CONSERVING THREATENED ECOLOGICAL COMMUNITIES THROUGHOUT WESTERN AUSTRALIA (ESPECIALLY OUTSIDE THE SOUTH WEST BOTANICAL PROVINCE)

ENVIRONMENT AUSTRALIA NATIONAL RESERVES SYSTEM COOPERATIVE PROGRAM: PROJECT NUMBER N727

INTERIM REPORT: JUNE 1998

by

V. English and J. Blyth

Research and the collation of information presented in this report was undertaken with funding provided by the Biodiversity Group, Environment Australia. The project was undertaken for the National Reserves System program (Project N727).

Western Australian Threatened Species and Communities Unit
Department of Conservation and Land Management
Western Australian Wildlife Research Centre
PO Box 51, Wanneroo, WA 6065.

INTERIM REPORT TO ENVIRONMENT AUSTRALIA NATIONAL RESERVES SYSTEM PROGRAM

Project title: 'Conserving threatened ecological communities (TECs) throughout Western Australia (especially outside the South West Botanical Province)'.

Project Number: N727

Project Officer: Valerie English

Commencement date of project: 3 March 1998 (initial proposed commencement date 1 January 1998). Interim Report due 30 June 1998

Extent of Project Area: The project area is the state of Western Australia, especially outside the southwestern agricultural area and within the pastoral and mining regions (see Figure 1).

Precis: Liaison has been established with stakeholder groups and individuals likely to influence the management of potentially threatened ecological communities. Information has been gathered from the literature and from people with expertise in various community types. From this, a list of 139 possibly threatened ecological communities outside of the South West Botanical Province has been developed.

A new Scientific Advisory Committee for the threatened ecological community projects has been formed. Two ecological communities have been entered on the database and assigned the category of Critically Endangered by the advisory group. An additional community has been assigned the category of Lower Risk. Maps indicating the location of these three communities have been produced.

Field assessment of occurrences of six communities has been conducted, in liaison with relevant landholders. Information on data requirements for assessing the status of TECs has been provided to relevant staff of CALM's Goldfields Region.

The main limitation of the study is lack of sufficient data for assessing many of the communities possibly threatened against the criteria for defining categories of conservation status. The defining characteristics and/or extent of many of the communities proposed for inclusion on the database are not known and require additional research.

Scope:

1. *Establish and maintain liaison with appropriate District staff of Agriculture WA, pastoral Land Conservation District Committees (LCDCs) and individual pastoralists, the Department of Minerals and Energy, the Environmental Committee of the Chamber of Mines and particular mining companies, Aboriginal communities and other relevant land managers.*

Representatives of all of the groups mentioned above have been contacted by letter and/or phone. A total of 96 letters were sent. The letters informed recipients about the original and the current threatened ecological community projects, and requested information about potentially threatened communities. A great deal of information has been provided by those contacted.

The goal of largely completing this scope item by August 1998 has been achieved. Liaison will be continued, as required, with those contacted.

2. *Gather information from the literature, and that held by CALM staff and other scientists, Agriculture WA, LCDCs, local naturalists, community groups and landholders, to identify possibly threatened ecological communities and areas that may contain them.*

A search of available literature has been conducted, and has revealed a significant number of communities that have been included on the list of potentially threatened ecological communities. In addition, as part of the liaison performed under Scope Item 1, above, information was obtained from many scientists, land holders and other groups and individuals about areas that may fit the definition of threatened ecological community. A list of 139 possibly threatened communities has been compiled to date from all information sources (refer Attachment 1). The original milestones proposed that forty possibly threatened communities would be identified by June 1998. This number has already been greatly exceeded, despite the project commencing two months later than expected.

3. *Provide training to staff of CALM's Midwest, Pilbara, Kimberley and Goldfields regions on the identification and conservation of threatened ecological communities.*

A field trip was conducted in April 1998 to the Goldfields and South Coast Region to investigate occurrences of the six possibly threatened ecological communities listed below. Field investigations were conducted with staff from CALM's Goldfields Region. Information was provided about data requirements for assessing the applicable category of threat to these staff in the field.

1	Microbialite community, Lake Cowan near Norseman
2	Permanent to semi-permanent brackish to fresh water wetlands with belts of *Samphire* and *Melaleuca* around the perimeter of the Goldfields region
3	Lignum Swamps of the Goldfields Region
4	Permanent to semi-permanent wetlands with *Ruppia* across the lake floor of the Goldfields region
5	Goldfields granite outcrop assemblages
6	Woodline Hills vegetation complexes

The original milestones proposed that training in the identification and conservation of threatened ecological communities would have been provided for two CALM regions by August 1998. This goal is likely to be reached by the specified time, despite the project commencing later than expected.

4. *Conduct field survey (with the agreement of land managers) to confirm the existence, distribution, boundaries and condition of any possibly threatened ecological communities and threatening processes affecting them.*

As mentioned under Scope Item 3, six potentially threatened ecological communities were investigated in the field in April 1998. Some occurrences were on leasehold land, (e.g. wetlands and ironstone hills on Madoonia Downs Station), and land managers were consulted prior to such surveys.

Information was collected about the boundaries of occurrences, condition and threatening processes during field investigations.

The original milestones proposed that field investigations would be carried out for five possibly threatened communities by June 1998. This number has already been exceeded.

5. *Begin to enter communities thus identified onto the TEC database, along with available data*

There was sufficient information on nomination forms to enter two communities on the database without the need for additional field work (the Cameron's Cave community and the Remipede Community of caves of the Cape Range). In addition, data on the stromatolites of Hamelin Pool has been updated following reassessment of the status of the community by the Advisory Group (refer Scope Item 6). A hard copy of data for these three communities from the computer database occurs as Attachment 2.

It was proposed that three communities would be entered on the database by August 1998. This goal is very likely to be achieved.

6. *Commence assessment of each community on the database and allocate it to one of the categories Critically Endangered, Endangered, Vulnerable, Data Deficient or Lower Risk.*

The first meeting of the Advisory Group was conducted on 23 June 1998. The committee utilised information from the database and nomination forms to assess three communities outside the south west of the state against the criteria. The categories assigned by the group are as follows:

TABLE 1 - Categories assigned to communities on the threatened ecological communities database

Community	**Category**	**Criteria met (refer Attachment 3) / Comments**
Cameron's Cave community	Critically Endangered	B (i) and B (ii)
Cape Range remipede community (Bundera Sinkhole)	Critically Endangered	B(i)
Hypersaline microbial community 2 (Hamelin Pool, Shark Bay)	Lower Risk	Survey of the boundaries of this community is continuing. Its status should be reviewed within one year.

This exceeds the stated June 1998 goal of two communities evaluated.

Maps indicating the locations of the communities that are on the threatened community database have been produced and will occur as attachments to the final report.

7. *In close liaison with other stakeholders, begin to develop management mechanisms for conserving and/or rehabilitating identified TECs. These mechanisms will include interim recovery plans, management agreements and acquisition in a variety of ways for addition to the reserve system.*

Information relevant to the assessment of management actions required has been gathered for communities on the database. In addition, the Advisory Group has provided suggestions about appropriate management mechanisms for the two communities identified as critically endangered (refer Scope Item 6). Management recommendations have been entered on the database (refer Attachment 2). Interim Recovery Plans that include such recommendations, where appropriate, are to be drafted as part of this project.

The two cave communities mentioned in Scope Item 6 occur in CALM's Pilbara region. Liaison has already been initiated between the Threatened Species and Communities Unit, the relevant CALM District and the land manager to ensure that conservation values are considered in developments that may impact the Cameron's Cave community.

Liaison to initiate appropriate management mechanisms will be ongoing throughout the project.

8. *Provide continual feedback on progress to all stakeholders, including Regional and State Assessment Panels, land managers and owners and land care groups, and use local media extensively to report regional and local achievements, including acknowledgment of the support provided by the National Reserve System program, and Natural Heritage Trust, where appropriate.*

Action has not yet begun on this scope item, as specified in the draft work schedule.

References

Beard, J. S., 1990. Plant Life of Western Australia. Kangaroo Press, Kenhurst, NSW.

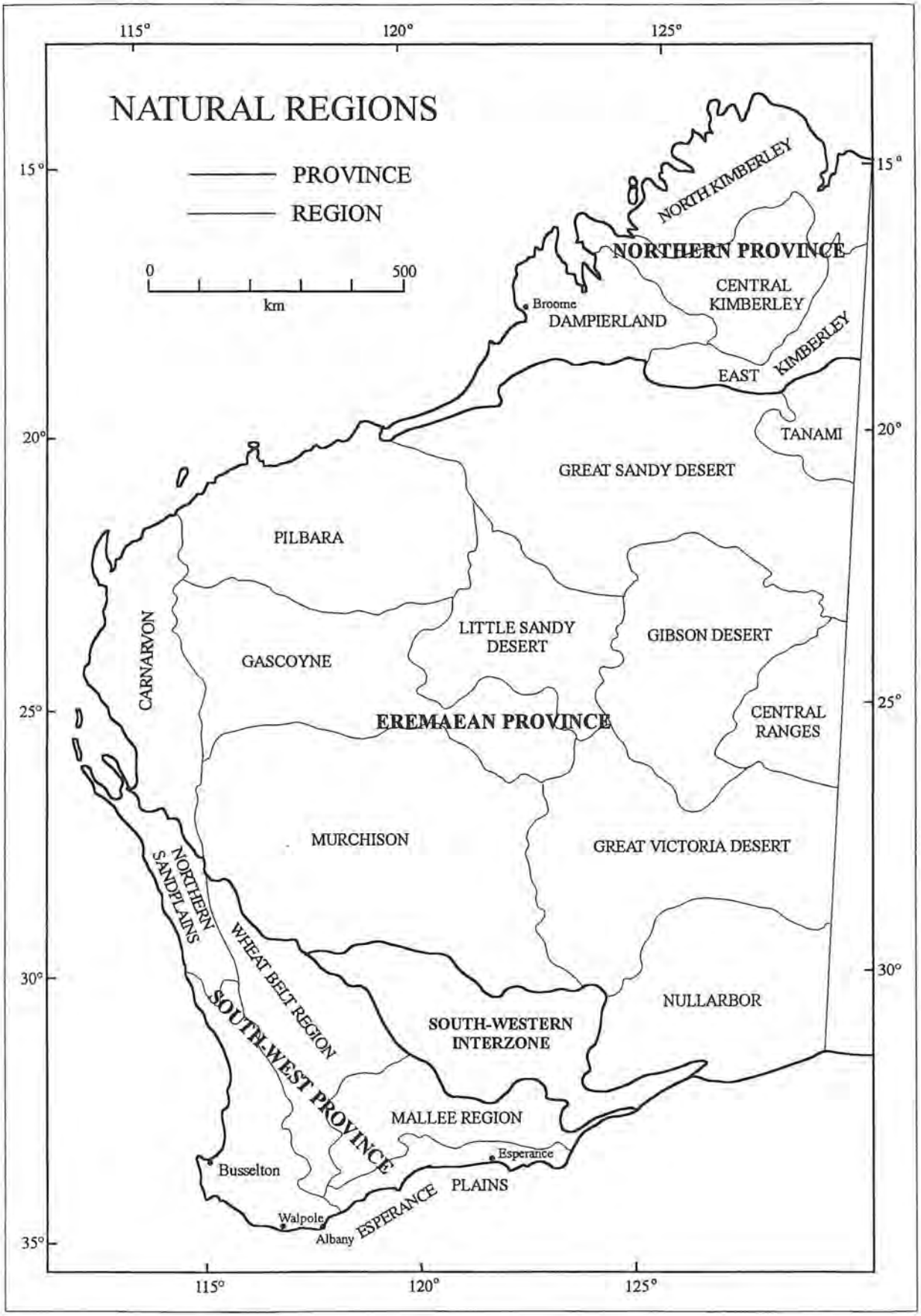

Figure 1: The study area of Project N727 (adapted from Beard 1990). Western Australia, especially outside the South West Botanical Province.

