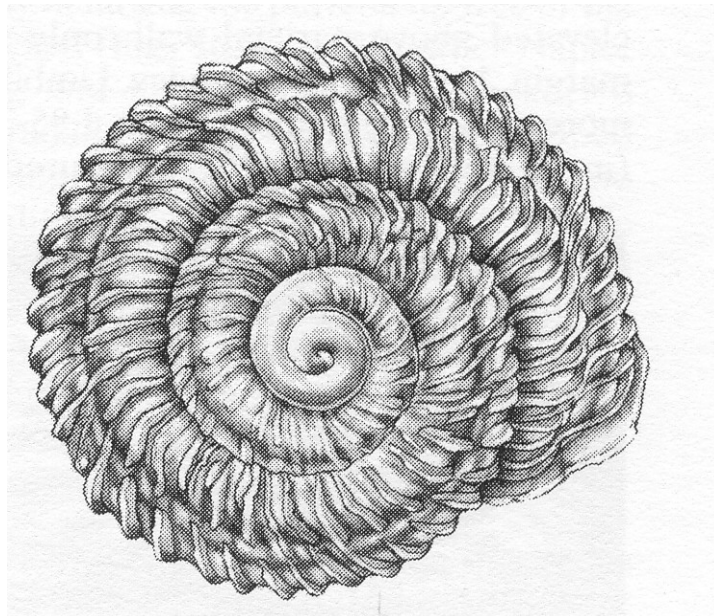


CAMAENID LAND SNAILS OF THE EAST KIMBERLEY INTERIM RECOVERY PLAN 2005-2010

By Kirsten Pearce



Shell of *Mouldingia orientalis*, Napier Range.
Drawing by Linnea Lahlum from Solum (1984), *Records of WA Museum* (17)

February 2005

INTERIM RECOVERY PLAN NO 194

**CAMAENID LAND SNAILS OF THE
EAST KIMBERLEY
INTERIM RECOVERY PLAN 2005-2010**

By Kirsten Pearce

February 2005

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FOREWORD

Interim Recovery Plans (IRPs) are developed within the framework laid down in the Department of Conservation and Land Management (CALM) Policy Statements 44 and 50.

IRPs outline the recovery actions that are required to urgently address those threatening processes most affecting the ongoing survival of threatened taxa or ecological communities and begin the recovery process.

CALM is committed to ensuring that threatened species and ecological communities are conserved through the preparation and implementation of Recovery Plans or Interim Recovery Plans and by ensuring that conservation action commences as soon as possible and always within one year of endorsement of that rank by the Minister.

This Interim Recovery Plan will operate from February 2005 to March 2010 but will remain in force until withdrawn or replaced. It is intended that, if the taxa is still ranked Vulnerable, this IRP will be reviewed after five years and the need for a full Recovery Plan will be assessed.

This Interim Recovery Plan was given Regional approval on 31 January 2005, and was approved by the A/Director of Nature Conservation on 4 April 2005. The allocation of staff time and provision of funds identified in this Interim Recovery Plan is dependant on budgetary and other constraints affecting CALM, as well as the need to address other priorities.

The information in this Recovery Plan was accurate at June 2004.

ACKNOWLEDGMENTS

The following people have provided assistance, and deserve thanks for their support in the preparation of this Interim Recovery Plan.

For their kind permission to work on their leasehold, and their co-operation in the development of management practices fundamental to recovery success:

Geoff Warriner (Pastoral Inspector for Consolidated Pastoral Company: Carlton Hill and Ivanhoe Pastoral Leases) and Stirling Buntine (Leaseholder: Lissadell Pastoral Lease).

For their enthusiasm, support and dedication to the environmental conservation: SEEKS (Save Endangered East Kimberley Species), Go Wild Adventure Tours and David Woods - local representative for the Western Australian Speleological Group.

For assistance with Camaenid ecology, comments on the draft, and for their kind permission to use unpublished material and collection coordinates representing many years of work: Norm McKenzie (CALM), and Vince Kessner (Adelaide River Health Centre, NT).

For the provision of information: The Kimberley Land Council, Department of Indigenous Affairs, Department of Agriculture, National Native Title Tribunal, Department of Industry and Resources, 'Go Wild Adventure Tours' and various CALM staff at Woodvale and Kununurra.

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SUMMARY

This IRP covers the following taxa:

Genus: <i>Turgenitubulus</i>	Genus: <i>Cristilabrum</i>	Genus: <i>Ningbingia</i>
<i>Turgenitubulus christenseni</i>	<i>Cristilabrum bubulum</i>	<i>Ningbingia australis australis</i>
<i>Turgenitubulus costus</i>	<i>Cristilabrum buryillum</i>	<i>Ningbingia australis elongata</i>
<i>Turgenitubulus depressus</i>	<i>Cristilabrum grossum</i>	<i>Ningbingia bulla</i>
<i>Turgenitubulus foramenus</i>	<i>Cristilabrum isolatum</i>	<i>Ningbingia dentines</i>
<i>Turgenitubulus opiranus</i>	<i>Cristilabrum monodon</i>	<i>Ningbingia laurina</i>
<i>Turgenitubulus pagodula</i>	<i>Cristilabrum primum</i>	<i>Ningbingia octava</i>
<i>Turgenitubulus tanmurrana</i>	<i>Cristilabrum rectum</i>	<i>Ningbingia res</i>
	<i>Cristilabrum simplex</i>	Genus: <i>Mouldingia</i>
	<i>Cristilabrum spectaculum</i>	<i>Mouldingia orientalis</i>
	<i>Cristilabrum solitudum</i>	Genus: <i>Ordtrachia</i>
		<i>Ordtrachea elegans</i>

The above twenty-four species and two subspecies of land snails belong to the Camaenidae, a family of pulmonate gastropods of the order Stylommatophora. They are all listed as threatened, and have been recorded only in the limestone ranges and outcrops of the East Kimberley. Twenty five of these taxa occur in the area of the Ningbing range and Jeremiah Hills north of Kununurra, and one south of Lake Argyle. The genera *Turgenitubulus*, *Cristilabrum*, and *Ningbingia* are endemic to the Ningbing Range and Jeremiah Hills areas.

All Camaenid species included in this Plan are short-range endemics with a known geographical range of less than 5.6km². They typically occur in shaded limestone crevices, under rocks or in leaf litter, and feed on decaying leaf and grass fragments. Emergence from aestivation is based on specific rainfall and humidity variables. Suitable nights for activity number approximately 80 each year.

Many areas within the limestone range have not been surveyed. It is expected that additional species, and perhaps genera, will become known when further sampling and taxonomic description are conducted.

CALM Region: Kimberley

CALM District: East Kimberley

Shire: Shire of Wyndham – East Kimberley (SWEK)

Suggested Recovery Team

Representatives from CALM (Western Australian Threatened Species and Communities Unit (WATSCU), Kimberley Region); SEEKS (Save Endangered East Kimberley Species); SWEK; Vince Kessner (Malacologist); Consolidated Pastoral Company (Carlton Hill and Ivanhoe Stations); lease holder, Lissadell Pastoral Lease; Western Australian Speleological Group; Miriuwung Gajerrong and Malarngowem peoples.

Current Status (see Appendix 1)

All of the taxa dealt with in this IRP are listed as “Specially Protected – Fauna that is rare or likely to become extinct”, under the Western Australian *Wildlife Conservation Act 1950*. Twenty are ranked Critically Endangered, 4 Endangered and 2 Vulnerable. They are also listed on the IUCN Red List. They are not currently listed under the *Commonwealth’s Environmental Protection and Biodiversity Conservation (EPBC) Act 1999*.

Benefits to other species/ecological communities: The limestone habitat in this region supports pockets of vine thickets that are highly distinctive communities. Recovery actions to protect land snail habitat will promote and conserve the biological integrity of this area.

International Obligations: This Plan is fully consistent with the aims and recommendations of the Convention on Biological Diversity, ratified by Australia in June 1993, and will assist in implementing Australia's responsibilities under that convention. The land snails are not listed under any specific international treaty however, and therefore this IRP does not affect Australia's obligations under any other international agreements.

Role and interests of indigenous persons: Native Title negotiations, claims and determinations are current over the land affected by this IRP (National Native Title Tribunal). The Miriwung Gajerrong Peoples, and the Malarngowem Peoples are claiming traditional ownership rights over respective localities. On determined land, the legal rights of traditional owners must be recognized. A co-operative approach with traditional owners and local indigenous communities (not necessarily the same) will be sought in all conservation measures adopted to facilitate the desired outcomes of this IRP. As discussed in Recovery Actions, input and involvement will be sought from groups that have an active interest in the areas that need to be managed for Camaenid recovery.

Social and economic impacts: Individuals and tour companies pursuing recreational activities, pastoral leaseholders, mineral exploration companies and local indigenous persons may be affected by the measures recommended to protect the threatened Camaenid species. In general, such effects are likely to be minor, and recovery actions refer to continued liaison between stakeholders with regard to these areas.

Distribution: Twenty-five of the threatened Camaenid species occur north of Kununurra in the Ningbing Range area, and one occurs to the south of Lake Argyle (Appendix 2).

Critical Habitat: Shaded rubble and crevices, leaf litter accumulation and associated vegetation assemblages found throughout the Upper Devonian Ningbing Limestone outcrops, provide the critical habitat required by the Camaenid land snails listed in this IRP. Given the highly restricted range of each species, all known habitat for wild and potentially translocated populations of each species should be treated as critical for their conservation.

