

Supplementary Material

Ecological consequences of land clearing and policy reform in Queensland

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Table S1. List of environmental programs funded by State and Federal Governments that are potentially undermined by ongoing broad-scale land clearing in Queensland, and calculated costs for issues exacerbated by land clearing

| Program name or general cost based on studies | Source of funding | Program time frame | Overall spending | Spending per year | Comment | Source |
|--|-----------------------|--------------------|------------------|-------------------|--|---|
| Agri-environmental schemes: National Landcare Program, Natural Heritage Trust 1 and 2, National Action Plan for Salinity and Water Quality, Caring for our Country | Australian Government | 1990–2008 | \$6.51 billion | | | Hajkowicz, S. (2009). The evolution of Australia’s natural resource management programs: towards improved targeting and evaluation of investments. <i>Land Use Policy</i> 26 , 471–478. |
| Emissions Reduction Fund | Australian Government | 2015–16 | \$2.5 billion | | Spent through four auctions in two years; average price per ton CO ₂ is \$10.69 | http://www.theguardian.com/australia-news/2016/feb/29/exclusive-land-clearing-surge-in-qld-set-to-wipe-out-direct-action-gains-report |
| 20 Million Trees | Australian Government | 4 years | \$525.4 million | | | Australian Government (2016). 20 Million Trees. Available at: http://www.nrm.gov.au/national/20-million-trees . Australian Government (2016). Field capture. Available at: https://fieldcapture.ala.org.au/home/projectExplorer . |
| Reef Rescue | Australian Government | 5 years | \$200 million | | | http://www.aph.gov.au/About_Parliament/Parliamentary_Departments/Parliamentary_Library/pubs/rp/BudgetReview201415/Environment |
| Reef Trust | Australian Government | 4 years | \$39.9 million | | | http://www.aph.gov.au/About_Parliament/Parliamentary_Departments/Parliamentary_Library/pubs/rp/BudgetReview201415/Environment |
| Saving the Great Barrier Reef policy | Queensland Government | 5 years | \$100 million | | | https://www.treasury.qld.gov.au/publications-resources/state-budget/2015-16/budget-papers/documents/bp5-ehp-2015-16.pdf |
| Climate Change Adaptation initiatives | Queensland Government | 2015–16 | \$5 million | | | https://www.treasury.qld.gov.au/publications-resources/state-budget/2015-16/budget-papers/documents/bp5-ehp-2015-16.pdf |
| NatureAssist | Queensland Government | 2015–17 | \$5 million | | | https://www.treasury.qld.gov.au/publications-resources/state-budget/2015-16/budget-papers/documents/bp5-ehp-2015-16.pdf |

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|--|----------------|----------|----------------|---|--|
| Emissions Reduction Fund | Estimated cost | 3 years | \$670 million | Woodland carbon sinks that are created by government payments to farmers will be cancelled out within three years of current clearing rates | http://www.theguardian.com/australia-news/2016/feb/29/exclusive-land-clearing-surge-in-qld-set-to-wipe-out-direct-action-gains-report ; http://www.parliament.qld.gov.au/documents/committees/AEC/2016/11-VegetationMangt/11-trns-ph18May2016.pdf |
| Emissions Reduction Fund | Estimated cost | | \$257 million | Cost for countering only emissions since 2009–10 clearing under current rate with average cost per tonne carbon being \$13 | http://www.cleanenergyregulator.gov.au/ERF/Auctions-results |
| Estimated actual cost for counteracting declines in waterquality General cost/various | Estimated cost | 10 years | \$5–10 billion | | Brodie J. and Pearson. R.G. (2016). Ecosystem health of the Great Barrier Reef: time for effective management action based on evidence. <i>Estuarine, Coastal and Shelf Science</i> 183 , 438–451. |
| | Estimated cost | | \$7 million | Current cost of sedimentation to water storage capacity and treatment in SE Qld | Marsden Jacob Associates (2011). The future of our bay. Report to Queensland Department of Environment and Resource Management. |
| General cost/various | Estimated cost | | \$32 million | 2031 cost of sedimentation to water storage capacity and treatment in SE Qld if not addressed | Marsden Jacob Associates (2011). The future of our bay. Report to Queensland Department of Environment and Resource Management. |
| Value of soil | Estimated cost | | \$14.3 million | Value of 477 670 tonnes soil eroded at a single farm | Unpublished data. SEQ Catchments in https://martinemaron.files.wordpress.com/2016/05/q_vma-science-subm_final_29apr16.pdf |

