Threatened plants and animals in Kakadu National Park: a review and recommendations for management

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Cover photograph: Arnhem rock-rat *Zyzomys maini* (photo: Greg Miles)

SUMMARY

This report comprises three main sections. The first section is an introduction that lists the currently recognised threatened plant and animal species that occur within Kakadu National Park; describes the process and criteria for listing; notes the substantial discrepancies in lists between the last comprehensive review of Kakadu's threatened species (1995) and this report; and notes also the substantial discrepancy between national and Northern Territory listings for threatened species occurring in Kakadu.

The second, and largest, section provides more specific information on each threatened species, noting in particular the status of each species within Kakadu National Park, as well as providing a broader conservation and management context.

The third section collates information on management and threats across the set of threatened species, and draws research and management priorities for Kakadu National Park.

The species occurring in Kakadu National Park that are listed as threatened under national and/or Northern Territory legislation are tabulated below. The current listing comprises a total of 16 plant species (of which 6 are listed at national level) and 31 animal species (of which 16 are listed at national level). An additional plant species has been nominated to be added at the next revision of the NT list. Information is also presented on four threatened plant species with records from near Kakadu, and considered reasonably likely to occur within Kakadu..

Plant species recorded from Kakadu NP and currently (August 2004) considered as threatened under the *Environment Protection and Biodiversity Conservation Act 1999* and/or the *Territory Parks and Wildlife Conservation Act*. Note that no Kakadu plant species was listed under Federal legislation at the time of the publication of the Endangered Species Program for Kakadu ("STATUS 1995": Roeger and Russell-Smith 1995). Abbreviations: CE=Critically Endangered; EN=Endangered; VU=Vulnerable. For Northern Territory status only: DD=Data Deficient. Four species indicated are proposed to be downlisted in the next revision of Northern Territory conservation status, and one (*Acacia* D19063 Graveside Gorge), not previously assessed (NA), is proposed to be added to the list, as Critically Endangered (CE). Kakadu significance is an assessment of the importance of Kakadu in the overall status of the species.

Scientific name	NT Status	EPBCA	STATUS 1995	Kakadu significance
Acacia D19063 Graveside Gorge	NA (-> CE)	not listed	not listed	High
Boronia laxa	near threatened	VU	not listed	High
Boronia rupicola	near threatened	VU	not listed	High
Boronia suberosa	VU (->near threatened)	VU	not listed	High
Boronia verecunda	near threatened	VU	not listed	High
Boronia xanthastrum	near threatened	VU	not listed	High
Calytrix inopinata	VU (->near threatened)	not listed	not listed	High
Cycas armstrongii	VU	not listed	not listed	Low
Dubouzetia australiensis	EN (->VU)	not listed	not listed	Low-Moderate
Gleichenia dicarpa	VU (-> DD)	not listed	not listed	Moderate
Helicteres D21039 linifolia	VU (->near threatened)	not listed	not listed	High
Hibiscus brennanii	VU	not listed	not listed	High
Lithomyrtus linariifolia	VU	not listed	not listed	High
Malaxis latifolia	VU	not listed	not listed	Moderate-High
Monochoria hastata	VU	not listed	not listed	Low-Moderate
Sauropus filicinus	DD	VU	not listed	High
Utricularia subulata	EN	not listed	not listed	Moderate

Animal species recorded from Kakadu NP and currently listed as threatened. Abbreviations as in Table above, plus LC=Least Concern, NT= near threatened. The list also includes one species (ghost bat) that was listed as threatened in 1995, but has since been de-listed.

Scientific name	Common Name	NT Status	EPBCA	STATUS 1995	Kakadu significance
Taractrocera ilia ilia	Northern Grassdart Butterfly	VU	not listed	not listed	Moderate
Cynoglossus heterolepis	Freshwater Tongue Sole	EN (->NT)	not listed	not listed	Uncertain
Glyphis sp.A.	Speartooth Shark	EN	CE	not listed	Moderate-High
Glyphis sp. C.	Northern River Shark	EN	EN	not listed	Uncertain
Pristis clavata	Dwarf Sawfish	VU	not listed	not listed	Low-Moderate
Pristis microdon	Freshwater Sawfish	DD	VU	not listed	Low-Moderate
Caretta caretta	Loggerhead Turtle	EN	EN	EN	Low
Chelonia mydas	Green Turtle	LC	VU	VU	Low
Lepidochelys olivacea	Olive Ridley	DD	EN	VU	Low-Moderate
Natator depressus	Flatback Turtle	DD	VU	not listed	Moderate
Diplodactylus occultus	Yellow-snouted Gecko	VU	not listed	not listed	Moderate
Morelia oenpelliensis	Oenpelli Python	VU	not listed	not listed	High
Dromaius novaehollandiae	Emu	VU	not listed	not listed	Low
Erythrotriorchis radiatus	Red Goshawk	VU	VU	VU	Low-Moderate
Ardeotis australis	Australian Bustard	VU	not listed	not listed	Low
Geophaps smithii smithii	Partridge Pigeon	NT	VU	not listed	Moderate
Tyto novaehollandiae kimberli	Masked Owl	NT	VU	not listed	Uncertain
Amytornis woodwardi	White-throated Grasswren	VU	not listed	not listed	High
Epthianura crocea tunneyi	Yellow Chat	EN	not listed	not listed	High
Falcunculus (frontatus) whitei	Northern Shrike-tit	DD	VU	not listed	Low
Erythrura gouldiae	Gouldian Finch	EN	EN	EN	Moderate
Dasyurus hallucatus	Northern Quoll	VU	(EN)*	not listed	Uncertain
Phascogale (tapoatafa) pirata	Northern Brush-tailed Phascogale	VU	not listed	not listed	Moderate-High
Isoodon auratus auratus	Golden Bandicoot	EN	VU	not listed	Uncertain
Saccolaimus saccolaimus nudicluniatus	Bare-rumped Sheathtail Bat	DD	CE	not listed	Uncertain
Macroderma gigas	Ghost Bat	DD	not listed	VU	
Hipposideros diadema inornata	Arnhem Leafnosed Bat	VU	not listed	not listed	High
Conilurus penicillatus	Brush-tailed Rabbit-rat	VU	not listed	not listed	Moderate-High
Mesembriomys macrurus	Golden-backed Tree-rat	EN	VU	VU	Uncertain
Xeromys myoides	Water mouse (False water-rat)	DD	VU	VU	Uncertain
Zyzomys maini	Arnhem Rock-rat	VU	not listed	not listed	High

* This species has recently been nominated, and is now in the process of assessment.

Most recommendations from the previous plan for a threatened species program for Kakadu NP (Roeger and Russell-Smith 1995) were achieved over the course of that planning period (1995-2002).

The threatened species comprise a very heterogeneous set. The most cohesive grouping of ecologically similar species is of a set of sandstone endemic plants, for which recent targeted surveys have provided relatively robust estimates of population size and status, quantitative baselines for an ongoing monitoring program, and explicit management recommendations. This set of species encompasses the most coherent management grouping of threatened species, typically responding negatively to frequent fire.

There are fewer groupings evident among the other listed species: although a set of four marine turtles, two sharks and two sawfish form a loose group that are threatened across their broader range by an array of factors, but relatively secure and protected from most threats within their variably significant Kakadu range. For most other species, the status and management requirements may be more idiosyncratic, thus reducing options for the management efficiency that may have been achieved had threatened species fallen into only a small set of tightly defined clusters.

The knowledge base for threatened species varies substantially. For some species (particularly for plants), there are reliable estimates of population size in Kakadu; for many others, there is relatively little information about population size. There are specific long-term monitoring programs for a few species; a baseline for subsequent monitoring has been established recently for many others; there is no monitoring program for some other species; and a monitoring program is unlikely to be feasible or cost-efficient for others. For some species, there is good information about threatening processes and response to management intervention; whereas for others such information is very limited.

This report considers, for every species, the adequacy of existing knowledge, monitoring and management advice; the extent to which Kakadu is important to the conservation of the species; the conservation status of the species; feasibility of actions; and other factors. From this consideration, it derives recommended priorities for research, management and monitoring of all threatened species.

Ten recommendations are listed here for consideration over the next planning period. These are:

1. Undertake targeted survey to define the abundance, distribution and status of those threatened species for which current status information is inadequate. Priority should be given to species listed under the EPBCA and to those other species listed under Northern Territory legislation that occur primarily or entirely within the Northern Territory.

2. Establish, implement and/or maintain specific monitoring programs that provide regular assessments of the trends in status for each threatened species in Kakadu NP, and relates such trends to management actions. Prioritisation among species should be assigned as in 1. above.

3. Maintain existing broad-scale plant and animal monitoring programs (notably the Kakadu Fire Monitoring Plots).

4. Assess the conservation status of sandstone heathland against criteria for listing as a threatened ecological community; and nominate it if appropriate.

5. Develop a strategic program for assessment of the conservation status of invertebrates in Kakadu.

6. To an appropriate extent, integrate conservation and management actions on threatened species in Kakadu with that of the broader region.

7. Enhance the entry, storage and display of threatened species data in Kakadu.

8. Continue to conduct targeted research on the response of selected threatened species to selected threatening processes and to management actions

9. Continue to manage to mitigate those factors that detrimentally affect threatened species.

10. Enhance communication about, and reporting on, threatened species in Kakadu.

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1. INTRODUCTION

History and legislative context

Threatened species have special value and consequence for natural resource management. Their threatened status may shed light on a particular management problem, issue or inadequacy; their occurrence may imbue an area with particular conservation significance, interest or priority; their population trajectory may suggest that they are the components of biodiversity most likely to disappear; and their status attracts particular legislative and regulatory management consequences.

The occurrence of threatened species was one of the attributes used to justify the establishment of Kakadu National Park (e.g. Rose 1972; Fox *et al.* 1977; Senate Standing Committee on Environment, Recreation and the Arts 1988), and is one of the three natural criteria on which its World Heritage status rests:

> "the most important and significant habitats where threatened species of plants and animals of outstanding universal value from the point of view of science and conservation still survive."

As land (and sea) (joint-)managed by a Commonwealth agency, Kakadu National Park has particular obligations, under the *Environment Protection and Biodiversity Conservation Act 1999*, relating to the management of threatened species (sections 172 to 175, in Box 1 below).

Management of threatened species in Kakadu National Park has been complicated by a transformation of the relevant legislation and ongoing overhauls of the listings of threatened species. Such issues are generic to land managers across Australia (e.g. Productivity Commission 2003), but are given added piquancy in Kakadu NP because of the management involvement of a Commonwealth agency and the explicit status of threatened species in its World Heritage listing and obligations.

The current Plan of Management of Kakadu National Park (Kakadu Board of Management and Parks Australia 1998), covering the period 1999-2004, considered threatened species within the provisions of the *Endangered Species Protection Act 1992*. Compared with its replacement, the *Environment Protection and Biodiversity Conservation Act 1999*, the *Endangered Species Protection Act 1992* provided very different (generally, less rigorous) criteria for the assessment of the threatened status of any species, and very different (typically, less onerous) requirements for managers on lands containing threatened species.

Overlapping with the 1999-2004 Plan of Management of Kakadu National Park, a specific Endangered Species Program was developed for Kakadu National Park over the period 1995-2002 by Roeger and Russell-Smith (1995). Reflecting its date of origin, that program, also, addressed species listed as threatened[1] under the *Endangered Species Protection Act 1992*. The Kakadu species considered under this Program are listed in Table 1. The Endangered Species Program report (Roeger and Russell-Smith 1995) also gave some consideration to additional species listed (in a range of categories, such as "rare" and "notable") under a range of then current non-regulatory sources, such as the listings of Rare or Threatened Australian Plants ("ROTAP": Briggs and Leigh 1988), of Northern Territory Plant Species of Conservation Significance (Leach *et al.* 1992), and of Australian threatened plants and animals maintained by the now defunct ANZECC.

[1] Note that, despite the title of the Act and the Program, both considered Vulnerable species as well as Endangered.

Box 1. Relevant sections of the ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION ACT 1999

Section 172. Inventories of listed threatened species etc. on Commonwealth land

(1) The Minister must prepare inventories that identify, and state the abundance of, the listed threatened species, listed threatened ecological communities, listed migratory species and listed marine species on Commonwealth land.

(2) Commonwealth land must be covered by an inventory:
(a) within 5 years after the commencement of this Act; or
(b) within 5 years after the land became Commonwealth land;
whichever is later.

(3) A Commonwealth agency that has an interest in Commonwealth land must provide all reasonable assistance in connection with the preparation under this section of an inventory that is to cover the land.

Section 173. Surveys of cetaceans, listed threatened species, etc. in Commonwealth marine areas

(1) The Minister must prepare surveys that identify, and state the extent of the range of:
(a) cetaceans present in Commonwealth marine areas; and
(b) the listed threatened species, listed threatened ecological communities, and listed marine species in Commonwealth marine areas.

(2) A Commonwealth marine area must be covered by a survey:
(c) within 10 years after the commencement of this Act; or
(d) within 10 years after the area became Commonwealth marine area;
whichever is later.

(3) A Commonwealth agency that has an interest in a Commonwealth marine area is to provide all reasonable assistance in connection with the preparation under this section of an inventory that is to cover the land.

Section 174. Inventories and surveys to be updated
The Minister must take reasonable steps to ensure that the inventories and surveys prepared under this Division are maintained in an up-to-date form.

Section 175. Obligations under this Act unaffected by lack of inventories or surveys
Obligations imposed by this Act are not affected, in their application in relation to Commonwealth land or Commonwealth marine areas, by any lack of inventories or surveys for such land or areas.

Another change since the publication of the Endangered Species Program for Kakadu National Park (Roeger and Russell-Smith 1995) has been a major revision of the principal wildlife legislation of the Northern Territory, the *Territory Parks and Wildlife Conservation Act*. Changes in that legislation introduced, for the first time, an assessment and listing process for threatened species for the Northern Territory (in which, of course, Kakadu National Park falls).

The assessment criteria for listing under the Northern Territory legislation are reasonably comparable to that of the *Environment Protection and Biodiversity Conservation Act 1999*, but there are some notable discrepancies in the two lists of threatened species. Such discrepancies arise from:

- assessments for the *Territory Parks and Wildlife Conservation Act* considering only the Northern Territory portion of a species' range, whereas the assessment for the *Environment Protection and Biodiversity Conservation Act 1999* requires consideration of the total Australian range. There are international guidelines for considering conservation status within only one region of a species' total range (Gardenfors *et al.* 2001). Discrepancies between State level and national-level status categorisations can arise where:
    - the national population is declining whereas the regional (in this case, Northern Territory) population remains relatively stable (arguably, the olive ridley, flatback and green turtle are such examples); or, conversely,
    - where the national population is regarded as relatively stable whereas only a small and/or declining population occurs in the Northern Territory (the golden-backed tree-rat is such an example: it remains reasonably abundant in the Kimberley, but is known in the Territory from only a handful of records (Palmer *et al.* 2003));

- the relatively minor differences in assessment criteria (Table 2) specified in the two Acts, most notably with the Northern Territory assessment being based on the explicit quantitative criteria adopted by the International Union for the Conservation of Nature (Criteria version 3.1; 2001), whereas the national criteria were defined in 1999, and less tied to explicit quantitative thresholds;

- listing "inertia": many species now listed under the *Environment Protection and Biodiversity Conservation Act 1999* were simply moved across from the earlier listings under the *Endangered Species Protection Act 1992*, which were based on different criteria and now somewhat dated information. In some cases, the status of these species has not been revised to reflect recent advances in knowledge;

- recency of review. Listings under the *Territory Parks and Wildlife Conservation Act* are reviewed every two years, with a comprehensive review undertaken in 2003-04. There is no comparable regular review of the federal listings; and there is an inevitable administrative (and public review) lag in adding species to the Commonwealth listing.

Note that nominations for listings under both the national and Northern Territory legislation provide provisions for public comment and review; and that all nominations and listings are widely publicised.

Current lists of threatened species occurring in Kakadu

The current listing of plant and animal species occurring in Kakadu National Park, that are considered as threatened under the *Environment Protection and Biodiversity Conservation Act 1999* and/or the *Territory Parks and Wildlife Conservation Act* is given in Table 1a and 1b respectively.

Table 1a. List of plant species recorded from Kakadu NP and currently (August 2004) considered as threatened under the *Environment Protection and Biodiversity Conservation Act 1999* and/or the *Territory Parks and Wildlife Conservation Act*. Note that no Kakadu plant species were listed under Federal legislation at the time of the publication of the Endangered Species Program for Kakadu ("STATUS 1995": Roeger and Russell-Smith 1995). Abbreviations: CE=Critically Endangered; EN=Endangered; VU=Vulnerable. For Northern Territory status only: NT=Near Threatened and DD=Data Deficient. Three species indicated are proposed to be downlisted in the next revision of Northern Territory conservation status (Kerrigan 2003). Note that this listing also includes one recently (re-)discovered species (*Acacia* D19063 Graveside Gorge) whose conservation status has not been assessed (NA) in previous considerations, but for which a listing of Critically Endangered (CE) is proposed by Kerrigan (2004) for the NT listing.

Scientific name	**NT Status**	**EPBCA**	**STATUS 1995**	**Kakadu significance**
Acacia D19063 Graveside Gorge ●	NA (-> CE)	not listed	not listed	High
Boronia laxa ●	NT	VU	not listed	High
Boronia rupicola ●	NT	VU	not listed	High
Boronia suberosa ●	VU (->NT)	VU	not listed	High
Boronia verecunda ●	NT	VU	not listed	High
Boronia xanthastrum ●	NT	VU	not listed	High
Calytrix inopinata ●	VU (->NT)	not listed	not listed	High
Cycas armstrongii ●	VU	not listed	not listed	Low
Dubouzetia australiensis ●	EN (->VU)	not listed	not listed	Low-Moderate
*Gleichenia dicarpa**	VU (-> DD)	not listed	not listed	Moderate
Helicteres D21039 linifolia ●	VU (->NT)	not listed	not listed	High
Hibiscus brennanii ●	VU	not listed	not listed	High
Lithomyrtus linariifolia ●	VU	not listed	not listed	High
Malaxis latifolia	VU	not listed	not listed	Moderate-High
Monochoria hastata	VU	not listed	not listed	Low-Moderate
Sauropus filicinus ●	DD	VU	not listed	High
Utricularia subulata	EN	not listed	not listed	Moderate

* n.b. Listed as *Gleichenia microphylla*, a name changed subsequently in light of recent taxonomic treatment (Short *et al.* 2003).

- Endemic to the Northern Territory

Table 1b. List of animal species recorded from Kakadu NP and currently (May 2004) considered as threatened under the *Environment Protection and Biodiversity Conservation Act 1999* and/or the *Territory Parks and Wildlife Conservation Act*. Also indicated is the nationally threatened status as at 1995, at the time of the publication of the Endangered Species Program for Kakadu (Roeger and Russell-Smith 1995). Abbreviations as in Table 1a, plus LC=Least Concern.

Scientific name	Common Name	NT Status	EPBCA	STATUS 1995	Kakadu significance
Taractrocera ilia ilia ●	Northern Grassdart Butterfly	VU	not listed	not listed	Moderate
Cynoglossus heterolepis ●	Freshwater Tongue Sole	EN (->NT)	not listed	not listed	Uncertain
Glyphis sp.A.	Speartooth Shark	EN	CE	not listed	Moderate-High
Glyphis sp. C.	Northern River Shark	EN	EN	not listed	Uncertain
Pristis clavata	Dwarf Sawfish	VU	not listed	not listed	Low-Moderate
Pristis microdon	Freshwater Sawfish	DD	VU	not listed	Low-Moderate
Caretta caretta	Loggerhead Turtle	EN	EN	EN	Low
Chelonia mydas	Green Turtle	LC	VU	VU	Low
Lepidochelys olivacea	Olive Ridley	DD	EN	VU	Low-Moderate
Natator depressus	Flatback Turtle	DD	VU	not listed	Moderate
Carettochelys insculpta	Pig-nosed Turtle	NT	(VU)**	not listed	High
Diplodactylus occultus ●	Yellow-snouted Gecko	VU	not listed	not listed	Moderate
Egernia obiri ●	Arnhemland Egernia	DD*	not listed	not listed	High
Morelia oenpelliensis ●	Oenpelli Python	VU	not listed	not listed	High
Dromaius novaehollandiae	Emu	VU	not listed	not listed	Low
Erythrotriorchis radiatus	Red Goshawk	VU	VU	VU	Low-Moderate
Ardeotis australis	Australian Bustard	VU	not listed	not listed	Low
Geophaps smithii smithii ●	Partridge Pigeon	NT	VU	not listed	Moderate
Tyto novaehollandiae kimberli	Masked Owl	NT	VU	not listed	Uncertain
Amytornis woodwardi ●	White-throated Grasswren	VU	not listed	not listed	High
Epthianura crocea tunneyi ●	Yellow Chat	EN	not listed	not listed	High
Falcunculus (frontatus) whitei	Northern Shrike-tit	DD	VU	not listed	Low
Erythrura gouldiae	Gouldian Finch	EN	EN	EN	Moderate
Dasyurus hallucatus	Northern Quoll	VU	(EN)***	not listed	Uncertain
Phascogale (tapoatafa) pirata ●	Northern Brush-tailed Phascogale	VU	not listed	not listed	Moderate-High
Isoodon auratus auratus	Golden Bandicoot	EN	VU	not listed	Uncertain
Saccolaimus saccolaimus nudicluniatus	Bare-rumped Sheathtail Bat	DD	CE	not listed	Uncertain
Macroderma gigas	Ghost Bat	DD	not listed	VU	
Hipposideros diadema inornata ●	Arnhem Leafnosed Bat	VU	not listed	not listed	High
Conilurus penicillatus	Brush-tailed Rabbit-rat	VU	not listed	not listed	Moderate-High
Mesembriomys macrurus	Golden-backed Tree-rat	EN	VU	VU	Uncertain
Xeromys myoides	Water mouse (False water-rat)	DD	VU	VU	Uncertain
Zyzomys maini ●	Arnhem Rock-rat	VU	not listed	not listed	High

* This species is not currently listed, but is likely to be added in the forthcoming (2005) revision of the Northern Territory's threatened species list.
** This species has been nominated as Vulnerable in 2004, and is now in the process of assessment.
*** This species was nominated in 2004, and is in the process of assessment.

comparison between current EPBCA listing and that of 1995, for species recorded from Kakadu NP

Clearly, there are clearly major discrepancies between the current compilation of listed threatened species in Kakadu NP, and the list considered in the previous consideration of threatened species in Kakadu (Roeger and Russell-Smith 1995).

Considering only nationally listed species, the earlier listing included no plant species, whereas the current listing includes six plant species; the earlier listing included eight animal species whereas the current listing comprises 16 species. One of the previously listed species (the ghost bat) is no longer considered as threatened at national level, but nine additional species have been added. Of the seven species on both the 1995 and current lists, six have maintained the same status, but one (the olive ridley) has been upgraded from Vulnerable to Endangered.

comparison between current national (EPBCA) and Northern Territory listings, for species recorded from Kakadu NP

There are pronounced disparities, for both plants and animals, between the national and Northern Territory lists. Of the 16 plant species listed as threatened on either the national or Northern Territory lists, only one species (*Boronia suberosa*) is included in both lists. The five other nationally listed plants are classified as either Data Deficient or Near Threatened in the Northern Territory lists. Nine Kakadu plant species listed as Vulnerable and one listed as Endangered on the Northern Territory list are not included in the national list.

Of a total of 31 listed threatened animals, only seven species are listed as threatened on both Northern Territory and national lists: of these seven, only four species (northern river shark, loggerhead turtle, red goshawk and gouldian finch) have the same threatened status on both lists; two species have higher threat status on the Northern Territory list (golden-backed tree-rat and golden bandicoot, which are both listed as Vulnerable nationally but Endangered on the Northern Territory list); and one species has a higher status on the national list (the speartooth shark, listed as Critically Endangered at national level, but Endangered on the Northern Territory list).

The nine species listed at national level, but not listed as threatened at the Northern Territory comprise the Freshwater Sawfish, Green Turtle, Olive Ridley, Flatback Turtle, Partridge Pigeon, Masked Owl, Northern Shrike-tit, Bare-rumped Sheathtail Bat and False Water-rat. For all of these except the Green Turtle, Partridge Pigeon and Masked Owl, the status in the Northern Territory regulations is Data Deficient, in recognition of the relatively limited information available from which to assess population size and trends.

Many more Kakadu animal species (21) are listed as threatened under Northern Territory regulations than under national regulations. The Kakadu taxa considered threatened under Northern Territory legislation but not national legislation are: Northern Grassdart Butterfly, Freshwater Tongue Sole, Dwarf Sawfish, Yellow-snouted Gecko, Oenpelli Python, Emu, Australian Bustard, White-throated Grass-wren, Yellow Chat, Northern Quoll, Northern Brush-tailed Phascogale, Arnhem Leaf-nosed bat, Brush-tailed Rabbit-rat and Arnhem Rock-rat.

Recognising the confusion stemming from such pronounced disparity in listings, the agencies responsible for national and Northern Territory listings are now undergoing a process for improving the alignment of these lists, with highest priority addressed to those plant and animal species that are endemic to the Northern Territory. Such species are indicated in Table 1. There is no specific timeframe for achieving this improved alignment.

Table 2a. Criteria used for assessing threatened status under the *Environment Protection and Biodiversity Conservation Act.*

Item	Criterion	Category		
		Critically Endangered	**Endangered**	**Vulnerable**
1	It has undergone, is suspected to have undergone or is likely to undergo in the immediate future	a very severe reduction in numbers	a severe reduction in numbers	a substantial reduction in numbers
2	Its geographic distribution is precarious for the survival of the species and is	Very restricted	restricted	limited
3	The estimated total number of mature individuals is .... and	Very low	low	limited
	(a) evidence suggests that the number will continue to decline at .... or	a very high rate	a high rate	a substantial rate
	(b) the number is likely to continue to decline and its geographic distribution is	precarious for its survival	precarious for its survival	precarious for its survival
4	The estimated total number of mature individuals is	Extremely low	very low	low
5	The probability of its extinction in the wild is at least	50% in the immediate future	20% in the near future	10% in the medium-term future

Table 2b. Criteria used for assessing threatened status under the *Territory Parks and Wildlife Conservation Act*.

Item	Criterion		Category		
			Critically Endangered	**Endangered**	**Vulnerable**
A.	Reduction in population size based on any of the following	1.An observed, estimated, inferred or suspected population size reduction of .... over the last 10 years or 3 generations, whichever is the longer, where the causes of the reduction are clearly reversible AND understood AND ceased, based on (and specifying) and of the following: (a) direct observation; (b) an index of abundance appropriate to the taxon; (c) a decline in area of occupancy, extent of occurrence and/or quality of habitat; (d) actual or potential levels of exploitation; (e) the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites.	>90%	>70%	>50%
		2.An observed, estimated, inferred or suspected population size reduction of .... over the last 10 years or 3 generations, whichever is the longer, where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (and specifying) and of (a) to (e) under A1.	>80%	>50%	>30%
		3.A population size reduction of ..., projected or suspected to be met within the next 10 years or 3 generations, whichever is the longer (up to a maximum of 100 years), based on (and specifying) and of (a) to (e) under A1.	>80%	>50%	>30%
		4.An observed, estimated, inferred or suspected population size reduction of .... over any 10 year or 3 generation period, whichever is the longer (up to a maximum of 100 years), where the time period must include both the past and the future, and where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (and specifying) and of (a) to (e) under A1.	>80%	>50%	>30%
B	Geographic range in the form of either B1 (extent of occurrence) OR B2 (area of occupancy) OR both:	1.Extent of occurrence estimated to be ...., and estimates including at least two of a-c: (a) Severely fragmented or known to exist at ... (b) Continuing decline, observed, inferred or projected in any of the following: (i) extent of occurrence; (ii) area of occupancy; (iii) area, extent and/or quality of habitat; (iv) number of locations or subpopulations; (v) number of mature individuals (c) Extreme fluctuations in any of the following: (i) extent of occurrence; (ii) area of occupancy; (iii) number of locations or subpopulations; (iv) number of mature individuals	<100 km^2 only a single location	<5000 km^2 no more than 5 locations	<20,000 km^2 no more than 10 locations

		2.Area of occupancy estimated to be less than ..., and estimates indicating at least two of a-c: (a) Severely fragmented or known to exist at ... (b) Continuing decline, observed, inferred or projected in any of the following: (i) extent of occurrence; (ii) area of occupancy; (iii) area, extent and/or quality of habitat; (iv) number of locations or subpopulations; (v) number of mature individuals (c) Extreme fluctuations in any of the following: (i) extent of occurrence; (ii) area of occupancy; (iii) number of locations or subpopulations; (iv) number of mature individuals	<100 km² only a single location	<500 km² no more than 5 locations	<2000 km² no more than 10 locations
C	Population size estimated to number fewer than ... and either:		250 mature individuals	2500 mature individuals	10,000 mature individuals
		1.An estimated continuing decline of at least ..., whichever is longer (up to a maximum of 100 years in the future) OR	25% within three years or one generation	20% within five years or two generations	10% within ten years or three generations
		2.A continuing decline, observed, projected or inferred, ion numbers of mature individuals AND at least one of the following (a-b): (a) Population structure in the form of one of the following: (i) no subpopulation estimated to contain more than .... OR (ii) at least ... of mature individuals in one subpopulation. (b) Extreme fluctuations in number of mature individuals	50 mature individuals 90%	250 mature individuals 95%	1000 mature individuals all
D.	Population size estimated to number fewer than ... OR (for Vulnerable only) population with a very restricted area of occupancy (typically <20km²) or number of locations (typically 5 or fewer) such that it is prone to the effects of human activities or stochastic events within a very short time period in an uncertain future		50 mature individuals	250 mature individuals	1000 mature individuals
E.	Quantitative analysis showing the probability of extinction in the wild is at least ..., whichever is the longer (up to a maximum of 100 years)		50% within the next 10 years or 3 generations	20% within the next 20 years or 5 generations	10% within the next 100 years

List stability

Natural resource managers, and the public generally, appreciate some stability in lists of threatened species. There has been little stability in the lists for Kakadu National Park over the last decade. This instability reflects legislative change, increased knowledge (indeed, discoveries) of some taxa, altered impacts of threats and their management, and taxonomic advances. These factors will continue to cause changes in listings of Kakadu's threatened species. Indeed, stability of lists will not occur until the ideal and unlikely situation that Kakadu's biota is perfectly known and all threatening factors are controlled.

The recent (re-)discovery of *Acacia* D19063 Graveside Gorge (Kerrigan 2004) is an example of list instability. Until 2004, this taxon was not recognised (because the location details on the only previous collection were vague and thought to be erroneous). As a result of its re-location in 2004 and sampling then, it is now likely to be recognised as the most endangered plant in Kakadu NP. It is a truism that the rarest species are typically those most likely not to be found in broad-ranging surveys, so it is to be expected that there may be many other comparable cases of new discoveries of highly restricted threatened plant species.

Invertebrates are poorly represented in the current listing. The Kakadu invertebrate fauna remains relatively poorly known, but is certain to contain many currently undescribed but narrowly endemic species. The current listing of Kakadu's threatened biota is probably most inadequate for at least some invertebrate groups.

Lists of threatened species change not only in the complement of species included, but also in the status code assigned to particular species. In Tables 1 and 3, I note for a number of species likely changes to the conservation status under Northern Territory legislation. Such changes are easier to predict for the Northern Territory list than for the national list, because of frequent (typically annual) review of the Northern Territory list, and a more streamlined process of incorporating recently collected information to the assessment. While these changes are foreshadowed here as likely, and are justified from detailed information provided mostly in Kerrigan (2003, 2004), these proposals still require due consideration. Where such proposed changes are approved, these are unlikely to be enacted until 2005.

Nearby threatened species

We present in this report some information on a set of four threatened plant species known from near, but not yet within, Kakadu National Park. Given their proximity, it is possible that further survey work will locate populations of these species within the Park. These species are listed in Table 3.

Table 3. List of threatened plant species known from near, but not within, Kakadu NP. Status codes and conventions as for Table 1.

species	NT status	EPBCA status	distribution (nearest known population)
Boronia quadrilata	CE (->VU)	VU	in stone country about 12km East of Park boundary (upper Magela Ck)
Cephalomanes obscurum	EN	not listed	in stone country about 12km East of Park boundary (upper Magela Ck)
Dichapetalum timoriense	VU	not listed	in stone country about 20km East of Park boundary
Ochrosperma sulcatum	CE (-> NT)	CE	in stone country about 5km East of Park boundary (17km ENE of Jabiru)

Recent advances in knowledge

There have been substantial advances in the knowledge of threatened species in Kakadu NP since, and indeed partly because of, the Roeger and Russell-Smith (1995) report. Some of the most notable of these advances include:

- commissioned surveys of the population size and distribution of a set of most of Kakadu's listed threatened plants (Kerrigan 2003, 2004);
- broad-scale surveys across northern Australia (including the Alligator Rivers) for threatened freshwater and estuarine sharks and rays (Larson 2000; Thorburn *et al.* 2003);
- ongoing surveys and monitoring of nesting marine turtles by Parks Australia North staff on Field Island (Winderlich 1998);
- the establishment of a substantial monitoring program for terrestrial vertebrates generally in Kakadu NP (Woinarski *et al.* 2002; Watson and Woinarski 2003, 2004), partly prompted by some long-term studies indicating decline in some mammal species (Woinarski *et al.* 2001);
- a long-term study of the ecology and management requirements of the threatened Partridge Pigeon (Fraser 2000; Fraser *et al.* 2003), largely undertaken within Kakadu NP;
- a long-term specific study of the response of the northern quoll to the invasion of cane toads, undertaken entirely within Kakadu NP (Oakwood 2004).

In addition to these studies and projects, the period since the Roeger and Russell-Smith (1995) report has also encompassed the Second *Atlas of Australian Birds* (1998-2002) (Barrett *et al.* 2003), that saw a substantial observation effort on birds across Australia, and provided an assessment of national and regional changes in abundance and distribution since the original *Atlas* (1977-81).

The period has also seen the production of information dossiers on every plant and animal species listed as threatened under the *Territory Parks and Wildlife Conservation Act*: These dossiers (Anon 2002) summarise current knowledge of the status of all Northern Territory threatened species.

Other recent sources of information concerning threatened species in Kakadu NP include:

- *The Action Plan for Australian Birds 2000* (Garnett and Crowley 2000);
- *The Action Plan for Australian Butterflies* (Sands and New 2002);
- *The Action Plan for Australian Bats* (Duncan *et al.* 1999); and the
- *Conservation Overview and Action Plan for Australian Threatened and Potentially Threatened Marine and Estuarine Fishes, 2002* (Pogonoski *et al.* 2002)

In each of these Action Plans, listing of species as threatened hasn't necessarily resulted (yet) in formal consideration and listing under the *Environment Protection and Biodiversity Conservation Act 1999*.

Some Kakadu threatened species have been considered within more detailed national recovery plans produced in the recent past. These plans indicate management actions appropriate for the conservation of these species. Such plans include for:

- **marine turtles** (Environment Australia 2003);
- three nationally-listed ***Boronia*** species (*B. quadrilata, B. tolerans* and *B. viridiflora*) [draft currently released for public comment: Gibbons and Liddle 2003];

- the **Golden Bandicoot** and **Golden-backed Tree-rat** [draft currently released for public comment: Palmer *et al*. 2003];
- the **Partridge Pigeon, Masked Owl** and **Northern (crested) shrike-tit** [draft currently released for public comment: Woinarski 2004].

Other recovery plans that concern species occurring in Kakadu NP are currently in preparation. These include plans for the gouldian finch (replacing a previous plan); Red Goshawk (replacing a previous plan); Freshwater Sawfish; and a combined plan for Speartooth Shark and Northern River Shark.

For further information, the addresses of relevant websites are listed in Table 4.

Table 4. Sources of more information on threatened species within Kakadu NP.

subject		**web address**
recent national Action Plans	bats	http://www.deh.gov.au/biodiversity/threatened/action/bats/index.html
	birds	http://www.deh.gov.au/biodiversity/threatened/action/birds2000/index.html
	butterflies	http://www.deh.gov.au/biodiversity/threatened/action/butterfly/index.html
	marine fish	http://www.deh.gov.au/coasts/species/marine-fish/index.html
current Recovery Plans	marine turtles	http://www.deh.gov.au/coasts/species/turtles/recovery/index.html
Draft Recovery Plans for public comment	three *Boronia* species	http://www.deh.gov.au/biodiversity/threatened/recovery/public-comment/b-quadrilata/index.html
	golden bandicoot; golden-backed tree-rat	http://www.deh.gov.au/biodiversity/threatened/recovery/public-comment/i-aurauts-m-macrurus/index.html
	northern shrike-tit; partridge pigeon; masked owl	http://www.deh.gov.au/biodiversity/threatened/recovery/public-comment/multi-species/index.html
IUCN Red List and criteria		http://www.redlist.org/
NT threatened species dossiers		http://www.nt.gov.au/ipe/pwcnt/index.html

Monitoring

More recently, the delivery of natural resource management across Australia, specifically through the Natural Heritage Trust, has been directed through a regional planning process that stipulates that natural resource management must address explicit environmental "matters for target", and that these matters will be monitored in prescribed ways that can chart progress towards agreed environmental outcomes. The major defined biodiversity matter for target is "significant native species and ecological communities". "Significant" species are taken to include those species listed as threatened under relevant State or national legislation, species listed as migratory under the *Environment Protection and Biodiversity Conservation Act 1999*, narrowly restricted or endemic species, species likely to become listed as threatened, and/or species whose long-term survival is likely to be jeopardised by the dominant land use or some other process within a specified region (Anon 2004).

Trends in the condition of these significant native species will be monitored through explicitly recommended indicators ("range area and location of each species"; "area, location and condition

of key habitat of each species", and "relative abundance of each species"), with this monitoring occurring in a consistent and stipulated manner. Further information on the matters for targets, recommended indicators and monitoring procedures is available at http://www.nrm.gov.au/monitoring/index.html

It is likely that the protocols and targets defined at the regional level will place an increasing emphasis on monitoring, particularly of the status and trend of threatened species and/or the factors that affect them; and that strategic choices will need to be taken in defining which species should be explicitly identified as indicators of progress in environmental management or restoration.

Threatened communities

The *Environment Protection and Biodiversity Conservation Act 1999* contains provisions for the nomination of threatened ecological communities, a provision not included in its precursor, the *Endangered Species Protection Act 1992*, nor the *Territory Parks and Wildlife Conservation Act*. To date, no ecological community occurring in Kakadu NP (nor for that matter anywhere else in the Northern Territory) has been nominated or listed as threatened. There is a reasonable argument that sandstone heathlands may meet the criteria for listing under the relevant provisions.

Other listed species

The *Environment Protection and Biodiversity Conservation Act 1999* includes consideration not only of threatened species, but also of migratory species. The former set comprise those species listed under bilateral and other international treaties - notably the Japan-Australia Migratory Bird Agreement, the China-Australia Migratory Bird Agreement and the Convention on the Conservation of Migratory Species of Wild Animals (the Bonn Convention). This report does not include explicit consideration of the status of such species, but Appendix C provides a tabulation of the 65 listed migratory species in Kakadu National Park.

2. INFORMATION DIGEST FOR INDIVIDUAL THREATENED SPECIES OCCURRING IN KAKADU NATIONAL PARK

In this section, information dossiers are presented for every plant and animal species known to occur in Kakadu National Park and currently listed as threatened under Australian or Northern Territory legislation.

For most species, these dossiers are adapted from those presented in Anon (2002), for threatened species in the Northern Territory as a whole. In such cases, the original compiler of the information sheet is listed. In all cases, I have revised the dossier as published in Anon (2002) and added more recent information (where available) and information specific to Kakadu National Park. Where no previous compiler is listed, the information sheet was prepared specifically for this report.

Plant species are listed first, in alphabetical order. Animal species are listed in taxonomic order. References are included at the end of each species' account, rather than within the reference section for this report as a whole.

For each species, the following information is presented:

Name	*common and scientific name*
Conservation status	*both at Australian and Northern Territory level*
Description	*brief general description*
Distribution	*total known range, along with map of this (generally for the Northern Territory only) and map of known occurrences within Kakadu. Where possible, records are differentiated as either historic or recent: o = pre 1970; • = post 1970.*
Conservation reserves	*list of all conservation reserves from which the species is known (note – in the Northern Territory only)*
Ecology	*brief description of relevant ecological information*
Conservation assessment	*assessment against current IUCN criteria, on which its conservation status is based. In most cases, this assessment relates to NT range only.*
Threatening processes	*assessment of known or presumed threats*
Conservation objectives	*broad priorities for research and/or management*
Kakadu status	*information on abundance and distribution within Kakadu NP*
Kakadu monitoring	*information on monitoring in Kakadu NP*
Importance of Kakadu	*relative to total range and status*
Compiler	*where applicable, compiler of the original (Anon 2002) information dossier on which this account is based*
References	*key relevant references only*

Note that this set of information sheets includes six plant species known from near (< *ca.* 20 km) but not within Kakadu. Information is presented for these species because there is a reasonable likelihood of them being present within Kakadu NP. In each case, the text for such species is explicit about the lack of current records from Kakadu. Information is also presented on three species not currently listed, but which have either been recently nominated for listing under the *EPBC Act* (pig-nosed turtle) or will be listed in the next revision of the Northern Territory threatened species list (Arnhemland Egernia and *Acacia* D19063 Graveside Gorge).

Acacia D19063 Graveside Gorge

Conservation status

Australia (*Environment Protection and Biodiversity Conservation Act 1999*):
Not Listed.

Northern Territory (*Territory Parks and Wildlife Conservation Act 2000*):
Not Assessed.
This plant was not recognised prior to the survey of Kerrigan (2004). That report recommends a coding of Critically Endangered, and this coding is likely to be approved in the next round of revisions of conservation status of NT plants and animals (due in 2005).

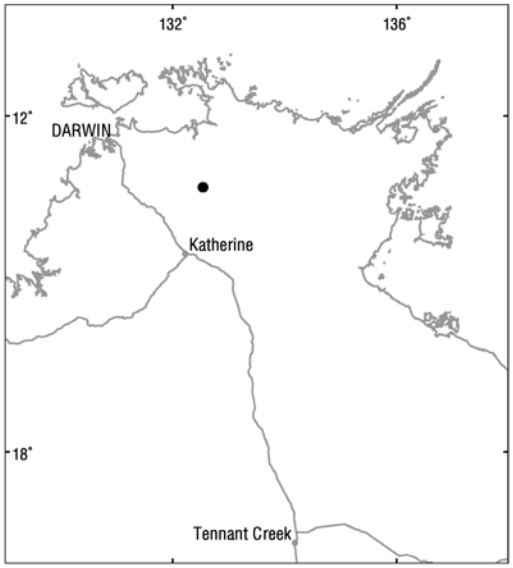
Description

A distinctive small shrub, with narrow needle-like leaves arranged in whorls around the stem. It is grey-green and distinctly hairy. The flower is globular and the seedpods short (Kerrigan 2004).

The only known mature individual of *Acacia* D19063 Graveside Gorge (Photo: Kym Brennan)

Distribution

Only known from a single locality near Graveside Gorge, Kakadu NP.



Known location of *Acacia* D19063 Graveside Gorge

Conservation reserves where reported:

Kakadu NP.

Ecology

The only known population occurs on a rocky slope near the top of a cliff line.

Conservation assessment

Kerrigan (2004) considered that it qualified as critically endangered because of its very small known total population size (single adult plant and 20 seedlings), single location,

and evidence of high sensitivity to fire (about 30 dead stems, killed by fire, near the single live adult)

Threatening processes

The limited evidence suggests that it is fire-sensitive and adults are killed by fire. It is likely to require fire-free intervals of at least 3-5 years to maintain population viability.

Conservation objectives and management

The main management objective is to impose a fire regime that is suitable to this species. Such a regime is likely to be characterised by low frequency and long intervals (>3 years) between fires. More precise information on life history parameters (time to maturity and lifespan) is required to tune fire management prescriptions.

Given the vulnerability of the single known population, it would be prudent to consider some *ex-situ* management, at least including seed collection. Further searches in appropriate habitat should be conducted. Monitoring should comprise at least annual scrutiny of fire occurrence, and counts of plants in at least every second year.

Information on abundance and/or status within Kakadu NP

The total known population comprises one adult plant and about 20 small seedlings, all at one site in Kakadu NP.

There is currently no information on trends in abundance in Kakadu NP.

Information on monitoring in Kakadu NP

One baseline monitoring sample undertaken by Kerrigan (2004) encompassing the single known population.

Importance of Kakadu NP relative to total range

The only known population is within Kakadu NP.

References

Kerrigan, R. (2004). *Kakadu Threatened Flora Report. Volume 2. Results of a threatened flora survey 2004*. (NT Department of Infrastructure Planning and Environment, Darwin.)

Boronia laxa

Conservation status

Australia (*Environment Protection and Biodiversity Conservation Act 1999*): Vulnerable

Northern Territory (*Territory Parks and Wildlife Conservation Act 2000*): Near Threatened.

Description

A semi-prostrate branching shrub to 1.5m long. Flowers white to mauve. Flowering and fruiting material has been collected between February and June. Note that the taxonomic status of this species is still incompletely resolved, and the taxon as currently recognised may comprise two species (Duretto 1999).

Boronia laxa (Photo R. Kerrigan.)

Distribution

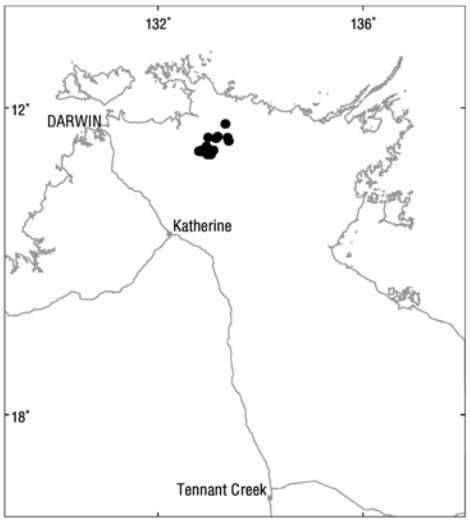
Restricted to Mt Brockman area and the main Arnhem Land Plateau.

Conservation reserves where reported:

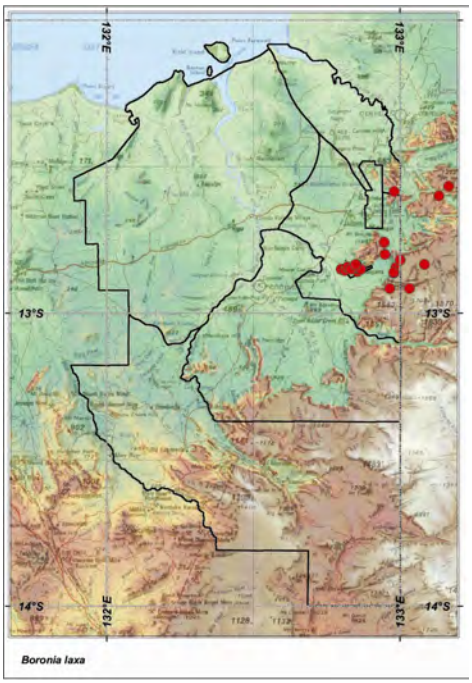
Kakadu NP.

Ecology

Boronia laxa occurs in woodland communities and sandstone heathlands, where it grows on sand and loam between sandstone rubble (Kerrigan 2003, 2004). The species is an obligate re-seeder, unable to resprout from rootstock, and hence susceptible to frequent fire (Kerrigan 2003).



Known distribution of *Boronia laxa*



Conservation assessment

Kerrigan (2003, 2004) considered that, although the species was uncommon and restricted, it did not meet any IUCN criteria for threatened status. The extent of occurrence is about 1140 km^2 and the total mature population is about 1300 individuals (Kerrigan 2003).

Threatening processes

As with other obligate re-seeder plants, it requires a fire free interval of at least 3-5 years for plants to mature sufficiently to set

seed, and hence to maintain viable populations.

Conservation objectives and management

Fire management is the single most important conservation action, with the objective being to ensure that fires occur no more frequently than at least 3-5 years apart. More precise information on life history parameters (time to maturity and lifespan) is required to tune fire management prescriptions.

Information on abundance and/or status within Kakadu NP

All known populations of this species are on the western Arnhem Land plateau. Kerrigan (2003, 2004) noted that a total of 17 disjunct populations were known, of which 9 were within Kakadu NP.

There is currently no information on trends in abundance in Kakadu NP.

Information on monitoring in Kakadu NP

Kerrigan (2003, 2004) established a baseline for ongoing monitoring for this species.

Importance of Kakadu NP relative to total range

High. Kakadu NP is the only conservation reserve, and only intensively managed area, containing this species. At least half of the total known population occurs within Kakadu NP.

References

Duretto, M.F. (1999). Systematics of *Boronia* section *Valvatae sensu lato* (Rutaceae). *Muelleria* **12**, 1-132.

Duretto, M.F., and Ladiges, P.Y. (1997). Morphological variation within the *Boronia grandisepala* Group (Rutaceae) and the description of nine taxa endemic to the Northern Territory, Australia. *Australian Systematic Botany* **10**, 249-302.

Kerrigan, R. (2003). *Kakadu Threatened Flora Report. Results of a threatened flora survey 2003*. (NT Department of Infrastructure Planning and Environment, Darwin.)

Kerrigan, R. (2004). *Kakadu Threatened Flora Report. Volume 2. Results of a threatened flora survey 2004*. (NT Department of Infrastructure Planning and Environment, Darwin.)

Boronia quadrilata

Conservation status

Australia (*Environment Protection and Biodiversity Conservation Act 1999*): Vulnerable.

Northern Territory (*Territory Parks and Wildlife Conservation Act 2000*): Critically Endangered.

Description

Erect slender shrub to 1.5 m; stems 4-angled. *Boronia quadrilata* differs from *B. viridiflora* by being erect, having elliptical leaves with acute tips and cuneate bases and having larger flowers and fruit.

Boronia quadrilata (Photo K. Brennan)

Distribution

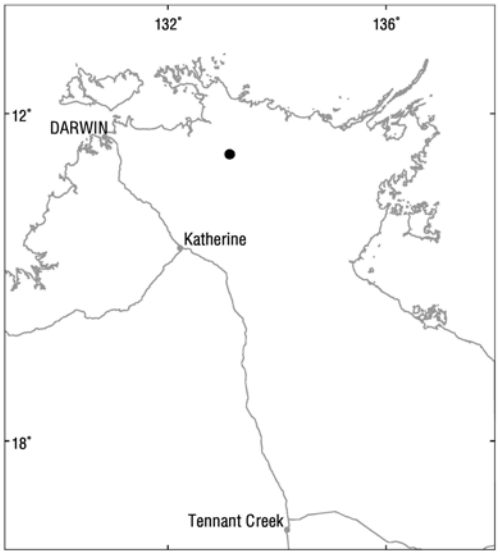
Endemic to the NT. Known only from the type locality at Magela Creek on the Arnhem Land plateau to the east of Kakadu National Park. At present this species is known only from a single population of about 1000 individuals (Kerrigan 2003).

Conservation reserves where reported:

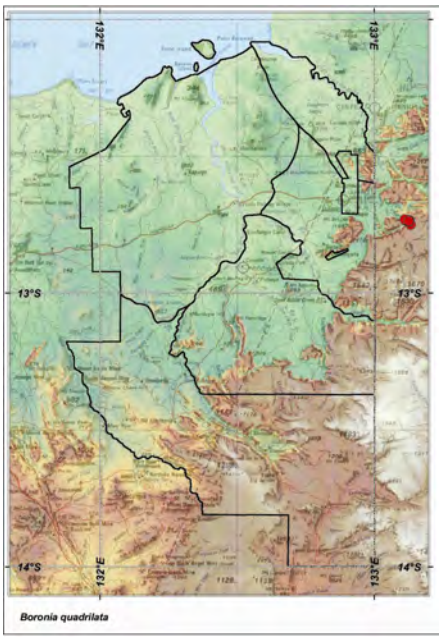
None.

