The natural history, conservation status and ecology of the eastern pygmy-possum (Cercartetus nanus) Ch. 6, pp. 255-341

Jamie Mark Harris
Southern Cross University

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CHAPTER 6: CONCLUDING DISCUSSION

6.1 Synthesis

This chapter will provide a concise synthesis of the thesis. In most of the papers published from within the thesis I have discussed the findings in the broader context of the biology and natural history of the species and to do so again would lead to repetition. However, it is important that a succinct overarching synthesis is provided here.

This thesis has contributed to knowledge of the natural history, conservation status and ecology of *C. nanus*. Studies were conducted to collate existing information embedded within the literature, both peer-reviewed published literature as well as the non peer-reviewed grey literature, and to use this information to document a greater understanding of the ecology of this species and to enable a re-evaluation of its conservation status across its geographic range. Field studies were also conducted to examine the ability of different methods to detect it, as well as to describe aspects of its population ecology and response to habitat regeneration at a fire-prone location.

Chapter 2 provided a detailed investigation into the historical zoology and taxonomy of the species, as well as a comprehensive review of its biology. Some fascinating aspects of its natural history were highlighted including its unusual longevity, ability to hibernate and likely role as an important pollinator of a range of plants. I assembled valuable data and observations on *C. nanus* that were previously scattered and relatively inaccessible and this is important for management as well as of academic interest.
Chapter 3 reported on the modern distribution, habitat and conservation status on a State-by-State basis. This species has a large range, but populations are typically small and localised and there are few locations where it appears abundant. Moreover, its geographic range is characterised by a retreat to high elevation in the northern parts which suggests this species will be vulnerable to increases in temperature associated with climate change. Many populations are threatened by habitat destruction, introduced predators, and inappropriate fire regimes. The prognosis for *C. nanus* is particularly bleak at the periphery of its range in SA and in Qld. Populations in SA and NSW are already classified as "threatened species”, and they probably should also be added to such lists in Qld, Victoria and Tasmania. Further discussion regarding these issues is provided in section 6.2.

In Chapter 4, data on the fossil occurrences of *C. nanus* coupled with distributional data on its modern range revealed that the species differs markedly from the range decline pattern observed in *Burramys parvus* and *C. lepidus*. However, there is evidence for an eastward contraction at the range periphery in Qld, and this is significant in terms of assessing its conservation status in that State. Further study of the fossil collections of *C. nanus* in museums could be undertaken, particularly in relation to establishing age limits for specific deposits. This would permit a better understanding of the species’ past occurrence.

Chapter 5 involved field studies at Jervis Bay, Barren Grounds and Royal National Park. Elliott trapping in trees, checking of nest-boxes, and pitfall trapping emerged as the most reliable survey techniques. Elliott trapping in trees (i.e. adjacent to flowering *Banksia* inflorescences) produced some of the highest capture rates yet recorded for *C. nanus*. 
Nest-boxes also proved effective, particularly in heathland, but the design used might need improvement, since occupation rates were very low in forest sites. Pitfall trapping with a short drift fence was much less effective than the long drift fence used in some previous studies (e.g. Andrew 2001; Tulloch 2001). A key insight from these studies has been that a combination of survey methods works best to detect *C. nanus*, and that late summer to early autumn is the best time to undertake surveys. Spotlightting and Elliott trapping on the ground were found to be highly inefficient approaches for detecting this species.

Field studies conducted in this thesis enable a broader understanding of similarities among *C. nanus* populations. For example, females in tableland populations (Barren Grounds [this study], Fernbrook [Bladon *et al.* 2002]) produced only one litter per year and during a restricted breeding period (December-February to June), whereas females in coastal populations (Royal [this study], Wilson’s Promontory [Turner 1985; Ward 1990]) bred throughout the year (almost any month) and could produce two litters. These observations suggest an elevation-induced influence on reproduction that may reflect a greater reliance on torpor during high elevation winters. An alternative hypothesis is that higher rainfall may wash away and dilute nectar leading to food shortages at high (>1700 mm pa) compared to low (~1000 mm pa) elevation. Also, it may be that lower temperature can reduce nectar flow. Although much is known in general about biological responses to elevation (Stevens 1983; Fabbro and Körner 2004; von Arx *et al.* 2006; Körner 2007; Milla *et al.* 2009; Wapstra *et al.* 2009), certainly more research is needed to improve our understanding of how *C. nanus* responds, since climate change is likely to result in range shifts along both altitudinal and latitudinal gradients.
6.2 Conservation status