Evaluation of the plan's performance: District and WATSCU staff, and recovery team are to review progress annually with a formal review mid-term and after five years. Funding identified in Recovery Actions will also need to be reviewed on an annual basis.

IRP Objective

- To conserve all known existing populations based on a whole of landscape management approach. Conservation measures recommended will protect entire occurrences of limestone-associated habitat, which encompass known and potential Camaenid range.
- To determine the extent and severity of threats facing populations of Camaenid land snails affected by this IRP and ameliorate those threats.

Recovery Criteria

- **For success:** An appropriate fire regime that includes cool burns (controlled, slow burns carried out in the late wet/early dry season, when an appropriate degree of moisture is still present in the soil and vegetation) is implemented as part of a fire management strategy around the periphery of limestone occurrences.
- Fencing is erected around the habitat of threatened camaenids where possible and appropriate.
- The health of limestone associated vegetation assemblages, particularly monsoon vine thicket occurrences, do not decline significantly in condition (due to cattle, fire or weed invasion).
- Traditional owners are supportive of and/or actively involved in management decisions and on-ground actions.

- Wet season assessment of numbers of live snails, or dry season counting of remnant sub-adult shells, indicates that populations of each known taxon are stable or increasing.

For failure:

- A regime of hot burns (burns carried out in the peak dry season, when vegetation is at its most volatile) persists on an annual basis and impacts upon the habitat of the Camaenid land snails.
- The vegetation habitat that supports threatened Camaenid populations declines in condition.
- Traditional owners are not supportive of recovery plans, and/or where Native Title is determined, decline access.
- Snail populations vulnerable to the effects of cattle are not protected where it is feasible to do so.
- Wet season assessment of numbers of live snails, or dry season counting of remnant sub-adult shells, indicates that populations of one or more known taxa are declining.

RECOVERY ACTIONS	
1	Confirm Recovery Team and coordinate actions.
2	Liaise with indigenous persons and groups.
3	Identify funding opportunities.
4	Identify and monitor the condition of representative vegetation and habitat.
5	Improve understanding of Camaenid ecology, taxonomy, distribution and threats.
6	Survey and establish monitoring for populations north of Kununurra.
7	Determine the status of <i>Mouldingia orientalis</i> on Lissadell pastoral lease.
8	Assess and monitor potential cane toad threat.
9	Map critical habitat.
10	Develop and implement a fire management strategy.
11	Identify and fence vulnerable populations.
12	Assess the impact of recreational activities.
13	Monitor proposed and existing mineral and petroleum activities.
14	Assess and monitor weed impact.
15	Develop relations with affected interests and regional experts.
16	Promote awareness.
17	Investigate the need for, and the feasibility of, translocation.
18	Review the need for a full Recovery Plan

1. BACKGROUND

Land snails of the family Camaenidae are believed to have arrived in Australia after the collision of the Australian and southeast Asian plates in the Miocene period approximately 12 million years BC (Solem and Christensen 1984). Many land snail genera and species remain to be discovered and hundreds in collections await taxonomic work. Non-marine molluscs are currently facing the most severe species decline of any major group, with approximately 280 documented extinctions world wide in the past 300 years according to IUCN listings (Ponder 1997). Despite these figures, they typically attract little public or political attention or funding (Ponder 1997).

The threatened Camaenids being addressed in this IRP all occur on Upper Devonian Ningbing limestone, which developed over 350 million years ago when a tropical sea covered the area. This reef system is unlike modern day reefs, which are formed from corals bound by algae; the Ningbing reefs are unique in that they were primarily formed from stromatolites and stromatoproids (Marsh 1997).

Alan Solem was the leading expert (Field Museum of Natural History, Chicago) on the Ningbing Camaenids, visiting the area on several occasions from 1976, until his death in 1989. Sampling in the Ningbing Range has primarily been restricted to the western side of the Ningbing Road which runs in a north south direction on the east of the range. Alan Solem was instrumental in determining species distribution patterns and providing taxonomic descriptions. He also made an assessment with Carl Christensen of the reproductive cycles and growth patterns of Camaenids in the Kimberley's north-west (Solem and Christensen 1984). To determine land snail assemblages and biogeography in Kimberley rainforests Alan Solem, Vince Kessner and Norm McKenzie undertook additional surveys in 1987 and 1988 (Solem 1991, Solem & McKenzie 1991). To date, over 40 land snail species have been recorded from the Ningbing Range (Solem 1988b) and more than 200 species of Camaenid land snails have been recorded from the Kimberley region (V. Kessner¹, personal communication).

Cristilabrum kessneri is a recently described Camaenid collected from the outlying eastern outcrops of the Jeremiah Hills. Although it is believed to occur within a linear range of approximately 100 meters and likely to be threatened (V. Kessner, personal communication), it is not currently recognized by any formal threatened species listing. In addition, it is expected that several new species await discovery in the Ningbing Range area, and two new genera from Lissadell Station remain undescribed (V. Kessner, personal communication). This IRP does not include the new species or any other potentially threatened but unlisted Camaenid species. However, the landscape management approach recommended in this IRP not only offers a feasible and economic means of habitat protection, it will also protect threatened Camaenids occurring within the recovery area that have not yet been officially described and/or listed.

Under the terms defined in the *Land Administration Act 1997*, government agencies were offered the opportunity to nominate areas of land deemed valuable for public purposes, to be excluded from pastoral leases that are due for renewal in 2015 (Department for Planning and Infrastructure 2004). Under this '2015 Pastoral Lease Renewal Process', areas of Carlton Hill Station have been proposed for exclusion by CALM on the basis of 'reservation for the conservation of flora and fauna'. The current proposed conservation estate incorporates the majority of the Ningbing Range. The southern most section of the range, from Ningbing Bore to Four Mile Bore and outlying outcrops, such as the Jeremiah Hills, will remain part of the pastoral lease.

Exclusion areas were also determined for Lissadell and Ivanhoe pastoral leases. One such area on Lissadell is approximately 3.5 hectares in total area, and was proposed by the Department of Indigenous Affairs to protect a sacred site (PA 65). This protected area is approximately 4kms from the collection site of *Mouldingia orientalis*. As the range of *M. orientalis* is currently unconfirmed, the bearing on recovery decisions is unclear. Threatened Camaenid species have been collected within a short distance (1-3km) of a proposed Ivanhoe Pastoral Lease exclusion zone (Weaber Range - this zone was proposed under the same conditions as that on Carlton Hill).

¹ Vince Kessner – malacologist

Although a road separates the sample points from the adjacent exclusion zone, the possibility should be considered that threatened Camaenid species might extend into this area where limestone is present.

In a discussion paper produced by CALM for the Department of Resources and Development, the recommended tenure for the Ningbing Range was Nature Reserve (Graham and White 1999).

2. DESCRIPTION /TAXONOMY

Taxonomic reviews for each species (with the exception of *Cristilabrum rectum*, *Ordtrachia elegans* and the subspecies of *Ningbingia australis*) can be found in “Camaenid Land Snails from Western and Central Australia, part III, IV and IV (Solem 1981, 1984 & 1985). The three exceptions can be found in the Journal of the Malacological Society of Australia (Solem 1988a).

Camaenid land snails from the Kimberley region are identified as different from non-Camaenid land snails by their large shell size (up to 30mm) (Appendix 3), globose shell shape and large shell aperture (Solem and McKenzie 1991). Shells are typically a pale yellow horn, sometimes with a white lip or base. No colour zoning is present. Shells are marked with varying intensity and patterns of radial ribbing (Solem 1981, 1984 & 1985).

Camaenids found in the Ningbing locality are regarded as unique in possessing “a prominent peripheral sulci [deep, narrow groove] on the body whorl”, and for frequently possessing a “high basal lip ridge that is marked externally by a deep curve on the last part of the body whorl.” (Solem 1981, 323). They also have a generalized jaw structure, which is consistent with the noted lack of feeding specializations (Solem 1988b).

Obvious morphological features alone are insufficient to identify the Camaenid species referred to in this IRP. Taxonomy is primarily based on the anatomy of genitalia, so field based identification is rarely possible (Solem 1991).

Some characteristics of the genera, *Turgenitubulus*, *Ningbingia*, and *Cristilabrum* (Solem 1981, 1985), and of *Mouldingia orientalis* (Solem 1984) are as follows:

Turgenitubulus displays an intensely swollen vas deferens, elongated free oviduct, and the downward shifting of the short spermathecal head from its normal position. “The penis... is usually very short, normally has a prominent apical plug and typically a conical to finger-like verge..” (Solem 1981, 324) and a shorter penis sheath than that of *Ningbingia* and *Cristilabrum*.

The shell is smaller than average with a less ovate shape and the spire is usually distinctly elevated with some apical rounding.

Ningbingia is recognized as having a “..vas deferens entering the penis sheath at or above the mid-point of its length” (Solem 1981, 324). The apical plug does not have a verge and there are “..no penial stimulators by the entrance of the vas deferens into the penis. (Solem 1981, 328)” Each species within the genus has two or three uniquely ornamented pilasters. The shell is of average size and has a distinctly raised spire with some apical rounding. Unlike *Turgenitubulus* and *Cristilabrum*, the shell of *Ningbingia* lacks postapical radial sculpture.

