Warren *(WAR – Warren)*

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Subregional description and biodiversity values

Description and area

Dissected undulating country of the Leeuwin Complex, Southern Perth Basin (Blackwood Plateau), South-West intrusions of the Yilgarn Craton and western parts of the Albany Orogen with loamy soils supporting Karri forest, laterites supporting Jarrah-Marri forest, leached sandy soils in depressions and plains supporting low Jarrah woodlands and paperbark / sedge swamps, and Holocene marine dunes with *Agonis flexuosa* and Banksia woodlands and heaths. The climate is moderate Mediterranean. The bioregion is not further divided into subregions and the area is 1, 027, 639ha.

Dominant land use
(see Appendix B, key b)

Mainly grazing (improved pastures), cultivation (irrigated horticulture), and conservation, with lesser but significant areas of forestry (native forests and plantations), rural residential, mining, and easements for roads, power lines etc.

Continental Stress Class

The Continental Stress Class for WAR is 5. However, the estimate supplied for data for the number of threatened flora is incorrect and if the number of threatened flora species are included, the combined stress level for the threatened species attribute at 3. Therefore the Continental Stress Class is 3, not 5. Biophysical naturalness attribute weights grazing heavily but ignores introduced disease processes - this does not take into account major impacts of *Phytophthora* on a major part of the vascular flora and most of the vegetation associations in the region, all which have major Proteaceous, Ericaceous and Myrtaceous elements. The Australian Dryland Salinity Assessment 2000 identifies large tracts of the region as at risk (National Land and Water Resources Audit 2001). Current downstream impacts of Salinity (for example the Kent River discharge basin and Owingup Swamp are not accounted for). Extensive loss through clearing in the important Scott River group of communities and those along the Leeuwin Naturaliste Ridge likewise appear to be missed (division of subregions based on geology and soils would have detected this element).

Known special values in relation to landscape, ecosystem, species and genetic values

Rare Features:
Notable values include the tall forests (Karri, Jarrah and the Tingles), the limestone systems with its cave fauna and the mound forming microbial associations in the west of the region, its relictual Gondwanan arachnid fauna including the tingle *Moggridgea* and Torndirrup's *Austrarchaea mainae* as well as other Gondwanan relics such as *Dardarus* sp. millipedes, *Cynotelopus notabilis* and velvet worms. A number of Critical Weight Range vertebrates also persist in the region, including Southern Brown Bandicoot (*Isoodon obesulus*), Chuditch (*Dasyurus geoffroii*), Brush-tailed Phascogale (*Phascogale tapoatafa*) and others. Rare birds include the Western Whipbird (*Psophodes nigrogularis oberon*) and several cockatoos and parrots.

Centres of Endemism:
The South-west of WA is considered to be a biodiverse area of the world for vascular plants with levels of endemism of between 75 and 80%. Lyons *et al.* (2000) reviewed the vascular flora of the Warren Bioregion and found the level of endemism at about 4%, most of the taxa occurring in more than one bioregion. The endemics were not uniformly distributed across the region (Lyons *et al.* 2000). Concentrations were noted for the Scott River Plains, the Leeuwin Naturaliste Ridge and the area around Walpole (Lyons *et al.* 2000). Similar concentrations of local endemics (species with ranges of less than 100km) were found during the RFA analysis of the South-West Forest Region (Commonwealth and Western Australian Governments 1999).

The aquatic fauna of the bioregion shows a similar, if not stronger pattern of endemism than the flora (Trayler *et al.* 1996). The freshwater cray genus *Engaewa* is endemic to the bioregion. The invertebrate fauna shows similar patterns with a significant endemic fauna in the forests and wetlands of the region.

Refugia:
Despite the impacts of climate fluctuations through the quaternary on the South-West, this bioregion primarily exists because it has to a large extent been buffered against the complete intrusion of the eremean. It is a narrow coastal strip and south to south west slopes rising to the darling plateau that have benefited from proximity to the southern ocean and the rain bearing weather systems that have trailed the coast even during the dries periods of the ice ages. As such it contains refugia with relict taxa of a wetter milder era with groups and species of vascular and cryptic flora and invertebrates normally associated with the rainforests / *Nothofagus* forests of South-Eastern Australia, these species now missing from the rest of the State. For example, Tingle forests provide habitat for relictual invertebrates (*Moggridgea* and velvet worms (Oncophora) and a range of like relict taxa) and peat / organic wetlands are home to relictual and other aquatic invertebrates. There are limestone cave and karst

features supporting endemic invertebrate fauna on the west coast, and the subregion contains the state's richest area for bryophytes (many of which are normally associated with rainforests).

High Species or Ecosystems Diversity:
High rainfall, and low evapotranspiration of the bioregion makes it unique (along with parts of the adjacent Southern Jarrah Forest (JF2)) in WA. The climate is such that the landscape is characterised by high forests, perennial rivers and wetland systems.

As a result of the climatic processes acting on its ancient landscape that have shaped the biota of the South Western corner of WA through the quaternary (and in particular the ice ages) speciation has been rampant and a highly endemic biota has emerged. This region, with its suites of endemics in its vascular flora (Myrtaceae, Rutaceae, Proteaceae, Papillionaceae, Restionaceae, Sterculeaceae, etc. (see Lyons *et al.* 2000). Similar patterns are being discovered for its invertebrate fauna (Horwitz 1997b, Storey 1998).

Existing subregional or bioregional plans and/or systematic reviews of biodiversity and threats

In 1974 and 1975 the Conservation Through Reserves Committee (CTRC) made recommendations for reserves within the in the CTRC Green and Red Books, as did the System 6 study of 1981 (Environmental Protection Authority 1975; Environmental Protection Authority 1983). Some but not all of these recommendations (with modification) were implemented over the following years.
The southern and western parts of the subregion are covered by a CALM Regional Management Plan published in 1994, that provides an overview of biota, addresses land and wildlife conservation issues, but was generalised in its approach. The reviews and strategies therein (for reserve system development or management of weeds, fire, feral animals, mining, ecosystem rehabilitation & disease quarantine) do not address the specific needs of the subregion, or even the bioregion (Department of Conservation and Land Management 1994a).

South West Forests Regional Forest Agreement throughout 1997 and 1998 reviewed all but Eastern parts of the Warren Bioregion against National CAR criteria and developed a reserve system and agreed strategies to conform to National Biodiversity Conservation Objectives (Lamont *et al.* 1997; Mattiske and Havel 1997; Atkins 1997; Christensen 1997; Commonwealth and Western Australian Governments 1999). The Forest Management Plan (draft) was released in 2002 and further develops the CAR reserve system established in the RFA process (Department of Conservation and Land Management and the Conservation Commission 2002).

The South West Regional Strategy for Natural Resource Management was released as a working draft in January 2001 (South West Catchment Council 2002a). The Bush & Biodiversity section based on the same data sets used for this Biodiversity Audit identified poorly conserved vegetation associations and nodes of high value fauna conservation. Other sections of the document deal with Waterways and Wetlands, Land Resources and Coastal Environs. The final draft in March 2002 establishes strategic targeted recommendations for implementation within the NRM Region and are relevant to the bioregion (South West Catchment Council 2002b).

