It's Not Just About the Worm

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Article

It's Not Just About the Worm: Social and Economic Impacts of Harvesting *Imbrasia Belina* larvae (Kruger National Park, South Africa)

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Abstract

A mopane worm (*Imbrasia belina*) harvesting project in the Kruger National Park (KNP) was used as a case study to test whether conservation related benefit sharing has a net positive impact on multiple dimensions of human well-being. Furthermore, the study assessed whether and to what degree, sharing such benefits influenced local perceptions of conservation, a requirement for the sustainability of protected areas across the globe. The project involved 263 people from 16 villages, adjacent to the KNP, harvesting 4,688 L worms contributing the equivalent of over half of the average household income during the months of harvest. Despite paying for transport, the participants gained from the experience; instilling the feeling that the park is opening up to them, and as a result seeing the park differently. For most participants the project provided them their first opportunity to visit the park, and participants perceived this to have further contributed positively to their wellbeing as a result of the associated learning experiences. Furthermore, participants enjoyed meeting and getting to know the park staff, with these new social connections contributing positively to social wellbeing. Respondents perceived their relationship with the park to be positive and expressed hope for building on this in the future. We conclude that measuring the multiple dimensions of human wellbeing in impact assessments is beneficial, and that the social connections that are built between neighbours, protected area staff and the natural and cultural resources within protected areas as a result of such projects can have mutually beneficial outcomes both for people and conservation.

Keywords: benefit sharing, communities, conservation, relationships, sustainability, well-being, Mopane worm harvesting, Kruger National Park (KNP)

INTRODUCTION AND BACKGROUND

Changing conservation mandates over the past three decades have seen many protected areas attempting to move away from colonial, elitist, and protectionist approaches that characterise many of their histories, towards a paradigm that embraces just and fair benefit sharing processes and approaches with a particular emphasis on rural neighbours (Pimbert and Pretty 1997; Brockington 2002; Brockington 2004; Hunt 2014; Boillat et al. 2018). As a result, many projects are implemented in and around conservation areas aiming to restore rights, share

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benefits, build relevance and support for conservation among the people living inside or adjacent to parks (Pimbert and Pretty 1997; Child 2004; Fabricius and Koch 2004). However, despite the wide scale implementation of such schemes, very little evidence exists of the real impact of such benefit sharing on participants and the subsequent impact on how participants view and experience conservation (Swemmer et al. 2017). Our study aims to explore these gaps in the literature by using a case study from South Africa involving benefit sharing through extractive resource use from within a protected area.

Recent increases in the poaching of threatened species (Ferreira et al. 2014) have led to local benefit sharing being further emphasised as a mechanism for promoting alternatives to and reducing the negative impacts of wildlife crime on people and wildlife (Biggs et al. 2016; Lunstrum 2014). In South Africa, 67% of the protected areas under state management are managed by South African National Parks (SANParks), the primary mandate of which is the conservation of biodiversity for the benefit of the nation (SANParks 2017). Although fair and just benefit sharing in SANParks is a key priority (Swemmer et al. 2017), historically, benefits have mostly accrued to visiting tourists in some parks (representative of specific demographic groups) (Biggs et al. 2014) with previously marginalised ethnic groups often excluded from accessing resources and being part of decision making processes about resources within parks. Ironically, these groups are most often those that bear the bulk of the costs of living adjacent to parks (Swemmer et al. 2015). Some parks have a history of forced resettlements, where original residents have been moved out of areas designated for conservation due to a perceived conflict between people and conservation objectives, at the time (Carruthers 1995).

