Pilbara 4 *(PIL4 – Roebourne synopsis)*

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Subregional description and biodiversity values

Description and area

Quaternary alluvial and older colluvial coastal and sub-coastal plains with a grass savannah of mixed bunch and hummock grasses, and dwarf shrub steppe of *Acacia stellaticeps* or *A. pyrifolia* and *A. inaequilatera*. Uplands are dominated by *Triodia* hummock grasslands. Ephemeral drainage lines support *Eucalyptus victrix* or *Corymbia hamersleyana* woodlands. Samphire, *Sporobolus* and mangal occur on marine alluvial flats and river deltas. Resistant linear ranges of basalts occur across the coastal plains, with minor exposures of granite. Islands are either Quaternary sand accumulations, or composed of basalt or limestone, or combinations of any of these three. Climate is arid (semi-desert) tropical with highly variable rainfall, falling mainly in summer. Cyclonic activity is significant, with several systems affecting the coast and hinterland annually. Subregional area is 2, 008, 983ha.

Dominant land use

Grazing – native pastures (ix) (see Appendix B, key b), Aboriginal lands and Reserves (x), Conservation (xiii), Mining leases (vii), Urban (i).

Continental Stress Class

The Continental Stress Class for PIL4 is 3.

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

Rare Features:

Off-shore islands of PIL4 are considered in the following groups; Dampier Archipelago, islands between Cape Preston and Onslow (as far west as Serrurier), islands between Cape Lambert and Hedland, islands off Poissonnier Point, and Bedout Island. PIL4 is interpreted to not include the Barrow, Lowendal or Montebello groups, or the Muiron islands, or islands west of Serrurier (i.e. those in Exmouth Gulf).

- Offshore islands, Dampier Archipelago (from Delambre to Eaglehawk). Geologically diverse (sand, limestone, basalt and granite, in various combinations). Vegetation generally *Spinifex longifolius* near beaches, and *Triodia* hummock grasslands elsewhere. Scattered *Acacia coriacea, A. bivenosa and A. pyrifolia. Ficus brachypoda, Brachychiton acuminatus* and *Terminalia canescens* associated with rockpiles. Large islands have *E. victrix* along ephemeral drainage lines. Maintained fox-free, through baiting. Legendre is the only large limestone island in this part of the Pilbara, and appears to contain a limited karst system (small sinkholes occur on the island). Abundant mammal and reptile fauna, including Rothschild`s Rock-wallaby (*Petrogale rothschildi*), Pale Field-rat (*Rattus tunneyi*), Water Rat (*Hydromys chrysogaster*), Pilbara Olive Python (*Liasis olivaceus barroni*). Dugongs (*Dugong dugon*) relatively common in inshore waters. Mixed sandy and rocky intertidal shores (tidal range up to 6m). Sea turtles (Loggerhead Turtle (*Caretta caretta*), Green Turtle (*Chelonia mydas*), Hawksbill Turtle (*Eretmochelys imbricata*) and Flatback Turtle (*Natator depressus*)) are all breeding in these islands (all four on Delambre, Rosemary and Legendre). Note that Rosemary nesting beaches have been subject of 15 years of monitoring and tagging of nesting turtles.

  Smaller islands support breeding seabirds, including Wedge-tailed Shearwater (*Puffinus pacificus*), Mangrove Heron (*Butorides striatus*), Reef Heron (*Egretta sacra*), Pied (*Haematopus longirostris*) and Sooty Oystercatchers (*Haematopus fuliginosus*), Silver Gull (*Larus novaehollandiae*), Fairy Tern (*Sterna nereis*), Caspian Tern (*Sterna caspia*), Crested Tern (*Sterna bergii*), Bridled Tern (*Sterna anaethetus*), White-bellied Sea Eagle (*Haliaeetus leucogaster*), Brahminy Kite (*Haliastur indus*), Osprey (*Pandion haliaetus*), Pelican (*Pelecanus conspicillatus*) (Keast and Cohen Islands) and Beach Stone Curlew (*Esacus neglectus*) (Enderby). Intense archaeological values; rock art, habitation sites, quarries, ethnographic sites. Local populations (Dampier Archipelago) of Brown Honeyeater (*Lichmera indistincta*) are probably sub-specifically distinct. Several historical sites; whaling (Malus), pearling camps (Gidley), graves (Eaglehawk, Dolphin, Enderby), abandoned pastoral homestead (West Lewis). Significant local mangroves include those on West Lewis, Legendre, Dolphin and Enderby. The surrounding waters are being considered as a marine reserve, and include diverse marine habitats, an abundant and diverse fish fauna, and diverse soft invertebrate (sponges, echinoderms etc) communities. Most islands have infestations of weeds, including kapok (most or all), buffel (most or all), prickly pear (two or three) and tamarisk (two islands).

- Offshore islands, Dampier to Onslow (from North East Regnard to Serrurier). Most are sandy, sometimes on a limestone base. Vegetation usually coastal species (*Spinifex longifolius, Acacia coriacea, A. bivenosa* etc), with some *Triodia* inland. Many seabird nesting records, including Pelicans (*Pelecanus conspicillatus*) (Little Rocky Island), Wedge-tailed Shearwater (*Puffinus pacificus*) and Pied Cormorants (*Phalacrocorax varius*). Mammal fauna includes Pale Field-rat (*Rattus tunneyi*), Little Red Kaluta (*Dasykaluta rosamondae*), Western Chestnut Mouse (*Pseudomys nanus*) (yet to be

determined whether it is the same subspecies found on Barrow) and Short-tailed Mouse (*Leggadina lakedownensis*) (Thevenard I, successfully translocated to Serrurier). Sea turtle nesting is known to occur, but details are sketchy. Dugongs (*Dugong dugon*) relatively common in inshore waters. Shores usually either sandy, with sand flat and / or limestone pavement intertidal. The exception to this pattern is Potter Island, which is predominantly banded iron formation (and unique among Pilbara islands in this regard). Potter has a relatively large reptile fauna and two mammals as well, being large, with more complex habitats, and close to the mainland. Feral animals (fox, cat) may be present on Carey Island, but appear to be absent from adjacent Potter Island. Most of the islands have small patches of mangal, while Potter and Carey have extensive mangrove areas. Buffel grass is present on many islands, while kapok bush is on some.