Wetlands

Wetlands of National significance (DIWA listings)

Name and Code	Description[1]	Condition[2]	Trend[3]	Reliability[4]	Threatening Processes[5]
Blackwood River (Lower Reaches) and Tributaries System, WAR001WA	B1, B2	ii, iii & iv	ii, iii & iv	iii	i, v (foxes, pigs, deer, horses, cats & rabbits), vi (Watsonia, East Coast Wattles, Exotic Grasses, Blue Gums, various clovers and allies), vii, viii (*Phytophthora* sp. dieback in adjacent forests and heaths), ix, x, xi (herbicides and fertilisers from agricultural and plantation landuses), xii (plantation harvesting and return to traditional agriculture on several significant holdings; Illegal Tea-Tree cutting for bean sticks, cray pots and brush fencing).
Broke Inlet System, WAR002WA	A10, B1, B2, B6, B10, B13, B15	iii & iv	iv	iii	v (foxes, pigs, cats & rabbits), vi (Watsonia, East Coast Wattles, Exotic Grasses, Blue Gums, various clovers and allies), vii, viii (*Phytophthora* sp. dieback in adjacent forests and heaths), xii (Mining - adjacent mining tenements if allowed to be developed could impact on lake and groundwater).

Name and Code	Description[1]	Condition[2]	Trend[3]	Reliability[4]	Threatening Processes[5]
Cape Leeuwin System, WAR003WA	B10, B17	ii, iii & iv	ii, iii & iv	iii	i, v (foxes, pigs, deer, horses, cats & rabbits), vi (Watsonia, Exotic Grasses, Blue Gums, various clovers and allies), vii, viii (*Phytophthora* sp. dieback in adjacent forests and heaths), ix, x, xi (herbicides and fertilisers from agricultural and plantation landuses), xii (plantation harvesting and return to traditional agriculture on several significant holdings; Illegal Tea Tree cutting for bean sticks, cray pots and brush fencing).
Dogerup Creek System, WAR004WA	B1, B4, B5, B15, B2, B10	ii, iii & iv	ii, iii & iv	iii	i (now notionally controlled but potential exists for large holding (Sandy Peak) West of system (hydrologically up stream) being cleared for a number of purposes), v (pigs, foxes, cats & rabbits), vi (Watsonia, Arum Lilly, Exotic Grasses, Victorian Tea Tree, *Pelergonium* spp.), vii, viii (*Phytophthora* sp. dieback in adjacent forests and heaths), x (development of road access to Sandy Peak and possible power to Windy Harbour), xii (Mining - adjacent mining tenements if allowed to be developed could impact on lake and groundwater).
Gingilup – Jasper Wetland System, WAR005WA	B5, B10, B13, B14, B15	ii, iii & iv	ii, iii & iv	iii	i (now controlled but impacts still surfacing from recent clearings especially at Scott River), v (pigs, foxes, cats & rabbits), vi (Watsonia, Arum Lilly, Exotic Grasses, various clovers and allies), vii, viii (*Phytophthora* sp. dieback in adjacent forests and heaths), x, xi (herbicides and fertilisers from agricultural and plantation landuses), xii (Plantation harvesting and return to traditional agriculture on several significant holdings; Illegal Tea Tree cutting for bean sticks, cray pots, wildflower industry and brush fencing; Mining - adjacent mining tenements when developed could impact on Lake Jasper, Lake Wilson and Lake Smith and groundwater and associated ephemeral wetlands – also acid sulfides associated with ore body).
Maringup Lake System, WAR006WA	B5, B15	iv	iv	iii	v (pigs, foxes, cats & rabbits), vii, viii (*Phytophthora* sp. dieback in adjacent forests and heaths), xi (herbicides from agricultural and plantation landuses), xii (Mining - adjacent mining tenements if allowed to be developed could impact on lake and groundwater).
Mt Soho Swamps, WAR007WA	B15	iii & iv	iv	iii	v (pigs, foxes, cats & rabbits), vi (East Coast Wattles, Exotic Grasses, Blue Gums, various clovers and allies, tagasaste), vii, viii (*Phytophthora* sp. dieback in adjacent forests and heaths, xii (upslope erosion filling important swamps).
Owingup Swamp System, WAR008WA	B1, B5, B10, B14	ii, iii	iii & iv	iii	i, v (foxes, cats & rabbits), vi (Typha, Exotic Grasses, various clovers and allies), vii, viii (*Phytophthora* sp. dieback in adjacent heaths), ix (salinity from affected Kent River), xi (herbicides and fertiliser from agricultural and plantation landuses).

[1]Appendix B, key d; [2]Appendix C, rank 2; [3]Appendix C, rank 3; [4]Appendix C, rank 1; [5]Appendix B, key e

Wetlands of Subregional significance (in addition to the DIWA listed wetlands)

Name and Components	Location	Special Values[1]	Description[2]	Condition[3]	Trend[4]	Reliability[5]	Threatening Processes[6]
Scott River and Gingilup Wetland Systems	AMG (AGD84) 348300, 6206100	ii, v	B2, B13	i	iii	iii	i, ii, iv, v (rabbits, pigs), vi (pasture grass, watsonia), vii, viii (*Phytopthora* sp.), x, xi (fertilizer runoff), xii (intensive agriculture/horticulture).
Bolghinup Lake Swamp (Black Point)	AMG (AGD84) 365900, 6190000	ii, v	B10, B13	iii – iv	iv	iii	vii, viii (*Phytophthora* sp.), xii (Recreation)

