POORLY CONSERVED AND POTENTIALLY THREATENED VEGETATION TYPES IN THE WESTERN AUSTRALIAN WHEATBELT. I. ASSOCIATIONS

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SUMMARY

This report details the first set of results of a project designed to contribute to the development of an inventory of Threatened Ecological Communities in Western Australia. The project builds on earlier work developing a digital vegetation map database for the State and assessing the levels of representation of each vegetation type in the conservation reserve system. This project focuses on the Western Australian wheatbelt where the native vegetation has been extensively cleared and where, as a consequence of the clearing, there are problems of rising groundwater and the related problem of salinisation. The project draws on data sets of native vegetation extent and soils low in the landscape with evidence of salinisation to identify vegetation types that are poorly represented in the present conservation reserve system, restricted in present extent and that are at risk from rising groundwater.

Data on some 184 vegetation associations are provided. Of these associations with some expression in the south-west corner of the State, 73 have less that 10% of their original areal distribution remaining, and a further 63 have <30% remaining. Forty-three vegetation associations have >2,000 ha remaining. Sixty eight vegetation associations are completely unrepresented in the conservation estate. These associations are not represented in conservation reserves that fit criteria for IUCN Reserve Categories I-IV, or on other categories of CALM-managed land. An additional one association is unrepresented in reserves that fall into IUCN Reserve Categories I-IV but is represented to a small degree on other CALM-managed lands. A further 88 vegetation associations have ,15% of their original areal extent in reserves that fal into IUCN Reserve Categories I-IV. A total of 29 associations are potentially at risk from rising groundwaters: 5 associations have 100% of their present extent on soils at risk from salinity, a further 23 associations have >70% of their present extent on soils at risk, and an additional 11 associations have >50% of their present extent on soils at risk.

The project identifies 13 vegetation associations that should be given priority for further assessment, and for on-ground planning and management, because they are extensively cleared, associated with saline soils and so potentially at risk, and poorly represented in the present conservation reserve system. With additional, detailed, on-ground survey, they may qualify for classifying as Threatened Ecological Communities. Maps of the 13 vegetation associations are included.

SCOPE ITEMS

This project is funded under the Natural Heritage Trust National Reserve System Program. The following scope items were developed for the project:

The objectives of the project are:

- to identify vegetation types which are currently not represented or poorly represented in the conservation reserve system in the Agricultural Region;
- to identify those at greatest risk from rising water tables; and
- to identify remnant examples for on-ground inspection and possible acquisition, covenanting etc.

Major outputs from the project will be:

- a list of the vegetation types of the Agricultural Region, derived from the 1:250,000 vegetation map database, and more finely discriminated where possible using Vegetation System boundaries and soil landform data;
- an assessment of the present reservation status of each vegetation type, derived by intersecting the vegetation map data with the cadastral data for the CALM estate;
- an assessment of potential threat to each vegetation type posed by rising water tables and salinisation, determined by intersecting the vegetation map with the digital elevation model (DEM) for the Region; and
- maps showing the patches of remnant vegetation within the distribution of each of those vegetation types which is under-represented in the CALM estate.

Schedule of Work

Scope item 1. Refine the vegetation map data by incorporating where possible sub-units that reflect Beard's Vegetation System boundaries and soil landscapes boundaries.

Scope item 2. Determine current reservation status of each of the vegetation types with in the Agricultural Region by intersecting the refined vegetation map data with the cadastral data for the CALM estate, and prepare a report showing reservation status by area and expressed as % of original areal extent.

Scope item 3. Develop a threat assessment of each vegetation type based on position in the landscape within a sub-catchment. Rank each vegetation type according to reservation status and results fo the threat assessment.

Scope item 4. Identify patches of remnant vegetation in the Agricultural Region that appear to contain the vegetation types which are under-represented in the CALM estate and are potentially at a high level of threat from rising water tables.

Scope item 5. Prepare the final report compiling the results of all the analyses and including as an appendix the individual reports for each vegetation type (with maps), and listing of patches of remnant vegetation to be searched.

PROGRESS AGAINST SCOPE ITEMS

Scope item 1. Subdivide vegetation units.

The digital capture of Beard's vegetation systems is complete. The definition of soil landscape zones is complete and the process of generating zone boundaries is underway. An analysis of vegetation units based on sub-divided units will follow this report.

Scope item 2. Determine current reservation status of each of the vegetation types.

The data set of conservation status of the association-level vegetation units has recently been up-dated to reflect recent additions to the conservation estate and improvements to the database. In addition, the present extent of each vegetation association has been determined by intersecting the pre-European vegetation type and extent data set with the present (1997) vegetation extent data set.

Scope item 3. Develop a threat assessment of each vegetation type.

A threat assessment has been completed using the soils data set which reports an estimated proportion of saline soil for each vegetation type.

Scope item 4. Identify priority patches of remnant vegetation.

Patches of remnant vegetation at risk, mapped as a vegetation type that is poorly represented in the conservation reserve system, have been identified, Patches of remnant vegetation at risk, mapped as a vegetation type that has been extensively cleared, have also been identified.

Scope item 5. Prepare a final report.

A report that summarises the results of this part of the study (Phase I) and the results of Phase II is I preparation.

PLANNED PROGRAM FOR THE COMPLETION OF THE PROJECT

This project entitled *Identification of Potentially Threatened and Poorly Conserved Vegetation Types in the Agricultural Region of Western Australia* is being carried out in two phases. Phase I (the subject of the present report) analyses the vegetation types at the association level. This enables readers to refer back to the 1996 study report (Hopkins *et al*. 1996) to provide context for the present work. Phase II involves sun-dividing the more extensive vegetation associations using the soil landscape zones, to better reflect the complex gradients of biodiversity across the South West of the State.

The original intention was to use SACRED[1] data for the Agricultural Region as a means of identifying remnant vegetation at risk from rising groundwater and salinisation. This has not been possible because of an incomplete data coverage of the study region. Data derived from the soil database for the State have been used instead – these attribute percentage classes of saline soils in larger units. Trials using the data have given reliable results, and so a decision has been made to continue with this methodology. The following analysis reports remaining work to be don against the Scope Items.

Scope item 1. Subdivide vegetation units.

The sub-division of vegetation associations by intersecting the vegetation map with the soil zone boundaries is in progress.

Scope item 2. Determine current reservation status of each of the vegetation types.

The assessment of the conservation status of each of the sub-divided vegetation units will commence once the sub-division process is complete. In addition, the remaining extent of each of the vegetation types will be assessed using the up-to-date vegetation extent data set.

Scope item 3. Develop a threat assessment of each vegetation type.

The threat assessment has been done against the present vegetation extent data set. This now becomes a simple data matching exercise.

Scope item 4. Identify priority patches of remnant vegetation.

Patches of remnant vegetation at risk, mapped as a sub-divided vegetation type that is poorly represented in the conservation reserve system, will be been identified. Clearing status of each of these vegetation types will also be reported..

Scope item 5. Prepare a final report.

A report that summarises the results of this part of the study (Phase I) and the results of Phase II is I preparation.

[1] SACRED (Stream and Catchment References for Environmental Data) is a logical procedure for subdividing river catchments into sub-catchments using streamline mapping from topographic maps and topographical data. see Wilson, P. and Nason, S. (1991).

METHODS

The data sets

Vegetation.

The vegetation map database for Western Australia developed over the past 14 years is described in Hopkins *et al*. (1996), Hopkins *et al*. (in press), Beard *et al*. (in press). In summary, the data set is based on the 1:250,000 scale mapping by J.S Beard for all but the south west corner, which was mapped by A.J.M Hopkins in 1998/99. The primary vegetation units are vegetation associations sensu Beard and Webb (1974), but equivalent to the sub-association of the National Vegetation Information System (ERIN 1999). The individual polygons of each vegetation association have been captured digitally and attributed with data characterising the vegetation, and worked into a seamless coverage for the State.

Vegetation extent

A new and up-to-date data set of present vegetation extent is currently being developed under Project DAW27 for the National Land and Water Resources Audit. The data set builds on the work done for the Australian Land Cover Change Project (Barson *et al*. 1999) using the recent aerial photo coverage converted to digital orthophoto coverage. A detailed description of the methodology will be available of completion of that project.

Soil landscapes.

For the intensive land-use zone of Western Australia that includes the Agricultural Region, soils are currently being mapped at the level of soil landscapes (Griffin, personal communication 1999). In the course of this, individual soil landscape polygons are attributed with data on the extent of saline soils and sub-soils determined by sampling or air-photo interpretation. Soil landscape polygons are scored into classes 0%, 0-10%, 10-30% and >30% reflecting the percentage of that polygon having saline soils or sub-soils.

Conservation estate

The Department of Conservation and Land Management holds an up-to-date set of cadastral data for all lands and waters managed by the Department. A comprehensive database sits behind the cadasta – this contains information on vesting, purpose and classification, and allows each parcel of land to be assigned to an IUCN reserve category. This database was used for the conservation assessments reported here.

Analyses

The vegetation type and extent, soils and CALM-managed lands data are held as vector data, feature coded and attributed to a database within Integraph's Modular GIS Environment (MGE). In order to perform analyses, it is necessary to create a topology. This topological file contains the mathematical representations of the spatial relationships that exist between graphical features; it also contains the original pointer to the data linkages from the graphical features to the relational database.

Topology files of the four discrete, spatially co-registered area-themes, pre-European vegetation, preent vegetation extent, saline soils and cadastral boundaries of the CALM-managed estate, were built and those four themes were overlaid and intersected in pairs, using the Modular GIS Analysis (MGA) module of MGE to

produce a further topological file describing the results of the intersection for example, the faces of vegetation units within the CALM-managed estate. The new topologies and the linked tables were used to generate a series of reports. The data from these reports were taken into a spreadsheet program for further sorting and minor computation.

Results

Some 184 vegetation associations were analysed in Phase I of this project. These are listed in Table 1. Included in the list are a number of sparsely-vegetated units such as bare ground and granite rock that are considered to support unique vegetation but in relatively limited amounts. The sparsely-vegetated units are referred to as vegetation associations for ease of discussion.

Also shown in Table 1 are the results of the intersection of pre-European vegetation type and extent with the present vegetation extent. Seventy-three vegetation associations have <10% of their original extent remaining. An additional 63 vegetation associations have ≥ 10% but <30% of their original extent remaining. Forty-three vegetation associations have less than 2,000 ha remaining – these include associations that are greatly reduced in extent. These vegetation associations are identified with the letter a, b and/or c respectively in the right column.

Table 2 shows the results of conservation assessment. Sixty eight vegetation associations are completely unrepresented in the conservation estate, which includes reserves that accord with IUCN Reserve Categories I - IV ie National Parks, Nature Reserves, Marine Parks, Marine Nature Reserves, Conservation Parks, and other categories of land managed for conservation by the Department of Conservation and Land Management (CALM). One more asssociation has a minor representation on other lands managed by CALM. An additional 88 vegetation associations have <15% of their original, pre-European extent in includes reserves that fall into IUCN Reserve Categories I – IV. The total number of associations (out of 184 analysed) that are poorly conserved is 157. Vegetation associations that are inadequately reserved are identified with the letter d , e or f respectively for these classes of representation.

Table 3 shows those vegetation associations that may be regarded as at risk from rising ground waters and associated salinisation. Five vegetation associations have 100% of their present extent in areas of soils at risk from salinity. A further 23 associations have >70% of their present extent in areas of soils at risk from salinity. Eleven associations have >50% of their present extent in areas of soils at risk from salinity. The total number of vegetation types at risk (out of the 183 analysed) is 39. These vegetation associations at risk are coded g, h, j respectively.

Table 4 represents a distillation of the data in Tables 1, 2, 3. The table shows those vegetation associations that are relatively restricted, poorly conserved and at risk. A total of 13 vegetation associations are identified. These vegetation associations should be investigated further, including by on-ground survey. They are potentially at great risk of extinctin and so warrant consideration for classifying a Threatened Ecological Communities, and for being given high priority for incorporation into the conservation estate.

Table 1. Vegetation types occurring in the Agricultural Region of south west Western Australia ordered by Vegetation Association code number. Results of calculations of amount of vegetation remaining are included

Veg Assoc	Beard Code	Description	Area rem veg in whole SW (ha)	Original Area	%Veg type remaining as rem veg	Codes*
3	e2,3Mc	Medium forest; jarrah-marri	1849205	4784290	38.65161	
4	e3,5Mi	Medium woodland; marri & wandoo	175524	1503502	11.67434	b
5	e5,45Mi	Medium woodland; wandoo & powderbark (E. accedens)	27216	54222	50.19365	
6	e2,4Mi	Medium woodland; tuart & jarrah	22962	79870	28.74922	b
7	e5,6Mi	Medium woodland; York gum (E. loxophleba) & wandoo	27044	260057	10.39926	b
8	e8,34Mi	Medium woodland; salmon gum & gimlet	29135	1090267	2.67228	a
10	e22Mi	Medium woodland; red mallee group	1006	152465	0.65982	ac
14	e2Lc	Low forest; jarrah	72709	117576	61.84000	
18	a1Li	Low woodland; mulga (Acacia aneura)	7	22924433	0.00003	ac
19	a1Li	Low woodland; mulga between sandridges	11	4351342	0.00025	ac
25	c5e6Li	Low woodland; Allocasuarina huegeliana & York gum	1404	9097	15.43366	bc
27	mLi	Low woodland; paperbark (Melaleuca sp.)	97881	338084	28.95168	b
31	e6Mr m5Sc	Shrublands; Melaleuca thyoides thicket with scattered York gum	702	2852	24.61431	bc
35	e6Mr a19Si	Shrublands; jam scrub with scattered York gum	19409	190059	10.21209	b
36	acSc	Shrublands; thicket, acacia-casuarina alliance ?species	20451	318959	6.41180	a
37	mSc	Shrublands; teatree thicket	46032	46413	99.17911	
41	mSi	Shrublands; teatree scrub	7771	200532	3.87519	a
42	eaSi	Shrublands; mallee & acacia scrub on south coastal dunes	72293	312767	23.11401	b
47	e26SZc	Shrublands; tallerack mallee-heath	305573	1120992	27.25916	b

