

# **Quantifying current and potential contributions of Australian indigenous peoples to threatened species management**

Ian Leiper<sup>1</sup>, Kerstin K. Zander<sup>2</sup>, Cathy J. Robinson<sup>2,3</sup>, Josie Carwadine<sup>3</sup>, Bradley J.

Moggridge<sup>1</sup>, Stephen T. Garnett<sup>1</sup>

1. Research Institute for the Environment and Livelihoods, Charles Darwin University, Darwin, NT 0909, Australia.
2. Northern Institute, Charles Darwin University, Darwin, NT 0909, Australia.
3. CSIRO Land and Water, CSIRO Ecosciences Precinct, 41 Boggo Rd, Dutton Park, QLD 4102, Australia.

## **Corresponding author**

Ian Leiper

Research Institute for the Environment and Livelihoods, Charles Darwin University, Darwin, NT 0909, Australia.

[ian.leiper@cdu.edu.au](mailto:ian.leiper@cdu.edu.au)

## **Running head**

Indigenous peoples and threatened species

## **Keywords**

Indigenous conservation partnerships, land and sea management, cultural species, conservation opportunities, bioregions, indigenous rights

## **Article Impact Statement**

Understanding the roles indigenous people play in threatened species conservation enhances planning and expands investment.

## **Abstract**

Formal engagement of indigenous peoples in conservation is increasing globally and leads to multiple benefits to communities while contributing to national and international biodiversity goals and obligations. This and ongoing declines in biodiversity have led to calls to increase opportunities for indigenous people to engage in managing their estates. However, there is no overarching understanding of indigenous peoples' involvement in conservation, which limits the identification of new opportunities. We amalgamated information across governments and large nongovernmental organizations in the megadiverse country of Australia to quantify the involvement of indigenous people in management of threatened species. We identified 153 Australian-based projects undertaken by different indigenous groups around the nation in 2015 and 2016 that included explicit funds for management of threatened species or threatened ecosystems. Most were in remote parts of western and northern Australia. Almost one-quarter of all threatened animals and 2% of threatened plants were the subject of some formal conservation action by indigenous people. Occurrence records for 1574 threatened species showed that 823 (89.2%) of 923 species recorded on indigenous peoples' lands were not listed in management projects. This gap may represent new opportunities for conservation initiatives. Because at least 59.5% of Australia's threatened species occur on indigenous peoples' lands, efforts to build appropriate and effective indigenous conservation alliances are vital. However, it is also important to recognise that threatened species are part of complex social, ecological, economic and cultural systems, and to achieve successful outcomes requires consideration of indigenous peoples' priorities, rights, and obligations and relationships with their traditionally owned land and sea.

## **Introduction**

Much of the world's biodiversity exists on land managed by indigenous peoples who are increasingly recognized for contributing to the conservation of biodiversity (Alcorn 1993; Gadgil et al. 1993). The importance of traditional and local knowledge is included in several Aichi Targets of the Convention on Biological Diversity (CBD 2010) and growing case-study evidence shows that empowerment of local indigenous communities can positively influence the success of conservation initiatives (e.g. Berkes et al. 2000; Hill et al. 2015).

For many indigenous peoples, being able to fulfil cultural responsibilities to 'country', a term currently used to describe traditionally owned land and sea estates, regardless of current overlying tenure, has benefits for the natural environment and the people involved (e.g. Garnett & Sithole 2007; Green & Minchin, 2012; Robinson et al. 2016a). More recently managing country has delivered monetary benefits. For example, in Australia land and sea management is the fastest growing sector for indigenous employment (Garnett et al. 2016). Similarly, in the United States, economic, employment and training opportunities for indigenous peoples are supported through Tribal Wildlife Grants that provide funding to tribal governments to develop and implement programs for the benefit of wildlife and their habitat, including species of tribal cultural or traditional importance (U.S. Fish & Wildlife Service 2007, 2013). In Canada, since 2004 the Aboriginal Fund for Species at Risk has provided more than \$34.6 million to 895 projects, helping indigenous organizations and communities strengthen capacity, document and conserve traditional knowledge, and participate in conservation management of species and habitat (Environment and Climate Change Canada 2017).