Ecology

Very little is known about the ecology of this species. Kerrigan (2003) reports it growing on the upper slopes of a rocky sandstone ridge, with individuals growing on sand between boulders, and in rock crevices.



Known location of *Boronia quadrilata*



Conservation assessment

This species is known only from one locality (where it was first collected in 1991). The most recent assessment of its status relative to IUCN criteria was that of Kerrigan (2003), who assessed it as Vulnerable, with an area of occupancy of 9 ha and an extent of occurrence of 39 ha.

Threatening processes

As with most other Boronias, its major threat is high frequency of fire.

Conservation objectives and management

A draft national recovery plan (Gibbons and Liddle 2003) includes this species. The main action recommended is for fire management, to ensure reasonably long (3+ years) fire-free intervals. The draft plan also recommends monitoring plots and considers the issue of ex situ propagation.

More precise information on life history parameters (time to maturity and lifespan) is required to tune fire management prescriptions.

Information on abundance and/or status within Kakadu NP

No populations are known from Kakadu NP. The sole known location of the species is 12 km east of the Kakadu NP border.

Information on monitoring in Kakadu NP

Nil, but Kerrigan (2003) provided a baseline for ongoing monitoring.

Importance of Kakadu NP relative to total range

Currently unrecorded from the Park.

Compiled by

Raelee Kerrigan, Ian Cowie, Bryan Baker [January 2002]

References

Duretto, M.F. (1999). Systematics of *Boronia* section *Valvatae sensu lato* (Rutaceae). *Muelleria* **12**, 1-132.

Gibbons, A., and Liddle, D.T. (2003). Recovery plan for three threatened *Boronia* species, *Boronia quadrilata, B. tolerans* and *B. viridiflora* of the Northern Territory of Australia, 2004 to 2008. (NT Department of Infrastructure Planning and Environment, Darwin.)

Kerrigan, R. (2003). *Kakadu Threatened Flora Report. Results of a threatened flora survey 2003*. (NT Department of Infrastructure Planning and Environment, Darwin.)

Boronia rupicola

Conservation status
Australia (*Environment Protection and Biodiversity Conservation Act 1999*):
Vulnerable

Northern Territory (*Territory Parks and Wildlife Conservation Act 2000*):
Near Threatened.

Description
A pendulous sub-shrub to 40 cm long, with yellow-green flowers. Leaves inconsistently compound.

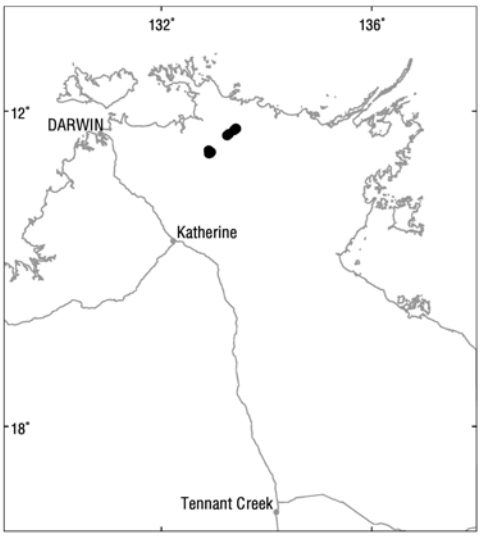
Flowering and fruiting material collected from March to July.

Boronia rupicola (Photo R. Kerrigan.)

Distribution
Known only from eight populations around Mt Brockman and near Nabalerk.

Conservation reserves where reported:
Kakadu NP.

Ecology
Restricted to vertical sandstone surfaces, presumably sites offering some refuge from frequent fire.



Known locations of *Boronia rupicola*

Conservation assessment
Kerrigan (2003) provides the most recent assessment of conservation status, with estimates of extent of occurrence of 178 km^2, area of occupancy of 6 ha, and at least 2000 mature individuals. On this basis, she considered that the national listing of Vulnerable was inappropriate.

Threatening processes
The species is probably sensitive to frequent fire, and now occurs only in sites offering topographic protection from fire.

Conservation objectives and management

The habitat where the species now occurs may provide adequate protection from fire. It is possible that it can expand from this range with reduction in fire frequency and intensity. The populations and fire regimes affecting them should be regularly monitored. More precise information on life history parameters (time to maturity and lifespan) is required to tune fire management prescriptions.

Information on abundance and/or status within Kakadu NP

Kerrigan (2003) counted individuals in defined area around Mt Brockman, recording around 2000 mature individuals.

There is currently no information on trends in abundance in Kakadu NP.

Typical occurrence of *Boronia rupicola* (Photo R. Kerrigan)

Information on monitoring in Kakadu NP

Kerrigan (2003) established a baseline for ongoing monitoring for this species, around Mt Brockman, with a permanent plot and marked transect route.

Importance of Kakadu NP relative to total range

High: Kakadu has about half of the known populations, and is the only area in which the species is reserved.

References

Duretto, M.F. (1997). Taxonomic notes on *Boronia* species of north-western Australia, including a revision of the *Boronia lanuginosa* group (*Boronia* section *Valvatae*: Rutaceae). *Nuytsia* **11**, 301-346.

Kerrigan, R. (2003). *Kakadu Threatened Flora Report. Results of a threatened flora survey 2003*. (NT Department of Infrastructure Planning and Environment, Darwin.)

Boronia suberosa

Conservation status

Australia (*Environment Protection and Biodiversity Conservation Act 1999*): Vulnerable.

Northern Territory (*Territory Parks and Wildlife Conservation Act 2000*): Vulnerable.

Description

Sprawling or pendulous, much branched sub-shrub to 50 cm. Leaves simple lanceolate, 7-20 mm long, 3-11 wide. Flowers green/white; foliage aromatic. Older stems characteristically develop massively corky bark.
Flowering: Feb, Apr, May. Fruiting: Apr.

Boronia suberosa (Photo K. Brennan)

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Distribution

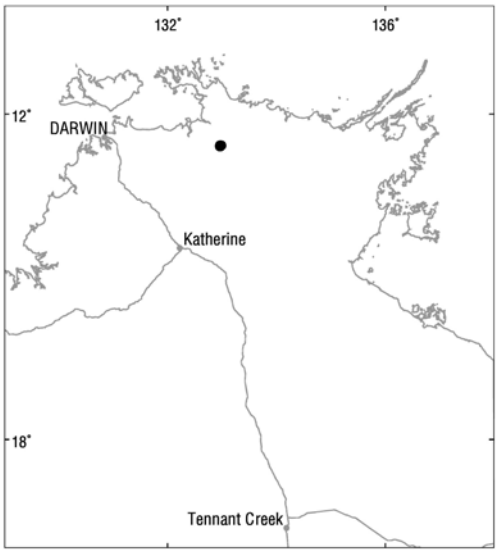
Endemic to the NT, this species is known only from the Ja Ja massif, near Jabiru, and a recently discovered population in nearby Arnhem Land (Kerrigan 2003).

Conservation reserves where reported:

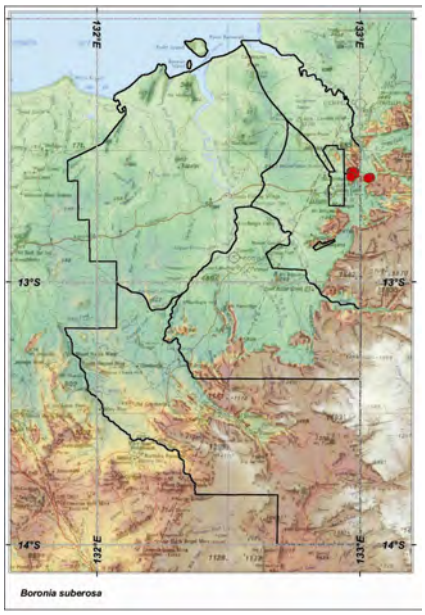
Kakadu National Park.

Ecology

Found on sandstone pavements and cliff faces.



Known locations of *Boronia suberosa*



Conservation assessment

Kerrigan (2003) reported a population of at least 2000 mature individuals at the Ja Ja site, an extent of occurrence of about 8 km², and area of occupancy of about 10 ha. Given these data, she considered that the species no longer met the criteria for Vulnerable status, and its status should be downgraded.

Threatening processes

The habitat of this species suggests an intolerance to fire and expansion of the population into areas exposed to frequent

fire is unlikely. Recruitment success appears to be low (no juveniles have been observed at the known populations), given the limited availability of suitable cliff face sites and the low probability of successful dispersal to these sites.

Conservation objectives and management

A monitoring program for the species has been established recently (Kerrigan 2003) and should be maintained. The species will be favoured by a regime of less frequent fires. More precise information on life history parameters (time to maturity and lifespan) is required to tune fire management prescriptions.

Information on abundance and/or status within Kakadu NP

Kerrigan (2003) provides detailed data on the distribution and population in Kakadu. At least 2000 mature individuals are known from the Ja Ja site.

There is currently no information on trends in abundance in Kakadu NP.

Information on monitoring in Kakadu NP

Kerrigan (2003) established the baseline for an ongoing monitoring program for this species in Kakadu.

Importance of Kakadu NP relative to total range

High: most of the known population lies within Kakadu NP, and this is the only conservation reserve from which the species is known.

Compiled by

Raelee Kerrigan, Ian Cowie, Bryan Baker [February 2002]

References

Duretto, M.F. (1999). Systematics of *Boronia* section *Valvatae sensu lato* (Rutaceae). *Muelleria* **12**, 1-132.

Duretto, M.F., and Ladiges, P.Y. (1997). Morphological variation within the *Boronia grandisepala* Group (Rutaceae) and the description of nine taxa endemic to the Northern Territory, Australia. *Australian Systematic Botany* **10**, 249-302.

Kerrigan, R. (2003). *Kakadu Threatened Flora Report. Results of a threatened flora survey 2003*. (NT Department of Infrastructure Planning and Environment, Darwin.)

Boronia verecunda

Conservation status

Australia (*Environment Protection and Biodiversity Conservation Act 1999*): Vulnerable

Northern Territory (*Territory Parks and Wildlife Conservation Act 2000*): Near Threatened.

Description

Boronia verecunda is a small (to 40 cm tall) erect sub-shrub, with red-edged leaves and sepals, and with new growth with dense covering of pinkish hairs. Flowers are white or pink, becoming green with fruit. This species is similar in appearance to *B. xanthastrum*, but distinguished by weak white hairs, narrower leaves and larger flowers. Flowering material has been collected from January to April, and fruiting material in April.

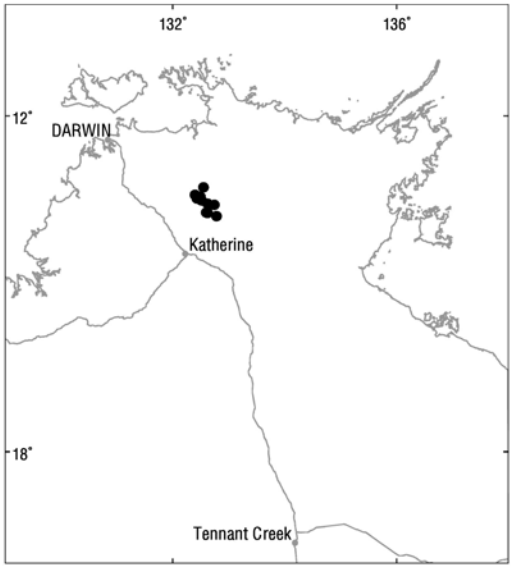
Boronia verecunda (Photo R. Kerrigan)

Distribution

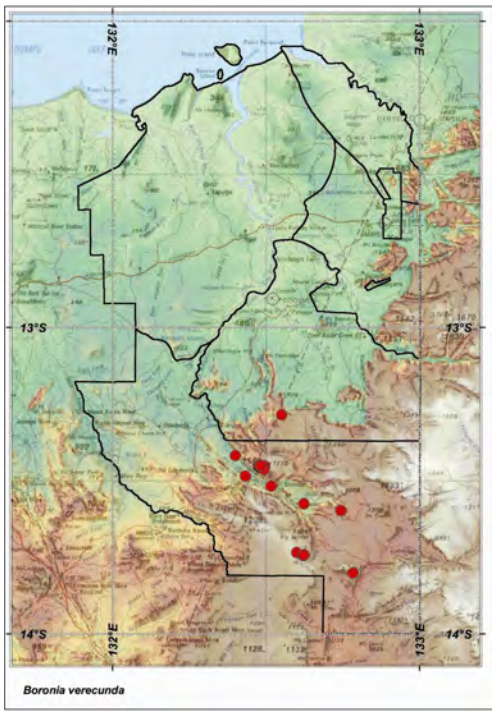
Restricted to the sandstone plateau of western Arnhem Land. Nine populations are known, all in the south of Kakadu NP (Kerrigan 2003, 2004).

Conservation reserves where reported:

Kakadu NP.



Known locations of *Boronia verecunda*



Ecology

Like other boronias, this is an obligate seeder, requiring fire-free intervals of at least 3 years to persist. It has been recorded growing on scree slopes of broken sandstone cobbles.

Conservation assessment

The most recent assessment of status was that of Kerrigan (2003, 2004), who estimated the total population probably

exceeded 1000 mature individuals and extent of occurrence of about 630 km².

Kerrigan (2003) considered that the population was sufficiently secure to be downlisted from Vulnerable.

Typical habitat of Boronia verecunda (Photo R. Kerrigan)

Threatening processes

Along with many other sandstone heathland species, this boronia is fire-sensitive, and will decline where fires recur at intervals of less than 3-5 years.

Conservation objectives and management

A monitoring program has recently been established (Kerrigan 2003, 2004) and should be maintained. The species is dependent upon the maintenance of favourable fire regimes (infrequent fire). More precise information on life history parameters (time to maturity and lifespan) is required to tune fire management prescriptions.

Information on abundance and/or status within Kakadu NP

Kerrigan (2003, 2004) provided information on the distribution and abundance of this species in Kakadu NP. The species occurs in Fire Plot 133, with a population of 116 mature individuals there in 2004.

There is currently no information on trends in abundance in Kakadu NP.

Information on monitoring in Kakadu NP

Kerrigan (2003, 2004) established a baseline for an monitoring program for this species in Kakadu NP.

Importance of Kakadu NP relative to total range

High: all of the known population occurs in Kakadu.

References

Duretto, M.F., and Ladiges, P.Y. (1997). Morphological variation within the *Boronia grandisepala* Group (Rutaceae) and the description of nine taxa endemic to the Northern Territory, Australia. *Australian Systematic Botany* **10**, 249-302.

Kerrigan, R. (2003). *Kakadu Threatened Flora Report. Results of a threatened flora survey 2003*. (NT Department of Infrastructure Planning and Environment, Darwin.)

Kerrigan, R. (2004). *Kakadu Threatened Flora Report. Volume 2. Results of a threatened flora survey 2004*. (NT Department of Infrastructure Planning and Environment, Darwin.)

Boronia xanthastrum

Conservation status

Australia (*Environment Protection and Biodiversity Conservation Act 1999*): Vulnerable.

Northern Territory (*Territory Parks and Wildlife Conservation Act 2000*): Near Threatened.

Description

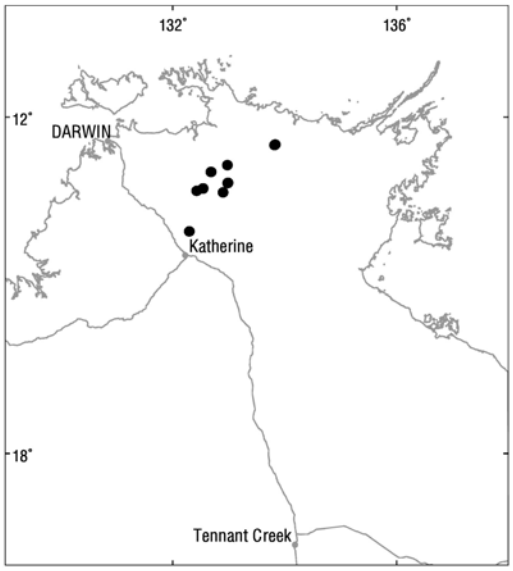
Boronia xanthastrum is an erect much-branched sub-shrub, to 40cm tall. It is densely covered with yellowish stellate hairs throughout. The flowers are yellow-green. Flowering and fruiting material has been collected between February and June.

Boronia xanthastrum (Photo: Kym Brennan)

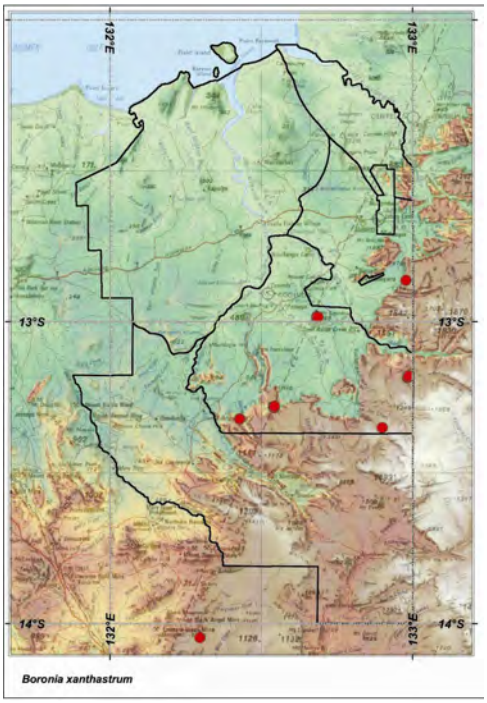
Distribution

Restricted to the sandstone plateau of western Arnhem Land. The most recent assessment (Kerrigan 2004) considered that there were six extant populations, mostly within Kakadu NP.

Conservation reserves where reported:
Kakadu NP.



Known locations of *Boronia xanthastrum*.



Ecology

Grows in both sandstone and schist geology, and in heath and woodland vegetation communities.

Conservation assessment

The most recent assessment of status was that of Kerrigan (2004), who noted six sub-populations, over an extent of occurrence of about 600 km², with a total population that

probably exceeded 1000 mature individuals. Although two previously known sub-populations may have disappeared, Kerrigan (2004) considered that the population was sufficiently secure to be downlisted from vulnerable.

Threatening processes

Along with many other sandstone heathland species, this boronia is fire-sensitive, and will decline where fires recur at intervals of less than 3-5 years.

Conservation objectives and management

A monitoring program has recently been established (Kerrigan 2003, 2004) and should be maintained. The species is dependent upon the maintenance of favourable fire regimes (infrequent fire). More precise information on life history parameters (time to maturity and lifespan) is required to tune fire management prescriptions.

Information on abundance and/or status within Kakadu NP

Kerrigan (2004) provided counts at a series of marked sits, including Graveside Gorge (9 mature individuals and 675 seedlings in a 0.05 h area), fire plot 76 (Mt Basedow: 100 mature individuals in a 1800 m^2 area), and fire plot 140 (a population recorded in 1999 was no longer present in 2004).

Beyond information from these two fire plots, there is currently no information on trends in abundance in Kakadu NP.

Information on monitoring in Kakadu NP

Kerrigan (2003, 2004) established a baseline for an ongoing monitoring program for this species in Kakadu NP, and trend data are currently available from two fire monitoring plots.

Importance of Kakadu NP relative to total range

High: most of the known population lies within Kakadu NP, and this is the only conservation reserve from which the species is known.

References

Duretto, M.F., and Ladiges, P.Y. (1997). Morphological variation within the *Boronia grandisepala* Group (Rutaceae) and the description of nine taxa endemic to the Northern Territory, Australia. *Australian Systematic Botany* **10**, 249-302.

Kerrigan, R. (2003). *Kakadu Threatened Flora Report. Results of a threatened flora survey 2003*. (NT Department of Infrastructure Planning and Environment, Darwin.)

Kerrigan, R. (2004). *Kakadu Threatened Flora Report. Volume 2. Results of a threatened flora survey 2004*. (NT Department of Infrastructure Planning and Environment, Darwin.)

Calytrix inopinata

Conservation status

Australia (*Environment Protection and Biodiversity Conservation Act 1999)*:
Not listed.

Northern Territory (*Territory Parks and Wildlife Conservation Act 2000*):
Vulnerable.

Description

Calytrix inopinata is a slender shrub to 3 m tall, stipules to 0.75 mm. Inflorescences are few to many, often clustered. Petals are white to pale pink. Flowering and Fruiting has been reported in April.

Calytrix inopinata (Photo K. Brennan)

Distribution

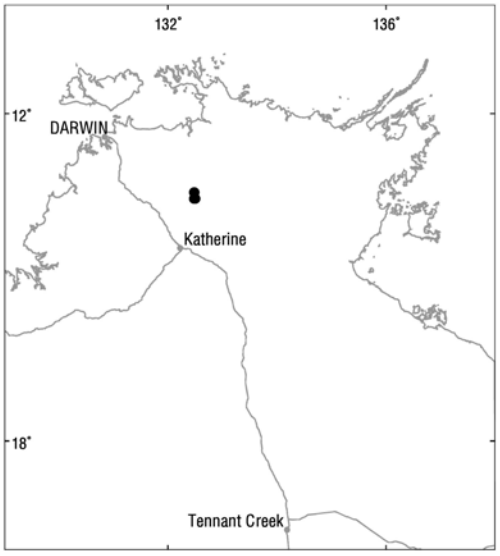
Calytrix inopinata is endemic to the NT. It is known only from two populations near El Sherana, Kakadu National Park. The populations are located north and south of the South Alligator River Valley.

Conservation reserves where reported:

Kakadu National Park.

Ecology

This species has been recorded in very open shrubland with spinifex and shrubs growing in cracks on a gently sloping sandstone pavement, and in cracks on an exposed sandstone knoll.



Known locations of *Calytrix inopinata*

Conservation assessment

The species is known from only two localities, with an extent of occurrence of 25 km². Based on recent counts, the total population size is estimated at > 7000 mature individuals (Kerrigan 2003). On this basis, Kerrigan (2003) proposed to de-list the species.

Threatening processes

With a very restricted distribution and small population size this species is susceptible to stochastic events. It is known from sandstone plateaux on a dissected sandstone

pavement in sparse shrubland with spinifex. The effect of fire is unknown but unfavourable fire regimes may be a threat. In the recent survey of Kerrigan (2003), no seedlings or juveniles were observed; and fire-affected individuals re-sprout.

Conservation objectives and management

A monitoring program has recently been established (Kerrigan 2003) and should be maintained. More precise information on life history parameters (time to maturity and lifespan) is required to tune fire management prescriptions.

Information on abundance and/or status within Kakadu

Kerrigan (2003) provided detailed counts of the two known populations, both occurring in Kakadu.

There is currently no information on trends in abundance in Kakadu NP.

Information on monitoring in Kakadu NP

Kerrigan (2003) provided baseline monitoring.

Importance of Kakadu NP relative to total range

High: all of the known population occurs in Kakadu.

Compiled by

Raelee Kerrigan, Ian Cowie, Bryan Baker [February 2002]

References

Craven, L.A. (1991), A New Species of *Calytrix* (Myrtaceae, Chamelaucieae) from Northern Australia. *Australian Systematic Botany* **4:** 535-537.

Kerrigan, R. (2003). *Kakadu Threatened Flora Report. Results of a threatened flora survey 2003*. (NT Department of Infrastructure Planning and Environment, Darwin.)

Cephalomanes obscurum

Conservation status

Australia (*Environment Protection and Biodiversity Conservation Act 1999)*:
Not listed.

Northern Territory (*Territory Parks and Wildlife Conservation Act 2000*):
Endangered.

Description

Cephalimanes obscurum is a terrestrial fern, erect to 20 cm tall. The leaf blade is 3-pinnate to 3-pinnate-pinnatifid, 5-15 cm long, 2-9 cm wide. Clusters of spores (sori) erect, borne on short lobes in the axils of tertiary segments.

Cephalomanes obscurum (Photo J. Risler)

Distribution

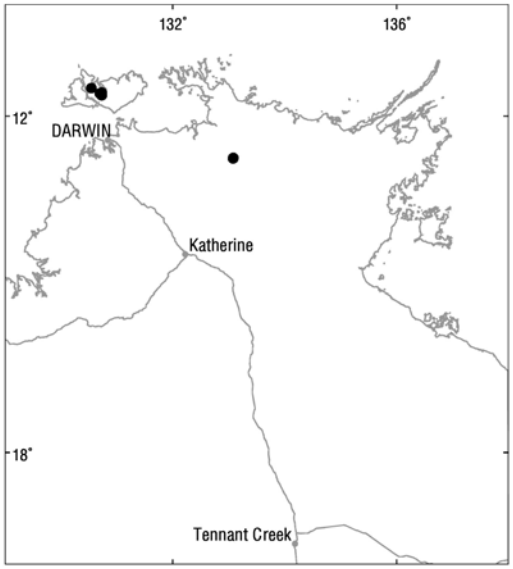
This species occurs from north-eastern Qld to north-eastern NSW; also in Sri Lanka, southern India to Taiwan, Malesia, Solomon Island and possibly Vanuatu. In the NT, it has been collected from three localities: Tarracumbie Falls and a nearby location on Melville Island, and Magela Creek in Arnhem Land.

Conservation reserves where reported:

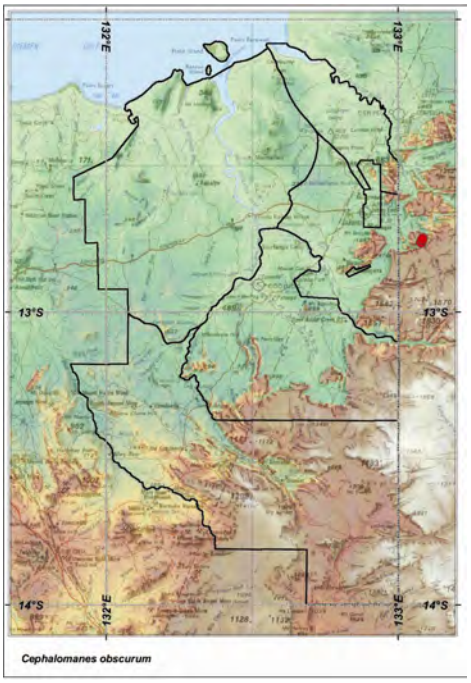
None.

Ecology

It has been recorded as growing in damp gullies along creek banks or under rock ledges, in tropical and subtropical rain forest. Short *et al.* (2003) described its primary habitat as "splash zones of permanent waterfalls". It has been described as a common coloniser, growing in dense patches, with young plants (sporelings) appearing in disturbed sites.



Known locations of *Cephalomanes obscurum*.
(o = pre 1970; • = post 1970)



Conservation assessment

This taxon qualifies for **Endangered** (under criteria D) based on the number of mature individuals in the total population estimated to be <250.

The Magela Creek population, collected in 1984, consisted of four individuals. The Tarracumbie population first collected in

1975 and last collected in 2000 consists of approximately 100 individuals. Additional populations have not been collected nor has the second population on Melville Island been located since 1994. This is despite substantial survey effort on the Tiwi Islands in the last 3-4 years.

It is possible that more populations exist. However, using the precautionary principle, the status of Endangered is given based on estimates of population size.

Threatening processes

With a small population size this species is susceptible to stochastic events. Changes to hydrology and infestation from exotic weeds have the potential to threaten known populations but at present they are not imminent threats.

Conservation objectives and management

Further survey is required to monitor the known populations and to search for others.

Information on abundance and/or status within Kakadu NP

Not yet reported from Kakadu.

Information on monitoring in Kakadu NP

Nil. No baseline monitoring from the nearby population.

Importance of Kakadu NP relative to total range

Nil: not yet reported from Kakadu.

Compiled by

Raelee Kerrigan, Ian Cowie, Bryan Baker [February 2001]

References

Bostock, P.D., and Spokes, M.T. (1998). Hymenophyllaceae. *Flora of Australia* **48**, 116-147.

Liddle, D.T., Russell-Smith, J., Brock, J., Leach, G.J., and Connors, G.T. (1994) *Atlas of the vascular rainforest plants of the Northern Territory.* Flora of Australia Supplementary Series No. 3, ABRS, Canberra.

Short, P., Dixon, D., and Osterkamp Madsen, M. (2003). A review of ferns and fern allies of the Northern Territory. *The Beagle* **19**, 7-80.

Cycas armstrongii

Conservation status

Australia (*Environment Protection and Biodiversity Conservation Act 1999*):
Not listed.

Northern Territory (*Territory Parks and Wildlife Conservation Act 2000*):
Vulnerable.

Description

This species is a medium cycad up to 6 m tall with a slender trunk 6-12 cm in diameter. Branching occurs along with occasional offsets and basal suckers. Leaves form an obliquely erect to spreading crown. Each has 160-300 leaflets attached to the rachis at about 70° with a prominent midrib above.

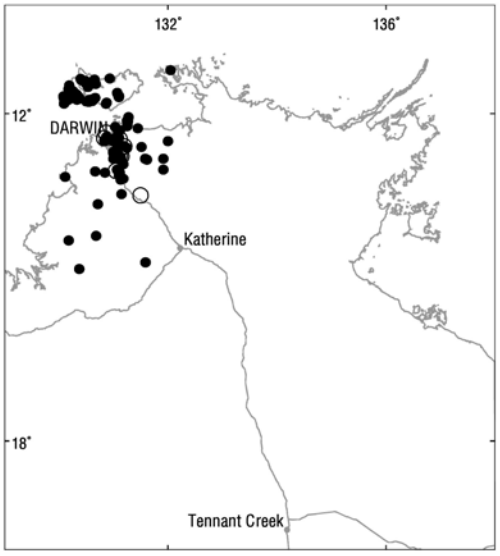
Cycas armstrongii (Photo D. Liddle)

Distribution

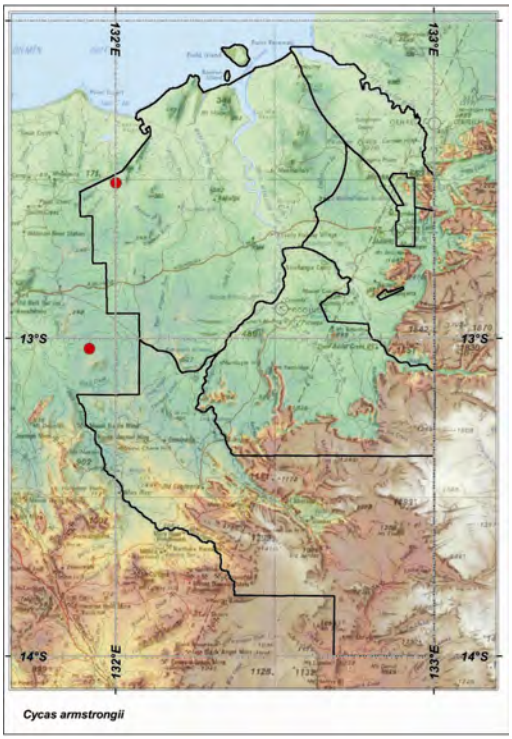
Endemic to the NT. Known from Gunn Point to Hayes Creek, west to Bradshaw and east to the Mary River catchment, with a few records from the Wildman River catchment. It also occurs on the Tiwi Islands and Cobourg Peninsula.

Conservation reserves where reported

Berry Springs Nature Park, Blackmore River Conservation Reserve, Casuarina Coastal Reserve, Djukbinj National Park, Garig Gunak Barlu National Park, Holmes Jungle Nature Park, Howard Springs Nature Park, Howard Springs Hunting Reserve, Kakadu NP, Litchfield National Park and Manton Dam Recreation Area.



Known locations of *Cycas armstrongii* (o = pre 1970; • = post 1970).



Ecology

This cycad occurs mainly in open grassy woodland on yellow and red earths, limited in the area by drainage.

Conservation assessment

This species is locally abundant with less than 1% of the population included in conservation reserves. Applying the precautionary principle within the range, this species qualifies as **Vulnerable** (under criteria A4ce) based on a predicted >30%

reduction in population size over a 100 year period commencing a decade ago (Liddle 2003).

Available habitat in and around Darwin and the Litchfield Shire has been reduced due to land clearing for urban, rural residential and horticultural purposes. Such land clearing is expected to continue as Darwin expands. In particular prime cycad habitat with deep loamy soil has been identified as land suitable for horticulture. It is anticipated that substantial areas of prime habitat on the Tiwi Islands will be cleared for forestry. In areas not subject to clearing there is a major threat from the combined impact of introduced grasses and fire whereby increased fuel loads lead to increased mortality of adult stems.

Threatening processes

Land clearing due to the expansion of Darwin, rural residential living, horticulture, agriculture and forestry are the major threats to the species. Prime habitat for *C. armstrongii* includes deep loamy soils suitable for horticulture, agriculture and forestry. Mortality in excess of 20% of adult stems per fire event has been recorded when subject to fuel loads of 20 tonnes per hectare (Liddle 2003). The exotic pasture species, Gamba Grass *Andropogon gayanus*, supports fuel loads up to 20 tonnes per hectare (Barrow 1995) and the exotic Perennial Mission Grass *Pennisetum polystachyon*, supports fuel loads up to 27 tonnes per hectare (Panton 1993). Both of these exotic species are spreading rapidly and have the potential to extend over the full range of *C. armstrongii*. Fire also reduces seed viability in *C. armstrongii* (Liddle 2003).

Conservation objectives and management

Reservation of high quality habitat, control of exotic grasses and fire management are priority management requirements. Promotion of the value of cycad habitat through the economic returns gained by the sustainable use of this species may assist conservation of the species.

Information on abundance and/or status within Kakadu NP

Reported in Kakadu only from the far northwest edge (Wildman River system).

Information on monitoring in Kakadu NP

Nil; some monitoring established in populations at Litchfield and Charles Darwin NPs.

Importance of Kakadu NP relative to total range

Low: Kakadu is geographically marginal to the main distribution and population.

Compiled by

Raelee Kerrigan, Ian Cowie, Bryan Baker [May 2002]

References

Anon. (1997). *A Management Program for Cycads in the Northern Territory of Australia.* (Parks and Wildlife Commission of NT, Darwin.)

Barrow, P. (1995). The Ecology and Management of Gamba Grass (*Andropogon gayanus* Kunth.) Final Report to the Australian Nature Conservation Agency. (NT Department of Primary Industry and Fisheries, Darwin.)

Liddle, D.T. (2003). The ecology of *Cycas armstrongii* and management of fire in Australia's tropical savannas. PhD Thesis. (Charles Darwin University, Darwin.)

Panton, W.J. (1993). Changes in Post World War II Distribution and Status of Monsoon Rainforests in the Darwin Area. *Australian Geographer* **24**, 50-59.

Dichapetalum timoriense

Conservation status

Australia (*Environment Protection and Biodiversity Conservation Act 1999)*:
Not listed.

Northern Territory (*Territory Parks and Wildlife Conservation Act 2000*):
Vulnerable.

Description

Climbing or creeping shrub, rarely a small tree up to 10 m. Leaves ovate to obovate 7-18 cm x 3-10 cm, pubescent. Fruit globular to ovoid, pear shaped or cordate, velvety pubescent, golden brown when fresh. Fruiting: Apr – May.

Dichapetalum timoriense (Photo K. Brennan)

Distribution

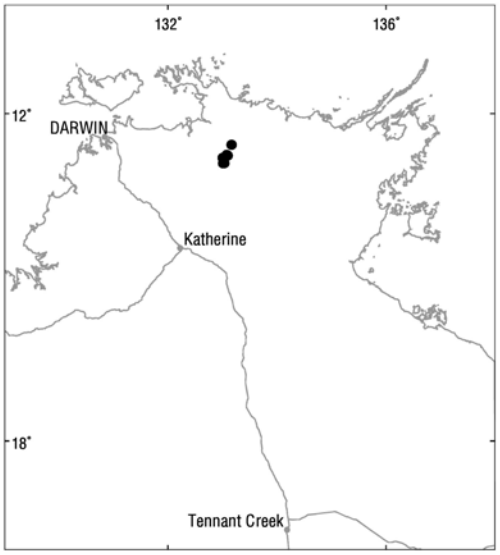
Recorded from Malesia, dubious from Melanesia. In Australia, known from the NT and Queensland. In the Northern Territory the species is known from three localities (Magela Creek Valley, Lightning Dreaming and upper East Alligator) in a restricted area of Arnhem Land.

Conservation reserves where reported:

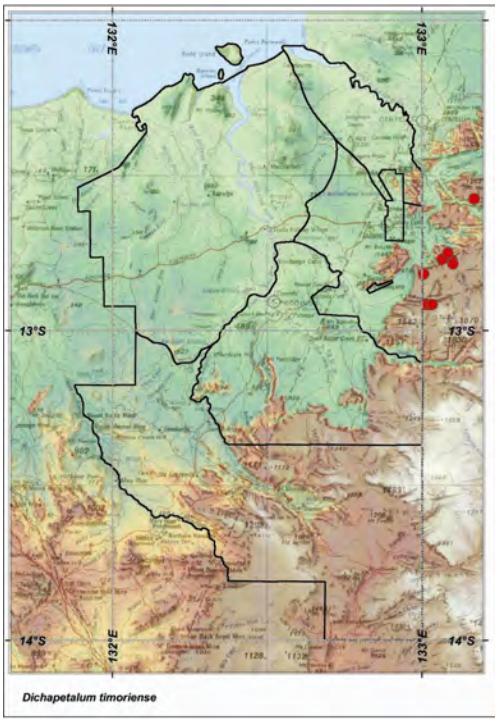
None.

Ecology

Very little is known of the ecology of this species. In the NT it is found on rocky scree slopes and protected gorges of sandstone escarpments in *Allosyncarpia* forest.



Known locations of *Dichapetalum timoriense*



Conservation assessment

It has been recorded growing in only three nearby localities in *Allosyncarpia* forests. However the potential habitat for this species is extensive and further populations may exist. Given that there has been some targeted search effort of this habitat in Arnhem Land, it was felt it was inappropriate to code this species as Data Deficient. Hence the status is considered Vulnerable (under criteria D1+2) based on:

- its restricted distribution (estimated to be <20 km², with an extent of occurrence of about 160 km²) and
- its low abundance (estimated to be <1000 mature individuals) (Kerrigan 2003).

Threatening processes

With a restricted distribution and small population this species is susceptible to stochastic events.

It is difficult, however, to identify likely stochastic events which would threaten this species as the deep sandstone gorges and valleys where *Allosyncarpia* forests grow are reasonably well protected from cyclonic events and fire.

As with other components of the *Allosyncarpia* forests, high fire frequency has probably forced it to retreat to fire-protected sites (Russell-Smith *et al.* 1993).

Conservation objectives and management

Research and further survey is required to establish the status of this population and the extent of its distribution. It is difficult to prescribe recovery actions without knowledge on the dynamics of the population or the associated threats.

Information on abundance and/or status within Kakadu NP

Not yet recorded from Kakadu NP, but reasonably likely to be present.

Information on monitoring in Kakadu NP

Nil: Kerrigan (2004) established a baseline for ongoing monitoring in nearby Arnhem Land.

Importance of Kakadu NP relative to total range

Not yet recorded from Kakadu NP.

Compiled by

Raelee Kerrigan, Ian Cowie, Bryan Baker [February 2002]

References

Kerrigan, R. (2004). *Kakadu Threatened Flora Report. Volume 2. Results of a threatened flora survey 2004*. (NT Department of Infrastructure Planning and Environment, Darwin.)

Leenhouts, P.W. (1955). Dichapetalaceae. *Flora Malesiana* **5**, Ser.1: 305-307.

Liddle, D.T., Russell-Smith, J., Brock, J., Leach, G.J., and Connors, G.T. (1994) *Atlas of the vascular rainforest plants of the Northern Territory*. Flora of Australia Supplementary Series No. 3, (ABRS, Canberra.)

Russell-Smith, J., Lucas, D.E., Brock, J., and Bowman, D.M.J.S. (1993). *Allosyncarpia*-dominated rain forest in monsoonal northern Australia. *Journal of Vegetation Science* **4**, 67-82.

Dubouzetia australiensis

Conservation status
Australia (*Environment Protection and Biodiversity Conservation Act 1999*):
Not listed.

Northern Territory (*Territory Parks and Wildlife Conservation Act 2000*):
Endangered.

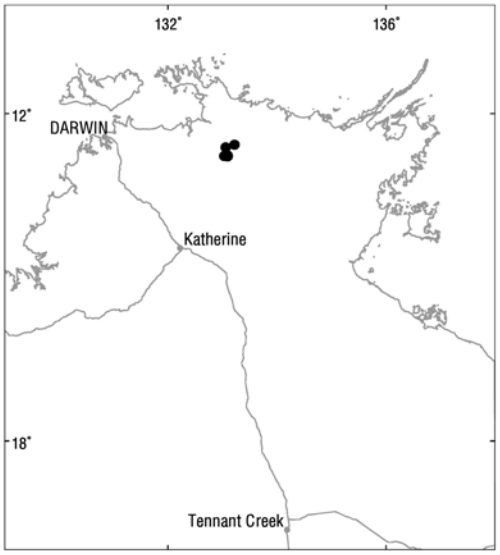
Description
Sub-shrub growing horizontally or pendulously from sandstone gorge cliffs. The twigs are slender, short and velvety. The flowers are faintly sweet smelling, creamy in colour.
Flowering: Jan, May, Sep, Oct.
Fruiting: May, Oct, Dec.

Dubouzetia australiensis (Photo: Kym Brennan)

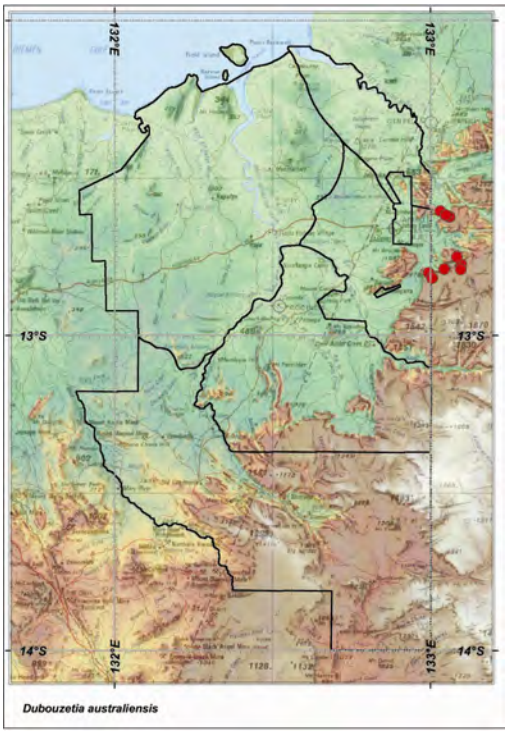
Distribution
Endemic to the NT. Known from a very restricted distribution of approximately six localities around the upper Magela Creek area, Arnhem Land.

Conservation reserves where reported:
Kakadu NP.

Ecology
Very little is known of the ecology of this species. It is found on the walls of a sandstone gorge, not far above the floodwater level of a permanent creek at low altitude. It was noted as being moribund in one collection.



Known locations of *Dubouzetia australiensis*



Conservation assessment
Kerrigan (2004) provided the most recent assessment of conservation status. She considered the most appropriate coding to be Vulnerable.

Threatening processes
The small population size of this taxon makes it susceptible to stochastic events such as rock falls, raised water levels or cyclonic events. The habitat suggests it is intolerant of fire and is unlikely to colonise areas exposed to fire. Recruitment potential

must be low given the limited availability of suitable sites and low probability of successful dispersal to these sites.

Conservation objectives and management

Research is required to establish the status of this population and the extent of its distribution. It is difficult to prescribe recovery actions without knowledge of the dynamics of the population or the associated threats. Propagation of material and translocation to a botanic gardens may be required in the future.

Information on abundance and/or status within Kakadu NP

Only one population is known within Kakadu (Kerrigan 2004), but the population size at this site is unknown.

There is currently no information on trends in abundance in Kakadu NP.

Information on monitoring in Kakadu NP

Nil. Kerrigan (2004) established a baseline for monitoring this species, at one site 500m east of the Kakadu border.

Importance of Kakadu NP relative to total range

Low-moderate: of six known broad locations, one is just within Kakadu NP (Kerrigan 2004).

Compiled by

Raelee Kerrigan, Ian Cowie, Bryan Baker [February 2002]

References

Coode, M.J.E. (1987). *Crinodendron*, *Dubouzetia* and *Peripentadenia*, closely related in *Elaeocarpaceae*. *Kew Bulletin* **42,** 777-814.

Kerrigan, R. (2004). *Kakadu Threatened Flora Report. Volume 2. Results of a threatened flora survey 2004*. (NT Department of Infrastructure Planning and Environment, Darwin.)

SCRAMBLING CORAL FERN
Gleichenia dicarpa

Conservation status

Australia (*Environment Protection and Biodiversity Conservation Act 1999)*:
Not listed.

Northern Territory (*Territory Parks and Wildlife Conservation Act 2000*):
Vulnerable.
(Note: listed there as *Gleichenia microphylla*).

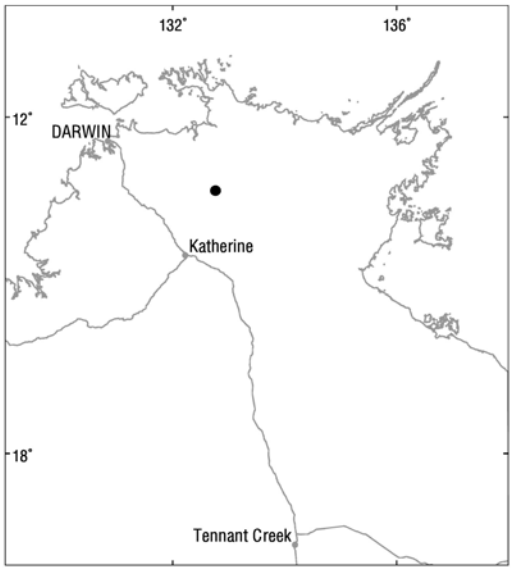
Description

Pendulous or erect fern to 50 cm. Leaves (fronds) of 1-3 tiers of branches, 9-200 cm long. Leaf stalk (stipe) 10-55 cm long. Pinnules oblong to triangular 1-2.5 mm long, 1-2 mm wide. Spores in clusters (sori) of 2-4 sporangia.
Fertile plant: Jan, Sep.

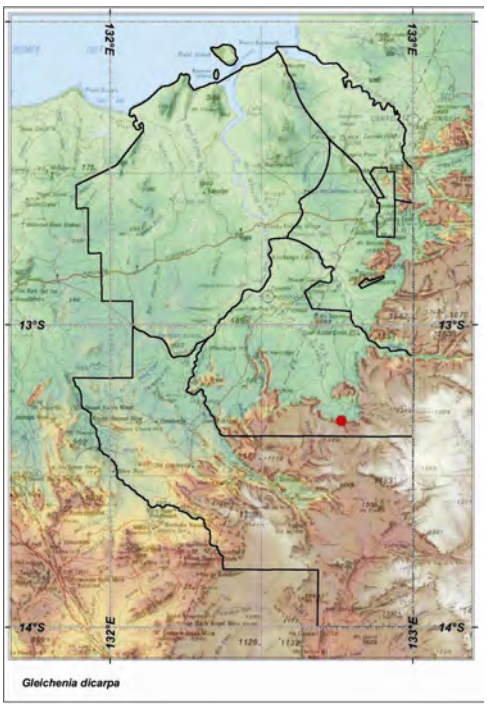
Gleichenia dicarpa (Photo K. Brennan)

Taxonomic Note

Note that the taxonomy of this fern remains unresolved. In the recent major Australian treatment of the ferns, Chinnock and Bell (1998) did not list this genus from the Northern Territory. More recently, Short *et al* (2003) labelled the fern from Twin Falls as *Gleichenia dicarpa* (rather than *G. microphylla* as previously labelled), and considered the Twin Falls site as the only known location of this species in the Northern Territory. Short *et al.* (2003) considered that records from the Victoria River Gorge previously referred to the same taxon should now be treated as a distinct taxonomic entity.



Known locations of *Gleichenia dicarpa*



Distribution

In the Northern Territory, it is known only from a gorge near Twin Falls (Short *et al.* 2003). Beyond the Northern Territory, *G. dicarpa* is known from SE Australia, with a disjunct population at Thornton Peak (NE

Queensland), and it occurs also in New Zealand, New Caledonia and Malaysia.

Ecology
In the NT it is found growing in seepage areas at the base of sandstone scarps or rock overhangs. Recorded in one collection as regrowing after fire damage.

Conservation assessment
Although there has been a substantial survey effort in Kakadu NP, extensive areas of potential habitat remain unsurveyed. It is likely therefore that this taxon may be more common than collections reflect.

The initial assessment of the conservation status of this species referred to *G. microphylla*, in which the Kakadu taxon and another taxon from the Victoria River District were combined. For that assessment, the taxon was scored as **Vulnerable** (under criteria D1+2) based on:

- a population size estimated to be <1000 individuals and
- a restricted area of occupancy estimated to be <20 km^2.

Subsequent to taxonomic reconsideration, the status of *G. dicarpa* is better considered to be Data Deficient (R. Kerrigan *pers. comm.*), reflecting the lack of targeted survey work for this species. This category is likely to be assigned at the next revision of the the NT list, due in 2005.

Threatening processes
This species is susceptible to stochastic events. Rock slides and changes to hydrology are a potential threat.

Conservation objectives and management
Research, further survey and monitoring is required to establish the status of this population and the extent of its distribution.

Information on abundance and/or status within Kakadu NP
No detailed information.

Information on monitoring in Kakadu NP
Nil.

Importance of Kakadu NP relative to total range
Medium: in the Northern Territory, the species is known only from Kakadu; however it has an extensive range beyond the Northern Territory.

Compiled by
Raelee Kerrigan, Ian Cowie, Bryan Baker [February 2002]

References
Chinnock, R.J., and Bell, G.H. (1998) Gleicheniaceae. *Flora of Australia* **48,** 148-161.

Short, P., Dixon, D., and Osterkamp Madsen, M. (2003). A review of ferns and fern allies of the Northern Territory. *The Beagle* **19**, 7-80.

Helicteres D21039 *linifolia*

Conservation status

Australia (*Environment Protection and Biodiversity Conservation Act 1999*):
Not listed.

Northern Territory (*Territory Parks and Wildlife Conservation Act 2000*):
Vulnerable.

Description

This species is a many stemmed perennial sub-shrub with annual above ground parts and woody rootstock. Flowers are mauve/red.
Flowering: Nov – Jan.
Fruiting: Dec – Jan, Mar.

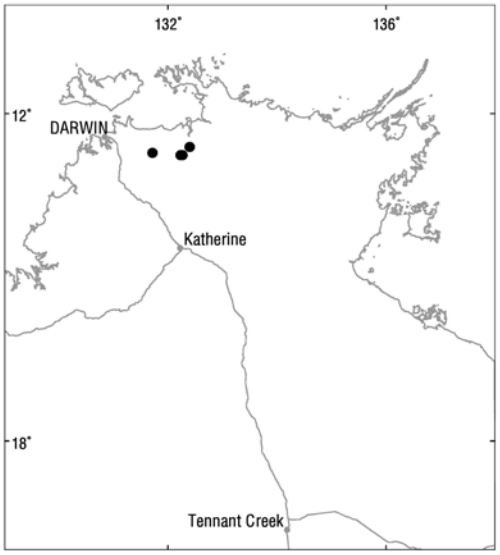
Helicteres D21039 *linifolia* (Photo K. Brennan)

Distribution

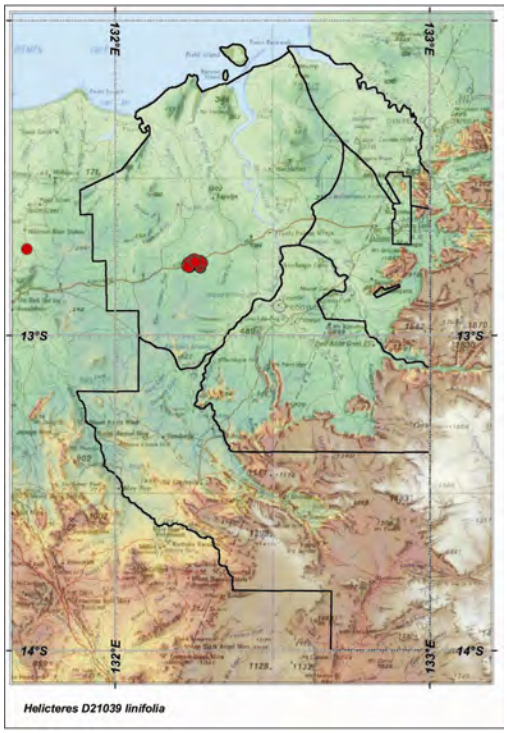
This species is endemic to the NT and known from a relatively restricted distribution of two broad localities between the Mary River and the South Alligator River.

