Project Plan SP 2021-046

Distribution and conservation status of the heath mouse (*Pseudomys shortridgei*) in Western Australia

BCS Animal Science

Project Core Team

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X X
Project Team granted
Program Leader granted
Directorate granted
Biometrician granted
Herbarium Curator not required
Animal Ethics Committee granted

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Program

BCS Animal Science

Departmental Service

Service 6: Conserving Habitats, Species and Communities

Project Staff

X X X	Role	Person	Time allocation (FTE)
	Supervising Scientist	Lesley Gibson	0.0
	Research Scientist	Saul Cowen	0.01
	Technical Officer	Kristen Nilsson	0.2
	Research Scientist	Mark Cowan	0.01

Related Science Projects

Proposed period of the project

Sept. 1, 2021 – Sept. 1, 2024

Relevance and Outcomes

Background

The heath mouse *Pseudomys shortridgei* (50-80g) is one of several native rodent species that have declined in distribution and abundance since European colonisation. According to subfossil records, the species was once widely distributed across the heathlands of Western Australia, South Australia and Victoria. It now occurs in species-rich and structurally complex heathland and woodland in two disjunct areas in south-western Victoria, and extending across the border into South Australia, and in southern Western Australia. The main ecological difference between these widely separated populations appears to be related to fire regime. In WA, the species tends to occur in long unburnt habitat with highest densities recorded in vegetation 30 years post-fire. Whereas in Victoria, highest densities have been recorded in habitat 5-15 years after fire. While there is some disparity in studies investigating their genetic differentiation (Cooper et al. 2003; , they are currently treated as a single species.

Populations in Victoria are restricted to the Grampian State Forest, Lower Glenelg National Park, Bats Ridge Fauna Reserve, and Mount Eccles National Park (Ovington 1978; Cockburn 1980; Watts and Aslin 1981; Wells 1991; Meulman 1997). From 2002-2008, South Australian populations of the heath mouse were recorded in Honeysuckle and Dry Creek Native Forest Reserves, and Lower Glenelg River Conservation Park (Kemper et al. 2010). A single individual was also recorded from Kangaroo Island in 1967, though the species has not been detected since then (Robinson et al. 2000).

Originally collected in 1906 near Pingelly in WA's wheatbelt, the heath mouse was thought to be extinct in WA until its rediscovery in 1987. Since then, it has been recorded in low numbers within the Fitzgerald River National Park, Dragon Rocks Nature Reserve, Ravensthorpe Range (and nearby) and Lake Magenta Nature Reserve. Until 2019, the last confirmed record of heath mouse in WA was in 2004, from Lake Magenta. The heath mouse is listed as Endangered under the *EPBC* Act and Vulnerable under the WA *Biodiversity Conservation Act*.

In WA, Quinlan et al. (2004) found that heath mice prefer long unburnt mixed laterite heath communities in Lake Magenta Nature Reserve. Sanders et al. (2012) found heath mice in shrub mallee with either a heath or scrub understorey on loamy-sand or sandy loam with a lateritic component. The vegetation at these sites was 30-70 years old, although capture rates were higher in younger vegetation (30 years). In the Ravensthorpe Range, they were captured in shrub mallee with a scrub understorey over sedges on loamy sand with laterite and

sandy light clay on greenstone. Heath mice appear to follow a seasonal breeding pattern with adults surviving into successive years. At Lake Magenta females were pregnant in July, lactating in October and juveniles were present in the population in March-April (D. Cancilla pers. comm.).

The lack of recent heath mouse records in WA instigated targeted surveys for this species in May/June 2019, which resulted in their capture at two locations south of Ravensthorpe and an area in the Great Western Woodlands 80km south east of Hyden. This preliminary survey provided confidence that the heath mouse was still extant in WA, but further surveys in 2020 failed to detect the species despite sampling in areas where it had previously been recorded (i.e., Lake Magenta Nature Reserve, Fitzgerald River National Park and Ravensthorpe Range). In general, trap success across all sights was remarkably low, and was thought to be due to successive years of low rainfall across the area.

