



Milestone Report 1.2 The existing components and administrative arrangements of the Western Australian vegetation information system.

Components of the current state vegetation information system – pre-European vegetation, vegetation extent and archived site data.

The current vegetation information system in Western Australia consists of 3 components:

A database and GIS-based digital dataset for pre-European vegetation in Western Australia. This is the outcome of work begun in 1986 to capture and improve mapping originally carried-out by J.S. Beard to develop an inventory of plant communities throughout the State.

This mapping attempted to depict the vegetation as it might have been at the time of settlement, prior to the extensive clearing for urban development and agriculture and the changes induced by pastoralism, depopulation of Aboriginal people and so on (ie. it represents pre-European vegetation type and extent).

Most of the map data are based on the work of J.S. Beard in the Vegetation Survey of Western Australia (1964-81) - 7 1:1,000,000 scale maps of the vegetation of the State, 24 1:250,000 maps for the south west part of the State between Shark Bay and Esperance; together with a number of additional publications (see Beard *et al.* in press (a) for a comprehensive bibliography).

Beard did not produce 1:250,000 scale maps of the extreme southwest corner of the State; rather, these three map sheets were produced by F.G. Smith, but based on a different mapping protocol. This gap has been filled (Hopkins *et al.* in press) so there is a complete, consistent coverage of vegetation mapping for the State.

The vegetation associations in the database have been agglomerated in a systematic way to give more general units suitable for mapping at smaller scales - see Figure 1.

30,186 polygons are incorporated into the graphics database. There is a greater level of detail and discrimination in the Intensive Land-use Zone. Despite this variation, we treat all the vegetation units as equivalent within the classification hierarchy: they are all attributed as associations.

These polygons are each attributed to one of the 831 vegetation associations that are in the vegetation database. The vegetation associations include 698 vegetation Types of which 46 occur only as components of mosaics, 120 mosaics or combinations of individual Types and 5 unvegetated Types.

The basic Types can be amalgamated into 199 Groups (197 vegetation Groups, 1 unvegetated Group, 1 Group of mosaics) which can, in turn, be amalgamated into the 50 Supergroups (48 Vegetation Supergroups, 1 Unvegetated Supergroup, 1 Mosaic Supergroup) used for producing a 1:3,000,000 scale map.

A flexible coding system that reflects the relationship between all the basic vegetation Types in the hierarchical classification has been used. The coding system uses the physiognomic classification lettering system developed by Beard with life form/height class represented by upper case letters (T-Tall tree, M-Medium tree, L- Low tree, S-Shrubland, Z-Dwarf shrub, H-Hummock grassland, C-Succulent Steppe, G-Grass). Cover or density are represented by lower case letters (d-dense, c-complete cover, i-incomplete cover, r-rare or open cover, p-patchy cover, b-practically bare). Where there are two or more structural layers the ecologically dominant layer is given first. If the layers are of the same density then the tallest layer is first. Where two layers differ considerably in density then the more open layer is given as a lower case eg eMr aSi becomes Sm, eLr aSr tHi becomes Hls. Potential for confusion with C being a structural layer and c a cover symbol is limited as C only occurs as Ci when with other layers, except for Sb Cr which is given the code Cr. The pindan shrublands, a three strata unit, is denoted as P and mangroves as A. The four groups of Kimberley grasses are prefixed by K or k to alleviate problems with transferring bold and italic lettering during the analysis (KG for Beards Gc - high grasses, kG for Gc - tall grasses, Kg for gc - short grasses and kg for Gc - curly spinifex. Mosaics are shown as component vegetation Types separated by a slash. Mosaics represent units where two distinct associations occur in complex spatial patterns. Eg dune and swale complexes.

The data are stored in a group of database tables described in Figure 2.

