Carnarvon 1 *(CAR1 - Cape Range subregion)*

PETER KENDRICK AND ROLAND MAU
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Subregional description and biodiversity values

Description and area

The Carnarvon bioregion is composed of quaternary alluvial, aeolian and marine sediments overlying Cretaceous strata. A mosaic of saline alluvial plains with samphire and saltbush low shrublands, Bowgada low woodland on sandy ridges and plains, Snakewood scrub on clay flats, and tree to shrub steppe over hummock grasslands on and between red sand dune fields. Limestone strata with *Acacia stuartii* or *A. bivenosa* shrubland outcrop in the north, where extensive tidal flats in sheltered embayments support mangal.

Cape Range and Giralia dunefields form the northern part of Carnarvon Basin. Rugged tertiary limestone ranges and extensive areas of red aeolian dunefield, Quaternary coastal beach dunes and mud flats. Acacia shrublands over *Triodia* on limestone (*Acacia stuartii* or *A. bivenosa*) and red dunefields, *Triodia* hummock grasslands with sparse *Eucalyptus* trees and shrubs on the Cape Range. Extensive hummock grasslands (*Triodia*) on the Cape Range and eastern dune-fields. Tidal mudflats of sheltered embayments of Exmouth Gulf support extensive mangroves. Beach dunes with *Spinifex* communities. An extensive mosaic of saline alluvial plains with samphire and saltbush low shrublands along the eastern hinterland of Exmouth Gulf. Islands of the Muiron, Barrow, Lowendal and Montebello groups are limestone-based. Climate is arid, semi-desert to sub-tropical climate, with variable summer and winter rainfall. Cyclonic activity can be significant, and cyclonic systems may affect the coast and hinterland annually. Subregional area for CAR1 is 2, 547, 911ha.

Dominant land use

Dominant land uses are grazing – native pastures (ix) (see Appendix B, key b), conservation (xiii), mining leases (vii), and urban (i).

Continental Stress Class

The Continental Stress Class for CAR1 is 3.

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

Off-Shore Islands:

Offshore islands of CAR1 are considered in the following groups; islands of Exmouth Gulf, the Muiron group (North and South Muiron Islands), the Lowendal group (Varanus and others), the Barrow group (Barrow, Middle, Boodie and associated smaller islands), and the Montebello group (Hermite, Trimouille and many other smaller islands, islets and rocks).

- Islands of Exmouth Gulf (including Doole, Roberts, Hope, Whitmore, Whalebone, Simpson, Burnside, Tent, Y, Gnanderoo, Somerville, Eva, Brown, Fly and Observation Islands, and the Islam Islets). Geologically uniform (sand and limestone). Vegetation generally *Spinifex longifolius* near beaches, and *Triodia* hummock grasslands inland on larger islands. Scattered *Acacia coriacea, A. bivenosa* and *A. pyrifolia*. Extensive mangal occur on larger islands in the east of the Gulf. Sea turtles (details of species unknown) breed on these islands. Smaller islands support breeding seabirds, including Caspian Tern (*Sterna caspia*), Fairy Tern (*Sterna nereis*), Pied Oystercatcher (*Haematopus longirostris*), Osprey (*Pandion haliaetus*), Eastern Reef Heron (*Egretta sacra sacra*) and Pelican (Gnanderoo) (*Pelecanus conspicillatus*). Significant mangal occurs around Doole and Tent Islands. A population of Shark Bay Mice (*Pseudomys fieldi*) has been reintroduced to Doole Island - 43 mice in June and September 1993, 8 in September 1995, 26 in November 1995, 30 in June 1997, 41 in August 1998, and 75 in November 2001 (to restore population after cyclonic activity). The first individuals released on Doole Island in 1993 and 1995 were sourced from Bernier Island, but animals translocated after 1995 were from Perth Zoo.

- Islands of the Muiron group (including North Muiron, South Muiron, and Sunday Island. Sandy, with a limestone base. Vegetation of typical coastal species (*Spinifex longifolius, Acacia coriacea* etc). Seabird nesting records include Wedge-tailed Shearwaters (*Puffinus pacificus*) and Osprey (*Pandion haliaetus*). South Muiron is an important Loggerhead (*Caretta caretta*) and Green Sea Turtle (*Chelonia mydas*) nesting island. Also some Hawksbill (*Eretmochelys imbricata bissa*) and occasionally Flatbacks (*Natator depressus*) visit the islands but numbers may not be significant; there is good coral cover and diversity on reefs surrounding island.

- Islands of the Lowendal group (including Varanus, Abutilon, Bridled, and Parakeelya Islands). Most are limestone, with small beaches. Vegetation of typical coastal species (*Spinifex longifolius* and *Acacia coriacea*), with some *Triodia angusta, Ficus platypoda* and *Pittosporum phylliraeoides* inland on Varanus Island. Seabird nesting records include Wedge-tailed Shearwater (*Puffinus pacificus*), Osprey (*Pandion haliaetus*), White-bellied Sea Eagle (*Haliaeetus leucogaster*), Caspian Tern (*Sterna caspia*), Crested Tern (*Sterna bergii*), Lesser Crested Tern (*Sterna bengalensis*), Roseate Tern (*Sterna dougallii*), Bridled Tern (*Sterna anaethetus*), Silver Gull (*Larus novaehollandiae*), Pied Cormorant (*Phalacrocorax varius*), Beach Stone Curlew (*Esacus neglectus*) and Pied Oystercatcher (*Haematopus*

longirostris). The islands are particularly important for tern breeding. House mice (*Mus musculus*) were introduced onto Varanus Island in 1993, but have been eradicated. Important sea turtle nesting occurs throughout the Lowendal group. Hawksbills (*Eretmochelys imbricata bissa*) and Greens Turtles (*Chelonia mydas*) nest on Varanus, Abutilon and Bridled Islands. Flatbacks Turtles (*Natator depressus*) are known to also nest on Varanus, in low numbers and occasional nesting by loggerheads has been recorded. Dugongs (*Dugong dugon*) are present in surrounding waters.

- Islands of the Barrow group, comprising Barrow, Boodie, Middle, Pascoe, Double, Boomerang. Islands are either limestone (some of which contain significant fossil deposits) or sand over limestone. Vegetation varies from entirely coastal species on small islands, to extensive hummock grasslands on Barrow Island. Stands of eucalypt and *Erythrina vespertilio* are also present, though restricted. The Barrow group supports 15 species of native terrestrial mammal. Several of these are listed as endangered: Golden Bandicoot (*Isoodon auratus barrowensis*), Barrow Island Euro (*Macropus robustus isabellinus*), Spectacled Hare-wallaby (*Lagorchestes conspicillatus conspicillatus*), Black-footed Rock Wallaby (*Petrogale lateralis lateralis*) and Burrowing Bettong (*Bettongia lesueur*). Dugong (*Dugong dugon*) are common in nearby waters, and a large number of dolphin and whale species have been recorded. Over 100 bird species are known from Barrow Island, including a black and white variant of the White-winged Fairy-wren (*Malurus leucopterus leucopterus*). The island supports a large reptile fauna, including an apparently troglobitic snake (*Ramphotyphlops longissimus*; Aplin 1998). Significant sea turtle nesting, particularly Green (*Chelonia mydas*) and Flatback Turtles (*Natator depressus*), occurs on Barrow and Middle Islands. An internationally significant troglofauna, comprising terrestrial and stygofaunal elements is known from Barrow Island, and is unlikely to be fully documented.

