Concept Plan SP 2021-008

Building resilience to change for mammals in a multi-use landscape: identifying refugia and landscape connectivity for small mammals in the Pilbara

BCS Animal Science

Project Core Team

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Update requested

Document endorsements and approvals as of Aug. 9, 2022, 2:33 p.m.

Project Team	granted
Program Leader	granted
Directorate	granted

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Program

BCS Animal Science

Departmental Service

Service 7: Research and Conservation Partnerships

Background

Identifying and protecting refugia and habitat corridors is the cornerstone of best-practice conservation in multi-use landscapes. Globally, the conservation community is recognising that a static, fragmented protected area system is, in many cases, inadequate to conserve populations and species in large areas, over long time-scales and given current rates of environmental change [1,2]. This recognition has motivated a paradigm shift in conservation thinking away from managing species at a local scale to a broader spatial and temporal perspective: managing species and ecological processes at a whole-of-landscape scale [3] and incorporating evolutionary processes to build species' capacity for adaptation to environmental change [4].

There are two key foci in this species' resilience conservation approach: (i) protecting refugia, areas of the landscape that offer temporally stable, climatically buffered habitat that species can retreat to, persist in and expand from under changing environmental conditions, and which represent potential reservoirs of genetic diversity for adaptation to change [5–8]; and (ii) promoting population connectivity to maintain metapopulation viability and to retain species' evolutionary potential [4,9].

Frameworks exist for the identification of refugia [7] and their incorporation into conservation planning including Australian examples [10,11]. Efforts to characterise landscape connectivity, however, are frequently hampered by the lack of empirical data on species dispersal with which to inform mechanistic models [12]. Emerging landscape genetics approaches that quantify gene flow as a proxy for realised dispersal to assess landscape connectivity hold promise to infer dispersal corridors, but to date there has been little uptake in conservation planning, both here and internationally [13]. Single-species case studies are available [14,15], however, to be useful as a landscape-scale conservation prioritisation tool, connectivity expectations across a range of species with different movement characteristics and/or habitat requirements is required for robust conservation decision-making [14].

Characterisation of the major modes of dispersal for different species types (guilds) and the landscape features that modify or promote connectivity is critical information for landscape-scale conservation planning. Further, in much the same way that the spatio-temporal stability of refugia are assessed, the stability of species' dispersal corridors should be evaluated under past, present and predicted future environmental conditions to inform crucial dispersal routes. Application of a spatio-temporal landscape genetics approach to multi-species conservation planning therefore represents a novel and significant advancement in this field, both nationally and internationally, and provides a means to move beyond a simple pattern- to process-based approach to species conservation [1,4,13].

The Pilbara biogeographic region in arid north-west Western Australia (WA) is one of the oldest landscapes on earth [16] and provides an excellent case study with which to demonstrate the application of this innovative approach. The Pilbara has a unique and incredibly rich biodiversity [16], and due to its vast mineral reserves, is also a critical source of income for the Australian economy, contributing 80% of WA's $103 billion mineral and petroleum industry [17]. The rapid pace of resource development in the Pilbara has generated conflict between the State's desire to support economic development whilst also upholding its responsibilities to protect biodiversity and environmental values as required by Federal (Environmental Protection and Biodiversity Conservation (EPBC) Act) and State legislation. The WA Government's recently released Pilbara Conservation Strategy identifies that a landscape-scale, coordinated approach to development and biodiversity conservation is critical to ensure sustainable outcomes for government, industry and the environment. This project is therefore significant in bringing together key government and industry stakeholders actively engaged in conservation management in the Pilbara bioregion to identify priority conservation management areas for the small-medium

sized mammal fauna, including four EPBC-listed threatened species (northern quoll, bilby, ghost bat, Pilbara leaf-nosed bat). These 'critical weight range' mammals are recognised as being the most 'at risk' to human-associated disturbances [18].