48	xSZc	Shrublands; scrub-heath	3665	20417	17.95073	b
49	xZc	Shrublands; mixed heath	20866	53997	38.64289	
51	xGc	Sedgeland; reed swamps, occasionally with heath	34790	146978	23.67021	b
53	e48Mi xLSr spGc	Mosaic: Grasslands/pindan; Medium woodland with mixed tree scrub over ?tall upland grass and plectrachne	6	981264	0.00061	ac
125	sl	Bare areas; salt lakes	16755	3679784	0.45533	a
126	fl	Bare areas; freshwater lakes	5749	228037	2.52108	a
128	r	Bare areas; rock outcrops	36005	316107	11.39013	b
129	ds	Bare areas; drift sand	12323	110673	11.13460	b
131	e8,34Mi/e10,27Si	Mosaic: Medium woodland; salmon gum & gimlet / Shrublands; mallee scrub, redwood & black marlock	11420	198070	5.76564	a
141	e6,8,34Mi	Medium woodland; York gum, salmon gum & gimlet	11269	583135	1.93249	a
142	e6,8Mi	Medium woodland; York gum & salmon gum	38085	934842	4.07395	a
145	e6,8Mi/amcSc	Mosaic: Medium woodland; York gum & salmon gum / Shrublands; thicket, acacia-casuarina-melaleuca alliance	406	8131	4.99324	ac
325	k1,3Ci	Succulent steppe; saltbush & samphire	860	65851	1.30598	ac
352	e6Mi	Medium woodland; York gum	53256	821606	6.48194	a
353	e6Mr eaSi	Shrublands; mallee & acacia scrub with scattered York gum	4464	91943	4.85518	a
354	e6Mr a19,23Si	Shrublands; jam and Acacia rostellifera (+hakea?) scrub with scattered York gum	5662	93014	6.08726	a
355	e6,22Lr a9,19Si	Shrublands; bowgada & jam scrub with scattered York gum & red mallee	151	62428	0.24188	ac
359	abSi	Shrublands; acacia & banksia scrub	9360	45228	20.69514	b
365	e6,22Mr a9,19Si	Shrublands; bowgada & jam scrub with scattered York gum & red mallee	1098	56268	1.95138	ac
371	a23Lc	Low forest; Acacia rostellifera	2216	33448	6.62521	a

372	x3SZc/acSc	Mosaic: Shrublands; scrub-heath on deep sandy flats / Shrublands; thicket, acacia-casuarina alliance	5741	83161	6.90348	a
377	x6SZc/e44Lp	Mosaic: Shrublands; scrub-heath on limestone in the northern Swan Region / Sparse low woodland; illyarrie	6000	64015	9.37280	a
378	x5SZc	Shrublands; scrub-heath with scattered Banksia spp E. todtiana & Xylomelum angustifolium on deep sandy flats in the Geraldton Sanplain Region	403	96453	0.41782	ac
379	x4SZc	Shrublands; scrub-heath on lateritic sandplain in the central Geraldton Sandplain Region	32404	556883	5.81882	a
380	x3SZc	Shrublands; scrub-heath on sandplain	22249	540046	4.11983	a
392	m5Sc	Shrublands; Melaeuca thyioides thicket	1381	3050	45.27869	c
393	c6Lr m5Sc	Shrublands; Melaleuca thyoides thicket with scattered Casuarina obesa	1325	5113	25.91434	bc
408	x2SZc	Shrublands; scrub-heath on coastal association, yellow sandplain	8569	341172	2.51164	a
412	mSi k3Ci	Succulent steppe with scrub; teatree (Melaleuca thyioides?) over samphire	390	9575	4.07311	ac
413	a33Sc	Shrublands; Acacia neurophylla & A. species thicket	531	8574	6.19314	ac
419	a9,19m6Sc	Shrublands; bowgada, jam and Melaleuca uncinata thicket	2921	316731	0.92223	a
420	a9,19Si	Shrublands; bowgada & jam scrub	6133	743906	0.82443	a
432	a23m3Sc	Shrublands; Acacia rostellifera & Melaleuca cardiophylla thicket	4871	5810	83.83821	
433	a23m3Sc/e44Lp	Mosaic: Shrublands; Acacia rostellifera & Melaleuca cardiophylla thicket / Sparse low woodland; illyarrie	13848	32837	42.17194	
435	a33,34,35Sc	Shrublands; Acacia neurophylla, A. beauverdiana & A. resinomarginea thicket	16753	1150819	1.45575	a

437	anSc	Shrubalnds; Mixed acacia thicket on sandplain	6745	361645	1.86509	a
440	a21Sr	Shrublands; Acacia ligulata open scrub	3275	5969	54.86681	
482	e11,22Mi	Medium woodland; merrit & red mallee	11361	1624931	0.69917	a
486	e8,22Mi/e15Si	Mosaic: Medium woodland; salmon gum & red mallee / Shrublands; mallee scrub Eucalyptus eremophila	27182	413183	6.57868	a
511	e8,9Mi	Medium woodland; salmon gum & morrel	28031	389158	7.20299	a
512	e15,32Si	Shrublands; mallee scrub, Eucalyptus eremophila & Forrest's marlock (E. forrestianna)	43722	237950	18.37445	b
516	e27Si	Shrublands; mallee scrub, black marlock	246684	1291503	19.10054	b
519	e15Si	Shrublands; mallee scrub, Eucalyptus eremophila	308258	1857233	16.59770	b
551	c3Sc	Shrublands; Allocasuarina campestris thicket	40036	324606	12.33372	b
552	c4Sc	Shrublands; Casuarina acutivalvus & calothamnus (also melalueca) thicket on greenstone hills	4919	33781	14.56144	b
631	e6Mi m5Sc k3Ci	Succulent steppe with woodland and thicket; york gum over Melaleuca thyoides & samphire	7414	109157	6.79205	a
676	k3Ci	Succulent steppe; samphire	936	1878260	0.04983	ac
684	e6Mr a19Si/c3Sc	Mosaic: Shrublands; Shrublands; jam scrub with scattered York gum in the valleys / Allocasuarina campestris thicket	29629	128283	23.09659	b
686	e6,22Mi	Medium woodland; York gum & red mallee	953	13078	7.28705	ac
691	edSc	Shrublands; Dryandra quercifolia & Eucalytpus spp. thicket	16753	46666	35.89980	
694	x8SZc	Shrublands; scrub-heath on yellow sandplain banksia-xylomelum alliance in the Geraldton Sandplain & Avon-Wheatbelt Regions	64656	348904	18.53117	b
695	c3Si	Shrublands; Allocasuarina campestris scrub	62	654	9.48012	ac
697	x7SZc	Shrublands; scrub-heath on lateritic sandplain in the southern Geraldton Sandplain Region	11937	74055	16.11910	b

698	x9SZc/e5,45Lp	Mosaic: Shrublands; scrub-heath Dryandra-Calothamnus assoc. with B. prionotes on limestone in the northern Swan Region / Sparse low woodland; wandoo & powderbark wandoo	1586	11496	13.79610	bc
924	e15,22Si	Shrublands; mallee scrub, Eucalyptus eremophila & red mallee	15239	82411	18.49146	b
929	e33Lc	Low forest; moort (E. platypus)	2739	10617	25.79825	b
931	e7Mi	Medium woodland; yate	12616	32223	39.15216	
934	e28Si	Shrublands; mallee scrub Eucalyptus nutans	28568	64935	43.99476	
936	e8Mi	Medium woodland; salmon gum	10304	915276	1.12578	a
938	e6,7Mi	Medium woodland; York gum & yate	16670	76713	21.73035	b
940	e27Si/e26SZc	Mosaic: Shrublands; mallee scrub, black marlock / Shrublands; tallerack mallee-heath	100778	261980	38.46782	
942	e7Mi/e27Si	Mosaic: Medium woodland; yate / Shrublands; mallee scrub, black marlock	8463	33559	25.21827	b
945	e8Mi/e10,27Si	Mosaic: Medium woodland; salmon gum / Shrublands; mallee scrub, redwood & black marlock	12196	185493	6.57491	a
946	e5Mi	Medium woodland; wandoo	15057	81955	18.37228	b
947	e64,45Mi	Medium woodland; powderbark & mallet	11528	32684	35.27108	
948	e6,18Mr	Medium woodland; York gum & river gum	144	1449	9.93789	ac
949	bLi	Low woodland; banksia	88857	228448	38.89594	
950	c6Mi	Medium woodland; Casuarina obesa	163	507	32.14990	c
951	e6,66Mp mSc k3Ci	Succulent steppe with sparse woodland & thicket; york gum & Kondinin blackbutt over teatree thicket & samphire	1728	27670	6.24503	ac
952	dZc	Shrublands; dryandra heath	9963	59691	16.69096	b
953	mSc k3Ci	Succulent steppe with thicket; teatree over samphire (m5?)	918	10019	9.16259	ac
954	a19c5Si	Shrublands; thicket, Jam & Allocasuarina huegeliana	1167	5775	20.20779	bc

955	x10SZc/c3Sc	Mosaic: Shrublands; scrub-heath (SE Avon)/ Shrublands; Allocasuarina campestris thicket	10434	138169	7.55162	a
956	e5Mr c3Sc	Shrublands; Allocasuarina campestris thicket with scattered wandoo	2716	25285	10.74155	b
959	e36,66Mp mSc k3Ci	Succulent steppe with sparse woodland & thicket; yorrell & Kondinin blackbutt over teatree & samphire	1641	13209	12.42335	bc
960	e10,27Si	Shrublands; mallee scrub, redwood & black marlock	14377	159165	9.03276	a
961	x10SZc/c4Sc	Mosaic: Shrublands; scrub-heath (SE Avon)/ Shrublands; Allocasuarina campestris thicket	4315	25002	17.25862	b
963	e7mMi	Medium woodland; yate & paperbark (Melaleuca spp)	1774	6670	26.59670	bc
965	e2,3Mi	Medium woodland; jarrah & marri	5017	10172	49.32167	
966	e8,9Mp mSc k3Ci	Succulent steppe with sparse woodland & thicket; salmon gum & morrell over teatree & samphire	84	3231	2.59981	ac
967	e5,7Mi	Medium woodland; wandoo & yate	36001	218106	16.50619	b
968	e2,3,5Mi	Medium woodland; jarrah, marri & wandoo	72374	170130	42.54041	
971	e67Si	Shrublands; mallee scrub, Eucalyptus decipiens	189	345	54.78261	c
972	e2,3,5,7Mi	Medium woodland; jarrah, marri, wandoo & yate	9257	23601	39.22291	
973	mLc	Low forest; paperbark (Melaleuca rhaphiophylla)	83422	7344	1135.92048	
975	e2Li	Low woodland; jarrah	15454	26122	59.16086	
976	mLi k3Ci	Succulent steppe with low woodland; myoporum over samphire	586	2172	26.97974	bc
981	e5,6,7Mi	Medium woodland; wandoo,York gum & yate	1174	10591	11.08488	bc
986	enSZc	Shrublands; mallee-heath (Stirling Ra.)	15156	30179	50.22035	
988	m5Sc k3Ci	Succulent steppe with thicket; Melaleuca thyoides over samphire	5162	100390	5.14195	a
990	agLc	Low forest: peppermint (Agonis flexuosa)	13301	41210	32.27615	
992	e2,5Mc	Medium forest; jarrah & wandoo (E. wandoo)	30815	259279	11.88488	b

998	e4Mi	Medium woodland; tuart	16033	43627	36.75018	
999	e3Mi	Medium woodland; marri	26771	284881	9.39726	a
1000	e2,3Mi/bLi/mLc	Mosaic: Medium forest; jarrah-marri / Low woodland; banksia / Low forest; teatree (Melaleuca Spp.)	30522	144420	21.13419	b
1001	e2Mb cbLi	Medium very sparse woodland; jarrah, with low woodland; banksia & casuarina	17313	58450	29.62019	b
1013	e3Mr/mSc	Mosaic: Medium open woodland; marri / Shrublands; teatree thicket	99	462	21.42857	bc
1014	bLi/mSc	Mosaic: Low woodland; banksia / Shrublands; teatree thicket	21620	41647	51.91250	
1018	e2,3Mi/bLi/mLc/c6Li	Mosaic: Medium forest; jarrah-marri / Low woodland; banksia / Low forest; teatree / Low woodland; Casuarina obesa	3367	14254	23.62144	b
1020	e2,3Mc/e3,5Mi	Mosaic: Medium forest; jarrah-marri / Medium woodland; marri-wandoo	1882	5677	33.15131	c
1023	e5,6,8Mi	Medium woodland; York gum, wandoo & salmon gum (E. salmonophloia)	96905	1352399	7.16541	a
1024	ecSc	Shrublands; mallee & casuarina thicket	52412	738180	7.10017	a
1025	e6,8,9Mi/k1,3Ci	Mosaic: Medium woodland; York gum, salmon gum & morrel / Succulent steppe; saltbush & samphire	40	1954	2.04708	ac
1026	a23,32m3Sc/a26m4Zc	Mosaic: Shrublands; Acacia rostellifera, A. cyclops (S) & Melaleuca cardiophylla (N) thicket / Shrublands; Acacia lasiocarpa & Melaleuca acerosa heath	55464	71136	77.96896	
1027	e2,3Mr bLi/e2,3,Mp	Mosaic: Medium open woodland; jarrah & marri, with low woodland; banksia / Medium sparse woodland; jarrah & marri	22112	40220	54.97762	
1028	e18Mi	Medium woodland; river gum	513	1139	45.03951	c

1029	x9SZc	Shrublands; scrub-heath Dryandra-Calothamnus assoc. with B. prionotes on limestone in the northern Swan Region	53204	71924	73.97253	
1030	b1,2Li	Low woodland; Banksia attenuata & B. menziesii	90011	142064	63.35947	
1031	hSZc/dZc	Mosaic: Shrublands; hakea scrub-heath / Shrublands; dryandra heath	95287	272628	34.95129	
1034	e3,5,45Mi	Medium woodland; marri, wandoo & powderbark	1085	1972	55.02028	c
1036	b3Li	Low woodland; Banksia prionotes	31965	87257	36.63316	
1037	e6,18Mi	Medium woodland; York gum & river gum (incl e6,18Mr?)	2177	2406	90.48213	
1039	e6Mr eSi	Shrublands; mallee with scattered York gum	1178	2073	56.82586	c
1040	c6e6Mi	Medium woodland; York gum & Casuarina obesa	526	2862	18.37876	bc
1041	c5a19Li	Low woodland; Allocasuarina huegeliana & Jam	1220	4787	25.48569	bc
1047	e29SZc	Shrublands; Eucalyptus incrassata mallee-heath	6999	220163	3.17901	a
1048	mSp/k3Ci	Mosaic: Shrublands; melaleuca patchy scrub / Succulent steppe; samphire	254	11422	2.22378	ac
1049	e5,6,8,9,34Mi	Medium woodland; wandoo, York gum, salmon gum, morrel & gimlet	20641	650062	3.17524	a
1051	e5,7Mr mSc	Shrublands; teatree thicket with scattered wandoo & yate	4573	14982	30.52329	
1053	e6Mr m6Sc	Shrublands; Melaleuca uncinata thicket with scattered York gum	1168	13913	8.39503	ac
1055	e6,39Si	Shrublands; York gum & Eucalyptus sheathiana mallee scrub	13268	127583	10.39950	b
1056	ac3Sc	Shrublands; thicket, acacia & Allocasuarina campestris	3113	20961	14.85139	b
1057	e8,34Mi/e6,39Si	Mosaic: Shrublands; Medium woodland; salmon gum & gimlet / York gum & Eucalyptus sheathiana mallee scrub	9819	163195	6.01673	a

