Australian Government
Department of the Environment and Energy

Consultation Document on Listing Eligibility and Conservation Actions

Zyzomys pendunculatus (central rock-rat)

You are invited to provide your views and supporting reasons related to:

1) the eligibility of *Zyzomys pendunculatus* (central rock-rat) for inclusion on the EPBC Act threatened species list in the Critically Endangered category; and

2) the necessary conservation actions for the above species.

Evidence provided by experts, stakeholders and the general public are welcome. Responses can be provided by any interested person.

Anyone may nominate a native species, ecological community or threatening process for listing under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) or for a transfer of an item already on the list to a new listing category. The Threatened Species Scientific Committee (the Committee) undertakes the assessment of species to determine eligibility for inclusion in the list of threatened species and provides its recommendation to the Australian Government Minister for the Environment.

Responses are to be provided in writing either by email to:
species.consultation@environment.gov.au

or by mail to:

The Director
Marine and Freshwater Species Conservation Section
Wildlife, Heritage and Marine Division
Department of the Environment
PO Box 787
Canberra ACT 2601

Responses are required to be submitted by 15 March 2017.

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General background information about listing threatened species

The Australian Government helps protect species at risk of extinction by listing them as threatened under Part 13 of the EPBC Act. Once listed under the EPBC Act, the species becomes a Matter of National Environmental Significance (MNES) and must be protected from significant impacts through the assessment and approval provisions of the EPBC Act. More information about threatened species is available on the department's website at: http://www.environment.gov.au/biodiversity/threatened/index.html.

Public nominations to list threatened species under the EPBC Act are received annually by the department. In order to determine if a species is eligible for listing as threatened under the EPBC Act, the Threatened Species Scientific Committee (the Committee) undertakes a rigorous scientific assessment of its status to determine if the species is eligible for listing against a set of criteria. These criteria are available on the Department's website at: http://www.environment.gov.au/biodiversity/threatened/pubs/guidelines-species.pdf.

As part of the assessment process, the Committee consults with the public and stakeholders to obtain specific details about the species, as well as advice on what conservation actions might be appropriate. Information provided through the consultation process is considered by the Committee in its assessment. The Committee provides its advice on the assessment (together with comments received) to the Minister regarding the eligibility of the species for listing under a particular category and what conservation actions might be appropriate. The Minister decides to add, or not to add, the species to the list of threatened species under the EPBC Act. More detailed information about the listing process is at: http://www.environment.gov.au/biodiversity/threatened/nominations.html.

To promote the recovery of listed threatened species and ecological communities, conservation advices and where required, recovery plans are made or adopted in accordance with Part 13 of the EPBC Act. Conservation advices provide guidance at the time of listing on known threats and priority recovery actions that can be undertaken at a local and regional level. Recovery plans describe key threats and identify specific recovery actions that can be undertaken to enable recovery activities to occur within a planned and logical national framework. Information about recovery plans is available on the department's website at: http://www.environment.gov.au/biodiversity/threatened/recovery.html.

Information about this consultation process

Responses to this consultation can be provided electronically or in hard copy to the contact addresses provided on Page 1. All responses received will be provided in full to the Committee and then to the Australian Government Minister for the Environment.

In providing comments, please provide references to published data where possible. Should the Committee use the information you provide in formulating its advice, the information will be attributed to you and referenced as a 'personal communication' unless you provide references or otherwise attribute this information (please specify if your organisation requires that this information is attributed to your organisation instead of yourself). The final advice by the Committee will be published on the department's website following the listing decision by the Minister.

Information provided through consultation may be subject to freedom of information legislation and court processes. It is also important to note that under the EPBC Act, the deliberations and recommendations of the Committee are confidential until the Minister has made a final decision on the nomination, unless otherwise determined by the Minister.

Zyzomys pendunculatus

central rock-rat

Taxonomy

Conventionally accepted as *Zyzomys pendunculatus* (Waite, 1896). No subspecies are recognised.

Species/Subspecies Information

Description

The central rock-rat is a small, stocky rodent, weighing approximately 50–120 grams (McDonald 2012). Its body grows to 14 cm long and its thick tail also grows to 14 cm long. The central rock-rat has long, yellow-brown fur on the upperside of its body and cream to white fur on the underside (Watts & Aslin 1981).The tail is densely furred and has a distinctive tuft at the tip (Nano 2008).