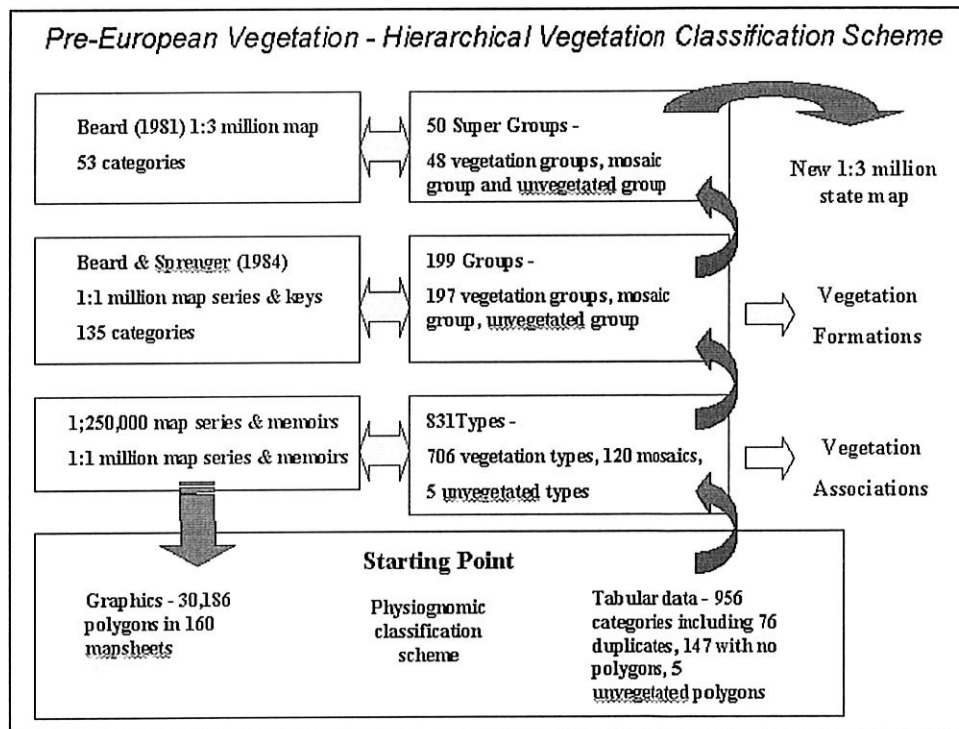


Figure 1. The hierarchical vegetation classification scheme used to describe pre-European vegetation in Western Australia.

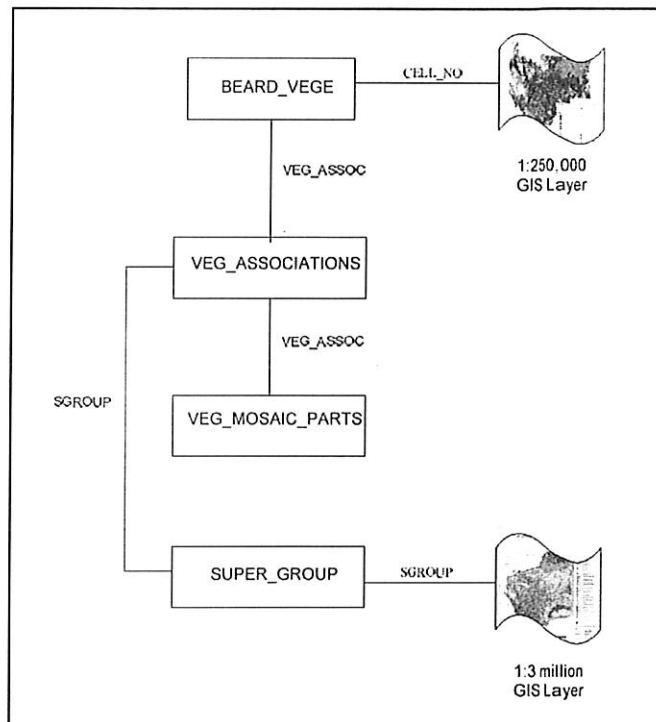


Figure 2. Detailed schematic of the current structure of the pre-European database.

During the National Land & Water Resources Audit (NLWRA) project the pre-European database was modified to remove a number of inconsistencies in the original mapping between 1:250,000 scale map sheets. Some detail was also added for particular vegetation types where new information is available. Finally, additional attributes have been compiled to the nationally - agreed National Vegetation Information System (NVIS) standards (Beeston *et al.* 2001).

The second component of the vegetation information system was originally based on the first inventory of the extent of remaining vegetation in the heavily - cleared agricultural region of south - western Australia. This inventory was compiled at the Department of Agriculture, Western Australia (DAWA) predominantly from hard-copy airphotos acquired during the 1980s (Beeston *et al.* 1994).

In 1996 the Commonwealth coordinated State agencies through the Bureau of Rural Sciences in the Australian Land Cover Change (ALCC) project (Barson *et al.* 2000). This project used Landsat TM satellite imagery to study gross change in vegetation cover in the intensive agricultural regions of Australia between 1990 and 1995. The opportunity was taken during this project to produce vegetation cover mapping current to 1995/1996.

