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ORIGINAL PAPER

Putting indigenous conservation policy into practice delivers biodiversity and cultural benefits

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Abstract In the midst of global species loss, Indigenous languages and culture are experiencing similar declines. Current international policies and programs advocate the involvement of local and Indigenous people in sustaining biodiversity and culture, but the anticipated benefits are not always realized or assessed. This paper draws on three objectives of current international and Australian policy to explore the biological and cultural benefits of a collaborative cross-cultural biodiversity project of Indigenous rangers and university ecologists in remote northern Australia. Policies promoting blends of biological and cultural conservation from International to national scale share the following objectives: (1) involve Indigenous Peoples in biodiversity conservation; (2) maintain and develop Indigenous knowledge and culture; and (3) recognize and promote Indigenous natural and cultural resource management and traditional knowledge. This paper reflects on the project benefits in the context of these objectives, with the aim of informing future policy and program development. Biodiversity benefits of the cross-cultural project included new public records for a relatively poorly known but species rich area that are being used to inform local Indigenous land management, as well as specimens and tissue samples with which to explore the genetic diversity and evolutionary history of the region. Cultural benefits included compiling a local field guide that contains ten different languages and engaging young people to facilitate intergenerational transfer of threatened traditional knowledge. Promotion of the work at local to national fora addressed the third objective and enhanced Indigenous involvement. We demonstrate that top-down policy

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directives can be implemented to deliver on-ground mutual benefits for science and Indigenous communities.

Keywords Indigenous biocultural knowledge (IBK) · Natural and cultural resource management (NCRM) · Traditional languages · Cross-cultural environmental management · Traditional ecological knowledge

Introduction

Global biodiversity is under threat from unprecedented levels of human-accelerated species loss (Ceballos et al. 2015). Similarly, linguistic and cultural diversity, which often correlate with biological diversity (Gorenflo et al. 2012; Turvey and Pettorelli 2014) are experiencing drastic declines (Maffi 2005), particularly in the tropics, Himalayas and northwestern North America (Amano et al. 2014). In response to these trends, holistic and inclusive on-ground approaches to concurrent biological and cultural (biocultural) conservation are advocated (Davidson-Hunt et al. 2012; Gavin et al. 2015).

Directives to include Indigenous and local communities in contemporary environmental conservation efforts have increasingly featured in International and national policy and programs (Borrini-Feyerabend et al. 2004; Ens et al. 2015), (Table 1). As a result, collaborative projects between non-Indigenous people (e.g. from governments, academia and non-government organisations) and Indigenous and local communities (sometimes known as cross-cultural or two-way projects) have also increased (Stephenson and Moller 2009; Ens et al. 2012; Hill et al. 2015). For example: in the Amazon, members of the Matses tribe have worked with ecologists to produce an Indigenous medicine encyclopedia (Acate Amazon Conservation 2015); tribes of northeast India are working with stakeholders to conserve traditional knowledge and biocultural resources (Singh et al. 2010); and the Maori of New Zealand are working with university ecologists to protect culturally and ecologically important sea birds (Moller 2009). Many cross-cultural collaborative conservation projects are delivering real and measurable benefits, but are not without substantial challenges, including time constraints, knowledge integration issues and power tensions (Ens et al. 2012; Muller 2012; Bohensky et al. 2013). These are well-documented challenges that often inhibit delivery of local benefits (Hill et al. 2013).

Ideally, as asserted in the UN Declaration of the Rights of Indigenous Peoples (Anaya & Wiessner Anaya and Wiessner 2007), cross-cultural projects should involve Indigenous people as active partners in planning, decision-making and governance (Hill et al. 2012). This paper describes some of the outcomes of a local on-ground Australian project that drew on national and international policy directives and strived to serve as a "best practice" example of co-designed, collaborative cross-cultural biodiversity research. The project aimed to deliver national biodiversity benefits, inform local natural and cultural resource management (NCRM), support Indigenous language maintenance, promote the value of Indigenous biodiversity knowledge, and provide local community socio-economic benefits. In this paper, we first provide a background on Indigenous NCRM in Australia and introduce the collaborative project between the Indigenous Yugul Mangi Rangers, university scientists and the Atlas of Living Australia (a national biodiversity data aggregator and information technology platform). Then, in order to appraise the project against current policy, we identify project outcomes that relate to three general policy

Table 1 Select international and Australian policies promoting involvement of Indigenous people in the management of biodiversity and cultural heritage, highlighting content which advocates indigenous biocultural conservation

