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FRONT COVER: Turtle Bay, west coast of Barrow Island.
(Photograph courtesy of ChevronTexaco)

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INSIDE BACK COVER
Advice to authors

Vegetation on and around granite rock outcrops in the Wellington National Park

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SUMMARY

A survey of vascular plant species associated with granite outcrops in Wellington National Park near Bunbury in the south west of Western Australia was carried out in spring and summer 2002. One hundred and eight species, including 10 exotic taxa, were identified. The most frequently represented genera were Orchidaceae (8 species), Asteraceae (8), Apiaceae (6), Myrtaceae (6), and Poaceae (6). The outcrop vegetation formed a continuum dependant mainly on soil depth, ranging from lichen encrusting otherwise bare rock surfaces, through moss swards and herbfields to shrublands and heathlands on deeper soils. It contrasts with that of the surrounding forest both in regard to species composition and structure. This is mainly because of a higher proportion of obligate seeders due to lower fire frequencies, the high summer water stress levels and a wide variety of habitat types within a relatively small area. Not under immediate threat, plant pathogens such as *Phytophthora cinnamomi*, physical disturbance and climate change may pose threats in the near future.

INTRODUCTION

In the south west of Western Australia granite (or granitoid) rocks occur mainly on the Darling Plateau, an ancient erosion surface that averages 300 m above sea level. The Darling Scarp marks the eroded western edge of the Darling Plateau and rises about 200 m from the Swan Coastal Plain. The Collie River, one of the major streams draining the Darling Plateau, cuts through the Darling Scarp about 180 km south of the State capital, Perth. The granite rock outcrops surveyed for this project occur along the lower Collie River valley, below the Wellington Dam, and on the slopes of valleys leading to the Collie River. Altitude of the outcrops varies from about 60 m beside the river where it leaves the national park to 320 m on Mt Lennard. Most of the outcrops are composed of porphyritic granite (Wilde & Walker, 1982), with some smaller areas of granitic gneiss and quartz feldspar biotite gneiss. Occasional doleritic dykes occur. The outcrops protrude from lateritic soils at the upper levels and along the lower slopes there are minor areas of alluvial soils. The average annual rainfall is about 1200 mm, with a prominent winter peak.

Little is known about the vegetation of outcrops in the Wellington National Park or in the Jarrah Forest Bioregion (Thackway & Cresswell, 1995) generally and this survey was carried out partly to remedy that lack of knowledge. In addition knowledge of the rock outcrop vegetation will be important in conserving and managing these restricted communities within the park. The intention was to survey not just the herbfields associated with the skeletal soils on the outcrops, but also the generally treeless vegetation on the shallow rocky soils on the margins of the outcrops.

The forms of the outcrops included the four types (dome, pavement, fugitive and tumulus) illustrated in York Main (1997) as well as another type that occurs along a stretch of the upper slopes on the northern edge of the Collie River Valley. This takes the form of a jumble of rocks, or tors, of varying shape and size interspersed with pockets of skeletal soils of varying depth, most of which are apparently too shallow for the growth of trees.

MATERIALS AND METHODS

In October 2002 five 100 m^2 (10 m x 10 m) quadrats were placed on outcrops within the national park, situated so that they included some portion of their area as bare rock (Table 1). In general the rock outcrop or lithic communities sampled in this survey were defined by the lack of trees, however occasionally in pockets of deeper soils small (< 5 m) individuals of *Corymbia calophylla* occurred. Three quadrats were sited on the north side of the Collie River and two on the south. All vascular plant species were identified within the quadrats and scored on a cover/abundance scale of 1–5. Additionally several other rock outcrops were visited and notes made of the dominant plant species. A follow-up visit was made to several of the outcrops in December 2002 to pick up late flowering species. Voucher specimens were collected and stored at the Department of Conservation and Land Management, Bunbury or deposited in the Western Australian Herbarium. Nomenclature follows Paczowska and Chapman (2000) and current usage at the Western Australian Herbarium (Perth).

TABLE 1
Location and other characteristics of the Wellington National Park quadrats. (see Figure 1)

ATTRIBUTE NAME	WNP01 BOOMER RIDGE	WNP02 LOOKOUT TRACK	WNP03 MT LENNARD I	WNP04 MT LENNARD II	WNP05 SIKA TRACK
Altitude (m) a.s.l.	200	200	287	307	247
Latitude	33° 19' 56.4"	33° 22' 18.2"	33° 21' 43.9"	33° 21' 40.4"	33° 23' 32.0"
Longitude	115° 55' 37.0"	115° 56' 53.3"	115° 53' 22.8"	115° 53' 33.8"	115° 57' 49.1"
% bare rock	10	15	5	5	60
Aspect	north	south west	north east	north	south west

RESULTS

Flora

The number of vascular plant species within the 100 m^2 quadrats ranged from 25 to 42, with a total of 108 species recorded including taxa found outside the quadrats, 10 of these being exotic (Appendix I). The most frequently represented families within the quadrats were Orchidaceae (8 species), Asteraceae (8), Apiaceae (6), Myrtaceae (6), and Poaceae (6).

The lithic vegetation associated with rock outcrops in Wellington National Park, and elsewhere in the Jarrah Forest bioregion, can be divided into three main communities determined by depth and development of soil. As determined by increasing depth of soil these are (1) the moss-lichen community with a few associated herbaceous annuals, (2) the herbfields of *Borya* species and various herbaceous annuals, and (3) the fringing heathlands and shrublands.

Vegetation and habitat

There was great variation in the vegetation associated with the outcrops, both in composition and structure. It ranged from patches of lichen on otherwise bare rock surfaces to moss swards where there was a minimal development of soil to herbfields which sometimes included mosses and were characterised by *Borya* species (resurrection plants), and geophytes such as *Stylidium* spp. (trigger plants) and *Drosera* spp. (sundews), and small annuals such as *Hydrocotyle* spp. (pennyworts), the small daisies *Podolepis lessonii* and *Podotheca gnaphalioides*, and the ubiquitous exotic grasses **Aira caryophyllea* and **Briza minor*. A robust from of *Stypandra glauca* (previously named *S. grandiflora*) was commonly found growing in narrow crevices in the rocks (cf. Ornduff, 1986, p. 16).

In deeper soil at the edges of the herbfields open heathland or shrubland (up to 1.5 m) usually dominated by *Verticordia plumosa* ssp. *plumosa* and *Grevillea bipinnatifida* was common. *Pimelea imbricata* ssp. *imbricata* and *Hypocalymma angustifolium* were also often present as well as a range of exotic and native herbaceous species. In places the shrubland is dominated by *Darwinia citriodora* with co-occurring shrub species such as *Daviesia hakeoides* ssp. *hakeoides* and *Hibbertia commutata*, particularly on the upper slopes of the north side of the Collie River valley where masses of tor-like boulders are interspersed with pockets of deeper soil.

DISCUSSION

Flora

Three Priority List[1] species were found during this survey, and the location of one species represented a significant range extension. The Priority 3 species (*Acacia oncinophylla* ssp. *oncinophylla*) usually associated with granite is quite common around outcrops on the lower slopes south of the river. *Calothamnus graniticus* ssp. *leptophyllus* (Priority 4) which was found on Mt Lennard during this survey had been collected from 'Collie Weir' in 1946 but otherwise all specimens in the WA Herbarium are from Oakley Dam near Dwellingup. Apart from one collection on a disturbed roadside on the coastal plain near Dardanup the discovery of *Daviesia hakeoides* ssp. *hakeoides* within Wellington National Park represents a significant range extension for this species. The nearest known populations within conservation reserves are between Perth and Toodyay. A new population of the Priority 3 species *Synaphea hians* was found in one of the quadrats during this survey.

Vegetation and habitat

The major significance of the granite outcrop communities in the national park is the contrast they present with the surrounding forest in terms of structure and plant species composition – they share very few species with the surrounding jarrah-marri forest and have a high level of endemism (Hopper et al. 1997). The evolution of a distinct suite of plant species associated with rock outcrops no doubt is due to a number of factors; the diversity of microhabitats (alternately extremely dry and very wet), high light levels (Baskin & Baskin, 1988), and a relatively longer interval between

[1] This lists flora that may be rare or threatened but for which there are insufficient survey data to accurately determine their status, as well as flora which is regarded as rare, but not currently threatened.

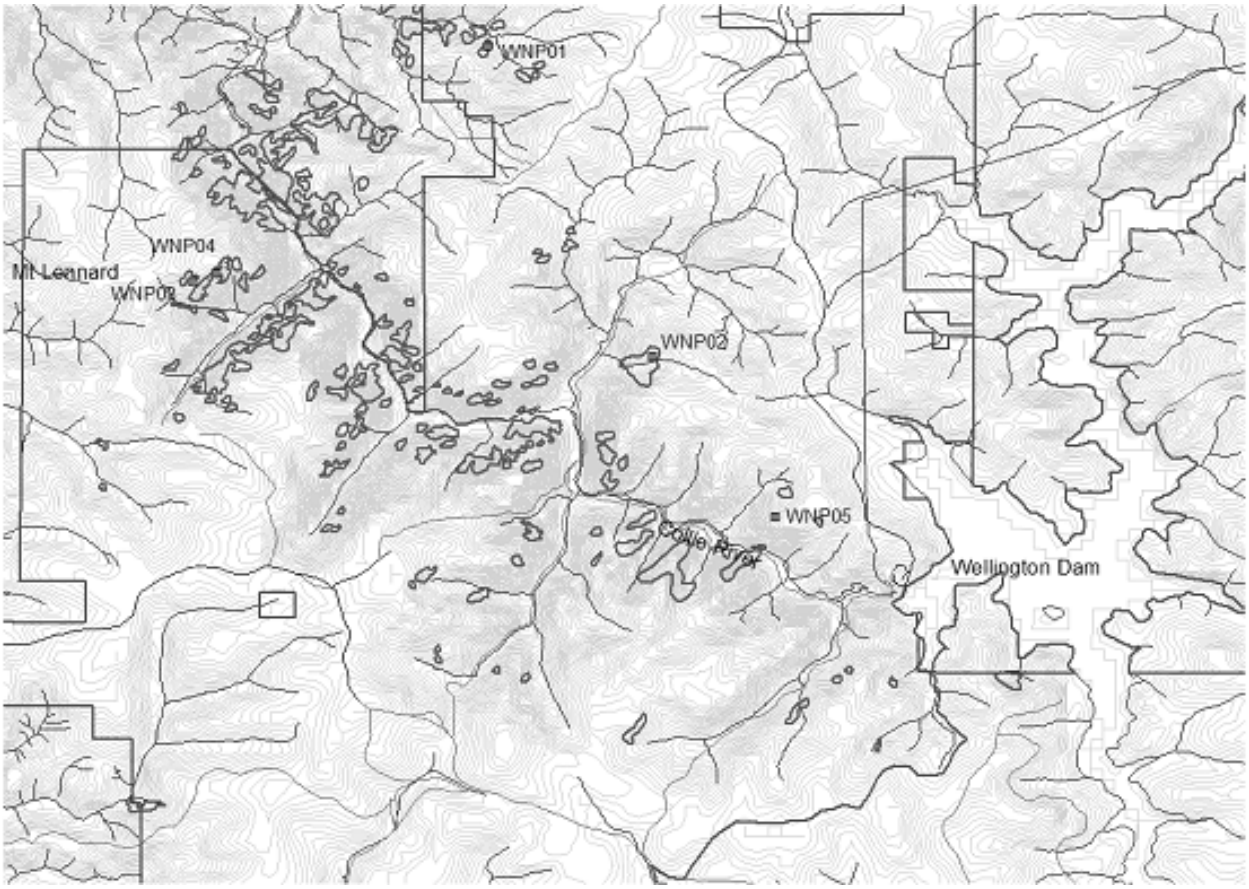


Figure 1. Map of part of Wellington National Park showing areas of rock outcrop and the location of 100 m² survey quadrats.

fires than the surrounding vegetation (as indicated by higher proportions of obligate seeders; Hopper et al., 1997; Clarke, 2002a, 2002b) being among the most important.

Insufficient information is available at this stage on the fire response characteristics of the Wellington National Park rock outcrop flora to be able to compare the proportion of obligate seeders with the rock outcrop vegetation surveyed by Clarke (2002b). Several of the dominant species of the Wellington National Park outcrop shrublands are seeders (*Darwinia citriodora, Daviesia hakeoides* ssp. *hakeoides, Calothamnus graniticus* ssp. *leptophyllus*) while several others are resprouters (e.g. *Dodonaea ceratocarpa, Hibbertia commutata, Hypocalymma angustifolium*).

There is little published data on the species composition of granite outcrop communities in the south west of Western Australia, and no attempt has been made to classify the communities. Hopper et al. (1997) listed 1320 vascular and cryptogram species represented in the Western Australian herbarium where the habitat description included the words 'rock outcrop', although they noted that this was far from comprehensive. Ornduff (1986) surveyed the vascular flora of 10 rock outcrops in the south west of Western Australia, including several in the medium-high rainfall zone of the northern jarrah forest. However he did not identify and record the woody flora surrounding the moss swards and herbfields, nor the members of the Orchidaceae, which are a very important component of the outcrop flora in terms of endemism (Hopper et al. 1997).

Comprehensive accounts have been published of the vascular flora of three granite outcrops in medium to high rainfall areas of Western Australia. These allow a comparison of species composition with those of Wellington National Park (Smith 1962; Abbott 1982; Pigott & Sage 1997; Keighery et al. 2002). However, they are more than 150 km from the study area.

In addition as part of this project, a survey was made of a 6 ha portion of gneissic outcrop in Mullalyup Forest Block, 40 km south of the study area (Appendix II). This, together with a report on the flora of an outcrop in Serpentine National Park (Holmwood 1987), allow comparison with areas which are in a similar rainfall zone, and are geographically much closer.

A comparison of the number of vascular species these other sites had in common with the flora of the rock outcrops in Wellington National Park is shown in Table 2. A partial list for Oakley Dam derived from records at the Western Australian Herbarium provides another source for comparison (Appendix III). It must be noted at this point that the species numbers used in Table 2 were derived using methods that are not strictly comparable. Those for the Porongurup Range, for

TABLE 2

Comparison of vascular plant species occurrence associated with granite outcrops in Wellington National Park and at five other locations. [2] Includes both Lithic and Thicket (granite apron) complexes.

	WELLINGTON NATIONAL PARK (THIS STUDY)	MULLALYUP BLOCK (THIS STUDY)	SERPENTINE NATIONAL PARK (HOLMWOOD, 1987)	YILLIMINING ROCK[2] (PIGOTT AND SAGE, 1997)	PORONGURUP RANGE (SMITH, 1962; ABBOTT, 1982)	DRUMMOND RESERVE (KEIGHERY ET AL., 2002)
Rainfall (mm)	1200	1000	1140	450	700	470
Distance (km)		40	110	150	230	220
Number of vascular species	113	45	39	160	145	45
Number in common with WNP outcrops		24 (53%)	12 (31%)	28 (17%)	24 (17%)	13 (29%)

instance, were derived from two surveys, the second extending over a period of six years (Abbott 1982) during which some species found during the earlier survey (Smith 1962) were not relocated.

Not unexpectedly the Mullalyup Block lithic communities had most species in common with those of Wellington National Park. The shrubland community in Wellington National Park and that at Mullalyup Block also have similar dominant species – *Darwinia citriodora*, *Grevillea bipinnatifida*, *Dodonaea ceratocarpa* and *Pimelea imbricata* are important in both. In addition the herbfield floras are quite similar, the fern *Cheilanthes sieberi* ssp. *sieberi, Stylidium calcaratum, Senecio quadridentatus* and the native grass *Neurachne alopecuroidea* being frequent. The shrubland at Oakley Dam is also quite similar with that in Wellington National Park with *D. citriodora*, *G. bipinnatifida* and *Calothamnus graniticus* ssp. *leptophyllus* being amongst



Figure 2. Surveying a quadrat at Mt Lennard (WNP04) with Andersonia aristata *in the foreground and* Verticordia plumosa *ssp.* plumosa *in the middle ground*

the dominant species. Somewhat surprisingly the flora on the granite outcrop in Serpentine National Park only 35 km north of the Oakley Dam site shares few shrub species with the Wellington National Park lithic communities, most of the plant species in common being exotic annuals and native herbaceous species. However on the evidence of the species list the Serpentine National Park survey may have been mainly confined to the rock outcrop *per se*, and does not include as many species in the slightly deeper soils at the margins as the Wellington National Park survey did.

Apart from *Darwinia citriodora* and *Hypocalymma angustifolium* the dominant species of the shrubland vegetation associated with granite outcrops in the Porongurup Range are different from those in the Wellington National Park. The species in common are predominantly those of the herbfields and the herbaceous component of the shrublands. The shrubland community associated with granite outcrops at the Drummond Nature Reserve (Keighery et al. 2002) 230 km to the north, where annual rainfall is less than half that in Wellington National Park, has only a single woody species (*Acacia pulchella*) in common with the latter area. Among the other species in common are the herbfield constituents *Borya sphaerocephala, Neurachne alopecuroidea, Hydrocotyle alata* and *Trachymene pilosa* as well as the exotic annuals **Hypochaeris glabra* and **Anagallis arvensis*. Likewise, the flora of the lithic and granite apron communities at Yilliminning Rock shares few shrub species with Wellington National Park. Notably however one of these is *Daviesia hakeoides* ssp. *hakeoides*, the Wellington National Park population of which represents a significant outlier.

Threats to the rock outcrop vegetation

Hopper et al. (1997) list the main threats to rock outcrop communities as being invasive weeds, feral animals, grazing, inappropriate fire regimes, clearing, loss of shrub layer, salinity and dieback disease. Eleven exotic plant species were found in the Wellington National Park rock outcrop vegetation – 12% of the total number of species. These were all small, mostly annual plants, with wind-dispersed seeds, most of which now have a cosmopolitan distribution and which appear to pose little further threat to the native species of the lithic communities. However rock outcrops appear to be more susceptible to weed invasion than most other plant communities in south-western Australia with relatively low levels of disturbance and there are situations where they have been invaded by less benign weeds (Pigott & Sage 1997; Pigott 1997). Monitoring for increases in weed invasion should take place within Wellington National Park where outcrops are readily accessible to the public, such as along Lennard Drive, the main access road along the lower Collie River Valley.

A related issue is disturbance by trampling which occurs when the general public has ready access to rock outcrops. If not controlled this can lead to loss of vegetative cover, erosion and increases in weed invasion. This is already apparent in some places along Lennard Drive.

The rock outcrops visited during this survey appear not to have been deleteriously affected by fire regimes. Prescribed burning has been carried out from time to time in the study area on the lateritic uplands either side of the lower Collie River Valley. The most recent prescribed burning within the Park was in spring 2001 in the area around Mt Lennard. This burnt less than 10% of the vegetation on the outcrops visited during this survey. Most of the vegetation on the fringes of the rock outcrops in this case appeared not to have burned primarily because of the protection afforded by areas of bare rock or sparse fuels. In addition, the moss sward is still damp in spring and less prone to burn in spring than during summer or autumn fires. It is possible that in the long-term a lack of fire could be a threat to the outcrop vegetation because many of the species have fire-stimulated germination.

A related issue is change of climatic conditions related to global warming. The diversity of microhabitats on the rock outcrops of south-western Australia appear to have acted as refugia for plants adapted by wet or dry conditions as the surrounding matrix waxed and waned climatically (Hopper et al. 1997). Rainfall amounts and patterns in the south-west have altered significantly over the last 30 years (IOCI 2002). There has been a 10–15% decrease in rainfall totals in the early winter months and a trend to fewer rain days and less rain in extreme days. In addition there has been a 0.7° increase in mean temperature over the last 50 years in the south-west (IOCI 2002). Both the increase in mean temperature and decline in winter and spring rainfall are expected to continue over the next 50 years.

A reduction in winter/spring rainfall amounts is likely to be accompanied by an increase in the area burnt by wildfires at a regional scale (Swetnam & Bettancourt, 1990). It is also likely to have an impact on the ease with which prescribed burning can be carried out safely. In recent years we have observed multiple drought-induced deaths of woody plants on the aprons of granite outcrops in the Jarrah Forest bioregion after particularly dry years. Reliant as they are on rainfall, rather than ground water, moss beds and associated herbfields may be amongst the first vegetation types to show the effects of the predicted climate change in south-western Australia.

CONCLUSIONS

The rock outcrop vegetation of Wellington National Park contrasts with that of the surrounding forest both in regard to species composition and structure, and also because it may have a higher proportion of obligate seeders. The high summer water stress levels of the outcrops, as well as the lower frequency of fires are probably the main contributors to this distinctiveness. Also, because of the wide variety of habitat types within a relatively small area the rock outcrop vegetation has a

higher diversity of composition and structure than equivalent areas of the forest matrix. The number of species observed during the survey compares well with others that examined rock outcrop vegetation in the south-west of Western Australia.

The rock outcrop vegetation does not appear to be presently under particular threat. The effect of the current regime of mainly spring fires and occasional autumn ones carried out at 8 – 10 year intervals over the last 40 years on the composition of outcrop vegetation is unknown. However, as noted already, the last prescribed fire in 2001 had little impact. While dieback disease, caused by the soil-borne pathogen *Phytophthora cinnamomi* is present in the national park there was no sign of deaths attributable to the disease during this survey.

Future risks to the outcrops include physical disturbance and opportunity for spread of plant disease that might come about through increased visitor use of the park. Climate change may cause unavoidable changes through reduced rainfall and increased evapotranspiration.

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APPENDIX I

Vascular plant species occurring (presence/absence) within 10 m x 10 m quadrats placed on rock outcrops in Wellington National Park

FAMILY	SPECIES	WNP01	WNP02	WNP03	WNP04	WNP05
Adiantaceae	*Cheilanthes sieberi* ssp. *sieberi* Kunze	1	0	1	0	1
	*Chamaescilla corymbosa (R.Br.)*Benth.	0	0	1	1	0
	Thysanotus manglesianus Kunth.	1	0	0	0	0
	Thysanotus patersonii R.Br.	0	0	0	0	1
	Tricoryne sp.	0	1	0	0	0
Apiaceae	*Daucus carota* L.	1	0	0	0	0
	Hydrocotyle alata A.Rich.	0	0	0	0	0
	Hydrocotyle callicarpa Bunge in Lehm.	0	0	1	1	0
	Pentapeltis peltigera (Hook.)Bunge in Lehm.	1	0	0	0	0
	Trachymene pilosa Sm. in Rees	0	1	1	1	1
Asteraceae	*Angianthus sp.*	0	1	0	0	0
	Brachyscome iberidifolia Benth. in Endl., Fenzl, Benth.and Schott	0	1	0	0	0
	**Hypochaeris glabra* L.	1	1	1	1	1
	Podolepis lessonii (Cass.)Benth.	0	1	0	0	1
	Podotheca gnaphalioides Graham	0	0	1	0	0
	Senecio quadridentatus Labill.	0	0	0	0	1
	Senecio ramosissimus DC.	0	1	0	0	1
Boryaceae	*Borya scirpoidea* Lindl.	0	0	1	1	0
	Borya sphaerocephala R.Br.	0	1	0	1	0
Caryophyllaceae	*Cerastium glomeratum* Thuill.	1	0	0	0	0
Centrolepidaceae	*Aphelia cyperoides* R.Br.	0	1	0	1	0
	Centrolepis aristata (R.Br.)Roem.and Schult.	0	1	0	1	0
Colchicaceae	*Burchardia umbellata*	0	1	0	0	0
Crassulaceae	*Crassula sp.*	1	1	1	0	0
Cyperaceae	*Schoenus ?odontocarpus* F.Muell.	0	1	1	0	0
Dilleniaceae	*Hibbertia commutata* Steud. in Lehm.	0	0	1	0	1
	Hibbertia hypericoides (DC.)Benth.	0	0	0	1	1
Droseraceae	*Drosera ?bulbosa* Hook.	1	1	1	0	0
	Drosera macrantha ssp. macrantha Endl.	0	1	1	1	0
	Drosera menziesii ssp. menziesii DC.	0	1	1	1	1
Epacridaceae	*Andersonia aristata* Lindl.	0	0	0	3	0
	Andersonia caerulea R.Br.	0	0	0	1	0
	Leucopogon capitellatus DC.	1	0	3	1	0
Euphorbiaceae	*Phyllanthus calycinus* Labill.	0	0	1	1	0
Geraniaceae	*Pelargonium littorale* Huegel	0	0	1	0	1
Goodeniaceae	*Velleia trinervis* Labill.	0	0	0	1	0
Iridaceae	**Orthrosanthus laxus* (Endl.)Benth.	0	0	0	0	1
	**Romulea rosea* (L.)Eckl.	1	0	0	0	0
Lamiaceae	**Mentha sp.*	0	1	0	0	0
Lentibulariaceae	*Utricularia multifida* R.Br.	0	1	0	1	0
Myrtaceae	*Calothamnus graniticus ssp. leptophylla* Hawkeswood	0	0	3	0	0
	Darwinia citriodora (Endl.)Benth.	4	1	2	1	0
	Hypocalymma angustifolium (Endl.)Schauer	1	0	1	0	2
	Melaleuca scabra R.Br. in W.T.Aiton	0	0	0	1	0
	Verticordia plumosa var. plumosa (Desf.)Druce	0	4	3	4	1
Olacaceae	*Olax benthamiana* Miq. in Lehm.	0	0	0	1	0
Orchidaceae	*Caladenia attingens* Hopper and A.P. Br.	0	0	1	0	0
	Caladenia flava R.Br.	0	0	1	0	0
	Caladenia marginata Lindl.	0	0	1	1	0
	Elythranthera brunonis (Endl.)A.S.George	0	0	0	1	1
	Pterostylis barbata (Lindl.)Szlach.	0	0	1	1	0
	Spiculaea ciliata Lindl.	0	0	0	1	0
	Thelymitra antennifera (Lindl.)Hook.f.	0	1	0	1	0
	Thelymitra crinita Lindl.	0	0	1	0	0
Mimosaceae	*Acacia pulchella* R.Br. in W.T. Aiton	0	0	0	0	1
Papilionaceae	*Daviesia hakeoides ssp. hakeoides* Meisn.	2	0	0	0	0
	Gastrolobium spinosum Benth. in Lindl.	0	0	1	1	0
	Gompholobium marginatum R.Br. in W.T.Aiton	1	0	1	0	1
	**Trifolium sp.*	1	0	0	0	0

Appendix I (cont.)

FAMILY	SPECIES	WNP01	WNP02	WNP03	WNP04	WNP05
Philydraceae	*Philydrella pygmaea* (R.Br.)Caruel	0	1	1	1	0
Poaceae	**Aira caryophyllea* L.	1	1	1	1	1
	**Briza minor* L.	1	1	1	0	0
	Neurachne alopecuroidea R.Br.	0	0	1	1	1
	Poa sp.	0	0	0	1	0
	**Vulpia muralis* (Kunth)Nees	1	1	1	0	1
Primulaceae	**Anagallis arvensis* L.	1	0	1	0	1
Proteaceae	*Grevillea bipinnatifida* R.Br.	2	1	0	1	1
	Grevillea pilulifera (Lindl.)Druce	0	0	0	1	0
	Hakea lissocarpha R.Br.	2	0	0	0	1
	Synaphea hians A.S.George	0	0	0	1	0
Rhamnaceae	*Cryptandra arbutiflora var. tubulosa* Fenzl in Endl., Fenzl, Benth.and Schott	0	0	1	0	0
	Trymalium ledifolium Fenzl.	0	0	0	0	1
Rubiaceae	**Galium murale* (L.)All.	1	0	0	0	0
Rutaceae	*Diplolaena drummondii* (Benth.)Ostenf.	0	0	1	0	1
Sapindaceae	*Dodonaea ceratocarpa* Endl. in Endl., Fenzl, Benth. and Schott	0	1	0	0	0
Scrophulariaceae	* *Parentucellia latifolia* (L.)Caruel in Parl.	0	0	1	1	0
Stackhousiaceae	*Tripterococcus brunonis* Endl. in Endl., Fenzl, Benth. and Schott	0	0	0	0	1
Stylidiaceae	*Levenhookia sp.*	0	0	1	0	0
	Stylidium ?despectum R.Br.	0	1	0	0	0
	Stylidium brunonianum Benth.	0	0	1	0	1
	Stylidium calcaratum R.Br.	0	1	1	1	1
Thymelaeaceae	*Pimelea imbricata ssp. imbricata* R.Br.	0	1	0	0	2
	Pimelea imbricata ssp. piligera R.Br.	0	0	1	0	0
Xanthorrhoeaceae	*Xanthorrhoea preissii* Endl. in Lehm.	2	1	0	1	1
	Number of species in quadrat	**28**	**31**	**44**	**40**	**32**

Appendix I (cont.)

Rock outcrop associated[3] vascular plant species found outside the quadrats in Wellington National Park. Those derived from the Western Australian Herbarium database (Florabase) are identified by the herbarium Sheet Numbers, otherwise they were identified as part of this project.

FAMILY	SPECIES
Amaranthaceae	*Ptilotus manglesii* (Lindl.)F.Muell.
Apiaceae	*Actinotus leucocephalus* Benth. in Endl.,Fenzl,Benth.and Schott
Asteraceae	*Angianthus preissianus* (Steetz)Benth.
	Rhodanthe citrina (Benth.)Paul G.Wilson
	Stuartina sp.
Droseraceae	*Drosera stolonifera*, Endl.
Goodeniaceae	*Dampiera hederacea* R.Br.
	Dampiera linearis R.Br.
	Velleia macrophylla (Lindl.)Benth.
Lobeliaceae	*Isotoma hypocrateriformis* (R.Br.)Druce
Myrtaceae	*Baeckea camphorosmae* Endl. in Endl.,Fenzl,Benth.and Schott
	Corymbia calophylla (Lindl.)K.D.Hill and L.A.S.Johnson
	Melaleuca parviceps Lindl., 5957338
	Eucalyptus drummondii Benth., 5571383
Orchidaceae	*Diuris aff magnifica* D.L. Jones
Papilionaceae	*Acacia oncinophylla* Lindl. ssp. *oncinophylla*
	Acacia insolita E.Pritz, 5470064
Phormiaceae	*Stypandra glauca* R.Br.,
Pittosporaceae	*Marianthus bicolor* (Putt.)F.Muell.
Poaceae	*Austrodanthonia setacea* (R.Br.)H.P.Linder
	**Briza maxima* L.
Proteaceae	*Conospermum huegelii* Endl.
Rutaceae	*Boronia defoliata* F. Muell., 5484863
Sapindaceae	*Dodonaea ceratocarpa* Endl. in Endl.,Fenzl,Benth.and Schott
Sterculiaceae	*Thomasia macrocarpa* Endl. in Endl.and Fenzl,

[3] Found within the generally treeless zone associated with the shallow outcrop soils.

APPENDIX II

Vascular plant species associated with a rock outcrop in Mullalyup Block near Kirup.

LATITUDE: 33° 44' 47.5" LONGITUDE: 115° 51' 59.6" ALTITUDE: 170–190 m

GEOLOGY: AUGEN GNEISS WITH LOCAL FOLIATION ANNUAL RAINFALL: 1000 mm

FAMILY	SPECIES
Adiantaceae	*Cheilanthes sieberi* ssp. *sieberi* Kunze.
Anthericaceae	*Thysanotus patersonii* R.Br.
Apiaceae	*Daucus glochidiatus* (Labill.)Fisch.,C.A.Mey.and Ave-Lall. *Trachymene* sp.
Asteraceae	**Hypochaeris glabra* L. *Hyalosperma cotula* (Benth.)Paul G.Wilson *Podolepis gracilis* (Lehm.) Graham *Senecio quadridentatus* Labill.
Boryaceae	*Borya scirpoidea* Lindl.
Casuarinaceae	*Allocasuarina humilis* (Otto and F.Dietr.)L.A.S.Johnson
Colchicaceae	*Burchardia umbellata* R.Br.
Cyperaceae	*Lepidosperma tenue* Benth.
Epacridaceae	*Leucopogon corifolius* Endl.
Euphorbiaceae	*Phyllanthus calycinus* Lindl.
Gentianaceae	*Centaurium spicatum* (L.)Janch.
Goodeniaceae	*Scaevola* sp. *Dampiera* aff. *linearis* R.Br.
Haemodoraceae	*Anigozanthos ?flavidus* Redoute and DC.
Lamiaceae	*Hemigenia aff. incana* (Lindl.)Benth. in A.DC.
Lobeliaceae	*Isotoma hypocrateriformis* (R.Br.)Druce
Mimosaceae	*Acacia stenoptera* Benth.
Myrtaceae	*Baeckea camphorosmae* Endl. in Endl.,Fenzl,Benth.and Schott *Corymbia calophylla* (Lindl.)K.D.Hill and L.A.S.Johnson *Darwinia citriodora* (Endl.)Benth. *Hypocalymma angustifolium* Endl.(Schauer) *Verticordia plumosa* var. *plumosa* (Desf.)Druce
Orchidaceae	**Disa ?bracteata* Sw.
Papilionaceae	**Lotus angustissimus* Lindl. *Gastrolobium spinosum* Benth. in Lindl.
Phormiaceae	*Stypandra glauca* R.Br.
Poaceae	**Avena fatua* L. **Briza maxima* L **Bromus* sp. **Vulpia muralis* (Kunth)Nees *Austrostipa ?semibarbata* (R.Br.)S.W.L.Jacobs and J.Everett *Neurachne alopecuroidea* R.Br.
Proteaceae	*Grevillea bipinnatifida* R.Br. *Hakea lissocarpha* R.Br.
Rhamnaceae	*Trymalium ledifolium* Fenzl.
Sapindaceae	*Dodonaea ceratocarpa* Endl. in Endl.,Fenzl,Benth.and Schott
Scrophulariaceae	**Parentucellia viscosa* (L.)Caruel in Parl.
Stylidiaceae	*Stylidium calcaratum* R.Br. *Stylidium ciliatum* Lindl.
Thymelaeaceae	*Pimelea imbricata* ssp. *imbricata*, R.Br.

APPENDIX III

A provisional list of vascular plant species associated with granite outcrop at Oakley Dam near Dwellingup in the northern jarrah forest.

LATITUDE 32° 39' 22", LONGITUDE 115° 57' 53" ANNUAL RAINFALL: 1200 mm

FROM THE WAHERB DATABASE OF THE WESTERN AUSTRALIAN HERBARIUM.

VOUCHERED SPECIMENS

FAMILY	SPECIES
Myrtaceae	*Calothamnus graniticus* ssp. *leptophyllus* (Benth.)Hawkeswood
	Darwinia citriodora (Endl.)Benth.
	Verticordia huegelii Endl. var *huegelii*
	Verticordia pennigera Endl.
Pittosporaceae	*Billardiera parviflora* D.C. var. *guttata* E.M. Benn.
Solanaceae	*Anthocercis gracilis* Benth.

UNVOUCHERED SPECIES REPORTED AS BEING ASSOCIATED WITH THE ABOVE TAXA

Casuarinaceae	*Allocasuarina huegeliana* (Miq.) L.A.S.Johnson
Convolvulaceae	**Convolvulus angustissimus* R.Br. (*"C. erubescens*")
Lamiaceae	*Hemigenia incana* (Lindl.) Benth.
Mimosaceae	*Acacia lateriticola* Maslin
	Acacia pulchella R.Br. in W.T. Aiton
	Acacia urophylla Lindl.
Myrtaceae	*Corymbia calophylla* (Lindl.) K.D.Hill and L.A.S.Johnson
Proteaceae	*Dryandra nivea* (Labill.) R.Br.
	Dryandra praemorsa Meisn. *var. praemorsa*
	Grevillea bipinnatifida R.Br.
	Hakea lissocarpha R.Br.
	Hakea undulata R.Br.
Rhamnaceae	*Trymalium ledifolium* Fenzl.
	Trymalium spatulatum (Labill.) Ostenf.
Rubiaceae	*Opercularia apicilfora,* Juss
	Opercularia echinocephala Benth.
Xanthorrhoeaceae	*Xanthorrhoea preissii* Endl. in Lehm.
Zamiaceae	*Macrozamia riedlei* (Gaudich.) C.A.Gardner

The distribution of terrestrial vertebrate fauna in the Montebello Islands

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SUMMARY

We present the current knowledge of the distribution of the native terrestrial fauna of the Montebello Islands by comparing previous work and our own observations. We found no new species for the archipelago but report on 15 new records of species on islands, including observations of three islands with no previous fauna records.

INTRODUCTION

The Montebello Islands, off the Pilbara coast, is an archipelago of approximately 180 islands, islets and rocks. For background information, history, reserve status and a map of the islands see Burbidge et al. 2000. This paper also summarized the present understanding of the terrestrial vertebrates on some of the islands. They presented historical knowledge of fauna as well as results of their own trapping data from 1994. In that year they established pit-fall traps on nine islands (Ah Chong, Alpha, Bluebell, Brooke, Crocus, Delta, Hermite, North-West and Primrose), actively searched for reptiles, recorded signs (e.g. mouse and varanid tracks) on these and other islands (Campbell and Trimouille) and collated a list of birds and their breeding records. They also collated opportunistic records from later years.

During August 2000, while on the islands searching for the presence of black rats (*Rattus rattus*) (see Burbidge & Morris 2002) we searched for reptiles and recorded birds when time allowed. We also collected data on islands that were not part of the 1994 survey.

In this paper, we present the contemporary understanding of the distribution of terrestrial vertebrates on the Montebello Islands by combining the data from Burbidge et al. (2000) and our own. We interpret these results in the context of seasonal variation, the feral animal control program on the islands (Burbidge & Morris 2002) and some comments made in Burbidge et al. (2000).

Data Collection and Presentation

As the primary aim of the visit was to search for signs of black rats and feral cats, searching for other vertebrates and their signs was conducted when time allowed. Our observations were made between 15 and 31 August 2000. Specimens were collected by actively searching, recording signs of reptiles and mammals and bird watching. Actively searching entailed rolling rocks and debris and dismantling termite mounds. Spotlighting was undertaken on Hermite Island but did not add additional species to our records. Thirteen islands (Ah Chong, Alpha, Bluebell, Brooke, Buttercup, Crocus, Delta, Gardenia, Hermite, North West, Primrose, Renewal and Trimouille) were visited.

The only bird data presented here are those records that add to the presence, breeding records or (in one case) density within the archipelago compared to Burbidge et al. (2000).

RESULTS AND DISCUSSION

Table 1 presents the current understanding of the distribution of terrestrial reptiles and mammals, excluding translocated and non-native species from Burbidge et al. (2000) and our data.

We report 15 new records of species on islands from which they had not been recorded before, eight of these are from islands that were part of the 1994 survey and seven are from islands that were not. We also found varanid tracks on two islands from where they had not been previously recorded: Crocus which was surveyed in 1994 and Gardenia, which was not.

Reptiles

We did not locate seven of the 21 terrestrial reptile species previously recorded on the archipelago: the gecko *Strophurus jeanae*, *Lerista elegans* and *Lerista sp.* (formerly part of the *Lerista muelleri* complex but now in review), the pygopod *Lialis burtonis*, the varanid *Varanus gouldii* (although we saw large varanid tracks on several islands) and the elapid snakes *Demansia rufescens* and *Furina ornata*.

One interesting record was of *Delma nasuta*, a species that has not been recorded since 1970. Our record of a live animal came from underneath corrugated iron at the Hermite Island ruins. This animal was retained for the collections of the Western Australian Museum.

TABLE 1

The distribution of terrestrial mammals (excluding translocations) and reptiles in the Montebello archipelago from Burbidge *et al.* (2000) and our data. Taxonomy follows Western Australian Museum checklists.

SPECIES BY CLASS OR FAMILY	ISLAND													
	Ah Chong	Alpha	Bluebell	Brooke	Crocus	Delta	Hermite	North-West	Primrose	Buttercup	Campbell	Gardenia	Renewal	Trimouille
MAMMALS														
Mus musculus[1]							B							B
Small mammal tracks	n	n	n	n	n	n	n	*[2]	n	n		n	n	n
GEKKONIDAE														
Gehyra pilbara		*			*	*	B*							*
Gehyra punctata														A
Heteronotia binoei	B	B		B*	B	*	B*		B					B*
Strophurus jeanae[3]							B							
PYGOPODIDAE														
Aprasia rostrata rostrata							P							
Delma borea							A							
Delma nasuta							A*							
Lialis burtonis		B					B							
AGAMIDAE														
Lophognathus gilberti gilberti[4]	B	*		*			B*						*	*
VARANIDAE														
Varanus acanthurus							B*							
Varanus gouldii		B	B			B	B	B	B		B			B
varanid tracks	n	*	*	n	*	ns	*	*	*	ns		*	ns	*
SCINCIDAE														
Ctenotus saxatilis	B	B	B	B*	B	B*	B*	B*	B	*	B	*	*	B
Glaphyromorphus isolepis	B	B	B		B	B*	B*	B	*		B		*	B*
Morethia ruficauda exquisita		*					B*							
Lerista bipes	B	B	B	B	B	B	B*	B						B
Lerista elegans			B				B							
Lerista sp. [5]				B			B							
TYPHLOPIDAE														
Ramphotyphlops diversus ammodytes							P							
BOIDAE														
Antaresia stimsoni stimsoni							B*							
ELAPIDAE														
Furina ornata							A[6]							
Demansia rufescens							B							

Columns are islands in the archipelago; those to the left of the double line were part of the 1994 survey and those to the right are incidental records. We visited all islands except Campbell. A represents records from Burbidge (1971); B represents records from Burbidge *et al.* (2000); P represents records prior to but not found by Burbidge (1971) or Burbidge *et al.* (2000); * represents our data; for tracks, n indicates tracks not recorded after specifically searching for them, and ns indicates that attribute not searched for on that island.

[1] *M. musculus* skull found on Hermite in 1983; seen on Trimouille in 1996 and 1998, tracks seen on the latter in 1998. No evidence found in 2000.

[2] Tracks on this island assumed to be the translocated Shark Bay Mouse (*Pseudomys fieldi*).

[3] *Diplodactylus jeanae* in Burbidge *et al.* (2000).

[4] *Gemmatophora gilberti gilberti* in Burbidge *et al.* (2000).

[5] Recorded as *L. muelleri* in Burbidge *et al.* (2000), though acknowledged as part of a complex, a review of this group is soon to be published (pers com. B. Maryan, WA Museum).

[6] Also collected by the WA Museum in 1981.

Birds

Our bird data largely agree with Burbidge et al. (2000), however three records are worth noting. The collared kingfisher (*Todiramphus chloris*) and sacred kingfisher (*Todiramphus sanctus*) have been recorded on the archipelago; the former has not been seen since 1955 and the latter was recorded as being uncommon. We saw a kingfisher (*Todiramphus* sp.) from mangroves in Vermouth Lagoon, Hermite Island, but were unable to allocate it to a species. Though 'hundreds' of zebra finches (*Taeniopygia guttata*) have been recorded on Hermite Island (Burbidge et al. 2000), only 13 were seen during our visit. These were apparently making

use of dewfall on the roof of the CALM hut on Hermite Island. The red-capped plover (*Charadrius ruficapillus*), while common throughout the archipelago (pers. obs.), has not been recorded breeding there before. We found a hatched egg on the rocky shores of Hermite Island.

Overview

Outside serendipity, the new reptile records on islands that were part of the 1994 survey may be due to several factors. Firstly, we were searching later in the year (August as opposed to May/June) so that activity may have increased. Second, there was a 'good' wet-season in 1998/1999. And, third, predation pressure from rats and cats has been reduced in the intervening years due to the feral animal control program (Burbidge et al. 2000; Algar et al. 2003).

The house mouse (*Mus musculus*) is thought to have been on both Hermite (skull found 1983) and Trimouille (sighting 1998) Islands. As house mouse numbers are known to increase in response to good seasons (Dickman et al. 1999; Moro & Morris 2000), Burbidge et al. (2000) speculated that the good seasons of 1998/1999 and a reduction in rat predation might lead to a mouse plague. Surprisingly, we found no evidence of *M. musculus* on any of the islands, but it is too early to imply that the species became locally extinct sometime between 1998 (when they were last recorded) and our visit.

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Evidence of altered fire regimes in the Western Desert region of Australia

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SUMMARY

The relatively recent exodus of Aboriginal people from parts of the Western Desert region of Australia has coincided with an alarming decline in native mammals and a contraction of some fire sensitive plant communities. Proposed causes of these changes, in what is an otherwise pristine environment, include an altered fire regime resulting from the departure of traditional Aboriginal burning, predation by introduced carnivores and competition with feral herbivores.

Under traditional law and custom, Aboriginal people inherit, exercise and bequeath customary responsibilities to manage their traditional country. Knowledge of the fire regime during an estimated 30 000 years of Aboriginal occupation of these lands and the involvement of Aboriginal communities in contemporary land management are important issues to be addressed if conservation lands are to be managed appropriately. As part of this process, Pintupi Aboriginal people were interviewed and observed in the field to obtain information about their traditional use of fire and to obtain their views on how country could be managed with fire. Of particular interest were the reasons for burning country and the temporal and spatial variation in the size and distribution of burnt patches. This valuable but largely qualitative oral information was supplemented with a quantitative study of fire scars in a chronological sequence of early black and white aerial photographs and more recent satellite imagery. The study focused on a remote region of the Western Desert, an area from which Aboriginal people living a traditional lifestyle had most recently departed. The earliest aerial photographs (1953) were taken as part of a military rocket development project over an area that was occupied by Aboriginal people living in a traditional manner at the time of the photography. The photography revealed a landscape mosaic of small burnt patches of vegetation at different stages of post-fire succession. This pattern was consistent with information provided by Pintupi; that fire was used purposefully, frequently and regularly across the landscape for many reasons but mainly to acquire food. Analysis of satellite imagery since the early 1970s, and since the cessation of traditional burning practices, revealed that the fine-grained fire mosaic has been obliterated in recent times and replaced by a simpler mosaic consisting of either vast tracts of long unburnt and senescing vegetation or vast tracts of vegetation burnt by lightning-caused wildfires.

INTRODUCTION

The Great Victoria, Gibson, Great Sandy and Little Sandy Deserts (the Western Desert) occupy some 1.6 million km^2 of Western Australia, of which more than 100 000 km^2 is managed for nature conservation. The conservation reserves in the Western Desert are large, remote and relatively undisturbed. A management option for such reserves is not to intervene and allow natural processes to continue to shape the biota. However, in spite of the apparent relative pristine nature of these reserves and the lack of direct European impact, a sudden and alarming decline in native mammals has been reported (Bolton & Latz 1978, Burbidge 1985, Burbidge et al. 1988, and Burbidge & McKenzie 1989). Burbidge and Jenkins (1984) reported that about 33 percent of Western Australian desert mammals are extinct or endangered. They noted that this decline had occurred over the last 30 to 50 years. Burbidge and McKenzie (1989) have shown that all declines and extinctions have been restricted to native mammals with a mean adult body weight in the range from 35 grams to 5 500 grams (the critical weight range). Three main hypotheses have been proposed to explain the decline and in some cases, extinction of desert mammals; change in fire regime, predation by feral animals and competition from feral herbivores (Burbidge & Johnson 1983). The notion of a changed fire regime contributing to mammal decline has some support among Western Desert Aborigines. For example, Ngaanyatjarra Aborigines from the Warburton area of Western Australia believe that the *mitika*, or burrowing bettong (*Bettongia lesueur*), had 'gone to the sky because the country had not been cleaned up' (de Graaff 1976). 'Clean up' is a term often used by desert Aborigines for burning the vegetation (Jones 1980). Kimber (1983) reported that Pintupi people believed that perhaps a 'big bushfire' caused the disappearance of the golden bandicoot (*Isoodon auratus*).

Aborigines first arrived on the Australian continent at least 50 000 – 60 000 years ago and occupied the deserts of the interior by at least 30 000 years ago (Mulvaney 1975, Flood 1983, Gould 1971 & O'Connor

et al. 1998). They showed remarkable resilience and resourcefulness to survive in a vast expanse of scattered food and water resources (Tonkinson 1978). They were highly mobile, were able to exploit a variety of resources in different areas at different times and developed a detailed knowledge of the environment.