In Australia there is substantial willingness of the wider population to pay for greater involvement of indigenous people in providing environmental services, including biodiversity conservation (Zander & Garnett 2011). The social benefits of indigenous cultural and natural

resource management include improved fire management, now closely linked with lower greenhouse gas emissions (Russell-Smith et al. 2013); weed and feral animal control; improved survival of native species and improved biosecurity. Employment of indigenous people in land management also reduces welfare dependency in indigenous communities (Barber and Jackson 2017) and leads to tangible savings on health costs (Campbell et al. 2011). The willingness of many indigenous peoples worldwide voluntarily to dedicate and manage at least some of their lands as protected areas contributes to global conservation targets (e.g. Godden & Cowell 2016; Jonas et al. 2017; Indigenous Circle of Experts' 2018). Management of the world's most threatened species is integral to land management activities and can provide income for indigenous peoples. Although most research on interactions between indigenous peoples and threatened species has focused on hunting (e.g. Goldman et al. 2010; Jenkins 2015; Shaffer et al. 2017a, b), indigenous people are also involved in monitoring, management, and decision making related to threatened species (e.g. Nursey-Bray 2009; Robinson et al. 2016b; Austin et al. 2017). For example, the Canadian Species at Risk Act requires recovery plans to consider traditional knowledge of indigenous peoples of Canada (Waples et al. 2013), and the Australian national Threatened Species Strategy emphasises the increasing potential for indigenous people to be formally involved in threatened species management (Department of Environment 2015). In Australia 74% of vertebrates listed as threatened under the country's national *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act) have at least part of their range on lands owned or managed by Indigenous Australians (Renwick et al. 2017). However, there is no national-level understanding of the extent to which indigenous peoples contribute to threatened species conservation, which limits appreciation of the extent of indigenous contributions and discovery of conservation opportunities.

To help understand and improve conservation efforts on indigenous lands in general, we analyzed the extent of indigenous involvement in threatened species management in Australia by reviewing a database of conservation projects in Australia to assess the characteristics of indigenous contributions to threatened species conservation. We determined target species, activities undertaken, and the geographic extent of the activity. We then used occurrence records of threatened species across Australia to identify gaps in management and opportunities where indigenous people could play a key role in threatened species conservation.

## **Methods**

### *Threatened species management projects*

Data on indigenous involvement in Australian threatened species management projects were assembled from 3 sources: the Monitoring, Evaluation, Reporting and Improvement Tool (MERIT); summaries of Indigenous Protected Areas; and lists of activities of nongovernmental conservation organizations involving indigenous people (the term species is taken to include threatened subspecies). For each project, we summarised information on the threatened species or ecosystem (described as threatened ecological community in Australian legislation) targeted for management in 2015 and 2016 and on management activities and their locations.

Reporting on all projects funded by the Australian Government Department for the Environment and Energy are aggregated in MERIT. We examined the database, particularly project descriptions and whether projects involved indigenous people. Database information was sometimes augmented with information from project practitioners (approved by the Charles Darwin University Human Research Ethics Committee [H13056]) or the internet.

Each Indigenous Protected Area (an area under indigenous tenure voluntarily contributing to the national protected area estate) has a summary of the values it protects and activities being undertaken to sustain those values by the indigenous traditional owners. We examined each summary for mention of threatened species and the actions being undertaken to retain them, and searched online for additional relevant information (e.g. from planning documents).

Many nongovernmental organisations (NGOs) are involved in land and sea management on lands they have acquired for conservation or through supporting groups undertaking conservation on lands of other tenure types or at sea. A list of NGO activities involving indigenous people was obtained from BirdLife Australia, the Australian Wildlife Conservancy, Bush Heritage Australia, and The Nature Conservancy.

The list of species and ecosystems mentioned in descriptions of these projects as being the subject of conservation action by indigenous peoples were compared with those listed as threatened under the EPBC Act and occurring on lands over which indigenous people had management responsibility historically.

#### *Categorization of project actions*

Actions undertaken by indigenous people on threatened species were also identified in descriptions of the projects. We reviewed these to derive categories for characterization. Each project was then ascribed to one or more of the following nine categories. Monitoring and surveying included a range of activities related to recording trends in the number of threatened animals or plants or the condition of habitat and involvement in surveys to get baseline information or to locate previously unknown populations. Weed control included physical and chemical control of invasive plant species where these were being controlled to improve the outlook for threatened species or ecosystems. Fire management included prescribed burning and fire fighting. Feral animal control included removal of all forms of feral animals that could affect threatened species or ecosystems. Habitat protection and

restoration included fencing of habitat remnants, development of nurseries of native plants for restoration of degraded habitats and protection of waterways and rock holes. Coastal management encompassed the removal of ghost nets and other debris from beaches and patrolling to ensure coastal species are not unduly disturbed by beach use. Cultural mapping and site management included documentation of culturally important sites or the protection of such sites from other threats. Such activities were listed by indigenous people as having benefits for threatened species and ecosystems on the basis that the strength of a cultural connection to an area necessarily has benefits for all species inhabiting that area. Education included active outreach to visitors and local students and raising awareness of indigenous values for threatened species through signage and publications. Education of young indigenous people is a part of nearly all projects but was not included here because it is not a service provided directly to help conserve threatened species or ecosystems.