Cristilabrum has a very long penis and vagina, a relatively long penis sheath and unornamented pilasters lining the penis cavity. With the exception of *C. bilarnium*, the vas deferens enters the penis sheath from the base.

Mouldingia orientalis' shell has approximately four coiled whorls, with a flat to emergent apex spire. The body whorl reflexes abruptly just before the aperture. The shell lip is expanded and reflected, with the lip thinning where it is attached to the parietal wall.

3. INTERNATIONAL OBLIGATIONS

This Plan is fully consistent with the aims and recommendations of the Convention on Biological Diversity, ratified by Australia in June 1993, and will assist in implementing Australia's responsibilities under that convention. The land snails are not listed under any specific international treaty however, and therefore this IRP does not affect Australia's obligations under any other international agreements.

There is currently an 'Action Plan for non-marine molluscs world wide' being developed through the Molluscs Specialist Group of the IUCN. From this an Action Plan for Australian Molluscs will be developed. (Ponder 1997). It is suggested that the Recovery Team for the Ningbing camaenids should observe the progress of this plan, and take into consideration any relevant outcomes or recommendations.

4. ROLES AND INTERESTS OF INDIGENOUS PERSONS

Several Claims for Traditional Ownership are current for the East Kimberley (National Native Title Tribunal 2004 and Shire of Wyndham – East Kimberley 2004).

A Native Title claim, 'Ningbingi' is currently registered by the Miriuwung Gajerrong Peoples and extends over the northern, central and southern Ningbing Range. This claim encompasses the majority of threatened Camaenid populations.

The determined Miriuwung Gajerrong claim (MG1) encompasses a coastal arc to the north, a narrow portion of land to the north and west of Kununurra township and extends to encompass Lake Argyle to the south. One threatened Camaenid species occurs within this determination area, to the north of Kununurra town site.

Still in negotiation, Miriuwung Gajerrong 2 (MG2) is a proposed claim for additional land north of Kununurra, which includes Carlton Hill and Ivanhoe pastoral leases and areas included in Stage 2 of the Ord River irrigation scheme. The area extends approximately east to the Northern Territory border, north to the coast and west to the determined MG 1 claim. The State is currently negotiating with the traditional owners about commercial, industrial, and residential issues which will be affected by the claim (Shire of Wyndham – East Kimberley 2004).

The Malarngowem Peoples have registered a Native Title claim for land south of Lake Argyle. One species, *Mouldingia orientalis*, included in this plan, occurs within this claim area. The Department of Indigenous Affairs (DIA) were the proponents for 'PA65' – a proposed approximately 3.5 hectare 'Protected Area' to be excluded as part of the 2015 lease renewal process within the Malarngowem claim area.

All associated limestone outcrops host numerous sites of spiritual and cultural significance. Within the 'Ningbingi' claim area, fourteen known sites are currently formally registered on the DIA Register of Aboriginal sites. These sites are concentrated on the eastern side of the Range. Within the Malarngowem claim, four closed sites, of ceremonial and/or mythological value, occur within 0.5 to 4km of the collection site of *Mouldingia orientalis* (DIA). Written permission from the DIA is required to view information on site files. Cultural Heritage sites are protected under the *Aboriginal and Torres Strait Islander Heritage Protection Act 1984*, the *Australian Heritage Commission Act 1975*, the *Aboriginal Heritage Act 1972* and the *Heritage of Western Australia Act 1990* (Kinhill Pty Ltd 2000).

All recovery measures will be negotiated and carried out in consultation and co-operation with interested and affected indigenous persons.

In addition to the Cultural Heritage Acts listed above, liaison and recovery activities will be undertaken by CALM and the recovery team in accordance with the *Native Title Act 1993* and the *Environment Protection and Biodiversity Conservation Act (EPBC) 1999* and additional relevant legislation. CALM's Draft Policy Statement: 'Aboriginal Involvement in Nature Conservation and Land Management' should also guide

negotiations. This draft policy employs key ideas promoting; liaison and consultation, joint management, the protection of biodiversity, Aboriginal representation and Aboriginal employment and training (CALM Draft Policy 2003).

5. SOCIAL AND ECONOMIC IMPACTS

A discussion document produced by CALM (Graham and White 1999) noted the potential for recreational development at both The Gorge and Point Spring Nature Reserve (and the nearby plains). It also noted the possibility for walkers and naturalists to explore in the valleys bisecting the limestone outcrops. The occurrence of threatened Camaenid land snails has the potential to restrict the commercial and recreational use predicted for this area.

Primary recreational interest in the Ningbing Range area is by cave enthusiasts (speleologists). The Gorge and the Jeremiah Hills are two of the popular caving locations. Jeremiah Hills is currently used by at least one commercial tour operator; “Go Wild” for caving activities. Collections of *Cristilabrum spectaculum* and *Turgenitubulus pagodula* have been made in the Jeremiah Hills and The Gorge respectively (Solem 1985, V. Kessner unpublished data). Camaenid species have also been collected on the plains approximately 5km south west of Point Spring Nature Reserve (Solem 1988b). Following more detailed human impact assessments and Camaenid surveys, it can be determined whether a recreational management strategy is required.

With the exception of *Ordtrachia elegans*, which occurs on Unallocated Crown Land, the remaining species of threatened Camaenids currently occur on pastoral leases. Consolidated Pastoral Companies is the leaseholder for both Ivanhoe and Carlton Hill Stations; twenty-four threatened Camaenid taxa occur within their boundaries. One Camaenid species, *Mouldingia orientalis*, occurs on Lissadell pastoral lease. Both lease holders (or their representative) have been informed of the Camaenid occurrences on their properties and have expressed support for the Recovery Plan process.

The limestone ranges do not sustain good cattle fodder, and in many instances are not traversable by cattle (Graham & White 1999). However, the land abutting the limestone occurrences on Carlton Hill and Ivanhoe pastoral leases is black soil plain, a soil system regarded as being high quality grazing country. On the plains at the base of the eastern side of the Ningbing Range several bores and natural watercourses provide stock with essential watering points. It is desirable that Camaenid populations can be managed with the least possible impact on the leaseholders, without compromising Camaenid recovery actions. It is a recommended action that liaison with station managers be ongoing.

Exploration permits (EP) and Exploration leases (E) are current in the Ningbing area and south of Lake Argyle (Department of Industry and Resources 2004 – TENGRAPH Database). More information is required on intended mineral exploration operations before it is possible to determine potential impacts on Camaenid populations or effects of this IRP on mineral and petroleum proposals.

- Kimberley Energy Group Pty Ltd – Exploration Permit, EP 386R1 (pending renewal) in Ningbing Range and Jeremiah Hills area.
- Helix Resources Ltd, E80/2910 (Applied for, Pending), Jeremiah Hills area.
- Trianko Resources Ltd, E80/1187 – (status: live), west of Point Spring Nature Reserve.
- AML Nominees Ltd, Ashton Argyle Holdings Pty Ltd, Capricorn Diamonds Ltd – AM 70/259 (Application granted, status: live), Lissadell area. Tenement within Conquest Mining Ltd – Proposed Bow River Diamond Exploration Program. A Notice of Intent is current for this Proposed Program. (AM 70/259 Agreement Act: Diamond Agreement Act 1981).

6. BENEFITS TO OTHER SPECIES AND COMMUNITIES

The central and northern Ningbing Range comprised one of five areas assessed by CALM in 1999 in response to a request by the Department of Resources and Development (DRD) to assess conservation, recreation and

tourism potential. The report acknowledged the vine thicket assemblage of the Ningbing Range as being uniquely diverse and species rich in comparison to similar occurrences in the North and East Kimberley (Graham and White 1999). Camaenid land snails are efficient nutrient recyclers, feeding off decaying leaf litter and possibly algae and fungi (V. Kessner, personal communication).

The fauna recorded for the Jeremiah Hills and Ningbing ranges includes at least twenty-one species of bat, sixty-five species of birds and at least the known twenty-six land-snail species. In a separate report, Rainbow Pittas (*Pitta iris*) were identified as preying on, and having a similar distribution to, Camaenid land snails in the Kimberley (Marsh 1997). Whilst the range of the rainbow Pitta includes the area north of Kununurra, to date, there are no records for the Ningbing area. It is thought that Camaenids may supplement the diet of native rats (V. Kessner, personal communication). Species of lizards and snakes are also recorded as feeding on snails; however there are no local data to support this for the Ningbing area.

Riparian vegetation, at locations such as Tanmurra Creek and The Gorge, is expected to benefit from the cooler fire regimes that are an anticipated outcome of this IRP.

The flora and fauna communities associated with the limestone outcrops will benefit from the measures taken to protect the Camaenid land snails.

7. DISTRIBUTION

With the exception of *Mouldingia orientalis*, the threatened Camaenids occur in the Ningbing area over a north-south linear distance of approximately 65 kilometers within the co-ordinates of Northing 8289 (2km south of Jeremiah Hills) and Northing 8352 (3km north of Knob Peak). The approximate area of the Ningbing Range and Jeremiah Hills is 85km² and 30.5km² respectively (Solem 1988b). Outliers occur at The Gorge (0460E, 8321N), and approximately 5km south west of Point Spring. *Mouldingia orientalis* occurs south of Lake Argyle, approximately 3km north west of the Lissadell Station homestead.