Recent changes in the fire regime are believed to be a direct consequence of the exodus of Aboriginal people from the desert to European settlements, missions, outstations and other communities (Gould 1971, de Graaf 1976, Latz & Griffin 1978, Kimber 1983, Saxon 1984 & Burbidge 1985). Latz and Griffin (1978) postulated that Aborigines created a stable ecosystem by 'burning the country in a mosaic pattern'. They believed that mosaic burning reduced the extent and continuity of heavy fuels, and therefore reduced the occurrence of large, intense wildfires. They also stated that a second effect of mosaic burning was to create a range of 'states' in the vegetation, from early post-fire plant communities to old mature patches and that such diversity of states would host a greater variety of plants and animals. Latz (1995) observed that many of the most important food plants are only abundant in the first few years after fire. He reported that of the twelve plants that are most important to desert Aborigines, five are 'fire weeds'.

The extensive use of fire by desert Aborigines was recorded by early explorers (e.g., Warburton 1875, Giles 1889 and Carnegie 1898) and more recently by anthropologists and ecologists (e.g., Finlayson 1943, Jones 1969, Calaby 1971, Gould 1971, de Graaf 1976, Tonkinson 1978, Kimber 1983, Latz 1995 and Bowman 1998). Kimber (1983) observed that Pintupi used fire in a skilful and controlled manner for many reasons, such as hunting, signalling, to 'clean up' country, for ceremonies, and for fun. He provided a general description of when fires were lit and the range in fire sizes and also made some crude estimates of the proportion of country burnt and the approximate age since the last fire, based on information in the diaries of Davidson, who explored parts of the Tanami Desert in 1900. Latz (1995) noted that, '*the judicious use of fire* (by Aborigines) *was, in the past, the single most important aspect of the desert economy*'. Recently Bird et al. (2003), working with Martu Aboriginal people of the Great Sandy Desert, have described and quantified the efficiency of burning as a hunting strategy and conclude that mosaic burning increases the efficiency of women hunting for burrowing game but not of men hunting larger, more mobile prey.

Quantitative data on past and present fire regimes are of considerable interest to managers of arid zone nature conservation reserves who aim to maintain and improve the biotic diversity of desert ecosystems. If the decline of native fauna is to be halted and faunal diversity restored, then active management is necessary to control introduced predators such as the fox (*Vulpes vulpes*) and the feral cat (*Felis catus*), to ensure a fire regime similar to that which persisted during traditional Aboriginal usage of the land and, where possible, to re-introduce locally extinct and endangered fauna. While there is a growing literature arguing that fire regimes in many Australian biomes have changed since the departure of traditional use of fire by Aborigines (e.g., see review by Bowman 1998), there is limited reliable quantitative information about the scale of this change in terms of the size and distribution of burnt patches.

This study aimed to document some of the ways in which Western Desert Aborigines used fire and to compare their oral evidence with fire scar information extracted from early black and white aerial photography. Importantly, this study aimed to quantify the scale of the fire mosaic created by traditional Aboriginal burning, and for the first time to our knowledge, present both quantifiable and oral evidence of a changed fire regime since a departure from traditional burning practices. By integrating these sources of evidence, and by studying a substantially larger area of the Western Desert (~240 000 ha), we build on the earlier work of Burrows and Christensen (1990), who studied aerial photographs and satellite imagery of a 54 000 ha area of the Western Desert. Knowledge of traditional Aboriginal burning practices, especially the scale of burnt patches, would greatly assist with the formulation of appropriate fire management strategies for desert conservation reserves. We comment on the benefits of not only incorporating Aboriginal knowledge into land management decisions, but of meaningfully involving Aboriginal communities in decision making and on-ground management activities.

METHODS

The departure of Aborigines from their desert homelands started with first European contact at the end of the nineteenth century. Amadio and Kimber (1988) present a summary of European exploration and contact with Aborigines of the northern portion of the Western Desert and also describe the movements of Aboriginal people away from their homelands and into European settlements.

To gather information about the traditional use of fire, we decided to focus the study on a region of the Western Desert from which Aborigines had most recently departed from a more-or-less traditional lifestyle. We learnt that a very remote tract of land in Western Australia north of the community of Kiwirrkurra and west of Lake Mackay in Western Australia was the last homeland utilized in a traditional manner by Pintupi people (Richard Kimber, Billy Nolan Tjapinati and Warlimpirringa Tjapaltjarri, pers. comm.).

This sparsely populated region lies on the eastern edge of the Great Sandy Desert between longitudes 127° 30' E and 128° 50' E and latitudes 22° 8' S and 22° 50' S. Annual rainfall is highly variable with the average being about 220 mm. Almost all rain comes from summer thunderstorms or occasional tropical cyclones. Summer maximum temperatures are consistently in the order of 35°–45° C, with winter maxima in the range 20°–25° C. The red sand plains that cover most of the region are

crossed by longitudinal, stable dunes, which trend east-west. Playas are scattered throughout the area, the largest playa being Lake Mackay, which has a total area of about 3 500 square kilometres (Blake 1977). As a result of the arid climate and sandy soils, the vegetation consists mainly of low hummock grasses, or spinifex (mainly *Triodia basedowii* and *T.schinzii*) and associated small shrubs, herbaceous plants and scattered low trees.

Spinifex forms the dominant ground cover (35%–40%) and the dominant source of fuel for a bushfire. Having fine, well-aerated leaves arranged in dome-shaped clumps, fire spreads rapidly through spinifex, especially under warm, dry and windy conditions (Griffin & Allan 1984, Burrows et al. 1991). The vegetation of the region displays a range of traits enabling it to persist in this fire prone environment, including the ability to resprout or regenerate from seed following fire (Latz 1995, Allan & Southgate 2002). The rate of post-fire recovery of the vegetation is largely dependent on rainfall, with a variety of short-lived grasses and herbs dominant in the early years, giving way to spinifex which resumes dominance (cover and biomass) by about 2–4 years after fire (Latz 1995 and Allan & Southgate 2002).

To the best of our knowledge, the main exodus of Pintupi from this region commenced in the early 1960s, with the last of the bush people coming into Wulungurru

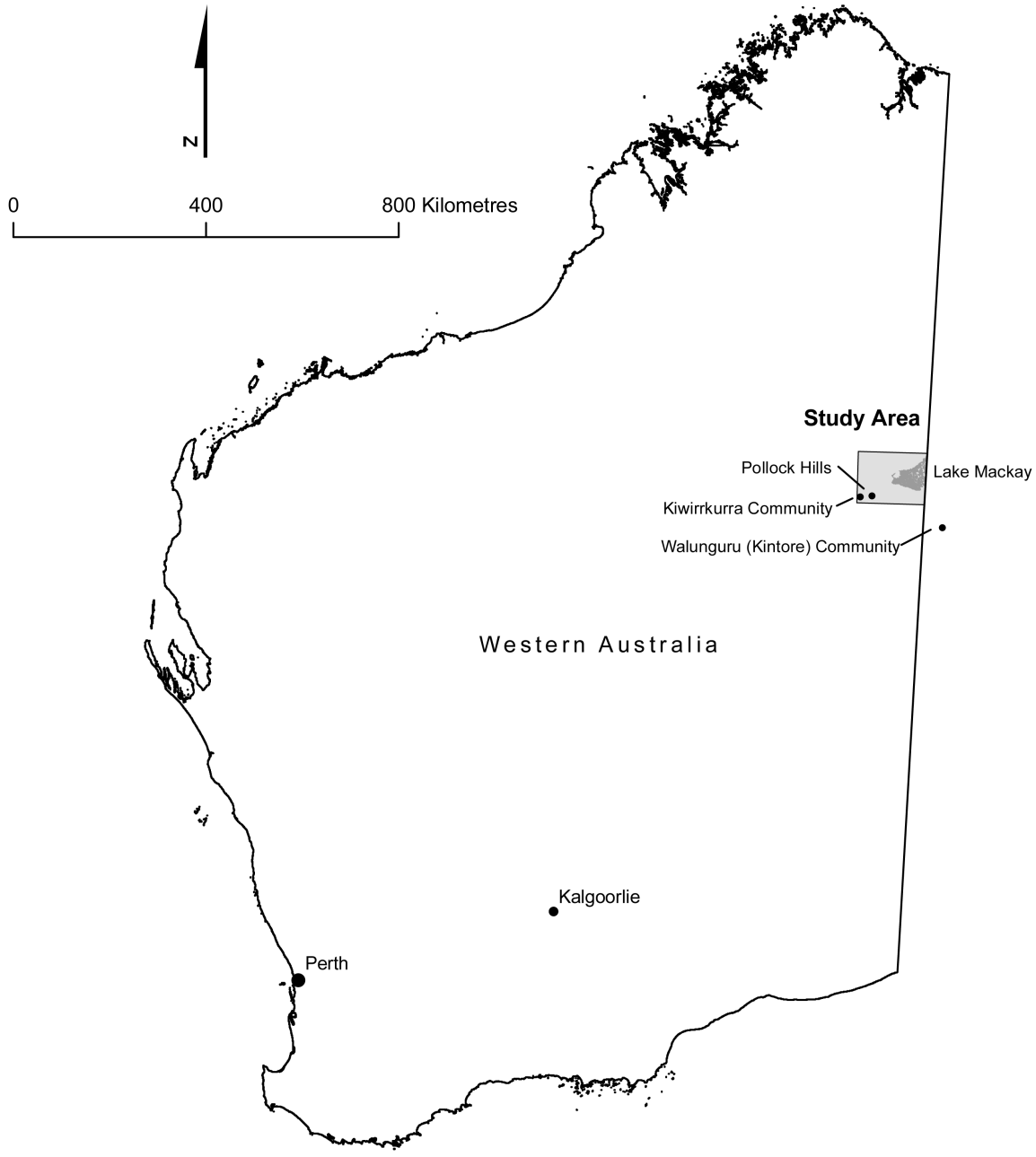


Figure 1. Location of the Aboriginal use of fire study area in the Western Desert.

(Kintore) and Kiwirrkurra communities in 1985. We interviewed men from the Kiwirrkurra-Kintore-Lake Mackay area (Figure 1) about their use of fire in the 'old days'. We compared this oral evidence with the quantitative data on temporal changes in fire size and distribution extracted from early aerial photographs and more recent satellite imagery, substantially increasing the size of the area studied by Burrows and Christensen (1990) to more than 240 000 ha; their original study area being about 54 000 ha.

Traditional Aboriginal Use of Fire: Oral Evidence

During August 1987, two of the authors (Andrew Burbidge and Phil Fuller) travelled to the remote desert Aboriginal communities of Mt Leibig, Walungurru (Kintore) and Kiwirrkurra (Figure 1) to talk to older Pintupi men and women about their traditional use of fire, especially bush fire. At this time, many people in this area had only recently come in contact with European society so retained a profound knowledge of their traditional lifestyle. In most cases, groups of people were interviewed at various communities. The individuals in the groups were older people who were willing to be interviewed and who had lived as nomads for a significant part of their lives. The groups of people interviewed were:

Group 1: 1 man interviewed at Mt Leibig.
Group 2: 3 women interviewed at Mt Leibig.
Group 3: 2 men interviewed at Walungurru.
Group 4: 3 men interviewed at Walungurru.
Group 5: several people (number not recorded) interviewed at Walungurru.
Group 6: 6 women interviewed at Walungurru.
Group 7: 2 women interviewed at Walungurru.
Group 8: 4 men interviewed at Kiwirrkurra

The interviews were conducted with the aid of a Pintupi linguist, John Heffernan. We experienced some difficulty obtaining interviews because of two local events that coincided with our visit. Many people had left the community to attend a sports meeting at Yuendumu, a community across the Western Australian border in the Northern Territory. Of much greater significance was the initiation ceremony being conducted at Kiwirrkurra, involving many of the knowledgeable old people with whom we wished to talk. We were not permitted to move about the area freely during the ceremony, which continued for several days. Eventually, we managed to conduct interviews with people recognised by the communities as knowledgeable and able to speak on the issue. As well as fire, we talked about the local mammals. We displayed the skins (obtained from the Western Australian Museum) of a number of mammals now locally or totally extinct. This proved a popular draw card with Aborigines and was a useful means of initiating more interviews and obtaining additional information about the animals and about fire. In September 1989, one of us (Neil Burrows) also spent seven days in a remote part of the Great Sandy Desert west of Lake McKay with Billy Nolan Tjapinati, a Pitjantjarra elder, and Warlimpirringa Tjapaltjarri, a Pintupi man who was one of a small group of people to recently emerge from this area, making first contact with Europeans in 1985. During the field trip we discussed how and why fire was used, visited sites where fire was used to hunt feral cats (*Felis catus*) and other game, and observed the two Aboriginal men regularly 'cleaning up country' by burning the spinifex.

Fire size and distribution: Remotely sensed evidence

We expanded on an earlier study by Burrows and Christensen (1990) who used early (1953) aerial photography and Landsat satellite imagery to map fire scars and to quantify the size and spatial distribution of burnt patches. They examined imagery that covered an area of some 54 000 ha west of Lake Mackay (Figure 1). This region was chosen for study because it was known to be one of the last areas in which traditional Aboriginal burning was practiced. While the exodus of Pintupi from a traditional lifestyle to European-style settlements probably began in the early 1960s, the last people (including one of our informants Warlimpirringa Tjapaltjarri), to lead a traditional lifestyle without European influence, emerged from this part of the Great Sandy Desert in 1985. As part of a military rocket research project by the Australian and British governments (the Blue Streak Rocket Project) the flight path of the rockets was mapped from low level (1:50 000) black and white aerial photography flown by the Royal Australian Air Force in July 1953. This coincidence of events provided a unique opportunity to investigate traditional Aboriginal burning practices, combining first hand Aboriginal knowledge and aerial photography. We substantially extended the original study by Burrows and Christensen (1990) by selecting a second sample area of about 80 km x 30 km (about 240 000 ha) some 80 km south-west of their original site.

Pereira (2003) identified many difficulties associated with mapping burned areas in tropical savannas using remotely sensed data, in particular, satellite imagery. These include short persistence of burn signals, heterogeneity of landform and vegetation, structural complexity of the vegetation and smoke haze and cloud cover. Bowman et al. (2003) reported that in tropical savannas in the Northern Territory, signatures of burnt areas faded within 100 days. However, visually identifying and mapping recent fire scars (up to 5–6 years since fire) in arid zone spinifex grasslands from aerial photographs or satellite imagery is relatively straightforward compared with some other vegetation types because:

- The vegetation is low (20–50 cm high) and simple in structure (ground cover only, little or no overstorey).
- Combustion of the vegetation is virtually complete, revealing the surface soil, the signature of which contrasts strongly with the unburnt vegetation,

- The red sandy loam soil is the dominant reflector post-fire, and is relatively uniform in colour and texture over large areas.
- Fire shapes in hummock grasslands are distinctive and are not readily confused with natural features such as changing vegetation types, surface geology or landforms.
- The rate of post-fire recovery of the perennial vegetation is relatively slow, with fire scars being visible for at least 5–6 years, and often longer during drought periods.
- There are few cloudy days.

We circumscribed (mapped) the boundaries of fire scars that were clearly visible on the 1:50 000 scale 1953 aerial photography and on a time sequence of relatively high resolution Landsat Multispectral Scanner (MSS) for 1973, 1981 and Landsat Thematic Mapper (TM)) for 1988, 1994 and 2000 satellite images. Satellite imagery only became available after the launch of the Landsat 1 satellite in July 1972. This time series of satellite imagery was a compromise between what we considered as adequate for detecting fire scars on the study area over this time frame and the cost of purchasing and processing images. The aerial photography provided a high level of resolution and we were confident of visually discriminating recently burnt patches larger than about 0.5 ha (approximately 70m x 70m). Landsat MSS imagery was processed to have a picture element (pixel) resolution of 50m and Landsat TM processed to a pixel resolution of 25m. Landsat MSS imagery was enhanced to display spectral band 3 (visible red), band 4 (near infared) and band 2 (visible green) in the red, green and blue colours respectively while Landsat TM (Landsat 5 and 7) was enhanced by displaying spectral band 5 (middle infared), band 4 (near infared) and band 3 (visible red) in the red, green and blue colours respectively. Landsat TM provided the greatest visual discrimination of recent fire scars in this landscape.

Because fire scars in this landscape remain clearly discernable on satellite imagery for at least 5–6 years, it was not necessary to use more complex mapping and processing techniques such as using difference thresholds between successive images, as described by Yates and Russell-Smith (2003). Ground truthing by deliberately burning different, known size patches of spinifex prior to acquiring satellite imagery (Landsat 5 MSS) of a test site showed that we were able to readily visually recognise fire scars larger than about 1 ha. We used a similar method of mapping and digitising fire scars to Burrows and Christensen (1990). Fire scars were mapped to a common, rectified base-map at a scale of 1: 50 000 with natural features such as small claypans and sand dunes mapped and used as control points. If the entire fire boundary was not readily discernible, then the fire scar was not mapped. Therefore, only relatively recent fire scars (probably up to 5–6 years since the fire) were mapped. Older fire scars were visible, but boundaries became diffuse as the vegetation recovered. However, the boundaries of some fire scars were still discernable on consecutive Landsat images up to 8 years apart. The 1981 Landsat imagery was difficult to interpret because several very large and often overlapping fires had burned almost the entire study area in the previous 10 years. While recently burnt vegetation was obvious, it was difficult to distinguish the boundaries of individual fires.

RESULTS

Oral evidence of the traditional use of fire

Not surprisingly, fire was an integral part of traditional Aboriginal life, as exemplified by the following summary of fire related Pintupi words and meanings (see Burbidge et al. (1988) for orthography):

waru is universally and commonly used for fire, firewood, and heat.

kunparatji is close relationship speech for *waru*.

kurrkalpi, *malarra*, and *kinparitji* are words for cooking fire.

tjangi is a firestick used for setting fire.

puyu is smoke.

kunarurru is a signalling fire in the distance (also a distant smoke plume or haze).

tili is flame.

tilirninpa is to make fire. Both men and women were able to make fire, although the implements used were different. Men used a *mirru* (spear thrower made from a hard wood such as mulga, *Acacia anuera*) on a piece of soft wood, often a *kurtitji* (a shield made from *Erythrina vespertilio* wood.) The verb for this is *patjipunginpa*. Women used a fire drill. Both sexes commonly carried fire sticks.

nyaru is the word most commonly used to describe the practice of burning off country. *Lunta* and *yarrpara* are synonyms. *Nyaruninpa* is the verb.

Pintupi people often referred to 'cleaning up country' with fire. We did not fully understand what was meant by this but took it to mean a combination of clearing the ground to facilitate access on foot and for regenerating food plants. 'Cleaning up country' also has spiritual connotations (Tonkinson 1978). At times during the interviews, we found it difficult to distinguish between information about fires lit for hunting and those lit to 'clean up country'. Fires were often lit to achieve a number of purposes. On the field trip into the Lake Mackay area, our Aboriginal guides found long unburnt and senescing spinifex aesthetically displeasing and would regularly 'clean up country' by setting fire to it. They claimed that firing made country 'healthy'.

We were told that everyone can light fires to hunt or 'clean up', even the children. We were frequently given long lists of animal species that were hunted using fire. Of the larger mammals, such as bandicoots and wallabies, all were hunted this way except those that inhabited burrows. Many reptiles were also hunted this way. Feral cats were often hunted by first flushing the animal from its cover, chasing it up a small tree, firing

the spinifex to deny the cat cover, then throwing sticks and stones at the cat bringing it to burnt ground where it was readily caught, often with the assistance of dogs (Warlimpirringa Tjapaltjarri *pers. comm.*). *Kipara*, or Australian bustard (*Ardeotis australis*) is a prized food item and we were told that the best way to catch *kipara* was to light a bush fire; *kipara* would see the smoke and fly in and land on the recently burnt ground to feed on insects and lizards exposed or killed by the fire.

Our Pintupi informants told us that the size of hunting and plant regeneration fires varied. Some fires went out soon after they were lit, and so were very small, and other fires burnt for long distances. When we asked about how far fires travelled, we were usually told that it depended on the wind and the amount of fuel.

Some quotes from our interview reports in relation to fire size are:

Question: 'How large did the fires get in the old days?'

Answer (informant A): 'You could follow a fire for up to a few days. Some were big and some were small. Fires would sometimes go out at night. Sometimes they would go on for several days'.

Answer (informant B): 'You would follow a fire, camp overnight and follow it again the next day.'

Answer (informant C): 'Sometimes they could get quite large; could go for five nights.'

Aborigines mentioned a recent fire that went from Kiwirrkurra to Jupiter Well (about 130 km). Another recent fire went from Kiwirrkurra to Walungurru (about 180 km). We were also told of a recent fire that went from Walungurru to Mount Liebig (180 km). These fires were considered by the Aborigines as very large and unusual.

An informant from near Tjukala said that in the old days fires often went only a short distance and they would often have to light them again. This suggests that burning may have been carried out under mild weather conditions, or that the spinifex cover and hence fuel load was low as a result of recent past burning.

Question: 'What would people look for when deciding to light up?'

Answer: 'When the spinifex gets dense. Sometimes you would light up small grass areas, often you would have to light these areas several times; it would depend on the wind and rain.'

'People would come back to burnt areas after rain and about one year later to gather food and to track goannas' (*Varanus spp.*).

One informant commented: 'We would burn areas and hunt while the fire was burning; then we would move on and return to these areas later to collect food from plants that had regenerated and to hunt animals that had moved in to feed on those plants'.

Question: 'Which animals can you find in burnt country sometime after fire?'

Answer: 'You could burn up country, go away, visit family and relatives, come back after rain when animals would be there. Kids would burn up country to catch lizards. Fires would make it easier to track animals. People would walk and keep up with the fire front so they could hit ***kuka*** on the head as they came out'. '***Kuka***' is literally meat, but in this context, it refers to food animals.

People could also tell whether an area needed burning by the amount of growth and by density of animal tracks. If, for example, they saw a lot of ***mala*** (rufous hare-wallaby) or goanna tracks they would burn so they could follow the tracks and find the burrows. ***Mala*** would move into sandhill areas to eat fresh plants after fire and rain. ***Mala*** were hunted with fire and were chased several hundred metres.

When questioned on their use of fire today, the Aborigines responded with: 'No need to go hunting with fire any more because there is no longer any ***kuka*** there'.

Question: 'How often were hunting fires lit?'

Answer: 'Every day'.

When it was suggested to one group of Aborigines that the mammals might have disappeared because the people were no longer out in the bush lighting fires we received the reply: 'That would be right; no longer any green shoots'.

We were also told that fires were often lit for communication. For example the women would light a fire to let the men know that they had collected food. Fire was also used to communicate between groups. A party entering another group's land would light fires to let them know that they were coming.

Pintupi people have a good understanding of the relationship between fire and the germination of many important food plants. We were frequently given long lists of plants that regenerate following fire and rain. ***Ukiri*** is generic for new growth and ***mirrka*** is a collective word for all the non-meat bush foods.

We were told that lightning could start fires any time during the hotter months. One informant described the start of the lightning season as the time when goannas come out of their burrows. Lightning fires were more common on the hills but also occurred on the plains. Some people told us that lightning fires were not under their control so they did not have much to do with them. Others, however, said that lightning fires were also used for hunting. Our impression was that no fire should be ignored if it was suitable for hunting.

Pintupi people (and other Western Desert Aborigines) regret the passing of medium sized mammals (Burbidge et al. 1988) and want them returned to their country. During this series of interviews, Aborigines made it clear they were worried that all the animals had 'finished' in their country. They would be pleased to see the animals back because they (Aborigines), 'had been eating white fellows meat for so long that they had become weak'. They wanted to eat their own ***kuka*** (meat from native mammals) so they would be strong again. After explaining to several older Ngaanyatjarra men that we wanted to reintroduce some of the mammals that were once common, they were overjoyed, but warned us that country had to be 'properly' burnt first to provide food for the animals.

Evidence from remote sensing

The 1953 black and white aerial photography of the 241 210 ha study area revealed a mosaic of numerous small, recently burnt patches (see example in Figure 2) with about 22% of the area having been burnt recently (probably < 5–6 years prior to the photography). A fire palimpsest was evident and appeared to be similar to the contemporary mosaic suggesting that the 1953 photography was not a temporal outlier. Seventy five per cent of the burnt patches were less than 32 ha and 50% were less than 5 ha (Table 1 and Figure 3). Of the recently burnt area, about 20% was burnt by fires < 100 ha, and 36% by fires > 1 000 ha; the largest fire being about 6 000 ha (Figure 4). While it was not possible to determine the ignition source of all fires, the shape of many of the burnt patches on the 1953 photography was consistent with having been lit by a person dragging a firestick. The 1953 fire pattern contrasts with the more recent fire patterns mapped from satellite imagery, which reveals very large, contiguous recent fire scars. Since 1953, the number of burnt patches in the study area has decreased dramatically from 846 to a low of 4 in 1981, and the size of the burnt patches has increased markedly (Table 1). Habitat boundary, which is the total fire perimeter within the study site and is a measure of the boundary between vegetation of different ages since fire, decreased from 3 888 km in 1953 to 392 km in 2000. This indicates a substantial reduction in the diversity of fire ages or states of post-fire succession within the landscape and a massive increase in fire scale, or grain size. These findings are consistent with those of Burrows and Christensen (1990).

The pattern of burnt patches evident on the 1953 photography was relatively uniform across the study area, although there were occasional patches of very concentrated burning such as around the Pollock Hills. A useful measure of the size and distribution of burnt and unburnt patches (patchiness), is the patch size variance-to-mean ratio (Peilou 1977). A random distribution of patch sizes produces a ratio near 1, a uniform or over dispersed distribution results in a ratio greater than 1, while a clumped or contiguous distribution yields a ratio value much less than 1. In 1953, the patchiness ratio of both burnt and unburnt areas was 0.62 to 0.72 respectively, indicating a near random distribution of patches (Burrows & Christensen 1990). They reported that mean length of continuous recently burnt vegetation had increased from 467 m in 1953 to 2 570 m in 1986 and the variance ratio had reduced to 0.43, indicating a clumped distribution of patch size and a significant increase in mosaic grain size.

It was difficult to identify significant areas of long unburnt vegetation on the 1953 aerial photographs. Areas not mapped as recently burnt showed evidence of having been burnt, but because the fire boundaries were diffuse, they were not mapped. By 1973, about a decade after Aborigines began to leave their homelands, Landsat imagery revealed that the small-grained mosaic of burnt patches evident on the 1953 photography had begun to be erased and to be replaced by a large-grained mosaic of tracts of recently burnt country that comprise about 16% of the study area, and large tracts long unburnt (probably > 10 years since fire), comprising about 80% of the study area. The largest fires were observed on the 1981 satellite imagery; four very large fires had burnt about 87% of the 240 210 ha study area in the last 5–6 years (Table 1).

Table 1

Area and perimeter statistics for recently burnt patches clearly visible on 1953 black and white aerial photography (1: 50 000 scale) and Landsat satellite imagery for a 241 210 ha study area 80 km south-west of Lake Mackay in the Western Desert of Western Australia. Burnt patches are estimated to be 5–6 years since fire (se = standard error).

YEAR	REMOTE SENSING MEDIUM	NUMBER OF BURNT PATCHES	TOTAL AREA RECENTLY BURNT (ha)	TOTAL BURNT PERIMETER (HABITAT BOUNDARY) (km)	MEAN BURNT PATCH SIZE (ha)	RANGE – BURNT SIZE (ha)	75TH PERCENTILE (ha)	50TH PERCENTILE (MEDIAN) (ha)
1953	Aerial photography	846	54 234 (22%)	3 888	63.9 (se = 10.2)	0.5 – 6 005	32.1	10.2
1973	Landsat 1 MSS	24	38 014 (16%)	518	1 583.9 (se = 1 086.1)	15 – 24 780	236.6	60.6
1981	Landsat 3 MSS	4	210 576 (87%)	1 324	52 644.0 (se = 26 096.7)	17 113 – 129 646	–	–
1988	Landsat 5 TM	19	94 447 (39%)	814	4 970.9 (se = 23 080.2)	1 – 71 346	1 581.7	390.9
1994	Landsat 5 TM	83	46 589 (19%)	1 053	561.3 (se = 181.3)	8 – 11 992	234.0	91.2
2000	Landsat 5 TM	25	11 121 (4.6%)	392	444.2 (se = 164.9)	19 – 3 683	412.3	78.2



Figure 2. An example of fire scars (light patches) evident on 1953 aerial photography of a 241 210 ha area near Lake Mackay in Western Australia. Pintupi Aborigines who occupied the desert at the time of photography probably lit most fires.

DISCUSSION

Fire size

Oral evidence gained from interviews is consistent with the 1953 photographic evidence. During Aboriginal occupation of country, fire was used widely, frequently and for many reasons, inducing a fine-grained mosaic of burnt patches across the landscape and reducing the opportunity for very large and intense wildfires to develop. The number and size class distribution of the burnt patches further supports the oral evidence that burning was done routinely throughout the year. The relatively small size of the burnt patches could only be achieved by either only burning under marginal weather conditions (light winds, moist fuels) so that fires did not develop, or by burning frequently, thereby reducing the quantity and continuity of flammable fuel. Both factors probably contributed to controlling fire size, but given that Pintupi burnt all year round, it is probably the latter, frequent burning, that has mostly influenced the small grain size of the patch-burn mosaic. Kimber (1983) suggested that Aborigines had a good deal of control over fire, using wind, humidity and natural fire barriers such as claypans and sand dunes to control the size and intensity of fires. This accords with our

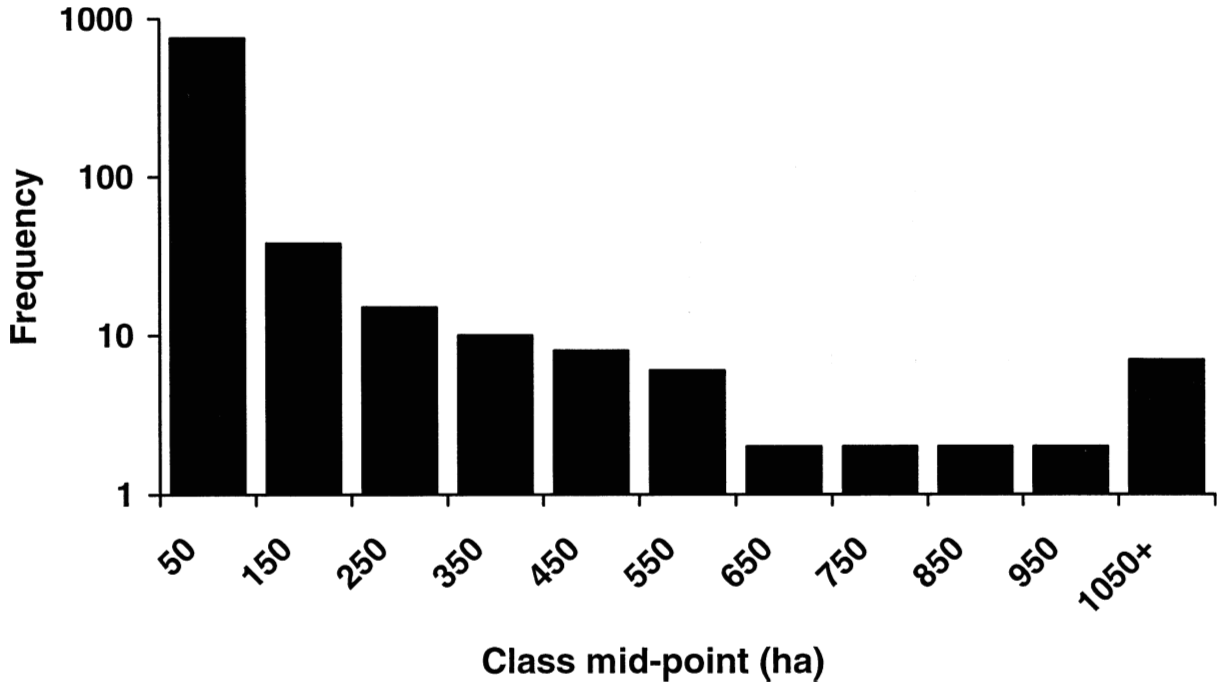


Figure 3. Frequency distribution of the size (ha) of recently burnt patches evident on 1953 black-and-white aerial photography of a 241 210 ha area of the Western Desert.

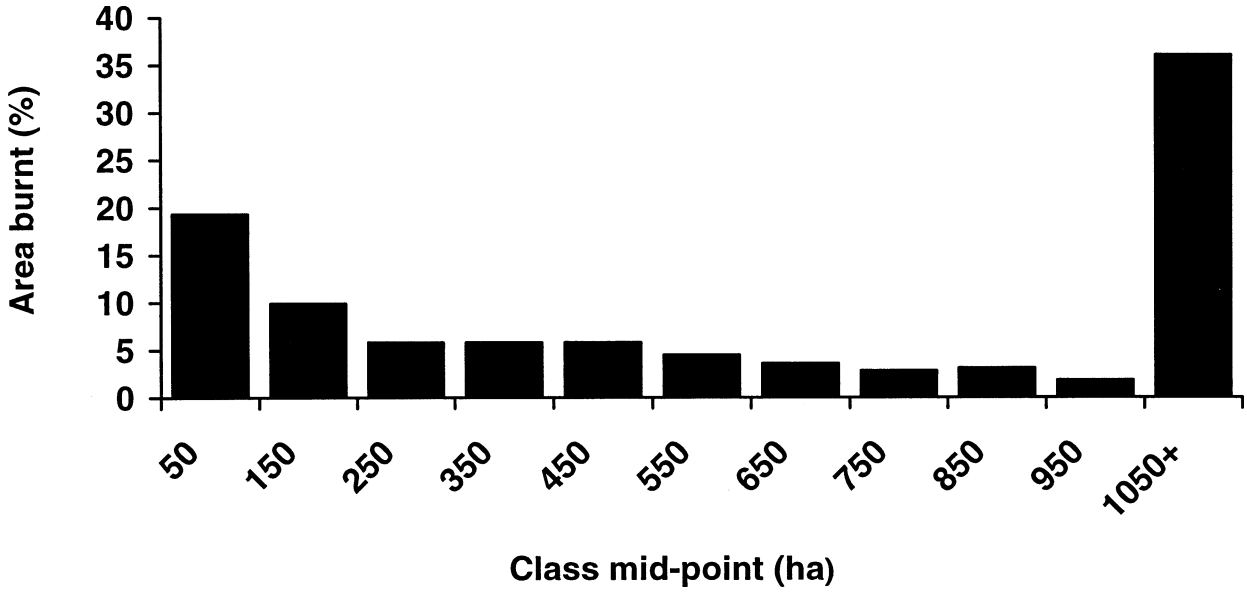


Figure 4. Proportion of the total area recently burnt (from 1953 photography) by burnt patch size classes.

observations while in the field with Aboriginal men. From our interviews with Pintupis, it was clear that they had a sound empirical understanding of the role of weather and fuel conditions in influencing fire behaviour.

Many generations of Aborigines frequently burning country as they moved through the landscape would have resulted in discontinuous, patchy fuels, ranging from recently burnt to occasional long-unburnt patches. However, when the human ignition source was removed from the desert, fuels accumulated over large, continuous tracts of land in a relatively short time. Today, lightning strikes often result in massive and intense wildfires, particularly during the hot and windy summer months. These fires can burn unchecked for days and sometimes weeks.

Fire interval

Following our discussions with Aboriginal informants, we were left with the impression that they burnt the vegetation as often as it would carry fire. Although it is only a snapshot in time, the 1953 photography of recent fires and the fire palimpsest supports this conclusion; there was evidence of only small patches of long unburnt vegetation within the study area. However, we cannot be confident of the spatial extent of this conclusion. If there were areas not frequented by Aborigines, then it is likely that these areas remained unburnt for longer periods. Griffin and Allan (1986) observed that Aboriginal burning patterns would have been intensified along popular travel routes. While rainfall history largely determines the rate of post-fire vegetation (fuel) development hence the minimum possible interval between fires (Griffin & Allan 1984, Griffin 1991, Allan & Southgate 2002), fire interval will also be influenced by the likelihood of ignition, which obviously decreases significantly in the absence of humans. Our observations suggest that for the study area the minimum possible interval between fires based, on fuel accumulation alone, is probably in the order of 5–7 years. However, we have observed that on some land systems in the Gibson Desert, a sequence of high rainfall events can encourage the growth of soft grasses and annual herbs which will support fire at more frequent intervals.

Time of year of fires

Our Pintupi informants told us they burnt all year round (every day). Kimber (1983) believed that most burning by Aborigines was done in August to October and immediately prior to rains in December to February. Occasionally, large fires caused either by Aborigines or by lightning, burnt during the hot, dry, windy summer months. In the area studied here, it would not have been possible for a fire to become larger than about 10 000 ha in 1953 because the fuels were discontinuous as a result of frequent broadscale patch-burning and natural fire barriers. Kimber suggests that the time of year for burning is not as important to Aboriginal people as the opportunity to burn, which was the impression we gained from our interviews. de Graaf (1976) observed that Aboriginal fires in the desert were lit all year round and not seasonally. Both de Graaf (1976) and Kimber (1983) reported that Aborigines did not burn certain areas of the desert because they did not visit these places for religious reasons, or feared that fire would destroy sacred objects. The season of burning was, however, very important in the monsoonal regions of the Northern Territory (Jones 1980, Haynes 1985 and Russell-Smith et al. 1997) and to Wadjuk Aborigines in the south-west of Western Australia (Hallam 1975). Today the main ignition source in the remote deserts, away from communities, roads and vehicle access tracks, is lightning. Thunderstorms are common over the summer months and large, lightning-caused wildfires have been reported (e.g., Griffin et al. 1983).

CONCLUSION

Traditional, or classical use of fire by Aborigines and patterns of alteration to the fire regime following the cessation of traditional Aboriginal burning practices reported here are similar to observations reported elsewhere for other Australian biomes (e.g., Hallam 1975, Haynes 1985, Bowman 1988, Russell-Smith 2002). Western Desert Aborigines used fire skilfully and for a myriad of purposes, probably for thousands of years. Oral evidence provided by Pintupi Aborigines and quantitative evidence obtained from early black and white aerial photographs is consistent and supports the hypothesis that the fire regime changed significantly and quickly in parts of the Western Desert following the departure of Aboriginal people and the cessation of traditional burning. The size and intensity of fires has increased dramatically over the last 50 years. Today, in the absence of regular burning by Aborigines, fuels have accumulated over vast areas and when lightning (or people) ignites these fuels and under hot, dry, windy summer conditions, large and intense wildfires sweep across the desert. With the cessation of anthropogenic burning throughout most of the vast Western Desert, landscapes alternate from large areas long unburnt to large areas recently burnt, usually following exceptional rainfall periods and lightning-caused ignitions. More research is required, but there is at least limited scientific evidence to suggest that this has contributed to the decline in some native mammal species. This change may have further predisposed mammals to predation by introduced predators.

It is reasonable to accept the importance of temporal and spatial diversity within a landscape on resource levels and habitat opportunities (Latz & Griffin 1978, Pielou 1977). Saxon (1984) stated, '*When large areas of a single landscape type are subjected to large uniform disturbances, they threaten the survival of wildlife species which depend on irregular boundaries of natural fire patterns to provide a fine grained mosaic of resources*'. Bolton and Latz (1978) have shown that a range of post-fire successional stages is important habitat for the western hare-wallaby (*Lagorchestes hirsutus*). Burbidge and Pearson (1989) explain the lack of rufous hare-wallabies in the Great Sandy Desert as being due to the lack of frequency of small-scale burns and to predation by foxes.

It is somewhat ironic that modern mammal extinctions in the Australian deserts may be due, in part, to the changed fire regime that resulted from the departure of Aborigines and cessation of traditional Aboriginal burning. Although contentious, some authors (e.g., Tindale 1959, Merrilees 1968, Jones 1968 and Flannery 1994) have suggested that extensive burning by Aborigines contributed to the extinction of the Pleistocene mega-fauna. Today, it is likely that the large, intense wildfires that occur throughout the deserts are placing extreme stress on some plant and animal communities (Griffin 1981, Latz 1995). These intense fires are damaging vast areas of fire-sensitive vegetation such as marble gum (*Eucalyptus gongylocarpa*), desert

oak *(Allocasuarina decaisneana*), and mulga (*Acacia anuera*) (Start 1986). There is sufficient evidence of the disadvantages of the current wildfire regime on the conservation status of desert reserves to warrant the development and implementation of managed fire regimes that mimic those in place during Aboriginal occupation of the land.

Limited resources available to conservation and land management agencies and the remoteness of many of the desert nature conservation reserves in Western Australia means that fire is not actively managed. There are many Aboriginal communities located in the Western Desert and given the knowledge and skills possessed by older people particularly, and the overwhelming desire by many Aboriginal people to care for country, a wonderful opportunity exists for co-management of these lands. The challenge for conservation and land management agencies is to develop processes that enable Aboriginal people to participate in land management in a meaningful and mutually beneficial manner. Hill (2003) presented a useful framework and mechanisms (bridging tools) to facilitate this. Her framework recognises an Indigenous 'toolbox' founded on traditional knowledge and customary law and a non-Indigenous toolbox founded on science, legislation and policy. She identifies processes such as joint management, native land title and planning as the 'bridging tools'.

Fire management on desert nature conservation lands provides an opportunity for conservation agencies to facilitate and resource the reintroduction of traditional burning. In addition to conservation benefits, co-management provides an opportunity for Aboriginal people in remote communities to participate in an economic activity on their own terms, while at the same time, ensuring that important connections with country and traditional knowledge and skills are maintained.

ACKNOWLEDGMENTS

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The assessment, monitoring and management of hiking trails: a case study from the Stirling Range National Park, Western Australia

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SUMMARY

Degradation of hiking trails is a recognised worldwide problem, but as of yet, no standard system for the assessment and monitoring of trail degradation has been established. The purpose of this study was to apply a trail problem assessment method, similar to that developed in the USA, to walking trails in an Australian national park, in order to assess the method's suitability as an international system for assessment and monitoring. The assessment method was also developed further to evaluate the effectiveness of trail maintenance. Results indicate that the method is well suited to a variety of trails, and provides an efficient system, however the method becomes more resource intensive when used for trails longer than 5 kilometres in length. The method provided detailed trail profiles describing selected environmental variables, degradation problems and maintenance. Assessment of constructed features revealed that efficient constructed features maintain good trail condition. Efficiency is achieved through the provision of sufficient numbers of constructed features and their regular upkeep.

Key words: Hiking trails, assessment, management monitoring, Western Australia

INTRODUCTION

Hiking impacts and degradation of trails is a recognised worldwide problem and presents as a significant management issue in many protected areas around the world. Trail usage results in various physical, biological and social impacts that degrade both trails and the surrounding environment. Physical impacts of trail use include soil compaction (Newsome et al. 2002), soil erosion (Leung & Marion 1999), track widening (Bayfield 1974; Leung & Marion 2000), increased bare ground (Cole & Spildie 1998), root exposure (Jewell & Hammitt 2000), wet or muddy tracks (Leung & Marion 2000), the creation of multiple tracks (Leung & Marion 2000) and disturbance of aquatic systems (Jewell & Hammitt 2000). Biological impacts such as fauna disturbance and vegetation damage, and social impacts including vandalism, litter, loss of wilderness values, unsafe travelling conditions and user conflicts on multi-use trails can also occur as a result of trail use (Cole & Spildie 1998; Deluca et al. 1998; Jewell & Hammitt 2000; Newsome et al. 2002).

Constructed features (eg. water bars and board walks) and continual upkeep of trails can minimise trail degradation (Burde & Renfro 1985; Marion & Leung 2001). Trail management includes educational and regulatory actions, as well as various management actions. Successful management is also dependent on formal systems of assessment that provide a sound basis for monitoring change. Such systems have been developed in the USA but have not been applied widely outside the US. Despite studies having been undertaken in the UK, Europe, USA and Australia (Bayfield 1973; Coleman 1977; Bratton et al. 1979; Sun & Walsh 1998; Leung & Marion 2000) there is, as yet, no international standard for assessing trail condition, Moreover, few studies have directly examined the influence of management on degradation.

The aim of this paper is to report on the application and usefulness of a Trail Problem Assessment Method (TPAM), developed in the USA by Leung and Marion (1999), and assess its suitability as an international system. We also developed the TPAM further in order to measure the impact that management maintenance actions have on trail degradation.

Case study: Stirling Range National Park, Western Australia

The Stirling Range National Park is located 330 km southeast of Perth and 75 km north of Albany in the south-west of Western Australia (Moon & Moon 2000). The park consists of two reserves, and covers a total area of 115 920 ha. (Figure 1). The Stirling Range National Park is managed by the Western Australian Department of Conservation and Land Management (CALM) for the Conservation Commission of Western Australia (Morphet 1996).

Records of park use prior to the 1960's are limited, although it is known that a local tourist association formed in the 1920's made efforts to construct roads in the area (Watson, 1993). Major road works occurred in the late 1960's when most of the current firebreaks and trails were established (Gillen & Watson 1993). Little is known about visitors to the park, although visitor numbers have increased over the years. Almost 42 000 cars were recorded in the Bluff Knoll car park in 1993, and this

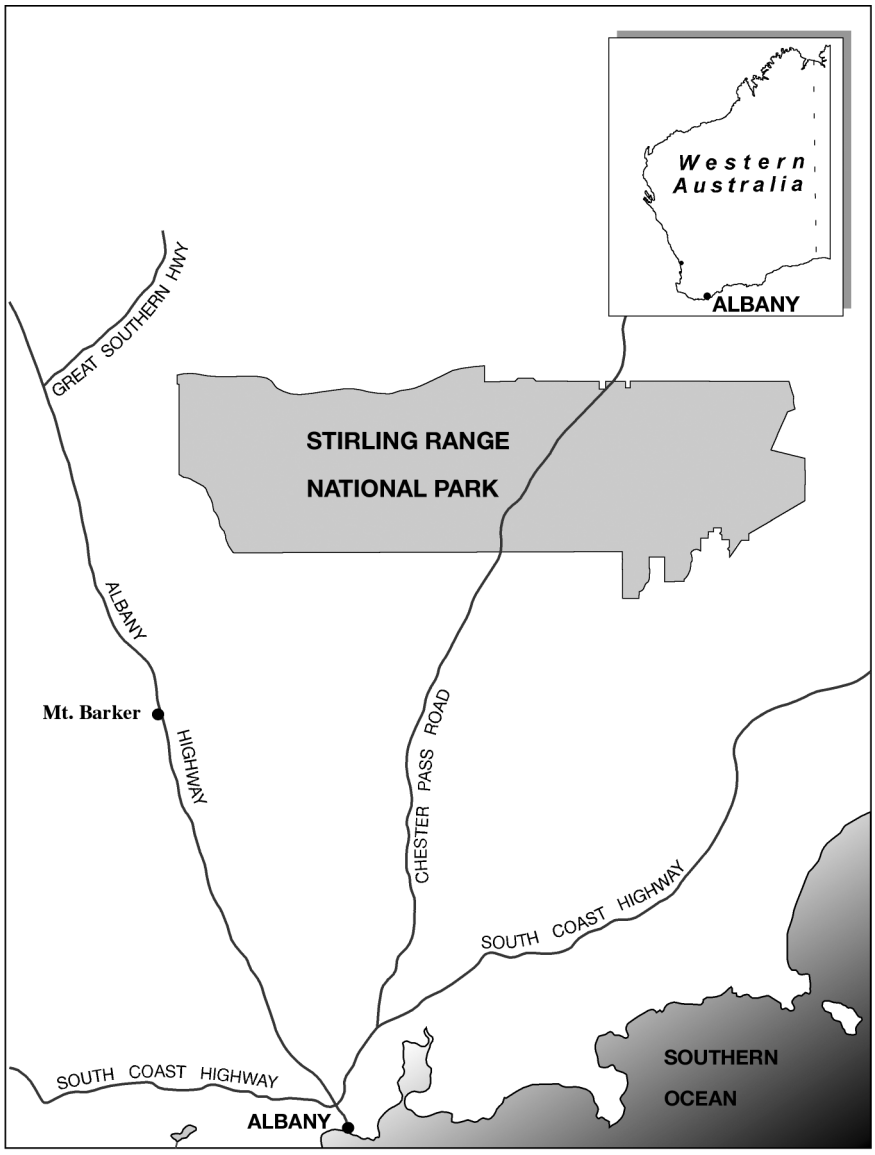


Figure 1. Map of the location of Stirling Range National Park, Western Australia.

figure rose to almost 50 000 in 2001 ([1]Harnett, pers. comm. 2002). In 1997–98, 90 000 people were estimated to have visited the Stirling Range National Park (CALM 1999). Exact visitor numbers walking various trails in the park are not known. However, the most popular trail is Bluff Knoll, which receives approximately 30 000 visitors per year ([2]Bains, pers. comm. 2002).