Distribution

The central rock-rat is endemic to the Northern Territory. Its current distribution is restricted to the West MacDonnell Ranges of central Australia. Its historic distribution was substantially larger, with specimens recorded more extensively across rocky range country of central Australia, including The Granites (Tanami Desert), Davenport Range, Alice Springs, Haast's Bluff and the Napperby Hills (Wurst 1990). Fossil and subfossil records extend this historic (or pre-European settlement) range even further across inland Western Australia to the coast at Cape Range, where the deposits are common (Baynes & Jones 1993; Burbidge 1996; Morris 2000).

Prior to its 'rediscovery' in 1996, the central rock-rat had not been recorded since 1960, despite targeted searches (Wurst 1990, 1995), and was thought to be extinct (Wurst 1990; Gibson & Cole 1996). From 1996 to 2002, the species was recorded from over 20 sites along a 60 km span of the West MacDonnell Ranges (Cole 1999). The species was not found from most of these sites between 2002 and 2006. Sampling between 2009 and 2012 recorded individuals at only two locations (at or around the summits of Mt Sonder and Mt Giles) (McDonald pers. comm. cited in Woinarski et al., 2014). The entire known range is on Aboriginal Land or National Parks (Ward pers. comm., 2016).

In 2015, the central rock-rat appeared to be widespread on higher elevation quartzite ridges and peaks between Ellery Creek and Ormiston Pound in the West MacDonnell National Park. This localised irruption was probably triggered by a series of high rainfall events over the preceding 12 months (McDonald et al., 2015b).

Relevant Biology/Ecology

The central rock-rat is a nocturnal terrestrial rodent. It appears to undergo large population fluctuations, with marked increases occurring in response to rainfall-driven resource pulses, and contractions to core refuge areas during more typical dry periods.

Its diet comprises mainly seeds but also includes some plant stem material and a low proportion of invertebrates (Nano et al., 2003; Edwards 2013a). In drier conditions, the proportion of seed in the diet declines and that of plant stem material increases. Plants contributing most seed to the diet during an irruption phase include *Sida* spp., *Solanum* spp., and *Triodia brizoides*; and most plant species reported in the irruption-phase diet are common, widespread and fire-tolerant (Edwards 2013a). From a limited data-set (of four individuals) collected in a non-irruptive phase (Jefferys 2011), seed and leaf material recorded in the diet was from a mix of heath-like species characteristic of the upper southern slopes of the range, e.g. *Leucopogon sonderensis,*

Hibbertia glaberrima (Guinea flower), and spinifex-community vegetation, e.g. *Exocarpus sparteus* (broom ballart), and *Pelatostylis cassioides* (butterfly bush).

The contemporary core habitat of the species during the non-irruptive phase of the population cycle is quartzite ridge tops and cliffs supporting spinifex (*Triodia* spp.) grasslands or shrublands, perhaps with scattered trees. In the irruptive phases they can be found in a much wider range of rugged rocky landforms and habitats, including scree slopes, hills and valley floors, on granites, limestone, quartzite and sandstone (Wurst 1995) supporting a range of vegetation types, including tussock and hummock grasslands, low shrublands and low open woodlands (Woinarski et al., 2007). Most sites have a stony ground cover (Cole 1999). Cole and Woinarski (2000) considered that during the contraction phase the species preferred relatively long-unburnt vegetation supporting fruit-producing plants, and Nano et al., (2003) noted a specialised diet of seeds during the irruption phase, including from plant species that are 'fire-encouraged'. It is likely that fire-protected areas with relatively high moisture availability may be critical refuge areas during low rainfall periods, with the species expanding its habitat range in wetter periods.

The known population declined severely following a period of low rainfall and extensive fire in 2002, with decline occurring in both burnt and unburnt areas (Edwards 2013b; Edwards pers. comm. cited in Woinarski et al., 2014). Like other Australian desert mammals, the central rock-rat appears to be a boom-bust species, and is likely to be disadvantaged by combined impacts of fire and feral predators superimposed on, and linked to, decadal-scale climatic variation (Letnic et al., 2005).