The resolution of the Landsat TM - derived data set is less than that of the previous work undertaken using airphotos, and there was a problem with the misclassification of vegetation types that do not have a substantial tree cover eg. open woodlands and the many shrubland and heath vegetation types that are widespread in south western Australia.

The opportunity was taken in during the National Land and Water Resources Audit to substantially enhance and up-date present vegetation extent data set using up-to-date aerial photography (Shepherd *et al.* 2001).

There are vegetation extent 470,633 polygons are incorporated into the graphics database. Polygons range in size from 0.0005 ha to 228,000 ha. The extent dataset contains few attributes - a unique identifier, area, and 1:100,000 mapsheet number.

The extent dataset has been intersected with the pre-European vegetation dataset to produce an extent-by-type dataset. It is important to note the difference in scales and reliability between the pre-European vegetation mapping (type and extent) and the present mapping (extent only) - the type and extent mapping should be used at scales no finer than that of the pre-European mapping, 1:250,000.

It should also be noted that attribution of vegetation types – the description of vegetation structure and floristic composition - is based on vegetation in a pristine or undisturbed state. In much of the ILZ and a large proportion of the ELZ vegetation has been significantly disturbed through human activities and the vegetation structure and composition altered from the original state.

The third component of the vegetation information system contains data from several surveys of remnant vegetation on privately owned land in the Western Australian wheatbelt conducted for DAWA. There are also data from surveys of public lands in the south - west conducted for DAWA and other government agencies. There are currently 9,594 records for remnant vegetation on private land, and 37,744 records in the public land database.

A detailed schematic diagram describing relationships between the tables in the archived database is presented in Figure 3.

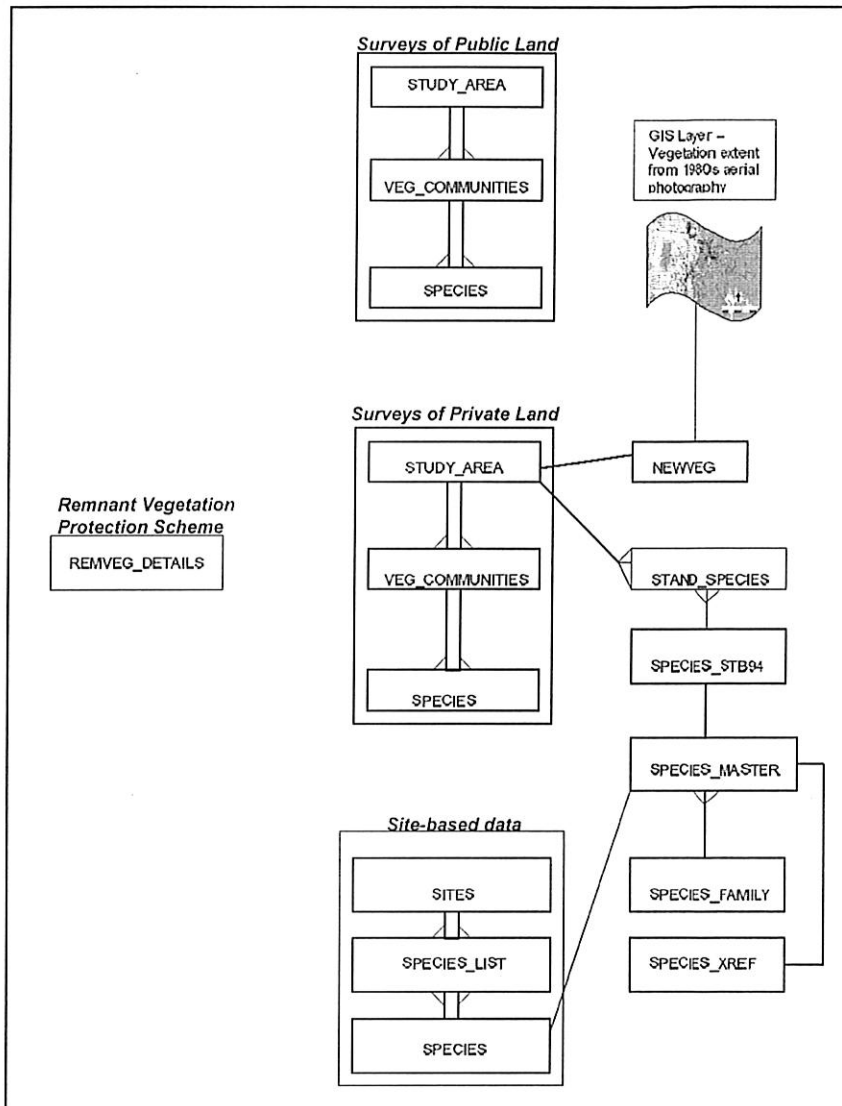


Figure 3. Detailed schematic of the current structure of the Archived Vegetation Database

Data fields have been used inconsistently between surveys in the archived database. Most records include basic information about survey sites (shire, site id, surveyor ... etc.). However, the amount and detail of information on floristic composition and structure, and other environmental parameters varies.