1058	e6,19Si	Shrublands; York gum & Eucalyptus gonglocarpa mallee scrub	262	9378	2.79377	ac
1061	e8,36Mp/k1,3Ci	Mosaic: Medium sparse woodland; salmon gum & yorrell / Succulent steppe; saltbush & samphire	5694	42864	13.28387	b
1062	e6Mr m5Sc k3Ci	Succulent steppe with open woodland & thicket; york gum over Melaleuca thyiodes & samphire	2409	22662	10.63013	b
1065	e5,34Mi/e6,39Si	Mosaic: Shrublands;Medium woodland; wandoo & gimlet / York gum & Eucalyptus sheathiana mallee scrub	438	8335	5.25495	ac
1067	e8,9,34,35Mi	Medium woodland; salmon gum, morrel, gimlet & rough fruited mallee	3859	15382	25.08776	b
1068	e8,9,34,39Mi	Medium woodland; salmon gum, morrel, gimlet & Eucalyptus sheathiana	26077	250104	10.42646	b
1073	e5,64Mi	Medium woodland; wandoo & mallet	6712	17748	37.81835	
1074	e5c6Mr mSc k3Ci	Succulent steppe with open woodland & thicket; wandoo & Allocasuarina obesa over teatree & samphire	1463	4626	31.62559	c
1075	e15,27Si	Shrublands; mallee scrub, Eucalyptus eremophila & black marlock (E.redunca)	29714	337619	8.80104	a
1079	e8,9Mr/k1Ci	Mosaic: Medium open woodland; salmon gum & morrel / Succulent steppe; saltbush	2107	6547	32.18268	
1080	eSr m6Sc (k3Ci)	Succulent steppe with malle & thickets; Mallee and Melaleuca uncinata thickets on salt flats	91	3938	2.31082	ac
1083	e5,8c6Mr mSi k3Ci	Succulent steppe with open woodland & scrub; wandoo, salmon gum & Allocasuarina obesa over teatree & samphire	2470	10738	23.00242	b
1085	e5,69Mi	Medium woodland; wandoo & blue mallet (E. gardneri)	5371	52126	10.30388	b
1087	e5,9,69Mi	Medium woodland; wandoo, morrell & blue mallet	261	750	34.80000	c

1091	b3c5Li	Low woodland; Banksia prionotes & Allocasuarina huegelianna	266	723	36.79115	c
1092	e5,6,9 Mi	Medium woodland; wandoo, York gum & morrell	5674	78484	7.22950	a
1093	ec6Mr mSc k3Ci	Succulent steppe with open woodland & thicket; eucalypts & Allocasuarina obesa over teatree & samphire	742	8299	8.94084	ac
1094	e6,8Mi/e15,27Si	Mosaic: Medium woodland; York gum & salmon gum / Shrublands; mallee scrub Eucalyptus eremophila & black marlock	4479	73112	6.12622	a
1096	e7,8Mi	Medium woodland; yate & salmon gum	180	354	50.84746	c
1098	e8,9Mp/k3Ci	Mosaic: Medium sparse woodland; salmon gum & morrel / Succulent steppe; samphire	1953	18236	10.70959	bc
1109	agSi	Shrublands; peppermint scrub, Agonis flexuosa	27935	111677	25.01410	b
1136	e3Mi (e2,5,18,c)	Medium woodland; marri with some jarrah, wandoo, river gum and casuarina	6122	112617	5.43612	a
1143	c3Sc xZi	Shrublands; Allocasuarina campestris thicket with patches of heath	1956	66241	2.95285	ac
1147	x10SZc	Shrublands; scrub-heath in the south-east Avon-Wheatbelt Region	2244	43600	5.14679	a
1154	anSc xZi	Shrublands; Acacia thicket with patches of heath	3285	39472	8.32236	a
1155	e6Mi/c3Sc	Mosaic: Medium woodland; York gum /Shrublands; Allocasuarina campestris thicket	3035	7873	38.54947	
1164	x8SZc/c3Sc	Mosaic: Shrublands; scrub-heath on sandplain (banksia-xylomelum alliance) in the Geraldton Sandplain & Avon-Wheatbelt Regions / Shrublands; Allocasuarina campestris thicket	20	2014	0.99305	ac
1198	m5Si k3Ci/a9Sr	Mosaic: Succulent steppe with thicket; Melaleuca thyiodes over samphire / Shrublands; bowgada open scrub	125	18221	0.68602	ac

1200	e8,9Mi/e15,27Si	Mosaic: Medium woodland; salmon gum & morrel / Shrublands; mallee scrub Eucalyptus eremophila & black marlock (E. redunca)	10213	125024	8.16883	a
1271	clay	Bare areas; claypans,	389	87338	0.44540	ac
1413	acmSc	Shrublands; acacia, casuarina & melaleuca thicket	139926	1959025	7.14263	a
1516	e27,32Si	Shrublands; mallee scrub, black marlock & Forrest's marlock	18338	126492	14.49736	b
1967	e5,7,18Mi	Medium woodland; wandoo, yate & river gum	5812	25734	22.58491	b
2048	x13SZc	Shrublands; scrub-heath in the Mallee Region	38971	323145	12.05991	b
2051	mLc xGc	Sedgeland; sedges with low tree savanna woodland; paperbarks over & various sedges	7500	10519	71.29955	
2093	e7Mi mSi k3Ci	Succulent steppe with open woodland & scrub; yate over teatree & samphire	2946	9296	31.69105	
3041	a19c5Li/rock	Mosaic: Low woodland; Allocasuarina huegeliana & jam around granite rocks	1487	6056	24.55416	bc
3048	x14SZc	Shrublands; scrub-heath on the Swan Coastal Plain	2432	12430	19.56557	b
4048	x15SZc	Shrublands; scrub-heath in the Esperance Plains incl. Mt Ragged scrub-heath	28653	66244	43.25373	
4801	nLr xZc	Shrublands; heath with scattered Nuytsia floribunda on sandplain	8238	58137	14.16998	b
6048	bSZc	Shrublands; banksia scrub-heath on sandplain in the Esperance Plains Region	17264	112522	15.34278	b
7048	bSZc	Shrublands; banksia scrub-heath on coastal plain in the Esperence Plains Region	30208	118907	25.40473	b

*codes are a = vegetation association with <10% of their original areal extent remaining, b = vegetation association with <30% of their original areal extent remaining, c = vegetation association with <2,000 ha remaining.

Table 2. Reservation status of vegetation associations in the south-west of western Australia (as at March 2000).

Veg Assoc	Beard Code	Description	Extent IUCN	%IUCN	Extent CALM	%CALM	Codes*
408	x2SZc	Shrublands; scrub-heath on coastal association, yellow sandplain	91616	26.85	91616	26.85	
1047	e29SZc	Shrublands; Eucalyptus incrassata mallee-heath	120380	54.68	120380	54.68	
377	x6SZc/e44Lp	Mosaic: Shrublands; scrub-heath on limestone in the northern Swan Region / Sparse low woodland; illyarrie	46055	71.94	46055	71.94	
129	ds	Bare areas; drift sand	36336	32.83	36355	32.85	
697	x7SZc	Shrublands; scrub-heath on lateritic sandplain in the southern Geraldton Sandplain Region	14018	18.93	14018	18.93	
42	eaSi	Shrublands; mallee & acacia scrub on south coastal dunes	71304	22.8	71304	22.8	
1109	agSi	Shrublands; peppermint scrub, Agonis flexuosa	23134	20.72	23134	20.72	
7048	bSZc	Shrublands; banksia scrub-heath on coastal plain in the Esperence Plains Region	77795	65.42	77795	65.42	
393	c6Lr m5Sc	Shrublands; Melaleuca thyoides thicket with scattered Casuarina obesa	3982	77.88	3982	77.88	
976	mLi k3Ci	Succulent steppe with low woodland; myoporum over samphire	434	19.97	434	19.97	
990	agLc	Low forest: peppermint (Agonis flexuosa)	9663	23.45	9663	23.45	
691	edSc	Shrublands; Dryandra quercifolia & Eucalytpus spp. thicket	14009	30.02	14009	30.02	
1036	b3Li	Low woodland; Banksia prionotes	14125	16.19	14125	16.19	
998	e4Mi	Medium woodland; tuart	6869	15.75	6881	15.77	
940	e27Si/e26SZc	Mosaic: Shrublands; mallee scrub, black marlock / Shrublands; tallerack mallee-heath	52303	19.96	52303	19.96	
49	xZc	Shrublands; mixed heath	13458	24.92	13458	24.92	
4048	x15SZc	Shrublands; scrub-heath in the Esperance Plains incl. Mt Ragged scrub-heath	23712	35.79	23712	35.79	

965	e2,3Mi	Medium woodland; jarrah & marri	1904	18.72	1904	18.72	
986	enSZc	Shrublands; mallee-heath (Stirling Ra.)	13383	44.35	13383	44.35	
971	e67Si	Shrublands; mallee scrub, Eucalyptus decipiens	77	22.25	77	22.25	
1034	e3,5,45Mi	Medium woodland; marri, wandoo & powderbark	467	23.67	467	23.67	
1039	e6Mr eSi	Shrublands; mallee with scattered York gum	1096	52.85	1096	52.85	
975	e2Li	Low woodland; jarrah	12699	48.62	12699	48.62	
1026	a23,32m3Sc/a26m4Zc	Mosaic: Shrublands; Acacia rostellifera, A. cyclops (S) & Melaleuca cardiophylla (N) thicket / Shrublands; Acacia lasiocarpa & Melaleuca acerosa heath	32412	45.56	32412	45.56	
432	a23m3Sc	Shrublands; Acacia rostellifera & Melaleuca cardiophylla thicket	2911	50.11	2911	50.11	
1037	e6,18Mi	Medium woodland; York gum & river gum (incl e6,18Mr?)	2310	95.99	2310	95.99	
355	e6,22Lr a9,19Si	Shrublands; bowgada & jam scrub with scattered York gum & red mallee	0	0	0	0	
10	e22Mi	Medium woodland; red mallee group	0	0	0	0	d
1198	m5Si k3Ci/a9Sr	Mosaic: Succulent steppe with thicket; Melaleuca thyiodes over samphire / Shrublands; bowgada open scrub	0	0	0	0	d
419	a9,19m6Sc	Shrublands; bowgada, jam and Melaleuca uncinata thicket	0	0	0	0	d
1164	x8SZc/c3Sc	Mosaic: Shrublands; scrub-heath on sandplain (banksia-xylomelum alliance) in the Geraldton Sandplain & Avon-Wheatbelt Regions / Shrublands; Allocasuarina campestris thicket	0	0	0	0	d
325	k1,3Ci	Succulent steppe; saltbush & samphire	0	0	0	0	d
1025	e6,8,9Mi/k1,3Ci	Mosaic: Medium woodland; York gum, salmon gum & morrel / Succulent steppe; saltbush & samphire	0	0	0	0	d
1048	mSp/k3Ci	Mosaic: Shrublands; melaleuca patchy scrub / Succulent steppe; samphire	0	0	0	0	d
1080	eSr m6Sc (k3Ci)	Succulent steppe with malle & thickets; Mallee and Melaleuca uncinata thickets on salt flats	0	0	0	0	d

966	e8,9Mp mSc k3Ci	Succulent steppe with sparse woodland & thicket; salmon gum & morrell over teatree & samphire	0	0	0	0	d
1058	e6,19Si	Shrublands; York gum & Eucalyptus gonglocarpa mallee scrub	0	0	0	0	d
1143	c3Sc xZi	Shrublands; Allocasuarina campestris thicket with patches of heath	0	0	0	0	d
1049	e5,6,8,9,34Mi	Medium woodland; wandoo, York gum, salmon gum, morrel & gimlet	11	0	17	0	d
412	mSi k3Ci	Succulent steppe with scrub; teatree (Melaleuca thyioides?) over samphire	0	0	0	0	d
145	e6,8Mi/amcSc	Mosaic: Medium woodland; York gum & salmon gum / Shrublands; thicket, acacia-casuarina-melaleuca alliance	0	0	0	0	d
1147	x10SZc	Shrublands; scrub-heath in the south-east Avon-Wheatbelt Region	0	0	0	0	d
1065	e5,34Mi/e6,39Si	Mosaic: Shrublands;Medium woodland; wandoo & gimlet / York gum & Eucalyptus sheathiana mallee scrub	0	0	0	0	d
131	e8,34Mi/e10,27Si	Mosaic: Medium woodland; salmon gum & gimlet / Shrublands; mallee scrub, redwood & black marlock	0	0	0	0	d
1057	e8,34Mi/e6,39Si	Mosaic: Shrublands; Medium woodland; salmon gum & gimlet / York gum & Eucalyptus sheathiana mallee scrub	0	0	0	0	d
1094	e6,8Mi/e15,27Si	Mosaic: Medium woodland; York gum & salmon gum / Shrublands; mallee scrub Eucalyptus eremophila & black marlock	0	0	0	0	d
951	e6,66Mp mSc k3Ci	Succulent steppe with sparse woodland & thicket; york gum & Kondinin blackbutt over teatree thicket & samphire	0	0	0	0	d
945	e8Mi/e10,27Si	Mosaic: Medium woodland; salmon gum / Shrublands; mallee scrub, redwood & black marlock	0	0	0	0	d
1024	ecSc	Shrublands; mallee & casuarina thicket	0	0	0	0	d

1023	e5,6,8Mi	Medium woodland; York gum, wandoo & salmon gum (E. salmonophloia)	0	0	0	0	d
511	e8,9Mi	Medium woodland; salmon gum & morrel	0	0	0	0	d
1092	e5,6,9 Mi	Medium woodland; wandoo, York gum & morrell	0	0	0	0	d
955	x10SZc/c3Sc	Mosaic: Shrublands; scrub-heath (SE Avon)/ Shrublands; Allocasuarina campestris thicket	0	0	0	0	d
1200	e8,9Mi/e15,27Si	Mosaic: Medium woodland; salmon gum & morrel / Shrublands; mallee scrub Eucalyptus eremophila & black marlock (E. redunca)	0	0	0	0	d
1053	e6Mr m6Sc	Shrublands; Melaleuca uncinata thicket with scattered York gum	0	0	0	0	d
1075	e15,27Si	Shrublands; mallee scrub, Eucalyptus eremophila & black marlock (E.redunca)	0	0	0	0	d
1093	ec6Mr mSc k3Ci	Succulent steppe with open woodland & thicket; eucalypts & Allocasuarina obesa over teatree & samphire	0	0	0	0	d
960	e10,27Si	Shrublands; mallee scrub, redwood & black marlock	0	0	0	0	d
953	mSc k3Ci	Succulent steppe with thicket; teatree over samphire (m5?)	0	0	0	0	d
695	c3Si	Shrublands; Allocasuarina campestris scrub	0	0	0	0	d
948	e6,18Mr	Medium woodland; York gum & river gum	0	0	0	0	d
1085	e5,69Mi	Medium woodland; wandoo & blue mallet (E. gardneri)	0	0	0	0	d
1055	e6,39Si	Shrublands; York gum & Eucalyptus sheathiana mallee scrub	0	0	0	0	d
1068	e8,9,34,39Mi	Medium woodland; salmon gum, morrel, gimlet & Eucalyptus sheathiana	0	0	0	0	d
1062	e6Mr m5Sc k3Ci	Succulent steppe with open woodland & thicket; york gum over Melaleuca thyiodes & samphire	0	0	0	0	d
1098	e8,9Mp/k3Ci	Mosaic: Medium sparse woodland; salmon gum & morrel / Succulent steppe; samphire	0	0	0	0	d