Attachment 1

POSSIBLY THREATENED ECOLOGICAL COMMUNITIES OUTSIDE THE SOUTHWEST BOTANICAL PROVINCE 24/6/98

Note;

i) Nothing in this table may be construed as a nomination for listing under the Commonwealth *Endangered Species Protection Act 1992*.

ii)The inclusion in this table of a community type does not necessarily imply any status as a threatened ecological community. Only communities that have been assessed (see column 1 "Assessed - category") and found to be critically endangered, endangered or vulnerable are defined as threatened ecological communities (TECs).

iii) Column 2 and 3 ("On dbase complete" or "incomplete") indicate that there is probably sufficient information to assess the community against the criteria for degree of threat, but this has generally not yet been done.

iv) Column 4 indicates only that the community has been surveyed in the field ("Field survey complete"), and has not necessarily been added to the database or assessed.

v) The final column (column 5 - "Insuff. info.") indicates there is currently insufficient information to know if the community should be on the database.

vi) Communities in the Table are in a roughly descending order of priority based on current knowledge of the community, its current extent and threats to it.

vii) Regions eg Midwest are based on Department of Conservation and Land Management regional boundaries

viii) For definitions of categories of threat (CR etc.) refer Attachment entitled "Definitions and Categories"

ix) Communities in italics are broadscale and require further survey to determine their status.

PILBARA

No.	Community	Assessed-category	On dbase complete	On dbase In-complete	Field survey complete	Insuff. info.
1	Remipede community (Cameron's Cave - Cape Range) (Hamilton-Smith *et al.* 1998; B. Humphries pers. comm.)	CR	+			
2	Remipede community (C-28 - Bundera Sinkhole, Cape Range) (B. Humphries pers. comm.)	CR	+			
3	Spring community (Weeli Wolli Spring ~ 400 m by 4 km) (S. van Leeuwen pers. comm)					
4	Barlee Range Clay pan community (Yadjiyagga ~ 10 ha) (Handley, 1997; ANCA, 1996; S. van Leeuwen pers. comm)					
5	Clay pan communities of the Fortescue Valley (*Themeda* grasslands) (M. Trudgen pers. comm.)					
6	Alluvial clay flat communities of Mt Bruce Flats, Munjina Claypan (Juna Downs Stn), Coondewanna Flats - Lake Robinson (Juna Downs Stn), Wunna Munna Flats) (S. van Leeuwen, M. Trudgen pers. comm.) (Speak to Andrew Mitchell re collections near Karratha - Abidos Plain)					
7	Alluvial clay flat communities dominated by *Themeda* sp (Hamersley Station) on the Hamersley Station Plains, see West Angelas report (M. Trudgen pers comm. S. van Leeuwen pers. comm.) threatened by grazing and inappropriate burning regimes.					

No.	Community	Assessed-category	On dbase complete	On dbase in- complete	Field survey complete	Insuff. info.
8	Seasonally inundated wetland and associated mulga flats on deep alluvial soils (Fortescue Marsh on the Fortescue River, east of Mulga Downs, on Marillana Station) (Handley, 1997; ANCA 1996; P. Kendrick, S. van Leeuwen, M. Trudgen pers. comm.; speak to Andrew Mitchell)					
9	Clay pan community dominated by *Nymphoides indica* and *Goodenia* sp. (~70 km south of Newman, just east of Gt Northern Hwy; threatened by grazing) (T. Start pers. comm.)					
10	*Heliotropium, Eragrostis* community on seepages (near Mt Montagu, Chichester Range) (M. Trudgen pers. comm.) (see West Angelas report)					
11	Cracking clay communities (Chichester Range; Mungaroona Range) (S. van Leeuwen P. Kendrick pers. comm.; Andrew Mitchell's and Malcolm Trudgen's reports) (Chichester tablelands cracking clays, grazed heavily at times in the past, still sometimes by feral and station cattle. Usually high in the landscape, sometimes perched on hill tops and on plateaus)					
12	Cracking clay communities in the West Angelas area, threatened by mine and infrastructure development, possible weed invasion and changes in fire regime, see West Angelas report (M. Trudgen pers comm.; S. van Leeuwen pers. comm.)					
13	Coastal grasslands (Roebourne Plains - Sherlock Station; Roebourne Common, Airport reserve between Dampier and Karratha - Seven Mile Creek) (Beard, 1975a; Rayne and Tille, 1992; CALM, 1992; P. Kendrick, S. van Leeuwen pers. comm; check Rangelands survey - Andrew Mitchell's work; speak to Norm McKenzie)					
14	Creekline communities dominated by *Cynanchum* aff. *floribundum* on sand drifts (east branch of the Harding River, near the escarpment) (M. Trudgen pers. comm.) (See West Angelas report)					
15	Remipede community (Barrow Island) (B. Humphreys pers. comm.)					
16	*Calothamnus oldfieldii* dominated plant community (Cape Range) (Trudgen 1988, 1989)					
17	Shrubland dominated by *Olearia ?axillaris* (Cape Range) (M. Trudgen pers. comm.)					
18	Shrubland / heathland dominated by Proteaceae and Myrtaceae on shallow soils over limestone (broadscale threat from buffel grass, goats) (Cape Range) (Trudgen 1989, 1988; S. van Leeuwen pers. comm; check Museum Records) Action needed - extend park to include.					
19	Delta wetlands (Millstream) (ANCA 1996; P. Kendrick; S. van Leeuwen pers. comm.)					
20	Alluvial wash areas adjacent to Savory Creek Little Sandy Desert (van Leeuwen 1997), threatened by grazing pressure from livestock and feral animals					
21	*Allocasuarina decaisneana* woodlands over shrub mallee and *Acacia* (Savory Creek - Little Sandy Desert) (van Leeuwin 1997) (speak to Steve about this one), threatened by grazing pressure from feral animals					

No.	Community	Assessed-category	On dbase complete	On dbase in- complete	Field survey complete	Insuff. info.
22	Aquatic herblands of hypersaline pools dominated by ?*Ruppia* (Mauds Landing, Coral Bay) (Trudgen 1995) (Speak to Malcolm)					
23	Playa systems that support novel *Halosarcia* (near Yanneri Lake - Little Sandy Desert) (van Leeuwin 1997) (speak to Steve about this one)					
24	*Mulga communities over Triodia wiseana; Triodia longiceps (flow lines); or diverse perennials (Robe River area) (check West Angelas report - discuss with Steve and Neil Gibson) (M. Trudgen pers. comm.) (Grazing threat)*					
25	*Eucalyptus victrix over Polygalaceae community (east of Mount Bruce, north east of Marandoo mine) (M. Trudgen pers. comm.) (Grazing threat)*					
26	*Sand dune communities of the Fortescue Botanical District (M. Trudgen pers. comm.) (get locations from Malcolm - only half a dozen remain) Marillana Station*					
27	*Calcrete communities on the edges of clay flats (M. Trudgen pers. comm.) (see West Angelas report)*					
28	*Plant communities of alluvial valleys (Barrow Island) (P. Kendrick S. van Leeuwen pers. comm.)*					
29	*Specific vegetation types (Mulga Downs) (M. Trudgen pers. comm.) (Check Rangelands survey - Andrew Mitchell's work)*					
30	*Rock pile ? ?and rock pool (Steve - mentioned in Blackwell et al. report) communities (Burrup Peninsula) (Blackwell et al. 1980; S. van Leeuwen pers. comm.) Comprise a mixture of Pilbara and Kimberley species, communities are different from those of the Hamersleys and Chichesters*					
31	*Gypsum based lakes (Little Sandy Desert) (S. van Leeuwen pers. comm.) threatened by grazing from feral animals*					
32	*Mulga communities, particularly mulga woodlands on gentle slopes with a spinifex understorey (Hamersley Range area - broadscale but threatened by burning) (Start* et al. *1991; van Leeuwin* et al., *1995; S. van Leeuwen pers. comm.)*					
33	*Offshore Islands of the Pilbara coast (P. Kendrick pers. comm.) (threatened by buffell grass invasion) Acacia shrub (Acacia coriacea) over spinifex communities on Pilbara coastal islands, threatened by invasion from Buffel Grass. (S. van Leeuwen, P. Kendrick, Fran Stanley, pers. comm.)*					
34	*Specific hilltop communities in the Hamersley Range (broadscale threat of too frequent fire) (S. van Leeuwen, P. Kendrick pers. comm.; see NRS progress reports)*					
35	*Coastal dune systems Cape Range to Coral Bay (broadscale threat of grazing by goats) (P. Kendrick pers. comm.)*					
36	*Riparian communities outside of ranges (broadscale grazing threat) (P. Kendrick pers. comm.)*					
37	*Mangroves of the Pilbara coast (Murdoch University, E. Paulling and V. Semeniuk researching)*					

GOLDFIELDS

No.	Community	Assessed-category	On dbase complete	On dbase in-complete	Field survey complete	Insuff. info.
1	Permanent to semi-permanent brackish to fresh water wetlands with belts of Samphire and *Melaleuca* around the perimeter of the Goldfields region (Swan Lake - Cowarna Downs Station; Cane Grass Lagoon - east of Rowles Lagoon) (Henry-Hall 1990; J. Angus, A. Chapman pers. comm.; speak to J. Lane)					
2	Lignum Swamps of the Goldfields Region (Sheehan Swamp - Cowarna Downs; Brown Lagoon - east of Rowles Lagoon; Lignum Swamp - Mt Vetters Station) (I. Kealley, A. Chapman pers. comm.) (threatened by mine dewatering and pastoralism) (need to check the regional distribution of this type of wetlands - Queensland, South Australia, WA deserts or WA wheatbelt - same dominants - *Muelhenbeckia cunninghamii*?)					
3	Permanent to semi-permanent wetlands with *Ruppia* across the lake floor of the Goldfields region (Lake Wannaway - Madoonia Downs; unnamed lake at 30km peg north of Norseman) (J. Angus, A. Chapman pers. comm.)					
4	Goldfields granite outcrop assemblages (rocks south of Balladonia, rocks east of Lake Johnson, Eranynia Hill - Cowarna Downs Station - proposal to mine) (Henry-Hall, 1990; J. Angus pers. comm.)					
5	Woodline Hills vegetation complexes (Newby *et al.*, 1984: Henry-Hall 1990) (N. Gibson, G. Keighery pers comm). (Speak to Neil, Greg, Nick Hall - just how unique are the ridge communities (*Baeckea recurva* shrubland)				+	
6	Duladgin Ridge vegetation complexes (G. Keighery and N. Gibson pers comm; Beard map)					
7	Mount Jumbo Range, Laverton area, (northeast goldfields) (G. Keighery and N. Gibson pers comm; Hall *et al.* 1994-not definitive; Beard 1974-not definitive)					
8	Mount Linden Range banded ironstone ridge vegetation (G. Keighery and N. Gibson pers comm)					
9	Helena and Aurora Range vegetation complexes (Beard 1972b; Dell *et al.* 1985; Henry-Hall 1990; Gibson *et al.* 1997a and b)					
10	Koolyanobbing vegetation complexes (G. Keighery and N. Gibson pers comm; Beard, 1972b)					
11	Highclere Hills vegetation complexes (Beard, 1972b; Newbey and Hnatiuk 1985; Dell *et al.*, 1985; Henry-Hall 1990; Gibson and Lyons, 1997b)					
12	Hunt Range vegetation complexes (Gibson and Lyons 1997c; Beard 1972b, 1978; Dell *et al.* 1985; Newbey and Hnatiuk 1985)					
13	Mount Dimer vegetation complexes (Beard 1972b; Gibson and Keighery pers. comm.)					
14	Diehardy Range vegetation complexes (G. Keighery and N. Gibson pers comm; Henry-Hall 1990: Beard 1972b)					
15	Mount Manning Range vegetation complexes (Beard 1972b; Beard 1990; Henry-Hall 1990; Keighery *et al.* 1995; Gibson and Lyons 1997a)					
16	Mount Jackson Range vegetation complexes (Henry-Hall 1990; G. Keighery and N. Gibson pers comm; Beard map)					
17	Yilgarn Hills vegetation complexes (G. Keighery and N. Gibson pers comm; Newbey *et al.* 1995; Beard 1972b)					

