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The Learning Generated Through Indigenous Natural Resources Management Programs Increases Quality of Life for Indigenous People – Improving Numerous Contributors to Wellbeing

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ABSTRACT

The critical role that Indigenous people play in natural resource management is globally recognized, with such endeavors frequently supported by Government and non-government funded programs. We explore the perceived impact of the knowledge-exchange opportunities arising from these programs, using data from a survey of Indigenous people from northern Australian communities involved in Indigenous land and sea management programs (ILSMPs). We find that ILSMPs are perceived as opportunities for exchange of both western and Indigenous-generated knowledge, with more people reporting opportunities to learn and share traditional rather than western generated knowledge. Aspects of life perceived as improved by learning and sharing were in relation to self, to others (community and family) and the Indigenous culture overall. Learning is having a positive impact on wellbeing; sharing is predominantly positive, but survey responses also reveal some negatives: mostly related to examples of sharing undertaken in culturally inappropriate exchanges, which not only impacts wellbeing, but also erodes the quality of the information exchanged. Reducing the negative sentiments related to sharing will not only improve the wellbeing of Indigenous people, but will also improve the quality of knowledge exchanged with consequent positive outcomes for the environment and society as a whole.

1. Introduction

The importance of indigenous peoples in sustainable land management has been recognized throughout the world (Garnett et al. 2018). In Australia, Aboriginal and Torres Strait Islander people (hereafter referred to as Indigenous people, using a capital 'I' as is appropriate under Australian protocols) have been managing their country for tens of thousands of years. Their deep understanding of 'Country' as a complex, interconnected system, and the knowledge of how to manage it is invaluable to western scientists interested in natural resource management (Ens et al. 2012; Ross et al. 2011).

The Australian Federal government first acknowledged the importance of investing in Indigenous land management during the 1980s (Australia. Committee of Review of Aboriginal Employment and Training Programs 1985) and the funding and scale of Indigenous Land and Sea Management Programs (ILSMPs) has grown significantly over the succeeding years. By 2018 there were almost 200 of these programs, involving 123 Indigenous ranger groups (Commonwealth of Australia 2018b) and 75 Indigenous Protected Areas (Commonwealth of Australia 2018) funded by the Federal government, in addition to many other programs funded by the Australian States or by philanthropic organisations. Apart from intended environmental benefits associated with ILSMPs, numerous social, health and wellbeing, and economic benefits have also been recognized (Addison et al. 2019; Barber and Jackson 2017; Hill et al. 2013; Jarvis et al. 2018a; Jarvis et al. 2018b; Larson et al., 2019a; Larson et al. 2019b; Pert et al. 2020).

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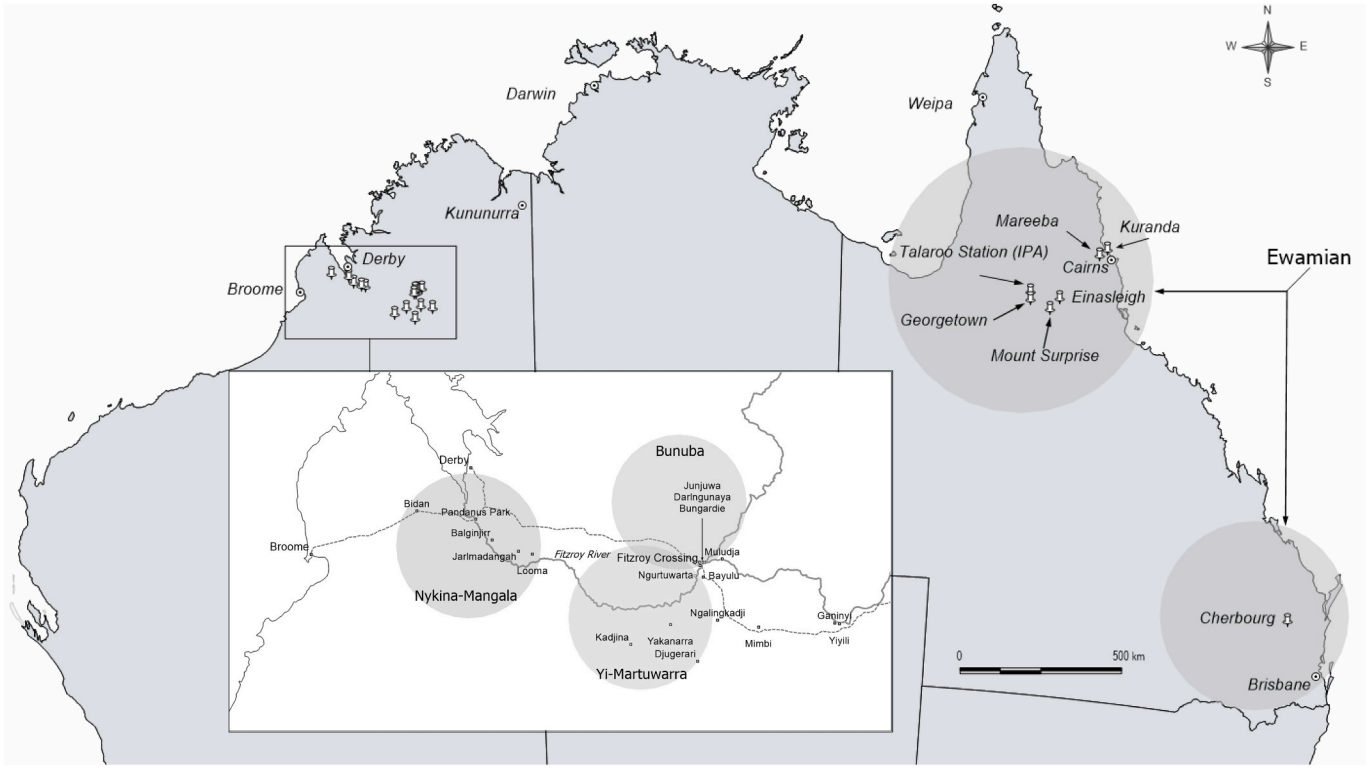