Although not thought to respond to changes in resource availability in a boom and bust dynamic, studies in the Grampians National Park in Victoria have shown a strong correlation between heath mouse abundance and rainfall. Here, abundance peaks following high rainfall events, and falls to very low densities during drought conditions (Senior 2014). This is also likely to be the case in WA, although the lack of long-term monitoring data makes this difficult to corroborate/discern.

As there is no recovery plan for the heath mouse, and there are clear indications of decline in distribution and abundance, further targeted survey is critically important to determine current conservation status. Given its low density and patchy distribution, developing a survey strategy that maximises the likelihood of detecting the species poses a challenge. Spatially explicit habitat suitability models based on historical records and relevant environmental data layers can assist but given the species appears to now be absent in many of the areas where it has been previously located, the reliability of such models is questionable. As annual rainfall has declined in south-west WA, and is predicted to decline further, projecting these models onto future climate scenarios may be useful for selecting survey locations in areas previously thought unsuitable.

Should populations of the heath mouse be found, a decision then needs to be made regarding what management actions are required to protect the species and promote its recovery. In-situ actions alone may not be adequate if their abundance is determined to be critically low. In this case, establishing a captive breeding program may be an option, with the goal to produce enough founders for reintroduction back into the wild. One location which has been proposed for a heath mouse reintroduction is Dirk Hartog Island. Structured decision making is a useful process for making conservation management decisions including a consideration of both ex-situ and in-situ measures.

Aims

Undertake targeted surveys for the heath mouse to:

- establish their current range and conservation status in WA
- identify populations that may be suitable for ongoing monitoring
- assess the possibility of sourcing heath mice for a captive breeding colony to provide founders for reintroductions

Expected outcome

- An improved understanding of the distribution and abundance of heath mice to inform effective conservation management and recovery actions.
- Identification of conservation management actions, including captive breeding and potential translocations, to establish sustainable populations of heath mice in the wild.

Given the unknown status of the heath mouse within their regions, both the South Coast and Wheatbelt have indicated a targeted survey of the heath mouse is a priority to determine conservation status and spatial distribution. This would inform targeting recovery actions and provide a baseline to determine population trends, revealing current and future management effectiveness. Targeted management activities aimed at recovering the species could include: fire management targeted at protecting and maintaining diverse and productive heath communities, introduced predator control reducing predation pressure on heath mouse populations by including Eradicat® into the baiting program, *Phytophthora cinnamomi* management given many of the heathland species required to maintain habitat suitable for heath mice are susceptible to Pc, captive breeding/translocations to provide secure populations, and develop ongoing monitoring methods that identify trends in heath mouse populations (size and occupancy) along with predator activity. Firstly, within sites identified as containing heath mice and secondly in habitat identified as likely to contain heath mice.

Knowledge transfer

Users: South Coast Regional PWS staff and Wheatbelt Regional PWS staff, BCS, Species and Communities, Western Shield

Outputs:

- Reports
- Scientific publications
- Maps/data/locational records
- Direct liaison
- Popular articles (e.g. Landscope)

Tasks and Milestones

- Review existing literature
- Collate species records and environmental variables
- Complete habitat suitability modelling
- PACES workshop – collate outputs
- Undertake surveys at selected sites
- Complete reports and publications

References

Baynes, A., A. Chapman and A. J. Lynam (1987). The rediscovery, after 56 years, of the Heath Rat Pseudomys shortridgei (Thomas, 1907)(Rodentia: Muridae) in Western Australia. Records of the Western Australian Museum 13 (2): 319-322.

Chapman, A., G. Harold, A. Saunders and R. J. Teale (2003). Vertebrate Fauna of the Southern Central Coast Region of Western Australia. Perth, Department of Conservation and Land Management.

Chapman, A. and K. R. Newbey (1995). A Biological survey of the Fitzgerald area, Western Australia. CALMScience Supplement 3: 1 -258.

