Extended methodology description

*Protected areas and other spatial data*

We sourced the spatial data on protected areas (PAs) in Australia from the work of Ivanova & Cook (2020): this presents the most recent compilation of PAs in the country that is inclusive of both public and private PAs. Importantly, only terrestrial PAs were included, due to the legal restrictions of private land not extending to coastal waters.

Ivanova & Cook (2020) used the Collaborative Australian Protected Area Database (CAPAD) 2018 edition as a source of all public PAs as well as the available privately protected PAs (PPAs) in the country. PPAs were identified by the “governance type” category in CAPAD, including all PAs listed as private (“P”), as well as South Australia’s Heritage Agreements listed as joint management (“J”). Spatial data on privately protected PAs (PPAs) were further supplemented with files sourced directly from the organisations responsible for administering the PPA contract. PPA data were obtained for the following programs: Department of Environment, Land, Water and Planning covenants (Victoria state), Voluntary Conservation Agreement (New South Wales state), Registered Property Agreement (New South Wales state), Nature Conservation Trust (New South Wales state), Department of Agriculture and Food covenants (Western Australia state), Department of Biodiversity, Conservation and Attractions covenants (Western Australia state) and Department of Environment and Natural Resources covenants (Northern Territory). See Table S1.2 of Ivanova & Cook (2020).

Concerning PA spatial data cleaning, Ivanova & Cook (2020) checked for spatial inconsistencies such as closely aligned PA boundaries which were averaged, and overlaps of which were resolved by reassigning the overlapped portion to the more numerically dominant PA type. Duplicates were deleted where present across multiple datasets upon their merging, and all PAs under 1 hectare in size were deleted due to the possibility of being geoprocessing artefacts and/or likely error in exact positioning which would create inaccuracies in further analyses.

The distribution data on the mammal species assessed was obtained from the IUCN Red List (version 2019\_3) in January 2020. According to the IUCN mapping standards guide (www.iucnredlist.org/resources/mappingstandards), the polygon distributions are prepared using the known occurrences of the species to set the range limits, together with expert knowledge pertaining to habitat specifics such as elevation. These distributions are likely to be overestimations of occurrence, as they should be used to communicate that the species probably only occurs within the defined polygons but not necessarily throughout them, as detailed in the guide.

A range of other spatial data was obtained to assist in the creation of species habitat models, presented in Table S1.1.

T**able S1.1.** List of other spatial data used in this study, their type, the source where obtained from and date of access

|  |  |  |
| --- | --- | --- |
| Datum description | Datum type | Source and date accessed |
| NVIS Major Vegetation Subgroups | Raster (100mX100m cells) | <http://www.environment.gov.au/fed/catalog/search/resource/downloadData.page?uuid=%7B3F8AD12F-8300-45EC-A41A-469519A94039%7D>“Australia - Present Major Vegetation Subgroups - NVIS Version 6.0”Accessed August 2018 |
| Rainfall | Vector (polygon) | <https://data.gov.au/data/dataset/8f6e9010-2ad5-4845-bd56-ecd1d416bd5d> “2016 SoE Inland Waters Average annual rainfall”Accessed November 2018 |
| Altitude | Raster (9’X9’ cells) | <https://ecat.ga.gov.au/geonetwork/srv/eng/catalog.search?node=srv#/metadata/66006> “GEODATA 9 second DEM and D8: Digital Elevation Model Version 3 and Flow Direction Grid 2008”Accessed November 2018 |
| Regolith | Raster (3’X3’ cells) | <https://data.gov.au/data/dataset/c28597e8-8cfc-4b4f-8777-c9934051cce2> “AUS Soil and Landscape Grid National Soil Attribute Maps - Depth of Regolith (3" resolution) - Release 2”Accessed December 2018 |
| National and state boundaries (Australia) | Vector (polygon) | <http://data.daff.gov.au/anrdl/metadata_files/pa_nsaasr9nnd_02211a04.xml#TO02_ID04_DF22_RS03_GR00_VR00_DL901> “Australian Coastal outline and Landmass with State boundaries”Accessed March 2019 |
| Atlas of Living Australia (ALA) | Vector (point) | <https://www.ala.org.au/> Accessed January 2020 |
| Human Footprint Index (Global) | Raster (~1km2 cells) | <https://sedac.ciesin.columbia.edu/data/set/wildareas-v3-2009-human-footprint> “Last of the Wild, v3, Human Footprint, 2018 Release (2009)”Accessed July 2020 |

*Study species selection and habitat delineation*

A total of 118 mammal species were selected for this study, the number being constrained by the availability of data on population density – a parameter necessary for viability estimations. Following Clements et al. (2018), density estimates for 90 species were obtained from the PanTHERIA database (Jones et al. 2009). For three of those, an error was identified in the density estimate and corrected with reference to literature (*Antechinus godmani*: <https://doi.org/10.1071/AM16050>; *Dactylopsila trivirgata*: <https://doi.org/10.1071/WR9960755>; *Tarsipes rostratus*: <https://doi.org/10.1071/ZO16068>). A further 28 species were identified for inclusion following the data search protocol outlined in PanTHERIA: selecting the most relevant journals and secondary sources, such as *Australian Journal of Zoology*, *Australian Zoologist*, and the *Australian Mammalogy*, and then searching for the names of each Australian native mammal species within those, as well as within Web of Science more generally. All papers identified relating to the searched species were probed with keywords such as "density", "individual/s", "per" and "ha", and density estimate value systematically recorded (see Table S1.2). Where multiple density estimates were found for a particular species, we followed PanTHERIA’s protocol to calculate the unique median value. Following the data search in July 2018, 28 species were added to the 90 found in PanTHERIA.

T**able S1.2.** Calculated density estimates for species added to the study via a literature search, including the raw values found and the literature source/s that contained them (where a peak is indicated, the bottom value was used in calculations)

|  |  |  |  |
| --- | --- | --- | --- |
| **Species** | **Density estimate/s found (ha)** | **Calculated population density (/km2)** | **Source/s** |
| *Antechinus adustus* | 3.4; 4.5 | 395 | https://doi.org/10.1071/AM16050 |
| *Conilurus penicillatus* | 2.2-6.6; 12.1-16.7; 6-16.2; 7.9-18.7 | 1080 | https://doi.org/10.1016/j.biocon.2010.02.027 |
| *Dasycercus cristicauda* | 0.23; 1-5 (peak) | 61.5 | <https://doi.org/10.1071/AM08008>https://doi.org/10.1071/WR00023 |
| *Dasykaluta rosamondae* | 1.9 | 190 | <https://doi.org/10.1071/AM08008> |
| *Leggadina lakedownensis* | 0.1-6.4; 0.6 | 192.5 | <https://doi.org/10.1111/j.1469-1795.2012.00530.x>https://doi.org/10.1071/WR99019 |
| *Mastacomys fuscus* | 10.9; 13.6; 14.0 | 1283 | https://doi.org/10.1071/ZO15033 |
| *Melomys burtoni* | 39.7; 11.2; 4.8; 3-14.4; 3.9-15.2 | 1479 | <https://doi.org/10.1111/j.1469-7998.1987.tb02923.x>https://doi.org/10.1016/j.actao.2018.03.006 |
| *Mesembriomys gouldii* | 0.27 | 27 | https://doi.org/10.1071/WR9870293 |
| *Ningaui ridei* | 1-5 (peak) | 100 | https://doi.org/10.1071/WR00023 |
| *Notomys alexis* | 4.9 (peak) | 490 | https://doi.org/10.1071/WR9960289 |
| *Pseudantechinus macdonnellensis* | 0.05-0.2; 0.05-0.3 | 15 | https://doi.org/10.1071/WR99063 |
| *Pseudocheirus occidentalis* | 2.9-6; 3.7-4.3; 2.4-4.5; 0.3-0.6; 0.1-0.4 | 252 | <https://doi.org/10.1071/AM09037>https://doi.org/10.1071/WR9940189 |
| *Pseudomys chapmani* | 2/ha | 200 | https://doi.org/10.1071/WR96093 |
| *Pseudomys delicatulus* | 0.1 | 10 | https://doi.org/10.1111/j.1469-1795.2012.00530.x |
| *Pseudomys desertor* | 2.4 | 240 | https://doi.org/10.1111/j.1469-1795.2012.00530.x |
| *Pseudomys gracilicaudatus* | 0.6 | 60 | https://doi.org/10.1111/j.1469-1795.2012.00530.x |
| *Pseudomys hermannsburgensis* | 5 (peak); 4.9 | 490 | <https://doi.org/10.1071/AM08008>https://doi.org/10.1071/WR9960289 |
| *Pseudomys novaehollandiae* | 0.1-16.7; 0-3.1; 0.5-1; 0.2-1.5; 0.6-1.3; 2-19; 1.5-17; 1.1-11.3; 24.3 (peak); 20 (peak); 4.4 | 792 | <https://doi.org/10.1071/ZO16084><https://doi.org/10.1071/AM05049><https://doi.org/10.1071/WR9910233>https://www.publish.csiro.au/wr/pdf/WR9870435 |
| *Pseudomys oralis* | 5 | 500 | https://doi.org/10.1071/AM02151 |
| *Pseudomys pilligaensis* | 1-2; 83 (eruption); 6.4; 30; 5-12; 13-21; 0-2; 6-8; 5 | 955 (excl. eruption value) | <https://doi.org/10.1071/ZO08043>https://doi.org/10.1071/ZO08042 |
| *Rattus colletti* | 192-635 (eruption) | 4758 | https://doi.org/10.1111/j.1442-9993.2006.01564.x |
| *Sminthopsis macroura* | 0.2 | 20 | https://doi.org/10.1111/j.1469-1795.2012.00530.x |
| *Sminthopsis youngsoni* | 1-5 | 300 | https://doi.org/10.1071/WR00023 |
| *Tachyglossus aculeatus* | 0.2 | 20 | https://doi.org/10.1111/j.1469-1795.2012.00530.x |
| *Trichosurus cunninghami* | 0.7-1; 0.8-1 | 87.5 | https://doi.org/10.1111/j.1469-7998.2006.00207.x |