Fig. 1. Map showing study regions.

Two-way knowledge exchange has been associated with the successful management of a variety of ecological systems, both in Australia and overseas (Barber and Jackson 2017; Ross et al. 2011; Stevenson 2006). Natural and cultural resource management can facilitate the exchange of Indigenous generated knowledge from Indigenous to non-Indigenous Peoples (Ens et al. 2012), of western generated knowledge from non-Indigenous to Indigenous Peoples (Fogarty 2012), and of all types of knowledge within and between Indigenous Peoples (Sithole et al. 2008), with the sharing and weaving of different knowledge systems contributing to improvements in land management practices (Tengö et al. 2017). In this paper, we use the phrase Indigenous generated knowledge to refer to the body of knowledge, the origins of which are (mostly) attributable to Indigenous people. The phrase Western generated knowledge is used as a catch-all for other knowledges (with recognition that not all non-Indigenous knowledge has a western origin). Opportunities for exchange of different types of knowledge have been attributed to ILSMPs specifically, as these programs encourage collaboration between Indigenous people and Western scientists and create numerous opportunities for learning and sharing knowledge (Hill et al. 2013). This type of knowledge exchange (KE) has been associated with positive ecological outcomes, as KE in general has been shown to improve the sustainable use and management of natural resources, and to promote the conservation of and reduce threats to biodiversity (Liedloff et al. 2013; Simpson et al. 2013). There is, arguably, relatively less known about the impact of natural resources management related KE on people, despite the fact that complex social-ecological systems comprise linked natural and human sub-systems or *realms* (Berkes et al. 2009), underscoring the importance of understanding the impact of KE on both the natural and human sub-systems. In this paper, we are primarily interested in assessing the benefits of the KE that is facilitated by ILSMPs, which accrues to Indigenous people (hereafter referred to as ILSMP-facilitated KE).

The knowledge exchange literature reveals that different cultures have different views about KE and the benefits that KE can bring. First, different cultures have distinct and different perspectives about what constitutes a body of knowledge and about what can contribute to this knowledge (Barber and Jackson 2015; Strang 2005). Second, different cultures and cultural values shape the way in which knowledge is exchanged (such as when western generated knowledge is mainly shared in writing within a formal education settings whilst Indigenous knowledge is more frequently shared orally as part of other cultural practices (Agrawal 1995)), with cultural protocols determining what types of knowledge can be shared, in which way, when and with whom (Tengö et al. 2017). Third, how much of any potential benefit of new knowledge and KE can be realised by a person or group of people, depends on their adaptive capacity and hence on their ability to take advantage of opportunities (Davies et al. 2008). And fourth, the ability of a person or group of persons to capitalize on potential benefits of KE also depends upon the extent to which legal systems do (or do not) protect the intellectual property rights of those who share their knowledge (Davies et al. 2008). A more comprehensive review of the literature regarding cross-cultural knowledge exchange is presented in the supplementary materials.

Personal benefits associated with KE that may arise for Indigenous people, such as an increased sense of pride, self-esteem and self-worth, have been described in the literature (Davies et al. 2008; Evans et al. 2010), but to the best of our knowledge, no one has sought to formally assess the welfare (i.e. human wellbeing) benefits of KE associated with natural resources management – colloquially, to assess the way in which KE affects life overall, in addition to different aspects of life. There is a large body of literature on 'wellbeing' – a core insight being that it can be measured in numerous ways, using a variety of different metrics. There is a predominance of research that relies almost exclusively on what is termed objective measures (such as income, education), with some claiming that objective measures of wellbeing are superior to subjective measures (Bertrand and Mullainathan 2001; Dale 1980; Veenhoven 2002). But the choice of objective indicators is often driven by pragmatic factors (such as data availability) and/or by the value-judgements of those undertaking the assessment. The process of selecting objective measures is thus an inherently subjective exercise (Diener

and Suh 1997). Further, in some cases, objective measures can miss crucially important contextual factors that moderate links between objective measures and wellbeing (Diener and Suh 1997; Li et al. 2017). We thus focus on the subjective self-reported links between KE, quality of life, and core contributors to wellbeing.