*Cercartetus nanus* is an example of a species that is widespread and which until recently was believed to not be under any threat of extinction. This changed with recognition of this species in NSW as a threatened species in 2001 (Bowen and Goldingay 2000; Dickman 2004) and in SA in 2002 (van Weenen 2002). Attention has been given to NSW populations in recent years (Curran 2001; Westcott 2003; Tulloch 2001, 2003; Tulloch and Dickman 2006, 2007; chapter 5), but much more research is needed to secure its conservation in this State. The NSW Department of Environment, Climate Change and Water have identified five strategies within a “Priority Action Statement” to help recover *C. nanus*, and each of these strategies has a number of actions within it (http://www.threatenedspecies.environment.nsw.go). These are (1) community and landholder liaison/ awareness and/or education; (2) control and monitoring of the abundance of feral predators; (3) providing operational guidelines to protect this species from fire, with a fire frequency of >10 years; (4) encouraging research on the ecology, movements, habitat use and genetics of populations; and (5) conducting field surveys to further delineate the distribution of key populations. This Priority Action Statement recognises a broad set of generic actions that may assist recovery of *C. nanus* at one level but it is likely that more specific actions are required (e.g. research to investigate its potential vulnerability to climate change) and to ensure rather than “encourage” that research occurs.

One of the aims of compiling the available data on locational records, habitat and detection methods was to be able to evaluate the conservation status of the species in
Victoria, Qld and Tasmania (this having been done for NSW and SA). Within these studies (see Chapter 3), an appraisal was made of the conservation status and a recommendation provided. In the case of Victoria, this was that the species should be considered for listing as “Vulnerable”. In the case of Qld, this was the species should be considered for listing as “Endangered”. In the case of Tasmania, this was that more surveys be conducted.

Following publication of the paper on the distribution, habitat and conservation status of *C. nanus* in Victoria (see section 3.3), R. Goldingay and I were involved in preparing a formal nomination to list the species as Vulnerable under the *Victorian Flora and Fauna Guarantee Act 1988*. In this nomination, it was argued that *C. nanus* was eligible to be listed because it meets several specified criteria i.e. that it is in a demonstrable state of decline which is likely to result in extinction (criterion 1.1); is significantly prone to future threats which are likely to result in extinction (criterion 1.2); and is very rare in terms of abundance or distribution (sub-criterion 1.2.1). The nomination was considered by the Victorian Scientific Advisory Committee (SAC) on 8 November 2005, but was rejected on the basis of insufficient evidence.

The Victorian SAC found for criterion 1.1 that “although limited evidence suggests populations of *C. nanus* have declined in some parts of Victoria, insufficient appropriately targeted survey efforts have been completed to demonstrate that these declines are of a magnitude that is likely to result in the extinction of the species”. For criterion 1.2, the SAC conceded that *C. nanus* is vulnerable to population decline
resulting from habitat fragmentation, habitat modification, inappropriate fire regimes, and predation by the red fox and the cat. However, it was also stated that “insufficient evidence was presented to demonstrate that these threats are likely to result in the extinction of the species”. Finally, for sub-criterion 1.2.1, it was found that “C. nanus is rarely observed or trapped in fauna surveys, [but] experts in trapping this species indicated to the Committee that only specialised trapping techniques are successful in detecting the presence of the species at a site. This makes estimating the abundance and distribution of the species very difficult. Experts on the species did not believe past untargeted trapping efforts give an indication of the species’ abundance and distribution, nor would they conclude that the species is very rare in the State”.