*The Mammals of Australia* (Third edition, 2008; Steve van Dyck and Ronald Strahan; New Holland Publishers)and *A Field Guide to Mammals of Australia* (Third edition, 2011; Peter Menkhorst and Frank Knight; Oxford University Press) were then searched for the 118 study species, recording habitat descriptions (Table S1.3) and thereafter manually matching those with the most appropriate NVIS vegetation subclasses. Thereafter, the ALA records were used to determine the top 5 vegetation subclasses in number of points, and where not contradictory with the habitat descriptions any additional subclasses not listed under habitat yet were included to make up the complete NVIS listing (Table S1.3).

T**able S1.3.** The descriptions of species habitats as contained in *A Field Guide to Mammals of Australia* and *The Mammals of Australia* (denoted by FG and MA respectively), and the NVIS vegetation subclasses selected to represent the habitat spatially (informed by the description as well as the top presence sites in the Atlas of Living Australia for each species)

|  |  |  |
| --- | --- | --- |
| Species | Habitat description | NVIS vegetation subclasses for habitat |
| Acrobates pygmaeus | Cool to temperate and tropical eucalypt forests, high diversity of trees/shrubs, wet and old-growth forest (FG);Tall forests and woodlands (MA) | 3;4;5;7;8;9;10;11;16;54;59;60;65;97 |
| Aepyprymnus rufescens | Grassy coastal forest, dry forest on inland slopes (FG); In sparse or grassy understorey in dry open woodlands of the Great Dividing Range through to tall eucalypt forests of the coast (MA) | 4;5;9;10;11;16;18;19;48;54;60;79;97 |
| Antechinus adustus | Dense upland tropical vine forest, dense tangled edge vegetation (FG); Relatively cool, moist rainforests at altitudes above 600m (MA) | 2;6;16;60;97 |
| Antechinus agilis | Most types of wet or moist forest, heath and woodland from sea level to 1800m (FG); In all forest, woodland and heathland habitats from the coast to an altitude of about 2000m (MA) | 3;4;5;7;8;9;11;13;14;15;16;19;20;24;26;28;30;45;47;48;50;53;54;56;58;59;60;65;71;74;75;79;96;97 |
| Antechinus bellus | Tall open forest in monsoonal tropics (FG);Woodland communities dominated by eucalypts (MA) | 5;7;9;15;16;48;96;97 |
| Antechinus flavipes | [Dry sclerophyll forest, heathy woodland and some semi-arid shrubland] – for south of distribution (VIC, SA, WA), [also in coastal heath, swampland and damp woodland, tropical vine forest] – in north of distribution (QLD) (FG);Broad spectrum of habitats from tropical vine-forests through swamps to dry mulga country (MA) | 4;5;8;10;12;13;14;16;21;22;25;26;28;30;32;47;53;54;65;68;69;70;74;79;80;97; in QLD also in 3;9;11;15;19;20;24;45;50;56;57;58;59;60;67;71;75 |
| Antechinus godmani | Rainforest above 600m (FG);At altitudes above 600m in all major rainforest types (MA) | 1;2;6;60;62;97 |
| Antechinus leo | Semi-deciduous vine forest (FG); Only in semi-deciduous mesophyll rainforest (MA) | 4;9;37;62;97 |
| Antechinus minimus | Dense wet heath and heathy woodland, sedgeland and dense tussock grassland rarely above 200m, also wet forest gullies up to 1000m (TAS only) (FG); Prefers damp habitats with a high percentage cover of understorey vegetation, and has been recorded in forest, woodland, heathland, tussock grassland and sedgeland, preference for low altitude sites (MA) | 4;8;9;13;14;15;16;19;20;21;24;25;26;28;29;30;32;34;35;36;37;38;45;47;48;49;50;53;55;56;57;59;61;63;64;65;67;68;69;71;74;75;79;97 |
| Antechinus stuartii | Moist habitats – rainforest, sclerophyll forest, woodland, heath, restricted to sub-tropical vine forest in QLD (FG); Widespread in a variety of forested and heathland habitats and occurs in highest density where there is thick groundcover and abundant logs (MA) | 2;3;4;5;8;9;13;14;15;16;26;28;30;47;48;53;54;59;60;61;97 |
| Antechinus swainsonii | Dense wet vegetation – coastal heath to wet sclerophyll forest, rainforest and subalpine heath (FG); Densest in mountainous areas where rainfall exceeds 1000mm, preferring in there the alpine heath or tall open forest with dense understorey of fern or shrub (MA) | 2;3;4;8;9;11;14;15;16;26;28;29;30;47;50;53;54;55;56;58;59;60;65;74;75;79;96;97 |
| Bettongia gaimardi | Dry grassy open forest on infertile soils (FG);Open, dry, fire-prone forests with a grassy or heath understorey on poor soil (forests often of Peppermint Gums and Silver Wattle) (MA) | 3;4;5;8;9;14;16;97 |
| Bettongia lesueur | Hummock grassland and scrub (FG); Most habitat types other than those with dense vegetation and higher rainfall (former range, on mainland) (MA) | 20;27;33;66;69;79;97 |
| Bettongia penicillata | Dry sclerophyll forest with dense understorey (FG); Wheatbelt reserves characterised by presence of thickets of plant genus *Gastrolobium* (MA) | 4;8;27;29;66;69;79;97 |
| Bettongia tropica | Dry, grassy eucalypt open forest and adjacent rainforest, mostly above 450m (FG);Elevations between 800 and 1200m, grassy eucalypt forests on granitic soils (ranging from tall open forest to the drier woodland – higher densities towards drier end) (MA) | 5;8;9;10;16;48;60;96;97 |
| Burramys parvus | Restricted to alpine, alpine rock scree with heathy vegetation above 1400m (FG); Shrubby heathland at altitudes of 1300-2228m (MA) | 9;17;30;32;38;53 |
| Cercartetus caudatus | Rainforest and fringing she-oak forest at altitudes above 300m, coastal rainforest and eucalypt-tea tree forest (FG); South of Daintree River occurs in rainforests and fringing *Casuarina* forests at an altitude of 300m or more, north of Daintree found on coastal plain and in fringing *Eucalyptus/Melaleuca* forests (MA) | 2;3;4;6;9;15;26;54;58;60;96;97 |
| Cercartetus nanus | Wet and dry eucalypt forest, subalpine woodland, coastal banksia woodland and wet heath (FG); From rainforest through sclerophyll forest to tree heath (MA) | 3;4;5;8;9;10;16;30;32;50;54;59;60;97 |
| Conilurus penicillatus | Moist areas with dense grassy understorey within coastal she-oak woodlands, sclerophyll forest, and pandanus thickets (FG); In mixed eucalypt open forest and woodland, or on dunes with *Casuarina*, in areas with understorey of predominantly perennial grasses and a sparse-to-moderate middle storey (MA) | 5;7;9;15;16;26;62;96;97 |
| Dactylopsila trivirgata | Rainforest and adjacent eucalypt and melaleuca woodlands (FG); Tropical rainforests and adjacent woodlands (MA) | 2;5;6;8;9;15;97 |
| Dasycercus cristicauda | Hummock grass plains, sand ridges, mulga shrubland on loamy sand (FG); On sand dunes with a sparse cover of Sandhill Canegrass or areas around salt lakes with Nitre Bush (MA) | 22;23;31;33;34;97 |
| Dasykaluta rosamondae | Subtropical arid hummock grassland (FG);Hummock grassland on sandy plains, clay plains, undulating stony clay plains, foot-slopes, scree-slopes and in the hill country (MA) | 20;23;24;33;37;97 |
| Dasyurus geoffroii | Wet and dry sclerophyll and mallee remnants (FG); Areas dominated by sclerophyll forest or drier woodland, heath and mallee shrubland (MA) | 4;8;20;21;27;29;30;33;55;65;68;69;97 |
| Dasyurus hallucatus | Rocky eucalypt woodland, also in a range of vegetation types, mostly within 200m of coast (FG); Most common on dissected rocky escarpment but are also found in eucalypt forest and woodland, around human settlements and occasionally in rainforest patches or on beaches (MA) | 4;5;7;8;9;10;16;17;42;59;65;96;97 |