No.	Community	Assessed-category	On dbase complete	On dbase in- complete	Field survey complete	Insuff. info.
18	Mt Gibson vegetation complexes (G. Keighery and N. Gibson pers. comm.; Beard map)					
19	Bremer Range vegetation complexes (Mt Day, Round Top Hill, Honman Ridge) (Gibson and Lyons, 1995; Beard 1972a, 1976; Newby and Hnatiuk 1988; Henry-Hall 1990; Newbey *et al.* 1995)					
20	Parker Range vegetation complexes (especially *Hakea pendula* Tall Shrubland - Newbey *et al.* 1995) (Beard 1972a, 1976; Newby and Hnatiuk 1988; Henry-Hall 1990; Newbey *et al.* 1995; Gibson and Lyons 1995)					
21	Fraser Range vegetation complex (*Dodonaea* scrub) (Beard 1975b; Hall and McKenzie 1993)					
22	Mt Belches *Acacia quadrimarginea / Ptilotus obovatus* banded ironstone community (R. Thomas pers. comm.)					
23	Microbialite community (Harpers Lagoon NNE of Kalgoorlie) (R. Sarti pers. comm.) (N.B. Rob Thomas has investigated three lakes in this area but has not located any microbial communities)					
24	Halophytic communities of salt lake systems of the goldfields (Lake Lefroy; VCL on Madoonia Downs Station) (Handley, 1991; J. Angus pers. comm)					
25	Yellow sandplain communities of the Great Victoria Desert (very diverse mammalian and reptile fauna, distinctive plant communities) (D. Pearson pers. comm.) (threatened by mining)					
26	Queen Victoria Spring (Great Victoria Desert) (Burbidge *et al.* 1976) (Speak to Alex George, Dave Pearson)					
27	*Melaleuca* sp. nov. Low Closed to Open Forest Strand Community (near Wiluna) (Blackwell and Trudgen 1980) (speak to Malcolm - regional distribution known?)					
28	*Calcyphytic casuarina acacia woodlands/shrublands (north-east Goldfields) (Pringle et al. 1994 - site type 7) Speak to Hugh Pringle - ask if site type maps are available, or if only land type maps produced. The former more closer approximate vegetation maps.*					
29	*Calcrete platform woodlands/shrublands (north-east Goldfields) (Pringle et al. 1994 - site type 8) Speak to Hugh Pringle - ask if site type maps are available, or if only land type maps produced. The former more closer approximate vegetation maps.*					
30	*Plain mixed halophyte low shrublands (north-east Goldfields) (Pringle et al. 1994 - site type 9)*					
31	*Silver saltbush (Atriplex bunburyana) low shrublands (north-east Goldfields) (Pringle et al. 1994 - site type 16) Speak to Hugh Pringle - ask if site type maps are available, or if only land type maps produced. The former more closer approximate vegetation maps.*					
32	*Mixed chenopod shrublands with mulga (Acacia aneura) overstoreys (north-east Goldfields) (Pringle et al. 1994 - site type 18) Speak to Hugh Pringle - ask if site type maps are available, or if only land type maps produced. The former more closer approximate vegetation maps.*					

No.	Community	Assessed-category	On dbase complete	On dbase in- complete	Field survey complete	Insuff. info.
33	*Mulga (Acacia aneura) shrublands with scattered chenopod low shrubs (north-east Goldfields) (Pringle et al. 1994 - site type 19) Speak to Hugh Pringle - ask if site type maps are available, or if only land type maps produced. The former more closer approximate vegetation maps.*					
34	*Mulga (Acacia aneura) drainage line shrublands/woodlands with chenopod understoreys (north-east Goldfields) (Pringle et al. 1994 - site type 20) Speak to Hugh Pringle - ask if site type maps are available, or if only land type maps produced. The former more closer approximate vegetation maps.*					
35	*Calcyphytic pearl bluebush (Maireana sedifolia) shrublands (north-east Goldfields) (Pringle et al. 1994 - site type 21) Speak to Hugh Pringle - ask if site type maps are available, or if only land type maps produced. The former more closer approximate vegetation maps.*					
36	*Stony bluebush (Maireana spp.) mixed shrublands (north-east Goldfields) (Pringle et al. 1994 - site type 22) Speak to Hugh Pringle - ask if site type maps are available, or if only land type maps produced. The former more closer approximate vegetation maps.*					
37	*Upland small bluebush (Maireana spp.) species shrublands (north-east Goldfields) (Pringle et al. 1994 - site type 23) Speak to Hugh Pringle - ask if site type maps are available, or if only land type maps produced. The former more closer approximate vegetation maps.*					
38	*Granite hill mixed shrublands (north-east Goldfields) (Pringle et al. 1994 - site type 25)*					
40	*Stony ironstone mulga (Acacia aneura) shrublands (north-east Goldfields) (Pringle et al. 1994 - site type 28) Speak to Hugh Pringle - ask if site type maps are available, or if only land type maps produced. The former more closer approximate vegetation maps.*					
41	*Rich ephemeral communities of outcrops and bottomlands (Kurnalpi-Kalgoorlie area) (McKenzie and Hall 1992)*					
42	*Mixed low woodlands of Eucalyptus oleosa, Casuarina cristata and Acacia aneura (Kurnalpi-Kalgoorlie area) (McKenzie and Hall 1992)*					
43	*Greenstone / banded ironstone ranges of the goldfields (J. Angus pers. comm.)*					
44	*Melaleuca spp. Scrub (70% alienated; Beard and Sprenger, 1984)) (Southern Goldfields, Darling, Eastern South Coast) (Hopkins, Beeston data?)*					
45	*Acacia - Casuarina - Melaleuca Thicket (80% alienated; Beard and Sprenger, 1984) (Wheatbelt, Southern Goldfields, Darling, Northern Sandplain, Eastern South Coast, Southwest Interzone) (Hopkins, Beeston data?).*					
46	*Eucalyptus, Acacia, Atriplex, Halosarcia Wooded Succulent Steppe (87% alienated; Beard and Sprenger, 1984) (Wheatbelt, Southern Goldfields, Southwest Interzone) (Hopkins, Beeston data?).*					

No.	Community	Assessed-category	On dbase complete	On dbase in-complete	Field survey complete	Insuff. info.
47	*Eucalyptus loxophleba, E. wandoo, E. salmonophloia Woodland (97% alienated; Beard and Sprenger, 1984)) (Darling, Wheatbelt, Southern Goldfields, Eastern South Coast, Northern Sandplain, South West Interzone) (Hopkins/Beeston data?).*					
48	*Wetlands of the Nullarbor region (J. Lane pers comm)*					

KIMBERLEY

No.	Community	Assessed-category	On dbase complete	On dbase in-complete	Field survey complete	Insuff. info.
1	Desert mound spring community (Dragon Tree Soak - Great Sandy Desert) (Handley, 1997; ANCA 1996; Burbidge and McKenzie 1983; recommendation 5.2 (McLarty Hills)- Burbidge *et al.*, 1991; N. McKenzie pers. comm.) (Ask Alex George if whole palaeodrainage channel should be considered 'unique')					
2	Coastal mound spring and moon spring communities (springs fed by moon tides) (Big Springs, Mandora Spring - Anna Plains Station (Speak to Norm McKenzie + unpublished reports to Environment Australia); Bunda Bunda – Dampier Peninsula (ANCA 1996; Kenneally *et al.* 1996) ; Lake Gladstone; Drysdale River; Derby mud flats - Joseph Bonaparte Coastline) (Mandora Mound Spring – recommendation 5.1 (Mandora) - Burbidge *et al.* 1991; G. Graham, pers. comm.) (General mound spring ref Knott and Jasinska, 1998)					
3	*Eucalyptus tectifera* community of the Gibb River and Mt Barnett regions (G. Graham, pers comm) (Gordon Graeme; Hnatiuk and Kenneally 1981 mention several alliances of this type, are any in particular under threat?).					
4	Naturally protected valley systems of the Kimberley region eg. Saw Ranges (G. Graham, pers comm)					
5	Inland Mangroves (Salt Creek - Mandora, Anna Plains Station) (recommendation 5.1 (Mandora) Burbidge *et al.* 1991; T. Willing pers. comm.)					
6	The Lake Gregory Wetland System (Halls Creek) (Halse, 1990, 1996; Burbidge and McKenzie 1983; recommendation 6.2 (Gregory Lake) in Burbidge *et al.* 1991; ANCA 1996) (Speak to Stuart about recent information on regional significance of invertebrate community, ? any more recent vegetation work)					
7	Spring communities (Logues Spring, south-west Kimberley) (McKenzie 1981) (Ask Norm if this community is rare and unthreatened)					
8	Clay pan community (Nimalaica - inland from Willie Creek) (Kenneally et al. 1996) (reference states it is unique, but ask Kevin Kenneally if it is under threat)					
9	Microbialite community, extant - McDonaldson Spring, Great Sandy Desert (Moore, 1993; Crowe *et al.* 1977)					
10	*Mangrove system (Doctor's Creek wetland system, Derby) (James Pillsbury pers. comm.)*					
11	*? Permanent fresh water ecosystems such as Airfield Swamp? Under threat from ?fire, grazing? Gordon Graeme? (ref: Hnatiuk and Kenneally 1981)*					

No.	Community	Assessed-category	On dbase complete	On dbase in- complete	Field survey complete	Insuff. info.
12	*Rainforest patches of the Kimberley region eg. rainforest rises in the Barren supratidal flats (McKenzie 1983; McKenzie* et al. *1991a and b; Hnatiuk and Kenneally 1981; {recommendations 3.8 (Point Spring – Andrew ? under threat from fire? Special uniqueness – as closed canopy rainforest in lowland of east Kimberley? Also recommendations 2.1 (Broome Townsite Vine Thickets), 2.2 (Dampier Peninsula - also Kenneally* et al. *1996), 4.1.3.(South–West Osborn), 4.4 (Cape Londonderry), 4.6 (Hunter River area) in Burbidge et al. 1991}; G. Graham, J. Lane pers comm).*					
13	*Permanent / ephemeral wetlands, damplands, and riparian habitat of the Kimberley region (G. Graham, J. Lane pers comm; speak to B. Humphreys and A. Storey)*					
14	*Callitris intratropica communities of the Kimberley region (Haynes 1985; Bowman and Panton 1993; Price and Bowman 1994; G. Graham, pers comm; T. Start pers. comm.).*					
15	*Rainforest vine thickets and adjacent wetlands (Hnatiuk and Kenneally 1981; T. Willing pers. comm.)*					
16	*Specific savanna types (speak to Savanna cooperative research - Andrew Mitchell??) (G. Graham, pers. comm.)*					
17	*Riparian communities of the Kimberley region (G. Graham, pers. comm.)*					
18	*Communities of the upper Fitzroy catchment (T. Willing pers. comm.)*					

SOUTH COAST

No.	Community	Assessed-category	On dbase complete	On dbase in- complete	Field survey complete	Insuff. info.
1	Microbialite community, extant - Lake Cowan near Norseman (Moore, 1993)					
2	*Acacia acuminata - A. ramulosa* Scrub or *Acacia - Banksia* Scrub (78% alienated; Beard and Sprenger, 1984) (Wheatbelt, Northern Sandplain, Eastern South Coast, Southwest Interzone) (Hopkins, Beeston data?).					

MID WEST

No.	Community	Assessed-category	On dbase complete	On dbase in- complete	Field survey complete	Insuff. info.
1	Permanent water soaks and wetlands (western edge of the Kennedy Ranges - extinct communities?) (B. Barton pers. comm.) (N. McKenzie Carnarvon Basin study?)					
2	Lake System, *Melaleuca* wetlands and spinifex areas (Muggon Station) (B. Barton, R. Shepherd pers. comm.) (Check Murchison Rangelands survey)					
3	Spinifex sand dune mesa topping the Kennedy Range National Park (B. Barton pers. comm.) (need to speak to Brad Barton about this one)					
4	Tallering Peak vegetation complexes (G. Keighery and N. Gibson pers. comm.)					
5	Samphire communities (Lake Macleod) (Burbidge and McKenzie 1995) (Speak to Allan, Norm)					
6	Mount Narryer and Jack Hills ?vegetation complexes (R. Shepherd, B. Barton pers. comm.; speak to Alex George; check Angus Hopkin's data)					
7	Gorge system pools and vegetation (Wooramel River) (B. Barton pers. comm.)					