956	e5Mr c3Sc	Shrublands; Allocasuarina campestris thicket with scattered wandoo	0	0	0	0	d
981	e5,6,7Mi	Medium woodland; wandoo,York gum & yate	0	0	0	0	d
959	e36,66Mp mSc k3Ci	Succulent steppe with sparse woodland & thicket; yorrell & Kondinin blackbutt over teatree & samphire	0	0	0	0	d
1061	e8,36Mp/k1,3Ci	Mosaic: Medium sparse woodland; salmon gum & yorrell / Succulent steppe; saltbush & samphire	0	0	0	0	d
1056	ac3Sc	Shrublands; thicket, acacia & Allocasuarina campestris	0	0	0	0	d
25	c5e6Li	Low woodland; Allocasuarina huegeliana & York gum	0	0	0	0	d
961	x10SZc/c4Sc	Mosaic: Shrublands; scrub-heath (SE Avon)/ Shrublands; Allocasuarina campestris thicket	0	0	0	0	d
1040	c6e6Mi	Medium woodland; York gum & Casuarina obesa	0	0	0	0	d
954	a19c5Si	Shrublands; thicket, Jam & Allocasuarina huegeliana	0	0	0	0	d
359	abSi	Shrublands; acacia & banksia scrub	0	0	0	0	d
1013	e3Mr/mSc	Mosaic: Medium open woodland; marri / Shrublands; teatree thicket	0	0	0	0	d
1083	e5,8c6Mr mSi k3Ci	Succulent steppe with open woodland & scrub; wandoo, salmon gum & Allocasuarina obesa over teatree & samphire	0	0	0	0	d
1018	e2,3Mi/bLi/mLc/c6Li	Mosaic: Medium forest; jarrah-marri / Low woodland; banksia / Low forest; teatree / Low woodland; Casuarina obesa	0	0	0	0	d
3041	a19c5Li/rock	Mosaic: Low woodland; Allocasuarina huegeliana & jam around granite rocks	0	0	0	0	d
1067	e8,9,34,35Mi	Medium woodland; salmon gum, morrel, gimlet & rough fruited mallee	0	0	0	0	d
1041	c5a19Li	Low woodland; Allocasuarina huegeliana & Jam	0	0	0	0	d
963	e7mMi	Medium woodland; yate & paperbark (Melaleuca spp)	0	0	0	0	d
1051	e5,7Mr mSc	Shrublands; teatree thicket with scattered wandoo & yate	0	0	0	0	d

1074	e5c6Mr mSc k3Ci	Succulent steppe with open woodland & thicket; wandoo & Allocasuarina obesa over teatree & samphire	0	0	0	0	d
2093	e7Mi mSi k3Ci	Succulent steppe with open woodland & scrub; yate over teatree & samphire	0	0	0	0	d
950	c6Mi	Medium woodland; Casuarina obesa	0	0	0	0	d
1079	e8,9Mr/k1Ci	Mosaic: Medium open woodland; salmon gum & morrel / Succulent steppe; saltbush	0	0	0	0	d
1087	e5,9,69Mi	Medium woodland; wandoo, morrell & blue mallet	0	0	0	0	d
947	e64,45Mi	Medium woodland; powderbark & mallet	0	0	0	0	d
1091	b3c5Li	Low woodland; Banksia prionotes & Allocasuarina huegelianna	0	0	0	0	d
1073	e5,64Mi	Medium woodland; wandoo & mallet	0	0	0	0	d
1155	e6Mi/c3Sc	Mosaic: Medium woodland; York gum /Shrublands; Allocasuarina campestris thicket	0	0	0	0	d
1096	e7,8Mi	Medium woodland; yate & salmon gum	0	0	0	0	d
1027	e2,3Mr bLi/e2,3,Mp	Mosaic: Medium open woodland; jarrah & marri, with low woodland; banksia / Medium sparse woodland; jarrah & marri	0	0	0	0	d
1271	clay	Bare areas; claypans,	0	0	97	0.11	e
18	a1Li	Low woodland; mulga (Acacia aneura)	212802	0.93	580136	2.53	f
19	a1Li	Low woodland; mulga between sandridges	327	0.01	327	0.01	f
53	e48Mi xLSr spGc	Mosaic: Grasslands/pindan; Medium woodland with mixed tree scrub over ?tall upland grass and plectrachne	141224	14.39	141224	14.39	f
676	k3Ci	Succulent steppe; samphire	22960	1.22	145548	7.75	f
378	x5SZc	Shrublands; scrub-heath with scattered Banksia spp E. todtiana & Xylomelum angustifolium on deep sandy flats in the Geraldton Sanplain Region	9426	9.77	9426	9.77	f
125	sl	Bare areas; salt lakes	116671	3.17	121931	3.31	f
482	e11,22Mi	Medium woodland; merrit & red mallee	34771	2.14	34771	2.14	f
420	a9,19Si	Shrublands; bowgada & jam scrub	444	0.06	920	0.12	f

936	e8Mi	Medium woodland; salmon gum	6388	0.7	8428	0.92	f
435	a33,34,35Sc	Shrublands; Acacia neurophylla, A. beauverdiana & A. resinomarginea thicket	31537	2.74	40658	3.53	f
437	anSc	Shrubalnds; Mixed acacia thicket on sandplain	24212	6.7	24212	6.7	f
141	e6,8,34Mi	Medium woodland; York gum, salmon gum & gimlet	9159	1.57	9159	1.57	f
365	e6,22Mr a9,19Si	Shrublands; bowgada & jam scrub with scattered York gum & red mallee	61	0.11	61	0.11	f
126	fl	Bare areas; freshwater lakes	9645	4.23	9645	4.23	f
8	e8,34Mi	Medium woodland; salmon gum & gimlet	19935	1.83	120767	11.08	f
41	mSi	Shrublands; teatree scrub	12637	6.3	12637	6.3	f
142	e6,8Mi	Medium woodland; York gum & salmon gum	11089	1.19	11257	1.2	f
380	x3SZc	Shrublands; scrub-heath on sandplain	72769	13.47	72769	13.47	f
353	e6Mr eaSi	Shrublands; mallee & acacia scrub with scattered York gum	60	0.06	60	0.06	f
988	m5Sc k3Ci	Succulent steppe with thicket; Melaleuca thyoides over samphire	1308	1.3	1308	1.3	f
1136	e3Mi (e2,5,18,c)	Medium woodland; marri with some jarrah, wandoo, river gum and casuarina	84	0.07	84	0.07	f
379	x4SZc	Shrublands; scrub-heath on lateritic sandplain in the central Geraldton Sandplain Region	59485	10.68	59485	10.68	f
354	e6Mr a19,23Si	Shrublands; jam and Acacia rostellifera (+hakea?) scrub with scattered York gum	411	0.44	411	0.44	f
413	a33Sc	Shrublands; Acacia neurophylla & A. species thicket	20	0.23	20	0.23	f
36	acSc	Shrublands; thicket, acacia-casuarina alliance ?species	1265	0.4	1265	0.4	f
352	e6Mi	Medium woodland; York gum	2107	0.26	2107	0.26	f
486	e8,22Mi/e15Si	Mosaic: Medium woodland; salmon gum & red mallee / Shrublands; mallee scrub Eucalyptus eremophila	9917	2.4	9917	2.4	f
371	a23Lc	Low forest; Acacia rostellifera	15	0.05	15	0.05	f
631	e6Mi m5Sc k3Ci	Succulent steppe with woodland and thicket; york gum over Melaleuca thyoides & samphire	1801	1.65	1801	1.65	f

372	x3SZc/acSc	Mosaic: Shrublands; scrub-heath on deep sandy flats / Shrublands; thicket, acacia-casuarina alliance	1605	1.93	1605	1.93	f
1413	acmSc	Shrublands; acacia, casuarina & melaleuca thicket	14301	0.73	14320	0.73	f
686	e6,22Mi	Medium woodland; York gum & red mallee	574	4.39	574	4.39	f
1154	anSc xZi	Shrublands; Acacia thicket with patches of heath	175	0.44	175	0.44	f
999	e3Mi	Medium woodland; marri	1172	0.41	1172	0.41	f
35	e6Mr a19Si	Shrublands; jam scrub with scattered York gum	187	0.1	187	0.1	f
7	e5,6Mi	Medium woodland; York gum (E. loxophleba) & wandoo	146	0.06	146	0.06	f
128	r	Bare areas; rock outcrops	17133	5.42	20433	6.46	f
4	e3,5Mi	Medium woodland; marri & wandoo	12880	0.86	12880	0.86	f
992	e2,5Mc	Medium forest; jarrah & wandoo (E. wandoo)	696	0.27	696	0.27	f
2048	x13SZc	Shrublands; scrub-heath in the Mallee Region	4448	1.38	4448	1.38	f
551	c3Sc	Shrublands; Allocasuarina campestris thicket	169	0.05	169	0.05	f
698	x9SZc/e5,45Lp	Mosaic: Shrublands; scrub-heath Dryandra-Calothamnus assoc. with B. prionotes on limestone in the northern Swan Region / Sparse low woodland; wandoo & powderbark wandoo	72	0.63	72	0.63	f
4801	nLr xZc	Shrublands; heath with scattered Nuytsia floribunda on sandplain	1839	3.16	1839	3.16	f
1516	e27,32Si	Shrublands; mallee scrub, black marlock & Forrest's marlock	6311	4.99	6311	4.99	f
552	c4Sc	Shrublands; Casuarina acutivalvus & calothamnus (also melalueca) thicket on greenstone hills	92	0.27	92	0.27	f
6048	bSZc	Shrublands; banksia scrub-heath on sandplain in the Esperance Plains Region	868	0.77	868	0.77	f
967	e5,7Mi	Medium woodland; wandoo & yate	339	0.16	339	0.16	f
519	e15Si	Shrublands; mallee scrub, Eucalyptus eremophila	80601	4.34	80601	4.34	f
952	dZc	Shrublands; dryandra heath	98	0.16	98	0.16	f
48	xSZc	Shrublands; scrub-heath	1536	7.52	1536	7.52	f
946	e5Mi	Medium woodland; wandoo	631	0.77	631	0.77	f

512	e15,32Si	Shrublands; mallee scrub, Eucalyptus eremophila & Forrest's marlock (E. forrestianna)	2463	1.04	2463	1.04	f
924	e15,22Si	Shrublands; mallee scrub, Eucalyptus eremophila & red mallee	1004	1.22	1004	1.22	f
694	x8SZc	Shrublands; scrub-heath on yellow sandplain banksia-xylomelum alliance in the Geraldton Sandplain & Avon-Wheatbelt Regions	30512	8.75	30512	8.75	f
516	e27Si	Shrublands; mallee scrub, black marlock	127106	9.84	127106	9.84	f
3048	x14SZc	Shrublands; scrub-heath on the Swan Coastal Plain	225	1.81	225	1.81	f
1000	e2,3Mi/bLi/mLc	Mosaic: Medium forest; jarrah-marri / Low woodland; banksia / Low forest; teatree (Melaleuca Spp.)	1963	1.36	1963	1.36	f
938	e6,7Mi	Medium woodland; York gum & yate	1223	1.59	1223	1.59	f
1967	e5,7,18Mi	Medium woodland; wandoo, yate & river gum	245	0.95	245	0.95	f
684	e6Mr a19Si/c3Sc	Mosaic: Shrublands; Shrublands; jam scrub with scattered York gum in the valleys / Allocasuarina campestris thicket	211	0.16	211	0.16	f
51	xGc	Sedgeland; reed swamps, occasionally with heath	17469	11.89	17469	11.89	f
31	e6Mr m5Sc	Shrublands; Melaleuca thyoides thicket with scattered York gum	376	13.19	376	13.19	f
942	e7Mi/e27Si	Mosaic: Medium woodland; yate / Shrublands; mallee scrub, black marlock	153	0.46	153	0.46	f
929	e33Lc	Low forest; moort (E. platypus)	34	0.32	34	0.32	f
47	e26SZc	Shrublands; tallerack mallee-heath	164382	14.66	164382	14.66	f
6	e2,4Mi	Medium woodland; tuart & jarrah	1582	1.98	1609	2.01	f
27	mLi	Low woodland; paperbark (Melaleuca sp.)	34250	10.13	34250	10.13	f
1001	e2Mb cbLi	Medium very sparse woodland; jarrah, with low woodland; banksia & casuarina	501	0.86	501	0.86	f
1020	e2,3Mc/e3,5Mi	Mosaic: Medium forest; jarrah-marri / Medium woodland; marri-wandoo	18	0.31	18	0.31	f
1031	hSZc/dZc	Mosaic: Shrublands; hakea scrub-heath / Shrublands; dryandra heath	31824	11.67	31824	11.67	f
3	e2,3Mc	Medium forest; jarrah-marri	83166	1.74	109556	2.29	f

949	bLi	Low woodland; banksia	19057	8.34	19091	8.36	f
931	e7Mi	Medium woodland; yate	1196	3.71	1196	3.71	f
972	e2,3,5,7Mi	Medium woodland; jarrah, marri, wandoo & yate	403	1.71	403	1.71	f
433	a23m3Sc/e44Lp	Mosaic: Shrublands; Acacia rostellifera & Melaleuca cardiophylla thicket / Sparse low woodland; illyarrie	1565	4.77	1565	4.77	f
968	e2,3,5Mi	Medium woodland; jarrah, marri & wandoo	9404	5.53	9404	5.53	f
934	e28Si	Shrublands; mallee scrub Eucalyptus nutans	981	1.51	981	1.51	f
1028	e18Mi	Medium woodland; river gum	117	10.27	117	10.27	f
392	m5Sc	Shrublands; Melaeuca thyioides thicket	152	4.97	152	4.97	f
5	e5,45Mi	Medium woodland; wandoo & powderbark (E. accedens)	2726	5.03	2726	5.03	f
1014	bLi/mSc	Mosaic: Low woodland; banksia / Shrublands; teatree thicket	91	0.22	91	0.22	f
440	a21Sr	Shrublands; Acacia ligulata open scrub	70	1.17	70	1.17	f
14	e2Lc	Low forest; jarrah	2511	2.14	2511	2.14	f
1030	b1,2Li	Low woodland; Banksia attenuata & B. menziesii	6488	4.57	6488	4.57	f
2051	mLc xGc	Sedgeland; sedges with low tree savanna woodland; paperbarks over & various sedges	290	2.76	290	2.76	f
1029	x9SZc	Shrublands; scrub-heath Dryandra-Calothamnus assoc. with B. prionotes on limestone in the northern Swan Region	10579	14.71	10579	14.71	f
37	mSc	Shrublands; teatree thicket	2175	4.69	2175	4.69	f
973	mLc	Low forest; paperbark (Melaleuca rhaphiophylla)	101	1.38	101	1.38	f

*codes are d = vegetation associations completely unrepresented in IUCN I- IV reserves or other CALM-managed lands, e = vegetation association unrepresented in IUCN I- IV reserves but <15% of their original areal extent in other CALM-managed lands, f = inadequately represented in the conservation reserve system with <15% of their original areal extent in IUCN I- IV and other CALM-managed lands.

Table 3. Vegetation associations potentially at risk from rising groundwaters and salinity.