Larson et al., 2019a considered the way in which 25 different factors, identified as being important to Indigenous wellbeing were impacted by ILSMPs; the found that 'sharing knowledge', defined as "*Sharing knowledge (traditional and new) within and outside community*", played a role in Indigenous wellbeing overall – it was, for example, considered much more important to overall quality of life than '*Having more money*', but it was less important than "*know that country was being looked after the right way*". That analysis did not, however, differentiate between learning and sharing or between the learning and sharing of different types of knowledges; neither did it explore linkages between KE and other factors known to be associated with wellbeing. This paper value-adds to that previous work (which served to 'scope' the importance of KE overall), to further improve our understanding of how KE contributes to wellbeing. We focus on the KE that is associated with ILSMPs.

Our investigation uses data collected via surveys with members of four northern Australian Indigenous communities that are involved in ILSMPs. We start by first asking whether ILSMPs are viewed as facilitating KE, differentiated between (a) learning and (b) sharing. For those who found this to be so, we probe deeper, asking if the learning and/or sharing has impacted their wellbeing (quality of life, overall) and if so, what aspects of their life it has impacted (positively or negatively).

This paper is structured as follows. In section 2 we focus on the empirical methods adopted, describing the regions in which we worked, the data collection process, and explaining our general methodological approach. Results are presented in section 3 and discussed in section 4. Conclusions are presented in section 5 alongside our recommendations.

2. Methods

2.1. Case Study Communities and Data Collection

This study is based on data collected within four Indigenous groups within northern Australia that are involved in ILSMPs: Ewamian people from Queensland and Nykina-Mangala, Bunuba and Yi-Martuwarra/Yanunijarra language groups within the western Kimberley region of Western Australia.

The Ewamian people were dispossessed of their lands during the late nineteenth century with a significant proportion of people forcibly moved to areas including Cherbourg in south Queensland, Palm Island and Mona Mona missions in North Queensland; others remained in the general area - many working as stockmen and domestic helpers through to the 1980s. Nowadays only a handful of Ewamian people live on their traditional country, while others live in the South Queensland (Brisbane/Cherbourg area) and in regional towns in North Queensland (Fig. 1).

The three collaborating groups in Western Australia mainly live in the Fitzroy River valley, with significant populations in the regional towns of Fitzroy Crossing, Derby and Broome (Fig. 1). Those groups were largely dispossessed in the late 19th and 20th century, and subsequently, resided and worked on missions and local cattle stations. Many of these missions and cattle stations were on traditional country. Thus, although these people were, like the Ewamian people, dispossessed of their lands and rights through colonization, many still live on or relatively close to their traditional lands in relatively small communities. Our primary engagement was with people living in the communities around the township of Fitzroy Crossing. Whilst populations often fluctuate in small communities, the median community had approximately 40 adults; with the largest - Looma – having a population of 374 adults. The smallest had a population of 10, just four of whom were adults. Most (but not all) communities had a primary school and a small shop; some communities also had a small health clinic; Looma also had a small police station and a church.

During the 1990s, all of the groups started organising to supporting applications for Native Title and land management. This process led to applications for Indigenous.

Protected Areas (IPAs) and/or involvement in other ILSMPs, such as 'Working on Country", and ranger programs. As a result, all four participating groups have recently or are currently engaged with various ILSMPs undertaking a range of land management activities which include: fire management; management of feral animals, weeds and invasive species; water, biodiversity and endangered species monitoring; landscape management, conservation, and rehabilitation; and the maintenance of cultural sites.

Working with each of these groups, face-to-face interviews were conducted between April and November 2017. Random sampling, most commonly used in western societies, is not appropriate in Indigenous communities (Watkin Lui et al. 2016). So we worked with cultural brokers to facilitate introductions within these remote communities and employed local interviewers with knowledge of local languages when working in the Kimberley, where English is often not a first language.

Table 1
Extract from survey instrument setting out specific questions posed relating to knowledge exchange.