#### *Geographical location of projects*

Each project was allocated to one or more interim biological regionalisation area (IBRA) (Department of the Environment and Energy 2012; Thackway & Cresswell 1995), which were developed to characterise 89 geographically distinct Australian landscapes based on commonalities in climate, geology, landform, native vegetation, and biodiversity. These were classified as belonging either to the intensive economic zone, where much land has been cleared for agriculture and where levels of indigenous land ownership are low, and the extensive economic zone, where much land still remains under indigenous control and the extent of conversion of land from native vegetation is low (Morgan 2001).

#### *Geographical location of threatened species*

The list of species that have been the subject of management projects involving indigenous peoples was compared with species listed as threatened under the EPBC Act and species on the list were categorized as mammals, birds, reptiles, frogs, fish, invertebrates, and plants.

Not all species listed as the subject of indigenous action were listed as threatened under the EPBC Act.

Occurrence records of threatened species were sourced from the Mammal Action Plan distributional data, BirdLife Australia, and the Atlas of Living Australia for mammals, birds, and all other animals and plants respectively (ALA 2017). Records were filtered according to year ( $\geq 1990$  for mammals for which there have been many recent rapid declines;  $\geq 1970$  for all other taxa) and positional accuracy ( $\leq 10\,000$  m where stated) before species presence was generalised to a 10-km<sup>2</sup> grid resolution. We used IBRA regions and the map of indigenous land across Australia described in Renwick et al. (2017) to determine the geographic extent of threatened species on lands where indigenous peoples have land management rights. Data processing and spatial analyses were carried out in R (version 3.3.3), QGIS (version 2.14.3) and ArcGIS (version 10.4.1).

Gaps in threatened species management and opportunities for partnerships involving indigenous peoples were identified by determining which threatened species had occurrence records on indigenous lands yet were not listed in any of the projects.

## **Results**

In 2015 and 2016, indigenous people were formally involved in at least 153 of the projects around Australia that receive funding from the Commonwealth, state governments, or large conservation NGOs. Of these, 123 addressed management of threatened species but not ecosystems, 13 involved threatened ecosystems but not species, and 17 involved both.

Projects occurred throughout the country (Fig. 1a) in the extensive and intensive economic zones, and most were in regions adjacent to the northern coastline.

Activities associated with 23 (15%) of the projects were related only to management of threatened species or ecosystems. The rest included broader land management activities, and

many explicitly mentioned social and economic benefits derived from the projects, such as employment; opportunities to establish related commercial enterprises; maintaining cultural links to country, strengthening leadership; building relationships; passing on indigenous knowledge; and improving health, well-being, confidence, and self-esteem.

#### *Threatened species listed in projects*

Indigenous people were involved in management of 128 species listed as threatened under Australia's EPBC Act (Table 1). This represents almost one-quarter of all listed animals, including approximately one-third of both mammals and birds and one-fifth of both frogs and reptiles but with much smaller proportions of fishes, invertebrates, and plants. The projects also mentioned they promoted the conservation of 19 mammals, ten birds, six reptiles, four frogs, one fish, and 24 plants not listed by the EPBC Act because they had not been assessed for listing, even though it may have been warranted, or because they had local cultural significance and were locally uncommon.

Project actions most frequently being undertaken for both animals and plants were monitoring and surveys (Table 2). For animals the next most important actions were weed control, fire management, and feral animal control, and habitat protection, restoration, and weed control were particularly important for plants.

#### *Threatened ecosystems listed in projects*

Thirty of the 153 projects (20%) aimed to improve the condition of 27 of the 77 threatened ecosystems listed under the EPBC Act, most of which threatened ecosystems had only one project devoted to their protection, but two each ("Grey Box (*Eucalyptus microcarpa*) Grassy Woodlands and Derived Native Grasslands of South-eastern Australia" and "White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland") had five separate projects and "Alpine Sphagnum Bogs and Associated Fens" and "Monsoon vine thickets on the coastal sand dunes of Dampier Peninsula" had four each. The most frequent

management action undertaken was weed control followed by habitat protection and restoration (Table 2).

### *Geographical location*

After filtering by year and coordinate precision, 579,580 occurrence records for 1574 EBPC listed species (103 birds, 47 fish, 29 frogs, 106 mammals, 55 invertebrates, 49 reptiles, and 1185 plants) were used to identify threatened species that have been recorded on indigenous lands (Fig. 1b). The number of species observed on indigenous lands per IBRA region ranged from 0 to 197 (median = 19); the highest values predominated in coastal regions of eastern Australia (Fig. 1c). Eleven IBRA regions had no occurrence records and only 1 of these had indigenous land (Warren, 0.4 km<sup>2</sup>). In 54 IBRA regions, over one-half of all species found in a region were observed on indigenous lands, including 16 IBRA regions where 100% of species had occurrence records on indigenous lands (Fig. 1d).