I would refute these conclusions of the Victorian SAC on several grounds. First, I believe that the SAC should have exercised caution when dismissing the substantial anecdotal evidence of regional decline of C. nanus populations. The best evidence available at present indicates local range extinction in several regions of Victoria and there remains serious conservation concern for populations in the south-west, northern and Melbourne regions of Victoria (see also Burbidge et al. 2008). I do not believe that maintaining a listing of “common” and “not-threatened” throughout Victoria is accurate. Certainly, more targeted survey effort needs to be undertaken to establish whether populations are indeed threatened over some or all of its range in Victoria, but nothing was recommended by the SAC in order to stimulate such research to be undertaken. Field studies conducted during the completion of this thesis have shown that pitfall trapping, Elliott trapping in trees, and nest-boxes are the most reliable survey methods. The first method is not a specialised technique, but is employed routinely in fauna surveys throughout Victoria and
elsewhere (see Bowen and Goldingay 2000; Harris and Goldingay 2005a). The latter two methods have been under-utilised in Victoria, and further targeted studies using these methods will need to be conducted in order to inform any future nominations. At the very least the nomination submitted has forced the SAC and others to look more carefully at the plight of *C. nanus*. This is reflected in the most recent *Advisory List of Threatened Vertebrate Fauna in Victoria* (Department of Sustainability and Environment, Victoria 2007), wherein *C. nanus* was listed as a mammal species that is “near-threatened”.

In SA, *C. nanus* is listed as “Vulnerable” under Schedule 8 of that State’s *National Parks and Wildlife Act 1972* because of its limited and fragmented distribution (see section 3.4). Recently, Bachmann (2007) provided eight additional *C. nanus* records from the very far south-east of SA not previously listed in departmental databases, and one from Rennick State Forest (Victoria). He also speculated that *C. nanus* was a “naturally” rare or uncommon species at some sites in SA and that there may be a “greater level of implied threat than is actually the case”. My own view is that the threat has not been exaggerated and there is nothing in these new data to suggest that *C. nanus* should be de-classified as a threatened species in SA. On the contrary, Bachmann’s (2007) new records further supports my contention that populations are indeed small and isolated (be it naturally or otherwise) and this makes them more vulnerable to localised extinction through chance catastrophic events (Clark and Seebeck 1990; Reed and Hobbs 2004). Certainly, the debate on the status of *C. nanus* in SA (and elsewhere) will continue as it rightly should, but the matter needs to be informed less through opinion and more through the use of assessment tools such as systematic survey and population modelling. Also, in the absence of management intervention, as is currently the case, and with the spectre of
climate change and increasing intensity of other threats, I predict that *C. nanus* populations in SA are likely to reduce further in both distribution and abundance. Thus, appropriate risk mitigation strategies should be put in place now to prevent further population decline. At a minimum, this should include habitat restoration activities aimed at increasing the area and connectedness of the small number of remnants with known *C. nanus* populations in SA. At present, as far as I am aware, there are no conservation programs currently underway that aim to benefit SA *C. nanus* populations specifically.

Following publication of the paper on the distribution, habitat and conservation status of *C. nanus* in Queensland (Qld) (see section 3.5), R. Goldingay and I were involved in preparing a nomination for listing it as a threatened species under the Qld *Nature Conservation Act 1992*. The paper was co-authored by Qld agency staff who contributed to the conclusion reached about the conservation status. This conclusion was the basis of the nomination which was considered by the Species Technical Committee (STC) at a meeting held on 4 June 2008 but was initially rejected for listing because *C. nanus* is not currently listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC) or the NSW *Threatened Species Act 1995*. The STC seemed unaware that the species had been listed as vulnerable in NSW since 2001. This was subsequently pointed out to the STC. Regardless, the *Nature Conservation Act 1992* pertains to the occurrence and status of species within the State of Qld, so a species’ status outside Qld was effectively of no legal consequence. The nomination was reconsidered by the STC on 2 April 2009, but the original decision was upheld. A listing of
‘least concern’ when there are only two small end-of-range populations occurring in Qld seems hard to justify and will not conserve this species in that State.

This outcome has been somewhat controversial because originally the official documentation provided stated that changes to a species status in Qld are assessed using the quantitative IUCN criteria, and these had been carefully followed in recommending a status upgrade for *C. nanus* (see section 3.5). However, for the re-appraisal in 2009 the STC adopted a set of qualitative assessment guidelines which make no reference to or in anyway use the established IUCN criteria. Certainly, the matter could be argued further, but it might be more pertinent to instead concentrate on preparing a nomination to list the species as threatened under Commonwealth legislation.