(a) For learning: *Thinking about the most important thing you have learnt because of the program, please tell us:*	(b) For sharing: *Thinking about the most important thing you have been able to share because of the program, please tell us:*
i. What did you learn? (open-ended question)	*i. What did you share? (open-ended question)*
ii. Has that new learning improved your overall quality of life? (yes/no response elicited)	*ii. Has this improved your overall quality of life? (yes/no response elicited)*
iii. How has learning about this thing improved your quality of life and what parts of your life have improved? (open-ended question).	*iii. If so, how has sharing this thing improved your quality of life and what parts of your life have improved? (open-ended question).*

2.2. Survey Instrument and Analysis

We used open-ended questions to discuss respondent experiences of ILSMP-facilitated KE. We used open ended questions to ensure that interviewers did not unintentionally focus the thoughts of respondent's on the things which the interviewers thought to be relevant, but which might not be centrally relevant to respondents. Participants were encouraged to simply talk about what they had learned/shared as part of that involvement and prompted to provide specific examples of the knowledge exchanged – first asking to tell us what they had learned, and second asking them to tell us what they had shared (taught), as set out in Table 1.

Qualitative responses to questions about the types of knowledge learned or shared as part of ILSMPs (as per question (i) above) were analysed independently by two researchers and grouped according to whether the examples provided by respondents referred to: (a) western-generated knowledge for management of country e.g. use of chemicals and spraying, driving boat, GIS mapping; (b) western generated knowledge for administrative and communication skills e.g. business management, managing budgets, applying for grants; or (c) traditional/Indigenous generated knowledge e.g. sacred sites, Dreamtime paintings, bush medicines, looking after the land.

We then summarized data on perceptions of learning or sharing improving the overall quality of life (question ii above), determining the proportion who reported that the learning/sharing had improved their overall quality of life. Two researchers independently analysed qualitative responses from the open-ended questions on aspects of life reported as improved by knowledge exchange (question iii above) – thematically grouping 'aspects of life' to better understand the way in which KE affects quality of life overall.

Table 2
Characteristics of respondents.

	Directly involved ($N = 45$)	Indirectly involved ($N = 129$)
Located within		
	42%	29%
- North Queensland	7%	22%
- South Queensland	51%	48%
- Western Australia		
Average age in years	48#	44
Gender – Female	45%#	62%
Finished Year 12 or higher level of education	47%#	40%#
Main source of household income from employment	59%#	36%#
Average number of people living within their household	4.1#	4.9#
Live on Country	37%#	32%#

Note: # not all respondents answered this question, % shown is the % of those that did respond.

3. Results

A total of 190 Indigenous people (91 Ewamian people and 99 people from three language groups in the western Kimberley region) participated. Of those, 45 reported direct involvement with the ILSMPs (e.g. working as rangers), 129 reported being indirectly involved (e.g. sharing a house, or living in a small community with someone who worked as a ranger), while 16 stated they were not involved at all. We focus on the subset of respondents who had at least some involvement; described in Table 2.

Within our focal subset of respondents, 62 reported having had an opportunity to learn or share as a result of ILSMPs (overall, this was 35% of those who had been either directly or indirectly involved). Most learning/sharing opportunities were provided to those directly involved in ILSMPs (43 out of 45, or 95% of those directly involved reported KE), but spill-overs were evident in that 15% of those who had not been directly involved, had KE opportunities (19 people).

3.1. Types of Knowledge Learnt or Shared

Table 3 and Table 4 provide an overview of responses to the open-ended questions about knowledge exchange, distinguishing between learning and sharing, type of knowledge learned or shared, and, where possible, who was involved in the sharing. This highlights that ILSMP-facilitated KE is a two-way exchange between Indigenous and non-Indigenous people, with multiple different types of knowledge exchanged. Moreover, while Indigenous-generated knowledge dominated the sharing experiences, learning more often involved a wider range of knowledges.

3.2. Impacts of KE on Overall Wellbeing and on Specific Aspects of Life

As shown in Table 5, the majority of respondents, whether directly or indirectly involved, reported that the opportunities for learning and/or sharing did not only benefit themselves, but also the wider community/society. For both groups (those directly and indirectly involved), 92% reported that learning improved their overall quality of life. Responses to questions about sharing were more varied with 78% of those who were indirectly involved reporting that the experience improved their overall quality of life; for those directly involved, the figure was 97%. Evident from Table 4, ILSMP-facilitated learning and sharing was generally viewed positively. However, some examples of sharing had negative sentiments associated with them, mostly related to situations where Indigenous generated knowledge was being shared (for example, 'The white trainers thought they knew everything so didn't listen when I wanted to give advice about country' [respondent S0020], 'I've been a

Table 3
Types of knowledge reported by study participants as having been learnt and/or shared through ILSMPs.