- Islands between Cape Lambert to Hedland. Many are sandy (Weerdee, Downes, Ronsard), sometimes on a limestone base, while Depuch is almost entirely basalt. Vegetation usually coastal species (*Spinifex longifolius, Acacia coriacea, A. bivenosa* etc), with some *Triodia* inland on larger islands. Biological information poor. Some seabird nesting records, including Wedge-tailed Shearwater (*Puffinus pacificus*) (Sable and West Moore), Osprey (*Pandion haliaetus*) and Reef Heron (*Egretta sacra*) (West Moore) - no records for East Moore, Depuch, Ronsard, Reefs, Downes or Weerdee Is). Mammal fauna poorly known, preliminary survey indicates that Water Rats (*Hydromys chrysogaster*) (tracks), and Pale Field-rat (*Rattus tunneyi*) may be present on West Moore. Cats were observed on Depuch in 1993. No sign of cats were observed in April 2000, although foxes were. Downes Island has a relatively large reptile fauna (8 species recorded), but only two native mammals (and both *Mus musculus* and *Rattus rattus;* there may also be foxes present). Sea turtle nesting is likely to occur, but no details are known. Dugongs (*Dugong dugon*) relatively common in inshore waters. Shores usually either sandy, with sand flat and / or limestone pavement intertidal. The exception to this pattern is Depuch Island, which is almost completely basalt rockpile (and unique in this regard). Depuch may have a relatively large reptile fauna, as it is large, contains sheltering habitats, and is close to the mainland. A local population of Rock-wallabys (*Petrogale lateralis*) is now extinct, due to fox predation. Contains an enormous amount of rock art, of high aesthetic quality. Contains an historic landing site, and historical graffiti.

- Islands off Poissonnier Point (Little Turtle and North Turtle) of unknown substrate. Nesting seabirds include Pelican (*Pelecanus conspicillatus*), Caspian Tern (*Sterna caspia*), Pied Cormorant (*Phalacrocorax varius*) and White-bellied Sea Eagle (*Haliaeetus leucogaster*) (North Turtle – no records for Little Turtle). Levels of weed invasion and other values are unknown.

- Bedout Island. Sandy island on limestone substrate. High value seabird nesting island; >1000 Brown Booby (*Sula leucogaster*) pairs nesting, >1000 Common Noddy (*Anous stolidus*), >1000 Crested Tern (*Sterna bergii*), 500-1000 Lesser Frigatebird (*Fregata ariel*), 100-500 Masked Booby (*Sula dactylatra*), as well as Lesser Crested Tern (*Sterna bengalensis*), Roseate Tern (Sterna dougallii), Sooty Tern (*Sterna fuscata*), Silver Gull (*Larus novaehollandiae*) and White-bellied Sea Eagle (*Haliaeetus leucogaster*). Several of these do not nest elsewhere in the Pilbara. A small infestation of buffel grass is present around the navigation beacon.

- Burrup Peninsula. Geologically simple (mainly basalts, some granite and coastal sands), but with relatively high and complex relief. A few near-permanent fresh water rockholes, fed by seepages. Baited to control foxes, to protect a low density population of Rothschild`s Rock-wallaby (*Petrogale rothschildi*) on the Burrup and on adjacent Dolphin Island. Olive Pythons (*Liasis olivaceus barroni*) from Hearsons Cove area are currently the subject of a radio-tracking study; this species is present all over the Burrup. Vegetation types generally distinct from mainland vegetation, and high level of flora endemism. Significant regional mangrove stands, particularly at Conzinc Bay, Cowrie Cove, Watering Cove, and adjacent to Dampier Salt Pond Zero intake. Intense archaeological values; very large rock art sites, some containing thousands of images. Many habitation sites, quarries, ethnographic sites. Several historical sites at the southern end, probably pearling camps. Significant weed infestation in disturbed sites (buffel grass and kapok bush).

- Cane River (Peedamulla) Swamp (Cyperaceae) Community. A unique community of seasonally inundated coolibah (*E. victrix*) over a mixed sedgeland comprised mainly of Cyperaceae, one of which may be undescribed (*Fimbristylis* sp. aff. *microcarya)*, with *Cyperus scariosus, C. vaginatus, C. carinatus* and *C. blakeanus*. Relatively large in extent (approximately 500Ha), the swamp is threatened by grazing, erosion and weeds (buffel, mesquite). Longer term, changes in the flow patterns of the Cane River may also endanger the swamp.

Centres of endemism:

- Burrup Peninsula: Apparently a minor centre of endemism for terrestrial gastropods (family Camaenidae). At least six species, of which two or three are undescribed.

Short Range Endemics

Generally very little is known about short range endemic invertebrates in the Pilbara.

Refugia:

- Burrup Peninsula: Fire and evolutionary refuge for flora.
- Islands provide refuges for fauna. Several mammal or reptile species are restricted to islands of PIL4. These are either naturally occurring, or have been placed there. Naturally occurring include Western

Chestnut Mouse (*Pseudomys nanus*), Pale Field-rat (*Rattus tunneyi*), Little Red Kaluta (*Dasykaluta rosamondae*), Short-tailed Mouse (*Leggadina lakedownensis*), *Ctenotus angusticeps*, sea turtles (four species) and seabirds (nesting).

- Basalt rockpiles: As fire refuges.

High Species and Ecosystem Diversity:

- Burrup Peninsula: Provides high habitat diversity for plants, and displays high species diversity for Camaenid landsnails.