Name and Components	Location	Special Values[1]	Description[2]	Condition[3]	Trend[4]	Reliability[5]	Threatening Processes[6]
Lake Charley - Donnelly Estuary Wetland System	AMG (AGD84) 385000, 6186100	ii, v	A5, B1, B2, B4, B9, B10, B13, B15, B17	iii – iv	iv	iii	v (foxes, pigs), vi (Arum Lilly, Blackberry, Watsonia, Typha), vii, viii (*Phytophthora* sp.), ix, x (altered flow regimes of river affecting river and riparian vegetation), xi (fertiliser load runoff from agricultural lands upstream)
Lower Warren River System (including the Meerup River)	AMG (AGD84) 400000, 6172000	ii, v	A5, A11, B1, B2, B4, B9, B10, B13, B15, B17	iii – iv	iv	iii	v (foxes, pigs), vi (Blackberry, Golden Dodder, Watsonia, Typha), vii, viii (*Phytophthora* sp.), ix (Salinity of river due to upstream clearing), x (altered flow regimes of river affecting river and riparian vegetation), xi (fertiliser load runoff from agricultural lands adjacent and upstream).
Deep River/Walpole River/Lower Frankland River and Walpole Nornalup Inlet Wetland System	AMG (AGD84) 475000, 6127000	ii, v	A4, A5, A6, A11, B1, B2, B4, B9, B10, B13, B15, B17	ii (Frankland) - iii (Walpole) – iv (Deep)	iv	iii	v (foxes, pigs), vi (Blackberry, Watsonia, Typha, Victorian Ti Tree), vii, viii (*Phytophthora* sp.), ix (Salinity of river – upstream clearing primarily on the Frankland River), x (altered flow regimes of river affecting river and riparian vegetation– upstream clearing), xi (fertiliser load runoff from agricultural lands adjacent and upstream primarily on the Frankland and the Walpole Rivers)
Bow River and Irwin Inlet Wetland System	AMG (AGD84) 496000, 6128000	ii, v	A5, A6, A11, B2, B4, B9, B10, B13, B15, B17	i – ii (Lower parts of catchment and river) – iv (headwaters of the Bow and its floodplains)	iv	iii	v (foxes, pigs), vi (Blackberry, Watsonia, Typha, Exotic grasses and other pasture species), vii, viii (*Phytophthora* sp.), x (altered flow regimes of river affecting river and riparian vegetation – down stream agricultural clearing), xi (fertiliser load runoff from agricultural lands of lower parts of River)
Kordabup River/Parry Inlet Wetland System	AMG (AGD84) 513000, 6126000	ii, v	A5, A6, A11, B2, B4, B9, B10, B13, B15, B17	i - ii – iii	iv	iii	i, ii, vi (Blackberry, Watsonia, Typha, Exotic grasses and other pasture species), vii, viii (*Phytophthora* sp.), x (altered flow regimes of river affecting river and riparian vegetation – up stream agricultural clearing), xi (fertiliser load runoff from agricultural lands)

Name and Components	Location	Special Values[1]	Description[2]	Condition[3]	Trend[4]	Reliability[5]	Threatening Processes[6]
Denmark River/Wilson Inlet Wetland System	AMG (AGD84) 536000, 6128000	ii, v	A5, A6, B2, B4, B10, B13, B17	i – ii	iv	iii	i, ii, vi (Blackberry, Watsonia, Typha, Gorse, Exotic grasses and other pasture species), vii, viii (*Phytophthora* sp.), ix (upstream clearing primarily on the Hay River, but also to some extent on the Denmark have affected the character of the estuarine waters and Denmark River), x (altered flow regimes of river and affecting opening of the bar), xi (fertiliser load runoff from agricultural lands adjacent and upstream primarily on the Hay River and the lower parts of the Denmark River)
Frenchman Bay /Vancouver Peninsular Wetland System	AMG (AGD84) 585000, 6116000	ii, v	A5, A11, B2, B10, B13, B17	ii	iv	iii	ii, vi (Exotic grasses and other pasture/domestic species), vii, viii (*Phytophthora* sp.)

[1]Appendix B, key d; [2]Appendix B, key c; [3]Appendix C, rank 2; [4]Appendix C, rank 3; [5]Appendix C, rank 1; [6]Appendix B, key e

Riparian zone vegetation

Name	Condition[1]	Trend[2]	Reliability[3]	Threatening Processes[4]
Margaret River	i	iii	iii	i, ii, vi (blackberry, Arum Lilly, pasture species), vii, x, xi, xii (recreation use; water diversion and storage upstream), iii, viii
Blackwood River	i – ii	iii	iii	i, ii, vi, vii, ix, x, xi, xii (recreation use; water diversion and storage upstream on freshwater tributaries), iii, viii
Scott River	i	iii	iii	i, ii, vi (Arum Lilly, blackberry, pasture species), vii, ix, x, xi (eutrophication), xii (mining), viii
Donnelly River (lower reaches in the WAR)/Barlee Brook/Beedalup Brook	i - ii (agricultural zones); ii - iii (forested zone)	iii - iv	iii	i, ii, v (pigs), vi (Arum Lilly, blackberry, pasture species), vii, ix, x, xi, xii (recreation use; water diversion and storage upstream on main River and on freshwater tributaries), viii
Warren River	i - ii	iii	iii	i, ii, v (pigs, horses, deer), vi (Blackberry, Golden Dodder, Pasture species), vii, ix, x, xi, xii (recreation use; eutrophication; water diversion and storage upstream on freshwater tributaries and in farm dams), viii
Gardner River/Canterbury River	ii – iii	iii - iv	iii	i, ii, vi (blackberry, Victorian Tea Tree, pasture species), vii, x, xi, xii (recreation use; water diversion), viii
Shannon River	iii – iv	iv	iii	v (pigs, horses, deer), vi (blackberry, Victorian Tea Tree, pasture species), vii, viii
Inlet River	iii – iv	iv	iii	vii, viii
Deep River/Weld River	iii – iv	iv	iii	v (pigs, horses, deer), vii, xii (recreation use), viii
Walpole River	ii – iii	iv	iii	i, ii, vi (blackberry, pasture species), vii, x, xi, xii (recreation use; proposed water storage and diversion), viii
Frankland River	i - ii	iii	iii	i, ii, v (pigs, horses, deer), vi (blackberry, pasture species), vii, ix, x, xi, xii (recreation use; water diversion and storage upstream on freshwater tributaries and in farm dams), viii
Bow River	i – ii (agricultural zone); ii – iii (natural landscape upstream)	iv	iii	i, ii, vi (blackberry, pasture species), vii, ix, x, xi, xii (proposed water storage and diversion), viii
Kent River/Styx River	i - ii	iii - iv	iii	i, ii, vi (blackberry, pasture species, gorse), vii, ix, x, xi, xii (proposed water storage and diversion), viii

[1]Appendix C, rank 2; [2]Appendix C, rank 3; [3]Appendix C, rank 1; [4]Appendix B, key e

Ecosystems at risk

Threatened ecological communities (TECs)

Plant communities dominated by or composed of susceptible species are threatened by dieback (*Phytopthora cinnamomi*).

Community	Status	NVIS[1]	Condition[2]	Trend[3]	Reliability[4]	Subregion	Threatening Processes[5]
Aquatic Root Mat Community Number 1 of Caves of the Leeuwin Naturaliste Ridge	CR	N/A	iv	vi	iii	WAR	vii, x, xi (ground water nutrient loads)
Aquatic Root Mat Community Number 2 of Caves of the Leeuwin Naturaliste Ridge	CR	N/A	iv	vi	iii	WAR	vii, x, xi (ground water nutrient loads)
Aquatic Root Mat Community Number 3 of Caves of the Leeuwin Naturaliste Ridge	CR	N/A	iv	vi	iii	WAR	vii, x, xi (ground water nutrient loads)

Aquatic Root Mat Community Number 4 of Caves of the Leeuwin Naturaliste Ridge	CR	N/A	iv	vi	iii	WAR	vii, x, xi (ground water nutrient loads)
Scott River Ironstone heaths Scott River area (N. Gibson and M. Lyons pers. comm.).	EN	28, 38	iii	iii	iii	WAR	i, ii, vi (pasture grass), vii, viii, xii (roadside disturbance)
Rimstone pools, algal nodules and cave structures formed by microbial activity on marine shorelines Extant marine shoreline stromatolitic community formed by inorganic precipitation of a mineral phase and with microbial control over morphology by various cyanobacteria: (Sea Cliffs, Augusta, Black Point) (Moore 1993)	EN	41	iii	iv	ii	WAR	vi (arum, kikuyu), x, xi (surface water nutrient loads)
Mt Lindesay - Little Lindesay Vegetation Complex	EN	29, 43	ii	iv	iii	WAR	viii, vii
Calothamnus graniticus heath on south west coastal granites (Meelup) (Keating and Trudgen 1986); N. Gibson, M. Lyons pers. comm.)	VN	32	iv	iv	ii	WAR/JF2	vii

[1]Appendix B, key f; [2]Appendix C, rank 2; [3]Appendix C, rank 3; [4]Appendix C, rank 1; [5]Appendix B, key e

Other ecosystems at risk

Plant communities dominated by or composed of susceptible species are threatened by dieback (*Phytophthora cinnamomi*).