The tables *STUDY_AREA*, *VEG_COMMUNITIES* and *SPECIES* were originally created for the 'Save the Bush' project, see Mollemans (1992) and Griffin (1995 a & b). These tables were created prior to field work for this project. However during field work the method of survey was modified from that originally planned with the result that some fields in these tables were not used. Other data was modified to fit to the existing field parameters.

For convenience, the set of three tables was later duplicated for the Public Lands project (see Shepherd 1995a). Botanical survey data for public lands have been gradually added in another ORACLE account.

Front-end data entry and query screens or forms were designed using SQL*FORMS. One set for entry of data to the public lands database, and another for entry of data from surveys of private remnants, principally for the 'Save the Bush' project.

Several other tables have also been established in the same ORACLE account for various botanical surveys. Data for these surveys were usually loaded directly from DBase 4™ files, without using a form. The tables SITES, SPECIES_LIST, and SPECIES contain data from detailed surveys of sandplain vegetation between Perth and Geraldton. These data have been collected by a number of botanists over several years but have been compiled and analysed by E.A. Griffin (see Griffin 1995).

A further set of tables SPECIES_MASTER, SPECIES_XREF, SPECIES_STB94, and STAND_SPECIES have been more recently added to the database. SPECIES_MASTER identifies each recognised taxa from the State Herbarium. This table is used as a reference for the Sandplains data set and for species lists compiled in the second and third stages of the 'Save the Bush' project (see Griffin 1995 a & b). SPECIES_XREF, SPECIES_STB94, and STAND_SPECIES link and cross - reference survey data to SPECIES_MASTER.

Another table, REMVEG_DETAILS, and form were created for the Remnant Vegetation Protection Scheme in a third account ORACLE account. Records in this table are more consistent. Here, site location and ownership details are combined with botanical survey data.

The table NEWVEG is linked to GIS layer of vegetation extent mapping from 1980s aerial photography. This contains data on the size and gross condition (modification from original state) of each patch of remnant vegetation in the south - west agricultural region. There are 125,592 records in this table.

A summary of survey data currently contained in this component of the database is described in Figure 4. A list of survey codes and the number of records for each is provided in Figure 5.

Survey Name and Author	Coverage	Database Tables
North-eastern Wheatbelt Study True, 1995	Cadoux-Manmanning LCD Cunderdin LCD Kalannie-Goodlands LCD Koorda LCD Mingenew LCD Nungarin LCD Quairading LCD Waddi Forest LCD	STUDY_AREA_NO VEG_COMMUNITES SPECIES
Northern Sandplains Griffin, 1994	Carnamah (part) Coorow (part) Dandaragan Gingin Irwin (part)	SITES_EAG SPECIES_EAG SPECIES_LIST_EAG SPECIES_MASTER SPECIES_XREF
Remnant Mallee Vegetation Survey of the South-eastern Wheatbelt Shepherd, 1995 (b)	Esperance Jerramungup Ravensthorpe	STUDY_AREA_NO VEG_COMMUNITES SPECIES
Save the Bush - Phase 1, 1991 Mollemans, 1992	Broomehill Corrigin Dumbleyung Katanning Kondinin Kulin Narrogin Tambellup Wagin Wickepin Woodanilling	STUDY_AREA_NO VEG_COMMUNITES SPECIES
Save the Bush - Phase 2, 1992 Griffin, 1995 (a)	Beverley Brookton Cranbrook Cuballing Gnowangerup Kent Lake Grace Plantagenet West Arthur Williams	STUDY_AREA_NO VEG_COMMUNITES SPECIES
Save the Bush - Phase 3, 1993 Griffin, 1995 (b)	Albany Augusta-Margaret R. Boddington Boyup Brook Bridgetown- Greenbushes Busselton Capel Collie Dardanup Denmark Donnybrook-Balingup Harvey Manjimup Murray Nannup Wandering Waroona	STUDY_AREA_NO VEG_COMMUNITES SPECIES STAND_SPECIES SPECIES_STB94 SPECIES_MASTER SPECIES_XREF
Remnant Vegetation Protection Scheme	Entire South -west	REM_VEG_DETAILS
Vegetation Profile of Public Land Project	Central Wheatbelt & Great Southern. Part of Northern & Eastern Wheatbelt	STUDY_AREA_NO VEG_COMMUNITES SPECIES

Figure 4. A list of survey data currently archived in the Western Australian Vegetation database.