	Directive	Year	Targets advocating Indigenous biocultural conservation	Key objectives[a]
International	Convention on biological diversity	2011–2020	AICHI biodiversity targets[b] include	
			Target 14 By 2020, ecosystems that provide essential services, including services related to water, and contribute to health, livelihoods and well-being, are restored and safeguarded, taking into account the needs of women, Indigenous and local communities, and the poor and vulnerable	1
			Target 18 By 2020, the traditional knowledge, innovations and practices of Indigenous and local communities relevant for the conservation and sustainable use of biodiversity, and their customary use of biological resources, are respected, subject to national legislation and relevant international obligations, and fully integrated and reflected in the implementation of the convention with the full and effective participation of Indigenous and local communities, at all relevant levels	1, 2
	Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES)	2012	Operating principles include	
			2*(d):* Recognise and respect the contribution of Indigenous and local knowledge to the conservation and sustainable use of biodiversity and ecosystems	1, 2, 3
	UN Declaration of the Rights of Indigenous People (DRIP)	2006	Articles include *Article 13 (1)* Indigenous peoples have the right to revitalize, use, develop and transmit to future generations their histories, languages, oral traditions, philosophies, writing systems and literatures, and to designate and retain their own names for communities, places and persons	2, 3
			Article 29 (1) Indigenous peoples have the right to the conservation and protection of the environment and the productive capacity of their lands or territories and resources	1

Table 1 continued

	Directive	Year	Targets advocating Indigenous biocultural conservation	Key objectives[a]
Australian	Environmental Protection and Biodiversity Conservation Act	1999	Objectives include	1, 3
			To promote a co-operative approach to the protection and management of the environment involving governments, the community, landholders and Indigenous peoples	1, 3 2
			To recognise the role of Indigenous peoples in the conservation and ecologically sustainable use of Australia's biodiversity; and	
			To promote the use of Indigenous peoples' traditional knowledge of biodiversity with the involvement of and in co-operation with, the owners of the knowledge	
	Caring for Country	2008	*Working on Country*: Builds on Indigenous traditional knowledge to protect and manage land and sea country	1, 2, 3
			Indigenous Protected Areas (IPAs): promoting biodiversity and cultural resource conservation	1, 2, 3
	Indigenous Advancement Scheme (IAS)	2014	Programs include	
			Jobs, land and economy: getting adults into work, fostering Indigenous business and assisting Indigenous people to generate economic and social benefits from the effective use of their land	1, 3
			Culture and capability supporting Indigenous Australians to maintain their culture	2, 3
			Remote Australia strategies: addressing the social and economic disadvantage in remote Australia and supporting solutions based on community and government priorities	1, 2, 3

[a] Key objectives include: 1—Involve Indigenous people in biodiversity conservation, 2—Maintain and develop Indigenous knowledge; and culture and 3—Recognise and promote Indigenous NCRM and traditional knowledge

[b] Derived from Article 8(j) of the convention on biological diversity

objectives that feature in the suite of Indigenous and biodiversity conservation policy and programs presented in Table 1. These objectives are:

1. Involve Indigenous peoples in biodiversity conservation
2. Maintain and develop Indigenous knowledge and culture
3. Recognise and promote Indigenous NCRM and traditional knowledge.

These objectives are used to frame the biodiversity and cultural benefits of the project, explore cross-cultural research lessons and inform policy and program development.

Australian indigenous natural and cultural resource management

Australia is a continent of high biodiversity in significant decline (McDonald et al. 2015; Woinarski et al. 2015). Its northern regions comprise one of the world's largest intact tropical savannas (Woinarski et al. 2007; Moritz et al. 2013) which is currently under threat from introduced species, habitat loss, altered fire regimes and over-exploitation (Evans et al. 2011). Australia also has high Indigenous cultural significance, with over 250 language groups (Evans 2010). Currently, over 30 % of Australia's land surface is legally recognised as Indigenous owned (Altman and Markham 2014). However prior to European colonization, Indigenous peoples occupied Australia for over 50,000 years (Roberts et al. 1994). Analogous to Australia's biodiversity decline, since European colonisation there has been a steady decline in the proportion of Indigenous people that speak traditional languages, with most languages considered endangered, or at best, heavily under pressure (McConvell and Thieberger 2001). Some even predict that, without a drastic reversal in trends, Australian languages will cease to be actively spoken by the end of this century (McConvell and Thieberger 2006). Fortunately, many Indigenous groups maintain strong cultural ties to the land, speak multiple languages, actively maintain traditional knowledge and aspire to pass these traditions on to younger generations. Aboriginal land management traditions are critical to ongoing NCRM in Australia (Ens et al. 2015).