For Tasmania, the status of *C. nanus* was reviewed in section 3.6. This revealed a widespread distribution, but the records were sparse and survey data were deficient for some areas. The state agency staff who co-authored this paper argued that a program of field research on the ecology of *C. nanus* in Tasmania should be a high priority. There was a sense here that ecologists within Tasmania had formed an impression that *C. nanus* was widespread and not under threat until the collated survey data revealed a situation not unlike that on the mainland. Further research may well support listing at a future date. Furthermore, the fact that Tasmanian populations have been isolated from the mainland for 10,000 years also suggests that there are likely to be genetic differences between Tasmanian and mainland Australian populations. Studies on some other marsupials have shown genetic differences to exist between the two areas e.g. eastern barred bandicoot *Perameles gunnii* (Robinson 1995) and *Dasyurus maculatus* (Firestone *et al.* 1999). Use
of molecular approaches should help clarify whether Tasmanian *C. nanus* represent a unique sub-species (Evolutionary Significant Unit), and this may be important in further considerations of conservation status.

Given the finding that the species is less than secure over much of its range, coupled with disparity in the ways that threatened species are assessed and managed under State-based legislation, I suggest that it would be better to adopt a consistent and whole-of-range approach and nominate *C. nanus* to be listed as Vulnerable under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. However, all the necessary survey data to do this are not currently available, but could be if management agencies allocated sufficient resources. Essentially, we need to ensure that the species has been reasonably well-surveyed across its range and we need more refined information on the extent of occurrence and area of occupancy (following IUCN definitions), as well as modelling to estimate this. Further population studies are required because available data suggest that there are only a relatively small number of locations in each state where the species is reasonably abundant. In NSW, one of these is at Barren Grounds where the local population was estimated to be approximately 15-30 individuals (see section 5.3).
6.3 Further research opportunities

There are some potentially valuable investigations that could be undertaken to improve our understanding of the ecology of *C. nanus*. Much is still unknown regarding this secretive possum, and further study is needed of its behavioural ecology. It is hoped that this thesis will provide some basis for the questions listed below to be explored in the future. Certainly the last word on the future conservation and management of *C. nanus* is yet to be written.

(1) Further field surveys are needed throughout the range of *C. nanus*, but particularly in Victoria, Queensland and Tasmania where more data are needed to ascertain whether or not populations are secure. However, we also need standard sampling methods to allow for reliable statistical comparisons between studies and between different habitats. There is currently no clear recipe for sampling *C. nanus* populations and questions remain as to what is the optimum arrangement for sampling devices? For example, some anecdotal observations made were that nest-boxes seemed to be more regularly used where they were placed in dense, difficult to reach, scrubby vegetation, suggesting that concealment of the nest-box could be an important factor in utilisation rates. Whether exposure to sunlight and nest-box temperature, or avoidance of predators affects nest-box use might be worth further investigation (see also Beyer and Goldingay 2006). Answers to this and similar questions will contribute to the development of more efficient and standardised methods for sampling *C. nanus* populations.
(2) More radio-tracking and trapping studies spanning several years (e.g. section 5.3; Turner 1985; Ward 1990; Bladon et al. 2002) are needed to better understand population dynamics and the longer-term movements of individuals in a population.

(3) Population modelling, using commercially available software (e.g. BIOCLIM [Busby 1991], ALEX [Possingham and Davies 1995], and MAXENT [Phillips et al. 2006]) is needed across the range of C. nanus to assist in conservation assessments. Modelling approaches can be used to provide a more objective and quantitative approach and make predictions in relation to the future distribution and abundance of C. nanus.