Little is known of reproduction seasonality or success. Captive females have given birth to 1–4 young (Cole 1999). In the wild, juvenile individuals have been reported in March, April, July and November, indicating that in suitable conditions breeding may occur throughout the year (Edwards 2013b). Generation length is assumed to be 1–2 years, based on age at sexual maturity (5–6 months; Begg 1981) and longevity (probably 2–3 years) for congeneric species.

Threats

The main threats to the central rock-rat are fires and predation by feral cats.

Table 1 – Threats impacting the central rock-rat in approximate order of severity of risk, based on available evidence

Threat factor	Threat type and status	Evidence base
Fire		
Extensive, frequent and intense fires	Known current	Fire impacts may vary with season, severity and extent, as well as soil moisture and post-fire rainfall patterns. There is moderately strong correlative evidence that the species is disadvantaged by extensive, frequent and intense fires (Nano 2008). Following severe, large-scale fires, the species' food availability is diminished in the short term. Landscape-scale fires may also affect central rock-rat movement patterns and facilitate increased predation by predators (McGregor et al., 2014; McGregor et al., 2015). Conversely, several fire-encouraged plant species have been recorded in central rock-rat diet (Nano et al., 2003; Edwards 2012) and fire may therefore play an important role in the availability of foods for this species (McDonald et al., 2015b).
Invasive Species		

Predation by feral cats (*Felis catus*)	Known current	Feral cats are a known predator of the central rock-rat (Woinarski et al., 2014; McDonald et al., 2015a). Central rock-rat remains have been recovered from cat scats and there is evidence that cats prefer rock-rats over alternative small mammal prey (McDonald et al., 2015a). Camera trapping data suggest that cats are resident in core refuge habitat (McDonald et al., 2015b). Given that central rock-rat populations are highly localised and likely have low fecundity during non-irruptive periods, they may be highly susceptible to even a single resident cat. This susceptibility may increase in the years following a wildfire event when vegetation groundcover has been eliminated or reduced (McDonald et al., 2015b).
Predation by foxes (*Vulpes vulpes*)	Potential	Not demonstrated, but plausible (Woinarksi et al., 2014). Foxes are generally uncommon in the central ranges (Edwards pers. comm. cited in Woinarksi et al., 2014) and are absent from core refuge habitat (McDonald et al., 2015b).
Habitat change due to exotic invasive grasses	Potential	Not demonstrated, but plausible. The widespread occurrence of buffel grass (*Cenchrus ciliaris*) in the MacDonnell Ranges poses a potential threat to the central rock-rat, as this weed species increases both the frequency and the intensity of fire (Butler & Fairfax 2003; Franks 2002). Buffel grass may also indirectly affect the central rock-rat through competition with preferred food plant species (McDonald et al., 2015b). While buffel grass occurs in comparatively low density in quartzite range habitat, where the majority of rock-rat records occur, the weed and its interaction with fire regimes may prevent the natural spread of the species during irruptive phases of the population cycle, preventing recolonisation and genetic exchange (McDonald et al., 2015b).
Impacts of domestic species		
Habitat degradation and resource depletion due to livestock and feral herbivores	Potential	Indicated as a threat to preferred food plants (Nano et al., 2003). Horses (*Equus ferus caballus*), camels (*Camelus dromedarius*) and cattle (*Bos indicus*) potentially threaten the survival of the species through habitat modification and competition for food. These animals cause erosion and soil compaction, damage vegetation, and, because they consume mainly grasses and forbs, possibly have considerable dietary overlap with the central rock-rat (McDonald et al., 2015b).
Parasites and disease		
Parasites and disease	Potential	*Aspiculuris tetraptera* (roundworms) have been recorded in captive central rock-rat individuals. This species is common in rodents (McDonald et al., 2015b). Post-mortem examination of captive central rock-rats has shown the presence of diseases such as lymphosarcoma, a common neoplasm in rodents, and post-mortem examinations of wild and captive-bred animals have shown individuals to be susceptible to Acute Respiratory Distress Syndrome (ARDS),

		which has implications for husbandry in the captive breeding of the central rock-rat (McDonald et al., 2015b).