Conservation reserves where reported:

Kakadu National Park, Mary River National Park (proposed).



Known locations of *Helicteres* D21039 *linifolia*



Ecology

Very little is known of the ecology of this taxon. It grows in sandy soil in Woollybutt *Eucalyptus miniata* open forest. It has been recorded re-sprouting readily after fire (Kerrigan 2003).

Conservation assessment

The most recent assessment (Kerrigan 2003) recommended de-listing (to Near Threatened). She considered the species is known from two localities, with extent of occurrence of 24 km², area of occupancy at

least 0.1 km² and up to 8 km²; and a total population of at least 4000 mature individuals.

Threatening processes

A small population size makes this species vulnerable to stochastic events such as unfavourable fire regimes and/or infestation from exotic weeds. The proximity of some populations to the roadside makes them vulnerable to further road development in the future. All known populations are located in conservation reserves.

Conservation objectives and management

Research into the population dynamics of this species is required to establish trends and potential impact of fire and weeds.

Information on abundance and/or status within Kakadu NP

Kerrigan (2003) counted 975 individuals along a 0.1 km² belt transect near the South Alligator ranger station, and estimated this population to be at least 4000 mature individuals. There is currently no information on trends in abundance in Kakadu NP.

Information on monitoring in Kakadu NP

Kerrigan (2003) provided a baseline for monitoring of the single Kakadu population.

Importance of Kakadu NP relative to total range

High: of the only two known populations, one is in Kakadu NP. The other population is also in a reserved area.

Compiled by

Raelee Kerrigan, Ian Cowie, Bryan Baker [February 2002]

References

Kerrigan, R. (2003). *Kakadu Threatened Flora Report. Results of a threatened flora survey 2003*. (NT Department of Infrastructure Planning and Environment, Darwin.)

Hibiscus brennanii

Conservation status

Australia (*Environment Protection and Biodiversity Conservation Act 1999)*:
Not listed.

Northern Territory (*Territory Parks and Wildlife Conservation Act 2000*):
Vulnerable.

Description

Hibiscus brennanii is an erect perennial shrub with woody base, to 1.8 m tall. The outer stems are prickly; the leaves are velvety green grey; the sepals pale brown; and the corolla pink. Flowering: Mar – May.

Hibiscus brennanii (Photo K. Brennan)

Distribution

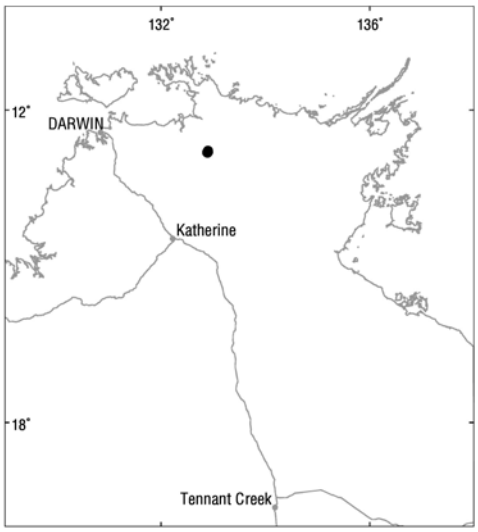
Endemic to the NT. Restricted to the Baroalba Creek, Mt Brockman area.

Conservation reserves where reported:

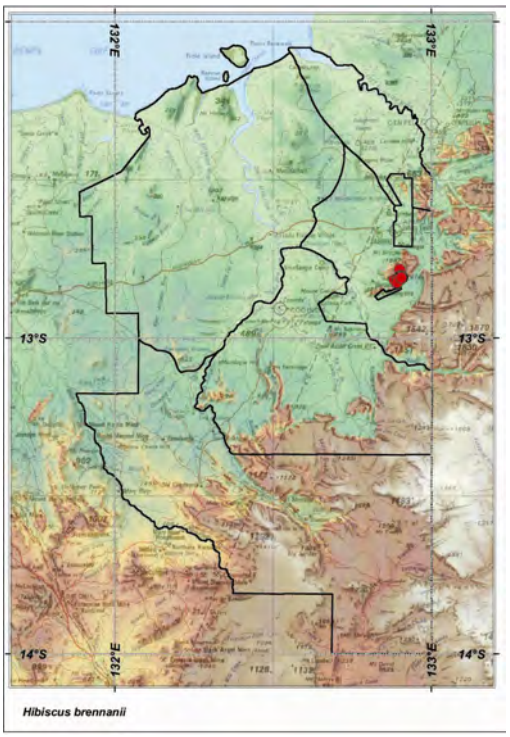
Kakadu National Park

Ecology

This species occurs on sandstone cliffs, in gullies and on broken sandstone pavements.



Known locations of *Hibiscus brennanii*



Conservation assessment

The entire known population is located in Kakadu National Park. Craven and Fryxell (1993) recorded several hundred plants from Baroalba Creek when collected in 1990.

Kerrigan (2003, 2004) provided the most recent assessment of status, based on more explicit counts and targeted surveys. She estimated that the extent of occurrence is 1.5 km^2 and the total population size is 441 mature individuals.

Threatening processes

At present no imminent threats are identified. *Hibiscus* species are often considered 'fire weeds', regenerating strongly after wildfire. As such, unfavourable changes to fire regimes may adversely affect the population. With a small population and limited distribution the species is vulnerable to stochastic events.

Conservation objectives and management

A monitoring program has recently been established (Kerrigan 2003, 2004) and should be maintained.

Research into the status of the population and the role of fire in its distribution is required. More precise information on life history parameters (time to maturity and lifespan) is required to tune fire management prescriptions.

Information on abundance and/or status within Kakadu NP

Kerrigan (2003, 2004) visited all known locations and estimated the total population to comprise 441 mature individuals. There is currently no information on trends in abundance in Kakadu NP.

Information on monitoring in Kakadu NP

Kerrigan (2003, 2004) established a baseline monitoring program for this species in Kakadu NP.

Importance of Kakadu NP relative to total range

High: the entire population is within Kakadu.

Compiled by

Raelee Kerrigan, Ian Cowie, Bryan Baker [February 2002]

References

Craven, L.A., and Fryxell, P.A. (1993) Additions to the Australian *Hibiscus* (Malvaceae): A new species and a new record. *The Beagle* **10**, 1-6.

Kerrigan, R. (2003). *Kakadu Threatened Flora Report. Results of a threatened flora survey 2003*. (NT Department of Infrastructure Planning and Environment, Darwin.)

Kerrigan, R. (2004). *Kakadu Threatened Flora Report. Volume 2. Results of a threatened flora survey 2004*. (NT Department of Infrastructure Planning and Environment, Darwin.)

Lithomyrtus linariifolia

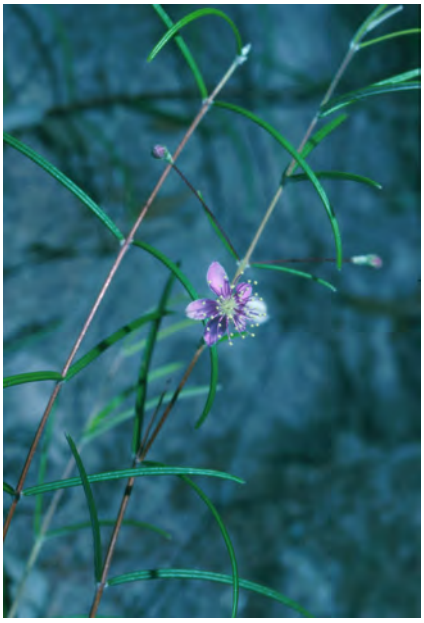
Conservation status

Australia (*Environment Protection and Biodiversity Conservation Act 1999*):
Not listed.

Northern Territory (*Territory Parks and Wildlife Conservation Act 2000*):
Vulnerable.

Description

Lithomyrtus linariifolia is a low spreading plant 0.1-0.2 (up to 1.0) m tall. Leaves opposite, linear 10-51 mm long, 1-3 mm wide. Bark brown to orangey. Flowers are pink, and fruit yellow-green or olive-green.
Flowering: Feb – Apr. Fruiting: Apr – May.



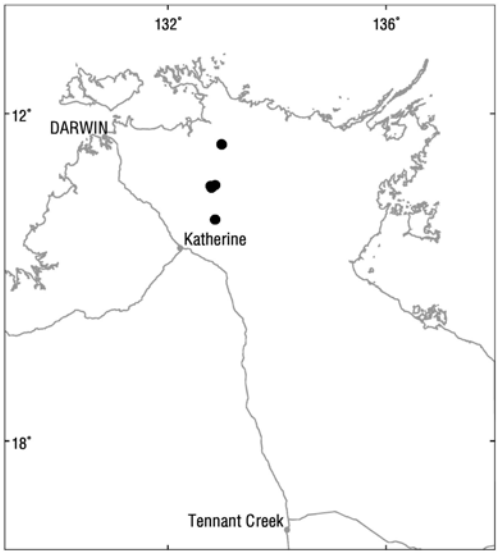
Lithomyrtus linariifolia (Photo K. Brennan)

Distribution

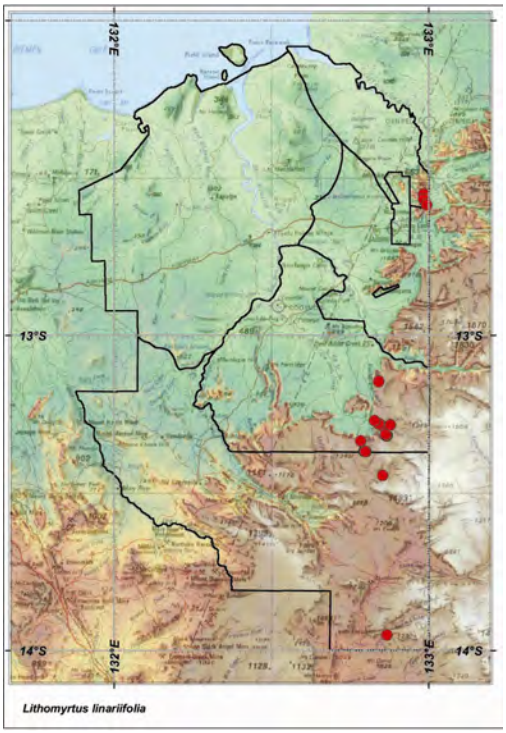
This species is an NT endemic, known from 14 locations in and around the western Arnhem Land plateau and escarpment.

Conservation reserves where reported:

Kakadu NP; Nitmiluk NP



Known locations of *Lithomyrtus linariifolia*



Ecology

Found in heaths or eucalypt woodlands on sandstone, in sandy or skeletal soils.

Conservation assessment

This taxon was classified by Snow and Guymer (1999) as **Vulnerable** (under criteria D1) based on a small population size estimated at <1000 mature individuals.

Kerrigan (2003, 2004) provided the most recent assessment of status, based on explicit counts and targeted surveys. She

estimated that the extent of occurrence is 3400 km² and the total population size is at least 200 mature individuals; and on this basis considered that it should be classified as Vulnerable.

Threatening processes

Unfavourable fire regimes seem the most likely threat to this taxon.

Conservation objectives and management

A monitoring program has recently been established (Kerrigan 2003, 2004) and should be maintained.

More precise information on life history parameters (time to maturity and lifespan) is required to tune fire management prescriptions.

Information on abundance and/or status within Kakadu NP

Kerrigan (2003, 2004) counted individuals at most of the known populations. The Kakadu population was estimated as <200 individuals. There is currently no information on trends in abundance in Kakadu NP.

Information on monitoring in Kakadu NP

Kerrigan (2003, 2004) established a baseline for an ongoing monitoring program for this species in Kakadu NP.

Importance of Kakadu NP relative to total range

High: 11 of the 14 known populations are within Kakadu.

Compiled by

Raelee Kerrigan, Ian Cowie, Bryan Baker [February 2002]

References

Kerrigan, R. (2003). *Kakadu Threatened Flora Report. Results of a threatened flora survey 2003*. (NT Department of Infrastructure Planning and Environment, Darwin.)

Kerrigan, R. (2004). *Kakadu Threatened Flora Report. Volume 2. Results of a threatened flora survey 2004*. (NT Department of Infrastructure Planning and Environment, Darwin.)

Snow, N., and Guymer, G. (1999) Systematic and cladistic studies of *Myrtella* F.Muell. and *Lithomyrtus* F.Muell. (Myrtaceae). *Austrobaileya* **5,** 173-207.

Malaxis latifolia

Conservation status

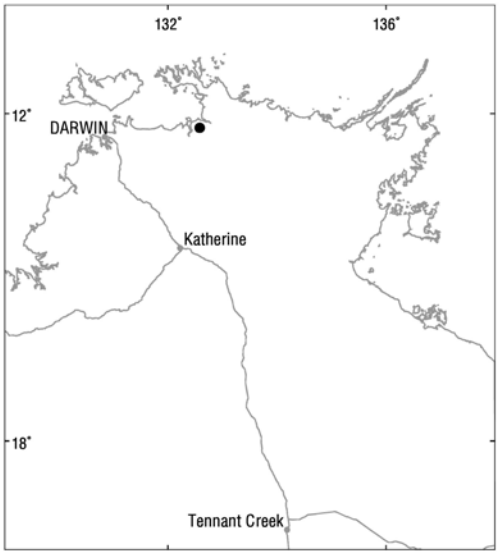
Australia (*Environment Protection and Biodiversity Conservation Act 1999*):
Not listed.

Northern Territory (*Territory Parks and Wildlife Conservation Act 2000*):
Vulnerable.

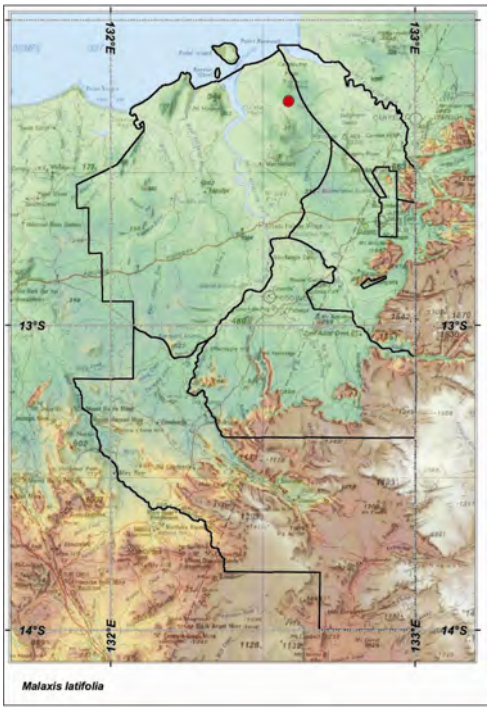
Description

Deciduous terrestrial orchid. Leaves to 30 cm x 9 cm, ovate, thin textured, bright green, sheathing at base, margins wavy. Flower stem to 30 cm tall, green-brown or purplish flowers. Lower lip of flower with three blunt apical teeth, the central one being longest and upturned. Plants conspicuous when in flower but are very difficult to detect when dormant. Flowering: Feb, May.

Malaxis latifolia (Photo: M. Armstrong)



Known locations of *Malaxia latifolia*



Distribution

Known from Qld, New Guinea, Indonesia, Malaysia and India to Japan. In the NT it is recorded from one population (at Bellyungardy Springs) in Kakadu National Park.

Conservation reserves where reported:

Kakadu National Park

Ecology

Across its broader range, Jones (1988) noted that the species is widespread and common in rainforests, along protected stream banks in open forest and sometimes close to low-lying swampy areas.

Conservation assessment

Despite broad-ranging surveys of more than 1000 rainforest patches in the Northern Territory (Russell-Smith 1991; Liddle *et al.* 1994), this species has been recorded from only one locality (27 plants) in the NT and was last recorded in 1993. Although these

data support a category of Critically Endangered, the ephemeral nature of the above ground parts has lead us to downgrade the species. It has been classified as **Vulnerable** (under criteria D1+2) based on:

- a restricted distribution estimated to be <20 km^2 and
- a small population.

The species was not relocated at this site in a detailed search in 2003 (Kerrigan 2003).

Threatening processes

With a small population this species is vulnerable to stochastic events. Feral pigs could detrimentally affect this population. Pressure from collectors is unlikely due to the remote locality.

Conservation objectives and management

Further research into the status of the population and the extent of the species is required. Additional searches at the single known locality (and nearby wet rainforests), at appropriate times, should be conducted. *Ex-situ* conservation may provide some conservation security. Experimental trials of exclosures should be conducted to assess the threat posed by feral pigs.

Information on abundance and/or status within Kakadu NP

The single known locality in Kakadu had a population of 27 plants in 1993; but no individuals were recorded in a thorough search of that location in 2003 (Kerrigan 2003).

Information on monitoring in Kakadu NP

The species has been censused in at least 1993 and 2003 at the single known location.

Importance of Kakadu NP relative to total range

Moderate to high: the single known population in the Northern Territory is in Kakadu NP; but the species is widespread beyond the Northern Territory.

Compiled by

Raelee Kerrigan, Ian Cowie, Bryan Baker [February 2002]

References

Jones, D. L. (1988*) Native Orchids of Australia*. (Reed, Sydney.)

Kerrigan, R. (2003). *Kakadu Threatened Flora Report. Results of a threatened flora survey 2003*. (NT Department of Infrastructure Planning and Environment, Darwin.)

Liddle, D.T., Russell-Smith, J., Brock, J., Leach, G.J., and Connors, G.T. (1994) *Atlas of the vascular rainforest plants of the Northern Territory*. Flora of Australia Supplementary Series No. 3, (ABRS, Canberra.)

Russell-Smith, J. (1991). Classification, species richness and environmental relations of monsoon rain forest in northern Australia. *Journal of Vegetation Science* **2**, 259-278.

Monochoria hastata

Conservation status
Australia (*Environment Protection and Biodiversity Conservation Act 1999*):
Not listed.

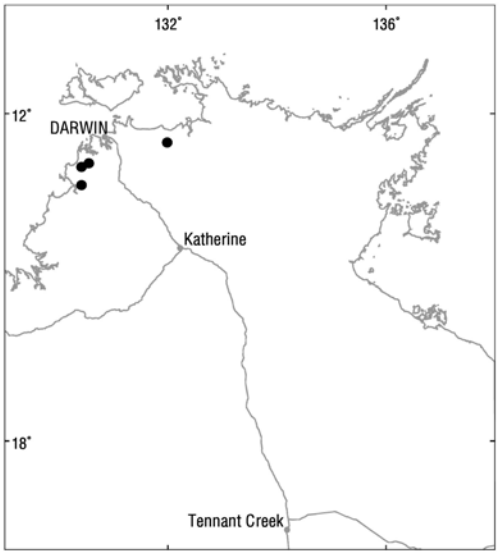
Northern Territory (*Territory Parks and Wildlife Conservation Act 2000*):
Vulnerable.

Description
Emergent aquatic herb with stems approximately 0.7-1.2 m long. Basal leaves arrow shaped. Inflorescence of 25-60 flowers in a dense spike 6-9 cm long. Flowers 13-16 mm long, purple or whitish. Capsule 7 mm long, 5-6 mm diameter.
Flowering: Mar – June.
Fruiting: Apr – Jun.

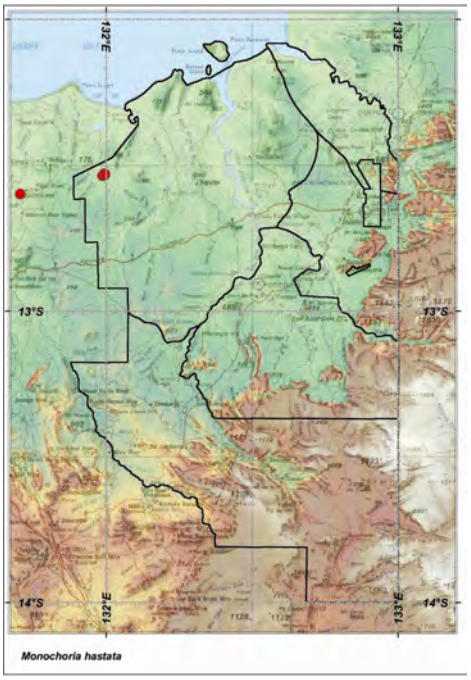
Monochoria hastata (Photo R. Kerrigan).

Distribution
Native to India, Sri Lanka and SE Asia and extending to New Guinea and Australia. In Australia the only records are from the NT, on floodplains of the Finniss, Reynolds and Wildman Rivers.

Conservation reserves where reported:
Kakadu National Park.



Known locations of *Monochoria hastata*



Ecology
Recorded as a component of floating mats in both the Finniss and Reynolds Rivers but also occurs on back-swamps. Overseas, recorded as being fed to cattle and used as a vegetable.

Conservation assessment
In the Northern Territory, this species has been recorded only from four localities, all from floodplains, either on floating mats or on back-swamps where it is considered to be locally abundant. It may be more

common than the few NT records suggest, as there has been relatively little systematic plant survey across wetland areas.

This species has been classified as **Vulnerable** (under criteria B1ab(iii,iv)+2ab(iii,iv); D2) based on:

- an inferred decline in quality of habitat and population numbers as a result of invasion by the weeds Para grass, Hymenachne and Mimosa
- a population estimated to be in the 1000s (I. Cowie) and
- an area of occupancy of known populations estimated to be <20 km^2.

Threatening processes

Invasion by introduced plant species such as Para grass (*Urochloa mutica*), *Hymenachne amplexicaulis* and *Mimosa pigra* appear to be the most imminent threats to this species. Saltwater intrusion of wetlands resulting from rising sea levels triggered by global warming or other factors would have an adverse impact on this species. As a floodplain species, changes to hydrology will affect populations, although no such changes are likely in the near future.

Conservation objectives and management

A monitoring program has recently been established (Kerrigan 2003) and should be maintained. The wetland habitat should be protected from invasion by para grass and/or other exotic plant.

Information on abundance and/or status within Kakadu NP

In Kakadu, *Monochoria hastata* is known only from Ben Bunga floodplain, Wildman catchment. At this site, Kerrigan (2003) estimated the population to be about 5000 individuals, having increased and expanded since reduction in buffalo populations.

Information on monitoring in Kakadu NP

Kerrigan (2003) established a baseline for monitoring at the single Kakadu location.

Importance of Kakadu NP relative to total range

Low to moderate: In the Northern Territory, Kakadu includes one of the four known populations, and the only site in which conservation is a priority management aim. The species also occurs widely beyond Australia.

Compiled by

Raelee Kerrigan, Ian Cowie, Bryan Baker [February 2002]

References

Cowie, I.D., Short, P.S., and Osterkamp Madsen, M. (2000) *Floodplain Flora*. Flora of Australia Supplementary Series No. 10. ABRS, Canberra/PWCNT, Darwin.

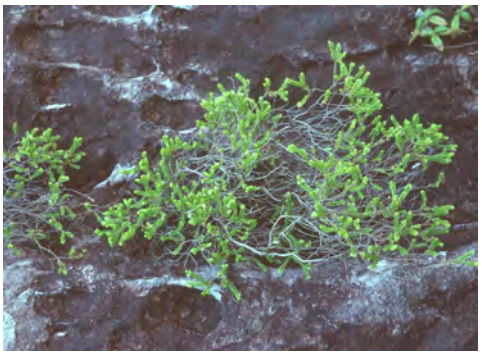
Kerrigan, R. (2003). *Kakadu Threatened Flora Report. Results of a threatened flora survey 2003*. (NT Department of Infrastructure Planning and Environment, Darwin.)

Ochrosperma sulcatum

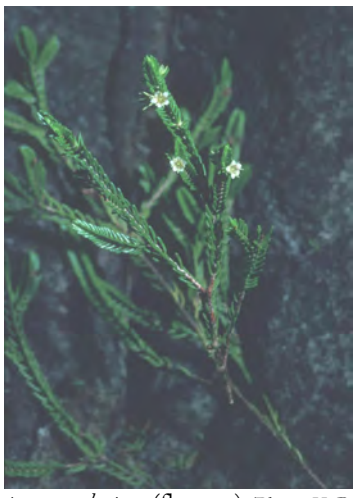
Conservation status
Australia (*Environment Protection and Biodiversity Conservation Act 1999*):
Not listed.

Northern Territory (*Territory Parks and Wildlife Conservation Act 2000*):
Critically Endangered.

Description
Ochrosperma sulcatum is a hanging or erect shrub to 0.5 m. The leaves are very small and narrow, and arranged in a succession of alternating pairs of opposite leaves. Fruiting: Nov.



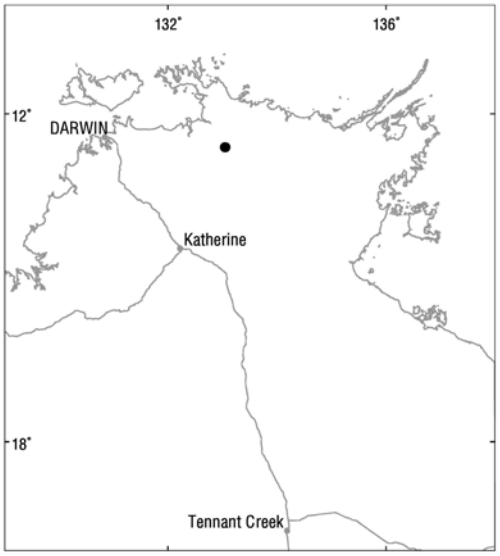
Ochrosperma sulcatum (whole plant) (Photo K. Brennan)



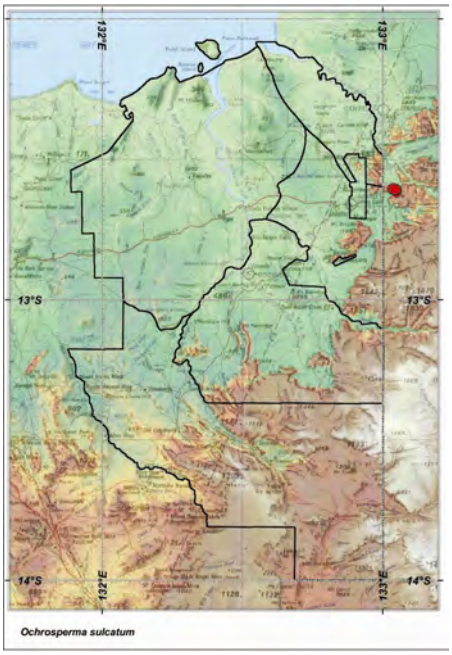
Ochrosperma sulcatum (flowers) (Photo K. Brennan)

Distribution
Endemic to the NT. This species is known only from the type locality ENE of Jabiru (just outside the eastern boundary of Kakadu National Park).

Conservation reserves where reported:
None.



Known locations of *Ochrosperma sulcatum*.



Ecology
The species grows in fissures of a sandstone cliff-face in association with *Mitrasacme geniculosa*.

Conservation assessment
The most recent assessment of conservation status was Kerrigan (2003). She considered it should be de-listed (to Near Threatened); and estimated the area of occupancy as 10

ha, and the population size of >3000 mature individuals.

Chalson and Keith (1995) assessed the risk category for this species as critical.

Threatening processes

With a cliff face habitat this species is susceptible to rock falls. Its habitat suggests an intolerance of fire. Recruitment is expected to be low given the limited availability of suitable sites and a low probability of successful dispersal to these sites.

Conservation objectives and management

More precise information on life history parameters (time to maturity and lifespan) is required to tune fire management prescriptions.

A monitoring program has recently been established (Kerrigan 2003) and should be maintained.

Information on abundance and/or status within Kakadu NP

Not yet recorded from Kakadu NP.

Information on monitoring in Kakadu NP

Nil: Kerrigan (2003) established a baseline for ongoing monitoring in nearby Arnhem Land.

Importance of Kakadu NP relative to total range

Not yet recorded from Kakadu NP, but reasonably likely to be present.

Compiled by

Raelee Kerrigan, Ian Cowie, Bryan Baker [January 2002]

References

Bean, A.R. (1997) A new species of *Thryptomene* Endl. and a new species of *Ochrosperma* Trudgen (Myrtaceae) from the Northern Territory, Australia. *Austrobaileya* **4,** 647-651.

Chalson, J.M., and Keith, D.A. (1995). *A Risk assessment scheme for vascular Plants: Pilot Application to the Flora of New South Wales.* (National Parks and Wildlife Service, Hurstville.)

Kerrigan, R. (2003). *Kakadu Threatened Flora Report. Results of a threatened flora survey 2003.* (NT Department of Infrastructure Planning and Environment, Darwin.)

Sauropus filicinus

Conservation status

Australia (*Environment Protection and Biodiversity Conservation Act 1999*): Vulnerable.

Northern Territory (*Territory Parks and Wildlife Conservation Act 2000*): Data Deficient (note that the most substantial recent survey of this species (Kerrigan 2004) proposes that this categorisation remains the most appropriate).

Description

Sauropus filicinus is a dwarf somewhat fern-like dioecious subshrub. Male flowers are clustered (3-15 per cluster) green to pink; female flowers solitary and red to pink.

Flowering known from April to August; fruiting known only from April.

Sauropus filicinus (Photo: Kym Brennan)

Distribution

The few known specimens are from the western Arnhem Land plateau.

Conservation reserves where reported:

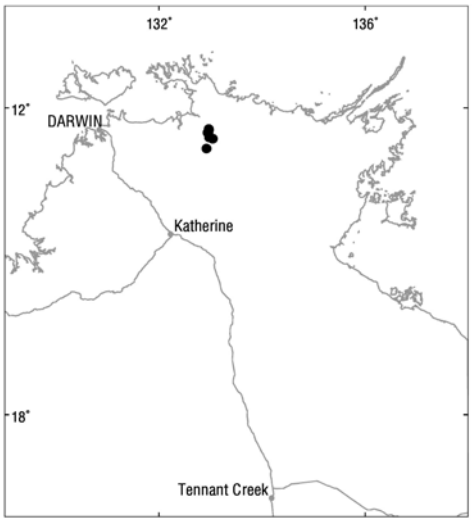
Kakadu NP.

Ecology

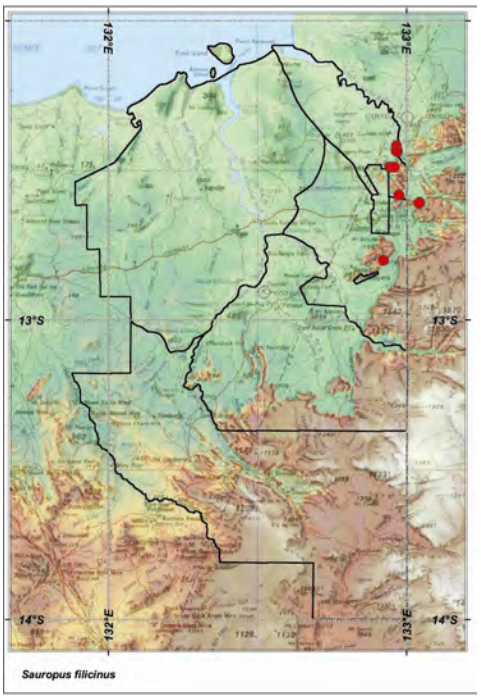
Restricted to crevices in sandstone cliffs.

Conservation assessment

The most recent assessment of status was that of Kerrigan (2004). She reported that this species was now known from 7 localities, with an extent of occurrence of 230 km^2.



Known locations of *Sauropus filicinus*



Threatening processes

There has been no rigorous assessment of threats. It is restricted to fire-protected sites, so is probably disadvantaged by frequent fire.

Conservation objectives and management

More precise information on life history parameters (time to maturity and lifespan) is required to tune fire management prescriptions.

A monitoring program has recently been established (Kerrigan 2003) and should be maintained.

Information on abundance and/or status within Kakadu NP

Kerrigan (2004) counted two populations around the northern outliers (north of Jabiru) and reported a total of 66 mature plants in a total transect length of 3.5 km. There is currently no information on trends in abundance in Kakadu NP.

Information on monitoring in Kakadu NP

Kerrigan (2003, 2004) established a baseline monitoring program for this species in Kakadu NP. However, she noted that this baseline may be unreliable due to confusion between the two similar taxa *S. filicinus* and *S. rimophilus*, and recommended that the baseline be revisited to provide greater certainty in counts.

Importance of Kakadu NP relative to total range

High: six of the seven known populations are within Kakadu NP; and this is the only part of the range in which conservation management is a primary objective.

References

Hunter, J.T., and Bruhl, J.J. (1997). New *Sauropus* (Euphorbiaceae: Phyllantheae) taxa for the Northern Territory and Western Australia and notes on other *Sauropus* occurring in these regions. *Nuytsia* **11**, 165-184.

Kerrigan, R. (2003). *Kakadu Threatened Flora Report. Results of a threatened flora survey 2003*. (NT Department of Infrastructure Planning and Environment, Darwin.)

Kerrigan, R. (2004). *Kakadu Threatened Flora Report. Volume 2. Results of a threatened flora survey 2004*. (NT Department of Infrastructure Planning and Environment, Darwin.)

Utricularia subulata

Conservation status

Australia (*Environment Protection and Biodiversity Conservation Act 1999*):
Not listed.

Northern Territory (*Territory Parks and Wildlife Conservation Act 2000*):
Endangered.

Description

Small to very small annual, terrestrial bladderwort. Inflorescence erect, solitary, simple or sometimes branched. Flower cleistogamous or chasmogamous 0.5-1cm long, yellow or white or reddish. Upper lip broadly ovate, lower lip deeply 3-lobed. Flowering: Mar, May.

Utricularia subulata. (Photo K. Brennan)

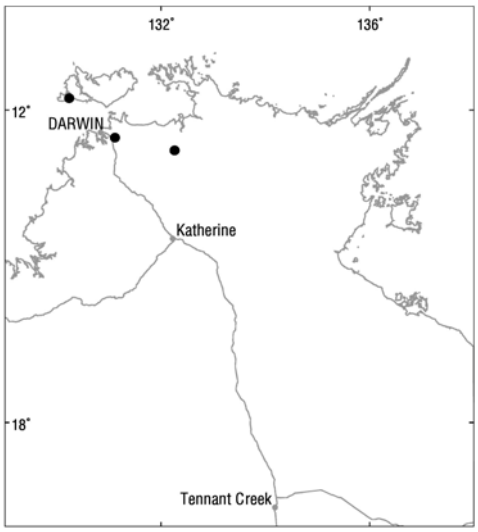
Distribution

Pan-tropical. This is the most widespread of all *Utricularia* species.

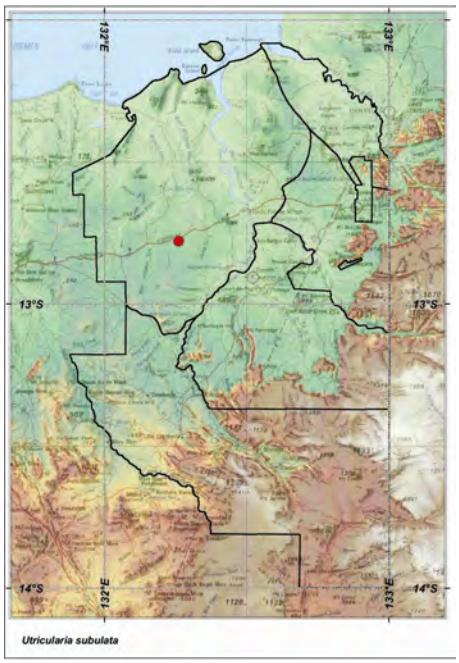
In the NT it is known from three localities, in Kakadu, on Bathurst Island and at McMinns Lagoon. The latter population was not relocated during a survey in 2001.

Not recorded from Kakadu NP until the survey of Kerrigan (2003).

Conservation reserves where reported:
Kakadu NP.



Known locations of *Utricularia subulata*.



Ecology

The species occurs in wet open grassland on the margins of drainage depressions.

Conservation assessment

This species is known from three localities and additional populations were not located in a recent *Utricularia* survey in the Darwin rural area. The McMinns Lagoon population may no longer be extant due to substantial changes in land use in the area.

Using a precautionary approach this species qualifies in the NT for **Endangered** (under criteria B1ab(iii)+2ab(iii)) based on:

- an extent of occurrence <5000 km^2
- an area of occupancy <500 km^2 and
- a projected decline as a result of sandmining and subdivision activity in the Howard Springs area.

Threatening processes

Sandmining, changes to hydrology and subdivision activity in the Howard Springs area.

Conservation objectives and management

Protection of habitat at known localities is required to maintain the status of the species. Further survey may yield additional localities.

Information on abundance and/or status within Kakadu NP

Known only from a single recent record (1.2 km S of the Arnhem Highway, on the west branch of the West Alligator River). Only three individual plants were recorded over a 20 min search of the wet sandsheet habitat (I. Cowie *pers. comm.*).

Information on monitoring in Kakadu NP

There is currently no information on trends in abundance in Kakadu NP. The site of the single Kakadu record could serve as a baseline for ongoing monitoring.

Importance of Kakadu NP relative to total range

Medium: in the Northern Territory, this species is known from only three locations – of these, only Kakadu is managed with a priority for conservation. However, this species occurs widely beyond the Northern Territory.

Compiled by

Raelee Kerrigan, Ian Cowie
[February 2002]

References

Cowie, I. (2002) *Preliminary report on a survey of Utricularia (Lentibulariaceae) in the Howard River-Shoal Bay area.* Unpublished report. Parks and Wildlife Commission of NT, Palmerston.

Kerrigan, R. (2003). *Kakadu Threatened Flora Report. Results of a threatened flora survey 2003.* (NT Department of Infrastructure Planning and Environment, Darwin.)

Taylor, P. (1989) *The Genus Utricularia: a taxonomic monograph.* Kew Bulletin Series XIV, HMSO, London.

NORTHERN GRASSDART BUTTERFLY *Taractrocera ilia ilia*

Conservation status

Australia (*Environment Protection and Biodiversity Conservation Act 1999*):
Not listed.

Northern Territory (*Territory Parks and Wildlife Conservation Act 2000*):
Vulnerable.

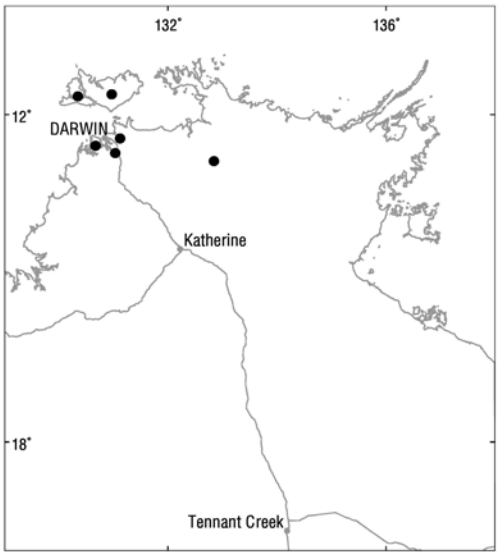
Description

The northern grassdart is a small orange butterfly about 20 mm across the outspread wings. It is similar to many other typical skippers, darters and swifts. The adult has a short, stocky body and the triangular forewings are usually held in a swept-back position like a jet fighter, but vertically over the body. The wings are dark brown with prominent orange markings. When in sunshine or feeding they frequently hold just their hind wings horizontally. The clubs at the end of the antennae are shaped like flattened spoons.

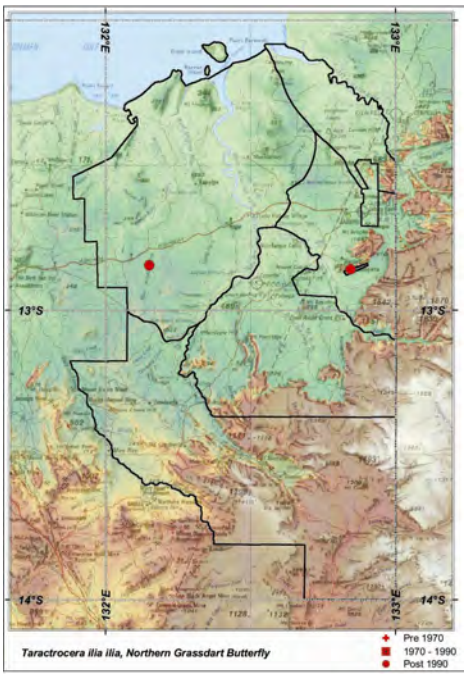
Northern grassdart butterfly. The male is on the left and the female is on the right. The top specimens show the upper side of the wings, and the lower specimens show the underside.
(Reproduced from Butterflies of Australia Vol 1 (M.F. Braby, 2000) with permission of CSIRO Publishing)

Distribution

This butterfly is known only from the Northern Territory, where adults have been collected at King River, Darwin, the Alligator Rivers region and Melville Island.



Known locations of the northern grassdart butterfly.



Conservation reserves where reported:

Kakadu NP

Ecology

Almost nothing is known of the ecology of this species. Its eggs and larvae are unknown, and adults have only rarely been collected. The larvae of related species are thought to feed almost exclusively on particular grasses (Poaceae). The adults congregate in areas near sandstone escarpments and during the heat of the day may shelter in caves (Sands and New 2002).

Conservation assessment

This butterfly is rarely recorded. Conservation categorisation is difficult as there is a lack of information on population trends. There is some evidence that other northern Australian butterflies whose larvae feed on grasses have declined in recent years due to an increase in the frequency and intensity of fires (T.L. Fenner *pers. comm.*), and it is reasonable to assume that the northern grassdart will be exposed to the same pressures.

In 2002, for the assessment of species under NT legislation, this butterfly was coded as **vulnerable** (under criterion B1ab(i,ii,iii,iv)) based on:

- extent of occurrence <20,000 km^2
- known to exist at <10 locations and
- continuing decline observed, inferred or projected.

In contrast, a subsequent assessment (Sands and New 2002) evaluated this taxon as of "no conservation significance". This inconsistency reflects a relatively sparse information base, disagreement abour abundance and decline and lack of clear measure of putative threatening processes.

Threatening processes

Larvae of this butterfly probably feed almost exclusively on particular species of grass. They are thus likely to be particularly vulnerable to the increased frequency and intensity of fires brought about by a greater density of settlement across their known range, and the extensive spread of gamba grass, mission grass and other exotic invasive pasture species.

Conservation objectives and management

There is no existing management program for the northern grassdart butterfly in the Northern Territory. As its host plants and life cycle are unknown, it is difficult to design a management program that will ensure its survival.

Research priorities are:
(i) to investigate the ecology of the species so that larval food plants and breeding sites can be identified and protected.

Management priorities are:
(i) to better safeguard potential breeding sites through encouraging burning practices that create a mosaic of grassland patches burnt at different frequencies and seasons; and
(ii) to better safeguard larval foodplants through controlling the spread of exotic perennial pasture grasses.

Sands and New (2002) also considered that "the impact of regular fires on populations of *T. ilia* needs evaluation", and that "surveys .. should be encouraged ... to ascertain its distribution".

Information on abundance and/or status within Kakadu NP

Little documented information.

Information on monitoring in Kakadu NP

No existing monitoring program.

Importance of Kakadu NP relative to total range

Medium: although occurring reasonably widely, Kakadu is the only site within that range that is managed with conservation as a priority. Sands and New (2002) considered that "no recovery actions are necessary for *T. ilia* because a major population is secure in Kakadu National Park".

Compiled by

Colin Wilson
[February 2002]

References

Braby, M. F. (2000). *Butterflies of Australia. Their identification, biology and distribution.* Vol. 1. CSIRO Publishing, Melbourne, pp. 198-199.

Common, I. F. B. and Waterhouse, D. F. (1981). *Butterflies of Australia.* CSIRO Publications, Melbourne.

Sands, D.P.A., and New, T.R. (2002). *The Action Plan for Australian Butterflies.* (Environment Australia, Canberra.)

FRESHWATER TONGUE SOLE
Cynoglossus heterolepis

Conservation status
Australia (*Environment Protection and Biodiversity Conservation Act 1999*):
Not listed.

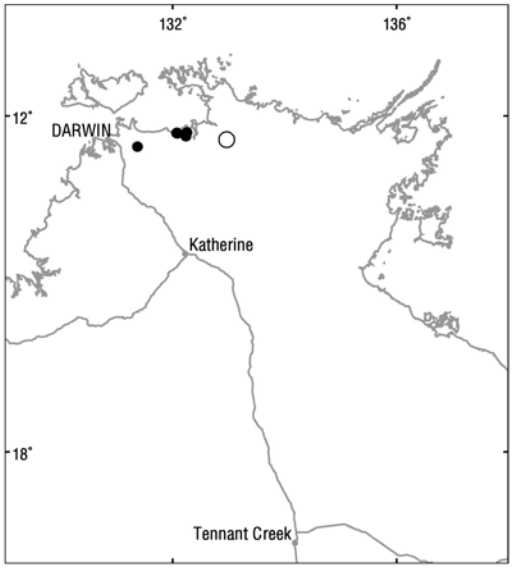
Northern Territory (*Territory Parks and Wildlife Conservation Act 2000*):
Endangered.
[but likely to be de-listed in the forthcoming revision]

Description
The freshwater tongue sole grows to around 25 cm in length. The body is uniformly brownish on the dorsal surface sometimes with narrow brown bars or blotches. The ventral surface is white. Tongue soles are distinguished from true soles by having eyes on the left side of the head and a more elongate body (Allen *et al.* 2002).

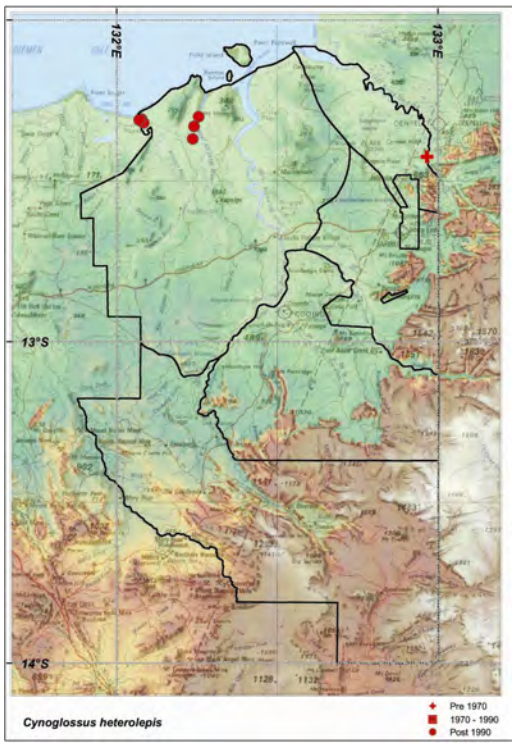
Distribution
The freshwater tongue sole is known from few records in the Northern Territory: these include six specimens collected in the East Alligator River, at Cahill's Crossing, in the 1940s (Allen *et al.* 2002), and more recent records from the Adelaide, West Alligator and Wildman Rivers.

Conservation reserves where reported:
Kakadu National Park.

Ecology
The species is poorly known. However, tongue soles occur in tropical and temperate seas and estuaries where they favour mud or sand bottoms. The species in the genus *Cynoglossus* occur in freshwater habitats. Tongue soles are well camouflaged benthic predators that partially bury themselves in mud or sand substrate and ambush passing prey. They feed on fish and invertebrates (Allen *et al.* 2002).



Known locations of the freshwater tongue sole



Conservation assessment
Conservation assessment is hampered by the lack of any information on trends or threatening processes.

The species was classified by PWCNT as **Endangered** (under criteria B2ab(v)) due to:

- populations known to exist at no more than 5 locations and
- inferred decline in the number of mature individuals.

The inferred decline was based on the fact that it has not been recorded since the 1940s.

More recent opinion (H. Larson, Museum & Art Gallery of the Northern Territory *pers. comm*., Aug 2004), based on consideration of substantially more records than those from which the original listing was proposed, is that this categorisation is not justified, and the species should be de-listed.

Threatening processes
No information. Rather than declining, the species may simply be rare and/or not readily collected.

Conservation objectives and management priorities
The managing authority for this species is the Fisheries Section of the Department of Business Industries and Resource Development.

The main research priority is to better define the distribution and status of this species.

Information on abundance and/or status within Kakadu NP
The species has now been recorded in Kakadu from the East Alligator, West Alligator and Wildman River systems. There is no substantial information on population size or trends in abundance.

Information on monitoring in Kakadu NP
The few specimens collected, and the relatively sparse survey effort, are inadequate baseline for a monitoring program.

Importance of Kakadu NP relative to total range
Unknown: there has been no systematic assessment of its range, or variation in abundance across that range. It is known from beyond Kakadu (in the Adelaide River system).

Compiled by
Simon Stirrat
[October 2002]

References
Allen, G.R., Midgley, S.H. and Allen, M. (2002). *Field Guide to Freshwater Fishes of Australia*. (Western Australian Museum, Perth.)

SPEARTOOTH SHARK *Glyphis* sp. A

Conservation status

Australia (*Environment Protection and Biodiversity Conservation Act 1999*): Critically Endangered.

Northern Territory (*Territory Parks and Wildlife Conservation Act 2000*): Endangered.

Description

The speartooth shark is a medium sized whaler shark that grows to 2 to 3 m in length. Australian specimens range from 0.7 m to 1.3 m in length. The dorsal surface is grey and the ventral surface paler, with an inconspicuous pale stripe on the flanks. It has a short, broadly rounded snout and small eyes. The dorsal fins are similar in size and the anal fin is about the same size as the second dorsal fin. There are no distinctive fin markings (Last and Stevens 1994). An illustration of the species can be found in Plate 29 of Last and Stevens (1994).

Distribution

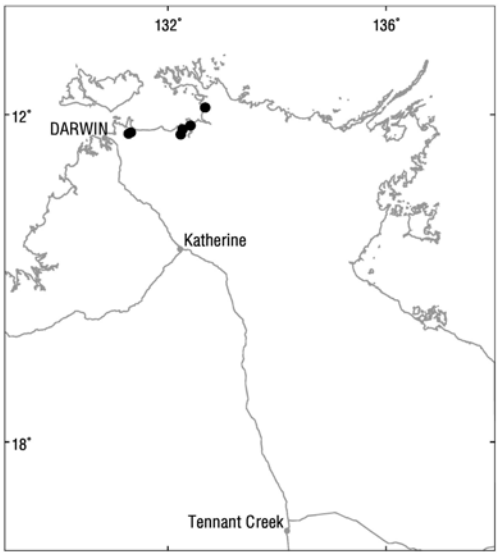
The taxonomy of the genus *Glyphis* is incompletely resolved. In Australia the speartooth shark is known only from two specimens collected in the Bizant River in Queensland and several specimens collected from the Adelaide River and the Alligator rivers region in Kakadu National Park (Thorburn *et al.* 2003). A *Glyphis* shark was also collected from Murganella Creek (Thorburn *et al.* 2003). The specimens from the Bizant River were collected in shallow, freshwater upper reaches of the river.

Conservation reserves where reported

Kakadu NP.

Ecology

Virtually nothing is known of the biology of the speartooth shark. The small eyes and slender teeth suggest that it is primarily a fish feeder adapted to life in turbid waters (Fowler 1997). Species in this genus have low fecundity, small litters and breed every year or two years. This species can occur in the upper reaches of rivers, well inland from the coast (Thorburn *et al.* 2003; Larson *et al.* 2004).



Known locations of the speartooth shark.

Conservation assessment

There are only very limited data from which to assess conservation status. In a recent review, Larson *et al.* (2004) noted "*Glyphis* are particularly problematic large sharks as both species appear to be undescribed and their true distribution and basic ecology is unknown". The speartooth shark may have

a very limited distribution in the Northern Territory. A recent search for the species at the known locations failed to locate any further specimens. The species is very rare, occupies restricted habitat and is vulnerable to capture (Department of Environment and Heritage 2004).