Veg Assoc	Beard Code	Description	% remaining veg that is at risk	Codes*
10	e22Mi	Medium woodland; red mallee group	92.74	h
18	a1Li	Low woodland; mulga (Acacia aneura)	85.71	h
31	e6Mr m5Sc	Shrublands; Melaleuca thyoides thicket with scattered York gum	70.94	h
41	mSi	Shrublands; teatree scrub	78.01	h
53	e48Mi xLSr spGc	Mosaic: Grasslands/pindan; Medium woodland with mixed tree scrub over ?tall upland grass and plectrachne	83.33	h
125	sl	Bare areas; salt lakes	57.83	j
393	c6Lr m5Sc	Shrublands; Melaleuca thyoides thicket with scattered Casuarina obesa	84.68	h
412	mSi k3Ci	Succulent steppe with scrub; teatree (Melaleuca thyioides?) over samphire	64.87	j
511	e8,9Mi	Medium woodland; salmon gum & morrel	60.40	j
676	k3Ci	Succulent steppe; samphire	56.41	j
695	c3Si	Shrublands; Allocasuarina campestris scrub	100.00	g
697	x7SZc	Shrublands; scrub-heath on lateritic sandplain in the southern Geraldton Sandplain Region	93.86	h
924	e15,22Si	Shrublands; mallee scrub, Eucalyptus eremophila & red mallee	60.34	j
948	e6,18Mr	Medium woodland; York gum & river gum	100.00	g
950	c6Mi	Medium woodland; Casuarina obesa	98.16	h
953	mSc k3Ci	Succulent steppe with thicket; teatree over samphire (m5?)	88.56	h

963	e7mMi	Medium woodland; yate & paperbark (Melaleuca spp)	87.32	h
966	e8,9Mp mSc k3Ci	Succulent steppe with sparse woodland & thicket; salmon gum & morrell over teatree & samphire	100.00	g
971	e67Si	Shrublands; mallee scrub, Eucalyptus decipiens	60.32	j
972	e2,3,5,7Mi	Medium woodland; jarrah, marri, wandoo & yate	99.44	h
988	m5Sc k3Ci	Succulent steppe with thicket; Melaleuca thyoides over samphire	70.63	h
1018	e2,3Mi/bLi/mLc/c6Li	Mosaic: Medium forest; jarrah-marri / Low woodland; banksia / Low forest; teatree / Low woodland; Casuarina obesa	60.47	j
1034	e3,5,45Mi	Medium woodland; marri, wandoo & powderbark	50.41	j
1036	b3Li	Low woodland; Banksia prionotes	73.36	h
1037	e6,18Mi	Medium woodland; York gum & river gum (incl e6,18Mr?)	99.86	h
1039	e6Mr eSi	Shrublands; mallee with scattered York gum	100.00	g
1040	c6e6Mi	Medium woodland; York gum & Casuarina obesa	91.25	h
1051	e5,7Mr mSc	Shrublands; teatree thicket with scattered wandoo & yate	80.71	h
1053	e6Mr m6Sc	Shrublands; Melaleuca uncinata thicket with scattered York gum	50.51	j
1074	e5c6Mr mSc k3Ci	Succulent steppe with open woodland & thicket; wandoo & Allocasuarina obesa over teatree & samphire	95.28	h

1079	e8,9Mr/k1Ci	Mosaic: Medium open woodland; salmon gum & morrel / Succulent steppe; saltbush	99.38	h
1083	e5,8c6Mr mSi k3Ci	Succulent steppe with open woodland & scrub; wandoo, salmon gum & Allocasuarina obesa over teatree & samphire	81.94	h
1091	b3c5Li	Low woodland; Banksia prionotes & Allocasuarina huegelianna	100.00	g
1093	ec6Mr mSc k3Ci	Succulent steppe with open woodland & thicket; eucalypts & Allocasuarina obesa over teatree & samphire	89.89	h
1096	e7,8Mi	Medium woodland; yate & salmon gum	97.78	h
1098	e8,9Mp/k3Ci	Mosaic: Medium sparse woodland; salmon gum & morrel / Succulent steppe; samphire	94.88	h
1200	e8,9Mi/e15,27Si	Mosaic: Medium woodland; salmon gum & morrel / Shrublands; mallee scrub Eucalyptus eremophila & black marlock (E. redunca)	55.52	j
1516	e27,32Si	Shrublands; mallee scrub, black marlock & Forrest's marlock	50.41	j
2093	e7Mi mSi k3Ci	Succulent steppe with open woodland & scrub; yate over teatree & samphire	95.59	h

*codes are g = vegetation associations with 100% of their remaining extent at risk, h = vegetation association with >70% or their remaining extent at risk, j = vegetation association with >50% or their remaining extent at risk.

Table 4. Summary of analyses showing the vegetation associations that are relatively restricted in areal extent, poorly conserved and at risk

Veg Assoc	Beard Code	Description	Limited present extent	Poorly conserved	At risk
10	e22Mi	Medium woodland; red mallee group	ac	d	h
695	c3Si	Shrublands; Allocasuarina campestris scrub	ac	d	g
948	e6,18Mr	Medium woodland; York gum & river gum	ac	d	g
950	c6Mi	Medium woodland; Casuarina obesa	c	d	h
953	mSc k3Ci	Succulent steppe with thicket; teatree over samphire (m5?)	ac	d	h
963	e7mMi	Medium woodland; yate & paperbark (Melaleuca spp)	bc	d	h
966	e8,9Mp mSc k3Ci	Succulent steppe with sparse woodland & thicket; salmon gum & morrell over teatree & samphire	ac	d	g
1040	c6e6Mi	Medium woodland; York gum & Casuarina obesa	bc	d	h
1074	e5c6Mr mSc k3Ci	Succulent steppe with open woodland & thicket; wandoo & Allocasuarina obesa over teatree & samphire	c	d	h
1091	b3c5Li	Low woodland; Banksia prionotes & Allocasuarina huegelianna	c	d	g
1093	ec6Mr mSc k3Ci	Succulent steppe with open woodland & thicket; eucalypts & Allocasuarina obesa over teatree & samphire	ac	d	h
1096	e7,8Mi	Medium woodland; yate & salmon gum	c	d	h
1098	e8,9Mp/k3Ci	Mosaic: Medium sparse woodland; salmon gum & morrel / Succulent steppe; samphire	bc	d	h

*codes are a = vegetation association with <10% of their original areal extent remaining, b = vegetation association with <30% of their original areal extent remaining, c = vegetation association with <2,000 ha remaining, d = vegetation associations completely unrepresented in IUCN I-IV reserves or other CALM-managed lands, e = vegetation association unrepresented in IUCN I- IV reserves but <15% of their original areal extent in other CALM-managed lands, f = inadequately represented in the conservation reserve system with <15% of their original areal extent in IUCN I- IV and other CALM-managed lands, g = vegetation associations with 100% of their remaining extent at risk, h = vegetation association with >70% or their remaining extent at risk, j = vegetation association with >50% or their remaining extent at risk.

Figures.

Map 1. South west Western Australia showing Vegetation Association 10, e_{22}Mi: Medium woodland; red mallee group.

Map 2. South west Western Australia showing Vegetation Association 695, c_{3}Si: Shrublands; *Allocasuarina campestris* scrub.

Map 3. South west Western Australia showing Vegetation Association 948, $e_{6,18}$Mr: Medium woodland; York gum & river gum.

Map 4. South west Western Australia showing Vegetation Association 950, c_{6}Mi: Medium woodland; *Casuarina obesa*.

Map 5. South west Western Australia showing Vegetation Association 953, mSc k_{3}Ci: Succulent steppe with thicket; teatree over samphire.

Map 6. South west Western Australia showing Vegetation Association 963, e_{7}mMi: Medium woodland; yate & paperbark (*Melaleuca* spp).

Map 7. South west Western Australia showing Vegetation Association 966, $e_{8,9}$Mp mSc k_{3}Ci: Succulent steppe with sparse woodland & thicket; salmon gum & morrell over teatree & samphire.

Map 8. South west Western Australia showing Vegetation Association 1040, $c_{6}e_{6}$Mi: Medium woodland; York gum & *Casuarina obesa*.

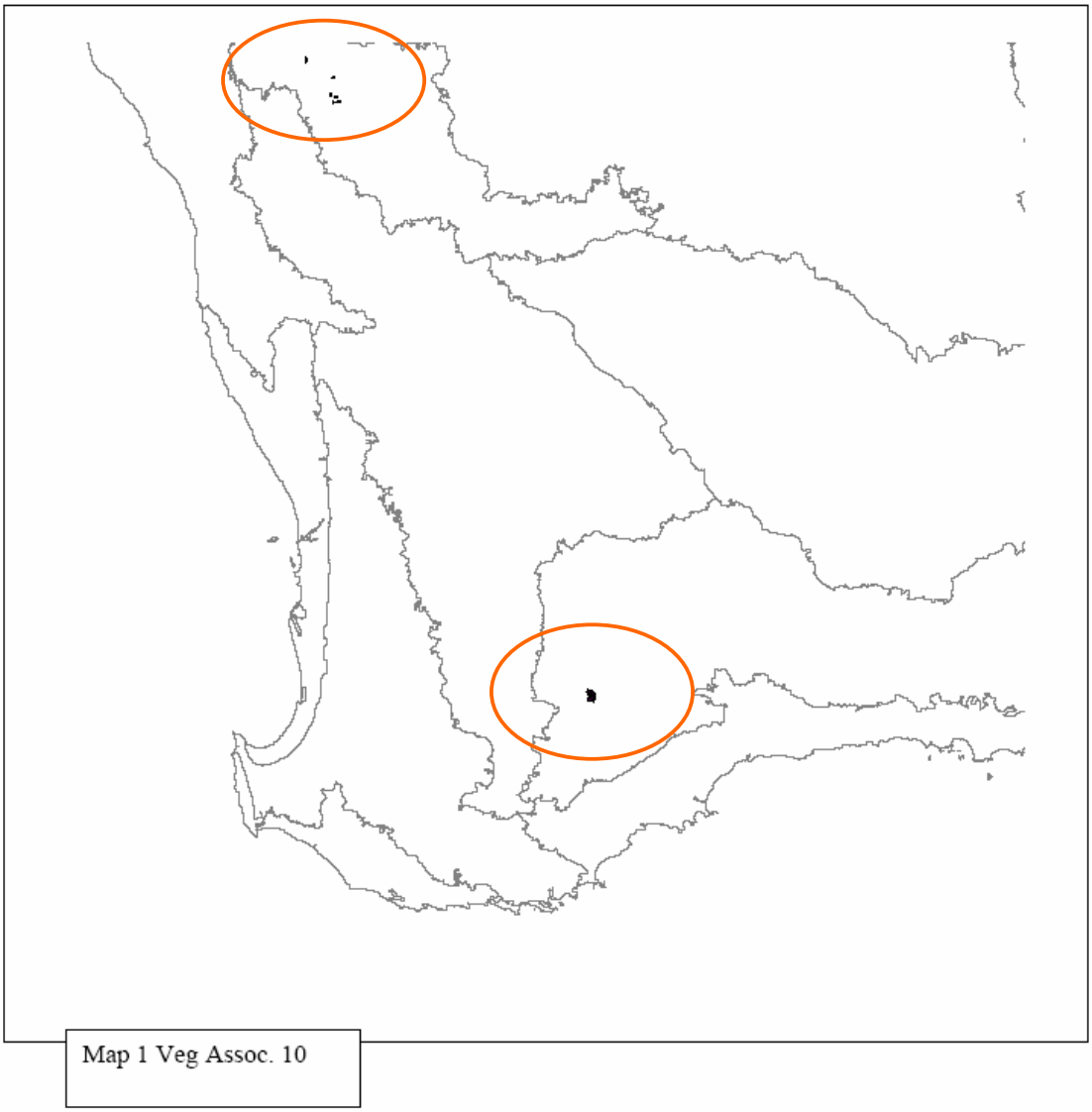
Map 9. South west Western Australia showing Vegetation Association 1074, $e_{5}c_{6}$Mr mSc k_{3}Ci: Succulent steppe with open woodland & thicket; wandoo & *Allocasuarina obesa* over teatree & samphire.

Map 10. South west Western Australia showing Vegetation Association 1091, $b_{3}c_{5}$Li: Low woodland; *Banksia prionotes* & *Allocasuarina huegelianna*.

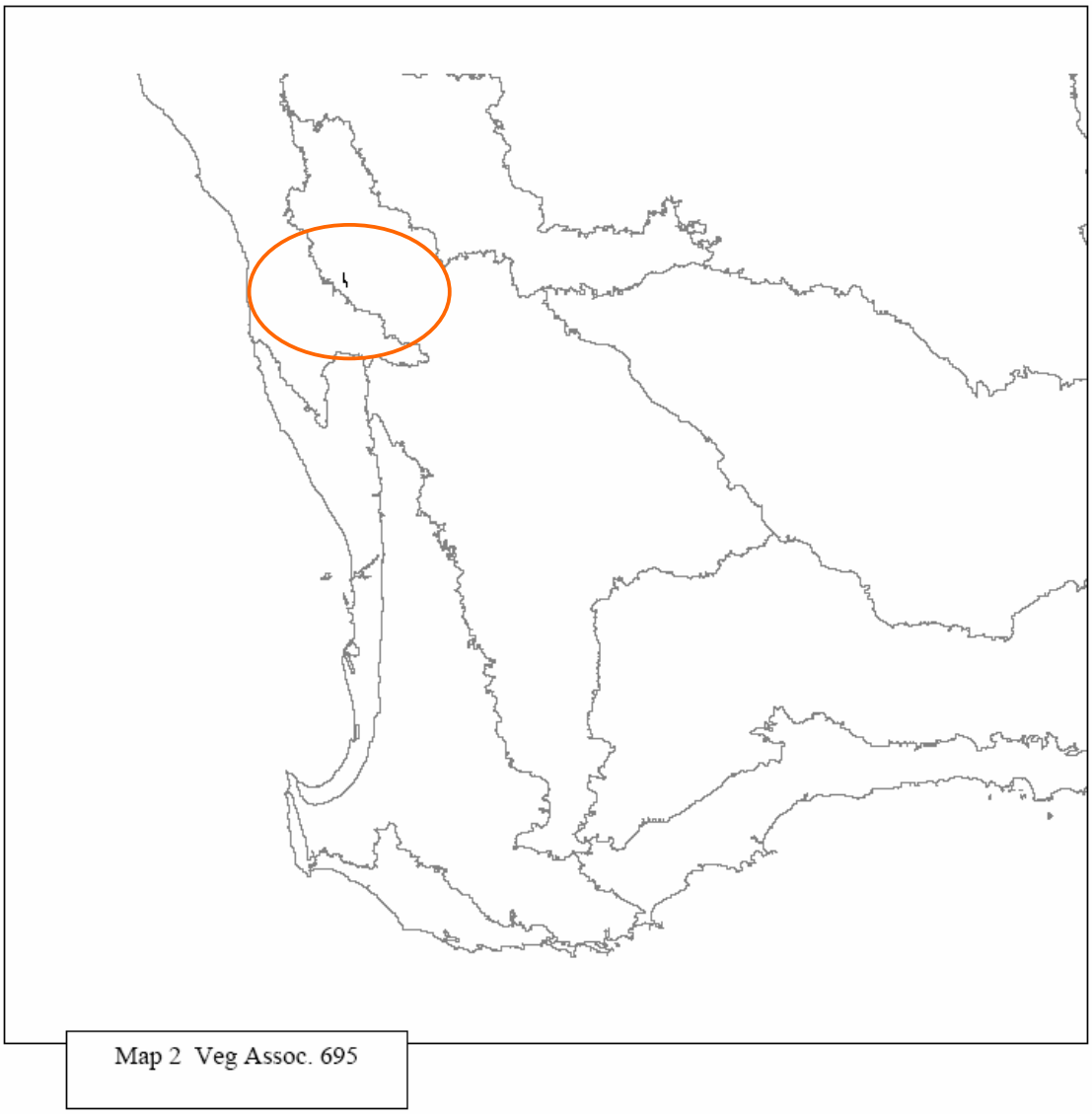
Map 11. South west Western Australia showing Vegetation Association 1093, ec_{6}Mr mSc k_{3}Ci: Succulent steppe with open woodland & thicket; eucalypts & *Allocasuarina obesa* over teatree & samphire.