In 1975 the Conservation Through Reserves Committee (CTRC) made recommendations for reserves within the Pilbara (System 8) (Environmental Protection Authority 1975), in the 'Red Book' reports of 1976 – 1984. Reserve recommendations in the Pilbara (including PIL4) included many reserve proposals for offshore islands, including the Dampier Archipelago and many islands between Onslow and Cape Keraudren. In 1993, the 'Red Book Status Report' reviewed the implementation of these recommendations (Environmental Protection Authority 1993). Most recommendations pertaining to islands had been implemented, including most of those relating to the declaration of reserves. Proposed B-class island reserves between Dixon Island and Cape Keraudren have not progressed. No other subregional or bioregional planning for biodiversity conservation has been attempted.

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

Wetlands

Wetlands of National significance (DIWA listings)

Name, Code	Description[1]	Condition[2]	Trend[3]	Reliability[4]	Threatening Processes[5]
De Grey River, PIL001WA	B1, B2, A6, A7, A8, B9	ii	iii	ii	iv (grazing and trampling by cattle), v (cattle, pigs, donkey, camel and horses), vi, (buffel grass and parkinsonia)
Leslie (Port Hedland) Saltfields System, PIL004WA	C4, A8, A9, A7	iii	iv	ii	System is largely artificial. ix (expansion of saltfield and consequent increase in salinity of present Pond Zero)

[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	Location	Description[1]	Special Values[2]	Condition[3]	Trend[4]	Reliability[5]	Threatening Processes[6]
Permanent pools of coastal rivers: Turner, Yule, Sherlock, Harding, Maitland, Fortescue	Pools within 40 km of coast	A11, B2, B9, B17	Large perm. pools, springs, large fish fauna, water birds, invertebrates	ii	iii	iii	iv, v (cattle, donkey, camel), vi (buffel grass, mesquite, parkinsonia), x (decreased flow due to dam on Harding River), xii (camping on banks of pools, e.g. Miaree Pool)

Name	Location	Description[1]	Special Values[2]	Condition[3]	Trend[4]	Reliability[5]	Threatening Processes[6]
Mangroves (from Johnstone 1990 and pers. comm.): mouth of De Grey, Turner, Yule, Harding and Cane Rivers, Port Hedland, Balla Balla, Dixon Island, West Intercourse Island, Nickol Bay, Fortescue River delta, Maitland river delta, Robe river delta, Cossack to Harding delta complex, Sherlock Bay, Ronsard Island area.	various	A9	Several unique birds (sub-species or varieties, R Johnstone), incl. grey-morph yellow silvereye and brown honeyeater, red mangrove herons at Cane River; limits of range for some species, including Shining flycatcher (Harding River), Redthroat	iii	iii-iv	iii	ix (via causeways, bunding, bridges, damming of Harding River), v (cattle, donkey, camel, from sheltering under trees), xi (urban and industrial, especially near ports and towns, also possibly bitterns outflows)
Cane River Swamp	Mouth of Cane River, 115 22.3'E 21 34.3' S		*E. victrix* over sedge (Cyperaceae) wetland. Episodically inundated.	ii	iii	iii	iv (grazing pressure), vi (buffel grass, mesquite, *Parkinsonia*), x (change in hydrology due to erosion; also changes in Cane River outflow channel)

[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]
Fortescue River	ii (Buffel grass very common, permanent and semi-permanent pools affected by cattle and feral animals)	iii	ii	iv, v (cattle, sheep and horse), vi (buffel grass, parkinsonia, mesquite), iv, vi, vii, v (foxes, cats, rabbits and goats), iii
Maitland River	ii	iii	ii	iv, v (cattle, sheep and horse), vi (buffel grass, parkinsonia, mesquite), iv, vi, vii, v (foxes, cats, rabbits and goats), iii
Turner River	ii	iii	ii	iv, v (cattle, sheep and horse), vi (buffel grass, parkinsonia, mesquite), iv, vi, vii, v (foxes, cats, rabbits and goats), iii
De Grey River	ii	iii	ii	iv, v (cattle, sheep and horse), vi (buffel grass, parkinsonia, mesquite), iv, vi, vii, v (foxes, cats, rabbits and goats), iii
George River	ii	iii	ii	iv, v (cattle, sheep and horse), vi (buffel grass, parkinsonia, mesquite), iv, vi, vii, v (foxes, cats, rabbits and goats), iii
Nichol River	ii	iii	ii	iv, v (cattle, sheep and horse), vi (buffel grass, parkinsonia, mesquite), iv, vi, vii, v (foxes, cats, rabbits and goats), iii
Sherlock River	ii	iii	ii	iv, v (cattle, sheep and horse), vi (buffel grass, parkinsonia, mesquite), iv, vi, vii, v (foxes, cats, rabbits and goats), iii

[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)

There are no Threatened Ecological Communities (TECs) in PIL4.

Other ecosystems at risk

Community	Status	NVIS[1]	Condition[2]	Trend[3]	Reliability[4]	Threatening Processes[5]
Mangrove communities that are at risk from mining and associated landuses and industry.	V	40	iii	iii	iii	ii, ix, x (loss of fresh water flushing from Harding Dam construction (monitoring to be confirmed)), xi (industrial pollution in Dampier and Port Hedland harbours (hydrocarbons, TBTs, sediment