In recognition of the need for Indigenous communities to be on-Country (on the land) in order to facilitate traditional knowledge transfer and to conserve biological and cultural resources, the Australian Government began the *Indigenous Protected Area* (IPA) program in 1995 (Caring for Country, Table 1) (Szabo and Smyth 2003). The program acknowledges the value of community-based Indigenous NCRM initiatives that balance socio-cultural and environmental interests and concurrently address many of Australia's conservation and human rights targets (Ross et al. 2009; Hill et al. 2013). Indigenous Protected Areas are formed when Traditional Owners voluntarily enter into an agreement with the Australian Government for the management and conservation of Aboriginal-owned land. By mid-2015, more than 60 IPAs had been declared and they constitute about 40 % of Australia's National Reserve System (Australian Government 2015). However, knowledge of species diversity and distributions across many IPAs, especially those in the north, is sparse, indicating mutual benefit for science and local communities from collaborative surveys and subsequent analyses (Moritz et al. 2013). In addition to establishing the IPAs, the Australian Government created the *Working on Country* (WoC) program (2007) to employ Indigenous land and sea managers (locally known as Rangers) to conduct NCRM. The WoC program currently provides more than 680 positions, employing local people in often remote Aboriginal communities (Australian Government 2015).

Biocultural knowledge collaboration between the Yugul Mangi Rangers and university ecologists

The Indigenous Yugul Mangi Ranger group was established in 2002 and represents seven clans of SE Arnhem Land, northern Australia (Daniels et al. 2012). The group is based in Ngukurr community which has a population of approximately 1000 people (over 90 %

Fig. 1 **a** Survey sites, towns and clean estates located in the proposed SEAL IPA and surrounds (clean ▶ names are capitalized; general clan boundaries are adapted from (Baker 2008). **b** Project and pre-project records for all reptiles, amphibians and mammals in the proposed SEAL IPA

Indigenous; Australian Bureau of Statistics 2011). The Rangers are responsible for managing 20,000 km^2 of very remote northern Australia soon to be declared as the South East Arnhem Land (SEAL) IPA (Gambold 2013; Fig. 1a). After conducting two formal targeted biodiversity surveys with government biologists (in 2005 and 2007; Daniels et al. 2012) the rangers expressed interest into expanding local fauna research (see Daniels et al. 2012) to inform IPA management planning. Therefore one of their research collaborators (and co-author of this paper E. Ens) sought funding from the Atlas of Living Australia (ALA; www.ala.org.au) and Centre for Biodiversity Analysis at the Australian National University to fulfill this aspiration. Based on conversations between the ecologists, rangers and funding partners, the key objectives of the funded project co-designed and were to: inform local land management planning; build local capacity to conduct cross-cultural biodiversity surveys; collect biodiversity data for this understudied remote part of Australia; contribute information to the ALA to give prominence to Indigenous knowledge as part of Australia's biodiversity knowledge bank; and provide advice to the ALA to help improve the relevance of the national biodiversity data aggregator platform to Indigenous Australians

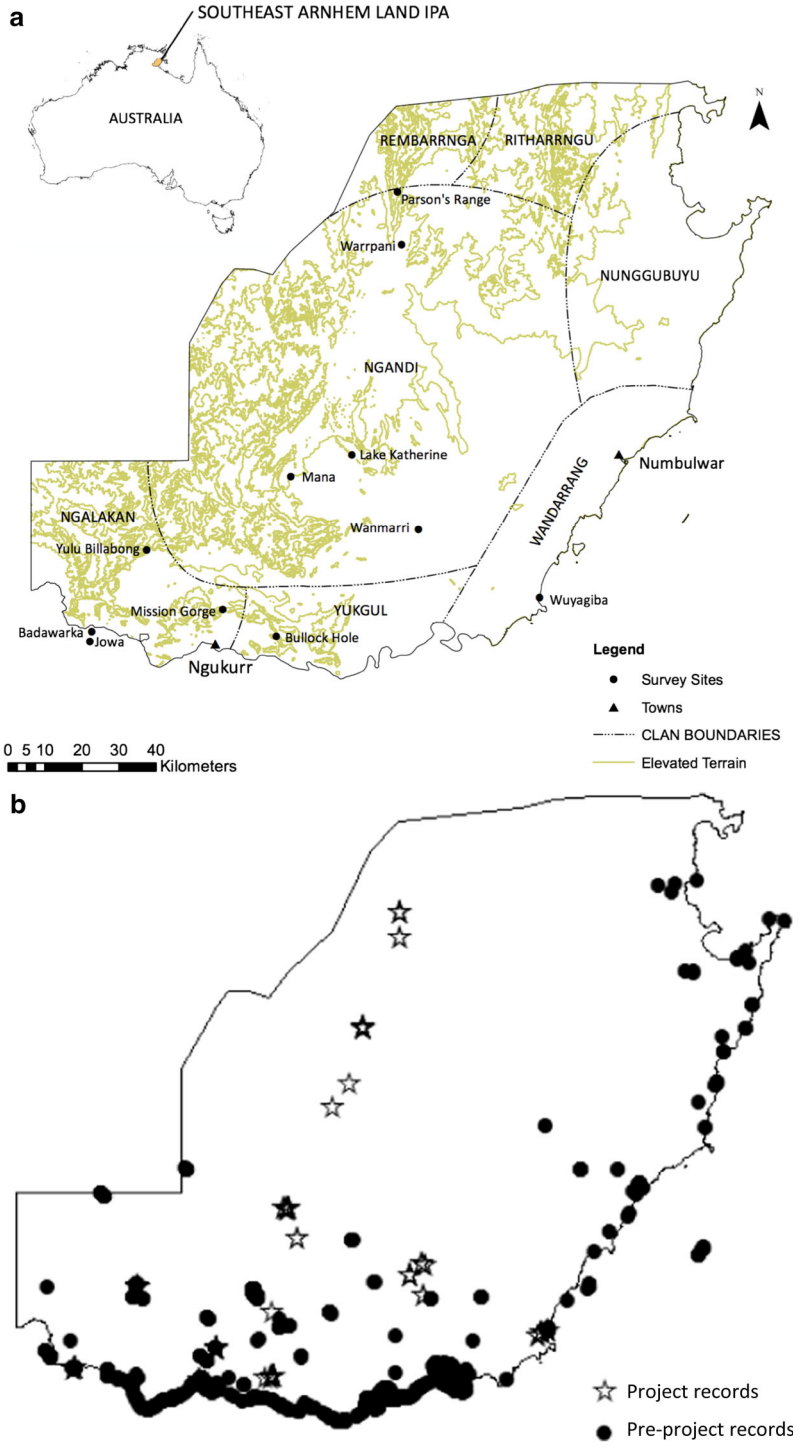
The Ranger group, in consultation with relevant senior Indigenous land owners, nominated sites to conduct biodiversity surveys. Sites were selected based on: access; availability of bush tucker and bush medicine that they wished to harvest; habitat (in relation to the species we wished to detect); burning regime; survey history; and availability of Indigenous land owners who were interested in conducting surveys on their ancestral Country. The sites were distributed across four local clan estates: Ngandi, Ngalakan, Wandarrang and Yukgul Country (Fig. 1a).