Assessment of available information in relation to the EPBC Act Criteria and Regulations

Criterion 1. Population size reduction (reduction in total numbers)
Population reduction (measured over the longer of 10 years or 3 generations) based on any of A1 to A4

	Critically Endangered Very severe reduction	Endangered Severe reduction	Vulnerable Substantial reduction
A1	**≥ 90%**	**≥ 70%**	**≥ 50%**
A2, A3, A4	**≥ 80%**	**≥ 50%**	**≥ 30%**

A1 Population reduction observed, estimated, inferred or suspected in the past and the causes of the reduction are clearly reversible AND understood AND ceased.

A2 Population reduction observed, estimated, inferred or suspected in the past where the causes of the reduction may not have ceased OR may not be understood OR may not be reversible.

A3 Population reduction, projected or suspected to be met in the future (up to a maximum of 100 years) [(*a) cannot be used for A3*]

A4 An observed, estimated, inferred, projected or suspected population reduction where the time period must include both the past and the future (up to a max. of 100 years in future), and where the causes of reduction may not have ceased OR may not be understood OR may not be reversible.

based on any of the followin

(a) direct observation [*except A3*]

(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

Evidence:

Nano (2008) considered the central rock-rat to be a 'boom-bust' species, but also 'rare, extremely limited'. From 1996 to 2002, the species was locally common at some sites in the West MacDonnell Ranges (Woinarski et al., 2014). Edwards (2013a) undertook 17 trapping sessions across five sampled sites at Ormiston Gorge from 2000 to 2006. During 2001 and 2002, which were very wet years, there were spikes in abundance and trap success rates were around 10 individuals per 100 trap-nights. The population in this area then crashed, and no individuals were reported at these sites in ten subsequent trapping periods, from 2002 to 2006 (Fig. 1). The significant decline in the abundance of the central rock-rat in June 2002 was likely food-related, as it coincided was a marked decline in the amount of seed availability due to the dry conditions (Edwards 2013b).