<i>Code</i>	<i>Number of records</i>	<i>Survey</i>
A	0	Railway reserve
C	592	Closed road
D	2	Drain reserve
F	67	State forest
L	3	Lease hold
M	0	Marine park
MAL95	118	Remnant Mallee Vegetation Survey of the South-eastern Wheatbelt
NEWS	343	North Eastern Wheatbelt Study
O	94	Timber reserve
P	51	Road isolation
PUB/V	37744	Public land remnants
STB91	912	Save the Bush - Phase 1
STB92	3458	Save the Bush - Phase 2
STB93	3979	Save the Bush - Phase 3
T	0	Tramway
W	7	Water feature
U	3	Unknown

Figure 5. Survey codes currently recognised in the archived database and the number of records for each.

Figure 6 summarises the existing components of the current Western Australian information system.

<i>Components of State or Territory vegetation information systems</i>	<i>Method/s used to collect, classify, derive or generate information level /category</i>	<i>Database/s used to collate and store derived data/information</i>
1. Site-based data	Site based data currently stored in the information system consists of data from detailed surveys of sandplain vegetation between Perth and Geraldton. These data have been collected by a number of botanists over several years. These data were collated and analyses by E.A. Griffin (see Griffin 1995). The data include detailed species lists. More detailed information for type mapping (pre - European and present) will be required to reconcile these data with mapped units.	ORACLE RDMS
2. Summary vegetation (polygon or secondary database)	Consists of two components. Vegetation extent mapping - one set captured from 1980s airphotos (Beeston <i>et al.</i> 1994), and another set captured using supervised Landsat TM classification with manual interpretation from digital ortho-rectified airphotos (Shepherd <i>et al.</i> 2001). Pre-European vegetation type and extent mapping (Hopkins <i>et al.</i> in press).	ORACLE RDMS, ORACLE SDO and Geomedia Access data warehouse
3. Lists of vegetation descriptions used (e.g. map legend)	A State - wide definitive list has been compiled from the pre-European vegetation extent and type mapping.	ORACLE RDMS and Access database Look-up table
4. Lists of ecological descriptions used (e.g. map legend)	The broad description used to describe pre-European vegetation units at the Association level includes an ecological description.	ORACLE RDMS and Access database Look-up table
5. Source code used for mapping in GIS	Map units in the pre-European vegetation database are linked to a look-up table of descriptions and NVIS level 1-4 data.	

Figure 6. The components of the Western Australian vegetation information system.

Management and utilization of the current state vegetation information system

The three components of the information system currently exist in separate table spaces and GIS datasets in an ORACLE 8.1.7 relational database and GIS environment. The three components can be linked on an ad-hoc basis to address various information needs. A simplified representation of the vegetation information system is presented in Figure 7.

This information system is shared between the Department of Agriculture, WA and the Department of Conservation and Land Management (CALM) and other state agencies and stakeholders utilise products from this information system.

The two other important vegetation datasets in Western Australia, that are not currently integrated with this information system operationally, are the rare and priority flora database and the Threatened Ecological Community (TEC) database. Both of these databases are maintained CALM. These databases have been assessed against datasets the information system for a number of applications. Examples include enhancement of the definition TECs and identification of likely ranges for rare and priority flora. In both cases the pre-European vegetation component of the information system was used.