The following three sections describe the benefits of the co-designed cross-cultural biodiversity surveys and post-field work data management, community engagement and communication activities against the three identified policy objectives.

Indigenous involvement in Australian biodiversity conservation

Prior to the on-ground biodiversity surveys, a baseline data search of the ALA for fauna previously recorded in the proposed SEAL IPA area revealed relatively few records (380 animal species and 7789 records), indicating large data gaps (Ens and Rangers 2013). No Indigenous collectors could be identified from the data. The present project aimed to redress this situation: the Indigenous Yugul Mangi Rangers and university ecologists ("the team") worked together to prepare for and carry out all biodiversity surveys. All collections have been attributed to the Yugul Mangi Rangers.

Planned surveys and opportunistic sightings were conducted during the day and night. Each planned survey consisted of a mix of Indigenous (searching for animals, tracks and scats) and scientific techniques (pitfall, funnel, Elliot and cage traps and motion-sensor cameras). Opportunistic sightings were recorded whenever animals were seen outside of planned surveys. Cross-cultural data was collected using a purpose built CyberTracker® (free online software) electronic data collection sequence that was developed by the team and uploaded onto touch-screen tablets for ease of use (large screen and text). The flexibility of CyberTracker® data collection in the form of numbers, words, photos and audio has been shown to facilitate cross-cultural knowledge and data capture worldwide


a
SOUTHEAST ARNHEM LAND IPA
AUSTRALIA
REMBARRNGA
RITHARRNGU
Parson's Range
Warrpani
NUNGGUBUYU
NGANDI
Lake Katherine
Mana
Numbulwar
WANDARRANG
NGALAKAN
Wanmarri
Yulu Billabong
Wuyagiba
Mission Gorge
YUKGUL
Badawarka
Jowa
Bullock Hole
Ngukurr
Legend
Survey Sites
Towns
CLAN BOUNDARIES
Elevated Terrain
0 5 10 20 30 40
Kilometers
b
Project records
Pre-project records

(Liebenberg 2003) and is used widely by Indigenous rangers in Australia (Ansell and Koenig 2011; Ens 2012b). Species locations, names and a photo were then transferred to the ALA online database (see http://sightings.ala.org.au/spotter/10403).

Nine planned surveys were conducted (23 trapping days and nights) and 60 terrestrial animal species were recorded: 11 mammals (including three small mammals and five introduced mammals); 32 reptiles; 10 amphibians (including the invasive cane toad, *Rhinella marina*); six birds; and the Leichhardt's Grasshopper (*Petasida ephippigera*) (Table 2). We recorded 363 individuals in total that added 16, 15 and 43 % to the number of previously recorded reptiles, mammals and amphibians respectively held in the ALA database (Fig. 1b). We recorded ten species that were not previously recorded in the ALA for the SEAL IPA region including seven reptiles, two small mammals and the introduced *Sus scrofa* (pig) (Table 2). Of note, we also added sightings of other culturally significant species such as six emu, two Bustard (Vulnerable, NT), and ten Leichhardt's Grasshopper (Near threatened, NT) to the ALA which previously held, two, 35 and zero sightings respectively (Table 2). In addition to the biodiversity data and distribution knowledge gained, the survey work enhanced the capacity of: the Ranger group to conduct biodiversity surveys; the university ecologists to better understand Indigenous knowledge and languages; and both groups to conduct cross-cultural research. Four sites were sampled for the first time, including the north east of the proposed SEAL IPA which was largely void of scientific knowledge prior to this project (Fig. 1b). This research intentionally added baseline data for future monitoring efforts. Thirty-eight community members (21 men, 17 women) were employed as casual workers during the project, paralleling Indigenous employment objectives of the Indigenous Advancement Scheme (Table 1).