- Islands of the Montebello group, including Hermite, Trimouille, North West, Bluebell, Alpha, Ah Chong, Crocus and Primrose, and a large number of smaller islands, islets and rocks throughout the archipelago. The islands are sandy on a limestone base, often with extensive vertical limestone shores and large areas of exposed limestone pavements outcropping on the island surfaces. Vegetation is typically coastal species (*Spinifex longifolius* and *Acacia coriacea*) along the beaches and on sandy areas, and hummock grasslands on areas of exposed limestone. Local mammal species became extinct in historical times. Recent translocations have resulted in the introduction of Mala (*Lagorchestes hirsutus*) to Trimouille Island, and *Pseudomys fieldi* on North West Island. *Aprasia rostrata* has not been recorded from Hermite Island since 1952. Many seabirds nest within the group, including Wedge-tailed shearwater, bridled tern, caspian tern, roseate tern, crested tern, fairy tern, white-bellied Sea Eagle (*Haliaeetus leucogaster*), Osprey (*Pandion haliaetus*), Brahminy Kite (*Haliastur indus*), Silver Gull (*Larus novaehollandiae*), Reef Heron (*Egretta sacra*), Pied Oystercatcher (*Haematopus longirostris*). Significant sea turtle nesting occurs on sandy beaches. Shallow marine environments support Dugong (*Dugong dugon*). Highly diverse and abundant fish and coral reef fauna. Diverse range of marine habitats. Mangals are furthest from mainland in state.

Karst System of Cape Range:
Elevated limestone range, with deeply dissected rugged topography. Extensive karst features within range, with over 600 karst features described (Darren Brooks, pers. comm.). Contains a large troglobitic fauna of international significance, including both terrestrial and stygofaunal elements. Fauna includes fish (*Ophisternon candidum* and *Milyeringa veritas*), shrimps (*Stygiocaris* spp., ostracods (*Danielopolona*), amphipods (*Liagoceradocus, Halosbaena*), Remipedes (*Lasionectes*), plus many other families and orders of terrestrial and aquatic species.

The flora of the Cape Range has a very rich flora for an arid area (Keighery and Gibson 1993). The tertiary limestones of Cape Range are vegetated by shrublands comprising *Acacia tetragonophylla, A. bivenosa, Grevillea variifolia* subsp. *variifolia, G. calcicola, Melaleuca cardiophylla* (or terraces north of Yardie Creek by *Ipomoea yardiensis*) (Keighery and Gibson 1993). Yardie Creek represents the northern extent of range for many southern taxa, and the creek system and permanent wetlands in the area provide refugia for these species at the extremities of their ranges (Keighery and Gibson 1993). Hummock grasses of the Cape Range include *Triodia wiseana* and *T. pungens*, and there are a whole suite of less common herbs and shrubs restricted to the community (such as *Ipomoea costata, Acacia arida, Centaurim spicatum* and *Portulaca conspicua*) (Keighery and Gibson 1993).

The younger limestones of the western coastal plain and the Rough Ranges display a different community type, which is dominated by *Melaleuca cardiophylla* and / or *Hibbertia spicata* low heaths over *Triodia* spp, occasionally also containing *Acacia* low heaths (Keighery and Gibson 1993). Less common characteristic species include *Dysphania plantaginella, Hibiscus sturtii* and *Threlkeldia diffusa* (Keighery and Gibson 1993).

Bundera Sinkhole:
Anchialine sinkhole south of Yardie Creek, on coastal plain. Only known example of Remipede (*Lasionectes exleyi*) community in southern hemisphere, and is characterised by a complex stratified hydrological environment. The sinkhole contains a rich stygobiont fauna, including fish, hadziid amphipods, gammarid amphipods, copepods and ostracods. The aquifer adjacent contains other species which may also live within the sinkhole; atyid shrimp, thermosbaenaceans, diverse amphipods and *Ophisternon* (the blind eel). The stratification of water layers within the water column of the sinkhole is important to the wellbeing of the resident fauna, as many species are found only below thermo-halocline. For this reason, investigation of the site is

difficult, as diving destroys the thermo-halocline (at least temporarily). Local management includes signage and vehicle barriers.

Camerons Cave:
A cave system near Exmouth townsite that contains a unique assemblage of terrestrial and aquatic troglofauna. These include 4 threatened fauna (*Milyeringa veritas, Draculoides bramstokeri, Hyella* sp., and *Stygiochiropus peculiaris*). Other aquatic fauna include copepods. The terrestrial troglomorphic fauna is diverse, containing, in addition to those listed above, an undescribed Opilionida (harvestman), four undescribed spiders (Araneae; one Hahniidae, one Pholcidae, one Ctenidae), an undescribed Hemiptera (*Phaconura* sp. nov.), as well as undescribed species of Isopoda, Hemiptera, Coleoptera, Blattodea, Collembola and Calanoida. This is the most diverse troglomorphic fauna known from the Cape Range karst province.

Ningaloo Reef Complex:
An extensive fringing barrier reef system, extending approximately 300 km southward from the tip of North West Cape to Quobba. Very diverse coral and fish communities.

Mangroves of eastern Exmouth Gulf:
Extensive mangal along the entire eastern coast of Exmouth Gulf, and including pockets on the western side such as Bay of Rest. Very significant nursery areas for economic and recreational fishing species, including prawns. Important habitat for immature sea turtles.

Centres of Endemism:
- Cape Range - Large group of troglobitic species endemic to karst system, including fish, amphipods, isopods, remipedes, insects.
- Barrow Island - Large group of troglobitic species endemic to karst system, including blind snakes, amphipods, isopods, insects.
- Ningaloo Reef - Corals, fish, molluscs, other invertebrates, algae.
- Bundera Sinkhole - Anchialine sinkhole south of Yardie Creek, on coastal plain. Only known example of Remipede community in southern hemisphere. Also contains other species of stygofauna.

Refugia:
The following refugia are listed in Morton *et al* (1995) as being valuable for their isolation from the mainland and it's associated threatening processes:
- Montebello Islands group - mammals, sea turtles, and seabirds.
- Barrow Island group - marsupials, troglofauna, and sea turtles.
- Islands of Exmouth Gulf - mammals, and seabirds.
- Caves and landforms provide unique habitats, or shelter from threatening processes.
- Cape Range caves and gorges - mammals, troglofauna and relictual plants.

High Species and Ecosystem Diversity:
- Cape Range caves and gorges (mammals, troglofauna and relictual plants).
- Ningaloo Reef (corals, fish, crustaceans, molluscs, algae, etc.).
- Barrow Island (troglobitic species, including blind vertebrates), mammals.
- Montebellos (marine species).

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

In 1975 the Conservation Through Reserves Committee (CTRC) made recommendations for reserves within the Pilbara (System 9; Recommendations 9.2, 9.3, 9.7 and 9.8), in the 'Red Book' reports of 1975. Reserve recommendations in System 9 (including CAR1) included extensions to the Cape Range National Park, (9.2), the creation of the Ningaloo Marine Park (9.3), many reserve proposals for island reserves in Exmouth Gulf and as far up the coast as Onslow (9.7; including Serrurier and Thevenard, treated within the PIL4 synopsis) and that studies be implemented on the biophysical characteristics of the tidal and supra-tidal flats of the Exmouth Gulf and Onslow coasts, and that industrial developments be restricted to occurring landward of mangal communities (9.8). In 1993, the 'Red Book Status Report' reviewed the implementation of these recommendations.

Recommendations have been partially implemented, as indicated below.
- Recommendation 9.2. Extensions to the Cape Range National Park are only partially complete, due to mineral extraction and commercial development possibilities.
- Recommendation 9.3. Ningaloo Marine Park is established, but acquisition of Ningaloo is stalled, and large residential developments are proposed for sites adjacent to the Ningaloo Marine Park.
- Recommendation 9.7. Some Island reservations are complete, others stalled.
- Recommendation 9.8. Small amount of work on coast of the Gulf, but not much. No current salt production proposals.

No other subregional or bioregional planning for biodiversity conservation has been attempted.