| Dasyurus maculatus | From sea level to sub-alps, in rainforest, wet and dry sclerophyll forest, coastal heath and scrub, sometimes Red Gum forest along inland rivers (FG); Wide range of treed habitats including tropical, subtropical and temperate rainforests, vine thickets, wet and dry sclerophyll forest, woodland and coastal scrub, in TAS also in heathland (MA) | 1;2;3;4;5;6;8;9;28;54;60;62;97 in TAS also in 30 |
| Dasyurus viverrinus | Open forest, scrubland and heath, especially where interspersed with grassy clearings (FG); Prefer open forest and woodland, open grasslands and alpine heaths (MA) | 3;4;5;8;9;12;14;16;26;28;30;60;97 |
| Dendrolagus bennettianus | Lowland vine forest, montane rainforest and adjacent eucalypt forest where vines are plentiful (FG); Patchy vine and gallery forests on northern edge of north QLD’s rainforest block (MA) | 2;5;6;9;60;97 |
| Dendrolagus lumholtzi | Montane rainforest (>800m) (FG); High altitude rainforests, most frequent from fragmented forests of the Atherton Tablelands, generally within rainforest types on basalt soils (MA) | 2;4;6;60;97 |
| Gymnobelideus leadbeateri | Montane wet sclerophyll forest, swamp woodlands, mixed-age eucalypt stands with dense acacia mid-storey (FG);Dense vegetation structure with smooth-barked eucalypts and tree hollows, most common in Mountain Ash and Shining Gum forests, but also in some sites dominated by Alpine Ash, Snow Gum and Mountain Swamp Gum (MA) | 1;3;4;5;8;9;53;58;60;97 |
| Hemibelideus lemuroides | Mature-age rainforest above 450m, above 1100m on Carbine Tableland (FG); In rainforest above 450m, small isolated population above 1100m on Mount Carbine Tableland (MA) | 2;6;9;60;97 |
| Hypsiprymnodon moschatus | Montane and lowland rainforest (FG); Tropical rainforest from sea level to over 1200m (MA) | 2;4;6;44;97 |
| Isoodon auratus | Hummock grass on sandstone, grassy woodlands and deciduous vine thickets (FG); Sand-dune and sandplain country with spinifex formations in the arid zone, sandplains with *Acacia* and *Eucalyptus* woodlands over tussock grasses in the tropical semiarid zone, rugged sand-stone-spinifex country and volcanic country (in and peripheral to rainforest patches, in low woodlands over tussock grasses) of the tropical, subhumid north-western Kimberley (MA) | 7;9;10;18;33;48;97 |
| Isoodon macrourus | Wet tropical and subtropical forest, woodland, scrub, grassland and gardens (FG); Grassland, woodland, open forest and occasionally closed forest, prefers areas with low groundcover (MA) | 4;5;7;8;9;10;11;12;13;14;15;16;18;19;20;26;29;33;34;35;36;37;38;47;48;50;53;58;59;61;79;97 |
| Isoodon obesulus | Heathy forest, heath and coastal scrub (FG); In forest, woodland, shrub and heath communities, generally with a combination of sandy soils and dense heathy vegetation in the lower stratum (MA) | 4;8;9;12;14;15;16;21;25;26;29;30;47;49;50;53;60;69;74;97 |
| Lagorchestes conspicillatus | Tropical tussock or hummock grassland with mid-dense or sparse tree and shrub cover (FG); Open forests, open woodlands, and tall shrublands over tussock grass and, in inland sites, of hummock grassland (MA) | 5;9;10;12;13;14;15;16;18;19;20;21;23;24;27;33;45;48;50;51;52;59;61;66;67;71;72;75;79;80;96;97 |
| Lagorchestes hirsutus | Hummock grass, sand-ridge country, and arid shrubland, particularly where patchy fires create a mosaic of vegetation age classes (FG); On sandplains with kwongan (heath) vegetation, together with spinifex hummock grasslands (MA) | 19;21;23;30;32;33;49;52;66;72;80;97 |
| Lagostrophus fasciatus | ---- (FG); Among dense thickets of *Acacia ligulata, A.coriacea* and *Alectryon oleifolium* scrub on the sandplains, and *Diplolaena dampieri* and *A.oleifolium* on the dunes (MA) | 22;23;28;29;33;42;97 |
| Lasiorhinus krefftii | Sandy grassy woodland (FG); Sand gullies or sand ridges with open eucalypt woodland with some patches of closed shrub (MA) | 4;9;14;18;19;47;48;53;97 |
| Lasiorhinus latifrons | semi-arid shrubland and mallee (FG); Semi-arid grasslands (MA) | 21;27;29;31;32;34;35;36;37;49;55;61;64;66;67;68;69;79;80;97 |
| Leggadina lakedownensis | Moist tussock grassland or tropical savannah on clay soils, stony hummock grassland (in the Pilbara) (FG); From the monsoon tropical coast to semiarid climates, including spinifex and tussock grasslands, samphire and sedgelands, *Acacia* shrublands, tropical *Eucalyptus* and *Melaleuca* woodlands and stony ranges, seasonally inundated on red or white sandy-clay soils (MA) | 7;9;11;15;19;21;23;24;32;33;34;35;36;37;38;39;48;51;63;64;80;97 |
| Macropus agilis | Wide range of grassy forest and woodland communities on plains, often in riverine environments, rare in hilly country (FG); Preferred habitat along rivers and streams in open forest and the adjacent grasslands, in NT it is abundant from the coastal sand dunes to the base of the more rugged inland hills (MA) | 5;8;9;10;15;16;21;37;47;96;97 |
| Macropus antilopinus | Tropical woodlands with perennial grasses, usually on plains and low hills (FG); Monsoonal tropical woodlands, broad range of vegetation types ranging from scattered to dense eucalypt woodlands through to tall open forests, all with grass-dominated understoreys, typically in flat to gently undulating terrain (MA) | 5;7;9;10;11;12;13;14;15;16;20;26;27;48;51;59;61;96;97 |
| Macropus dorsalis | Sclerophyll forest and brigalow scrub with dense shrub cover (FG); In the southern part of its range prefers rainforest margins, brigalow scrub, open forest with thick acacia or other shrub understorey, and lantana thickets, in the northern part of the range prefers dry vine thickets, Rubber Vine thickets and open forest or woodland with a shrub understorey (MA) | 4;5;8;9;12;13;16;54;56;62;96;97 |
| Macropus eugenii | Dense coastal heath and scrub, and some dry sclerophyll forests with dense patches of cover (FG); Coastal scrub, heath, dry sclerophyll forest and thickets in mallee and woodland (MA) | 4;8;16;21;28;29;30;32;50;97 |
| Macropus fuliginosus | ---- (FG);Preference for shrubby cover, winter-dominated rainfall with 303mm being annual average (MA) | 4;8;12;13;14;16;21;22;25;26;29;31;32;47;49;51;53;55;57;58;68;69;74;80;97 |
| Macropus giganteus | Higher rainfall (>300mm/year) open forest, woodland, farmland with patches of remnant vegetation, extends into semi-arid, all altitudes up to subalpine woodland (FG); Annual rainfall 600mm on average, prefers sclerophyll forest, woodlands (including mallee scrub), shrubland and heathland, also occurs in highly modified habitats (MA) | 4;5;7;8;9;10;11;12;13;14;15;16;18;19;20;21;22;23;24;25;26;27;28;29;30;32;45;47;48;49;50;51;52;53;55;56;57;58;59;61;65;66;67;68;69;70;71;72;73;74;75;79;80;96;97 |
| Macropus irma | Dry sclerophyll forest and woodland, including some mallee areas, with a grassy understorey and thickets of shrubs (FG); Open forest or woodland, particularly favouring rather open, seasonal wet flats with low grasses and open, scrubby thickets, also found in some larger areas of mallee and heathland in the wheatbelt (MA) | 4;5;8;12;16;18;19;20;22;23;24;27;29;30;45;47;48;52;53;55;56;61;66;67;68;70;71;72;73;74;75;79;96;97 |
| Macropus parryi | Grassy open forest in hilly areas (FG); Undulating or hilly country with open forest and a grassy understorey (MA) | 4;5;9;60;97 |