There are currently ten formal trails to summits in the Stirling Range National Park, covering a total of 32.7 km. (Figure 2). The trails in the Stirling Range National Park are restricted to pedestrians. Horse riding, cycling and off-road vehicles are not permitted due to the risk of spreading dieback disease an accidentally introduced fungus, *Phytophthora cinnamomi*, which has been shown to kill a wide range of plant species (CALM 1999). However, under road traffic regulations, these forms of transport are all permitted on the public roads in the park.

There is currently no formal management strategy for the trails in the Stirling Range National Park. Two rangers oversee the park and are responsible for maintaining the trails. Monitoring consists of walking the trails and making a mental note of the problem areas, which are repaired at a later date ([1]Harnett, pers. comm. 2002). Bluff Knoll is monitored as often as once a week during periods of heavy visitation. Mt Hassell, Mt Talyuberlup and Mt Trio are only monitored once a year. Written records of monitoring are kept ([1]Harnett, pers. comm. 2002). Maintenance involves the repair of problem areas as noted by informal monitoring.

[1] Ranger in Charge, Stirling Range National Park, Department of Conservation and Land Management

[2] Assisting Ranger, Stirling Range National Park, Department of Conservation and Land Management

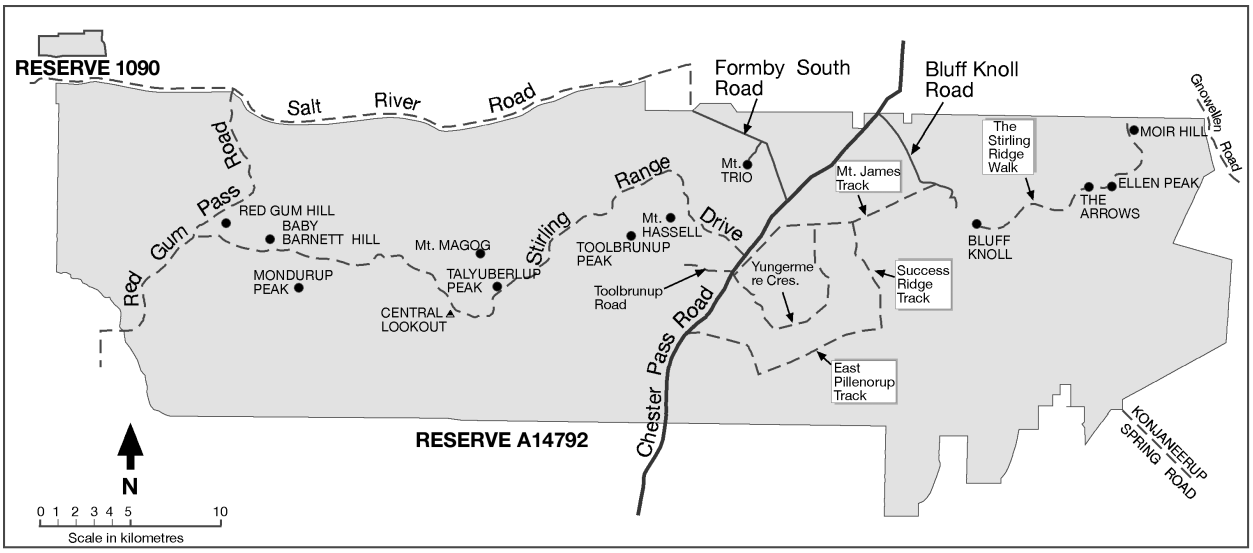


Figure 2. Location of footpaths in the Stirling Range National Park.

Research methods

Fieldwork was completed from 27 May to 14 June 2002. During this time, all the major recreational trails in the Stirling Range National Park were assessed to provide comprehensive baseline information on trail condition in the park. The trails in the park were evaluated by walking each trail from the summit to the start of the trail. This facilitated trail assessment by decreasing time taken to measure variables, as it was easier to walk uphill first and measure downhill, rather than to measure uphill. The total distance of each trail was measured by pushing a measuring wheel (100 cm circumference) along its length. Numerous variables categorised as descriptive variables, trail degradation indicators and constructed features were evaluated along the length of each trail (Table 1). Both point sampling and the trail problem assessment method (TPAM) were used to assess trail condition. It was decided due to time and resource constraints, and in order to provide an efficient and easy evaluation of the trails, that some variables were better suited to point sampling whilst the TPAM was more appropriate for other variables (Table 1).

Point sampling provided a fast, efficient and precise method of measuring three descriptive variables at intervals of 100 metres. Descriptive variables give an inventory of general footpath attributes and provide information for footpath planning and management (Monz 2000; Marion & Leung 2001). A database of current footpath condition can be built through the

TABLE 1
Variables assessed to evaluate trail condition in the Stirling Range National Park

POINT SAMPLING DESCRIPTIVE VARIABLES	RAPID PROBLEM ASSESSMENT METHOD		
	DESCRIPTIVE VARIABLES	DEGRADATION INDICATORS	CONSTRUCTED FEATURES
Trail width Slope Rockiness (% rock cover)	Soil texture	Erosion – E1: A segment of the trail that has been eroded 5 to 10 cm below the estimated original surface level. – E2: A segment of the trail that has been eroded 11 to 15 cm below the estimated original surface level. – E3: A segment of the trail that has been eroded 16 to 20 cm below the estimated original surface level. – E4: A segment of the trail that has been eroded more then 20 cm below the estimated original surface level. Excessive trail width Multiple trails Exposed roots	Constructed features – benches, board walks, bridges, boot cleaning stations, retaining walls, sand traps, signposts, stairways, water bars

evaluation of degradation indicators. Such indicators can be utilised to monitor footpaths for on-going deterioration. In particular the assessment of soil erosion provides a trail inventory that identifies problem areas. Measurement of erosion was started at 5 cm, as this is clear evidence that erosion has been initiated. Increases in 5 cm intervals as indicators of progressive severity were chosen to facilitate data collection. Excessive track width is taken as a segment of footpath that exceeds a width of 130 cm. Multiple trails reflect former off-road vehicle tracks or more commonly the creation of social trails that proliferate from the formal managed trail. Root exposure was measured as a segment where the top and sides of roots are visibly exposed. The depth of exposed root was recorded as the maximum depth measured from the top of an exposed root to the soil surface, perpendicular to the footpath surface.

Constructed features are an important management tool used to counteract footpath degradation. It is important to evaluate constructed features in order to provide information on existing or needed maintenance work on the path (Marion & Leung 2001). Constructed features were interpreted as an object constructed out of natural or artificial materials to maintain and manage the footpath, increase user comfort and/or provide information to footpath users. Although typically not considered as a construction feature that helps to reduce trail degradation 'boot cleaning stations' are included here because of their importance in the Australian context of helping to prevent wider ecosystem damage as a result of *Phytophthora* spores being moved via a trail network.

The data for individual trails were tabulated. Comparisons between descriptive variables, degradation indicators and constructed features were made through graphical representations. Data for all the trails were averaged and tabulated to enable comparisons between the trails.

RESULTS

Descriptive variables

The longest trail assessed was Bluff Knoll, although a longer trail, the Stirling Ridge walk extends from Bluff Knoll to a firebreak past Ellen Peak, covering a total distance of 17 km (Figure 2). Only 3 km of the Stirling Ridge walk was evaluated. The shortest trail was Central Lookout, at 390 metres. The steepest trail was

TABLE 2

Comparison of erosion recorded on the footpaths in the Stirling Range National Park

FOOTPATH	AVERAGE EROSION 1 (m/100 m)	AVERAGE EROSION 2 (m/100 m)	AVERAGE EROSION 3 (m/100 m)	AVERAGE EROSION 4 (m/100 m)	AVERAGE TOTAL EROSION (m/100 m)
Baby Barnett Hill	15.4	0.0	0.0	0.0	15.4
Bluff Knoll	14.9	0.2	0.4	0.0	15.5
Central Lookout	15.6	0.0	0.0	0.0	15.6
Mt Hassell	14.8	1.6	0.0	0.0	16.4
Mt Magog	8.6	6.4	2.3	0.1	17.4
Mt Trio	0.7	0.0	0.0	0.0	0.7
Red Gum Hill	40.3	2.7	0.0	0.0	43
Stirling Range Walk	20.6	4.5	0.0	4.1	29.2
Talyuberlup	23.1	20.9	10.3	23.8	78.1
Toolbrunup	0.0	0.0	0,0	0.0	0.0

TABLE 3

Comparison of excessive width, footpath proliferation and root exposure recorded on the footpaths in the Stirling Range National Park

FOOTPATH	AVERAGE EXCESSIVE WIDTH (m/100 m)	AVERAGE FOOTPATH PROLIFERATION (m/100 m)	AVERAGE EXPOSED ROOTS (#/100 m)	AVERAGE DEPTH OF EXPOSED ROOTS (cm)
Baby Barnett Hill	0.0	0.3	3.8	1.8
Bluff Knoll	0.3	0.5	6.1	3.0
Central Lookout	1.2	3.6	7.9	6.5
Mt Hassell	0.1	5.7	12.5	4.6
Mt Magog	0.0	32.3	6.9	4.2
Mt Trio	0.0	1.2	2.6	3.1
Red Gum Hill	0.0	0.0	5.0	2.0
Stirling Range Walk	0.2	13.9	9.9	2.9
Talyuberlup	6.4	2.8	24.7	9.4
Toolbrunup	0.6	1.8	6.0	7.3

Talyuberlup with an average slope of 39 degrees, followed closely by Toolbrunup (34 degrees) and Mt Hassell (33 degrees). Central Lookout had the gentlest average slope of 16 degrees. The average trail rockiness varied from 21 percent (Bluff Knoll) to 98 percent (Toolbrunup). Bluff Knoll was the widest trail, with an average width of 123 centimetres, whilst the narrowest trail was the Stirling Ridge walk (Ellen Peak section) at 50 centimetres.

A total of nine soil types were recorded on the trails. Clayey sand was the most common soil type, covering a total of 5.3 km of trail in the park. Other soil types recorded were sand (3.5 km), rock (2.8 km), sandy loam (2.3 km), clayey loam (1.5 km), loamy sand (0.9 km), sandy clay loam (0.8 km), lam (0.7 km) and medium clay (0.1 km). No single soil type stood out as being the most eroded in the Stirling Range National Park.

Degradation indicators

Erosion E1 was the most common degradation problem on the trails (Table 2). The Talyuberlup trail was the most eroded trail in the park (Figure 3). Talyuberlup had the highest average erosion E4 (23.8 m/100 m), E3 (10.3 m/100 m) and E2 (20.9 m/100 m), as well as the highest total erosion (78.1 m/100 m). The Red Gum Hill trail was the second most eroded trail in the park (43 m/100 m) and had the highest erosion E1 (40.3 m/100 m). The least eroded trail was the Toolbrunup trail, which had no erosion (Figure 4). Exposed roots were also found on all the trails (Table 3), mainly occurring in conjunction with erosion. Talyuberlup had the highest number of exposed roots (353), whilst Mt Trio had the least amount (43).

Trail proliferation (Table 3) occurred on all trails except Red Gum Hill. There were 97 instances of trail proliferation in total, covering a total of 1.7 km. Mt Magog had the most trail proliferation in terms of metres (32.3 m/100 m), although the majority of the proliferation on Mt Magog was old vehicle tracks that were in the process of being rehabilitated. Central Lookout had the highest number of extra trails (1.5 extra trails/100 m). The Stirling Ridge walk had the second highest amount of trail proliferation (13.9 m/100 m), and the second highest number of extra trails (1.2 extra trails/100 m).

Excessive width (Table 3) was the least common problem in the Stirling Range National Park, occurring 25 times, but only covering a total distance of 0.1 km. Most trails recorded less than one percent of excessive width, with four trails recording no excessive width at all (Table 3). The Talyuberlup trail was most affected by excessive width (6.4 m/100 m).

Constructed features

The constructed features found on the trails are listed in Table 1. Most trails assessed had an average of less than

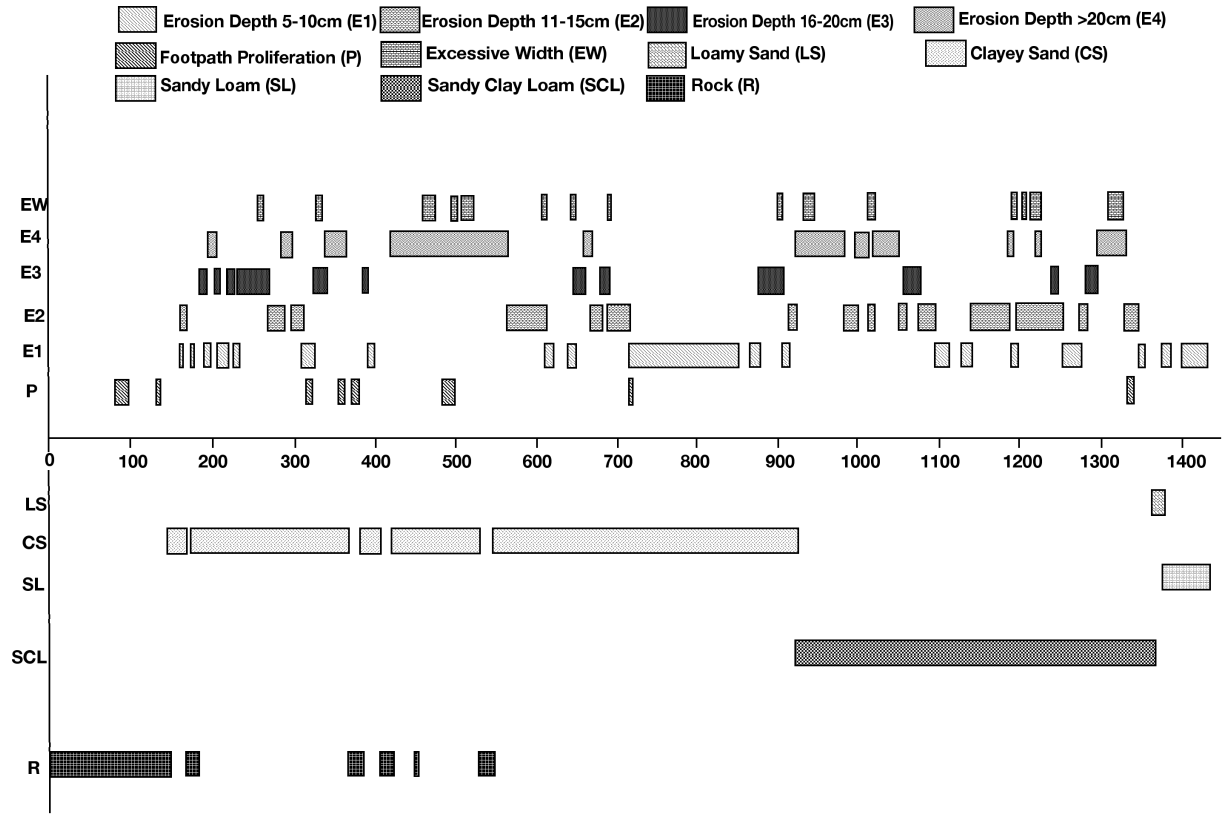


Figure 3. Location and lineal extent of degradation indicators and soil types on the Talyuberlup footpath. The path length is from the summit (0m) to the start of the path (1430).

six constructed features per 100 metres, although Baby Barnett Hill and Red Gum Hill had no constructed features (Table 4). Whilst Bluff Knoll had the highest total number of constructed features (1215), Mt Trio had the most constructed features on average (43.7/100m). The Mt Trio trail also had the most features designed to assist in degradation control (725 boardwalks, bridges, retaining walls, sand traps, stairways and water bars). Mt Hassell had the most signposts (57), followed by Toolbrunup (53).

At least 79% of the constructed features found on each trail were in good condition (Table 4). The Toolbrunup trail had the highest percentage of constructed features in moderate condition (16.9%) whilst Talyuberlup (Figure 5) had the most constructed features in poor condition (13%). Despite the fact that the majority of constructed features in the park were in good condition, many were found to be either moderately effective or ineffective. For example, all of the constructed features on the Central Lookout trail were in good condition, but only 22.8% were very effective, with 54.5% being moderately effective and 22.8% being ineffective. The Talyuberlup trail had the highest percentage of ineffective features (Figure 6). Mt Trio and Bluff Knoll had the highest percentage of very effective constructed features (99.3% and 91% respectively).

Table 4

Comparison of the number, condition and effectiveness of constructed features recorded on the footpaths in the Stirling Range National Park

FOOTPATH	TOTAL NUMBER	FEATURES IN GOOD CONDITION (%/100 m)	FEATURES IN POOR CONDITION (%/100 m)	VERY EFFECTIVE FEATURES (%/100 m)	INEFFECTIVE FEATURES (%/100 m)
Baby Barnett Hill	0	0	0	0	0
Bluff Knoll	1215	96.3	0.7	91	1.4
Central Lookout	22	100	0	22.8	22.8
Mt Hassell	68	97	0	85.0	1.5
Mt Magog	179	83.8	5	76.2	6.0
Mt Trio	725	99.7	0	99.3	0
Red Gum Hill	0	0.0	0	0	0
Stirling Ridge Walk	29	89.7	0	77.8	0
Talyuberlup	23	87	13	31.2	56.3
Toolbrunup	54	79.2	5.7	80.8	9.2

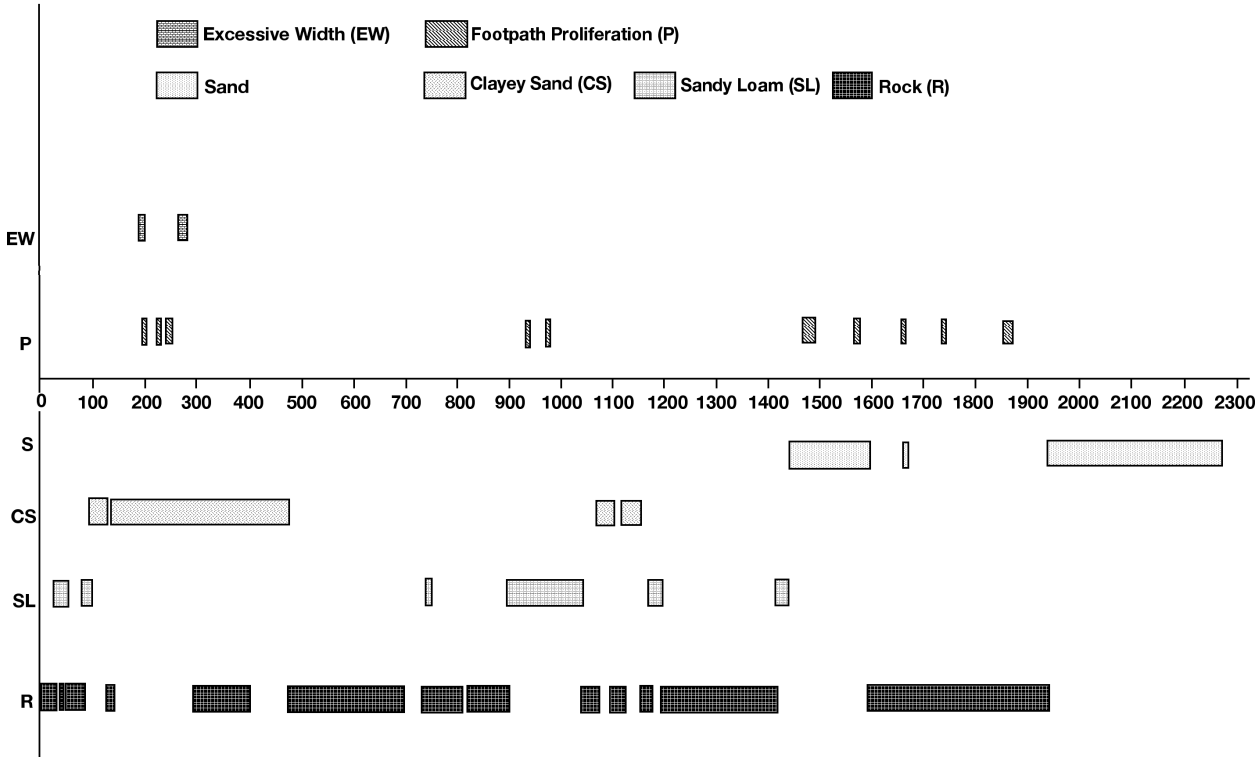


Figure 4. Location and lineal extent of degradation indicators and soil types on the Toolbrunup footpath. The path length is from the summit (0m) to the start of the path (2266m).

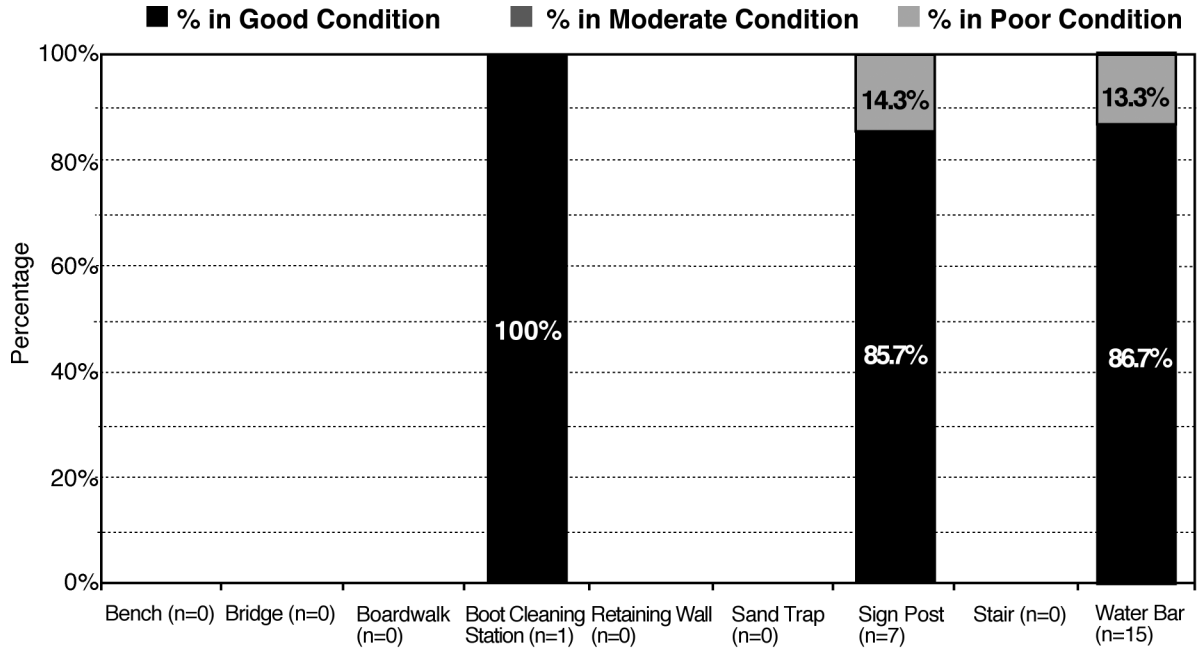


Figure 5. The percentage maintenance features on the Talyuberlup footpath classified as being in good condition, moderate condition and poor condition.

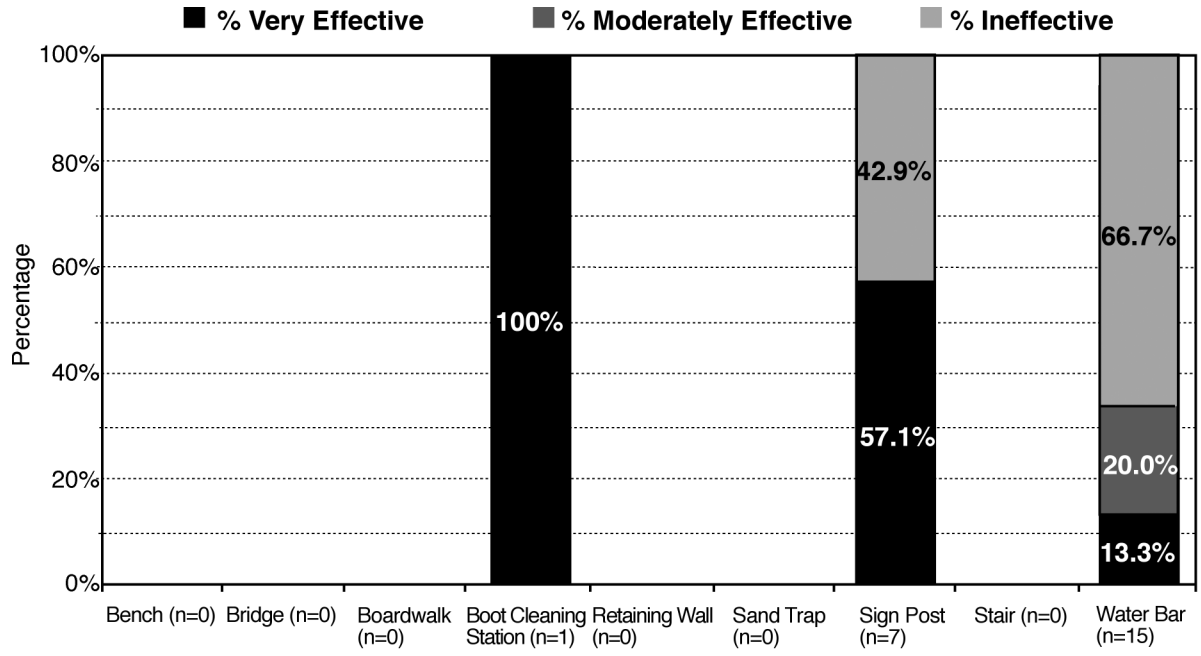


Figure 6. The percentage maintenance features on the Talyuberlup footpath classified as very effective, moderately effective and ineffective.

DISCUSSION

Degree of maintenance of constructed features in the Stirling Range National Park

The current levels of degradation on some of the trails, in particular the high percentage of erosion occurring on most trails may be due to a combination of historical factors such as poor trail location and the on-going use of user-developed trails (trail proliferation) which in some cases arose from old off-road vehicle tracks that had been used to access lower lying areas. The results also suggest that on some trails not enough effective constructed features have been installed or that regular maintenance has not been carried out to ensure maximum effectiveness of constructed features.

Regular trail maintenance should include the upkeep of constructed features, to ensure that they are in good condition and very effective. Some trails, such as Central Lookout and Talyuberlup had a high percentage of moderately effective or ineffective constructed features. This could be rectified by maintenance. For example, most of the water bars on the Central Lookout trail were moderately effective (54.8%) to ineffective (22.8%) because debris, namely gravel and small rocks, had built up around the water bars. Regular maintenance would keep water bars free of debris, making them more effective.

Ongoing trail maintenance is also very important in the Australian context in that it helps to control the spread of *Phytophthora cinnamomi*, the spores of which are spread through the movement of water through soil, and also through the movement of eroded soil. The further water or eroded soil moves, the further the spores can move. Infected upland areas can act as a source of spores that spread downhill as water is shed off trails and eroded soil moves downslope (see Newsome 2003). Ongoing maintenance can ensure that water flow along trails is minimised and that water is dispersed into specific drainage areas before it can build up to any appreciable volume. Such actions will help to prevent soil erosion and in doing so will reduce the wider spread of *P. cinnamomi*. The Bluff Knoll and Mt Trio trails were the only trails that had maintenance work done in 2002 ([2]Bains, pers. comm. 2002). Marion and Leung (2001) discuss the importance of trail management, including the installation and upkeep of adequate constructed features (Table 1), and highlight that these actions are vital to limiting trail degradation.

Condition of constructed features versus effectiveness of constructed features

Assessment of the constructed features on the trails in the park revealed that constructed features in good condition did not necessarily mean they were very effective. For example, 100% of the constructed features on Central Lookout were judged to be in good condition, yet only 22.8% were assessed as being very effective, while 54.5% were moderately effective and 22.8% were ineffective. There are two main reasons why these differences occur. Effectiveness of a constructed feature does not depend entirely on its condition, but rather on its placement and the total number of features. Placement of constructed features includes where they are placed in relation to environmental variables such as slope, how well features have been installed on the trail and how far apart they are placed from one another. For example, water bars placed at the base of Talyuberlup did little to prevent the severe erosion occurring on the slopes further uphill. The Mt Hassell trail had 6 water bars placed within a 50 metre segment at the base of the hill. The 50 metre segment containing the water bars on Mt Hassell was not eroded, suggesting that a sufficient number of water bars are present in that segment. However, further uphill, erosion was recorded on slopes that had no constructed features. The placement of different types of constructed features together, such as retaining walls, steps and water bars all working in conjunction with each other, can also improve the efficiency of individual structures.

It is also important to have sufficient constructed features on each trail. Most trails in the park averaged between 0.9 and 5.6 constructed features per 100 metres. Bluff Knoll and Mt Trio averaged 35.8 and 43.7 constructed features per 100 metres respectively, which contributes to the similarities between their condition and effectiveness. If enough constructed features are present, there will be less pressure on individual structures, and the combined effects of constructed features will increase their effectiveness. The Stirling Ridge walk (Ellen Peak), for example, had 20 steps and nine water bars within a 100 metre segment (1692 to 1792 metres from the summit), that was very steep (45 to 70 degrees). Despite the steps being very effective, and the water bars being very to moderately effective, erosion E4 occurred for most of the 100 metre section, and a 14 metre segment of erosion E2 was also recorded. The steps in this segment were made of large stones, and were judged as being very effective because they enabled trail users to climb the steep slope, and reinforced the soil immediately around each step. However, the steps and water bars were 2 to 18 metres apart, and erosion was present in the intervals between constructed features. More constructed features are required in this segment to control the erosion. A well constructed and maintained staircase, rather than individual steps placed far apart, as well as additional means of erosion control, e.g. water bars and retaining walls, would stabilise the slope and shed water off the trail, helping to control erosion in this segment.

The importance of trail maintenance

Without ongoing regular maintenance and upkeep of constructed features, trail conditions in the park will

[2] Assisting Ranger, Stirling Range National Park, Department of Conservation and Land Management

continue to deteriorate. Degraded trails detract from the aesthetics of the park, and make travel conditions difficult and unsafe. They also make it difficult to achieve the managerial goals of the park, such as developing and maintaining trails to appropriate standards to provide safe and enjoyable walking experiences, and implementing maintenance to arrest erosion and provide safe access (CALM 1999). The trails in the park are promoted as tourist attractions, and tourist facilities such as car parks and picnic areas provide access to trails, so it is important to maintain good trail condition. This can be achieved by adhering to trail management and monitoring programs.

Basis for a management and monitoring program

Once a trail inventory has been gathered and the trail condition assessed, it is important to monitor trails. Similar or even identical indicators as those used to assess trails can also be used as a monitoring system (Monz 2000). Monitoring involves methodical collection and analysis of data over time (Newsome et al. 2002), and is important in many ways. Firstly it identifies the impacts of hikers on trails and assesses the changes over time, thus describing any trends in trail condition and alerting managers to trail degradation (Burde & Renfro 1985; Hendee et al. 1990; Monz 2000). Secondly, monitoring systems can be used to assess the effectiveness of trail maintenance. Information gathered by monitoring trails can be utilised by managers to evaluate and update resource conditions and management programs (Monz 2000). Monitoring also provides important data that can be used in the planning and design of trails (Hendee et al. 1990).

Three main monitoring techniques have been developed to evaluate trails. These are permanent point surveys, sampling based rapid surveys and problem based rapid surveys. Each of these methods has advantages and disadvantages, and relays different information to managers of natural areas. Visitor surveys may also be used to monitor some aspects of trails, such as trail use, and provide qualitative and some quantitative data.

The interval sampling and problem assessment method employed in the Stirling Range National Park evaluated descriptive variables, degradation indicators and constructed features to provide the baseline information on current trail condition. The same method can be used to monitor the trails, which would allow direct comparison to the data gathered in this preliminary assessment, thus providing information on changes in trail profiles and evaluation of trail maintenance and management programs. Some minor adjustments would need to be made to make the assessment method suitable for monitoring. For example, the descriptive variables (slope, rockiness, width, length, soil type) and shallow exposed roots would not need to be monitored unless trails are re-aligned, relocated or new trails are built. These were included in the preliminary assessment to describe the trail environments and to allow comparison of environmental controls with trail degradation. The descriptive variables are fairly constant (e.g. slope would not be expected to change much over time) and therefore it is not necessary to monitor them. Exposed roots were often found in segments with no erosion, due to the shallow soils found on the slopes in the park. Also, many of the exposed roots were mallee roots, which are naturally partially exposed. Most exposed roots found were uncovered to a depth of 1 to 5 cm, and did not create problems such as tripping hazards or increased travel difficulty. Roots exposed to a depth of 10 cm and over should be monitored because they were often found in conjunction with erosion, and have the potential to be hazardous to trail users. Monitoring the depth of root exposure can alert managers to increases in root exposure depth, which is indicative of continuing degradation.

The location and lineal extent of erosion, excessive width and trail proliferation should be monitored to alert trail managers to problem areas and to assess degradation trends over time. Constructed features used in the preliminary assessment should also be monitored. For example, initial assessment of a trail, using the problem assessment method, may find a 2 metre segment of erosion, starting 3 metres from the summit and finishing at 5 metres from the summit. The trail managers may take action, such as placing water bars at the start and finish of the erosion problem and backfilling the eroded section. Further monitoring of the trail, using the same method, will detect whether the 2 metre segment of erosion re-occurs after maintenance action has been taken, or whether maintenance has been effective and the segment remains rehabilitated. Monitoring will also provide information on the condition and effectiveness of any new water bars, alerting trail managers to any ongoing maintenance that may be required, such as clearing rock and debris from water bars or replacing wooden water bars after severe fires if they have been burnt and rendered ineffective.

Practical applications and limitations

The trail problem assessment method used in this study provided a simple and very efficient evaluation of trails in the Stirling Range National Park. Comprehensive profiles of trail condition can be obtained as indicated by the data derived from Toolbrunup (Figure 4) and Talyuberlup (Figure 3). Because it can be easily used in any environment, whether it be steep mountain trails or lowland trails, the technique appears to be well suited to international trail assessment. One of the main limitations to the approach taken here, however, is that although deemed especially suitable for trails 1–5 km in length it is not likely to be applicable in situations where much longer trail distances (>10 km) are involved. With much longer trail systems such levels of detail, such as overall trail profiles, would be much more resource intensive to acquire and managers are likely to choose a sampling based rapid survey technique (Marion & Leung 2001; Newsome et al. 2002).

Practical aspects of undertaking this work included

the need to take care when using the measuring wheel in order to avoid inaccuracy. It is important to ensure that the measuring wheel does not bounce over rough terrain and that people do not walk backwards with it, as this can increase distances measured. The measuring wheel also needs to be kept in the middle of the trail. If the measuring wheel swings across the trail from side to side, the distance is again increased. Measuring wheel inaccuracy can be overcome by staff training.

At the local site level there was difficulty in defining the summit of some trails (e.g. Baby Barnett Hill, Bluff Knoll). This could be improved by providing discrete markers, such as metal pins set into the ground. The markers would then be used as the start of the measuring.

There was also some degree of subjectivity in the method in that personal judgment was needed to decide where degradation starts and finishes, and what condition/effectiveness the constructed features are in. This can be improved through staff training, by using photographs to demonstrate examples of degradation indicators and constructed features, and through workshops designed to teach and improve measurement techniques.

A significant constraint in this study was the lack of information on visitor numbers and trail use in the park. Without this data, the influence of environmental controls on trail degradation cannot be fully understood. Visitor information is also very important for managerial decisions, such as prioritising trails, and choosing appropriate management and monitoring actions.

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BiblioBarrowIsland – An Annotated Bibliography of the Natural History of Barrow Island 1622 – 2004

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SUMMARY

This annotated bibliography contains information on 474 documents relating to the natural history of Barrow Island, one of Australia's most important biodiversity conservation reserves. Papers have been sorted into 41 broad categories including the biophysical environment, the native and introduced biota, environmental impact studies, and environmental management. Many of these documents are unpublished reports authored by staff of Western Australian government departments or were commissioned by the oil company West Australian Petroleum Pty Ltd (WAPET), later ChevronTexaco Australia (CVX), during the past forty years when a Petroleum Act production lease existed over the same area as a Class A Nature Reserve.

INTRODUCTION

Barrow Island, the second largest island of Western Australia (WA), is one of Australia's most important nature reserves. It supports 14 species of native mammals, over 100 species of birds, 54 species of reptiles and more than 400 species of plants. In addition, many troglobitic and stygobitic fauna are found in its caves and groundwater. Located 80 kilometres off the Pilbara coast west of Cape Preston and north of Onslow, this 233 km^2 island is unique in being a producing oilfield with over 900 wells and other items of associated infrastructure as well as being a very valuable biodiversity conservation reserve. It is the intact array of native mammal species and the absence of rabbits, foxes, cats, rats and mice that



Figure 1. Turtle Bay, west coast of Barrow Island (Photograph courtesy of ChevronTexaco)

makes Barrow Island an important zoological asset for Australia. Six of the 14 species of native mammals that occur there are listed as threatened pursuant to Western Australian and Australian Commonwealth legislation.

History

Aboriginal people inhabited what is now Barrow Island, prior to it becoming an island 6 000 to 8 000 years ago, but there is no evidence of occupation after rising sea levels separated Barrow from the mainland. The first English visitors in 1840 found 'no traces of natives'. The earliest reported European sighting of Barrow Island was by the crew of the ill-fated English ship *Tryal* which ran aground and sank on a reef to the north of Barrow in 1622. The French navigator Baudin thought it to be part of the mainland as he sailed along the north-west coast in 1803, naming several prominent landmarks on the island such as Cape Poivre, Flacourt Bay and Cape Dupuy. It wasn't until 1818 that Lieutenant PP King determined that Barrow was an island and he named it after John Barrow, Secretary of the Admiralty at that time. In 1840, Lieutenant JL Stokes in HMS *Beagle* explored and charted the east coast of Barrow Island. Improved geographical and hydrological knowledge resulted in 1899 when Commander Combe in HMS *Penguin* was commissioned to survey Mary Anne Passage, to the south of Barrow Island.

As the settlement of the Pilbara mainland expanded after the 1860s, Barrow was held under lease for turtle fishing and pastoralism, although there is no evidence that Barrow Island was ever used for grazing sheep, goats or cattle. The pearling industry was also expanding in the Pilbara and several pearling camps were located on Barrow Island. The well-known naturalist, JT Tunney collected mammals for the Western Australian Museum (WAM) and Lord Rothschild in 1900. In 1908, Barrow Island was declared an Aboriginal Reserve specifically for the treatment of venereal disease. However, these plans did not proceed and in the same year, the island was declared a reserve for 'Protection of flora and fauna'. In 1910, the reserve was declared Class A, that is, its purpose could not be changed without approval from both Houses of State Parliament. In 1917–18, FL Whitlock made two extended visits to the island reporting mainly on the bird life. He also reported for the first time the presence of the introduced black rat on some of the small islands close to the east coast of Barrow Island—these were probably introduced from pearling vessels.

In the 1950s, the island was visited by personnel associated with the testing of the first British nuclear weapon and was, for a while, considered as a potential site for these tests. By this time the value of Barrow Island to mammal conservation had been recognised and it was proposed that the native fauna could be herded to the southern end of the island, a fence constructed



Figure 2. Lufkin pump at sunset (Photograph courtesy of ChevronTexaco)

across it (a distance of approximately 10 km) and the atomic weapons detonated at the northernmost point. Fortunately this option was not pursued and the nuclear weapon tests were carried out in the Montebello Islands, 40 km to the north of Barrow. A joint Commonwealth Scientific and Industrial Research Organisation (CSIRO)/WAM expedition to Barrow and adjacent islands in 1958 collected six species of native mammal, including the first record of a fat-tailed antechinus for the island.

The well-known naturalist Harry Butler commenced his long association with Barrow Island in May 1964, and again in April 1965 when he spent several weeks on the island, recording wildlife and collecting specimens for the WAM. During these trips, which coincided with the start of an extensive drilling program by West Australian Petroleum (WAPET), he made the first Barrow Island collections of the brushtail possum, boodie, common rock-rat, water rat and two species of bat, as well as many reptile species. Since that time Butler has been a consultant to the oil company and has been responsible for developing and implementing the early environmental management operations on the island.

The oil industry

In 1953, after WAPET discovered oil at Rough Range, near Exmouth, an expanded program of oil exploration commenced along the nearby, and geologically similar, Pilbara coast and islands. The potential of Barrow Island as an oil reservoir was recognised in 1954 and extensive geological and seismic surveys commenced after the area was reopened in 1963, post atomic testing in the Montebellos. The first well was drilled in May 1964 and oil was produced soon after. Commercial operations began in 1967 and the first shipment of oil occurred in April that year. Now CVX operates the oilfield. Currently there are over 450 producing oil wells, more than 250 water injection wells and a number of other exploration wells, and more than 1000 km of roads on the island. There is also accommodation infrastructure to support the 150–200 personnel who work and live on the island in two-week shifts. In 2000, 668 000 kl of oil were produced. Barrow, having a long all weather airstrip is used as a transport hub for the other producing oilfields on nearby Thevenard and Varanus Islands and several offshore platform operations.

In February 2003, CVX prepared an environmental, social and economic (ESE) review of their proposal to develop the Gorgon gas field, 80 km off the west coast of Barrow Island. One of the options examined was to use Barrow Island as the site for a gas processing plant and shipping facility. Later in 2003 the Western Australian Government provided in-principle support for CVX to proceed with planning for this development on Barrow Island providing the necessary environmental reviews were undertaken and approved.

One of the first steps taken was to establish an independent Quarantine Expert Panel to provide advice to CVX on international best practice for the necessary



Figure 3. Drilling rig on Barrow Island (Photograph courtesy of ChevronTexaco)

quarantine measures required to protect the valuable biodiversity of Barrow Island should the Gorgon project be approved and proceed. Early recommendations of this expert panel were that adequate baseline studies be undertaken on the biodiversity of Barrow Island. To assist in the development of this it was further recommended that a bibliography on the natural history of Barrow Island be assembled and published, with copies of critical documents made available to the public through the WAM and Department of Conservation and Land Management (CALM) libraries. CALM was contracted to prepare the bibliography. The bibliography provided below comprises 474 documents and covers the historic, biophysical, climatic and environmental management aspects of Barrow Island to June 2004. To retain maximum benefit from the bibliography, regular updates need to be made as further documents become available.

METHODS

The bibliographic search started with titles extracted from the CALM Library Catalogue, CALM's Environmental Protection Section collection, the reference list from the Gorgon ESE Review and the original bibliographies on Barrow Island compiled by Harry Butler and Jacqueline Cox of WAPET. The references contained within these titles were checked and added if considered relevant. This process continued until as many relevant references as possible were identified. Searches were also conducted in online catalogues of other Libraries, such as the State Library of Western Australia and the National Library of Australia. Other online databases were also searched. This process was subjective to some extent. In addition to articles focussing on Barrow Island, this bibliography includes historical accounts, documents that mention Barrow Island only in passing, and the 'grey' literature and papers in obscure journals.

Journal articles, book chapters, reports and unpublished materials have been included. WAPET/CVX, CALM and other government department reports make up the majority of titles. Only those documents which are relevant to the scope of this bibliography have been included. Published journals are disseminated worldwide using online information systems such as Dialog, Biosis and Current Contents. URLs for site-specific information have also been included.

Fifty Australian and Western Australian legislative Acts and Regulations and Codes of Practice that pertain to Barrow Island have been included as a supplementary, but not exhaustive, list.

Copyright permission was sought from publishers and authors for the reproduction of abstracts or significant sentences from introductions or summaries. The copyright in some titles has expired as it has been 50 years since the death of the author, and in others copyright is held by the Crown. The remainder of the summaries were considered not significant enough to request permission to reproduce.

For convenience the references are listed alphabetically by author or corporate body. If no author has been attributed, the papers can be found at the beginning of the sequence organized by date and then title. Each title has been allocated an item number which relates back to the listed numbers under the broad subject categories.

Every effort has been made to obtain a copy of each reference and lodge it in the CALM Wildlife Science Library (Woodvale), WAM Library (Welshpool) and CVX Library (Perth). However in some cases this has not been possible, but the majority of titles can be viewed by prior appointment at one of the libraries mentioned above.

The bibliography will be updated as new materials become available. Updates can be obtained from the CALM Wildlife Science Library on request. Notification of relevant materials for inclusion should also be sent to the CALM Library.

ACKNOWLEDGMENTS

A number of scientific experts were contacted to discuss the format and terminology to be used in this bibliography and the authors acknowledge the support from: Dr Andrew Burbidge, Harry Butler, Norm Caporn, Ursula Davies, Dr Stefan Eberhard, Dr Bill Humphreys, Russell Lagdon, Loisette Marsh, Dr Bob Prince, Dr John Scott, Dr Jeff Short and Dr Tony Start.

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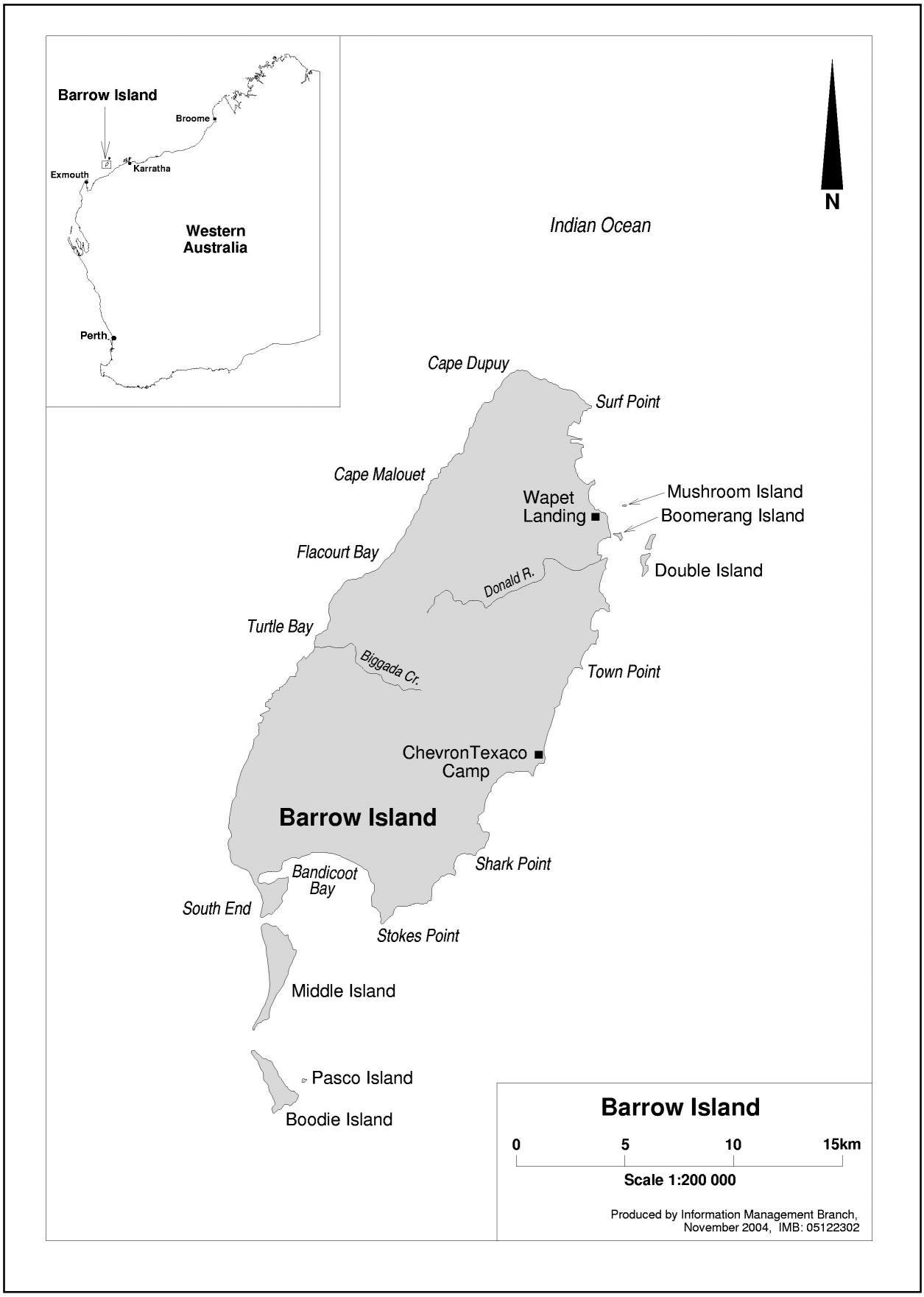


Figure 4. Map of Barrow Island, 80 km off the Pilbara coast, west of Cape Preston and north of Onslow, Western Australia.