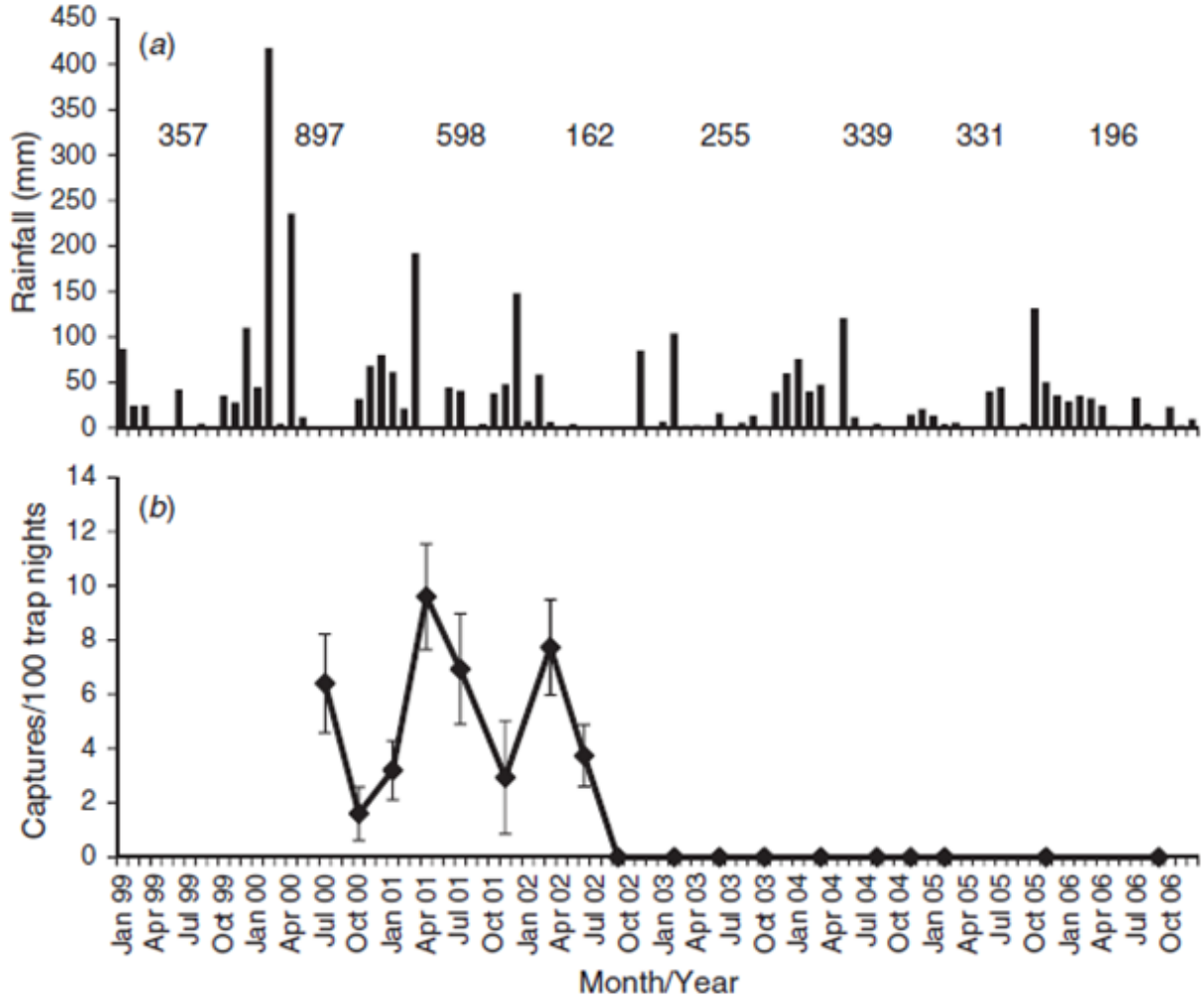

Fig. 1. (a) Monthly rainfall at Ormiston Gorge for the period January 1999 to December 2006. The total rainfall for each calendar year is shown above the year; the mean annual rainfall is 321.4 mm. (b) The number of central rock-rats captured per 100 trap-nights (+/-s.e.). From Edwards (2013a).

Subsequent sampling indicated that some sites continue to tenuously support small subpopulations, but there has been no robust estimate of the population size, nor that of most subpopulations. Sampling targeted locations (sites of previous occurrence and modelled suitable habitat) from 2009−12 resulted in captures of only eight individuals at five 'sites' (all at or around the summit of Mt Giles and Mt Sonder) from 5000 trap-nights at 55 'sites' (McDonald pers. comm., cited in Woinarski et al., 2014).

The above data indicates that the population size declined by more than 80% during the period 2001-2012. However, the population trend over the most recent 10 year period (2005−2015) is unclear. Changes in abundance may also be associated in part with rainfall variation.

The data presented above appear insufficient to demonstrate whether the species is eligible for listing under this criterion. However, the purpose of this consultation document is to elicit additional information to better understand the species' status. This conclusion should therefore be considered to be tentative at this stage, as it may be changed as a result of responses to this consultation process.

Criterion 2. Geographic distribution as indicators for either extent of occurrence AND/OR area of occupancy			
	Critically Endangered Very restricted	**Endangered Restricted**	**Vulnerable Limited**
B1. Extent of occurrence (EOO)	**< 100 km²**	**< 5,000 km²**	**< 20,000 km²**
B2. Area of occupancy (AOO)	**< 10 km²**	**< 500 km²**	**< 2,000 km²**
AND at least 2 of the following 3 conditions indicating distribution is precarious for survival:			
(a) Severely fragmented OR Number of locations	**= 1**	**≤ 5**	**≤ 10**
(b) Continuing decline observed, estimated, inferred or projected in any of: (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: (i) extent of occurrence; (ii) area of occupancy; (iii) number of locations or subpopulations;(iv) number of mature individuals			

Evidence:

Based on post-1992 records, the EOO is estimated at 1126 km^2 (i.e. restricted) and the AOO estimated at 76 km^2 (restricted); however, these are probably over-estimates of current values given that the range of this species has declined severely since 1992 (Woinarski et al., 2014). The species occurs at a single location, satisfying condition (a). Habitat quality is likely to be decreasing and there have been extreme fluctuations in abundance, which satisfies conditions (b)(iii) and (c)(iv) respectively.

The data presented above appear to demonstrate that the species is **eligible for listing as Endangered** under this criterion. However, the purpose of this consultation document is to elicit additional information to better understand the species' status. This conclusion should therefore be considered to be tentative at this stage, as it may be changed as a result of responses to this consultation process.