No.	Community	Assessed-category	On dbase complete	On dbase In- complete	Field survey complete	Insuff. info.
8	Mangrove communities dominated by *Avicennia* (Shark Bay) (B. Barton pers. comm.)					
9	Snakewood-bowgada communities on undulating plains of the Carnarvon Basin (Burbidge and McKenzie 1995) (Speak to Allan, Norm)					
10	Coastal heath (Steep Point) (P. Brown pers. comm.)					
11	Mallee scrubs of the southern Carnarvon Basin (Burbidge and McKenzie 1995) (Speak to Allan, Norm)					
12	Jeeaila River Downs vegetation complexes - east of Mount Augustus (proposed Nature Reserve) (B. Barton pers. comm.) (Brad - specific assemblages within this area that are unique and under threat?)					
13	Hypersaline community number 2 (Stromatolites of Hamelin Pool) (Burne 1991; P. Brown pers. comm.)	LR	+			
14	Mammal assemblages (Bernier and Dorre Islands) ?Threats – Paul, Keith? (Baynes 1990; Morris *et al.* 1991; P. Brown pers. comm.; speak to Keith Morris)					
15	*Floodplains of the Carnarvon Basin (Wooramel, Gascoyne Rivers) (Burbidge and McKenzie 1995) (Speak to Allan, Norm)*					
16	*Inland Granites (Murchison) (A. Brown, S. Hopper pers. comm.- data not yet analysed)*					
17	*Permanent and ephemeral pools of fresh to brackish rivers of the Murchison, Gascoyne and Carnarvon Botanical Districts (Badeadda and Windalla Pool on the Lyndon River; Coolkilya, Joolabin and Williambury Pools on the Manilya River; Pool at Yangbana Yard Crossing, Cattle and Karabura Pools on the Lyons River; Rocky, Fishy, Yinnemmarra, Teamarra and Deep Pools on the Gascoyne River; Msedo, Walarrie and Irrida Pools on the Wooramel River) (M. Mahoney pers. comm.)*					
18	*Breakaway Systems Cue to Mt Magnet (Geraldton District Reports; R. Cranfield pers. comm.)*					
19	*Reptile assemblages of islands, gulfs and peninsulas (Shark Bay) (Storr and Harold 1990) Under threat?? (speak to Greg Harold)*					
20	*Bluebush (Atriplex / Maireana spp.) communities on breakaway footslopes (R. Shepherd pers. comm.; check Murchison rangelands reports) (speak to Norm McKenzie and Angus Hopkins)*					
21	*Hardpan mulga (Acacia aneura) shrublands (Murchison River catchment) (Curry* et al., *1994) (speak to Alan Payne - ask if vegetation types mapped, or only land types) (speak to Norm McKenzie and Angus Hopkins)*					
22	*Bluebush (Maireana spp.) shrublands (Murchison River catchment) (Curry* et al., *1994) (speak to Alan Payne ask if vegetation types mapped, or only land types) (speak to Norm McKenzie and Angus Hopkins)*					
23	*Mixed halophytic shrublands (Murchison River catchment) (Curry* et al., *1994) (R. Shepherd pers. comm; speak to Alan Payne) (speak to Norm McKenzie and Angus Hopkins)*					
24	*Saltbush (Atriplex spp.) shrublands (Murchison River catchment) (Curry* et al., *1994) (R. Shepherd pers. comm.; speak to Alan Payne) (speak to Norm McKenzie and Angus Hopkins)*					

No.	Community	Assessed-category	On dbase complete	On dbase in- complete	Field survey complete	Insuff. info.
25	*Stoney snakewood (Acacia xiphophylla) shrublands (Murchison River catchment) (Curry* et al., *1994) (speak to Alan Payne)*					
26	*Calcrete shrubby grasslands (Murchison River catchment) (Curry* et al., *1994) (speak to Alan Payne)*					
27	*Non-calcareous shrubby grasslands (Murchison River catchment) (Curry* et al., *1994) (speak to Alan Payne)*					
28	*Creekline grassy shrublands (Murchison River catchment) (Curry* et al., *1994) (speak to Alan Payne)*					
29	*Calcrete Eucalypt woodlands (Murchison River catchment) (Curry* et al., *1994) (speak to Alan Payne)*					
30	*Specific lake communities (Lake Austen, Lake Annean) (ANCA 1996 - Lake Annean) (R. Shepherd pers. comm.)*					
31	*Riverine communities in rangeland areas (including some Eucalyptus camaldulensis woodlands that are Major Mitchell nesting sites on Berringarrah and Milly Milly Stations along the Murchison River) (N. McKenzie data) (P. Brown, R. Shephard, B. Barton pers. comm.)*					
32	*Fresh water lake systems in rangeland areas (S. Halse data) (P. Brown pers. comm.)*					

DESERTS

No.	Community	Assessed-category	On dbase complete	On dbase in- complete	Field survey complete	Insuff. info.
1	*Gorge communities - desert ranges (D. Pearson pers. comm.)*					

NON SPECIFIED AREAS

No.	Community	Assessed-category	On dbase complete	On dbase in- complete	Field survey complete	Insuff. info.
1	*Specific Seagrass Communities ? under threat? (Shark Bay and other areas) (Walker 1990; Walker 1991)*					

PERSONAL COMMUNICATIONS AND SOURCES OF DATA

Mr J. Addison - Agriculture WA, Derby
Mr B. Barton - Department of Conservation and Land Management, Denham
Mr G. Beeston - Agriculture WA, Perth
Mr A. Brown - Department of Conservation and Land Management, Woodvale
Mr A. Chapman - Environmental Consultant
Mr R. Cranfield - Department of Conservation and Land Management, Herbarium
Mr G. Graham - Department of Conservation and Land Management, Kimberley Region
Dr N. Gibson - Department of Conservation and Land Management, Woodvale
Dr S. Halse - Department of Conservation and Land Management, Woodvale
Dr S. Hopper - Kings Park and Botanical Garden
Dr A Hopkins - Department of Conservation and Land Management, Woodvale
Dr B. Humphreys - Western Australian Museum
Mr G. Keighery - Department of Conservation and Land Management, Woodvale
Dr P. Kendrick - Department of Conservation and Land Management, Pilbara Region
Mr J. Lane - Department of Conservation and Land Management, Busselton
Mr N. McKenzie - Department of Conservation and Land Management, Woodvale
Mr A. Mitchell - Agriculture Western Australia
Mr D. Pearson - Department of Conservation and Land Management, Woodvale
Mr R. Sarti - Agriculture WA, Kalgoorlie
Dr V. Semeniuk - Environmental Consultant
Mr R. Shepherd - Department of Conservation and Land Management, Geraldton
Dr T. Start - Department of Conservation and Land Management, Woodvale
Mr M. Trudgen - Environmental Consultant
Dr S. van Leeuwen - Department of Conservation and Land Management, Pilbara Region
Mr T. Willing - Department of Conservation and Land Management, Broome

REFERENCES

Australian Nature Conservation Agency (1996). *A Directory of Important Wetlands in Australia*. Second edition. Commonwealth of Australia. Canberra, ACT.

Baynes, A. (1990). The mammals of Shark Bay, Western Australia. pp 313-325 In: Berry, P.F. Bradshaw, S.D. and Wilson, B.R. (eds) *Research Shark Bay. Report of the France-Australia Bicentenary Expedition Committee*. Western Australian Museum. Perth.

Beard, J.S. (1972a). *Vegetation survey of the Southern Cross area, Western Australia*. Map and explanatory memoir. 1:250,000 series. Vegmap Publications, Sydney.

Beard, J. S. (1972b). *Vegetation survey of the Jackson area, Western Australia*. Map and explanatory memoir. 1:250,000 series. Vegmap Publications, Sydney.

Beard, J. S. (1974). *Vegetation survey of Western Australia, Great Victoria Desert 1:1,000,000 Vegetation Series*. Explanatory notes to Sheet 3. University of Western Australia Press.

Beard, J. S. (1975a). *Vegetation survey of Western Australia, Pilbara 1:1,000,000 Vegetation Series*. Explanatory notes to Sheet 5. University of Western Australia Press.

Beard, J.S. (1975b). *Vegetation survey of Western Australia, Nullarbor 1:1,000,000 Vegetation Series*. Explanatory notes to Sheet 4. University of Western Australia Press.

Beard, J.S. (1976). *Vegetation survey of the Boorabin and Lake Johnson areas, Western Australia*. Map and explanatory memoir. 1:250,000 series. Vegmap Publications, Sydney.

Beard, J. S. (1978). *Vegetation survey of the Kalgoorlie area, Western Australia*. Map and explanatory memoir. 1:250,000 series. Vegmap Publications, Perth.

Beard, J.S. (1990). *Plant Life of Western Australia*. Kangaroo Press, Kenhurst.

Beard, J. S., Sprenger, B. S., (1984). *Geographic Data from the Vegetation Survey of Western Australia. Occasional Paper No. 2.* Vegmap Publications. Applecross, Western Australia.

Blackwell, M.I., Trudgen, M.E., and Weston, A.S (1980). *Vegetation and Floristics of the Burrup Peninsula and the southern part of Dolphin Island.* Report prepared for Woodside Petroleum Pty. Ltd. North West Shelf Development Project. Perth.

Blackwell, M.I., and Trudgen, M.E. (1980). *Report on the flora and vegetation of the Lake Way Joint Venture uranium project: together with assessment of the impact of this project upon the landscape, flora and vegetation of this area and its regeneration potential. Appendix 3, flora and vegetation survey.* Report prepared for Lake Way Joint Venture. Perth.

Bowman, D.M.J.S. and Panton, W.J. (1993). Decline of *Callitris intratropica* R.T. Baker & H.G. Smith in the Northern Territory: implications for pre- and post-European colonisation fire regimes. *Journal of Biogeography*, 20: 373-381.

Burbidge, A.A. and McKenzie, N.L. (1983). Wildlife of the Great Sandy Desert. *Wildlife Research Bulletin* 12: 1-127.

Burbidge, A.H. and McKenzie, N.L. (1995). Patterns in Nature: the biodiversity of the Carnarvon Basin. *Landscope*. v 11 no. 2; 15-.

Burbidge, A.A., McKenzie, N.L., Chapman, A. and Lambert, P.M. (1976). The Wildlife of some Existing and Proposed Reserves in The Great Victoria and Gibson Deserts, Western Australia. Wildlife Research Bulletin. 5: 1-16.

Burbidge, A.A., McKenzie, N.L. and Kenneally, K.F. (1991). *Nature Conservation Reserves in the Kimberley Western Australia.* Department of Conservation and Land Management. Perth.

Burne, R.V. (1991). Lilliput's Castles. Stromatolites of Hamelin Pool. *Landscope*. 7, 2: 34-40.

Crowe, R.W.A., Yeates, A.N., and Grey, K. (1977). Living stromatolites in the northern Great Sandy Desert, Western Australia: A modern analogue for probable Tertiary Deposits in the Area . *Geological Survey of Western Australia. Annual Report*. 73-75.

Curry, P.J., Payne, A.L., Leighton, K.A., Hennig, P. and Blood, D.A. (1994). *An inventory and condition survey of the Murchison River catchment and surrounds, Western Australia.* Technical Bulletin No. 84. Department of Agriculture.

Dell, J., How R. A., Newby, K. R. and Hnatiuk, R. J (1985). The biological survey of the eastern goldfields of Western Australia. Part 3 Jackson - Kalgoorlie study area. *Records of the Western Australian Museum Supplement* 23.

Department of Conservation and Land Management (1992). *A Nature Conservation Strategy for Western Australia. A Draft for Public Comment.* Department of Conservation and Land Management. Como, Western Australia.

Gibson, N. and Lyons, M. N. (1995). *Floristic Survey of the Bremer and Parker Ranges of the Eastern Goldfields of Western Australia.* Unpublished report for the Australian Heritage Commission prepared by Department of Conservation and Land Management.

Gibson, N. and Lyons, M. N. (1997a). *Floristic Survey of the Mt Manning Range of the Eastern Goldfields of Western Australia.* Unpublished report for the Australian Heritage Commission prepared by Department of Conservation and Land Management.

Gibson, N. and Lyons, M. N. (1997b). *Floristic Survey of the Highclere Hills of the Eastern Goldfields of Western Australia.* Unpublished report for the Australian Heritage Commission prepared by Department of Conservation and Land Management.