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*Figure 5. Barrow Island euros (*Macropus robustus isabellinus*) (Photograph courtesy of ChevronTexaco)*

BiblioBarrowIsland

1. (1907) Western Australian fauna: necessity for preservation: a valuable asset: interview with Mr. Shortridge: useful information and suggestions. *West Australian* **Jun 18**, 7.
Summary: Interview in 1907 with Mr GC Shortridge, a zoologist attached to the British Museum, who has spent the last two years in Western Australia, collecting specimens and information on the fauna of Western Australia.
Copyright note: Copyright expired 2000

2. (1967) Cinderella Island. *Petroleum Gazette* **Jun**, 182–185.
Summary: The traditional rags to riches theme closely fits Barrow Island, the once unwanted, uninhabited, reef-girt land speck which has now become Australia's largest oilfield.
Copyright note: Summary reproduced with permission from the Australian Institute of Petroleum – http://www.aip.com.au/

3. (1967) WAPET begins shipping Barrow crude: oilfield confirms judgement of 20 years ago. *Australasian Oil and Gas Journal* **13(8)**, 24–39.
Summary: WAPET shipped its first cargo of Barrow Island crude oil to Kwinana on April 23 1967.
Copyright note: Unable to locate contact details for the copyright holder. Please notify us if you can provide them

4. (1970) When oil and fauna mix. *Eco* **Jul**, 1–3.
Summary: Undisturbed for the best part of the 12 000 years since it became separated from the Australian mainland, Barrow Island came into national prominence when it was declared a commercial oilfield. Strong measures have now been taken to protect its fauna and flora.
Copyright note: Unable to locate contact details for the copyright holder. Please notify us if you can provide them

5. (1974) Barrow: WAPET's island in the sun. *Industrial Review and Mining Year Book* **1974**, 89, 91, 93–94.
Summary: Brief overview of Barrow Island since WAPET began producing oil in 1966. The research grants available from WAPET or the Western Australian Wildlife Authority are discussed.
Copyright note: Permission not required for this summary

6. (1976) Where the earth moves at sundown. *Texaco Star* **63**, 18–19.
Summary: Notes on the wildlife of Barrow Island.
Copyright note: Summary reproduced with permission from ChevronTexaco Australia – http://www.chevrontexaco.com/

7. (1977) Barrow Island: Western Australia's first commercial oilfield. *WAPET Journal* **1977**, 20–28.
Summary: The history of WAPET on Barrow Island.
Copyright note: Summary reproduced with permission from ChevronTexaco Australia – http://www.chevrontexaco.com/

8. (1977) Bird man on Barrow. *WAPET Journal* **1977**, 32.
Summary: Eric Sedgwick was awarded the WAPET annual research grant in 1976 with a proposal for making bird population surveys on Barrow Island.
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9. (1977) Piecing together a picture of oil and gas prospects. *WAPET Journal* **1977**, 8–13.
Summary: The history of WAPET on Barrow Island.
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10. (1977) The WAPET story: the pursuit of a dream made industrial history. *WAPET Journal* **1977**, 2–4.
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11. (1977) Wildlife and wildcats. *WAPET Journal* **1977**, 30–31.
Summary: An account of WAPET's environmental care and management which includes Barrow Island.
Copyright note: Permission not required for this summary

12. (1978) Ants under investigation. *WAPET Journal* **1978**, 28–29.
Summary: The insects of Barrow Island, especially the ants, were investigated under an annual research grant awarded by WAPET in association with the Western Australian Wildlife Authority.
Copyright note: Summary reproduced with permission from ChevronTexaco Australia – http://www.chevrontexaco.com/

13. (1979) Barrow Island fauna check list.
Summary: List of birds on Barrow Island. Copied off: Wildlife and Nature Reserves: Tenure: Barrow Island Game Reserves A 11648. Volume 4: file no. 014581F3102.
Copyright note: Permission not required for this summary

14. (1981) Barrow Island. *Aviary Bird & Wildlife Magazine* 11, 15.
Summary: Notes on the wildlife of Barrow Island.
Copyright note: Permission not required for this summary

15. (1981) Barrow Island marine animals much the same, after 15 million years. *Your Museum* **Nov/Dec**, 2–3.
Summary: Dr McNamara and Mr Kendrick were awarded the Barrow Island Research Grant for 1981. They collected more than 50 species of fossil molluscs and about 10 species of sea urchins from the island. Some of the fossils found on the island are undescribed species.
Copyright note: Summary reproduced with permission from the Western Australian Museum – http://www.museum.wa.gov.au/

16. (1988) Barrow Island fauna check list.
Summary: List of reptiles, amphibians, birds and mammals. Nomenclature has been verified by the WA Museum.
Copyright note: Permission not required for this summary

17. (1989) Barrow Island vegetation. West Australian Petroleum, Perth.
Summary: List of vegetation collected by RC Buckley in October 1980 and held at the Herbarium Australiense and by earlier collections by WH Butler, held in the Barrow Island Herbarium. A total of 213 species are supported by voucher specimens.
Copyright note: Summary reproduced with permission from ChevronTexaco Australia – http://www.chevrontexaco.com/

18. (1989) Barrow's burrowing bettong: looking for new digs. *WAPET Journal* **1989**, 18.
Summary: A report on the research on the burrowing bettong, *Bettongia lesueur* being carried out by CSIRO scientists Jeff Short and Bruce Turner. The main objective of this research is to determine whether the bettong can be successfully re-introduced to parts of its former range.
Copyright note: Summary reproduced with permission from ChevronTexaco Australia – http://www.chevrontexaco.com/

19. (1989) Playing tag with turtles. *WAPET Journal* **1989**, 18.
Summary: Discusses the long term turtle tagging program to determine the distribution, breeding patterns and migration of turtles. Threatening processes includes predation on hatchlings from perenties, bandicoots and seabirds.
Copyright note: Summary reproduced with permission from ChevronTexaco Australia – http://www.chevrontexaco.com/

20. (1991) Barrow under scrutiny. *Landscope* **6(2)**, 8.
Summary: Research scientists have been granted $240 000 by the Australian Research Council for a three-year study. The study will gather ecological data on a range of mammal, bird and reptile species and investigate how each species interacts with its semi-arid environment. West Australian Petroleum (WAPET) have committed resources worth $25 000 a year to the project.
Copyright note: Permission not required for this summary

21. (1998) Threatened invertebrates occurring on Barrow Island as listed in the Wildlife Conservation (Specially Protected Fauna) Notice 1998: gazetted 14 July 1998. Department of Conservation and Land Management, Como, WA.
Summary: List of threatened invertebrates and references to the available descriptions.
Copyright note: Permission not required for this summary

22. Abbott I, Burbidge AA (1995) The occurrence of mammal species on the islands of Australia: a summary of existing knowledge. *CALMScience* **1**, 259–324.

Summary: Presentation of databases summarizing the most recent available information on the occurrence of species of mammals on Australian islands. These databases include 512 islands, 171 species of mammal, and 1768 authenticated insular records. Relevant physical, climatic and anthropological data for each island and the source of each record (320 references) are also provided.
Copyright note: Permission not required for this summary

23. ABC Natural History Unit (2000) Barrow Island [VIDEORECORDING]. 1 video. ABCNHU, Melbourne.
Summary: Barrow Island is one of Australia's most important conservation reserves, and has 15 land mammals, seven marine mammals, 110 species of bird and 40 reptiles, many of which are rare.
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24. Access Economics (2003) Environmental, social and economic review of the Gorgon gas development on Barrow Island. Appendix K, national and Western Australian economic impacts of the Gorgon gas supply and LNG projects. ChevronTexaco Australia, Perth.
Summary: An assessment of the national and Western Australian economic and budgetary impacts of development of the Gorgon gas fields, situated near Barrow Island off the Western Australian coast. ChevronTexaco is the major partner (with a 4/7th share) in a consortium that also comprises Shell (2/7ths) and ExxonMobil (1/7th). In undertaking this analysis, Access Economics have relied heavily on input data provided by the client. The results obtained are predicted on project information provided by ChevronTexaco. Most of the Gorgon field gas is converted into LNG at a plant on Barrow Island and then exported. The project also generates condensate for export, and natural gas piped onshore for the Western Australian domestic market.
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25. Acil Tasman (2003) Environmental, social and economic review of the Gorgon gas development on Barrow Island. Appendix L, the social impact of the proposed Gorgon gas development. ChevronTexaco Australia, Perth.
Summary: Background to the economic, social, environmental and strategic assessment of the proposed Gorgon gas development on Barrow Island. The objective of this analysis is to assess the social impact on local communities, the Pilbara region, and Perth and the rest of Western Australia of the construction and operation of the proposed development. For the purposes of this study, the local communities are the towns of Karratha, Dampier, Onslow and Roebourne in the Shires of Ashburton and Roebourne. In addition to the background information set out in this document, the assessment of the social effects of the development draws heavily on records of interview with some 30 representatives of stakeholder groups from state and local government, business and indigenous organisations, a social welfare agency, and education institutions.
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26. Allens Consulting Group (2003) Proposed access to Barrow Island for gas development: advice on social, economic and strategic considerations: a report to the WA Department of Industry and Resources. DIR, Perth.
Summary: An assessment of the social, economic and strategic aspects of the ESE Review was undertaken for the Department of Industry and Resources.
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27. Amaoka K, Arai M (1998) Redescription of a rare bothid, *Asterorhombus bleekeri* (Macleay), and description of a new species of *Asterorhombus* from northwestern Australia (Teleostei: Pleuronectiformes). *Ichthyological Research* **45**, 249–257.
Summary: Description of *Asterorhombus osculus* sp.nov. found at Barrow Island, Shark Bay and Rowley Shoal.
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28. Ambrose SJ, Bradshaw SD, Withers PC, Murphy DP (1996) Water and energy balance of captive and free-ranging spinifexbirds (*Eremiornis carteri*) North (Aves: Sylviidae) on Barrow Island, Western Australia. *Australian Journal of Zoology* **44**, 107–117.
Summary: The study of field water turnover rates and field metabolic rates of the spinifexbird (*Eremiornis carteri*) from 4–21 May 1992 (wet season) and from 1–14 December 1992 (dry season) on Barrow Island. Standard metabolic rates, evaporative water loss and thermal conductances of captive spinifexbirds were also examined over a range of ambient temperatures during December.
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29. Ambrose SJ, Murphy DP (1994) Synchronous breeding of land birds on Barrow Island, Western Australia, after cyclonic summer rains. *Emu* **94**, 55–58.
Summary: Breeding notes on 10 of the 15 species of land birds observed during a visit to Barrow Island from 4–21 May 1992 after the desert island had experienced cyclonic summer rains.
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30. Annandale D, Lantzke R (2003) An evaluation of site selection work contained in ChevronTexaco's environmental social, and economic review of the Gorgon gas development on Barrow Island. Murdoch University, Murdoch, WA.

Summary: This review focuses on two documents; the Environmental, social, and economic review of the Gorgon gas development on Barrow Island (the ESE Review), and Technical appendix C: Identification of suitable locations for a land-based gas processing facility linked to the Gorgon gas field.
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31. Aplin KP (1988) Three new blindsnakes (Squamata: Typhlopidae) from northwestern Australia. *Records of the Western Australian Museum* **19**, 1–12.
Summary: Three new species of *Ramphotyphlops* are described from localities in northwestern Western Australia. Two are represented by a single specimen only, the third by four specimens. Each of the new species differs markedly from all previously described members of the genus. The discovery of these new species highlights the very incomplete state of knowledge of the fossorial herpetofauna of northwestern Australia, in particular the Typhlopidae.
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32. Astron Environmental Pty Ltd (2002) Environmental, social and economic review of the Gorgon gas development on Barrow Island. Appendix E, survey of avifauna on the east and north coasts of Barrow Island, September 2002. ChevronTexaco Australia, Perth.
Summary: Barrow Island has a diverse avifauna comprising at least 110 species, including 11 resident land birds, 22 species of migratory waders, six resident shorebirds, eight resident seabirds, 17 visiting seabirds and 43 irregular visitors. The aims of this survey were to assess the distribution and abundance of seabirds and shorebirds within the proposed Gorgon gas development area, and to identify nesting sites of any seabirds or shorebirds in these areas. It also aimed to assess the potential impacts of the Gorgon gas development on birds in the area.
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33. Astron Environmental Pty Ltd (2002) Environmental, social and economic review of the Gorgon gas development on Barrow Island. Appendix F, preliminary vegetation and flora survey of proposed Gorgon gas development, Barrow Island. ChevronTexaco Australia, Perth.
Summary: Numerous studies of the vegetation of Barrow Island have been made. All studies concur that the vegetation is dominated by *Triodia* hummock grassland with scattered shrubs. Eight major vegetation units are recognised for Barrow Island. As a result of flora surveys by Buckley (1983), Trudgen (1989) and EM Mattiske and Associates (1993, 1997), a total of 350 vascular plants representing 64 families have been recorded on Barrow Island. A vegetation survey of the proposed Gorgon gas development was conducted by Astron Environmental in August 2002. Assessment of the vegetation was made in relation to the previous mapping of vegetation on Barrow Island by Mattiske (1993).
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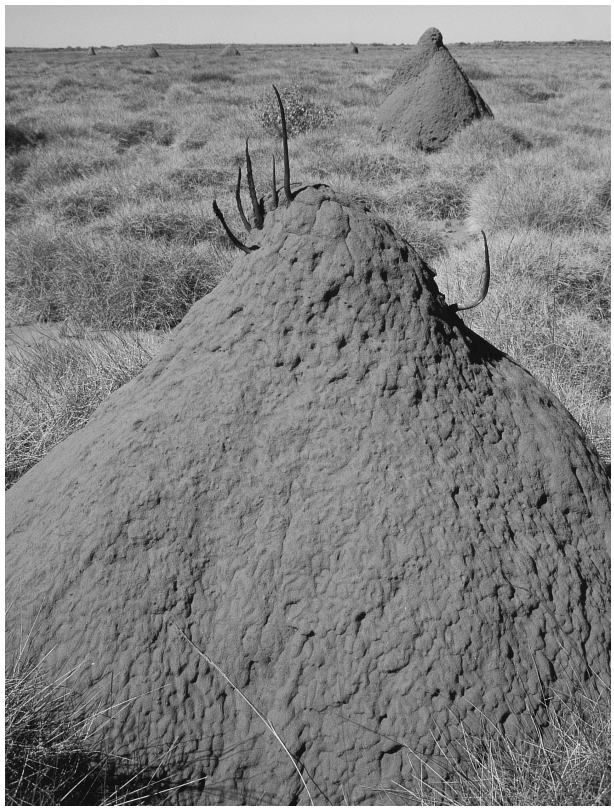


Figure 6. Termite mounds and spinifex (Photograph courtesy of ChevronTexaco)

34. Astron Environmental Pty Ltd (2002) WA oil asset: Barrow and Thevenard Islands: weed management plan 2001. ChevronTexaco Australia, Perth.
Summary: Chevron recognises its responsibility to conserve the biodiversity of flora and fauna species on these islands. To this end, it ensures that all operations undertaken within its lease areas have no unacceptable direct or indirect impact on the diversity, density and distribution of native species. The introduction of weeds to Barrow and Thevenard Islands, through the continual transfer of workforce and equipment, has long been recognised as a potential risk to the existing ecosystems. The prevention of environmental weed species introduction and invasion is therefore paramount to protecting the conservation values within the Barrow and Thevenard Island Nature Reserves.
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35. Astron Environmental Pty Ltd (2002) Weed management plan: annual review 2002: prepared for ChevronTexaco Australia Pty Ltd. ChevronTexaco Australia, Perth.
Summary: In 2002, ChevronTexaco Australia implemented an integrated weed management plan as part of its commitment to weed management. The aim of this document was to formalise and direct the existing program of weed control on Barrow and Thevenard islands by offering a detailed and improved framework for integrated weed management. Three specific objectives for overall weed management on ChevronTexaco's onshore permits were identified. These were to eradicate environmental weeds from Barrow and Thevenard islands, where practicable; prevent the introduction of weeds to ChevronTexaco's island lease areas during Company logistical operations and prevent and minimise the spread of recalcitrant weeds on Barrow and Thevenard islands.
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36. Astron Environmental Pty Ltd (2004) WA oil asset: Barrow and Thevenard Islands: weed management plan: prepared for Chevron Texaco Australia Pty Ltd. ChevronTexaco Australia, Perth.
Summary: The introduction of weeds on Barrow and Thevenard Islands, through the continual transfer of workforce and equipment, has long been recognised as a potential risk to the existing ecosystems. Environmental weeds are defined as 'plants that establish themselves in natural ecosystems and proceed to modify natural processes, usually adversely, resulting in the decline of the communities they invade' (CALM, 1999). The prevention of environmental weed species introduction and invasion is therefore paramount to protecting the conservation values within the Barrow and Thevenard Island nature reserves. This document offers a revised edition of the 2002 Weed Management Plan, the purpose of which is to further develop and improve the existing integrated system of weed management on Barrow and Thevenard islands.
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37. Atkins K (2004) Declared rare and priority flora list for Western Australia. Department of Conservation and Land Management, Kensington, WA.
Summary: Contains conservation code, CALM region, distribution and flowering period details for declared rare and priority flora.
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38. Australian Academy of Science Committee on National Parks Western Australian Sub-Committee (1965) Barrow Island Reserve. In *National Parks and Nature Reserves in Western Australia* pp. 193–196. AAS, Perth.
Summary: Provides a description of the Reserve, its location, reservation state, area, literature and the opinion of the Sub-Committee as to its vesting.
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39. Baglin D, Mullins B (1972) Islands of the west. In *Islands of Australia* pp. 52–63. Ure Smith, Sydney.
Summary: Photographs and brief description of Barrow Island.
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40. Bakker HR, Bradshaw SD (1983) Renal function in the spectacled hare-wallaby, *Lagorchestes conspicillatus*: effects of dehydration and protein deficiency. *Australian Journal of Zoology* **31**, 101–108.
Summary: Renal function was studied in a marsupial, the spectacled hare-wallaby *Lagorchestes conspicillatus*, and the effects of acute dehydration and exposure to a low-protein diet assessed.
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41. Bakker HR, Bradshaw SD (1989) Rate of water turnover and electrolyte balance of an arid-zone marsupial, the spectacled hare-wallaby (*Lagorchestes conspicillatus*) on Barrow Island. *Comparative Biochemistry and Physiology. Part A* **92**, 521–529.
Summary: The work reported in this paper describes aspects of the water and electrolyte metabolism of free-ranging spectacled hare wallabies (*Lagorchestes conspicillatus*) on Barrow Island in Western Australia. Previous surveys have indicated that the density of hare wallabies is greater in disturbed areas of Barrow Island. Dietary analysis suggests that this unequal distribution results from a greater availability of preferred plant species growing in these disturbed areas.
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42. Bakker HR, Main AR (1981) Water and electrolyte metabolism of the spectacled hare wallaby (*Lagorchestes conspicillatus*) on Barrow Island. University of Western Australia, Crawley, WA.
Summary: Two populations were studied, one population on the southern part of the island in a producing oil field, the second population in the northern part.
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43. Bamford Consulting Ecologists (2002) Environmental, social and economic review of the Gorgon gas development on Barrow Island. Appendix G, the terrestrial vertebrate fauna of Barrow Island in relation to the Gorgon gas development, August 2002. ChevronTexaco Australia, Perth.

Summary: The terrestrial vertebrate fauna of Barrow Island has been well-documented over a number of decades due to the conservation value of the island and the support of ChevronTexaco and its predecessors, and is of particular significance because of species that have declined or become extinct on the mainland and because of endemic races. The fauna likely to occur within the area of the proposed Gorgon gas development can therefore be predicted with a high degree of confidence. As a result, the fauna assessment was based upon a review of available information and a thorough site inspection to put this information into the context of the site. The key impacts and issues associated with the Gorgon gas development are summarised in this document.

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44. Bancroft KP (1999) Planning and pre-declaration processes for a marine protected area in the Montebello/Barrow Islands region. Department of Conservation and Land Management, Marine Conservation Branch, Progress Report **MRI/PI/MBI 22/1999**

Summary: The Marine Conservation Branch of the Department of Conservation and Land Management is conducting this project as part of the Marine Reserve Implementation Programme. The aims of the project are to initiate planning and pre-declaration processes for the proposed Montebello/Barrow Islands marine conservation reserve; to compile the ecological and socioeconomic information; to provide advice to the WA Government, through the stakeholder/community advisory process, on the suitable reserve category, boundaries and management zoning options, and; to develop and implement a community consultation process.

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45. Bancroft KP (1999) Resource assessment field survey of the Montebello/Barrow Islands and the Dampier Archipelago/Cape Preston regions, 14–25 June 1999. Department of Conservation and Land Management, Marine Conservation Branch, Field Program Report **MRI/PI/MBI & DA 20/1999**

Summary: This report presents details of a resource assessment field survey to be undertaken aboard the research vessel RV *Bidthangara*, along the northwest coast of Western Australia during 14–25 June 1999. The survey, which will improve knowledge base on the natural, cultural, social and economic resources of the West Pilbara region, which will be carried out in the proposed Montebello/Barrow Islands and the Dampier Archipelago/Cape Preston marine reserves. The objectives of this resource assessment were to undertake ground truthing to develop a habitat map for currently unmapped areas in the proposed reserve regions; to assess the accuracy of existing benthic habitat maps; obtain still photographs and video footage for public participation and management planning processes; to investigate the status of the reefs through an investigation of the extent of known crown-of-thorns sea-star infestations SW reef off Montebello Islands, Nelson Rocks and Kendrew Island); an investigation of the extent of cyclone damage to the fringing coral reefs (both regions); an investigation of the extent of recovery of known coral spawn death events (Dugong Reef); to raise the community awareness of planning process; to familiarize CALM's planning staff with the major marine habitats and human activities in the region; to identify areas of high multiple use (outer reefs, trawl grounds and potential aquaculture); to opportunistically consult with mariculture managers (whose leases are likely to be examined during the planning process), charter operators and the recreating public; to document incidental sightings of marine fauna and to record the number of users observed at selected sites through out the region.

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46. Bancroft KP, Davidson JA, Looker O (2000) Marine wildlife distribution in the proposed Montebello/Barrow islands and Dampier Archipelago/Cape Preston marine conservation



Figure 7. Corals in the proposed Montebello/Barrow Islands Marine Conservation Reserve (Photograph courtesy of ChevronTexaco)

reserves. Department of Conservation and Land Management, Marine Conservation Branch, Report **MRI/PI/MBI&DAR 44/2000**
Summary: The Marine Conservation Branch of the Department of Conservation and Land Management has undertaken the mapping of the distribution of marine wildlife for the study areas of the proposed Montebello/Barrow islands and the Dampier Archipelago/Cape Preston marine conservation reserves. The information has been compiled and incorporated into a map, which has been prepared as a contribution to the planning processes underway for these two proposed marine conservation reserves. Areas of high conservation value, in relation to marine wildlife, have been delineated. Data for this exercise has been sourced from existing documentation, and from direct communication from people (internal and external to CALM) with expert knowledge in the distribution of marine wildlife in these two areas.
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47. Bancroft KP, Sheridan MW (2000) The major marine habitats of the proposed Montebello/Barrow Islands Marine Conservation Reserve. Department of Conservation and Land Management, Marine Conservation Branch, Report **MRI/PI/MBI 48/2000**
Summary: In December 1997, the Western Australian Government, following advice provided by the Western Australian Marine Parks and Reserves Authority, announced the Montebello/Barrow islands region, as one of its priority areas for establishment as a marine conservation reserve. Subsequently, CALM through the Marine Conservation Branch (MCB), has initiated the planning process for implementing a marine conservation reserve in the region. The purpose of this report is to detail the major marine benthic habitats of the Montebello/Barrow Islands region in the form of a broadscale habitat map; document the methods used to produce the broadscale habitat map; provide a comprehensive description of habitat types presented; document the metadata for the GIS information layers developed, and document the storage location of the GIS information layers.
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48. Bancroft KP, Sheridan MW, Davidson JA (2000) Developing broadscale habitat maps for the Montebello/Barrow islands and the Dampier Archipelago/Cape Preston regions. Department of Conservation and Land Management, Marine Conservation Branch, Data Report **MRI/PI/MBI & DAR-34/2000**
Summary: This report presents the results of a preliminary resource assessment field survey and a follow-up survey undertaken aboard the research vessel RV *Bidthangara*, along the northwest coast of Western Australia during 14–25 June 1999 and from 22–25 May 2000. The surveys were carried out in the proposed Montebello/Barrow Islands and the Dampier Archipelago/Cape Preston marine conservation reserves, under the coordination of CALM Marine Conservation Branch (MCB). The data collected has improved the knowledge base on the natural, cultural, social and economic resources of the West Pilbara region, which is vital for the implementation of the proposed marine reserves. The objectives of the preliminary survey were to undertake ground truthing to develop a habitat map for currently unmapped areas in the proposed reserve regions; to assess the accuracy of existing benthic habitat maps; obtain photographs and video footage for public participation and management planning processes; to investigate the status of the reefs through an investigation of the extent of known crown-of-thorns sea-star infestations, the extent of recovery of known coral spawn death events, and an investigation of the extent of cyclone damage to the fringing coral reefs; to raise the community awareness of planning process; to familiarize CALM's planning staff with the major marine habitats and human activities in the region; to identify areas of high multiple use (outer reefs, trawl grounds and potential aquaculture); to opportunistically consult with mariculture managers (whose leases are likely to be examined during the planning process), charter operators and the recreating public; to document incidental sightings of marine fauna and to record the number of users observed at selected sites through out the region. The data acquired during these surveys is important in determining and refining the major habitat types of the proposed marine reserves and the respective conservation values of these marine areas.
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49. Bannister JL (1967) A list of the species of mammals collected by WH Butler for the Archbold collections of the American Museum of Natural History and for the Western Australian Museum 1963–66. *Western Australian Museum, Annual Report* **1967**, 61–76.
Summary: This list includes all species identified so far, apart from sub-fossil material. A number of specimens still to be identified will form the basis of a supplementary list to be issued at a later date.
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50. Barron H (.1916) The Game Act, 1912–13: Proclamation.
Summary: Proclamation by His Excellency Major General Sir Harry Barron, Knight Commander of the Most Distinguished Order of St. Michael and St. George, Commander of the Royal Victorian Order, Governor in and over the State of Western Australia and its Dependencies in the Commonwealth of Australia declaring Barrow Island to be a Reserve for Native Game. The official notice can be found in the Government

Gazette, 23 Jun 1916, p. 1153. Copied off: Nature Reserves: Tenure: Barrow Island Game Reserves A 11648. Volume 1: file no. 014578F3102.
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51. Baynes A, Jones B (1993) The mammals of Cape Range peninsula, north-western Australia. *Records of the Western Australian Museum. Supplement* **45**, 207–225.
Summary: Since the mammal material from the cave deposits of Cape Range was last studied two decades ago, the results of two collections of modern mammals, archaeological excavations in rock shelters in the western terraces and mammal remains collected as a by-product of surveys of the Cape Range cave invertebrates, have become available. The taxonomy of several mammal species has also been revised during that time, providing solutions to a number of outstanding problems of identification. The mammal fauna of Barrow Island is a subset of the Cape Range peninsula fauna. Once thought to be fully representative of the adjacent mainland, the Barrow Island fauna is shown to be restricted, lacking the vast majority of regional small mammals. At least half of the original Cape Range peninsula mammal fauna appears to have become extinct since European colonization of Australia.
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52. Beard JS (1975) *Vegetation Survey of Western Australia: Pilbara, 1:1 000 000 Vegetation Series, Explanatory Notes to Sheet 5: the Vegetation of the Pilbara Area*. University of Western Australia Press, Nedlands, WA.
Summary: Includes climate, geology, topography, soils, human influence, fire and vegetation.
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53. Beard JS (1980) A new phytogeographic map of Western Australia. *Western Australian Herbarium Research Notes* **3**, 37–58.
Summary: F von Mueller (1867) first drew attention to the special character of southwestern Australia as a phytogeographic region. Diels (1906) delimited a South-West Botanical Province. Clarke (1926) divided the state into natural regions on an ecological basis. Gardner (1942) added a Northern Botanical Province and (1956) extended Diels' Botanical districts to the whole state. There is a considerable degree of agreement between Clarke's and Gardner's treatments but both were restricted to small scale sketch maps for the expression of their ideas as mapping techniques had not yet become sufficiently developed. Detailed vegetation mapping (Beard 1969 et seq.) has shown that ecological regions can be recognised and given precise boundaries on a larger scale, published at 1:1 000 000 and reduced to 1:2 500 000 in the general map which accompanies this paper. Details of the climate, geology, soils, vegetation of each botanical district are given.
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54. Belles X (1998) A new subgenus and two new species of *Sphaericus* (Coleoptera: Ptinidae) from Western Australia. *European Journal of Entomology* **95**, 263–268.
Summary: A new subgenus *Leasphaericus* (of *Sphaericus*) with two new species, *S.(L.) flavipennis* and *S.(L.) diversvillosus*, are described from North West Cape and Barrow Island, in Western Australia. With the exception of one anthropophilous and paracosmopolitan species, the genus *Sphaericus* has been recorded only from the southern Palaearctic area. The discovery of Australian autochthonous *Sphaericus* suggests that this genus may be more diversified in other areas, namely Africa.
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55. Beveridge I (1976) *Progamotaenia lagorchestis* (Lewis). *Australian Journal of Zoology. Supplementary Series* **44**, 55–58.
Summary: The record of this cestode is from the stomach and intestine of *Lagorchestes conspicillatus* Gould, 1842, Hermite I., Monte Bello Is, Western Australia, 1914(?) PD Montague; location unknown, presumed lost.
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56. Beveridge I, Thompson RCA (1979) The anoplocephalid cestode parasites of the spectacled hare-wallaby, *Lagorchestes conspicillatus* Gould, 1842 (Marsupialia: Macropodidae). *Journal of Helminthology* **53**, 153–160.
Summary: Progamotaenia gynandrolinearis sp.nov. is described from the small intestine of *Lagorchestes conspicillatus* Gould, 1842 from Barrow I., Western Australia. The helminth fauna of the spectacled hare-wallaby, *Lagorchestes conspicillatus* Gould, 1842 is very poorly known, only a few species of anoplocephalid cestode having so far been reported. The hare-wallaby occurs in widely scattered areas in the northern part of the Australian continent, but is abundant only on islands off the Western Australian coast. The present paper reports cestode collections made from Western Australia, as well as from northern Queensland. The material described includes a new species and also shows that in the past, two distinct species have been confused under the name *Progamotaenia lagorchestis*.
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57. Billiards SS, King JM, Agar NS (1999) Comparative erythrocyte metabolism in three species of marsupials from Western Australia. *Comparative Haematology International* **9**, 86–91.
Summary: The erythrocyte metabolism of the burrowing bettong, the Barrow Island euro and the mainland euro are compared.
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58. Biota Environmental Services (2002) Environmental, social and economic review of the Gorgon gas development on Barrow Island. Appendix I, Barrow Island Gorgon development subterranean fauna survey, August 2002. ChevronTexaco Australia, Perth.
Summary: The Environmental, Social and Economic Review (ESE review) will address the Gorgon gas development's ability to mitigate potential on-site impacts and generate social and economic benefits for the region, state and the nation. The ESE Review will also aim to demonstrate that the development could meet a range of broad strategic criteria and achieve net conservation benefits. This report on subterranean ecosystems represents a supporting technical document, providing input to the ESE Review on this ecological factor.
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59. Black PG, Buchan SJ, Cohen RL (1999) Tropical cyclone eyewall mesovortex: a physical mechanism explaining extreme peak gust occurrence in TC Olivia, 4 April 1996 on Barrow Island, Australia. In *Proceedings of the Annual Offshore Technology Conference, Houston, Texas, 3–6 May 1999* 333–337. OTC, Richardson, Tex.
Summary: During the passage of Tropical Cyclone Olivia on April 10, 1996, a possible world record peak 3-sec wind gust measuring 220 kt was recorded on Barrow Island. Radar images from the Bureau of Meteorology radar at Learmonth showed that this event took place at the maximum reflectivity gradient at the inner edge of the eyewall as it passed over the island observing station. Observations revealed that the event occurred just after the minimum pressure of 930 mb.
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60. Blacket MJ, Adams M, Krajewski C, Westerman M (2000) Genetic variation within the dasyurid marsupial genus *Planigale*. *Australian Journal of Zoology* **48**, 443–459.
Summary: Genetic variation within the genus *Planigale* was examined through analyses of 12S rRNA gene sequences and allozymes. The level of genetic divergence between the five currently recognised *Planigale* species was compared and the magnitude of divergence among populations assessed. This examination of molecular variation within the genus revealed that *Planigale* contains far more taxonomic diversity than is currently recognised. Specifically, the Pilbara region of Western Australia probably contains two currently unrecognised *Planigale* species and there is substantial genetic heterogeneity within the widespread species *P. maculata*.
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61. Bowdler S (1995) Offshore islands and maritime explorations in Australian prehistory. *Antiquity* **69**, 945–958.
Summary: The settlement of mainland Australia at an early (and uncertainly known) date required a water-crossing. What about the settlements of the islands, neither numerous nor large compared with the island continent itself, that are offshore from Australia? The evidence reviewed shows a late settlement for nearly all of them, and a perplexing lack of pattern.
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62. Bowman Bishaw Gorham (1996) Barrow Island intertidal survey, 1995. West Australian Petroleum, Perth.
Summary: A phased program of intertidal surveys of Barrow Island was commissioned by WAPET in 1995. The objective of the 1995 survey was to gain an overview of the intertidal biota and major habitats and community types present. This report presents the results of the 1995 survey of rocky shore and coral reef habitats on the west coast of the island. Includes echinoderms, corals and other cnidarians, shelled molluscs and marine plants.
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63. Bowman Bishaw Gorham (1997) Survey of the intertidal shores of the eastern side of Barrow Island: prepared for West Australian Petroleum Pty Ltd. WAPET, Perth.
Summary: This report is based on surveys conducted during spring tides in November 1996 and February 1997. A summary of the 1997 survey with site habitat descriptions was given in a separate report to WAPET. However the detailed species data are included in this account. The object of the report is to provide an overview of the intertidal biota, major habitats and community types.
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64. Bowman Bishaw Gorham (2002) Environmental, social and economic review of the Gorgon gas development on Barrow Island. Appendix D, marine and intertidal environmental survey for the Gorgon gas development on Barrow Island. ChevronTexaco Australia, Perth.
Summary: Bowman Bishaw Gorham surveyed marine benthic and intertidal habitats and assemblages in the area of the proposed development to assist in preliminary assessment of the environmental implications of the proposal. The report describes the results of the surveys and previous surveys in the area in relation to potential impacts associated with the proposed development.
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65. Bradbury JH (2002) Melitid amphipods from Barrow Island, Western Australia. Part II, recent discoveries. *Records of the Western Australian Museum* **21**, 83–104.
Summary: Investigation of new sites of underground waters on Barrow Island, Western Australia, yielded amphipods of the families Melitidae and Bogidiellidae at seven location not previously sampled. Described species of the genus *Nedsia*, family Melitidae, were found at several of these locations; three new species of the genus are described from two sites. Keys to the known species of *Nedsia* are extended to include the three new ones.
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66. Bradbury JH, Williams WD (1996) Freshwater amphipods from Barrow Island, Western Australia. *Records of the Australian Museum* **48**, 33–74.
Summary: Amphipods collected from bore-holes and caves on Barrow Island, Western Australia are reported. Seven new species of the family Melitidae, genus *Nedsia* Barnard & Williams, 1995, and one of the family Bogidiellidae, genus *Bogidomma* n.gen., are described. A key to the species of *Nedsia* is provided.
Copyright note: Summary reproduced with permission from the Editor – http://www.amonline.net.au/publications/

67. Bradbury JH, Williams WD (1996) Two new species of anchialine amphipod (Crustacea: Hadziidae: *Liagoceradocus*) from Western Australia. *Records of the Western Australian Museum* **17**, 395–409.
Summary: It is becoming clear that the systematic boundary between amphipods inhabiting epicontinental waters and coastal marine waters in Australia is indistinct. There are many species which, though found in Australian freshwaters, belong to genera or families of typically marine habit, or which display features linking them with marine ancestors. It has been considered best to treat them separately and not to regard them as an integral part of the Australian inland aquatic amphipod fauna. This paper describes two new species of *Liagoceradocus*, *L. subthalassicus* and *L. branchialis*, from anchialine habitats (hypogean waters of marine origin) on Barrow Island and North West Cape.
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68. Bradshaw SD (1990) The molecular basis of adaptations maintaining species diversity in an arid zone ecosystem: proposal for an integrated research programme, 1990–1994: supporting statement. University of Western Australia, Crawley, WA.
Summary: To analyse the ecological partitioning of limited material and energy resources between vertebrate species in a discrete ecosystem in the arid zone. Some of the research will be carried out on Barrow Island which is a unique site for such a study.
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69. Bradshaw D (1990) Report on April 1990, trip 0, to Barrow Island: April 2–12, 1990. University of Western Australia, Crawley, WA.
Summary: The purpose of this trip was to establish a small mammal and reptile trapping grid and to assess the efficacy of available macropod traps.
Copyright note: Summary reproduced with permission from the Author

70. Bradshaw D (1990) Report on trip 1 to Barrow Island, October 31–November 22, 1990. University of Western Australia, Crawley, WA.
Summary: An eight member team trapped animals in John Wayne country on Barrow Island. Small radio-transmitters were used extensively to track bandicoots and the small eutherian mammals and these provided the first evidence of large-scale movements by, especially, the bandicoots. Once it was realised that bandicoots and rock rats trapped on the grid move distances of up to one kilometre, a second trapping grid was established to the east of West Coast Highway in an attempt to gain information on the condition of small mammals in this primarily spinifex dominated habitat.
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71. Bradshaw D (1991) Barrow Island, trip 2, April 1991: summary of grid mammal trapping. University of Western Australia, Crawley, WA.
Summary: Brief discussion on the mammals trapped at John Wayne Country and West Coast Highway, Barrow Island.
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72. Bradshaw D (1992) L'ecophysiologique d'une ile desertique en Australie. *Bulletin de la Societe d'Ecophysiologie. Supplement* **17**, 83–92.
Summary: The islands off the coast of Western Australia, discovered for the most part by French explorers in the late 18th and early 19th century, have functioned as refugia for species of wildlife now extinct or seriously threatened on the mainland. Massive habitat changes have accompanied European colonisation of Australia, with the clearing of vast tracts of land for agricultural and pastoral purposes. Along with the alienation of land, the introduction of exotic predators and diseases has had a disastrous effect on native wildlife and 200 vertebrate species have become extinct in Australia in as many years. Barrow Island, 80 km off the arid Pilbara coast of Western Australia, still harbours a rich fauna including eight species of marsupials, four of which are now either extinct or extremely rare on the continent. An ecophysiological investigation of key elements of the vertebrate fauna was initiated in 1990 and both radio-active and stable isotopes are being used to measure turnover rates and circulating levels of key hormones are also being

monitored in order to assess the extent to which animals are able to maintain physiological homeostasis during periods of extended drought. The study is providing unique information on the relevant energetic and environmental costs of survival for a wide range of vertebrate species living in a desert environment that appears deficient in all the essential nutrients necessary to sustain life.
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73. Bradshaw D (1999) Ecophysiological studies on desert mammals: insights from stress physiology. *Australian Mammalogy* **21**, 55–65.
Summary: Ecophysiology is the study of the physiological responses of animals living in their natural environment and can provide information substantially different from that obtained in laboratory situations where animals are constrained by artificial surroundings. Recent work with arid-living mammals in WA has focused on the measurement of seasonal responses of free-ranging individuals to drought and has involved measurements of rates of turnover of water, together with changes in the kidney function and circulating levels of antidiuretic hormone (ADH), the pituitary hormone essential for the conservation of water. Central to these studies has been an attempt to identify periods when animals in the field may be exposed to physiological stress due to lack of adequate supplies of water and to document their responses to this. Stress is here defined as the physiological resultant of demands that exceed an organisms regulatory capacities and is detected through the combination of a significant perturbation of the milieu intérieur of the animal, despite the maximum deployment of normal homeostatic responses. This approach also raises the possibility of determining the vulnerability to extinction of threatened and endangered species by comparing their actual rates of water turnover in the dry part of the year with allometric predictions. One predicts that species which display a profligate pattern of water usage would be much more susceptible to any environment changes that might reduce the availability of water.
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74. Bradshaw D (2003) Case studies of stress: Barrow Island macropods. In *Vertebrate Ecophysiology: an introduction to its principles and applications* (D Bradshaw), pp. 82–84. Cambridge University Press, Cambridge.
Summary: As part of a four-year ecophysiological study of all the major vertebrate species on Barrow Island, the potential stress of long periods of drought was investigated.
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75. Bradshaw SD, Morris KD, Bradshaw FJ (2001) Water and electrolyte homeostasis and kidney function of desert-dwelling marsupial wallabies in Western Australia. *Journal of Comparative Physiology. B* **171**, 23–32.
Summary: Prolonged drought, necessitating conservation of water, is one of the major environmental challenges faced by many Australian marsupials. Radioactive isotopes of water and sodium were used to assess the ability of two species of marsupial wallabies to maintain water and electrolyte balance during periods of extreme water deprivation in the arid Pilbara region of Western Australia. The spectacled hare-wallaby, *Lagorchestes conspicillatus*, has the lowest mass-specific rate of water turnover reported for any mammal and was two or three orders of magnitude lower than that of the Rothschild's rock-wallaby, *Petrogale rothschildi*. Studies on renal function show that the hare-wallaby conserves water by producing a highly concentrated urine under the influence of lysine vasopressin, the anti-diuretic hormone in macropodid marsupials.
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76. Bradshaw SD, Morris KD, Dickman CR, Withers PC, Murphy D (1991) Field metabolism and turnover in the golden bandicoot (*Isoodon auratus*) and other small mammals from Barrow Island, Western Australia. *Australian Journal of Zoology* **42**, 29–41.
Summary: Discusses the turnover rates of water and sodium for the golden bandicoot (*Isoodon auratus*) and two rodent species, the Barrow Island mouse (*Pseudomys nanus*) and the rock rat (*Zyzomys argurus*) during a dry period and after rain. The data document the impressive ability of these mammals to avail themselves of extremely limited resources and maintain physiological homoiostasis under conditions of extreme aridity.
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77. Bruce NL, Humphreys WF (1993) *Haptolana pholeta*, sp.nov., the first subterranean flabelliferan isopod crustacean (Cirolanidae) from Australia. *Invertebrate Taxonomy* **7**, 875–884.
Summary: The genus *Haptolana* Bowman, 1966 is rediagnosed, and is characterised by the unique synapomorphy of perepods 2–7 having an expanded propodus, the palm of which contains a v-shaped series of spines and a haptorial dactylus which folds in between these spines. *Haptolana pholeta*, from anchialine waters on Barrow island, Western Australia, is described, and is distinguished from the two other species of *Haptolana* in possessing a frontal lamina that is anteriorly rounded, that separates the antennule bases and is visible in dorsal view.
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78. Buckley R (1980) Barrow Island: vegetation of Bandicoot Bay, South End, Middle Island, Boodie Island & Pascoe Island. Australian National University, Canberra.