There is no evidence for decline in the known range of the species but this may be due to lack of reporting (Department of Environment and Heritage 2004). However, it is possible that the species has declined due to fishing pressure and other anthropogenic factors such as habitat alteration. Thorburn *et al.* (2003) noted that this species has not been recorded again from the site of its original collection in Queensland, despite several surveys and ongoing commercial fishing occurring in the area.

Pogonoski *et al* (2002) recommended that the Australian status of the speartooth shark be Endangered. In the Nothern Territory, it qualifies as **Endangered** (under criteria B2ab(v)) due to:

- area of occupancy <500 km^2;
- known to occur at no more than 5 locations; and
- projected continuing decline in the number of mature individuals.

Declines are inferred based on susceptibility to capture.

The species was listed as Critically Endangered in the IUCN regional Red List 2003 (Thorburn *et al.* 2003).

Threatening processes

Barramundi gillnetting and recreational fishing are threatening processes in the Northern Territory (Department of Environment and Heritage 2004).

Conservation objectives and management

Currently there is no management program for the speartooth shark in the Northern Territory.

The research priorities are:
(i) to obtain information on the distribution and status of the species
(ii) to monitor and limit the impacts of commercial and recreational fishing operations in estuarine areas.

Commercial fishing (involving gill-nets) is not permitted within Kakadu NP, and there are no data to suggest that recreational fishing activities currently affect the species within the Kakadu area.

Information on abundance and/or status within Kakadu NP

Based on very limited information, Department of Environment and Heritage (2004) estimated the population in the Alligator River estuaries as no more than a few hundred individuals. Larson (2000) captured 7 specimens of *Glyphis* shark (including both *G.* sp.A and *G.* sp.C) from the West, South and East Alligator Rivers.

Information on monitoring in Kakadu NP

Larson (2000) undertook monitoring of this and other estuarine fish in Kakadu NP, but the few specimens of this species collected provide a relatively meagre baseline.

Importance of Kakadu NP relative to total range

Moderate to high: Department of Environment and Heritage (2004) considered that its current distribution may be relictual, with recreational and commercial fishing, and habitat degradation, eliminating the species elsewhere. As such, the relative lack of disturbance in the Alligator Rivers systems render this population extremely significant. Although the data are extremely limited, Environment Australia (2004) infer that the Kakadu population may comprise half of the national population.

Compiled by

Simon Stirrat and Helen Larson
[June 2002]

References

Department of Environment and Heritage (2004). *Glyphis* sp. A (Speartooth Shark). http://www.deh.gov.au/biodiversity/threatened/species/speartooth-shark.html

Fowler, S. (1997). River shark discovered in Sabah. *Shark News. Newsletter of the IUCN Shark Specialist Group* **9**:11.

Larson, H.K. (2000). *Report to Parks Australia on estuarine fish monitoring of Kakadu National Park, northern Australia.* (Museum and Art Gallery of the Northern Territory: Darwin.)

Larson, H., Gribble, N., Salini, J., Pillans, R., and Peverell, S. (2004). Sharks and rays. In *Descriptions of key species groups in the northern planning area.* pp. 59-73. (National Oceans Office, Hobart.)

Last, P.R. and Stevens, J.D. (1994). *Sharks and Rays of Australia.* CSIRO, Melbourne.

Pogonoski, J.J. Pollard, D.A and J.R.Paxton. 2002. *Conservation Overview and Action Plan for Australian Threatened and Potentially Threatened Marine and Estuarine Fishes.* (Environment Australia., Canberra.)

Thorburn, D.C., Peverell, S., Stevens, J.D., Last, P.R., and Rowland, A.J. (2003). *Status of freshwater and estuarine elasmobranchs in northern Australia.* Report to Natural Heritage Trust, Canberra.

NORTHERN RIVER SHARK
Glyphis sp. C.

Conservation status
Australia (*Environment Protection and Biodiversity Conservation Act 1999)*: Endangered.

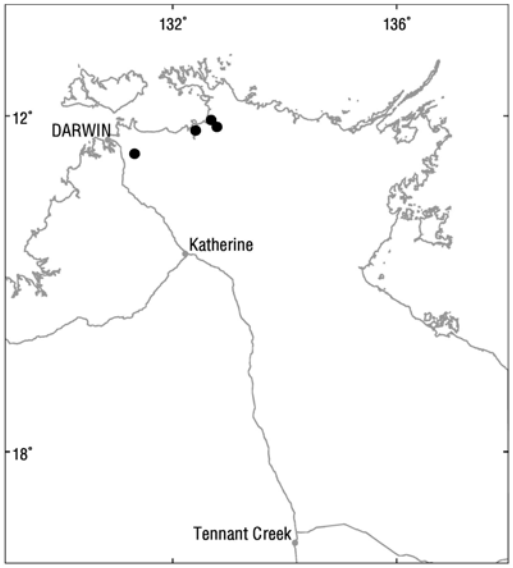
Northern Territory (*Territory Parks and Wildlife Conservation Act 2000*): Endangered

Description
The northern river shark is similar to the more common bull shark that occurs in the same habitat and range. However, this species is a steely-grey colour and may achieve a length of over 2 m. The northern river shark also has a triangular shaped first dorsal fin, and a second dorsal fin that is two thirds the height of the first dorsal fin. Its small eye is located in the grey shaded part of the head (Last and Stevens 1994).

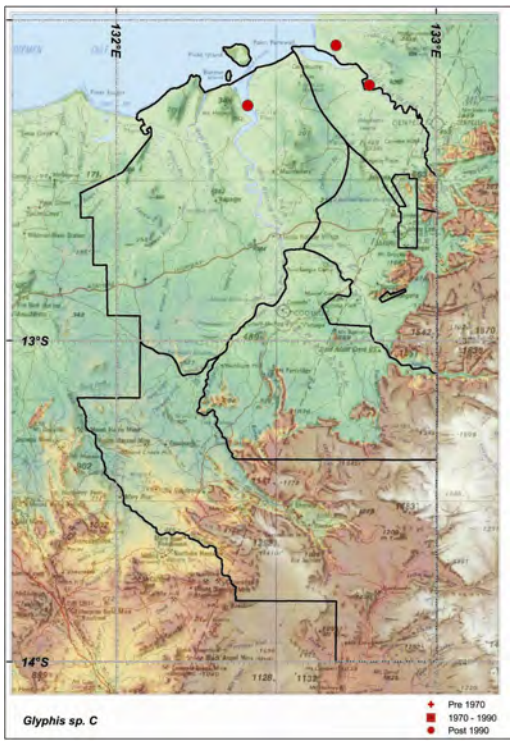
Distribution
In Australia the northern river shark is so far known only from the Adelaide and Alligator River systems in the Northern Territory, and the Fitzroy system (Doctors Creek) in the west Kimberley (Thorburn *et al.* 2003).

Conservation reserves where reported:
Kakadu NP.

Ecology
Little is known of the ecology of the northern river shark but it is probably restricted to the shallow, freshwater to brackish reaches of the Adelaide and Alligator River systems. This conclusion is based on the fact that it has not yet been caught in the coastal marine areas despite considerable fishing and collecting activity in these habitats. This species can occur in the upper reaches of rivers, well inland from the coast: one specimen was collected 60km up the South Alligator River (Thorburn *et al.* 2003; Larson *et al.* 2004).



Known locations of the northern river shark



Conservation assessment
In a recent review, Larson *et al.* (2004) noted "*Glyphis* are particularly problematic large sharks as both species appear to be undescribed and their true distribution and basic ecology is unknown". The northern river shark has a limited distribution in the Northern Territory, similar to the speartooth shark (*Glyphis* sp. A). It was only recently that these two species were recognised as both occurring in the

Northern Territory. The northern river shark probably has a small population size and may be subject to threatening processes of barramundi gill-netting and recreational fishing.

Pogonoski *et al* (2002) recommended that the Australian status of the northern river shark be Endangered. As it only occurs in the Northern Territory its status here should be equivalent to its Australian status. It qualifies as **Endangered** (under criteria B1ab(v)+2ab(v)) due to:

- extent of occurrence <5,000 km^2;
- area of occupancy <500 km^2;
- known to occur at no more than 10 locations; and
- continuing decline, observed inferred or projected in number of mature individuals).

The species was listed as Critically Endangered in the IUCN regional Red List 2003 (Thorburn *et al.* 2003).

Threatening processes

Potential threatening processes in Northern Territory waters include recreational fishing and barramundi gill-netting.

Conservation objectives and management

The managing authority for this species is the Fisheries Section of the Department of Business Industries and Development. Currently there is no management program for the northern river shark in the Northern Territory.

The research priorities are:
(i) to establish the distribution and status of the species across the Northern Territory.
(ii) to assess the potential impacts of fishing operations on populations.

Information on abundance and/or status within Kakadu NP

Department of Environment and Heritage (2004) report two records from Kakadu – one from the South Alligator River in 1996, and two specimens from the East Alligator Rivers system in 1999.

Information on monitoring in Kakadu NP

Larson (2000) undertook monitoring of this and other estuarine fish in Kakadu NP, but the few specimens of this species collected provide a relatively meagre baseline.

Importance of Kakadu NP relative to total range

Uncertain (moderate?): Other than a set of specimens collected on the Adelaide River in 1989, the Kakadu records comprise the only Northern Territory records of this species (Department of Environment and Heritage 2004). However, Thorburn *et al.* (2003) noted that it also occurred in the Fitzroy River, WA.

Compiled by

Simon Stirrat and Helen Larson
[June 2002]

References

Department of Environment and Heritage (2004). *Glyphis* sp. C (Northern River Shark). http://www.deh.gov.au/biodiversity/threatened/species/speartooth-shark.html

Larson, H.K. (2000). *Report to Parks Australia on estuarine fish monitoring of Kakadu National Park, northern Australia.* (Museum and Art Gallery of the Northern Territory: Darwin.)

Larson, H., Gribble, N., Salini, J., Pillans, R., and Peverell, S. (2004). Sharks and rays. In *Descriptions of key species groups in the northern planning area.* pp. 59-73 (National Oceans Office, Hobart.)

Last, P.R. and Stevens, J.D. (1994). *Sharks and Rays of Australia.* CSIRO, Melbourne.

Pogonoski, J.J. Pollard, D.A and J.R.Paxton. 2002. *Conservation Overview and Action Plan for Australian Threatened and Potentially Threatened Marine and Estuarine Fishes.* (Environment Australia., Canberra.)

Thorburn, D.C., Peverell, S., Stevens, J.D., Last, P.R., and Rowland, A.J. (2003). *Status of freshwater and estuarine elasmobranchs in northern Australia.* Report to Natural Heritage Trust, Canberra.

DWARF SAWFISH
Pristis clavata

Conservation status
Australia (*Environment Protection and Biodiversity Conservation Act 1999*):
Not listed.

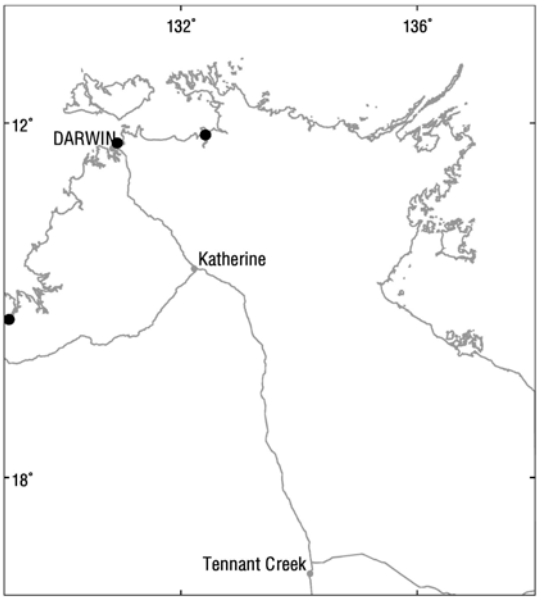
Northern Territory (*Territory Parks and Wildlife Conservation Act 2000*):
Vulnerable.

Description
A small, robust shark-like sawfish that grows to at least 1.4 m long. The rostrum (snout) is broad and bears 18 to 22 pairs of lateral teeth starting from the base. Nostrils behind the eyes are broad with large nasal flaps. The body is usually greenish-brown and white ventrally. The pectoral fins are broadly triangular with broad bases and the dorsal fins are tall and pointed with the first dorsal fin positioned over or just forward of the pelvic fin origin. The lower lobe of the caudal fin is small and the posterior margin of the caudal fin almost straight (Last and Stevens 1994). An illustration of the species can be found in Plate 43 of Last and Stevens (1994).

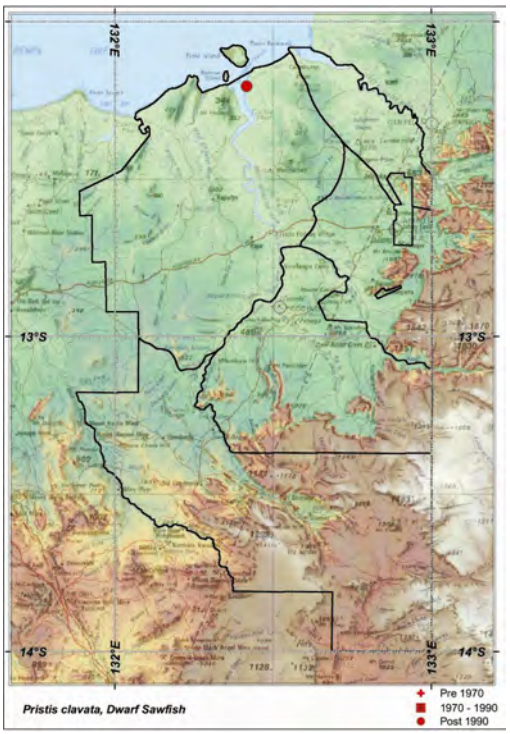
Distribution
The dwarf sawfish occurs in shallow waters (2-3 m) in coastal and estuarine areas of tropical Australia, from the west Kimberley to the Mission River in Queensland. In the Northern Territory it has been recorded in several catchments, including Keep River, Buffalo Creek and Rapid Creek (Darwin Harbour), Victoria River and the South Alligator River.

Conservation reserves where reported:
Kakadu NP, Casuarina Coastal Reserve

Ecology
There is little known of the biology of this species (Peverell *et al.* 2004). Like other sawfishes it may feed on slow-moving shoaling fish, which are stunned by sideswipes of the snout, and molluscs and crustaceans that are swept out of the mud by the saw (Allen 1982). Most frequently recorded from saltwater at lower estuarine sites, but one specimen has been recorded over 100 km from the sea in the Victoria River (Thorburn *et al.* 2003).



Known locations of the dwarf sawfish.



Conservation assessment
The species is on the 2000 IUCN Red List of Threatened Species and its recommended status in Australia is Endangered (Pogonoski *et al* 2002). The IUCN shark specialist group categorised all Australian sawfishes as endangered on the basis of

their rapid decline in range (Cavanagh *et al.* 2003).

In the Northern Territory, the species is classified as **Vulnerable** (under criterion A2d) due to:

- an inferred population size reduction of ≥30% over the last 10 years or three generations where the reduction may have not ceased (based on potential levels of exploitation).

Declines are inferred based on the susceptibility of the species to various fishing practices in coastal and estuarine habitats.

Note that it was considered for listing as Vulnerable under the *Endangered Species Protection Act 1992*, but not listed then, on the grounds of insufficient information (Pogonoski *et al.* 2002).

Threatening processes

Populations have been significantly reduced as a result of bycatch in commercial gillnet and trawl fisheries (Pogonoski *et al* 2002). Recreational fishing may also affect the species.

Conservation objectives and management

In the Northern Territory, the managing authority for this species is the Fisheries Section of the Department of Business Industries and Development. Currently there is no specific management program for the dwarf sawfish in the Northern Territory. Recently, a draft national plan of action has been developed for this and related species (Anon 2002).

The research priorities are to: (i) clarify the distribution and status of the species, and (ii) assess the impacts of fishing operations in estuarine areas in known locations.

Information on abundance and/or status within Kakadu NP

There is little information on the abundance or status of this species in the Kakadu area. The only confirmed record is of a single specimen from Brooks Creek, in the South Alligator system.

Information on monitoring in Kakadu NP

Larson (2000) undertook monitoring of this and other estuarine fish in Kakadu NP, but the few specimens of this species collected provide a relatively meagre baseline.

Importance of Kakadu NP relative to total range

Low to moderate: the species has a wide geographic range. However, it has been reported from few other conservation reserves, and most other sites where it occurs are subject to commercial or recreational fishing, so the Kakadu occurrences are probably unusually secure.

Compiled by

Simon Stirrat and Helen Larson
[June 2002]

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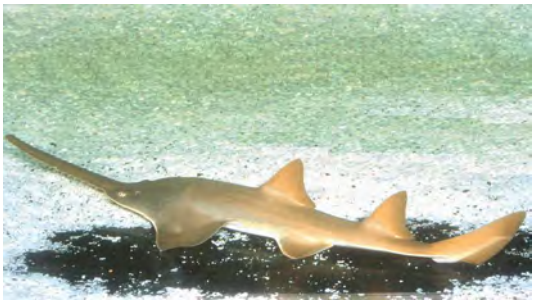
FRESHWATER SAWFISH
Pristis microdon

Conservation status
Australia (*Environment Protection and Biodiversity Conservation Act 1999)*:
Vulnerable.

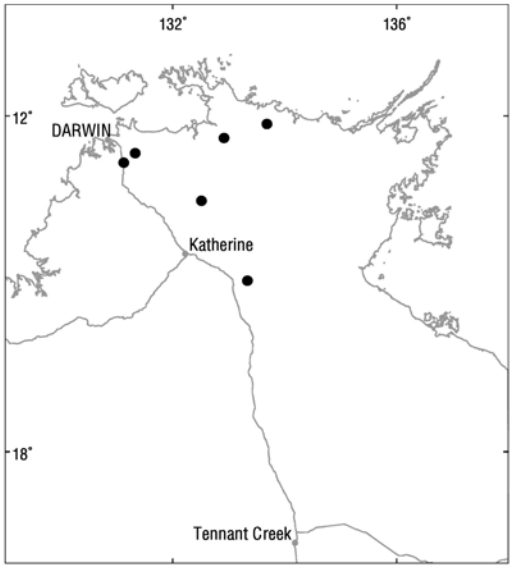
Northern Territory (*Territory Parks and Wildlife Conservation Act 2000*):
Data Deficient.

Description
The freshwater sawfish is a medium sized sawfish with a body length up to 3 m although reputed to reach up to 7 m. The body is slender and shark-like with a blade-like rostrum (snout) bearing mostly 20-22 pairs of lateral teeth. The teeth start near the rostrum base. The body is yellowish to greyish with a white ventral surface. Pectoral fins are broadly triangular with broad bases and dorsal fins tall and pointed with the first dorsal fin positioned well forward of the pelvic fin origin. The lower lobe of the caudal fin is small and the posterior margin of the caudal fin concave (Last and Stevens 1994).

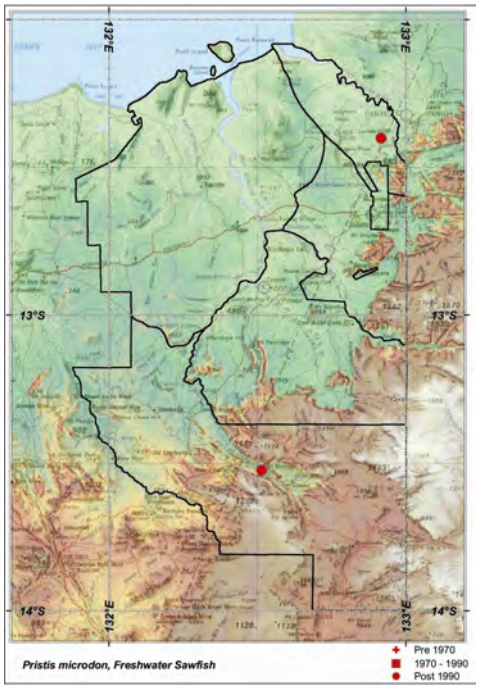


Freshwater sawfish. (Source: Neil Armstrong)

Distribution
The freshwater sawfish is known from many river systems in northern Australia from the Fitzroy River in the west Kimberley to Normanby River in Queensland (Thorburn *et al.* 2003; Peverell *et al.* 2004). In the Northern Territory it has been recorded from the Keep, Victoria, Adelaide, Alligators, Daly, McArthur (Toogangini Creek), Wearyan, Robinson, Roper and Goomadeer River catchments, and Manton Dam.



Known locations of the freshwater sawfish.



Conservation reserves where reported:
Kakadu NP.

Ecology
There is little known of the biology of this species (Peverell *et al.* 2004). Freshwater sawfishes prefer mud bottoms of freshwater areas and upper reaches of estuaries. They usually occur in water greater than 1 m depth but may move into shallow water to feed (Wilson 1999). They have been recorded from main river channels, larger tributaries and backwaters, in river mouths

and up to 400km inland (Thorburn *et al.* 2003).

Sawfishes feed on slow-moving shoaling fish, which are stunned by sideswipes of the snout, and molluscs and crustaceans that are swept out of the mud by the saw (Allen 1982). Freshwater sawfishes are viviparous and produce from 1 to 12 young. In Queensland spawning occurs at the beginning of the wet season.

Conservation assessment

There is little information to determine changes in population sizes or ranges but the species is extremely vulnerable to gillnet fishing (Pogonoski *et al.* 2002). Serious declines are evident in overseas populations (Pogonoski *et al.* 2002) because of habitat loss and fishing impacts.

The IUCN shark specialist group categorised all Australian sawfishes as endangered on the basis of their rapid decline in range (Cavanagh *et al.* 2003).

The species has been classified as **Data Deficient** in the Northern Territory. Although fishing is a potential threatening process it is not clear to what extent this may be affecting the species detrimentally. Although the freshwater sawfish is probably susceptible to gillnet fishing, there is no gillnet fishing allowed in freshwater in the NT. A few rivers are open to gillnet fishing a few kilometres upstream but not in freshwater reaches. There are no reports of by-catch of freshwater sawfish from any commercial fishery, but they are occasionally caught by recreational fishers.

Threatening processes

The impact of fishing practices on freshwater sawfish is unknown. Increasing development in the Northern Territory, resulting in water pollution and loss of riverine habitat may also threaten the species.

Conservation objectives and management

The managing authority for this species is the Fisheries Section of the Department of Business Industries and Development. Currently there is no specific management program for the freshwater sawfish in the Northern Territory. Recently, a draft national plan of action has been developed for this and related species (Anon 2002).

The research priorities are:
(i) to establish the status of the species in the Northern Territory; and
(ii) to assess impacts of commercial and recreational fishing operations in both estuarine and freshwater sections of rivers where they are known to occur.

Information on abundance and/or status within Kakadu NP

There is very little information on its distribution or status in Kakadu. A skull collected recently on the bank of the South Alligator River opposite El Sherana suggests that the species may be distributed well into the upper reaches of the mian river systems.

Information on monitoring in Kakadu NP

Larson (2000) undertook monitoring of this and other estuarine fish in Kakadu NP, but the few specimens of this species collected provide a relatively meagre baseline.

Importance of Kakadu NP relative to total range

Low to moderate: the species has a wide geographic range. However, it has been reported from few other conservation reserves, and most other sites where it occurs are subject to commercial or recreational fishing, so the Kakadu occurrences are probably unusually secure.

Compiled by

Simon Stirrat and Helen Larson
[June 2002]

References

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Anon (2002). *Australian National Plan of Action for the conservation and management of sharks.* Consultation Draft. (Department of Agriculture Fisheries and Forestry – Australia Shark Advisory Group, Canberra.)

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LOGGERHEAD TURTLE
Caretta caretta

Conservation status
Australia (*Environment Protection and Biodiversity Conservation Act 1999*): Endangered.

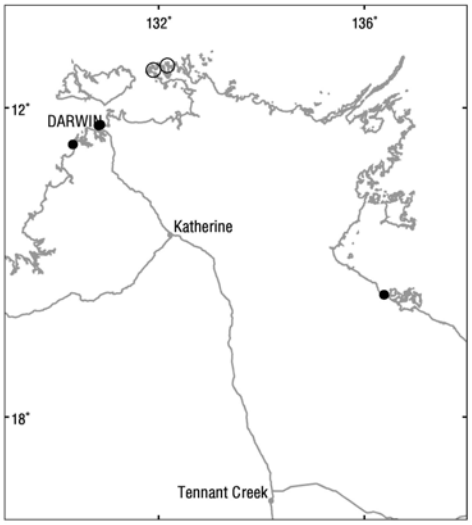
Northern Territory (*Territory Parks and Wildlife Conservation Act 2000*): Endangered.

Description
The loggerhead is a marine turtle with a red-brown to brown shell of ~1 m length and a relatively large head. It usually has five pairs of large scales down each side of the shell (costal scales). When ashore it moves with an alternating gait. Eggs are intermediate in size (mean diameter = 4.1 cm) compared with other species. Hatchlings are dark brown dorsally and light brown ventrally.

Loggerhead turtle. (Copyright: State of Queensland)

Distribution
The species has a global distribution. In Australia, breeding is centred in the southern Great Barrier Reef and adjacent mainland, on Dirk Hartog Island (Shark Bay) and Muiron Island (North West Cape) in Western Australia. The eastern and western populations are genetically distinct. No breeding is known to occur in the Northern Territory, or elsewhere in northern Australia (Limpus and Chatto 2004). Loggerheads from Australia migrate to the Pacific Islands and southern Asia. The animals that feed in Northern Territory waters appear to come from both the eastern and western breeding populations. When feeding in inshore areas they inhabit subtidal and intertidal coral and rocky reefs and seagrass meadows, as well as deeper, soft bottomed habitats. Feeding loggerheads are known to occur in Northern Territory waters but are infrequently encountered.

Conservation reserves where reported: Kakadu, Garig Gunak Barlu, Barranyi.



Known locations of the loggerhead turtle

Note: although we are aware of some observations of this species from Kakadu, we have located no geocoded records.

Ecology
Loggerheads eat shellfish, crabs, sea urchins and jellyfish. Females migrate up to 2600 km from feeding areas to traditional nesting beaches. Females lay up to six clutches of around 125 eggs each season with 3-4 years between breeding. After hatching young turtles take up a drifting existence in surface waters and feed on macro zooplankton. As partially grown immature turtles (shell length of ~75 cm) they move to inshore areas. They settle in one area and do not appear to move large distances, except to breed.

Conservation assessment
The population trends in the western stock are not known but between 1985 and 1992 the population in the southern Great Barrier Reef declined by 20% and between 1985 and 1998 a decline of 65% occurred in the number of loggerheads nesting on Heron

Island (Chaloupka and Limpus 2001). No data are available on trends in numbers feeding in Northern Territory waters but as the threatening processes are operating here (see below) it is concluded that a decline is likely.

If it is assumed the same decline is occurring in Northern Territory waters as is occurring in Queensland then the species qualifies as **Endangered** (under criteria A2b) due to:

- population reduction of ≥50% over the last 10 years or three generations.

Threatening processes

Simulation models suggest that increased fox predation on eggs and mortality of pelagic juveniles from incidental capture in coastal otter trawl fisheries and oceanic longline fisheries have led to the observed declines (Chaloupka and Limpus 2001). The main anthropomorphic mortality factor operating within Territory waters is probably capture of turtles by prawn trawlers (Poiner and Harris 1996). Loggerhead turtles have a greater propensity than other sea turtles to consume baited longline hooks (Witzell 1998)

Conservation objectives and management

This species is included within a current Recovery Plan (Environment Australia 2003). The main components of that plan are a series of measures to reduce mortality (particularly from by-catch, customary harvest and entanglement in marine debris), to establish and integrate monitoring programs, and to enhance habitat suitability around nesting areas and at feeding sites.

Information on abundance and/or status within Kakadu NP

There is little information on the status of the species in Kakadu NP. Roeger and Russell-Smith (1995) reported that it was rare in Kakadu's coastal waters. Given the preference of this species for deeper water, it probably only occurs rarely in Kakadu waters (where the boundary is to the low water matk).

Information on monitoring in Kakadu NP

No current monitoring program.

Importance of Kakadu NP relative to total range

Low. Major Australian breeding sites are on the east and west coast (Limpus 1993), and there are few reliable sightings of this species in Kakadu waters.

Compiled by

Robert Taylor and Ray Chatto
[March 2002]

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GREEN TURTLE
Chelonia mydas

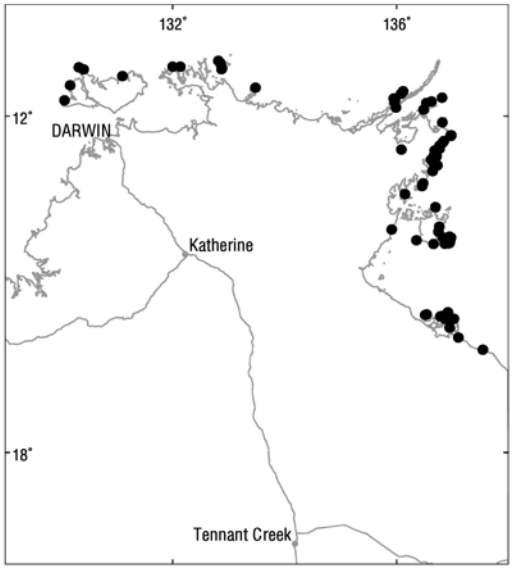
Conservation status
Australia (*Environment Protection and Biodiversity Conservation Act 1999)*:
Vulnerable

Northern Territory (*Territory Parks and Wildlife Conservation Act 2000*):
Not threatened (Least Concern)

Description
The green turtle has a high domed carapace, olive-green above, usually patterned with reddish-brown. The shields on the side of the face are conspicuously pale edged. There are four costal shields on each side of the upper shell. Total length to 1m. On sand, flipper drag marks are opposite rather than alternate.

Green turtle. (Copyright: State of Queensland)

Distribution
Pantropical distribution across the world. Many nesting sites occur in the Northern Territory. Nationally significant nesting beaches occur along the eastern coastline of Arnhem Land and the eastern coast of Groote Eylandt but nesting generally occurs from the western end of Melville Island to near the border with Queensland (Chatto 1998).



Known locations of the green turtle.

Note: although there are observations of this species from Kakadu waters, we obtained no geocoded records to map.

Conservation reserves where reported:
Kakadu, Garig Gunak Barlu, Barranyi, Casuarina Coastal Reserve.

Ecology
Adult green turtles are herbivorous; but young are carnivores. Green turtles breed across much of their Australian range, with females producing about 100 round, smallish parchment-shelled eggs per clutch.

Conservation assessment
There are no population trend data for the Northern Territory (Limpus and Chatto 2004); however Aboriginal landowners have expressed some concerns about decline in north-eastern Arnhem Land (Kennett *et al.* 1998).

A recent assessment of trends for this species in the southern Great Barrier Reef has shown that the overall population increased by 11% per annum over 8 years (1985-1992) and the female nesting population increased by 3% per annum between 1974 and 1998 (Chaloupka and Limpus 2001).

Threatening processes

As with other sea turtles, the populations are threatened by a wide range of factors, including fishing by-catch, entanglement in marine debris ("ghost nets"), harvesting, marine pollution, coastal development, and predation of eggs and young by feral dogs and pigs.

Conservation objectives and management

This species is included within a current Recovery Plan (Environment Australia 2003). The main components of that plan are a series of measures to reduce mortality (particularly from by-catch, customary harvest and entanglement in marine debris), to establish and integrate monitoring programs, and to enhance habitat suitability around nesting areas and at feeding sites.

Information on abundance and/or status within Kakadu NP

Winderlich (1998) noted that green turtles were common around reefs adjacent to Field Island, counting 20 individuals over a 2 hr search period. In contrast, Roeger and Russell-Smith (1995) noted that they are rare in the waters off Field Island and West Alligator Head. There are no records of nesting in Kakadu.

Information on monitoring in Kakadu NP

A study of green turtles foraging adjacent to Green Island has been established since 2002. Tissue samples from individuals captured in this study have been forwarded to a national study of the population genetics of this species (R. Kennett *pers. comm.*)

Importance of Kakadu NP relative to total range

Low. Main breeding sites for this species in the Northern Territory are along the east coast (north-western Gulf of Carpentaria) (Chatto 1998). There are many other major breeding sites along the Queensland coast, northern Western Australia, and islands of the Pacific and SE Asia (Limpus 1993).

Compiled by

Robert Taylor and Ray Chatto
[April 2002]

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OLIVE RIDLEY
Lepidochelys olivacea

Conservation status
Australia (*Environment Protection and Biodiversity Conservation Act 1999*):
Endangered

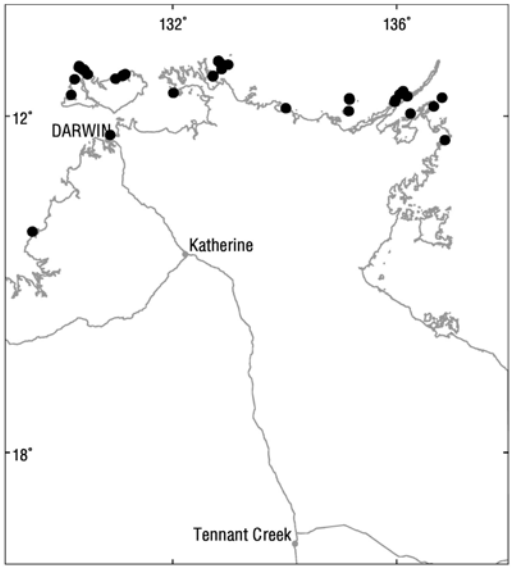
Northern Territory (*Territory Parks and Wildlife Conservation Act 2000*):
Data Deficient

Description
The olive ridley (also known as pacific ridley) is a small sea turtle. It is grey or olive-grey above, typically without conspicuous blotchings or other markings. The head is large. The shell is broadly heart-shaped. There are 6 or more pairs of costal scutes. Total length to 1.5 m.

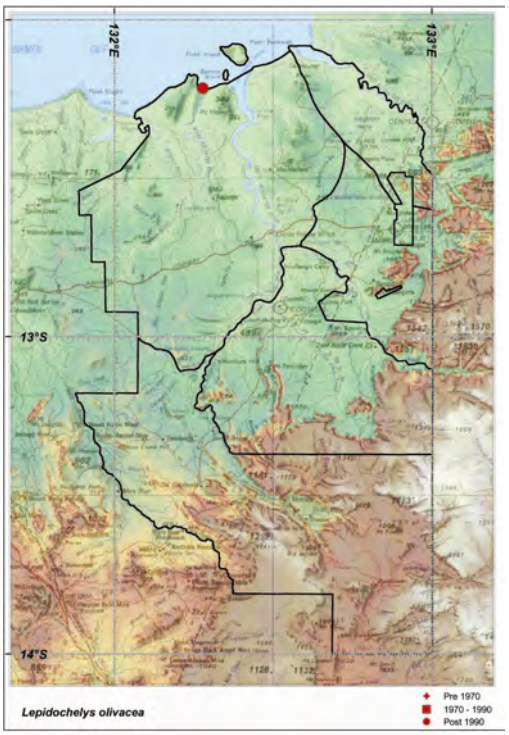
Olive ridley turtle. (Copyright: State of Queensland)

Distribution
The vast majority of the nesting population in Australian waters occurs in the Northern Territory (Limpus 1993; Environment Australia 2003). Nesting has been recorded from Melville Island to Groote Eylandt with the highest nesting occurring on Melville Island, islands to the east of Croker Island and some islands off northeast Arnhem Land (Chatto 1998 and unpublished data).

Conservation reserves where reported:
Kakadu, Garig Gunak Barlu, Barranyi, Casuarina Coastal Reserve.



Known locations of the olive ridley turtle.



Ecology
Olive ridleys live in shallow protected waters and feed on benthic molluscs, crabs, echinoderms and gastropods. Clutches comprise about 100 large round parchment-shelled eggs.

Conservation assessment
There are no accurate population estimates. The female breeding population in the Northern Territory is very roughly

estimated to be between 1,000 to 5,000. Mortality of animals does occur due to capture in fishing nets. The worst recorded occurrence was in Fog Bay in 1991 when an estimated 300 turtles were killed in one incident. Of 100 turtles examined from this kill, 85% were olive ridleys. This level of mortality is, however, exceptional and annual bycatch is likely to be normally much lower.

Given the lack of information on population size and trends in the Northern Territory, the species is best classified as **Data Deficient**.

Threatening processes

As with other sea turtles, the populations are threatened by a wide range of factors, including fishing by-catch, entanglement in marine debris ("ghost nets"), harvesting, marine pollution, coastal development, and predation of eggs and young by feral dogs and pigs.

Conservation objectives and management

This species is included within a current Recovery Plan (Environment Australia 2003). The main components of that plan are a series of measures to reduce mortality (particularly from by-catch, customary harvest and entanglement in marine debris), to establish and integrate monitoring programs, and to enhance habitat suitability around nesting areas and at feeding sites.

Information on abundance and/or status within Kakadu NP

Roeger and Russell-Smith (1995) noted that Olive Ridleys have been observed nesting on beaches of Field Island and West Alligator Head. However, no nesting of this species has been observed on Field Island over the last 10 years of the monitoring program for flatback turtles.

Information on monitoring in Kakadu NP

A breeding marine turtle monitoring program was commenced at West Alligator Head in 1987, with ranger staff involved from 1989-90 (Roeger and Russell-Smith 1995). Numbers of olive ridleys nesting on the Kakadu mainland are very low (<10 per year), and hence the monitoring program for this species was discontinued around 1990.

Importance of Kakadu NP relative to total range

Low to moderate. The Kakadu breeding sites are minor relative to other nesting areas across Arnhem Land (Chatto 1998; Limpus and Chatto 2004).

Compiled by

Robert Taylor and Ray Chatto
[April 2002]

References

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FLATBACK TURTLE
Natator depressus

Conservation status
Australia (*Environment Protection and Biodiversity Conservation Act 1999*):
Vulnerable

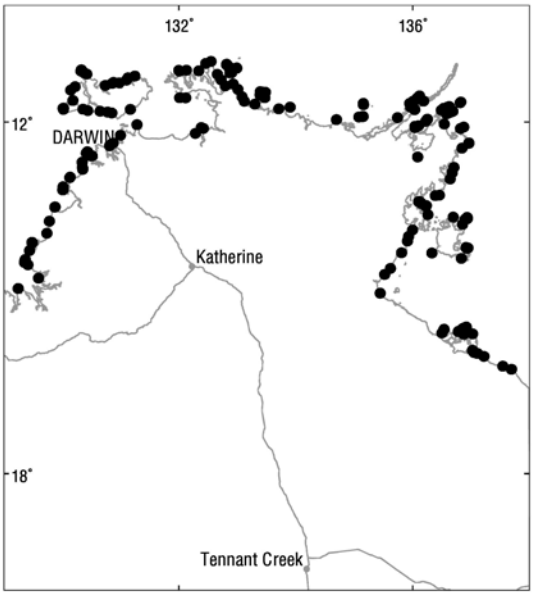
Northern Territory (*Territory Parks and Wildlife Conservation Act 2000*):
Data Deficient

Description
The flatback turtle is a moderately large, marine turtle. It is grey to olive above, with the plates of the carapace covered by a thin fleshy skin. It is creamy-yellow below, extending to the sides of the neck and face. The shell is broadly oval, with upturned edges. There are four costal shields on each side. Total length to 1.2 m. On sand, flipper drag marks are opposite rather than alternate.

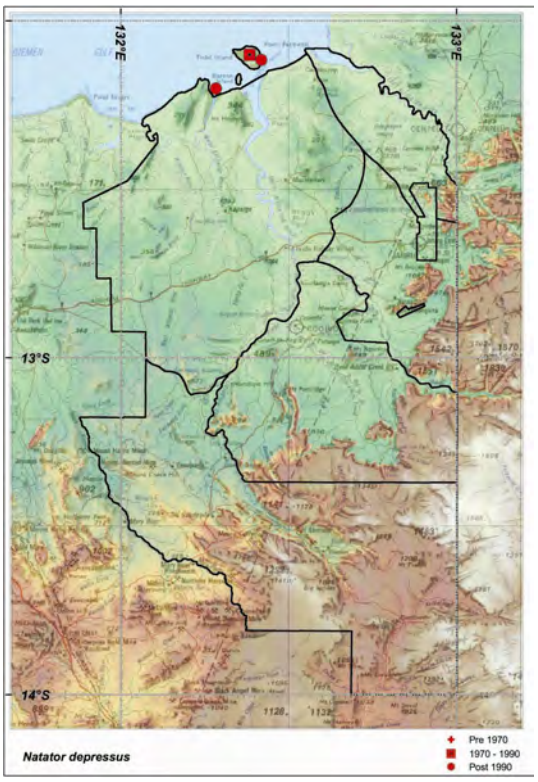
Flatback turtle. (Photo: Ray Chatto)

Distribution
Flatbacks largely occur in Australian continental waters but can be found in low numbers in Indonesia and Papua New Guinea.

Flatback turtles only breed in Australia and breed all around the coastline and offshore Islands of the Northern Territory. Flatbacks probably constitute the highest breeding numbers of any sea turtle in the Northern Territory (Chatto 1998).



Known locations of the flatback turtle.



Conservation reserves where reported:
Kakadu, Garig Gunak Barlu, Barranyi, Casuarina Coastal Reserve.

Ecology
Flatback turtles inhabit shallow, soft bottomed sea beds. They are carnivores, feeding mainly on soft corals and soft bodied animals such as jellyfish and sea cucumbers. Eggs are the largest of all

Australian marine turtles, other than the rare leatherback turtle.

Conservation assessment

Mortality due to bycatch in nets and predation of eggs does occur. However, there are no quantitative data on the impacts of this mortality or trends in population size. In the Northern Territory, the species is best classified as **Data Deficient** as threatening processes are operating but no data are available to assess their impacts on the species.

Threatening processes

As with other sea turtles, the populations are threatened by a wide range of factors, including fishing by-catch, entanglement in marine debris ("ghost nets"), harvesting, marine pollution, coastal development, and predation of eggs and young by feral dogs and pigs (Limpus and Chatto 2004).

At the Kakadu mainland nesting sites, Vanderlely (1995) reported unsustainable rates of predation on eggs by goannas; however, subsequent observations (Winderlich 1998) reported far lower predation rates.

Conservation objectives and management

This species is included within a current Recovery Plan (Environment Australia 2003). The main components of that plan are a series of measures to reduce mortality (particularly from by-catch, customary harvest and entanglement in marine debris), to establish and integrate monitoring programs, and to enhance habitat suitability around nesting areas and at feeding sites.

Information on abundance and/or status within Kakadu NP

There are no published estimates of the abundance of flatback turtles in Kakadu, but Winderlich (1998) and Schuable, Kennett and Winderlich (*unpubl.*) provide some information on the number of turtles tagged on Field Island and nearby mainland beaches.

Information on monitoring in Kakadu NP

Winderlich (1998) provided some background information and preliminary monitoring data for nesting populations at Field Island and nearby mainland beaches. This monitoring program commenced at West Alligator Head in 1987, with ranger staff involved from 1989-90. The Field Island population has been monitored since 1990 (Roeger and Russell-Smith 1995; Schuable, Kennett and Winderlich *unpubl.*).

Importance of Kakadu NP relative to total range

Moderate. In a review of breeding sites around the entire NT coastline, Chatto (1998) mapped part of Field Island and beaches near West Alligator Head as of "medium density" for marine turtle nesting, and all other Kakadu coastal areas as of "low density". Neither of the two main Kakadu sites was rated among the set of 16 "major" nesting areas for this species in the Northern Territory.

Nonetheless, Field Island and the nearby mainland beaches have some significance, as few other breeding sites are reserved, and these sites also have value because there has been some longer-term (10+ years) monitoring there (Winderlich 1998; Schuable, Kennett and Winderlich *unpubl.*).

The national recovery plan for marine turtles (Environment Australia 2003) listed Field Island as one of Australia's 12 "key monitoring sites" for flatback turtles.

Compiled by

Robert Taylor and Ray Chatto
[April 2002]

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PIG-NOSED TURTLE
Carettochelys insculpta

Conservation status

Australia (*Environment Protection and Biodiversity Conservation Act 1999*):
Not listed; but currently nominated as Vulnerable (assessment in progress)

Northern Territory (*Territory Parks and Wildlife Conservation Act 2000*):
Near Threatened.

Description

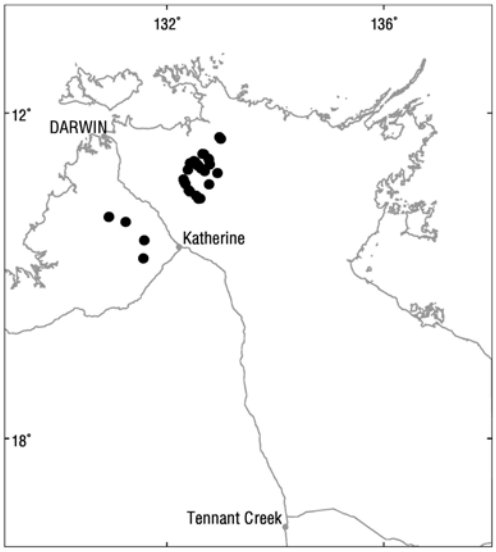
The pig-nosed turtle is a highly distinctive species, the sole surviving member of the once widespread family Carettochelyidae. It is large freshwater turtle, with distinctive unusual snout, a pitted shell (lacking the protective bony scutes that are typical of other freshwater turtles), and clawed paddle-like flippers.

Pig-nosed turtle (Photo: Greg Miles)

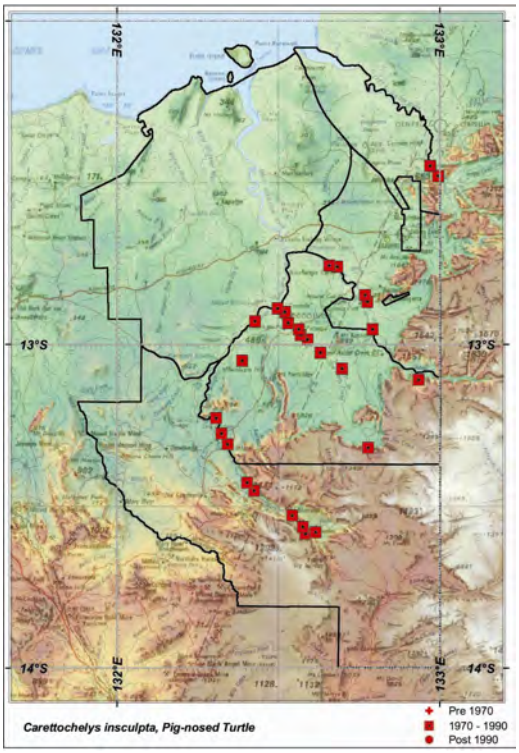
Distribution

The pig-nosed turtle occurs in southern New Guinea (the Fly River drainage) and in the Northern Territory (the Daly, South Alligator, East Alligator, Victoria, Goomadeer and PeterJohn systems). Within these systems it occurs in lowlands, generally above estuarine influences.

Conservation reserves where reported:
Kakadu NP, Daly Esplanade, Gregory, Flora River



Known locations of the pig-nosed turtle



Ecology

The pig-nosed turtle is a long-lived herbivorous freshwater turtle. It leaves water only to breed, in adjacent (typically clean and unvegetated) sand deposits. It is long-lived, with minimum age at female maturity of at least 25 years (Heaphy 1990). Nesting occurs in the mid to late dry season, in order to allow the hatchlings to emerge before wet season floods. As with marine

turtles, the sex ratio of young is dependent upon nest temperatures.

Conservation assessment

Anon (2004) provides a detailed assessment of its conservation status in Australia, and its fit to Vulnerable status under IUCN criteria. This estimates the total extent of occurrence and area of occupancy at <50 km^2; mature population at about 2900 individuals, with this likely to decline because of increasing water extraction for horticultural development (Daly system).

Threatening processes

Intensification of horticultural production in the Daly River (involving increased offtake of water, increased runoff from cleared areas, and chemical pollution) was seen as the greatest acute pressure on this species (Anon 2004). However, across its entire range, reproductive success may be reduced by predation of eggs by feral pigs; there is some hunting of adults; and weeds of riparian areas may reduce access to the bare sandy beaches required for nesting. It is possible that rapid climate change may affect the species through altered sex ratios of hatchlings and/or altered flooding regimes affecting nest site availability and reproductive success.

Conservation objectives and management

Within Kakadu NP, control of feral pigs, at least in the vicinity of important nesting sites, may be the most important management consideration. There is relatively little data on extent of take by hunting, or what sustainable levels may be (Roeger and Russell-Smith 1995). In catchments beyond Kakadu, the major threats are changes to water quality and flow regimes, due to horticultural production. Erskine *et al.* (2003) have assessed water flow requirements for management of this species, and how these requirements may be affected by varying levels and regimes of water use.

Information on abundance and/or status within Kakadu NP

Anon (2004) estimates the total adult population in the South Alligator River catchment as 980, and that in the East Alligator at 158. Relatively high densities of pig-nosed turtles are found in the upper South Alligator, notably at Pul Pul Billabong (Georges and Kennett 1989).

Information on monitoring in Kakadu NP

There is no formal monitoring program for this species in Kakadu NP, but estimates of abundance (27 turtles +/-9) and population size distribution were provided for Pul Pul Billabong in September-October 1987 by Georges and Kennett (1989).

Importance of Kakadu NP relative to total range

High. The South Alligator population is estimated to comprise 33% of the total Australian population, and that in the East Alligator 5% (Anon 2004). These populations may be critical for the conservation of the species, because they are the only ones occurring in large catchments without current or proposed horticultural development.

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YELLOW-SNOUTED GECKO
Diplodactylus occultus

Conservation status

Australia (*Environment Protection and Biodiversity Conservation Act 1999*):
Not listed

Northern Territory (*Territory Parks and Wildlife Conservation Act 2000*):
Vulnerable.

Description

A small ground gecko (snout-vent length 40mm); dark brown above with a reddish head, four large, squarish pale brown blotches along the back, and whitish spots scattered on the flanks and limbs.

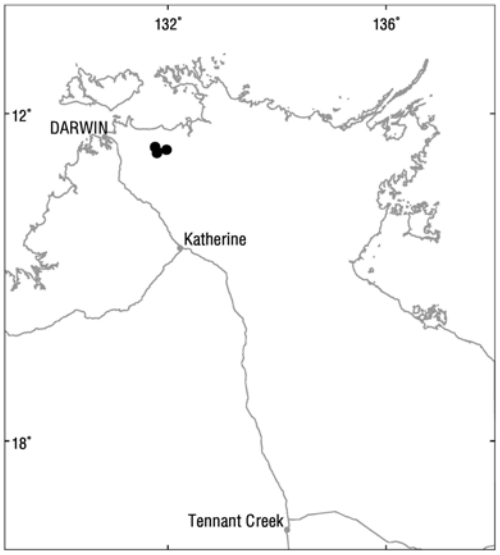
Yellow-snouted gecko *Diplodactylus occultus* (Photo: M. Armstrong)

Distribution

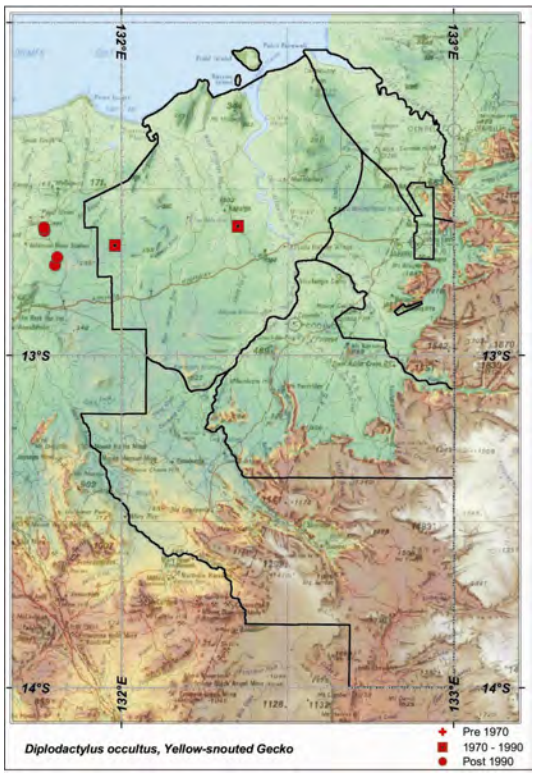
The yellow-snouted gecko is endemic to the Northern Territory and is known from only a few locations. Until the recent discovery of this species on Wildman Reserve (Armstrong *et al.* 2002), previous records were limited to only three specimens, all from the northwest of Kakadu National Park (King *et al.* 1982). One individual was also recorded recently (2003) from the military training area of Mt Bundey (L. Corbett *pers. comm.*).