Gibson, N. and Lyons, M. N. (1997c). *Floristic Survey of the Hunt Range, Yendilberin and Watt Hills of the Eastern Goldfields of Western Australia*. Unpublished report for the Australian Heritage Commission prepared by Department of Conservation and Land Management.

Gibson, N., Lyons, M. N. and Lepschi, B. J. (1997a). Flora and vegetation of the eastern goldfields ranges, Part I: Helena and Aurora Range. *CALMScience* 2 (3): 231-246.

Gibson, N. and Lyons, M. N. and Lepschi, B. J. (1997b). Flora and Vegetation In: *A biological survey of the Helena and Aurora Range, eastern goldfields Western Australia*. Unpublished report for the Australian Heritage Commission prepared by Department of Conservation and Land Management.

Hall, N. J., McKenzie, N. L., and Keighery, G. J. (eds) (1994). *The biological survey of the eastern goldfields of Western Australia. Part 10. Sandstone - Sir Samuel and Laverton - Leonora study areas*. Records of the Western Australian Museum Supplement Number 47. Perth.

Hall, N.J. and McKenzie, N.L. (eds) (1993). *The biological survey of the eastern goldfields of Western Australia. Part 9 Norseman - Balladonia study area*. Records of the Western Australian Museum Supplement Number 42. Perth.

Halse, S.A. (1990). The Natural Features of Lake Gregory: A Preliminary Review. Proceedings of a Workshop on Lake Gregory held at Woodvale April 1989. *Department of Conservation and Land Management. Occasional Paper 2/90*. Perth, Western Australia.

Halse, S.A. (1996). Lake Gregory. Case Study 2: Australia. Pp 173-175 *In Wetlands, Biodiversity and the Ramsar Convention. The Role of the Convention on Wetlands in the Conservation and Wise Use of Biodiversity*. ed by A. J. Hails. Ramsar Convention Bureau. Ministry of Environment and Forests, India.

Hamilton-Smith, E., Kiernan, K. and Spate, A. (1998). *Karst Management Considerations for the Cape Range Karst Province Western Australia*. Report prepared for the Western Australian Department of Environmental Protection.

Handley, M. (1997). *Australian Wetlands Conservation Project*. Final Report prepared by the World Wide Fund for Nature for the Australian Heritage Commission.

Handley, M. A. (1991). *The biota of inland salt lakes of the Kambalda region, and coastal salt lakes of Esperance, Western Australia - a comparative study*. Unpublished Honours thesis. Curtin University of Technology.

Haynes, C.D. (1985). The pattern and ecology of *munwag*: traditional Aboriginal fire regimes in north-central Arnhemland. *Proceedings of the Ecological Society of Australia*. 13: 203-214.

Henry-Hall, N. J. (1990). *Nature Conservation Reserves in the Eastern Goldfields, Western Australia. (Southern Two Thirds of CTRC System 11)*. Report submitted to the EPA Red Book Task Force.

Hnatiuk, R.J. and Kenneally, K.F. (1981). A survey of the vegetation and flora of Mitchell Plateau, Kimberley, Western Australia. Pp 13-94 In: *Biological survey of Mitchell Plateau and Admiralty Gulf, Kimberley, Western Australia*. Western Australian Museum. Perth

Keighery, G.J., Milewski, A.V. and Hall, N.J. (1995). Vegetation and flora. In: The biological survey of the Eastern Goldfields of Western Australia. Part 12. Barlee Menzies study area. *Records of the Western Australian Museum Supplement* 49: 183-207.

Kennealy, K.F., Choules Edinger, D. , Willing, T. (1996). *Broome and Beyond. Plants and People of the Dampier Peninsula, Kimberley, Western Australia*. Department of Conservation and Land Management. Perth.

McKenzie, N.L. (1983). Wildlife of the Dampier Peninsula, South-west Kimberley, Western Australia. *Wildlife Research Bulletin*. No. 11.

McKenzie, N.L. (1981). Wildlife of the Edgar Ranges Area, South-west Kimberley, Western Australia. *Wildlife Research Bulletin*. No. 10.

McKenzie, N.L. and Hall, N.J. (1992). The biological survey of the eastern goldfields of Western Australia. Part 8 Kurnalpi-Kalgoorlie study area. *Records of the Western Australian Museum Supplement 41.*

McKenzie, N.L., Johnston, R.B. and Kendrick, P.G. (1991a). *Kimberley Rainforests of Australia*. Surrey Beatty & Sons. Chipping Norton, NSW.

McKenzie, N., Kenneally, K. and Done, C. (1991b). King Leopold's Treasures. *Landscope*. 7, 3: 43-47.

Knott, B. and Jasinska, E.J.J. (1998). Mound Springs of Australia. In: *Studies in Crenobiology. The biology of springs and springbrooks* ed by L. Botosaneanu. Backhuys Publishers, Leiden.

Moore, L. (1993) *The Modern Thrombolites of Lake Clifton, Southwestern Australia*. Unpublished PhD Thesis. University of Western Australia.

Morris, K. Alford, J. and Shepherd, R. (1991). Islands of Contrast. *Landscope*. 7, 2: 28-33.

Newbey, K. R., and Hnatiuk, R. J. (1985). Vegetation and Flora In: The biological survey of the eastern goldfields of Western Australia. Part 3 Jackson - Kalgoorlie study area. *Records of the Western Australian Museum Supplement* 23: 11-38.

Newbey, K. R., and Hnatiuk, R. J. (1988). Vegetation and Flora In: The biological survey of the eastern goldfields of Western Australia. Part 4 - Lake Johnson - Hyden study area. *Records of the Western Australian Museum Supplement* 30: 17-42.

Newbey, K. R., Dell, J., How, R. A. and Hnatiuk, R. J. (1984). The biological survey of the eastern goldfields of Western Australia. Part 2 Widgiemooltha - Zanthus study area. *Records of the Western Australian Museum Supplement* 18: 101.

Newbey, K.R., Keighery, G.J. and Hall, N.J. (1995). Vegetation and Flora. In: The Biological Survey of the Eastern Goldfields of Western Australia. Part 11 Boorabin-Southern Cross Study Area. *Records of the Western Australian Museum Supplement No. 49: 17-30.*

Price, O. and Bowman, D.M.J.S. (1994). Fire-stick forestry: a matrix model in support of skilful fire management of *Callitris intratropica* R.T. Barker by north Australian Aborigines. *Journal of Biogeoraphy*. 21: 573-580.

Pringle, H.J.R., Van Vreeswyk, A.M.E. and Gilligan, S.A. (1994). An inventory and condition survey of the north-eastern Goldfields, Western Australia. *Department of Agriculture Technical Bulletin. No. 87.*

Start, T., van Leeuwin, S., Fuller, P., and Bromilow, B. (1991). Mulga & Fire. *Landscope*. v 6, no. 4; -27.

Storre, G.M. and Harold, G. (1990). pp 279-285 In: Berry, P.F. Bradshaw, S.D. and Wilson, B.R. (eds) *Research Shark Bay. Report of the France-Australia Bicentenary Expedition Committee*. Western Australian Museum. Perth.

Trudgen, M. (1988). *A report on the rare and restricted flora and vegetation of an area on the North West Cape*. Unpublished report prepared for Ampol Exploration. Perth.

Trudgen, M. (1989). *A report on the rare and restricted flora and vegetation of part of the Cape Range National Park and adjoining Commonwealth land*. Unpublished report prepared for Ampol Exploration. Perth.

Trudgen, M. (1995). A Flora and Vegetation Survey and Assessment of Conservation Values for Flora and Vegetation of the Area of the Proposed Coral Coast Marina. Appendix H in: *Coral Coast Resort Mauds Landing Public Environmental Review.* Prepared for Coral Coast Marina Development Pty Ltd by Bowman Bishaw Gorham. West Perth.

van Leeuwin, S. (1997). *Biological survey of the Little Sandy Desert.* Final report to the Australian Nature Conservation Agency by the Department of Conservation and Land Management. Project N706.

van Leeuwin, S., Start, A.N., Bromilow, R. B., Fuller, P.J. (1995). Fire and floristics of mulga woodlands in the Hammersley Ranges, Western Australia. In *Ecological Research and Management in the Mulgalands - Conference Proceedings* (Eds M.J. Page and T.S. Beutel) pp. 169-175 University of Queensland Gatton College, Australia.

Walker, D.I. (1990). Seagrass in Shark Bay, Western Australia. pp 101-106 In: Berry, P.F. Bradshaw, S.D. and Wilson, B.R. (eds) *Research Shark Bay. Report of the France-Australia Bicentenary Expedition Committee.* Western Australian Museum. Perth.

Walker, D. (1991). Grasses of the Sea. *Landscope.* 7, 2: 42-46.

ATTACHMENT 2

Community Number: 43
Community Name: Camerons
Community Description: Camerons Cave Troglobitic Community
Former Range: Very narrow endemic community, total range <50 square km or <20 km linear
Range Decline: Unknown but thought to be small
Occurrences Decline: Unknown but thought to be small
Listing: On Current TEC Listing
Original Area: 0.22
Area Accuracy: 0.10
Publications:

Harvey, M. S.
(1993). The systematics of the Hyidae (Pseudoscorpionida). Invertebrate Taxonomy 7: 1-32
Harvey, M.S., Gray, M.R., Hunt, G.S. and Lee, D.C.
(1993). The cavernicolous Arachnida and Myriapoda of Cape Range, Western Australia. Records of the Western Australian Museum, Supplement. 45:129-144
Harvey, M.S., and Humphreys, W.F.
(1995). Notes on the genus Draculoides Harvey (Schizomida: Hubbardiidae), with the description of a new troglobitic species. Records of the Western Australian Museum, Supplement No. 52: 183-189.
Hoch, H.
(1993). A new troglobitic planthopper species (Hemiptera: Fulgoroidea: Meenoplidae) from Western Australia. Records of the Western Australian Museum 16: 393-398.
Humphreys, W.F.
(1994). The subterranean fauna of the Cape Range coastal plain, northwestern Australia. Report to the Australian Heritage Commission and the Western Australian Heritage Commission Committee. 202 pp. Unpublished.
Humphreys. W.F. and Shear, W.A.
(1993). Troglobitic millipedes (Diplopoda: Paradoxosomatidae) from semi-arid Cape Range, Western Australia - systematics and biology. Invertebrate Taxonomy 7: 173-195
Shear, W.A. and Humphreys, W.F.
(1996). A new Stygiochiropus from a North West Cape (Western Australia) coastal plain cave (Diplopoda, Polydesmida, Paradoxosomatidae). Records of the Western Australian Museum 17: 447-449.