Wetlands

Wetlands of National significance (DIWA listings)

Name & Code	Description[1]	Condition[2]	Trend[3]	Reliability[4]	Threatening Processes[5]
Cape Range subterranean waterways (includes Bundera sinkhole and other karst feature waterways) CAR001WA	B19	iii	iv	iii	iv (goats), v (pollution of cave entrances), ix (increased salinity caused by water abstraction), xi (pollution from townsite).
Exmouth Gulf East CAR002WA	A2, A7, A9, A8	iii	iv	ii	iv (goats), v (pollution of cave entrances), vi (buffel grass)

[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	Condition[1]	Trend[2]	Reliability[3]	Threatening Processes[4]
Yardie Creek	iii	iv	iii	xii (visitor impacts), iv, v (rabbits & goats)
Mangrove Bay	iv	iv	ii	xii (visitor impacts)
Bay of Rest	iii	iv	ii	No known threatening processes
Ningaloo Reef	iii	iii	iii	xii (visitor impacts such as anchors, fishing, shell collecting in the past, fauna interactions especially with whales, turtles, whale sharks, and dugongs), xii (coral bleaching and sporadic *Drupella* infestation)
Subterranean waterways of Barrow Island	ii	iii	iii	xi (leakage from infrastructure, deliberate disposal to shallow aquifers)
Intertidal Communities of the Montebellos	iii - iv	iv	ii	xii (visitor impacts - fishing)

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

Riparian Zone Vegetation

Name	Condition[1]	Trend[2]	Reliability[3]	Threatening Processes[4]
Lyndon – Minilya Rivers	i	iii	ii	iv, v (cattle, sheep and goats), vi (buffel grass), vii
Permanent and semi-permanent pools	i	iii	ii	iv (grazing pressure), v (cattle, sheep, horse), vi (buffel grass)

[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)

Community	Status	NVIS[1]	Condition[2]	Trend[3]	Reliability[4]	Threatening Processes[5]
Cape Range Remipede Community	CR	N/A	iii	iv	iii	xii (visitor impacts), xi (pollution)
Camerons Cave Troglobitic Community	CR	N/A	iii	iv	iii	xi (pollution), xii (unique community so a once off-event can lead to extinction), xii (visitor impacts

[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

Community	Status	NVIS[1]	Condition[2]	Trend[3]	Reliability[4]	Threatening Processes[5]
Stygofauna communities on Barrow Island	unknown	N/A	ii	iii - vi	iii	xi
Terrestrial troglodytes on Barrow Island	unknown	N/A	iii	iii	iii	xi, xii (human visitation)

Community	Status	NVIS[1]	Condition[2]	Trend[3]	Reliability[4]	Threatening Processes[5]
Stygofauna communities on North West Cape	unknown	N/A	iii	iii	iii	xi, ix, xii (mining)
Marine environments generally (including Ningaloo reef, Exmouth Gulf, Shallow marine areas around Barrow Island and Montebellos)	unknown	40, + marine	iii	iii	iii	xi
Sea turtle nesting areas	unknown	41	i - ii	iii - iv	iii	v (fox, cat), xii (vehicles on beaches)
Ephemeral creekline drainage communities	unknown	37	i - ii	iii	iii	xii (mining, gravel extraction), vii, x

[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)					
Petrogale lateralis	E	islands: iii mainland: i	iv - iii	iii	v (fox, cat), iv, xii (human disturbance)
Bettongia lesueur	E	islands: iii mainland: EX	iv	iv	Possibly viii, no current threatening processes
Isoodon auratus auratus	E	islands: iii mainland: EX	iv	iv	Possibly viii, no current threatening processes
Lagorchestes conspicillatus conspicillatus	E	islands: iii mainland: EX	iv	iv	Possibly viii, no current threatening processes
Lagorchestes hirsutus	E	islands: iii mainland: EX	v	iv	Possibly viii, no current threatening processes
Macropus robustus isabellinus	E	iii	iv	iv	Possibly viii, no current threatening processes
Pseudomys fieldi	E	islands: iii mainland: EX	v	iv	Possibly viii, no current threatening processes
SCHEDULE 1; RARE/LIKELY TO BECOME EXTINCT, DIV 2 (BIRDS)					
Amytornis textilis textilis	E	iii	vi	ii	v (fox, cat)
Malurus leucopterus edouardi	E	iii	iv	ii	Possibly viii, no current threatening processes
SCHEDULE 1; RARE/LIKELY TO BECOME EXTINCT, DIV 3 (REPTILES)					
Aprasia rostrata rostrata	E	unknown	vi	ii	v (rats)
Caretta caretta	E	ii	iii - iv	iv	xii (human disturbance), v (fox)
Dermochelys coriacea	V	unknown	vi	ii	xii (fishing and shipping)
Chelonia mydas	V	ii	vi	iii	xii (human interference)
Natator depressor	V	ii	vi	iii	xii (human interference)
Eretmochelys imbricata	V	iii	vi	iii	xii (human interference)
SCHEDULE 1; RARE/LIKELY TO BECOME EXTINCT, DIV 5 (FISH)					
Ophisternon candidum	E	iii	vi	ii	xi, xii (mining), v (feral fish)
Milyeringa veritas	E	iii	vi	ii	xi, xii (mining), v (feral fish)
SCHEDULE 1; RARE/LIKELY TO BECOME EXTINCT, DIV 7 (ARACHNIDS)					
Bamazomus sp. Nov. (WAM #95/748)	E	iii	vi	ii	xi, xii (mining)
Draculoides bramstokeri	E	iii	vi	ii	xi, xii (mining)
Draculoides sp. Nov (WAM # 96/1 15 1)	E	iii	vi	ii	xi, xii (mining)
Hyella sp. nov. (BES 1154.2525.2546.2554	E	iii	vi	ii	xi, xii (mining)
SCHEDULE 1; RARE/LIKELY TO BECOME EXTINCT, DIV 8 (CRUSTACEANS)					
Bogidoma australis	E	iii	vi	ii	xi, xii (mining)
Lasionectes exleyi	E	iii	vi	iii	xi, xii (human disturbance via cave diving)
Species	Status	Condition[1]	Trend[2]	Reliability[3]	Threatening Processes[4]
Liagoceradocus branchialis	E	iii	vi	ii	xi, xii (mining)
Liagoceradocus subthalassicus	E	iii	vi	ii	xi, xii (mining)
Nedsia fragilis	E	iii	vi	ii	xi, xii (mining)
Nedsia humphreysi	E	iii	vi	ii	xi, xii (mining)
Nedsia hurlberti	E	iii	vi	ii	xi, xii (mining)
Nedsia marosculptilis	E	iii	vi	ii	xi, xii (mining)
Nedsia sulptilis	E	iii	vi	ii	xi, xii (mining)
Nedsia straskraba	E	iii	vi	ii	xi, xii (mining)
Nedsia urifimbriata	E	iii	vi	ii	xi, xii (mining)
Stygiocaris lancifera	E	iii	vi	ii	xi, xii (mining)
SCHEDULE 1; RARE/LIKELY TO BECOME EXTINCT, DIV 9 (MILLIPEDES)					
Speleostrophus nesiotes	E	iii	vi	ii	xi, xii (mining)
Stygiochiropus isolatus	E	iii	vi	ii	xi, xii (mining)

Stygiochiropus peculiaris	E	iii	vi	ii	xi, xii (mining)
Stygiochiropus sympatricus	E	iii	vi	ii	xi, xii (mining)
SCHEDULE 4; OTHER SPECIALLY PROTECTED FAUNA. DIVISION 1 (MAMMALS)					
Dugong dugon	SP	iii	iii - iv	iii	xii (human disturbance)
SCHEDULE 4; OTHER SPECIALLY PROTECTED FAUNA. DIVISION 2 (BIRDS)					
Falco peregrinus	SP	iv	vi	ii	Unknown threatening processes
OTHER SPECIES AT RISK WITHIN THE SUBREGION					
Rhinocodon thypus		iii	vi	vi	xii (human interference)

[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

Species Name	Status	Condition[1]	Trend[2]	Reliability[3]	Threatening Processes[4]
PRIORITY 1					
Ptilotus stipitatus	1	iii	vi	ii	vi, vii
PRIORITY 2					
Abutilon sp. (Cape Range AS George 1312)	2	iii	vi	i - ii	vi, vii
Acanthocarpus rupestris	2	iii	vi	ii	vi, vii
Daviesia pleurophylla	2	iii	vi	ii	vi, vii
Eremophila occidens ms	2	unknown	vi	ii	vi, vii
Harnieria kempeana subsp. *rhadinophylla*	2	iii	vi	ii	vi, vii
Verticordia serotina	2	iii	vi	ii	vi, vii
OTHER SPECIES AT RISK					
Livistona alfredii	4	i	iii	iv	v (goats), xii (natural processes such as cyclones and fire)