Conservation reserves where reported:

Kakadu National Park, Wildman Reserve



Known locations of the yellow-snouted gecko.



Ecology

Very little is known of the ecology of this species. All individuals captured to date have occurred in conjunction with well-developed leaf litter and grasses (King *et al.* 1982; K. Beggs *unpubl.*) in open forests dominated by *Eucalyptus miniata* and *E. tetrodonta*. Records from Wildman Reserve include sites with sparse to moderate

occurrences of introduced gamba grass (*Andropogon gayanus*).

Habitat on Wildman Reserve – open *Eucalyptus miniata – E. tetrodonta* forest.

Conservation assessment

Conservation categorisation for the yellow-snouted gecko is problematic because of lack of information on its distribution and population trends at the known sites. However, it can be reasonably inferred that this species has a relatively small total population within its limited and fragmented range. Since its description, there has been only one further record from Kakadu National Park (L. Corbett *unpubl.*), eight records from four locations on Wildman Reserve (K. Beggs *unpubl.*) and one recent record from Mt Bundey. The species qualifies as **Vulnerable** (under criteria B1ab(ii,iii,iv,v)) due to:

- extent of occurrence <20,000km^2;
- known to exist at <10 locations;
- continuing decline, observed, inferred or projected;

Threatening processes

Based on meagre data, the likely threats to the yellow-snouted gecko are related to inappropriate fire regimes and spread of introduced pasture species. There have been no further records from Kakadu National Park since the capture of one individual near Kapalga in 1988, where part of its habitat was subjected to frequent, intense fire regimes. It is therefore likely that this species requires conservative fire management (small areas burnt early in the dry season, and no extensive late dry season fires). It is also likely this species will be disadvantaged by the spread of exotic pasture grasses (namely gamba grass) which form a denser understorey and promote more intense and extensive fires.

Conservation objectives and management

There is no existing management program for the yellow-snouted gecko in the Northern Territory.

Since August 2000, two individuals from Wildman Reserve have been maintained in captivity in the Territory Wildlife Park, and in March 2001, produced two hatchlings.

Research priorities are:

(i) to undertake further survey work and baseline ecological research aimed at establishing the distribution, abundance and ecological requirements of the yellow-snouted gecko; and

(ii) to identify the impact upon this species of increased cover of exotic pasture grasses, the fire regimes associated with such grasses, and the measures used to control them.

Until more is known about the ecological requirements of this species, its population size, and the threatening processes operating, management priorities cannot be described with any confidence.

Information on abundance and/or status within Kakadu NP

Despite substantial pitfall trapping surveys in the area occupied by this species, few individuals have been encountered. The only records from Kakadu are the three individuals considered in the species' description, and one subsequent individual, all from Kapalga.

Information on monitoring in Kakadu NP

There is no current monitoring of this species in Kakadu, and the few individuals captured to date are inadequate to form a reasonable baseline. In 2004, a monitoring program was established in Wildman Reserve.

Importance of Kakadu NP relative to total range

Moderate. Kakadu probably comprises about half of the range area and total population of this apparently highly localised species.

Compiled by

Kerry Beggs and Martin Armstrong [November 2001]

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ARNHEMLAND EGERNIA
Egernia obiri

Conservation status
Australia (*Environment Protection and Biodiversity Conservation Act 1999*):
Not listed.

Northern Territory (*Territory Parks and Wildlife Conservation Act 2000*):
Data Deficient.
(Likely to be listed as Vulnerable in the forthcoming revision of the list).

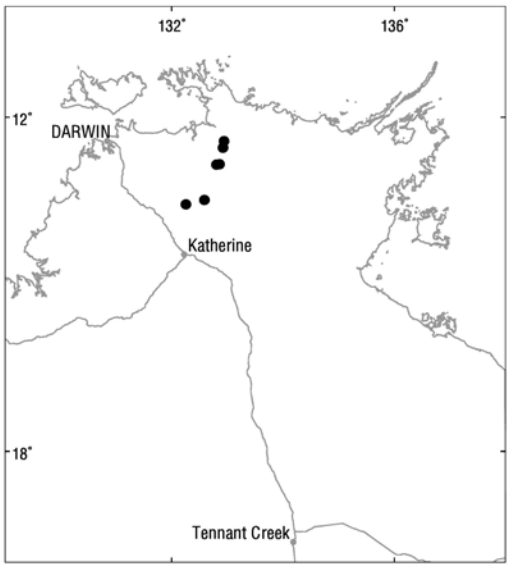
Description
Egernia obiri is a large (to at least 20cm snout-vent length) thickset ground-dwelling skink (resembling a blue-tongue lizard in shape). It is grey to light brown above, with a brown longitudinal streak. Legs are short and chunky.

Until recently, the species was more widely known as *Egernia arnhemensis* (Sadlier 1990).

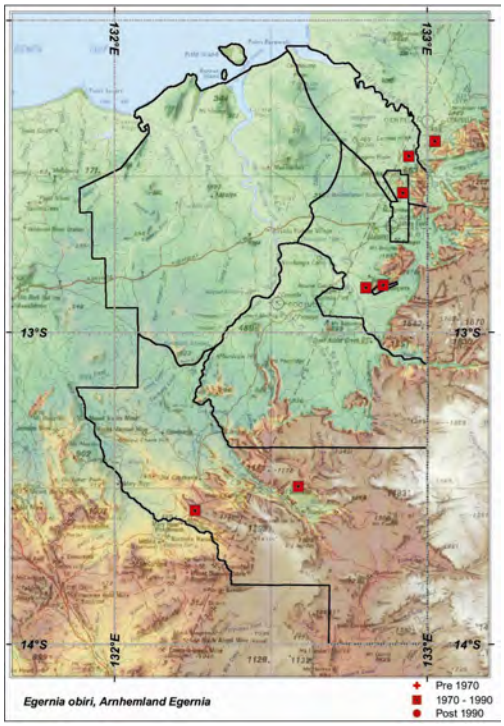
Arnhemland Egernia (Photo: Martin Armstrong)

Distribution
Restricted to the western Arnhem Land plateau and outliers (e.g. Jabiluka). Within this range, it has been recorded at relatively few locations, including Nawurlandja (Little Nourlangie Rock), Jabiluka, near Oenpelli, near El Sherana and Koolpin Gorge.

Conservation reserves where reported:
Kakadu National Park.



Known locations of the Arnhemland egernia



Ecology
This species is largely restricted to sandstone outcrops, typically with extensive fissures and cave systems. It is probably at least partly nocturnal or crepuscular (Sadlier 1990).

Conservation assessment
There is little information on its population, distribution or trends in abundance. As with other endemics of the western Arnhem

Land massif, its total range spans about 34,000 km^2. However, the limited data suggest that it is very patchily distributed, with the population comprising a set of (semi-) isolated subpopulations. The best baseline information on status is that of many individuals caught as "by-catch" in mammal surveys at Nawurlandja in the late 1970s (Begg *et al.* 1981). No Arnhemland egernias have been caught there in more recent surveys that used identical procedures (Watson and Woinarski 2003). On the basis of its presumed decline, limited extent of occupancy and probable total population of <10,000 mature individuals, the species qualifies as Vulnerable.

Threatening processes

The ecology of this species is very poorly known. It may be affected by predation by cats or changes in food resources caused by altered fire regimes.

Conservation objectives and management priorities

Current knowledge is insufficient to provide much guide to management. Research is required to more precisely delineate distribution, habitat preferences, ecology, and to identify threatening factors. This research should also provide a baseline for ongoing monitoring.

Information on abundance and/or status within Kakadu NP

There is little information on its abundance or status in Kakadu NP, or across the rest of its limited range. The most substantial data are that of the late 1970s mammal study at Little Nourlangie Rock, in Kakadu, however the data collected there on this lizard were imprecise. A current (2004) research program (by M. Armstrong and A. Dudley) aims to collate all previous records, search all of these sites that are accessible and provide an estimate of population status.

Information on monitoring in Kakadu NP

As described above, there is no firm baseline for monitoring. A current (2004) research project aims to provide such a baseline and to establish a longer-term monitoring program.

Importance of Kakadu NP relative to total range

High. As with other species endemic to the western Arnhem Land massif, Kakadu NP is important for this species, because it includes about one quarter of the range and population, and is the only area in which management for biodiversity conservation is a primary priority.

References

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OENPELLI PYTHON
Morelia oenpelliensis

Conservation status
Australia (*Environment Protection and Biodiversity Conservation Act 1999*):
Not listed.

Northern Territory (*Territory Parks and Wildlife Conservation Act 2000*):
Vulnerable.

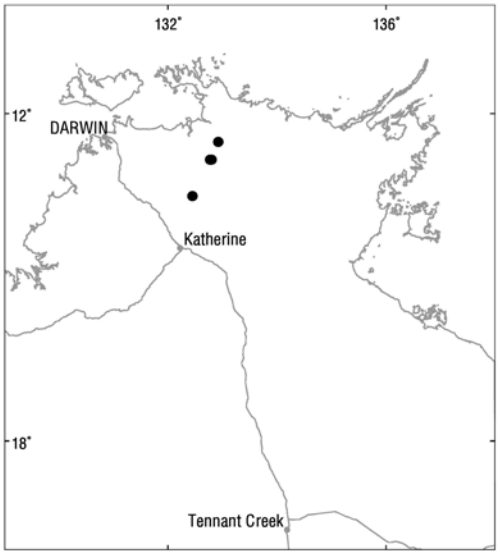
Description
A very large (to 4 m length) dark olive-brown python, patterned with darker blotches. Underside is cream to dull yellow.

Oenpelli python (Photo: Ian Morris)

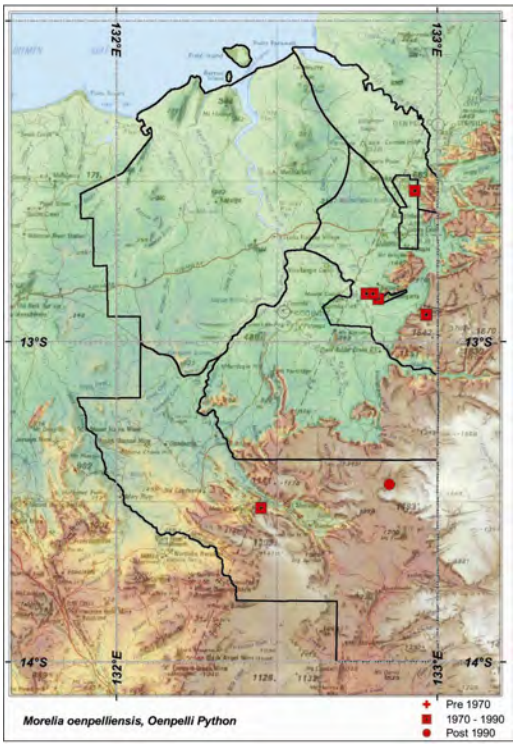
Distribution
The Oenpelli python is restricted to the sandstone massif of western Arnhem Land. Within this area, it has been reported from the upper catchments of the Cadell, South Alligator and East Alligator River systems.

Conservation reserves where reported:
Kakadu National Park.

Ecology
There have been no detailed studies of this species. It shelters in cracks, caves and crevices of rugged broken sandstone escarpments and gorges. Within this environment, it has been reported from monsoon rainforest patches, riparian areas, woodlands, open heathlands and bare rock pavements. Its diet comprises mostly large mammals, particularly possums and macropods.



Known locations of the Oenpelli python.



Conservation assessment
There has been no assessments of total population size or trends in abundance. Hence, it is difficult to provide a detailed assessment of status.

The total area of the western Arnhem Land massif is about 34,000 km². Within this area, much of the habitat is probably unsuitable (insufficiently rocky or topographically complex). As a large solitary predator feeding on prey at

relatively low abundance, its population density is probably generally low. On this basis, the total population size is probably under 10,000 mature individuals.

There is some anecdotal indication of at least local decreases, possibly associated with illegal collecting in the most accessible sites. There is also some possibility of decline associated with changing fire regimes.

Accordingly, the Oenpelli python may be classified as **Vulnerable** (under criteria C2a(i)) due to:

- population size estimated at <10,000 mature individuals;
- continuing decline, observed, projected or inferred, in numbers of mature individuals; and
- no subpopulation estimated to contain more than 1000 mature individuals,

This case is weak, in that evidence for decline is scant, circumstantial or conjectural, and there is no information available on population substructure.

Threatening processes

This species is sought by some illicit herpetological collectors. This impact is probably minor and localised, as much of the range is almost inaccessible.

More pervasively, fire regimes across its range have changed over the last 50 or so years, to now include a far higher incidence of extensive hot, late dry season fires (Russell-Smith *et al.* 1998). It is possible that this may increase direct mortality, but, more likely, the resulting vegetation change may reduce habitat suitability either directly for this species or indirectly to its prey species.

Conservation objectives and management

Research priorities are to:
(i) examine the impacts of fire regimes upon the Oenpelli python directly, or its preferred prey species; and
(ii) attempt to establish some quantitative sampling technique, to derive some estimate of relative abundance, habitat associations and total population size.

Management priorities are to:
(i) establish a monitoring program for this species, particularly with reference to its response to fire management;
(ii) continue to deter illicit reptile collectors.

Information on abundance and/or status within Kakadu NP

There have been no quantitative estimates of abundance in Kakadu NP.

Information on monitoring in Kakadu NP

Nil.

Importance of Kakadu NP relative to total range

High. Kakadu probably comprises about one quarter of the range and total population of this species, and is the only conservation reserve from which the species is known.

Compiled by

John Woinarski
[February 2002]

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EMU
Dromaius novaehollandiae

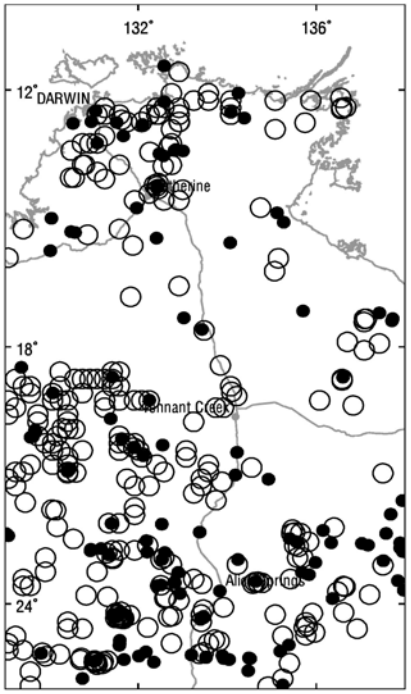
Conservation status
Australia (*Environment Protection and Biodiversity Conservation Act 1999*):
Not listed.

Northern Territory (*Territory Parks and Wildlife Conservation Act 2000*):
Vulnerable.

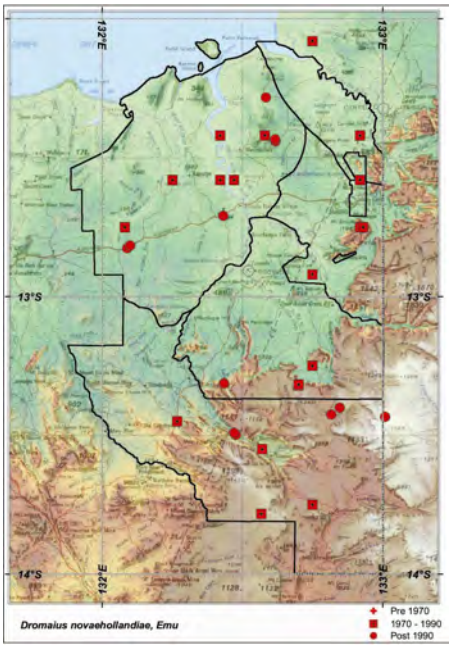
Description
The emu is an unmistakeable huge flightless bird (height 150-190 cm) with long legs and neck. The plumage is shaggy and varying colouration, from pale greyish brown or warmer brown to greyish buff with black spots or mainly blackish. The skin of the face, throat and upper neck is almost bare and conspicuously bluish. The wings are rudimentary, hanging limply below the breast. The young are striped with dark brown/black-brown over a buff down.

Emu.

Distribution
The emu is distributed throughout most of the Northern Territory but is scarce in the dry desert regions and densities are low in most of the Top End woodlands (Marchant and Higgins 1990).



Distribution records of the emu.
o = pre 1990; • = post 1990.



Conservation reserves where reported:
Alice Springs Desert Park; Chamber's Pillar Historical Reserve; Connells Lagoon Conservation Reserve; Dulcie Ranges National Park; Garig Gunak Barlu National Park; Illamurta Springs Conservation Reserve; Kakadu National Park; Litchfield National Park; Longreach Waterhole Protected Area; Mary River National Park; Nitmiluk National Park; Purta Co-

management Area; Uluru-Kata Tjuta National Park; Watarrka National Park; and West MacDonnell National Park.

Ecology
Emus can move large distances in response to changes in food or water resources. They are probably more sedentary in the north than the south of the Territory. Emus are omnivorous taking seeds, fruits, insects and the growing tips of plants. They often occur in loose flocks. The male incubates the eggs in a ground nest and broods the chicks.

Conservation assessment
Barrett *et al.* (2003) reported a significant national decline in the reporting rate for the emu between the first (1997-81) and second (1998-2001) Australian bird atlases. The Northern Territory showed an 80% decrease (the highest of all states/territories). However, it is difficult to compare the results of the two surveys as different methods were used and the second atlas covered a period with a substantially different climate to that of the first atlas. Ian Morris (*pers. comm.*) reports that Aboriginal landowners in the Kimberley and Arnhem Land believe emus are becoming rarer. We have taken a precautionary approach and listed the species as **Vulnerable** (under criteria A2b) due to an inferred reduction in population size of >30% over the last 10 years.

Threatening processes
In the Top End declining numbers could possibly be associated with the occurrence of too frequent extensive fires. Such fires lead to a reduction in food supplies, particularly in the size and abundance of plants that produce fleshy-fruit, and in the crop of fruit produced. Fires at the wrong time of year can also lead to destruction of eggs. In Central Australia declines may be also be related to altered fire regimes or to vegetation change associated with pastoralism.

There is a generally held view in the Kimberley that the disappearance of emus coincided with the heavy use of 1080 dingo poison in the pastoral industry (I. Morris *pers. comm.*). However this would not explain a decline in Arnhem Land where 1080 is not used.

Conservation objectives and management
Research priorities are to determine the causes of the decline in numbers. Management priorities cannot be determined until factors threatening the species are understood. However, a reduction in the extent and frequency of fires is likely to benefit the species.

Information on abundance and/or status within Kakadu NP
Although this is a large and culturally significant species, there is little information on the abundance and distribution of emus in Kakadu, or the Top End as a whole. The relatively small quadrat size used as standard in wildlife survey in Kakadu is generally unsuitable for sampling of such large, wary and thinly dispersed species. There has been no systematic attempt to assess population size in Kakadu. Feasibly, this could be done as part of other general aerial survey, and/or through recording of traditional knowledge.

Information on monitoring in Kakadu NP
Nil.

Importance of Kakadu NP relative to total range
Probably low: the population in Kakadu is likely to be small compared with its total range. However, compared with the rest of the sparse Top End population, Kakadu may offer some security from hunting and unfavourable fire regimes.

Compiled by
Rob Taylor
[August 2003]

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RED GOSHAWK
Erythrotriorchis radiatus

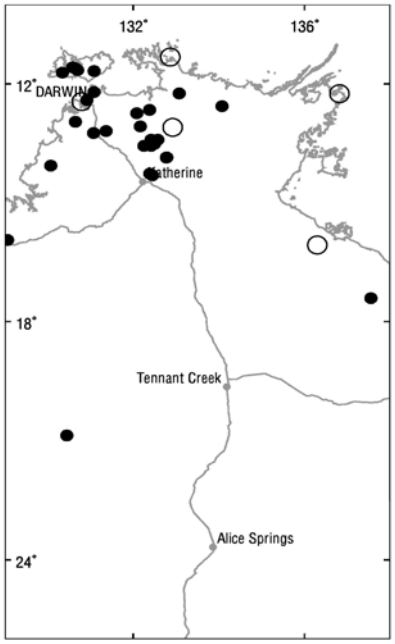
Conservation status
Australia (*Environment Protection and Biodiversity Conservation Act 1999*): Vulnerable.

Northern Territory (*Territory Parks and Wildlife Conservation Act 2000*): Vulnerable.

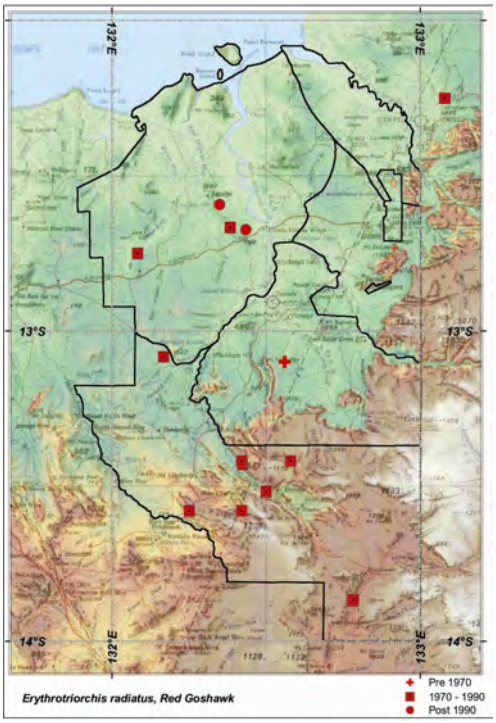
Description
A large reddish-brown goshawk, with conspicuous dark streaks from chin to belly, conspicuously barred on the underwing and tail. The head is whitish with dark streaks. The legs and feet are strong and yellowish, with prominent red feathering ("trousers"). Compared with the common Brown Goshawk, the wings are longer and more pointed and the tail is shorter.

Red goshawk.

Distribution
The red goshawk occurs across much of northern Australia, from near Broome in the south-west Kimberley to south-eastern Queensland. Within this range it generally occurs in taller forests characteristic of higher rainfall areas, but there are some isolated recent records from central Australia. It appears to be unusually common on the Tiwi Islands (Bathurst and Melville).



Known locations of the red goshawk.
o = pre 1970; • = post 1970.



Conservation reserves where reported:
Kakadu, Litchfield, Nitmiluk and Garig Gunak Barlu National Parks

Ecology

The red goshawk hunts mainly for medium-sized birds (up to the size of kookaburras and black cockatoos). Territory size is typically very large (up to 200 km^2) (Debus and Czechura 1988; Czechura and Hobson 2000). The preferred habitat is tall open eucalypt forest and riparian areas (including paperbark forest and gallery forests). The conspicuous basket-shaped stick nest is typically placed in large trees near watercourses (Aumann and Baker-Gabb 1991).

Conservation assessment

Based on a series of surveys across northern Australia (Debus and Czechura 1988; Aumann and Baker-Gabb 1991; Czechura and Hobson 2000), there is now reasonably reliable information available on distribution and total population. Garnett and Crowley (2000) collated these surveys to estimate the population size as 1000 breeding birds, and considered it to be vulnerable at the national level, on the IUCN 1994 criterion of D1 (<1000 mature individuals).

Based on the proportion of the known distribution, the Northern Territory population probably accounts for about one-third of the total population (that is, about 330 mature individuals). Of this tally, about 120 live on Melville Island (Woinarski *et al.* 2000). Proposed forestry operations are likely to reduce this Melville Island population by about 10%. Given these figures, the red goshawk qualifies as **Endangered** in the Northern Territory (under criteria C2a(i)) due to:

- population size estimated to number <2500 mature individuals;
- a continuing decline (observed, projected or inferred); and
- population structure with no subpopulation containing more than 250 mature individuals.

Threatening processes

Nationally, the red goshawk has been threatened chiefly by clearance of preferred habitat for agriculture, with some localised problems related to illegal egg-collection, shooting, and fire (Garnett and Crowley 2000). In the Northern Territory, the most immediate threat is clearing of prime habitat on Melville Island for short rotation plantations of exotic pulpwood.

Conservation objectives and management

The management priorities are:
(i) to minimise the impact of the proposed Melville Island forestry development, through retention of adequate habitat especially around known nest sites, and
(ii) the establishment of an appropriate monitoring program.

Information on abundance and/or status within Kakadu NP

Roeger and Russell-Smith (1995) noted that there were three known breeding pairs in Kakadu, in paperbark forest fringing the South Alligator upstream from El Sherana, and Naramu at Kapalga.

Information on monitoring in Kakadu NP

Studies reported in Aumann and Baker-Gabb (1991) provide a baseline of known nesting sites in Kakadu; that could be used as the basis for ongoing monitoring.

Importance of Kakadu NP relative to total range

Low-medium. Red goshawks have a wide distribution across northern Australia, albeit typically at low densities. Kakadu comprises only a small proportion of this range and total population.

Compiled by

John Woinarski
[May 2002]

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AUSTRALIAN BUSTARD
Ardeotis australis

Conservation status

Australia (*Environment Protection and Biodiversity Conservation Act 1999*):
Not listed

Northern Territory (*Territory Parks and Wildlife Conservation Act 2000*):
Vulnerable

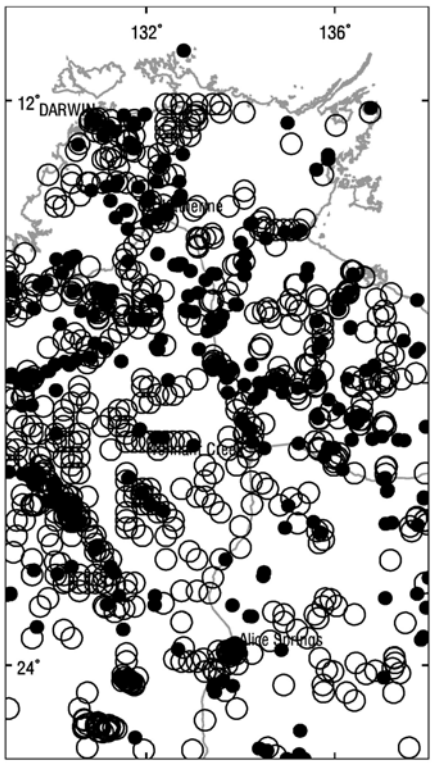
Description

The Australian Bustard is a large, stately bird that exhibits significant sexual size dimorphism between males and females, with males (5-10 kg) up to three times heavier than females (2-3 kg). The crown is brown-black, and the neck and breast grey-white with a distinct black breast band. The bend of wing is patterned black and white. Back, wings and tail are brown with fine buff markings. Females have a narrower brown crown, less distinct or absent breast band and greyer neck and breast.

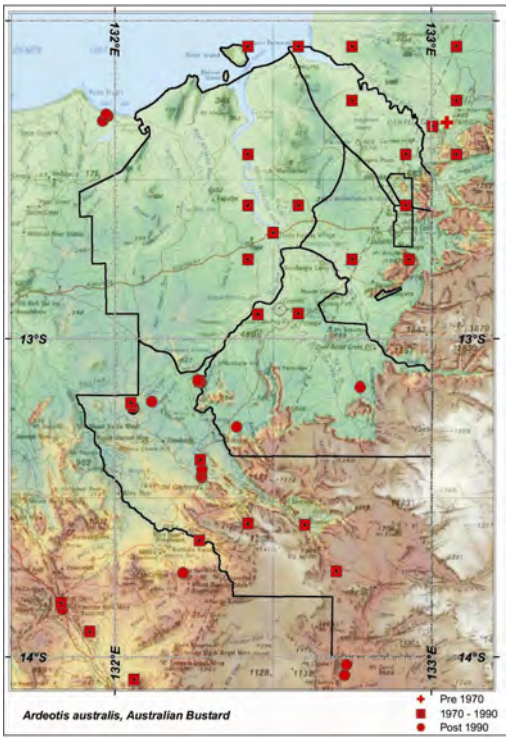
Male Australian Bustard (Photo: Mark Ziembicki)

Distribution

The Australian Bustard is widespread though generally relatively scarce in the Northern Territory. It is more locally common away from settled parts when prevailing conditions are favourable. Its strongholds in the Northern Territory include the Barkly Tableland, Daly River region, the Victoria River District and the Tanami Desert.



Known locations of the Australian Bustard in the Northern Territory.
O = pre 1990; • = post 1990



Conservation reserves where reported:
It has been recorded from numerous reserves including Alice Springs Telegraph

Station Historical Reserve, Black Jungle / Lambells Lagoon Conservation Reserve, Bullwaddy Conservation Reserve, Caranbirini Conservation Reserve, Connells Lagoon Conservation Reserve, Cutta Cutta Caves Nature Park, Davenport Range National Park (Proposed), Douglas River / Daly River Esplanade Conservation Area, Elsey National Park, Flora River Nature Park, Gregory National Park, Ilparpa Swamp Wildlife Protected Area, Junction Reserve, Kakadu National Park, Keep River National Park, Kuyunba Conservation Reserve, Litchfield National Park, Longreach Waterhole Protected Area, Mary River National Park (Proposed), Nitmiluk (Katherine Gorge) National Park, Purta Co-management Area, Rainbow Valley Conservation Reserve, Uluru-Kata Tjuta National Park, Watarrka National Park, West MacDonnell National Park.

Although the species has been recorded from a range of reserves its highly mobile nature means that very few reserves host permanent, let alone viable, populations of bustards year round and many records are of single individuals. They have most commonly been recorded from Uluru-Kata Tjuta National Park, Watarrka National Park, Kakadu National Park and Gregory National Park.

Ecology

The Australian Bustard is a bird of open country preferring grasslands, low shrublands, grassy woodlands and other structurally similar but artificial habitats such as croplands, golf courses and airfields (Downes and Speedie 1982). However, they respond readily to fire and are often found on recently burnt country, even in more wooded areas.

Bustards have a broad, omnivorous diet largely comprising seeds, fruit, vegetation, invertebrates and small vertebrates. They apparently move readily, tracking rainfall, fires and food resources (e.g. grasshopper outbreaks) across the landscape opportunistically. Their movements are not well defined. However, they are believed to be nomadic or irruptive in the arid and semi-arid regions and migratory with more regular north-south movements in relation to wet/dry seasons in the north. Some populations in the Top End may also be sedentary.

The species' reproductive biology is unique in that it exhibits an "exploded" lek mating system. In lek systems males aggregate in display arenas that are visited by females for the purpose of mating. The lek system of the bustard is referred to as "exploded" as the display arenas of the males are well spaced apart and aggregation may not be detectable until they are mapped over a larger area. Following mating males play no further role in the breeding process and females care for young until independence.

Conservation assessment

Although still widespread in the Northern Territory the species is relatively scarce. Localised fluctuations in numbers occur in response to rainfall and fire events and they are locally common and possibly sedentary in several horticultural regions (e.g. Douglas-Daly Rivers region). Populations in the north are generally more robust than those in the south.

Outside the Northern Territory the species' overall population size is still substantial. However, there has been a very large historical decline in abundance in southern Australia and parts of the north such that Garnett and Crowley (2000) categorised the Australian Bustard as Near Threatened in the *Action Plan for Australian Birds 2000*.

The widespread declines in the Northern Territory are evident from Bird Atlas reporting rates for bustards that have dropped by 70% between the first and second atlases (highest for any state/territory) (Barrett *et al.* 2003). These declines have been largest in the southern regions. These trends are consistent with anecdotal evidence from mail surveys of pastoral properties and private submissions that suggest that bustards are now completely absent from some areas where they were previously commonly recorded. Although populations in the north are more robust, similar declining trends are evident with consistent reports of lower overall

numbers (e.g. flocks of 50+ in the past to present flocks of <20 at a time).

Assessing numbers of highly mobile birds such as bustards is inherently difficult because of their readiness to move across the landscape in response to variable climatic conditions and patchily distributed resources and naturally large population fluctuations. However, given the evidence consistently suggests an overall decline, a precautionary approach has been adopted. In the Northern Territory, the species qualifies as Vulnerable (under criteria A2b) based on an estimated population reduction of >30% over the last 10 years.

In addition to conservation significance, this species is of cultural significance and an important item of bush tucker in many areas of teh Northern Territory.

Threatening processes

The widespread decline in bustard numbers has been variously attributed to a combination of factors including predation, altered fire regimes, hunting, disturbance, habitat alteration (e.g. woody weed infestation), pesticides and grazing (Marchant and Higgins 1993; Garnett and Crowley 2000), yet there exists little information regarding the relative effects of these threats.

Another potential threatening process is traditional hunting. Breakdown of controls on traditional hunting compounded by access to modern weapons and vehicles may potentially be one of the most serious threats to bustards in the N.T., possibly explaining the patchy declines in numbers in northern Australia. The conspicuousness and size of males during the breeding period may make them particularly susceptible to hunting resulting in significant male-biased harvesting rates. Such a bias may have serious implications for the specialized lek mating system of the species.

Conservation objectives and management

Research priorities are to:

(i) determine population size, distribution and habitat relationships (especially in relation to fire, land use and grazing).
(ii) assess patterns of movements
(iii) establish an effective. monitoring program and model numbers in relation to landscape factors including rainfall and fire.
(iv) identify key areas used for breeding and refuge sites in times of drought.
(v) assess factors affecting breeding success.
(vi) quantify the relative impact of hunting of the species, including assessment of the implications of significant male-biased harvesting.

Management priorities are to:

(i) develop fire management programs, with the collaboration of Aboriginal land owners, that are not detrimental to this taxon.
(ii) develop harvesting protocols to minimize impacts.
(iii) control feral predators in key breeding habitats.

Information on abundance and/or status within Kakadu NP

There is little information on the abundance and distribution of bustards in Kakadu, or the Top End as a whole. The relatively small quadrat size used as standard in wildlife survey in Kakadu is generally unsuitable for sampling of such large, wary and thinly dispersed species. There has been no systematic attempt to assess population size in Kakadu. Feasibly, this could be done as part of other general aerial survey, and/or through recording of traditional knowledge. As bustards are highly mobile, populations in Kakadu probably vary substantially between seasons and years.

Information on monitoring in Kakadu NP

Nil.

Importance of Kakadu NP relative to total range

Probably low: the population in Kakadu is likely to be small compared with its total range. However, compared with the rest of the sparse Top End population, Kakadu may offer some security from hunting and unfavourable fire regimes.

Compiled by

Mark Ziembicki
[August 2003]

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PARTRIDGE PIGEON (eastern subspecies) *Geophaps smithii smithii*

Conservation status

Australia (*Environment Protection and Biodiversity Conservation Act 1999*): Vulnerable.

Northern Territory (*Territory Parks and Wildlife Conservation Act 2000*): Lower Risk (near threatened).

Description

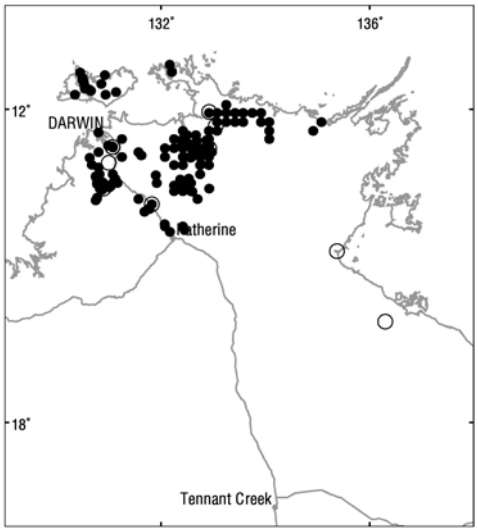
The partridge pigeon is an unmistakable ground-dwelling pigeon. It is medium-sized (slightly smaller than the feral pigeon *Columbia livia*: weights about 220g cf. 300g respectively), grey-brown bird with conspicuous white leading edge to the wing and red bare skin on the face. It forages entirely on the ground, and, except when flushed in alarm, rarely flies. The subspecies occurring in the Northern Territory *G. smithii smithii* differs from the other subspecies *G. s. blauwii* (of the Kimberley) in colour of the bare skin around the face.

Partridge pigeon.

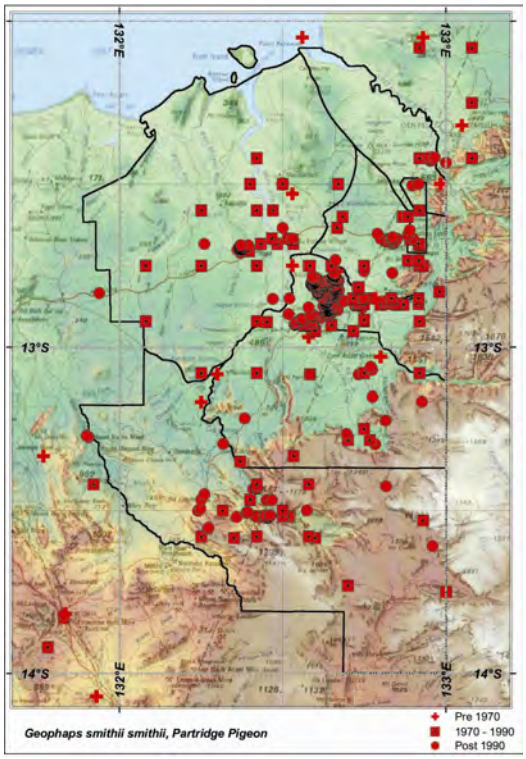
Distribution

The partridge pigeon occurs across the Top End of the Northern Territory and Kimberley. However it has declined or disappeared from much of the lower rainfall parts of this range over the last century.

Conservation reserves where reported: Kakadu, Litchfield, Nitmiluk and Garig Gunak Barlu National Parks.



Known locations of the partridge pigeon. o = pre 1970; • = post 1970.



Ecology

The diet of the partridge pigeon comprises seeds, mostly of grasses but also from *Acacia* and other woody plants (Higgins and Davies 1996). It is largely sedentary, although may make local-scale movements (up to 5-10km) in response to seasonal variations in water and food availability (Fraser 2001). It typically occurs singly or in small family

groups, but larger aggregations may occur, especially in the late dry season, around water sources. It nests on the ground, mostly in the early dry season (Fraser 2001), with "nest" location preferentially in sites with relatively dense grass cover. Such sites contrast to the relatively open (typically burnt) areas preferred for feeding, and suggest that the species may be much affected by fire regimes. Small, patchy fires have been recommended for the management of this species (Fraser 2001).

Partridge pigeons occur principally in lowland eucalypt open forests and woodlands, with grassy understoreys; but also occur in some other vegetation types including paperbark woodlands and around plantation edges.

Conservation assessment

The partridge pigeon has declined substantially in the Northern Territory, and probably also in the Kimberley (Johnstone 1981; Garnett and Crowley 2000; Fraser 2001; Woinarski 2004), although is still abundant in some locations (e.g. parts of Kakadu NP, Litchfield NP and Tiwi Islands: Woinarski *et al*. 2000). The timing and currency of this decline is poorly resolved, but may have occurred gradually over the last century (Franklin 1999). Neither the extent nor the recency of this decline quite meets the IUCN criteria for vulnerable status. However, it is likely that declines will continue and possibly escalate, given the recent rapid spread of exotic grasses and their consequential impact of increasing the intensity, extent and severity of fires.

Threatening processes

Partridge pigeons face a number of threats, whose relative impacts have not been well established. As they forage, nest and roost on the ground, partridge pigeons are highly susceptible to predation by feral cats. Partridge pigeons are also dependent upon daily access to water for drinking, so are likely to do poorly in relatively dry years, and will be affected by any manipulation of water sources.

But probably the most importantly threats are the inter-related changes in grass composition and fire regimes. Across much of the Top End (and including parts of the Tiwi Islands), exotic grasses (including mission grass *Pennisetum polystachion*, gamba grass *Andropogon gayanus* and/or other African and South American grasses) have spread rapidly over recent decades (e.g. Kean and Price 2003), and, where now present, have greatly reduced the diversity of native grasses. This will change the diversity, timing and abundance of seeds available as food to the partridge pigeon. Fire regimes have also changed appreciably over the Top End (and Tiwi islands) over the last century, and continue to change. Traditional Aboriginal fire regimes were probably far more patchy and fine-scale than the regimes now prevailing. The partridge pigeon was probably greatly advantaged by a regime of frequent, patchy but localised fire, and is probably disadvantaged by the current regime of fewer but more extensive fires (Fraser *et al*. 2003). That current regime is now being made even more disadvantageous by the high fuel loads associated with exotic grasses, that make for hotter and more extensive fire.

Partridge pigeons may also be affected by the change in vegetation composition and structure caused by livestock and feral animals, although the direction and magnitude of this impact is uncertain. In some cases, grazing by stock may create the more open and patchy ground layer preferred by partridge pigeons (Fraser 2001).

Partridge pigeons occur principally in tall eucalypt open forest, and their population will be reduced wherever these areas are cleared. This habitat is that currently most subjected to conversion for horticulture or forest plantation.

Conservation objectives and management

The major conservation management objective is to maintain extensive areas of eucalypt open forest with intact native grass species composition, and exposed to a fine-scale relatively frequent fire regime.

Information on abundance and/or status within Kakadu NP

The partridge pigeon is widespread and at least patchily common in the lowlands of Kakadu. There has been no broad-scale assessment of its total population, but indices of relative abundance can be drawn from the wildlife surveys of Stages I and II (Braithwaite 1985) and Stage III (Woinarski and Braithwaite 1991), and recent surveys of fire monitoring plots (Watson and Woinarski 2004). Unlike much of the rest of its range (Woinarski 2004), there is no evidence of decline in Kakadu.

Information on monitoring in Kakadu NP

The set of all fire plots provides some baseline for ongoing monitoring of this species. As at July 2004, 114 fire plots had been sampled for fauna, and partridge pigeons have been recorded in 11 of those plots (Watson and Woinarski 2004). The Kakadu Stages I and II survey sites (Braithwaite 1985) also provide some baseline for broad-scale monitoring.

Fraser *et al.* (2003) provided a protocol and initial results for monitoring the response of partridge pigeons to mosaic fire management.

Importance of Kakadu NP relative to total range

Moderate; the partridge pigeon remains widespread across the Top End of the Northern Territory, including the Tiwi Islands, but it has declined across much of this range. Kakadu may represent a major stronghold, probably because of the relative lack of grazing by livestock and because of the imposition of fine-scale landscape burning.

Compiled by

John Woinarski
(May 2003)

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MASKED OWL (north Australian mainland subspecies) *Tyto novaehollandiae kimberli*

Conservation status

Australia (*Environment Protection and Biodiversity Conservation Act 1999*): Vulnerable.

Northern Territory (*Territory Parks and Wildlife Conservation Act 2000*): Near Threatened.

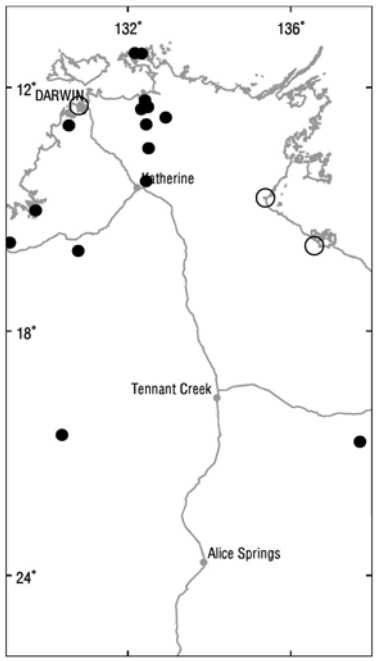
Description

The masked owl is a large dark owl, most likely to be confused with the barn owl *Tyto alba*, which is noticeably smaller and paler, with far weaker legs and feet and with far less feathering on the legs. It is most likely to be detected from its loud call, which comprises a highly varied set of shrieks and complex whistles.

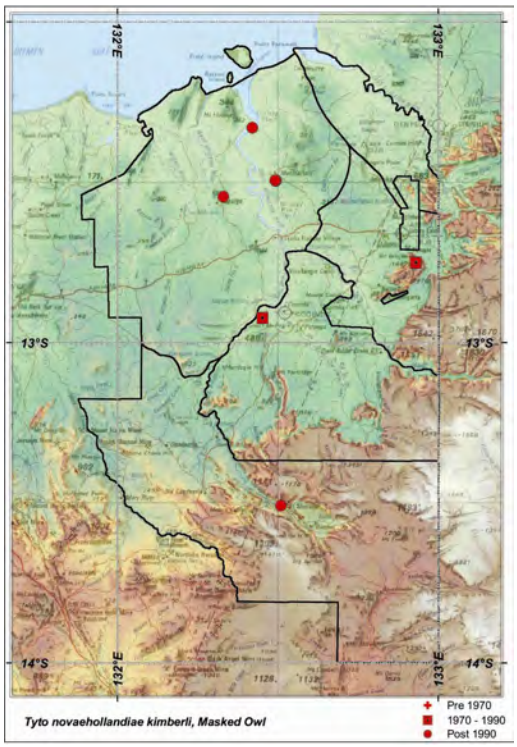
The subspecies occurring on the north Australian mainland is only weakly differentiated from the subspecies *T. n. melvillensis* occurring on the Tiwi Islands. Both are appreciably smaller than the two other subspecies from south-eastern and south-western Australia.

Distribution

The distribution of the mainland north Australian masked owl subspecies *T.n.kimberli* is very imperfectly known, with remarkably few records across its broad range. Based on compilation of records from 1998-2002, the New Atlas of Australian Birds (Barrett *et al.* 2003) reported it from only one 1/4 ° grid cell (from a total of about 130) in northern Western Australia, two (of a total of about 320) in the Top End of the Northern Territory, one on the Barkly Tableland, and five in northern Queensland. The circumscription of this distribution is confused by (i) a number of dubious or at least unconfirmed records away from its main range (Higgins 1999), such as on the south-west of Cape York Peninsula and in semi-arid Northern Territory; and (ii) whether or not the northeast Cape York Peninsula population is recognised as subspecifically distinct.



Known locations of the masked owl
o = pre 1970; ● = post 1970.



Recognising the shortcomings in survey information, the current range can be considered to include the north and north-west coastal Kimberley; the Top End of the Northern Territory, including Cobourg Peninsula, extending south to around Katherine (Storr 1977), with a handful of isolated records from further south, including Jasper Gorge (the Victoria River District), McArthur River station, and Avon Downs (Barkly Tablelands) (Storr 1977; Higgins 1999; Barrett *et al.* 2003); north-eastern Queensland, including a few early records from north-eastern Cape York Peninsula (Archer-Watson Rivers) (the putative subspecies *T.n. galei*), with a broader distribution centred on Townsville.

Conservation reserves where reported:
In the Northern Territory, the masked owl is known from Kakadu, Gregory and Garig Gunak Barlu NP.

Ecology

The masked owl occurs mainly in eucalypt tall open forests (especially those dominated by Darwin woollybutt *Eucalyptus miniata* and Darwin stringybark *E. tetrodonta*), but also roosts in monsoon rainforests, and forages in more open vegetation types, including grasslands. Although it may roost in dense foliage, it more typically roosts, and nests, in tree hollows (Debus 1993). Mammals, up to the size of possums, constitute the bulk of its diet (Higgins 1999).

Although there is no detailed information for this subspecies, masked owls of other subspecies occupy large home ranges, estimated at 1-10 km² (Debus 1993; Kavanagh and Murray 1996).

Conservation assessment

Too little information is known about the distribution, population size and trends in population to ascribe conservation status with any confidence.

Threatening processes

There is no reliable information on what factors may affect the status of this subspecies. It is possible that food resources may be diminishing, through broad-scale decline of small and medium-sized native mammals, a decline itself possibly due to changed fire regimes (Woinarski *et al.* 2001; Pardon *et al.* 2003). The greatly increased cover and height of invasive exotic grasses (Rossiter *et al.* 2003) possibly cause a reduction in foraging efficiency for this owl.

The current regime of more intense, frequent and extensive fires may reduce the availability of large trees and hollows (Williams *et* al. 2003) required for nesting. Conversely, more extensive and less patchy fires may lead to greater foraging efficiency (Oakwood 2000).

Conservation objectives and management

A draft management plan has recently been compiled for the north Australian masked owl (Woinarski 2004). The main research priority is to:
(i) derive more precise information on population size, home range, habitat requirements, and response to putative threatening processes. Recent studies on the Tiwi Islands have demonstrated that playback of calls is likely to significantly increase probability of detection of this species (Woinarski *et al.* 2003).

Information on abundance and/or status within Kakadu NP

There is very little general information, and no quantitative data, on the status of masked owls in Kakadu.

Information on monitoring in Kakadu NP

Nil.

Importance of Kakadu NP relative to total range

Uncertain. The status of masked owls across their north Australian range generally remains very poorly known (Woinarski 2004).

Compiled by
John Woinarski
[June 2004]

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WHITE-THROATED GRASS-WREN *Amytornis woodwardi*

Conservation status

Australia (*Environment Protection and Biodiversity Conservation Act 1999*):
Not listed.

Northern Territory (*Territory Parks and Wildlife Conservation Act 2000*):
Vulnerable.

White-throated grass-wren (Photo: Ian Morris)

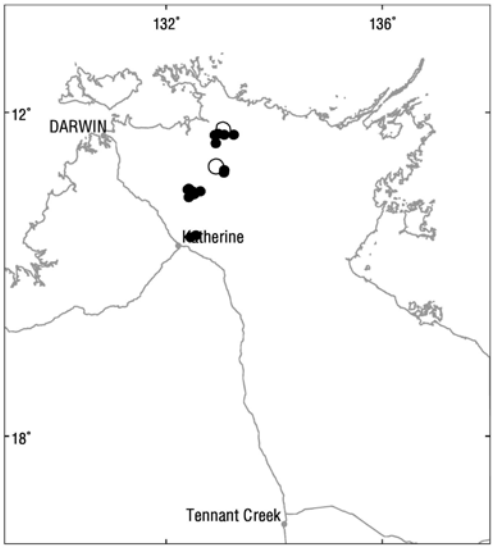
Description

The white-throated grass-wren is a small shy ground-dwelling bird. It is secretive, and most observers get little more than a blurred impression of a mouse-like movement between clumps of spinifex, or darting rapidly behind rocks. This species is noticeably larger than the common red-backed fairy-wren. Its distinctive features include a long tail typically held upright or half-upright when stationary, but lowered when moving; a conspicuous white throat contrasting sharply with the head and upper parts that are black with white streaks, and a dark chestnut brown belly, rump and tail. Its presence is often revealed first by its distinctive call, a mixture of complex trills and chirps, and an alarm call characterised as a sharp "tzzzt".

Distribution

The white-throated grass-wren is restricted to the rugged sandstone massif of western Arnhem Land, extending south-west as far as Nitmiluk National Park and northeast as far as the Mann River (Noske 1992a).

Within this range of about 14,000 km², it is patchily distributed.



Known locations of the white-throated grass-wren.
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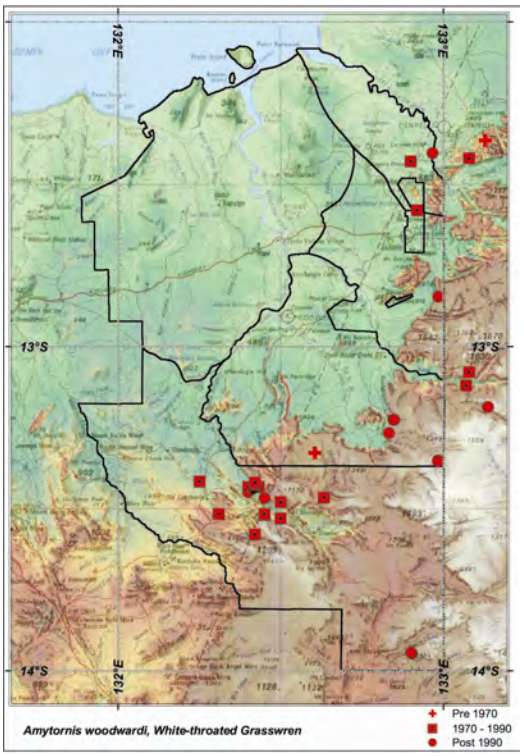

Conservation reserves where reported

It occurs in two conservation reserves, Nitmiluk and Kakadu National Parks.