Reviews: 23/06/98 - J. Blyth, V. English, B. Humphreys, D. True, J. Colman, A. Hopkins, A. Storey, S. Hamilton-Brown

Categories:
Effect Date - 23/06/98
Category - Critically Endangered
Comment - Threatening processes associated with urbanisation are acting now
Review Date - 26/03/2000
Criteria:
Current distribution limited, and currently subject to known threatening processes which are likely to result in total destruction in the immediate future (within approx 5 years)
Current distribution limited and very few occurrences, each of which is small and/or isolated and extremely vulnerable to known threatening processes

History:
Date - 13/05/98
Area Decline - Unknown but thought to be small
Comment - Camerons cave is thought to be the only cave that contains this community

Recommendations: 23/06/98 - The Advisory Group suggested an IRP that recommends appropriate management of surrounding developments with potential to impact the community be drafted and implemented

Actions:
Current Area: .22 +/- .01 ha
Number of Occurrences: 1
Minimum Longitude: 114° 7' 14"
Maximum Longitude: 114° 7' 14"
Minimum Latitude: -21° 57' 57"
Maximum Latitude: -21° 57' 57"
Tenure Areas: Vacant Crown Land - .22 ha
Degradation Areas: Insignificantly modified - .22 ha

Occurrence Number: 1
Description: Within Exmouth town site
Boundary Description: Camerons Cave covers about 34 m east-west by 65 m north-south

Occurrence Area: .22 +/- .01 ha

Site Identifications:
Site ID, Longitude, Latitude
CAMERON01, 114° 7' 14", -21° 57' 57"

Biological Processes: Community relies on food resource (leaf litter) coming in from outside the cave (from the surface)

Non Biological Processes: Community is reliant on the humidity created through contact with the local water table and specific surface conditions

Land Use:
13/05/98 (Actual Occurrence) - Remnant public land. Cave is currently on land that is VCL, but is planned for residential and marine / canal development and water abstraction
13/05/98 (Adjacent Land) - Remnant public land. Surrounding land is also planned for residential, marina / canal development and water abstraction
21/05/98 (Adjacent Land) - Race course. Racecourse reserve 41753 is 130 m south east of cave

Surveys:
13/05/98 (Dr B. Humphreys) - Previously surveyed by Bill Humphreys and Mark Harvey for condition, extent and compostion

Threats

Hydrological changes - water quality and/or quantity
Modification - Marina, canal residential and changed surfaced conditions are likely to impact on the humidity levels in the cave that are essential for survival of the community, and may pollute cave waters
Other - Development is occuring in the area now, and is expected in the immediate area in the very near future
Current Percentage Affected - 100%
Current Impact - Insignificant to Low
Potential Impact - High to Extreme

Changing surface conditions altering food supply
Modification - Changed surface conditions may intercept the allochthonous food resource for the community (food coming from outside the cave).
Other - Development is occurring in the area at the moment, and is expected in the immediate area of the cave in the near future
Current Percentage Affected - 0%
Current Impact - Insignificant to Low
Potential Impact - High to Extreme

Surface subsidence
Modification - If used too close to the cave, heavy equipment or explosives have the potential to cause cave collapse.
Other - Risk of cave collapse is most likely when areas immediately adjacent are being developed
Current Percentage Affected - 0%
Current Impact - Insignificant to Low
Potential Impact - High to Extreme

Condition
100% Insignificantly modified -

Recommendations:
13/05/98 - CALM to ensure the planning process places controls on landuses which have the potential to impact the cave systems
21/05/98 - CALM to liaise with DOLA and WA Museum to determine suitable boundaries for reserve around the cave
21/05/98 - CALM to seek to have appropriate area vested with NPNCA as A class reserve for cave conservation
21/05/98 - CALM to implement recommendations in the IRP, when IRP is developed

Actions:
28/05/98 - Letter drafted to DOLA requesting input to determining boundaries of reserve to be established around the cave

Community Name: **Camerons**
Community Description: **Camerons Cave Troglobitic Community**
Occurrence Number: 1
Confidential: No
Site Identifications: **Site ID, Longitude, Latitude**
CAMERON01, 114° 7' 14", -21° 57' 57"
Source: GPS in field
Description: Within Exmouth town site
Boundary Description: Camerons Cave covers about 34 m east-west by 65 m north-south
Boundary Reliability: Very Good

Beard District: Carnarvon District
Beard Region: Carnarvon
Beard Province: Eremaean Province
Dola Reference: Lyndon
CTRC System: Pilbara
CTRC Recommendation: N/A
Commonwealth Listings: N/A
Original Area 0.22
Area Accuracy: 0.10
Data:
Other: Location given is cave entrance - as determined by DOLA surveyor

Soil: Alluvium, clay silt sand and gravel (van de Graaff, 1981) Onslow 1;250,000. Geol Survey of WA.
Surface Geology: Limestone
Landform Element: Cave
Water: Cave goes down to watertable
Drainage:
Vegetation Structure:
Classification: Other
Other Attributes:
Map: Exmouth 1:10,000 Cadastral
Beard Map: Pilbara, 1 : 1,000,000
Beard Description:

Districts: Exmouth - Pilbara Region
Tenures **Vacant Crown Land**
Land Tenure Number - Loc1387
Address - Lyndon Location 1387
Purpose - No purpose Listed
Vesting - Public Land
Contact - DOLA Perth - Ken McCracken 9273 7237
Management Plan Planned -
Management Plan Draft -
Management Plan Final -
Management Plan Produced By -
Shires
Shire - Shire of Exmouth
Tenure Area - 22.62 +/- 0.00 ha
Extent Area - 0.22 +/- 0.01 ha

Extents: 21/05/98 - 0.22 +/- 0.10 ha (Source Ground Survey)
Area Decline - Unknown but thought to be small. Community is thought not to have declined in area, but to only occur in Camerons Cave

Land Use: 13/05/98 (Actual Occurrence) - Remnant public land. Cave is currently on land that is VCL, but is planned for residential and marine / canal development and water abstraction
13/05/98 (Adjacent Land) - Remnant public land. Surrounding land is also planned for residential, marina / canal development and water abstraction
21/05/98 (Adjacent Land) - Race course. Racecourse reserve 41753 is 130 m south east of cave

Biological Processes: Community relies on food resource (leaf litter) coming in from outside the cave (from the surface)

Non Biological Processes: Community is reliant on the humidity created through contact with the local water table and specific surface conditions

Fire History:

Flora Species:

Other Species:

Armadillidae sp. - Dominant
Assamiidae sp. - Dominant
Blattodea sp.1 - Dominant
Centrogonus? sp. - Dominant
Collembola sp.1 - Dominant
Ctenidae sp.
Draculoides bramstokeri (Threatened Fauna) - Dominant
Hahniidae sp. - Dominant
Hyella sp. nov. (Threatened Fauna) - Dominant
Milyeringa veritas (Threatened Fauna) - Dominant
Phaconeura sp. nov. - Dominant
Phalangodidae sp. - Dominant
Ploiaria sp.1 - Dominant
Stygiochiropus peculiaris (Threatened Fauna) - Dominant
Trichocyclus sp. - Dominant
Trogidae sp.1 - Dominant

Surveys:

13/05/98 (Dr B. Humphreys) - Previously surveyed by Bill Humphreys and Mark Harvey for condition, extent and compostion

Threats

Hydrological changes - water quality and/or quantity

Modification - Marina, canal residential and changed surfaced conditions are likely to impact on the humidity levels in the cave that are essential for survival of the community, and may pollute cave waters
Other - Development is occuring in the area now, and is expected in the immediate area in the very near future
Current Percentage Affected - 100%
Current Impact - Insignificant to Low
Potential Impact - High to Extreme

Changing surface conditions altering food supply

Modification - Changed surface conditions may intercept the allochthonous food resource for the community (food coming from outside the cave).
Other - Development is occurring in the area at the moment, and is expected in the immediate area of the cave in the near future
Current Percentage Affected - 0%
Current Impact - Insignificant to Low
Potential Impact - High to Extreme

Surface subsidence

Modification - If used too close to the cave, heavy equipment or explosives have the potential to cause cave collapse.
Other - Risk of cave collapse is most likely when areas immediately adjacent are being developed
Current Percentage Affected - 0%
Current Impact - Insignificant to Low
Potential Impact - High to Extreme

Condition

100% Insignificantly modified -

Recommendations:

13/05/98 - CALM to ensure the planning process places controls on landuses which have the potential to impact the cave systems
21/05/98 - CALM to liaise with DOLA and WA Museum to determine suitable boundaries for reserve around the cave
21/05/98 - CALM to seek to have appropriate area vested with NPNCA as A class reserve for cave conservation
21/05/98 - CALM to implement recommendations in the IRP, when IRP is developed

Actions:

28/05/98 - Letter drafted to DOLA requesting input to determining boundaries of reserve to be established around the cave

Community Number: 44
Community Name: Bundera
Community Description: Cape Range remipede community
Former Range: Very narrow endemic community, total range <50 square km or <20 km linear
Range Decline: Unknown but thought to be small
Occurrences Decline: Unknown but thought to be small
Listing: Not on Current TEC Listing
Original Area:
Area Accuracy:
Publications:

Humphreys, W.F.
(1994). The subterranean fauna of the Cape Range coastal plain, northwestern Australia. Report to the Australian Heritage Commission and the Western Australian Heritage Committee. 202 pp. Unpublished.
Barnard, J.L., and Williams, W.D.
(in press). The taxonomy of freshwater Amphipoda (Crustacea) from Australian freshwaters: Part 2. Records of the Australian Museum.
Bradbury, J.H. and Williams, W.D.
(1996). Two new species of anchialine amphipod (Crustacea: Hadziidae: Liagoceradocus) from Western Australia. Records of the Western Australian Museum, 17: 395-409.
Bruce, N.L. and Humphreys, W.F.
(1993). Haptolana pholeta, sp. nov., the first subterranean flabelliferan isopod crustacean (Circolanidae) from Australia. Invertebrate Taxonomy 7: 875-884.
Holsinger, J.R.
(1989). Preliminary zoogeographic analysis of five groups of crustaceans from anchialine caves in the West Indian region. Proceedings 10th International Congress of Speleology, Budapest 2, 25-26.
Holsinger, J.R.
(1992). Two new species of the subterranean amphipod genus Bahadzia (Hadziidae) from the Yucatan Peninsula region of southern Mexico, with an analysis of phylogeny and biogeography of the genus. Stygologia 7, 85-105.
Humphreys, W.F.
(1993). Stygofauna in semi-arid tropical Western Australia: a Tethyan connection? Memoires de Biospeologie 20, 111-116.
Humphreys, W.F.
(1993). The significance of the subterranean fauna in biogeographical reconstruction: examples from Cape Range peninsula, Western Australia. Records of the Western Australian Museum, Supplement 45, 165-192.
Humphreys, W.F. and Adams, M.
(1991). The subterranean aquatic fauna of the North West Cape Peninsula, Western Australia. Records of the Western Australian Museum 15, 383-411.
Iliffe, T.M.
(1987). Observations on the biology and geology of anchialine caves. Proceedings of the 3rd Symposium, Geol. of Bahamas 73-79.
Iliffe, T.M.
(1992). Anchialine cave biology. In: The natural history of Biospeleology. ed. Ana Isabel Camacho. Monografias Museo Nacional de Ciencias Naturales, Madrid: 614-636.
Pohlman, J.W., Iliffe, T.M. and Cifuentes, L.A.
(1997). A stable isotope study of organic cycling and the ecology of an anchialine cave ecosystem. Marine Ecology Progress Series 155: 17-27.
Poore, G.C.B. and Humphreys, W.F.
(1992). First record of Thermosbaenacea (Crustacea) from the Southern Hemisphere: a new species from a cave in tropical Western Australia. Invertebrate Taxonomy 6, 719-725.
Sket, B.
(1981). Fauna of anchialine (coastal) cave waters, its origin and importance. Proceedings 8th International Congress of Speleology 646-647.
Sket, B.
(1996). The ecology of anchihaline caves. Trends in Ecology and Evolution 11: 221-255.
Yager, J.
(1987). Cryptocorynetes haptodiscus, new genus, new species, and Speleonectes benjamini, new species, of Remipede crustaceans from anchialine caves in the Bahamas, with remarks on distribution and ecology. Proc. Biol. Soc. of Wash. 100, 302-320.
Yager, J.
(1987). Speleonectes tulumensis, n. sp. (Crustacea: Remipedia) from two anchialine cenotes of the Yucatan Peninsula, Mexico. Stygologia 3, 160-166.
Yager, J.

(1991). The Remipedia (Crustacea): recent investigations of their biology and phylogeny. Verhandlungen der Deutschen Zoologischen Gesellschaft 84, 261-269.
Yager, J.
(1994). Speleonectes gironensis, new species (Remipedia: Speleonectidae), from anchialine caves in Cuba, with remarks on biogeography and ecology. Journal of Crustacean Biology 14, 752-762.
Yager, J. and Humphreys, W.F.
(1996). Lasionectes exleyi, sp. nov., the first remipede crustacean recorded from Australia and the Indian Ocean, with a key to the world species. Invertebrate Taxonomy 10: 171-187.
Yager, J., Spokane, R.B., Bozanic, J.E., Williams, D.W and Balado, E.
(1994). An ecological comparison of two anchialine caves in Cuba with emphasis on water chemistry. Second Internat. Conference on Ground Water Ecology, (U.S. Env Prot Agency, Americal Water Res Ass), Stanford, J.A. and Valett, M.H. (eds.) March: 95-101.