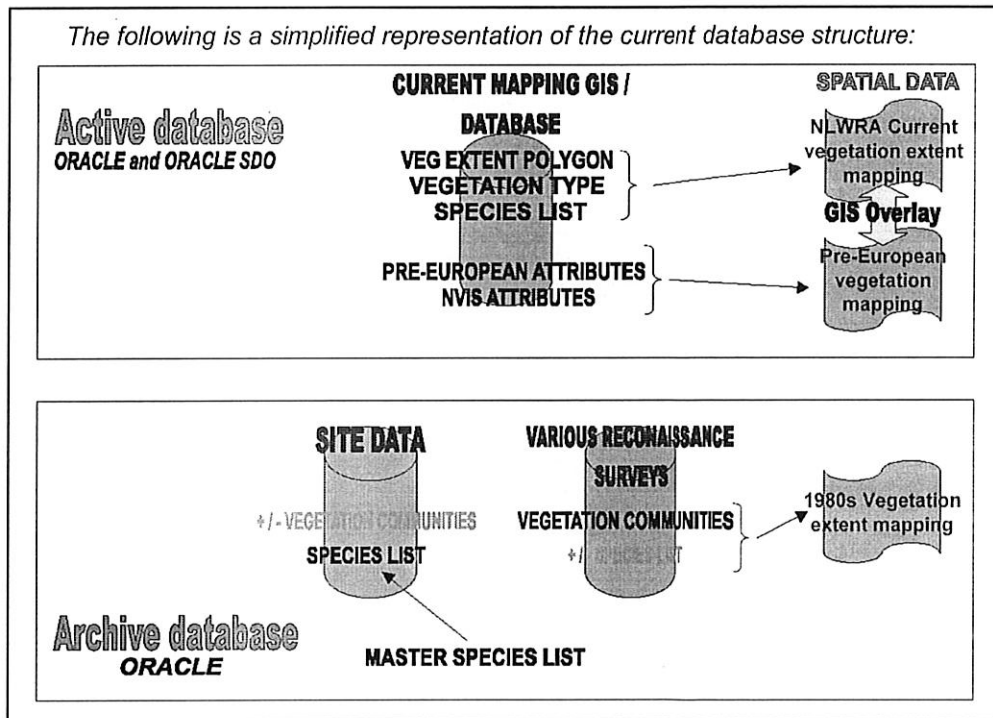


Figure 7. Simplified schematic of the current structure of the Western Australian vegetation information system.

The following are examples of applications of the information system made to-date:

Shire - based Native Vegetation Handbooks: a series of Shire-based Native Vegetation Handbooks that bring together relevant local information including original and existing vegetation, relief, soils, drainage, wetlands, flora and fauna. The publications are written in consultation with the local community and distributed to libraries, schools, community groups, local government and interested individuals.

Natural Resource Atlases: a series of Catchment-based Natural Resource Atlases that bring together a similar range of information as the Handbooks.

A GIS-based Model for the Assessment of the Conservation Value of Remnant Vegetation: this was used in an assessment of the values of native vegetation in the Blackwood Basin in 1999 and currently in the Department of Agriculture's Rapid Catchment Appraisal (RCA) Process.

Assessment of the Conservation Estate using Comprehensive, Adequate and Representative (CAR) criteria: for the state and within regions eg. Gascoyne-Murchison Strategy.

The Bush and Biodiversity study for the South - West Catchments Coordinating Council (SWCC): assessment of the status of vegetation in this region and identification of vegetation of unique and/or threatened values.

Assessment of the status of vegetation for the National Land & Water Resources Audit: assessment of the status of vegetation for the Vegetation and Ecosystem Health Themes of the Audit.

The National Vegetation Information System (NVIS) – Work completed for during the National Land & Water Resources Audit.

State agencies in Western Australia received a working version of the NVIS data entry tool or compiler in October 1999. During November and December 1999 State collaborators compiled NVIS attributes for the pilot project areas from the existing pre-European digital dataset. The populated state data compiler and associated digital spatial datasets were then forwarded to the Bureau of Rural Sciences in January 2000.

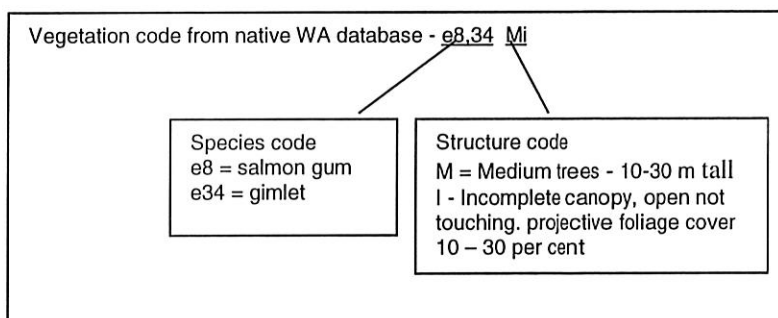
During compilation of data for NVIS we considered the vegetation association from the Western Australian information system to be equivalent to Level 5 – Association – in the NVIS structure. Unfortunately, the floristic data required to describe fully describe these units to NVIS Level 5 does not currently exist in the native Western Australian information system and is time consuming to derive from the source information.

Some detailed information has been compiled over a number of years for the 50 or so units in the 1:3 million-scale map of vegetation for Western Australia. However, we did not consider it practical to compile this level of information for all 833 associations mapped in WA for NVIS Stage 1.