Ecology

The white-throated grass-wren is confined to hummock grasslands ("spinifex"), sometimes with open shrubland or woodland overstorey, mixed among boulder fields and sandstone pavements (Schodde 1982; Noske 1992a). The diet comprises invertebrates, seeds and other vegetable matter (Noske 1992a). Like other grass-wrens and fairy-wrens, it often occurs in small family groups (typically of 3-6 birds), but also occurs singly or in pairs (Noske 1992a). Breeding occurs from December to June, and territory size is around 10 ha (Noske 1992a).

Conservation assessment

There has been some dispute about the status of this species. Based largely on an estimate of the area of potentially suitable habitat, and population density estimates at eight sites, Noske (1992a) estimated the total population at about 50,000 individuals (with a range of between 14,000 and 182,000), and considered that it was not threatened, although with the caveat that "it may be rash to assume that (it) is totally secure despite its apparent abundance". Woinarski (1992) re-analysed these and additional data, and estimated that the total population size was about 5,000 to 10,000 individuals, and that the species was threatened by broad-scale habitat change associated with altered fire regimes. In response, Noske (1992b) provided a revised estimate of "in excess of 10,000" individuals. The most recent assessment is that of Garnett and Crowley (2000), who considered that the total population was 8,000 breeding birds, albeit with a low reliability for this estimate.

It can be regarded as **Vulnerable** (under criteria B1ab(ii,iii)+2ab(ii,iii); C2a(i)) due to:

- extent of occurrence <20,000 km^2;
- area of occupancy <2000 km^2;
- severely fragmented;
- continuing decline, observed, inferred or projected;
- population size <10,000 mature individuals, and
- no subpopulation estimate to contain more than 1000 mature individuals.

In all cases, the decline is presumed based on broad-scale change in habitat quality associated with altered fire regimes (Russell-Smith *et al.* 2002). The subpopulation structure of the species is not well known, and the fragmentation or continuity of populations across the Arnhem Land plateau is uncertain.

It was listed as *Vulnerable* in the recent *Action Plan for Australian Birds 2000* (Garnett and Crowley 2000).

Threatening processes

Fire regimes in the sandstone environments of western Arnhem Land have changed dramatically over the last 10-50 years, as traditional Aboriginal management has been disrupted or broken down. There is now a markedly increased incidence of extensive late dry season fires, leading to substantial vegetation change. The extent to which this change reduces habitat suitability for grass-wrens is uncertain, but the meagre evidence suggests that a high frequency of fires is deleterious (Woinarski 1992).

Conservation objectives and management

The principal research objectives are to:
(i) investigate the relationship between grass-wrens, habitat suitability and fire regimes; and
(ii) improve the assessment of total population numbers, distribution and meta-population structure.

Subsequent to results from (i), the main management objective is to implement a fire management program that maintains or enhances habitat quality across the range of this species.

Information on abundance and/or status within Kakadu NP

The species is patchily distributed in Kakadu (and throughout its range across the western Arnhem Land plateau). This patchiness makes it hard to estimate its total population. The Kakadu population is probably somewhere between 3000 and 20,000 birds (Noske 1992a, 1992b; Woinarski 1992; Garnett and Crowley 2000).

Information on monitoring in Kakadu NP

There is no current monitoring program for this species. Noske (1992a) provides population estimates for some sites, and these may serve as a baseline for ongoing monitoring.

White-throated grass-wrens have been recorded too infrequently in the general quantitative wildlife surveys of Kakadu (Braithwaite 1985; Woinarski and Braithwaite 1991) to use such sources alone as a basis for reliable monitoring. However, as at July 2004, they had been recorded from 3 of the 114 fire plots that had been sampled for fauna (Watson and Woinarski 2004); and this set could contribute to a broader monitoring program.

Importance of Kakadu NP relative to total range

High: Kakadu includes about one quarter of the known range of this species, and is the only area in which it occurs that is managed with a priority for biodiversity conservation. Relatively accessible populations of this species (notably at Gunlom) regularly attract many bird-watchers to Kakadu.

Compiled by

John Woinarski
[May 2002]

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YELLOW CHAT
(Alligator Rivers subspecies)
Epthianura crocea tunneyi

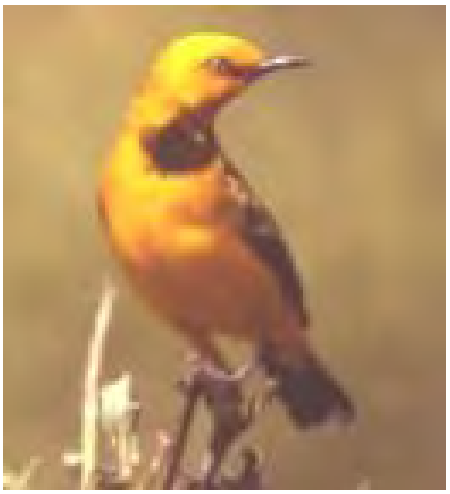
Conservation status

Australia (*Environment Protection and Biodiversity Conservation Act 1999*):
Not listed.

Northern Territory (*Territory Parks and Wildlife Conservation Act 2000*):
Endangered.

Description

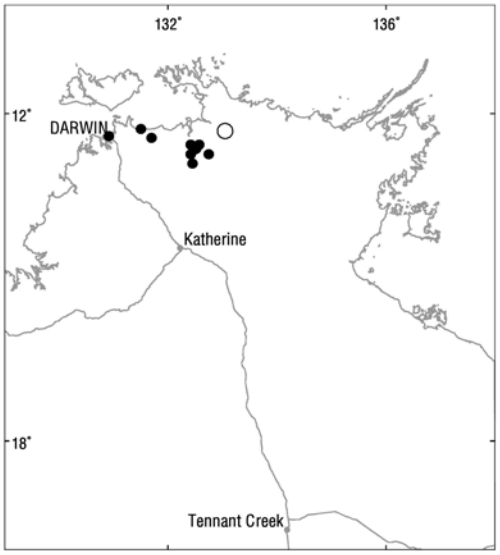
The yellow chat is a small bird that typically forages on the ground, in dense grass or in low shrubs. The male is a bright golden-yellow, with a prominent black chest band. The female is pale lemon yellow, and has no chest band.



Yellow chat (Photo: M. Armstrong)

Distribution

Yellow chats occur patchily across northern Australia, most typically in chenopod shrublands and grasslands around water sources in semi-arid areas. However, the subspecies *Epthianura crocea tunneyi* is restricted to a small geographic area encompassing the floodplains from the Mary River to the East Alligator River (Schodde and Mason 1999), and within this area it is known from only about 12 sites.



Known locations of the yellow chat.
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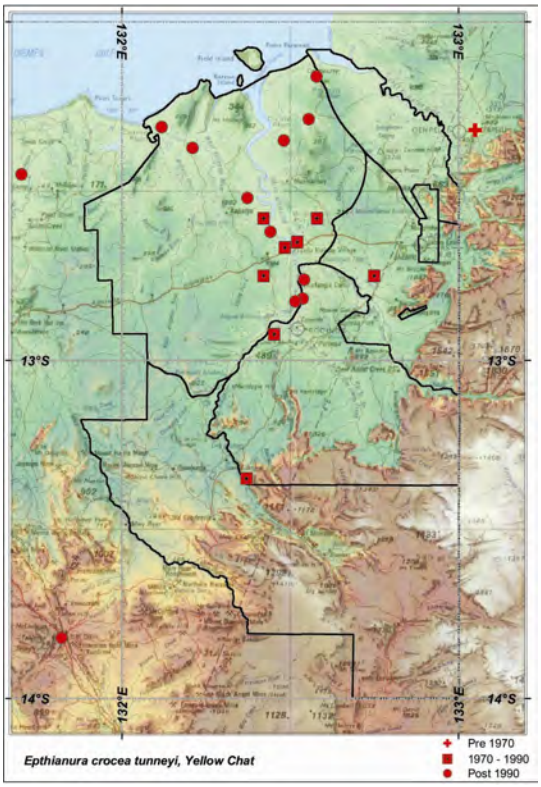

Conservation reserves where reported:

Kakadu National Park and the Mary River National Park.

Ecology

In the floodplain area, yellow chats occur in tall grasslands and samphire shrublands (on coastal saltpans). The diet is mostly invertebrates (Higgins *et* al. 2001). Yellow

chats typically occur in small groups of 2-10 individuals.

Conservation assessment

For this endemic Northern Territory subspecies, Garnett and Crowley (2000) estimated the extent of occurrence as 500 km², area of occupancy at 100 km², and the total number of breeding birds as 500. However, these estimates are of relatively low reliability. The subpopulation structure is unknown: Garnett and Crowley (2000) considered there was only one subpopulation, but it may be that there are small resident subpopulations in the floodplain system associated with each river system in the Mary to East Alligator area. It is probable that its status is being affected by expansion of exotic weeds in the floodplain habitats (notably by *Mimosa pigra*, para grass *Brachiaria mutica* and gamba grass *Andropogon gayanus*), and possibly by habitat change caused by grazing of cattle and buffalo and by altered fire regimes.

Based on these estimates, the floodplains subspecies of yellow chat qualifies as **Endangered** (under criteria C2a(i) or (ii)) due to:

- population size estimated at fewer than 2500 mature individuals;
- a continuing decline (observed, projected or inferred) in numbers of mature individuals and
- population structure either with no subpopulation containing more than 250 mature individuals or at least 95% of mature individuals in one subpopulation.

It was listed as *Endangered* in the recent *Action Plan for Australian Birds 2000* (Garnett and Crowley 2000).

Threatening processes

The preferred floodplain habitats are being altered by expansion of exotic plant species and vegetation change due to grazing by buffalo and cattle and by altered fire regimes. Saltwater intrusion and sea-level rise may further consume preferred habitat. Notwithstanding this array of threatening processes, there may have been some improvement in habitat suitability over the last 20-50 years as a consequence of drastic reduction in the number of buffalo (and their resulting environmental degradation) on the floodplains between the Adelaide and East Alligator Rivers (Letts *et al.* 1979).

Conservation objectives and management

The principal research prioritiy is to provide more informed estimates of population size, distribution, patterns of movement, habitat preference and response to the putative threatening processes.

The management priority is to maintain extensive areas of suitable habitat, most likely through control of exotic plants and feral animals.

Information on abundance and/or status within Kakadu NP

There is no robust measure of total population in Kakadu, nor on trends in abundance. Yellow chats appear to be very patchily distributed, and may disperse seasonally over at least tens of kilometres, with both of these factors rendering population estimate difficult. If the total population of this taxon is indeed fewer than 2500 individuals, the Kakadu population is probably about 1000 birds.

Information on monitoring in Kakadu NP

Nil; however a targeted study of this species to occur in late 2004 will aim to establish a baseline for ongoing monitoring.

Importance of Kakadu NP relative to total range

High: Kakadu probably comprises about a half of the total range (floodplain habitat) of this species, and may represent the area in which habitat suitability is most likely to be maintained or enhanced by management intervention.

Compiled by

John Woinarski
[May 2002]

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NORTHERN (CRESTED) SHRIKE-TIT *Falcunculus (frontatus) whitei*

Conservation status

Australia (*Environment Protection and Biodiversity Conservation Act 1999*): Vulnerable.

Northern Territory (*Territory Parks and Wildlife Conservation Act 2000*): Data Deficient.

Description

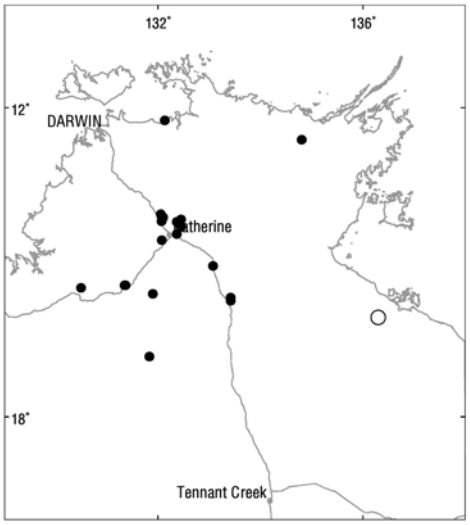
The northern shrike-tit is a distinctive medium-sized bird. It has a dull green back and wings, yellow belly and boldly marked black and white head, with a small black crest. Its bill is unusually deep, strong and hooked.

Northern shrike-tit (Photo: Don Franklin).

Distribution

This taxon forms part of a superspecies of three geographically isolated populations, in eastern and south-eastern Australia, south-western Australia and northern Australia. These taxa are variously accorded subspecific (Christidis and Boles 1994) or full specific (Schodde and Mason 1999) status.

There are remarkably few records of the northern shrike-tit (Robinson and Woinarski 1992). However, these are scattered widely from the south-west Kimberley east to near Borroloola. Most recent records from the Northern Territory have been in the Sturt Plateau and Arnhem Land.



Known locations of the northern shrike-tit.
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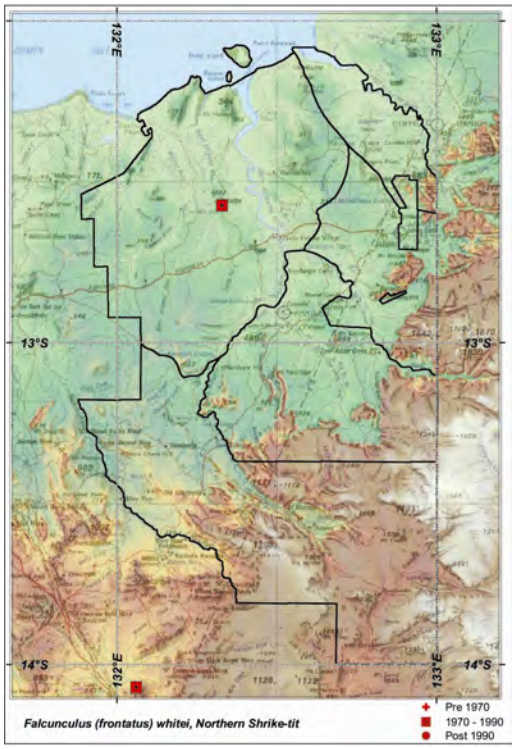

Conservation reserves where reported:

Within the Northern Territory, the northern shrike-tit is known from three reserves (Kakadu, Nitmiluk and Elsey).

Ecology

There have been no detailed studies on the northern shrike-tit. A recent review of all records (Robinson and Woinarski 1992) suggested that it occurred across a range of eucalypt forests and woodlands.

There is more information available on the two other shrike-tit taxa. Shrike-tits are insectivorous. They forage in tree canopies, generally quietly and slowly seeking invertebrates on foliage or under bark. In south-eastern Australia, a high proportion of foraging is from the peeling bark of manna gum *Eucalyptus viminalis* and similar species; however no Northern Territory trees have this feature. The massive bill is extremely strong, and is used for chiselling and tearing bark and branches to access invertebrates sheltering within.

Most of the few records of the northern shrike-tit refer to small parties of 2-5 birds.

Conservation assessment

Assessment of conservation status is hampered by the paucity of records, lack of information on any change in status, and lack of information on limiting factors or threatening processes. Robinson and Woinarski (1992) suggested a possible decline (based largely on absence of recent records from the original collecting site near Borroloola) and a possible impact from frequent fire, but the available evidence is limited.

Garnett and Crowley (2000) considered it to meet criteria C2a for listing as Endangered (total population <2,500 mature individuals, no sub-population with >250 mature individuals, and declining). However, they recognised that the reliability of these estimates was low. The northern shrike-tit appears to be present at low densities over an extensive area and across a broad range of habitats. On current information, a total population size of >10,000 may be as likely an estimate as one of <2,500. This level of uncertainty probably renders the category of **Data Deficient** more apt.

Threatening processes

The lack of information on the ecology of this species means that it is impossible to assess threatening processes with any degree of confidence. Most likely, habitat quality will be affected by fire regimes, as these may determine the density of large trees and the abundance of the principal food items. However, there is a need to determine the optimum fire regime.

Conservation objectives and management

Research priorities are to:
(i) provide a more precise estimate of total population size and trends;
(ii) investigate the ecology of the species, with particular attention to characteristics associated with habitat suitability; and
(iii) assess the impacts of a range of fire regimes.

Information on abundance and/or status within Kakadu NP

The sole known Kakadu record is from 1976, at Kapalga (Robinson and Woinarski 1992).

Information on monitoring in Kakadu NP

Nil.

Importance of Kakadu NP relative to total range

Uncertain but probably low. Although infrequently recorded throughout its range, the northern shrike-tit has a broad distribution from the Kimberley to Arnhem Land. Most records are from woodlands in lower rainfall areas than Kakadu (notably around Katherine-Larrimah).

Compiled by

John Woinarski
[April 2002]

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GOULDIAN FINCH
Erythrura gouldiae

Conservation Status
Australia (*Environment Protection and Biodiversity Conservation Act 1999*): Endangered.

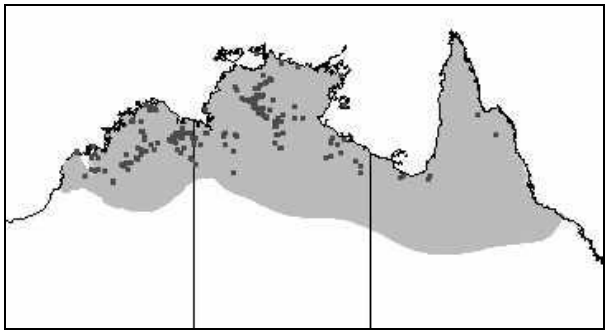
Northern Territory (*Territory Parks and Wildlife Conservation Act 2000*): Endangered.

Description
An easily recognised finch with mature adults having purple chest, yellow breast and green back. Females are duller than males and juveniles are completely dull green. Three colour morphs exist in the wild: black face, red face and yellow face. No subspecies are recognised.

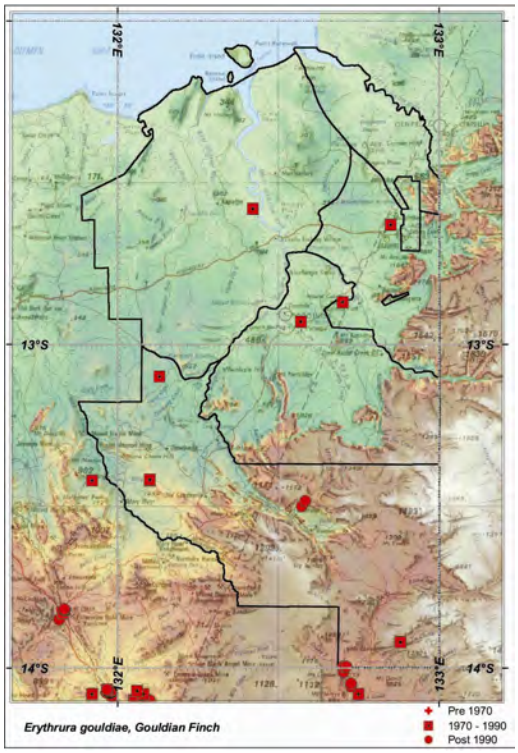
Male black-headed gouldian finch (top right) and juvenile (middle left).

Distribution
Formerly the gouldian finch was distributed throughout the tropical savannas of northern Australia. It is now restricted to isolated areas mostly within the Northern Territory and the Kimberley. Although the decline has occurred throughout the entire range there is a more noticeable reduction in population numbers in an east-west direction.

Conservation reserves where reported:
Kakadu, Nitmiluk, Limmen, Garig Gunak Barlu and Gregory National Parks.



Past (grey) and present (dark grey) distribution of the gouldian finch.



Ecology
Gouldian finches occupy two different regions of the landscape on an annual cycle. In the dry season and part of the late wet season, between February and October, they live within wooded hills that contain a group of *Eucalyptus* species commonly referred to as "snappy gum". These species of trees provide nesting sites. During this period they feed upon native sorghum and find water at small rocky waterholes that remain within the hills until the next wet. In the wet season gouldians move from the

hills into lowland drainages to feed upon perennial grasses that begin to seed in mid December. These grasses include soft spinifex, cockatoo grass and golden beard grass.

Clutch size averages 5.2 and fledging rate is 1.5 young per pair (Tidemann *et al.* 1999). Pairs may raise several clutches per year.

Conservation assessment

There is evidence of range contraction and anecdotal and quantitative evidence of population decline for the gouldian finch. Data from the returns of licensed finch trappers operating in the Kimberley region of Western Australia suggested a rapid decline throughout the 1970s. The gouldian finch is considered **Endangered** (under criteria A2c; C2a(i)b) due to:

- an observed population size reduction of ≥50% over the last 10 years;
- the population size estimated to number <2,500 mature individuals;
- continuing decline observed in the number of mature individuals;
- no subpopulation estimated to contain more than 250 mature individuals;
- extreme fluctuations in the number of mature individuals.

Stand of *Eucalyptus tintinnans* in the Yinberrie Hills north of Katherine (Northern Territory) used as a breeding site.

Threatening processes

A variety of factors has been proposed to explain the decline of gouldian finches. These include the parasitic mite *Sternostoma tracheacolum* (Tidemann e*t al.* 1992, Bell 1996), trapping (Dostine 1998), and pastoral grazing practices (Tidemann *et al.* 1990).

Current data suggest that the previously observed processes have increased in frequency because of a much broader change in the landscape. New evidence suggests that current practices of large-scale late dry season burning is reducing the seed crops of grass species essential to gouldian finch survival.

Conservation objectives and management

The management priority is to improve current burning practises through reduction of extent of late dry season burning with special focus on wet season feeding grounds.

For Kakadu, the most important research priority is to delineate the breeding sites and evaluate the relative significance of the population.

A management plan for this species will be published in late 2004, to supersede that of Dostine (1998).

Information on abundance and/or status within Kakadu NP

There is little information on the status of this species in Kakadu. It has been recorded only infrequently in general wildlife surveys, there has been no specific search, and most records are largely anecdotal and fleeting. There is probably a breeding population of between 50 and 500 in the southern part of the park, with local dispersal after the breeding season.

Information on monitoring in Kakadu NP

Nil. The few previous records are insufficient to serve as a monitoring baseline. A long-established monitoring program is in place in the Yinberrie Hills, about 60km SSW of Mary River ranger station, Kakadu: this program is based on counts of individuals drinking at a set of waterholes (O. Price *in prep.*)

Importance of Kakadu NP relative to total range

Uncertain, but possibly high. If the entire population of Gouldian Finches across their range is indeed <2,500 mature individuals, then it is possible that Kakadu may encompass 2-20% of that total. However, these figures remain little more than educated guesses.

Kakadu has importance because it is one of the few conservation reserves in which a substantial population is known, and one of the few components of the species' range in which there is little grazing by stock and in which relatively benign burning regimes are imposed.

Compiled by

Milton Lewis
[October 2001]

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NORTHERN QUOLL
Dasyurus hallucatus

Conservation status

Australia (*Environment Protection and Biodiversity Conservation Act 1999*): Not Listed, but recent (late 2004) submission (in review) proposes Endangered.

Northern Territory (*Territory Parks and Wildlife Conservation Act 2000*): Vulnerable.

Description

The northern quoll is a distinctive carnivorous marsupial. It is the size of a small cat (weight 300-1100 g), with prominent white spots on a generally dark body, with a long sparsely furred tail.

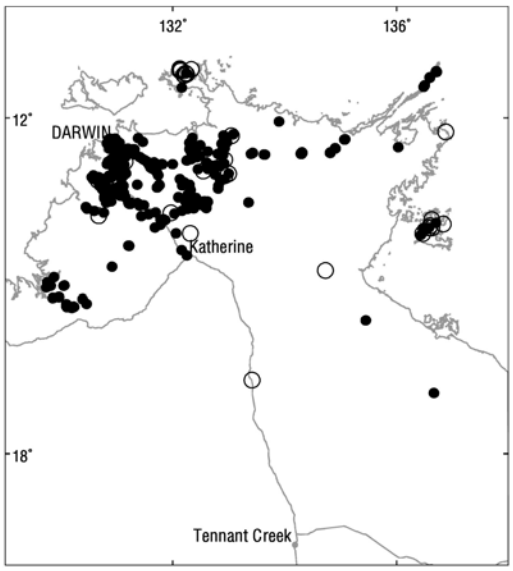
Northern quoll (Photo: Ian Morris)

Distribution

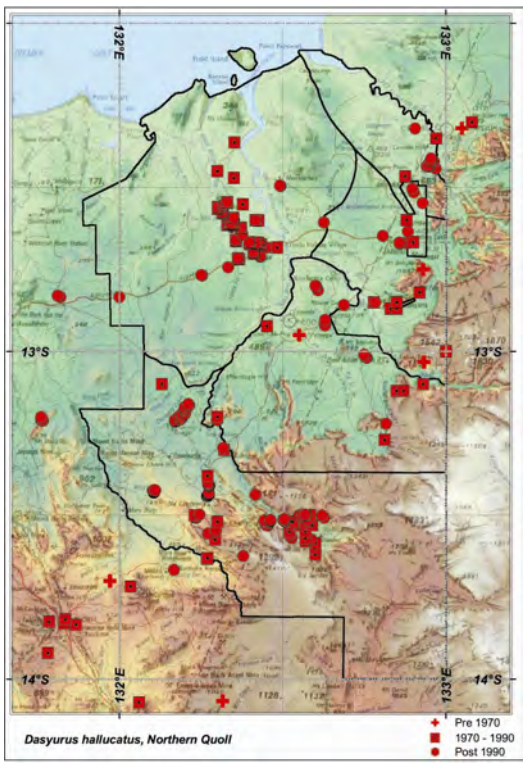
The northern quoll occurs across much of northern Australia, from southeastern Queensland to the southwest Kimberley, with a disjunct population in the Pilbara. It has declined across much of this range (Braithwaite and Griffiths 1994).

In the Northern Territory, it is restricted to the Top End. A 1905 record from Alexandria (Thomas 1906) marks the southern limit of its known Northern Territory distribution, now far from any recent records.

It has been recorded from Groote Eylandt and the nearby North-east Island, Marchinbar Island (in the Wessel group), Inglis Island (in the English Company Islands group) and Vanderlin Island (Sir Edward Pellew group).



Known locations of the northern quoll.



Conservation reserves where reported:

In the Northern Territory, it has been recorded from 15 conservation reserves (Kakadu, Litchfield, Garig Gunak Barlu, Mary River, Manton Dam, Nitmiluk, Umbrawara Gorge, Fogg Dam, Charles Darwin, Black Jungle, Tjuwaliyn (Douglas

Hot Springs), Berry Springs, Limmen, Leaning Tree Lagoon and Howard Springs).

Ecology

The northern quoll is a generalist predator, consuming a wide range of invertebrates and small vertebrate prey. It dens in hollow logs, rock crevices and caves, and in tree hollows. Most foraging is on the ground, but it is also an adept climber.

It occurs in a wide range of habitats, but the most suitable habitats appear to be rocky areas. It is also common in many eucalypt open forests.

Northern quolls typically have an annual life cycle, with almost all males living for only one year (Oakwood 2000; Oakwood *et al.* 2001). Young are born in the mid dry season (June), and attain independence in the early wet season (November). Mating is highly synchronised, occurring in late May/early June. Males then die. During the non-breeding season, home ranges are about 35 ha, but this increases to about 100 ha for males in the breeding season (Oakwood 2002).

Conservation assessment

Broad-scale decline of the northern quoll was described by Braithwaite and Griffiths (1994), but the extent and rate of this decline did not quite reach the relevant threshold values for IUCN threatened status.

Since that review, recent studies have suggested collapse of northern quoll populations in those parts of Kakadu National Park recently invaded by cane toads *Bufo marinus* (Watson and Woinarski 2003; Oakwood 2004). Given the likely occurrence of cane toads across all of the mainland Top End over the next few years, a similar pattern elsewhere suggests that the northern quoll fits the category Endangered, on the basis of criterion A3 (population size reduction of >50%, projected or suspected to be met within the next 10 years, based on direct observation, and the effects of introduced taxa).

Threatening processes

Quolls appear to have been declining in the Northern Territory for at least several decades (Braithwaite and Griffiths 1994; Woinarski *et al.* 2001), possibly because of impacts from feral cats, disease or changed fire regimes. However, the spread of cane toads adds a far more catastrophic threat (Van Dam *et al.* 2002). Quolls appear to be particularly susceptible to the poison of cane toads, and are killed when they attempt to kill or consume the toads. Major declines to regional extinction have been reported for quolls following cane toad invasion on Cape York Peninsula (Burnett 1997).

Conservation objectives and management

In the short to medium term, it is unlikely that any control mechanism can be imposed on cane toads, the primary threat to quolls. Given this outlook, the management priority is to secure the existing island populations from colonisation by cane toads, and to increase the probability of the species' survival by translocation to establish new populations on additional islands.

Information on abundance and/or status within Kakadu NP

Prior to the arrival of cane toads, northern quolls were generally abundant and widespread in Kakadu, although there was some evidence of at least local declines (Woinarski *et al.* 2001). Quantitative estimates of local abundance can be derived from the autecological studies by Oakwood (2000, 2002) and Begg (1981), and from broader survey results (Braithwaite 1985; Woinarski and Braithwaite (1991).

Information on monitoring in Kakadu NP

Prior to the arrival of cane toads, there were a series of studies and sites that provided a good baseline for ongoing monitoring, and some such monitoring had been conducted. These sites were:

<u>Kapalga</u>

Substantial baseline mark-recapture and radio-telemetry studies by Oakwood (2000, 2002), and grid-based sampling by Braithwaite and Muller (1997), re-sampled

by Woinarski *et al.* (2001). Results from the latter summarised in the Table below.

Mean abundance of northern quolls (% trap success) at Kapalga, 1986-99 (October sampling).

86	87	89	90	91	92	93	99
1.3	1.6	0.7	0.7	0.5	0.6	0.7	0.1

Nawurlandja (Little Nourlangie Rock).
An intensive study of this species was undertaken in four habitats at Nawurlandja from 1977-1980 (Begg 1981; Begg *et al.* 1981) that serves as a good baseline for ongoing monitoring. The sampling regime was replicated in 2002 (Watson and Woinarski 2003). The results are summarised below.

Mean abundance of northern quolls (% trap success) in 4 habitats at Nawurlandja (March-May sampling).

	1977-79	**1980**	**2002**
rocky crevices	1.00	0.93	0
closed forest	0.89	0.86	0
rocky slopes	1.11	1.72	0
scree slopes	0.30	0.25	0.17

Jabiluka
Around Jabiluka, Kerle and Burgman (1984) sampled 40 sites over the period 1979-81; these sites were revisited in 2003 (Watson and Woinarski 2004).

Mean abundance (% trap success) of northern quolls across 40 sub-sites around Jabiluka.

1979-81	**2003**
0.6	1.6

Stage III fauna survey sites
In Stage III (Mary River district) of the Park, 263 quadrats were sampled in 1988-90 and again in 2001 (Woinarski *et al.* 2002). The results are summarised below.

Mean abundance of northern quolls (% trap success) across 263 quadrats in Stage III.

1988-90	**2001**
0.42	0.34

As at July 2004, 114 fire plots had been sampled for fauna. Northern quolls have been recorded in 36 of those plots (Watson and Woinarski 2004). The set of all fire plots provides some baseline for ongoing monitoring of this species.

Subsequent to the arrival of cane toads, cane toads have been intensively monitored at two sites (Mary River and East Alligator) by Oakwood (2004); and more extensively across a set of Stage III sites by Watson and Woinarski (2003). The latter results are summarised in the Table below:

Mean abundance of northern quolls (% trap success) in 2001 and 2002, across sites with and without cane toad invasion in the period between the samples.

	2001	**2002**
control	1.05	1.30
toad invaded, 2001-02	0.55	0

Importance of Kakadu NP relative to total range
Uncertain. Quoll populations in Kakadu, as in most of the Top End of the Northern Territory, are in rapid decline because of the invasion of cane toads. At present rates, the population in Kakadu may decline to extinction in the near future. If some residual population survives the establishment of cane toads, such a population may have regional significance.

Compiler
John Woinarski
[February 2002]

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NORTHERN BRUSH-TAILED PHASCOGALE *Phascogale (tapoatafa) pirata*

Conservation status

Australia (*Environment Protection and Biodiversity Conservation Act 1999*):
Not listed.

Northern Territory (*Territory Parks and Wildlife Conservation Act 2000*):
Vulnerable.

Description

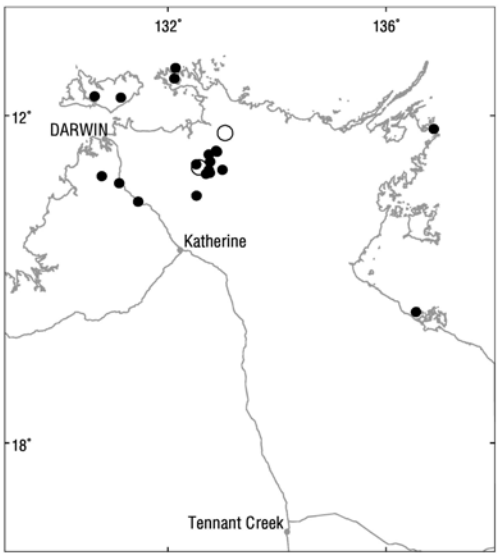
The northern brush-tailed phascogale is a carnivorous marsupial about midway in size between the larger northern quoll and the small antechinuses and dunnarts. Its most notable feature is the long dark hairs on the tail, which form a distinctive brush. The hairs can be stiffened when alarmed, giving a bottle-brush appearance. The general body colour is dark grey, the snout is notably pointed and the eyes are large. Body weight is about 150-200 g.

Northern brush-tailed phascogale.

Distribution

Recent taxonomic studies (Rhind *et al.* 2001, Spencer *et al.* 2001) have suggested that the northern population of brush-tailed phascogale is specifically distinct from that in south-western and south-eastern Australia. As redefined, the northern brush-tailed phascogale is known only from a few locations in Top End of the Northern Territory, and is probably specifically distinct from populations elsewhere in northern Australia.

In the Northern Territory, there are recent (post 1980) records from the Tiwi Islands, Cobourg Peninsula, Groote Eylandt, West Pellew Island, Kakadu National Park (notably around Jabiru and near Jim Jim ranger station), and Litchfield National Park. There are older records from the Gove and Katherine areas.



Known locations of the northern brush-tailed phascogale.
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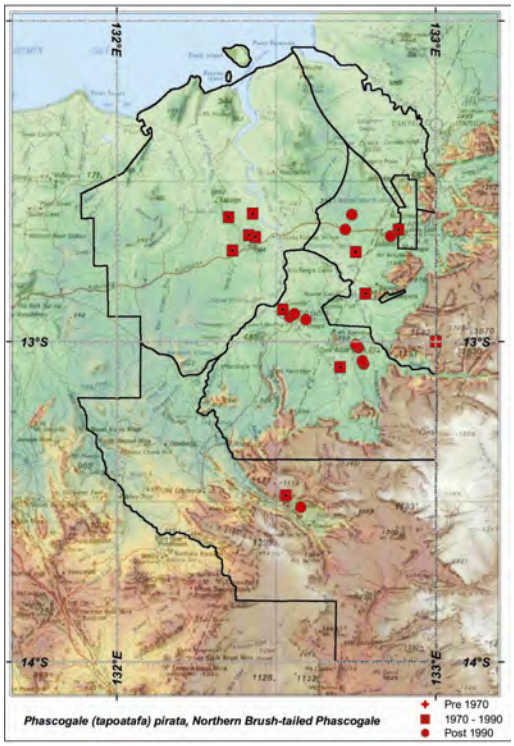

Conservation reserves where reported:

It is known to still exist in three Northern Territory reserves: Kakadu, Litchfield and Garig Gunak Barlu (formerly Gurig) National Parks.

Ecology

There have been no detailed studies of the northern brush-tailed phascogale, but its ecology is probably similar to that reported for its temperate relatives (Rhind 1998). The diet is predominantly invertebrates with some small vertebrates. It is a nocturnal mammal, feeding both in trees and on the ground. It shelters in tree hollows during the day. Most records are from tall open forests dominated by *Eucalyptus miniata* (Darwin woollybutt) and *E. tetrodonta* (Darwin stringybark).

Conservation assessment

Conservation assessment is hampered by the lack of precise information on range, population size and trends. Decline is evident from variation between historic statements about status and current assessments: most notably Dahl (1897) reported that "*on the rivers Mary and Katherine it was frequently observed. In fact nearly everywhere inland it was very constant, and on a moonlight walk one would generally expect to see this little animal*". This is certainly no longer the case. Surveys by PWCNT across the Top End over the last decade have resulted in fewer than 10 captures of brush-tailed phascogales in more than 350,000 trap-nights. However this meagre tally may also partly reflect some degree of trap-shyness.

It best fits the status of **Vulnerable** (under criteria C2ai) based on:

- population size estimated to number fewer than 10,000 mature individuals;
- a continuing decline, observed, projected or inferred, in numbers of mature individuals; and
- no subpopulations estimated to contain more than 1000 mature individuals.

Threatening processes

There are no data available to evaluate threatening processes. The apparent decline to coastal areas and especially islands suggests either exotic predators (cats) or disease. Other factors potentially involved may include vegetation change due to altered fire regimes and/or pastoralism. As a predator of small vertebrates, this species may be affected by the arrival of cane toads, but there is no relevant information available to assess the likelihood of this potential threat.

Conservation objectives and management

The major priority is to firm up knowledge of the distribution, abundance, habitat requirements and trends for this species. This will require a detailed autecological study and a distributional survey.

Information on abundance and/or status within Kakadu NP

The northern brush-tailed phascogale has been recorded rarely in wildlife surveys in Kakadu (Thomas 1904; Calaby 1973; Braithwaite 1985; Braithwaite and Muller 1997; Woinarski and Braithwaite 1991; Woinarski *et al.* 2001; Watson and Woinarski 2004), providing too little data to provide any robust estimate of population size; other than a recognition that it is generally uncommon. However, there are some places in Kakadu where it appears to be relatively more numerous: these include the area around Jabiru and the main visitor centre, and the area around Cooinda, Mardugal campsite and Jim Jim ranger station.

Information on monitoring in Kakadu NP

There are probably too few records of this species across the general wildlife surveys to provide an adequate baseline for ongoing monitoring. For example, this species has been recorded by only two individuals in two quadrats of the 114 fire plots sampled (Watson and Woinarski 2004). An explicit targeted study may be required to provide sufficient data on population size to serve as a foundation for ongoing monitoring.

Importance of Kakadu NP relative to total range

Moderate to high. Notwithstanding its uncommon status in Kakadu, it is probably more abundant here than in any other sampled area in the Top End of the Northern Territory. Recent taxonomic

studies suggest that this species occurs only in the Top End.

Compiled by

John Woinarski
[March 2002]

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GOLDEN BANDICOOT
Isoodon auratus

Conservation status

Australia (*Environment Protection and Biodiversity Conservation Act 1999)*: Vulnerable.

Northern Territory (*Territory Parks and Wildlife Conservation Act 2000*): Endangered.

Description

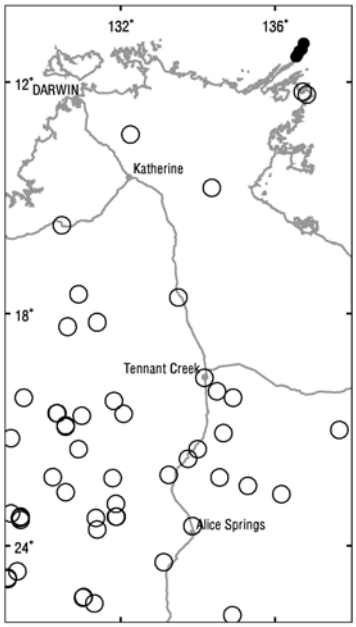
A small bandicoot weighing up to 550 g. Superficially similar to the more common northern brown bandicoot *Isoodon macrourus*, from which it can be distinguished in the field by its smaller size, by its flatter and more elongate head shape, and by the shape and other characteristics of the hair.

Golden bandicoot (Photo: K. Brennan).

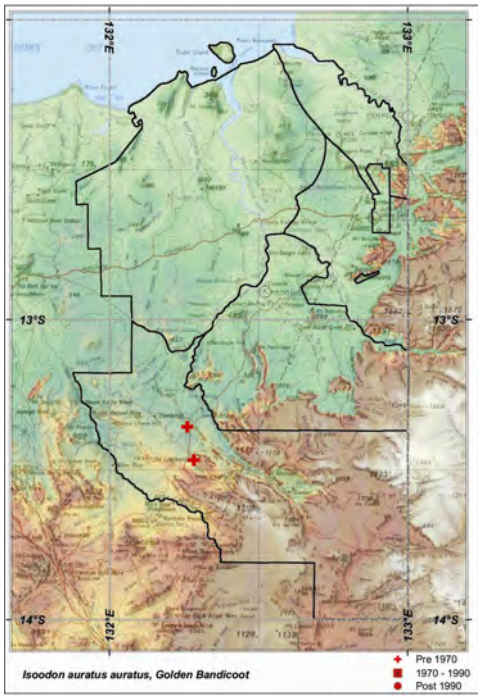
Distribution

In the Northern Territory it is now known from only one location, Marchinbar Island on the Wessel chain, north-east Arnhem Land. Beyond the Territory, the same subspecies *I.a. auratus* also occurs on a small portion of the mainland of the north Kimberley (WA) and from a nearby island, Augustus Island. Another subspecies, *I.a. barrowensis* occurs on Barrow and nearby Middle Islands off the Pilbara coast.

The taxonomic position of these forms is currently under review. A recent study (Pope *et al.* 2001) has suggested that golden bandicoots may be conspecific with the southern brown bandicoot *I. obesulus*, with very similar genetic composition albeit some marked morphological differences. The conservation status of the taxon within the Northern Territory is unaffected by the resolution of this taxonomic issue.



Known locations of the golden bandicoot. o = pre 1970; ● = post 1970.



The golden bandicoot formerly occurred across most of northern, central and western Australia, extending to south-western NSW, and across a very broad variety of habitats. However, it declined

precipitously within decades of European settlement, and disappeared from the central deserts between the 1940s and 1960s. The last specimen from the mainland NT was from The Granites (northwest Tanami) in 1952. There have been very few specimen records from the Territory mainland north of the Tanami, but these have included the Roper River area (in 1911) and South Alligator River (around 1900). There are also more recent records (1950s to 1980s) from mainland north-eastern Arnhem Land that are probably referable to this species (Lyne and Mort 1981; I. Morris *unpubl.*).

Conservation reserves where reported:
The only post 1950 record from any conservation reserve is in Kakadu NP.

Ecology

Most information on the ecology of the golden bandicoot is from a single short-term study on Marchinbar Island (Southgate *et al.* 1996). There it occurs mainly in heathland and shrubland on sandstone or sandsheets, and avoids vegetation with greater tree cover. Individuals maintain overlapping home ranges of from 12-35 ha. Their diet comprises a broad range of invertebrates.

Preferred habitat on Marchinbar Island - heathland on sandstone.

Conservation assessment

In 1994-95, the total population at its single known NT site was roughly estimated at around 1400 individuals, occurring across most of the 210 km² extent of Marchinbar Island (Southgate *et al.* 1996). There is no information on trends in this population.

The decline in the mainland population and range generally occurred earlier than relevant to IUCN status assignation criteria (i.e. >10 years or 3 generations ago), although the status of the population, if any, on mainland northeast Arnhem Land remains unresolved.

Conservation categorisation is problematical because of lack of information on the population trends at the sole known site. However, it can be reasonably inferred that there is some likelihood that this population may be exposed in the future to the same factor(s) that have so effectively extirpated populations elsewhere. Given this premise, the species qualifies as **Endangered** (under criteria B1ab+2ab; C2) based on:

- extent of occurrence <5,000 km²
- known to exist at <5 locations
- continuing decline, observed, inferred or projected
- area of occupancy <500 km²
- population size <2,500 mature individuals; and
- >95% of mature individuals in one subpopulation.

Threatening processes

No single factor has been demonstrated to have caused the decline of golden bandicoots, but the extent of loss on the mainland and the maintenance of some island populations suggests that it is not due to land use factors but rather to either disease or exotic predators. The most likely causal factor is predation by feral cats.

Marchinbar Island has no feral cats, although feral dogs have been present for around 30-50 years, and these are known to take some bandicoots. Bandicoots on Marchinbar Island are hunted occasionally by Aboriginal landowners. Golden bandicoots may be affected by fire regimes, and appear to prefer areas which have been burnt relatively recently (2-5 years previously) and within a fine-scale mosaic. The maintenance of such a fire regime is dependent upon management by Aboriginal landowners.

The greatest threat to the Marchinbar population is the deliberate or inadvertent introduction of cats to the island, either by visiting Aboriginal landowners, by visiting fishermen or yachties, or by refugee boat-people.

Conservation objectives and management

There is no existing management program for the wild population of this species in the Northern Territory. However, a national draft recovery plan has been produced (Palmer *et al.* 2003) and is now being assessed. This plan includes actions that (1) develop and implement cooperative management arrangements on lands with important populations; (2) establish a multiple species recovery team; (3) monitor populations; (4) survey sites of historic and recent unconfirmed records; (5) and undertake targeted research to identify key threatening factors and viable methods to mitigate these.

Information on abundance and/or status within Kakadu NP

The only records of this species from the Kakadu area are of three specimens collected in 1902-03 at "South Alligator River" (Thomas 1904) and one specimen at Goodparla, collected in 1967. It has not been recorded from any of the extensive wildlife surveys of the Park conducted since then, suggesting that it is very uncommon and/or highly localised. However, it is possible that animals caught over that period were misidentified as juveniles of the morphologically similar but far more common northern brown bandicoot *I. macrourus*. The specific identity of the 1967 specimen should be confirmed by more detailed scrutiny of its hair and/or genetic analysis.

Information on monitoring in Kakadu NP

Consistent with the lack of recent records, there is currently no monitoring program for this species in Kakadu NP.

Importance of Kakadu NP relative to total range

Uncertain (either low or high). There are no known surviving populations of this species from the mainland of the Northern Territory (and indeed, the entire mainland range is now restricted to a small number of populations in the Kimberley). If the species persists in Kakadu, that population is clearly of major conservation significance.

Compiled by

John Woinarski.
[October 2001]

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BARE-RUMPED SHEATHTAIL BAT *Saccoilamus saccoilamus*

Conservation status

Australia (*Environment Protection and Biodiversity Conservation Act 1999*):
Critically Endangered.

Northern Territory (*Territory Parks and Wildlife Conservation Act 2000*):
Data Deficient.

Description

The bare-rumped sheathtail bat is a large (50 g) insectivorous bat. As with other sheathtail bats, the tip of the tail is free of the tail membrane. The fur is dark red-brown to almost black, with white speckles, and this fur doesn't extend to the rump.

Distribution

This species has a wide distribution from India through south-eastern Asia to the Solomon Islands, and including north-eastern Queensland and the Northern Territory. The north-eastern Australian populations are described as the subspecies *S. s. nudicluniatus*, although it is not clear whether this should be applied to the Northern Territory population (Duncan *et al.* 1999).

It was first recorded in the Northern Territory from two specimens collected in 1979 and 1980 at Kapalga (McKean *et al.* 1981), and there have been no records since (Thomson 1991: D. Milne *unpubl.*).

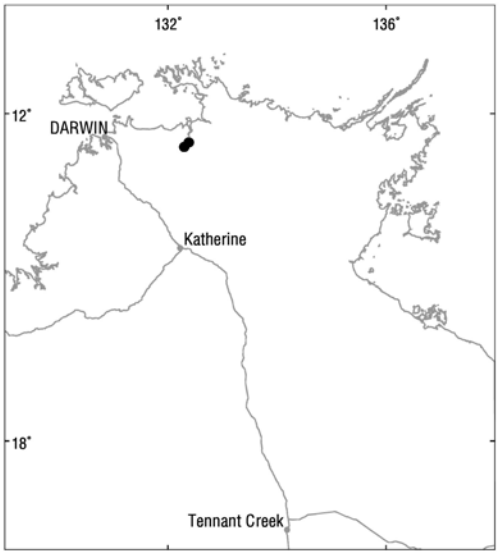
Conservation reserves where reported:

Kakadu NP.

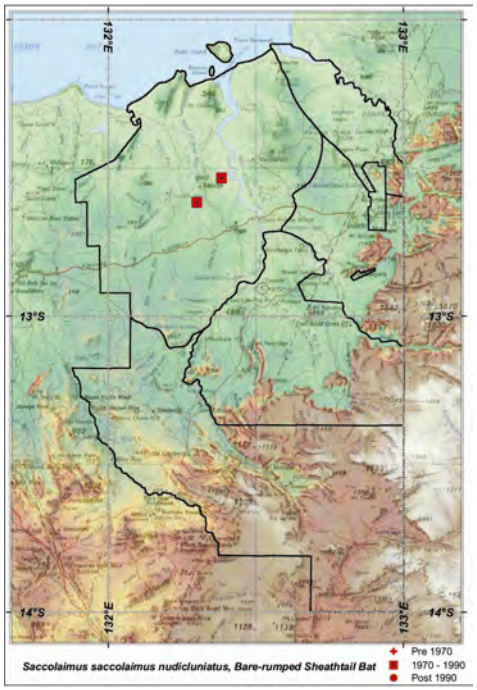
Ecology

This is a high-flying insectivorous bat. The Kakadu specimens were collected from open *Pandanus* woodland fringing the sedgelands of the South Alligator River (Friend and Braithwaite 1986). In the Northern Territory, it has also been recorded from eucalypt tall open forests (Churchill 1998). In Queensland, it is known mainly from coastal lowlands, including eucalypt woodlands and rainforests (Duncan *et al.* 1999).

It roosts in tree hollows and caves (Duncan *et al.* 1999).



Known locations of the bare-rumped sheathtail bat.



Conservation assessment

The national assessment of Critically Endangered was based on the apparent absence of recent records from its relatively small known historic range in north-eastern Queensland, associated with substantial vegetation clearance there.

Its status in the Northern Territory is very difficult to assign, given the remarkably few records. One problem is that there is no record of a diagnostic call assigned to this species that can be used for detection (Duncan *et al.* 1999).

In the Northern Territory, there is no information from which to consider trends in status, and no obvious threatening process. While the known range is currently very limited, this may largely reflect sampling problems. Given this lack of critical information, the taxon is best considered **Data Deficient**.

Threatening processes

There are no obvious threatening processes. Hollow availability may be reduced by increasing levels of clearing in the Darwin-Mary River area, but this will not affect populations within Kakadu National Park.

Vegetation change associated with saltwater intrusion and/or invasion by exotic species (such as *Mimosa pigra*) may affect habitat suitability.

Conservation objectives and management

Research priorities are to:
(i) undertake a targeted study to better define habitat, distribution, population size, and status, and to develop more effective detection techniques.
(ii) resolve the taxonomic status of the Northern Territory population relative to that in north-eastern Queensland.

Information on abundance and/or status within Kakadu NP

The only records of this bat from Kakadu (and indeed from the Northern Territory) are the two specimens collected at Kapalga in 1979-80. It has not been recorded since, despite considerable recent surveys in Kakadu and elsewhere in the Top End of the Northern Territory (e.g. Milne *et al.* 2004).

Information on monitoring in Kakadu NP

Nil.

Importance of Kakadu NP relative to total range

Uncertain. The Kapalga records represent a considerable disjunction from the rest of this taxon's range (itself a relatively small portion of north-eastern Queensland).

Compiled by

John Woinarski and Damian Milne
[February 2002]

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ARNHEM LEAF-NOSED BAT
Hipposideros diadema inornata

Conservation status
Australia (*Environment Protection and Biodiversity Conservation Act 1999*):
Not listed.