| | | | | |
|--|----------------|--|--|---|
| Tropical rainforest replanting | Estimated cost | \$20 000–30 000, up to \$50 000 ha ⁻¹ | during 2011 Brisbane flood Only partial success after 2–3 decades | Catterall, C. P. and Harrison, D. A. (2006). Rainforest restoration activities in Australia’s tropics and subtropics. Rainforest CRC, Cairns. Available at: http://www.jcu.edu.au/rainforest/reports.htm . Catterall, C. P., Freeman, A. N. D, Kanowski, J., and Freebody, K. (2012). Can active restoration of tropical rainforest rescue biodiversity? A case with bird community indicators. <i>Biological Conservation</i> 146 , 53–61. Shoo, L. P., Freebody, K., Kanowski, J., and Catterall, C. P. (2016). Slow recovery of tropical old-field rainforest regrowth and the value and limitations of active restoration. <i>Conservation Biology</i> 30 , 121–132. |
| Woodland replanting | Estimated cost | \$20 000 ha ⁻¹ | | Schirmer, J., and Field, J. (2000). The cost of revegetation. Final report. ANU Forestry and Greening Australia. Munro, N., Fischer, J., Wood, J., and Lindemayer, D. B. (2009). Revegetation in agricultural areas: the development of structural complexity and floristic diversity. <i>Ecological Applications</i> 19 , 1197–1210. |
| Stabilising riverbanks after deforestation | Estimated cost | \$16 000–\$5 million km ⁻² | | https://martinemaron.files.wordpress.com/2016/05/q_vma-science-subm_final_29apr16.pdf |

Table S2. Percentage area of preclearing Regional Ecosystems in 1999 dominated by woody vegetation, percentage area of remnant Regional Ecosystems in 1999 dominated by woody vegetation, area of woody vegetation cleared since 1999, and area of woody vegetation cleared for pasture since 1999 in Queensland

See Text S1 for details of the methodology used to obtain these figures

| Bioregion | Bioregion area | Preclearing woody vegetation | | Remnant woody vegetation in 1999 | | Woody vegetation cleared since 1999 | | Woody vegetation cleared for pasture since 1999 | |
|--------------------------|----------------|------------------------------|------|----------------------------------|------|-------------------------------------|------|---|------|
| | (ha) | (ha) | % | (ha) | % | (ha) | % | (ha) | % |
| Brigalow Belt | 36528106 | 34722327 | 95.1 | 15329574 | 42.0 | 2052767 | 13.4 | 1932184 | 12.6 |
| Channel Country | 23217288 | 5589799 | 24.1 | 7346631 | 31.6 | 21029 | 0.3 | 10931 | 0.1 |
| Central Queensland Coast | 1484277 | 1375604 | 92.7 | 933704 | 62.9 | 105133 | 11.3 | 21223 | 2.3 |
| Cape York Peninsula | 12305219 | 10905299 | 88.6 | 10764794 | 87.5 | 28026 | 0.3 | 20052 | 0.2 |
| Desert Uplands | 6941095 | 6501762 | 93.7 | 5588124 | 80.5 | 331822 | 5.9 | 326551 | 5.8 |
| Einasleigh Uplands | 11625726 | 11153550 | 95.9 | 10904959 | 93.8 | 46076 | 0.4 | 36180 | 0.3 |
| Gulf Plains | 21910942 | 16762750 | 76.5 | 18599574 | 84.9 | 46161 | 0.2 | 39050 | 0.2 |
| Mitchell Grass Downs | 24162329 | 9489754 | 39.3 | 10280791 | 42.5 | 274015 | 2.7 | 273181 | 2.7 |
| Mulga Lands | 18605811 | 17090880 | 91.9 | 13641521 | 73.3 | 1644019 | 12.1 | 1636907 | 12.0 |
| New England Tableland | 774795 | 773799 | 99.9 | 259256 | 33.5 | 30285 | 11.7 | 28663 | 11.1 |
| North-west Highlands | 7343635 | 7029718 | 95.7 | 7031204 | 95.7 | 7163 | 0.1 | 5376 | 0.1 |
| South East Queensland | 6248417 | 5942497 | 95.1 | 2404362 | 38.5 | 234797 | 9.8 | 116664 | 4.9 |
| Wet Tropics | 1992899 | 1886345 | 94.7 | 1426549 | 71.6 | 15780 | 1.1 | 7706 | 0.5 |