Criterion 3. Population size and decline				
		Critically Endangered Very low	**Endangered Low**	**Vulnerable Limited**
Estimated number of mature individuals		**< 250**	**< 2,500**	**< 10,000**
AND either (C1) or (C2) is true				
C1	An observed, estimated or projected continuing decline of at least (up to a max. of 100 years in future)	**Very high rate 25% in 3 years or 1 generation (whichever is longer)**	**High rate 20% in 5 years or 2 generation (whichever is longer)**	**Substantial rate 10% in 10 years or 3 generations (whichever is longer)**
C2	An observed, estimated, projected or inferred continuing decline AND its geographic distribution is precarious for its survival based on at least 1 of the following 3 conditions:			
(a)	(i) Number of mature individuals in each subpopulation	**≤ 50**	**≤ 250**	**≤ 1,000**
	(ii) % of mature individuals in one subpopulation =	**90 – 100%**	**95 – 100%**	**100%**
(b)	Extreme fluctuations in the number of mature individuals			

Evidence:

The population size of the species is poorly known, but is estimated to be fewer than 1000 mature individuals (Woinarski et al., 2014), which meets the threshold for Endangered. Sampling targeted locations (sites of previous occurrence and modelled suitable habitat) from 2009−12 resulted in captures of only eight individuals at five “sites” (all at or around the summit of Mt Giles and Mt Sonder) from 5000 trap-nights at 55 “sites” (P. McDonald pers. comm., cited in Woinarski et al., 2014).

The population is inferred to be declining due to a decline in habitat quality, and there have been extreme fluctuations in the number of individuals, which satisfies Criterion C2(b).

The data presented above appear to demonstrate that the species is **eligible for listing as Endangered** under this criterion. However, the purpose of this consultation document is to elicit additional information to better understand the species’ status. This conclusion should therefore be considered to be tentative at this stage, as it may be changed as a result of responses to this consultation process.

Criterion 4. Number of mature individuals			
	Critically Endangered Extremely low	**Endangered Very Low**	**Vulnerable Low**
Number of mature individuals	**< 50**	**< 250**	**< 1,000**

Evidence:

The population size of the species is poorly known, but is estimated to be fewer than 1000 mature individuals (Woinarski et al., 2014), which meets the threshold for Vulnerable. Sampling targeted locations (sites of previous occurrence and modelled suitable habitat) from 2009-12 resulted in captures of only eight individuals at five “sites” (all at or around the summit of Mt Giles and Mt Sonder) from 5000 trap-nights at 55 “sites” (P. McDonald pers. comm., cited in Woinarski et al., 2014).

The data presented above appear to demonstrate that the species is **eligible for listing as Vulnerable** under this criterion. However, the purpose of this consultation document is to elicit additional information to better understand the species’ status. This conclusion should therefore be considered to be tentative at this stage, as it may be changed as a result of responses to this consultation process.

Criterion 5. Quantitative Analysis			
	Critically Endangered Immediate future	**Endangered Near future**	**Vulnerable Medium-term future**
Indicating the probability of extinction in the wild to be:	**≥ 50% in 10 years or 3 generations, whichever is longer (100 years max.)**	**≥ 20% in 20 years or 5 generations, whichever is longer (100 years max.)**	**≥ 10% in 100 years**

Evidence:

Population viability analysis appears not to have been undertaken, and there are insufficient data to demonstrate if the species is eligible for listing under this criterion. However, the purpose of this consultation document is to elicit additional information to better understand the species’ status. This conclusion should therefore be considered to be tentative at this stage, as it may be changed as a result of responses to this consultation process.

Conservation Actions

Recovery Plan

A recovery plan for the central rock-rat was developed by the Northern Territory (Cole 1999) and adopted as a national recovery plan under the EPBC Act in 2007. An updated recovery plan is being drafted by the Northern Territory (McDonald et al., 2015b), and a process of adopting this plan as a national recovery plan is underway.