References

[1] Moritz, C. and Agudo, R. (2013) *Science*. 341, 504–508. [2] Hannah, L. et al. (2007) *Front. Ecol. Environ.* 5, 131–138. [3] Pressey, R.L. et al. (2007) *Trends Ecol. Evol.* 22, 583–592. [4] Sgrò, C.M. et al. (2011) *Evol. Appl.* 4, 326–337. [5] Byrne, M. et al. (2008) *Mol. Ecol.* 17, 4398–4417. [6] Byrne, M. (2008) *Quat. Sci. Rev.* 27, 2576–2585. [7] Keppel, G., Van Niel, K.P., Wardell-Johnson, G.W., Yates, C.J., Byrne, M. et al. (2012) *Glob. Ecol. Biogeogr.* 21, 393–404. [8] Moritz, C. (2002) *Syst. Biol.* 51, 238–254. [9] Christie, M.R. and Knowles, L.L. (2015) *Evol. Appl.* 8, 454–463. [10] Keppel, G., Mokany, K. et al. (2015) *Front. Ecol. Environ.* 13, 106–112. [11] Rosauer, D.F., Blom, M.P.K., Bourke, G., Catalano, S., Donnellan, S., Gillespie, G., Mulder, E., Oliver, P.M., Potter, S., Pratt, R., Rabosky, D.L., Skipwith, P.L. and Moritz. C. (2016) *Biol. Conserv.* 204, 83–93. [12] Huntley, B., Barnard, P., Altwegg, R., Chambers, L., Coetzee, B., Gibson, L.A. et al. (2010) *Ecography*. 33, 621–626. [13] Keller, D. et al. (2015) *Conserv. Genet.* 16, 503–512. [14] Harradine, E.L., Andrew, M.E., Thomas, J.W., How, R.A., Scmitt, L.H., Spencer, P.B.S. (2015) *Conserv. Biol.* 29, 1704–1714. [15] Braunisch, V. et al. (2010) *Mol. Ecol.* 19, 3664–3678. [16]* Pepper, M. et al. (2013) *J. Biogeogr.* 40, 1225–1239. [17] Abeysinghe, P.B. (2013) Commodity highlights and statistical trends in mineral exploration in Western Australia for 2011-12. Geological Survey of Western Australia, East Perth. [18]* Burbidge, A. et al. (2008) *Aust. J. Zool.* 56, 411-422.

Aims

This project aims to evaluate and apply novel spatio-temporal landscape genetic methods to identify refugia and dispersal corridors that build evolutionary resilience for mammal fauna, essential for best-practice conservation under global change. Our approach is applied to spatial and genetic datasets assembled for 13 small-medium sized mammal species, including four that are endangered nationally, in the multi-use landscape of the Pilbara bioregion that is a resource-rich Australian biodiversity hotspot. A key outcome is to identify strategic landscape-scale conservation priorities for habitat protection and threat management via systematic conservation planning (SCP). This project is significant in advancing new methodologies to incorporate connectivity modelling into multi-species conservation planning, identifying the major factors contributing to species landscape use and providing a framework for prioritising evolutionary resilient landscapes that can be applied to conservation management in multi-use landscapes globally. We address our aims through the following objectives:

[1] Locate core habitat (refuges) and connectivity pathways (corridors) for species and species' guilds under current environmental conditions by modelling habitat suitability and contemporary gene flow;

[2] Locate key areas for persistence under changing climates by inferring locations of evolutionary refugia from population genomic data and spatial modelling of range dynamics under historical and predicted future environments; and

[3] Using SCP, identify cost-effective conservation strategies to enhance and protect these areas for optimal combinations of threatened and other species or species' guilds.

Expected outcome

This project aims to identify evolutionarily stable refugia and dispersal corridors for a suite of mammal species in the Pilbara IBRA region using novel landscape genetic and macroecological modelling approaches. Refugia and corridors will be assessed for individual species, guilds of species and in total. The placement of conservation reserves or use of targeted threat management activities to protect or enhance stable refugia and corridors will be assessed using a systematic conservation planning framework.

Strategic context

This project will contribute to multiple strategic goals outlined in the Science Strategic Plan 2018-21, including:

- Biodiversity knowledge:

  - Conduct biological survey, including genetic survey, in priority management areas, and for key species and ecological communities.
  - Effectively acquire and share knowledge of biodiversity

- Conservation of threatened species and ecological communities:
  - Undertake research to address knowledge gaps for threatened species and ecological communities

- Pressures and threats to ecosystem composition, function and values
  - Understand the pressures and threats acting on ecosystems
  - Develop and evaluate effectiveness of mitigation strategies to inform management planning and conservation of species and ecosystems

- Impacts of climate change on biodiversity and ecosystem function:
  - Develop and evaluate effectiveness of adaptation strategies for incorporation into management planning, management of threatened species and communities, and sustainable use of natural resources

- Innovative science and effective use of technology:
  - Identify and realise opportunities for adoption of technical advances and innovative approaches for conservation.

Expected collaborations

This project is a result of a successful ARC Linkage grant involving collaborators at Murdoch University (Prof. Peter Spencer), Australian National University (Prof. Craig Moritz), CSIRO (Karel Mokany), WABSI (Dr Lesley Gibson [also DBCA]) and Western Australian Museum (Dr Kenny Travouillon). Roy Hill Pty Ltd and Biologic Pty Ltd are external partner organisations.

Multiple DBCA Biodiversity and Conservation Science staff are involved in the project including Lesley Gibson and Kym Ottewell in Animal Science, Katherine Zdunic, Janine Kinloch, Bart Huntley, Georgina Pitt from Remote Sensing and Spatial Analysis and Margaret Byrne (ED, Biodiversity and Conservation Science).

Proposed period of the project

Oct. 1, 2018 – March 31, 2022

Staff time allocation

Role	Year 1	Year 2	Year 3
Scientist	0.65	0.75	0.55
Technical	0.2		
Volunteer			
Collaborator			

Indicative operating budget

Source	Year 1	Year 2	Year 3
Consolidated Funds (DBCA)			
External Funding	194438	239367	106945