Map 12. South west Western Australia showing Vegetation Association 1096, $e_{7,8}$Mi: Medium woodland; yate & salmon gum.

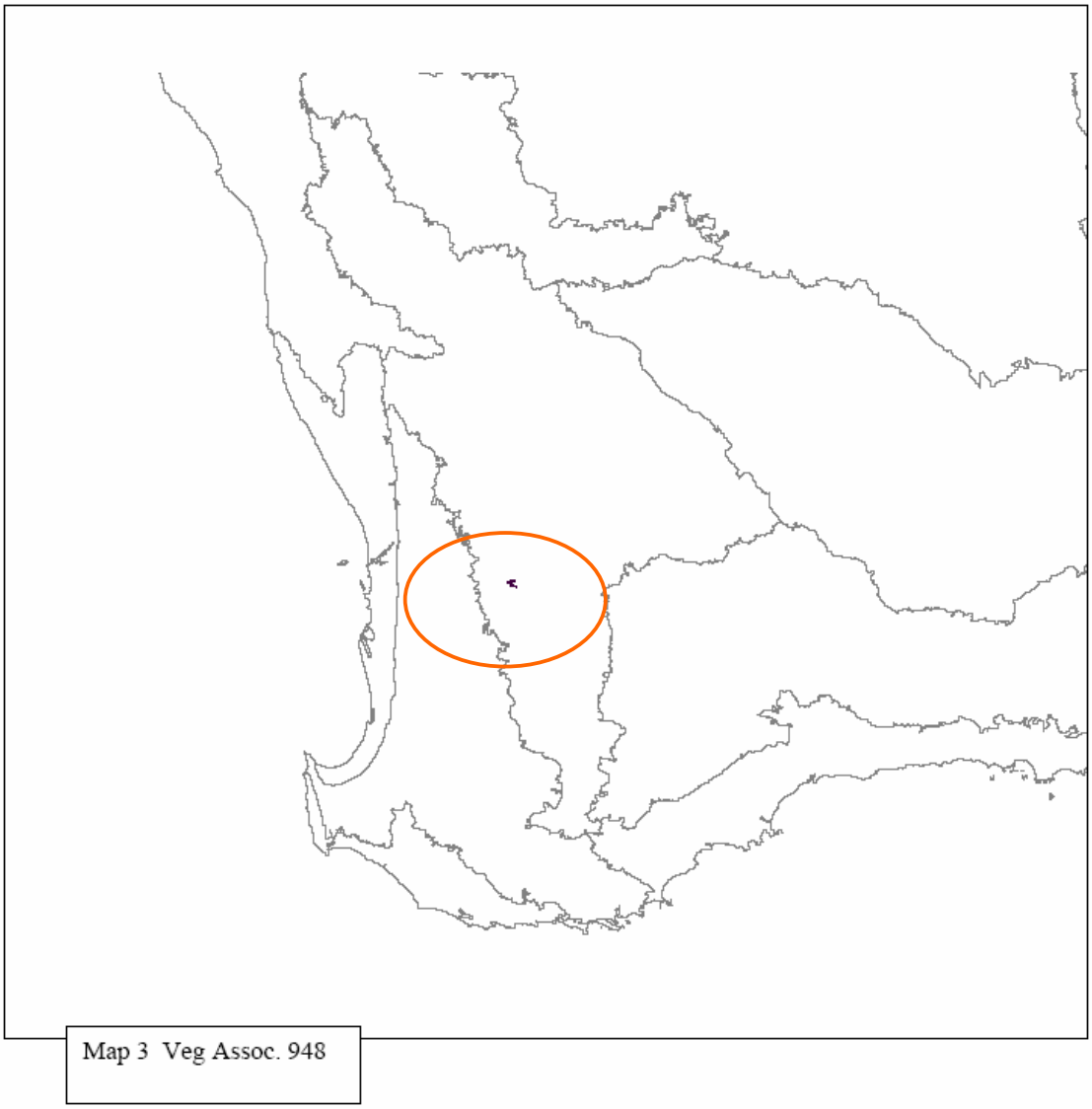
Map 13. South west Western Australia showing Vegetation Association 1098, $e_{8,9}$Mp/k_{3}Ci: Mosaic: Medium sparse woodland; salmon gum & morrel / Succulent steppe; samphire.



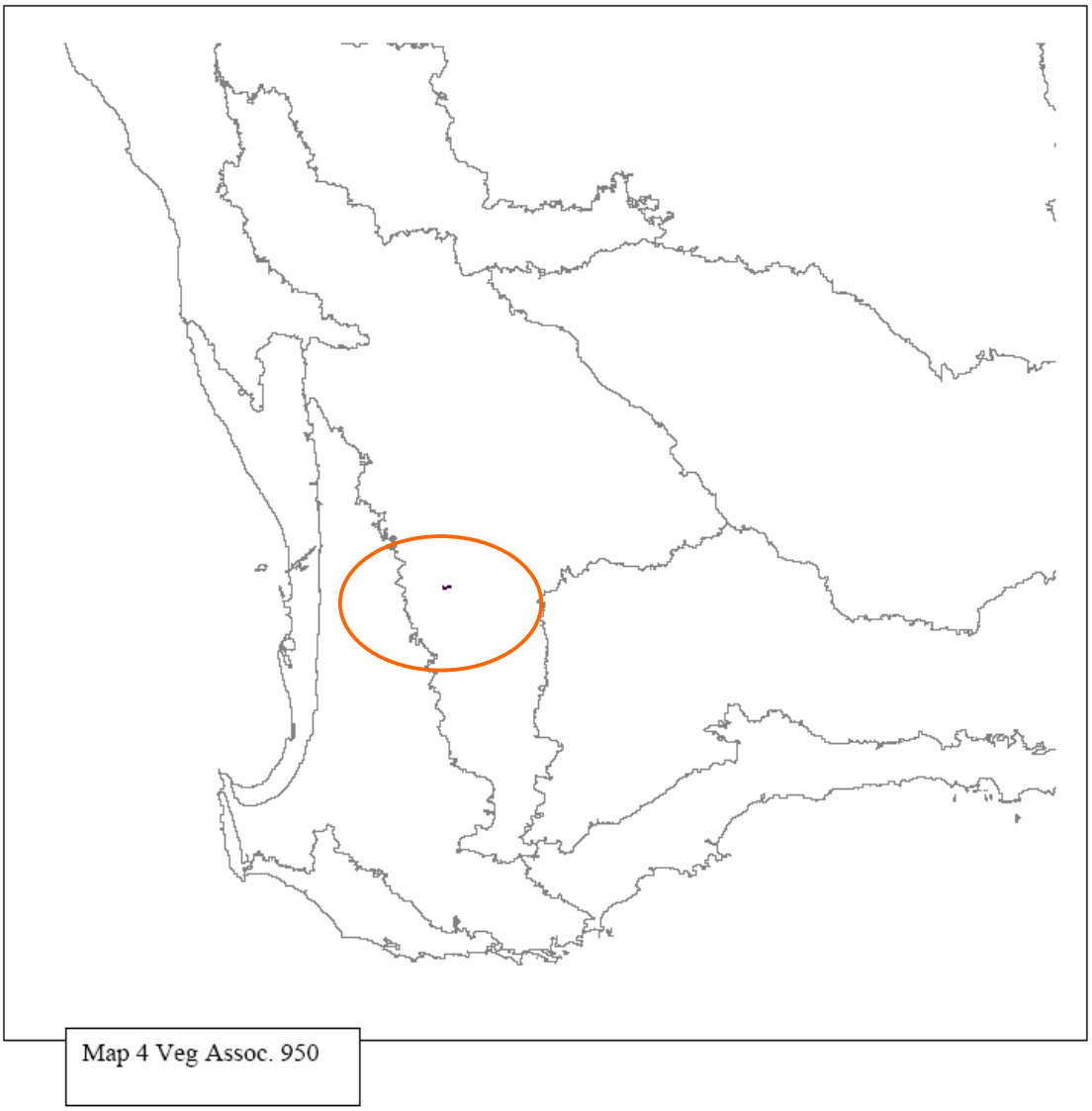
Map 1. South west Western Australia showing Vegetation Association 10, e22Mi: Medium woodland; red mallee group



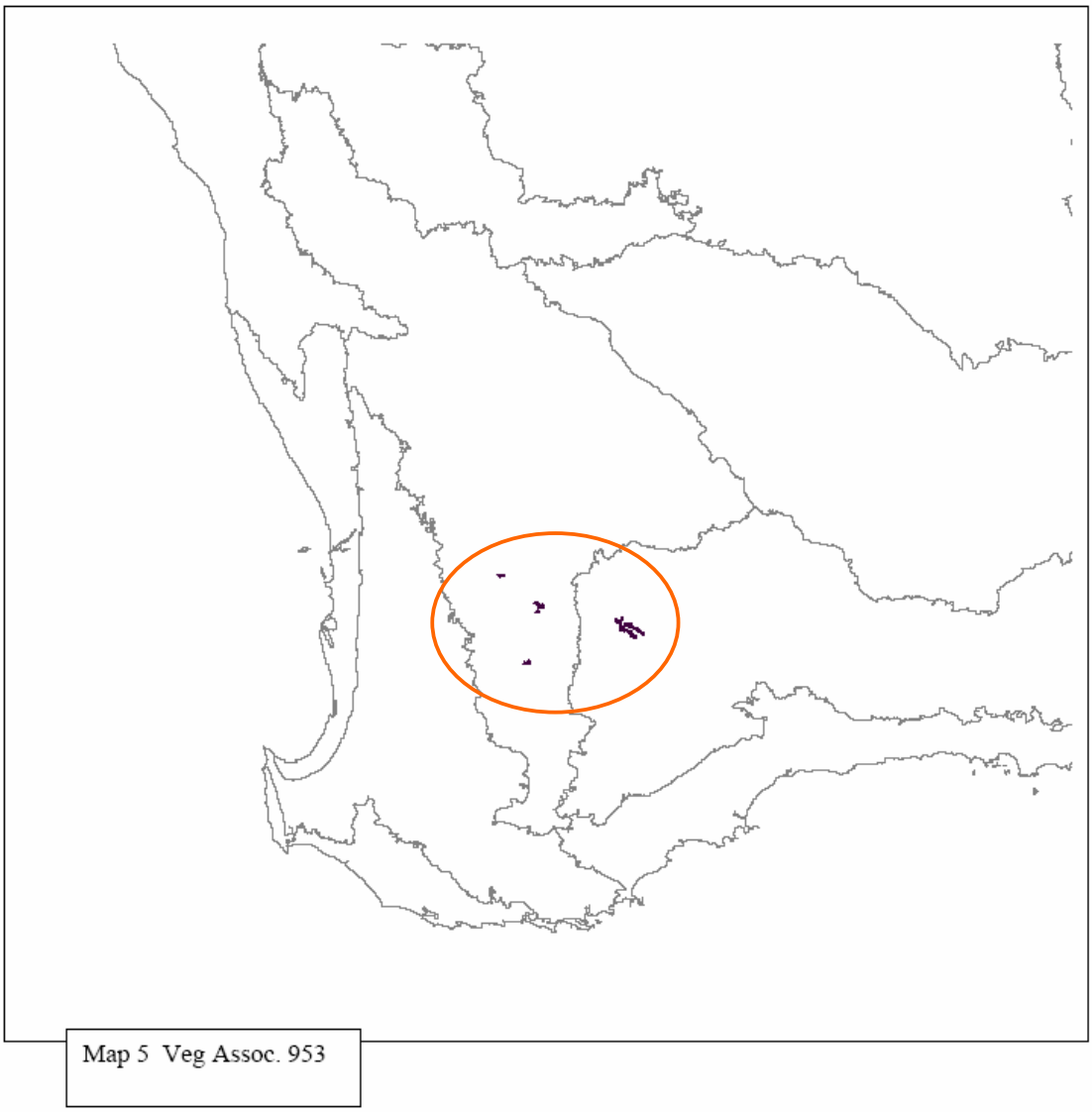
Map 2. South west Western Australia showing Vegetation Association 695, c3Si: Shrublands; *Allocasuarina campestris* scrub.



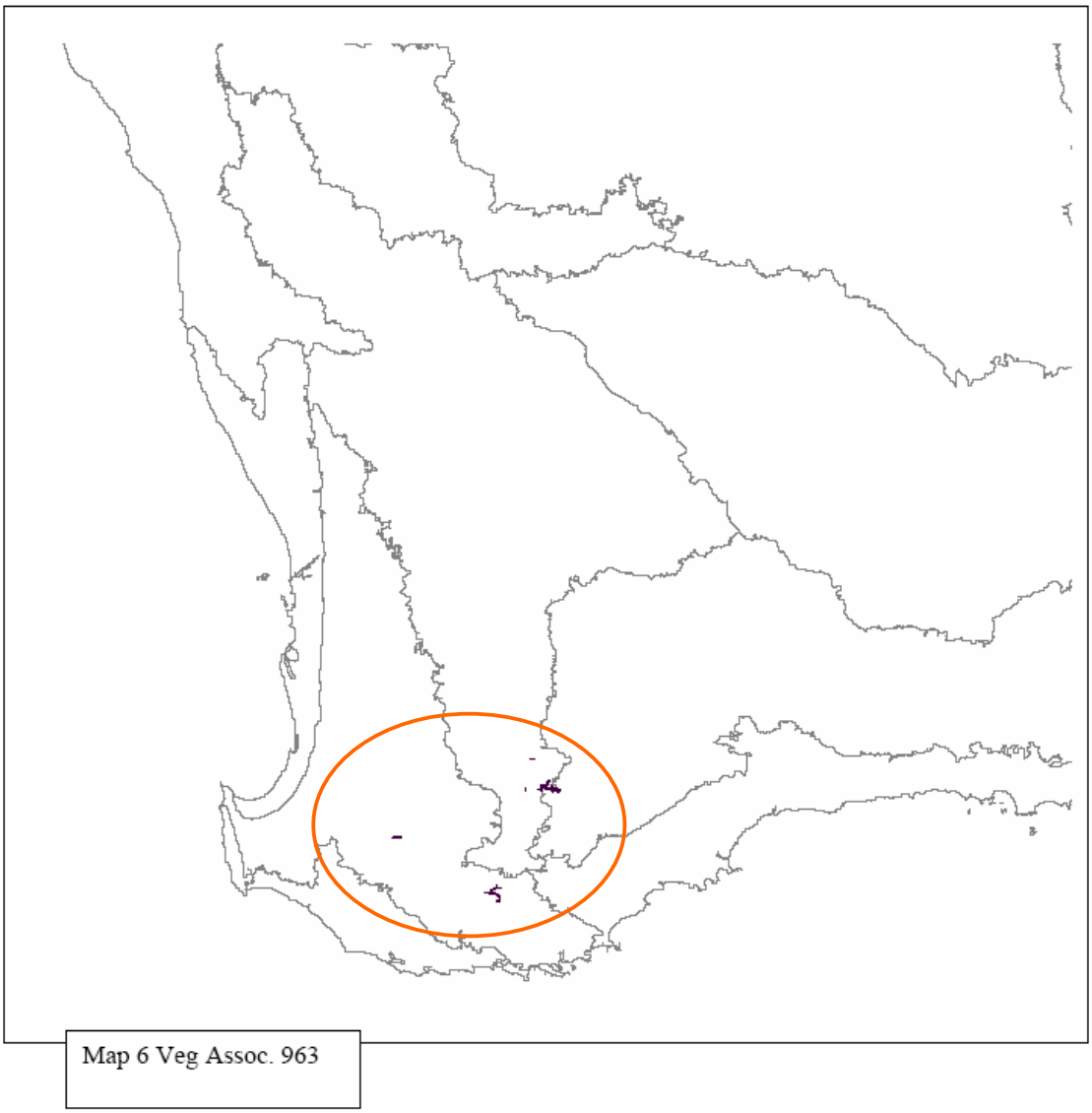
Map 3. South west Western Australia showing Vegetation Association 948, e6,18Mr: Medium woodland; York gum & river gum.