| Macropus robustus | Rocky ranges, isolated hills, scarps and plateaux, arid shrubland and grasslands to wet eucalypt forests and subalpine woodland (FG); Steep escarpments, rocky hills or stony rises, may overlap lower slopes and plains but then are associated either with drainage lines or areas of dense scrub (MA) | 4;5;7;8;9;10;12;16;21;23;32;33;52;59;64;65;66;67;68;69;70;96;97 |
| Macropus rufogriseus | Sclerophyll forest and coastal scrub (FG); Eucalypt forests with a good shrub stratum and open vegetation nearby, as well as heath, sedge and buttongrass communities (MA) | 4;5;8;9;28;30;50;60;63;96;97 |
| Macropus rufus | Semi-arid plains, grasslands, woodlands and some dry open forests (on Great Dividing Range), avoids rocky country, sparse in desert country (FG); Prefers open plains, at greatest densities in sheep rangelands of NSW and QLD (MA) | 5;9;10;16;18;19;20;22;23;24;27;31;34;35;36;37;39;45;48;51;61;64;66;67;71;72;97 |
| Macrotis lagotis | *Acacia* shrubland and hummock grassland, clay and stony downs (Channel Country in south-west QLD) (FG); Mitchell Grass and stony downs country of cracking clays, the desert sandplains and dune fields sometimes containing laterite, with hummock grassland (spinifex) and massive red earths with *Acacia* shrubland (MA) | 21;25;32;33;34;35;36;37;42;97 |
| Mastacomys fuscus | Alpine sedges and heath, wet sedge and grass patches in forest down to sea level, in west TAS inhabits buttongrass sedgeland and sub-alpine heath to 1350m (FG); Alpine and subalpine heathlands (Snowy Mountains, Victorian Alps, Barrington Tops), in clearings with dense undergrowth in the wet sclerophyll forests (Dandenong and Otway Ranges), in wet sedgelands and subalpine heathlands (TAS) (MA) | 3;4;5;9;30;37;38;54;63;97 |
| Melomys burtoni | Grasslands, sedgelands, canefields, edges of rainforest, sclerophyll forest and woodland with grassy understorey; in WA and NT in grassland, monsoon forest, riparian vegetation and mangroves (FG); In QLD prefers tall grasslands, sedgelands, open forest, woodland and grassy patches within rainforests; in WA and NT it has a clear preference for monsoon forests and vine thickets, swamps and riparian woodlands (with pandanus and paperbark trees), mangroves and tussock grasslands; in NSW in heathland bordering eucalypt woodland (MA) | In QLD 5;7;9;10;12;13;14;15;16;18;19;20;23;24;27;33;34;35;36;37;38;48;51;61;63;64;66;67;71;72;75;79;97; in WA and NT 3;7;11;15;16;34;35;36;37;38;40;50;59;62;64;97; in NSW 30;97 |
| Melomys cervinipes | Rainforest, particularly where understorey is dense and tangled, in south also in wet sclerophyll forest, coastal woodlands, mangrove forests (FG); In a variety of forested habitats including rainforest, vine thicket, wet sclerophyll forest, wooded coastal swamps, and mangroves (MA) | 1;2;3;5;6;15;16;20;40;50;54;59;60;62;96;97 |
| Mesembriomys gouldii | Moist areas with well-developed shrub layer within tropical woodlands and open forest (FG); Tropical woodlands and open forests, strongly correlated with patches of tall *Eucalyptus miniata* and *E. tetrodonta* open forest on deep loamy soils supporting a moderately dense midstorey of shrubs and small trees (MA) | 3;4;5;7;8;9;11;15;16;54;96;97 |
| Myrmecobius fasciatus | Remnant forests e.g. Dryandra and Perup Forests (FG); Dominated by eucalyptus, contracted to Jarrah forest and Wandoo woodland (MA) | 3;4;27;54;60;69;79;96;97 |
| Ningaui ridei | Hummock grassland with scattered trees and shrubs growing on dunes and sand plains (FG); On sandy surfaces (dunes, sandplains and buckshot plains) supporting spinifex hummock grasslands, shrubs such as *Thryptomene maisonneuvei, Acacia ligulata,* or *Grevillea eriostachya*, mallee such as *Eucalyptus youngiana* and/or trees such as Desert Oak, Corkwood, Cypress Pine, Gidgee, Mulga or Bara Gum (MA) | 20;27;29;33;66;72;97 |
| Notomys alexis | Sandy deserts on dunes and swales covered with hummock grass, also loamy sands carrying mulga or melaleuca (FG); Sandy areas, arid (MA) | 15;20;33;37;49;51;72;97 |
| Onychogalea fraenata | *Acacia*-dominated woodland and shrubland (FG); On more fertile soils that support open eucalypt forest and woodland, and brigalow scrub (MA) | 4;5;8;9;10;13;27;59;65;66;71;96;97 |
| Parantechinus apicalis | Old-growth mallee heath, low heath (FG); ---- (MA) | 28;29;30;32;42;97 |
| Perameles bougainville | Dense shrubby vegetation behind dunes (FG); In scrub associated with vegetated dunes behind the beaches, also in low heath and hummock grassland associations (MA) | 20;21;30;31;33;49;50;97 |
| Perameles gunnii | Open grassland, including introduced pasture, with patches of dense vegetation (FG); Open grasslands and areas of pastoral development where there are patches of dense groundcover (MA) | 3;4;8;33;34;35;36;37;38;48;64;97 |
| Perameles nasuta | Wet sclerophyll forest, scrub, rank grass and suburban gardens (FG); Elevations less than 1000m, prefers heath and forest habitats close to grassy, open feeding sites, suburban gardens (MA) | 4;5;9;30;50;59;60;96;97 |
| Petauroides volans | Wet and damp sclerophyll forest on the ranges, coastal plains (FG); In a variety of eucalypt-dominated habitats, ranging from low open forests on the coast to tall forests in the ranges and low woodland westwards of the Great Dividing Range, it does not penetrate into rainforests (MA) | 3;4;5;7;8;9;10;18;19;47;48;50;53;54;56;59;60;65;96;97 |
| Petaurus australis | Wet and damp sclerophyll forest (FG); Open forest (MA) | 3;4;5;7;9;12;13;14;15;16;26;58;60;96;97 |
| Petaurus breviceps | Wet and dry sclerophyll forest and woodland, frequently in rainforest in south0east QLD (FG); Open forest habitats with dense patches of acacias, thrives in habitat patches (MA) | 3;4;5;8;9;10;13;14;20;51;59;60;65;96;97 |
| Petaurus gracilis | Swampy, lowland forest (FG); Open woodland between sea level and 120m altitude (MA) | 4;5;9;15;18;19;47;48;50;53;56;97 |
| Petaurus norfolcensis | Dry sclerophyll forest on inland slopes and nearby riverine corridors, in south-east QLD and NSW also in damp coastal eucalypt/banksia forest and woodland (FG); Woodland and open forest, with an overstorey including *Eucalyptus, Angophora* or *Corymbia* species and a shrubby understorey of *Acacia* or *Banksia* (MA) | 4;5;8;9;10;13;14;16;20;50;51;59;60;65;96;97 |
| Petrogale assimilis | Hinterland (FG); Rocky slopes, cliffs, rocky outcrops and boulder piles within tropical woodland and open forest (MA) | 4;5;7;8;9;10;11;15;16;19;48;59;65;96;97 |
| Petrogale lateralis | ---- (FG);From temperate rocky islands in the Southern Ocean to spinifex-clad rocky hills in the central deserts and pandanus-lined sandstone gorges in the tropical north-west of Australia – rocky habitat, granitic outcrops in remnants of mallee scrub (MA) | 18;20;21;33;37;64;66;68;69;97 |
| Petrogale penicillata | Rock piles and cliffs with numerous crevices and ledges in vegetation ranging from rainforest to dry sclerophyll forest (FG); Wide variety of rocky habitat within rainforest, wet and dry sclerophyll forest, and open woodland (MA) | 1;2;3;4;5;6;7;8;9;10;11;12;13;14;15;16;18;19;20;26;47;48;50;51;53;54;56;58;59;60;62;65;96;97 |
| Petrogale persephone | Boulder outcrops in pockets of semi-deciduous vine forest on foothills near grassy open forest (FG); Rocky outcrops and boulder piles, usually within semi-deciduous vine thickets, but sometimes on the outer margins of rainforest (MA) | 2;4;5;8;9;62;96;97 |