The Camaenid Land Snails of the Ningbing Range and Jeremiah Hills provide an extreme example of multi-species short-range endemism. With a minimum total range of 0.01km², and a maximum total range of 5.6km² (Appendix 2), twenty-five Camaenid species occur within an overall area of 115km² (Solem 1988b). It should be noted that actual area of occupancy for each of the species is likely to be much smaller than the total ranges referred to above and in Appendix 2.

The Ningbing Range is a non-continuous limestone range with primary outcrops, which rarely exceed 2km in width, and are known as the northern, central and southern Ningbing Range. There are several smaller outlying outcrops and numerous isolated occurrences. Elevation rarely exceeds 100 meters. Typically, a formation is characterized by deep horizontal and vertical crevices, large cave systems and sharp, unstable boulders and talus; these intrinsic features offer a degree of protection from wandering cattle, humans, and even fire.

The majority of land snail collections were made on the eastern side of the three primary occurrences.

Alan Solem published comprehensive analyses of the allopatric and mycosympatric distribution trends of the majority of Camaenid species affected by this Plan (Solem 1981, 1985, 1988c, Solem & McKenzie 1991). In brief, within the Ningbing Range, *Ningbingia* occurs in the northern Ningbing Range; *Turgenitubulus* occurs in the central Ningbing Range and in isolated hills to the north and in The Gorge and The Pillars; and *Cristilabrum* occurs in the southern Ningbing Range and in the Jeremiah Hills (and outliers) (Appendix 2).

With the possible exception of *Ordtrachia elegans*, the ranges of the Camaenids that are the subject of this IRP are not expected to increase. There is insufficient suitable habitat in the Ningbing area for large-scale colonization and it is considered that the current radiation of species occupies all available habitat (Solem 1988b). Combined with the low dispersal ability of Camaenid species, existing opportunities for colonization are limited (Solem and McKenzie 1991).

The range of *Mouldingia orientalis* is believed to be restricted to its type locality following the flooding of the Ord River Valley to form Lake Argyle. (CALM Fauna nomination forms). *Ordtrachia elegans*, defined as a 'short range endemic', is not however restricted to its current range. With additional suitable habitat in the vicinity, it is still expanding its range (Solem 1988b). *Ordtrachia elegans* was collected from a limestone ridge with adjacent examples of limestone pavement; a formation vulnerable to threats of fire, cattle and human activity (unpublished data, V. Kessner).

8. HABITAT

The threatened Camaenids are exclusive to limestone occurrences. Nearby sandstone outcrops support no threatened Camaenids, and very few additional land snail species, despite the proximity to populations in the limestone areas (Solem 1981, 1988b). The majority of the larger limestone outcrops in the Southern Ningbing Range were noted to occur abruptly, with either vertical limestone faces or steep talus slopes. At the base of outcrops, pavement limestone, readily accessible to cattle may occur.

Vegetation assemblages in the ranges are most commonly described as pockets of open and closed deciduous vine thicket, with additional scattered Boab trees (*Adansonia gregorii*) (Graham & White 1999; Marsh 1997; V. Kessner unpublished data; N. McKenzie unpublished data). Stands of grasses also occur; often patchily over the lower slopes, throughout open vine thicket alcoves and in the valleys bisecting the outcrops. The abutting plains support scattered Eucalypt woodland over tall grassland, with frequent seasonal creeks and waterways. Cattle graze throughout these plains.

The monsoonal climate of the region provides an average annual rainfall of approximately 780mm at Carlton Hill, and 600mm at Lissadell, between the months of November and April (Solem 1988b). This is markedly drier than locations further to the east or west in the Kimberley region (Solem 1988b).

9. CRITICAL HABITAT

Critical Habitat is habitat defined as being critical to the survival of a listed threatened species or a listed threatened ecological community. *Habitat* is defined as the biophysical medium or media occupied (continuously, periodically or occasionally) by an organism or group of organisms or once occupied (continuously, periodically or occasionally) by an organism or a group of organisms, and into which organism of that kind have the potential to be reintroduced (EPBC Act 1999).

All twenty-six taxa of threatened Camaenids occur in the litter piles, rubble heaps and deep crevices of limestone outcrops. Some may also occur under limestone boulders or pavements (Solem 1988b, V. Kessner, personal communication). Conditions that permit periods of 100% humidity, provide shade, and provide a catchment for leaf litter, are required to support these Camaenid populations. The Camaenids may inhabit continuous outcrops or small isolated outcrops. Of the entire limestone occurrence, only a very small area may be habitable according to the conditions outlined above (Solem 1988b). Camaenids aestivating at inadequately protected depths in crevices will dry out and die. Those preferring habitat in crevices of excessive depths may be buried in silt washed in during monsoon rain events (Solem 1988b).

Nearby vegetation is required to provide food for the snails. Deciduous vine thicket species, and additional deciduous species such as the Kapok Tree (*Cochlospermum fraseri*) and the Boab (*Adansonia gregori*), maintain a seasonal supply of litter, which not only provides for their dietary requirements, but in some cases, also provides a litter bed for shade. Populations may occur on barren slopes, in which case wind is relied upon to blow litter into the crevices they inhabit (V. Kessner, personal communication). Collection data however suggests that the majority of Camaenid sites are associated with near-by vegetation (V. Kessner unpublished data; N. McKenzie unpublished data).

There appears to be no minimum range required to host a population. A colony may inhabit an area no greater than a small pocket of rocks providing it provides adequate protection (Solem 1981, 1988b). *Ningbingia australis elongata* occupies a range of only 0.01km² (Solem 1988b).

As each species occupies a highly restricted range, all known range, and potential range, should be regarded as critical habitat. To clarify critical habitat, it is a recommended action to study the distances traveled by Camaenid species during periods of activity.

10. BIOLOGY AND ECOLOGY

As discussed under Distribution above, the Camaenid Land Snails being dealt with in this plan provide a remarkable example of multi-species short-range endemism. This has made them an ideal group for zoogeographic and evolutionary studies.

Substantial work has been carried out on the biogeography of the threatened Camaenid species occurring in the Ningbing Range area. *Turgenitubulus*, *Ningbingia* and *Cristilabrum* display an allopatric (no overlap) distribution at the genus level. The transition of species is mainly sudden and absolute, with only eight instances of species microsympatry known to date (Solem 1988b). The overlapping occurrence of *Ordtrachia elegans* and *Cristilabrum spp* is the only known example of intergeneric sympatry (Solem 1988b). Whilst the genera *Turgenitubulus*, *Cristilabrum* and *Ningbingia* are all endemic to the Ningbing area, *Ordtrachia* has a range that extends to the Nicholson River in the South (Solem 1984).

Species diversification is believed to have occurred in-situ, with populations isolated by seasonal floods and fires (Solem 1988b). There is anecdotal evidence that the plains abutting the Ranges flooded on occasion prior to the damming of the Ord River. Floods may have provided a mechanism for migration to nearby isolated outcrops, and possibly continue to do so (Solem 1981, 1988b). Although the patchy nature of the outcrops is considered to have had a significant effect on distribution patterns, not all species' ranges are delineated by breaks in rock mass (Solem 1988b).

Camaenid species require a shaded, moist and humid habitat in order to be active. During dry periods the species will aestivate. They produce a seal of calcified mucous across their shell aperture, (they are 'free sealers', not attaching to any substrate) and remain dormant, until suitable conditions prevail. Camaenids may perish if they aestivate in exposed conditions, in spite of their shell seal (Solem 1998b). Sub adults may also perish if they have not developed the 'shell lip' required to produce a seal over the aperture before conditions dry out. (N. McKenzie², personal communication).

Approximately 10mm of rain is required to break aestivation and stimulate activity of these camaenids. The duration of activity is affected by the moisture-retaining ability of the snail's microhabitat. The limestone itself is characteristically porous, with a significant moisture holding capacity. In the Ningbing area, Camaenids are active for approximately 80 days each year. Peak periods of activity are in November, December, February and March.

Camaenid land snails are hermaphroditic, engaging in mutual sperm transfer and fertilizing their eggs internally. Their development is restricted to periods of activity in the wet season. Under typical cycles the male reproductive system will mature by the third wet season, with the female system maturing later in the third wet season. Only by the fourth wet season (with some variation) are they functional hermaphrodites. Life span is believed to be at least 8 years (Solem and Christensen 1984).

² Norman McKenzie – CALM Science Division

11. THREATENING PROCESSES

A threatening process is any process or activity that threatens a species with extinction by reducing its population or by causing a reduction in species range and habitat.

Each known habitat site faces a unique combination of threats with the most commonly recognized threats being cattle grazing and trampling and inappropriate fire regimes. The potential impacts of weed invasion, the likely advent of cane toads and recreational pursuits are less well known. Some rugged rocky areas are naturally protected from the primary threats of cattle and/or fire. In contrast other areas appear to be under significant threat. The scale of the area at issue, and the dissimilar threat assessments current at each site, have prompted a broad scale management approach, whereby the limestone occurrences will be managed as a whole, in preference to managing the range of individual species. For this reason, threats will be broadly discussed with little or no reference to individual species.

Ningbingia laurina in the northern Ningbing Range, has been identified as potentially being in serious decline, and thus, at significant risk (Solem 1988b). Priority should be given to the assessment and management of threatening processes within this vicinity.