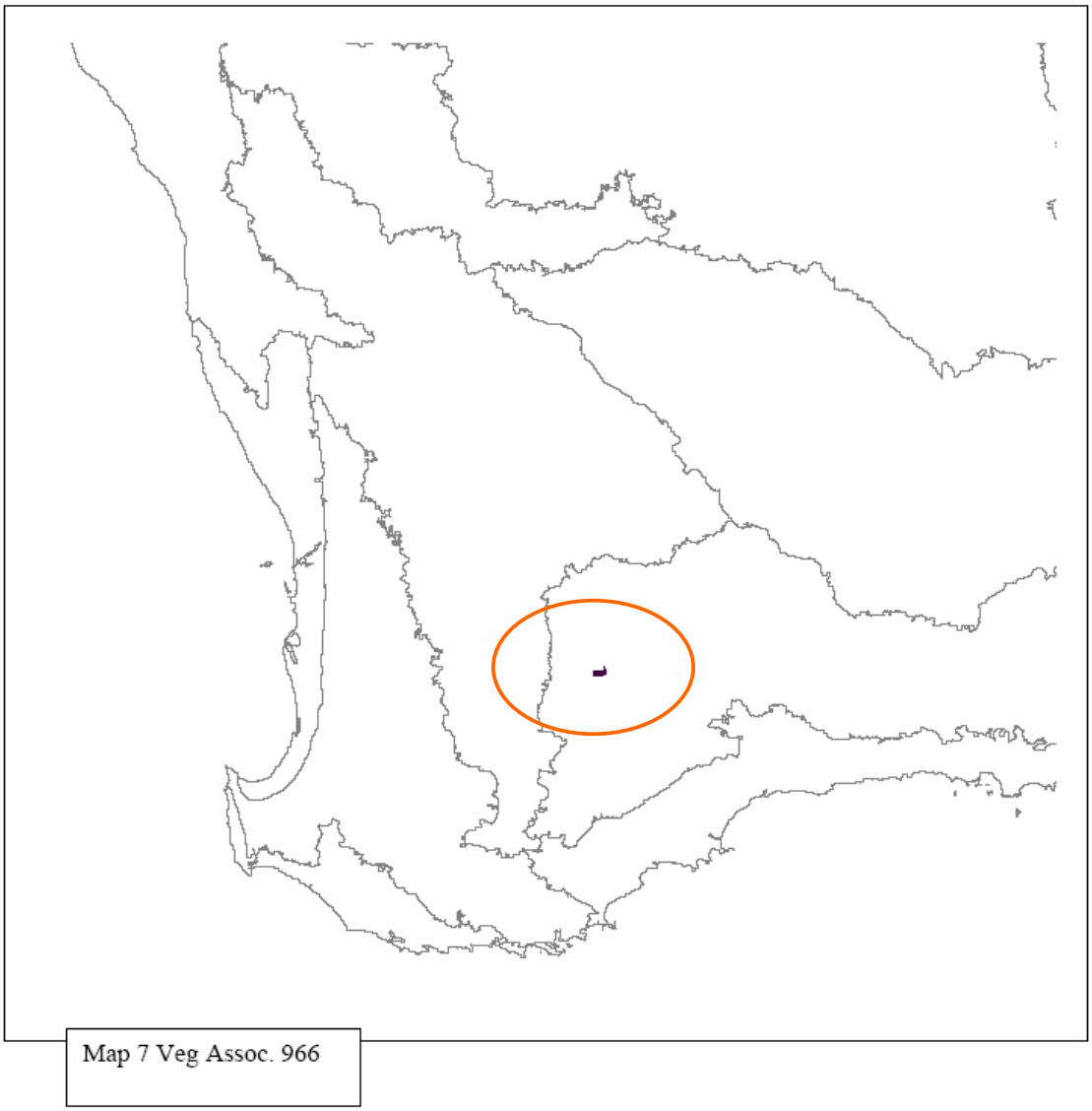
Map 4. South west Western Australia showing Vegetation Association 950, c6Mi: Medium woodland; *Casuarina obesa*.



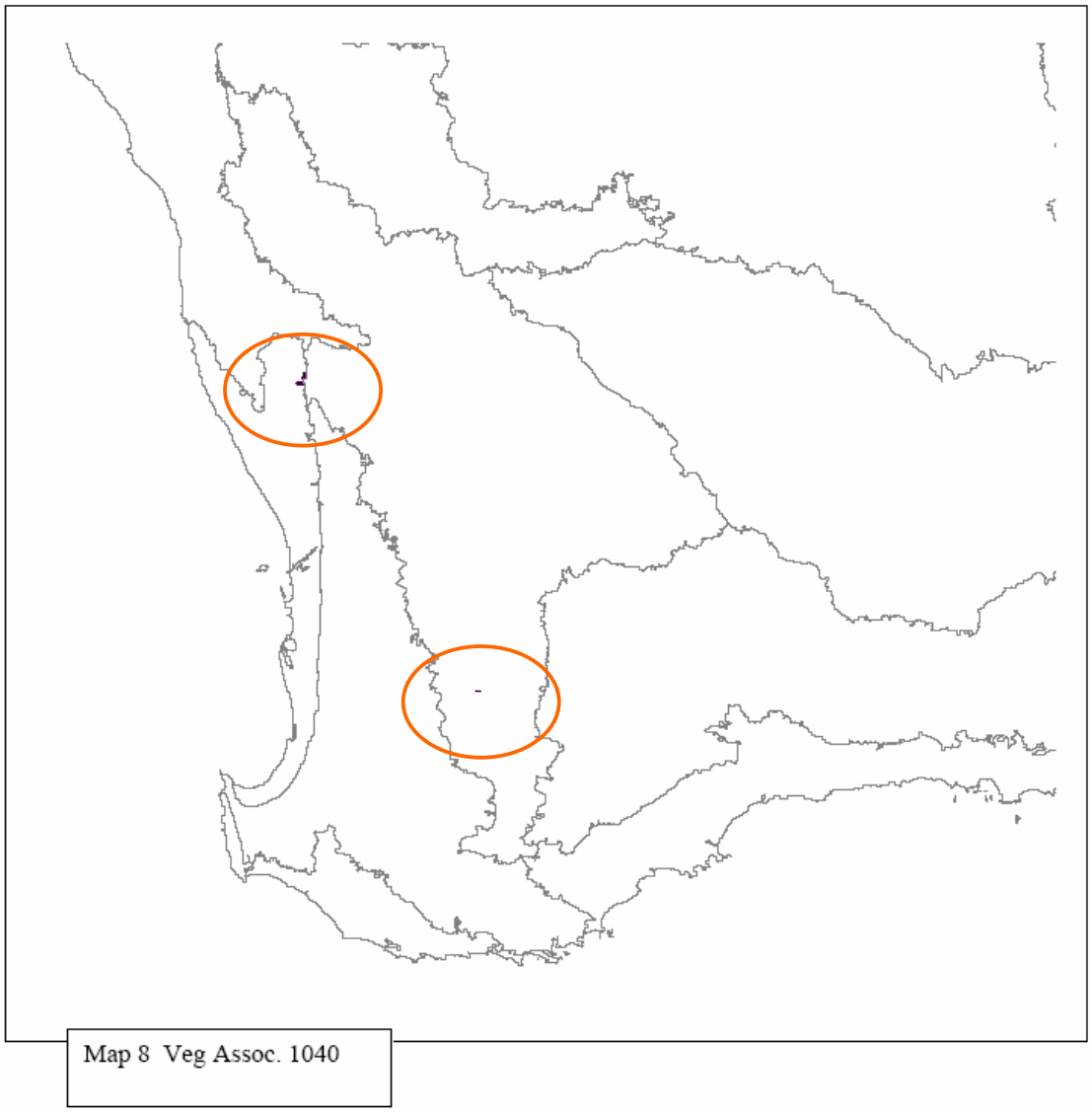
Map 5. South west Western Australia showing Vegetation Association 953, mSc k3Ci: Succulent steppe with thicket; teatree over samphire.



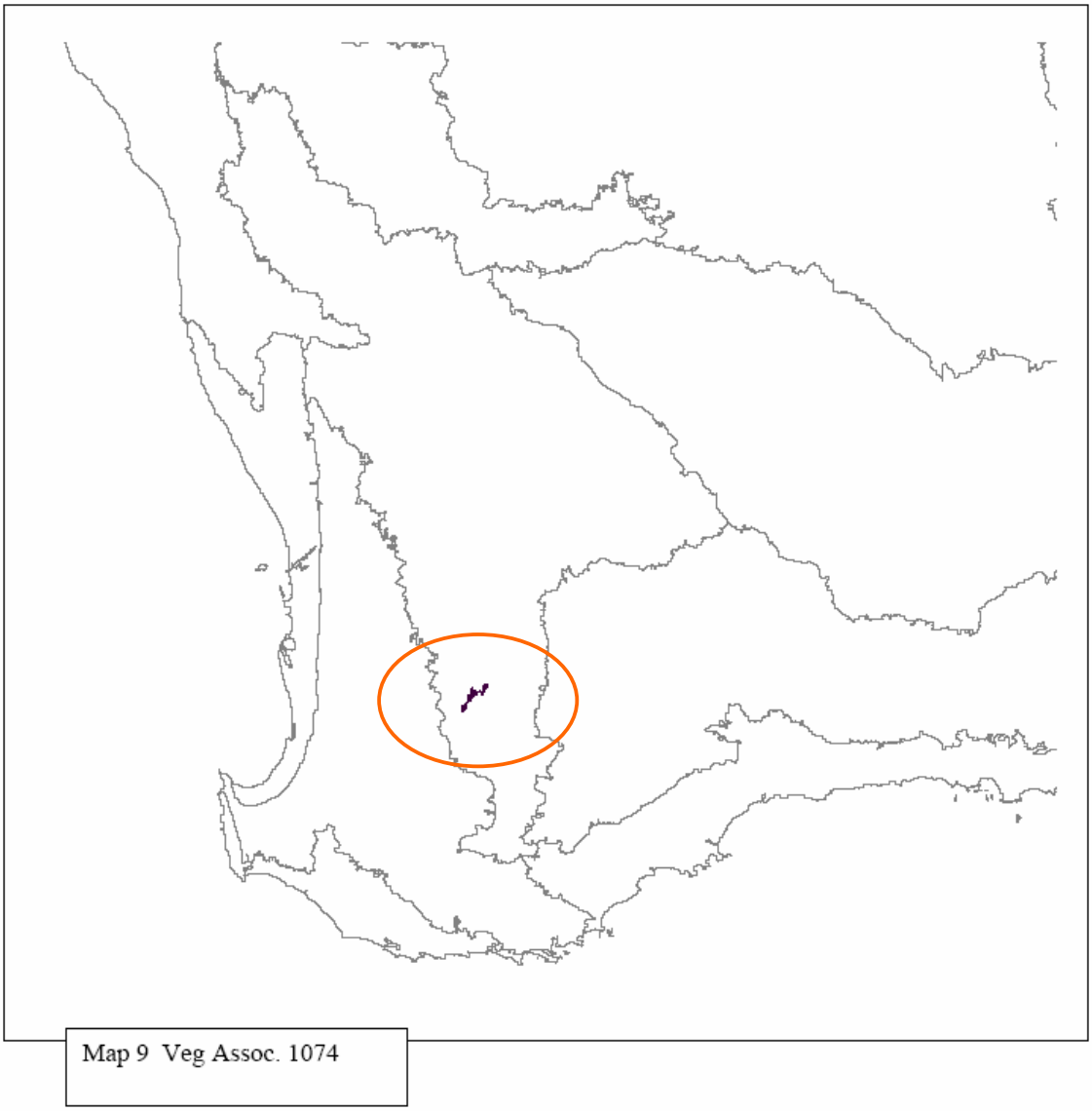
Map 6. South west Western Australia showing Vegetation Association 963, e7mMi: Medium woodland; yate & paperbark (*Melaleuca* spp).