| Petrogale xanthopus | Broken, rock scree and low cliffs in semi-arid ranges (FG); Rocky ranges, associated with permanent or semi-permanent water sources (MA) | 22;31;33;45;57;97 |
| Petropseudes dahli | Rocky escarpment country with eucalypt woodland or vine forest thickets (FG); Rocky outcrops with high diversity of food trees (MA) | 5;7;8;9;10;59;62;65;96;97 |
| Phascogale tapoatafa | Dry sclerophyll forest and monsoonal forest and woodland (FG); Prefers open forest with sparse groundcover, but uses habitats ranging from mallee to rainforest (MA) | 4;5;7;9;15;16;27;29;55;60;61;96;97 |
| Phascolarctos cinereus | Sclerophyll forest and woodland on foothills and plains, in central NSW and north-central VIC along riverine forests (FG); At lower altitudes in foothills and coastal plains, not in montane forests in the south of range, follow River Red Gums along watercourses inland in the north (MA) | 3;4;5;8;9;10;15;50;59;60;65;96;97 |
| Planigale gilesi | Lignum, canegrass and sedgeland on floodplains and dune swales, and grassy plains with cracking clay soils (FG); Found in habitats with deep cracking clay soils: floodplains of creeks and rivers, away from creeks on grassy plains and in the clay interdune areas among sandhills (MA) | 8;20;31;34;35;36;37;38;39;57;63;64;97 |
| Potorous longipes | Temperate rainforest and wet sclerophyll forest with adjacent dry ridges (FG); Altitude from 100 to 1100m, inhabits warm temperate rainforest, riparian forest and damp or wet sclerophyll forest on sheltered aspects with deep, moist soils (MA) | 3;4;5;6;8;15;54;60;96;97 |
| Potorous tridactylus | In TAS inhabits moist sclerophyll forest with dense shrub layer, in VIC mostly coastal heathy woodland, in n. of range rainforest adjacent to wet sclerophyll forest, and coastal wallum (FG); Areas receiving greater than 760mm rainfall, inhabits coastal heath and both dry and wet sclerophyll forests, relatively thick groundcover needed, concentrated in areas where the soil is light and sandy (MA) | 3;9;60 In TAS 4;8;13;14;15;51;96;97; in VIC 1;50;96;97 |
| Pseudantechinus macdonnellensis | Sparsely vegetated rocky slopes and adjacent plains (FG); Found mainly on rocky hills and breakaways, but also occurs in red sandplains (e.g. the Tanami Desert) (MA) | 18;20;21;23;33;97 |
| Pseudocheirus occidentalis | Forest patches, gardens, Weeping Peppermint is important in habitat (FG); Closely associated with Peppermint (*Agonis flexuosa*) forest and woodland, and Tuart (*Eucalyptus gomphocephala*) forest usually with a Peppermint midstorey; in Jarrah (*Eucalyptus marginate*), Wandoo (*E. wandoo*) and Marri (*Corymbia calophylla*) forest (MA) | 3;4;5;8;21;32;54;60;96;97 |
| Pseudocheirus peregrinus | Open and closed forests, coastal scrub and gardens, especially where tall shrub layer is dense and diverse (FG); A variety of vegetation types including rainforest, where shrubs form dense, tangled foliage (MA) | 1;2;3;4;6;8;9;13;14;15;16;26;28;50;51;54;60;62;96;97 |
| Pseudochirops archeri | Montane tropical rainforest above 300m (FG); Dense upland rainforest (MA) | 2;5;6;44;97 |
| Pseudochirulus cinereus | Montane tropical rainforest above 400m (FG); At altitudes above 420m in rainforests (MA) | 2;6;9;60;97 |
| Pseudochirulus herbertensis | Montane tropical rainforest above 350m (FG); In rainforests above 350m, occasionally found in tall eucalypt open forests fringing the western edge of the rainforests (MA) | 2;3;4;6;54;60;97 |
| Pseudomys chapmani | Stony hillsides with hummock grassland (FG); On gentler slopes of rocky ranges where ground is covered by a stony mulch and vegetated by hard spinifex, often with a sparse overstorey of eucalypts and scattered shrubs, typically *Senna, Acacia* and *Ptilotus* (MA) | 20;23;33;37;51;66;97 |
| Pseudomys delicatulus | Open country with friable soils and sparse ground cover, such as sand dunes, sparse grassland or spinifex (FG); Sandy soils – sand dunes, grass as understorey (MA) | 5;7;8;9;33;97 |
| Pseudomys desertor | Sandplains carrying mature hummock grass, or samphire, Nitre bush and sedges (in Lake Eyre region) (FG); From open eucalypt, acacia and riparian woodlands to heaths, samphire and Nitre bush shrublands, sedge communities, spinifex grasslands and cane-grass dunes; dense groundcover of grasses, sedges or shrubs (MA) | 14;18;19;20;23;30;31;32;33;34;35;36;37;38;39;47;48;51;53;56;63;72;80;97 |
| Pseudomys gracilicaudatus | A range of vegetation from grassy and heathy open forests to heath and swampy depressions (FG); Grassy understorey of open woodlands and open dry sclerophyll forests in QLD, tall, open, wet sclerophyll forest, with grassy ground layers (Blady Grass, *Imperata cylindrica*), often on ridgetops, in heathland (most common in dense wet heath and swampy areas) in NSW (MA) | 7; in QLD 5;9;10;12;16;26;51;96;97; in NSW 3;5;30;54;60;96;97 |
| Pseudomys hermannsburgensis | Inhabits a variety of vegetation, mostly fairly open and on friable soil, including dune swales and loamy flats (FG); From hummock and tussock grasslands to stabilised sand dunes and sand fields (MA) | 20;31;33;34;35;36;37;38;45;64;72;97 |
| Pseudomys higginsi | Wet sclerophyll forest, rainforest, alpine heath and boulder screes, up to 1600m (FG); In cool temperate rainforest, wet sclerophyll forest, wet scrub, alpine boulder fields and scree (MA) | 1;3;4;5;17;30;50;54;60;63;96;97 |
| Pseudomys novaehollandiae | In dry coastal heath or heathy sclerophyll forest, also further inland (to 100km) and higher (to 900m) in north-east NSW and south-east QLD in dry sclerophyll forest often with little ground or shrub cover (FG);Occurs in heathlands, woodlands, open forest and paperbark swamps, preference for a heathy understorey of leguminous shrubs less than 1 metre high and sparse ground litter (MA) | 4;5;8;14;15;16;26;29;30;44;50;51;58;65;96;97 |
| Pseudomys oralis | Mid to high altitudes (mostly between 500 and 600m), mostly in damp, dense fern or sedge understorey along drainage lines, but also utilises drier areas with grassy or heathy ground cover (FG); Open eucalypt forest at altitudes ranging from 300-1250m with a groundcover that mostly comprises grasses, ferns or the mat-rush *Lomandra* sp., although heathy shrubs are occasionally present (MA) | 3;5;54;59;60;96;97 |
| Pseudomys pilligaensis | Mixed woodlands of cypress-pine, eucalypt and she-oak with sparse shrub and ground cover, but often close to creeks with dense stands of callistemon and broombush (FG); ---- (MA) | 8;12;15;26;27;47;51;55;65;97 |
| Rattus colletti | Dense grassland on swampy treeless plains that are flooded for long periods in wet season (FG); Lives on the broad, flat, treeless alluvial floodplains of meandering tidal rivers that are bordered by mangroves and low, wide levees; grass and sedge (MA) | 5;9;15;34;35;36;37;38;40;57;63;64;97 |
| Rattus fuscipes | Inhabits most moist vegetation with dense ground cover from sea level to sub-alps, lowland and montane rainforest (between Townsville and Cooktown) (FG); Occurs in subalpine woodland, coastal scrub, eucalypt forest and rainforest (MA) | 2;3;4;5;8;9;10;16;50;54;59;60;65;96;97 |
| Rattus lutreolus | Mostly in low altitudes but also in high altitude grassy forests (in south-east QLD), found in wet, dense vegetation including heath, fern thickets, sedgeland, dune scrub, rank grassland including ungrazed pasture, and gardens (FG); In wetter areas of dense heath, grass or sedge; in TAS also in alpine areas, wet sclerophyll forest and the moist parts of dry sclerophyll forest and rainforest, as well as buttongrass moorlands and heathlands (MA) | 4;5;8;30,61;63;96,97; in TAS 1;3;4;5;30,54;60;63,96,97 |