Broad type of knowledge	Specific examples given by respondents
Western-generated knowledge for management of country	about the western science things on country biodiversity (animal and species identification, types of insects) using machines to track animals for conservation learning about different trees and plants use of chemicals and spraying use of chainsaw (certificate) weed identification and program for weed control burning training about cattle, fencing to keep cattle out about the weather and tides driving boat trapping crocodiles clean-up clearing nets sustainability - animal saving and helping wildlife in hunting season dealing with wild cats water hole and springs management GIS mapping
Western-generated knowledge for administrative and communications skills	new rules about the environment, understanding legislation business management decision making planning build capacity learning how to make programs 'run smoothly' office/administration skills managing budgets reporting for funders applying for grants paperwork governance understanding Government plans and funding options program workers all working together with the community going out to other places, meeting other people and learning from them meeting other rangers dealing with stakeholders - Councils, Department of Heritage and Protection, pastoralists, scientists forming a network of people e.g. rangers elsewhere getting ideas from other people for grant applications
Traditional / Indigenous generated knowledge	Learning from elders about geography of country where our land is learnt so much about our culture, and about country art and cultural sites, recording significant sites, carvings, artefacts sacred sites rock art Dreamtime paintings learning stories dance finding and recording cultural sites names of water holes burning and use of fire plants and animals bush tucker and bush medicine learning language / language training being on country is a great opportunity for learning and sharing determination helped with learning and

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Table 3 (*continued*)

Broad type of knowledge	Specific examples given by respondents
	sharing looking after the land learning important cultural aspect from the elders who were involved with the program learnt respect for country and for other peoples country teaching young kids and keeping them out of trouble surviving in the desert, where the waterholes are connections for specific areas and places

bit wary about sharing cultural stuff with the young fellas – they're not there yet for that secret stuff' [respondent S0029], Table 4).

Themes emerging from the analysis of data on aspects of life reported as impacted by KE, as well as some verbatim examples are reported in Table 6.

4. Discussion

The critical role that Indigenous people play in natural resources management is globally recognized, with government and non-government funded programs supporting such endeavors. Those programs provide numerous opportunities for Indigenous and non-Indigenous people to exchange knowledge, for the benefit of the environment and society as a whole. Using data from a survey of Indigenous people from communities that are involved in Indigenous land and sea management programs (ILSMPs) in northern Australia, we explore the costs and benefits, to Indigenous people, of the opportunities for knowledge exchange (KE) that arise from these programs.

We found evidence that ILSMPs do indeed facilitate learning and/or sharing of knowledge, and that this KE enhances the wellbeing of Indigenous people, findings similar to previous reports (Hill et al. 2013; Larson et al., 2019a). The examples of sharing experiences that were provided to us by respondents were dominated by descriptions of Indigenous generated knowledge; examples of learning experiences encompassed a broader range of knowledges – with ILSMPs thus providing a mechanism by which both Indigenous and non-Indigenous knowledge is diffused through communities. Importantly, it is clear that both learning and sharing impacts multiple different life domains and that learning extends beyond those directly involved with ILSMPs; with other members of the community reporting learning experiences related to the programs that had improved their overall quality of life (Fig. 2).

Our analysis reveals mostly positive sentiments related to learning – and this applies to both Indigenous and Western-generated knowledge. Although those sharing knowledge through ILSMPs reported that this sharing helped to improve their overall quality of life, some negative sentiments were evident around that sharing. Most of this was in the context of sharing Indigenous-generated knowledge. Negative impacts associated with the knowledge sharing within land management contexts have been reported elsewhere, and the negative experiences reported by our survey respondents appear consistent with these previous findings. We suggest the negative impacts may be due to a range of different causes set out below.

- Firstly, those sharing their knowledge may feel that the knowledge, and hence the culture it represents, is not given the respect and recognition that is due, resulting in the knowledge sharer feeling disrespected or unappreciated. This can arise as a result of the differing perspectives of those involved, with regard to their world views and their expectations from the collaboration. For example, from a non-Indigenous narrow science based view the Indigenous

Table 4
Quotes from the survey respondents on their perceptions of learning and sharing of Indigenous- and Western-generated knowledge facilitated by ILSMPs.