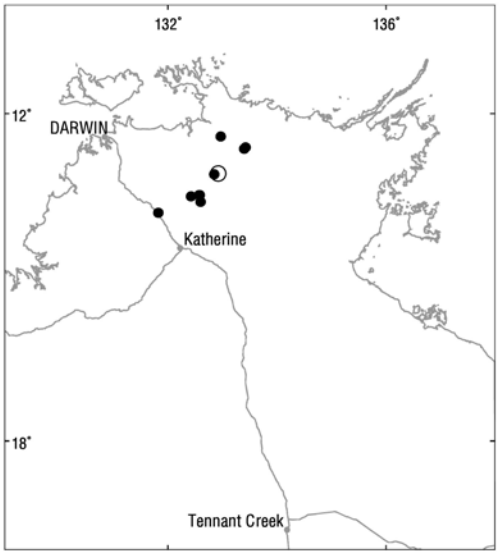
Northern Territory (*Territory Parks and Wildlife Conservation Act 2000*):
Vulnerable

Description
The Arnhem leaf-nosed bat is a moderately large (30 g) insectivorous bat. It is pale brown above and slightly paler on the belly. It has large, acutely pointed ears and a very well-developed nose-leaf. There are no similar species in the Northern Territory.

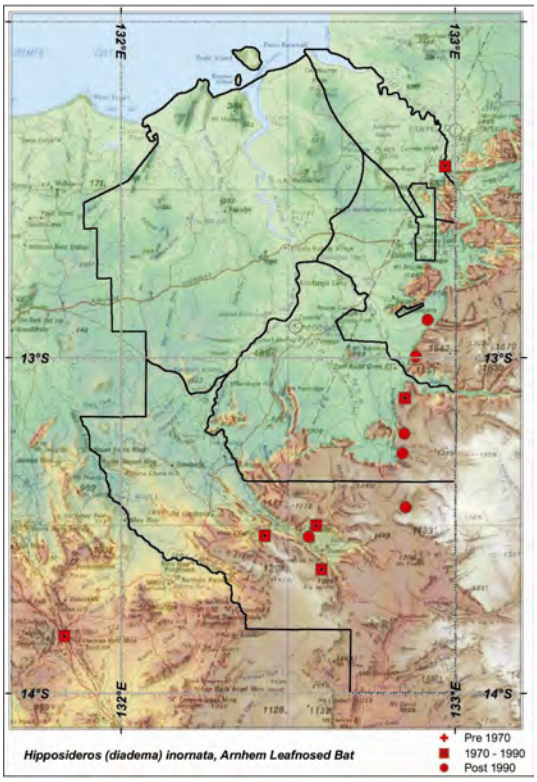
This bat is currently considered to be a very distinctive subspecies of a polymorphic species that ranges from the Asian mainland through to the Solomon Islands, and includes a larger subspecies *H. d. reginae* from north-eastern Queensland.

Arnhem leaf-nosed bat (Photo: Damian Milne)

Distribution
The Arnhem leaf-nosed bat was first collected as recently as 1969 (McKean 1970) and has been recorded only from a few locations in the western Arnhem Land sandstone massif (Deaf Adder Gorge and upper South Alligator River area) and from one site (Tolmer Falls) in Litchfield National Park (McKean and Hertog 1979).



Known locations of the Arnhem leaf-nosed bat.
o = pre 1970; • = post 1970.



Conservation reserves where reported:
This taxon is known from two conservation reserves, Litchfield and Kakadu National Parks. However, it has not been recorded from Litchfield since 1983 (Churchill 1998).

Ecology
This bat roosts in caves or abandoned mine adits in cool draughty areas, close to water (Churchill 1998; Corbett and Richards

2002). Little is known of its foraging habitat or diet, but it has been reported foraging in riparian areas and in eucalypt tall open forests. Its main diet is large invertebrates.

Conservation assessment

This bat appears to have a very restricted distribution (although large areas of the rugged western Arnhem Land escarpment have not been sampled), fairly narrow habitat (roost-site) requirements, is probably highly sensitive to disturbance, and has probably disappeared from one of its few known sites over the last two decades.

The species fits **Vulnerable** (under criteria B2ab(i,ii,iii,iv,v)) based on:

- an area of occupancy estimated to be <2000 km^2;
- severely fragmented or known to exist at no more than 10 locations; and
- a continuing decline, observed, inferred or projected.

[Note that it is considered *Data deficient* in the national Bat Action Plan (Duncan *et al.* 1999)].

Threatening processes

The disappearance of the population at Litchfield National Park may have been due to disturbance from humans visiting roosting caves (Corbett and Richards 2001). At this site, this threat has now been ameliorated. The known sites in western Arnhem Land are generally remote and very rarely visited.

Conservation objectives and management

The main research priorities are to:
(i) survey to determine whether this bat still occurs within Litchfield National Park.

Management priorities are to:
(i) maintain controls over visitation to sites known to be used for roosting and breeding. Such controls are currently in place in both National Parks from which it is known.
(ii) establish a non-intrusive monitoring program in at least one site.

Information on abundance and/or status within Kakadu NP

There is no substantial quantitative assessment of abundance of Arnhem leaf-nosed bats in Kakadu. Recent advances in knowledge of its echolocation calls now enable more comprehensive objective sampling (Milne 2002).

Information on monitoring in Kakadu NP

As at July 2004, 114 fire plots had been sampled for fauna. With recent advances in recording and identification of bat calls, Arnhem leafnosed bats have now been recorded in 4 of those plots (Watson and Woinarski 2004). The set of all fire plots will provide some baseline for ongoing monitoring of this species; and especially so henceforth, as recording of bat calls becomes more routine and sophisticated.

Importance of Kakadu NP relative to total range

High: most of the known records of this taxon are from Kakadu. The only other known population within a conservation reserve may have become locally extinct.

Compiled by

John Woinarski and Damian Milne.
[February 2002]

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BRUSH-TAILED RABBIT-RAT *Conilurus penicillatus*

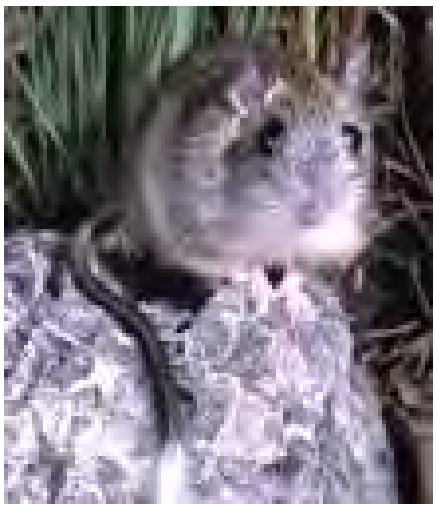
Conservation status

Australia (*Environment Protection and Biodiversity Conservation Act 1999*):
Not listed.

Northern Territory (*Territory Parks and Wildlife Conservation Act 2000*):
Vulnerable.

Description

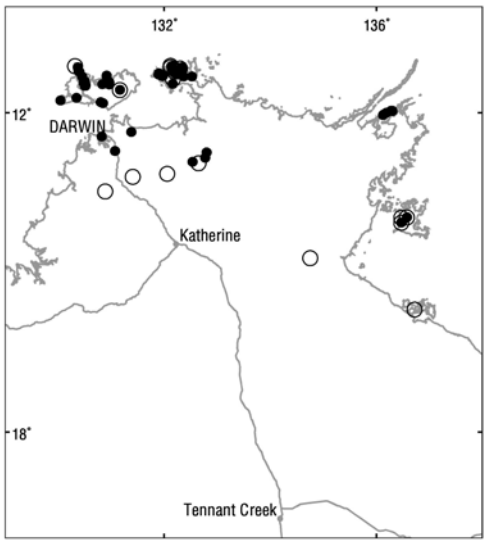
A moderately large (about 150 g) partly arboreal rat, with long brush-tipped tail (with the distal third either black or white), long ears. Fur colour is relatively uniformly coloured brown above, and cream below. Also known as the brush-tailed tree-rat, it is distinctly smaller than the two other long-tailed tree-rats in the Northern Territory.



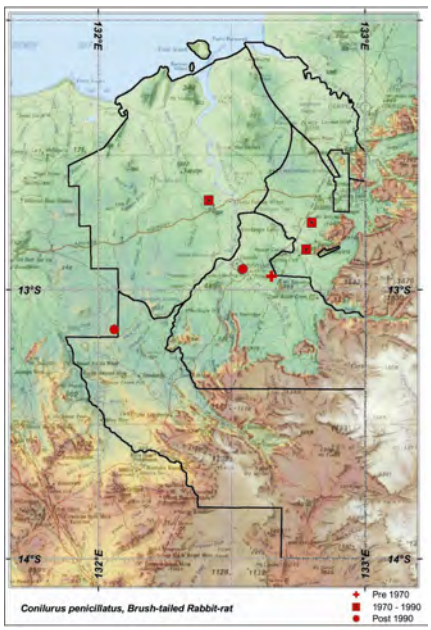
Brush-tailed rabbit-rat. (Photo: M. Armstrong)

Distribution

In the Northern Territory, this species has been recorded from near-coastal areas from near the mouth of the Victoria River in the west to the Pellew Islands in the east, and including Bathurst, Melville, Inglis and Centre Islands and Groote Eylandt (Parker 1973; Kemper and Schmitt 1992; Woinarski 2000). There are no recent records from much of this historically recorded range, and it is currently known to persist in the Northern Territory only on Cobourg Peninsula, Bathurst, Melville, Inglis and Centre Islands, Groote Eylandt, and a small area within Kakadu National Park. Two weakly-defined subspecies are recognised from the Northern Territory: *C.p. melibius* from the Tiwi Islands, and *C.p. penicillatus* from all other Australian areas (Kemper and Schmitt 1992). Beyond the Northern Territory, the species also occurs from higher rainfall, near-coastal areas of the north Kimberley, Bentinck Island (Queensland) and a small area of southern New Guinea.



Known locations of the brush-tailed rabbit-rat.
o = pre 1970; • = post 1970.



Conservation reserves where reported:
In the Northern Territory, it is known from two conservation reserves, Kakadu and

Garig Gunak Barlu (formerly Gurig) National Park.

Ecology

Preferred habitat is eucalypt tall open forest, generally with a relatively dense tall shrubby understorey (Fig. 3). However, at least on Cobourg Peninsula, it also occurs on coastal grasslands (with scattered large *Casuarina equisetifolia* trees, beaches, and stunted eucalypt woodlands on stony slopes.

It shelters in tree hollows, hollow logs and, less frequently, in the crowns of pandanus or sand-palms. Most foraging is on the ground, but it is also partly arboreal. The diet comprises mainly seeds (especially of grasses), with some fruits, invertebrates and leaves and grass.

Preferred habitat of the brush-tailed rabbit-rat - tall eucalypt forests with shrubby understorey.

Conservation assessment

Conservation assessment is hampered by lack of knowledge concerning the timing, extent and currency of geographic decline, and the lack of a recent assessment of status on Groote Eylandt and Centre Island. Its range and population size in the Northern Territory has probably declined by well over 50% since European settlement, but this decline cannot be dated with any assurance. Certainly, its current status no longer matches that reported more than 100 years ago: "in Arnhem Land is everywhere common in the vicinity of water" (Dahl 1897), "numerous all over Arnhem Land, and in great numbers on the rivers of the lowlands" (Collett 1897). There is some suggestion of a decline within the last 20 years at Kakadu National Park, but this is based on very few records (Woinarski *et al.* 2001).

Current research will provide some assessment of the population size (or at least an index of abundance, whose assessment can be consistently repeated) on Bathurst and Melville Islands, Cobourg Peninsula and Kakadu. A recent study (PWCNT 2001) found very high population density (>6 individuals/ha) in at least two locations on Cobourg Peninsula.

Its status best fits **Vulnerable** (under the criteria B1ab(i,ii,iii,iv,v) based on:

- extent of occurrence estimated to be <20,000 km^2;
- severely fragmented or known to exist at no more than 10 locations; and
- continuing decline, observed, inferred or projected.

Within this set, the estimate of extent is most arguable, as the islands where it is present are widely scattered. The total area of the islands known to be occupied is 11813 km^2, and that of Cobourg Peninsula is 2207 km^2. Elsewhere on the Territory mainland it is known to persist only in a small area (<20 km^2) within Kakadu National Park.

The Tiwi Island subspecies *C.p. melibius* unequivocally meets this set of criteria (with total extent of occupancy of about 8300 km^2). The other subspecies *C.p. penicillatus* would meet the set of criteria B2ab(i,ii,iii,iv,v).

Threatening processes

No single factor has been demonstrated to have caused the decline of brush-tailed rabbit-rats, but the extent of loss on the mainland and the maintenance of some island populations suggests that it is probably not due to land use factors but rather to either disease or exotic predators. The most likely causal factor is predation by feral cats.

However, it is possible that broad-scale habitat change may have contributed to the apparent decline. Changed fire regimes, weeds and grazing by livestock and feral animals may have changed the availability of

preferred or vital food resources (e.g. seeds from particular grass species), and more frequent hot fires may have reduced the availability of hollow logs, tree hollows and the tall fruit-bearing understorey shrubs.

Conservation objectives and management

Management priorities are to:
(i) establish a monitoring program in at least two sites, which can also measure responses to management actions. The baseline for this monitoring has now been established, with current studies on Cobourg Peninsula and in Kakadu National Park.
(ii) maintain effective quarantine actions for island populations, most particularly relating to maintaining at least some of these islands cat-free. Note that all islands occupied are Aboriginal lands.
(iii) develop effective captive population breeding programs, and evaluate the possibility of establishing translocated populations (either to currently uninhabited islands or to appropriately managed conservation reserves).

Information on abundance and/or status within Kakadu NP

The species was at least locally common in Kakadu lowlands at the turn of the twentieth century (Dahl 1897; Thomas 1904). Its range appears to have contracted markedly since. The Alligator Rivers Fact-finding study of the early 1970s recorded it as "a reasonably common species in the region" (Calaby 1973). It was subsequently recorded, rarely, at only three of the 30 sites sampled over the period 1980-84 in the CSIRO fauna surveys of Stages I and II (Braithwaite 1985) and recorded by only a few individuals in the substantial set of ecological studies undertaken at Kapalga over the period 1986-1993 (Braithwaite and Muller 1997); then it was not recorded at all in the intensive and extensive fauna sampling of Stage III of the park (Mary River District) between 1988 and 1990 (Woinarski and Braithwaite 1991), nor in re-sampling of Kapalga sites in 1999 (Woinarski *et al*. 2001). It has also not been recorded in recent extensive fauna surveys to the immediate west of Kakadu, in the Mary River catchment (Armstrong *et al*. 2002) and Mt Bundey Training Area (L. Corbett *pers. comm*.). However, a population persists in woodlands in the area around Cooinda, Jim Jim Ranger Station and Mardugal campground, and this locally abundant population has been studied over the period 2000-2003 (R. Firth *unpubl*.)

Information on monitoring in Kakadu NP

The Mardugal population has been sampled in a consistent and repeatable manner (unpublished study by R. Firth, Charles Darwin University), and this sampling would provide a good baseline for ongoing monitoring of this single known population.

Importance of Kakadu NP relative to total range

Moderate to high: Other than Cobourg Peninsula, the Kakadu population is the only known mainland population surviving on the mainland of the Northern Territory. Beyond this, the species remains common on the Tiwi Islands, and is known from one site in Queensland, a few records in New Guinea, and as a rare species in the Kimberley.

Compiled by

John Woinarski.
[February 2002]

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GOLDEN-BACKED TREE-RAT *Mesembriomys macrurus*

Conservation status

Australia (*Environment Protection and Biodiversity Conservation Act 1999*): Vulnerable.

Northern Territory (*Territory Parks and Wildlife Conservation Act 2000*): Endangered.

Description

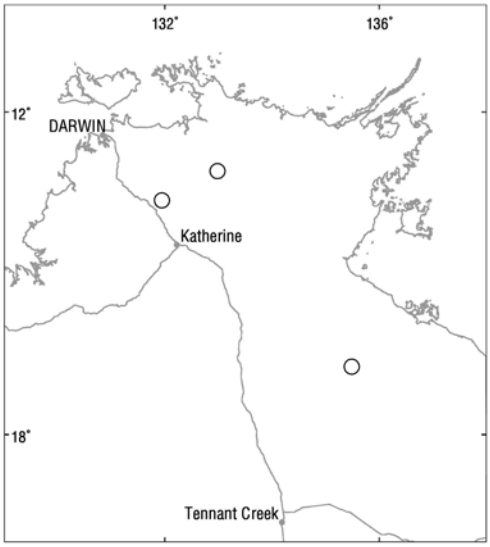
A large rodent (about 300 g), midway in size between the Territory's other two large semi-arboreal species, the smaller brush-tailed tree-rat and the larger black-footed tree-rat. Distinctive features include a long slightly brush-tipped tail that is white for at least the distal half, white feet, and a broad chestnut-gold stripe along the back from the crown to the base of tail.

Golden-backed tree-rat.

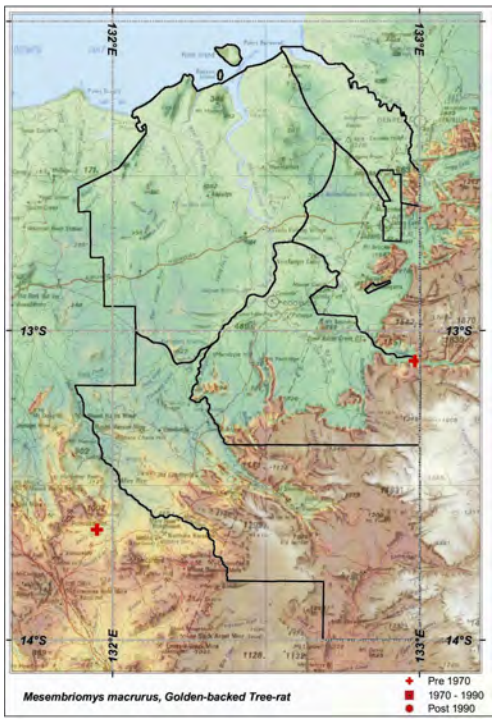
Distribution

In the Northern Territory, the golden-backed tree-rat is known from only three records (Parker 1973): at "Balanbrinni" (probably Balbarini) in the upper McArthur in 1901; from four specimens collected at Nellie Creek (in the upper Mary) in 1903 (Thomas 1904); and from Deaf Adder Gorge in 1969. It has not been confirmed elsewhere despite many substantial surveys across much of the Top End over the last 30 years. However, there are several unconfirmed records based on possible sightings and limited hair samples (Woinarski 2000).

Beyond the Territory, it occurs in coastal areas of the north Kimberley, and five offshore islands there (Carlia, Conilurus, Hidden, Uwins, and Wollaston) (Abbott and Burbidge 1995).



Known locations of the golden-backed tree-rat. o = pre 1970.



Its range has declined substantially in Western Australia. It appears to have become regionally extinct from the Pilbara, and in at least the more arid southern margins of the Kimberley (McKenzie 1981). For example, Dahl (1897) reported that "*the houses of settlers* (around Broome) *are always*

tennanted by (this species)", but it has not been reported from there subsequently.

Conservation reserves where reported:
Two of the three Northern Territory records of golden-backed tree-rat are from the edges of Kakadu National Park (imprecision in the location of historic records is such that it is not clear whether the records were from within or beyond the border of Kakadu NP). It is not known from any other conservation reserve in the Territory.

Ecology

There is very little known of the ecology of this species. The only information from the Northern Territory is that all three records were from riverine vegetation. In the Kimberley, it has been recorded from a broad range of vegetation types, including eucalypt open forests with tussock grass understorey, rainforest patches on a variety of landforms and soils, eucalypt woodlands with hummock grass understorey, rugged sandstone screes, beaches, and blacksoil plains with pandanus. It roosts in tree hollows or, less commonly, in loosely woven nests under the spiky crown of pandanus. Its diet includes seeds, fruits, invertebrates, grass and leaves, and it forages both on the ground and in trees.

Conservation assessment

The remarkably few records from the Northern Territory provide a poor base for assessing status. A decline can be inferred based on the lack of recent records despite substantial survey effort, but it is not possible to say when the decline occurred, or if it is ongoing. The scarcity of historic records suggests that it was already rare in the Northern Territory at the onset of European settlement, or that it declined extremely rapidly thereafter. Historic and ongoing decline in the Territory population and range can be reasonably inferred from the marked decline evident in the better record from north Western Australia.

The Northern Territory status can be considered to be **Endangered (**under criteria B1ab(I,ii,iii,iv,v); C2a(i)) based on:

- extent of occurrence estimated to be <5,000 km^2
- population size estimated to number <2,500 mature individuals
- severely fragmented or known to exist at no more than five locations
- a continuing decline, observed, projected or inferred and
- no subpopulation estimated to contain more than 250 mature individuals.

There is a high level of uncertainty (about total population size and extent of occurrence), but the assessment is probably reasonable.

Threatening processes

No single factor has been demonstrated to have caused the decline of golden-backed tree-rats, but the extent of loss on the mainland and the maintenance of some island populations (in WA) suggests that it is probably not due to land use factors but rather to either disease or exotic predators. The most likely causal factor is predation by feral cats (Palmer *et al.* 2003).

However, it is possible that broad-scale habitat change may have contributed to the apparent decline. Changed fire regimes, weeds and grazing by livestock and feral animals may have changed the availability of preferred or vital food resources (e.g. seeds from particular grass species), and more frequent hot fires may have reduced the availability of hollow logs, tree hollows and the tall fruit-bearing understorey shrubs.

Conservation objectives and management

There is no existing management program for the wild population of this species in the Northern Territory. However, a national draft recovery plan has been produced (Palmer *et al.* 2003) and is now being assessed. This plan includes actions that (1) develop and implement cooperative management arrangements on lands with important populations; (2) establish a multiple species recovery team; (3) monitor populations; (4) survey sites of historic and recent unconfirmed records; (5) and undertake targeted research to identify key threatening factors and viable methods to mitigate these.

Information on abundance and/or status in Kakadu NP

The status of this species in Kakadu NP, and the Northern Territory generally, is puzzling. It is clearly very uncommon and/or highly localised. It has not been recorded in any of the extensive fauna surveys undertaken over the last 30 years in Kakadu NP, despite sampling in apparently suitable habitat and use of suitable traps. The last confirmed record in the Kakadu area was the Deaf Adder Gorge specimen, in 1969. There has been only very limited subsequent sampling in this area (McKenzie and Kerle 1995). One unconfirmed record near Gerowie Creek in 1993 (Fisher et al. 1993) was further investigated, unsuccessfully, by trapping and searching of tree hollows.

Information on monitoring in Kakadu NP

Consistent with the lack of recent records, there is currently no monitoring program for this species in Kakadu NP. Should a population be relocated in either of both Nellie Creek or Deaf Adder Gorge area, that population, and its response to management, should be monitored at 2-3 year intervals.

Importance of Kakadu NP relative to total range

Uncertain: the Deaf Adder record is the most recent confirmed report from the Northern Territory, and hence may represent one of the few remaining pockets of its NT distribution. However, it is not certain that the Deaf Adder population (or any other in Kakadu) persists.

Beyond the Northern Territory, the Kimberley is the stronghold of this species (Palmer *et al.* 2003), although it is in decline in at least parts of its range there.

Compiled by

John Woinarski.
[February 2002]

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FALSE WATER-RAT
Xeromys myoides

Conservation status

Australia (*Environment Protection and Biodiversity Conservation Act 1999*): Vulnerable.

Northern Territory (*Territory Parks and Wildlife Conservation Act 2000*): Vulnerable.

Description

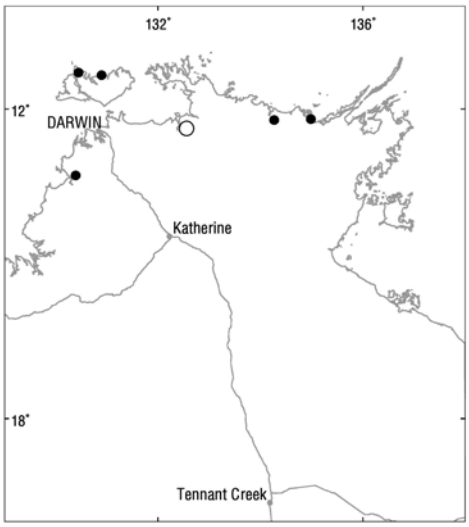
The false water-rat is a small (35-50g) rodent of unmistakeable appearance. The most distinctive external features are a broad relatively short face, and very short sleek fur. Fur colour is pale grey above and white below. Eyes and ears are relatively small.

False water-rat

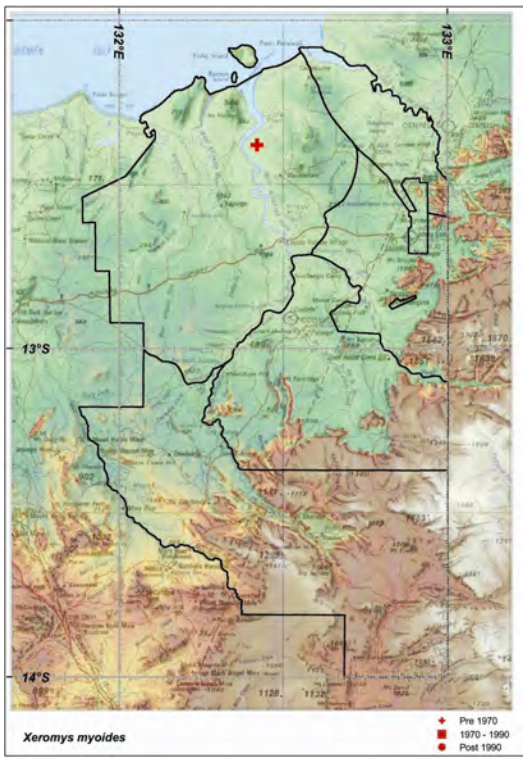
Distribution

In the Northern Territory, it is known from only 10 records at 6 sites (South Alligator River in 1903, Daly River floodplain in 1972, two sites on the Tomkinson River in 1975, Melville Island in 1975 and Glyde River floodplain in 1998 and 1999) (Redhead and McKean 1975; Magnusson *et al.* 1976; Woinarski *et al.* 2000). Beyond the Northern Territory, it is also known from three sites in coastal south-eastern Queensland and one site in New Guinea.

Conservation reserves where reported: Kakadu National Park.



Known locations of the false water-rat.
o = pre 1970; • = post 1970.



Ecology

The ecology of the species is reasonably well known from a detailed study on North Stradbroke Island, Queensland (Van Dyck 1996). The false water-rat is a nocturnal predator eating mainly marine and freshwater invertebrates, especially including crabs, pulmonates and molluscs. It forages entirely on the ground, and is an adept swimmer. It builds and shelters in either burrows or substantial earthen mounds.

Its habitats comprise mangrove forests, freshwater swamps and floodplain saline grasslands (Woinarski *et al.* 2000).

Conservation assessment

Conservation assessment is hampered by the lack of precise information on range, population size and trends, to such an extent that it may qualify best as *data deficient*. However, in the Northern Territory, it can be assigned the status of **vulnerable** on the set of criteria B2ab (area of occupancy estimated to be less than 2000km^2; severely fragmented or known to exist at no more than 10 locations; and continuing decline, observed, inferred or projected in area of occupancy, area, extent and/or quality of habitat, and number of locations or subpopulations.

This assignment rests on a presumption that only a small proportion of the Territory's mangroves and floodplains is suitable for (and/or occupied by) the species, and that a range of factors (including saltwater intrusion, spread of weeds, especially *Mimosa pigra*, and grazing of the floodplains by domestic and feral water buffalo and cattle) are operating to reduce habitat quality.

Threatening processes

There is insufficient information available to assess the impacts of possible threatening processes. There may be some predation by feral cats. However, the most plausible threatening processes relate to broad-scale habitat changes, especially those due to saltwater intrusion, spread of weeds and impacts of grazing. However, it is not clear that these changes necessarily reduce habitat quality for this species, and they are unlikely to diminish the extent of mangrove communities.

Conservation objectives and management

The main priorities are to better define the distribution and status of this species and to assess the impacts of a range of putative threatening processes. Such information is needed before management prescriptions can be formulated appropriately.

Information on abundance and/or status within Kakadu NP

The only record from Kakadu was one specimen collected in 1903, considered to be from "the coastal plain and tidal section of the South Alligator" (Parker 1973).

Information on monitoring in Kakadu NP

No existing monitoring. The single specimen collected, and the relatively sparse survey effort, are inadequate baseline for a monitoring program.

Importance of Kakadu NP relative to total range

Uncertain. With no records from Kakadu for more than a century, the species may no longer be present. However, there has been relatively little recent survey work in its presumed habitat. If still present in Kakadu, this would be the only reserved population in the Northern Territory.

Compiler

John Woinarski
[March 2002]

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ARNHEM ROCK-RAT
Zyzomys maini

Conservation status

Australia (*Environment Protection and Biodiversity Conservation Act 1999*):
Not listed.

Northern Territory (*Territory Parks and Wildlife Conservation Act 2000*):
Vulnerable.

Description

The Arnhem rock-rat is a large (100-150 g) rat distinguished from most other Northern Territory rodents by its large whiskers, typically swollen tail (especially at the base), the long hairs towards the tip of the tail, and the characteristic roman nose. It shares these features with the much smaller (30-70 g) common rock-rat *Z. argurus* , from which it can be separated by size, colour (typically more grey than brown), and higher density of long hairs on the tail.

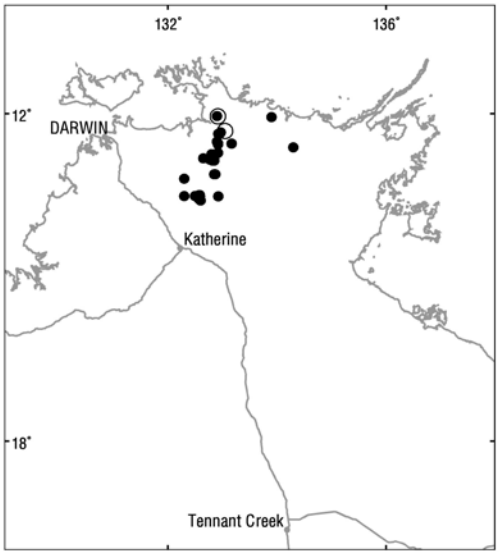
The rock-rats have fragile tails and fur, and many individuals may have no or greatly reduced tails, presumably as a consequence of predator attack.

Arnhem rock-rat (Photo: Greg Miles)

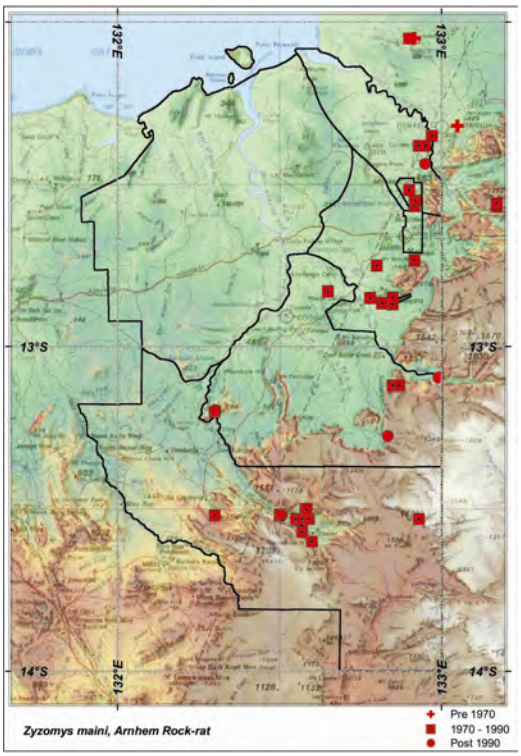
Distribution

The Arnhem rock-rat is endemic to the sandstone massif of western Arnhem Land. This area encompasses about 34,000 km², but a high proportion of this area comprises habitat that is probably unsuitable for this species.

Until recently, it was considered conspecific with the Kimberley rock-rat *Z. woodwardi*, now regarded as restricted to the north Kimberley (Kitchener 1989).



Known locations of the Arnhem rock rat.
o = pre 1970; ● = post 1970.



Conservation reserves where reported:
Kakadu National Park.

Ecology

The ecology of the Arnhem rock-rat is relatively well known from a series of studies at Little Nourlangie Rock in Kakadu National Park (Begg and Dunlop 1980,

1985; Begg 1981; Begg *et al.* 1981). It is an entirely terrestrial, nocturnal species, restricted to areas with large sandstone boulders or escarpment with fissures and cracks. It occurs in these areas very patchily, being restricted mostly to monsoon rainforest patches, notably in gullies and along creeklines, or in fire-protected refugia. This is a much narrower habitat than that occupied by the common rock-rat. The Arnhem rock-rat's diet comprises mainly seeds, fruit and some other vegetable matter. The seeds eaten include those from many species of rainforest tree. Large seeds may be cached, or at least moved to be eaten at relatively safe sites, resulting in distinctive piles of chewed hard seeds in rock fissures or under large overhangs. On the basis of its response to a single large fire, the Arnhem rock-rat appears to be unusually fire-sensitive, with substantial decline for at least 1-2 years post-fire (Begg *et al.* 1981). A high frequency of fire will result in diminution of its preferred sandstone monsoon rainforests (Russell-Smith *et al.* 1993, 1998).

Conservation assessment

Conservation assessment is hampered by the lack of precise information on range, population size and trends. Decline can be presumed on the basis of the current high frequency of fire across much of the western Arnhem Land plateau (Russell-Smith *et al.* 1998), and resultant decline in its preferred habitat, monsoon rainforests, there (Russell-Smith and Bowman 1992; Russell-Smith *et al.* 1993, 1998).

It best fits the status of **Vulnerable** (under criteria B1ab(ii,ii,iv,v)+2ab(ii,ii,iv,v)) based on:

- extent of occurrence estimated to be <20,000km^2;
- area of occupancy estimated to be <2,000km^2;
- severely fragmented or known to exist at no more than 10 locations; and
- continuing decline, observed, inferred or projected.

Threatening processes

The major threatening process appears to be reduction in habitat suitability and/or extent due to increased frequency of extensive hot late dry season fires. It is possible that this species will benefit from the invasion of cane toads, as these may reduce the abundance of the rock-rat's predators.

Conservation objectives and management

Management priorities are:
(i) to reduce the incidence of extensive, hot late dry season fires; and
(ii) to establish a program for monitoring the status of at least one subpopulation, but preferably more, and preferably in association with a range of fire management practices, in order to help refine best management practice.

Information on abundance and/or status within Kakadu NP

The Arnhem rock-rat is (or was) locally common in sandstone sites with massive boulders, escarpment and fissures, and especially so where these sites support monsoon rainforest plants that bear fleshy fruits. There are quantitative estimates of abundance at two main sites in Kakadu - Nawurlandja (Begg 1981) and Jabiluka (Kerle and Burgman 1984), and measures of abundance and distribution arising from a series of more broad-ranging wildlife surveys (Woinarski *et al.* 2002). While these studies and samples provide local measures of abundance, the patchy nature of its distribution means that these estimates cannot be reliably extrapolated to an estimate of the total number in Kakadu.

Information on monitoring in Kakadu NP

There are four components that could contribute to a regular monitoring program for this species in Kakadu.

Nawurlandja (Little Nourlangie Rock).
An intensive study of this species was undertaken in four habitats at Nawurlandja from 1977-1980 (Begg 1981; Begg *et al.* 1981) that serves as a good baseline for ongoing monitoring. The sampling regime was replicated in 2002 (Watson and Woinarski 2003). The results are summarised below.

Mean abundance of Arnhem rock-rat (% trap success) in 4 habitats at Nawurlandja (March-May sampling).

	1977-79	1980	2002
rocky crevices	0.41	1.00	0
closed forest	0.81	1.00	0
rocky slopes	0	0.93	0
scree slopes	0.22	0.75	0

Jabiluka

Around Jabiluka, Kerle and Burgman (1984) sampled 40 sites over the period 1979-81; these sites were revisited in 2003 (Watson and Woinarski 2004).

Mean abundance (% trap success) of Arnhem rock-rat across 40 sub-sites around Jabiluka.

1979-81	2003
0.48	0.15

Stage III fauna survey sites

In Stage III (Mary River district) of the Park, 263 quadrats were sampled in 1988-90 and again in 2001 (Woinarski *et al.* 2002). The results are summarised below.

Mean abundance of Arnhem rock-rat (% trap success) across 263 quadrats in Stage III.

1988-90	2001
0.24	0.04

Fire Monitoring Plots

As at July 2004, 114 fire plots had been sampled for fauna. Arnhem rock-rats have been recorded in 3 of those plots (Watson and Woinarski 2004). The set of all fire plots provides some baseline for ongoing monitoring of this species.

Importance of Kakadu NP relative to total range

High: Kakadu includes about one quarter of the known range of this species, and is the only area in which it occurs that is managed with a priority for biodiversity conservation.

Compiled by

John Woinarski
[March 2002]

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3. RESEARCH AND MANAGEMENT IMPLICATIONS AND PRIORITIES

Research and management priorities for Kakadu threatened species, 1995-2004.

The last planning document for a threatened species program for Kakadu National Park (Roeger and Russell-Smith 1995) provided a set of research and management recommendations for the period 1995-2002. These recommendations are collated in Table 5, and serve to provide a context and baseline for current priorities. In general, these recommendations were explicitly or implicitly included within the Kakadu Plan of Management for the period 1999-2004 (Kakadu Board of Management and Parks Australia 1999).

As evident from Table 4, most of the recommended actions were undertaken, to at least some degree, over the 1995-2002 period. For the purposes of this report, activities conducted in 2002-04 are also included. In addition, Kakadu threatened species benefited from broad-scale park management of fire, feral animals and weeds; and the establishment of a broad-scale monitoring program for terrestrial vertebrates (Watson and Woinarski 2003, 2004) provided some additional information on the abundance, distribution and trends in status for some threatened animal species, and served to highlight concerns for some species not yet listed as threatened.

The relevance of the set of recommended actions for threatened species management from 1995 has also been affected by the substantial increase in the number of threatened species listed since 1995; with many actions undertaken in recent years for species that were not considered as threatened at the time of writing of the 1995 report.

The recommendations not fully enacted over the 1995-2004 period most notably include:

(i) specific surveys for gouldian finch, golden-backed tree-rat, false water-rat, oenpelli python, and yellow-snouted gecko;

(ii) establishment of monitoring programs for the brush-tailed phascogale and pig-nosed turtle (and of an ethnoecological study of the latter, considering particularly issues related to sustainable use);

(iii) the development of an invertebrate issues paper; and

(iv) the development of an enhanced GIS, data base and data entry facility more widely used by Kakadu staff and visitors.

Table 5. Recommendations for actions proposed for the 1995-2002 Endangered Species Program in Kakadu NP (Roeger and Russell-Smith 1995), along with assessment of whether the recommended action was taken and successful.

Reference no.	species affected	Described recommended action	Activity 1995-2004
3.2. (i)	loggerhead turtle	Given the low numbers of these turtles sighted in Kakadu coastal waters no specific research or monitoring program is warranted. A general survey of the Van Diemen Gulf area is warranted, in conjunction with the CCNT, as well as the undertaking of a more extensive survey of the Arafura Sea to the east. Such a survey would benefit from the involvement of Aboriginal custodians and communities throughout the region, given that they hold detailed ecological knowledge of this species.	Marine resource inventory of east Van Diemen Gulf , Goulburn Islands area and Castlereagh Bay to be conducted in November 2004, in collaboration with NLC, NOO, NT DIPE and MAGNT.
3.2. (ii)	green turtle	as above	Survey conducted of foraging turtles adjacent to Field Island in 2002 and 2003, and samples contributed to national population genetics (stock assessment) program under the national recovery plan for marine turtles.
3.2. (iii)	olive ridley	As for loggerhead turtle generally, but given that this species is known to nest occasionally on Field Island and at West Alligator Head in the Park, ongoing monitoring of nesting success of this species is warranted. Such a program has been undertaken over the past two years in the Park, focusing on the unlisted flatback turtle; ongoing support for this program is required.	Monitoring program on Field Island was maintained, as recommended. Note that no nesting of this species was recorded at Field Island over this period.
3.2.(iv)	gouldian finch	Evident need for a comprehensive survey of potential breeding habitats in the Park, and also of woodland habitats in the late dry season in general to assess the status of Kakadu as a refuge for this species. This survey should be undertaken in conjunction with the Gouldian Finch Recovery Team and Plan. Advice of Aboriginal custodians should be sought also given detailed local knowledge and information concerning this species.	No specific survey undertaken, but some incidental records acquired as part of more broadly-based wildlife survey and monitoring programs.
3.2. (v)	ghost bat	There appears little requirement for further survey work on this species in Kakadu at the present time.	subsequently de-listed
3.2. (vi)	red goshawk	There is little need for further survey work in Kakadu concerning this species. Monitoring of nests may be required to stop human predation. Opportunistic monitoring of known nesting sites by reputable	As recommended, no substantial action.

Reference no.	species affected	Described recommended action	Activity 1995-2004
		researchers should continue, but the location of nest sites should not be made known to the public.	
3.2. (vii)	golden-backed tree-rat	Further survey work in the vicinity of the recent sighting in Kakadu should be undertaken, in consultation with the CCNT	Some detailed search undertaken around the Gerowie Creek possible sight record.
3.2. (viii)	false water-rat	A survey of potential habitat in Kakadu should be undertaken, but only after seeking expert advice. Survey to be undertaken in conjunction with CCNT	No survey conducted.
6.2.1. (i)		ANCA continue to support a long-term program for marine and estuarine inventory in the Park	As recommended, estuarine fish surveys were conducted in collaboration with MAGNT (Larson, 1997, 1999 and 2002). Further marine surveys to be conducted in 2004 (see 3.2 (i) above.
6.2.1. (ii)		ANCA should provide no consultancy funding to the Australian Littoral Society until their unfinished and long-overdue report on tidal wetlands and marshes in Kakadu is completed.	Wetlands survey data were recovered by *eriss* and a follow-up survey undertaken by them in 2003 (Saynor *et al.* 2003; Mitchell *et al.* 2003).
6.2.1. (iii)		ANCA continue to support botanical survey work targeting sandstone heath communities of the Arnhem Land plateau and escarpment.	Major surveys for threatened plants were commissioned in 2003 and 2004, with focus particularly on sandstone environments(Kerrigan 2003 and 2004). Ongoing work has been undertaken examining the response of fire-sensitive obligate seeder , heath shrub species, with two papers published (Russell-Smith et al. 1998, 2002). Further studies are being undertaken with respect to reproductive ecology of *Callitris intratropica*, and *Petraeomyrtus* (syn. *Regelia*) *punicea*, and more generally associated with sandstone fire monitoring plots.
6.2.1. (iv)		ANCA commission an invertebrate issues paper addressing prioritised survey requirements for the Park. Further, it is recommended that such a paper should target: (a) species/groups of the escarpment and plateau, particularly those which may provide useful indicators with respect to fire regime; and (b) freshwater and marine groups which likewise may	No specific invertebrate issues paper was commissioned. eriss has conducted studies on freshwater invertebrates as indicators of water quality (for assessing mining impact), and taxonomic and distribution/abundance

Reference no.	species affected	Described recommended action	Activity 1995-2004
		act as useful indicators of water/habitat quality.	studies (esp. endemic stone country taxa) to contribute to understanding World Heritage values (Bruce 1993, Bruce & Short 1993). Apart from type specimens referred to in published taxonomic studies, the substantial collection of invertebrates held by eriss is yet to be catalogued.
6.2.1. (v)	Leichhardt's grasshopper	ANCA fund the undertaking of research into the fire ecology of the flagship invertebrate species, the Leichhardt's grasshopper, and other grasshoppers in sandstone escarpment and plateau habitats.	As recommended, a major study on Leichhardt's grasshopper was commissioned (Wilson et al 2003, Barrow 2004).
6.2.2. (i)		ANCA fund the undertaking of ecological research into the role of fire in Arnhem Land escarpment and plateau communities as a matter of high and urgent priority. Such research should target also the Leichhardt's grasshopper and a number of other identified faunal species.	Fire monitoring plots established to record response of plants and animals to fire regimes, with particular emphasis on sandstone environments (Turner *et al.* 2001).
6.2.2. (ii)		ANCA continue to support research into the control and monitoring of important feral plants (especially Mimosa, Salvinia, Para grass, Mission grass, Gamba grass and legumes in general), and animal species (especially pigs, buffalo, horses, cats, cane toads, and European bees).	Ongoing funding for management and collaboration with partners including eriss, Charles Darwin University and CSIRO into feral and weed control and management (Cook *et al.* 1996, Cook 1998, Douglas *et al.* 2001, Hoffman and O'Connor 2004). A feral animal strategy was commissioned in 2001 with final report due in 2004.
6.2.3. (i)		Key identified data sets need to be digitised and thus made available on Kakadu's GIS; in particular, the CSIRO fauna survey of Stages I and II of the Park, and the unfinished Australian Littoral Society's tidal wetlands survey	As recommended, the CSIRO fauna data have been recorded in data files. Wetlands survey data were recovered by *eriss* and a follow-up survey undertaken by them in 2003 (Saynor *et al.* 2003; Mitchell *et al.* 2003).
6.2.3. (ii)		Key fauna sites need to be relocated, their locations accurately recorded with GPS, and the sites themselves permanently marked; in particular five as yet unrelocated fauna sites from the CSIRO Stages I and II survey, and all CSIRO Stage III survey sites.	A high proportion of the CSIRO Stage III survey sites were re-visited and their location precisely recorded with GPS.
6.2.3. (iii)		All future biological survey consultancies in Kakadu to provide data in	All major fauna surveys have provided data

Reference no.	species affected	Described recommended action	Activity 1995-2004
		an appropriate digital form, accessible to the Park's GIS	in digital form.
6.2.3. (iv)		That recording of incidental sightings of notable fauna species be undertaken in conjunction with the CCNT's Biological Records Scheme	No data base for entry of incidental sightings has been established and promulgated; but records of some such sightings have been data based.
6.2.3. (v)		ANCA continue to support the development of a fine-scale (1:25,000) habitat map of the Park. Such development needs to be staged, with the mapping of sandstone escarpment and plateau habitats a first and high priority. Mapping of lowland and floodplain habitats should then be undertaken sequentially.	Some fine-scale vegetation mapping of the western Arnhem Land plateau is currently being undertaken.
6.2.3. (vi)		ANCA provide a full-time designated position for undertaking the management and curation of databases acquired over the years in a range of project areas in Kakadu, including those assembled for the Park's GIS. This is an urgent and high priority given that millions of dollars have been spent acquiring these data.	Some management and curation of data bases is being maintained.
7.1		Species surveys*. Surveys should be conducted to determine the status of gouldian finch (priority 1); golden-backed tree-rat, false water-rat (priority 2); oenpelli python, yellow-snouted gecko, partridge pigeon, and brush-tailed rabbit-rat (priority 3).	Of the 7 species listed, studies of the status of two species (partridge pigeon (Fraser 2000, 2003), brush-tailed rabbit-rat) have been conducted.
7.2		Species monitoring*. Monitoring programs should be implemented for the flatback turtle, pig-nosed turtle, and brush-tailed phascogale. An ethno-ecological study should be implemented for the pig-nosed turtle.	Of the 3 species listed, a monitoring program has been maintained for one (flatback turtle – Schauble 2002; KNP 2004).

* the list of species suggested for survey and monitoring included additional species that were not listed as threatened in either 1995 or now, and these species are not listed here.

Current priorities: Introduction and collation

The collection of threatened species reported here from Kakadu NP spans an extraordinary range of taxonomic groups, habitats and management issues. The urgency and significance of management actions is great for some species, but relatively minor for others. Management obligations are complex, affected by a web of regulations arising from Australian legislation, laws operating in the Northern Territory and international treaties. Limitations on resource availability will inevitably constrain research and management actions. In this section of the report, the information from all threatened species is collated (Table 6) in order to attempt to distil priorities for ongoing research and management.

There are a set of overlapping or independent criteria that can be used to help guide prioritisation for management action. These are each summarised below.

1. *Legislative requirements.* Australia's overarching environmental legislation, the *EPBC Act*, places particular emphasis on the conservation and management of species listed as threatened at national level. For Kakadu, this set comprises:

    Boronia laxa
    B. rupicola
    B. suberosa
    B. verecunda
    B. xanthastrum
    Sauropus filicinus
    speartooth shark
    northern river shark
    dwarf sawfish
    freshwater sawfish
    loggerhead turtle
    green turtle
    olive ridley
    flatback turtle
    red goshawk
    partridge pigeon
    masked owl
    northern shrike-tit
    gouldian finch
    golden bandicoot
    bare-rumped sheath-tail bat
    golden-backed tree-rat
    false water-rat.

    Further, this legislation states that agencies responsible for managing Commonwealth lands (a category which includes Kakadu NP) should prepare inventories/surveys that assess the abundance of those terrestrial species and the range of those marine species that are listed as threatened under the *EPBC Act*.

    While recent targeted surveys have provided some assessments of the abundance of the six federally-listed plant species, for most of the listed animal species, there is little suitable abundance data available. It follows that one priority action should be targeted surveys that aim to assess the population size within Kakadu NP of the 16 federally-listed animal species.

2. *Persistence in Kakadu*. Some of the listed threatened species have not been recorded in Kakadu for many years. In some case, the species may no longer be present within the Park area: and such ghost species should not influence ongoing management. The species not recorded in recent years from Kakadu are:

species	**last recorded in Kakadu**	**notes**
northern shrike-tit	1976	the only report from Kakadu
golden bandicoot	1967	one of only two reports from the Kakadu area, the previous being in 1903
bare-rumped sheathtail-bat	1980	one of only two reports from the Kakadu area, the previous being in 1979
golden-backed tree-rat	1969	one of only two reports from the Kakadu area, the previous being in 1903
false water-rat	1903	the only report from Kakadu

There is merit in attempting to clarify the currently very uncertain status of these species in Kakadu, by explicit carefully targeted searches.

3. *Significance of Kakadu for the conservation of the species*. For some threatened species, Kakadu includes all or most of their known range and population. For other species, Kakadu populations are peripheral, marginal or relatively minor. Management in Kakadu may make more contribution to the conservation for the former set of species rather than for the latter. The threatened species for which Kakadu comprises an important part of the range or population are:

Acacia D19063 Graveside Gorge
Boronia laxa
B. rupicola
B. suberosa
B. verecunda
B. xanthastrum
Calytrix inopinata
Hibiscus brennani
Lithomyrtus linariifolia
Sauropus filicinus
pig-nosed turtle
yellow-snouted gecko
Arnhemland egernia
oenpelli python
partridge pigeon
white-throated grass-wren
yellow chat
northern brush-tailed phascogale
Arnhem leaf-nosed bat
Arnhem rock-rat;

with uncertain but possibly high significance for the freshwater tongue sole, speartooth shark, northern river shark, freshwater sawfish, golden bandicoot, bare-rumped sheathtail-bat, golden-backed tree-rat and false water-rat.

4. *Degree of threat*. It can be argued that prioritisation for remedial actions and management should reflect the urgency of threat, with endangered species meriting more attention than vulnerable species. On either national or Northern Territory lists, the following species are considered:

critically endangered:	speartooth shark bare-rumped sheath-tail bat
endangered:	*Utricularia subulata*, freshwater tongue sole northern river shark loggerhead turtle olive ridley yellow chat gouldian finch golden bandicoot golden-backed tree-rat.

The currently unlisted plant *Acacia* D19063 Graveside Gorge has been proposed to be listed as Critically Endangered in the forthcoming revision of the Northern Territory's listing.

5. *Decrease prioritisation to species likely to be de-listed.* Largely because of research commissioned by PAN, increased information now suggests that the current listing of some species is not justified. These species are:

   Boronia suberosa, Calytrix inopinata, Helicteres D21039 *linifolia*, and freshwater tongue sole (all to be de-listed from the Northern Territory threatened species list); and

   Boronia laxa, B. rupicola, B. suberosa, B. verecunda and *B. xanthastrum*. (all considered to be no longer eligible for threatened status at national level).

   These species should not be discounted completely, because all are undoubtedly rare and/or relatively restricted, and most continue to be affected by some threatening processes. Also, the process of de-listing (especially for federally-listed species) can take some considerable time, even after submission of a case for such de-listing, so these species may well be retained on Kakadu's list of threatened species for many years yet, and it would be inappropriate to omit them from management considerations at least over that period.