						others), bitterns discharges, NO_2 emissions), xii (development and expansion of mining sites and infrastructure)
Rock pool communities, Burrup Peninsula: Calcareous (tufa) deposits, aquatic mollusc fauna of interest (undescribed species of molluscs).	V	33	Unknown	iii	ii	xi (industrial emissions)
Rock pile communities, Burrup Peninsula and Dolphin Island: Fauna is a mixture of Kimberley and Pilbara species, different to adjacent Chichester Range rockpile communities.	V	33	ii	iii	iii	ii, vi (buffel), xi (in dust emissions)
Roebourne Plains coastal grasslands, Sherlock Station and Roebourne Common, Airport Reserve (between Roebourne and Karratha), 7 Mile Creek.	V	36	ii	iii	iii	iv, vi (buffel, kapok, parkinsonia)
Peedamulla (Cane River) Swamp Cyperaceae community, near mouth of Cane River.	V	9	ii	ii	iv	iv (cattle), vi (mesquite, buffel), x (gully erosion), xii (recreation)
Mount Salt, calcareous mound spring. Large calcareous mound, recently dry (possibly due to depression of local water table by mesquite weed).	V	41	ii	iv	iii	vi (mesquite has depressed local water table)
Roebourne Plains stony chenopod association.	V	31	ii	iii	ii	iv, v, vi (buffel)
Creekline communities dominated by *Cynanchum* aff. *floribundum*, east branch of Harding River, near Chichester escarpment.	V	8	ii	iii	ii	iv, v, vi (buffel)
Pilbara off-shore island communities (fauna and flora)	V	33, 24, 23,	ii	ii-iii	iii	vi (buffel grass, kapok bush)

[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)					
Rhinonicteris aurantius	V	ii	iii (known to be declining at disturbed sites)	iii	xii (human disturbance associated with tourism, mining, scientific activity)
Petrogale lateralis	V	i	i (extinct on Depuch, possibly to be reintroduced from Calvert Range)	iii	v (fox, cat)
SCHEDULE 1; RARE/LIKELY TO BECOME EXTINCT, DIV 2 (BIRDS)					
Caretta caretta	E	Unknown	iii - iv	iv	xii (human disturbance), v (fox)
Chelonia mydas	V	Unknown	iii - iv	iv	xii (human disturbance), v (fox)
Eretmochelys imbricata	V	Unknown	iii - iv	iv	xii, human disturbance, v (fox),
Species	Status	Condition[1]	Trend[2]	Reliability[3]	Threatening Processes[4]
Natator depressus	V	Unknown	iii - iv	iv	xii (human disturbance, including hunting), v (fox)
Dermochelys coriacea	V	Unknown	iii - iv	ii	xii (human disturbance)
Ctenotus angusticeps	V	iii	iii - iv	iii	xii (human disturbance, oil base), vi (buffel grass)
Liasis olivaceus barroni	V	iii	iv	ii	Not threatened, or likely to be. Shouldn't be on list, common, widespread, and not declining
SCHEDULE 4; OTHER SPECIALLY PROTECTED FAUNA. DIVISION 1 (MAMMALS)					
Dugong dugon	SP	iii	iii - iv	iii	xii (human disturbance, hunting)
SCHEDULE 4; OTHER SPECIALLY PROTECTED FAUNA. DIVISION 2 (BIRDS)					
Falco peregrinus	SP	Unknown	iv	ii	No known threatening processes
SCHEDULE 4; OTHER SPECIALLY PROTECTED FAUNA. DIVISION 3 (REPTILES)					
Crocodylus porosus	SP	iii	v	ii	xii (human disturbance)

[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					
Abutilon sp. Onslow (F Smith sn 10.9.1961)	1	Unknown	vi	i - ii	Unknown threatening processes
Goodenia omearana ms	1	Unknown	vi	i - ii	xii (mining)
Helichrysum oligochaetum	1	Unknown	vi	i - ii	Unknown threatening processes
Ptilotus appendiculatus var. *minor*	1	Unknown	vi	i - ii	xii (industrial development), iv

Ptilotus stipitatus	1	Unknown	vi	i	Unknown threatening processes
Terminalia supranitifolia	1	Unknown	iv	ii	xii (industrial development), iv
Fimbristylis aff. *microcarya*	1	Unknown	ii	ii	iv (grazing pressure), vi (buffel grass, mesquite, parkinsonia), x (change in hydrology due to erosion; changes in Cane River outflow channel)
PRIORITY 2					
Carpobrotus sp. Thevenard Island (MR White 050)	2	Unknown	vi	i - ii	xii (Petroleum development), vi (buffel grass)
Euphorbia clementii	2	Unknown	vi	i	Unknown threatening processes
Gomphrena cucullata	2	Unknown	vi	i	Unknown threatening processes
Gomphrena pusilla	2	Unknown	vi	i	Unknown threatening processes