[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	Vegetation Association Description	IUCN I-IV	Non-IUCN Reserve	CALM-Purchased Lease	Priority
11	Medium woodland; coolibah (*E. microtheca*)	0.0	0.0	0.0	H
43	Low forest; mangroves (Kimberley) or thicket; mangroves (Pilbara)	1,535.1	0.0	0.0	H
95	Hummock grasslands, shrub steppe; acacia & grevillea over *Triodia basedowii*	0.0	0.0	0.0	M
98	Hummock grasslands, shrub steppe; kanji over soft spinifex & *T. basedowii*	316.8	0.0	54,725.4	L
103	Hummock grasslands, shrub steppe; snakewood over soft spinifex & *T. wiseana*	0.0	0.0	0.0	M
117	Hummock grasslands, grass steppe; soft spinifex	32.5	1,522.5	0.0	M
127	Bare areas; mudflats	0.0	0.0	0.0	H

Beard Veg Assoc	Vegetation Association Description	IUCN I-IV	Non-IUCN Reserve	CALM-Purchased Lease	Priority
151	Sedgeland; sedges with open low trees; coolibah over various sedges	0.0	0.0	0.0	H
152	Hummock grasslands, grass steppe; soft & hard spinifex soft spinifex	0.0	0.0	0.0	M
158	Hummock grasslands, shrub steppe; kanji over *Triodia basedowii*	0.0	0.0	0.0	M
162	Shrublands; snakewood scrub	0.0	0.0	0.0	H
244	Shrublands; *Acacia sclerosperma* & *A. victoriae* scrub	0.0	0.0	0.0	M
264	Low woodland; *Acacia victoriae* & snakewood	0.0	0.0	0.0	M
267	Succulent steppe with open scrub; scattered *Acaica sclerosperma* & *A. victoriae* over saltbush & bluebush	0.0	0.0	0.0	H
307	Low woodland; bowgada & *Acacia subtessarogona*	0.0	0.0	0.0	H
345	Mosaic: Shrublands; *Acacia sclerosperma* & *A. victoriae* patchy scrub, barren/Succulent steppe; saltbush & bluebush	0.0	0.0	0.0	M
585	Mosaic: Shrublands; snakewood & *Acacia victoriae* scrub/Hummock grasslands, shrub-steppe; kanji over soft spinifex & *T. basedowii*	0.0	0.0	0.6	M
589	Mosaic: Short bunch grassland - savannah/grass plain (Pilbara)/Hummock grasslands, grass steppe; soft spinifex soft spinifex	0.0	0.0	0.0	H
606	Hummock grasslands, shrub steppe; *Acacia victoriae* & snakewood over soft spinifex	0.0	0.0	0.0	M
608	Mosaic: Shrublands; *Acacia victoriae* & snakewood scrub patches/Short bunch grassland - savannah /grass plain (Pilbara)	0.0	0.0	2,224.7	L
641	Medium woodland; coolibah & river gum	0.0	0.0	0.0	H
658	Shrublands; *Acacia sclerosperma* & snakewood scrub (also with some waterwood)	0.0	0.0	0.0	M
662	Hummock grassland; shrub steppe; mixed acacia scrub & dwarf scrub with soft spinifex & *T. basedowii*	7,136.4	63.8	0.0	L
663	Hummock grasslands, shrub steppe; waterwood over soft spinifex	7,051.2	1,460.0	0.0	L
664	Hummock grasslands, sparse tree-steppe; scattered bloodwood over soft spinifex & *T. sp. indet. aff. angusta*	37,528.0	21.3	0.0	L
670	Hummock grasslands, shrub steppe; scattered shrubs over *Triodia basedowii*	0.0	0.0	3,023.1	L
674	Hummock grasslands, shrub steppe; bowgada & snakewood over *Triodia basedowii*	0.0	0.0	0.0	M
676	Succulent steppe; samphire	40.1	51.4	0.0	H
678	Hummock grasslands, sparse shrub steppe; *Acacia bivenosa* over hard spinifex	0.0	0.0	0.0	M
680	Hummock grasslands, shrub steppe; *Acacia bivenosa* over *Triodia basedowii*	3,009.3	0.0	0.0	L
681	Shrublands; open dwarf scrub, waterwood (*Acacia coriacea*) on recent dunes	267.3	0.0	0.0	H
1162	Hummock grasslands, grass steppe; hard spinifex *Triodia wiseana* & *T. basedowii*	0.0	0.0	0.0	M
1271	Bare areas; claypans	0.0	0.0	0.0	H
1322	Shrublands; *Acacia sclerosperma*, *A. victoriae* & snakewood scrub	0.0	0.0	0.0	H
1325	Succulent steppe with very open low trees; coolibah over saltbush & samphire	0.0	0.0	0.0	H
1601	Mosaic: Shrublands; snakewood & *A. victoriae* scrub/Hummock grasslands; grass steppe, hard spinifex *Triodia basedowii*	0.0	0.0	0.0	H
1684	Succulent steppe with open scrub; scattered snakewood over bluebush	0.0	0.0	0.0	H
2675	Hummock grasslands, low tree & shrub steppe; scattered eucalypts, kanji over *Triodia pungens* & *T. basedowii*	0.0	0.0	0.0	H
2685	Shrublands; *Acacia quadrimarginea* & jam scrub on greenstone	0.0	0.0	0.0	H

Subregional constraints in order of priority
(see Appendix B, key g)

Irreplacibility: Karst systems of Cape Range and Barrow Island are unique. Ningaloo Reef is unique.

Economic Constraints: In terms of the cost of land acquisition as well as constraints in terms of implementing management. Most land is pastoral lease, and relatively productive. Aboriginal lands are probably not available for reservation, but pastoral leases should be acquired, due to poor management and high conservation values. Turtle nesting management will require baiting on pastoral leases.

Competing Land Uses: In particular prospective mining interests (limestone and oil) over karst, and pastoral production.

Other: Inappropriate recreation developments (marina resorts) are also proposed

Bioregional and subregional priority for reserve consolidation

CAR is reservation class 3 (see Appendix D, and Appendix C, rank 4) with only 3.45% of area in conservation reserve (IUCN I-IV). At the subregional level CAR1 has 2.2% in reserve (IUCN I-IV) while CAR2 has 3.9% in conservation reserve. The current reserve system is highly biased in terms of CAR criteria and is not comprehensive or representative in terms of ecosystem representation so Class 2 with possibility of changing to a higher primary classification is appropriate.

Reserve management standard

In CAR1, have one national park (Cape Range National Park), one marine park (Ningaloo Marine Park), two conservation parks (Bundegi and Jurabi Conservation Parks), one large island nature reserve (Barrow Island) and many smaller island nature reserves (Gulf islands, Muiron Islands, and Lowendal, Barrow and Montebellos groups). Cape Range National Park has resident staff (one ranger). Ningaloo Marine Park has one resident staff (at Coral Bay). Other areas have no resident staff. Barrow Island has a large resident oilfield workforce (between 200-400 people). Lowendal has a small resident oilfield workforce (30-50 people). Montebellos have a pearl farming operation with a resident staff of 5-30 people.

CAR2 reserves are generally large and with little access; management resources are hampered by the logistics of travel etc; wildfire management facilities are limited by resources, with no strategic fire breaks or prescribed burning; feral herbivore grazing activities now widespread (e.g. Callicivirus hasn't made a observable difference to rabbit numbers, goats are common throughout), and feral predator control systems are not in place in any area. Reserve Management Rank is (i) (see Appendix C, rank 5).

National Park: Rank (ii), fair. Cape Range National Park has a management plan, but this is now due for revision (in 2002). Currently has a minimal goat control program, but foxes are baited effectively. There is no fire management, as prescribed in the existing management plan. However, weed issues (buffel grass) will be impossible to resolve.

Marine Park: Rank (iii), good. Ningaloo has two staff, and management funds. Has an operational management plan. Recreational and commercial fishing is managed. Effective management of whale shark watching industry is required. Limited monitoring of sea turtles, and fox control in some parts of marine park shore.

Conservation Parks: Rank (ii), fair. Jurabi and Bundegi Conservation Parks have interim management guidelines. No current fox control, despite high turtle nesting values, constrained due to public use.