There are a range of other factors that can affect prioritisation of research and management actions for Kakadu's threatened species. These include the cultural significance of the species; the significance of the species for ecological function; the achievability (and cost-effectiveness) of research and management actions for the species; the value of the species as an indicator for a broader range of species or management concerns; and the extent to which work on the species is being conducted outside Kakadu.

Table 6. Summary list of threatened species recorded from Kakadu NP, indicating significance of Kakadu, major threats, existence of any monitoring program and habitat. Abbreviations: CE=Critically Endangered; EN=Endangered; VU=Vulnerable. For Northern Territory status only: NT=Near Threatened, LC=Least Concern and DD=Data Deficient.

Scientific name	Common Name	NT Status	EPBCA	significance of Kakadu to species	major threats	existing monitoring in Kakadu	habitat
Acacia D19063 Graveside Gorge		NA*	not listed	high	Fire	baseline	sandstone
Boronia laxa		NT	VU	high	Fire	recently established	sandstone
Boronia rupicola		NT	VU	high	Fire	recently established	sandstone
Boronia suberosa		VU#	VU	high	Fire	recently established	sandstone
Boronia verecunda		NT	VU	high	Fire	recently established	sandstone
Boronia xanthastrum		NT	VU	high	Fire	recently established	sandstone
Calytrix inopinata		VU#	not listed	high	Fire	recently established	sandstone
Cycas armstrongii		VU	not listed	low	fire, exotic grasses	nil	lowland woodland
Dubouzetia australiensis		EN	not listed	low-medium	Fire	recently established	sandstone
Gleichenia dicarpa		VU#	not listed	medium	Fire	nil	sandstone
Helicteres D21039 linifolia		VU#	not listed	medium	Fire	recently established	lowland woodland
Hibiscus brennanii		VU	not listed	high	Fire	recently established	lowland woodland
Lithomyrtus linariifolia		VU	not listed	high	fire	recently established	sandstone
Malaxis latifolia		VU	not listed	medium	feral pigs	nil	lowland rainforest
Monochoria hastata		VU	not listed	low	exotic grasses; saltwater intrusion	recently established	swamp
Sauropus filicinus		DD	VU	high	fire	recently established	sandstone
Utricularia subulata		EN	not listed	low	hydrological change	nil	lowland wet heath
Taractrocera ilia ilia	Northern Grassdart Butterfly	VU	not listed	medium	fire	nil	sandstone
Cynoglossus heterolepis	Freshwater Tongue Sole	EN	not listed	?high	?	nil	f/w river
Glyphis sp.A.	Speartooth Shark	EN	CE	?high	?fishing	nil	estuarine; f/w river
Glyphis sp. C.	Northern River Shark	EN	EN	?high	?fishing	nil	estuarine; f/w river
Pristis clavata	Dwarf Sawfish	VU	not listed	medium	?fishing	nil	marine; estuarine; f/w river
Pristis microdon	Freshwater Sawfish	DD	VU	?high	?fishing	nil	estuarine; f/w river
Caretta caretta	Loggerhead Turtle	EN	EN	low	?fishing; harvesting;	nil	coastal&marine
Chelonia mydas	Green Turtle	LC	VU	medium	?fishing, harvesting	nil	coastal&marine
Lepidochelys olivacea	Olive Ridley	DD	EN	low	?fishing, harvesting	limited	coastal&marine

Scientific name	Common Name	NT Status	EPBCA	significance of Kakadu to species	major threats	existing monitoring in Kakadu	habitat
Natator depressus	Flatback Turtle	DD	VU	medium	?fishing, harvesting; nest predation by feral pigs, dogs and goannas	regular, at breeding sites	coastal&marine
Carettochelys insculpta	Pig-nosed Turtle	NT	(VU)**	high	feral pigs; water quality; harvesting	baseline	f/w river
Diplodactylus occultus	Yellow-snouted Gecko	VU	not listed	high	fire; exotic grasses	nil	lowland woodland
Egernia obiri	Arnhemland Egernia	DD*	not listed	high	?cats; fire	nil	sandstone
Morelia oenpelliensis	Oenpelli Python	VU	not listed	high	?illegal take	nil	sandstone
Dromaius novaehollandiae	Emu	VU	not listed	low	fire	nil	lowland woodland
Erythrotriorchis radiatus	Red Goshawk	VU	VU	low-medium	?fire	nil	lowland woodland
Ardeotis australis	Australian Bustard	VU	not listed	low	?fire; hunting	nil	lowland woodland; grassland
Geophaps smithii smithii	Partridge Pigeon	NT	VU	high	fire; predation by feral cats, dogs and pigs	some irregular counts	lowland woodland
Tyto novaehollandiae kimberli	Masked Owl	NT	VU	low	?fire	nil	lowland woodland
Amytornis woodwardi	White-throated Grasswren	VU	not listed	high	fire	nil (although some baseline information)	sandstone
Epthianura crocea tunneyi	Yellow Chat	EN	not listed	high	fire; exotic grasses; feral stock	nil	floodplain
Falcunculus (frontatus) whitei	Northern Shrike-tit	DD	VU	low	?fire	nil	lowland woodland
Erythrura gouldiae	Gouldian Finch	EN	EN	medium	fire; exotic grasses; grazing	nil	lowland woodland
Dasyurus hallucatus	Northern Quoll	VU	(VU)**	?	toads; fire		sandstone; lowland woodland
Phascogale (tapoatafa) pirata	Northern Brush-tailed Phascogale	VU	not listed	high	?fire	nil	lowland woodland
Isoodon auratus auratus	Golden Bandicoot	EN	VU	?	?fire; predation by feral cats	nil	sandstone (?)
Saccolaimus saccolaimus nudicluniatus	Bare-rumped Sheathtail Bat	DD	CE	?	?fire	nil	lowland woodland
Hipposideros (diadema) inornata	Arnhem Leafnosed Bat	VU	not listed	high	?	nil	sandstone
Conilurus penicillatus	Brush-tailed Rabbit-rat	VU	not listed	medium	?fire; predation by feral cats; grazing; exotic grasses	some baseline	lowland woodland

Scientific name	Common Name	NT Status	EPBCA	significance of Kakadu to species	major threats	existing monitoring in Kakadu	habitat
Mesembriomys macrurus	Golden-backed Tree-rat	EN	VU	?	?fire; predation by feral cats; grazing; exotic grasses	nil	sandstone (?)
Xeromys myoides	Water mouse (False water-rat)	DD	VU	?	?fire; grazing; exotic grasses; predation by feral cats	nil	floodplain; swamps; mangroves
Zyzomys maini	Arnhem Rock-rat	VU	not listed	high	fire	some baseline and re-sample	sandstone

* These species is not currently listed, but are likely to be added in the near future.

** These species have been nominated as Vulnerable in 2004, and are now in the process of assessment.

\# downlisting proposed

Threatened species occur across all of Kakadu's management districts (Appendix B). They occur in most of Kakadu's main habitats (Table 6), but probably especially so in sandstone plateau and escarpment areas.

The threatened species span a broad range of life forms and management issues. In some cases, populations in Kakadu are quarantined from the factors that have detrimentally affected the species elsewhere (for example, gill-netting). In other cases (such as marine turtles), protection of populations in Kakadu does not provide such a quarantine, because individuals range widely from Kakadu to areas that offer far less protection. In yet other cases, the factors that affect the threatened species operate across the entire landscape and may be little or no more controlled in Kakadu than in lands under other tenure: feral cats may be such an example.

Table 6 provides a coarse summary of the main threatening factors affecting listed species in Kakadu. In some cases, there is little or no certainty about which factors are actually affecting threatened species, or the relative importance of individual factors. In almost all cases, there is little or no quantitative data on the extent of response of threatened species to differing levels of management control of putative threatening processes, such that it is impossible to derive any detailed or justified cost-benefit information for a range of possible management alternatives.

Nonetheless, some major threat themes are evident from the collation of species in Table 6. Each is discussed briefly below.

fire

Fire is a presumed threatening process for almost all of the listed terrestrial plant and animal species, and may be the factor most amenable to management intervention. For most of the threatened species affected by fire, the preferred fire regime would seem to be less frequent – or requiring greater temporal and spatial heterogeneity - than that currently operating. This appears to apply particularly to species associated with the stone country, and especially so to a set of obligate re-seeder plant species. Management for threatened species in the stone country should aim to reduce fire frequency and extent.

In the lowlands, fewer threatened species are as clearly affected by fire. The preferred fire regime of threatened lowland species (such as partridge pigeon and northern quoll) may be a fine-scale mosaic of burnt and unburnt patches, with fires optimally being relatively small (<10 ha) and cool.

feral animals

There is little evidence that feral animals are a major factor affecting threatened species in Kakadu NP. In part, this may be because the influence of feral animals is more diffuse and less noticeable than the operation of fire on the landscape.

Predation by feral cats may be a primary cause of decline in some of Kakadu's threatened mammals (golden-backed tree-rat, brush-tailed rabbit-rat, false water-rat, golden bandicoot, northern brush-tailed phascogale) and possibly ground-dwelling and -nesting birds (such as partridge pigeons), but there are few data to support or refute this case. Management of feral cats in Kakadu is difficult (Watson and Woinarski 2004), but broad-based control mechanisms

specifically targeting feral cats are being developed in other jurisdictions, and may become more widely available and feasible over the course of the next decade.

The recent arrival of cane toads in Kakadu has led directly to the precipitous decline of northern quoll, and marked reduction in some other species not currently listed as threatened (notably some goanna species). At this stage, there is no management action that is likely to reduce the abundance of cane toads over large areas of Kakadu. One alternative response has been the translocation of some of Kakadu's northern quolls to "safer" locations – islands off the coast of Arnhem Land, which have a much reduced probability of colonisation by cane toads. A broader management option may be to include consideration of such translocations for other susceptible native animal species. Given the rapid spread of toads throughout Kakadu, such action is probably now too late. In the near future, some native species currently not listed as threatened may qualify for listing because of their rapid decline caused by cane toads.

Feral pigs are probably a main cause of decline for at least one threatened plant species (*Malaxis latifolia*), and may reduce nesting success for threatened marine and freshwater turtles. The threatened plant is highly localised, and may be amenable to exclosure fencing. The impact of feral pigs on other threatened species is unknown.

Grazing by livestock and feral stock has contributed to the extensive decline of some bird and mammal species across much of northern Australia. Much of the rest of the north Australian landscape is managed for pastoral production, and away from pastoral leases and conservation reserves feral stock remain largely unchecked. Within this landscape context, a prime conservation attribute of Kakadu is the relatively minor impact of grazing by stock. Nonetheless, feral horses, cattle and buffalo are present across many areas of Kakadu, and this presence reduces the distinction in conservation benefit between Kakadu and surrounding lands. At least some threatened species (probably including yellow chat and the aquatic plant *Monochoria hastata*) have probably benefited substantially by the great reduction in numbers of feral buffalo that occurred in Kakadu from the 1960s to 1990s. There are few data that describe the relationships between differing densities of stock and responses of threatened plant and animal species, so it is not yet possible to describe cost-effective strategies for managing feral stock numbers for the benefit of threatened species.

Feral dogs are known to have a substantial impact on the breeding success of marine turtles in many areas of northern Australia. There are few turtle breeding areas on the Kakadu mainland, and predation of eggs and hatchlings by feral dogs at these sites is not yet considered a substantial management problem.

None of the threatened species present in Kakadu are known to be affected by exotic invertebrates (such as big-headed ants and honey bees). This may be because there is no such detrimental response; because the conservation status of native invertebrates (the group most likely to be threatened by exotic invertebrates) has not yet been adequately considered; or because the incidence, extent and/or abundance of exotic invertebrates in Kakadu has not yet reached a threshold sufficient to have marked detrimental impacts on threatened species.

weeds

Exotic plants are listed as a direct threat to few of Kakadu's threatened species. In part, this may be because weeds have been kept relatively well in check to date in Kakadu; and in part it may be because there has been little research on the impacts of weeds on threatened species. Several lowland animal species (including yellow chat, partridge pigeon and yellow-snouted gecko) are considered to be adversely affected by the spread of exotic pasture grasses (especially gamba and mission grass), and the compounded effect of such grasses and increasingly intense fire regimes will probably increase the risks to many more threatened lowland plant and animal species. One

threatened wetland plant species (*Monochoria hastata*) may be affected by invasion of its wetland habitat by the exotic para grass.

fishing

The listed threatened shark and sawfish species have been adversely affected across their range by fishing, particularly commercial gill-netting. Kakadu offers security for such species from this threat. Line-based recreational fishing is a less serious threat to these threatened fish, but there are documented cases elsewhere of substantial rates of mortality for at least the threatened sawfish *Pristis microdon* due to recreational fishing (Thorburn *et al.* 2003).

hunting

Within Kakadu, some threatened species are subject to some hunting pressure by traditional owners. These species include bustard, emu, partridge pigeon, marine turtles and pig-nosed turtle. In most cases, the level of take is probably very small, but there are few data available to demonstrate sustainability or otherwise.

hydrological and climate change

Kakadu's environments are changing in response to local management and global factors, and the rate of this change may accelerate. Sea level rises leading to saltwater intrusion to floodplain and lowland wetland areas may be the most marked manifestation of this change, and this process is affecting, or is likely to affect, some threatened species (such as the plant *Monochoria hastata* and yellow chat) in these environments. Kakadu is likely to experience increased temperatures over the next few decades (Hennessy *et al.* 2004) , and such climate change may increase fire intensity and extent, and thus magnify the impact of fire on a broad range of threatened species.

Assessing overall priorities

The previous sections have described some criteria for assigning research and management priorities amongst the set of threatened species in Kakadu. There is no objective or mathematical way of collating these disparate criteria to develop a single index for the relative priority for management response across different species, or amongst possible recovery actions within any single species. In the general recommendations below, and in the tabulation of recommended actions for each species (Table 7 below), I have used my judgement to integrate and distil the many elements into a more systematic array of priorities and coherent set of actions. In general, this prioritisation does not consider cultural values that may influence prioritisation, as this factor is beyond the brief of this consultancy.

In addition to prioritisation based on the likely contribution of any action towards species recovery, I have attempted to provide a guide to the practicability of that action in achieveing conservation gain ("feasibility"). This assessment is not necessarily easy to derive, nor to compare across very different activities and taxonomic groups; and achievability is likely to be much influenced by the amount of resources available for a specified action. Again, my categorisation of feasibility is a subjective one, based on the best information available, and following consideration of the now extensive history of the fate of research and management actions for different threatened species in northern Australia.

Recommended actions

Based on the information and obligations reported above, a threatened species management plan for Kakadu for 2004-2010 should include the following actions.

Recommendation 1. Undertake targeted survey to define the abundance, distribution and status of those threatened species for which current status information is inadequate.

Justification: (1) This is an explicit obligation under the *EPBC Act* for federally-listed species on lands managed by Commonwealth agencies. (2) Management for these species requires a firm foundation of knowledge of their current status.

Species involved (* indicates federally-listed species): the ferns *Cephalomanes obscurum* and *Gleichenia dicarpa*, *Malaxis latifolia, Utricularis subulata*, northern grassdart butterfly, freshwater tongue sole, speartooth shark*, northern river shark*, dwarf sawfish*, freshwater sawfish*, yellow-snouted gecko, oenpelli python, emu, Australian bustard, red goshawk*, masked owl*, white-throated grass-wren, northern shrike-tit*, gouldian finch*, northern brush-tailed phascogale, golden bandicoot*, bare-rumped sheath-tail bat*, golden-backed tree-rat*, false water-rat*.

Prioritisation: Within the set above, prioritisation should be given to those species for which the importance of Kakadu is designated as high in Table 6.

Comment: Over the last two years, targeted surveys (Kerrigan 2003, 2004) have provided such necessary baseline information for most of Kakadu's threatened plants. Recent general vertebrate surveys (Watson and Woinarski 2003, 2004) have provided adequate information on distribution and abundance for some of the more widespread threatened vertebrate species (such as Arnhem rock-rat, brush-tailed rabbit-rat, northern quoll).

Note that there is a fine but indistinct line between species that are now exceedingly threatened in Kakadu (and hence which may demand substantial management priority) and species that have become extinct in Kakadu sometime over the course of the last hundred years (and hence which are now irrelevant for management). Five animal species listed above (in the section "persistence in Kakadu") fall into this currently unresolved situation: their status may be so parlous that they need urgent management intervention, or alternatively, they are now defunct in Kakadu and merit no further management consideration. Such ambiguity can be resolved, if at all, only following targeted and intensive search.

Targets: By 2010, specific surveys for each species will have provided robust estimates of the abundance and distribution of every threatened species in Kakadu.

Recommendation 2. Establish, implement and/or maintain specific monitoring programs that provide regular assessments of the trends in status for each threatened species in Kakadu NP, and relates such trends to management actions.

Justification: (1) Natural resource management funding will be increasingly tied to reporting on the outcomes of such management, with trends in the status of significant species being an explicit measure of management efficacy; (2) Sound knowledge of the

trends in status of threatened species will help determine research and management priorities, and help improve management actions.

Species involved (* indicates federally-listed species):

(i) *Existing monitoring programs*: Monitoring programs have been in place for about a decade for flatback turtle*. Monitoring programs were established in 2003-04 for the threatened plants *Acacia* D19063 Graveside Gorge, *Boronia laxa*, B. rupicola*, B. suberosa*, B. verecunda*, B. xanthastrum*, Calytrix inopinata, Helicteres D21039 linifolia, Hibiscus brennani, Lithomyrtus linariifolia, Monocharia hastata* and *Sauropus filicinus*.* Monitoring programs are being established in 2004 for yellow chat and Arnhemland egernia.

(ii) *Baseline information sufficient to seed a monitoring program*. For another set of species, although there is no current "formal" monitoring program, there is adequate information on abundance at one or more sites for this to form a baseline for ongoing monitoring. Such species include: pig-nosed turtle, partridge pigeon*, white-throated grasswren, northern quoll, brush-tailed rabbit-rat and Arnhem rock-rat.

(iii) *Monitoring program needs to be established*. For all other species, there is no current monitoring program, and an inadequate basis for establishing one from existing information. Most of these species are in the set of species described in Recommendation 1 above (for survey to assess status), and the survey suggested in that action should incorporate a component that establishes a baseline monitoring.

Comment: (i) The monitoring programs established need to be robust, useful, and of sufficient power; they should also shed light on responses of the focal species to management actions, and on potential causes of decline. (ii) The necessary frequency and intensity of ongoing monitoring episodes should be assessed through analysis of existing data, either from Kakadu or elsewhere. (iii) Monitoring data should be properly data based, archived and stored; (iii) Monitoring results should be analysed annually, to a regular reporting framework. (iv) Where possible, monitoring programs in Kakadu for a threatened species should be integrated with, or at least complementary to, any comparable monitoring of that species occurring outside the Park.

Targets: By 2008, a monitoring program for every threatened species will be established in Kakadu. By 2010, annual reporting of trends in each threatened species will be implemented.

Recommendation 3. Maintain existing broad-scale plant and animal monitoring programs (notably the Kakadu Fire Plots).

Justification: (1) The existing monitoring programs (notably the Kakadu Fire Monitoring Program) are well established and provide a major assessment of the trends in Kakadu's biodiversity generally, and the response of this to one of the main management issues, fire. (2) These monitoring programs provide some information on trends in the status of some threatened species, and may provide early warnings of unfavourable trends in species likely to be, but not yet, listed as threatened.

Species involved (* indicates federally-listed species): The fire plot sampling has included records of the following threatened species: *Boronia verecunda*, B. xanthastrum*,* emu, partridge pigeon*, white-throated grasswren, northern quoll, northern brush-tailed phascogale, Arnhem leaf-nosed bat and Arnhem rock-rat. The CSIRO

fauna plots include records of oenpelli python, partridge pigeon*, masked owl*, white-throated grasswren*, gouldian finch*, northern quoll, northern brush-tailed phascogale, brush-tailed rabbit-rat and Arnhem rock-rat.

Prioritisation: Monitoring of these existing fire and fauna monitoring plots should continue on a 5-year cycle.

Comment: Recent analyses of fire plot monitoring results from Kakadu (Edwards *et al.* 2003) and fauna plot monitoring data from both Kakadu (Watson and Woinarski 2003, 2004) and Litchfield (Woinarski *et al.* in press) conclude that biodiversity monitoring in conservation reserves should comprise two main components – a broad-brush approach that considers as many species as practicable, complemented by more specifically targeted monitoring programs for threatened species. This two-prong approach is necessary because threatened species are typically rare and/or highly restricted and hence unlikely to be well represented in more general survey.

Targets: Complete re-sampling of all existing fire plots and fauna monitoring plots on a 5-year rotation as scheduled. Analyse and review all results within a year of major re-sampling events.

Recommendation 4. Assess the conservation status of sandstone heathland communities against criteria for listing as a threatened ecological community; and nominate it if appropriate.

Justification: (1) Most of Kakadu's threatened plant species and many of its threatened animal species are restricted to the sandstone plateau and escarpment of western Arnhem Land. There is obvious efficiency in considering management at the whole ecological community level rather than idiosyncratic management responses to each of a long list of individual species. (2) This recommendation is an extension of a recommendation [6.2.1.(iii): see Table 5 above] from the 1995 threatened species program (Roeger and Russell-Smith 1995), that has not yet been completely enacted.

Prioritisation: The prioritisation of this action is dependent upon assessment of the management benefit that may flow from listing. Perhaps the most important benefit will be in helping attract resources to management in that currently poorly-resourced part of the sandstone plateau that lies in Arnhem Land itself rather than in Kakadu.

Comment: Nomination of sandstone heathland as a threatened ecological community is not necessarily a responsibility of PAN. Indeed, any individual or group can provide such a nomination. Any nomination would first involve considerable consultation and collaboration with traditional owners and their representatives from across the extent of the Arnhem Land plateau.

Recommendation 5. Develop a strategic program for assessment of the conservation status of invertebrates in Kakadu.

Justification: (1) Compared with plants and vertebrates, there has been no substantial attempt to consider the conservation status of invertebrates in Kakadu. (2) This recommendation echoes one [recommendation 6.2.1.(iv): see Table 5 above] from the 1995 threatened species program (Roeger and Russell-Smith 1995), that has not yet been enacted.

Comment: Invertebrates have received far less attention than plants and vertebrate animals in Kakadu's inventory, monitoring and management. With the notable exception of a recent research project on Leichhardt's grasshopper (a species not currently considered threatened), most of the study of invertebrates in Kakadu has involved the ecology of relatively common species and/or management of pest species, rather than species of conservation concern.

Targets: By 2007, develop a strategic plan for the conservation of invertebrates in Kakadu. By 2010, complete a conservation status assessment for representative invertebrate groups.

Recommendation 6. To an appropriate extent, integrate conservation and management actions on threatened species in Kakadu with that of the broader region

Justification: (1) Only a minority of the threatened species occurring in Kakadu are restricted to Kakadu. The maintenance of threatened species in the landscape (including Kakadu) is ultimately dependent upon their management across the full extent of their range. There is obvious efficiency and enhanced capability in coordinating conservation responses in Kakadu with those actions taken beyond its borders. (2) The management of many threatened species is coordinated through national recovery plans and teams, and actions taken in Kakadu should be consistent with such plans.

Comment: This is at least partly an administrative issue. Where Kakadu is a significant component of the range of a threatened species, PAN should be represented on any Recovery Team for that species. More generally (for relatively few of the set of threatened species occurring in Kakadu are served by an existing Recovery Team), there should be at least an annual forum/meeting involving those NRM officers responsible for threatened species management in Kakadu with those in the Northern Territory as a whole; with that meeting serving to coordinate management responses, resourcing, revisions to lists, and other related issues.

Targets: By 2006, establish an at least annual meeting of PAN staff involved in threatened species recovery and management with their counterpart NT Government staff, and other relevant agencies and individuals.

Recommendation 7. Enhance the entry, storage and display of threatened species data in Kakadu

Justification: (1) Reliable information on the location of threatened species should be a fundamental ingredient in the management actions of District managers and other staff. At present such information is widely scattered and probably not readily accessible to many District staff. (2) Many PAN staff, Aboriginal residents and visitors may have valuable observations of threatened species, but there is no straightforward and consistent system in place for data entry for such records, and hence they tend to be lost. (3). This recommendation is an extension of a recommendation [6.2.3.(vi): see Table 5 above] from the 1995 threatened species program (Roeger and Russell-Smith 1995), that has not yet been completely enacted.

Species involved: All threatened species.

Targets: By 2006, a collated data base of current threatened species records is distributed across the Park's GIS, and is routinely used by Park managers. By 2006, a consistent consolidated data entry scheme is established that captures ongoing and past records of threatened species from Parks staff, Aboriginal residents and others.

Recommendation 8. Continue to conduct targeted research on the response of selected threatened species to selected threatening processes and to management actions

Justification: (1) There is only very limited information about the ecology of many of Kakadu's threatened species, and this information is insufficient to critically assess the relative impacts of different threatening processes or to fine-tune management responses. While recommended actions above (notably 1 and 2) will provide substantially more data on distribution and abundance, there is still a need for targeted ecological studies of at least some of the threatened species. To most usefully enhance management responses, such studies should be positioned within an adaptive management framework.

Species involved: (1) life history studies and modeling (responses to a range of fire regimes) for the set of fire-sensitive (obligate seeder) plant species;

(2) habitat requirements, life history studies (and responses to fire) for northern grassdart butterfly, white-throated grasswren and oenpelli python; and habitat requirements, life history studies (and responses to fire and/or exotic pasture grasses) for northern brush-tailed phascogale and yellow chat.

Comment: Note that the species included in this action were selected primarily because of the relatively little existing relevant information about their ecology. Some other threatened species may be selected as higher priority for ecological research if populations are (re-)located in Kakadu (e.g. golden-backed tree-rat).

Targets: By 2010, ecological information is adequate to provide a detailed description of optimum management for most of Kakadu's threatened species.

Recommendation 9. Continue to manage to mitigate those factors that detrimentally affect threatened species.

Justification: (1) Threatened species are affected by a broad array of factors. As a National Park, Kakadu offers protection from some of these factors (e.g. land clearing) and mitigation from others (e.g. invasion of exotic pasture grasses and feral animals, inappropriate fire regimes). One of the objectives of Kakadu is to manage the lands to deliver a conservation benefit, and particularly so for threatened species.

Species involved: All threatened species.

Prioritisation: The wise management of fire, feral animals, weeds and visitor impacts is the primary operational mechanism for PAN staff and Aboriginal residents.

Comment: This recommendation recognises that most threatened species in Kakadu derive much benefit from the current major investments in management of fire, weeds, feral animals and visitor impacts. Any threatened species management plan for Kakadu will always be dependent upon this foundation. Such management has been and will continue to be refined, as impacts of management actions (or inactions) are increasingly being measured. With improved and more frequent monitoring of the status of

individual threatened species (recommendation 2 above), and with increased understanding of the responses of threatened species to particular threats and management interventions (recommendation 8 above), there will be increasing power to quantify and compare the impacts of different putative threats, and to quantify the costs and benefits of a variety of management responses. This should produce increasingly sophisticated, cost-effective and efficient management of threatened species, and natural resource generally.

Targets: By 2010, establishment and implementation of precise, costed, cost-effective management guidelines for most individual threatened species.

Recommendation 10. Enhance communication about, and reporting on, threatened species in Kakadu.

Justification: (1). Historically, much of the information about Kakadu's threatened species is widely scattered and largely retained only in limited copies of reports. Given the marked changes in composition of threatened species lists, general knowledge of threatened species issues in Kakadu is often somewhat dated. (2) Increased dissemination of information is likely to increase awareness and hence lead to an contribution of records from ranger staff and others.

Species involved: All threatened species.

Comment: One mechanism for enhanced communication would be to disseminate the dossiers presented here for individual species, to all ranger staff, District offices, the Kakadu Board, and Aboriginal residents and Associations, and to make these available to Park visitors. A plain English annual overview of activity on threatened species should be distributed to Kakadu stakeholders. Annual summaries of trends in status of each monitored threatened species should be distributed to ranger staff and resource managers, to provide feedback on the efficacy of management actions.

Targets: By 2006, an annual report on trends in monitored threatened species should be established and circulated to all ranger staff as feedback on Park management.

Table 7. Summary of management and other recommendations for individual threatened species recorded from Kakadu. For each listed action, a prioritisation (P) is assigned as *** high; ** medium, * low; and a feasibility (F) of the action is assigned as *** high, ** medium, * low. Note that the prioritisation indicated here takes into account the relative importance of Kakadu for the species' survival: that is, actions for species for which Kakadu is relatively insignificant are generally accorded relatively low priorities.

Scientific name	Common Name	Research		Survey		Monitoring		Management	
		activities	priorities	activities	priorities	activities	priorities	activities	priorities
Acacia D19063 Graveside Gorge		identify optimum fire regimes	P***, F**	search suitable locations to seek new populations	P***, F*	maintain monitoring of plants at 2-5 yr intervals, and fire history annually	P***, F***	reduce fire frequency around known site; establish *ex-situ* propagation in Kakadu, if possible	P***, F** P***, F**
Boronia laxa		identify optimum fire regimes	P**, F**	search suitable locations to seek new populations	P*, F*	maintain monitoring of plants at 2-5 yr intervals, and fire history annually	P**, F***	reduce fire frequency around known sites	P***, F**
Boronia rupicola		identify optimum fire regimes	P***, F**	search suitable locations to seek new populations	P*, F*	maintain monitoring of plants at 2-5 yr intervals, and fire history annually	P***, F***	reduce fire frequency around known sites	P***, F**
Boronia suberosa		identify optimum fire regimes	P***, F**	search suitable locations to seek new populations	P*, F*	maintain monitoring of plants at 2-5 yr intervals, and fire history annually	P**, F***	reduce fire frequency around known sites	P***, F**
Boronia verecunda		identify optimum fire regimes	P**, F**	search suitable locations to seek new populations	P*, F*	maintain monitoring of plants at 2-5 yr intervals, and fire history annually	P**, F***	reduce fire frequency around known sites	P***, F**
Boronia xanthastrum		identify optimum fire regimes	P**, F**	search suitable locations to seek new populations	P*, F*	maintain monitoring of plants at 2-5 yr intervals, and fire history annually	P**, F***	reduce fire frequency around known sites	P***, F**
Calytrix inopinata		identify optimum fire regimes	P**, F**	search suitable locations to seek new populations	P*, F*	maintain monitoring of plants at 2-5 yr intervals, and fire history annually	P**, F***	reduce fire frequency around known sites	P**, F**

Scientific name	Common Name	Research		Survey		Monitoring		Management	
		activities	priorities	activities	priorities	activities	priorities	activities	priorities
Cycas armstrongii		nil		assess total population size and extent of Kakadu population	P*, F***	establish monitoring program for this species; monitor distribution of exotic pasture plants	P*, F*** P**, F***	reduce incidence and extent of exotic pasture plants	P**, F*
Dubouzetia australiensis		identify optimum fire regimes	P**, F**	search suitable locations to seek new populations	P*, F*	maintain monitoring of plants at 2-5 yr intervals, and fire history annually	P**, F***	reduce fire frequency around known sites	P**, F**
Gleichenia dicarpa		identify factors regulating distribution and abundance	P**, F*	search suitable locations to seek new populations	P**, F*	establish baseline for monitoring, and thence monitor at 2-5 year intervals	P**, F***	none yet known	
Helicteres D21039 linifolia		identify optimum fire regimes	P**, F**	search suitable locations to seek new populations	P*, F**	maintain monitoring of plants at 2-5 yr intervals, and fire history annually	P**, F**	reduce incidence and extent of exotic pasture plants	P**, F*
Hibiscus brennanii		identify optimum fire regimes	P**, F**	search suitable locations to seek new populations	P*, F**	maintain monitoring of plants at 2-5 yr intervals, and fire history annually	P**, F**	preferred fire regime not yet clarified.	
Lithomyrtus linariifolia		identify optimum fire regimes	P**, F**	search suitable locations to seek new populations	P*, F**	maintain monitoring of plants at 2-5 yr intervals, and fire history annually	P**, F**	reduce fire frequency around known sites	P**, F**
Malaxis latifolia		identify factors regulating distribution and abundance	P**, F**	search suitable locations to seek new populations	P**, F**	attempt to re-locate plants at single known site; and thence, establish ongoing monitoring	P***, F* P**, F*	examine need for and practicality of pig exclosure fencing; reduce incidence of feral pigs in area around known site	P**, F** P**, F*

Scientific name	Common Name	Research		Survey		Monitoring		Management	
		activities	priorities	activities	priorities	activities	priorities	activities	priorities
Monochoria hastata		identify factors regulating distribution and abundance	P*, F**	search suitable locations to seek new populations	P**, F**	maintain monitoring of plants at 2-5 yr intervals	P**, F**	reduce incidence and extent of exotic pasture plants; reduce incidence of feral pigs and/or buffalo around known site	P***, F* P**, F**
Sauropus filicinus		identify optimum fire regimes	P**, F**	search suitable locations to seek new populations	P*, F**	maintain monitoring of plants at 2-5 yr intervals, and fire history annually	P**, F**	reduce fire frequency around known sites	P**, F**
Utricularia subulata		identify factors regulating distribution and abundance	P**, F*	search suitable locations to seek new populations	P*, F**	establish baseline for monitoring, and thence monitor at 2-5 year intervals	P**, F**	not yet determined	
Taractrocera ilia ilia	Northern Grassdart Butterfly	identify optimum fire regimes ; identify food plants	P***, F** P**, F**	estimate population size and extent of Kakadu population, and identify key habitats	P**, F**	establish baseline for monitoring, and thence monitor at 2-5 year intervals	P**, F**	reduce fire frequency around known sites	P**, F**
Cynoglossus heterolepis	Freshwater Tongue Sole	identify habitat preferences and threats	P*, F*	assess population size and distribution	P*, F*	establish baseline for monitoring	P*, F*	nil	
Glyphis sp.A.	Speartooth Shark	identify habitat preferences and threats	P*, F*	assess population size and distribution	P**, F*	establish baseline for monitoring, and thence monitor at 2-5 year intervals	P**, F*	maintain existing bans on gill-netting and commercial fishing, and constraints on recreational fishing	P**, F***
Glyphis sp. C.	Northern River Shark	identify habitat preferences and threats	P*, F*	assess population size and distribution	P**, F*	establish baseline for monitoring, and thence monitor at 2-5 year intervals	P**, F*	maintain existing bans on gill-netting and commercial fishing, and constraints on recreational fishing	P**, F***

Scientific name	Common Name	Research		Survey		Monitoring		Management	
		activities	priorities	activities	priorities	activities	priorities	activities	priorities
Pristis clavata	Dwarf Sawfish	identify habitat preferences and threats	P*, F*	assess population size and distribution	P**, F*	establish baseline for monitoring, and thence monitor at 2-5 year intervals	P**, F*	maintain existing bans on gill-netting and commercial fishing, and constraints on recreational fishing	P**, F***
Pristis microdon	Freshwater Sawfish	identify habitat preferences and threats	P*, F*	assess population size and distribution	P**, F*	establish baseline for monitoring, and thence monitor at 2-5 year intervals	P**, F*	maintain existing bans on gill-netting and commercial fishing, and constraints on recreational fishing	P**, F***
Caretta caretta	Loggerhead Turtle	nil		nil		nil		constrain commercial fishing in Kakadu coastal areas	P*, F**
Chelonia mydas	Green Turtle	examine dispersal patterns, and relationships with other Australian stocks	P*, F*	assess population size, distribution and critical habitat	P*, F*	nil		constrain commercial fishing in Kakadu coastal areas	P*, F**
Lepidochelys olivacea	Olive Ridley	examine dispersal patterns, and relationships with other Australian stocks	P*, F*	assess population size, distribution and critical habitat	P*, F*	nil		constrain commercial fishing in Kakadu coastal areas	P*, F**
Natator depressus	Flatback Turtle	examine dispersal patterns, and relationships with other Australian stocks	P*, F*	assess population size, distribution and critical habitat	P*, F*	maintain ongoing monitoring of breeding numbers, success and predation	P***, F***	constrain commercial fishing in Kakadu coastal areas; control feral dogs and pigs around breeding sites	P*, F** P**, F**
Carettochelys insculpta	Pig-nosed Turtle	assess levels of use and sustainability	P*, F**	assess population size, distribution and critical habitat	P*, F*	monitor populations at previously sampled sites, at 2-5 year intervals	P***, F**	control feral pigs around breeding sites	P**, F**

Scientific name	Common Name	Research		Survey		Monitoring		Management	
		activities	priorities	activities	priorities	activities	priorities	activities	priorities
Diplodactylus occultus	Yellow-snouted Gecko	identify optimum fire regimes	P**, F*	assess population size and distribution	P**, F*	establish baseline for monitoring, and monitor populations, at 2-5 year intervals; monitor distribution of exotic pasture plants	P**, F* P***, F***	reduce incidence and extent of exotic pasture plants; reduce fire frequency around known site	P**, F* P**, F**
Egernia obiri	Arnhemland Egernia	identify habitat preferences and threats	P**, F*	assess population size and distribution	P**, F*	establish baseline for monitoring, and monitor populations, at 2-5 year intervals	P**, F*	not yet determined	
Morelia oenpelliensis	Oenpelli Python	identify habitat preferences and threats	P**, F*	assess population size and distribution	P**, F*	establish baseline for monitoring, and monitor populations, at 2-5 year intervals	P**, F*	not yet determined	
Dromaius novaehollandiae	Emu	identify optimum fire regimes	P**, F**	assess population size and distribution	P**, F**	establish baseline for monitoring, and monitor populations, at 2-5 year intervals	P**, F**	reduce incidence and extent of exotic pasture plants; reduce fire frequency, intensity and extent in lowlands	P**, F* P**, F*
Erythrotriorchis radiatus	Red Goshawk	identify threats	P*, F*	assess population size and distribution	P*, F*	establish baseline for monitoring, and monitor populations, at 2-5 year intervals	P**, F**	maintain some vigilance at known nest sites to prevent poaching	P*, F**
Ardeotis australis	Australian Bustard	identify optimum fire regimes; assess levels of use and sustainability	P*, F** P*, F**	assess population size and distribution	P*, F**	establish baseline for monitoring, and monitor populations, at 5 year intervals	P*, F*	maintain or increase fine-scale patchiness of lowland fires	P*, F**
Geophaps smithii smithii	Partridge Pigeon	identify response to exotic grasses	P**, F*	assess population size and distribution	P*, F**	establish baseline for monitoring, and monitor populations, at 2-5 year intervals	P**, F***	maintain or increase fine-scale patchiness of lowland fires	P***, F**
Tyto novaehollandiae kimberli	Masked Owl	identify habitat preferences and threats	P**, F*	assess population size, distribution and optimum survey protocol	P**, F**	establish baseline for monitoring, and monitor populations, at 2-5 year intervals	P**, F**	not yet determined	

Scientific name	Common Name	Research		Survey		Monitoring		Management	
		activities	priorities	activities	priorities	activities	priorities	activities	priorities
Amytornis woodwardi	White-throated Grasswren	identify optimum fire regimes	P**, F**	assess population size and distribution	P*, F**	establish baseline for monitoring, and monitor populations, at 2-5 year intervals	P**, F**	reduce fire frequency in stone country	P**, F**
Epthianura crocea tunneyi	Yellow Chat	identify habitat preferences and threats	P**, F**	assess population size and distribution	P**, F**	establish baseline for monitoring, and monitor populations, at 2-5 year intervals	P**, F**	reduce incidence and extent of exotic pasture plants; reduce risks of saltwater intrusion	P**, F* P*, F*
Falcunculus (frontatus) whitei	Northern Shrike-tit	identify habitat requirements and threats	P*, F*	assess population size and distribution	P*, F*	establish baseline for monitoring, and monitor populations, at 2-5 year intervals	P**, F*	not yet determined	
Erythrura gouldiae	Gouldian Finch	identify optimum fire regimes	P**, F*	assess population size and distribution	P**, F**	establish baseline for monitoring, and monitor populations, at 2-5 year intervals	P**, F**	maintain or increase fine-scale patchiness of lowland fires	P***, F**
Dasyurus hallucatus	Northern Quoll	identify mechanisms to mitigate impacts of cane toads	P**, F*	search for residual populations (as part of broad-brush wildlife monitoring program)	P**, F**	maintain monitoring at established sites	P*, F**	uncertain. maintain health of translocated populations	P**, F**
Phascogale (tapoatafa) pirata	Northern Brush-tailed Phascogale	identify habitat preferences and threats	P***, F***	assess population size and distribution	P**, F**	establish baseline for monitoring, and monitor populations, at 2-5 year intervals	P***, F**	reduce incidence of feral cats; reduce incidence and extent of exotic pasture plants; maintain or increase fine-scale patchiness of lowland fires	P**, F* P**, F* P*, F**

Scientific name	Common Name	Research		Survey		Monitoring		Management	
		activities	priorities	activities	priorities	activities	priorities	activities	priorities
Isoodon auratus auratus	Golden Bandicoot	if population located, identify habitat preferences and threats	P**, F*	undertake targeted search at sites where previously recorded	P**, F*	if re-located, establish baseline monitoring, and monitor at 2-5 year intervals	P*, F*	reduce incidence of feral cats; reduce incidence and extent of exotic pasture plants; maintain or increase fine-scale patchiness of lowland fires	P**, F* P**, F* P*, F**
Saccolaimus saccolaimus nudicluniatus	Bare-rumped Sheathtail Bat	undertake intensive research to assess status, habitat requirements and threats; undertake genetic study to determine the taxonomic status of NT population	P**, F* P*, F*	undertake targeted search at sites where previously recorded; undertake more broad-brush bat community studies using recording devices	P**, F* P*, F**	if re-located, establish baseline monitoring, and monitor at 2-5 year intervals	P*, F*	not yet determined	
Hipposideros diadema inornata	Arnhem Leafnosed Bat	identify habitat preferences and threats	P*, F*	assess population size and distribution	P*, F**	establish baseline monitoring, and monitor at 2-5 year intervals	P*, F*	maintain constraints on access to known maternity sites	P**, F**
Conilurus penicillatus	Brush-tailed Rabbit-rat	identify habitat preferences and threats	P***, F*	assess population size and distribution	P*, F**	maintain existing monitoring program, and sample at 2-5 y intervals	P**, F**	reduce incidence of feral cats; reduce incidence and extent of exotic pasture plants; maintain or increase fine-scale patchiness of lowland fires	P**, F* P**, F* P*, F**
Mesembriomys macrurus	Golden-backed Tree-rat	identify habitat preferences and threats	P**, F*	undertake targeted search at sites where previously recorded; if successful, assess population size and distribution	P***, F** P**, F*	establish baseline for monitoring, and monitor populations, at 2-5 year intervals	P**, F*	reduce incidence of feral cats; reduce incidence and extent of exotic pasture plants; maintain or increase fine-scale patchiness of lowland fires	P**, F* P**, F* P*, F**

Scientific name	Common Name	Research		Survey		Monitoring		Management	
		activities	**priorities**	**activities**	**priorities**	**activities**	**priorities**	**activities**	**priorities**
Xeromys myoides	Water mouse (False water-rat)	identify habitat preferences and threats	P**, F*	undertake targeted search in potentially suitable habitat; if successful, assess population size and distribution	P***, F** P**, F*	establish baseline for monitoring, and monitor populations, at 5 year intervals	P**, F*	reduce incidence of feral cats; reduce incidence and extent of exotic pasture plants	P**, F* P**, F*
Zyzomys maini	Arnhem Rock-rat	identify optimum fire regimes	P**, F**	assess population size and distribution	P*, F**	maintain existing monitoring programs, and sample these at 2-5 yr intervals	P**, F**	reduce fire frequency in stone country	P**, F**

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Appendix A. Schedule for consultancy NHTKNP01 Threatened plant and animal species in Kakadu National Park - 2004

THE SCHEDULE

Consultancy Services

The consultancy service ... will involve:

i) Compiling a review of the status in Kakadu NP of all nationally and NT-listed threatened plants and animals. This should include:

- a collation of all documented distributional records;
- where appropriate, an explanatory note describing any variation in assigned conservation status between national and NT lists; and
- information on abundance and/or status within Kakadu, wherever possible.

ii) Preparation of a management strategy for threatened species in Kakadu NP, for 2004-2011. This should include, for every listed species:

- assessment of threats and their probable impact;
- description of any existing monitoring programs;
- recommendations for ongoing monitoring; and
- recommendations for management.

iii) Carrying out fieldwork to assess the conservation status and/or to establish baseline monitoring for at least two listed animal species in Kakadu NP. The species to be surveyed will be identified by the Consultant and Project Officer by March 2004.

Appendix B. Known distribution of threatened species across Kakadu management districts.

Scientific name	Common Name	district				
		South Alligator	Mary River	Nourlangie	East Alligator	Jim Jim
Acacia D19063 Graveside Gorge						√
Boronia laxa				√	√	
Boronia rupicola				√		
Boronia suberosa				√	√	
Boronia verecunda			√			√
Boronia xanthastrum				√		√
Calytrix inopinata			√			
Cycas armstrongii		√				
Dubouzetia australiensis				√		
Gleichenia dicarpa				√		
Helicteres D21039 linifolia		√				
Hibiscus brennanii				√		
Lithomyrtus linariifolia			√	√	√	√
Malaxis latifolia		√				
Monochoria hastata		√				
Sauropus filicinus				√	√	
Utricularia subulata		√				
Taractrocera ilia ilia	Northern Grassdart Butterfly	√		√		
Cynoglossus heterolepis	Freshwater Tongue Sole	√			√	
Glyphis sp.A.	Speartooth Shark	√			√	
Glyphis sp. C.	Northern River Shark	√			√	
Pristis clavata	Dwarf Sawfish	√				
Pristis microdon	Freshwater Sawfish		√		√	
Caretta caretta	Loggerhead Turtle	√				
Chelonia mydas	Green Turtle	√				
Lepidochelys olivacea	Olive Ridley	√				
Natator depressus	Flatback Turtle	√				
Carettochelys insculpta	Pig-nosed Turtle		√	√	√	√
Diplodactylus occultus	Yellow-snouted Gecko	√				
Egernia obiri	Arnhemland Egernia		√	√	√	
Morelia oenpelliensis	Oenpelli Python		√	√	√	
Dromaius novaehollandiae	Emu	√	√	√	√	√
Erythrotriorchis radiatus	Red Goshawk	√	√			√
Ardeotis australis	Australian Bustard	√	√	√	√	√
Geophaps smithii smithii	Partridge Pigeon	√	√	√	√	√
Tyto novaehollandiae kimberli	Masked Owl	√	√	√		√
Amytornis woodwardi	White-throated Grasswren		√	√	√	√
Epthianura crocea tunneyi	Yellow Chat	√		√	√	√
Falcunculus (frontatus) whitei	Northern Shrike-tit	√				
Erythrura gouldiae	Gouldian Finch	√	√	√		√
Dasyurus hallucatus	Northern Quoll	√	√	√	√	√
Phascogale (tapoatafa) pirata	Northern Brush-tailed Phascogale	√	√	√		√
Isoodon auratus auratus	Golden Bandicoot		√			
Saccolaimus saccolaimus nudicluniatus	Bare-rumped Sheathtail Bat	√				
Hipposideros (diadema) inornata	Arnhem Leafnosed Bat		√	√	√	√
Conilurus penicillatus	Brush-tailed Rabbit-rat	√	√	√		√
Mesembriomys macrurus	Golden-backed Tree-rat					√
Xeromys myoides	Water mouse (False water-rat)	√				
Zyzomys maini	Arnhem Rock-rat		√	√	√	√

Appendix C. Species occurring in Kakadu that are listed migratory species under the *EPBC Act.*

CAMBA=China-Australia Migratory Bird Agreement; JAMBA=Japan-Australia Migratory Bird Agreement; BONN=Bonn Convention. "Threatened" = listed as threatened under either the *EPBCA* and/or Northern Territory legislation.

		common name	threatened	CAMBA	JAMBA	BONN
Crocodylus	*porosus*	Saltwater Crocodile				√
Caretta	*caretta*	Loggerhead Turtle	√			√
Chelonia	*mydas*	Green Turtle	√			√
Lepidochelys	*olivacea*	Olive Ridley	√			√
Natator	*depressus*	Flatback Turtle	√			√
Anas	*querquedula*	Garganey				
Sula	*leucogaster*	Brown Booby		√	√	
Fregata	*minor*	Great Frigatebird		√	√	
Fregata	*ariel*	Lesser Frigatebird		√	√	
Egretta	*sacra*	Eastern Reef Egret		√		
Ardea	*alba*	Great Egret		√	√	
Ardea	*ibis*	Cattle Egret		√	√	
Plegadis	*falcinellus*	Glossy Ibis		√		
Pandion	*haliaetus*	Osprey				
Haliaeetus	*leucogaster*	White-bellied Sea-eagle		√		
Grus	*antigone*	Sarus Crane		√		
Gallinago	*hardwickii*	Latham's Snipe		√	√	√
Gallinago	*megala*	Swinhoe's Snipe		√	√	√
Limosa	*limosa*	Black-tailed Godwit		√	√	√
Limosa	*lapponica*	Bar-tailed Godwit		√	√	√
Numenius	*minutus*	Little Curlew		√	√	√
Numenius	*phaeopus*	Whimbrel		√	√	√
Numenius	*madagascariensis*	Eastern Curlew		√	√	√
Tringa	*stagnatilis*	Marsh Sandpiper		√	√	√
Tringa	*nebularia*	Common Greenshank		√	√	√
Tringa	*glareola*	Wood Sandpiper		√	√	√
Xenus	*cinereus*	Terek Sandpiper		√	√	√
Actitis	*hypoleucos*	Common Sandpiper		√	√	√
Heteroscelus	*brevipes*	Grey-tailed Tattler		√	√	√
Arenaria	*interpres*	Ruddy Turnstone		√	√	√
Calidris	*tenuirostris*	Great Knot		√	√	√
Calidris	*canutus*	Red Knot		√	√	√
Calidris	*alba*	Sanderling		√	√	√
Calidris	*ruficollis*	Red-necked Stint		√	√	√
Calidris	*melanotos*	Pectoral Sandpiper			√	√
Calidris	*acuminata*	Sharp-tailed Sandpiper		√	√	√
Calidris	*ferruginea*	Curlew Sandpiper		√	√	√
Limicola	*falcinellus*	Broad-billed Sandpiper		√	√	√
Pluvialis	*squatarola*	Grey Plover		√	√	√
Charadrius	*hiaticula*	Ringed Plover		√	√	√
Charadrius	*dubius*	Little Ringed Plover		√		√
Charadrius	*mongolus*	Lesser Sand Plover		√	√	√
Charadrius	*leschenaultii*	Greater Sand Plover		√	√	√
Charadrius	*veredus*	Oriental Plover			√	√
Glareola	*maldivarum*	Oriental Pratincole		√	√	
Sterna	*caspia*	Caspian Tern		√	√	
Sterna	*bengalensis*	Lesser Crested Tern		√		
Sterna	*sumatrana*	Black-naped Tern		√	√	
Sterna	*hirundo*	Common Tern		√	√	
Sterna	*albifrons*	Little Tern		√	√	
Sterna	*anaethetus*	Bridled Tern		√		
Chlidonias	*leucopterus*	White-winged Black Tern		√	√	

		common name	threatened	CAMBA	JAMBA	BONN
Cuculus	*saturatus*	Oriental Cuckoo		√	√	
Hirundapus	*caudacutus*	White-throated Needletail		√	√	
Apus	*pacificus*	Fork-tailed Swift		√	√	
Merops	*ornatus*	Rainbow Bee-eater			√	
Poecilodryas	*superciliosa*	White-browed Robin				
Falcunculus	*whitei*	Northern Shrike-tit	√			
Coracina	*tenuirostris*	Cicadabird				
Motacilla	*flava*	Yellow Wagtail		√	√	
Motacilla	*cinerea*	Grey Wagtail		√		
Hirundo	*rustica*	Barn Swallow		√	√	
Erythrura	*gouldiae*	Gouldian Finch	√			
Acrocephalus	*australis*	Clamorous Reed-Warbler				
Dugong	*dugon*	Dugong				√