Reviews: 23/06/98 - J. Blyth, V. English, B. Humphreys, D. True, J. Colman, A. Hopkins, A. Storey, S. Hamilton-Brown

Categories:
Effect Date - 23/06/98
Category - Critically Endangered
Comment - A single one-off event such as dumping of waste into the cave has the potential to destroy community
Review Date - 23/06/2000
Criteria:
Current distribution limited and very few occurrences, each of which is small and/or isolated and extremely vulnerable to known threatening processes

History:
Date - 22/05/98
Area Decline - Unknown but thought to be small
Comment -

Recommendations: 22/05/98 - CALM to develop an IRP for the community that incorporates consideration of land management

Actions:

Current Area: .50 +/- .50 ha
Number of Occurrences: 1
Minimum Longitude: 113° 45' 51"
Maximum Longitude: 113° 45' 51"
Minimum Latitude: -22° 24' 51"
Maximum Latitude: -22° 24' 51"
Tenure Areas: Freehold, Non CALM - .50 ha
Degradation Areas: Moderately modified - .50 ha

Occurrence Number: 1
Description: In RAAF's military exercise area and bombing range, western side of the Cape Range peninsula.
Boundary Description: Cave waters have subsurface connections with seawater, so boundaries of community are difficult to determine.
Occurrence Area: .50 +/- .50 ha
Site Identifications:
Site ID, Longitude, Latitude
BUNDERA01, 113° 45' 51", -22° 24' 51"
Biological Processes: Remipedes occur at depths from 20-30.5 m, beneath a density interface and would rely on very specific physico-chemical conditions
Non Biological Processes: Subsurface Cave that has a single inland entrance and subsurface links to seawater

Significant cave animals occur below a strong density interface, in anoxic conditions, with hydrogen sulphide layers in mid-water
Physico-chemical conditions in the cave are complex and easily disrupted by divers

Land Use:
22/05/98 (Actual Occurrence) - Military exercise area and bombing range. There is good track access to the cave and the surrounding area is commonly used for recreation
22/05/98 (Adjacent Land) - Military exercise area and bombing range.
22/05/98 (Adjacent Land) - Ocean. Marine Park Reserve No. 2 is 1.7 km west (as indicated in nomination form), but coordinates indicate ocean and reserve are about 3.3km west

Surveys:
22/05/98 (B. Humphreys has conducted extensive survyes of composition and extent of the community) -
Threats
Pollution
Modification - Pollution episodes such as dumping of oil or other waste have the potential to destroy the community

Other - Complete destruction of the community is likely if the cave waters become polluted.
Current Percentage Affected - 0%
Current Impact - Insignificant to Low
Potential Impact - High to Extreme

Nutrient enrichment
Modification - Nutrient levels fall within range reported for caves considered grossly polluted. May be caused by goat faeces, but may be naturally eutrophic.
Other - Nutrient levels may continue to increase unless goat numbers and/or their access to the cave is controlled.
Current Percentage Affected - 100%
Current Impact - Medium to High
Potential Impact - High to Extreme

Disruption of physico-chemical stratification
Modification - Diving causes mixing of cave waters. These communities are characteristically associated with chemical stratification.
Other - Cave is outside conservation reserves and access is not well controlled.
Current Percentage Affected - 0%
Current Impact - Insignificant to Low
Potential Impact - Medium to High

Invasion by feral fish
Modification - Feral fish occur on the eastern side of the Cape Range peninsula, and if introduced to this cave, have the potential to severely impact the community through competing with native species.
Other - Potential for introduction of feral fish unless access to the cave is more tightly controlled
Current Percentage Affected - 0%
Current Impact - Insignificant to Low
Potential Impact - Medium to High

Surface subsidence
Modification - Potential for cave collapse if explosions (such as ordnance used on the bombing range) occur near the cave.
Other - Potential for use of ordnance near cave unless Commonwealth enters management agreement or tenure altered
Current Percentage Affected - 0%
Current Impact - Insignificant to Low
Potential Impact - Medium to High

Condition
100% Moderately modified - May be polluted with nutrients from goat faeces (B. Humphreys pers. comm.)

Recommendations:

24/05/98 - CALM and Biodiveristy Unit of Environment Australia liaise with Commonwealth of Australia on management. If a management plan that would conserve this TEC is not being developed or implemented, CALM seek cooperative involvement in such a plan
24/05/98 - If conservation management seems unlikely, CALM seek to acquire community, and revest as Class A reserve for 'Cave Conservation' vested in NPNCA.
24/05/98 - If area vested in NPNCA, CALM implement control of threatening processes including controlling goats, diverting tracks away from the cave, and monitoring water quality and species composition

Actions:

Community Name: **Bundera**
Community Description: **Cape Range remipede community**
Occurrence Number: 1
Confidential: No
Site Identifications: **Site ID, Longitude, Latitude**
BUNDERA01, 113° 45' 51", -22° 24' 51"
Source: GPS in field
Description: In RAAF's military exercise area and bombing range, western side of the Cape Range peninsula.
Boundary Description: Cave waters have subsurface connections with seawater, so boundaries of community are difficult to determine.
Boundary Reliability: Poor

Beard District: Carnarvon District
Beard Region: Carnarvon
Beard Province: Eremaean Province
Dola Reference: Lyndon
CTRC System: Pilbara
CTRC Recommendation: N/A
Commonwealth Listings: N/A
Original Area Area Accuracy: N/A
Data:
Other:

Soil: Pilgramunna - quartzose, cross-bedded calcarenite and coralgal limestone. 1;250,000 Yanrey-Ning geol
Surface Geology: Limestone
Landform Element: Cave
Water: Community below pycnocline in anchialine cave
Drainage: Cave has subsurface connections with seawater
Vegetation Structure:
Classification: Other
Other Attributes:
Map: Ningaloo 1:250,000 topo-cadastral
Beard Map: Pilbara, 1 : 1,000,000
Beard Description: N/A

Districts: Exmouth - Pilbara Region
Tenures **Freehold, Non CALM**
Land Tenure Number - LOC97
Address - Lyndon Location 97
Purpose - Military exercise area and bombing range
Vesting - Commonwealth of Australia - RAAF
Contact - Bill Humphreys - WA Museum
Management Plan Planned -
Management Plan Draft -
Management Plan Final -
Management Plan Produced By -
Shires
Shire - Shire of Exmouth
Tenure Area - 18,781.00 +/- 0.00 ha
Extent Area - 0.50 +/- 0.50 ha

Extents: 21/05/98 - 0.50 +/- 0.50 ha (Source Ground Survey)
Area Decline - Unknown but thought to be small. Area occupied by community unknown as cave has subsurface connections with seawater
Land Use: 22/05/98 (Actual Occurrence) - Military exercise area and bombing range. There is good track access to the cave and the surrounding area is commonly used for recreation
22/05/98 (Adjacent Land) - Military exercise area and bombing range.
22/05/98 (Adjacent Land) - Ocean. Marine Park Reserve No. 2 is 1.7 km west (as indicated in nomination form), but coordinates indicate ocean and reserve are about 3.3km west

Biological Processes: Remipedes occur at depths from 20-30.5 m, beneath a density interface and would rely on

very specific physico-chemical conditions

Non Biological Processes:

Subsurface Cave that has a single inland entrance and subsurface links to seawater

Significant cave animals occur below a strong density interface, in anoxic conditions, with hydrogen sulphide layers in mid-water
Physico-chemical conditions in the cave are complex and easily disrupted by divers

Fire History:

Flora Species:

Lamprothamnium papulosum - Dominant
Rhizoclonium tortuosum - Dominant

Other Species:

Danielopolina sp. nov - Dominant
Halicyclops sp. nov.
Halosbaena sp.
Haptolana sp.
Iravadia sp.
Kiefferulus intertinctus
Lasionectes exleyi (Threatened Fauna) - Dominant
Liagoceradocus sp. nov. - Dominant
Milyeringa veritas (Threatened Fauna)
Orphisternon sp.
Spionidae sp.
Stygiocaris stylifera

Surveys:

22/05/98 (B. Humphreys has conducted extensive survyes of composition and extent of the community) -

Threats

Pollution

Modification - Pollution episodes such as dumping of oil or other waste have the potential to destroy the community
Other - Complete destruction of the community is likely if the cave waters become polluted.
Current Percentage Affected - 0%
Current Impact - Insignificant to Low
Potential Impact - High to Extreme

Nutrient enrichment

Modification - Nutrient levels fall within range reported for caves considered grossly polluted. May be caused by goat faeces, but may be naturally eutrophic.
Other - Nutrient levels may continue to increase unless goat numbers and/or their access to the cave is controlled.
Current Percentage Affected - 100%
Current Impact - Medium to High
Potential Impact - High to Extreme

Disruption of physico-chemical stratification

Modification - Diving causes mixing of cave waters. These communities are characteristically associated with chemical stratification.
Other - Cave is outside conservation reserves and access is not well controlled.
Current Percentage Affected - 0%
Current Impact - Insignificant to Low
Potential Impact - Medium to High

Invasion by feral fish

Modification - Feral fish occur on the eastern side of the Cape Range peninsula, and if introduced to this cave, have the potential to severely impact the community through competing with native species.
Other - Potential for introduction of feral fish unless access to the cave is more tightly controlled
Current Percentage Affected - 0%
Current Impact - Insignificant to Low
Potential Impact - Medium to High

Surface subsidence

Modification - Potential for cave collapse if explosions (such as ordnance used on the bombing range) occur near the cave.
Other - Potential for use of ordnance near cave unless Commonwealth enters

management agreement or tenure altered
Current Percentage Affected - 0%
Current Impact - Insignificant to Low
Potential Impact - Medium to High

Condition
100% Moderately modified - May be polluted with nutrients from goat faeces (B. Humphreys pers. comm.)

Recommendations:

24/05/98 - CALM and Biodiveristy Unit of Environment Australia liaise with Commonwealth of Australia on management. If a management plan that would conserve this TEC is not being developed or implemented, CALM seek cooperative involvement in such a plan
24/05/98 - If conservation management seems unlikely, CALM seek to acquire community, and revest as Class A reserve for 'Cave Conservation' vested in NPNCA.
24/05/98 - If area vested in NPNCA, CALM implement control of threatening processes including controlling goats, diverting tracks away from the cave, and monitoring water quality and species composition

Actions:
Additional Data:

Community Number: 35
Community Name: HAMELIN STROMATOLITE
Community Description: Hypersaline microbial community number 2 (hypersaline tidal stromatolite aragonite community formed by trapping and binding by a variety of cyanobacteria and eukaryotes)
Former Range: Narrow endemic, total range < 500 square km or 100 km linear
Range Decline: Occupies most or all of former geographic range
Occurrences Decline: Most or all former occurrences remain
Listing: Not on Current TEC Listing
Original Area: 10,000.00
Area Accuracy: 5,000.00
Publications:
Logan, B.W.
(1971). Conservation in Hamelin Pool: a marine-basin environment with unique algal stromatolites, in Shark Bay, Western Australia
Department of Conservation and Environment
(1975). Conservation in Hamelin Pool, Western Australia. Bulletin number 5. Department of Conservation and Environment.
Reviews: 20/06/96 - M.Brooker, A. Hopkins, N.Gibson, J. Blyth, P. Jennings, R. Safstrom (V.English present; special address by L. Moore on microbial communities)
23/06/98 - J. Blyth, V. English, B. Humphreys, D. True, J. Colman, A. Hopkins, A. Storey, S. Hamilton-Brown
Categories: Effect Date - 20/06/96
Category - Data Deficient
Comment - Actual extent of community unknown
Review Date - 20/06/2001
Criteria:
An ecological community which has not been adequately evaluated with respect to status or where there is currently insufficient information to assign it to a particular category.
Effect Date - 23/06/98
Category - Lower Risk
Comment - No apparent short to medium term threats
Review Date - 23/06/99
Criteria:
An ecological community that does not qualify for any of the above categories of threat and appears unlikely to be under threat of significant modification or destruction in the short to medium term future.
History: Date - 13/05/96
Area Decline - Occupies most or all of former area
Comment - Area occupied by community probably has not declined
Recommendations: 6/11/96 - CALM liaise with experts on the community to determine actual extent and level of threat to community
23/06/98 - Advisory Group to reassess community when data on boundaries completed by CALM's Marine Branch
Actions: 13/05/96 - Many conservation actions already undertake at this date eg. boardwalk to prevent crushing, reservation of marine area, management of nutrient input to Hamelin Pool.
23/06/98 - CALM's Marine branch is undertaking a study of the boundaries of the community using remote sensing data. The group is also investigating suitable parameters for monitoring including water quality.
Current Area: 10000.00 +/- 5000.00 ha
Number of Occurrences: 1
Minimum Longitude: 114° 5' 27"
Maximum Longitude: 114° 5' 27"
Minimum Latitude: -26° 26' 7"
Maximum Latitude: -26° 26' 7"
Tenure Areas: Marine Reserve - Marine Nature Reserve - 10000.00 ha
Degradation Areas: Insignificantly modified - 10000.00 ha