Occurrence records of 923 (58.6%) species were from indigenous lands, and 100 species (6.4%) were the subject of threatened species management projects. The number of species listed in projects ranged from 0 to 20 (median = 2) per IBRA region. The two IBRA regions with the most species listed in projects also had the most projects. Wet Tropics and Cape York Peninsula had 20 and 17 species listed in projects respectively and 13 and 12 projects in each region respectively. Regions with the highest percentage of species targeted were in central and western Australia (Fig. 1e). Four IBRA regions had at least 50% of species that occurred on indigenous lands listed in projects, including Yalgoo, where only 1% of the region is indigenous lands. Eighteen (1.1%) species were listed in project descriptions, although the data set we used held no occurrence records for these species on indigenous lands and 633 (40.2%) species had neither occurrence records on indigenous lands nor were listed in any projects. A synopsis of which species existed on indigenous lands and which species were noted in projects, per IBRA region, is in Supporting Information.

The number of species per IBRA region observed on indigenous lands but not listed in projects ranged from 0 to 192 (median = 17) (Fig. 1f). Of the 78 IBRA regions where EBPC listed species occurred on indigenous lands, 27 had no species listed in any project and a further 20 had <10% of the species that occur on indigenous lands listed in projects. All regions in eastern mainland Australia had <25% of species that occur on indigenous lands listed in projects, including 15 regions where none of the species were listed.

## **Discussion**

Opportunities exist for indigenous peoples to increase their important and already significant contribution to biodiversity conservation across the world (Sobrevila 2008). We found that Australian indigenous lands harbored almost 60% of the 1574 threatened species and contained a high percentage of the taxonomic diversity within most IBRA regions. Gaps and opportunities for management projects are greatest in eastern Australia, where the highest numbers of threatened species occurred on indigenous lands yet very few of these species were the subject of conservation action. For example, Sydney Basin had the highest number of species recorded on indigenous lands (197), accounting for 77.6% of Sydney Basin's threatened species despite indigenous lands covering only 28% of the region (Figure 1). Four projects in this region listed just one plant, the Prickly Bush-pea (*Pultenaea parviflora*), five ecosystems, and seven migratory shorebirds. Even in central and western Australian IBRA regions, where a much higher percentage of species that occurred on indigenous lands were listed in projects, there remain many opportunities for indigenous participation in biodiversity conservation. The Little Sandy Desert had the highest percentage of species on indigenous lands listed in projects (60%). Because indigenous lands cover 92% of the region, engagement of indigenous peoples in the stewardship of threatened species is imperative for continued management of species listed in current projects and potentially to conserve the remaining 40% of listed species.

Engagement of indigenous peoples in threatened species management brings both challenges and opportunities. Significant gaps remain in scientific and indigenous knowledge of many threatened species, and there can be ambiguity around best approaches to managing threats to these species and their habitats. Garnett and Woinarski (2007) argue that threatened species are not often part of indigenous traditional land management systems and activities because these species are very rare, may not have any practical function or spiritual significance to traditional owners, or strategies required to achieve threat reduction (e.g. elimination of feral animals) may not be part of or align with traditional and local knowledge systems or skills. Many indigenous people may wish to continue to use threatened species and their habitats to sustain their livelihoods and exercise their human and indigenous rights to make decisions on how these areas are managed (cf. Robinson et al. 2016c). In some places, this has led to conflicts between biodiversity conservation and the needs and demands of local and indigenous communities (Joppa et al. 2008).

Some indigenous peoples argue that species, including threatened species, have owners, as opposed to being common property, and this ownership is governed by indigenous laws (e.g. Robinson 2016). These laws determine who has the right to do what, including rights to and establishment of protocols for hunting and harvesting and rights to exclude access to territory. Laws also frame the ways in which the rights and responsibilities of indigenous peoples are conceived and embedded in an identifiable group collective (e.g. Harvey 1988; Agrawal 2002). Conservation of threatened species is therefore often highlighted as demonstrating the inequalities that have emerged from colonialism and has, on indigenous territory, become central to attempts to consider opportunities for indigenous social and ecological justice (Walker et al. 2013). Efforts to reconcile conservation with indigenous rights often focus on improving the state and fate of culturally important species and their cultural-ecological systems by allowing traditional owners to access conservation areas and be empowered to

contribute to conservation decisions. Threatened species therefore need to be considered as part of a complex social, ecological, economic, and cultural system, the care of which is central to indigenous environmental knowledge and governance (Robinson & Mununggurij 2001; Hill et al. 2010). Emerging international agreements and local partnerships offer innovative approaches to wildlife use and environmental management based on genuine partnerships founded on respect for cultural differences (Austin et al. 2017; Tengo et al. 2017).

There is likely some overlap between species and ecosystems that have cultural relevance to indigenous peoples and those considered threatened under Australian law, but there is no more reason to assume all threatened species are of interest to indigenous people than there is for any other sector of society (Garnett & Woinarski 2007). It cannot be assumed that indigenous people will be willing to provide a service, even if funds are available, if delivering that service is not consistent with their other cultural priorities (Zander et al. 2013). That there is an abiding interest in maintaining the natural environment in a manner consistent with biodiversity conservation is attested to by the large area of land (68 million ha) and proportion of the land owned by indigenous people (40%) that has been contributed voluntarily to the national protected-area estate under an agreement with the Commonwealth. The area and proportion of other forms of private land in Australia owned by nonindigenous people that has been dedicated to conservation is far smaller (9 million ha or 2% of private land [Fitzsimons 2015]).