Text S1. Methodology for Table S2 and Fig. 3

The pre-clearing extent of woody vegetation was taken from Version 9 of the regional ecosystem mapping released in 2013. The extent of remnant woody vegetation was established from remnant Regional Ecosystem mapping for 1999 Version 3 published in 2001 (<https://www.qld.gov.au/environment/plants-animals/plants/herbarium/mapping-ecosystems/>) as this coincided with the introduction of the *Vegetation Management Act 1999* and the start of the SLATs monitoring of the tree clearing. Gaps existed in the 1999 data for parts of Cape York, north-west and south-west Queensland (see Fig. S1). Data for these unmapped areas were taken from the first regional ecosystem maps that provided coverage (Version 7 for Cape York and Version 9 for north-west and south-west Queensland). Where remnant regional ecosystems were not mapped in detail, preclearing data were used. Since these areas occurred only in western Queensland (see black box on Fig. S1), there is a high likelihood that clearing has been minimal. All shapefiles were projected into GDA_1994_Australia_Albers central meridian 132°E and the area (in hectares) for each regional ecosystem was calculated. The shapefiles were split to match each of the Queensland bioregions. Tables were summarised based on Broad Vegetation Groups at a scale of 1 : 5 million to identify wooded from non-wooded regional ecosystems. The total amount of total woody vegetation clearance between 1999 and 2014 and the proportion of land cleared for grazing were summed from the SLATs reports for the relevant years (<https://www.qld.gov.au/environment/land/vegetation/mapping/slats-reports/>).