[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 Code	Ecosystem Description	IUCN I-IV	Non-IUCN Reserve Ha	CALM-Purchased Lease	Priority
11	Medium woodland; coolibah (*E. microtheca*)				M
29	Sparse low woodland; mulga, discontinuous in scattered groups				M
43	Low forest; mangroves (Kimberley) or thicket; mangroves (Pilbara)		3,580.0		H
82	Hummock grasslands, low tree steppe; snappy gum over *Triodia wiseana*				M
93	Hummock grasslands, shrub steppe; kanji over soft spinifex		386.3		M
98	Hummock grasslands, shrub steppe; kanji over soft spinifex & *T. basedowii*			0.5	M
101	Hummock grasslands, shrub steppe; *Acacia pachycarpa* over soft spinifex				M
117	Hummock grasslands, grass steppe; soft spinifex	7,444.8	7,851.7		L
125	Bare areas; salt lakes				L
127	Bare areas; mudflats		30,345.4		L
152	Hummock grasslands, grass steppe; soft & hard spinifex soft spinifex	1,508.5			M
157	Hummock grasslands, grass steppe; hard spinifex *Triodia wiseana*	0.1	10.5		M
Beard Veg Code	Ecosystem Description	IUCN I-IV	Non-IUCN Reserve Ha	CALM-Purchased Lease	Priority
158	Hummock grasslands, shrub steppe; kanji over *Triodia basedowii*				M
173	Hummock grasslands, shrub steppe; kanji over soft spinifex & *T. wiseana* on basalt				M
175	Short bunch grassland - savannah/grass plain (Pilbara)		363.8		H
196	Hummock grasslands, shrub steppe; kanji over *Triodia wiseana* on hills of dolerite and shale				M
197	Sedgeland; sedges with scattered medium trees; coolibah over various sedges & forbes				H
583	Hummock grasslands, sparse shrub steppe; kanji & *Acacia bivenosa* over hard spinifex *Triodia basedowii* & *T. wiseana*				M
584	Open low woodland; *Eucalyptus* sp. aff. *aspera*	781.6			M
585	Mosaic: Shrublands; snakewood & *Acacia victoriae* scrub/Hummock grasslands, shrub-steppe; kanji over soft spinifex & *T. basedowii*	37667.1		63,455.3	L
587	Mosaic: Hummock grasslands, open low tree-steppe; snappy gum over *Triodia wiseana*/Hummock grasslands, shrub-steppe; kanji over *T. pungens*				M
589	Mosaic: Short bunch grassland - savannah/grass plain (Pilbara)/Hummock grasslands, grass steppe; soft spinifex soft spinifex	13,507.6	250.7		M
600	Sedgeland; sedges with open low tree savannah; *Eucalyptus* sp. aff *aspera* over various sedges		1,036.2		H
601	Mosaic: Sedgeland; various sedges with very sparse snakewood/Hummock grasslands, shrub-steppe; kanji over soft spinifex		2,326.3		M
603	Hummock grasslands, sparse shrub steppe; *Acacia bivenosa* over hard spinifex				M
604	Hummock grasslands, shrub steppe; kanji & snakewood over soft spinifex		199.4		M
605	Hummock grasslands, shrub steppe; *Acacia pachycarpa* & waterwood over soft spinifex	276.4			M
606	Hummock grasslands, shrub steppe; *Acacia victoriae* & snakewood over soft spinifex				M
608	Mosaic: Shrublands; *Acacia victoriae* & snakewood scrub patches/Short bunch grassland - savannah/grass plain (Pilbara)				H
619	Medium woodland; river gum (*E. camaldulensis*)				H
620	Hummock grasslands, shrub steppe; snakewood over soft spinifex				M
629	Mosaic: Short bunch grassland - savannah/grass plain (Pilbara)/Hummock grasslands, grass steppe; hard spinifex *Triodia wiseana*				H
640	Sedgeland; sedges with scattered medium trees; coolibah & river gum over various sedges				H
641	Medium woodland; coolibah & river gum				H
646	Hummock grasslands, shrub steppe; snakewood over *Triodia basedowii*				M

647	Hummock grasslands, dwarf-shrub steppe; *Acacia translucens* over soft spinifex				H
649	Sedgeland; Various sedges with very sparse snakewood				H
667	Hummock grasslands, shrub-steppe; scattered shrubs over *Triodia wiseana* & *T.* sp. indet. aff. *angusta*	19,948.6			M
670	Hummock grasslands, shrub steppe; scattered shrubs over *Triodia basedowii*				M
676	Succulent steppe; samphire		1,077.1		H
699	Shrublands, pindan; *Acacia eriopoda* shrubland with scattered low bloodwood (*E. dichromophloia*)& *E. setosa* over soft & curly spinifex on sandplain				H

Subregional constraints in order of priority

(see Appendix B, key g)

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 held by mineral producers may be available.

Competing Land Uses: In particular prospective mining interests and pastoral values. Major resource developments are planned for coastal locations (including Cape Preston), and on some islands. Some islands (Legendre, West Intercourse, Dixon) are still nominated for future industrial development.

Bioregional and subregional priority for reserve consolidation

PIL has 7.75% of its surface under some form of conservation tenure and therefore has a reservation class of 3 (see Appendix D, and Appendix C, rank 4). Within the bioregion, PIL1 has 6.56% or its area reserved, PIL2 has 0.79%, PIL3 has 14.10%, and PIL4 has 9.56%. The reservation class for PIL4 is appropriate.

Reserve management standard

PIL4 contains parts of one national park, one conservation park and many island nature reserves. Millstream–Chichester National Park has resident staff, however, other areas have no resident staff. Island nature reserves vary from being visited on a weekly basis (Dampier Archipelago) to being visited perhaps once every 4 years (e.g. Bedout Island).

National Parks: Reserve Management Rank is good (iii) (see Appendix C, rank 5). Millstream-Chichester National Park has a draft management plan, has high level of ecological monitoring, extensive weed control and rehabilitation operations, fire management. However, has weed issues (buffel, ruby dock) that will be impossible to solve.

Conservation Parks: Reserve Management Rank is fair (ii). Cane River / Mount Minnie / Barlee Range has interim management guidelines, feral herbivore control is progressing, and a resident caretaker is looking after fences, roads and facilities, some fire management.

Island Nature Reserves: Reserve Management Rank is poor (i). Many have buffel grass (*Cenchrus ciliaris*) and kapok bush (*Aerva javanica*) on them, which appear to be rapidly spreading. Some predator control (foxes) is undertaken on islands with rock wallaby populations. Visitor use is problematic in some cases (weeds mainly, occasionally feral predators such as dogs and cats). Thevenard Island has an oil base and recreation accommodation development. These have contributed to spread of weeds (buffel grass) and feral animals (house mice). No attempt so far to manage fire on any islands. Fauna and flora reasonably well known, but not complete, particularly for islands between Cape Lambert and Port Hedland. Dampier Archipelago has management plan which is due to be rewritten. Increasing use by locals, tourists and charter operators could increase risk of feral introductions or spread of weeds. Airlie Island has an oil base which has contributed to spread of weeds (buffel), but control is taking place. Dampier Archipelago / Cape Preston proposed marine reserve in planning phase. Some uncontrolled camping and commercial operations on nature reserve islands (e.g. Regnards, Sholl, Steamboat, Serrurier). Lighting management is important on islands with infrastructure to protect nesting turtles (Thevenard, Airlie).