For the purposes of NVIS Stage 1, attributes were compiled to NVIS Level 3 or 4. Consequently there is an information gap in the current attribution of the Western Australian NVIS Stage 1 dataset.

The following is an example:

Map Unit 8 - Medium woodland; salmon gum (*E. salmonophloia*) & gimlet (*E. salubris*)



Information on the structure and composition of each stratum had to be collated from the published memoirs of J.S. Beard. Some unpublished information had also been collated during the development of the native WA vegetation database and was used to derive NVIS Levels 1 to 3 or 4.

The following are NVIS attributes derived from the previous example:

Map Unit 8 - Medium woodland; salmon gum (*E. salmonophloia*) & gimlet (*E. salubris*)

MU_SRC_DESC	Medium woodland; salmon gum (<i>E. salmonophloia</i>) & gimlet (<i>E. salubris</i>)
MU_SRC_COD	e8,34Mi
MU_LVL	Association
MU_SPA_MIX	Pure
MU_NUM_VG	1
MU_CLASS (Level 1)	Tree
MU_STR_FOR (Level 2)	Medium woodland
MU_BFL_FOR (Level 3)	Eucalyptus woodland
MU_SUB_FOR (Level 4)	+ Eucalyptus woodland
MU_ASSOC (Level 5)	U+ <i>Eucalyptus salmonophloia</i> , <i>Eucalyptus salubris</i> Tree/7lo; M <i>Acacia acuminata</i> , <i>Acacia orinacia</i> , <i>Alyxia buxifolia</i> Shrub/4fi G <i>Olearia muelleri</i> , <i>Rhagodia nutans</i> , <i>Scaevola spinoscens</i> Shrub/2fi

NVIS attributes are now maintained as a look-up to the existing database tables in the pre-European component of the state information system. Since NVIS Stage 1 and the work for the Audit NVIS level 5 attributes have been compiled for some units. The majority, however, are still only attributed to NVIS level 3 or 4.

Database redesign and updates planned for the current project

This work builds on that already completed last year through the National Land and Water Resources Audit and NVIS Stage 1. The project will address an important information gap in NVIS (spatial) data sets for Western Australia (pre - European and current extent) identified following the completion of NVIS Stage 1. This is the lack of NVIS levels 4 and 5 attributes and collation of floristic data for map units from which to compile these attributes.

A second issue that will be resolved in the current project are map unit mis - matches across 1:250,000 mapsheet boundaries. These occur mainly where the original mapping was published at different scales (ie. 1:250,00 and 1:1,000,000). This change in published map scale broadly defines the boundary between intensive land-use in the south west of WA and extensive land-use (mainly pastoralism) in the remainder of the State.

A third issue that will be resolved in the current project is poor rectification of the pre - European type mapping in some areas of the State. This occurs mainly on the south - west and north - western coastlines.

The project will also facilitate the future maintenance of NVIS in Western Australia by re-designing the Western Australian database, establishing NVIS attributes as a core component of the Western Australian vegetation information system. The proposed structure of the vegetation information system at the conclusion of the current project is illustrated in Figure 8.