Our results reinforce the view that indigenous peoples have interests consistent with biodiversity conservation; almost one-quarter of all threatened animal species are the subject of indigenous conservation action, including approximately one-third of both mammals and birds. There is no comparable list of species subject to action by nonindigenous people apart from birds, for which 66% of the same list of species is currently the subject of at least some

conservation action in Australia (S. Garnett, personal observation). Far fewer threatened plants are currently the subject of direct indigenous conservation action primarily because many listed plants are threatened because tiny populations persist in highly developed landscapes in southern and eastern Australia. In contrast, threatened animals are generally extinct in such settings and now persist primarily on lands subject to indigenous management (Renwick et al. 2017), as reflected by the geographic extent of projects with indigenous involvement. Over one-third of all EPBC-listed threatened ecosystems are the subject of management projects involving indigenous peoples and provide protection for animals and plants at a habitat or landscape level.

Monitoring and survey work was the principal activity described for most projects but fire, weed, and feral-animal management were collectively the subject of 122 projects (79%). Such land management activities are likely to have benefits at a landscape scale as well as for the target threatened species. Indeed, the threatened species will often benefit from activities aimed at generating wider benefits.

The drivers of the conservation action described here are likely to vary. For some indigenous groups, conservation actions will be undertaken to fulfil contracts without there necessarily being an innate desire to effect conservation. For others there will be a strong desire among the indigenous people involved to retain the species for its own sake. Finally, a threatened species will have deep cultural significance for an indigenous group, and they will work to conserve it. Although we were unable to test the nature of the relationship between indigenous people and the species on which they were working, some species stand out. For instance, there were 31 projects across northern Australia (20% of all projects) aimed at conserving one or more marine turtle species, which are both hunted for food and cultural reasons but which are also totems in many indigenous societies in Australia (Robinson 2016).

One of our most striking findings was that work on threatened species and ecosystems is being undertaken by indigenous peoples across the country. Most projects were in northern Australia, particularly in coastal areas, where indigenous people have retained their strongest legal ties to country and where the greatest proportion of indigenous people still live on lands to which they retain cultural ties. However, there were also many projects in the intensive economic zone, where the opportunities for ongoing indigenous connection to country has been severely compromised by two centuries of legal and environmental alienation. This included many projects in and around urban areas, such as Sydney and Melbourne, and in Tasmania, where it was long maintained that the Aboriginal population was “extinct” (Crowley 1993).

Our results represent a conservative estimate of the number of species on indigenous lands and of the role indigenous peoples do and could play in biodiversity conservation. There were not filtered occurrence records for all extant EPBC-listed species, and the records did not always cover the known range of species, some of which occur on indigenous lands.

Threatened species associated with the threatened ecosystems listed in projects were seldom reported and could therefore not be included when assessing involvement of indigenous peoples in conservation action. For example, 102 threatened species occurred on indigenous lands in the Victoria Midlands, yet none were listed in either of the region’s two projects; six threatened ecosystems were listed.

Indigenous peoples in Australia are deeply involved in the conservation of threatened species and ecosystems, often in areas to which their connection has been severely challenged by two centuries of colonisation. Gaps in species management and opportunities for further involvement of indigenous people in biodiversity conservation exist in Australia for threatened species that occur on indigenous lands that are not currently listed in projects and for threatened species that are listed in current projects but only for a limited part of their

range. Opportunities also abound through the prevention of species and ecosystems becoming a conservation concern in the first place. In 2014 Canada acknowledged this, by creating the Aboriginal Fund for Species at Risk Prevention Stream that focuses on species beyond those listed on Schedule 1 of the Species at Risk Act, (Environment and Climate Change Canada 2017). The extent to which indigenous people become involved in threatened species conservation depends partly on available funding and partly on the priority given to other activities being conducted by managers and traditional owners. However, highlighting the opportunities for threatened species conservation in indigenous territories of particular bioregions may help ensure that the needs of threatened species in those areas are at least considered in indigenous land and sea management planning and by those funding such plans. Indigenous peoples have been active in this dialogue, as they seek ways for indigenous rights, traditional knowledge, and local livelihoods to be supported through conservation activities and partnerships (Daniel et al. 2012; Hill et al. 2012; Rao et al. 2016). By demonstrating the level of indigenous involvement in threatened species management in Australia, it suggests that those funding conservation of threatened species should consider not only indigenous knowledge of those species, as is increasingly mandated under Australian and Canadian laws (EPBC Act 1999, Species at Risk Act 2002) , but the active engagement and remuneration of indigenous peoples in threatened species management.