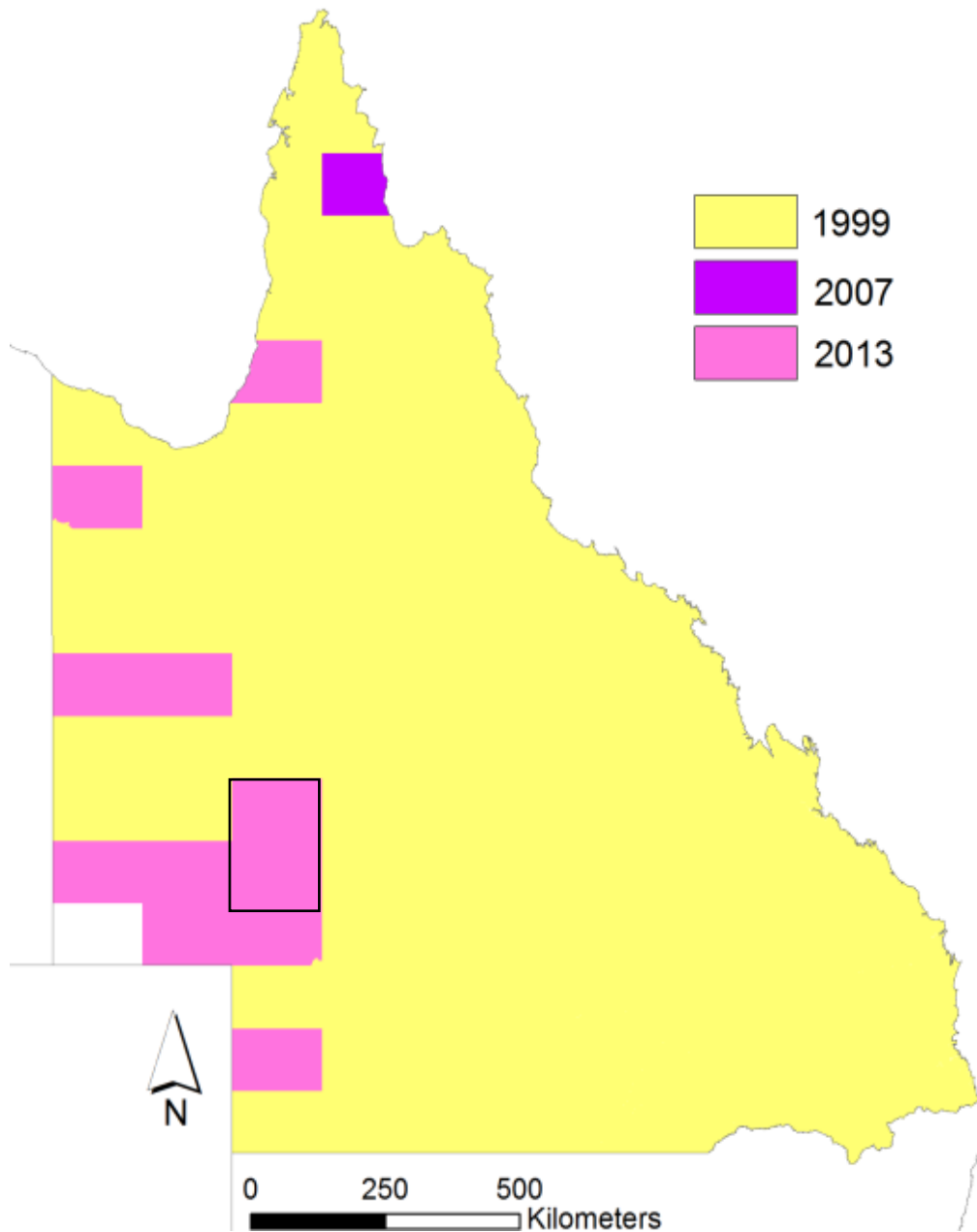


Fig. S1. Regional ecosystem maps used to calculate the change in woody vegetation in Queensland.

Table S3. List of threatened terrestrial fauna species in Queensland under the Nature Conservation Act 1992 (Queensland) grouped by threatening process

Excludes extinct animals, sea or shore birds, amphibians, marine mammals, and fish. Some species are also listed under the Environment Protection and Biodiversity Act 1999 (EPBC Act)

| Subgroup | Scientific name | Common name | Location | Status |
|--|--|--|-----------------------------|------------|
| <i>Species listed as vulnerable for which loss of habitat containing woody vegetation is a key threatening process (for endangered species in this category see Table 2 in the main paper)</i> | | | | |
| Bird | <i>Atrichornis rufescens</i> | Rufous scrub-bird | SE Qld | Vulnerable |
| Bird | <i>Bolemoreus hindwoodi</i> | Eungella honeyeater | Central Qld coast | Vulnerable |
| Bird | <i>Calyptorhynchus lathami</i> | Glossy black-cockatoo | Brigalow Belt | Vulnerable |
| Bird | <i>Calyptorhynchus lathami erebus</i> | Glossy black-cockatoo (northern) | Brigalow Belt | Vulnerable |
| Bird | <i>Calyptorhynchus lathami lathami</i> | Glossy black-cockatoo (eastern) | Brigalow Belt | Vulnerable |
| Bird | <i>Casuarius casuarius johnsonii</i> (northern population) | Southern cassowary (northern population) | Wet Tropics | Vulnerable |
| Bird | <i>Cyclopsitta diophthalma macleayana</i> | Macleay's fig-parrot | Wet Tropics | Vulnerable |
| Bird | <i>Eclectus roratus macgillivrayi</i> | Eclectus parrot (Cape York Peninsula) | Cape York | Vulnerable |
| Bird | <i>Epthianura crocea</i> | Yellow chat | Inland northern Qld | Vulnerable |
| Bird | <i>Epthianura crocea crocea</i> | Yellow chat (gulf) | Gulf Country | Vulnerable |
| Bird | <i>Falco hypoleucos</i> | Grey falcon | Northern Qld | Vulnerable |
| Bird | <i>Geophaps scripta scripta</i> | Squatter pigeon (southern subspecies) | Brigalow Belt, SE Qld | Vulnerable |
| Bird | <i>Grantiella picta</i> | Painted honeyeater | SE Qld, Brigalow Belt, Gulf | Vulnerable |
| Bird | <i>Lophochroa leadbeateri</i> | Major Mitchell's cockatoo | Inland southern Qld | Vulnerable |
| Bird | <i>Malurus coronatus</i> | Purple-crowned fairy-wren | Gulf Country | Vulnerable |
| Bird | <i>Ninox strenua</i> | Powerful owl | SE Qld | Vulnerable |
| Bird | <i>Pezoporus wallicus wallicus</i> | Ground parrot | SE Qld, western Qld | Vulnerable |
| Bird | <i>Podargus ocellatus plumiferus</i> | Plumed/marbled frogmouth | Cape York, SE Qld | Vulnerable |
| Bird | <i>Stipiturus malachurus</i> | Southern emu-wren | SE Qld | Vulnerable |
| Bird | <i>Turnix melanogaster</i> | Black-breasted button-quail | SE Qld, Brigalow Belt | Vulnerable |