Occurrence Number: 1
Description: Marine Nature Reserve Number 6, Hamelin Pool
Boundary Description: Stromatolites occur on periphery of Hamelin Pool where water depth is below ~3m, between Faure Sill in the north and southern extremity of embayment
Occurrence Area: 10000.00 +/- 5000.00 ha
Site Identifications: **Site ID, Longitude, Latitude**

HAMPLSTH, 114° 5' 27", -26° 26' 7"

Biological Processes: Hypersaline waters are inappropriate for marine gastropods which forage algae. This would be a major factor in survival of stromatolites

Non Biological Processes: Exchange of water between the embayment and ocean is limited by the Faure Sill - seagrass bed and sand bar. Evaporation causes waters of embayment to be hypersaline
Stromatolites will not grow where water depth >3m
If inflow of water into bay is further restricted, waters will become even more salty and stromatolites will colonise deeper waters
If inflow of water into bay is cut off, Hamelin Pool will eventually dry out
If Faure Sill is breached, allowing full exchange with sea water, then seagrass and perhaps corals would displace stromatolites

Land Use: 13/05/96 (Actual Occurrence) - Conservation Reserve. Whole of Marine embayment is nature reserve
13/05/96 (Adjacent Land) - Preservation of Sediment Deposits. Reserve for preservation of sediment deposits surrounds Hamelin Pool from LWM to HWM

Surveys: **13/05/96 (Not surveyed) -**

Threats

Disturbance due to recreational activities
Modification - Stromatolites crushed underfoot or due to vandalism
Other - Boardwalk ameliorates accidental damage, however, deliberate vandalism cannot be avoided
Current Percentage Affected - 0%
Current Impact - Insignificant to Low
Potential Impact - Low to Medium

Water level changes as a result of greenhouse effect
Modification - Likely that Faure Sill would be breached if water level rose sufficiently. This would alter salinity and seagrass and perhaps corals would replace stromatolites
Other - Water level changes possible in long term future
Current Percentage Affected - 0%
Current Impact - Insignificant to Low
Potential Impact - High to Extreme

Nutrient enrichment
Modification - Efflent from small tourist development on shore of Hamelin Pool may alter nutrient levels in embayment
Other - Provided size of development is kept small, nutrient inputs should be correspondingly relatiely low in comparison to volume of embayment
Current Percentage Affected - 0%
Current Impact - Insignificant to Low
Potential Impact - Low to Medium

Condition
100% Insignificantly modified -

Recommendations: 13/05/96 - CALM ensure Management Plan for area incorporates monitoring and management of; water quality in embayment, destruction of stromatolites due to vandalism, effects of developments on Faure Sill

Actions:

Community Name: HAMELIN STROMATOLITE
Community Description: **Hypersaline microbial community number 2 (hypersaline tidal stromatolite aragonite community formed by trapping and binding by a variety of cyanobacteria and eukaryotes)**
Occurrence Number: 1
Confidential: No
Site Identifications: **Site ID, Longitude, Latitude**
HAMPLSTH, 114° 5' 27", -26° 26' 7"
Source: Derived from Map
Description: Marine Nature Reserve Number 6, Hamelin Pool
Boundary Description: Stromatolites occur on periphery of Hamelin Pool where water depth is below ~3m, between Faure Sill in the north and southern extremity of embayment
Boundary Reliability: Good

Beard District: Irwin District
Beard Region: Northern Sandplains
Beard Province: Southwest Province
Dola Reference: Abbotts
CTRC System: Central West Coast
CTRC Recommendation: 9.1.6 Hamelin Pool and Faure Sill
Commonwealth Listings: Part of Shark Bay World Heritage Listed area as at Feb '93, on Register of National Estate
Original Area 10,000.00
Area Accuracy: 5,000.00
Data: Derived from area of Hamelin Pool/depth contours
Other: HAMPLSTH is in central southern portion of stromatolite area

Soil:
Surface Geology:
Landform Element: Hypersaline marine embayment - effectively a lake
Water: Hypersaline
Drainage: Exchange of marine waters with open ocean is limited by Faure Sill
Vegetation Structure:
Classification: Aplin
Other Attributes:
Map: Yaringa 1:250,000 cadastral
Beard Map: Ajana area, 1 : 250,000
Beard Description:

Districts: Gascoyne - Midwest Region
Tenures
Marine Reserve - Marine Nature Reserve
Land Tenure Number - MNR6
Address - Marine Nature Reserve number 6 - Hamelin Pool (A class)
Purpose - Marine Nature Reserve
Vesting - NPNCA
Contact - P. Brown Denham CALM District Office
Management Plan Planned -
Management Plan Draft -
Management Plan Final -
Management Plan Produced By -
Shires
Shire - Shire of Shark Bay
Tenure Area - 132,000.00 +/- ha
Extent Area - 10,000.00 +/- 5,000.00 ha

Extents: 13/05/96 - 10,000.00 +/- 5,000.00 ha (Source Soil and/or Landform Map)
Area Decline - Occupies most or all of former area. Does not appear to have declined in area
Land Use: 13/05/96 (Actual Occurrence) - Conservation Reserve. Whole of Marine embayment is nature reserve
13/05/96 (Adjacent Land) - Preservation of Sediment Deposits. Reserve for preservation of sediment deposits surrounds Hamelin Pool from LWM to HWM

Biological Processes: Hypersaline waters are inappropriate for marine gastropods which forage algae. This would be a major factor in survival of stromatolites

Non Biological Processes:

Exchange of water between the embayment and ocean is limited by the Faure Sill - seagrass bed and sand bar. Evaporation causes waters of embayment to be hypersaline
Stromatolites will generally not grow where water depth >3m
If inflow of water into bay is further restricted, waters will become even more salty and stromatolites will colonise deeper waters
If inflow of water into bay is cut off, Hamelin Pool will eventually dry out
If Faure Sill is breached, allowing full exchange with sea water, then seagrass and perhaps corals would displace stromatolites

Fire History:

Flora Species:

Other Species:

Entophysalis major - Dominant
Microcoleus chthonoplastes - Dominant
Phormidium hypersalinum - Dominant
Schizothrix sp. - Dominant

Surveys:

13/05/96 (Not surveyed) -
Threats
Disturbance due to recreational activities
Modification - Stromatolites crushed underfoot or due to vandalism
Other - Boardwalk ameliorates accidental damage, however, deliberate vandalism cannot be avoided. Stromatolites on eastern side of bay are inaccessible, however.
Current Percentage Affected - 0%
Current Impact - Insignificant to Low
Potential Impact - Low to Medium

Water level changes as a result of greenhouse effect
Modification - Likely that Faure Sill would be breached if water level rose sufficiently. This would alter salinity and seagrass and perhaps corals would replace stromatolites
Other - Water level changes possible in long term future
Current Percentage Affected - 0%
Current Impact - Insignificant to Low
Potential Impact - High to Extreme

Nutrient enrichment
Modification - Effient from small tourist development on shore of Hamelin Pool may alter nutrient levels in embayment
Other - Provided size of development is kept small, nutrient inputs should be correspondingly relatiely low in comparison to volume of embayment
Current Percentage Affected - 0%
Current Impact - Insignificant to Low
Potential Impact - Insignificant to Low

Condition
100% Insignificantly modified -

Recommendations:

13/05/96 - CALM ensure Management Plan for area incorporates monitoring and management of; water quality in embayment, destruction of stromatolites due to vandalism, effects of developments on Faure Sill

Actions:

Additional Data:

ATTACHMENT 3

CRITERIA FOR PRESUMED TOTALLY DESTROYED, CRITICALLY ENDANGERED, ENDANGERED, VULNERABLE, DATA DEFICIENT AND LOWER RISK ECOLOGICAL COMMUNITIES

PRESUMED TOTALLY DESTROYED (PD)

An ecological community will be listed as presumed totally destroyed if there are no recent records of the community being extant **and either** of the following applies (A or B);

A) Records within the last 50 years have not been confirmed despite thorough searches of known or likely habitats **or**

B) All occurrences recorded within the last 50 years have since been destroyed

CRITICALLY ENDANGERED (CR)

An ecological community will be listed as **Critically Endangered** when it has been adequately surveyed and is found to be facing an extremely high risk of total destruction in the immediate future. This will be determined on the basis of the best available information, by it meeting **any one or more of** the following criteria (A, B or C);

A) The estimated geographic range, and/or total area occupied, and/or number of discrete occurrences since European settlement have been reduced by at least 90% **and either or both** of the following apply (i or ii);

i) geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is imminent (within approximately 5 years)

ii) modification throughout its range is continuing such that in the immediate future (within approximately 5 years) the community is unlikely to be capable of being substantially rehabilitated

B) Current distribution is limited, **and one or more** of the following apply (i , ii or iii):

i) geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the immediate future (within approximately 5 years)

ii) there are very few occurrences, each of which is small and/or isolated and extremely vulnerable to known threatening processes

iii) there may be many occurrences but total area is very small and each occurrence is small and/or isolated and extremely vulnerable to known threatening processes

C) The ecological community exists only as highly modified occurrences which may be capable of being rehabilitated if such work begins in the immediate future (within approximately 5 years)

ENDANGERED (EN)

An ecological community will be listed as **Endangered** when it has been adequately surveyed and is not Critically Endangered but is facing a very high risk of total destruction in the near future. This will be determined on the basis of the best available information by it meeting **any one or more of** the following criteria (A, B, or C);

A) The geographic range, and/or total area occupied, and/or number of discrete occurrences have been reduced by at least 70% since European settlement **and either or both** of the following apply (i or ii);

i) the estimated geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is likely in the short term future (within approximately 10 years)

ii) modification throughout its range is continuing such that in the short term future (within approximately 10 years) the community is unlikely to be capable of being substantially restored or rehabilitated

B) Current distribution is limited, **and one or more** of the following apply (i, ii or iii):

i) geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the short term future (within approximately 10 years)

ii) there are few occurrences, each of which is small and/or isolated and all or most occurrences are very vulnerable to known threatening processes

iii) there may be many occurrences but total area is small and all or most occurrences are small and/or isolated and very vulnerable to known threatening processes

C) The ecological community exists only as very modified occurrences which may be capable of being substantially restored or rehabilitated if such work begins in the short term future (within approximately 10 years)

VULNERABLE (VU)

An ecological community will be listed as **Vulnerable** when it has been adequately surveyed and is not Critically Endangered or Endangered but is facing a high risk of total destruction or significant modification in the medium to long term future. This will be determined on the basis of the best available information by it meeting **any one or more of** the following criteria (A, B or C);

A) The ecological community exists largely as modified occurrences which are likely to be capable of being substantially restored or rehabilitated.

B) The ecological community can be modified or destroyed and would be vulnerable to threatening processes, is restricted in area and/or range and/or is only found at a few locations.

C) The ecological community may be still widespread but is believed likely to move into a category of higher threat in the medium to long term future because of existing or impending threatening processes.

DATA DEFICIENT (DD)

An ecological community that has not been adequately evaluated with respect to status or where there is currently insufficient information to assign it to a particular category. (Often an ecological community with poorly known distribution or biology that is suspected to belong to any of the above categories. These ecological communities have a high priority for survey and/or research)

LOWER RISK (LR)

An ecological community that has been adequately surveyed and does not qualify for any of the other categories of threat and appears unlikely to be under threat of significant modification or destruction in the short to medium term future.

Note: The application of terms used in the criteria including "very few", "few", "highly modified", "very modified", "small", "isolated", "imminent", "short term future", "extremely vulnerable", and "very vulnerable" will depend on individual cases and will be determined on the basis of expert opinion.