| Rattus villosissimus | When population contracts, occupies moist patches along streams and bore overflows (most habitats occupied during irruption) (FG); ---- (MA) | 4;5;15;31;33;34;38;45;57;59;97 |
| Sarcophilus harrisii | Most common in dry sclerophyll forest and coastal woodland with patches of open grassland, found in most habitats including outer suburban areas (FG); Open dry eucalypt forests, grassy woodlands, coastal scrub and pasture/dry-bush mosaics (MA) | 3;4;5;8;9;10;16;20;26;28;45;50;51;52;96;97 |
| Setonix brachyurus | On mainland requires dense, wet ground cover in forest or swampy flats, on Rottnest Island occupies wide range of semi-arid habitats, plus gardens and township land (FG); Rainfall of 1000mm or more, thickets of *Acacia, Melaleuca* and sedges (*Gahnia*) on Rottnest island, northern mainland range consists of tea-tree *Taxandria linearifolia* bordering swamps and watercourses with complex structural mosaic, in southern mainland range in thicket, dense streamside beds of rushes, Karri (*Eucalyptus diversicolor*), ridges supporting Karri and Red and Yellow Tingle (*E.guilfoylei* and *E.jacksonii*), also occur widely in forest supporting sword-sedge (*Lepidosperma effusum*) (MA) | 4;5;14;15;20;21;38;42;49;51;54;63;96;97 |
| Sminthopsis crassicaudata | Tussock and hummock grassland, gibber plain, saltbush and bluebush plains, claypans, rough pasture and the edges of stubble paddocks (FG); In a variety of habitats including open woodland, low shrublands of saltbush and bluebush, tussock and spinifex grasslands on clay or sandy soils, gibber plain and, in the southern part of its range, farmlands (MA) | 18;19;20;22;23;24;25;31;33;34;35;36;37;38;39;45;47;48;52;53;56;66;67;68;69;70;71;72;73;74;75;79;97 |
| Sminthopsis leucopus | Lowland heathy woodland and forest, coastal scrub, coastal dune grassland, an outlying population in upland rainforest of the Paluma area in north-east QLD (FG); Wet tropics population is found only in mature or regenerating notophyll vine forest at altitudes of at least 750m, variety of vegetation types in the south including sclerophyll forest, heath and rainforest (MA) | 62 in north-east QLD population; 1;2;3;4;5;6;7;8;9;10;11;12;13;14;15;16;20;26;30;34;35;36;37;50;51;54;58;59;60;62;64;65;96;97 |
| Sminthopsis macroura | Dune hummock grassland, tussock grassland, arid shrubland (FG); In low shrublands of saltbush and bluebush, in tussock grasslands on clay, sandy or stony soils, in spinifex grasslands on sandy soils, among sparse *Acacia* shrublands, on open salt lakes and on low, shrubby, rocky ridges (MA) | 20;25;31;33;34;35;36;37;39;41;43;64;80;97 |
| Sminthopsis murina | In a variety of heathy dry sclerophyll forest and mallee heath (FG); In woodland, open forest and heathland, also in transitional habitats close to rainforest, except in coastal VIC (another species in those habitats there) (MA) | 4;5;8;9;10;12;13;14;15;16;20;26;27;29;30;51;55;58;59;65;96;97 |
| Sminthopsis youngsoni | Where hummock grassland is present on sandy substrates in the arid interior (FG); Variety of plant communities associated with reddish desert sandplains, sand dunes and inter-dune swales: open shrublands of *Acacia, Thryptomene, Grevillea* or *Melaleuca*, often with sparse *Owenia, Casuarina* or *Eucalyptus* trees, over *Triodia* hummock grasslands (MA) | 18;20;21;33;45;49;72;74;80;97 |
| Tachyglossus aculeatus | In almost all terrestrial habitats except intensively managed farmland (FG); From alpine regions to deserts with no particular habitat requirements (MA) | 1;2;3;4;5;6;7;8;9;10;11;12;13;14;15;16;17;18;19;20;21;22;23;24;25;26;27;28;29;30;31;32;33;34;35;36;37;38;39;40;41;42;45;47;48;49;50;51;52;53;54;55;56;57;58;59;60;61;62;63;64;65;66;67;68;69;70;71;72;73;74;75;76;77;78;79;80;81;82;83;84;85;86;87;88;89;90;91;92;93;94;95;96;97 |
| Tarsipes rostratus | In floristically rich heath, needs high diversity of shrubs (for year-round nectar provision) (FG); Coastal sandplain heaths of south-west WA (MA) | 8;29;30;32;50;97 |
| Thylogale billardierii | Dense vegetation adjacent to open patches, including paddocks and gardens, rainforest, wet sclerophyll forest, coastal heath and scrub, gullies in drier forests (FG); Favours dense vegetation of wet sclerophyll forests, rainforests and tea-tree scrubs (MA) | 1;2;3;4;6;8;50;54;58;60;62;96;97 |
| Thylogale stigmatica | In rainforest, sometimes in adjacent wet sclerophyll forest (FG); Tropical and subtropical rainforests, also occurs in wet sclerophyll forests and occasionally in deciduous vine thickets (MA) | 2;3;5;6;54;60;62;97 |
| Thylogale thetis | Around fringes of rainforest and wet sclerophyll forest (FG); Dense rainforest and eucalypt forests, most numerous where the forest edge adjoins grassy areas or pasture (MA) | 1;2;3;5;6;54;60;62;97 |
| Trichosurus caninus | Cool to temperate wet forest and subtropical rainforest with a luxuriant understorey of non-sclerophyllous shrubs and ferns (FG);Moist forests (MA) | 1;2;3;6;60;97 |
| Trichosurus cunninghami | Cool to temperate wet forest with a luxuriant understorey of non-sclerophyllous shrubs and ferns (FG); A variety of wetter forest types, altitudes above 300m (MA) | 1;2;3;4;6;54;60;97 |
| Trichosurus vulpecula | Found in most treed environments, including cities, towns and farmland, exclude wet sclerophyll forest in south-east of range (FG); Mostly restricted to River Red Gums along creeks and rivers in the semi-arid country, declining in tropical and temperate woodlands, prefers dry eucalypt forests and woodlands (MA) | 4;5;8;9;10;59;60;65;96;97 |
| Vombatus ursinus | In wet forest above 600m (for QLD and north NSW), further south also inhabits drier forest, coastal scrub and heath from sea level to above snowline (FG); In south QLD and north NSW occurs only in sclerophyll forest above 600m, further south also occurs at lower altitudes and in more open vegetation such as woodland, coastal scrub and heathland (MA) | In QLD 3;4;5;54;60;96;97; in NSW 3;4;5;7;8;9;10;11;12;13;14;15;16;20;26;30;50;51;54;59;60;65;96;97 |
| Wallabia bicolor | In wide range of forest, woodland, scrub and heath from tropical rainforest to dry brigalow, box-ironbark and some mallee associations (FG); In thick undergrowth in forest, woodland and heath, brigalow scrub particularly favoured in QLD (MA) | 1;2;3;4;5;6;7;8;9;10;11;12;13;14;15;16;20;26;27;29;50;51;54;55;59;60;61;62;65;96;97 |
| Wyulda squamicaudata | Low open woodland, riparian forest and vine thickets (FG); Shelters exclusively in rocks, inhabits very rugged, rocky country (rocky outcrops), inhabits open woodland and closed forest (sometimes with rainforest vegetation elements) (MA) | 7;8;18;19;28;33;47;48;53;56;62;97 |
| Zyzomys argurus | Associated with fractured rock outcrops or scree slopes, usually within vegetation with monsoon forest elements (FG); Associated with rocky outcrops, particularly sandstone formations, with vegetation varying from riverine communities through open forest, to woodland with an understorey of spinifex or tropical grasses, may also occupy monsoon forest patches and dry vine thickets (MA) | 4;5;7;9;10;12;13;14;18;20;51;62;96;97 |