Montebellos Islands Conservation Park: Rank (ii), fair. CALM has an accommodation facility on the island, which is used sporadically. Major management operations have included the terrestrial fauna survey, eradication of rats and cats, marine biodiversity and monitoring surveys, and introductions of endangered (non-local) fauna (*Pseudomys fieldi* and *Lagorchestes hirsutus*). Rat control is currently still ongoing (last baiting in October 2001). No current plans to control weeds (major infestations of buffel and kapok on most, if not all major islands of group). No current Management Plan, or Interim Management Guidelines, but planning for surrounding Marine reserve is underway.

Barrow Island Nature Reserve (BINR): Rank (ii / iii), fair to good. CALM has Interim Management Guidelines, drafted in cooperation with the oilfield operator. Access to BINR is restricted to third parties, as it is within a Petroleum Act lease. Fire management is restricted to suppression. Quarantine breaches have resulted in various vertebrate (rat, house mouse), invertebrate (bees, wasp nests and possibly others) and weed (buffel grass, kapok bush, and possibly other) invasions, but these have been generally promptly managed (usually with CALM assistance). The exceptions are weeds on minor islands (kapok on Middle Island and buffel grass on Boodie Island). Oilfield operations are a potential threat to biodiversity, particularly from continuing shallow well disposal of produced (oil-contaminated) water, but Chevron (the operator) does have comprehensive environmental management procedures. Access to the island for researchers and CALM staff is facilitated, and generally relations are highly cooperative. CALM, DEP and Conservation Commission visit Barrow annually, or otherwise for specific purposes. Planning for surrounding Marine reserve is underway.

Lowendal Islands Nature Reserve: Rank (ii / iii), fair to good. Generally as above. Apache (the operator) and CALM have a similarly cooperative relationship regarding biodiversity and conservation management on these islands. CALM, DEP and Conservation Commission visit Lowendal annually, or otherwise for specific purposes. Presence of oil base is a negative influence for nature conservation, through potential for weed and feral animal introduction, pollution and land disturbance. Industrial lighting and flares may affect nesting turtles and

hatchlings. Planning for surrounding Marine reserve is underway.

Exmouth Gulf Islands: Rank (ii), fair. No management plan. Episodic management visits. No control of weeds. Near-coastal islands have feral animals (fox, goat, and possibly rats).

Class	Purpose	Name	Category	Reserve Management Rank[1]
A	Conservation of fauna and flora & Recreation.	Cape Range National Park	National Park	ii
A	Conservation of marine fauna and flora & Recreation.	Ningaloo Marine Park	Marine Park	iii
	Conservation Park	Jurabi Conservation Park	Conservation Park	ii
	Conservation Park	Bundegi Conservation Park	Conservation Park	ii
A	Conservation of fauna and flora	Barrow Island group	Nature Reserve	ii/iii
C	Conservation of fauna and flora	Lowendal Islands	Nature Reserve	iii
A and C	Conservation of fauna and flora	Montebello Islands	Conservation Park	ii
	Conservation of fauna and flora	Exmouth Gulf Islands	Nature Reserves	ii

[1]Appendix C, rank 5

Off reserve conservation

Priority species or groups

Species Name	Ecosystem Type or Status	Location	Threatening Processes[1]
Petrogale lateralis		Present in gorges of Cape Range, more common on the west side than the east	v (foxes), v (goats), xii (human disturbance at Yardie Creek)
Bettongia lesueur		Secure and abundant on Barrow Island, and a smaller secure population on Boodie Island	No current threats, possibly vulnerable to disease.
Isoodon auratus auratus		Secure and abundant on Barrow Island, and a smaller secure population on Middle Island. Plan to re-introduce *I. auratus* back onto Hermite Island, Montebellos	No current threats, possibly vulnerable to disease.
Lagorchestes conspicillatus conspicillatus		Secure and abundant on Barrow Island, and a smaller secure population on Middle Island. Plan to re-introduce *L. conspicillatus* back onto Hermite Island, Montebellos.	No current threats, possibly vulnerable to disease.
Lagorchestes hirsutus		Population (sourced from Tanami Desert) released recently onto Trimouille Island, apparently now secure	No current threats, possibly vulnerable to disease.
Macropus robustus isabellinus		Secure and abundant on Barrow Island	No current threats, possibly vulnerable to disease.
Pseudomys fieldi		Populations released onto North West Island recently are apparently now secure. Population also been released onto Doole Island between 1993 and 2001	No current threats, possibly vulnerable to disease.
Amytornis textilis textilis		Appears to be a rare species around Exmouth Gulf	v (cat), iv (changes to vegetation structure)
Malurus leucopterus edouardi		Secure and abundant on Barrow Island	No current threats, possibly vulnerable to disease.
Aprasia rostrata rostrata		Was collected from Hermite Island (Montebellos) in 1950's, but has not been recorded since	v (rats)

Species Name	Ecosystem Type or Status	Location	Threatening Processes[1]
Caretta caretta		Loggerheads usually nest further south, in Shark Bay. Some nesting on South Muiron Island, and nesting on mainland e.g. just to north of Coral Bay. Occasional recordings of loggerheads are made in other islands of CAR1.	
Chelonia mydas	Beaches, foredunes, mangroves	Green turtles nest on islands throughout CAR1 (Barrow, Montebellos, Lowendals), as well as mainland beaches of Ningaloo Marine Park and Jurabi Conservation Park.	Mainland populations: v (foxes & cats take eggs and hatchlings), xii (some hunting of adults during nesting time by Aboriginal people at Cardabia; beaches are disrupted by vehicles, which destroy nests; Ecotourism needs to be managed closely). Island populations: xii (human interference; industrial lighting and flares is a significant issue for islands with oil bases; prawn fishery in Exmouth Gulf), viii ('floating turtle syndrome' possibly caused by heavy parasite loads and bacterial infection producing large gas bubbles in the organ cavity)
Eretmochelys imbricata	Beaches, foredunes, mangroves	Hawksbill turtle known to nest on the Lowendals and Montebello Islands.	Island populations: xii (industrial lighting and flares associated with oil bases; prawn fishery in Exmouth Gulf)
Natator depressus	Beaches, foredunes, mangroves	Flatback turtle known to nest on mainland beaches of CAR1, and islands, including Barrow and Montebellos.	Mainland breeding: v (foxes & cats take eggs and hatchlings). Island populations: xii (industrial lighting and flares on islands with oil bases; prawn fishery in Exmouth Gulf).
Dermochelys coriacea		An occasional visitor	xii (fishing and shipping). Reports of this species are very occasional, and there is no data on local threats of mortality.
Ophisternon candidum	Karst	Restricted to karst waters of North West Cape.	xi (townsite; chemical; sedimentation), xii (mining), v (feral fish found in cave systems near Exmouth)
Milyeringa veritas	Karst	Restricted to karst waters of North West Cape and Barrow Island.	xi (townsite; chemical; sedimentation; shallow aquifer disposal of oily produced water at Barrow Island), xii (mining), v (feral fish found in cave systems near Exmouth)
Rhincodon typus	Marine	Whale Sharks visit waters of Ningaloo Reef, subject to intensive eco-tourism whale watching industry.	xii (human interference)
Bamazomus sp. nov. (WAM #95/748)	Karst	Western Cape Range *Bamazomus* (Arachnida). Restricted to terrestrial karst of western North West Cape (full distribution unknown).	xi (townsite; industrial), xii (mining)
Draculoides bramstokeri	Karst	Restricted to terrestrial karst of Barrow Island (full distribution unknown).	xi (townsite; industrial; shallow aquifer disposal of oily produced water is at Barrow Island), xii (mining)
Draculoides sp. Nov (WAM # 96/1 15 1)	Karst	Restricted to terrestrial karst of western North West Cape (full distribution unknown).	xi (townsite; industrial), xii (mining)
Hyella sp. nov. (BES 1154.2525.2546.2554)	Karst	Restricted to terrestrial karst of eastern North West Cape (Camerons Cave; full distribution unknown).	xi (townsite; industrial), xii (mining)
Species Name	Ecosystem Type or Status	Location	Threatening Processes[1]
Bogidoma australis	Karst	Restricted to karst waters of Barrow Island (full distribution unknown).	xi (townsite; industrial; shallow aquifer disposal of oily produced water is at Barrow Island), xii (mining)
Lasionectes exleyi	Karst	Restricted to karst waters of western North West Cape (Bundera sinkhole; full distribution unknown).	xi (townsite; industrial), xii (mining; Camerons Cave has been visited by recreational cave divers)
Liagoceradocus branchialis	Karst	Restricted to terrestrial karst of North West Cape (full distribution unknown).	xi (townsite; industrial), xii (mining)
Liagoceradocus subthalassicus	Karst	Restricted to karst waters of Barrow Island (full distribution unknown).	xi (townsite; industrial; shallow aquifer disposal of oily produced water is at Barrow Island), xii (mining)
Nedsia fragilis (Barrow Island amphipod)	Karst	Restricted to karst waters of Barrow Island (full distribution unknown).	xi (townsite; industrial; shallow aquifer disposal of oily produced water is at Barrow Island), xii (mining)
Nedsia humphreysi (Barrow Island amphipod)	Karst	Restricted to karst waters of Barrow Island (full distribution unknown).	xi (townsite; industrial; shallow aquifer disposal of oily produced water is at Barrow Island), xii (mining)