Summary: Field work carried out from 5th–24th September 1980 as part of a broader study of Barrow Island vegetation. Voucher specimens are held by the author, WH Butler and the Herbarium Australiense.
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79. Buckley RC (1983) The flora and vegetation of Barrow Island, Western Australia. *Journal of the Royal Society of Western Australia* **66**, 91–105.
Summary: Barrow Island is a limestone island 233 km^2 in area off the northwest coast of Western Australia. Its flora comprises both coastal and arid elements. Undisturbed vegetation may be classified into the following main types, listed in decreasing order of areal extent: *Triodia wiseana* hummock grassland on limestone uplands; *Triodia angusta* hummock grassland on watercourses and lowland loams; *Triodia pungens* hummock grassland on red sand; coastal complex, primarily *Spinifex longifolius* assemblage on white calcareous foredunes; short forb community on floodout flats; salt flat; and mangroves. These are mapped and described, a total of 29 subtypes being recognised. Vegetation patterns in undisturbed areas are controlled primarily by substrate, but fire, grazing and exposure to salt-laden winds are also involved.
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80. Burbidge AA (1971) The fauna and flora of the Monte Bello Islands. *Department of Fisheries and Fauna, Western Australia, Report* **9**, 1–19.
Summary: Two visits were made to the Montebello Islands in 1970 and 1971. The second visit was made in conjunction with a visit to Barrow Island.
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81. Burbidge AA (1971–1991) Field note book, Barrow Island and adjacent islands. 5 books. Department of Fisheries and Fauna, Perth.
Summary: Notes from trips in 1971, 1972, 1975, 1977, 1979, 1981, 1983, 1985, 1987, 1989 & 1991. Includes original spotlighting traverses, notes from offshore islands including Montebello, bird lists, radiotracking data (hare-wallabies and boodies for 1971) and general notes of interest.
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82. Burbidge AA (1977) Barrow Island: inspection, January 1977.
Summary: Report on a survey of fauna and flora management being carried out by WAPET on Barrow Island. Copied off: Wildlife and Nature Reserves: Tenure: Barrow Island Game Reserves A 11648. Volume 3: file no. 014580F3102.
Copyright note: Permission not required for this summary

83. Burbidge AA (1981) Barrow Island: report on the annual inspection, 9–13 February, 1981.
Summary: The main inspection areas on the tour were the disposal of rubbish and road side litter. Copied off: Wildlife and Nature Reserves: Tenure: Barrow Island Game Reserves A 11648. Volume 3: file no. 014580F3102.
Copyright note: Permission not required for this summary

84. Burbidge AA (1983) Burrowing bettong, *Bettongia lesueur*. In *Complete Book of Australian Mammals: the National Photographic Index of Australian Wildlife* (ed R Strahan), 187–188. Angus & Robertson, Sydney.
Summary: Brief description and location of the burrowing bettong, *Bettongia lesueur*.
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85. Burbidge AA (1983) Rats on Boomerang Island [personal communication].
Summary: File note on the capture of a *Rattus rattus* on Boomerang Island. Copied off: Wildlife and Nature Reserves: Tenure: Barrow Island Game Reserves A 11648. Volume 4: file no. 014581F3102.
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86. Burbidge AA (1989) The value of Western Australian islands as biological reservoirs and the development of management priorities. *Department of Conservation and Land Management, Western Australia, Occasional Paper* **2/89**, 17–24.
Summary: Many of Western Australia's 3400 islands have high nature conservation values. Of particular importance are those which harbour relictual populations of mammals, some of which are now restricted to islands and others of which are endangered on the mainland. In addition, islands contain endemic taxa and distinct populations; they provide breeding places for 29 species of seabird, 20 of which breed only on islands, and for seals and turtles. An examination of the values of islands has led to the development of three categories of management priorities. The highest category includes three islands – Barrow, Bernier and Dorre – which protect mammalian species now extinct on the mainland.
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87. Burbidge AA (1991) Barrow Island spotlighting traverses. Department of Conservation and Land Management, Woodvale, WA.
Summary: Results of spotlighting traverses in 1972, 1975, 1977, 1979, 1981, 1983, 1985, 1987, 1989, 1991 both inside and outside the oilfield.
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88. Burbidge AA (1995) Burrowing bettong, *Bettongia lesueur* (Quoy and Gaimard, 1824). In *The Mammals of Australia: the National Photographic Index of Australian Wildlife* (ed R Strahan), 289–291. Reed, Sydney.
Summary: Brief description and location of the burrowing bettong, *Bettongia lesueur*.
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89. Burbidge AA (1998) Extract from the seabird islands database: Barrow, Boomerang, Boodie, Middle, Double and Pasco islands. Department of Conservation and Land Management, Woodvale, WA.
Summary: A spreadsheet containing details of seabirds, including date, number sighted and the reference of the citation.
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90. Burbidge AA (1999) Conservation values and management of Australian islands for non-volant mammal conservation. *Australian Mammalogy* **21**, 67–74.
Summary: At least 16 species of Australian mammals have become extinct over the past 200 years. Without islands, however, this figure would be even worse as nine species that were formerly widespread on mainland Australia were or are restricted to land-bridge islands. In addition, 13 species and subspecies of endangered and vulnerable mainland mammals that still occur on the mainland have island populations, reducing their chance of extinction. In all, 43 islands protect 29 taxa of Australian threatened mammals. Since European settlement some island mammal populations have become extinct, while many new populations, of both Australian and exotic mammals, have been established. The extinction of island native mammal populations significantly correlates with the introduction of exotic mammals. Management of island needs to concentrate on four areas; quarantine, monitoring (of both native mammals and possible introduction of exotics), eradication of exotics and translocations of native species. Prevention of introduction and establishment of further exotics to important islands through quarantine procedures is vital, especially for islands with permanent or temporary human habitation. Eradication or control of existing exotics is required for many islands and eradication of further introductions, as soon after detection as possible, should be a high priority action for nature conservation agencies. Past exotic mammal eradications and needs for the future are discussed. Translocations of island mammal populations to the mainland should take place only where the species is extinct on the mainland. Translocations to islands, where translocation to or on the mainland is not feasible, is an important conservation technique. Islands with exotics can be of value for re-introduction of locally extinct mammals or introductions (marooning) of threatened species that are at risk from feral predators on the mainland once the exotics have been eliminated.
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91. Burbidge AA, Drew M, Pearson D, Kendrick P (2004) Mammal monitoring, Barrow Island Nature Reserve, October 2003. Department of Conservation and Land Management, Woodvale, WA.
Summary: Monitoring of abundance and condition of native mammals on Barrow Island was conducted during October 2003 at five trapping locations and along two spotlighting transects as described in previous reports. In addition, trapping of black-flanked rock-wallabies was conducted at Well Q21 and two transects on the west coast were searched on foot for rock-wallabies.
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92. Burbidge AA, Evans T (1976) The management of nature reserves in Western Australia. *Department of Fisheries and Wildlife, Western Australia, Report* **23**, 1–32.
Summary: The number and area of nature reserves in Western Australia has grown rapidly in recent times. Management of nature reserves by the Department of Fisheries and Wildlife has not kept pace with this growth. A plan for the development of more effective management is presented.
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93. Burbidge AA, George AS (1978) The flora and fauna of Dirk Hartog Island, Western Australia. *Journal of the Royal Society of Western Australia* **60**, 71–90.
Summary: Dirk Hartog Island (62 000 ha), which lies off Shark Bay, Western Australia has been visited and studied by a succession of visitors since 1616. Of special interest is the black-and-white wren (*Malurus leucopterus*) which is restricted to Dirk Hartog and Barrow islands.
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94. Burbidge AA, Johnson PM (1983) Spectacled hare-wallaby, *Lagorchestes conspicillatus*. In *Complete Book of Australian Mammals: the National Photographic Index of Australian Wildlife* (ed R Strahan), 197–198. Angus & Robertson, Sydney.
Summary: Brief description and location of the spectacled hare-wallaby, *Lagorchestes conspicillatus.*
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95. Burbidge AA, Johnson PM (1995) Spectacled hare-wallaby, *Lagorchestes conspicillatus* (Gould, 1842). In *The Mammals of Australia: the National Photographic Index of Australian Wildlife* (ed R Strahan), 313–315. Reed, Sydney.
Summary: Brief description and location of the spectacled hare-wallaby, *Lagorchestes conspicillatus.*
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96. Burbidge AA, Main AR (1971) Report on a visit of inspection to Barrow Island, November 1969. *Department of Fisheries and Fauna, Western Australia, Report* **8**, 1–26.
Summary: The aim of the inspection was to examine the effects on the fauna and flora of the oil exploration initiated in mid-1963 by West Australian Petroleum Pty Ltd and the construction and development program which followed in 1966 and which is now nearing completion.
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97. Burbidge AA, McKenzie NL (1989) Patterns in the modern decline of Western Australia's vertebrate fauna: causes and conservation implications. *Biological Conservation* **50**, 143–198.
Summary: The conservation status of terrestrial vertebrates occurring on the mainland of Western Australia was assessed. Extinctions and declines are virtually confined to non-flying mammals with mean adult body weights between 35 g and 4200

g. Variation in patterns of attrition within this critical weight range (CWR) can be explained almost entirely by a combination of regional patterns in rainfall and, to a lesser extent, species habitat and dietary preferences. Similar patterns of mammal attrition were recognisable throughout the continent, except that the CWR was 35 to 5500 g. Environmental changes since European settlement have emulated an increase in aridity by reducing the environmental productivity available to vertebrates. These include the diversion of environmental resources to humans and introduced species, and a reduction in vegetative cover by exotic herbivores and changed fire regimes. Our analyses support the view that the reduction in available productivity has caused CWR mammals to suffer the greatest attrition because of their limited mobility, but relatively high daily metabolic requirements. The direct elimination of confined populations of mammals by exotic predators has exacerbated this attrition. We derive priorities for the conservation of Australian mammals.

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98. Burbidge A, Morris K (1987) Visit to Barrow Island, May 1987. Department of Conservation and Land Management, Woodvale, WA.

Summary: From 4 to 8 May 1987 a party visited Barrow Island to carry out the official biennial visit; the first since the creation of CALM and the vesting of the Barrow Island Nature Reserve in the NPNCA. As has been the custom on past visits the party were able to visit and inspect all of WAPET's facilities and inspect and discuss all field operations. Particular attention was paid to hygiene from materials being brought to the island from the mainland; rubbish disposal and rehabilitation of disturbed areas. Copied off: Nature Reserves: Tenure: Barrow Island A 11648. Volume 5: file no. 014582F3102.

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99. Burbidge AA, Morris KD (2002) Introduced mammal eradications for nature conservation on Western Australian islands: a review. In *Turning the Tide: the Eradication of Invasive Species: Proceedings of the International Conference on Eradication of Island Invasives* (eds CR Veitch, MN Clout), 64–70. IUCN, Gland.

Summary: There are about 3400 islands off the Western Australian coast, many of which have high nature conservation values. Eleven species of introduced mammals occur or occurred on 124 islands, including three domestic animals (horse, camel and sheep) that have not become feral. In addition, Aborigines introduced dingoes to at least four islands before European settlement. Six exotic mammals (red fox, feral cat, goat, rabbit, black rat and house mouse) have now been eradicated from more than 45



Figure 8. CALM researchers Andrew Burbidge and Geoff Kregor monitoring mammals on Barrow Island (Photograph courtesy of CALM)

islands in a series of projects since the 1960s. Most effort has been directed at black rats with more than 31 islands now clear of this species. Pindone, vacuum-impregnated into oats, was used until the 1990s, when bran pellets with brodifacoum were used in the Montebello Islands. Rabbits have been eradicated using carrots soaked in sodium monofluoroacetate (1080), red foxes with dried meat baits impregnated with 1080 and cats with a combination of baiting and trapping. After a period of 20 years of ground shooting, goats were finally eradicated from Bernier Island using an experienced shooter operating from a helicopter. The house mouse has been eradicated from Barrow Island four times after introductions in food and equipment, and from Varanus and adjacent islands after introduction in food containers. Both islands are utilised by the petroleum industry. Difficulties and how they were overcome, and future eradication priorities are discussed.
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100. Burbidge A, Morris K, Boggs W (1998) Mammal monitoring, Barrow Island Nature Reserve, November 1998. Department of Conservation and Land Management, Woodvale, WA.
Summary: Barrow Island, as well as being of considerable nature conservation significance for other reasons, is one of Australia's most important mammal conservation areas. It supports 13 terrestrial mammal species, of which five are listed as threatened pursuant to the WA Wildlife Conservation Act. Barrow Island has been a producing oilfield since the mid-1960s, the operator being West Australian Petroleum Pty Ltd. This report covers a visit from 2–11 November 1998 during which five mammal trapping grids were established, opportunistic trapping at other sites and spotlighting transects were conducted.
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101. Burbidge AA, Morris K, Drew M (2000) Mammal monitoring, Barrow Island Nature Reserve, October 2000. Department of Conservation and Land Management, Woodvale, WA.
Summary: Barrow Island, as well as being of considerable nature conservation significance for other reasons, is one of Australia's most important mammal conservation areas. It supports 13 terrestrial mammal species, of which five are listed as threatened pursuant to the Wildlife Conservation Act 1950 and the Commonwealth Environment Protection and Biodiversity Conservation Act 1999.
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102. Burbidge AA, Scott JK (2003) Report on baseline studies and data gaps. ChevronTexaco Australia, Perth.
Summary: Among the key issues that arose from the Gorgon Quarantine Expert Panel meeting on 3 and 4 November 2003 were to establish: what's there now, what may come on to Barrow and surrounds, what constitutes introduced, information to make decisions. The relevant objective statement developed at the meeting was Objective 2: Identify the major organism groups of concern and the required baseline surveys (designed to incorporate future monitoring). The strategic action identified for Objective 2 was: Establish a Baseline Survey Group to discuss and identify the species from island knowledge to be a likely threat of introduction (including literature search); short term planned commencement of baseline studies; longer term ongoing studies required in future (biological survey expert to be consulted).
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103. Bureau of Meteorology Australia (2004) Barrow Island climate. Available at http://www.bom.gov.au/ [accessed 25.10.2005].
Summary: Daily weather observations, climate averages, significant weather events and tide predictions are available at this site.
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104. Butler WH (1965) Field notes: Barrow Island 1964/65. H Butler, Perth.
Summary: Field observations of Barrow Island, 1964–1965.
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105. Butler WH (1966) On the trail of wyulda. *Nature and Science* **4**, 2–6.
Summary: Describes Harry Butler's search in the Kimberley's for the wyulda. Mention is made of his activities in discovering what animals were on Barrow Island before drilling commences.
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106. Butler WH (1967) Field diary: December 15th, 1966–January 17th, 1967. H Butler, Perth.
Summary: Field observations taken at Barrow Island 1966–1967.
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107. Butler WH (1967) Report to Explorers Club, New York: a report on the flora and fauna of Barrow Island, WA. EC, New York.
Summary: This report on the Barrow Island fauna survey was carried out with an exploration fund grant. The purpose of the grant (US$750) was to examine the increasing industrial development of Barrow Island and the effects of this development on the fauna. The report is compiled mainly from the results obtained by the author on three visits to Barrow Island, however it also incorporates pertinent material from other collections.
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108. Butler WH (1970) Alphabetical botanical list for Barrow Island: checked and corrected by A George, WA State Herbarium. WASH, Perth.
Summary: Alphabetical botanical list.
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109. Butler WH (1970) A formal report on conservation and industry based entirely on Barrow Island oilfield. West Australian Petroleum, Perth.
Summary: A number of documents are included in this report covering the ecology of Barrow Island and its inhabitants and actions on recommendations from Butler's report to the Explorers Club (1967). Included as appendices are: A natural history reconnaissance of Barrow and Montebello Islands, 1958; Report to Explorers Club, New York (1967); Report on Barrow Island with supplementary fauna list (1969); Alphabetic botanical list for Barrow Island (1970); Summary of the vertebrate fauna of Barrow Island (draft, 1970).
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110. Butler WH (1970) A summary of the vertebrate fauna of Barrow Island, WA. *Western Australian Naturalist* **11**, 149–160.
Summary: The faunal lists presented in this article are the results of several collecting visits made to Barrow Island since 1964.
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111. Butler H (1973) Barrow Island discoveries. *Nature Walkabout* **9**, 34–38.
Summary: An account of Harry Butler's visits to Barrow Island to study the wildlife.
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112. Butler WH (1975) Additions to the fauna of Barrow Island, WA. *Western Australian Naturalist* **13**, 78–80.
Summary: Subsequent to the publication of the list of the vertebrate fauna of Barrow Island, the author visited the island on a number of occasions. These are new or further records to add to the published list.
Copyright note: Summary reproduced with permission from the Western Australian Naturalist's Club

113. Butler H (1977) Barrow Island: the living laboratory, the key to survival, the cycle of life. In *In the Wild with Harry Butler* pp. 41–62. Australian Broadcasting Commission, Sydney.
Summary: An account of the environment and the fauna of Barrow Island.
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114. Butler H (1980) Roos and rigs. *Western Australia* **1(4)**, 31–37.
Summary: An account of Harry Butler's introduction to Barrow Island.
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115. Butler WH (1983) The Barrow Island experience: a presentation to the 53rd ANZAAS Congress, Perth, 1983. In *Selection of Abstracts and Papers: 53rd ANZAAS Congress, Perth, 16–20 May 1983* 98–105. Western Australian Institute of Technology, School of Social Sciences, Bentley, WA.
Summary: A brief history of discovery, fauna and vegetation of Barrow Island.
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116. Butler WH (1987) Management of disturbance in an arid remnant: the Barrow Island experience. In *Nature Conservation: the Role of Remnants of Native Vegetation* (eds DA Saunders GW Arnold AA Burbidge, AJM Hopkins), pp. 279–285. Surrey Beatty, Sydney.
Summary: Barrow Island, a 259 km² island off the coast of the arid zone of Australia, contains one of the richest assemblages of native fauna on an offshore Australian island. The island is an A-class conservation reserve and since 1966 it has also been a major commercial oilfield. Conflict between conservation values and demands for oil production has been avoided by careful considered management of development and conservation. Four principles have emerged from the management of Barrow Island. These are: 1. education and involvement of the community; 2. clearly defined goals for management; 3. active management is essential; and 4. the control of exotic species is necessary. The lessons learnt from the 20 years of management of Barrow Island may be applied to the management of disturbance on other remnants of native vegetation after the goals for the management of such areas have been defined.
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117. Butler WH (1989) Management of Barrow Island. *Department of Conservation and Land Management, Western Australia, Occasional Paper* **2/89**, 193–199.
Summary: Barrow Island, the second largest of Western Australia's offshore islands, is a class A Reserve vested in Department of CALM., and a producing oilfield under the control of West Australian Petroleum (WAPET). Because of government agreements the preservation of the island's wildlife values has become the responsibility of WAPET. A plan of management supportive of the compatibility of conservation and development in accordance with the World Conservation Strategy and the National Conservation Strategy for Australia, was developed to implement the preservation of Barrow Island conservation values. Lessons learned on Barrow Island may have application in other island management situations but it must be recognised that the special significance of islands is reflected in the special requirements of individualised management.
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118. Butler WH, Cox JM (1975) *Barrow Island*. West Australian Petroleum, Perth.
Summary: A brief documentary of the natural history of Barrow Island and the surrounding islands.
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*Figure 9. WAPET/CVX environmental consultant Harry Butler and perentie (*Varanus giganteus*) (Photograph courtesy of ChevronTexaco)*

119. Butler WH, Cox JM (1982) *Barrow Island*. West Australian Petroleum, Perth.
Summary: A brief documentary of the natural history of Barrow Island and the surrounding islands.
Copyright note: Summary reproduced with permission from ChevronTexaco Australia – http://www.chevrontexaco.com/

120. Butler H, Johnson S (1973) Lesson of Barrow Island. *Reader's Digest* **Aug**, 105–110.
Summary: An account of Harry Butler's introduction to Barrow Island and shows how an oil company and the natural environment can co-exist.
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121. CALM (1985–1986) Fauna: Reptiles and amphibians: marine turtles. Volume 1. Department of Conservation and Land Management, Como, WA.
Summary: Records file containing correspondence and reports.
Copyright note: Permission not required for this summary

122. CALM (1985–1988) Nature reserves: Tenure: Barrow Island A 11648. Volume 5: file no. 014582F3102. Department of Conservation and Land Management, Como, WA.
Summary: Records file containing correspondence, reports, permits and details of field visits to Barrow Island.
Copyright note: Permission not required for this summary

123. CALM (1986–1988) Fauna: Reptiles and amphibians: marine turtles. Volume 2. Department of Conservation and Land Management, Como, WA.
Summary: Records file containing correspondence and reports.
Copyright note: Permission not required for this summary

124. CALM (1988–1991) Fauna: Reptiles and amphibians: marine turtles. Volume 3. Department of Conservation and Land Management, Como, WA.
Summary: Records file containing correspondence and reports.
Copyright note: Permission not required for this summary

125. CALM (1988–1993) Nature reserves: Tenure: 11648 Barrow Island and 38728 Middle Island, Boodie Island, Double Island. Volume 6: file no. 026646F3102. Department of Conservation and Land Management, Como, WA.
Summary: Records file containing correspondence, reports and details of field visits to Barrow Island.
Copyright note: Permission not required for this summary

126. CALM (1989) Petroleum lease 1H: condition 10: proposed environmental conditions for Barrow and Middle Islands: draft. Department of Conservation and Land Management, Como, WA.
Summary: Terms and conditions of the environmental agreement between the Lessees and the Department of Conservation and Land

Management. Copied off: Nature Reserves: Tenure: Barrow Island A 11648. Volume 5: file no. 014582F3102.
Copyright note: Permission not required for this summary

127. CALM (1989–1996) Fauna: Reptiles and amphibians: WA marine turtles general. Volume 2: file no. 028674F3804. Department of Conservation and Land Management, Como, WA.
Summary: Records file containing correspondence and reports on marine turtles in Western Australia.
Copyright note: Permission not required for this summary

128. CALM (1990) Eradication of the black rat on Barrow Island: briefing paper. Department of Conservation and Land Management, Como, WA.
Summary: In early August 1990 an extensive trapping program was carried out by CALM and WAPET on the southern portion of Barrow Island to determine how widespread black rats were in this area, and which native mammal species were present.
Copyright note: Permission not required for this summary

129. CALM (1990–1991) Barrow Island: small mammals: *Isoodon auratus*, *Pseudomys nanus*, *Zyzomys argurus*. Volume 1. Department of Conservation and Land Management, Como, WA.
Summary: Records file containing details of field trips, reports and general correspondence.
Copyright note: Permission not required for this summary

130. CALM (1993–1996) Nature reserves: Tenure: 11648 Barrow Island and 38728 Middle Island, Boodie Island, Double Island. Volume 7: file no. 034447F3102. Department of Conservation and Land Management, Como, WA.
Summary: Records file containing correspondence, field visits, reports on kapok on Middle Island and buffel grass on Boodie Island and the eradication of the house mouse from Barrow Island.
Copyright note: Permission not required for this summary

131. CALM (1994) Management of north west islands for conservation, June 1994: policy statement no. 52. Department of Conservation and Land Management, Como, WA.
Summary: Well over 150 islands are located along the north west coast of Western Australia between Exmouth and Port Hedland. Ranging in size from small sand cays to the 23 000 hectares of Barrow Island, around half of them are Nature Reserves vested in the National Parks and Nature Conservation Authority (NPNCA). The Monte Bello Islands have been vested in the NPNCA as Conservation Park. Most of the other islands are vacant crown land. Most are subject to the EPA Red Book recommendations. The Dampier Archipelago islands and Depuch Island are of high and documented Aboriginal heritage value, and other island groups are proving to have similar values e.g. the Monte Bello and Barrow islands. The Barrow, Lowendal and Thevenard groups are being used as bases for on-shore and off-shore oilfield developments.
Copyright note: Permission not required for this summary

132. CALM (1996–1998) Nature reserves: Tenure: 11648 Barrow Island and 38728 Middle Island, Boodie Island, Double Island. Volume 8: file no. 039808F3102. Department of Conservation and Land Management, Como, WA.
Summary: Records file containing correspondence, reports and details of field visits to Barrow Island.
Copyright note: Permission not required for this summary

133. CALM (1997–2002) Wildlife conservation: Research: Fauna: Barrow Island: file no. 1999F000502. Department of Conservation and Land Management, Como, WA.
Summary: Records file containing correspondence, reports and details of field visits to Barrow Island.
Copyright note: Permission not required for this summary

134. CALM (1998–1999) Nature reserves: Tenure: 11648 Barrow Island and 38728 Middle Island, Boodie Island, Double Island. Volume 9: file no. 043146F1998. Department of Conservation and Land Management, Como, WA.
Summary: Records file containing correspondence, reports, permits and details of field visits to Barrow Island.
Copyright note: Permission not required for this summary

135. CALM (1999) Interim management guidelines for necessary operations: Barrow Island group (A 11648 and C 38728). Department of Conservation and Land Management, Karratha, WA.
Summary: These Interim Management Guidelines for necessary operations on the Barrow Island group are intended to provide the basis for the protection of persons, property, flora, fauna and other natural values, in the absence of a formal management plan. The guidelines will be reviewed five years after the date of approval, unless preceded by the completion of a management plan. West Australian Petroleum Pty Ltd have assisted in the production of this document by providing information on the natural environment of Barrow Island and their operations on the island. Also included is a chapter on environmental quarantine. The chief purpose of this section is the detailing of the minimum standards that should be applied to prevent the introduction of foreign species to Barrow and Thevenard islands through WAPET operations. Foreign species to which these minimum standards apply include vermin, such as house mouse, black rat and cats; insects, such as European bees, ticks and wood borers; flora, such as kapok bush, buffel grass, Noogoora burr, mesquite and Mexican poppy. These minimum standards also apply to the eggs, seeds and other life cycle stages and any juveniles, living matter or soil, that may be associated with such pests.
Copyright note: Permission not required for this summary

136. CALM (2000) Marine Turtle Research Project Rosemary Island: volunteers newsletter. – Issue 1

(Oct 2000). Department of Conservation and Land Management, Karratha, WA.
Summary: Report on the turtle tagging season in Western Australia.
Copyright note: Permission not required for this summary

137. CALM (2001) Marine Turtle Research Project Rosemary Island: volunteers newsletter. – Issue 2 (Jan 2001). Department of Conservation and Land Management, Karratha, WA.
Summary: Report on the turtle tagging season in Western Australia.
Copyright note: Permission not required for this summary

138. CALM (2001) Marine Turtle Research Project Rosemary Island: volunteers newsletter. – Issue 3 (May 2001). Department of Conservation and Land Management, Karratha, WA.
Summary: Report on the turtle tagging season in Western Australia.
Copyright note: Permission not required for this summary

139. CALM (2001) Marine Turtle Research Project Rosemary Island: volunteers newsletter. – Issue 4 (Dec 2001). Department of Conservation and Land Management, Karratha, WA.
Summary: Report on the turtle tagging season in Western Australia.
Copyright note: Permission not required for this summary

140. CALM (2002) Marine Turtle Research Project Rosemary Island: volunteers newsletter. – Issue 5 (Feb 2002). Department of Conservation and Land Management, Karratha, WA.
Summary: Report on the turtle tagging season in Western Australia.
Copyright note: Permission not required for this summary

141. CALM (2002) Marine Turtle Research Project Rosemary Island: volunteers newsletter. – Issue 6 (Oct 2002). Department of Conservation and Land Management, Karratha, WA.
Summary: Report on the turtle tagging season in Western Australia.
Copyright note: Permission not required for this summary

142. CALM (2003) Environmental, social and economic review of the Gorgon gas Development on Barrow Island: submission. Department of Conservation and Land Management, Kensington, WA.
Summary: The Department is opposed to the use of Barrow Island for an industrial complex as proposed by ChevronTexaco on behalf of the Gorgon proponents. This opposition is based on the unacceptable risks to the unique biodiversity values of Barrow Island, which are of international conservation significance, and the failure of the proponents to demonstrate either their full appreciation of those values or that these values would be adequately protected or compensated for should in principle support for the proposal to be approved.
Copyright note: Permission not required for this summary

143. CALM (2003) Marine Turtle Research Project Rosemary Island: volunteers newsletter. – Issue 7 (Jan 2003). Department of Conservation and Land Management, Karratha, WA.
Summary: Report on the turtle tagging season in Western Australia.
Copyright note: Permission not required for this summary

144. CALM (2004) Barrow Island species list from FloraBase. Department of Conservation and Land Management, Kensington, WA.
Summary: List of flora species for Barrow Island supported by voucher specimens held by the Western Australian Herbarium.
Copyright note: Permission not required for this summary

145. CALM (2004) Indicative management plan for the proposed Montebello/Barrow islands marine conservation reserves 2004. Department of Conservation and Land Management, Fremantle, WA.
Summary: The Department of Conservation and Land Management (CALM) undertook an assessment of the existing biological and social information relevant to the area before commencing the planning and consultation process. CALM subsequently undertook field surveys of marine habitats in June 1999 and compiled human usage information on recreational and commercial use. The assessment process involved gathering information from government agencies, industry and community groups, as well as reports produced by CALM's Marine Conservation Branch. The assessment process also involved consultation with stakeholders to gain an understanding of community views.
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146. Campbell AJ (1900) Description of a new wren or *Malurus*. *Victorian Naturalist* **17**, 203–204.
Summary: This new wren was the discovery of the collector of the Perth Museum, and was procured amongst spinifex grass on Barrow Island, during December, 1900.
Copyright note: Copyright expired 1980

147. Campbell IR, Tait AM, Reiser RF (1984) Barrow Island oilfield, revisited. *APEA Journal* **24**, 289–298.
Summary: Geology and stratigraphy of the Barrow Island oilfield.
Copyright note: Permission not required for this summary

148. Campbell IR, Willmott SP (1956) Barrow Island survey, 1956. West Australian Petroleum, Perth.
Summary: Sufficient work was done on this survey to support the idea that Barrow Island is an anticlinal uplift. The axis of the anticline roughly parallels the main watershed of the island. There is fairly strong evidence of an anticlinal nose to the north of Trig. 155'. Insufficient work has been done to prove any closure to the south, or to calculate the magnitude or vertical closure or the area of closure.
Copyright note: Summary reproduced with permission from ChevronTexaco Australia – http://www.chevrontexaco.com/

149. Cary JL, Milton K, Stanley F (2000) Human usage in Montebello/Barrow Islands. Department of Conservation and Land Management, Marine Conservation Branch, Data Report
Summary: CONFIDENTIAL. Contains personal data. The Montebello/Barrow Islands region has been selected by the state government for consideration as a marine conservation reserve under the CALM Act. The region was selected after being identified in the report, A Representative Marine Reserve System for Western Australia (CALM 1994) as an area worthy of reservation. To assist in the planning process, data have been gathered on the human activities currently undertaken in the study area. This report presents the spatial boundaries and intensities of various human activities, including recreation and industrial activities, as of December 1999. The human usage data are being continually updated for the marine reserve planning process and the data presented in this report were the first attempt by CALM at data collection for the study area. The updated data are on the Marine Conservation Branch database. The human usage data has been used in the report Regional Perspective of Montebello/Barrow Islands (CALM 2000).
Copyright note: Permission not required for this summary. Enquiries regarding this document should be directed to CALM's Marine Conservation Branch, Fremantle.

150. Casson N (2003) Overview of the influence of fire on spinifex ecosystems, with particular reference to the ecosystem of Barrow Island: report to the Department of Environmental Protection. DEP, Perth.
Summary: A concise account of the stages in one fire-cycle in hard spinifex grassland. The terms of reference were to provide an overview of the fire ecology of spinifex dominated ecosystems; provide a succinct review of any available records on the frequency, intensity and extent of fires on Barrow Island since development of the Barrow Island oil field; prepare advice for the EPA Service Unit in support of the EPA on the potential dependence on or vulnerability to fire of the range of broad ecosystems on Barrow Island; provide advice on the potential impacts of fire exclusion and of fire at more frequent intervals than that likely to have occurred naturally; provide any other advice relevant to the potential impacts and their management of altered fire regimes on Barrow Island.
Copyright note: Permission not required for this summary

151. Chevron Australia (2000) Barrow Island annual environmental report, 1999. Chevron Australia Pty Ltd, Perth.
Summary: The scope of the report includes significant operational activities and facility changes; significant environmental impacts and incidents; environmental monitoring status and results; environmental specialist studies; significant project-specific environmental management and annual discharges and pollution prevention licence reporting requirements.
Copyright note: Summary reproduced with permission from ChevronTexaco Australia – http://www.chevrontexaco.com/ This document is the property of ChevronTexaco Australia Pty Ltd and/or its co-joint venturers. Enquiries regarding the availability of the document should be directed to ChevronTexaco Australia Pty Ltd.

152. Chevron Australia (2001) Barrow Island annual environmental report, 2000. Chevron Australia Pty Ltd, Perth.
Summary: The report incorporates data collected between 1 January 2000 and 31 December 2000, and provides a summary of the results, including discussion of any impacts on the environment arising from operations. A description of any environmental projects is also provided, as is a description of exploration and production project work planned for 2001. The scope of the report includes operational activities and changes; significant environmental incidents; environmental monitoring status and results; environmental studies; project-specific environmental management and annual discharges and pollution prevention licence reporting requirements.
Copyright note: Summary reproduced with permission from ChevronTexaco Australia – http://www.chevrontexaco.com/ This document is the property of ChevronTexaco Australia Pty Ltd and/or its co-joint venturers. Enquiries regarding the availability of the document should be directed to ChevronTexaco Australia Pty Ltd.

153. Chevron Australia (2002) Barrow Island operations annual environmental report, 2001. Chevron Australia Pty Ltd, Perth.
Summary: This report goes well beyond simply complying with licence requirements. It also provides substantial additional information on the activities undertaken by the operator on Barrow Island during the year. This information includes a review of operations undertaken on the island and proposals for the following year; a summary of environmental incidents which occurred on the island, and discussion of the more significant incidents; a review of the status of regular monitoring programs undertaken; activities undertaken to rehabilitate disturbed and contaminated land and decommission redundant facilities; a review of the various research programs and studies undertaken or sponsored by the operator of the oilfield on the island; a review of the status of various environmental management initiatives; and a review of the various audits.
Copyright note: Summary reproduced with permission from ChevronTexaco Australia – http://www.chevrontexaco.com/ This document is the property of ChevronTexaco Australia Pty Ltd and/or its co-joint venturers. Enquiries regarding the availability of the document should be directed to ChevronTexaco Australia Pty Ltd.

154. Chevron Australia (2003) Barrow Island operations annual environmental report, 2002. Chevron Australia Pty Ltd, Perth.

Summary: The scope of the report includes operational activities and facility changes; significant environmental incidents, environmental monitoring status and results; environmental studies; project specific environmental management and annual discharges and pollution prevention licence reporting requirements.
Copyright note: Summary reproduced with permission from ChevronTexaco Australia – http://www.chevrontexaco.com/ This document is the property of ChevronTexaco Australia Pty Ltd and/or its co-joint venturers. Enquiries regarding the availability of the document should be directed to ChevronTexaco Australia Pty Ltd.

155. ChevronTexaco Australia (2002) Environmental Protection Authority visit to Barrow Island, 19th & 20th September, 2002. ChevronTexaco Australia Pty Ltd, Perth.
Summary: Includes itinerary and general information on the Barrow Island camp for the EPA visit.
Copyright note: Summary reproduced with permission from ChevronTexaco Australia – http://www.chevrontexaco.com/

156. ChevronTexaco Australia (2002) Environmental, social and economic review of the Gorgon gas development on Barrow Island. Appendix A, the Gorgon gas development: environmental, social and economic review scoping document. ChevronTexaco Australia Pty Ltd, Perth.
Summary: The purpose of this document is to obtain Western Australian Government endorsement for the planned scope of the ESE review investigations and provides: background to the Gorgon gas development and an outline of the broad development concept; an overview of the existing environment and social setting; a summary of those environmental, social, economic and strategic aspects considered important at this stage of the ESE review; a preliminary assessment of impacts; an outline of the proposed scope of investigations to be conducted as part of the ESE review; indicative management strategies, and; an outline of the plans for stakeholder consultation.
Copyright note: Summary reproduced with permission from ChevronTexaco Australia – http://www.chevrontexaco.com/

157. ChevronTexaco Australia (2002) Environmental, social and economic review of the Gorgon gas development on Barrow Island. Appendix J, Barrow Island environmental quarantine procedures. ChevronTexaco Australia Pty Ltd, Perth.
Summary: Details the minimum standards that shall be applied to prevent the introduction of foreign species to Barrow and Thevenard Islands, or neighbouring island-based facilities, through ChevronTexaco operations.
Copyright note: Summary reproduced with permission from ChevronTexaco Australia – http://www.chevrontexaco.com/

158. ChevronTexaco Australia (2003) Environmental, social and economic review of the Gorgon gas development on Barrow Island. ChevronTexaco Australia Pty Ltd, Perth.
Summary: This environmental, social and economic review (ESE Review) will the assist the Western Australian Government's consideration of the restricted use of Barrow Island for the proposed Gorgon gas development. The gas fields discovered in the Gorgon area represent Australia's largest undeveloped gas resource. As custodian of this resource, the Gorgon venture accepts responsibility for developing this important resource in a sustainable manner. The Gorgon Venture also recognises the importance of the conservation values of Barrow Island to the community. The appendices have been indexed separately.
Copyright note: Summary reproduced with permission from ChevronTexaco Australia – http://www.chevrontexaco.com/

159. ChevronTexaco Australia (2003) Environmental, social and economic review of the Gorgon gas development on Barrow Island: executive summary. ChevronTexaco Australia Pty Ltd, Perth.
Summary: The Gorgon field development plan is based on the installation of a sub-sea gathering system and a 70 km sub-sea pipeline to Barrow Island. A gas processing facility located on the central-east coast of Barrow Island would process the gas. Reservoir carbon dioxide would be removed and reinjected into deep saline reservoirs below the island. The liquid hydrocarbon product would then be transported by ship to international markets. Compressed domestic gas would be delivered via a sub-sea pipeline to the Western Australian mainland for use in the industrial and domestic gas markets. This document briefly describes the facilities that would be required for this Gorgon Venture to be undertaken. This includes minimising the impact on the surrounding environment by avoiding areas of high conservation value. Key marine and terrestrial resources of Barrow Island were identified and recorded and assessed by independent, specialist ecologists for their relative importance to the island's biodiversity, ecological function and conservation value.
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160. ChevronTexaco Australia (2003) Environmental, social and economic review of the Gorgon gas development on Barrow Island: response to submissions prepared for the Environmental Protection Authority. ChevronTexaco Australia Pty Ltd, Perth.
Summary: In response to the Gorgon Venture's approach for in-principle approval of the restricted use of Barrow Island for the development of Gorgon gas, the Western Australian Government

requested that all relevant information on the environmental, social, economic and strategic ramifications of the proposed development be presented in the form of an Environmental, Social and Economic Review (ESE Review). The release of the Gorgon Venture's ESE Review on 10th February 2003 was followed by a six-week public comment period. Public submissions have been received and this document provides an overview of those submissions. A total of 44 submissions were received.
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161. ChevronTexaco Australia (2003) Gorgon development draft quarantine risk assessment. ChevronTexaco Australia Pty Ltd, Perth.
Summary: Quarantine management of Barrow Island has been integral to operation of the oilfield since 1967. During this time a substantial body of information relating to quarantine management has developed and has been stored initially anecdotally, but more recently on a systematic basis. In addition to quarantine procedures, invasive species monitoring and control measures have played a key role in mitigating the environmental consequences of species that have evaded quarantine procedures. Environmental consequences of invasive species introductions were established from inspecting ChevronTexaco environmental monitoring records. Due to the management of invasive species, environmental consequences are considered to be minor with the exception of buffel grass which moderate consequences. On completion of both quantitative and qualitative risk assessment, the risk of an invasive species introduction to Barrow Island has been determined as moderate. The risk level is based on the likelihood and consequence of an invasive species breaching the quarantine system. The Gorgon Venture's clear quarantine objective is zero invasive species introductions to Barrow Island. To reduce this moderate level of risk the Gorgon Venture has committed to developing and implementing a more rigorous quarantine system including the development of innovative invasive species detection, eradication and control techniques.
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162. ChevronTexaco Australia (2004) Barrow Island operations annual environmental report, 2003. ChevronTexaco Australia Pty Ltd, Perth.
Summary: The report goes well beyond simply complying with licence reporting requirements. It also provides substantial additional information on the activities undertaken by the operator on Barrow Island during the year. This information includes a review of operations undertaken on the island during the year and proposals for the following year; a review of the status of all regular monitoring programs undertaken during the year; activities undertaken to rehabilitate disturbed and contaminated land and decommission redundant facilities; a review of the various research programs and studies undertaken or sponsored by the operator on the island during the year; a review of the status of various environmental management initiatives undertaken during the year; a review of the various audits undertaken by both the operator and independent auditors during the year and a summary of all environmental incidents which occurred on the island during the year, and discussion of the more significant incidents.
Copyright note: Summary reproduced with permission from ChevronTexaco Australia – http://www.chevrontexaco.com/ This document is the property of ChevronTexaco Australia Pty Ltd and/or its co-joint venturers. Enquiries regarding the availability of the document should be directed to ChevronTexaco Australia Pty Ltd.

163. ChevronTexaco (2004) ChevronTexaco. Available at http://www.chevrontexaco.com/ [accessed 25.10.2005].
Summary: A global enterprise highly competitive across all energy sectors, the newly formed company brings together a wealth of talents, shared values and a strong commitment to developing vital energy resources around the globe.
Copyright note: Summary reproduced from the Web page

164. ChevronTexaco Australia (2004) Gorgon: Australian gas. Available at http://www.gorgon.com.au [accessed 25.10.2005].
Summary: ChevronTexaco, Shell and ExxonMobil are leading companies in the global oil and gas industry with proven technical and management skills for safe, efficient and environmentally responsible development. The Gorgon Venture brings a wealth of international and domestic experience in oil and gas processing and LNG operations covering all aspects of the development, ranging from drilling to sub-sea production systems, offshore operations, gas plant operations, and product shipping.
Copyright note: Summary reproduced from the Web page

165. ChevronTexaco Australia (2004) Guidelines for an environmental impact statement and environmental scoping document for an environmental review and management programme for the proposed Gorgon development. ChevronTexaco Australia Pty Ltd, Perth.
Summary: The purpose of this scoping document is to assist the Gorgon Venture to identify issues which should be addresses in the Environmental Impact Statement/Environmental Review and Management Programme (EIS/ERMP) and the actions and investigations to be undertaken in addressing these issues. To place the proposed scope in context, these guidelines also provide background to the Gorgon Development, including an outline of the broad development concept and the development alternatives

considered during the previous environmental, social and economic review (ESE Review). This scope has been prepared to meet both Western Australian and Commonwealth legislative requirements.
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166. Christensen P, Burrows N (1994) Project Desert Dreaming: experimental reintroduction of mammals to the Gibson Desert, Western Australia. In *Reintroduction Biology of Australian and New Zealand Fauna* (ed M Serena), pp. 199–207. Surrey Beatty, Sydney.
Summary: Burrowing bettongs, *Bettongia lesueur* and golden bandicoots, *Isoodon auratus* were introduced from an island off the north-west coast of Western Australia to the Gibson Desert on the Australian mainland. Both species quickly adapted to their new mainland habitat and had gained weight within a few weeks. The golden bandicoots also bred well. Measures to control introduced predators successfully reduced dingo *Canis familiaris* and fox *Vulpes vulpes* numbers but resulted in increased numbers of feral cats *Felis catus*. The reintroduced species showed different biological and behavioural traits affecting their vulnerability to predation. Bettongs were highly vulnerable to predation by feral cats so we believe it will be difficult to establish this species, and others with similar traits, in the presence of anything but extremely low densities of introduced predators. Golden bandicoots were less vulnerable to predation so it should be possible to establish viable populations of this species in the arid zone, providing introduced predator numbers are significantly reduced and animals are released into areas of optimum habitat.
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167. Cogger H, Cameron E, Sadlier R, Eggler P (1993) *The Action Plan for Australian Reptiles.* Australian Nature Conservation Agency, Canberra.
Summary: Includes species survival status, worldwide distribution, Australian distribution, conservations status under State and Commonwealth legislation, organisations responsible for conservation of species and individuals involved, other organisation and individuals involved and references. Species profiles for Australia's vulnerable marine turtles, pp. 196–207.
Copyright note: Summary reproduced with permission from the Department of Environment and Heritage, Australia – http://www.deh.gov.au/

168. Conservation Commission of Western Australia (2003) Biodiversity conservation values on Barrow Island Nature Reserve and the Gorgon gas development: advice to Government from the Conservation Commission of Western Australia. CCWA, Crawley, WA.
Summary: Part 1, Should the Gorgon gas development be located on Barrow Island Nature Reserve? Part 2, Advice on relevant issues should the Government approve the location of the Gorgon gas development on Barrow Island Nature Reserve.
Copyright note: Permission not required for this summary

169. Cooper NK, Adams M, Anthony C, Schmitt LH (2003) Morphological and genetic variation in *Leggadina* (Thomas, 1910) with special reference to Western Australian populations. *Records of the Western Australian Museum* **21**, 333–351.
Summary: Recent collections of specimens from the Pilbara attributed to *Leggadina lakedownensis* stimulated an investigation of genetic and morphometric variation in *L. lakedownensis* and *L. forresti* to confirm the taxonomic status of these species, determine the extent of intraspecific variation, and develop useful markers for classification.
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170. Cooper NK, Aplin KP, Adams M (2000) A new species of false antechinus (Marsupialia: Dasyuromorphia: Dasyuridae) from the Pilbara region, Western Australia. *Records of the Western Australian Museum* **20**, 115–136.
Summary: Pseudantechinus roryi sp.nov. from the Pilbara region of Western Australia is described. The new species is close genetically to *P. macdonnellensis* but differs from that species and all other members of the genus in aspects of cranial, dental and external morphology. *Pseudantechinus roryi* is found in regional sympatry with *P. woolleyae*, but is narrowly allopatric with *P. macdonnellensis* of the central Australian uplands. A revised generic diagnosis of *Pseudantechinus* is given and the phylogenetic position of *Pseudantechinus* within the Dasyurinae is discussed.
Copyright note: Summary reproduced with permission from the Western Australian Museum – http://www.museum.wa.gov.au/

171. Cornell C (1974) *The Journal of Post Captain Nicholas Baudin, Commander-in-Chief of the Corvettes, Géographe and Naturaliste: Assigned by Order of the Government to a Voyage of Discovery.* Libraries Board of South Australia, Adelaide.
Summary: A general description of the area in December 1801, pp. 280–281 and then again in March 1803, pp.517–519.
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172. Cox JM (1977) Barrow Island: an historical documentation. J Cox, Perth.
Summary: An historical account that excludes the oilfield exploration history which commenced in 1954.
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173. Crank K (1973) Geology of Barrow Island oil field. *APEA Journal* **1973**, 49–57.
Summary: Regionally the Barrow Island Sub-basin is a geological province of the greater Carnarvon Basin. WAPET geologists first visited the island in 1954 and again in 1956 when preliminary geological surveys were made. The known sedimentary section on Barrow Island ranges from Late Jurassic to Miocene.
Copyright note: Unable to locate contact details for the copyright holder. Please notify us if you can provide them

174. CSIRO Australia (2004) Threatened mammals: conserving populations and understanding why they decline. Available at http://www.cse.csiro.au/research/aglands/threatenedspecies/index.htm [accessed 25.10.2005].
Summary: CSIRO research on endangered animals has contributed significantly to Australia's biodiversity conservation effort. Research to understand extinction processes and re-construct threatened native mammal communities in the Western Australian wheatbelt and Shark Bay region represents an example of this work, and is a recognised research achievement for CSIRO. The work included management of introduced predators, habitat preservation in altered landscapes, investigating reasons for population decline and techniques for re-establishment. The Heirisson Prong project was originally developed by CSIRO researchers and local communities working together with a mining company near Useless Loop on Heirisson Prong in the Shark Bay region of Western Australia. The focus of this project was to investigate effective reintroduction techniques using three native mammals – the burrowing bettong, the western barred bandicoot and the greater stick-nest rat.
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175. Dalens H (1993) Two new genera of terrestrial isopods (Crustacea: Isopoda: Oniscidea) from north-western Western Australia. *Records of the Western Australian Museum* **16**, 257–267.
Summary: Oniscidea collected from the Kimberley region and Barrow Island, Western Australia belong to the families Ligiidae, Olibrinidae, Philosciidae and Armadillidae. The family Olibrinidae is recorded for the first time from Australia. Two new genera of Armadillidae, *Kimberleydillo* gen.nov. and *Barrowdillo* gen.nov., and two new species, *Kimberleydillo waldockae* sp.nov. and *Barrowdillo pseudopyrgoniscus* sp.nov., are described.
Copyright note: Summary reproduced with permission from the Western Australian Museum – http://www.museum.wa.gov.au/

176. Dawson WR (1971) Thermoregulation in the marsupial, *Lagorchestes conspicillatus*. *Journal de Physiologie* **63**, 239–241.
Summary: Discusses the temperature regulation of the spectacled hare-wallaby *Lagorchestes conspicillatus*, which gets both food and shelter from the *Triodia* habitat on Barrow Island.
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177. Dawson WR, Bennett AF (1978) Energy metabolism and thermoregulation of the spectacled hare wallaby (*Lagorchestes conspicillatus*). *Physiological Zoology* **51**, 114–130.
Summary: The physiological performance of the spectacled hare-wallabies (*Lagorchestes conspicillatus*) is compared with animals of a similar size and ecology.
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178. Deegan PM (1992) Monte Bello and Lowendal Islands bibliography: report prepared as part of a study of the Monte Bello Islands and surrounding waters with funds provided through the Great Barrier Reef Marine Park Authority from the Ocean Rescue 2000 Program. Department of Conservation and Land Management, Como, WA.
Summary: Generally only references specific to the Monte Bello or Lowendal islands have been included. However, references to Barrow Island are also present.
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179. Department of Environment (2003) Consideration of access to Barrow Island for gas development: advice for Government's environmental, social, economic and strategic deliberations: overview. DoE, Perth.
Summary: This overview explains the process which is being used to assess the Gorgon gas development plan for the use of Barrow Island; provides a summary of the environmental, biodiversity conservation, social, economic and strategic advice to Government about access to Barrow Island; and describes the next steps in the Government decision making process.
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180. Department of Fisheries (1908–1964) Nature reserves: Tenure: Barrow Island Game Reserves A 11648. Volume 1: file no. 014578F3102. DF, Perth.
Summary: Records file containing correspondence, reports and details of field visits to Barrow Island.
Copyright note: Permission not required for this summary

181. Department of Fisheries (1950–1964) Fisheries: Species: WA turtles: General file. Volume 1: file no. 248/50. DF, Perth.
Summary: Records file containing correspondence and reports on marine turtles in Western Australia.
Copyright note: Permission not required for this summary

182. Department of Fisheries and Fauna (1964–1970) Nature reserves: Tenure: Barrow Island Game Reserves A 11648. Volume 1: file no. 014578F3102. DFF, Perth.
Summary: Records file containing correspondence, reports and details of field visits to Barrow Island.
Copyright note: Permission not required for this summary

183. Department of Fisheries and Fauna (1964–1974) Fisheries: Species: WA turtles: General file. Volume 1: file no. 248/50. DFF, Perth.