Inappropriate Fire Regimes

Fires often occur on an annual basis in the East Kimberley. Frequently these fires occur during the peak dry season, when fuel levels are high and very dry, and the resulting fires are extremely hot. Regular, hot fires are well documented as causing significant detriment to native flora and fauna assemblages (Solem 1988b, Davies 1995, Williams et al. 1999). Although the northern savanna landscape is considered to be fire resilient, the susceptibility of numerous flora species to adverse effects increases where fire regimes include intense fires and frequent fires. Resilience is increased with less intense fires in the late wet season or early dry season (Yates & Russell-Smith 2003).

At present little is known about the long term effect of fire on molluscs, although fire is considered to have contributed to cases of low molluscan diversity in some dry forest habitats (Ponder 1997). Locations damaged by both cattle and fire were noted in the Kimberley Rainforest Survey to contain fewer molluscan shells (Solem 1991). A lack of, or non-continuous, vegetation on the limestone outcrops will inhibit fires in places, and will protect the Camaenids from the majority of fire occurrences (Solem 1988b). However, fuel levels in the valleys, in vine thicket alcoves, throughout some pavement limestone and on the lower slopes of outcrops are sufficient to carry fires. The microclimate in a dense spinifex hummock provides a suitable habitat for aestivating Camaenids. Species occurring in a habitat of this nature are under a direct fire threat (V Kessner, personal communication). Fires are not only a direct threat to the Camaenid's physical existence; they also remove the living vegetation and ground litter, which shades and sustains them. The incremental encroachment of fire into the limestone vegetation, particularly the vine thickets, which are fire sensitive (Williams et al. 1999, Yates & Russell-Smith 2003), threatens Camaenid populations.

Camaenid activity is triggered by approximately 10mm of rainfall (Solem 1988b). At the start of the wet season fire may continue to be a threat. In certain conditions fire can be carried in grass species such as cane grass (*Sorghum sp.*) following a rainfall of up to 30mm (D. Grosse³, personal communication). Thus the design of a fire regime requires great care as cool, less intense fires, which benefit local vegetation, may still pose a threat to active and exposed Camaenid populations.

Cattle

Given the crevices, unstable boulders and the sharp, angular nature of limestone outcrops, cattle will rarely be seen negotiating this element in the landscape. However sites exist where cattle are able to cross the lower

³ David Grosse – CALM Kununurra

slopes, traverse pavement limestone, and access vine thicket alcoves. Grazing habits of cattle are well documented as altering floristic diversity (Davies 1985, McKenzie & Belbin 1991). The impact cattle have on environmental systems “is most severe in species rich areas such as vine thickets which cattle are attracted to” (Davies 1985, 3). It has also been suggested that cattle movement into vine thicket vegetation may assist the movement of fire into these thickets by opening up the sites and encouraging the establishment of fire prone annual grasses (Done 2000, McKenzie & Belbin 1991).

Aestivation sites in crevices and among talus and boulders largely protect the Camaenids from the direct impact of cattle for the majority of the year. However, aestivation sites in leaf litter deposits or sites such as spinifex hummocks remain vulnerable year-round. During the approximately 80 days each year during which Camaenids are active and exposed, they are under greatest risk of being trampled by cattle. In particular, Camaenids inhabiting the margins of outcrops, pavement limestone formations or small hillocks are at risk from cattle movements (V. Kessner, personal communication).

Weeds

Weeds occurring in the Southern Ningbing Range include *Passiflora foetida* and *Calatropis procera*. The vine *Passiflora foetida* threatens native flora by smothering the host plant. *Calatropis procera* was recorded on the plains abutting the outcrops. At the southern sites visited, neither were noted to occur in significant numbers, however both have the potential to do so. The native species, which provide the Camaenids with their food source, may be under threat from these species in the future. A weed survey and impact assessment is a recommended action in this IRP.

Cane Toads

No information confirming records of Cane Toads (*Bufo marinus*) consuming land snails have been found to date. However, they have been recorded as feeding on marine molluscs (Cameron 2002). Cane Toads must be considered as a potential threat to Camaenid populations. They are indiscriminate feeders, and have been quoted as “eating virtually anything” (Burkshire Council 2004). The presence of permanent water and seasonal creeks may be sufficient to allow Cane Toad populations to establish (VanDam et al. 2002). Further research is required on this topic.

The State Government has identified the Ningbing camaenid land snails as a group that may be at particular risk from cane toads.

Recreational Activities

Caving and general exploration activities throughout and around the limestone occurrences are a potential threat to the Camaenid populations. Camaenids are primarily exposed to human impacts during their active periods in the wet season; however, aestivation sites in leaf litter deposits or sites such as spinifex hummocks remain vulnerable year-round. As access to the Ningbing area is currently constrained by poor road conditions in the wet season, it has been hypothesized that the impact of recreational activities will be limited (V. Kessner, personal communication). It is a recommended action that an impact assessment is undertaken to determine the potential threat of recreational activities to the threatened Camaenid species. Although the Ningbing Road is close to the outcrops in some places, the threat of traffic is considered negligible based on the impassable state of the road in the wet season.

12. GUIDE FOR DECISION-MAKERS

Information above provides details of current and possible future threats. Developments in the immediate vicinity of the populations or within the defined critical habitat of any of the camaenid taxa require assessment. No developments should be approved unless the proponents can demonstrate that they will have no significant impact on the taxa, or their habitat or potential habitat, or the local surface hydrology.

13. EVALUATION OF THE PLAN'S PERFORMANCE

As the implementation of an Interim Recovery Plan for Camaenid Land Snails has not previously been undertaken, it is important that recovery actions are subject to constant review. Staff from CALM's East Kimberley District, WATSCU and the recovery team are to review progress annually with a formal review mid-term and after five years. Funding identified in Recovery Actions will also need to be reviewed on an annual basis.

Objectives

- To conserve all known existing populations based on a whole of landscape management approach. Conservation measures recommended will protect entire occurrences of limestone-associated habitat, which encompass known and potential Camaenid range.
- To determine the extent and severity of threats facing populations of Camaenid land snails affected by this IRP and ameliorate those threats.

Recovery Criteria

For success:

- An appropriate fire regime that includes cool burns (controlled, slow burns carried out in the late wet/early dry season, when an appropriate degree of moisture is still present in the soil and vegetation) is implemented as part of a fire management strategy around the periphery of limestone occurrences.
- Fencing is erected where possible.
- The health of limestone associated vegetation assemblages, particularly monsoon vine thicket occurrences, do not decline significantly in condition (due to cattle, fire or weed invasion).
- Traditional owners are supportive of and/or actively involved in management decisions and on-ground actions.
- Wet season assessment of numbers of live snails, or dry season counting of remnant sub-adult shells, indicates that populations of each known taxon are stable or increasing.

For failure:

- A regime of hot burns (occurring in the peak dry season, when vegetation is at its most volatile) persists on an annual basis and impacts upon the habitat of the Camaenid land snails.
- The vegetation habitat that supports threatened Camaenid populations declines in condition.
- Traditional owners are not supportive of recovery plans, and/or where Native Title is determined, decline access.
- Snail populations Vulnerable to intrusion by cattle are not protected where it is feasible to do so.
- Wet season assessment of numbers of live snails, or dry season counting of remnant sub-adult shells, indicates that populations of one or more known taxa are declining.

14 RECOVERY ACTIONS

At all times the participation of the appropriate land managers and traditional owners will be sought prior to recovery actions being undertaken. Where levels of interest have not been ascertained or confirmed, some parties have not been included in the 'responsible' category. This does not assume their disinterest. The following recovery actions are roughly in order of descending priority; however this should not constrain addressing any of these priorities if funding is available for 'lower' priorities and other opportunities arise.

1. Confirm Recovery Team and coordinate actions

The formation of a recovery team has been initiated, with the interested persons and organizations listed in the Summary. The managers of Carlton Hill, Ivanhoe and Lissadell Pastoral Leases have been approached and are supportive of the recovery process.

Responsibility: CALM (Kimberley Region, WATSCU)

Costs: \$2,000 per year

Completion date: Ongoing

2. Liaise with indigenous persons and groups

Liaise with traditional owners and indigenous communities (not necessarily the same). Indigenous interests are present over the majority of Camaenid habitat. Where possible engage interested persons and organizations in recovery actions such as monitoring and fire management.

Apply the protocol of the Kimberley Land Council (KLC) and the Department of Indigenous Affairs (DIA) where liaison with traditional representatives is sought, and where on ground activities are planned which may affect sacred sites.

Responsibility: CALM, Recovery Team

Costs: \$3000 per year

Completion date: ongoing.

3. Identify funding opportunities

Funding opportunities will be identified to assist community groups, traditional owners and pastoral managers to implement recovery actions. Local group SEEKS provides a suitable mechanism through which to apply for community grants.

Responsibility: Recovery Team, CALM (East Kimberley District and WATSCU)

Costs: \$1000 per year

Completion date: ongoing

4. Identify and Monitor the condition of representative vegetation and habitat

The condition of vegetation assemblages occurring throughout the limestone Ranges and outlying occurrences will be monitored in locations including the Northern, Central and Southern Ningbing Range, The Gorge, Jeremiah Hills and South West of Point Springs (see Recovery Action 5a). Monitoring the condition of vegetation will offer a means to assess the stability of Camaenid populations. A quadrat system to monitor Camaenid distribution in the Ningbing Ranges was established by Alan Solem. A selection of these quadrats, which were approximately 250 meters across, were later used in 1995 during a departmental survey to study patterns in limestone biodiversity (N. McKenzie unpublished data). Flora, land-snail, bat, and soil data have all been recorded within the quadrats included in the 1995 survey. Of these quadrats numbers 2, 2a, 3, 6, 6a, 7, 9, and 10 contain 8 of the 26 threatened Camaenid species (Appendix 2). Only the Southern and Northern Ningbing Range is well represented. These quadrats are able to form the basis for a vegetation and Camaenid (see Recovery Action 5a) monitoring system. Additional sites will need to be selected to represent populations located in the Central Ningbing Range, The Gorge, Jeremiah Hills (west of the Ningbing Track), and locations south west of Point Springs Nature Reserve.