Species’ distributions were refined in ArcGIS Pro 2.3 by the NVIS subclasses, along with any rainfall, altitude and rocky outcrop preferences contained in the habitat descriptions, to delineate species habitat. This involved several steps: distributions were trimmed to the relevant NVIS subclasses first (using spatial tools Clip and Extract by Attributes), these in turn were trimmed by rainfall requirements where present, then by altitude, and lastly by rocky outcrop requirements (the three latter parameters were carried out using Clip, preceded by an Image Classification exercise for altitude and rocky outcrops). Rocky outcrop areas were defined as those where regolith depth was less than 2 centimetres, which allows for the accumulation of some weathering debris on bare rock (Shtober-Zisu & Wittenberg, 2021). To complete the habitat models, the dispersal distance of each species – calculated following Santini et al. (2014) - was used as a buffer around the habitat polygon obtained, accounting for possible sightings outside primary habitat but within a distance the individual may have travelled.

ALA record data for each species was trimmed to the extent of the relevant IUCN distribution and then used to validate the habitat models derived for each species, by converting the data to polygons and running the Select by Location tool. On average, 84.9 ±2.1% of ALA records lay within the defined polygons, which can be considered a strong performance, representative of the species’ actual location.

*Setting habitat quality*

The Human Footprint Index (HFI) was used to inform habitat quality underlying protected areas. Converting the PPAs and public PAs spatial layers to raster format, Zonal Statistics was used to extract the mean HFI score for each protected area. To match the raster PAs, the HFI was resampled at the 50X50m cell size and its extent shifted to ensure the two layers overlapped exactly. The raster HFI scores were converted to points, and merged with the PA layers by Spatial Join. 224 of the 8035 public PAs lay outside the HFI layer (had a “Null” HFI scoring), as were 47 out of 9878 PPAs. These were individually assigned a score based on the HFI value of the closest point, except where they were small offshore islands entirely occupied by the reserve, where a value of 0 was assigned i.e. intact habitat quality was assumed.

The algorithm used by Hilbers et al. (2017) in determining minimum viable population (MVP) threshold for species relied on the maximum intrinsic population growth rate (*rm*) for different body sizes. They modelled five additional scenarios that account for varying habitat quality, applying fractional growth rates of 80%, 60%, 40%, 20% and 0%; which represents progressively unfavourable habitat. The HFI discussed above is, on the other hand, a continuous measure ranging in score between 0 and 50 (the higher the score, the more transformed the habitat). Therefore, we reconciled the two scales by grouping the HFI scores into the six *rm* categories. We applied five different grouping techniques: Jones et al. (2018) grouping (where HFI >=4 was defined as intense human activity), a grouping based on the natural breaks in the HFI scores found in our data, another based on quantiles, quantile grouping with no habitat penalty for PA <1km2, and finally, no penalty on the HFI (Table S1.4). The rationale behind the fourth grouping is that the native resolution of the HFI is ~1km2, therefore PAs that are smaller than that have a likelihood of being assimilated into a mean HFI score that includes largely the surrounding matrix.

T**able S1.4**. The five methods of habitat grouping applied on the continuous Human Footprint Index (HFI) scoring system to form six categories of intrinsic population growth rate (*rm*) used by Hilbers et al. (2017)

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| Intrinsic population growth rate (%) | HFI scores (0-50) included under grouping type |
| Jones et al. (2018) | Natural Breaks | Quantile | Quantile with no penalty for <1km2 | No penalty |
| 100 | 0 - 0.8 | 0 - 3.385422 | 0 - 3 | 0 – 3\* | 0 - 50 |
| 80 | 0.8 - 1.6 | 3.385423 - 6.488088 | 3.000001 - 5.529412 | 3.000001 - 5.529412\* | N/A |
| 60 | 1.6 - 2.4 | 6.488089 - 9.85623 | 5.529413 - 7.680672 | 5.529413 - 7.680672\* | N/A |
| 40 | 2.4 - 3.2 | 9.85624 - 14.372549 | 7.680673 - 9.786885 | 7.680673 - 9.786885\* | N/A |
| 20 | 3.2 - 4 | 14.37255 - 23.645523 | 9.786886 -12.806452 | 9.786886 -12.806452\* | N/A |
| 0 | >= 4 | >= 23.645524 | >= 12.806453 | >= 12.806453\* | N/A |

\*Not applied to PAs smaller than 1km2, for which a 100% *rm* was assumed

The mean HFI values for PAs as calculated previously were adjusted to reflect the *rm* score (the relevant column was reclassified in ArcGIS following if/elif code structure), for each grouping. We selected the quantile grouping to proceed with, as it yielded what we considered to be the most fitting *rm* scoring for our PA dataset: the Jones et al. group penalised PAs harshly and unfavourably for the smaller PAs, the natural breaks group was too lenient with poor habitat quality, the quantile group with no penalty for PAs <1km2 did not differ significantly from the quantile group in result, and the no penalty group was used only for comparative purposes.