Summary: Records file containing correspondence and reports on marine turtles in Western Australia.
Copyright note: Permission not required for this summary

184. Department of Fisheries and Fauna (1970–1974) Nature reserves: Tenure: Barrow Island Game Reserves A 11648. Volume 2: file no. 014579F3102. DFF, Perth.
Summary: Records file containing correspondence, permits, reports and details of field visits to Barrow Island.
Copyright note: Permission not required for this summary

185. Department of Fisheries and Wildlife (1974–1975) Nature reserves: Tenure: Barrow Island Game Reserves A 11648. Volume 2: file no. 014579F3102. DFW, Perth.
Summary: Records file containing correspondence, permits, reports and details of field visits to Barrow Island.
Copyright note: Permission not required for this summary

186. Department of Fisheries and Wildlife (1975–1982) Wildlife and nature reserves: Tenure: Barrow Island Game Reserves A 11648. Volume 3: file no. 014580F3102. DFW, Perth.
Summary: Records file containing correspondence, reports and details of field visits and regulation permits to Barrow Island.
Copyright note: Permission not required for this summary

187. Department of Fisheries and Wildlife (1980–1984) Fauna: Reptiles and amphibians: marine turtles. Volume 1. DFW, Perth.
Summary: Records file containing correspondence and reports.
Copyright note: Permission not required for this summary

188. Department of Fisheries and Wildlife (1982–1983) Wildlife and nature reserves: Tenure: Barrow Island Game Reserves A 11648. Volume 4: file no. 014581F3102. DFW, Perth.
Summary: Records file containing correspondence, reports, permits and details of field visits to Barrow Island. This file includes original scientific papers by CN Smithers on insects of Barrow Island and nearby islands.
Copyright note: Permission not required for this summary

189. Department of Fisheries and Wildlife (1983–1985) Nature reserves: Tenure: Barrow Island A 11648. Volume 5: file no. 014582F3102. DFW, Perth.
Summary: Records file containing correspondence, reports, permits and details of field visits to Barrow Island.
Copyright note: Permission not required for this summary

190. Department of Mineral and Petroleum Resources (2002) Environmental, social and economic review of the Gorgon gas development on Barrow Island. Appendix B, guidelines for the social, economic and strategic evaluation of the Gorgon gas development proposal. ChevronTexaco Australia, Perth.
Summary: The Government of Western Australia has determined that a high level evaluation of the Gorgon gas proposal (the proposal) is required to allow it to make an informed decision on whether to reject or, to provide in principle approval, for the use of Barrow Island as the location for a gas processing complex as part of the initial development of the Gorgon gas project. The proposal, for the limited use of Barrow Island, is a unique proposal of State significance to Western Australia. This significance stems from the size and potential economic value of the Gorgon project gas fields, the high conservation values (including biodiversity) of Barrow Island and the social importance of these economic and conservation values. The objectives of these guidelines is to provide a framework for the social, economic and strategic evaluation of this proposal.
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191. Department of Mines (1988) Renewal of petroleum lease under section 134A: Western Australia, Petroleum Act, 1967. DM, Perth.
Summary: Legal document pertaining to the renewal of petroleum lease 1H.
Copyright note: Permission not required for this summary

192. Devine WT (1985) Report on participation at a workshop on offshore island management: held on Barrow Island, Western Australia, November 1985. Department of Lands & Survey, Wellington.
Summary: This report takes the form of an introduction, a commentary on the operation of an oilfield in the Barrow Island reserve, draws conclusions as lessons for NZ, highlights some points about island management emerging during the workshop and rounds off with final comments. The objective of the workshop was to gather together a series of comprehensive review papers on island survey, ecology and management in the Australia-New Zealand region and to publish the collection as a statement of the current art of island biological conservation.
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193. Doig P, Fritz S (1996) Narcissus flycatcher in Australia. *Wingspan* **6**, 23.
Summary: The first confirmed sighting for Australia of the east-Asian narcissus flycatcher was made recently at Barrow Island in Western Australia by employees of the oil company, West Australian Petroleum Pty Ltd.
Copyright note: Summary reproduced with permission from Birds Australia – http://www.birdsaustralia.com.au/

194. Dortch CE, Morse K (1984) Prehistoric stone artefacts on some offshore islands in Western Australia. *Australian Archaeology* **19**, 31–47.
Summary: Aboriginal sites on Australian offshore islands reflect one or more of the following forms of occupation – prehistoric, regular or sporadic and irregular visits. All three kinds of occupation are taken into account in this paper, which describes the fragmentary record of Aboriginal occupation sites on offshore islands as far north as Barrow Island.

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195. Driskell AC, Pruett-Jones S, Tarvin KA, Hagevik S (2002) Evolutionary relationships among blue- and black-plumaged populations of the white-winged fairy-wren (*Malurus leucopterus*). *Australian Journal of Zoology* **50**, 581–595.
Summary: The white-winged fairy-wren male plumage on the mainland is bright blue with white wings, whereas on Dirk Hartog and Barrow islands the plumage is black with white wings.
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196. E-systems Pty Ltd (2004) How-to guide for conducting risk-based assessments of quarantine hazards on Barrow Island. ChevronTexaco Australia, Perth.
Summary: Outlines the methodology for conducting a risk-based assessment of potential quarantine hazards on Barrow Island. There is a need to address the potential hazards of introduced terrestrial and marine pests during the construction and operation of the proposed Gorgon LNG gas plant, and associated marine terminal and CO^2 re-injection facilities. Increased movements of personnel and material on aircraft and marine vessels present a threat to the unique conservation values of the Island as a Class A nature reserve. The development of a world's best practice Quarantine Management System (QMS) is being undertaken with advice from the Gorgon Joint Venture Quarantine Expert Panel. The outcomes of the risk-based assessment are to contribute to the development of the QMS.
Copyright note: Summary reproduced with permission from ChevronTexaco Australia – http://www.chevrontexaco.com/

197. Eldridge MDB, Close RL (1995) Black-footed rock-wallaby, *Petrogale lateralis* (Gould, 1842). In *The Mammals of Australia: the National Photographic Index of Australian Wildlife* (ed R Strahan), 377–381. Reed, Sydney.
Summary: Brief description and location of the black-footed rock-wallaby, *Petrogale lateralis.*
Copyright note: Permission not required for this summary

198. Eldridge MDB, King JM, Bradshaw SD (IN PRESS) Low levels of genetic diversity, inbreeding and reduced fitness in the Barrow Island population of the euro *Macropus robustus* (Marsupialia: Macropodidae). *Molecular Ecology*

199. Eldridge MDB, King JM, Loupis AK, Spencer PBS, Taylor AC, Pope LC, Hall GP (1999) Unprecedented low levels of genetic variation and inbreeding depression in an island population of the black-footed rock wallaby. *Conservation Biology* **13**, 531–541.
Summary: It has been argued that demographic and environmental factors will cause small, isolated populations to become extinct before genetic factors have a significant negative impact. Islands provide an ideal opportunity to test this hypothesis because they often support small, isolated populations that are highly vulnerable to extinction. To assess the potential negative impact of isolation and small population size, we compared levels of genetic variation and fitness in island and mainland populations of the black-footed rock-wallaby (*Petrogale lateralis* (Marsupialia: Macropodidae)). Our results indicate that the Barrow Island population of *P. lateralis* has unprecedented low levels of genetic variation. Despite a long period of isolation and small effective population size, demographic and environmental factors have not yet driven this population to extinction. Nevertheless, it has been effected significantly by genetic factors. It has lost most of its genetic variation and become highly inbred and it exhibits reduced fitness.
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*Figure 10. Black-footed rock-wallaby (*Petrogale lateralis lateralis*) (Photograph courtesy of ChevronTexaco)*

200. Eldridge MDB, Kinnear JE, Zenger KR, McKenzie LM and Spencer PBS (2004) Genetic diversity in remnant mainland and pristine island populations of three endemic Australian macropodids (Marsupialia): *Macropus eugenii*, *Lagorchestes hirsutus* and *Petrogale lateralis*. *Conservation Genetics* **5**, 325–338.

Summary: Since European settlement, mainland Australia has experienced a wave of mammal extinctions and population declines. However, some species have persisted on off-shore islands, which are now viewed as important wildlife refuges. The level of genetic diversity was assessed, at 7–11 microsatellite loci, in island and remnant mainland populations of three endemic species of macropodid marsupial; the tammar wallaby *Macropus eugenii*; rufous hare-wallaby *Lagorchestes hirsutus* and black-footed rock-wallaby *Petrogale lateralis*.
Copyright note: Summary reproduced with permission from Kluwer Academic Publishers – http://www.wkap.nl

201. Environment Australia Biodiversity Group (1998) *Draft Recovery Plan for Marine Turtles in Australia*. EA, Canberra.
Summary: Five of the six species of marine turtles found in Australian waters are listed on Schedule 1 of the Endangered Species Protection Act 1992 (ESP Act). The ESP Act identifies the need for the preparation of a Recovery Plan and specifies the content of the plan. The flatback turtle has not been listed under the ESP Act but the threats to the Australian flatback populations are similar to other turtle species, and it has been included for completeness. This plan has identified five different habitat types that marine turtles use at different stages of their lives. They are: the natal beach; mating areas; internesting habitat; feeding; and pelagic. In the absence of detailed information about populations of marine turtles in Australia, this plan has adopted a threat based approach. The premise of this approach is to reduce the likelihood that current threats will cause mortalities, or to modify the activity to reduce the potential for future mortalities at all stages of a marine turtle's life. The specific objectives are to: Reduce the mortality of marine turtles and, where appropriate, increase natural survivorship; develop management strategies, with Aboriginal and Torres Strait Islander communities, based on customary and common law, for the conservation of marine turtles; develop programs and protocols to monitor marine turtle stocks in Australia, assess the size and status of those stocks, the causes of their mortality and address information gaps; manage factors that affect successful marine turtle nesting; identify, monitor and protect habitats that are critical for the survival of marine turtles; communicate the results of recovery actions and educate stakeholders; and support and maintain existing agreements and develop new collaborative programs with neighbouring countries for the conservation of shared turtle stocks.
Copyright note: Summary reproduced with permission from the Department of Environment and Heritage, Australia – http://www.deh.gov.au/

202. Environmental Protection Authority (2003) Environmental advice on the principle of locating a gas processing complex on Barrow Island Nature Reserve: Gorgon Venture: section 16 report and recommendations of the Environmental Protection Authority. *Environmental Protection Authority, Western Australia, Bulletin* **1101**, 1–60.
Summary: This report is the environmental contribution to the Government's strategic economic, social and environmental assessment of a proposal to locate a gas processing complex on Barrow Island. Part A provides the EPA's advice on access to Barrow Island for industry. Should Government decide to agree to access, Part B provides the EPA's recommendations on managing the environmental issues that would arise. This strategic level process is designed to guide and assist in the making of an in-principle decision by Government. Formal environmental assessment would still be necessary under the provisions of Section 38 of the Environmental Protection Act and the Commonwealth Environment Protection and Biodiversity Conservation Act. Appendices 1, 1a, 1b & 1c are the supporting data on conservation values of Barrow Island and lists species endemic to the island, restricted, not common and widespread.
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203. Environmental Protection Authority (2004) Gorgon Gas project information. Available at http://www.epa.wa.gov.au/template.asp?ID=36&area=EIA&Cat=Gorgon+Gas+Project+Information or http://tinyurl.com/jmx45) [accessed 25.10.2005].
Summary: Contains PDFs of reports of Gorgon gas project information. The Environmental Protection Act 1986 Part IV provides the legislative framework for the EIA process. Under this process, the EPA looks at statutory planning schemes and development proposals to assess their likely impacts on the environment. If the impacts are likely to be significant then the EPA provides advice to the Minister for the Environment on whether the proposal or scheme should be allowed to proceed and, if so, under what conditions to ensure that the environment is protected.
Copyright note: Summary reproduced from the Web page

204. Fitzgerald LG (2004) Gorgon geotechnical investigations: record of meeting, 2 March 2003. Department of Industry and Resources, Perth.
Summary: Meeting held to discuss the process required for obtaining approval for access to Barrow Island to undertake geotechnical investigations (for plant/onshore pipeline route/offshore jetty and turning basin).
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205. Fraser M (1876) Return of islands in Western Australia for which temporary and other tenures have been given. *Minutes and Votes and Proceedings of the Parliament (Western Australian Legislative Council)* **A11**, 1–3.
Summary: A table detailing the name of the island, the occupant, tenure, duration of tenure, amount of rent or royalty paid, for what purpose and remarks. The information on Barrow Island is: JG Anderson had a six month tenure in 1874 at a

cost of 30 pounds per annum for pastoral purposes, catching turtles, etc. which was renewable for seven years.
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206. Freedman L, Rightmire GP (1972) Skull and tooth variation in Australian bandicoots (Peramelidae: Marsupialia): the genus *Isoodon* and multivariate comparisons with *Perameles*. *Journal of the Royal Society of Western Australia* **54**, 21–31.
Summary: The morphological and metrical features of the skull and teeth of certain taxa of the genus *Isoodon* are described and analysed. Multivariate comparisons are then made between these and a number of *Perameles* taxa. The main multiple discriminant analyses, using either cranial or dental features alone, achieve good separation of the genera (principally on the 1st function), and of the lower taxa within each genus (mainly by the 2nd function).
Copyright note: Summary reproduced with permission from the Royal Society of Western Australia – http://www.ecu.edu.au/pa/rswa/

207. Furnival GM (1967) The WAPET story: from Rough Range to Barrow Island. *Australian Mining* **59(7)**, 11–21.
Summary: Brief history of West Australian Petroleum Pty Ltd and the search for oil on Barrow Island.
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208. Geotechnical Services Pty Ltd (1998) Chemical analysis of rock oysters and sediments collected in February 1998 from the intertidal zone near to the terminal tank area, Barrow Island. West Australian Petroleum, Perth.
Summary: Previous chemical analysis of sediments obtained from shallow boreholes adjacent to the Terminal storage tanks on the east coast of Barrow Island has revealed that they contain petroleum hydrocarbons. Historical operational losses of petroleum are likely to have contributed to these hydrocarbons in the soil sub-surface, with the Terminal tanks being obvious likely sources. To ascertain whether petroleum hydrocarbons have entered the nearshore marine environment, samples of intertidal rock oysters (*Saccostrea cucullata*) were obtained from the beaches adjacent to the Terminal tanks. An additional oyster sample was collected from a remote pristine location on the western coast of Barrow Island, namely Obe's Beach. Rock oysters bioaccumulate, and therefore concentrate, petroleum hydrocarbons from the seawater in which they reside by several orders of magnitude. Therefore, oysters were sampled rather than individual grab samples of water since they provide a more representative indication of the sea water quality. Sediment samples were also collected from the intertidal region of the beach in instances where rock oysters were not present. Although not as useful indicators of exposure history as the rock oysters, detailed chemical analyses of these samples may indicate petroleum hydrocarbon contamination if present. All samples were subjected to detailed chemical analysis to determine the total hydrocarbon concentration and to characterise the petroleum hydrocarbons present. In summary, the oyster samples collected from near to the Terminal tanks did not contain significantly more total hydrocarbons than did the sample of oysters collected from Obe's Beach, which was shown to be uncontaminated by petroleum.
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209. Glauert L (1932) The distribution of the marsupials in Western Australia. *Journal of the Royal Society of Western Australia* **19**, 17–32.
Summary: Since the appearance of Shortridge's Account of the geographical distribution of the marsupials and monotremes of south-west Australia in 1910, distribution maps of the Western Australian mammalian fauna have been kept up to date, and this paper indicates the present range of the fauna, based principally upon specimens that have reached the museum in the last ten years. *Isoodon barrowensis* is listed in this paper.
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210. Goodall DW (1969) Species distribution maps for Barrow Island. West Australian Petroleum, Perth.
Summary: Maps showing the distribution of vegetation on Barrow Island.
Copyright note: Permission not required for this summary

211. Gould J (1841) Mr Gould exhibited four new species of kangaroos from his collection. *Proceedings of the Zoological Society of London* **1841**, 80–83.
Summary: Skins and description of animals collected by Captain Stokes, of HMS *Beagle*.
Copyright note: Copyright expired 1932

212. Graetz RD (1993) Managing the ecological impact of the proposed 1993 3-D seismic survey on Barrow Island. West Australian Petroleum, Perth.
Summary: This report was solicited by WAPET to obtain an independent contribution to the management of the environmental aspects of the 3-D seismic survey program proposed for Barrow Island in 1993.
Copyright note: Summary reproduced with permission from ChevronTexaco Australia – http://www.chevrontexaco.com/

213. Green B, King D, Butler H (1986) Water, sodium and energy turnover in free-living perenties, *Varanus giganteus*. *Australian Wildlife Research* **34**, 589–595.
Summary: Isotope turnover rates of perenties, *Varanus giganteus*, were determined during two consecutive summers on Barrow I., WA. The turnover rates were significantly lower in the first summer than those in the second, and there were

considerable differences in turnover rates between individuals in both years. Estimated rates of prey consumption were 7.3 and 36.4 g kg^{-1} day, respectively, during the two summers, and perenties were more active during the second summer. The mean daily energy expenditure for a 10 kg perentie was much higher in both years than that predicted by allometric equations for reptiles, which illustrates the need for obtaining data from larger species of reptiles in determining allometric relationships.
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214. Hall G, Onus M, Kinnear J (1993) A survey of Barrow Island for the black flanked rock wallaby (*Petrogale lateralis lateralis*). Department of Conservation and Land Management, Woodvale, WA.
Summary: The aim of the study was to conduct a survey of the distribution and abundance of the black-flanked rock-wallaby on Barrow Island and compare the data with the information available from the 1960s.
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215. Halse N (1989) Visit to Barrow and Thevenard islands, March 1989. National Parks and Nature Conservation Authority, Crawley, WA.
Summary: This report summarises the results of a visit to Barrow and Thevenard Islands by the National Parks and Nature Conservation Authority (NPNCA) Chairman in 1989. Copied off: Nature reserves: Tenure: 11648 Barrow Island and 38728 Middle Island, Boodie Island, Double Island. Volume 6: file no. 026646F3102.
Copyright note: Permission not required for this summary

216. Hammond LS (1976) Interim report: 1974 Barrow Island Research Grant. L Hammond, Perth.
Summary: Checklist of identifications of littoral fauna which have been made and confirmed. Copied off: Wildlife and Nature Reserves: Tenure: Barrow Island Game Reserves A 11648. Volume 3: file no. 014580F3102.
Copyright note: Permission not required for this summary

217. Hancock P (1989) Euro with an isle all its own. *Daily News* **Dec 5**, 7.
Summary: Information supplied by the Department of Conservation and Land Management. Describes the species, covering: name details, conservation status, distribution, habitat and natural predators.
Copyright note: Permission not required for this summary

218. Harvey M (1999) Barrow Island draculoides (*Draculoides bramstokeri*). *Western Australian Museum, Information Sheet* **Jul**
Summary: Name and description of the Barrow Island draculoides (*Draculoides bramstokeri*).
Copyright note: Summary reproduced with permission from the Western Australian Museum – http://www.museum.wa.gov.au/

219. Harvey MS, Humphreys WF (1995) Notes on the genus *Draculoides* Harvey (Schizomida: Hubbardiidae), with the description of a new troglobitic species. *Records of the Western Australian Museum. Supplement* **52**, 183–189.
Summary: A second species of *Draculoides, D. bramstokeri* sp.nov., is described from coastal caves of Barrow Island and Cape Range, Western Australia. The species differs from *D. vinei* (Harvey) in the shape and setation of the male flagellum and the presence of a female gonopod. The diagnoses of *Draculoides* and *D. vinei* are emended. Both species included in the genus are cavernicoles.
Copyright note: Summary reproduced with permission from the Western Australian Museum – http://www.museum.wa.gov.au/

220. Hayes K (2003) Gorgon development: quarantine risk assessment: external peer review report: Department of Environmental Protection, WA. DEP, Perth.
Summary: The Department of Environmental Protection asked specific questions about the quarantine risk assessment report by ChevronTexaco and an independent reviewer discusses the report in terms of those questions.
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221. Heatwole H, Butler H (1981) Structure of an assemblage of lizards on Barrow Island, Western Australia. *Australian Journal of Herpetology* **1**, 37–44.
Summary: A sample of the reptile fauna from a *Triodia* habitat on Barrow Island provided 12 species of lizards.
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222. Heatwole H, Reddan S (2004) Barrow Island ants [personal communication (email)].
Summary: Heatwole has been conducting research which compares the community structure of ants in different environments. One site was Barrow Island.
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223. Henn PU (1935) The Tryal Rocks. *Early Days* **2**, 38–43.
Summary: The wreck of the English ship *Tryal* in 1622 is proof that English sailors were on the west Australian coast sixty-six years earlier than is usually supposed, namely, at the time of Dampier's buccaneering expedition in 1688.
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224. Hill AK (2001) Community participation in the declaration processes for the proposed Dampier Archipelago/Cape Preston and Montebello/Barrow islands marine protected areas. Department of Conservation and Land Management, Marine Conservation Branch, Progress Report **MRI/PI/DAR & CPR 50/2001**
Summary: The Marine Conservation Branch of the Department of Conservation and Land

Management is conducting this project as part of the Marine Reserve Implementation Programme. The aim of this project is: to facilitate the negotiation and resolution of zoning and management strategies within the framework of the advisory committees for the proposed Dampier Archipelago/Cape Preston and Montebello/Barrow islands reserves. This report details progress achieved up to February 2001.
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225. Hill AK, Jonker LJ (2000) Planning and pre-declaration processes for a marine protected area in the Montebello/Barrow Islands region. Department of Conservation and Land Management, Marine Conservation Branch, Final Report **MRI/PI/MBI 38/2000**
Summary: The overall aims of the project were to initiate planning and pre-declaration processes for the proposed Montebello/Barrow islands marine conservation reserve. This has been fully achieved with the process underway to consider the area as a potential marine conservation reserve; to compile the ecological and socioeconomic information; to provide advice to the WA Government, through the stakeholder/community advisory committee process, on the suitable reserve category, boundaries and management zoning options, and to develop and implement a community consultation process.
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226. Hill A, Thomson-Dans C (2004) Montebello and Barrow Islands marine conservation reserves. *Landscope* **19(4)**, 32–39.
Summary: Proposals to create two new marine parks and a marine management area around the Montebello and Barrow Islands will protect of 212 000 hectares of ocean. This major initiative will bring the total number of marine parks in Western Australia to nine, and result in the creation of the State's very first marine management area.
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227. Hill FL (1955) Notes on the natural history of the Monte Bello Islands. *Proceedings of the Linnean Society of London* **165**, 113–124.
Summary: The author was sent to the Monte Bello Islands in connection with the testing of the first British Atomic Weapon. Hill paid a brief visit (two hours) to Barrow Island during this expedition and he recorded some flora and fauna. He identified wallabies on the island and other species of mammal which he could not identify. Some lizards were collected and 20 plants different from those to be found in the Monte Bello Islands. Insects were collected on the Monte Bello Islands.
Copyright note: Summary reproduced with permission from the Linnean Society of London – http://www.linnean.org/

228. Hirst DB (1998) *Irileka*, a new heteropodine genus (Araneae: Heteropodidae) from Western Australia. *Records of the Western Australian Museum* **19**, 141–144.
Summary: A new genus of the Heteropodinae, *Irileka*, and a new species, *I. iridescens* are described from Western Australia.
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229. Hoffman RL (1994) Studies on spiroboloid millipeds. XVIII, *Speleostrophus nesiotes*, the first known troglobotic spiroboloid milliped, from Barrow Island, Western Australia (Diplopoda: Pachybolidae: Trigoniulinae). *Myriapodologica* **3(3)**, 19–24.
Summary: The new genus and species *Speleostrophus nesiotes* are based on a small series of specimens taken in a cave on Barrow Island, off the northern coast of Western Australia. The complete lack of ocelli and body pigmentation suggests that the animal is an obligate troglobiont, but features of the male genitalia do not differ greatly from the ground plan seen in such genera as *Leptogoniulus* and *Trigoniulus*. The few trigoniulids known to be endemic in Australia are confined to the eastern coast: Queensland and New South Wales.
Copyright note: Summary reproduced with permission from the Editor – http://www.vmnh.net/Publications/bmyriaof.htm

230. Hopkins A (1975) Report on a visit to Barrow Island, 20–24 October 1975.
Summary: In December 1972 a number of permanent sampling sites were established in areas of disturbance to monitor the regeneration of the vegetation. Copied off: Wildlife and Nature Reserves: Tenure: Barrow Island Game Reserves A 11648. Volume 3: file no. 014580F3102.
Copyright note: Permission not required for this summary

231. Hore-Lacy I, Parr-Smith G (1995) Barrow Island, WA. In *Enhancing Nature Conservation Through Complementary Land Uses* pp. 11–12. Australian Mining Industry Council, Canberra.
Summary: Brief description of Barrow Island and the oil company West Australian Petroleum Pty Ltd.
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232. Humphreys WF (1991) The distribution of Australian cave fishes. *Records of the Western Australian Museum* **19**, 469–472.
Summary: The known occurrence and distribution of two species of blind cave fish, the blind gudgeon (*Mileringa veritas* Whitely) and the cave eel (*Ophisternon candidum*) are described. Both are listed as endangered under Western Australian fauna legislation and are found only on the Cape Range Peninsula of northwestern Australia. They are generally found in sympatry close to the coast and up to 4.3 km inland. Their habitat is predominantly anchialine system with a fresh to brackish water lens overlying a seawater edge. While there appears to be a major extension of the range of *M. veritas* to Barrow Island, WA, the inclusive known range of the two species has not increased since 1991.

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233. Humphreys WF (1991) Troglobites on Barrow Island, Western Australia. *Western Caver* **31**, 11–14.
Summary: In addition to a diverse assemblage of land mammals, Barrow Island is now known to be home to an endemic and highly adapted cave fauna of great antiquity but clearly related to the Cape Range troglobitic fauna. This finding is the result of a short field trip in September 1991 to survey for troglobitic fauna (obligatory cave inhabiting species).
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234. Humphreys WF (1993) Stygofauna in semi-arid tropical Western Australia: a tethyan connection? *Mémoires de Biospéologie* **20**, 111–116.
Summary: The recent finding, in semi-arid Western Australia, of a rich troglobite fauna derived from wet tropical forest communities, has confirmed the richness of the cave fauna of tropical Australia. However, the aquatic fauna of these areas is poorly known, both as to its occurrence and affinities.
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235. Humphreys WF (1995) Subterranean fauna of Barrow Island. Western Australian Museum, Perth.
Summary: Briefing notes prepared for the site visit to Barrow Island by members of the NPNCA. The species density of fauna and flora on the exposed limestones of the Cape Range peninsula and Barrow Island is exceptionally high for the region owing to the geomorphological diversity of the area. The surface biota is, nonetheless, unexceptional being essentially an arid zone biota with little endemism. By contrast the subterranean fauna is exceptional as the below ground habitats have been buffered from the major surface changes associated with the onset of aridity. All the cave fauna is endemic and there is an exceptional degree of generic endemism.
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236. Humphreys WF (2000) The hypogean fauna of the Cape Range peninsula and Barrow Island, northwestern Australia. In *Subterranean Ecosystems* (eds H Wilkens DC Culver, WF Humphreys), pp. 581–601. Elsevier, Amsterdam.
Summary: Rich troglobite communities have recently been found to inhabit caves in tropical limestones and lavas of both oceanic islands and continental areas. This chapter addresses the nature of the karst area on the Cape Range peninsula of Western Australia and includes references to the geologically related Barrow Island lying 170 km to the northeast on the North West Shelf.
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237. Humphreys WF (2000) The Pilbara stygofauna: a synopsis: a report to the Water and Rivers Commission. WRC, East Perth.
Summary: Outlines the distribution and nature of stygofauna (obligate groundwater dependent animals) in the Pilbara and adjacent coastal regions (principally Cape Range and Barrow Island) of Western Australia. The fauna of the island is principally derived from marine ancestors and has Tethyan affinities; it is typical of the Cape Range/Barrow Island fauna. The Pilbara stygofauna is distinct from that found in the Kimberley and the Yilgarn. The stygofauna is an important component of the biodiversity of the Pilbara, is of clear continental significance and is substantially diverse in an international context. Sustained research needs to be initiated on the impact of water abstraction on the stygofauna of the Pilbara to permit informed management of these important ecosystems.
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238. Humphreys WF (2001) *Milyeringa veritas* (Eleotridae), a remarkably versatile cave fish from the arid tropics of northwestern Australia. *Environmental Biology of Fishes* **62**, 297–313.
Summary: The blind cave gudgeon *Milyeringa veritas* is restricted to groundwaters of Cape Range and Barrow Island, northwestern Australia. It occurs in freshwater caves and in seawater in anchialine systems. It is associated with the only other stygobitic cave vertebrate in Australia, the blind cave eel, *Ophisternon candidum*, the world's longest cave fish, and a diverse stygofauna comprising lineages with tethyan tracks and widely disjunct distributions, often from North Atlantic caves. The cave gudgeon inhabits a karst wetland developed in Miocene limestones in an arid area. There is an almost complete lack of information on the basic biology of this cave fish, despite it being listed as threatened under the Western Australian Wildlife Conservation Act.
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239. Humphreys WF (2001) The subterranean fauna of Barrow Island, northwestern Australia, and its environment. *Mémoires de Biospéologie* **28**, 108–127.
Summary: No work has been published specifically addressing the nature of the Barrow Island karst. This paper considers the nature of the subterranean ecosystems of Barrow Island and summarises the information available on the diverse subterranean fauna inhabiting the island.
Copyright note: Summary reproduced with permission from the Editor – http://www.fi.cnr.it/sibios/memoires.htm

240. Humphreys WF, Vine B (1991) The caves of Barrow Island and their fauna: a report to West Australian Petroleum Pty Ltd. WAPET, Perth.

Summary: In addition to a diverse assemblage of land mammals, Barrow Island is now known to be home to an endemic and highly adapted cave fauna of great antiquity but clearly related to the Cape Range troglobitic fauna. This finding is the result of a short field trip in September 1991 to survey for troglobitic fauna (obligatory cave inhabiting species). The troglobitic fauna is a living time capsule from days when wet forest covered the area. Additional work will certainly show that the troglobite community is much more diverse than is currently known. The fauna is out of sight but highly sensitive to environmental change; its incorporation into the environmental management philosophy and practice for Barrow Island should be expedited.

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241. Ingleby S (1991) Distribution and status of the spectacled hare-wallaby, *Lagorchestes conspicillatus*. *Wildlife Research* **18**, 501–519.

Summary: Past and present distribution of *Lagorchestes conspicillatus* were compared using data from museums, explorer's records and recent field surveys. These data indicated that *L. conspicillatus* has declined in distribution and abundance during the last century. This species is now rare in the Pilbara and Kimberley regions of Western Australia. It is moderately common between latitudes 16 º and 18 ºS. However, the southern limits of its range in the Northern Territory have contracted northward by over 200 km and it is rarely recorded below 21 ºS. *L. conspicillatus* remains widespread in Queensland although its numbers in several areas appear to have declined in the last 10–15 years. The status of *L. conspicillatus* should be regarded as vulnerable. Most of its preferred habitats are currently under pastoral lease and at risk of alteration by introduced herbivores or clearing. Unfavourable fire regimes and feral animals may also pose a threat to its survival in some areas. Habitats suitable for *L. conspicillatus* are very poorly represented in National Parks throughout northern Australia and this situation should be rectified.

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242. IUCN SSC Invasive Species Specialist Group (2004) Global invasive species database Available at http://issg.appfa.auckland.ac.nz/database/welcome/ [accessed 25.10.2005].

Summary: Lists invasive species for Western Australia. Invasive plants and animals are a major threat to natural ecosystems and their species, second only to direct destruction of habitats by humans. The impacts of invasive species are particularly devastating to island ecosystems, which harbour much of the world's threatened biodiversity. Amongst these isolated populations, extinction rates are especially high. This problem is growing in severity and geographic extent as volumes of international trade and travel increase. In spite of such serious effects, both national and multinational leaderships remain under-informed regarding the scope and gravity of the invasive species problem. Useful initiatives, which contribute to better management practices and a reduced incidence of biological invasion, are being taken by communities all over the world. Invasive alien species are now a major focus of international conservation concern and the subject of cooperative international efforts, such as the Global Invasive Species Programme (GISP).

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243. Jenner KCS, Jenner M-NM, McCabe KA (2001) Geographical and temporal movements of humpback whales in Western Australian waters. *APPEA Journal* **41**, 749–765.

Summary: Through compilation of historical whaling data, together with recent aerial and boat-based survey data, a general framework for the overall peaks of migration has been estimated for the temporal and spatial movements of Group IV humpback whales along the Western Australian coast. The major migratory paths of humpback whales along the Western Australian coast lie within the continental shelf boundary or 200 m bathymetry. The northern and southern migratory paths have been shown to be divergent at the Perth Basin, Dampier Archipelago and Kimberley regions. In all cases the northern migratory route is further off-shore.

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244. Johnson PM (1993) Reproduction of the spectacled hare-wallaby, *Lagorchestes conspicillatus* Gould (Marsupialia: Macropodidae), in captivity, with age estimation of the pouch young. *Wildlife Research* **20**, 97–101.

Summary: Lagorchestes conspicillatus has a widespread distribution across northern Australia. Observations were made on reproduction in captive animals and a key produced for age determination of pouch young. Females commence breeding at about one year of age and males when slightly older. Reproduction in this species involved an oestrous cycle of 30 days, a gestation period of 29–31 days and a mean pouch life of 152 days. A postpartum oestrus and mating following a birth was the normal pattern of reproduction.

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245. Karanovic T (2003) First representative of the genus *Allocyclops* Kiefer, 1932 (Crustacea: Copepoda: Cyclopoida) from the Australian subterranean waters. *Annales de Limnologie* **39**, 141–149.

Summary: A new species of the genus *Allocyclops*

Kiefer, 1932 (Cyclopidae: Cyclopinae) is described from the subterranean waters of Barrow Island, Western Australia. It belongs to the subgenus *Psammocyclops* Kiefer, 1955, but has not any close relatives among the recent known species. With the addition of the new representative the genus *Allocyclops* now includes thirteen species on all continents, except Asia and Antarctica. A key to aid in their identification is provided.
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246. Kendrick P, Mau R (2003) Carnarvon 1 (CAR1 – Cape Range subregion). In *A Biodiversity Audit of Western Australia's 53 Biogeographical Subregions in 2002* (eds JE May, NL McKenzie), pp. 69–86. Department of Conservation and Land Management, Kensington, WA.
Summary: The islands of the Barrow group, comprising Barrow, Boodie, Middle, Pascoe, Double and 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. The Barrow group supports 15 species of native terrestrial mammals and over 100 bird species are known from Barrow Island. The island supports a large reptile fauna, including an apparently troglobitic snake (*Ramphotyphlops longissimus*). 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.
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247. Kerle JA (1983) Northern brushtail possum, *Trichosurus arnhemensis*. In *Complete Book of Australian Mammals: the National Photographic Index of Australian Wildlife* (ed R Strahan), 149. Angus & Robertson, Sydney.
Summary: Brief description and location of the northern brushtail possum, *Trichosurus arnhemensis*.
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248. King D, Green B (1993) Dimensions of the perentie (*Varanus giganteus*) and other large varanids. *Western Australian Naturalist* **19**, 195–200.
Summary: The body mass and total length of 84 *Varanus giganteus* captured on Barrow Island, WA, were determined. These were compared with published data on the dimensions of *V. varius*, *V. salvator* and *V. komodoensis*. The largest Australian monitor is *V. giganteus*, which is exceeded in body mass and total length by both *V. salvator* and *V. komodoensis*.
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249. King D, Green B, Butler H (1989) The activity pattern, temperature regulation and diet of *Varanus giganteus* on Barrow Island, Western Australia. *Australian Wildlife Research* **16**, 41–47.
Summary: The daily activity pattern of the perentie *Varanus giganteus* on Barrow Island, was bimodal in summer with activity concentrated during the morning and late afternoon. Animals were active on most days in summer. Mean activity temperatures were approximately 36 °C, which is similar to those of other varanid species. The heating rate for one animal was 0.09 °C min^{-1}. The activity areas of animals ranged from 2.9–21.5 ha. The diet consisted mainly of turtle eggs or hatchlings and other vertebrates. Mating and egg-laying appear to take place in the spring.
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250. King J (1998) Indicators of stress in island populations of macropodid marsupials: the implications for conservation. Thesis (PhD) — University of Western Australia.
Summary: Genetic variation was measured in mainland and island populations of macropods using highly-variable microsatellites, and levels of fluctuating asymmetry, a measure of developmental stability, were also determined in these populations. On Barrow Island, which has an arid environment, evidence of stress due to lack of water was investigated through the use of physiological parameters including haematology, condition indices, water metabolism and changes in the concentrations of regulatory hormones. The hypothesis that the lack of genetic variation in the Barrow Island populations should make them more susceptible to habitual environmental stressors, such as lack of water, was not supported in this study. There was very little evidence of stress in the Barrow Island populations despite their low levels of genetic variation and exposure to environmental stressors. There is also no evidence to suggest that the Barrow Island macropods are physiologically compromised by the activities of the oil field on the island.
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251. King PP (1827) *Narrative of a Survey of the Intertropical and Western Coasts of Australia Performed Between the Years 1818 and 1822 with an Appendix Containing Various Subjects Relating to the Hydrography and Natural History in Two Volumes. Vol. I.* John Murray, London.
Summary: The naming of Barrow Island by King on the 20th June 1818, pp.140–141. King also describes the type of craft (log of wood) used by natives seen in the water visiting offshore islands of Dampier Archipelago, 26th–27th February 1818, pp. 42–45.
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252. King PP (1827) *Narrative of a Survey of the Intertropical and Western Coasts of Australia Performed Between the Years 1818 and 1822 with*

an Appendix Containing Various Subjects Relating to the Hydrography and Natural History in Two Volumes. Vol. II. John Murray, London.
Summary: Sighting of Barrow Island, January 1822, pp. 192–193.
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253. Kinhill Stearns (1985) Harriet oilfield development: notice of intent. Volume 1, report. Bond Oil P/L, Perth.
Summary: This notice of intent submission for the proposed Harriet oilfield development addresses three alternatives for the transport and storage of crude from the proposed offshore platform, (i) a pipeline to the existing WAPET facilities on Barrow Island, (ii) a pipeline to a new tank farm located on the main Lowendal Island, and (iii) a short pipeline from the platform to a moored tanker. This report format was selected at a time when the Barrow Island option was preferred as it minimised the cost of installation of additional facilities. However, the Lowendal option is now clearly preferred. Environmental effects and management are discussed.
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254. Kinnear JE, Bromilow RN, Onus ML, Sokolowski RES (1993) The Bromilow trap: a new risk-free soft trap suitable for small to medium-sized macropodids. *Australian Wildlife Research* **15**, 235–237.
Summary: This report describes a trap which minimises the chance of injury to rock wallaby species such as *Petrogale lateralis* and *P. rothschildi*. Both these species show a tendency to injure themselves by hurling themselves repeatedly against wire cages.
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255. Kitchener DJ, Vicker E (1981) *Catalogue of Modern Mammals in the Western Australian Museum, 1895 to 1981.* WAM, Perth.
Summary: List of voucher specimens held at the Western Australian Museum. This catalogue contains their registration number, latitude, longitude, reserve, collector and the date collected. The catalogue arose from a need to be able to retrieve information about mammal species from the Western Australian Museum collections rapidly and efficiently.
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256. Kriewaldt M (1964) *Dampier and Barrow Island, Western Australia: Australia 1:250 000 Geological Series, SF 50-02, SF 50-01.* Geological Survey of WA, Perth.
Summary: Explanatory notes and map on the geology of Dampier and Barrow Island.
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257. LeProvost Environmental Consultants (1991) Shallow marine habitats and biotic assemblages of Barrow Island: report to West Australian Petroleum Pty Limited. WAPET, Perth.
Summary: Intertidal and shallow subtidal areas are considered to be at most risk from accidental oil spills, and, as such, WAPET's management responsibilities at Barrow Island have included the development and updating of an Oil Spill Contingency Plan (OSCP). The value of any OSCP depends on knowledge of the type and distribution of shallow marine habitats located in the vicinity of the oilfield and associated production and transfer facilities. Since little information was available on the type and distribution of subtidal and intertidal marine habitats off the south and east coasts of Barrow Island, WAPET commissioned field surveys of these areas. The objectives of these field surveys were to determine the range and type of intertidal and shallow subtidal habitats located along the south, east and north-east coast of Barrow Island and map their distribution; describe the biotic assemblages associated with each habitat; determine the present nature and amount of hydrocarbons within intertidal habitats; establish monitoring sites to enable quantitative sampling of biotic characteristics at selected locations along the east coast of Barrow Island and subsequently allocate priorities for the protection of sensitive resources in the event of an oil spill. Assistance in the identification of taxa was provided by curators at the Western Australian Museum.
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258. Lewis MM (1994) Species composition related to spectral classification in an Australian spinifex hummock grassland. *International Journal of Remote Sensing* **15**, 3223–3239.
Summary: Discusses the methods needed to relate vegetation and spectral classifications so that variations in species composition can be mapped.
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259. Lewis MM, Grierson IT (1990) Land units and soils of Barrow Island: report on research conducted under the West Australian Petroleum Pty Ltd. Research Grant, 1988. WAPET, Perth.
Summary: This report presents the results of research conducted with the assistance of the West Australian Petroleum Pty Ltd Barrow Island Research Grant for 1988. The study aimed to describe and classify the soils of the island, map land units and cover types from interpretation of Landsat imagery, and establish a geographic information system for the island.
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260. Lewis RC (1914) On two new species of tapeworms from the stomach and small intestine

of a wallaby, *Lagorchestes conspicillatus*, from Hermite Island, Monte Bello Islands. *Proceedings of the Zoological Society of London* **28**, 419–433.
Summary: These specimens were obtained by Mr PD Montague on an expedition to the Montebello Islands. The parasites come from the intestines and stomach of a species of wallaby, *Lagorchestes conspicillatus*, found only on two or three of the Monte Bello Islands. The specimens were compared with those in the collection at the Berlin Museum.
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261. Limpus CJ (1981) The status of Australian sea turtles populations. In *Biology and Conservation of Sea Turtles: Proceedings of the World Conference on Sea Turtle Conservation, Washington, D.C., 26–30 November, 1979* (ed KA Bjorndal), 297–303. Smithsonian Institution Press, Washington.
Summary: Six species of sea turtles occur in Australia. There still needs to be a complete survey of Western Australian populations.
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262. Limpus CJ (2002) Western Australian marine turtle review: a study commissioned by Western Australian Department of Conservation and Land Management. CALM, Woodvale, WA.
Summary: A review the current turtle conservation and management programs in Western Australia in order to advise CALM on future directions.
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263. Lyne AG, Mort PA (1981) A comparison of skull morphology in the marsupial bandicoot genus *Isoodon*: its taxonomic implications and notes on a new species, *Isoodon arnhemensis*. *Australian Mammalogy* **4**, 107–134.
Summary: A series of 763 skulls of the genus *Isoodon*, comprising all known forms from Australia and Papua New Guinea, has been examined in order to review the taxonomy of the group. Original type descriptions of all forms (species and subspecies) have been compared with our findings and a new species, *Isoodon arnhemensis*, is described from Cape Arnhem, Northern Territory. Anatomical features as well as measurements were used to compare the various forms which included *I. barrowensis*.
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264. Main AR, Bakker HR (1981) Adaptation of macropod marsupials to aridity. In *Ecological Biogeography of Australia. Volume 3* (ed A Keast), pp. 1489–1519. Junk, The Hague.
Summary: This chapter has been restricted to the adaptations of macropodid marsupials to arid and semi-arid environments. Radio telemetry has been used to determine the ambient temperature in places occupied by the hare wallaby on Barrow Island. These studies showed that when in preferred cover in large tussocks of *Triodia angusta*, the ambient temperature never rose above 30 °C. In this way the hare wallaby appears to be dependent on shelter in the same way that the euro is dependent on rock piles.
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265. Main AR, Yadav M (1971) Conservation of macropods in reserves in Western Australia. *Biological Conservation* **3**, 123–133.
Summary: In Western Australia various offshore islands, and in particular Barrow Island, form natural laboratories and ecological information derived from them can provide useful guidelines for the selection and management of reserves elsewhere in Australia. The adequacy of reserves depends on the size of the population to be retained on the reserve and on the species' requirements with respect to shelter and food. Species which use rock piles as shelter can persist in very small areas.
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266. Marine Parks and Reserves Selection Working Group (1994) *A Representative Marine Reserve System for Western Australia: Report*. Department of Conservation and Land Management, Como, WA.
Summary: The aims of this report are to review what is known of the flora and fauna, habitats and geomorphology of Western Australian coastal waters, and to identify areas that have particular value for conservation, scientific and public recreation, making them worthy of reservation for these public purposes. Each set of recommendations in the body of the text is preceded by background information about the natural attributes of the area in question and the reasons the Working Group selected it as a worthy candidate for reservation. 3.11.2 Barrow Island, pp. 46–48.
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267. Marsh LM (1993) Cnidaria, other than scleractinian corals. In *Survey of the Marine Fauna and Habitats of the Montebello Islands, August 1993: Report to the Department of Conservation and Land Management* (ed PF Berry), pp. 32–34. CALM, Karratha, WA.
Summary: The Montebello Islands have a rich and varied cnidarian fauna, apart from corals, including reef-dwelling Alcyoniidae and Nephtheidae and sand-dwelling sea-pens of three families, zoanthids and anemones.
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268. Marsh LM (1993) Echinoderms. In *Survey of the Marine Fauna and Habitats of the Montebello Islands, August 1993: Report to the Department of Conservation and Land Management* (ed PF Berry), pp. 74–85. CALM, Karratha, WA.
Summary: The survey reported on here is the most intensive conducted so far of marine habitats and fauna of the Montebellos. It lists the first extensive

collection of echinoderms from the Montebello Islands and uses comparative records from Barrow Island based on the collection made by Dr L Hammond in 1974.
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269. Marsh LM (1993) Scleractinian corals. In *Survey of the Marine Fauna and Habitats of the Montebello Islands, August 1993: Report to the Department of Conservation and Land Management* (ed PF Berry), pp. 23–31. CALM, Karratha, WA.
Summary: The report lists the first extensive collection of corals from the Montebello Islands and uses comparative records from Barrow Island based on a collection made by Dr L Hammond in 1974.
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270. EM Mattiske and Associates (1993) Flora and vegetation, Barrow Island: prepared for West Australian Petroleum Pty Limited. WAPET, Perth.
Summary: A total of 47 families, 107 genera and 166 vascular plant species were recorded on Barrow Island in the recent 1993 botanical survey. The total number of vascular plant species recorded on Barrow Island is estimated to be in the vicinity of 300.
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271. EM Mattiske and Associates (1994) Assessment of vegetation on 1994 3-D seismic lines, Barrow Island: prepared for West Australian Petroleum Pty Limited. WAPET, Perth.
Summary: In February 1994 the plant growth was assessed on the proposed 3-D seismic lines on Barrow Island prior to the commencement of the seismic program. The main objectives were to establish some baseline, pre-clearing assessments and then to investigate the differences in soil surface compaction associated with the receiver and source lines, the ripping treatments and litter replacement. The results clearly illustrate a significant decrease in plant cover and plant numbers; although the results for the plant numbers were not as extreme. The latter largely was related to the occurrence of root material in many of the outcropping areas. WAP003/116/94.
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272. Mattiske Consulting Pty Ltd (1997) 1996 assessment of revegetation on seismic lines, Barrow Island: prepared for West Australian Petroleum Pty Limited. WAPET, Perth.
Summary: A series of seismic lines have been established on Barrow Island by WAPET since the early 1960s. In September 1996 an assessment was made of the regeneration of native plant species on 1963, 1974, 1981, 1987, 1989 and 1994 seismic lines. Results indicated that the floristic structure and composition of regrowth on seismic lines usually differs from the pre-disturbance state even decades after clearing. WAP007/005/97.
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273. Mattiske Consulting Pty Ltd (1999) Review of *Triodia angusta* communities on Barrow Island: prepared for West Australian Petroleum Pty Limited. WAPET, Perth.
Summary: As part of their ongoing operations there has been a need to disturb some areas on Barrow Island for extracting borrow material for constructing roads, well sites and associated infrastructure needs. Consequently over the years of operation a series of areas have been disturbed in predominantly dry creeklines and valleys dominated by *Triodia angusta*. This report provides an assessment of the potential areas of *Triodia angusta* which have not been disturbed by any operational activities and also an overview of the rehabilitation findings on disturbed areas by comparing the undisturbed or control areas, the disturbed and rehabilitated seismic lines and the rehabilitated borrow pits. The data for the latter has been extracted from previous studies on the island by Mattiske and Trudgen.
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274. Maxwell FC (2003) Nesting attendance and population dynamics of marine turtles in the Lowendal Islands, Western Australia. Thesis (BScHons) — Murdoch University, Western Australia.
Summary: Analysis of data from a long-term tagging program of three species of marine turtle. A major green turtle (*Chelonia mydas*) rookery is on Barrow Island.
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275. Maxwell S, Burbidge A, Morris K (eds) (1996) *The 1996 Action Plan for Australian Marsupials and Monotremes.* Wildlife Australia, Canberra.
Summary: Describes the species, covering name details; conservation status; distribution; habitat; reasons for decline; additional studies required; recovery objectives; management actions completed, under way or required; organisations involved with the species; staff and financial resources required. Barrow Island golden bandicoot, pp. 96–97; boodie (Barrow+Boodie Is.), pp. 105–106; Barrow Island spectacled hare-wallaby, pp. 111–112; Barrow Island euro, pp.