Community	Status	NVIS[1]	Condition[2]	Trend[3]	Reliability[4]	Subregion	Threatening Processes[5]
Aquatic invertebrate communities of peat swamps (Storey 1998, A. Storey pers. comm.)	EN	42	i -ii	iii	iii	WAR/JF2	vii, ix, x, xi
Reedia spathacea peat swamps or the Warren Region (C. Tauss, N. Gibson, G. Keighery)	NE/VU	42, 43	ii	iii	ii	WAR/JF2	v (pigs), vii, xii (urban development)
Relictual peat community (eg Lake Surprise) (South Coast Region pers. comm.)	P1	42	ii	iii	iii	WAR/JF2	vii, ix, x, xi, xii (mining)
Taxandria linearifolia, Acacia pulchella thicket (Rosa Glen variant). South of Margaret River. (A. Weston pers comm.)	P2	28	iii	vi	ii	WAR	vi (lotus reed)
Melaleuca lanceolata forests, Leeuwin Naturaliste Ridge (A. Weston, N. Gibson pers comm.)	P2	15	ii	vi	ii	WAR	ii, vii, xii (recreation site development)
Sphagnum communities of the Tingle Forest (only 3 known occurrences - Walpole area) (G. Wardell-Johnston data; R. Hearn pers comm.)	P2	43	i	iii	iii	WAR	vii, x, xii (climate change)
Community	Status	NVIS[1]	Condition[2]	Trend[3]	Reliability[4]	Subregion	Threatening Processes[5]
Basalt association (Black Point - near Augusta) (R. Hearn pers. comm.)	P2	30	ii - iii	iii- iv	ii	WAR	vii, vii
Saprolite association/Palusmont wetlands (Walpole Inlet) (R. Hearn pers comm.; V. and C. Semeniuk data)	P2	6, 38	iii	iii	iv	WAR	x, xii (urban development)
Grasslands of the South Coast (R. Hearn and T. Macfarlane, pers. comm.)	P2	37	i - iii	iv	iii	WAR	vi, vii
Southern Granite community (eg Muirillup Rock, Northcliffe; subset of wheatbelt granites; insufficient information to distinguish discrete community type/s at this point) (N. Marchant pers. comm; I. Bayly data)	P2	28	i - iv	ii - iv	ii	WAR/JF2	v (pigs), vii, viii, xii (recreation users and tourists)
Cryptogams associated with *Trymalium floribundum* and *Chorilaena quercifolia* in the karri forests of south-western WA (R. Hearn and T. Macfarlane, pers. comm.)	P3	16	ii - iii	ii	iii	WAR/JF2	vii
Naturally brackish/saline coastal lakes in the south west region (S. Halse pers comm.)	NE	26,40, 39	i - iii	iii	ii	JF2/WAR	ix, x, xi
Aquatic invertebrates associated with permanent freshwater/brackish pools (S. Halse pers. comm.)	NE	42	i - iii	iii	ii	JF2/WAR	ix, x, xi
Diatom assemblages of south-west rivers (John 1998)	NE	42	i - iii	iii	ii	WAR/JF2	ix, x, xi

[1]Appendix B, key f; [2]Appendix C, rank 2; [3]Appendix C, rank 3; [4]Appendix C, rank 1; [5]Appendix B, key e

Species at risk

Fauna

Species	Status	Condition[1]	Trend[2]	Reliability[3]	Threatening Processes[4]

SCHEDULE 1; RARE/LIKELY TO BECOME EXTINCT, DIV 1 (MAMMALS)					
Parantechinus apicalis	E	i	i	iii	xii (climate change)
Dasyurus geoffroii	V	iii	v	iii	v (fox)
Pseudocheirus occidentalis	V	iii	iii	iii	i., ii, v (fox) vii, xii (logging)
Setonix brachyurus	V	iii	v	iii	v (fox), vii
SCHEDULE 1; RARE/LIKELY TO BECOME EXTINCT, DIV 2 (BIRDS)					
Pezoporus wallicus flaviventris	E	i	i	iii	v (foxes), vii. This species has no known populations in subregion, but WAR is part of it's former range.
Atrichornis clamosus	V	i	i	iv	vii. This species has no known populations in subregion, but WAR is part of it's former range.
Cacatua pastinator pastinator	V	ii	iii	iii	i, xii (illegal culling)
Calyptorhynchus baudinii	V	iii	iii	ii	ii, vii, ix
Dasyornis longirostris	V	ii	iii	iii	v (fox) vii
Botaurus poiciloptilus	V	ii	iii	iii	vii, ix
Leipoa ocellata	V	i	i	iii	v (foxes, cats, rabbits), vii
Psophodes nigrogularis oberon	V	ii	iii	iii	i., ii, v (fox), vii
SCHEDULE 1; RARE/LIKELY TO BECOME EXTINCT, DIV 4 (FROGS)					
Geocrinia alba	CR	ii	iii	iv	i., ii, iv, v (pigs) vii, viii, x
Spicospina flammocaerulea	V	iii	iv	iv	vii, xii (physical damage to swamps; mining; collection for illegal trade), v (pigs), x (siltation; construction of dams), viii, xi (chemical and surfactant)
SCHEDULE 1; RARE/LIKELY TO BECOME EXTINCT, DIV 6 (SNAILS)					
Austroassiminea letha	V	iii	vi	i.	x
SCHEDULE 1; RARE/LIKELY TO BECOME EXTINCT, DIV 7 (ARACHNIDS)					
Austrarchaea mainae	V	iii	iv	ii	vii