### **Acknowledgments**

We are grateful to J. Woinarski and D. Milne who kindly provided mammal distribution data, G. Ehmke who provided BirdLife Australia data, N. dos Remedios and M. Nicholls at the Atlas of Living Australia who helped extract data on other taxa, and state and territory authorities who provided permission to use sensitive data. J. Radford of Bush Heritage Australia, J. Fitzsimons from The Nature Conservancy, J. O'Connor from BirdLife Australia, and J. Kanowski from the Australian Nature Conservancy kindly provided detail on recent

projects led by their organisations in which indigenous people have been involved. This research has been supported by the National Environment Science Program Threatened Species Hub.

### **Supporting Information**

A synopsis of which species exist on indigenous lands and which species were noted in projects per IBRA region (Appendix S1) is available online. The authors are solely responsible for the content and functionality of these materials. Queries (other than absence of the material) should be directed to the corresponding author.

### **Literature Cited**

- ALA 2017. Atlas of Living Australia. Australian Government, Canberra. Available from <http://www.ala.org.au> (accessed June 2017).
- Alcorn JB. 1993. Indigenous peoples and conservation. *Conservation Biology* **7**:424–426.
- Agrawal A. 2002. Indigenous knowledge and the politics of classification. *International Social Science Journal* **54**:277–281.
- Austin BJ, Vigilante T, Cowell S, Dutton IM, Djanghara D, Mangolomara S, Puermora B, Bundamurra A, Clement Z. 2017. The Unguu monitoring and evaluation committee: intercultural governance of a land and sea management programme in the Kimberley, Australia. *Ecological Management and Restoration* **18**: 124–133.
- Barber, M., and S. Jackson. 2017. Identifying and categorizing cobenefits in state-supported Australian indigenous environmental management programs: international research implications. *Ecology and Society* **22** DOI: 10.5751/ES-09114-220211.
- Berkes F, Colding J, Folke C. 2000. Rediscovery of traditional ecological knowledge as adaptive management. *Ecological Applications* **10**:1251–1262.

- Campbell D, Burgess CP, Garnett ST, Wakeman J. 2011. Potential primary health care savings for chronic disease care associated with Australian Aboriginal involvement in land management. *Health Policy* **99**:83–89.
- Crowley T. 1993. Tasmanian Aboriginal Language: Old and New Identities. Pages 51–72 in Walsh M, Yallop C, editors. *Language and Culture in Aboriginal Australia*. Aboriginal Studies Press, Canberra.
- Daniel TC, et al. 2012. Contributions of cultural services to the ecosystem services agenda. *Proceedings of the National Academy of Sciences of the United States of America* **109**:8812–8819.
- Department of the Environment. 2015. *Threatened Species Strategy*. Commonwealth of Australia, Canberra.  
<http://www.environment.gov.au/biodiversity/threatened/publications/strategy-home> (accessed June 2017)
- Department of the Environment and Energy. 2012. *Interim Biogeographic Regionalisation for Australia (Regions - States and Territories) v. 7 (IBRA) [ESRI shapefile]*. Department of the Environment and Energy, city. Available from <http://intspat01.ris.environment.gov.au/fed/catalog/search/resource/details.page?uuid=%7BFB89EEC9-5ABE-4CCD-B50E-7D485A3BAA4C%7D> (accessed June 2017)
- Environment and Climate Change Canada. 2017. *Species at risk act annual report for 2016*. Gatineau, Quebec: Environment and Climate Change Canada.
- Fitzsimons JA. 2015. Private protected areas in Australia: current status and future directions. *Nature Conservation* **10**:1–23
- Gadgil M, Berkes F, Folke C. 1993. Indigenous knowledge for biodiversity conservation. *Ambio* **22**:151–156.

- Garnett ST, Austin BJ, Zander KK. 2016. Culture-based enterprise opportunities for indigenous people in the Northern Territory, Australia. Pages 111–132 in Iankova K, Hassan A, L'Abbé R, editors. Indigenous people and economic development. An international perspective. Gower, Farnham.
- Garnett ST, Sithole B. 2007. Sustainable Northern Landscapes and the Nexus with indigenous Health: Healthy Country Healthy People. Land and Water Australia, Canberra.
- Garnett ST, Woinarski, JCZ. 2007. A case for indigenous threatened species management. Pages 38–44 in Luckert MK, Campbell BM, Gorman JT, Garnett ST, editors. Investing in indigenous Natural Resource Management. Charles Darwin University Press, Darwin.
- Godden L, Cowell S. 2016. Conservation planning and indigenous governance in Australia's Indigenous Protected Areas. *Restoration Ecology* **24**:692–697.
- Goldman MJ, De Pinho JR, Perry J. 2010. Maintaining complex relations with large cats: Maasai and lions in Kenya and Tanzania. *Human Dimensions of Wildlife* **15**, 332
- Green D, Minchin L. 2012. The co-benefits of carbon management on country. *Nature Climate Change* **2**:641–643.
- Harvey M. 1988. The Dreaming. Pages xi–xii in Bradley J, editor. Yanyuwa country: the Yanyuwa people of Borroloola tell the history of their land. Greenhouse Publications, Richmond.
- Hill R, Williams KJ, Pert PL, Robinson CJ, Dale AP, Westcott DA, Grace RA, O'Malley T. 2010. Adaptive community-based biodiversity conservation in Australia's tropical rainforests. *Environmental Conservation* **37**:73–82.
- Hill R, Grant C, George M, Robinson C, Jackson S, Abel N. 2012. A typology of indigenous engagement in Australian environmental management: implications for knowledge integration and social-ecological system sustainability. *Ecology and Society* **17** DOI:

- Hill R, Davies J, Bohnet I, Robinson CJ, Maclean K, Pert PL. 2015 . Collaboration mobilises institutions with scale-dependent comparative advantage in landscape-scale biodiversity conservation. *Environmental Science & Policy* **51**:267–277.
- Indigenous Circle of Experts'. 2018. We Rise Together. Achieving Pathway to Canada Target 1 through the creation of Indigenous Protected and Conserved Areas in the spirit and practice of reconciliation. Available from <http://www.conservation2020canada.ca/resources/> (accessed April 2018)
- Jenkins D. 2015. Impacts of neoliberal policies on non-market fishing economies on the Yukon River, Alaska. *Marine Policy* **61**:356-365.
- Jonas HD, Lee E, Jonas HC, Matallana-Tobon C, Sander Wright K, Nelson F, Enns E. 2017. Will 'other effective area-based conservation measures' increase recognition and support for ICCAs? *Parks* **23.2**:63-78. DOI: 10.2305/IUCN.CH.2017.PARKS-23-2HDJ.en
- Joppa LN, Loarie SR, Primm SL. 2008. On the protection of "protected areas". *Proceedings of the National Academy of Sciences of the United States of America* **105**:6673–6678.
- Morgan G. 2001. Landscape health in Australia: a rapid assessment of the relative condition of the bioregions and subregions of Australia. Environment Australia and National Land and Water Resources Audit, Canberra.
- Nurse-Bray M. 2009. A Guugu Yimmathir Bam Wii: Ngawiya and Girrbithi: Hunting, planning and management along the Great Barrier Reef, Australia. *Geoforum* **40**:442–453.
- Rao M, Nagendra H, Shahabuddin G, Carrasco LR. 2016. Integrating community-managed areas into protected area systems. Pages 169–189 in Joppa LN, Baillie JEM, Robinson JG, editors. *Protected areas: are they safeguarding biodiversity?* John Wiley & Sons, Chichester.

- Renwick AR, Robinson CJ, Garnett ST, Leiper I, Possingham HP, Carwardine J. 2017. Mapping indigenous land management for threatened species conservation: an Australian case-study. *PLoS ONE* **12** (e0173876) DOI: .
- Robinson CJ, Munungguritj N. 2001. Sustainable balance: A Yolngu framework for cross-cultural collaborative management. Pages 92–107 in Baker R, Davies J, Young E, editors. *Working on Country: indigenous environmental management in Australia*. Oxford University Press, Melbourne.
- Robinson CJ. 2016. Hunting for Country and Culture: the challenges surrounding Indigenous collaborative partnerships on the coast of Northern Australia. Pages 355–370 in Margerum RD, Robinson CJ, editors. *The Challenges of Collaboration in Environmental Governance. Barriers and Responses*. Edward Elgar Publishing, Cheltenham.
- Robinson CJ, Renwick AR, May T, Gerrard E, Foley R, Battaglia M, Possingham H, Griggs D, Walker D. 2016a. Indigenous benefits and carbon offset schemes: an Australian case study. *Environmental Science & Policy* **56**:129–134.
- Robinson CJ, Maclean K, Hill R, Bock E, Rist P. 2016b. Participatory mapping to negotiate indigenous knowledge used to assess environmental risk. *Sustainability Science* **11**:115–126.
- Robinson, CJ, James, G, Whitehead PJ. 2016c. Negotiating indigenous benefits from payment from ecosystem (PES) schemes, *Global Environmental Change* **28**, 21-29.
- Russell-Smith J, Cook GD, Cooke PM, Edwards AC, Lendrum M, Meyer C, Whitehead PJ. 2013. Managing fire regimes in north Australian savannas: applying Aboriginal approaches to contemporary global problems. *Frontiers in Ecology and the Environment* **11**:e55–e63.