Primary Conservation Objectives

1. Control the numbers of feral cats in areas occupied by central rock-rats
2. Reduce the extent, frequency and intensity of fires within the species' range

Conservation and Management priorities

The central rock-rat is currently listed as Endangered under the EPBC Act. The species is also listed as Endangered in the Northern Territory under the *Territory Parks and Wildlife Conservation Act 2000* and listed as Listed as Critically Endangered in Western Australia under the *Wildlife Conservation Act 1950.*

Fire

- Develop and implement fire management strategies that benefit this species (Woinarski et al., 2014) by reducing the extent, frequency and intensity of fires within the species' range. Specifically, establish and maintain strategic firebreaks in spinifex grasslands, and undertake landscape-scale burning of soft grasses in response to high rainfall periods, to reduce the extent and severity of wildfire across the MacDonnell Ranges. Undertake fine-scale burning of dense spinifex grasslands in areas adjacent to known rock-rat populations to maintain the protective cover of spinifex while promoting food resources (McDonald et al., 2015b).
- Manage fire to produce a fine-scale mix of vegetation of differing ages, including some relatively long-unburnt vegetation.
- Ensure that a high proportion of the habitat is maintained with a post-fire age sufficient to provide adequate cover for the species.
- Ensure immediate and ongoing post-fire predator control within the habitat when fires do occur.
- Implement strategic management of invasive grasses, such as buffel grass, to reduce fire fuel loads within the species' range.
- Provide maps of known occurrences to managers of Aboriginal Land, National Parks, and surrounding private land (Ward pers. comm. 2016), as well as local and state Rural Fire Services and seek inclusion of mitigation measures in bush fire risk management plan/s, risk register and/or operation maps. Physical damage to the habitat and individuals of the species must be avoided during and after fire operations. Fire management authorities and land management agencies should install field markers to avoid damage to the species.

Invasive species

- Where possible, control feral cats in and around sites where the central rock-rat occurs, using a broad-scale, targeted feral cat eradication technology or other method, ensuring there are no detrimental effects on other species. For example, when the Curiosity® bait for feral cats is available, and if broad-scale baiting proves feasible and effective for feral cat control (with minimal or acceptable non-target impacts), then implement its widespread aerial deployment in national parks and other conservation areas identified

by local or regional groups. Ensure the Curiosity® bait is available to large landholders controlling feral cats.

- Implement management of feral cats and foxes, through poison baiting, in the MacDonnell Ranges National Park. Specifically focus baiting efforts in core central rock-rat populations, as well as buffer areas surrounding central rock-rat populations to allow these populations to expand. Baiting with 1080 or para-aminopropiophenone (PAPP) in winter (when there is lower reptile activity) during times of low rainfall (when there is lower native mammal activity) is likely to have the greatest chance of success in controlling introduced predators. Use camera traps to monitor the pre- to post-bait response from rock-rats and predators (through changes in occupancy) (McDonald et al., 2015b). Design the baiting to minimise impacts on dingoes, which are likely to control both foxes and cats.

Impacts of domestic species

- Where livestock grazing occurs in or near known central rock-rat habitat, ensure land managers use an appropriate management regime and stock density that does not detrimentally affect the species' habitat.
- Manage total grazing pressure at important sites through exclusion fencing or other barriers.

Breeding and other ex situ recovery actions

- Develop a translocation program that includes a risk assessment of the potential impacts on wild populations of removal of individuals for captive breeding (McDonald et al., 2015b).
- Re-establish an insurance captive breeding program (Woinarski et al., 2014; McDonald et al., 2015b) if the translocation program risk assessment indicates it is prudent to do so (Ward pers. comm. 2016).
- Trial translocation to suitable areas within the species' former range (or nearby) where key threats have been controlled.

Stakeholder Engagement

- Undertake consultation with the Central Land Council and other relevant Aboriginal organisations and communities before undertaking recovery actions on Aboriginal land. Where possible, engage traditional owners/Indigenous ranger groups in undertaking survey, monitoring and management actions. Engage traditional ecologists to provide advice on biological aspects, threatening processes and the cultural significant of this species.
- Undertake consultation with property managers when recovery actions are occurring on pastoral leases. Where feasible, encourage pastoralists to play a role in management of outlier populations (McDonald et al., 2015b).
- Land managers (including pastoralists and indigenous communities) should be given information about managing fire for the benefit of the species.
- Collaborate with appropriate research institutions to achieve the research components of the recovery actions.
- Establish education and information programs targeting public and private land managers, the general public and relevant non-government organisations.