Nedsia hurlberti (Barrow Island amphipod)	Karst	Restricted to karst waters of Barrow Island (full distribution unknown)	xi (townsite; industrial; shallow aquifer disposal of oily produced water is at Barrow Island), xii (mining)
Nedsia marosculptilis (Barrow Island amphipod)	Karst	Restricted to karst waters of Barrow Island (full distribution unknown).	xi (townsite; industrial; shallow aquifer disposal of oily produced water is at Barrow Island), xii (mining)
Nedsia sulptilis (Barrow Island amphipod)	Karst	Restricted to karst waters of Barrow Island (full distribution unknown).	xi (townsite; industrial; shallow aquifer disposal of oily produced water is at Barrow Island), xii (mining)
Nedsia straskraba (Barrow Island amphipod)	Karst	Restricted to karst waters of Barrow Island (full distribution unknown).	xi (townsite; industrial; shallow aquifer disposal of oily produced water is at Barrow Island), xii (mining)
Nedsia urifimbriata (Barrow Island amphipod)	Karst	Restricted to karst waters of Barrow Island (full distribution unknown).	xi (townsite; industrial; shallow aquifer disposal of oily produced water is at Barrow Island), xii (mining)
Stygiocaris lancifera (Exmouth cave shrimp)	Karst	Restricted to karst waters of western North West Cape (full distribution unknown).	xi (townsite; industrial), xii (mining)
Speleostrophus nesiotes (Barrow Island millipede)	Karst	Restricted to terrestrial karst of Barrow Island (full distribution unknown).	xi (townsite; industrial; shallow aquifer disposal of oily produced water is at Barrow Island), xii (mining; recreational visitation to the only cave it occurs in has recently been stopped by Chevron)
Stygiochiropus isolatus (Cape Range millipede)	Karst	Restricted to terrestrial karst of North West Cape (full distribution unknown).	xi (townsite; industrial), xii (mining)
Stygiochiropus peculiaris (Cape Range millipede)	Karst	Restricted to terrestrial karst of North West Cape (full distribution unknown).	xi (townsite; industrial), xii (mining)
Stygiochiropus sympatricus (Cape Range millipede)	Karst	Restricted to terrestrial karst of North West Cape (full distribution unknown).	xi (townsite; industrial), xii (mining)
Dugong dugon (Dugong)		Relatively common in inshore waters around islands, and within Exmouth Gulf. Ecosystem types; shallow marine, over seagrass.	xii (some mortality from shipping, possibly also trawl fishery)
Falco peregrinus (Peregrine falcon)		Appears to be a rare visitor to CAR1. No recent breeding records known.	Unknown
Abutilon sp. (Cape Range AS George 1312).	P1		No other data
Species Name	Ecosystem Type or Status	Location	Threatening Processes[1]
Ptilotus stipitatus	P1	Known from Peedamulla Rd, Onslow	Unknown
Acanthocarpus rupestris	P1	Known from shallow soils over limestone and on foothill slopes of the Cape Range. Localities: 5.5 km S Exmouth; 6 km along old Shothole Canyon Rd; W of No. 2 oil well site.	Unknown
Daviesia pleurophylla	P2	Known from the Cape Range. Localities: 11 km N of Yardie Creek; 7.5 km SE of Sandy Point, at gate into inner part of bombing range; 200m W of 'Ningaloo no. 1'.	Unknown
Eremophila occidens ms	P2		No other data
Harnieria kempeana subsp. *rhadinophylla*	P2		No other data
Verticordia serotina	P2		No other data
Livistona alfredii	P4	A tiny relictual population (several trees) in a very atypical habitat (on top of Cape Range)	iv, v (goats), xii (fire and cyclones appear to be main threat. Recently, Cyclone Vance destroyed the tree with Thomas Carter's initials engraved in the trunk)

[1]Appendix, key e.

Existing recovery plans

Species	Specific Recovery Plan	General Recovery Plan
Petrogale lateralis	No	Action Plan for Australian Marsupials and Monotremes
Bettongia lesueur	No	Action Plan for Australian Marsupials and Monotremes
Isoodon auratus auratus	No	Action Plan for Australian Marsupials and Monotremes
Lagorchestes conspicillatus conspicillatus	No	Action Plan for Australian Marsupials and Monotremes
Lagorchestes hirsutus	No	Action Plan for Australian Marsupials and Monotremes
Macropus robustus isabellinus	No	Action Plan for Australian Marsupials and Monotremes
Pseudomys fieldi	Yes - IRP	Action Plan for Australian Rodents
Dugong dugon	No	No
Falco peregrinus	No	Action Plan for Australian Birds
Amytornis textilis textilis	Yes - IRP	Action Plan for Australian Birds
Malurus leucopterus edouardi	No	Action Plan for Australian Birds
Aprasia rostrata rostrata	No	Action Plan for Australian Reptiles

Caretta caretta	No	Action Plan for Australian Reptiles
Ophisternon candidum	No	Cape Range Remipede Community (Bundera Sinkhole) and Cape Range Remipede Interim Recovery Plan 2000-2003
Milyeringa veritas	No	Cape Range Remipede Community (Bundera Sinkhole) and Cape Range Remipede Interim Recovery Plan 2000-2003; Camerons Cave Troglobitic Community, Camerons Cave and Camerons Cave Pseudoscorpion Interim Recovery Plan 2000-2003
Rhincodon typus	No	unknown
Bamazomus sp. Nov. (WAM #95/748)	No	No
Draculoides bramstokeri	No	Camerons Cave Troglobitic Community, Camerons Cave and Camerons Cave Pseudoscorpion Interim Recovery Plan 2000-2003
Draculoides sp. Nov (WAM # 96/1 15 1)	No	No
Hyella sp. nov. (BES 1154.2525.2546.2554	Yes - IRP	Camerons Cave Troglobitic Community, Camerons Cave and Camerons Cave Pseudoscorpion Interim Recovery Plan 2000-2003
Bogidoma australis	No	No
Lasionectes exleyi	Yes – IRP	Cape Range Remipede Community (Bundera Sinkhole) and Cape Range Remipede Interim Recovery Plan 2000-2003
Species	Specific Recovery Plan	General Recovery Plan
Liagoceradocus branchialis	No	Cape Range Remipede Community (Bundera Sinkhole) and Cape Range Remipede Interim Recovery Plan 2000-2003
Liagoceradocus subthalassicus	No	No
Nedsia fragilis	No	No
Nedsia humphreysi	No	No
Nedsia hurlberti	No	No
Nedsia marosculptilis	No	No
Nedsia sulptilis	No	No
Nedsia straskraba	No	No
Nedsia urifimbriata	No	No
Stygiocaris lancifera	No	Cape Range Remipede Community (Bundera Sinkhole) and Cape Range Remipede Interim Recovery Plan 2000-2003
Speleostrophus nesiotes	No	No
Stygiochiropus isolatus	No	No
Stygiochiropus peculiaris	No	No
Stygiochiropus sympatricus	No	No
Abutilon sp. (Cape Range AS George 1312)	No	No
Ptilotus stipitatus	No	No
Acanthocarpus rupestris	No	No
Daviesia pleurophylla	No	No
Eremophila occidens ms	No	No
Harnieria kempeana subsp. *rhadinophylla*	No	No
Verticordia serotina	No	No

