and Land Management, Department of Environmental Protection, Department of Land Administration, Main Roads Western Australia and The Water and Rivers Commission and the Commonwealth, agency CSIRO Mathematical and Information Sciences), accepts no responsibility for any inaccuracies in this map and persons relying on this map do so at their own risk.
4 August 1999
DONGARA
MINGENEW
MORAWA
THREE SPRINGS
CARNAMAH
ENEABBA
COOROW
JURIEN
WATHEROO
CERVANTES
MOORA
DANDARAGAN
LANCELIN
GINGIN
QUADRAT SITES
(within the West Midlands study area)
Quadrat Sites 2000
Localities
Study Area
Local Government Authority Boundaries
Woody Vegetation Cover 1998
Woody Vegetation
No Woody Vegetation
Water
0 10 20 Kilometers
Data source:
Quadrat Sites [CALM, 2000]
Woody Vegetation Cover 1998 [Land Monitor Project, using 1996 satellite data]
Design of a Network of Protected Areas
in the West Midlands, Western Australia.

Figure 7

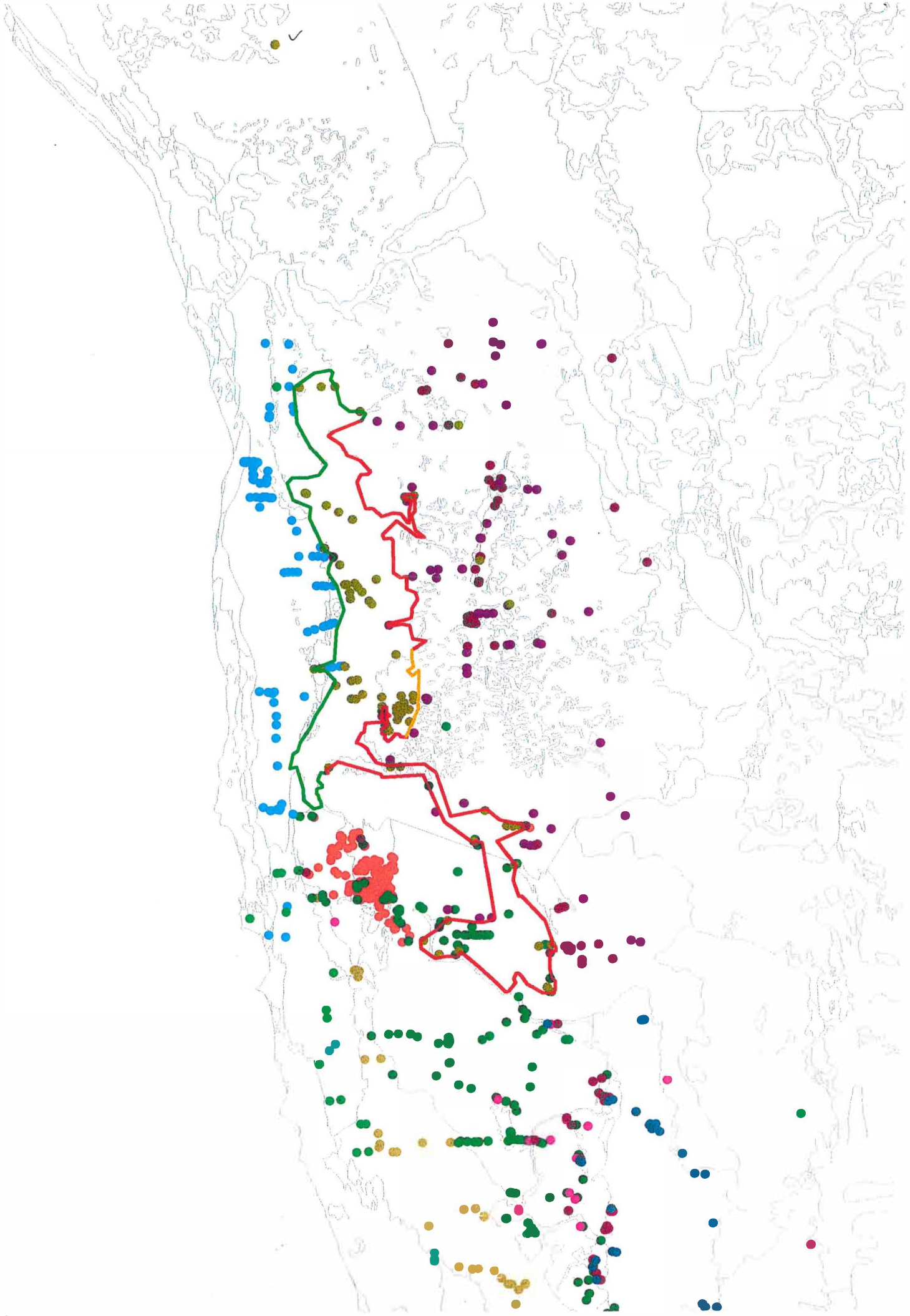
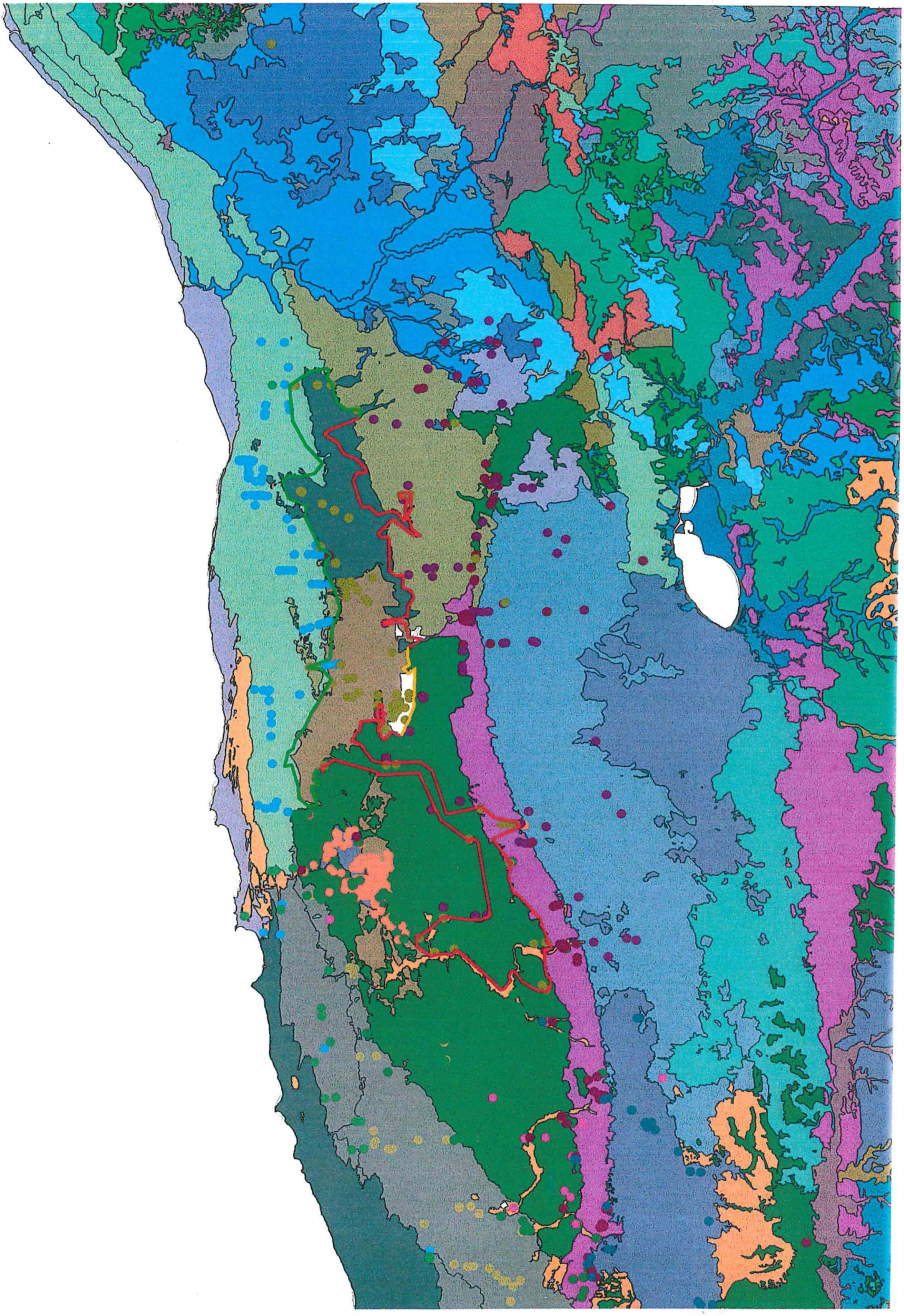


Figure 8



Set 9

Figure 9