Survey and Monitoring priorities

- Use targeted surveys to more precisely assess the species' entire geographic extent, changes in extent of occurrence/area of occupancy, relative abundance, and viability of

populations across the species' range. Carry out mark-recapture surveys and radio tracking to obtain information on habitat use and movements.

- Establish an integrated monitoring program across populations. Specifically monitor the abundance of feral predators in response to management actions, and monitor the incidence of fire, and monitor the response of populations to fire and predator control, using an appropriate measure (occupancy, population abundance, individual mortality, ranging behaviour, breeding success, etc) based on knowledge of the ecology of the species, and with a monitoring design that aims to improve understanding of the species' response to fire and predators.
- Keep precise fire history records for areas containing extant populations and suitable habitat for the species.
- Identify sites suitable for translocations.
- Monitor the progress of recovery, including the effectiveness of management actions to inform future management actions.

Information and research priorities

Fire

- Improve understanding of the mechanisms of response to different fire regimes and identify appropriate fire regimes for conservation of the species by:
    - Use understanding and research on fire responses among related or functionally similar species to develop fire management strategies for conservation.
    - Assess the extent to which preferred habitat may be affected by fire regimes
    - Assess the extent to which food availability may be affected by fire regimes, and assess the extent to which food availability may limit population size or reproductive success.
    - Assess the efficacy and impacts of management options to reduce fire incidence, extent and intensity.

Invasive Species

- Assess the current and potential distribution of buffel grass in and around important sites, and consequential impacts on fire regimes. In addition, assess the effectiveness of control programs for buffel grass at and around sites with important habitat for rock-rats in their irruptive phase.
- Assess the abundance of feral cats, foxes and dingoes in the range of this species, and the impact of predation on population viability. In addition, assess the effectiveness of options for broad-scale control of feral predators; or of local scale control at sites with important populations.
- Assess impacts of feral herbivores on important dietary plant species in and around occupied sites and suitable habitat.

Translocation

- Write a translocation program that includes a plan for captive breeding of the species and a risk assessment of the captive breeding and translocation processes (McDonald et al., 2015b). Include an investigation of the factors limiting success of captive breeding programs.

Disease and Parasites

- Investigate the incidence, and assess the potential impact of, diseases (such as lymphosarcoma and Acute Respiratory Distress Syndrome) and parasites (such as

roundworms) on wild and captive populations of the central rock-rat. In particular, assess implications for husbandry in captive breeding populations.

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Consultation questions

1. Do you agree with the current taxonomic position of the Australian Faunal Directory for this taxon (as identified in the draft conservation advice)?

2. Can you provide any additional references, information or estimates on longevity, age of maturity, average life span and generation length?

3. Has the survey effort for this taxon been adequate to determine its national distribution and adult population size?

4. Do you accept the estimate provided in the nomination for the current population size of the taxon?

5. For any population with which you are familiar, do you agree with the population estimate provided? If not, are you able to provide a plausible estimate based on your own knowledge? If so, please provide in the form:
   Lower bound (estimated minimum):
   Upper bound (estimated maximum):
   Best Estimate:
   Estimated level of Confidence: %

6. Can you provide any additional data, not contained in the current nomination, on declines in population numbers over the past or next 10 years or 3 generations, whichever is the longer?

7. Is the distribution as described in the nomination valid? Can you provide an estimate of the current geographic distribution (extent of occurrence or area of occupancy in km^2) of this taxon?

8. Has this geographic distribution declined and if so by how much and over what period of time?

9. Do you agree that the taxon is eligible for inclusion on the threatened species list, in the category listed in the nomination?

10. Do you agree that the threats listed are correct and that their effects on the taxon are significant?

11. To what degree are the identified threats likely to impact on the taxon in the future?

12. Can you provide additional or alternative information on threats, past, current or potential that may adversely affect this taxon at any stage of its life cycle?

13. In seeking to facilitate the recovery of this taxon, can you provide management advice for the following:
    - What individuals or organisations are currently, or need to be, involved in planning to abate threats and any other relevant planning issues?
    - What threats are impacting on different populations, how variable are the threats and what is the relative importance of the different populations?
    - What recovery actions are currently in place, and can you suggest other actions that would help recover the taxon? Please provide evidence and background information.

14. Can you provide additional data or information relevant to this assessment?

15. Can you advise as to whether this species is of cultural significance to Indigenous Australians?