In addition, the project also detected several sensitive and sparsely distributed species. For example, we recorded a population of Leichhardt's Grasshopper (*Petasida ephippigera*), listed as Near Threatened in the Northern Territory (Northern Territory Government 2012). Probably once more widespread, this species is now known only to persist in small sections of Kakadu National Park and surrounds, with few stand-alone records in Arnhem Land (Wilson et al. 2003). Local community members were very excited to handle this species and were unaware of its nearby presence. Some of the elders recalled hearing stories about it when they were young but had never seen it. Leichhardt's Grasshopper only feeds on a few species of *Pityrodia* (Lamiaceae family; Lowe 1995) and is sensitive to infrequent or intense fires (Barrow 2009). Since this discovery the Rangers have constructed firebreaks around the population and have a heightened interest in preventing destructive late dry season wild fires where the grasshopper population was found.

According to the ALA, the proposed SEAL IPA contains many other species listed as Vulnerable and Near Threatened, although they were not detected in the biodiversity surveys (Gambold 2013). Regular surveys will improve knowledge of species presence and absence which is integral to strategic land management. At Wuyagiba (Fig. 1) community members commented on the presence of a threatened species, the Northern Hopping Mouse (*Notomys aquilo*). This species was observed at Wuyagiba in the past by local Indigenous people and in formal surveys, but was not detected in the present project. However, during this project the Red-cheeked Dunnart (*Sminthopsis virginiae*) was trapped at Wuyagiba with locals previously unaware of its presence. This may be the furthest south record of this species in the Northern Territory (it was not previously recorded in the SEAL IPA region in the ALA), expanding current knowledge of its range (Menkhorst and Knight 2010). Other significant records include those for all taxa observed in the previously unsampled Parsons Range region an isolated sandstone block (Fig. 1).

Table 2 Species detected on biodiversity surveys and previously recorded in the ALA, including traditional names recorded from interviews and available resources (Ngukurr Language Centre)

Traditional group name (scientific name-language group)	Species traditional name (language group)	*Scientific species name*	Common name	Status	Number of individuals found	Number of previous records in ALA
Dupurrurru (Grasshoppers-Wagilak)	A-rdapurrurruh (Ngandi)	*Petasida ephippigera*	Leichardt's Grasshopper	Near Threatened (NT)	10	0
(Mammals)	A-olherrk (Ngandi)	*Macropus agilis*	Agile Wallaby		7	13
	Yarrgarla (Alawa)	*Macropus antilopinus*	Antilopine Wallaroo		1	2
	Rdukgurlah (Ngalakan)	*Petropseudes dahli*	Rock Ringtail Possum		1	4
	Yarraman (Ngalakan)	*Brumby*	Horse	Introduced	2	10
	Nganaparrah (Ritharngu)	*Bubalus bubalis*	Buffalo	Introduced	2	26
	Garrwiri (Marra)	*Canis lupus*	Dingo	Introduced	1	4
	Biggi biggi (Kriol)	*Sus scrofa*	Pig	Introduced	1	0
	Bujigan anao (Nunggubuyu)	*Felis catus*	Cat	Introduced	1	6
Burrudburrud (Small mammals-Marra)		*Zyzomys argurus*	Common Rock Rat		9	20
		Planigale maculata	Planigale		1	0
		Sminthopsis virginae	Red-Cheeked Dunnart		1	0
(Crocodile)	Dardajarra (Marra)	*Crocodylus johnstoni*	Freshwater Crocodile		20	12
	Barrardukah (Ritharngu)	*Crocodylus porosus*	Saltwater Crocodile		1	78
Rlokrlok (Dragons-Ngalakan)	Mirruwah (Wagilak)	*Chlamydosaurus kingii*	Frillneck Lizard		4	3
Garngurrug-urru (Small dragons-Ngandi)		*Diporiphora bilineata*	Two-lined Dragon		10	10