	Learning	Sharing
Indigenous generated	From Indigenous person/s: '*I have learnt so much about our culture, where our land is… How important is it to learn about and know about country, and the need to get more people involved. It's opened up my mind, I've realised there is a lot more out there, it's made my life richer. I feel more peaceful when I'm up there [on country]*' [Respondent S0007] '*Before I became a ranger I didn't realise how important it was to look after country. Before I saw a tree, now I see medicine and food and resources (boomerang, tools) and I see the seasonal changes*' [respondent S5080] '*I've learnt more about where I come from*' [respondent S0023] '*I have learnt about where we've come from and how it all started, what connects us to the land. Being able to access the land improves my life, and improves my relationship with my children*' [respondent S0030].	To Indigenous person/s: '*It made me feel good to share about what's on country*' [respondent S5127] '*I share my experiences with my family and friends. I now can take an active role in caring for my country*' [respondent S5068] '*It feels good to help - no point having knowledge if you don't share it. I share that it is our country, we need to get out on the land and just do it. Doing things ourselves might take longer but it's good as people are learning*' [respondent S0027] '*I taught about where my family is from which has created feelings of empowerment in me. Letting people know what they need to know is empowering*' [respondent S0011]. "*I've learnt a little … but have done more sharing. I taught the rangers … I've been a bit wary of sharing cultural stuff with the young fellas - they're not there yet for that secret stuff*" [respondent S0029]. To non-Indigenous person/s: '*I went on a training program for weed control. The white trainers thought they knew everything so didn't listen when I wanted to give advice about country*' [respondent S0020] '*[sharing knowledge has] improved with more awareness of culture, but still a huge need for empathy and understanding from outside community*' [respondent S5001] '*Not feeling [sharing knowledge] valued in the town*' [respondent S5023] "*Really important … the more you learn about it the more I want to share it … How to protect that knowledge … What is the benefit sharing model … want to share in ethical responsible way - $1000 per ounce oil from Boab for perfume and how to share? $ for PBC, $ for others?*" [respondent S5105]
Western generated	From Indigenous or non-Indigenous person: '*I've learnt about business management, and gained lots of skills*' [respondent S0001] '*I've been involved in applying for grants, learning that many are*	To indigenous person: '*Shared about governance - doing a strategic plan, doing a charter, what Board responsibilities are*' [respondent S0049] '*If we do things right, if we continue with the programs, and*

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Table 4 (*continued*)

	Learning	Sharing
	available … Seeing grants that other people get and that are available gives us ideas as to what [our people] can do themselves to make things better, whether there is funding or not … I can see that grants are helping to improve people's lives and make things better. It makes you feel like something is being done' [respondent S0027].	*do things correctly, we will get future funding and be able to establish our own sustainable community - be successful in our own right. Teaching others about this has had an indirect improvement on my life'* [respondent S0001]

Table 5
Summary of respondents who reported learning and sharing knowledge as part of being directly or indirectly involved with an ILSMP, as % of respondents who answered the question.

	Indirectly involved	Directly involved
Number who learned/shared knowledge	19	43
% Reported learning/sharing traditional knowledge	88%#	100%#
% Reported learning/sharing western knowledge	25% #	93%#
Reported learning improved quality of life	92%	92%
Reported sharing improved quality of life	78%	97%

Note: # not all respondents answered questions such that the type of knowledge exchanged could be classified, thus % shown is the % of those for whom their KE could be classified.

knowledge may be seen as peripheral or irrelevant, whereas from the Indigenous more holistic view the relevance of the cultural and contextual knowledge offered is obvious; to ignore this would indicate a lack of respect (Muller 2012) and imply that the sharing of such knowledge was not valued (Ross et al. 2011). In a further example, disrespect to culture and to the knowledge sharer may be shown by taking knowledge out of context and attempting to transform and combine it with other modes of knowledge (Tengö et al. 2017).

- Secondly, those sharing their knowledge may feel they have been taken advantage of as they receive little benefit from their knowledge, whilst those using their knowledge do benefit (such as Indigenous and non-Indigenous rangers being paid to use the traditional knowledge they have learned from others within the community). For example, knowledge may have been shared in the expectation of a two-way engagement whereby other knowledge would have been shared in return; failing to receive this benefit results in the dissatisfaction of the sharer (Muller 2012).
- Thirdly, those sharing their knowledge may feel that they have been pressured to share knowledge that was culturally inappropriate to share. The literature has recognized this issue, clearly identifying the importance of gaining agreement of key knowledge holders, such as Elders, prior to any sharing of traditional knowledge to ensure that all involved can be satisfied that such sharing is appropriate (Tengö et al. 2017).

Research has suggested that adverse consequences of sharing Indigenous knowledge as part of natural resource management programs, such as those described above, may arise from an imbalance of power between the Indigenous communities and those providing the funding and/or institutional support for the programs (Ens et al. 2012; Muller 2012; Ross et al. 2011; Stevenson 2006; Tengö et al. 2017). Such problems can be compounded by the consequent bureaucratic requirements and inefficiencies (Ross et al. 2011; Stevenson 2006). Several methods have been proposed in the literature to combat power

Table 6
Aspects of life reported by respondents as impacted by knowledge exchange.