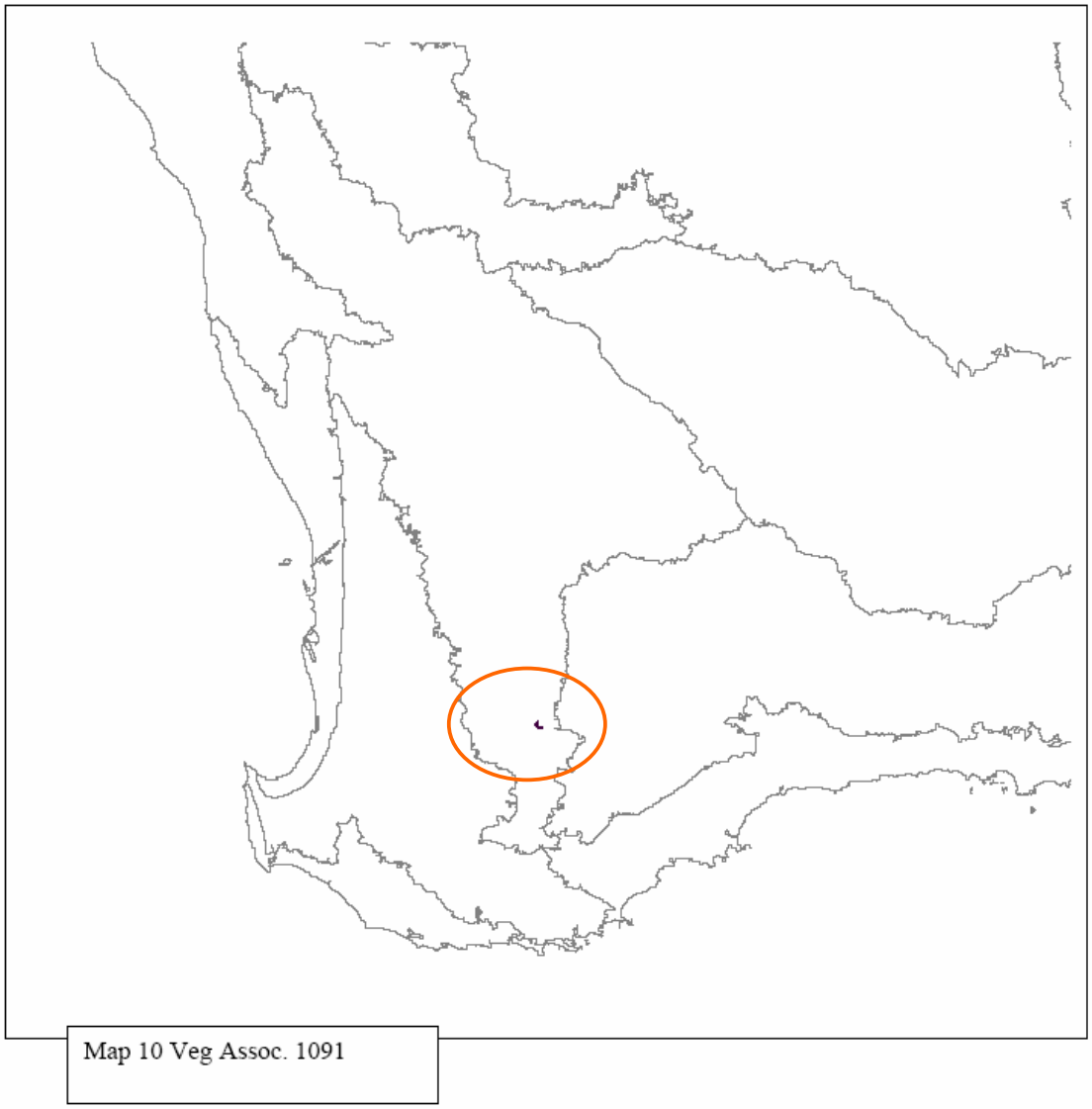
Map 7. South west Western Australia showing Vegetation Association 966, e8,9Mp mSc k3Ci: Succulent steppe with sparse woodland & thicket; salmon gum & morrell over teatree & samphire.



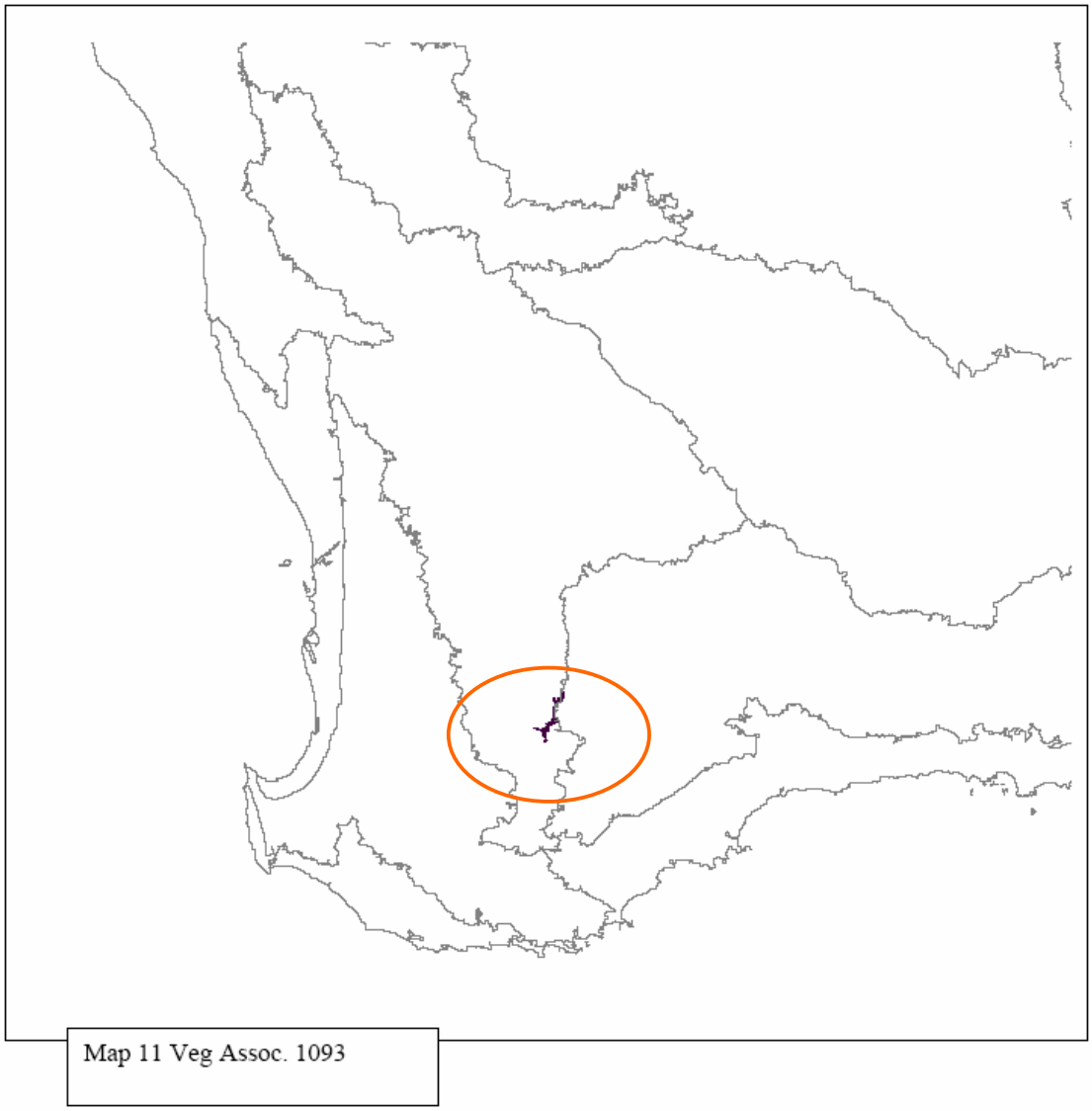
Map 8. South west Western Australia showing Vegetation Association 1040, c6e6Mi: Medium woodland; York gum & *Casuarina obesa*.



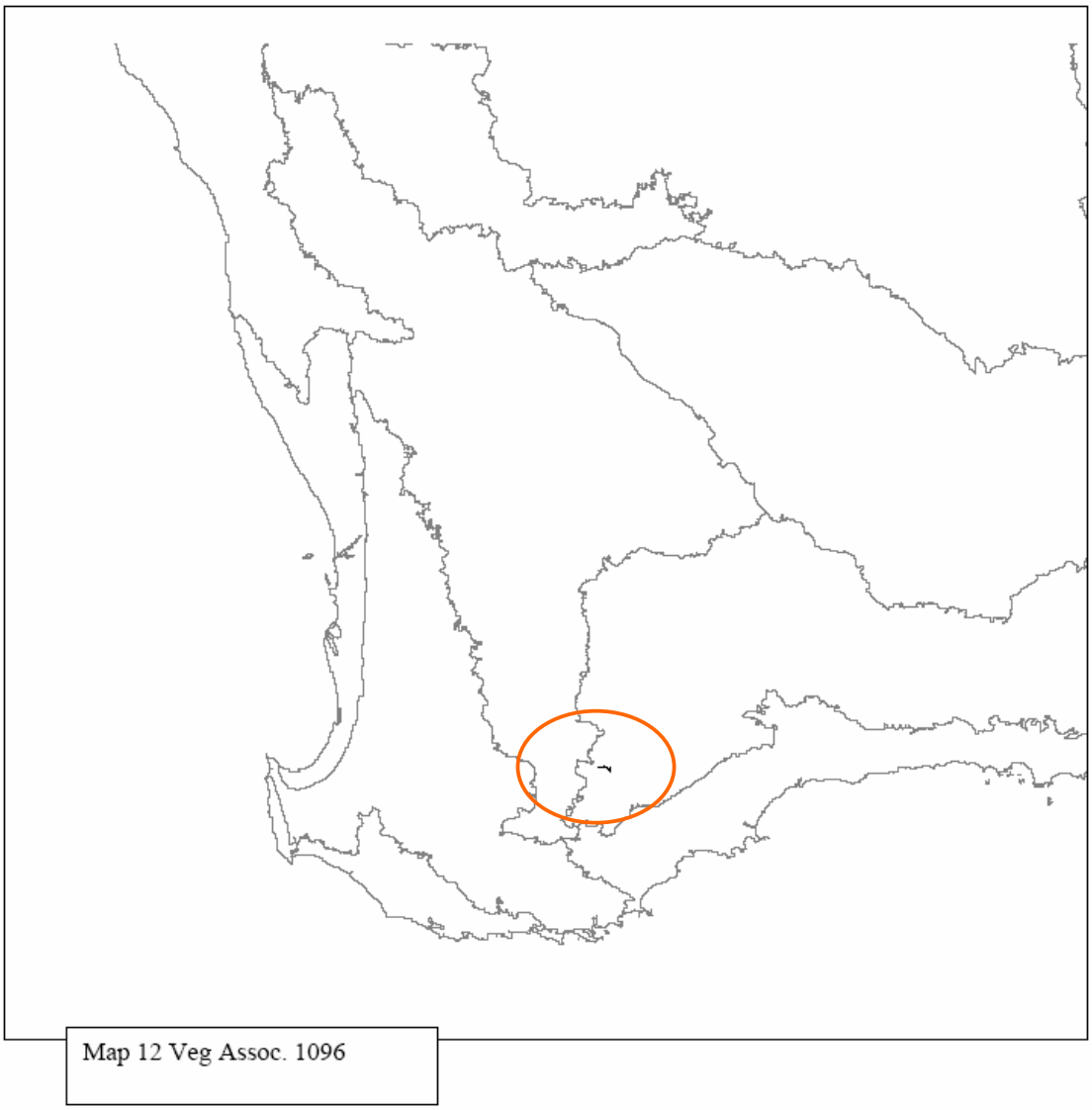
Map 9. South west Western Australia showing Vegetation Association 1074, e5c6Mr mSc k3Ci: Succulent steppe with open woodland & thicket; wandoo & *Allocasuarina obesa* over teatree & samphire.



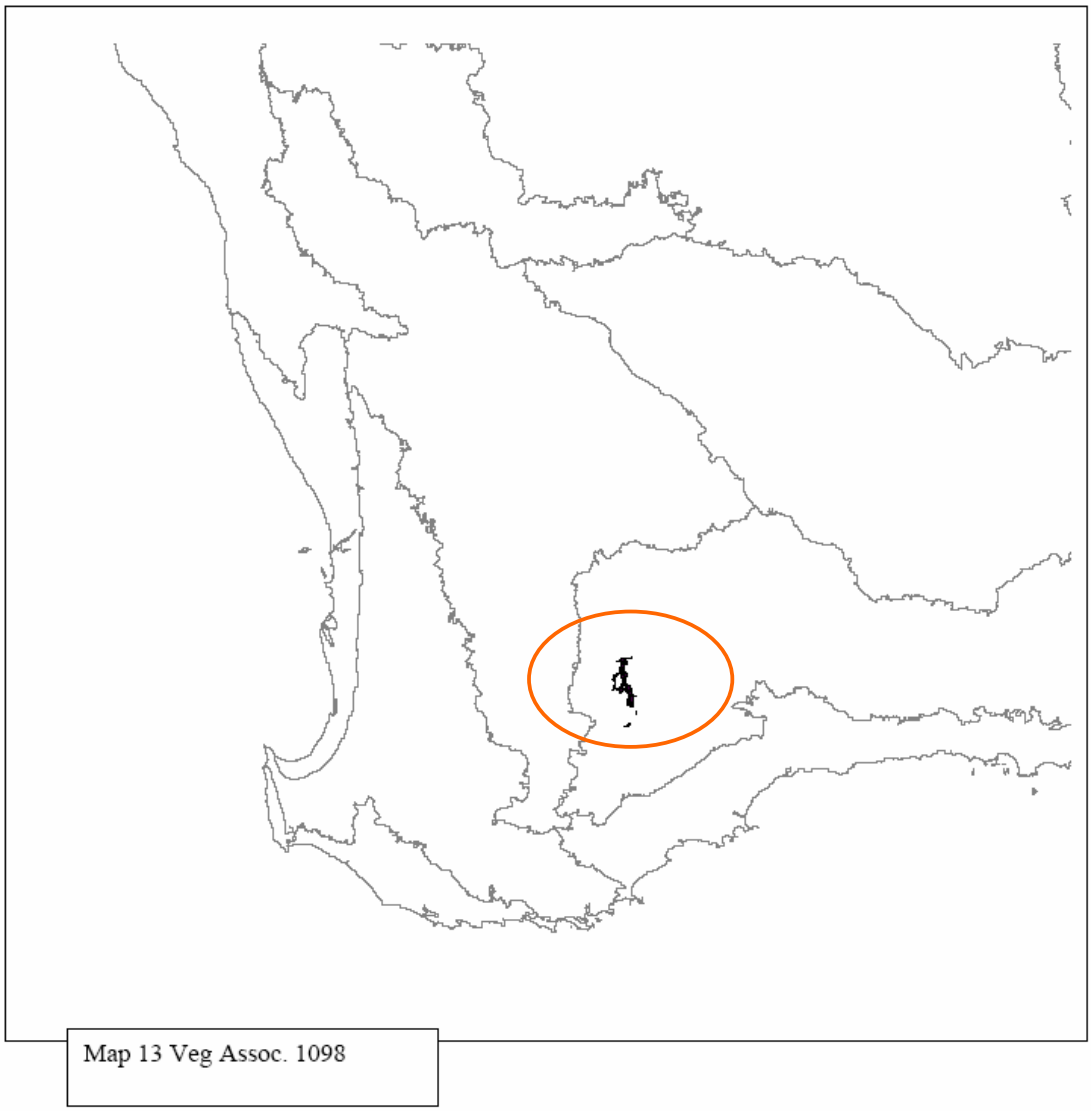
Map 10. South west Western Australia showing Vegetation Association 1091, b3c5Li: Low woodland; *Banksia prionotes* & *Allocasuarina huegelianna*.



Map 11. South west Western Australia showing Vegetation Association 1093, ec6Mr mSc k3Ci: Succulent steppe with open woodland & thicket; eucalypts & *Allocasuarina obesa* over teatree & samphire.



Map 12. South west Western Australia showing Vegetation Association 1096, e7,8Mi: Medium woodland; yate & salmon gum.



Map 13. South west Western Australia showing Vegetation Association 1098, e8,9Mp/k3Ci: Mosaic: Medium sparse woodland; salmon gum & morrel / Succulent steppe; samphire.

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