Species	Status	Condition[1]	Trend[2]	Reliability[3]	Threatening Processes[4]
SCHEDULE 4; OTHER SPECIALLY PROTECTED FAUNA. DIVISION 3 (REPTILES)					
Aspidites ramsayi	P1	i	vi	iii	i, ii, v (foxes and cats), vii (this is not a forest species)
OTHER SPECIES AT RISK WITHIN THE SUBREGION					
Daphnia occidentalis	P1	ii	vi	ii	iv, xii (sand mining), vii
Calamoecia elongata	P1	ii	vi	ii	x (altered drainage), xii (roadworks)
Moggridgea sp. Tingle	P1	i	vi	ii	vii
Arbanitis inornatus,	P1	i	iii	iii	i, ii, x, xii (extremely long lived 30-40 years+)
Kawaniphila pachomai	P1	i	vi	ii	xii (housing developments
Ninox connivens connivens	P2	i	ii	iii	xii (logging practices, reduction in tree hollows), loss of small mammal fauna
Ixobrychus flavicollis	P2	ii	ii	ii	i., ii, v, vii, ix, x
Bothriembryon irvineanus	P2	i	vi	ii	i, ii, iv, xii (tourism)
Austromerope poultoni	P2	i	vi	ii	i, xii (logging; mining); vii (this species has only been found from pitfall traps and never been seen alive)
Fibulacamptus bisetosus	P2	i	vi	ii	xii (recreational activity)
Engaewa walpolea	P2	i	vi	ii	vii, x, xi, xii (urban development), trampling

[1]Appendix C, rank 2; [2]Appendix C, rank 3; [3]Appendix C, rank 1; [4]Appendix B, key e

Declared rare and priority flora

Susceptible plant species are threatened by dieback *(Phytophthora cinnamomi*).

Species	Status	Condition[1]	Tend[2]	Reliability[3]	Threatening Processes[4]
DECLARED RARE FLORA					
Leptomeria dielsiana	X	i	vi	i.	xii (last seen in 1957 – rpresumed extinct)
Isopogon uncinatus	CR	ii	v	iv	vii, viii (*Phytopthora* sp.)
Rhacocarpus webbianus	CR	i	v	iii	xii (recreation)
Adenanthos x cunninghamii	E	iii	iv	iii	ix (small number of individuals), viii (*Phytopthora* sp.)
Banksia brownii	E	ii	iv		vii, viii (*Phytopthora* sp.)
Boronia exilis	E	iii	iv	iii	ii, vii, viii
Caladenia excelsa	E	iii	iv	ii	ii, v (rabbits), vi (pasture grass), vii, xi (roadside disturbance)
Caladenia huegelii	E	iii	iv	iii	ii, v (rabbit), vi (pasture grass), vii, xii (roadside disturbance)
Caladenia winfieldii	E	ii	v	iv	iv, v (pigs), vii, x, xii (timber harvesting)
Darwinia ferricola ms	E	iii	iii	ii	ii, vii, viii (*Phytopthora* sp.), xi (roadside disturbance)
Dryandra nivea subsp. *uliginosa*	E	iii	iii	ii	i,ii, vii, viii (*Phytopthora* sp.), xii (roadside disturbance)
Grevillea brachystylis subsp. *australis*	E	iii	iv	iii	i, ii, vii, viii (*Phytopthora* sp.)
Kennedia macrophylla	E	iii	iv	iii	ii, vii, xii (urban development)
Lambertia orbifolia subsp. Scott River Plains	E	iii	iv	ii	ii, vii, viii (*Phytopthora* sp.)
Sphenotoma drummondii	E	i - ii	iii - iv	iii	vii, viii (*Phytopthora* sp.)
Verticordia plumosa var. vassensis	E	iii	iii	iii	ii, v (rabbits), vi (watsonia), vii, viii (*Phytopthora* sp.), x, xii (roadside disturbance)
Asplenium obtusatum subsp. *northlandicum*	V	iii	iv	iii	xii (restricted distribution)
Banksia verticillata	V	ii - iii	iv		vii, viii (*Phytopthora* sp.)
Caladenia harringtoniae	V	ii	iii	ii	vii
Diuris drummondii	V	ii - iii	iii	iii	v (pigs), vii, ix, x,
Drakaea micrantha ms	V	iii	iii	iii	vii, xii (roadside disturbance, small number of populations)
Kennedia glabrata	V	iii	iv	iii	iv, v (pigs), vii, xii (recreation)
Laxmannia jamesii	V	iii	iv	ii	xii (small number of individuals)
Meziella trifida	V	iii - iv	iv	ii	x
Microtis globula	V	i	ii	iii	vii, x
Species	Status	Condition[1]	Tend[2]	Reliability[3]	Threatening Processes[4]
Pleurophascum occidentale	V	iii	iv	iii	vii, xii (climate change)
PRIORITY 1					
Andersonia redolens ms	1	ii	iii	iii	vii, viii (*Phytopthora* sp.)
Austrofestuca littoralis	1	ii	iv	i	vi (marrum grass)
Caladenia evanescens	1	i	ii	ii	vii, x
Deyeuxia inaequalis	1	i	iii	ii	vi (agricultural), vii
Eriochilus scaber subsp. *orbifolia* ms	1	i	iii	ii	vii
Grevillea manglesioides subsp. *ferricola*	1	iii	v	ii-iii	xii (mining – now ceased), i, ii, vii,

					viii (*Phytopthora* sp.), xii (roadside disturbance)
Haloragis tenuifolia	1	iii	iv	ii	ii, v (rabbit), vii, viii (*Phytopthora* sp.)
Philydrella pygmaea subsp. *minima*	1	iii	vi	ii	x
Pterostylis aff. *turfosa*	1	i	iv	iii	vii, xii (known from one collection only)
Schoenus indutus	1	iii	vi	ii	iv
Selliera radicans	1	ii - iii	iv	iii	x, xi
Andersonia redolens ms	1	ii	iii	iii	iv
PRIORITY 2					
Acacia mooreana	2	iii	iv	ii	vii,
Acacia subracemosa	2	iii	iv	ii	vii,
Alexgeorgea ganopoda	2	iii	iv	iii	vii, x, xii (road works)
Amperea protensa	2	iii	iv	iii	xii, x
Andersonia auriculata	2	ii	iii	iii	vii, viii (*Phytopthora* sp.)
Anthocercis sylvicola	2	iii	iv	iii	ii (lack of recruitment), vii
Caladenia abbreviata	2	iii	iv	ii	vii
Calothamnus sp. Scott River *[aff. crassus]*	2	iii	v	ii	x
Calymperastrum latifolium	2	ii	iv	iii	xii (low numbers; climate change)
Chamaexeros longicaulis	2	iii	iv	ii	xii (low recruitment)
Chamelaucium floriferum subsp. *floriferum*	2	iii	iv	ii	xii, xiii
Chordifex isomorphus	2	iii	iv	ii	i, vi, vii, x
Chordifex jacksonii	2	iii	iv	ii	ix, x
Conospermum quadripetalum	2	iii	vi	ii	No known threatening processes
Acacia mooreana	2	iii	iv	ii	vii, x
Diuris heberlei	2	iii	iv	ii	x, xii (recreation)
Drepanocladus aduncas	2	ii	iv	iii	vii, x
Drepanocladus fluitans	2	ii	iv	ii	v (pigs), vii, x
Drosera binata	2	i - ii	iii	iii	vii, viii (*Phytopthora* sp.)
Dryandra sessilis var. *cordata*	2	iii	iv	ii	ii (lack of recruitment)
Eucalyptus virginae ms	2	iii	iii - iv	ii	xii (small number of individuals and populations)
Fabronia hampeana	2	iii	vi	i.	xii (climate change)
Hakea tuberculata	2	iii	vi	ii	vii, i
Hemiandra australis ms	2	iv	iv	iii	No known threatening processes
Hybanthus volubilis	2	iii	iv	ii	vii
Juncus meianthus ms	2	i	vi	ii	x, xi, ix
Leptomeria furtiva ms	2	iii	vi	ii	xii (plant is very hard to find for surveying)
Melaleuca incana subsp. Gingilup	2	iii	iv	ii	vii, xii (recreation)
Melaleuca ringens	2	iii	iv	iii	vii
Schizaea rupestris	2	ii	iii	iii	x
Schoenus fluitans	2	iii	iii	ii	x, xi, ix
Schoenus loliaceus	2	iii	iii	ii	x, xi, ix
Sphagnum novozelandicum	2	i	iii	iii	x, xi, ix, vii
Spyridium spadiceum	2	iii	vi	ii	ii
Thomasia quercifolia	2	iii	vi	iii	vii, x, xii (climate change)
Trichocline sp. Treeton	2	iii	vi	ii	x, ix