Class	Purpose	Name	Category	Reserve Management[1]
A	Conservation of fauna and flora & Recreation	Millstream-Chichester National Park	National Park	iii
	Conservation Park	Cane River/Mount Minnie/Barlee Range	Conservation Park	ii
	Conservation of fauna and flora	Many island nature reserves	Nature Reserve	i

[1]Appendix C, rank 5

Off reserve conservation

Priority species or groups and existing recovery plans

Species	Location	Threatening Processes[1]	Specific Recovery Plan	General Recovery Plan
Macroderma gigas	Low density occurrence in abandoned mines in vicinity of Pinderi Hills, and it may forage over the coastal plains.	xii (human disturbance of disused mines; barbed wire fencing on Karratha and Mount Welcome Stations (No reports of entangled bats yet))	No	Action Plan for Australian Bats
Petrogale lateralis	Recently extinct on Depuch Island	v (control of fox would be required, also possibly cats)	No	Action Plan for Australian

				Marsupials and Monotremes
Petrogale rothschildi	At present common throughout Pilbara. However, island populations are known to decline in presence of foxes.	v (fox control required on near-coastal islands). Foxes have been removed from islands in the eastern part of the Dampier Archipelago, including Dolphin, Angel, Gidley, Legendre and Hauy Islands over the last 12 – 15 years	No	Action Plan for Australian Marsupials and Monotremes
Caretta caretta	Loggerhead turtle known to nest on Delambre, Rosemary, Legendre but only in very low numbers	v (fox and cat predation of nests and young turtles); xii (human disturbance of nests). No hunting of adults is known. Prawn fishery probably kills unknown but significant number of adults (TEDs not applied in Nickol Bay or Onslow fisheries).	No	Action Plan for Australian Reptiles
Species	Location	Threatening Processes[1]	Specific Recovery Plan	General Recovery Plan
Chelonia mydas	Green turtles nest on islands and occasionally on mainland beaches (Cape Preston, Cape Lambert, and possibly others)	Mainland breeding is disrupted by (v) feral predators (especially fox, also cat) taking eggs and hatchlings. Also reports of (xii) significant hunting of adults during nesting time by Aboriginal people. This occurred mainly at Munda, and that beach is now closed to the public. Minor hunting by boat by Thursday Island people. Mainland beaches are also disrupted by vehicles, which destroy nests. Township lighting (xii) is an issue, particularly at Hedland. Island populations are at risk from (v) fox and cat (where present), and to a much smaller extent by (xii) human interference. Industrial lighting is a significant issue for islands with oil bases (xii). Prawn fishery (xii) probably kills unknown but significant number of adults (TEDs not applied in Nickol Bay or Onslow fisheries). Small Greens Turtles are commonly found with 'floating turtle syndrome'; many appear to die from this condition, the cause of which is unknown.	No	Action Plan for Australian Reptiles
Eretmochelys imbricata	Hawksbill turtle known to nest on Delambre, Rosemary, Legendre, and others.	v (fox and cat predation of nests and young turtles), xii (human disturbance of nests). No hunting of adults is known. Prawn fishery probably kills unknown but significant number of adults (TEDs not applied in Nickol Bay or Onslow fisheries).	No	Action Plan for Australian Reptiles
Natator depressus	Flatback turtle known to nest on mainland beaches (Munda, Port Hedland, Wickham, Cape Preston), and islands (Delambre, Rosemary, Legendre, Thevenard).	Mainland breeding is disrupted by (v) feral predators (especially fox, also cat) taking eggs and hatchlings. Also reports of significant hunting (xii) of adults during nesting time by Aboriginal people. This occurred mainly at Munda, which is now closed to the public, and in Port Hedland. Township lighting (xii) is an issue, particularly at Hedland. Island populations are at risk from fox and cat (where present), and to a much smaller extent by human interference. Industrial lighting is a significant issue for islands with oil bases. Prawn fishery (xii) probably kills unknown but significant number of adults (TEDs not applied in Nickol Bay or Onslow fisheries).	No	Action Plan for Australian Reptiles
Dermochelys coriacea	An occasional visitor. May be at risk from fishing and shipping.	Reports of this species are very occasional, and there is no data on local threats of mortality.	No	Action Plan for Australian Reptiles
Ctenotus angusticeps	Airlie Island and Thevenard Islands	Airlie Island has an oil base facility and buffel grass, which is being controlled in a trial of broad-scale control for Pilbara islands (with success). A mainland population is known from Roebuck Bay, but the genetic status of these two populations is unknown.	No	Action Plan for Australian Reptiles

Species	Location	Threatening Processes[1]	Specific Recovery Plan	General Recovery Plan
Liasis olivaceus barroni	Known from rocky areas on the mainland, particularly along water courses, and from the Burrup Peninsula, Dolphin and West Lewis Islands	This species is common and widespread in the Pilbara. It is not threatened, and should not be listed as such.	No	Action Plan for Australian Reptiles
Dugong dugon	Relatively common in inshore, protected waters	xii (low-level human hunting by TI community; some mortality from shipping, possibly also trawl fishery and small boats)	No	No
Crocodylus porosus	Recently (re)established in inshore marine and creek systems between Balla Balla and Cape Keraudren. Not likely to be breeding, due to lack of suitable fresh-water habitat.	Human populations have a very low tolerance of crocodiles. Several have been shot by landholders. Others have been trapped and relocated to crocodile farms. Limits of range are not likely to have been reached yet. Possible that crocodiles could extend as far as Exmouth Gulf (unconfirmed reports of tracks have been made).	No	Action Plan for Australian Reptiles
Priority 1 and 2 flora including: *Abutilon* sp. (Onslow (F Smith sn 10.9.1961), *Carpobrotus* sp. Thevenard I (MR White 050), *Helichrysum oligochaetum, Ptilotus appendiculatus* var. *minor, Terminalia supranitifolia, Fimbristylis* sp. aff. *microcarya*	Require more survey to confirm their conservation status.	Wide range of threatening processes	No	No

