

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

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/>).

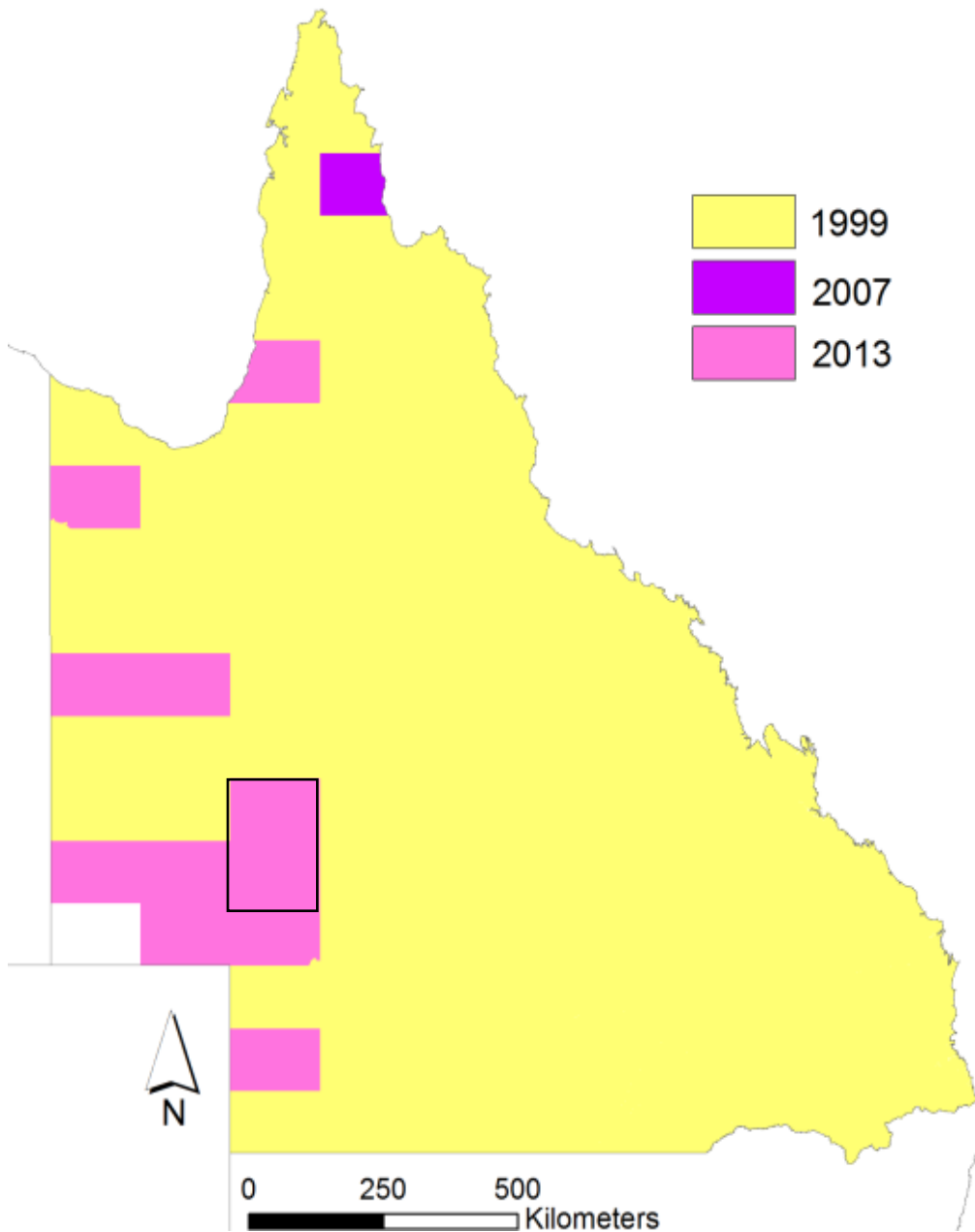


Fig. S1. Regional ecosystem maps used to calculate the change in woody vegetation in Queensland.

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>Calyptrorhynchus lathamii</i>	Glossy black-cockatoo	Brigalow Belt	Vulnerable
Bird	<i>Calyptrorhynchus lathamii erebus</i>	Glossy black-cockatoo (northern)	Brigalow Belt	Vulnerable
Bird	<i>Calyptrorhynchus lathamii lathamii</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 thornntonensis</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

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

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