*Species viability within protected areas*

To extract the protected areas overlapping the habitat models created for the study species, the public PAs and PPAs spatial layers were iteratively trimmed to the extent of each habitat model using the beta version of a new Pairwise Clip tool in ArcGIS. This yielded a layer of protected areas and parts thereof that overlap each species’ identified habitat. We then recalculated the area of each PA listed to account for this trimming, i.e. the habitat area within the PA, grouping the outputs into 3 broad size classes: <1km2, 1-5km2, and >5km2 (see Appendix 2, “Viability of PA size classes” sheet, for numbers of PAs concerning each species). The first threshold of 1km2 was chosen as it is common for studies to refer to PAs in terms of being more or less than that specific size, and labelling those below as being “small” or “relatively small” (e.g. UNEP-WCMC, 2018). Another typical point of PA categorisation is at 10km2 (e.g. de la Fuente et al., 2020; Ward, 2020), however to ensure a sufficient sample size of PAs within the upper size category we chose a midway point of 5km2. The primary purpose of grouping the continuous habitat sizes within PAs was that it allowed for a direct comparison between habitat sizes across species.

Determining viability of each species involved the consideration of several parameters: the number of MVPs possible across the PA remnants identified as overlapping, the number of PAs that contribute MVPs (some remnants being too small to contain an MVP), as well as the area of the species habitat defined (smaller area requiring higher fractional protection).

To estimate the number of MVPs for each species, the *rm*score reported for each PA determined the Minimum Viable Area (MVA) required for an MVP to be sustained: in Microsoft Excel, a formula was set up that divided the PA/PA remnant size by the identified MVA size, rounding down the output to the nearest whole number (i.e. if 1.9 MVPs fit in a PA, it was recorded as 1). The MVAs themselves were based on the MVP estimations of Hilbers et al. (2017), divided by the population density in km2 (refer to the “Study species selection and habitat delineation” section above for the description of density data sources).

The number of PAs supporting at least a single MVP were assessed both in absolute terms (i.e. the raw number of PAs/PA remnants that are viable), as well as proportionally (i.e. the fraction of all overlapping PAs that are viable). These figures depended on the size of the overlapping PA remnant, as well as on the habitat quality therein (*rm* score). We used the input variables of viable PA count, the MVP count and the habitat area to carry out a K-clustering procedure in IBM SPSS Statistics 27 to identify viability groups based on the raw numbers. Clustering was heavily influenced by outlier values for all clusters attempted (2, 3, 4 and 5). We stopped at five groups (Figure S1.1) as further division would not assist interpretation of the findings.



**Figure S1.1**. Five emergent groups from viability assessment of 118 native mammal species across the terrestrial protected area network of Australia. Clustering was based on the number of minimum viable populations (MVPs) hypothetically possible for each species (z-axis), the number of protected areas contributing to viability (x-axis), and the habitat area derived from habitat models (y-axis).

This method was therefore considered uninformative, and instead, an approach was taken to use proportions rather than raw values. We performed a K-clustering analysis using the proportion of PAs that contributed to viability (i.e. viable PAs) – in total for each species, as well as broken down by land tenure type (i.e. public PAs and PPAs). While there are many recognised ways of defining clusters, we followed the Elbow method (Syakur et al. 2018) and tested clusters of 2-10 groups, selecting 4 groups as most useful (Figure S1.2). Subjectively, at 4 groups, the clustering provided the most evenly split clusters with a reasonable convergence in cluster centres (5 iterations).

 

**Figure S1.2**. Elbow Method for K-means clustering determination of number of clusters. Y-axis shows the within-cluster sum of square for the different numbers of clusters on X-axis. The selected “elbow” is shown at 4 clusters.

Furthermore, the habitat area was used to inform a viability threshold: defined as per Clements et al. (2018), with a PA coverage target of 100% for habitat <1 000km2 scaled linearly all the way to 10% for habitat >10 000km2. Whether the species viability threshold was met depended on the area of the species habitat model and the area of viable PAs identified for the species.

*The role of private land*

In addition to the K-clustering analysis that factored in the proportion of PPAs that were deemed viable, discussed above, we analysed the numeric contribution of PPAs towards the MVP count, their viability potential across PA size classes, and compared their *rm* scores (habitat quality) to those of public PAs. We also determined the potential of land under private tenure to conserve the study species in future PPA allocations by iteratively overlapping the habitat models with a spatial layer of private land, sourced from Ivanova & Cook (2020).

References

Clements, H.S., Kearney, S.G. & Cook, C.N., 2018. Moving from representation to persistence: of Australia's National Reserve System populations. Diversity and Distributions, 24, 1231-1241. <https://doi.org/10.1111/ddi.12759>

de la Fuente, B., Weynants, M., Bertzky, B., Delli, G., Mandrici, A., Bendito, E.G. & Dubois, G., 2020. Land productivity dynamics in and around protected areas globally from 1999 to 2013. PLOS ONE 15(8), e0224958. <https://doi.org/10.1371/journal.pone.0224958>

ESRI 2019. ArcGIS Desktop: Release 10.7. Redlands, CA: Environmental Systems Research Institute.

ESRI 2019. ArcGIS Pro: Release 2.3.0. Redlands, CA: Environmental Systems Research Institute.

Hilbers, J.P., Santini, L., Visconti, P., Schipper, A.M., Pinto, C., Rondinini, C. & Huijbregts, M.A.J., 2017. Setting population targets for mammals using body mass as a predictor of population persistence. Conservation Biology, 31, 385-393. <https://doi.org/10.1111/cobi.12846>

IBM Corp., 2020. IBM SPSS Statistics for Windows, Version 27.0. Armonk, NY: IBM Corp.

Ivanova, I.M. & Cook, C.N., 2020. The role of privately protected areas in achieving biodiversity representation within a national protected area network. Conservation Science and Practice, 2(12), e307. <https://doi.org/10.1111/csp2.307>

Jones, K.E., Bielby, J., Cardillo, M., Fritz, S. A., O'Dell, J., Orme, D., Safi, K., Sechrest, W., Boakes, E.H., Carbone, C., Connolly, C., Cutts, M., Foster, J., Greyner, R., Habib, M., Plaster, C.A., Price, S.A., Rigby, E.A., Rist, J., Teacher, A., Bininda-Emonds, O.R.P., Gittleman, J.L., Mace, G.M. & Purvis, A., 2009. PanTHERIA: a species-level database of life history, ecology, and geography of extant and recently extinct mammals. Ecology, 90(9), 2648. <https://doi.org/10.1890/08-1494.1>

Jones, K.R., Venter, O., Fuller, R.A., Allan, J.R., Maxwell, SL., Negret, P.J. & Watson, J.E.M., 2018. One-third of global protected land is under intense human pressure. Science, 360(6390), 788-791. <https://doi.org/10.1126/science.aap9565>

Shtober-Zisu, N. & Wittenberg, L., 2021. Long-term effects of wildfire on rock weathering and soil stoniness in the Mediterranean landscapes. Science of the Total Environment, 762, 143125. <https://doi.org/10.1016/j.scitotenv.2020.143125>

Syakur, M.A., Khotimah, B.K., Rochman, E.M.S. & Satoto, B.D., 2018. Integration K-Means Clustering Method and Elbow Method For Identification of The Best Customer Profile Cluster. IOP Conference Series: Materials Science and Engineering 336: 012017. <https://doi.org/10.1088/1757-899X/336/1/012017>

UNEP-WCMC, 2018. 2018 United Nations List of Protected Areas. Supplement on protected area management effectiveness. UNEP-WCMC: Cambridge, UK. <https://www.sprep.org/attachments/VirLib/Global/2018-list-protected-areas.pdf>

Ward, M., Saura, S., Williams, B., Ramírez-Delgado, J.P., Arafeh-Dalmau, N., Allan, J.R., Venter, O., Dubois, G. & Watson, J.E.M., 2020. Only ten percent of the global terrestrial protected area network is connected via intact land. Nature Communications, 11 (4563), <https://doi.org/10.1038/s41467-020-18457-x>