- Shaffer CA, Milstein MS, Yukuma C, Marawanaru E, Suse P. 2017a. Sustainability and comanagement of subsistence hunting in an indigenous reserve in Guyana. *Conservation Biology* **31**: 1119-1131.
- Shaffer CA, Yukuma C, Marawanaru E, Suse P. 2017b. Assessing the sustainability of Waiwai subsistence hunting in Guyana by comparison of static indices and spatially explicit, biodemographic models. *Animal Conservation* DOI: 10.1111/acv.12366.
- Sobrevila C. 2008. The Role of indigenous peoples in Biodiversity Conservation: The Natural but Often Forgotten Partners. The International Bank for Reconstruction and Development / The World Bank, Washington, D.C.
- Tengö M, Hill R, Malmer P, Raymond CM, Spierenburg M, Danielsen F, Elmquist T, Folke C. 2017. Weaving knowledge systems in IPBES, CBD and beyond—lessons learned for sustainability. *Current Opinion in Environmental Sustainability* **26–27**:17–25.
- Thackway R, Cresswell ID, editors. 1995. An Interim Biogeographic Regionalisation for Australia: a framework for establishing the national system of reserves, Version 4.0. Australian Nature Conservation Agency, Canberra.
- U.S. Fish & Wildlife Service. 2007. Tribal Wildlife Grant and Tribal Landowner Incentive Program Periodic Report, 2006. US Fish and Wildlife Service, Washington, DC.
- U.S. Fish & Wildlife Service. 2013. Summary of Projects Supported by the U.S. Fish and Wildlife Service. Tribal Wildlife Grants Program (2007 – 2012). US Fish and Wildlife Service, Washington, DC.
- Walker R, Jojola T, Natcher D. 2013. Reclaiming indigenous Planning. McGill-Queen's University Press, Montreal.
- Waples RS, Nammack M, Cochrane JF, Hutchings JA. 2013. A Tale of Two Acts: Endangered Species Listing Practices in Canada and the United States. *BioScience* **63(9)**:723–734

Zander KK, Garnett ST. 2011. The economic value of environmental services on indigenous-held lands in Australia. PLoS ONE **6**: e23154.

Zander KK, Dunnett DR, Brown C, Campion O, Garnett ST. 2013. Rewards for providing environmental services - where indigenous Australians' and western perspectives collide. Ecological Economics **87**:145–154.



Table 1. The number of invertebrates, plants, and vertebrate species listed as threatened under Australian law that are currently the subject of formal conservation by indigenous peoples and the percentage this number represents of the total number of species listed in that taxonomic group.

EPBC* status	Invert							Plants
	Birds	Fish es	Frog s	Mammal s	Invertebrate s	Reptile s	Total animals	
Critically Endangered	9 (56)	1 (13)	0 (0)	1 (20)	0 (0)	0 (0)	11 (15)	3 (2)
Endangered	15 (31)	2 (13)	2 (14)	13 (35)	2 (9)	4 (22)	38 (24)	11 (2)
Vulnerable	17 (25)	2 (8)	4 (40)	25 (38)	2 (18)	7 (21)	57 (27)	8 (1)
Total	41 (31)	5 (10)	6 (21)	39 (36)	4 (7)	11 (18)	106 (24)	22 (2)
No. listed species	132	48	29	108	60	61	438	1271

\*Environment Protection and Biodiversity Conservation Act 1999

Table 2. Number of projects that entail particular types of actions of indigenous people to conserve listed threatened species and ecosystems in Australia.\*

Action	Animals (%)	Plants (%)	Ecosystems (%)	Total (%)
Monitoring & survey	92 (60)	13 (8)	5 (3)	98 (64)
Weed control	58 (38)	10 (6)	17 (11)	67 (44)
Fire management	62 (40)	4 (3)	5 (3)	65 (42)
Feral animal control	48 (31)	4 (3)	6 (4)	53 (34)
Cultural mapping & site management	43 (28)	5 (3)	4 (3)	46 (30)
Habitat protection and restoration	33 (21)	10 (6)	12 (8)	43 (28)
Coastal management	23 (15)	0 (0)	3 (2)	25 (16)
Education	15 (10)	1 (1)	4 (3)	17 (11)

---

\*Percentage is out of 153 total projects

Figure 1. (a) Distribution of projects undertaken by indigenous people with the object of conserving threatened species or ecosystems, (b) occurrence records filtered by year ( $\geq 1990$  for mammals for which there have been many recent rapid declines;  $\geq 1970$  for all other taxa) and positional accuracy ( $\leq 10\ 000$  m where stated) of *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act) listed species generalised to a 10-km<sup>2</sup> grid resolution, (c) number of EPBC-listed species in each interim biological regionalisation area (IBRA) region with occurrence records on indigenous land, (d) percentage of species in each IBRA region with occurrence records on indigenous land; (e) percentage of species in each IBRA region that occur on indigenous lands and are listed in projects, and (f) number of EPBC-listed species in each IBRA region with occurrence records on indigenous lands but not listed in projects.