[1]Appendix C, rank 2; [2]Appendix C, rank 3; [3]Appendix C, rank 1; [4]Appendix B, key e

Analysis of appropriate management scenarios

Reservation priorities of ecosystems

Beard Veg Assoc	Beard Vegetation Association description	IUCN Reserve I-IV	Non IUCN Reserve	CALM Purch Leases	Reserve Priority	Notes
969	Mosaic: Medium forest; jarrah-marri/Low forest; jarrah	1%	6%		H	Area is essentially that land east and west of Denmark considered suitable for agriculture and consequently extensively cleared or alienated; a few pockets remain and should be sought for reservation or protected from clearing
977	Low forest; teatree & casuarina	1%	44%		M	Area is essentially that land North of Denmark considered suitable for agriculture and consequently extensively cleared or alienated; reservation of most of the CALM managed State Forest component of this as Mt. Lindesay National Park (mostly part of JF2) in the near future will secure important landscapes including the TEC and its large suite of rare and endemic species

1116	Tall forest; jarrah (*E. marginata*)	1%	99%		L	Difficult to map units, most occurrences within Jarrah and Karri ecotypes, most existing areas contained within the CALM managed estate, and no longer available for chipwood production
1132	Medium forest; marri	0%	59%		M	Difficult to map units, most occurrences within Jarrah and Karri ecotypes, most existing areas contained within the CALM managed estate, and no longer available for chipwood production
1138	Low forest; jarrah & marri	6%	0%		H	Area near Margaret River essentially alienated and cleared – little capacity to reserve additional areas but some control at planning level may be possible
1157	Tall forest; jarrah & marri	0%	96%		L	Difficult to map units within the jarrah forest, but the majority is protected within SF, part to become Nature Reserve with planned tenure changes

Subregional constraints in order of priority

(see Appendix B, key g)

Other: RFA reserve recommendations already in process of being implemented, and will include the above reserve consolidation priorities where feasible with existing tenures.

Irreplacibility, Limited Opportunity to Meet CAR Criteria, Economic Constraints and Competing Land Uses: Major components of the landscape are covered by mines, mining tenements and exploration leases and most land is already cleared.

Bioregional and subregional priority for reserve consolidation

WAR is reservation Class 5 (see Appendix D, and Appendix C, rank 4). With current proposed reservation from UCL and State Forest to various Conservation Reserve tenures, most types within the bioregion will be reserved to the extent possible, only minor additions being possible, these mostly at the expense of areas earmarked for water storage and delivery infrastructure, and mining, and these probably only to accommodate threatened species.

Reserve management standard

The Warren subregion contains 25 nature reserves and 14 national parks. There are no conservation parks within this subregion, although Regional Forest Agreement CAR reserves and Government proposals for additional national parks are in the early stages of implementation (new reserves have been excluded from this discussion).

Nature Reserves: Reserve management standard is (ii) fair (see Appendix C, rank 5) as biodiversity values and or management issues are poorly identified, resource degradation is occurring though retrievable. Nature Reserves vary in size from 12 ha to 4300 ha. The majority (20) of these reserves are small (<100 ha). The reserves are not distributed evenly across the subregion, with a noticeable absence of Nature Reserves in the central part of the subregion (the main forest belt). There are no resident staff for these reserves, management visitation is generally limited to minimum of once per year. Very few of these reserves have formal approved management plans or interim management guidelines. Their small size and often remnant vegetation function has resulted in most reserves having significant weed invasion, especially pasture grasses, clovers and associated weed species. Feral animals (foxes, rabbits and increasingly in the western section, pigs) are not controlled in all but the largest reserves. In all parts of the subregion, *Phytophthora* disease is impacting on vegetation communities in the reserves. This is compounded by the seasonal inundation many of the reserves experience. In the very small reserves understorey species composition is often depauperate and in a degraded state resulting from feral and native animal grazing impacts, extended fire frequencies and grass invasion from surrounding farmlands.

National Parks: Reserve management standard is (iii) Good for all parks except Scott which is (ii) fair as a result of pathogen (*Phytophthora*) and feral pig impacts. Warren contains eleven national parks in their entirety and the major portions of three others (Leeuwin Naturaliste, Mt Frankland and Shannon National Parks). The parks range in size from 50 ha to approx 117 000 ha. Three parks are less than 1000 ha, six less than 5000 ha, four less than 10 000 ha and one greater than 100 000ha. Management plans exist for Leeuwin Naturaliste (Frewer and Western Australian Department of Conservation and Land Management 1989), Shannon (Walker and Western Australian Department of Conservation and Land Management 1987), D'Entrecasteaux (Walker and Western Australian Department of Conservation and Land Management 1987) and Walpole Nornalup (Annear *et al.* 1992) National Parks. Staff reside at Leeuwin Naturaliste, Walpole Nornalup, Torndirrup and William Bay National Parks, and the other parks are serviced on a needs basis from the nearest CALM office.

Primary factors impacting on conservation values are: 1) linear design of Sir Mitchell and in parts, Leeuwin Naturaliste and William Bay National Parks. Sir James Mitchell National Park is effectively two strips of roadside vegetation each approx 100m in width, in places abutting state forest, and elsewhere is cleared farmland. Leeuwin Naturaliste is restricted to 150m width at its narrowest points and is comprised of numerous fragmented reserves. William Bay is two reserves joined by a 100m wide by 5 km long coastal strip. 2) Semi rural land developments and an intensification of agricultural practices on adjoining lands is impacting on surface water flows into the Leeuwin Naturaliste and Scott National Park. 3) Regular and routine feral animal (fox, some limited rabbit) control undertaken in all of the National

Park. Declared weeds and selected environmental weeds are subjected to annual control programs in the most accessible areas. Spread of some weeds (especially African thistle) is being exacerbated by high recreational visitor numbers in Leeuwin Naturaliste National Park. Both feral animal and weed control programs are constrained by funding limitations and for some parks proximity to urban developments. Fire regimes are strongly influenced by high visitation numbers and protection of adjoining land uses in parks close to urban and semi rural developments. The development and implementation of fire regimes consistent with biodiversity goals is absent from all of these parks.