Habitat will be monitored for weed occurrence, appropriate fire management, and also for bovine and recreational impact. Combining on-ground work with Remote Sensing technology (to determine stability or loss

of vegetation) is an approach that requires further consideration. Community involvement could incorporate regular photographic monitoring at nominated sites.

Responsibility: CALM, Recovery Team.

Costs: \$8,000 for year 1, \$ 4,000 per year for subsequent years.

Completion date: Initiate in Year 1, with annual monitoring.

5. Improve understanding of Camaenid ecology, taxonomy, distribution and threats

While it is useful to consider three distinct elements of survey and monitoring separately, as is done below, they should be planned together, to take advantage of positive synergies and to ensure the maximum benefit to the threatened species.

6. Survey and establish monitoring for populations north of Kununurra

The understanding of Camaenid ecology is limited due to the restrictions imposed by wet season logistics, which make it difficult to investigate the threatened Camaenid species during their periods of activity. Additional sampling and survey work to gather more accurate data on Camaenid distribution and ecology in the wet and dry seasons will be undertaken to facilitate recovery decisions. For example, understanding the distance traveled by Camaenid species during active periods will have implications for burning and fencing actions, and possibly on critical habitat definitions. Several new Camaenid species from the Ningbing Range, and two new genera from Lissadell Station remain undescribed. These genera and species will be described, and where appropriate, new species (such as *Cristilabrum kessneri*) will be nominated for threatened species listing. Additional sampling has been recommended to verify species distributional limits, taxonomy, sympatry (Solem 1981), and minimum habitable hill size (Solem 1988c). Although all major areas of Camaenid habitat have been sampled in the Ningbing area, sites including The Gorge, Jeremiah Hills, the western face of the Ningbing Range, and species within the known range of the genus *Turgenitubulus* have been recommended for further sampling (Solem 1981, 1988c).

Data gathered by such research should also provide the basis upon which to establish a monitoring program that is able to identify any decline in Camaenid populations. It has been suggested that by monitoring each year's dead, sub adult shells, it will be possible to infer whether Camaenid populations are still recruiting (N. McKenzie, personal communication). Not all Camaenid shells develop in sufficient time to produce the 'lip' required to seal the shell aperture that protects them from drying out, so a number of sub adults can be expected to perish at the end of each wet season. Recently perished sub adult shells are distinct from the previous years' by their colouration. Whilst this approach offers the flexibility of dry season sampling, it is possible that the rummaging required to unearth such specimens will have a detrimental effect on living, aestivating specimens (N. McKenzie, V. Kessner, personal communication). An alternative is wet season monitoring which may involve quadrats or transects designed to monitor populations that are invariably drawn from their crevices in moist conditions (V. Kessner, personal communication). The 'milky' colouration of these Camaenids reportedly makes them very visible thus reducing the risk posed to species by field staff. Logistically this is more complex as it would require helicopter transport, on ground transport, and timing would be crucial to match monitoring with periods of snail activity.

Few people have the expertise to accurately identify terrestrial molluscs, especially the Camaenid family. It is possible that Departmental staff could undertake ecological research and sampling activities, whilst the identification and description process could be offered to consultants in the field of Malacology.

Responsibility: CALM.

Costs: \$15,000/year for years 1 – 3, \$5,000 Years 4 – 5.

Completion date: Distribution and ecological data - Years 1 – 3. Monitoring – ongoing.

7. Determine the status of *Mouldingia orientalis* on Lissadell pastoral lease

The status, range and habitat of *Mouldingia orientalis* will be confirmed. No definite range has been identified for this species. The collector recalls the collection site as a very narrow, small, limestone ridge (V. Kessner, personal communication). Cattle are present in the area and no strategic fire regime is in place. The level of threat posed by these and/or other elements is currently unknown. The lease Holder has no objection to field assessments on his lease, requesting only to be kept informed. Given the proximity of sacred sites (Closed sites), activities in the area need to be carried out with the involvement of the Malarngowem Peoples. The site will also be monitored for impacts of the proposed Bow River Diamond Exploration Program if and when it commences.

Responsibility: Recovery Team, CALM.

Costs: \$4000 per year for first two years

Completion date: Year 2 (Monitoring will be ongoing if the proposed exploration or subsequent mining program commences).

8. Assess and monitor potential cane toad threat

The State Government has determined that the movement of Cane Toads into the Kimberley region will be monitored, as will target species and groups of native species prior to, and after the arrival, of cane toads. The Ningbing camaenids have been identified as a target group for monitoring as a part of that program. Significant resources will be needed for wet season monitoring of the cane toads, and such operations, probably involving the use of helicopters, may also allow wet season monitoring at least some of the camaenids.

Responsibility: Recovery Team, CALM (Science Division, Kimberley Region)

Costs: to be determined

Completion date: ongoing

9. Map critical habitat

It is a requirement of the EPBC Act 1999 that spatial data relating to critical habitat be determined. Although critical habitat is described in this plan, the areas have not all been mapped. If any additional populations are located, this critical habitat will also be determined and mapped for these locations.

Mapping data and coordinates from the field collections of Alan Solem, Norm McKenzie and Vince Kessner, the Western Australian Museum specimen database, and the data collected as a result of recovery actions, will be amalgamated and updated.

Responsibility: CALM

Costs: \$7,000

Completion date: Year 2

10. Develop and implement a fire management strategy

With support from fire staff of Agriculture Western Australia, Carlton Hill pastoral lease already has a degree of fire management in place, with a preference for cooler burns every two years (Warriner 1998). However current fire management is of an opportunistic nature and the development and implementation of a CALM assisted fire management strategy is needed to ensure that conservation requirements are met. Controlled cool burns around the periphery of the Ningbing Range and Jeremiah Hills will be undertaken not only to protect the outer range from hot, damaging dry season fires, but also in an attempt to offer some protection to vegetated alcoves occurring within the ranges.

A fire management plan will be developed and implemented for the Camaenid occurrence south of Lake Argyle. The area is currently burnt when fuel loads are sufficient to carry a fire. The spinifex at this location restricts fire occurrences to every 3 to 4 years (S. Buntine⁴, personal communication).

Given the limited road access to the area following periods of rainfall, helicopter transport will be required to facilitate on ground burning. Where conditions permit, this will be coordinated with the control burn regime for Point Springs Nature Reserve.

Responsibility: Recovery team and CALM

Costs: \$5,000 (biennial)

Completion date: Ongoing

11. Identify and fence vulnerable populations

The potential for fencing populations vulnerable to stock incursions, such as in pavement limestone areas, on small exposed hillocks, and in vine thicket alcoves, will be assessed following the prioritization of vulnerable sites.

Given the monsoonal climate, the scale, and the nature of landscapes in question, fencing has not been recommended for the entire area of Camaenid occurrence. Seasonal creek lines drain water from the ranges in the wet season. The annual reconstruction of fences would be required where these creek lines intersect fence lines. In addition to the numerous sacred sites identified on the eastern side of the Ningbing Range, fencing must also be considerate of the numerous watering points for stock on the eastern side of the Range. The frequency of fire will also weaken the fencing infrastructure. It is preferable that cattle are not fenced from sites where their impact is deemed negligible.

The detailed investigations of threatened Camaenid occurrences referred to in Action 5 will be used to determine the extent of vulnerable populations, and the practicality of fencing these sites. Liaison between CALM, traditional owners and affected pastoralists will be necessary to develop a fencing strategy. The use of aerial photographs (1:50 000 – 1999, located at Agriculture Western Australia), and in-situ assessment is also recommended to facilitate this process.

Responsibility: The Recovery Team, CALM

Costs: \$20,000 years 1 and 2, \$3,000/yr maintenance.

Completion date: Construction Year 2/Year 3, dry season.

12. Assess the impact of recreational activities

The impact of recreational users at high interest sites such as The Gorge and Jeremiah Hills will be determined. Jeremiah Hills caving sites KJ 13, KJ 5 and KJ7 are used by adventure tour company 'Go Wild'. Recently accredited as an Eco Tour, a spokesman for Go Wild has expressed his support in helping to protect Camaenid occurrences where they may be at risk from recreational activities. Local representatives of the Western Australian Speleological Group have also expressed their support and willingness to be actively involved in the Camaenid recovery process. In line with the 'Minimal Impact Caving Code' and caving safety regulations of the Australian Speleological Federation, a local representative of the Western Australian Speleological Group has offered to show CALM staff safely to the caves where they can then determine whether threatened Camaenid species may be impacted upon by cave enthusiasts accessing the cave locations.

Following a recreation impact assessment, the need for fencing vulnerable populations at recreational sites will be assessed.