117–118; black-flanked rock-wallaby, pp. 124–125
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276. McKenzie NL (1983) Golden bandicoot, *Isoodon auratus*. In *Complete Book of Australian Mammals: the National Photographic Index of Australian Wildlife* (ed R Strahan), 98. Angus & Robertson, Sydney.
Summary: Brief description and location of the golden bandicoot, *Isoodon auratus*.
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277. McKenzie NL, Morris KD, Dickman CR (1995) Golden bandicoot, *Isoodon auratus* (Ramsay, 1887). In *The Mammals of Australia: the National Photographic Index of Australian Wildlife* (ed R Strahan), 172–173. Reed, Sydney.
Summary: Brief description and location of the golden bandicoot, *Isoodon auratus*.
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278. McNamara KJ (1982) A new species of the echinoid *Rhynobrissus* (Spatangoida: Brissidae) from north-west Australia. *Records of the Western Australian Museum* **9**, 349–360.
Summary: A new species of *Rhynobrissus*, *R. tumulus*, is described on the basis of 21 tests found on the northern coast of Barrow Island, Western Australia. The species ranges from Barrow Island north to Broome. Significant ontogenetic changes are described and discussed. A revised key for *Rhynobrissus* is presented.
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279. McNamara KJ, Kendrick GW (1983) Middle Miocene echinoids & molluscs of Barrow Island, Western Australia: a report to West Australian Petroleum Pty Ltd and the Western Australian Wildlife Authority. WAPET, Perth.
Summary: Barrow Island, situated some 55 km off the Pilbara coast of Western Australia is composed predominantly of Miocene limestones. It forms the northern-most exposure of a series of anticlines of Miocene limestone which outcrop between Shark Bay and Barrow Island, the principle exposure being in the Cape Range. In 1981 Kendrick and McNamara visited Barrow Island to collect fossils. The two principal groups of marine invertebrates collected were echinoids and molluscs. The aims of collecting the fauna was to obtain representative collections of the Miocene invertebrate fauna on Barrow Island and to allow future description of the echinoid and the mollusc fauna. The authors were able to use the information gained from these descriptions to analyse the only tropical Miocene marine invertebrate fauna in Australia in order to ascertain faunal relationships of the echinoids and molluscs.
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280. McNamara KJ, Kendrick GW (1994) Cenozoic molluscs and echinoids of Barrow Island, Western Australia. *Records of the Western Australian Museum. Supplement* **51**, 1–50.
Summary: A survey of the Cenozoic fossil fauna of Barrow Island, northwest Australia, has yielded a rich fauna of Middle Miocene and Late Pleistocene molluscs, and a rich Middle Miocene echinoid fauna. This paper, in recording 179 species, represents the first documentation of the fossil fauna on Barrow Island.
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281. McWhae JRH, Parry JC (1954) Barrow Island geological reconnaissance. West Australian Petroleum, Perth.
Summary: There was a suggestion that a geological reconnaissance of the island should be undertaken to see whether a detailed geological survey was warranted. The geological conditions suggested that a detailed survey should be carried out and hence data concerning fresh water supplies, possible landing beaches, the nature of the surface for vehicle transport, tidal and weather conditions were obtained.
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282. Montague PD (1913) The Monte Bello Islands. *Geographical Journal* **42**, 34–44.
Summary: Comments from PD Montague on the discovery and flora and fauna of the Monte Bello Islands.
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283. Montague PD (1914) A report on the fauna of the Monte Bello Islands. *Proceedings of the Zoological Society of London* **11**, 625–652.
Summary: A detailed description of the local fauna with an account of their environment. Some Barrow Island mammals are included in this report.
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284. Moro D, Stanley F (2001) Pearls of the Pilbara. *Landscope* **16**, 34–40.
Summary: More than 300 islands lie off the Pilbara coast between North West Cape and Port Hedland. They support unique ecosystems and internationally important turtle rookeries, and they provide a haven for seabirds and threatened marsupials and rodents. They vary from small cays and rocky islets to an island of more than 20 000 hectares. Barrow Island is Western Australia's second largest island and one of the State's most important conservation reserves.
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285. Morris K (1983-) Field note book, Barrow Island and adjacent islands. 10 books. Department of Fisheries and Wildlife, Perth.
Summary: Field observations of Barrow and

Montebello islands since field work commenced in 1983. The field notes contain trapping and spotlighting data, animal tracks, scats and observations of marine turtles, mammals, birds, reptiles, invertebrates, climate and vegetation. Radio-tracking details are recorded for *Isoodon auratus barrowensis*, *Planigale maculata* and *Pseudomys nanus*.
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286. Morris KD (1983) Trapping programme – Barrow Island (18/4/1983-23/4/1983). Department of Fisheries and Wildlife, Karratha, WA.
Summary: The trapping program, intended to detect *Rattus rattus*, was concentrated on the sandy areas for approximately 2 km north and south of the barge landing area on Barrow Island. A total of 263 traps (of the 306 available) were set in this area. No *Rattus rattus* tracks were seen in the trapping areas on Barrow Island. Copied off: Wildlife and Nature Reserves: Tenure: Barrow Island Game Reserves A 11648. Volume 4: file no. 014581F3102.
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287. Morris K (1983) Visit to Barrow Island, 16–21 October, 1983. Department of Fisheries and Wildlife, Karratha, WA.
Summary: Between 16–21 October, 1983, Double and Pasco islands were baited with loose oats saturated with Pindone in oil. Boomerang Island was also revisited during this period and it appears that *Rattus* have been eradicated from this island. Three nights were spent on Boodie Island to learn more about *Bettongia* and their warren system. An eradication program for *Rattus* on Boodie island is discussed. Copied off: Nature Reserves: Tenure: Barrow Island A 11648. Volume 5: file no. 014582F3102.
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288. Morris KD (1987) Turtle egg predation by the golden bandicoot (*Isoodon auratus*) on Barrow Island. *Western Australian Naturalist* **17**, 18–19.
Summary: In Australia sea turtle eggs are taken by several terrestrial predators including varanid lizards, foxes, dingoes, pigs and humans. On Barrow Island, off the Pilbara coast of Western Australia, the perentie *Varanus giganteus* is believed to be the major predator of turtle eggs.
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289. Morris K (1989) Barrow Island euro, *Macropus robustus isabellinus*. Department of Conservation and Land Management, Woodvale, WA.
Summary: Describes the species, covering: name details, conservation status, distribution, habitat and natural predators.
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290. Morris KD (1989) Feral animal control on Western Australian islands. *Department of Conservation and Land Management, Western Australia, Occasional Paper* **2/89**, 105–111.
Summary: Feral mammals occur on many of the islands off the WA coast, and control has been undertaken on four species, the rabbit, rat, goat and fox. Rabbits were deliberately introduced to Carnac and Mistaken Islands in the 1820s and 1830s, prior to their arrival in the south west of WA by migration from the eastern states. They overgraze vegetation causing loss of cover and erosion and in some cases compete with nesting seabirds for burrow sites. Rabbits have been effectively eradicated on some islands using trials of carrot cubes impregnated with 1080. The rat occurs on many north west islands, predating nesting seabirds and competing with native fauna for shelter and food. On islands of less than 100 ha rats have been eradicated using oats impregnated with Pindone. Despite the goat surviving on Bernier Island for nearly 90 years and overgrazing the vegetation, the six species of native mammal on the island have survived and not showed any sign of decline in numbers. The goat has now been eradicated using an experienced shooter operating from a helicopter. The decline of rock wallabies on offshore islands has been attributed to predation by the fox, however fox eradication is difficult as these islands are connected to the mainland at some stage allowing post baiting invasion to occur. Control of fox numbers at acceptably low levels through continuous baiting with fresh meat and 1080 is possible.
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291. Morris KD (1990) Eradication of *Rattus rattus* on Barrow Island: results of a trial baiting program and description of operational procedures. Department of Conservation and Land Management, Woodvale, WA.
Summary: When the introduced black rat, *Rattus rattus* was discovered on the south end of Barrow Island in July 1990, an eradication program was initiated. This involved two phases: trial baiting program to determine the effectiveness of raised bait stations in killing *Rattus* while reducing the hazard to native mammal species; an operational program using proven baiting techniques to eradicate *Rattus* from the remainder of the south end of Barrow Island and Middle Island.
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292. Morris KD (1990) A report on the introduced black rat, *Rattus rattus* on Barrow Island. Department of Conservation and Land Management, Woodvale, WA.
Summary: Between 7–12 August 1990, an extensive trapping program was undertaken on the south end portion of Barrow Island. Its aims were to determine the extent and density of *Rattus* in this area; determine which native mammal species were present. Using this information, an eradication program was developed. The trapping results suggest that *Rattus* is distributed throughout the south end of Barrow Island, north to approximately the Eagle Nest track. They may have been there for some time after having invaded

from Middle Island or from a pearling camp on Barrow Island at the turn of the century. They are not likely to be a recent introduction from the activities of WAPET on the island. There is no doubt that a baiting program is required to eradicate *Rattus* from Barrow and Middle Islands as soon as possible.
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293. Morris K (1990) A report on the *Rattus rattus* eradication program on Boodie Island. Department of Conservation and Land Management, Woodvale, WA.
Summary: Since 1981, the Department of Conservation and Land Management has been conducting a program of eradicating the introduced rat *Rattus rattus* from islands off the north west coast of Western Australia. The rats are believed to have been introduced to the islands from pearling and fishing boats which frequented the islands in the late 1800s/early 1900s. Successful eradications, using oats and Pindone, have been conducted on five islands.
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294. Morris KD (2000) The status and conservation of native rodents in Western Australia. *Wildlife Research* **27**, 405–419.
Summary: Examines the conservation status of Western Australia's native rodent fauna using IUCN criteria and compares this with their current status under State and Commonwealth legislation, as well as that recommended in the Rodent Action Plan. Thomas (1902) described *Pseudomys ferculinus* from Barrow Island; this taxon is now recognised as a subspecies of *P. nanus*. The Barrow Island mouse (*Pseudomys nanus ferculinus*) is not currently listed as threatened under Western Australian or Commonwealth legislation and was not described or assessed in the Rodent Action Plan. It is known only from Barrow Island, where it is reasonably abundant, and should be considered vulnerable because of its restricted distribution. There is a need to confirm this taxonomy with current genetic assessment techniques.
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295. Morris KD (2002) The eradication of the black rat (*Rattus rattus*) on Barrow and adjacent islands off the north-west coast of Western Australia. In *Turning the Tide: the Eradication of Invasive Species: Proceedings of the International Conference on Eradication of Island Invasives* (eds CR Veitch, MN Clout), 219–225. IUCN, Gland.
Summary: The black rat (*Rattus rattus*) has been introduced to many islands around the world and has been shown to have a detrimental impact on a wide range of fauna. It is known from about 1% of Australian Islands, of which many are adjacent to the Western Australian Pilbara or Kimberley coasts. Rats were accidentally introduced to these islands in the late 1800s by the pearling industry. Barrow and adjacent islands are nature reserves with significant conservation value, particularly for threatened mammals. Rats were known to inhabit the six smaller adjacent islands, but it was not until 1990 that they were located on the south end of Barrow Island. Eradication programs on North and South Double, Boomerang, Pasco and Boodie islands in 1983–1986 have been successful, but most of these islands had no non-target mammals. Seven mammals were considered to be at risk from an oat-based baiting program on Barrow Island. Barrow Island was also considerably larger than other islands where successful eradication had occurred (23 000 ha vs 5 ha-1000 ha). The rats on the smaller islands, without non-target mammals, were successfully eradicated using oats impregnated with the anticoagulant Pindone. Monitoring of these reserves is continuing.
Copyright note: Summary reproduced with permission from the IUCN – http://www.iucn.org/

296. Morris K, Burbidge AA (2002) Bountiful Barrow. *Landscope* **17**, 18–24.
Summary: Brief introduction of Barrow Island, including discovery, Aboriginal presence, natural history and the oil industry.
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297. Morris K, Burbidge AA, Drew M, Kregor G (2001) Mammal monitoring, Barrow Island Nature Reserve, October 2001. Department of Conservation and Land Management, Woodvale, WA.
Summary: Monitoring of the abundance and condition of native mammals on Barrow Island was conducted at five trap locations and along two spotlighting transects. In addition, monitoring of black-flanked rock-wallabies commenced via trapping and spotlighting. Trapping for the presence of introduced mammals (particularly rodents) was conducted around the Base and landing warehouses and in dunes adjacent to Boomerang Island. No other islands were visited during this survey.
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298. Morris K, Burbidge AA, Drew M, Kregor G (2002) Mammal monitoring, Barrow Island Nature Reserve, October 2002. Department of Conservation and Land Management, Woodvale, WA.
Summary: Monitoring of the abundance and condition of native mammals on Barrow Island was conducted at the five trapping locations and along the two spotlighting transects. In addition. monitoring of black-flanked rock-wallabies via trapping and spotlighting. Trapping for the presence of introduced mammals (particularly rodents) was conducted in dunes at Narrow Neck. After reports of rat tracks on North Double Island, North and South Double Islands in addition to Boomerang Island were surveyed.
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Figure 11. South End, Barrow Island (Photograph courtesy of ChevronTexaco)

299. Morris K, Burbidge AA, Stanley F (1999) Mammal monitoring, Barrow Island Nature Reserve, October 1999. Department of Conservation and Land Management, Woodvale, WA.
Summary: Barrow Island, as well as being of considerable nature conservation significance for other reasons, is one of Australia's most important mammal conservation areas. It supports 13 terrestrial mammal species, of which five are listed as threatened pursuant to the Wildlife Conservation Act. Barrow Island has been a producing oilfield since the mid-1960s, the operator being West Australian Petroleum Pty Ltd. This report covers the second mammal monitoring visit undertaken between 11–20 October, 1999. During this period five grids were trapped and spotlighting transects were conducted.
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300. Morton SR, Short J, Barker RD (1995) *Refugia for Biological Diversity in Arid and Semi-Arid Australia: a Report to the Biodiversity Unit of the Department of Environment, Sport and Territories.* DEST, Canberra.
Summary: A brief overview of the biogeographic region, type of refuge, quality of refuge, area, chief refuge value, general description, ANZECC-listed species, key threats and land tenure. Reference number WA4: refuge area: Barrow Island group, pp. 72–73.
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301. Muchmore WB (1982) The genus *Anagarypus* (Pseudoscorpionida: Garypidae). *Pacific Insects* **24**, 159–163.
Summary: The genus *Anagarypus* is redefined based on study of the type-species, *Anagarypus oceanusindicus*, and of two new species, *A. australianus* and *A. heatwolei*, from Australia.
Copyright note: Summary reproduced with permission from Bishop Museum Press – http://www.bishopmuseum.org/press/

302. Mulholland P (1990) Ledge Cave, Barrow Island. *Caver's Chronicle* **17**, 5.
Summary: A very brief report of Peter Mullholland's caving activities on Barrow Island.
Copyright note: Permission not required for this summary

303. Murray R (1991) *From the Edge of a Timeless Land: a History of the North West Shelf Gas Project.* Allen & Unwin, Sydney.
Summary: A detailed account of the history of the project from the establishment of Woodside Petroleum in the early 1950s, to the drilling, of the first well in 1967.
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304. Mutton R (2003) Playing tag with turtles. *Landscope* **19(2)**, 10–16.
Summary: This article discusses the marine turtle

monitoring program in Western Australia and the threatening processes associated with the survival of marine turtles.
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305. Nagy KA, Bradshaw SD (2000) Scaling of energy and water fluxes in free-living arid-zone Australian marsupials. *Journal of Mammalogy* **81**, 962–970.
Summary: Rates of field metabolism and water influx of six endangered species of marsupials living on Barrow Island, Western Australia, were measured using doubly labeled water. The remarkably similar reduction in daily energy and water needs of arid versus nonarid Australian marsupials, compared with arid versus nonarid North American and African eutherians, suggests that this similarity is an example of convergent evolution.
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306. National Parks and Nature Conservation Authority (1991) Report of visit to Barrow Island and to Thevenard Island, June 1991. NPNCA, Crawley, WA.
Summary: The principal objective is to see that operations at Barrow Island are not imperilling the future of the island as an extraordinarily valuable nature reserve. The party (two from NPNCA and two from CALM) guided by Russell Lagdon and Harry Butler, were able to meet this objective and also discussed a number of specific issues of interest to CALM and to WAPET concerning their respective responsibilities. A number of particular issues relating to present or future activities at Barrow Island or Thevenard Island were identified and listed in this report.
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307. National Parks and Nature Conservation Authority (1993) Report on visit to Barrow and Thevenard islands, 28 April 1993–3 May 1993. NPNCA, Crawley, WA.
Summary: This report summarises the results of a visit to Barrow and Thevenard Islands by the National Parks and Nature Conservation Authority (NPNCA). These visits have been carried out because of the importance of Barrow Island in the conservation estate, which was recognised by its vesting as a Class A Reserve as early as 1910 (Reserve No. 11648 for the protection of flora and fauna). Barrow Island's importance to conservation lies in the large populations of species of marsupials which are rare or extinct in other parts of its former range, and in the vegetation which maintains these populations. Other values include the flora, because of its biogeographical position and isolation; protection of the islands from many impacts experienced by mainland nature reserves; the aquatic cave fauna; and a significant landscape. Management of the reserve is of particular concern because of its use as a very productive petroleum lease, held by West Australian Petroleum Pty Ltd (WAPET). Control by the Company of its impacts on the environment and the success of its work on the rehabilitation of disturbed areas, are relevant to the acceptability of proposals from WAPET and other companies which may impact other nature reserves. The visits are also important to the NPNCA because they provide the only direct contact between the Authority and the Company at which issues can be directly and informally discussed, sites visited and communication improved. The text contains a number of comments and recommendations relevant to management and these were summarised at the end of the document.
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308. National Parks and Nature Conservation Authority (1995) Report on visit to Barrow and Thevenard islands, 23 October–27 October 1995. NPNCA, Crawley, WA.
Summary: This report summarises the results of the visit to Barrow and Thevenard Islands by four members of the NPNCA. WAPET have held a lease over Barrow Island for the production of oil since 1967 and Thevenard Island since 1988. In addition to viewing operations of the existing oil bases, the group were briefed on the Gorgon development which is proposed, and on the alternative sites being considered (Exmouth, Barrow Island and Karratha). Authority members inspected the two sites where a plant may be built on the island, at Surf Point or in the general area of the tank farm.
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309. National Parks and Nature Conservation Authority (1997) NPNCA and CALM visit to Barrow and Thevenard Island, 8–11 September 1997. NPNCA, Crawley, WA.
Summary: This report summarises the results of a visit to Barrow and Thevenard Islands by the National Parks and Nature Conservation Authority (NPNCA). These visits have been carried out because of the importance of Barrow Island in the conservation estate, which was recognised by its vesting as a Class A Reserve as early as 1910 (Reserve No. 11648 for the protection of flora and fauna). Barrow Island's importance to conservation lies in the large populations of species of marsupials which are rare or extinct in other parts of its former range, and in the vegetation which maintains these populations. Other values include the flora, because of its biogeographical position and isolation; protection of the islands from many impacts experienced by mainland nature reserves; the aquatic cave fauna; and a significant landscape. Management of the reserve is of particular concern because of its use as a very productive petroleum lease, held by West Australian Petroleum Pty Ltd (WAPET). Control by the Company of its impacts on the environment and the success of its work on the rehabilitation of disturbed areas, are relevant to the acceptability of proposals from WAPET and other companies

which may impact other nature reserves. The visits are also important to the NPNCA because they provide the only direct contact between the Authority and the Company at which issues can be directly and informally discussed, sites visited and communication improved. The text contains a number of comments and recommendations relevant to management and these were summarised at the end of the document.
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310. Ogawa E, Billiards SS, King JM, Agar NS (2000) Methaemoglobin formation in euros and bettong. *Comparative Haematology International* **10**, 196–199.
Summary: The methaemoglobin in the erythrocytes of the Barrow Island euro, the mainland euro and the brushtailed bettong is tested
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311. Oliver G (1990) Report on the capture of *Rattus rattus* on Barrow Island. Department of Conservation and Land Management, Karratha, WA.
Summary: The black rat, *Rattus rattus* is known to occur on Middle Island 250 m to the south of Barrow Island, Double Island 1 km to the east of Barrow and to have occurred prior to 1985 on Boodie Island 10 km to the south of Barrow. Oliver visited Barrow Island between July 24 and 27, and 49 medium sized Elliott traps were set over two nights on a 10 m grid on the south-west end of Barrow Island. One *Rattus rattus* was trapped on the southern end of Barrow Island. It may be a recent immigrant from Middle Island or it may have been present on Barrow Island for many years undiscovered. The recommendations are for an extensive trapping program to determine the extent of the distribution of *Rattus rattus* on Barrow Island.
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312. Oliver G, Hughes M (1990) Report on a visit to Boodie Island July 1990. Department of Conservation and Land Management, Karratha, WA.
Summary: Boodie Island (470 ha) is located 10 km south of Barrow Island and forms part of the C Class Reserve No. 38728. CALM personnel visited the island on 25 and 26 July 1990 to implement a program for monitoring Pindone degradation in oats and to generally inspect the reserve.
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313. Osborne S, Bancroft K, D'Adamo N, Monks L (2000) *Montebello/Barrow Islands: Regional Perspective 2000*. Department of Conservation and Land Management, Fremantle, WA.
Summary: This document provides a broad regional perspective on the ecological, cultural and socio-economic setting of the region as background information for a community-based advisory committee and for members of the general community who have an interest in the marine environment of the area.
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314. Osborne S, Monks L (2000) An analysis of issues relating to the proposed Montebello/Barrow Islands marine conservation reserve. Department of Conservation and Land Management, Marine Conservation Branch, Report **MRI/PI/MBI 46/2000**
Summary: Face to face and telephone discussions were conducted, during April and May 2000, with 43 people from a wide range of interest and user groups and the results of these discussions are reported.
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315. Ovington D (1978) *Australian Endangered Species: Mammals, Birds and Reptiles*. Cassell, Sydney.
Summary: Description, breeding, distribution, ecology and conservation of the boodie, *Bettongia lesueur*.
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316. Palmer C, Taylor R, Burbidge AA (2003) Recovery plan for the golden bandicoot, *Isoodon auratus*, and golden-backed tree-rat, *Mesembriomys macrurus*, 2004–2009. Department of Infrastructure, Planning & Environment, Darwin.
Summary: Populations of surviving golden bandicoots and golden-backed tree-rats are recorded on a range of tenures including defence land, Aboriginal land, conservation land and unallocated Crown land. Golden bandicoot populations have been estimated for Barrow Island (tens of thousands) and Middle Islands (1000) in WA and Marchinbar Island (1400) in the NT. There are no population estimates for either species from the mainland or Kimberley islands. This Recovery Plan has been developed as a two-species recovery plan. However, recovery actions detailed in this document will include monitoring both populations to determine population trends, identify key threatening processes and develop and implement cooperative management arrangements, between relevant agencies, land managers and landowners (Commonwealth, State, Territory and regional levels).
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317. Parry JC (1967) The Barrow Island oilfield. *APEA Journal* 130–133.
Summary: The Barrow Island oilfield was declared a commercial discovery in May 1966. Thirty-three wells had been drilled by December 31, 1966, and 144 wells, average depth 2450 ft will be drilled in 1967. The objective of this drilling is exploitation of the Lower Cretaceous Windalia Sand pool. The reservoir is an unconsolidated shaly sand. Recoverable reserves estimated at 114 million barrels are contained in a broad north plunging nose truncated at the south by a fault. The known

sedimentary section at Barrow Island ranges from Upper Jurassic to Miocene and there appears to be no hiatus between the Jurassic and the Cretaceous in this area. A number of additional hydrocarbon accumulations have been discovered in the Neocomian-Tithonian section, however, these are small and irregular and are not in themselves commercial.
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318. Pendoley K (1997) Sea turtles and management of marine seismic programs in Western Australia. *PESA journal* **25**, 8–16.
Summary: Sea turtles are an important component of the Western Australian marine ecosystem. They have existed in the worlds of oceans for over a 100 million years, however the past two hundred have seen a major decline in population levels globally, primarily as a result of human consumption of meat and eggs and a demand for turtle shell decorative items. They are protected under international, national and state regulations and should be considered in any environmental impact assessment of geophysical programs in west Australian waters. The known nesting sites in Western Australia for green, flatback, loggerhead and hawksbill turtles are identified in the paper, however this should only be considered preliminary as it is likely that other major rookeries exist but are yet to be confirmed. All seismic programs should be assessed and managed on a case-by-case basis making allowances for surveys to be tailored to fit specific environmental, meteorological, operational and regulatory conditions.
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319. Pendoley K (2002) Sea turtle records, Barrow Island, Western Australia. *Western Australian Naturalist* **23**, 207–209.
Summary: Previously published records for Barrow Island sea turtle fauna include reference to *Chelonia mydas* nesting on local beaches and small *Eretmochelys imbricata* swimming in the shallow offshore waters. The CALM West Australian Marine Turtle Research Program has confirmed the west coast of Barrow Island as a major green turtle rookery while Yacht Club Beach north of the WAPET camp is recognised as a flatback turtle rookery.
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320. Penn JW (1985) Barrow Island scallop survey. *Fins* **18**, 12–13.
Summary: Late in 1983 a scallop survey was carried out by MG Kailis Pty Ltd in an area near Barrow Island but the results were not encouraging. Numbers of *Amusium balloti* were too low to make commercial trawling worthwhile.
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321. Perry DH (1972) Some notes on the termites (Isoptera) of Barrow Island and a check list of species. *Western Australian Naturalist* **12**, 52–55.
Summary: The author visited Barrow Island during the period March 29 to April 5, 1971. The main reason being to determine if the genus *Drepanotermes* was represented on the island and if so to collect and describe any species present. The opportunity was also taken to collect as thoroughly as possible, in the time available, any other species of termite that might be located.
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322. Platnick NI (2000) *Lampona barrow*, new species. *Bulletin of the American Museum of Natural History* **245**, 58–59.
Summary: Description of *Lampona barrow*, a new species of spider from Barrow Island.
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323. Poole WE (1983) Common wallaroo, *Macropus robustus*. In *Complete Book of Australian Mammals: the National Photographic Index of Australian Wildlife* (ed R Strahan), 250–251. Angus & Robertson, Sydney.
Summary: Brief description and location of the common wallaroo, *Macropus robustus*.
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324. Poole WE (1995) Common wallaroo, *Macropus robustus* (Gould, 1841). In *The Mammals of Australia: the National Photographic Index of Australian Wildlife* (ed R Strahan), 347–349. Reed, Sydney.
Summary: Brief description and location of the common wallaroo, *Macropus robustus*.
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325. Pope L, Storch D, Adams M, Moritz C, Gordon G (2001) A phylogeny for the genus *Isoodon* and a range extension for *I. obesulus peninsulae* based on mtDNA control region and morphology. *Australian Journal of Zoology* **49**, 411–434.
Summary: Short-nosed bandicoots, *Isoodon*, have undergone marked range contractions since European colonisation of Australia and are currently divided into many subspecies, the validity of which is debated. Discriminant function analysis of morphology and a phylogeny of *Isoodon* based on mtDNA control region sequences indicate a clear split between two of the three recognised species, *I. macrourus* and *I. obesulus/auratus*. It seems plausible that what is currently considered as two species, *I. obesulus* and *I. auratus*, was once one continuous species now represented by isolated populations that have diverged morphologically as a consequence of adaptation to the diverse environments that occur throughout their range. The taxonomy of these populations is discussed in relation to their morphological distinctiveness and genetic similarity.

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326. Prince RIT (1986) Dugong in northern waters of Western Australia, 1984. *Department of Conservation and Land Management, Western Australia, Technical Report* **7**, 1–38.
Summary: The dugong is included in the IUCN Mammal Red Data Book, Part 1 as a species vulnerable to extinction, and in Western Australia it is similarly placed in accord with provisions of the Western Australian Wildlife Conservation Act, 1950, within the special category of fauna considered likely to become extinct, or is rare or otherwise in need of special protection. Information includes investigation into the possible distribution and abundance of dugong and dugong habitat in these areas, and the possible role of traditional subsistence hunting as a factor affecting these dugong populations.
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327. Prince RIT (1993) Western Australian marine turtle conservation project: an outline of scope and an invitation to participate. *Marine Turtle Newsletter* **60**, 8–14.
Summary: Six of the world's seven species of marine turtle frequent the Western Australian region, but only four are confirmed as breeding here: the green turtle (*Chelonia mydas*), flatback (*Natator depressus*), hawksbill (*Eretmochelys imbricata*), and loggerhead (*Caretta caretta*).
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328. Prince RIT (1994) The flatback turtle (*Natator depressus*) in Western Australia: new information from the Western Australian Marine Turtle Project. In *Proceedings of the Australian Marine Turtle Conservation Workshop: Sea World Nara Resort, Gold Coast, 14–17 November, 1990* (ed R James), 146–148. Australian Nature Conservation Agency, Canberra.
Summary: Further information on the flatback turtle (*Natator depressus*) in Western Australia shows that it occurs as a nesting species off the south-western Pilbara coast, but there is no substantial evidence of its occurrence in Exmouth Gulf, or further southward. The southernmost presently known rookeries are in the Pilbara region, on Barrow Island, the Lowendal Islands, and within the Dampier Archipelago.
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329. Prince RIT (1994) Status of the Western Australian marine turtle populations: the Western Australian Marine Turtle Project 1986–1990. In *Proceedings of the Australian Marine Turtle Conservation Workshop: Sea World Nara Resort, Gold Coast, 14–17 November, 1990* (ed R James), 1–14. Australian Nature Conservation Agency, Canberra.
Summary: Four species of marine turtles nest at Western Australian rookeries. The green turtle (*Chelonia mydas*) is by far the most abundant, with nesting use of individual major rookeries observed over the past three years varying from c. 3000 to 10 000 or more females per season. Information becoming available for the flatback turtle (*Natator depressus*) is suggesting that this turtle may be the next most abundant species, with annual nesting of hundreds to thousands of females. Nesting hawksbill (*Eretmochelys imbricata*) and loggerhead turtles (*Caretta caretta*) appear to be much less abundant than the flatback. The leatherback turtle (*Dermochelys coriacea*) has not been recorded nesting, but appears to be a regular feeding migrant. Knowledge which is necessary to improve the approach to conservation of Western Australian region dependent marine turtle populations is being sought within the framework of the Western Australian Marine Turtle Project managed by CALM. Work in progress is being guided by our developing knowledge of these turtle populations, and is being greatly assisted by participation of volunteers from the general community, members of Aboriginal communities in the Kimberley region, and by cooperation of staff of other government authorities and organisations.
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330. Prince RIT (1994) Update: sea turtles in Western Australia. *Marine Turtle Newsletter* **64**, 18–19.
Summary: An update of sea turtle behaviour and numbers tagged for the 1992/93 season in WA.
Copyright note: Summary reproduced with permission from the Editor – http://www.seaturtle.org/mtn/archives/mtn64/mtn64p18.shtml

331. Prince RIT (2001) Environment Australia, Marine Species Protection Program funding agreement with Department of Conservation & Land Management, WA for aerial survey of the distribution and abundance of dugongs and associated macrovertebrate fauna: Pilbara coastal and offshore region, WA: completion report. CALM, Woodvale, WA.
Summary: Early reconnaissance studies of the Western Australian Pilbara coastal and offshore waters pointed to the significance of this area for dugong, but the regional surveys required to provide information on distribution and abundance of dugongs in that area had not previously been supported. Findings from the April 2000 survey confirm the regional importance of the Pilbara coastal and offshore waters as an integral part of the resource areas sustaining dugong presence on the Western Australian coast. The need to consider requirements for dugong conservation at an appropriately wide regional scale is apparent. Critical connectivity across the Shark Bay to Pilbara coast region at least is indicated. Linkages to areas further north can also be anticipated. The likely longer term pattern of temporal and spatial



*Figure 12. Green turtle (*Chelonia mydas*), west coast of Barrow Island (Photograph courtesy of ChevronTexaco)*

variability of capacity of key habitat areas needed to support the Western Australian dugong population provides the reason for the wider focus required. This must be taken into account in review of the current proposals for designation and management of new marine protected areas (MPAs) for the Western Australian Pilbara and other coastal regions extending into the Kimberley. This report includes data analysis to provide population estimates for the dugongs, sea turtles and small cetaceans (dolphins) recorded in the survey; sightings data have been mapped to show distributions of the dugongs, sea turtles and small cetaceans (dolphins) recorded on survey.

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332. Pruett-Jones SG, O'Donnell E (2004) Land birds on Barrow Island: status, population estimates and responses to oil-field development. *Journal of the Royal Society of Western Australia* **87**, 101–108.

Summary: A census of land birds on Barrow Island, Western Australia was carried out during September and October 2001. A total of 178 transects was conducted in six major vegetation zones, with 777 individuals of 16 species of birds recorded.

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333. Pruett-Jones SG, Tarvin KA (2001) Aspects of the ecology and behaviour of white-winged fairy-wrens on Barrow Island. *Emu* **101**, 73–78.

Summary: The study of white-winged fairy-wrens (*Malurus leucopterus edouardi*) on Barrow Island during September and October 1998. Birds were most abundant on ridges in upland areas where *Triodia wiseana* was the dominant vegetation and was interspersed with open areas. They were less abundant in foredune areas and on red dunes, and were rare in other habitats. Males were significantly larger than females in most morphological measurements. Group size averaged 2.4 individuals with six of nine groups consisting of just one male and one female. In one of nine groups, the only male present was a completely brown male. Sex ratio of adults in these nine groups was 0.83 (males/females). The display vocalisation was nearly identical in structure to that of birds on the mainland. Three nests were each approximately 0.5 m high in a shrub adjacent to a *Triodia angusta* plant. In most aspects of their behaviour and ecology, white-winged fairy-wrens on Barrow Island appear to be almost identical to birds on the mainland.

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334. Quartermaine Consultants (1994) Aboriginal site survey: report on an archaeological survey programme, Barrow Island. West Australian Petroleum, Perth.
Summary: CONFIDENTIAL. This report describes an archaeological survey investigation for Aboriginal sites at Barrow Island situated off the coast of the Pilbara region in Western Australia. The archaeological investigation involved a search of the Aboriginal Site Register, a study of previous research material, a systematic field survey based on previous research and local environment. Twelve archaeological sites were discovered during the survey. The newly recorded sites are all surface artefact scatters. Most of the artefact scatters were recorded in full. Details are provided in the report. Based on the results of the research, survey and analysis, it is considered that the island, which would have been a limestone upland on a peninsula connected to the mainland during times of low sea levels, was little used with most evidence of occupation concentrated around the claypan areas.
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335. Rathburn MK, Montgomerie R (2003) Breeding biology and social structure of white-winged fairy-wrens (*Malurus leucopterus*): comparison between island and mainland subspecies having different plumage phenotypes. *Emu* **103**, 295–306.
Summary: White-winged fairy-wrens have a clan mating system wherein up to three cooperative breeding groups (breeding pair plus any helpers) are contained within the larger territory of a nuptial-plumaged male who also has a mate (likely with helpers). Nuptial-plumaged males of island and mainland subspecies have different plumage phenotypes: in the mainland Australian subspecies (*Malurus leucopterus leuconotus*) nuptial males are blue with white wings, whereas in the subspecies on Dirk Hartog (*M. l. leucopterus*) and Barrow (*M. l. edouardi*) islands males are black with white wings. Here, we compare island and mainland populations of white-winged fairy-wrens in morphology, breeding biology and social behaviour based on data collected over two breeding seasons on Dirk Hartog Island and near Lancelin, Western Australia, on the mainland.
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336. Reardon M (1995) The good oil on conservation. *Australian Geographic* **37**, 92–109.
Summary: Barrow Island is an oilfield and wildlife refuge off Western Australia. Oil company WAPET has ensured that its operations have had minimal effect on the island's endangered animals. This island supports 14 land mammal species, at least seven marine mammal species, 110 bird species and 54 species of reptiles. It is also the rookery for two of Western Australia's five turtle species. WAPET's key conservation policies include workforce education, strict quarantine control, widely spaced drilling, rehabilitation of disturbed areas, fire control, careful waste disposal and restrictions on the movements of vehicles and personnel. The result of this management plan has meant that the island supports healthy populations of all of its native species, some of which even favour the oilfields, where they can find water, shade and tasty new growth among the wells. Land restoration and rehabilitation policies have helped to ensure that only 4% of the island is affected by its activities. Once an operation is completed, earthmoving machines are used to re-profile the area and to replace the topsoil. These areas are generally left to regenerate naturally.
Copyright note: Summary reproduced with permission from Australian Geographic – http://www.australiangeograhic.com.au

337. Reid G (1986) Land Act, 1933 (section 33): Vesting Order. Government of WA, Perth.
Summary: Vesting Order by Professor Gordon Reid, Governor in and over the State of Western Australia and its Dependencies in the Commonwealth of Australia declaring that Barrow Island is vested in and held by the National Parks and Nature Conservation Authority, Oct 1986. Also contains the memo regarding vesting in the Western Australian Wildlife Authority in 1985 and the Government Gazette notice of 18 Jan 1985, amending the size of the reserve and its change of purpose. Copied off: Nature Reserves: Tenure: Barrow Island A 11648. Volume 5: file no. 014582F3102.
Copyright note: Permission not required for this summary

338. Ride WDL (1970) *A Guide to the Native Mammals of Australia*. Oxford University Press, Melbourne.
Summary: General description and brief details. Great kangaroos, pp. 40–44; hare-wallabies, pp. 54–58; rock-wallabies, pp. 58–62; rat-kangaroos, pp. 62–68; large possums and cuscuses, pp. 70–72; short-nosed bandicoots, pp. 95–96; native-mice, pp. 152–155
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339. Robinson AC (1983) Western chestnut mouse, *Pseudomys nanus*. In *Complete Book of Australian Mammals: the National Photographic Index of Australian Wildlife* (ed R Strahan), 398. Angus & Robertson, Sydney.
Summary: Brief description and location of the western chestnut mouse, *Pseudomys nanus*.
Copyright note: Permission not required for this summary

340. Robinson AC (1992) Perenties, predators and prey. *South Australian Naturalist* **67**, 30–34.
Summary: General observation and information about the population of perenties on Barrow Island.
Copyright note: Permission not required for this summary

341. Robinson AC (1995) Western chestnut mouse, *Pseudomys nanus*, (Gould, 1858). In *The Mammals of Australia: the National Photographic Index of Australian Wildlife* (ed R Strahan), 609–610. Reed, Sydney.
Summary: Brief description and location of the western chestnut mouse and the sub-species *Pseudomys nanus ferculinus.*
Copyright note: Permission not required for this summary

342. Rodda GH, Dean-Bradley K (2002) Excess density compensation of island herpetofaunal assemblages. *Journal of Biogeography* **29**, 623–632.
Summary: Some herpetofaunal species can reach very high densities on islands.
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343. Romero A, Vanselow PBS (2000) Threatened fishes of the world: *Ophisternon candidum* (Mees, 1962) (Synbranchidae). *Environmental Biology of Fishes* **58**, 214.
Summary: Common name, status and identification of the blind cave eel listed as threatened under the Western Australian Wildlife Conservation Act. This species of troglobitic fauna is distributed along the western and northeastern coastal plain of the Cape Range peninsula and Barrow Island.
Copyright note: Summary reproduced with permission from Kluwer Academic Publishers – http://www.wkap.nl

344. Sedgwick EH (1976) Avifauna. E Sedgwick, Perth.
Summary: A draft copy of the author's paper on Barrow Island avifauna.
Copyright note: Permission not required for this summary

345. Sedgwick EH (1976) Barrow Island files: a population study of the Barrow Island avifauna. 2 v.. E Sedgwick, Perth.
Summary: Two volumes containing the photographs, maps and correspondence of E Sedgwick with WAPET prior to his trip to Barrow Island. There is also a draft copy of his paper on Barrow Island avifauna.
Copyright note: Permission not required for this summary

346. Sedgwick EH (1978) A population study of the Barrow Island avifauna. *Western Australian Naturalist* **14**, 85–108.
Summary: Four weeks of intensive field work on Barrow Island (c. 22 260 ha) in August 1976 on the status of birds then present, particularly the black-and-white wren and the spinifex-bird, was mainly concentrated upon their population strength. The count methods are described and the results given in detail. The most numerous species was found to be the spinifex-bird with 17 800 individuals, followed by the welcome swallow, 8500; the black-and white wren, 8150; the tree-martin, 7050; the white-breasted wood-swallow, 3450; the singing honeyeater, 3050 and the kestrel, 1650. The remaining species were represented by fewer than 1000 individuals, the most numerous of these being the Horsfield bronze-cuckoo with 910 individuals. Sea and shore-birds were the subjects of separate counts.
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347. Serventy DL, Marshall AJ (1964) A natural history reconnaissance of Barrow and Montebello Islands, 1958. *CSIRO Division of Wildlife Research, Technical Paper* **6**, 1–23.
Summary: The results of a brief zoological survey of Barrow, Lowendal and Montebello islands in September 1958 are reported, mention being made of the flora and annotated lists provided of the mammals and birds. Barrow Island (55 000 acres), with six (perhaps seven) species of native terrestrial mammals, is possibly the most mammal rich island off the Western Australian coast. A new addition to the fauna is the fat-tailed marsupial-mouse, *Antechinus macdonnellensis*, known previously only from mainland arid habitats. The three terrestrial native mammals known to have occurred on the Montebello Islands (one, the boodie, *Bettongia lesueur*i, first recorded in the present paper) are now extinct. The extermination, which must have occurred during the 90 years prior to 1950, may perhaps have been due to the depredations of the feral cat and/or the deterioration of the climate. There has been no comparable extinction on nearby Barrow Island. The fauna and flora of the Montebello Islands, so far as could be judged by the brief inspection, had not been adversely affected by the British atomic explosion of 1952.
Copyright note: Summary reproduced with permission from CSIRO Sustainable Ecosystems – http://www.cse.csiro.au/

348. Sharman GB, Maynes GM (1983) Black-footed rock-wallaby, *Petrogale lateralis.* In *Complete Book of Australian Mammals: the National Photographic Index of Australian Wildlife* (ed R Strahan), 209–210. Angus & Robertson, Sydney.
Summary: Brief description and location of the black-footed rock-wallaby, *Petrogale lateralis.*
Copyright note: Permission not required for this summary

349. Short J (1988) Conservation of threatened macropods: project proposal, 9th June 1988. CSIRO Division of Wildlife and Ecology, Helena Valley, WA.
Summary: An understanding of the reason or reasons for the decline of species now represented only by remnant populations is necessary for their on-going management and to aid their re-introduction to areas of their former range.
Copyright note: Summary reproduced with permission from CSIRO Sustainable Ecosystems – http://www.cse.csiro.au/

350. Short J (2004) Baseline survey and subsequent monitoring strategy to detect exotic terrestrial species on Barrow Island: report to ChevronTexaco Australia Pty Ltd. CSIRO Sustainable Ecosystems, Floreat, WA.
Summary: ChevronTexaco approached CSIRO Sustainable Ecosystems to develop a baseline survey for exotic species. The aims of this consultancy were to: Design a sampling strategy

for a baseline survey of terrestrial species on Barrow Island, with an emphasis on detecting any exotic species that may currently be present. Develop a monitoring protocol to maximise detection of future incursions of exotic species during the Gorgon construction phase. Develop a timetable, works program and team of experts to meet the above aims.
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351. Short J, Cale P, Lagdon R, Butler WH (1988) Summary of results of trip to Barrow Island, 22 June–6 July 1988. CSIRO Division of Wildlife and Ecology, Helena Valley, WA.
Summary: The aim of the trip was to become familiar with the island, bettongs, plants and WAPET administration and procedures.
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352. Short J, Turner B (1989) A test of the habitat mosaic theory: bettongs, bandicoots and possums on Barrow Island. CSIRO Division of Wildlife and Ecology, Helena Valley, WA.
Summary: Part I aims to establish the distribution, abundance, and habitat preference of burrowing bettongs on Bernier, Dorre, and Barrow islands. These islands are now the only remaining places where this species in known to survive. Part II of the project explores a major hypothesis put forward to explain the extinction or near extinction of many medium-sized macropods and bandicoots over the last 30–50 years, the habitat mosaic theory. The objectives of the project are to establish whether burrowing bettongs require a mosaic of vegetation of different seral stages after disturbance to maintain their populations, or to enhance the well-being of the populations and to establish whether this requirement for a habitat mosaic can be adequately met from the close juxtaposition of diverse vegetation types or landscape units.
Copyright note: Summary reproduced with permission from CSIRO Sustainable Ecosystems – http://www.cse.csiro.au/

353. Short J, Turner B (1990) P102: the experimental reintroduction of the burrowing bettong to mainland Australia. Part II, the importance of a vegetation mosaic to the burrowing bettong: final report to World Wide Fund for Nature Australia, June 1990. CSIRO Division of Wildlife and Ecology, Helena Valley, WA.
Summary: The habitat mosaic hypothesis suggests that medium-sized mammals such as bettongs, hare-wallabies, bandicoots and possums require a habitat which is a fine-grained mosaic of different vegetation types or seral stages. This fine-grained mosaic is believed to have been created in the spinifex deserts of mainland Australia by Aboriginal burning. The loss of this mosaic is said to be a primary reason for mainland extinction of many species of medium-sized mammals and major reductions in range of other species. This study tested that theory for the burrowing bettong, the golden bandicoot and the northern brush-tailed possum on Barrow Island. The abundance, condition and reproductive status of each species was assessed in 24 trapping grids, each of 6.24 ha, distributed across the spectrum of habitat diversity found on the island.
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354. Short J, Turner B (1991) Distribution and abundance of spectacled hare-wallabies and euros on Barrow Island, Western Australia. *Wildlife Research* **18**, 421–429.
Summary: Report of a survey of the distribution and abundance of two species of macropod on Barrow Island: the spectacled hare-wallaby (*Lagorchestes conspicillatus*) and the euro (*Macropus robustus isabellinus*). Barrow Island is the second largest island off the coast of Western Australia and is both a conservation reserve and a commercial oilfield. Barrow Island has been a commercial oilfield since 1964 yet there is little information available on the effect of this operation on the mammal fauna.
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355. Short J, Turner B (1993) The distribution and abundance of the burrowing bettong (Marsupialia: Macropodoidea). *Wildlife Research* **20**, 525–534.
Summary: The burrowing bettong (*Bettongia lesueur*) has been extinct on mainland Australia since the early 1960s, but was believed to persist on four islands off the coast of Western Australia – Bernier, Dorre, Barrow and Boodie. These islands were surveyed in 1988–89 to ascertain the status of bettongs and other endangered mammals. Bettongs were widespread and comparatively abundant on three islands but absent from the fourth. Bettongs occurred at estimated densities of c. 14–17 km^2 on Bernier, Dorre and Barrow islands, suggesting approximate minimum populations of 650, 1000 and 3400 respectively and a total minimum population for the species of c. 5000 individuals. It would appear that a poisoning campaign in 1985 to eliminate *Rattus rattus* from Boodie Island also eliminated the bettong. The burrowing bettong has apparently been absent from a fifth island and its type locality, Dirk Hartog Island in Shark Bay, since early this century. The vulnerability of this species is highlighted by its extinction on mainland Australia and by the loss of two of its five island populations. It now occupies less than 0.01% of its historical range. Its status as rare and endangered is justified.
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356. Short J, Turner B (1994) A test of the vegetation mosaic hypothesis: a hypothesis to explain the decline and extinction of Australian mammals. *Conservation Biology* **8**, 439–449.