Appropriate species recovery actions

Species	Recovery Actions[1]	Recovery Descriptions
Petrogale lateralis	vii	Control of goats, foxes.
Bettongia lesueur	x, xiv	Translocation to Boodie Island, Monitoring
Isoodon auratus auratus	x, xiv	Translocation to Hermite Island, Monitoring
Lagorchestes conspicillatus conspicillatus	x, xiv	Translocation to Hermite Island, Monitoring
Lagorchestes hirsutus	xiv	Monitoring
Macropus robustus isabellinus	xiv	Monitoring
Pseudomys fieldi	xiv	Monitoring
Dugong dugon	xiv	Monitoring
Falco peregrinus	xiv	Monitoring
Amytornis textilis textilis	xiv	Monitoring
Malurus leucopterus edouardi	xiv	Monitoring
Aprasia rostrata rostrata	xii	Relocate on Hermite island, then monitor.
Caretta caretta	x, xiv, vii	Further research into nesting distribution and requirements, then Monitoring; control of fox if on mainland, restrict human use of nesting beaches
Ophisternon candidum	xiv	Monitoring
Milyeringa veritas	xiv	Monitoring (on Barrow as well)
Rhincodon typus	x, xiv	Further research on distribution and habitat requirements, Monitoring
Bamazomus sp. Nov. (WAM #95/748)	x, xiv	Further research on distribution and habitat requirements, Monitoring
Draculoides bramstokeri	x, xiv	Further research on distribution and habitat requirements, Monitoring

Draculoides sp. Nov (WAM # 96/1 15 1)	x, xiv	Further research on distribution and habitat requirements, Monitoring
Hyella sp. nov. (BES 1154.2525.2546.2554	x, xiv	Further research on distribution and habitat requirements, Monitoring
Bogidoma australis	x, xiv	Further research on distribution and habitat requirements, Monitoring
Lasionectes exleyi	x, xiv	Further research on distribution and habitat requirements, Monitoring
Liagoceradocus branchialis	x, xiv	Further research on distribution and habitat requirements, Monitoring

Species	Recovery Actions[1]	Recovery Descriptions
Liagoceradocus subthalassicus	x, xiv	Further research on distribution and habitat requirements, Monitoring
Nedsia fragilis	x, xiv, xiii	Further research on distribution and habitat requirements; Monitoring; Raise awareness in oil industry about oil and other pollution
Nedsia humphreysi	x, xiv, xiii	Further research on distribution and habitat requirements; Monitoring; Raise awareness in oil industry about oil and other pollution
Nedsia hurlberti	x, xiv, xiii	Further research on distribution and habitat requirements; Monitoring; Raise awareness in oil industry about oil and other pollution
Nedsia marosculptilis	x, xiv, xiii	Further research on distribution and habitat requirements; Monitoring; Raise awareness in oil industry about oil and other pollution
Nedsia sulptilis	x, xiv, xiii	Further research on distribution and habitat requirements; Monitoring; Raise awareness in oil industry about oil and other pollution
Nedsia straskraba	x, xiv, xiii	Further research on distribution and habitat requirements; Monitoring; Raise awareness in oil industry about oil and other pollution
Nedsia urifimbriata	x, xiv, xiii	Further research on distribution and habitat requirements; Monitoring; Raise awareness in oil industry about oil and other pollution
Stygiocaris lancifera	x, xiv	Further research on distribution and habitat requirements, Monitoring
Speleostrophus nesiotes	x, xiv,	Further research on distribution and habitat requirements, Monitoring
Stygiochiropus isolatus	x, xiv	Further research on distribution and habitat requirements, Monitoring
Stygiochiropus peculiaris	x, xiv	Further research on distribution and habitat requirements, Monitoring
Stygiochiropus sympatricus	x, xiv	Further research on distribution and habitat requirements, Monitoring
Abutilon sp. (Cape Range AS George 1312)	x, xiv	Further research on distribution and habitat requirements, Monitoring
Ptilotus stipitatus	x, xiv	Further research on distribution and habitat requirements, Monitoring
Acanthocarpus rupestris	x, xiv	Further research on distribution and habitat requirements, Monitoring
Daviesia pleurophylla	x, xiv	Further research on distribution and habitat requirements, Monitoring
Eremophila occidens ms	x, xiv	Further research on distribution and habitat requirements, Monitoring
Harnieria kempeana subsp. *rhadinophylla*	x, xiv	Further research on distribution and habitat requirements, Monitoring
Verticordia serotina	x, xiv	Further research on distribution and habitat requirements, Monitoring

[1]Appendix B, key h.

Ecosystems and existing recovery plans

Beard Veg Assoc	Vegetation Association or Community Description	Specific Recovery Plan	General Recovery Plan
	Cape Range Remipede Community	Yes - IRP	Cape Range National Park Management Plan
	Camerons Cave Troglobitic Community	Yes - IRP	Cape Range National Park Management Plan
11	Stygofauna communities on Barrow Island	No	Interim Management Guidelines for Necessary Operations, Barrow Island Group

Beard Veg Assoc	Vegetation Association or Community Description	Specific Recovery Plan	General Recovery Plan
43	Terrestrial troglodytes on Barrow Island	No	Interim Management Guidelines for Necessary Operations, Barrow Island Group
127	Stygofauna communities on North West Cape	No	No
151	Marine environments generally (including Ningaloo reef, Exmouth Gulf, Shallow marine areas around Barrow Island and Montebellos)	No	Ningaloo Marine Park Management Plan
162	Sea turtle nesting areas	No	Turtle and Dugong Management Plan for Western Australia
267	Ephemeral creekline drainage communities	No	No

Appropriate ecosystem recovery actions

Beard Veg Assoc	Vegetation Association Description	Recovery Actions[1]	Recovery Descriptions
	Cape Range Remipede Community	i, ii, iii, xii, xiii	Habitat retention through reserves, private lands or on other State lands; Research into all aspects of troglofauna species, particularly distribution and requirements; Building capacity of industry and landholders (pastoral) to contribute, especially to marine and troglofauna, and to feral animal control
	Camerons Cave Troglobitic Community	i, ii, iii, xii, xiii	Habitat retention through reserves, private lands or on other State lands; Research into all aspects of troglofauna species, particularly distribution and requirements; Building capacity of industry and landholders (pastoral) to contribute, especially to marine and troglofauna, and to feral animal control
11	Stygofauna communities on Barrow Island	i, ii, iii, xii, xiii	Habitat retention through reserves, private lands or on other State lands; Research into all aspects of troglofauna species, particularly distribution and requirements; Building capacity of industry and landholders (pastoral) to contribute, especially to marine and troglofauna, and to feral animal control
43	Terrestrial troglodytes on Barrow Island	i, ii, iii, xii, xiii	Habitat retention through reserves, private lands or on other State lands; Research into all aspects of troglofauna species, particularly distribution and requirements; Building capacity of industry and landholders (pastoral) to contribute, especially to marine and troglofauna, and to feral animal control
127	Stygofauna communities on North West Cape	i, ii, iii, xii, xiii	Habitat retention through reserves, private lands or on other State lands; Research into all aspects of troglofauna species, particularly distribution and requirements; Building capacity of industry and landholders (pastoral) to contribute, especially to marine and troglofauna, and to feral animal control
151	Marine environments generally (including Ningaloo reef, Exmouth Gulf, Shallow marine areas around Barrow Island and Montebellos)	i, vii, xiii	Habitat retention through reserves; Feral predator control, mainly fox; Building capacity of industry and landholders (pastoral) to contribute, especially to marine and troglofauna, and to feral animal control
162	Sea turtle nesting areas	i, ii, iii, vi, vii, xiii	Habitat retention through reserves, private lands or on other State lands; Weed control on islands; Feral predator control, mainly fox; Building capacity of industry and landholders (pastoral) to contribute, especially to marine and troglofauna, and to feral animal control
267	Ephemeral creekline drainage communities	i, ii, iii, vi, vii, xiii	Habitat retention through reserves, private lands or on other State lands; Weed control; Feral predator control, mainly fox; Building capacity of industry and landholders (pastoral) to contribute, especially to marine and troglofauna, and to feral animal control

[1]Appendix B, key h.