Table 2 continued

Traditional group name (scientific name-language group)	Species traditional name (language group)	*Scientific species name*	Common name	Status	Number of individuals found	Number of previous records in ALA
		Diporiphora lalliae	Lally's Two-lined Dragon		2	1
		Diporiphora magna	Yellow-sided Two-lined Dragon		1	35
		Gowidon temporalis	Swamplands Lashtail		5	0
Yaminji (Geckos-Marra)		*Diplodactylus conspicillatus*	Fat-tailed Diplodactylus		2	2
		Gehyra australia	Northern Dtella		11	6
		Gehyra nana	Spotted Gecko		7	5
		Heteronotia binoei	Bynoe's Prickly Gecko		15	23
		Oedura marmorara	Marbled Velvet Gecko		10	9
		Oedura rhombifa	Zig-Zag Velvet Gecko		1	2
	Awaran (Alawa)	*Strophurus cilliarus*	Northern Spiny-tailed Gecko		1	4
Wardarbanya (Goannas-Wandarrang)	Rdabalun (Marra)	*Varanus baritji*	Black-spotted Spiny-tailed Monitor		1	0
	Galamu ngarra (Nunggubuyu)	*Varanus mertensi*	Mertens Water Monitor		1	0
Kulkia ngining (Snake-lizards-Wagilak)	Ngamini (Ritharrngu)	*Lialis burtonis*	Burton's Legless Lizard		2	10
Garlarlgarlarl (Skinks-Marra)		*Carlia amax*	Bauxite Rainbow-Skink		6	26
A-rlecrlec (Skinks-Ngandi)		*Carlia munda*	Shaded-litter Rainbow skink		20	34

Table 2 continued

Traditional group name (scientific name-language group)	Species traditional name (language group)	*Scientific species name*	Common name	Status	Number of individuals found	Number of previous records in ALA
Binybiny (Small skinks-Alawa)		*Cryptoblepharus metallicus*	Metallic Snake-eyed Skink		7	0
		Cryptoblepharus ruber	Tawny Snake-eyed Skink		1	0
		Morethia ruficauda	Lined Firetail Skink		3	5
		Eremiascincus isolepis	Northern Bar-lipped Skink		4	0
		Proablepharus tenuis	Northern soil-crevice skink		2	2
Arlaj (Fat skinks-Nunggubuyu)		*Ctenotus asticus*	Elegant ctenotus		4	5
		Ctenotus inornatus	Bar-shouldered Ctenotus		5	23
		Ctenotus robustus	Robust Ctenotus		8	9
		Ctenotus essingtonii	Essington's Ctenotus		5	0
Baapi (Snakes-Ritharrngu)	Rumbarumba (Ngandi)	*Dendrelaphis punctulatus*	Green Tree Snake		2	13
	Birritjji (Wagilak)	*Liasis olivaceus*	Olive Python		2	4
	A-banbalngu (Ngandi)	*Tropidonophis mairii*	Keelback		5	17
	Wuliynmirri (Nunggubuyu)	*Boiga irregularis*	Brown Tree Snake		4	18
(Turtles)	Wulwarndi (Marra)	*Chelodina oblonga*	Northern Snake-necked Turtle		1	4
Rnardi (Frogs-Marra)		*Cyclorana australis*	Striped Burrowing Frog		1	5
Bagung-bagung (Frogs-Wagilak)		*Cyclorana longipes*	Long-footed Frog		1	6

Table 2 continued

Traditional group name (scientific name-language group)	Species traditional name (language group)	*Scientific species name*	Common name	Status	Number of individuals found	Number of previous records in ALA
		Limnodynastes convexiusculus	Marbled Frog		1	6
	Jadbelg (Alawa)	*Litoria caerulea*	Green Tree Frog		1	19
		Litoria nasuta	Rocket Frog		2	17
		Litoria pallida	Pale Frog		2	45
		Litoria rothii	Roth's Tree Frog		2	14
		Litoria rubella	Desert Tree Frog		3	14
		Platyplectrum ornatum	Ornate Burrowing Frog		27	13
(Toads)	(no traditional names)	*Rhinella marina*	Cane Toad	Introduced	98	30
Rayi (Birds-Marra)	Warnghwarng (Ngalakan)	*Corvus orru*	Torresian Crow		12	98
	A-wurparn (Ngandi)	*Dromaius novaehollandiae*	Emu		6	2
	Barrirhbarrir (Ritharrngu)	*Merops ornatus*	Rainbow bee-eater		1	138
	Walpurungu (Wagilak)	*Ardeotis australis*	Bustard	Vulnerable (NT); Near Threatened (IUCN)	2	35
	Gurrgurr (Alawa)	*Podargus strigoides*	Tawny frogmouth		1	22
	Gurrgurr (Marra)	*Ninox novaeseelandiae*	Southern boobook		1	46

Each species may have different name across seven local languages, and multiple names per language. We have selected one each for this table