[1]Appendix B, key e

Appropriate species recovery actions

Species	Recovery Actions[1]	Recovery Descriptions
Macroderma gigas	xiv	No problem yet, but should be kept in mind that cattle fencing may cause problems. Ongoing monitoring is required.
Petrogale lateralis	vii, x	Translocation of desert animals to Pilbara islands is a possibility. Target island not yet decided.
Petrogale rothschildi	vii	Islands of Dampier Archipelago to be maintained fox-free.
Caretta caretta	i, ii, iii, vii	Habitat retention through reserves or on other State lands or on private lands.
Chelonia mydas	i, ii, iii, vii	Retention of island reserves, and protection of other nesting locations on leasehold or other reserve lands. Likely that control of foxes and cats would contribute to recovery.
Eretmochelys imbricata	i, ii, iii, vii	Retention of island reserves, and protection of other nesting locations on leasehold or other reserve lands. Likely that control of foxes and cats would contribute to recovery.
Natator depressus	i, ii, iii, vii	Habitat retention through reserves or on other State lands or on private lands. Likely that control of foxes and cats would contribute to recovery.
Dermochelys coriacea	xii	Monitoring and research needed. Little known about population, or use of WA waters.
Ctenotus angusticeps	i, ii, iii, xiii	Habitat retention through reserves or on other State lands or on private lands. Capacity building required with industry.
Liasis olivaceus barroni	none	No recovery actions required.
Dugong dugon	i, xii, xiv	Protection of habitat within Dampier Archipelago (Marine Park) and elsewhere. Research into hunting pressure required. Periodic monitoring from air needed.

Species	Recovery Actions[1]	Recovery Descriptions
Crocodylus porosus	ii, xii, xiv	Protection of habitat on east Pilbara coasts. Monitoring of numbers present required. Determining breeding status required.
Priority 1 and 2 flora including: *Abutilon* sp. (Onslow (F Smith sn 10.9.1961), *Carpobrotus* sp. Thevenard I (MR White 050), *Helichrysum oligochaetum, Ptilotus appendiculatus* var. *minor*	xii	Further research of species is required.
Terminalia supranitifolia	i	Protection of habitat on Burrup Peninsula required. No other action necessary.
Fimbristylis sp. aff. *microcarya*	ii, v, vii, viii, xi, xiii	Fencing of cattle, and control of cattle if they become feral. Rehabilitation of land, especially in gullies and high erosion impact areas, and addition measures to control erosion. Capacity building with station owners and managers is required.

[1]Appendix B, key h

Ecosystems and existing recovery plans

Ecosystem	Location	Threatening Processes[1]	Specific Recovery Plan	General Recovery Plan
Mangrove communities that are at risk from mining and associated landuses and industry.	PIL4	ii, ix, x (loss of fresh water flushing from Harding Dam construction (monitoring to be confirmed)), xi (industrial pollution in Dampier and Port Hedland harbours (hydrocarbons, TBTs, sediment others), bitterns discharges, NO_2 emissions)), xii (development and expansion of mining sites and infrastructure)	No	No
Rock pool communities, Burrup Peninsula: Calcareous (tufa) deposits, aquatic mollusc fauna of interest (undescribed species of molluscs).	PIL4	xi (industrial emissions)	No	No
Rock pile communities, Burrup Peninsula and Dolphin Island: Fauna is a mixture of Kimberley and Pilbara species, different to adjacent Chichester Range rockpile communities.	PIL4	ii, xi (in dust. emissions)	No	No
Roebourne Plains coastal grasslands, Sherlock Station and Roebourne Common, Airport Reserve (between Roebourne and Karratha), 7 Mile Creek.	PIL4	iv, vi (buffel, kapok, parkinsonia)	No	No
Peedamulla (Cane River) Swamp Cyperaceae community, near mouth of Cane River.	PIL4	iv (cattle), vi (mesquite, buffel), x (gully erosion)-recreation	No	No
Mount Salt, calcareous mound spring. Large calcareous mound, recently dry (possibly due to depression of local water table by mesquite weed).	PIL4	vi (mesquite has depressed local water table)	No	No
Roebourne Plains stony chenopod association.	PIL4	iv, v, vi (buffel)	No	No
Creekline communities dominated by *Cynanchum* aff. *floribundum*, east branch of Harding River, near Chichester escarpment.	PIL4	iv, v, vi (buffel)	No	No
Pilbara off-shore island communities (fauna and flora)	Islands are scattered all along the Pilbara coast	iv (Buffel grass rapidly colonising most islands. These islands will have greatly reduced flora communities within 10 years. Includes many unvested islands).	No	No
Ecosystem	Location	Threatening Processes[1]	Specific Recovery Plan	General Recovery Plan
Sea turtles (Greens and Flatbacks) at Munda	Coast, Munda, Cape Preston, Port Hedland, Pilbara islands (PIL 4)	xii (human predation of eggs and adults; human disturbance of eggs by vehicles), xi (light pollution from industrial facilities (iron ore mine at Cape Preston; town lights at Port Hedland)); v (feral predators - fox)	No	No
Wetlands of De Grey River (from confluence with Nullagine River to sea)	PIL4	i, ii (none of this wetland is reserved, all occurs on pastoral lease), iv (high stocking rates (cattle) because country is so productive), vi (significant weed problems within river valley), v (feral pigs a major concern, moving upstream from De Grey	No	No

		station), vii.		