Subregion priority for off reserve conservation

The subregional priority for off park conservation in CAR1 is (ii) (see Appendix C, rank 6), indicating that large off park measures are required.

Conservation actions as an integral part of NRM

Existing NRM actions

Threat Abatement Planning: Pastoral management of feral animals is currently very poor.

Industry Codes of Practice: Oil industry has some codes of practice that are improving with time, however further improvement is still needed.

Capacity Building: Some capacity in oil industry, however this could also be improved.

Feasible opportunities for NRM

Legislation: Legislative control over pastoral management for controlling feral animals.

Institutional Reform: Review of pastoral production on State lands within CAR1.

Threat Abatement Planning: Control of goat, fox and island weeds.

Industry Codes of Practice: Needs to be developed within the oil industry with particular reference to troglofauna and other operations (sea turtles and lighting).

Capacity Building: Within oil industry and pastoral industry for conservation.

Other Planning Opportunities: Planning for CAR reserve system, to be acquired in 2015.

Impediments or constraints to opportunities

- Lack of funding to acquire lands on open market. Lack of funds to adequately manage our existing estate, let alone any further acquisitions. Lack of long-term planning in pastoral acquisition for CAR reserve system, particularly with reference to 2015 lease surrender.
- Impediments exist in operations of the Pastoral Lands Board (need to re-structure unviable leases after reserve areas are removed);
- High value conservation areas are still targeted by industry (Cape Range, offshore islands) for either raw materials, or processing sites;
- Need to increase awareness of conservation values through education of various industries (mining, pastoral) and the public in general.
- Limited financial resources are also a major constraint.
- High value conservation areas are held under pastoral leases, and we can't afford to purchase them, therefore resumption is the only option.
- Weed control is limited to a few species, in a few places – broad scale control of buffel grass on offshore islands looks possible, but appears too expensive for our resources.
- Lack of basic research into troglofauna – distributions, basic habitat requirements.

Subregions where specific NRM actions are a priority to pursue

CAR1 has a NRM rank of (ii) (see Appendix C, rank 7), indicating that there are significant constraints to integrate conservation as part of a production / development system. This mainly applies to pastoral and oil industry.

Data gaps

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

Vegetation and Regional Ecosystem Mapping: No environmental geology or regolith mapping at better than 1:250 000. No broad-scale soil mapping is available at finer scale than 1:2 000 000 (Bettenay *et al.* 1967).

Quantitative Fauna Survey: Subregional survey of fauna has not been undertaken.

Floristic Data: Subregional flora is poorly known, with few intensive studies. Only small areas have been examined in detail by botanists, usually for industrial development. Quadrat-based floristic data is available from only a few localities. Inventory sites were surveyed by the Departments of Agriculture and Land Administration in the Carnarvon Basin rangelands providing limited plant identification.

Ecological and Life History Data: There are few detailed data on ecological requirements and life histories of virtually all invertebrate species, plants, persisting CWR mammals, uncommon vertebrate and plant species, and ecologically dominant plant species (e.g. hummock grasses). There are little data to provide a regional context on population-trends for even ecologically significant species (e.g., native rodents, dasyurids, spinifex reptile communities, termites, ants, weeds such as buffel grass, kapok bush and ruby dock).

Other Data Gaps Include:

- Troglobitic fauna is not well understood. The fauna is known to be highly significant, yet many species are known from few or single localities.
- No estimate available of impact that recreational access to cave systems has on troglofauna.
- No understanding of impacts of shallow-aquifer disposal of oil-contaminated produced water on Barrow Island.
- No understanding of impacts of gravel extraction on Barrow Island.

- No knowledge of desirability or otherwise of fire and fire management (including suppression) on island ecosystems.
- No quantitative data on the impact of exotic herbivores on aquatic systems, or subterranean systems, especially effects of heavy loads of goat dung in cave inflows.
- No quantitative data on the impact of changes to fire regimes in hummock grasslands, particularly upon vertebrate communities, invertebrate communities, and non-vascular plants.
- No assessment of the impact of global warming upon coastal and island communities, including increasing sea levels and possible increases in frequency and intensity of cyclonic events.
- No quantitative data on the impact of weed colonisation (especially buffel grass) on coastal and island communities, particularly upon recruitment of perennial flora species, and consequent effects on invertebrate, vertebrate communities and other plants.
- Inventory survey has been undertaken for many islands within CAR1 (Exmouth Gulf, Barrow, Lowendal and Montebello groups). However, some islands within the Gulf are still poorly known.
- Poor state of knowledge of sea turtle nesting away from locations where monitoring and / or tagging occurs. Many islands and mainland beaches are known to support nesting, but numbers and species are unknown.
- Poor state of knowledge of sea bird nesting on islands of Exmouth Gulf.

Source

References cited

No.	Author	Date	Title	Publication Details	Pub. Type
023	Aplin, K.P.	(1998).	Three new blindsnakes (Squamata, Typhlopidae) from northwestern Australia.	Records of the Western Australian Museum 19: 1-12.	J
091	Bettenay, E., Churchward, H.M., McArthur, W.M. and Northcote, K.H.	(1967).	Atlas of Australian Soils. Explanatory data for Sheet 6, Meekatharra - Hamersley Range area. Commonwealth Scientific and Industrial Research Organisation, and Melbourne University Press.	Cambridge University Press, London and New York.	O
181	Cogger, H., Cameron, E., Sadlier, R. and Eggler, P.	(1993).	The Action Plan for Australian Reptiles.	Australian Nature Conservation Agency, Canberra.	R
242	Department of Conservation and Land Management	(in prep).	Turtle and Dugong Management Plan for Western Australia.	Department of Conservation and Land Management, Perth.	R
246	Department of Conservation and Land Management	(1999).	Interim Management Guidelines for Necessary Operations, Barrow Island Group.	Unpublished IMG, Department of Conservation and Land Management, Karratha.	R
228	Department of Conservation and Land Management	(1989).	Ningaloo Marine Park Management Plan, 1989 - 1999. Management Plan No. 12.	Western Australian Department of Conservation and Land Management.	R
243	Department of Conservation and Land Management	(1987).	Cape Range National Park Management Plan, 1987 - 1997. Management Plan No. 8.	Western Australian Department of Conservation and Land Management.	R
298	Garnett, S.T. and Crowley, G.M.	(2000).	The Action Plan for Australian Birds.	Environment Australia, Canberra.	R
810	Keighery, G. and Gibson, N.	(1993).	Biogeography and composition of the flora of the Cape Range Peninsula, Western Australia. In The Biogeography of the Cape Range Western Australia, W.F. Humphreys (Ed)	Records of the Western Australian Museum, Supplement No 45.	B

483	Maxwell, S., Burbidge, A.A. and Morris, K. (eds).	(1996).	The 1996 Action Plan for Australian Marsupials and Monotremes. Wildlife Australia Endangered Species Program Project Number 50.	Environment Australia, Canberra.	R
519	Morton S.R., Short, J. and Barker, R.D. with an Appendix by Griffin, G.F. and Pearce, G.	(1995).	Refugia for Biological Diversity in Arid and Semi Arid Australia. Biodiversity Series, Paper No 4. Biodiversity Unit.	Department of Environment Sport and Territories. Canberra	R

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

Other Relevant Publications

See reference numbers 011, 022, 025, 026, 031, 036, 037, 038, 039, 048, 092, 093, 094, 118, 148, 150, 173, 182, 245, 258, 268, 268, 280, 281, 282, 342, 350, 383, 387, 392, 393, 396, 397, 398, 399, 400, 401, 403, 407, 418, 419, 421, 422, 430, 443, 443, 462, 493, 515, 518, 533, 557, 591, 595, 601, 625, 634, 635, 636, 637, 638, 648, 656, 682, 684, 687, 688, 694, 699, 705 and 706 in Appendix A.