	Learning	Sharing
Life overall	6 respondents: It's opened up my mind, I've realised there is a lot more out there, it's made my life richer. I feel more peaceful when I'm up there [S0007]. It's made me just happier, knowing my ancestors were there [S0029]. We are now in control of our own destiny [S5042].	2 respondents: Teaching others about this has had an indirect improvement on my life [S0001]. I felt right sharing knowledge about country. The ranger programme has helped me learn, I go there [Talaroo station] and share knowledge with others. This sharing relates to all factors [wellbeing overall] [S0031].
Self-respect and empowerment	7 respondents: The more you learn, the more say you have about what happens on country [S0001]. I feel better as a person [S5067]. Biggest difference is in confidence [S5116]. Learn what is in ourselves [S5050].	11 respondents: Sharing with others makes me feel better about myself, I like to learn and share [S0007]. I taught about where my family is from which has created feelings of empowerment in me [S0011]. It feels good to help - no point having knowledge if you don't share it [S0027]. The opportunity to be a role model, improving my personal and professional skills as an evaluator and spokesperson [S5042]. [feeling good passing] the knowledge of something they never knew [S5023].
Maintaining the culture	11 respondents: Knowing this has helped me connect with culture [S0001]. Knowing people can work together to protect country makes me happy [S5016]. Knowing sacred sites are protected [makes me happy] [S5019]. Getting out of town [makes me happy] [S5014]. …proud of where my ancestors came from [S5122].	8 respondents: I taught passion and pride and how to be on country. I'm at a point in my life where I'm now a male elder, it's my job, it's an important role [S0029]. I taught about cultural history of engravings, sites etc… [give you] feeling of being strong in culture and helping obtain legal protection [S0017]. Being able to connect to country. Knowing that there's good people to work with. Being out on country] S5069].
Strengthening community	9 respondents: I've learnt about grant processes and funding. I can see that grants are helping to improve people's lives and make community better [S0027]. Co-operating, working	5 respondents: If we do things right, if we continue with the programmes, and do things correctly, we will get future funding and be able to establish our own sustainable community - be successful in our own right [S0001].

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Table 6 (*continued*)

	Learning	Sharing
	together, getting culture back in school. Seeing people benefit in the community [S5023].	They have had trust developed in the community and community members [S5072].
Strengthening family connections	3 respondents:	1 respondent:
	It brought me closer to family [S0003]	I have learnt about where we've come from and how it all started [sharing this knowledge with children] improves my relationship with them [S0030].
	Being able to access the land improves my life, and improves my relationship with my children [S0030].	
Indigenous/non-Indigenous partnerships and pride in culture	3 respondents:	0
	…keep that strong connection between aboriginal and non-aboriginal people [S5074].	
	Public awareness to non-Indigenous people, especially tourists, this makes me proud [S5075].	
Meaningful Employment	2 respondents:	3 respondents:
	Feeling valued when I work [S5008].	What work is available on our country and what opportunities there are? I am now able to help train people to do some work [S0027].
		Sharing information about jobs [S5015]

imbalance and improve future design of natural resources management programs, including the increase of multi-level Indigenous involvement; increased respect for the inherent differences in culture and methods; and the use of bridging organisations to enhance cooperation between all parties involved (Berkes 2009; Preuss and Dixon 2012).

The literature also notes that successful knowledge sharing requires the building of relationships between the parties, based on mutual trust and respect (Preuss and Dixon 2012; Ross et al. 2011; Tengö et al. 2017) and that engagement with key knowledge holders, such as Elders, is vital to ensure agreement that the proposed sharing of traditional knowledge is relevant and appropriate. It has also been recommended that protocols be developed to guide KE with, but also within, the Indigenous communities (Robinson et al. 2016; Tengö et al. 2017), and suggested that benefit-sharing agreements be used, either instead of, or in conjunction with, any of the various IP options that may be available (Davis et al. 2009; Morse and Janke 2010). Indigenous led control over the knowledge exchange process, as articulated in best practice "Our Knowledge, Our Way" guidelines (Woodward et al. 2020), may also help enhance the benefits to Indigenous people from the learning and sharing of knowledge. We agree with these proposals in the literature; such potential program design improvements would all assist with reducing the negative sentiment connected to sharing that we have found.

Several aspects of life were perceived as improved by learning and sharing. Similar to the literature, these included Self-respect and empowerment; Stronger family connections; Importance of maintaining culture; Partnership and pride in culture (towards non-Indigenous people); Strong community; Employment; and Life overall (Davies et al. 2008; Evans et al. 2010; Hill et al. 2013; Whyte 2018; Williams and Hardison 2013). Any of the improvements proposed would likely provide not only benefits to individuals within Indigenous communities, but also benefits in terms of improved management of natural resources. Reducing the negative impacts of knowledge sharing should encourage greater sharing which contributes to improved natural resource management in a range of ways; for example, increasing the integrative and contextual understanding of different knowledges (Weiss et al. 2013) and providing opportunities for the weaving of different knowledges into new and innovative approaches to resource management (Tengö et al. 2017). Further, survey respondents indicated that the benefits they perceived from KE extend well beyond those which they personally incur, indicating that the 'knowledge' is an example of a complex social good. Stoeckl et al. (2018) argue that methodological barriers to quantifying the 'value' of complex social goods have led to their frequent omission from natural resources management deliberations. Given our findings, we suggest that further explorations of KE as a complex social good, and other complex social goods, are warranted.