[1]Appendix B, key e

Appropriate ecosystem recovery actions

Ecosystem	Recovery Actions[1]	Recovery Descriptions
Mangrove communities that are at risk from mining and associated landuses and industry.	i, ii, iii, xiii, xiv	Habitat retention through reserves or on other State lands. Capacity building with mining companies. Ongoing monitoring of pollution and hydrology issues.
Rock pool communities, Burrup Peninsula. Calcareous (tufa) deposits, aquatic mollusc fauna of interest (undescribed species of molluscs).	xiv, xii	Research and monitoring.
Rock pile communities, Burrup Peninsula and Dolphin Island. Mixture of Kimberley and Pilbara species, different to adjacent Chichester Range rockpile communities.	i, ii, iii, vi, vii	Habitat retention through reserves or on other State lands. Capacity building with mining companies. Buffel grass control. Feral predator control, mainly fox.
Roebourne Plains coastal grasslands, Sherlock Station and Roebourne Common, Airport Reserve (between Roebourne and Karratha), 7 Mile Creek.	i, ii, iii, vi, vii	Habitat retention through reserves or on other State lands. Capacity building with mining companies. Buffel grass control. Feral predator control, mainly fox.
Peedamulla (Cane River) Swamp Cyperaceae community, near mouth of Cane River.	i, ii, iii, vi, vii	Habitat retention through reserves or on other State lands. Capacity building with mining companies. Buffel grass control. Feral predator control, mainly fox.
Mount Salt, calcareous mound spring. Large calcareous mound, recently dry (possibly due to depression of local water table by mesquite weed).	i, ii, iii, vi, vii, xi	Habitat retention through reserves or on other State lands. Capacity building with mining companies. Mesquite weed control. Feral predator control, mainly fox. Reinstatement of hydrology.
Roebourne Plains stony chenopod association.	i, ii, iii, vi, vii	Habitat retention through reserves or on other State lands. Capacity building with mining companies. Buffel grass control. Feral predator control, mainly fox.
Creekline communities dominated by *Cynanchum* aff. *floribundum*, east branch of Harding River, near Chichester escarpment.	i, ii, iii, vi, vii	Habitat retention through reserves or on other State lands. Capacity building with mining companies. Buffel grass control. Feral predator control, mainly fox.
Pilbara off-shore island communities (fauna and flora)	vi	Buffel grass will dominate most island flora communities within decades, if not sooner. Impacts upon fauna (vertebrate and invertebrate) are unknown.
Sea turtles (Greens and Flatbacks) at Munda	xiv, xii	Research and monitoring.
Wetlands of De Grey River (from confluence with Nullagine River to sea)	i, ii, v, vi, vii	Protection from weeds, stock and feral herbivores. Fencing is required if lands remain under cattle production.

[1]Appendix B, key h

Subregion priority for off reserve conservation

The priority for off park conservation in PIL4 is (iii) (see Appendix C, rank 6), indicating that a range of off park measures required.

Conservation actions as an integral part of NRM

Existing NRM actions

Threat Abatement Planning as Part of NRM: e.g. pest management.

Capacity Building: In place through Land Conservation District Committees, local land-holder liaison.

Feasible opportunities for NRM

Legislation: Including duty of care for leasehold and other lands.

Institutional Reform: e.g. Rural reconstruction, industry reconstruction, new tenure and management arrangements; includes resumption of high quality lands for reservation from existing pastoral leases.

Threat Abatement Planning as Part of NRM: e.g. Pest management; particularly fox, and feral herbivore control on pastoral lands.

Capacity Building: Further capacity building in resource and pastoral industries, particularly possibility for joint or compatible management of pastoral leases owned by mining companies.

Other Planning Opportunities: Including local and State government planning.

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. Impediments exist in operations of the Pastoral Lands Board (need to re-structure unviable leases after reserve areas are removed). Reserve acquisition is obstructed by poor use of industrial lands (e.g. large areas tied up in non-producing long term leases, while other high quality conservation areas are alienated to industrial purposes). Some high quality conservation areas are still in inappropriate industrial land use (e.g. Legendre Island). There is a need to increase awareness of conservation values through education of various industry (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 off-shore islands looks possible, but prohibitively expensive.

Subregions where specific NRM actions are a priority to pursue

The NRM priority for PIL4 is (i-ii) (see Appendix C, rank 7), indicating that there are significant or major constraints to implement effective NRM actions and to integrate conservation as part of a production / development system. This is relevant primarily to the pastoral industry.

Data gaps

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

Vegetation and Regional Ecosystem Mapping: No environmental geology / 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 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.

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 Priority Data Gaps Include:

- No quantitative data on the impact of exotic herbivores on aquatic systems, or other communities, especially effects on invertebrate and non-vascular plant communities.
- 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 on 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 species, and consequent effects on invertebrate and vertebrate communities.
- Inventory survey has been undertaken for most islands between the Dampier Archipelago and Onslow. However, islands between Cape Lambert and Hedland 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.

Sources

References cited

No.	Author	Date	Title	Publication Details	Pub. Type
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
258	Duncan, A., Barry Baker, G. and Montgomery, N.	(1999).	The Action Plan for Australian Bats.	Environment Australia.	R
278	Environmental Protection Authority	(1993).	Conservation Reserves for Western Australia. Red Book Status Report. EPA Report 15.	Environmental Protection Authority. Perth, Western Australia.	R
273	Environmental Protection Authority	(1975).	Conservation Reserves for Western Australia. Systems 4,8,9,10,11,12..	Environmental Protection Authority. Perth, Western Australia.	R
298	Garnett, S.T. and Crowley, G.M.	(2000).	The Action Plan for Australian Birds.	Environment Australia, Canberra.	R
418	Johnstone, R.E.	(1990).	Mangroves and Mangrove Birds of Western Australia.	Records of the Western Australian Museum, Supplement No 32.	J
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

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

Other relevant publications

See reference numbers 023, 026, 028, 036, 037, 038, 039, 091, 094, 100, 111, 118, 122, 149, 150, 173, 181, 182, 242, 244, 246, 258, 268, 273, 278, 298, 383, 387, 407, 418, 419,463, 483, 492, 493, 504, 515, 534, 535, 536, 558, 559, 592, 595, 625, 634, 635, 636, 637, 638, 647, 648, 651 and 699 in Appendix A.