Off reserve conservation

Priority species or groups and existing recovery plans

Species	Specific Recovery Plan	General Recovery Plan
Dasyurus geoffroii	Yes - RP	Action Plan For Australian Marsupials and Monotremes; Forest Management Plan (draft)
Pseudocheirus occidentalis	Yes - IRP	Action Plan For Australian Marsupials and Monotremes; Forest Management Plan (draft)
Setonix brachyurus	No	Action Plan For Australian Marsupials and Monotremes; Forest Management Plan (draft)
Atrichornis clamosus	Yes - RP	Action Plan for Australian Birds; Forest Management Plan (draft)
Psophodes nigrogularis oberon	No	Action Plan for Australian Birds; Forest Management Plan (draft)
Calyptorhynchus baudinii	No	Action Plan for Australian Birds; Forest Management Plan (draft)
Pezoporus wallicus flaviventris	Yes - IRP	Action Plan for Australian Birds; Forest Management Plan (draft)
Dasyornis longirostris	No	Action Plan for Australian Birds; Forest Management Plan (draft)
Spicospina flammocaerulea	Yes - RP	Action Plan for Australian Frogs; Forest Management Plan (draft)
Large numbers of P1 and P2 on freehold land and non Conservation estate	No	Declared rare and poorly known flora in the Southern Forest (Warren) Region (currently in preparation); Forest Management Plan (draft)

Appropriate species recovery actions

Species	Recovery Actions[1]	Recovery Descriptions
Dasyurus geoffroii	xii, xiv, x	Research about the impact of fire regimes on diet; Research into effects of foxes and fox baiting; Population and habitat monitoring; Further surveys on distribution and habitat requirements, especially in eastern part of subregion. Other -Maintenance of adequate refuge and den logs; Rehabilitation after mining; Prevention of further clearing, especially in riparian areas. Captive breeding and translocations.
Pseudocheirus occidentalis	ii, iii, xiv, x, xiii	Conservation on public lands managed by CALM. Other - Research into impacts of logging and minimise impacts of land developments; Management of injured, displaced or nuisance possums. Translocations into areas of fox control. Capacity building with community and landholders including education, liaison and communication.
Setonix brachyurus	ix, vii, xii	Fire management. Feral animal control – foxes and pigs. Survey reported occurrences especially on the Swan Coastal Plain to determine presence or absence. Further surveys of southern jarrah forest and south coast populations to establish population size, extent of emigration and immigration and assess range of habitat types used by Quokkas.
Atrichornis clamosus	ix, vii, iii, x, xii, xiii	Fire management at Two People's Bay, Waychinicup National Park, Many Peaks Nature Reserve and Gull Rock Nature Reserve. Feral animal control. Habitat protection on other state lands. Translocations. Research to monitor population numbers. Capacity building and publicity with community, education groups and sponsors.
Psophodes nigrogularis oberon	xii	Research to survey of all known subpopulations; Assessment of taxonomic of populations in WA; Monitoring of subpopulations in relation to changing post fire age and a fox control programme; Research of microhabitat requirements.
Calyptorhynchus baudinii	xii, xi	Research - Develop repeatable population monitoring technique and monitor in different areas of the birds' range. Other – Help orchardists develop non-lethal damage control measures, and make shooting of birds illegal.

Pezoporus wallicus flaviventris	xii, xiv, x	Research to survey all known populations; Monitoring of subpopulations in relation to changing post fire age and fox control programme; Research into micro-habitat requirements and breeding success. Prepare IRP. Evaluation of the use of translocation for this species.
Dasyornis longirostris	xii, x	Research to survey known subpopulations; Monitoring of subpopulations in relation to post fire age; Research microhabitat requirements. Evaluation of translocation for management of species.
Spicospina flammocaerulea	xii, ix, xiii	Research into development of predictive models for calling activity; Search for new populations; Monitoring of population size. Fire management, especially prevention of burning in population areas. Capacity building with private landholders.
Large numbers of P1 and P2 on freehold land and non Conservation estate	i, ii, iii, vi, ix, xii, xiii	Habitat retention and protection through reserves, on private lands and on other state lands. Weed control. Fire management. Research. Capacity building required with community, landholders, industry and institutions.

[1]Appendix B, key h.

Ecosystems and existing recovery plans

Ecosystem	Specific Recovery Plan	General Recovery Plan
Wetlands, rivers and estuaries throughout the region at risk from off reserve upstream landuse, past and current, salinisation, eutrophication and inundation.	No	Forest Management Plan (draft)
Remnant vegetation, specifically of poorly reserved complexes, on private property in the Scott River, Denmark Plains and Leeuwin Naturaliste Ridge	No	Declared rare and poorly known flora in the Southern Forest (Warren) Region (currently in preparation); Forest Management Plan (draft)
Scott River Ironstone heaths Scott River area	No	Declared rare and poorly known flora in the Southern Forest (Warren) Region (currently in preparation); Forest Management Plan (draft)
Mt Lindesay - Little Lindesay Vegetation Complex	No	Declared rare and poorly known flora in the Southern Forest (Warren) Region (currently in preparation); Forest Management Plan (draft)
Wetlands, rivers, cave rootmat communities and estuaries throughout the region	No	Forest Management Plan (draft)
All ecosystems within WAR	No	Declared rare and poorly known flora in the Southern Forest (Warren) Region (currently in preparation); Forest Management Plan (draft)

Appropriate ecosystem recovery actions

Ecosystem	Recovery Actions[1]	Recovery Descriptions
Wetlands, rivers and estuaries throughout the region at risk from off reserve upstream landuse, past and current, salinisation, eutrophication and inundation.	xiii, xi, xiv	Capacity building is required to integrate community and Government NRM action to abate threats and reverse trends in upstream areas. Reinstatement of hydrology. Other – Change in landuse upstream.
Remnant vegetation, specifically of poorly reserved complexes, on private property in the Scott River, Denmark Plains and Leeuwin Naturaliste Ridge.	i, ii, iii	Habitat retention and protection through reserves, on private land and on other state lands, with options for covenanting or acquisition being explored.
Mt Lindesay - Little Lindesay Vegetation Complex	xiv	Mt Lindesay - Little Lindesay Vegetation Complex is being prepared for Phosphite treatment to harden the community/repair the community from the effects of *Phytopthora* dieback disease.
Scott River Ironstone heaths Scott River area	xiii	Capacity building is required to integrate community and Government NRM action to abate the threat, reverse trends.
Wetlands, rivers, cave rootmat communities and estuaries throughout the region.	xiii	Capacity building is required to integrate community and Government NRM action to abate threats and reverse trends in upstream areas.
All ecosystems within WAR	vi, vii	All ecosystems within WAR generally face two major threats: Weeds – work with other agencies and the community to resource environmental weed control programs on and off reserve; assess potential of exotic taxa as weeds and develop control programs for those considered threats. Feral animals – maintain and expand existing baiting and control programs; develop techniques for cats, rabbits, etc. and integrate these into farm planning and community schemes.