(4) Studies are needed that aim to develop a better understanding of how C. nanus populations respond to known threatening processes such as inappropriate fire regimes, habitat destruction, road traffic, and predation by introduced predators. This could lead to the development of mitigation measures. For instance, in the case of road traffic it is probably not widely recognised that many C. nanus fatalities do occur on the roads since larger road-kill species are more frequently noticed. However, a recent unpublished study from Royal National Park conducted over 3 years reported 54 C. nanus found dead on the main roads (Schulz and Madden 2010). There are many examples in the recent literature of how science can be applied to understand and manage impacts associated with road traffic (e.g. Taylor and Goldingay 2009; Benitez-López et al. 2010; Hobday 2010) and it is appropriate to now consider for example how exclusion fencing designs might be applied for a species as diminutive as C. nanus.
(5) A better understanding is needed of threats to *C. nanus* and its habitat from climate change impacts. Temperature in Australia is predicted to rise by 1-6.0°C by 2070 (Hughes 2003). A 3°C increase in average ambient temperature is equivalent to range shifts north of 300-400 km and shifts up in elevation of 500 m (Hughes 2000). Bennett *et al.* (1991) have estimated that under a modest climate change scenario of a 1°C increase in temperature (and 5% increase in summer rain; 5% in winter rain), the range of the smoky mouse (*Pseudomys fumeus*) will decrease by >50%. This species has a range broadly coincident with *C. nanus* in Victoria, so a similar contraction in range could be expected for Victorian *C. nanus*. Furthermore, significant range contractions would probably occur in Queensland and SA where its distribution is ultra-limited. Accordingly, a climate change analysis for *C. nanus* is required.

(6) Another emerging threat to *C. nanus*, that is potentially highly significant, is *Phytophthora cinnamomi* infestation of habitat trees, particularly *Banksia* and *Xanthorrhoea*. Some recent work undertaken in Victoria (Laidlaw and Wilson 2003) suggested that heathland regenerating after *P. cinnamomi* infestation would provide sub-optimal habitat for *C. nanus* for decades. However, there has not yet been any research conducted to look more closely at this potential problem.

(7) Further study of the fossil collections of *C. nanus* could be undertaken. This would involve further examination of museum collections to establish age limits for specific deposits and also to discern the types of predatory accumulators involved. Also, there are many cave sites, particularly in Tasmania, that have not yet been subjected to paleontological and archaeological study, and there are good chances that such cave sites will produce more *C. nanus* fossil material.
REFERENCES


Anon (1946). Report to the trustees of Kosciusko State Park by the joint scientific committee of the Linnean Society of N.S.W and the Royal Zoological Society of N.S.W on a reconnaissance natural history survey of the park, January-February, 1946.


Cuvier, G.B. (1827). Synopsis of the species of the class Mammalia as arranged with reference to their organization with specific characters, synonyma etc etc. In Cuvier, B. and Griffith, E. The animal kingdom, arranged in conformity with its organization with additional descriptions of all the species hitherto named, and of many not before noticed. G.B. Whittaker, London. **5**, 198.


Green, R.H. (1967a). Notes on the devil (Sarcophilus harrisii) and the quoll (Dasyurus viverrinus) in northwestern Tasmania. Records of the Queen Victoria Museum 27, 1-13.


Gulliver, G. (1875). Observations on the sizes and shapes of the red corpuscles of the blood of vertebrates, with drawings of them to a uniform scale, and extended and revised tables of measurements. *Proceedings of the Zoological Society of London* 1875, 474-495.


Krefft, G. (1871). The mammals of Australia, with a short account of all the species hitherto described. Government Printer, Sydney.


corridors) and contiguous stands of montane ash forest in the central highlands of Victoria, southeastern Australia. *Forest Ecology and Management* 67, 113-133.


Marshall, B. (1985). Taphonomic studies into owl-pellet bone and its implications for the archaeology of cave and rock-shelter sites. Honours Thesis, La Trobe University,


Assessment and Data Unit, Central Conservation Programs and Planning Division, Hurstville.


Owen, R. (1845). Odontography; or a treatise on the comparative anatomy of the teeth; their physiological relations, mode of development, and microscopic structure, in the vertebrate animals. Volume 1 (text) p.383 and Volume 2 (atlas) plate 100, figure 3 (skull).


SAC (Scientific Advisory Committee) (2002). Final recommendation on a nomination for listing: Threats to native flora and fauna arising from the use by the feral honeybee *Apis mellifera* of nesting hollows and floral resources (Nomination No. 560). Scientific Advisory Committee, Flora and Fauna Guarantee. Department of Natural Resources and Environment, Melbourne.


APPENDIX 1: Data from Royal National Park

Table A2.1. Summary of survey effort and number of *C. nanus* captures (independent individuals only) at Royal NP. Data are segregated for heath and forest plots at each site. The nest-box data correspond with the trapping period (20.12.04 to 14.1.07).

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<td>Number of nest-box checks (and captures)</td>
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