Chapman, A. and K. R. Newbey (1995). A Vertebrate fauna survey and some notes on the vegetation of the Ravensthorpe Range, Western Australia. CALMScience 1(4): 465-508.

Cockburn, A. (1978). "The Distribution of Pseudomys shortridgei (Muridae: Rodentia) and it's Relevance to that of other Heathland Pseudomys." Australian Wildlife Research 5: 213-219.

Cockburn, A. (1980). The ecology of Pseudomys spp. in South-Eastern Australia. Zoology. Melbourne, Monash: 329.

Cockburn, A. (2000). Heath Rat; Pseudomys shortridgei. The Mammals of Australia. R. Strahan. Sydney, Reed New Holland: 617-618.

Cockburn, A., R. W. Braithwaite and A. K. Lee (1981). The Response of the Heath Rat, Pseudomys shortridgei, to Pyric Succession: A Temporally Dynamic Life-History Strategy. Journal of Animal Ecology 50: 649-666.

Cooper, N. K., T. Bertozzi, A. Baynes and R. J. Teale (2003). "The relationship between eastern and western populations of the Heath Rat, Pseudomys shortridgei (Rodentia : Muridae)." Records of the Western Australian Museum 21: 367-370.

Kemper, C., Medlin, G. and Bachmann, M., 2010. The discovery and history of the heath mouse Pseudomys shortridgei (Thomas, 1907) in South Australia. Transactions of the Royal Society of South Australia, 134: 125-138.

Lee, A. K. (1995). The Action Plan for Australian Rodents. Canberra, Australian Nature Conservation Agency.

Meulman, E. P. (1997). The Ecology of the Heath Mouse (Pseudomys Shortridgei) in the Grampians national park, Victoria. Melbourne, Charles Stuart University.

Ovington, D. (1978). Australian Endangered Species; Mammals, Birds and Reptiles. Sydney, Cassel Australia.

Quinlan, K., D. Moro and M. Lund (2004). Improved trapping success for rare species by targeting habitat types using remotely sensed data: a case study of the heath mouse (Pseudomys shortridgei) in Western Australia. Wildlife Research 31: 219-227.

Robinson, A.C., Kemper, C.M., Medlin, G.C. and Watts, C.H.S., 2000. The rodents of South Australia. Wildlife Research, 27: 379-404.

Saunders, A. (1997). Monitoring in the Fitzgerald Biosphere Reserve, Department of Conservation and Land Management.

Senior K. 2014. Rainfall as a dominant influence on small mammal recovery after wildfire: implications for fire management in a mesic environment. Deakin University, Melbourne.

Short, J. (2004). Mammal decline in southern Western Australia - perspectives from Shortridge's collections of mammals in 1904-07. Australian Zoologist 32: 605-628.

Watts, C. H. S. and H. J. Aslin (1981). The Rodents of Australia. Sydney, Angus & Robertson.

Wells, A. G. (1991). Heath Rat. Endangered Animals of Australia. R. T. Hoser. Sydney, Pierson & Co: 178-179.

Study design

Methodology

Site selection

For the selection of survey sites in 2019, maps of potentially suitable habitat were generated by overlaying all heath mouse records on State Vegetation Association and Soil Type layers using GIS software. The following attributes were linked to most of the heath mouse capture locations.

Vegetation:

- Mallee/Mallee-heath
- Mallee-heath
- Scrub-heath

Soils:

- Felsic intrusives (74292)
- Ferruginous duricrust (38498)
- Pallinup Formation (14796)
- Sand plain (38499)

All areas where the above vegetation associations and soil types coincided were mapped and then clipped using the current remnant vegetation layer to determine areas that maintained potentially suitable remnant native vegetation. Fire history mapping was then overlayed (using 5-year increments) to help eliminate areas that had recently been burnt and therefore would have a lower likelihood of heath mouse occurrence.

For future surveys, these maps will be compared to those generated using the habitat suitability model software Maxent projected on future climate scenarios (see below). Additionally, as the amount of rainfall received in 2020/21 was above average, some sites where the species has been previously recorded will also be resampled as per the 2020 survey.