| | | | | |
|--------------|--|---|------------------------|------------|
| Invertebrate | <i>Acrodipsas illidgei</i> | Illidge's ant-blue butterfly | SE Qld | Vulnerable |
| Invertebrate | <i>Adclarkia cameroni</i> | Brigalow woodland snail | SE Qld | Vulnerable |
| Invertebrate | <i>Hypochrysops apollo apollo</i> | Apollo jewel butterfly (Wet Tropics subspecies) | Wet Tropics | Vulnerable |
| Invertebrate | <i>Jalmenus eubulus</i> | Pale imperial hairstreak | Brigalow Belt | Vulnerable |
| Invertebrate | <i>Ornithoptera richmondia</i> | Richmond birdwing butterfly | SE Qld | Vulnerable |
| Mammal | <i>Chalinolobus dwyeri</i> | Large-eared pied bat | SE Qld | Vulnerable |
| Mammal | <i>Dasyurus maculatus maculatus</i> | Spotted-tailed quoll (southern subspecies) | SE Qld | Vulnerable |
| Mammal | <i>Hipposideros cervinus</i> | Fawn leaf-nosed bat | Cape York | Vulnerable |
| Mammal | <i>Macroderma gigas</i> | Ghost bat | North Qld, Cape York | Vulnerable |
| Mammal | <i>Murina florium</i> | Tube-nosed insectivorous bat | Cape York | Vulnerable |
| Mammal | <i>Nyctophilus corbeni</i> | Eastern long-eared bat | Brigalow Belt | Vulnerable |
| Mammal | <i>Petaurus australis</i> (unnamed subsp.) | Yellow-bellied glider (northern subspecies) | Qld coast | Vulnerable |
| Mammal | <i>Petrogale penicillata</i> | Brush-tailed rock-wallaby | SE Qld | Vulnerable |
| Mammal | <i>Petrogale sharmani</i> | Sharman's rock-wallaby | NE Qld | Vulnerable |
| Mammal | <i>Phascolarctos cinereus</i> | Koala | Most of Qld | Vulnerable |
| Mammal | <i>Potorous tridactylus tridactylus</i> | Long-nosed potoroo | SE Qld | Vulnerable |
| Mammal | <i>Pseudomys oralis</i> | Hastings River mouse | SE Qld | Vulnerable |
| Mammal | <i>Pteropus conspicillatus</i> | Spectacled flying-fox | Wet Tropics, Cape York | Vulnerable |
| Mammal | <i>Xeromys myoides</i> | False water-rat | Coastal Qld | Vulnerable |
| Reptile | <i>Acanthophis antarcticus</i> | Common death adder | Most of Qld | Vulnerable |
| Reptile | <i>Calyptotis thorntonensis</i> | Thornton Peak calyptotis | Wet Tropics | Vulnerable |
| Reptile | <i>Cryptoblepharus fuhni</i> | Fuhn's snake-eyed skink | Wet Tropics | Vulnerable |
| Reptile | <i>Cryptophis incredibilis</i> | Pink snake | Cape York | Vulnerable |
| Reptile | <i>Ctenotus monticola</i> | Atherton striped skink | Wet Tropics | Vulnerable |
| Reptile | <i>Ctenotus rawlinsoni</i> | Cape Heath ctenotus | Wet Tropics | Vulnerable |
| Reptile | <i>Ctenotus serotinus</i> | Gravel-downs ctenotus | Inland central Qld | Vulnerable |
| Reptile | <i>Delma torquata</i> | Collared delma | Brigalow Belt, SE Qld | Vulnerable |
| Reptile | <i>Denisonia maculata</i> | Ornamental snake | Brigalow Belt | Vulnerable |
| Reptile | <i>Egernia rugosa</i> | Yakka skink | Brigalow Belt | Vulnerable |