[1]Appendix B, key h.

Subregional constraints in order of priority

The off park conservation rank for WAR is (iv) (see Appendix C, rank 6), which indicates that limited off park measures are required.

Conservation actions as an integral part of NRM

Existing NRM actions

Incentives: Farm forestry sharefarm schemes; Remnant vegetation fencing under various programs; establishment of perennial crops and revegetation on farms as part of salt and water management actions.

Institutional Reform: Hardwood timber industry restructure via the RFA / post RFA process; State Planning policy now requires Rural Planning Strategies and Schemes to address NRM issues.

Threat Abatement Planning as Part of NRM: Coast Care planning; feral animal control programs (Western Shield – limited cooperative participation by landholders); State Weed Strategy.

Industry Codes of Practice: The Plantation industry code of practice; move to a range of Agricultural codes as facilitated by Department of Agriculture.

Environmental Management Systems: EMS for forest management (harvesting) developed.

Capacity Building: Department of Agriculture, Department of Conservation and Land Management, and Water and Rivers Commission all contribute to community forums, workshops and education as part of increasing understanding processes and management actions available to landowners and community in relation to salt and water issues; Weed action groups are supported by the Departments of Conservation and Land Management and Agriculture.

Other Planning Opportunities: Regional NRM strategies (e.g. South West Catchments Council) include or will include (eg SCRIPT) biodiversity issues; Shire Rural Strategies and Town Planning schemes now addressing biodiversity and environmental issues within an NRM context as a result of Ministry for Planning and Infrastructure requirements.

Integration With Property Management Planning: Some application at this stage mostly associated with water / salt management in eastern agricultural zone; some input to planning stage of development proposals through Ministry for Planning and Infrastructure and Local Government referrals.

Feasible opportunities for NRM

Incentives: Extend Landcare and revegetation funding options to landowners. Explore options in tax or rate relief for owners for returning or protecting native vegetation.

Institutional Reform: Finalise reservation actions pending for many years. Explore options in tax or rate relief for owners for returning or protecting native vegetation. Facilitate greater input from State agencies to developing Regional NRM Strategies. Staff agencies with sufficient capable people who understand and are able to plan and implement NRM actions.

Threat Abatement Planning as Part of NRM: Extend resourcing of preparation of catchment plans. Coast access planning and coastal management plans extended.

Industry Codes of Practice: During development of codes, develop systems to contain impacts of industry to owner / operator land.

Capacity Building: Facilitate greater community education and involvement in a range of areas in conservation biology and NRM.

Other Planning Opportunities: Continued development of Regional NRM strategies; Input to Shire Rural Strategies and Town Planning.

Impediments or constraints to opportunities

Economic Constraints: Limited financial resources are a major constraint.

Other: Lack of resourcing with agency staff trained in conservation biology and NRM – numbers capability and resourcing.

Subregions where specific NRM actions are a priority to pursue

Warren has an NRM priority of (iii) (see Appendix C, rank 7), indicating that NRM instruments are in place with some achieved biodiversity outcomes.

Data gaps

Gaps in data needed for the identification of biodiversity values and management responses

Vegetation and Regional Ecosystem Mapping:
Vegetation mapping under several different systems (Beard 1979e) is available at a resolution of 1:100000 or 1:250000, whilst the mapping by Mattiske and Havel (1998a and 1998c) is available at a resolution of 1:50 000 and published at 1:250 000.The mapping for these systems is based on (informed and attributed) structural types or (informed and attributed) underlying geomorphic / landscape relationships with vegetation communities present. Both have strengths and weaknesses in development of a CAR reserve system.

Community identification based on floristics has been done for most of the bioregion (see Mattiske and Havel 1997) but complexity of pattern on the landscape (hence

cost of mapping) has prevented vegetation and ecosystem mapping based on the community types delineated, although localised areas have been mapped at the more detail local scale.

Systematic Fauna Survey:
No systematic fauna surveys (vertebrate or invertebrate) have been conducted across the bioregion. Some areas have preliminary survey data for a range of taxa, but this effort is only a start in resolving conservation issues and conservation taxa. The area has been identified as a significant area for relict taxa and their habitat, in particular for invertebrates (Main 1996; Horwitz 1997a; Horowitz 1997b), but targeted survey and assessment has only just begun.

Floristic Data:
Regional survey of vascular flora has been mostly completed, but it is based on sampling quadrats positioned on widespread surface-types as well as some of the localised substrates of particular interest. There are a range of sample designs dependent on the objectives of the individual studies that combined can be considered to be the Regional Survey. Studies have been done on the distinctive tingle trees (Wardell-Johnson and Williams 1996 and Wardell-Johnson *et al.* 1995), frogs (Wardell-Johnson and Roberts 1993 and Wardell-Johnson *et al.* 1995), Warren and South coast wetlands (Lyons *et al.* 2000) and Scott River National Park (Gibson *et al.* 2001 and Gibson *et al.* 2000). Some gaps were identified during the RFA study of the South-West forests and additional plots & quadrats established (see summary by Mattiske and Havel 1997).

Regional survey of the non-vascular flora has not been undertaken. However based on the collections made by a number of local botanists and enthusiasts and those made by international and interstate bryologists, the bioregion (and WA) has a severely depleted moss and liverwort flora compared to equivalent community types in Tasmania, Victoria and New South Wales. Climate change and land management under a changing climatic regime place a large part (that usually associated with rainforest and wet forest ecotypes) of this remaining flora at risk.

Both qualitative and quantitative macro fungi assessment work has been undertaken in the Tingle, Karri and South Coast heath and Jarrah forests, but it is not comprehensive across the region (Bougher 1997).

Rare flora surveys and monitoring are ongoing, but the work is limited by resources. Status of many taxa remains in doubt and it is likely that many of the P1 and P2 taxa listed in this document will end up listed as Endangered or Vulnerable.

Ecological and Life History Data:
Limited accessible data on population ecology and biology of persisting CWR mammals. Generally less for all other vertebrates, particularly the uncommon ones.

No accessible data on habitat requirements, life histories, ecology or distributions of virtually all invertebrate species.

Limited accessible data on population ecology and biology of the vascular flora of the bioregion limiting decision making on conservation status of and conservation management of the many rare and priority taxa. Likewise communities as reflected by the flora.

Other Priority Data Gaps:
- No consistent regolith mapping available at better than 1:250000 scale.
- No quantitative data on the affect of exotic predators, weed colonisation, fragmentation & farm clean-up, mineral-extraction on heavy metals, etc.
- Fire effect / response data is limited to few communities and taxa.
- An understanding of the effect of salinity / inundation on species and communities (including saline wetlands) is limited or lacking.
- Detailed *Phytophthora* mapping lacking for most of the region. Detail data on impacts on individual species and communities limited.
- Mapped location of Peat Communities absent.

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R = Report; J = Journal article; O = Other.

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