⁴ Stirling Buntine – Leaseholder, Lissadell Station

Responsibility: The Recovery Team, CALM

Costs: \$5,000

Completion date: Year 1

13. Monitor proposed and existing mineral and petroleum activities

Where mining or petroleum exploration occur in the Ningbing area, on-site environmental managers will be advised with regard to the conservation of threatened Camaenid populations. All protocols will be subject to the appropriate level of environmental impact assessment.

Conquest Mining Ltd released a Notice of Intent in May 2004. The Proposed 2004/2005 Bow River Diamond Exploration Program (Environ Australia Pty Ltd: 2004) includes a proposed Project Area, which occurs in the approximate vicinity of the occurrence of *Mouldingia orientalis*. The proposed Project Area and nearby exploration areas occur on the Northern aspect of Lissadell Road, whilst the Camaenid species occurs on a small, narrow ridge on the Southern aspect of Lissadell Road. Continuing liaison with Conquest Mining Ltd is required to determine the potential for impact on this Camaenid species. Where a risk is deemed to be present, education and management recommendations will be required. Conquest Mining Ltd have been notified of the location of *Mouldingia orientalis*. When and if operations commence, the site will be monitored by CALM staff at regular intervals. This operation (I.D. AM70/259) is governed by a State Agreement - The Diamond Agreement Act. 1981.

Responsibility: CALM

Costs: to be determined.

Completion date: N/A

14. Assess and monitor weed impact

The extent of weed occurrence in the limestone ranges will be assessed. Quadrats will be established to monitor the spread and impact of weed species on native vegetation, and leaf litter accumulation. Weed occurrences will be mapped.

Responsibility: Recovery Team, CALM

Costs: \$7,000 per year

Completion date: ongoing (to be carried out in conjunction with vegetation monitoring).

15. Develop relations with affected interests and regional experts

The Mollusc Specialist Group of the IUCN is currently developing the Action Plan for Australian Molluscs. Where timeframes allow, recommendations in the Action Plan will be considered in the recovery approach under this IRP.

Relevant outcomes of the World Malacology Congress (July 2004) will be considered in recovery actions.

The Kimberley Regional Fire Management Project (KRFMP) is currently working on projects with indigenous communities to implement traditional on-ground burning practices. The framework developed by the KRFMP may be applicable to assisting the implementation of traditional burning practices around the limestone outcrops. KRFMP have agreed that they will be available to discuss their experience in this project and may be in a position to offer advice.

Agriculture Western Australia staff have two long-term fire study sites on the Dinnabung Land System (adjacent to the Ningbing Range) on Carlton Hill Station. These sites experience a fire every 1 to 3 years. Results from this monitoring program will be used to assist in the development of a burning strategy.

Vince Kessner –malacologist, currently residing in the Northern Territory, has extensive experience with the Camaenid land snails in the Ningbing area.

Intergrated Natural and Cultural Resources Management Option for Pastoral Lands in the East Kimberley is a joint project between Agriculture Western Australia and Ord Land and Water. Carlton Hill/Ningbing Range has been selected as an initial project site. There is significant overlap in priorities developed in the above project and this IRP. Where possible, a coordinated approach will be developed to promote the desired outcomes of both projects.

Responsibility: CALM and interdepartmental interests.

Costs: N/A

Completion date: ongoing

16. Promote Awareness

All affected interests and the wider public require information to encourage their understanding and involvement in the recovery process.

It is necessary to continue to promote awareness among conservation agencies and organizations, and recreational groups. Contact has been initiated with SEEKS in informal discussions at monthly meetings. Newsletter articles have been developed for Ord Land and Water and WATSCU to promote local and expert knowledge of the Camaenid situation. These initial contacts require reinforcement as management progresses. Local ABC Radio has also expressed interest in the threatened Camaenid story.

In addition to organized caving tours, a small, active group of cavers are present in Kununurra. As information becomes known about the status of the Camaenids at caving sites, information sessions with these groups will be necessary. Caving awareness will preferably be developed inline with the 'Minimal Impact Caving Code'; a comprehensive set of guidelines developed by the Australian Speleological Federation to protect environmental values.

Responsibility: CALM

Costs: \$2,000 per year.

Completion date: ongoing.

17. Translocation

The need for, and feasibility of, a translocation program for one or more species will be investigated. Species under gravest threat will be identified, as will the opportunities for on-site recovery, and if appropriate, possible sites for translocation will be investigated. The feasibility of artificial habitats (terrariums) or the storage of aestivating specimens whilst translocation options are clarified will also be considered.

Responsibility: Recovery Team, CALM.

Costs: \$5000

Completion date: Year 4 or 5

18. Review the need for a full Recovery Plan

At the end of the fourth year of the five-year term of this Interim Recovery Plan, the need for further recovery will be assessed. If the taxon is still ranked Critically Endangered at that time the need for further recovery actions, a full Recovery Plan or to update this IRP will be assessed.

Action: Review the need for a full Recovery Plan
Responsibility: CALM
Cost: \$23,000 in the fifth year (if required).

15. TERM OF PLAN

This Interim Recovery Plan will operate from February 2005 to March 2010 but will remain in force until withdrawn or replaced. After five years, the need to review this IRP or to replace it with a full Recovery Plan will be determined.

REFERENCES

Burkeshire Council (2004) Cane Toads (information adapted from an article by James Baker)
www.burkeshirecouncil.com/Canetoads.htm Accessed in June 2004.

Cameron, E (2002) Cane Toads, Giant Toads or Marine Toads - Fact Sheets, Australian Museum on Line.
www.amonline.net.au/factsheets/canetoad.htm Accessed June 2004.

Davies, R.J.P. (1985) *East Kimberley Impact Assessment Project - Conservation priorities in north west Australia*. East Kimberley Working Paper No. 16.

Department for Planning and Infrastructure (2004) (pastoral lease exclusion data)
www.dpi.wa.gov.au Accessed in June, 2004

Department of Conservation and Land Management (2002) – *Fauna Nomination Forms for 26 taxa of camaenid land snails*

Department of Conservation and Land Management (2003) Intranet, *Draft Policies*
www.CALM.wa.gov.au/projects/pdf_files/abpolicy/abpol/pdf Accessed in June 2004.

Department of Indigenous Affairs (sacred site database ‘Aboriginal Sites Register’)
www.dia.wa.gov.au Accessed in May, 2004

Department of Industry and Resources (2004) (TENGRAPH On Line database and Mineral Titles On Line)
www.doir.wa.gov.au Accessed in June 2004

Done, C, (2000) Fire management of conservation reserves in the Kimberley – Kimberley Society Past Talks
<http://users.bigpond.net.au/sellwood/kimsoc/> Accessed in June, 2004

Environ Australia Pty Ltd, Notice of Intent: *Proposed 2004/5 Bow River Diamond Exploration Program*, Conquest Mining Limited, May 2004.

Graham, G. and White, K. (Eds) Discussion Document on the “Proposed Conservation Areas Associated with Ord Stage Two Development – Kununurra WA”, Department of Conservation and Land Management, 1999.

IUCN Red List (2000) www.iucn.org/redlist/2000/ Accessed in May 2004

IUCN (2001) IUCN Red List Categories: Version 3.1. Prepared by the *IUCN Species Survival Commission*. IUCN, Gland, Switzerland and Cambridge, UK.

Kessner, V., Distribution coordinates and habitat data of land snail collections. (Unpublished).

Kinhill Pty Ltd, (2000) Environmental Review and Management Program. *Draft Environmental Impact Statement. Proposed Development of the M2 Area – Main Report*.

Marsh L, “Botany of the Ningbing Range”, July 1997.
Kimberley Society Past Talks – www://users.bigpond.net.au/sellwood/kimbsoc/index.html

McKenzie, N.L., Keighery, G.J., Start, A.N., Kessner, V., Handerside, T., *Patterns in the Biodiversity of the Limestone Ranges East of Cambridge Gulf, Western Australia*. Unpublished.

McKenzie, N.L., Belbin, L. (1991) Kimberley Rainforest Communities: reserve recommendations and management considerations: 453-680. In: NL McKenzie, RB Johnson and PG Kendrick (Eds.) *Kimberley Rainforests Australia*. Surrey Beatty and Sons, Chipping Norton, NSW

National Native Title Tribunal (*Native Title Applications – maps and spatial data*)
www.nntt.gov.au/publications/maps.landing.html Accessed in June 2004.

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Ponder, W. (1997) *Conservation status, threats and habitat requirements of Australian terrestrial and freshwater mollusca*. In: *Memoirs of the Museum of Victoria*, 56(2): 421-430
www.amonline.net.au/pdf/edanger.pdf Accessed May 2004.

Queensland Government Department of Natural Resources, Mines and Energy Fact Sheet – Pest Series. *The Cane Toad (Bufo marinus)*.
www.nrme.qld.gov.au/factsheet/pdf/pest/PAZI.pdf Accessed June 2004.

Shire of Wyndham East Kimberley/SWEK (2004) – Local Planning Strategy. *Fact Sheet No. 3 'Native Title and Aboriginal Heritage'*.

Solem, A (1981) Camaenid Land Snails from Western and Central Australia (Mollusca: Pulmonata: Camaenidae) III. Taxa from the Ningbing Ranges and nearby areas. *Records of the Western Australian Museum*. Supplement No. 11: 321-425.