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|---------|----------------------------------|--------------------------------|----------------------|------------|
| Reptile | <i>Furina dunmalli</i> | Dunmall's snake | Brigalow Belt | Vulnerable |
| Reptile | <i>Karma tryoni</i> | Tryon's skink | Central Qld coast | Vulnerable |
| Reptile | <i>Lerista ameles</i> | Limbless fine-lined slider | Inland north Qld | Vulnerable |
| Reptile | <i>Lerista cinerea</i> | Vine-thicket fine-lined slider | Near Charters Towers | Vulnerable |
| Reptile | <i>Lerista ingrami</i> | Ingram's lerista | Wet Tropics | Vulnerable |
| Reptile | <i>Lerista storri</i> | Chillagoe fine-lined slider | Inland north Qld | Vulnerable |
| Reptile | <i>Lerista vittata</i> | Mount Cooper striped lerista | Charters Towers | Vulnerable |
| Reptile | <i>Liburnascincus scirtetis</i> | Black Mountain rainbow-skink | Wet Tropics | Vulnerable |
| Reptile | <i>Lygisaurus tanneri</i> | Endeavour River litter-skink | Wet Tropics | Vulnerable |
| Reptile | <i>Magmellia luteilateralis</i> | Orange-speckled forest-skink | No information | Vulnerable |
| Reptile | <i>Nactus galgajuga</i> | Black Mountain gecko | Wet Tropics | Vulnerable |
| Reptile | <i>Orraya occultus</i> | McIllwraith leaf-tailed gecko | Cape York | Vulnerable |
| Reptile | <i>Phyllurus caudiannulatus</i> | Ringed thin-tailed gecko | Charters Towers | Vulnerable |
| Reptile | <i>Phyllurus isis</i> | Leaf-tailed gecko | Central Qld coast | Vulnerable |
| Reptile | <i>Pygmaescincus sadlieri</i> | Magnetic Island dwarf skink | Magnetic Island | Vulnerable |
| Reptile | <i>Saproscincus eungellensis</i> | Eungella shadeskink | Central Qld coast | Vulnerable |
| Reptile | <i>Techmarscincus jigurru</i> | Bartle Frere skink | Wet Tropics | Vulnerable |

Threats do not list loss of habitat contained woody vegetation as a key element (fire, grazing, and loss of grassland habitat are among the common threats)

| | | | | |
|--------------|--------------------------------------|----------------------------------|----------------------|------------|
| Bird | <i>Neochmia phaeton evangelinae</i> | Crimson finch (white-bellied) | Cape York | Endangered |
| Bird | <i>Pedionomus torquatus</i> | Plains-wanderer | SW Qld | Vulnerable |
| Bird | <i>Psephotus chrysopterygius</i> | Golden-shouldered parrot | Cape York | Endangered |
| Bird | <i>Tyto novaehollandiae kimberli</i> | Masked owl (northern subspecies) | North Qld, Gulf | Vulnerable |
| Invertebrate | <i>Trisyntopa scatophaga</i> | Antbed parrot moth | Cape York | Endangered |
| Mammal | <i>Dasyuroides byrnei</i> | Kowari | SW Qld | Vulnerable |
| Mammal | <i>Hipposideros stenotis</i> | Northern leaf-nosed bat | Gulf Country | Vulnerable |
| Mammal | <i>Macroderma gigas</i> | Ghost bat | North Qld, Cape York | Vulnerable |
| Mammal | <i>Macrotis lagotis</i> | Bilby | SW Qld | Endangered |
| Mammal | <i>Murina florium</i> | Tube-nosed insectivorous bat | Cape York | Vulnerable |
| Mammal | <i>Notomys aquilo</i> | Northern hopping-mouse | Cape York | Vulnerable |

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|--|------------------------------------|----------------------------|-------------|------------|
| Mammal | <i>Notomys fuscus</i> | Dusky hopping-mouse | SW Qld | Endangered |
| Mammal | <i>Petrogale coenensis</i> | Cape York rock-wallaby | Cape York | Vulnerable |
| Mammal | <i>Pseudomys australis</i> | Plains rat | SW Qld | Endangered |
| Mammal | <i>Rhinonictoris aurantia</i> | Orange leaf-nosed bat | NW Qld | Vulnerable |
| Mammal | <i>Sminthopsis douglasi</i> | Julia Creek dunnart | Central Qld | Endangered |
| Mammal | <i>Sminthopsis leucopus</i> | White-footed dunnart | Inland Qld | Vulnerable |
| Reptile | <i>Phyllurus gulbaru</i> | Gulbaru gecko | Wet Tropics | Endangered |
| <i>There is no specific information on the processes threatening these species</i> | | | | |
| Bird | <i>Turnix olivii</i> | Buff-breasted button-quail | Cape York | Endangered |
| Invertebrate | <i>Nacaduba pactolus cela</i> | Bold blue-line butterfly | Cape York | Vulnerable |
| Mammal | <i>Antechinus argentus</i> | Silver-headed antechinus | NE Qld | Vulnerable |
| Mammal | <i>Antechinus arktos</i> | Black-tailed antechinus | SE Qld | Endangered |
| Mammal | <i>Petrogale purpureicollis</i> | Purple-necked rock-wallaby | NW Qld | Vulnerable |
| Reptile | <i>Emoia atrocostata australis</i> | Littoral whip-tail skink | Cape York | Vulnerable |