Wide table, included as separate file at this stage

Prior to these collaborative surveys, no tissues for genetic analyses were available for the SEAL IPA—prior tissue collections focused on non-Indigenous owned areas adjacent to this region. In this project, team members from the ANU visited the Ngukurr community and described the purpose of genetic analyses and how they could lead to discovery of new species and yield understanding of relationships among geographic areas. With approval of the Traditional Owners and participation of Rangers and children, joint surveys across the region yielded 110 tissue samples from 27 species of lizards, filling a complete void in scientific knowledge. Initial genetic analyses of these samples have revealed genetically divergent lineages that are near-restricted to the SEAL IPA including the geckos *Gehyra nana* and *Gehyra australis*, and the skink *Morethia ruficauda*. For the gecko *Heteronotia binoei* and several species of skinks (*Carlia amax*, *Carlia munda*, *Cryptoblepharus metallicus* and *Eremiascincus isolepis*) the SEAL IPA is a zone of contact between widespread genetic lineages from the Gulf region to the south and eastern Arnhem Land to the north.

Maintaining and developing indigenous knowledge and culture

An integral part of the project was recording local Indigenous knowledge of the species and survey sites. Formal and informal interviews with six of the remaining traditional language speakers of the community revealed numerous traditional language names of plants and animals (Table 3). Documented language resources (including dictionaries) from the local Ngukurr Language Centre were used to supplement interview knowledge. The number of names recorded during interviews was fewer than those recorded in other resources (Table 3). In line with recent predictions (McConvell and Thieberger 2006) older members of the community were the main speakers of traditional languages and their ability to recall animal names in those languages varied greatly. The names recorded during the project are being compiled into a local multi-lingual Field Guide by the project team in collaboration with the Ngukurr language Centre.

Similar to other Indigenous languages in Australia (e.g. Telfer and Garde 2006) some Western species had multiple traditional names, differentiated by their size, age, behavior or season. For example, in Marra, sand goannas (*Varanus gouldii*) are called *girraba* (very young), *barmunu* (juvenile), *wadjurnrdu* (adult) and *barlirri* (very old). Conversely, some less conspicuous groups of species (e.g. small mammals; skinks) were referred to with only one name in interviews and resources (*bandayamah* generally means gecko in Ritharrngu). It may be the case that these groups of species previously had individual names; however, they were not recorded or remembered by the people interviewed.

A primary threat to the loss of traditional Indigenous Knowledge is a shift in the interests of the younger generation towards contemporary "Western" culture (Baker and Community 1992; Davies 2007; Singh et al. 2010). This project involved young members of the community to support inter-generational transfer of knowledge and stimulate interest in traditional language, biodiversity and NCRM. Community members lamented that some children did not have opportunities to visit their ancestral Country due to limited access to vehicles and older people's guidance. Twelve children were involved in the fauna surveys and video interviews of Traditional Owners. All these activities are noted as effective ways to support intergenerational transfer of knowledge (Hill et al. 2013). Two students with outstanding school attendance were rewarded with an excursion with older project team members to southern Australian scientific institutions (outlined below). Engaging youth in Indigenous Ranger programs has been shown to strengthen cultural responsibilities, traditional knowledge maintenance and connection to Country (Fogarty 2012). The Yugul

Table 3 Number of traditional fauna names recorded from interviews and resources

Language	Source of mammal names (of 34 known mammal species in the IPA)			Source of frog names (of 19 known frog species in the IPA)			Source of reptile names (of 72 known reptile species in the IPA)			Source of bird names (of 61 known bird species in the IPA)			Senior knowledge holders involved
	Interview	Resource	In common	Interview	Resource	In common	Interview	Resource	In common	Interview	Resource	In common	
Marra	3	20	1	0	2	0	5	14	4	0	44	0	1 (CD)
Ritharrngu	0	13	0	0	1	0	2	19	1	0	44	0	1 (KR)
Wagilak	16	0	0	1	0	0	32	0	0	44	0	0	3 (ALP, NR, BW)
Ngandi	7	15	5	1	1	1	3	20	6	0	39	0	1 (CD)
Nunggubuyu	11	17	10	1	1	1	24	21	14	21	37	12	1 (HN)
Ngalakan	4	16	2	1	1	1	8	26	3	3	19	2	4 (HP, HD, CD, KR)
Alawa	0	17	0	0	2	0	0	21	0	0	17	0	0
Wandarrang	0	0	0	0	1	0	0	1	0	0	0	0	1 (CD)

Mangi Rangers are currently exploring development of a 'Junior Ranger' program in collaboration with external stakeholders.

In Australia, many Indigenous people maintain strong ties to their ancestral estate. Unfortunately, revisiting homelands is easier for some than others, as terrain and distance can be a significant barrier (Hill et al. 2013). For members of the Ngandi clan it is very difficult to access much of their Country, as it is bounded by vast river systems and rugged landscapes (Fig. 1). The Aboriginal land access permit system has also prevented non-Indigenous scientific research in this region in the past. This project provided a unique opportunity and resources to assist members of the Ngandi clan to return to their traditional lands, and with ecologists, collaboratively conduct innovative cross-cultural biodiversity surveys in a highly under-sampled area.