*Figure 13. Osprey (*Pandion haliaetus*) (Photograph courtesy of ChevronTexaco)*

Summary: The vegetation mosaic hypothesis suggests that medium-sized mammals occupying arid and semi-arid areas of Australia require a habitat that is a fine-grained mosaic of different vegetation types or seral stages. This mosaic is believed to have been created in the spinifex deserts of central Australia by Aboriginal burning practices. Its loss in the period 1940–1960 is postulated to be a primary reason for both major reductions in range and mainland extinctions of many species of medium-sized mammals at this time. This study measured the responses of three species of medium-sized mammals to vegetation patterns within spinifex grasslands that ranged from comparatively uniform to highly diverse. The abundance, condition, and reproductive status of golden bandicoots, northern brush-tailed possums, and burrowing bettong were assessed with vegetation mosaics of various scales on Barrow Island, off the northwest coast of Australia. Scale of mosaic proved to have no significant effect on the numbers, condition, or reproductive status of any of the three species. Similarly, the creation of fine-grained mosaics of early seral-stage vegetation mixed within climax vegetation by extensive oil-field operations over nearly half the island had no significant effect on the number or condition of animals. Hence, scale of mosaics seems unlikely to be related to the mainland decline or extinction of these species. The pattern of decline and extinction on the mainland but continued survival on offshore islands is more consistent with the presence (mainland) or absence (islands) of introduced predators (foxes and cats) and herbivores (rabbits and stock).

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357. Short J, Turner B, Cale P (1988) The distribution and relative abundance of rare macropods and bandicoots on Barrow and Dorre islands: final report for the 6 month consultancy program entitled Feasibility of reintroducing the burrowing bettong *B. lesueur* to mainland Western Australia phase 1, to National Kangaroo Monitoring Unit, Australian National Parks and Wildlife Service. CSIRO Division of Wildlife and Ecology, Helena Valley, WA.

Summary: Distribution and abundance of the medium-sized mammals on Barrow and Dorre Islands. Drought and plenty, successional stage after fire, and competitive interactions between species may alter the relative abundances of these species over time. The major threat to the continued survival of all species on these islands is the introduction of exotic predators, the cat or fox.

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358. Short J, Turner B, Majors C (1989) The distribution, relative abundance and habitat preferences of rare macropods and bandicoots on Barrow, Boodie, Bernier and Dorre islands: final report for the 2 year consultancy program entitled Feasibility of reintroducing the burrowing bettong *B. lesueur* to mainland Western Australia phase 1, to National Kangaroo Monitoring Unit, Australian National Parks and Wildlife Service. CSIRO Division of Wildlife and Ecology, Helena Valley, WA.

Summary: Three islands off the coast of Western Australia – Barrow, Bernier and Dorre – provide a refuge for six species of rare bettong, hare-wallaby and bandicoot. Three species have been absent from the Australian mainland for over 30 years; three have only remnant populations remaining on the mainland. Hence their protection and management on these islands is of critical importance to the overall survival of each species. This study provides the first systematic surveys of their abundance and distribution on Barrow, Bernier, and Dorre Islands. In addition, we provide the results of a survey for bettongs on Boodie Island, a small island off the southern tip of Barrow Island. The surveys employed a mixture of spotlighting and trapping. Techniques were standard across islands. A total of 200 km of transect were spotlighted on foot across the four islands and cage traps were laid for a total of 2116 trap nights.

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359. Slack-Smith SM (2002) Environmental, social and economic review of the Gorgon gas development on Barrow Island. Appendix H, a preliminary survey of the terrestrial molluscan fauna of areas within and adjacent to the land-based component of the proposed Gorgon development, Barrow Island, Western Australia, September 2002. ChevronTexaco Australia, Perth.

Summary: The fieldwork component of a preliminary survey of the terrestrial molluscan fauna of Barrow Island, Western Australia was carried out from the 9th to 13th of August 2002. The stations sampled included areas which may be impacted by the land-based components of the proposed Gorgon gas development, and those immediately adjacent to them. This is the first survey of the non-marine molluscan fauna of any part of Barrow Island. Specimens and data collected during this survey have significantly augmented those previously available in the collections of the Western Australian Museum, which had comprised few and generally poor-localised snail specimens.

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360. Smith DN (1962) Barrow Island geological survey, Carnarvon Basin, WA. West Australian Petroleum, Perth.

Summary: A surface geological and gravity survey were conducted on Barrow Island in July 1962. The field crews in each case operated from vessels anchored close offshore. Exposures of Tertiary limestones were mapped by plane table and telescopic alidade and a structure map was drawn to the base of the Miocene Trealla Limestone. Barrow Island is clearly a regional high in the Tertiary of the Carnarvon Basin and therefore is almost certainly high in basal cretaceous rocks. Previous aerial magnetometer work suggests that the total sedimentary thickness beneath Barrow Island may be considerably in excess of 7000 feet. This is the deepest reliable depth estimate we have from aeromagnetics. The geological survey of Barrow Island was made to map the exposed Tertiary Limestone structure and to evaluate various engineering geological problems that would be associated with possible future drilling operations.

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361. Smith L (1973) List of reptiles collected on Barrow Island 17 August–13 September 1973. L Smith, Perth.

Summary: A list of specimens collected as part of the West Australian Petroleum 1973 research grant. Copied off: Nature reserves: Tenure: Barrow Island Game Reserves A 11648. Volume 2: file no. 014579F3102.

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362. Smith LA (1976) The reptiles of Barrow Island. *Western Australian Naturalist* **13**, 125–136.

Summary: The 38 terrestrial and six marine species of reptiles from Barrow Island are listed, including the first specimen of the sea snake, *Emydocephalus annulatus* from Western Australia. The biology of the terrestrial species is discussed with respect to their distribution on the island, breeding condition, diet, body size and time of activity. The relationships of the Barrow Island fauna to the mainland fauna are discussed.

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363. Smithers CN (1982) General report on work carried out under WAPET Research Grant, 1982. WAPET, Perth.

Summary: The main object of this visit was to collect insect specimens from Barrow and surrounding islands. Ten islands were visited, including some of the Lowendals and Montebellos and smaller islands near Barrow. The greatest part of the work was carried out on Barrow Island. By comparison with the vertebrate animals, the insects have been relatively poorly studied on the islands.

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364. Smithers CN (1982) The Psocoptera of Barrow and Boodie islands, Western Australia. *Entomologica Scandinavica* **15**, 215–226.



Figure 14. Spinifex grassland on Barrow Island (Photograph courtesy of ChevronTexaco)

Summary: This paper records the first Psocoptera known from Barrow and Boodie islands, off the west coast of Western Australia. *Liposcelis entomophilus* (Enderlein), *Caecilius* sp., *Peripsocus fici* sp.n. and *Barrowia insularis* gen. et sp.n. occur on Barrow Island; *Cladioneura foliata* sp. occurs on both Barrow and Boodie islands.
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365. Smithers CN (1984) The Neuroptera of Barrow and nearby islands off the west coast of Western Australia. *Australian Entomological Magazine* **11**, 61–68.
Summary: Sixteen species of Neuroptera are listed from Barrow and Montebello Islands off the northwest coast of Western Australia. These include two coniopterygids, one of which is named, one new genus and species of berothid and seven species of chrysopids, of which two are new records for the area. Five myrmeleontids are listed, of which two are probably new species, two are new records for the islands and the fifth probably a synonym of one of the new records from Barrow Island. The single species of *Ascalaphid* is a new species.
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366. Smithers CN (1985) New records of *Pogonella bispinus* (Stål) (Homoptera: Membracidae) from eastern Australia and Barrow Island, Western Australia. *Australian Entomological Magazine* **12**, 35–36.
Summary: This paper gives new locality records for *Pogonella bispinus* (Stål) (Membracidae) in eastern Australia and on Barrow Island, northwestern Western Australia, and records *Plumbago zeylanica* as a host plant.
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367. Smithers CN (1988) Four additional antlion records from Barrow island, Western Australia (Neuroptera: Myrmeleontidae). *Australian Entomological Magazine* **15**, 2.
Summary: Four species of antlions are recorded for the first time from Barrow Island, Western Australia.
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368. Smithers CN, Butler WH (1982) The butterflies (Lepidoptera: Hesperioidea and Papilionoidea) of Barrow and nearby islands, Western Australia. *Western Australian Naturalist* **15**, 141–145.
Summary: This paper contains a synopsis of records of butterflies from Barrow Island and nearby island groups. Sixteen species are recorded from eleven islands, their distribution amongst the islands is tabulated and larval host plants discussed.
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369. Smithers CN, Butler WH (1985) Dragonflies and damselflies (Odonata) from Barrow and nearby islands off the coast of Western Australia. *Australian Entomological Magazine* **12**, 9–12.

Summary: This paper provides records of six species of recently collected Odonata from the Montebello, Lowendal and Barrow Island groups off the coast of Western Australia.
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370. Solem A (1997) *Quistrachia barrowensis* sp.nov. *Records of the Western Australian Museum. Supplement* **50**, 1821–1827.
Summary: Description and range of *Quistrachia barrowensis* sp.nov. from Barrow Island and its associated islets.
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371. Specht RL, Roe EM, Boughton VH (1974) Conservation in Western Australia. In *Conservation of Major Plant Communities in Australia and Papua New Guinea* 519–590. CSIRO, Melbourne.
Summary: Details plant communities on Barrow Island.
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372. Start AN (1995) Barrow Island: feral cat sighting. Department of Conservation and Land Management, Woodvale, WA.
Summary: The objective was to investigate the likelihood of the report of a feral cat sighting being accurate and if so, to arrange for a program to eliminate the animal.
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373. Stokes JL (1846) *Discoveries in Australia: with an Account of the Coasts and Rivers Explored and Surveyed During the Voyage of HMS Beagle, in the Years 1837-38-39-40-41-42-43 by Command of the Lords Commissioners of the Admiralty, also a Narrative of Captain Owen Stanley's Visits to the Islands in the Arafura Sea. Vol. I.* T. & W. Boone, London.
Summary: Sighting of Barrow Island, January 1838. pp. 66–67
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374. Stokes JL (1846) *Discoveries in Australia: with an Account of the Coasts and Rivers Explored and Surveyed During the Voyage of HMS Beagle, in the Years 1837-38-39-40-41-42-43 by Command of the Lords Commissioners of the Admiralty, also a Narrative of Captain Owen Stanley's Visits to the Islands in the Arafura Sea. Vol. II.* T. & W. Boone, London.
Summary: Stokes explored and surveyed Barrow Island and Montebello Island during August 1840. He noted that Barrow Island would make a good penal settlement. pp. 207–214
Copyright note: Permission not required for this summary

375. Stoklosa RT (1988) The relevance of risk assessment in environmental approvals and decision making. *APPEA Journal* **38**, 715–723.
Summary: The relevance of ecological risk assessment is the principal subject of this paper. The petroleum industry has demonstrated expertise in characterising process safety, risk, and can confidently analyse the circumstances of accidental or routine emissions to the environment.
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376. Stoklosa RT (1999) Practical application of environmental risk management: Gorgon LNG Project case study. *APPEA Journal* **39**, 606–620.
Summary: Stoklosa Engineering has been working with the petroleum industry to develop an environmental risk management methodology that can be generally applied to petroleum industry activities. In particular, the methodology is for assessing and managing ecological risk in sensitive marine environments. This paper introduces a management and technical methodology for the risk assessment process that has been applied to planning scenarios for the Gorgon LNG Project. The methodology has evolved from earlier efforts by petroleum operators and government in Western Australia to quantify ecological risk.
Copyright note: Summary reproduced with permission from the Author

377. Storr GM (1984) Birds of the Pilbara Region, Western Australia. *Records of the Western Australian Museum. Supplement* **16**, 1–63.
Summary: This paper is an annotated list of the 284 species of birds recorded from the Pilbara, in the arid north-west of Western Australia. It includes birds recorded from Barrow, Montebello and adjacent islands.
Copyright note: Summary reproduced with permission from the Western Australian Museum – http://www.museum.wa.gov.au/

378. Strickland G (1909) The Game Act, 1892: Proclamation.
Summary: Proclamation by His Excellency Sir Gerald Strickland, Knight Commander of the Most Distinguished Order of St. Michael and St. George, Governor in and over the State of Western Australia and its Dependencies, etc. etc. etc. declaring Barrow Island to be a Reserve for Native Game. The official notice can be found in the Government Gazette, 5 Nov 1909, p. 3533. Copied off: Nature Reserves: Tenure: Barrow Island Game Reserves A 11648. Volume 1: file no. 014578F3102.
Copyright note: Permission not required for this summary

379. Sylvester F, McIlroy J (1979) Interview with Frank Sylvester [SOUND RECORDING]. 1 sound cassette. Western Australian Museum, Perth.
Summary: Frank Sylvester, a NW identity talking to Jack McIlroy about Onslow, Barrow Island and the Kimberleys in the early 20th century. The interview was in connection with Dampier Sites survey.
Copyright note: Permission not required for this summary

380. Thomas BM (1971) Revision of the Upper Cretaceous-Lower Tertiary in the Barrow Island area and its structural significance. West Australian Petroleum, Perth.

Summary: This project is concerned with defining accurately the thickness, extent, and lateral variations in two units, the Toolonga Calcilutite and the Upper Gearle Siltstone. The top of the Lower Gearle Siltstone was also studied, since if defines the base of the lower unit. The Upper Gearle is of Turonian to Cenomanian age; the Toolonga is Santonian to Campanian, together comprising the Upper Cretaceous in this area. The Toolonga Calcilutite is unconformable on the Upper Gearle, and is unconformably overlain by the Tertiary Cardabia Group.
Copyright note: Summary reproduced with permission from ChevronTexaco Australia – http://www.chevrontexaco.com/

381. Thomas BM (1974) Carnarvon Basin: the Neocomian and Tithonian of Barrow Island: a review. West Australian Petroleum, Perth.
Summary: This report follows the completion of the first stage of a full review of Barrow Island and the surrounding areas.
Copyright note: Summary reproduced with permission from ChevronTexaco Australia – http://www.chevrontexaco.com/

382. Thomas BM (1975) The Aptian to Miocene geology of Barrow Island: a review. West Australian Petroleum, Perth.
Summary: This report represents a continuation of the review of Barrow Island geology and complements the report, The Neocomian and Tithonian of Barrow Island: a review by BM Thomas. The present study is concerned mainly with the Winning Group (Early-Late Cretaceous), Toolonga Calcilutite (Late Cretaceous) and basal part of the Cardabia Group (Palaeocene).
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383. Thomas O (1888) *Catalogue of the Marsupialia and Monotremata in the Collection of the British Museum (Natural History)*. BMNH, London.
Summary: Descriptions of specimens held in the British Museum (Natural History). *Macropus isabellinus*, pp. 25; *Petrogale lateralis*, pp. 68–69; *Lagorchestes conspicillatus*, pp. 80–82; *Bettongia lesueur*i, pp. 112–114; *Perameles bougainvillei,* pp. 246–248
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384. Thomas O (1901) On some kangaroos and bandicoots from Barrow Island, NW Australia and the adjoining mainland. *Novitates Zoologicae* **8**, 394–396.
Summary: Discussion on the identification of specimens of kangaroos and bandicoots collected by Mr Tunney. The Tring Museum holds the original specimens of *Macropus robustus*, provided by Mr BH Woodward, Curator of the Western Australian Museum.
Copyright note: Copyright expired 1980

385. Tindale NB (1974) Catalog of Australian Aboriginal tribes: Noala. In *Aboriginal Tribes of Australia: Their Terrain, Environmental Controls, Distribution, Limits and Proper Names* p. 254. Australian National University Press, Canberra.
Summary: Tindale suggests that the Noala tribe visited the Barrow and Montebello islands by using logs as watercraft. He used evidence from King's voyage (26th–27th February, 1818) in which King observed the Noala tribe and their use of watercraft. This was a log that the natives would sit astride and move by propelling it through the water with their hands.
Copyright note: Summary reproduced with permission from the South Australian Museum – http://www.samuseum.sa.gov.au/

386. Trudgen M (1989) A report on the progress of the regeneration of vegetation on areas disturbed during oil production on Barrow Island: prepared for West Australian Petroleum Pty Limited. WAPET, Perth.
Summary: Provides background information on regeneration of disturbed areas on Barrow Island for a review of the environmental management of Barrow Island (and surrounding waters) initiated by WAPET. The study was designed to enable an objective assessment of the progress of the regeneration of Barrow Island. To do this quantitative data from regeneration areas and comparable data from nearby undisturbed areas was collected. The analysis of this data has also meant that practical suggestions for improvements to the restoration program could be made.
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387. URS Australia Pty Ltd (2003) Environmental, social and economic review of the Gorgon gas development on Barrow Island. Appendix C, identification of suitable locations for a land-based gas processing facility linked to the Gorgon gas field. ChevronTexaco Australia, Perth.
Summary: This study has been undertaken to identify suitable onshore locations at which a site for the development of a gas processing facility and export facilities to service the Gorgon gas field, offshore north-western Australia could be established. Environmental, social, logistic, economic and regional planning limitations have been investigated to identify locations having low levels of overall constraint. The outcome of this study process is to identify locations within a broad region where it may be possible to identify specific development sites based on further detailed site specific technical and financial investigations.
Copyright note: Summary reproduced with permission from ChevronTexaco Australia – http://www.chevrontexaco.com/

388. Veitch CR, Clout MN (2002) *Turning the Tide: the Eradication of Invasive Species: Proceedings of the International Conference on Eradication of Island Invasives.* Occasional paper of the IUCN Species Survival Commission **27**

Summary: This 2001 Conference report provides papers on conservation practices used world wide to combat invasive species.
Copyright note: Permission not required for this summary

389. Veritas DGC (2004) 2D Barrow Island. Available at http://www.veritasdgc.com/bins/content_page.asp?cid=6-74-81-314 [accessed 25.10.2005].
Summary: No sector of the oil and gas service industry benefits greater from the advance of technology than companies operating in the geophysical services sector. On the cutting edge of that technology is Veritas DGC Inc., offering the oil and gas industry a comprehensive suite of integrated geophysical services designed to manage exploration risk and enhance drilling and production success worldwide.
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390. Veritas DGC (2004) 3D Barrow Island. Available at http://www.veritasdgc.com/bins/content_page.asp?cid=6-74-81-1818 [accessed 25.10.2005].
Summary: No sector of the oil and gas service industry benefits greater from the advance of technology than companies operating in the geophysical services sector. On the cutting edge of that technology is Veritas DGC Inc., offering the oil and gas industry a comprehensive suite of integrated geophysical services designed to manage exploration risk and enhance drilling and production success worldwide.
Copyright note: Summary reproduced from the Web page

391. Veron JEN, Marsh LM (1988) Hermatypic corals of Western Australia: records and annotated species list. *Records of the Western Australian Museum. Supplement* **29**, 1–136.
Summary: A list of hermatypic coral species from Western Australia is presented for the first time, based principally on the Western Australian Museum collections. Locality and habitat data are given for specimens of 318 species, of 70 genera, from the coast of Western Australia and many of its offshore islands and reefs. Computer analysis of distribution patterns show a major division between reefal and non-reefal regions. Within reefal regions the offshore reefs are distinguished from the more southerly onshore reefs while the Houtman Abrolhos reefs are relatively distinct. Northern and southern non-reefal regions form distinct groups.
Copyright note: Summary reproduced with permission from the Western Australian Museum – http://www.museum.wa.gov.au/

392. Waite ER (1901) A description of *Macropus isabellinus*, Gould. *Records of the Australian Museum* **4**, 131–134.
Summary: The subject of the following description was obtained by Mr JT Tunney at Barrow Island, north-western Australia, on the 16th November, 1900. The prepared skin, together with the skull and leg bones, was forwarded to the Trustees by Mr BH Woodward, Curator of the Western Australian Museum. It represents an adult male, and as ascertained by an examination of the skull, the animal was what Mr Thomas calls 'aged', the fourth molar tooth being in place.
Copyright note: Summary reproduced with permission from the Australian Museum – http://www.amonline.net.au/publications/

393. WAPET (1957) Derby bound July, 1957: being an overland trip of some 2 000 miles through the north-west and Kimberley areas of Western Australia. West Australian Petroleum, Perth.
Summary: This handbook provides the full story of the search for commercial oil in Western Australia and also relates something about the various pioneering enterprises. Included in this report is a list of members of the party and the itinerary.
Copyright note: Summary reproduced with permission from ChevronTexaco Australia – http://www.chevrontexaco.com/

394. WAPET (1981) List of references on Barrow Island and adjacent areas. West Australian Petroleum, Perth.
Summary: List of references compiled by the WAPET library as part of the Barrow Island Research Grant, February 1981.
Copyright note: Permission not required for this summary

395. WAPET (1987) Barrow Island environmental research: list of references on Barrow Island and adjacent areas. West Australian Petroleum, Perth.
Summary: List of references compiled by Technical Information Services.
Copyright note: Permission not required for this summary

396. WAPET (1987) Quarantine policy: Barrow and Thevenard islands. West Australian Petroleum, Perth.
Summary: The objective of WAPET's quarantine policy is to prevent the introduction of foreign species to Barrow Island and Thevenard Island via WAPET's operation. The policy will be implemented through the application of procedures to prevent weed invasion or rodent or insect infestation and the education and awareness of all personnel involved in WAPET's operation. This document provides procedures and guidelines for the quarantine program.
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397. WAPET (1988) Barrow Island fishing guidelines. West Australian Petroleum, Perth.
Summary: These rules express Company policy relative to recreational fishing and shelling at Barrow Island which is an A class Fauna and Flora Reserve.
Copyright note: Summary reproduced with permission from ChevronTexaco Australia – http://www.chevrontexaco.com/

398. WAPET (1988) Quarantine policy and procedures for Barrow Island, February 1988. West Australian Petroleum, Perth.
Summary: The aim of WAPET's quarantine policy is to prevent the introduction of foreign species to Barrow Island through WAPET's operations. The success of this policy is achieved through the implementation of procedures to prevent weed invasion or rodent or insect infestation and the education and awareness of all personnel involved in WAPET's operation. This document provides procedures and guidelines for the quarantine program.
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399. WAPET (1989) Barrow Island oilfield (petroleum lease 1.H): environmental review, 1963 to 1988. West Australian Petroleum, Perth.
Summary: During the development of the Barrow Island Oilfield, WAPET pioneered environmental protection measures and rehabilitation techniques that have now become standard practice throughout the industry. The Barrow Island operation demonstrates that with proper management and planning, development and conservation are not incompatible. This document incorporates an historical account of the oilfield from an environmental perspective and assembles the information and experience accumulated over the years by WAPET employees and consultants who have a wealth of knowledge of the oilfield development and the Barrow Island ecosystem.
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400. WAPET (1989) Barrow Island oilfield (petroleum lease 1.H): environmental review: appendices. West Australian Petroleum, Perth.
Summary: This part of the environmental review is comprised of Appendix A, climate; Appendix B, vegetation; Appendix C, fauna.
Copyright note: Summary reproduced with permission from ChevronTexaco Australia – http://www.chevrontexaco.com/

401. WAPET (1989) Contractor induction. West Australian Petroleum, Perth.
Summary: A procedures manual for personnel working or visiting Barrow Island. This manual includes environmental policy and procedure, vehicle operations, policy and procedure, animal hazards, pressure hazards in the field, safety policy and standards, emergency procedures and fishing regulations.
Copyright note: Permission not required for this summary

402. WAPET (1991) Barrow Island contractor induction. West Australian Petroleum, Perth.
Summary: A procedures manual for personnel working or visiting Barrow Island. This manual includes environmental requirements and policy; safety policy, guidelines and emergency procedures; radio procedures; vehicle operations; animal hazards; recreational and fishing guidelines.
Copyright note: Summary reproduced with permission from ChevronTexaco Australia – http://www.chevrontexaco.com/

403. WAPET (1991) Barrow Island oilfield (petroleum lease 1.H): environmental review update, 1989–1991. West Australian Petroleum, Perth.
Summary: Three years ago it was considered timely to formalise a conservation strategy for Barrow Island into a document that established a benchmark for the on-going environmental management program. This document is the first update of the environmental and operational activities. The update builds on the historical account of the oilfield recorded in the original document. Appendix A is a progress report of a University of Western Australia study.
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404. WAPET (1992) Proposed 1993 Barrow Island 3-D seismic survey: presentation to National Parks and Nature Conservation Authority, August 1992. West Australian Petroleum, Perth.
Summary: The objective of this survey is to further delineate stratigraphic oil prospects recognised in the northern part of Barrow Island on the existing 2-D seismic data. Those prospects which are matured following interpretation of this 3-D data set will become candidates for possible drilling in 1994/1995.
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405. WAPET (1993) *Barrow Island*. West Australian Petroleum, Perth.
Summary: A brief summary of the early history, the natural history and the arrival of West Australian Petroleum P/L to explore for oil in 1964.
Copyright note: Summary reproduced with permission from ChevronTexaco Australia – http://www.chevrontexaco.com/

406. WAPET (1994) Close-out environmental report, 1994 north Barrow 3D seismic program : project 482. West Australian Petroleum, Perth.
Summary: This rehabilitation project was conducted between January and June 1994. Approximately 743 km of line was cleared (minus those areas which were not cleared due to environmental sensitivity). A total of 886 km of line were recorded of which 376 km were source lines and 520 km were receiver lines. Appendix 2 is the Progress report on the review of revegetation techniques on the seismic lines, Barrow Island, by EM Mattiske and Associates. Copied off: Nature Reserves: Tenure: 11648 Barrow Island and 38728 Middle Island, Boodie Island, Double Island. Volume 7: file no. 034447F3102.
Copyright note: Summary reproduced with permission from ChevronTexaco Australia – http://www.chevrontexaco.com/

407. WAPET (1995) General project description for the Gorgon LNG development. West Australian Petroleum, Perth.
Summary: This document describes the Gorgon LNG Project as it is currently understood, and details to some extent the environmental implications of the Project. Its purpose is to provide sufficient detail about the Project and its environmental implications, for the government to be able to determine the level and method of environmental assessment for the Project under the relevant environmental protection acts.
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408. WAPET (1995) Preliminary environmental report on the Gorgon LNG development. West Australian Petroleum, Perth.
Summary: This document describes the Gorgon LNG Project as it is currently understood, and details to some extent the environmental implications of the project. This document was written to fulfil several requirements. It is intended to provide enough information so that the Commonwealth and Western Australian Ministers can consider the environmental significance of the Project and address statutory obligations associated with anticipated requests for Foreign Investment Review Board (FIRB) approval, to give approval for the export of LNG, to award Production and Pipeline Licences and the associated State Licences. The background to the project, description and the environmental issues associated with the project are included in this document.
Copyright note: Summary reproduced with permission from ChevronTexaco Australia – http://www.chevrontexaco.com/

409. WAPET (1997) Barrow Island oilfield environmental review, 1992–1996. West Australian Petroleum, Perth.
Summary: The objective of this review is to expand the record of development and environmental management on Barrow Island by documenting important activities which have taken place during the period 1992 to 1996. This information is of use for the ongoing environmental management of WAPET's operations. The general structure of this document follows that of the original document and builds on the historical data base. The report reviews new projects and changes within the oilfield, natural events affecting the island's ecology, scientific projects and visits by interested parties.
Copyright note: Summary reproduced with permission from ChevronTexaco Australia – http://www.chevrontexaco.com/

410. WAPET (1999) Barrow Island annual environmental report, 1998. West Australian Petroleum, Perth.
Summary: The scope of the report includes significant operational and facility activities and changes; significant environmental impacts and incidents; environmental monitoring status and results; environmental specialist studies; significant project-specific environmental management; and annual discharge and pollution prevention licence reporting requirements.
Copyright note: Summary reproduced with permission from ChevronTexaco Australia – http://www.chevrontexaco.com/

411. Westerman M, Krajewski C (2000) Molecular relationships of the Australian bandicoot genera *Isoodon* and *Perameles* (Marsupialia: Peramelina). *Australian Mammalogy* **22**, 1–8.
Summary: The two Australian bandicoot genera *Perameles* and *Isoodon* diverged in the middle Miocene. The Barrow Island *Isoodon auratus* may not be recognisable as a separate subspecies.
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412. White HL (1918) Black-and-white wren of Barrow Island, WA. *Emu* **17**, 179.
Summary: Describes the nest of the black-and-white wren.
Copyright note: Copyright expired 1978

413. White HL (1918) Descriptions of two new nests and eggs. *Emu* **18**, 127–128.
Summary: Mr Whitlock visited Barrow Island under a special permit from the Western Australian Government. He was asked to pay particular attention to the black-and-white wren *Malurus leucopterus edouardi* and collect some eggs. He also collected the nest and eggs of *Eremiornis carteri*, desert-bird.
Copyright note: Copyright expired 1978

414. White M (1993) Combined vascular plant species list. M White, Perth.
Summary: This combined vascular plant species list includes collection details from Buckley, Lewis & Grierson, Mattiske and Trudgen as well as those held in the Barrow Island, Karratha and Perth herbariums. Copied off: Nature Reserves: Tenure: 11648 Barrow Island and 38728 Middle Island, Boodie Island, Double Island. Volume 7: file no. 034447F3102.
Copyright note: Permission not required for this summary

415. Whitlock FL (1918) Notes on north-western birds. *Emu* **17**, 166–179.
Summary: Notes on birds seen on Barrow Island, October 1918.
Copyright note: Copyright expired 2004

416. Whitlock FL (1919) Notes on birds breeding in Dampier Archipelago, NW coast of Australia. *Emu* **18**, 240–253.
Summary: Notes of a visit and account of fauna seen by Whitlock to Barrow Island, 1918.
Copyright note: Permission not required for this summary

417. Whittell HM (1938) Notes on field-trips of JT Tunney. *Emu* **38(3)**, 322–326.
Summary: An account of the expeditions of JT Tunney who collected specimens for the WA Museum. JT Tunney arrived on Barrow Island on October 20, 1900.
Copyright note: Copyright expired 2005



Figure 15. Barge at WAPET Landing (Photograph courtesy of ChevronTexaco)

418. Withers PC (1992) Metabolism, water balance and temperature regulation in the golden bandicoot (*Isoodon auratus*). *Australian Journal of Zoology* **40**, 523–531.
Summary: The Barrow Island golden bandicoot (*Isoodon auratus*) is a small arid-adapted marsupial. It has a low and labile body temperature, a low basal metabolic rate, a low thermal conductance, and a low rate of evaporative water loss. Its metabolic, thermal and hygric physiology resembles that of another arid-adapted bandicoot, the bilby, and differs from temperate and tropical bandicoots.
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419. Withers P, Pedler S, Guppy M (1997) Physiological adjustments during aestivation by the Australian land snail *Rhagada tescorum* (Mollusca: Pulmonata: Camaenidae). *Australian Journal of Zoology* **45**, 599–611.
Summary: Specimens of the camaenid snail *Rhagada tescorum* were collected from Barrow Island, where they typically aestivate underground during the long dry season and emerge after heavy rainfall.
Copyright note: Summary reproduced with permission from CSIRO Publishing – http://www.publish.csiro.au/journals/ajz

420. Wood Jones F (1922) The external characters of pouch embryos of marsupials. No. 3, *Isoodon* barrowensis. *Transactions of the Royal Society of South Australia* **46**, 39–45.
Summary: Notes on the three embryonic stages obtained for description. Specimens were from the Perth Museum.
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421. Woodward BH (1905) Recent discoveries regarding the fauna of Western Australia. *Journal of the West Australian Natural History Society* **2**, 7–20.
Summary: A collection of descriptions of mammals and birds.
Copyright note: Permission not required for this summary

422. Wooller RD, Bradley JS (1981) Consistent individuality in the calls of the spinifexbirds *Eremiornis carteri* on Barrow Island, WA. *Emu* **81**, 40.
Summary: The spinifexbird *Eremiornis carteri*, as its name suggests, is found mainly in areas of spinifex *Triodia* spp, in north-western Australia with records from central Northern Territory and central Queensland. On the mainland it is a shy secretive bird and thus rarely recorded by casual observers. It is the most common bird on Barrow Island.
Copyright note: Summary reproduced with permission from Birds Australia – http://www.birdsaustralia.com.au/

423. Wooller RD, Calver MC (1981) Diet of three insectivorous birds on Barrow Island, WA. *Emu* **81**, 48–50.
Summary: The diets of the three most common birds on the island: singing honeyeater *Meliphaga virescens*, spinifexbird *Eremiornis carteri* and black-and-white fairy-wren *Malurus I. leucopterus.*
Copyright note: Summary reproduced with permission from Birds Australia – http://www.birdsaustralia.com.au/

424. Young R (1995) Population differentiation in the burrowing bettong *Bettongia lesueur*: determined using restriction fragment length polymorphisms (RFLPs) of the mitochondrial genome. Thesis (BScHons) — La Trobe University, Victoria.
Summary: As the burrowing bettong is an endangered species, information about the genetic structure of the different island populations could be useful for the conservation of the species' diversity.
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Relevant Australian and Western Australian Acts and Codes of Practice

(IN ALPHABETICAL ORDER BY TITLE)

1. Government of Western Australia (1972). Aboriginal Affairs Planning Authority Act 1972. Government Printer, Perth. 1 v.
Summary: An Act to make provision for the establishment of an Aboriginal Affairs Planning Authority, a Commissioner for Aboriginal Planning and an Aboriginal Affairs Advisory Council for the purpose of providing consultative and other services and for the economic, social and cultural advancement of persons of Aboriginal descent in Western Australia, to repeal the Native Welfare Act 1963, and for incidental and other purposes.

2. Government of Australia (1984). Aboriginal and Torres Strait Islander Heritage Protection Act 1984. Australian Government Publishing Service, Canberra. 1 v.
Summary: An Act to preserve and protect places, areas and objects of particular significance to Aboriginals, and for related purposes.

3. Government of Western Australia (1972). Aboriginal Heritage Act 1972. Government Printer, Perth. 1 v.
Summary: An Act to make provision for the preservation on behalf of the community of places and objects customarily used by, or traditional to the original inhabitants of Australia or their descendants, or associated therewith, and for other purposes incidental thereto.

4. Government of Western Australia (2002). Animal Welfare Act 2002. Government Printer, Perth. 1 v.
Summary: An Act to provide for the welfare, safety and health of animals, to regulate the use of animals for scientific purposes, and for related purposes.

5. Government of Western Australia (2003). Animal Welfare (General) Regulations 2003. Government Printer, Perth. 1 v.
Summary: The accompanying Regulations to the Animal Welfare Act, 2002, to provide for the welfare, safety and health of animals, to regulate the use of animals for scientific purposes, and for related purposes.

6. Government of Western Australia (2003). Animal Welfare (Scientific Purposes) Regulations 2003. Government Printer, Perth. 1 v.
Summary: The accompanying Regulations to the Animal Welfare Act, 2002, to provide for the welfare, safety and health of animals, to regulate the use of animals for scientific purposes, and for related purposes.

7. National Health and Medical Research Council, Australia (2004). Australian code of practice for the care and use of animals for scientific purposes. – 7th ed. Available at mrc.gov.au/publications/synopses/ea16syn.htm [accessed 25.10.2005]. National Health and Medical Research Council, Canberra. 84 p.
Summary: The Code encompasses all aspects of the care and use of, or interaction with, animals for scientific purposes in medicine, biology, agriculture, veterinary and other animal sciences, industry and teaching. It includes their use in research, teaching, field trials, product testing, diagnosis, the production of biological products and environmental studies. The Code provides general principles for the care and use of animals, specifies the responsibilities of investigators and institutions, and details the terms of reference, membership and operation of AECs. It also provides guidelines for the humane conduct of scientific and teaching activities, and for the acquisition of animals and their care, including their environmental needs. The Code covers all live non-human vertebrates and higher order invertebrates. Investigators and teachers should take into account emerging knowledge, ethical values when proposing to use other animal species not covered by the Code. Animals in early stages of their development, that is in their embryonic, fetal and larval forms, can experience pain and distress but this occurs at different stages of development in different species and thus decisions as to their welfare should, where possible, be based on evidence of their neurobiological development.
Summary reproduced from the Web page

8. Government of Australia (1975). Australian Heritage Commission Act 1975. Australian Government Publishing Service, Canberra. 1 v.
Summary: An Act to establish an Australian Heritage Commission.

9. Government of Western Australia (2003). Barrow Island Act 2003. Government Printer, Perth. 1 v.
Summary: An Act: to ratify, and authorise the implementation of, an agreement between the State and the Gorgon joint venturers relating to a proposal to undertake offshore production of natural gas and other petroleum and a gas processing and infrastructure project on Barrow Island; the agreement having been entered into having regard to the need to minimise environmental disturbance on Barrow Island (a class A nature reserve) and providing for the support of conservation programs relating to Barrow Island and other parts of the State; to make provisions to enable land on Barrow Island (but no more than 300 ha in total of uncleared land) to be used, under the Land Administration Act 1997, for gas processing project purposes; to make provisions as to the conveyance and underground disposal of carbon dioxide recovered during gas processing on Barrow Island, and for incidental purposes.

10. Government of Western Australia (1985). Barrow Island Royalty Trust Account Act 1985. Government Printer, Perth. 1 v.
Summary: An Act relating to the royalty payable

under the Barrow Island petroleum lease and incidental and other matters.

11. Government of Western Australia (1985). Barrow Island Royalty Variation Agreement Act 1985. Government Printer, Perth. 1 v.
Summary: An Act to ratify an agreement between the State of Western Australia and West Australian Petroleum Pty. Limited relating to Petroleum Lease 1H granted under the Petroleum Act 1936, to amend the Petroleum Act 1967 and for related purposes.

12. Government of Western Australia (1954). Bush Fires Act 1954. Government Printer, Perth. 1 v.
Summary: An Act to make better provision for diminishing the dangers resulting from bush fires, for the prevention, control and extinguishment of bush fires, for the repeal of the Bush Fires Act 1937 (2) and for other purposes.

13. Government of Western Australia (1984). Conservation and Land Management Act 1984. Government Printer, Perth. 1 v.
Summary: An Act to make better provision for the use, protection and management of certain public lands and waters and the flora and fauna thereof, to establish authorities to be responsible therefore, and for incidental or connected purposes.

14. Government of Australia (1903). Defence Act 1903. Australian Government Publishing Service, Canberra. 1 v.
Summary: An Act to provide for the naval and military defence and protection of the Commonwealth and of the several States

15. Government of Australia (1999). Environment Protection and Biodiversity Conservation Act 1999. Australian Government Publishing Service, Canberra. 1 v.
Summary: An Act relating to the protection of the environment and the conservation of biodiversity, and for related purposes.

16. Government of Australia (1981). Environment Protection (Sea Dumping) Act 1981. Australian Government Publishing Service, Canberra. 1 v.
Summary: An Act providing for the protection of the environment by regulating dumping into the sea, incineration at sea and artificial reef placements, and for related purposes.

17. Government of Western Australia (1986). Environmental Protection Act 1986. Government Printer, Perth. 1 v.
Summary: An Act to provide for an Environmental Protection Authority, for the prevention, control and abatement of environmental pollution and environmental harm, for the conservation, preservation, protection, enhancement and management of the environment and for matters incidental to or connected with the foregoing.

18. Government of Australia (1999). Environmental Reform (Consequential Provisions) Act 1999. Australian Government Publishing Service, Canberra. 1 v.
Summary: An Act relating to the protection of the environment and the conservation of biodiversity, and for related purposes

19. Government of Western Australia (1961). Explosives and Dangerous Goods Act 1961. Government Printer, Perth. 1 v.
Summary: An Act to consolidate and amend the law relating to explosives; to regulate the manufacture, importation and use of explosives, and the classification, marking, storage, carriage, and sale of explosives and dangerous goods; and for other incidental purposes.

20. Government of Western Australia (1994). Fish Resources Management Act 1994. Government Printer, Perth. 1 v.
Summary: An Act relating to the management of fish resources, to repeal and amend certain Acts, and for related purposes.

21. Government of Western Australia (1928). Harbours and Jetties Act 1928. Government Printer, Perth. 1 v.
Summary: An Act to amend the law relating to the liability of owners of ships for damage to harbours and jetties, and works connected therewith.

22. Government of Western Australia (1911). Health Act 1911. Government Printer, Perth. 1 v.
Summary: An Act to consolidate and amend the law relating to public health.

23. Government of Western Australia (1990). Heritage of Western Australia Act 1990. Government Printer, Perth. 1 v.
Summary: An Act to provide for, and to encourage, the conservation of places which have significance to the cultural heritage in the State, to establish the Heritage Council of Western Australia, and for related purposes.

24. Government of Australia (1976). Historic Shipwrecks Act 1976. Australian Government Publishing Service, Canberra. 1 v.
Summary: An Act relating to the protection of certain shipwrecks and relics of historic significance

25. Government of Western Australia (1997). Land Administration Act 1997. Government Printer, Perth. 1 v.
Summary: An Act to consolidate and reform the law about Crown land and the compulsory acquisition of land generally, to repeal the Land Act 1933 and to provide for related matters.

26. Government of Western Australia (1981). Marine and Harbours Act 1981. Government Printer, Perth. 1 v.
Summary: An Act to provide for the advancement of efficient and safe shipping and effective boating and port administration through the provision of

certain facilities and services, and for incidental and connected purposes.

27. Government of Western Australia (1973). Marine Navigational Aids Act 1973. Government Printer, Perth. 1 v.
Summary: An Act relating to the establishment, maintenance and use of marine navigational aids.

28. Government of Western Australia (1973). Maritime Archaeology Act 1973. Government Printer, Perth. 1 v.
Summary: An Act to make provision for the preservation on behalf of the community of the remains of ships lost before the year 1900, and of relics associated therewith, and for other purposes incidental thereto.

29. Government of Western Australia (1978). Mining Act 1978. Government Printer, Perth. 1 v.
Summary: An Act to consolidate and amend the law relating to mining and for incidental and other purposes.

30. Government of Australia (1993). Native Title Act 1993. Australian Government Publishing Service, Canberra. 1 v.
Summary: An Act about native title in relation to land or waters, and for related purposes.

31. Government of Australia (1998). Native Title Amendment Act 1998. Australian Government Publishing Service, Canberra. 1 v.
Summary: An Act to amend the Native Title Act 1993, and for related purposes.

32. Government of Western Australia (1999). Native Title (State Provisions) Act 1999. Government Printer, Perth. 1 v.
Summary: An Act to make: alternative provisions to those contained in Part 2 Division 3 Subdivision P of the Native Title Act 1993 of the Commonwealth, in accordance with sections 43 and 43A of that Act; provisions that are supplementary to those in section 24MD(6B) of that Act; and, provision for delegations in respect of the State under section 199F of that Act, to consequentially amend certain Acts, and for related purposes.

33. Government of Western Australia (1989). Occupational Safety and Health Act 1984. Government Printer, Perth. 1 v.
Summary: An Act to promote and improve standards for occupational safety and health, to establish the Commission for Occupational Safety and Health, to facilitate the co-ordination of the administration of the laws relating to occupational safety and health and for incidental and other purposes.

34. Government of Western Australia (1967). Petroleum Act 1967. Government Printer, Perth. 1 v.
Summary: An Act relating to the exploration for, and the exploitation of, petroleum resources, and certain other resources, within certain lands of the State; to repeal the Petroleum Act 1936, and for incidental and other purposes.

35. Government of Western Australia (1969). Petroleum Pipelines Act 1969. Government Printer, Perth. 1 v.
Summary: An Act relating to the construction, operation and maintenance of pipelines for the conveyance of petroleum and for purposes connected therewith.

36. Government of Western Australia (1999). Petroleum Safety Act 1999. Government Printer, Perth. 1 v.
Summary: An Act relating to the safety and health of persons at, and in respect of, petroleum sites and for related purposes.

37. Government of Australia (1967). Petroleum (Submerged Lands) Act 1967. Australian Government Publishing Service, Canberra. 1 v.
Summary: An Act relating to the exploration for, and the exploitation of, the petroleum resources, and certain other resources, of, and to the transfer of petroleum resources (wherever recovered) across, the Continental Shelf of Australia and of certain Territories of the Commonwealth and certain other submerged land

38. Government of Western Australia (1982). Petroleum (Submerged Lands) Act 1982. Government Printer, Perth. 1 v.
Summary: An Act to make provision with respect to the exploration for and the exploitation of the petroleum resources, and certain other resources, of certain submerged lands adjacent to the coast of Western Australia, to repeal the Petroleum (Submerged Lands) Act 1967, and for incidental and other purposes.

39. Government of Australia (2001). Petroleum (Submerged Lands) Legislation Amendment Act 2001. Australian Government Publishing Service, Canberra. 1 v.
Summary: An Act to amend the Petroleum (Submerged Lands) Act 1967, and for other purposes

40. Government of Western Australia (1987). Pollution of Waters by Oil and Noxious Substances Act 1987. Government Printer, Perth. 1 v.
Summary: An Act relating to the protection of the sea and certain waters from pollution by oil and other noxious substances discharged from ships and places on land and for related purposes.

41. Government of Australia (1981). Protection of the Sea (Civil Liability) Act 1981. Australian Government Publishing Service, Canberra. 1 v.
Summary: An Act relating to civil liability for pollution damage

42. Government of Australia (1981). Protection of the Sea (Powers of Intervention) Act 1981. Australian Government Publishing Service, Canberra. 1 v.

Summary: An Act authorizing the Commonwealth to take measures for the purpose of protecting the sea from pollution by oil and other noxious substances discharged from ships, and for related purposes.

43. Government of Australia (1983). Protection of the Sea (Prevention of Pollution from Ships) Act 1983. Australian Government Publishing Service, Canberra. 1 v.
Summary: An Act relating to the protection of the sea from pollution by oil and other harmful substances discharged from ships

44. Government of Australia (1908). Quarantine Act 1908. Australian Government Publishing Service, Canberra. 1 v.
Summary: An Act relating to quarantine

45. Government of Western Australia (1967). Shipping and Pilotage Act 1967. Government Printer, Perth. 1 v.
Summary: An Act relating to shipping and pilotage in and about the ports, fishing boat harbours and mooring control areas of the State; to repeal the Shipping and Pilotage Act 1855 and the Ports and Harbours Act 1917; and for incidental and other purposes.

46. Government of Western Australia (1966). Transport Co-ordination Act 1966. Government Printer, Perth. 1 v.
Summary: An Act to provide for the co-ordination, planning and advancement of all forms of transport in this State, to provide for the review, control and licensing of transport services and for incidental and other purposes.

47. Government of Western Australia (1982). Western Australian Marine Act 1982. Government Printer, Perth. 1 v.
Summary: An Act to regulate navigation and shipping.

48. Government of Western Australia (1981). Western Australian Marine (Sea Dumping) Act 1981. Government Printer, Perth. 1 v.
Summary: An Act to provide for the protection of the environment by regulating the dumping into the sea, and the incineration at sea, of wastes and other matter and the dumping into the sea of certain other objects, and for other purposes.

49. Government of Western Australia (1950). Wildlife Conservation Act 1950. Government Printer, 1 v.
Summary: An Act to provide for the conservation and protection of wildlife

50. Government of Western Australia (1970). Wildlife Conservation Regulations 1970. Government Printer, 1 v.
Summary: The accompanying Regulations to the Wildlife Conservation Act, 1950, to provide for the conservation and protection of wildlife