Four broad sites will be surveyed – Lake Magenta Nature Reserve and Dragon Rocks Nature Reserve, Frank Hann National Park and surrounding UCL, Fitzgerald River National Park, and the UCL in the Fitzgerald Biosphere near Ravensthorpe and Kundip townsites and north of Cocanarup Timber Reserve.

Trapping

Elliott traps will be set in parallel lines of 10 traps (20 traps per site) placed approximately 25 m apart with 50m between lines. Traps will be baited with a mixture of peanut paste, oats and sultanas. All traps will be checked daily within 3 hours of sunrise. Trap grids will be run for five consecutive nights. At times it may be appropriate to use a transect survey design rather than a grid, i.e. when suitable habitat follows a linear feature such as a creekline or road. Transects will involve up to 50 trap sites placed ~50m apart.

Habitat suitability modelling - Maxent

A total of 43 presence records of heath mouse were utilised in the SDM. A 200km buffer was created around presence points to serve as a background region. In total, 87 environmental variables were used as candidate layers for the SDM. These environmental layers were sourced from the CSIRO, TERN, bccvl, WorldClim, Department of Agriculture, Water and Environment and Department of Biodiversity, Conservation and Attractions. Environmental variables were realigned and forced to share a resolution of 30m. All processing was undertaken using R, and subsequent SDMs were performed using package SDMtune 1.1.3.

A post-hoc assessment using the fire history layers, as well as remnant vegetation, was also undertaken.

Both preliminary manual selection and a data-driven selection, using the SDMtune package, was undertaken to refine the number of environmental predictors used in the model. Data-driven selection using SDMtune removes highly correlated variables in a complex step wise process. Variables were ranked according to their percent contribution and a jack-knife test removed variables that decreased model performance the least, according to AUC.

Once the final model was created, it was used to predict the distribution of the species by incorporating future climate data. Future climate data, represented by BioClim variables, were taken from four global climate models with two shared socio-economic pathways each. Socio economic pathways refer to the relative severity of the global climate model. Best case scenario (ssp126) and worst-case scenario (ssp585) were used along with four different GCMs: CNRM-ESM2-1, IPSL-CM6A-LR, MIROC-ES2Land MRI-ESM2-0.

Structured Decision Making

The PACES tool: Planning and Assessment for Conservation through Ex-Situ management

The PACES tool is an Excel-based decision tool designed to support planning and assessment of ex-situ management for a threatened species. It can be used by a sole decision-maker, or in a collaborative workshop setting with a group of managers and/or experts. The tool facilitates a structured approach to the decision to initiate or continue ex-situ management of a species by comparing likely outcomes under ex-situ and in-situ management. Decisions made using a structured approach are more likely to achieve their objectives and can be defended and explained to others. The approach involves separating predictions (based on science or expert knowledge) from the evaluation of outcomes, thus enabling evidence-based decisions that can also account for differing stakeholder perspectives.

Biometrician's Endorsement

granted

Data management

No. specimens

Herbarium Curator's Endorsement

granted

Animal Ethics Committee's Endorsement

granted

Data management

- All data and associated information will be stored on the Animal Science Program SharePoint site and shared with South Coast and Wheatbelt Regions.
- Records of heath mice will be sent to Species and Communities to be entered in the Threatened Species Database.

Budget

Consolidated Funds

to | X | X | X | X |

Source	Year 1	Year 2	Year 3
FTE Scientist	0.5	0.5	0.2
FTE Technical	0.2	0.2	0.1
Equipment	3,000	3,000	
Vehicle	30,000	30,000	15,000
Travel	7,000	7,000	5,000
Other			
Total	40,000	40,000	20,000

External Funds

to | X | X | X | X |

Source	Year 1	Year 2	Year 3
Salaries, Wages, Overtime			
Overheads			
Equipment			
Vehicle			
Travel			
Other			
Total	5000	5000	5000