Ngandi Jungayi (Traditional Manager) Marjorie Daniels said of the trip:

> "Well for me I reckon it was really good to go out there…look all the different place, look all the different plants and different animals. That environment is a bit different to where we stay in the community [Ngukurr].
>
> And I been want him to see that place really badly…so I've seen it now and I am happy I've been out there with my son. It's a great experience for kids. For little kids like my little daughter now, my niece and the two little boys of [my sister]. All that mob it's all been really good for that mob so they can learn. Learn about both ways—blekbala [Indigenous] way and munanga [non-Indigenous] way.
>
> To me it was really good going out. I love travelling out. It was a really great experience to me 'cause I never been in that area since I was born. Now I'm 49 years of age, nearly 50, that's the time I went out to see my mum's area. You know. She hasn't [taken] us there for a long, long time.

On one of the biodiversity surveys, the rangers and ecologists uncovered rock art which was previously unknown to the ranger group and wider community. The discovery sparked discussions about how the site should be looked after. The proposed SEAL IPA is a vast, largely unpopulated and rugged area which many community members have never experienced. Future surveys will continue to benefit the community by facilitating access and re-discovery of other culturally significant areas.

Recognising and promoting indigenous NCRM and traditional knowledge

Effective communication is essential to the success of ongoing collaborative projects between scientists and Indigenous communities and can be facilitated by engaging people at all stages of the project and project co-design (Ens 2012a). Current policy encourages promotion and recognition of Indigenous involvement in conservation of biodiversity and culture (Table 1), but does not adequately guide delivery of the potential benefits from effective cross-cultural communication on the local and national scale.

In addition to directly involving local Indigenous people we found that providing feedback to the community in the local language style with large pictures was effective in engaging people's attention. To further engage the community and provide feedback on the project, the team collaboratively made a reptile and amphibian specimen collection and conducted presentations at the local high school and pre-school. These activities helped familiarize students with the ranger program, biocultural conservation and the biodiversity of the region. Students were encouraged that if they attended school and worked hard they

could come on future biodiversity surveys. Therefore, this project also supported outcomes in line with Australia's Indigenous Advancement Strategy and the UN DRIP (Table 1).

On a national scale, Indigenous members of the team gave well-received seminars at three universities (Macquarie University, University of New South Wales, and Australian National University) in southeastern Australia. These outreach and external engagement activities were conducted to raise awareness of more urban Australian people about the benefits and challenges of remote cross-cultural and collaborative biodiversity projects. The group also visited national cultural and scientific institutions including the Australian Institute of Aboriginal and Torres Strait Islander studies (AIATSIS), the Atlas of Living Australia (CSIRO), the Australian National University, the Australian National Insect Collection and Commonwealth Science and Industrial Research Organisation (CSIRO).

The biocultural surveys provided new opportunities for recognising and promoting Indigenous NCRM via the ALA. The ALA serves as a vast repository of biodiversity records, and is widely used for research and biodiversity conservation purposes. It is accessed by environmental managers, conservation planners, ecologists, biological collections, citizen scientists, educators, policy makers, community groups and the general public. The new records from Indigenous collectors provided by this project are contributing to the body of biodiversity information widely accessible to the global community and are filling gaps in information for this remote area not previously available. Other types of knowledge and information collected during the project are providing insights into adaptations required to enhance the ALA platform in order to enable effective two-way participation in biodiversity information collection, management and access.

Putting practice into policy

Considering recent policy emphasis on promoting rights of Indigenous peoples and their involvement in contemporary conservation efforts (Table 1), it is timely to feed back outcomes and lessons from on-ground projects. Some lessons learnt from this project that could inform similar future projects include: ensuring plenty of time for cross-cultural understanding, engagement, project co-design and collaborative work; promotion of Aboriginal and Western scientific knowledge and methods; co-development of objectives; and ensuring that the community receives tangible and agreed benefits from the collaboration that have longer term effects. From the present project, we suggest that future policy objectives elaborate on the role of collaboration (and not simply participation) in Indigenous NCRM and advocate for enhanced cross-cultural communication strategies between Indigenous community and external stakeholders. Due to the drastic erosion of biodiversity and Indigenous culture, projected losses into the next century may be irretrievable. As highlighted by the Convention on Biological Diversity, UN DRIP and IPBES (Table 1), a respect for Indigenous traditions and culture, inclusive participation, and acknowledging the rights of Indigenous peoples in conservation practice is integral for effective inclusive NCRM into the future. This project lead to real biodiversity and socio-cultural benefits at the local to national levels. However to maintain and enhance these benefits, Indigenous communities require continued support and program adaptation from collaborators and funding partners as well as policy makers that reflect ongoing learning and development of the cross-cultural nature of the Indigenous land and sea management sector (Ens et al. 2012).

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