5. Conclusion

This case study explored types of knowledge learnt and shared as a result of Indigenous land and sea management programs (ILSMPs), and the perceived impacts of this knowledge exchange on various aspects of wellbeing. We find that ILSMPs facilitate knowledge exchange (KE), encouraging learning and sharing of both traditional and western knowledge; and that opportunities to learn and share extended beyond those directly involved with ILSMPs to other members of community. But sharing was not always a positive experience: there were examples of situations where Indigenous generated knowledge was being shared (or was asked to be shared) in culturally inappropriate ways, with negative sentiments expressed about those situations.

Aspects of life perceived as improved by learning and sharing were not only in relation to self, such as Self-respect and empowerment and Employment; but also in relation to others (Strong community; Stronger family connections) and the Indigenous culture overall (Importance of maintaining the culture; Partnership and pride in culture (towards non-Indigenous people)).

Consequently, we recommend that when designing future natural resources management programs, consideration be given to how these negative impacts could be minimized. Solutions reported in the literature include the increase of multi-level Indigenous involvement; increased respect for the inherent differences in culture and methods; the use of bridging organisations to enhance cooperation between all parties involved; the design of protocols for KE within and with the Indigenous communities; benefit-sharing agreements and other IP –protection options.

Finally, we suggest that reducing negative impacts of KE on Indigenous people would not only result in improved wellbeing, but also in long-term benefits to natural resource management. Traditional Owners have a wealth of knowledge – actions that increased their willingness and ability to share it would bring benefits to all.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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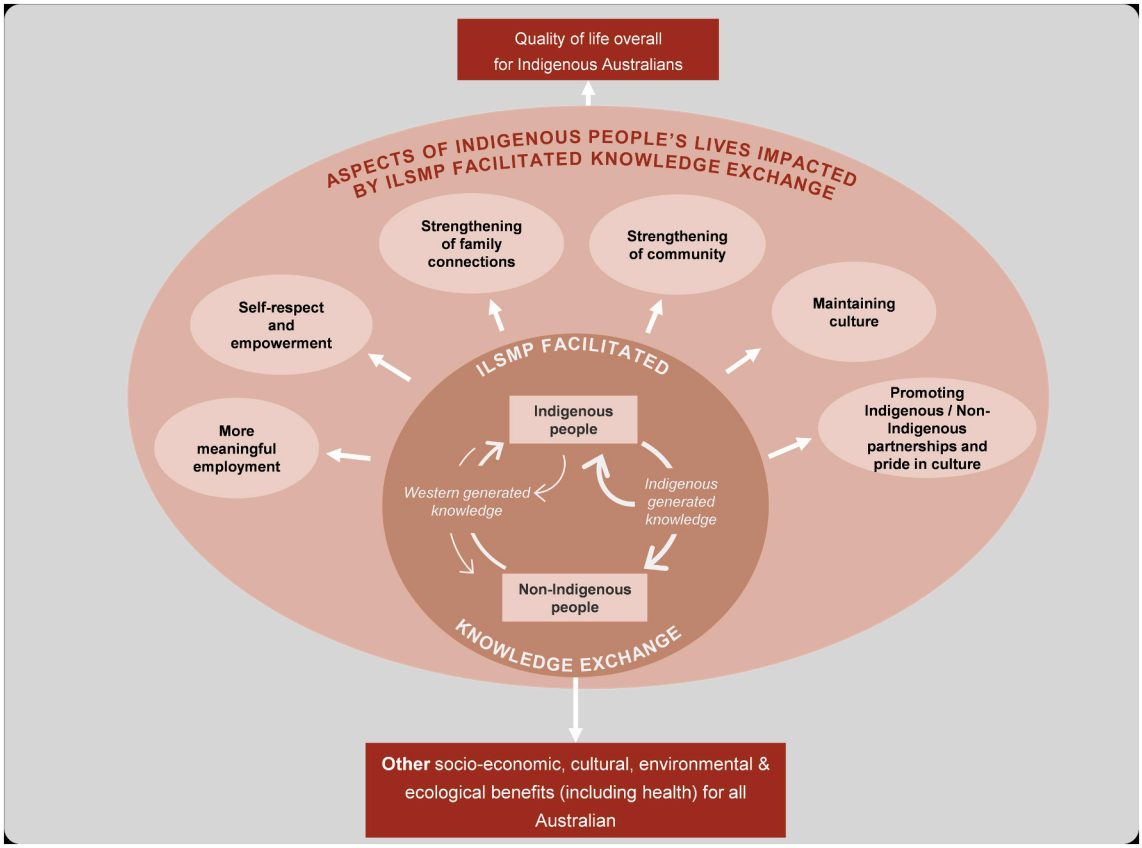

Fig. 2. Conceptualisation of the way in which ILSMP facilitated knowledge exchange improves the quality of life of Indigenous Australians (Figure developed by Natalie Stoeckl adapted from figure by Jane Thomas, 2019).

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ecolecon.2020.106899.

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