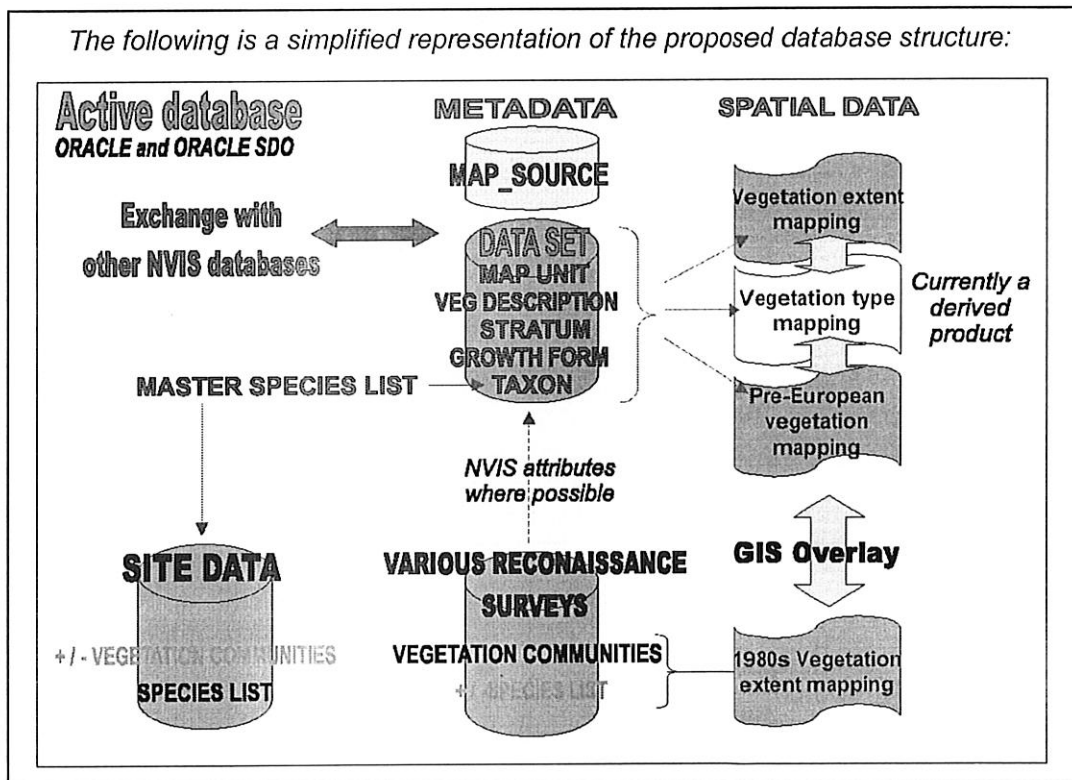


Figure 8. Simplified schematic of the proposed structure of the Western Australian vegetation information system.

References

- Barson, M.M., Randall, L.A. and Bordas, V. (2000) Land Cover Change in Australia. Results of the collaborative Bureau of Rural Sciences – State agencies' Project of Remote Sensing of Land Cover Change. Bureau of Rural Sciences, Canberra.
- Beard, J.S., Beeston, G.R., Harvey, J. and Hopkins, A.J.M. (in press a) The vegetation of Western Australia. 1:3,000,000 Map with Explanatory Memoir. Second Edition. *CALMScience* Special Publication. Department of Conservation and Land Management, Kensington.
- Beecham, B.B., Hopkins, A.J.M., Beeston, G.R. and Lambeck, R.J. (1998) Description of the study area. In K.J. Wallace (editor) Dongolocking Pilot Planning Project for Remnant Vegetation. Final Report (Phase I). Department of Conservation and Land Management, Kensington. Pp 21-33.
- Beeston, G.R., True, D. and Mlodawski, R.G. (1994) An inventory of remnant vegetation in south-western Australia. Resource Management Technical Report. Department of Agriculture WA, South Perth
- Beeston, G.R., Hopkins, A.J.M. and Shepherd, D.P. (eds.) (2001) Land-use and Vegetation, Western Australia. Unpublished Report. Department of Agriculture Western Australia, South Perth and National Land and Water Resources Audit, Canberra.
- Griffin, EAG (1994) *Floristic survey of northern sandplains between Perth & Geraldton.* Unpublished Report to the Heritage Council of WA
- Griffin, EAG (1995 a) *Distribution and ecological significance of on-farm bush remnants in the southern wheatbelt region of Western Australia - Phase 2.* Unpublished Report to the Division of Resource Management, Agriculture WA
- Griffin, EAG (1995 b) *Distribution and ecological significance of on-farm bush remnants in the southern wheatbelt region of Western Australia - Phase 3.* Unpublished Report to the Division of Resource Management, Agriculture WA
- A J M Hopkins, G R Beeston , J M Harvey, H. Lemin and D P Shepherd (2002) A Database on the Vegetation of Western Australia. Stage 1. Resource Management Technical Report 250. (in press). Department of Agriculture WA, South Perth
- Mollemans, F (1992) *Distribution and ecological significance of on-farm bush remnants in the southern wheatbelt region of Western Australia - With a key for assessing the ecological significance of on-farm bush remnants.* Unpublished report to the Resource Management Division, Department of Agriculture, WA
- Shepherd, DP (1995 a) *Vegetation Profile of Public Land Project.* Unpublished report to the Spatial Resource Information Group, Department of Agriculture, WA

- Shepherd, DP (1995 b) *Remnant mallee vegetation survey of the south-eastern wheatbelt.*
Unpublished report to the Department of Agriculture, WA
- Shepherd, D.P., Beeston, G.R. and Hopkins A.J.M. (2001) Native vegetation in Western Australia.
Technical Report 249. Department of Agriculture, Western Australia,
South Perth.
- True, D (1995) *Survey of Remnant Vegetation in the north-eastern wheatbelt.*
Unpublished report to the Department of Agriculture, WA