Solem, A (1984) Camaenid Land Snails from Western and Central Australia (Mollusca: Pulmonata: Camaenidae) IV. Taxa from the Kimberley, *Westraltrachia* Iredale, 1933 and related genera. *Records of the Western Australian Museum*. Supplement No. 20: 707-981.

Solem, A (1985) Camaenid Land Snails from Western and Central Australia (Mollusca: Pulmonata: Camaenidae) V. Remaining Kimberley Taxa and addenda to the Kimberley. *Records of the Western Australian Museum*. Supplement No. 20: 707-981.

Solem A. (1988a) New Camaenid Land Snails from the North East Kimberley, *Journal of the Malacological Society of Australia*. 9: 27-58.

Solem A. (1988b) Maximum in the Minimum: Biogeography of land snails from the Ningbing Ranges and Jeremiah Hills, northeast Kimberley, *Journal of the Malacological Society of Australia*. 9: 9-113

Solem, A. (1991) Land snails from Kimberley rainforest patches and biogeography of all Kimberley land snails: 145 – 246. In: NL McKenzie, RB Johnson and PG Kendrick (Eds.) *Kimberley Rainforests Australia*. Surrey Beatty and Sons, Chipping Norton, NSW.

Solem, A. and Christensen, C.C (1984) Australian Land Snail Reproductive Cycle and Growth Patterns in Semi Arid Areas of North West Australia, *Australian Journal of Zoology*. 32:471-91.

Solem, A, and McKenzie, N.L. (1991) The Composition of Land Snail Assemblages in Kimberley Rainforests, In: NL McKenzie, RB Johnson and PG Kendrick (Eds.) *Kimberley Rainforests Australia*. Surrey Beatty and Sons, Chipping Norton, NSW.

VanDam, R.A, Walden, D.J., Begg.,G.W. (2002) *A Preliminary risk assessment of Cane Toads in Kakadu National Park*.

www.deh.gov.au Accessed June 2004.

Warriner, G, (1988) Kimberley Pastoral Memo – *Carlton Hill Fire Prevention Management Plan*, Dec 1998 p, 7-8. (www.savanna.ntu.edu.au Accessed May 2004.

Williams, R.J., Cook G.D., Gill, A.M., Moore, P.H.R.,(1999) Fire regime, fire intensity, and tree survival in a tropical savanna in northern Australia. *Australian Journal of Ecology*. 24: 50-59.

Wildlife Conservation (Specially Protected Fauna) Notice 2003. *Government Gazette*, 11th April 2003: 1158 – 1167 (Wildlife Conservation Act 1950)

www.calm.wa.gov.au/plants_animals/watscu_lists.html Accessed May 2004.

Yates, C., & Russell-Smith, J., (2003) Fire regimes and vegetation sensitivity analysis: an example from Bradshaw Station, monsoonal northern Australia. *International Journal of Wildland Fire*, 12: 1-10.

Appendix 1. Threatened species rankings

Species	Ranking: Wildlife Cons. Act. 1950	Ranking and criteria: IUCN (2003)
<i>Cristilabrum bubulum</i>	EN	EN C2b
<i>Cristilabrum buryillum</i>	CR	EN C2b
<i>Cristilabrum grossum</i>	CR	EN C2a
<i>Cristilabrum isolatum</i>	EN	VU D2
<i>Cristilabrum monodon</i>	CR	VU D2
<i>Cristilabrum primum</i>	CR	VU D2
<i>Cristilabrum rectum</i>	CR	VU D2
<i>Cristilabrum simplex</i>	CR	VU D2
<i>Cristilabrum spectaculum</i>	EN	EN C2b
<i>Cristilabrum solitudum</i>	CR	LR/nt
<i>Ningbingia australis australis</i>	CR	VUB1 + 2bc, D2
<i>Ningbingia australis elongata</i>	CR	
<i>Ningbingia bulla</i>	CR	VU D2
<i>Ningbingia dentiens</i>	CR	VU D2
<i>Ningbingia laurina</i>	CR	VU D2
<i>Ningbingia octava</i>	CR	VU D2
<i>Ningbingia res</i>	CR	VU D2
<i>Turgenitubulus christenseni</i>	EN	
<i>Turgenitubulus costus</i>	CR	VU D2
<i>Turgenitubulus depressus</i>	CR	VU B1 + 2bc, D2
<i>Turgenitubulus foramenus</i>	CR	VU B1 + 2bc, D2
<i>Turgenitubulus opiranus</i>	CR	VU B1 + 2bc, D2
<i>Turgenitubulus pagodula</i>	VU	VU D2
<i>Turgenitubulus tanmurrana</i>	CR	VU B1 + 2bc, D2
<i>Mouldingia orientalis</i>	VU	EN C2b
<i>Ordtrachia elegans</i>	CR	VU D2

CR Critically Endangered**EN** Endangered**VU** Vulnerable

extreme fluctuations in numbers.

continuing decline and fluctuations.

IUCN 2001, IUCN Red List Categories

Wildlife Conservation (Specially Protected Fauna) Notice

Appendix 2. Range and distribution

Species	Distribution	Total Range* (km ²)	Linear Range* (km)
<i>Cristilabrum bubulum</i>	southern Ningbing Range	0.66	5.0
<i>Cristilabrum buryillum</i>	southern Ningbing Range	1.02	2.7
<i>Cristilabrum grossum</i>	southern Ningbing Range	0.31	0.5
<i>Cristilabrum isolatum</i>	b/w southern end Ningbing Range and Jeremiah Hills	0.15	5.3
<i>Cristilabrum monodon</i>	southern Ningbing Range	0.61	0.9
<i>Cristilabrum primum</i>	southern Ningbing Range	0.90	1.2
<i>Cristilabrum rectum</i>	south of central Ningbing Range	0.29	1.2
<i>Cristilabrum simplex</i>	southern Ningbing Range	1.02	2.7
<i>Cristilabrum spectaculum</i>	Jeremiah Hills	1.20	1.6
<i>Cristilabrum solitudum</i>	south of central Ningbing Range	1.70	2.9
<i>Ningbingia australis australis</i>	northern Ningbing Range	1.05	1.0
<i>Ningbingia australis elongata</i>	northern Ningbing Range	0.01	0.1
<i>Ningbingia bulla</i>	northern Ningbing Range	0.74	3.9
<i>Ningbingia dentiens</i>	northern Ningbing Range	0.38	1.0
<i>Ningbingia laurina</i>	northern Ningbing Range	3.95	5.0
<i>Ningbingia octava</i>	northern Ningbing Range	5.60	4.5
<i>Ningbingia res</i>	northern Ningbing Range	4.40	4.1
<i>Turgenitubulus christenseni</i>	Central Ningbing Range	0.65	2.9
<i>Turgenitubulus costus</i>	Central Ningbing Range	2.20	1.8
<i>Turgenitubulus depressus</i>	Central Ningbing Range	0.26	0.2
<i>Turgenitubulus foramenus</i>	Central Ningbing Range	0.75	1.2
<i>Turgenitubulus opiranus</i>	Central Ningbing Range	2.65	3.1
<i>Turgenitubulus pagodula</i>	Central Ningbing Range, The Gorge The Pillars	3.75	2.7
<i>Turgenitubulus tanmurrana</i>	Central Ningbing Range	1.13	2.0
<i>Mouldingia orientalis</i>	South of Lake Argyle	< 5.00	<5.00
<i>Ordtrachia elegans</i>	Eastern outliers of Jeremiah Hills	0.32	0.7

*Range was determined on the premise that if a species occurred on one area of a limestone mass, it more than likely occupied the entire mass (Solem: 1988c)

Solem: 1988c, 1984

CALM - fauna nomination forms

Appendix 3. Shell morphology

Species	Average Shell Height (mm)	Average Shell Diameter (mm)
<i>Cristilabrum bubulum</i>	8.94	17.41
<i>Cristilabrum buryillum</i>	8.05	16.28
<i>Cristilabrum grossum</i>	11.29	20.95
<i>Cristilabrum isolatum</i>	10.75	19.80
<i>Cristilabrum monodon</i>	8.93	17.45
<i>Cristilabrum primum</i>	9.01	17.07
<i>Cristilabrum rectum</i>	11.78	19.22
<i>Cristilabrum simplex</i>	10.60	18.58
<i>Cristilabrum spectaculum</i>	11.49	20.80
<i>Cristilabrum solitudum</i>	10.77	18.01
<i>Ningbingia australis (australis)</i>	11.70	18.20
<i>Ningbingia australis (elongata)</i>	11.55	18.15
<i>Ningbingia bulla</i>	11.35	17.96
<i>Ningbingia dentiens</i>	7.95	16.71
<i>Ningbingia laurina</i>	11.70	17.52
<i>Ningbingia octava</i>	11.44	15.82
<i>Ningbingia res</i>	12.80	19.48
<i>Turgenitubulus christenseni</i>	9.83	16.13
<i>Turgenitubulus costus</i>	8.93	15.22
<i>Turgenitubulus depressus</i>	7.29	14.27
<i>Turgenitubulus foramenus</i>	9.62	16.28
<i>Turgenitubulus opiranus</i>	9.32	16.19
<i>Turgenitubulus pagodula</i>	8.53	16.83
<i>Turgenitubulus tanmurrana</i>	9.01	15.50
<i>Mouldingia orientalis</i>	4.30	9.90
<i>Ordtrachia elegans</i>	6.70	13.20

(Solem: 1981, 1988b, 1984)