Restricted access policies in South Africa further excluded the majority of South Africans from visiting parks until the advent of democracy in South Africa in 1994 which sparked an increased emphasis on sharing benefits from SANParks more fairly (Swemmer and Taljaard 2011). This included the promotion of access to new opportunities and resources within parks as well as a land restitution process that involves restoring rights to people to access and benefit from their land. This aimed to contribute towards conservation sustainability by enhancing relevance to broader society both by fair benefit distribution and accrual mechanisms, as well as more inclusive governance processes leading to the sharing of benefits, in the context of environmental justice (Hunt 2014). In many cases, outcomes of such processes are assumed but not measured, with impact assessments focusing on quantitative outputs of benefit sharing such as numbers of participants or income generated (Swemmer and Taljaard 2011). Seldom are the multiple dimensions (both tangible and intangible) of human wellbeing included in such impact assessments and as such the *real or felt* impact remains elusive as does the subsequent impact of benefit distribution on conservation related attitudes and behaviour (Swemmer et al. 2015, Swemmer et al. 2017). Furthermore, unintended negative consequences of parks on people and of individual projects, remain undetected or are ignored despite an acknowledgement of their importance, making cost-benefit trade-offs in the context of human well-being and biodiversity, difficult to assess (Botha et al. 2007; Swemmer et al. 2015). The subjective and multidimensional nature of human wellbeing, defined for the context of this study as a state of mind and body that encompasses happiness, harmony, and peace of mind further adds to the complexity of such assessments (Narayan et al. 2000).

A recent framework attempts to highlight the importance of these research gaps, demonstrating that the impact of benefit sharing should be interpreted in the context of multiple dimensions of human wellbeing (Swemmer et al. 2017). The framework further suggests that net impact on wellbeing will drive pro-or anti-conservation related attitudes and behaviour through the building of vested interest in the conservation estate, a requirement for protected area sustainability (Swemmer et al. 2017). The framework acknowledges several untested assumptions; firstly, that benefit accrual from conservation related action leads to a net positive impact on human wellbeing, and secondly that benefit distribution from conservation related action leads to positive conservation-related outcomes. The purpose of this research was to use the harvesting of a popular edible insect— the larvae of the emperor moth (*Imbrasia belina*), commonly referred to as *mopane worms*— from within the KNP to assess whether facilitating access to direct benefits arising from the flow of ecosystem services within a conservation area has a net-positive, measurable impact on the multiple dimensions (qualitative and quantitative) of human wellbeing. Secondly, to explore whether and to what degree participation in this project had any impact on the conservation estate, specifically in the context of participant perceptions of and relationship with the KNP, under the additional assumption that positive perceptions will lead to pro-conservation attitudes and behaviour (Swemmer et al. 2017). Although the focus was on the participants, we also noted the impact of the project on the perceptions of broader, non-participating stakeholder groups due to the mandate of protected areas to be of value to broader society. We believe that insights from this study will contribute to the robustness of benefit sharing frameworks currently used and as such could lead towards more effective benefit sharing approaches and processes used by conservation agencies globally.

Resource use within protected areas remains an ongoing controversial topic all over the world based on the varying ways in which people's value systems and world views influence how they perceive the associated rights, risks, and opportunities thereof (Chester 1996; Nie 2003). In the South African context, both international agreements (Dudley 2008; CBD 2011), local policies and legislation (SA constitution 1996; NEMPAA 2003) provided a framework upon which enabling policies and procedures within SANParks were developed that make allowance for and promote the *sustainable* use of natural resources within and adjacent to parks (SANParks 2018; Scheepers et al. 2011; Swemmer et al. 2015, Vermeulen et al. 2019). Within the context of the SANParks

policy (SANParks 2018), sustainable resource use is defined as "resource use that maintains the integrity of the ecosystem, is economically viable and is socially just and acceptable".

In SANParks, sustainable resource use is used as a conservation tool for the purposes of managing biodiversity, generating revenue, sharing social and economic benefits, building relationships and promoting and diversifying just and fair opportunities to access parks in the context of environmental justice (SANParks 2018). Although natural resources have been and continue to be harvested from parks both illegally and legally (Van Wilgen and Herbst 2017), historically, legal resource harvesting was mostly implemented in accordance with specifications in park management plans (SANParks 2019) and/or codes of conduct (SANParks 2015). However, the development of a SANParks Resource Use Policy facilitated the formalising of existing resource use initiatives, as well as encouraged the exploration of new opportunities for resource use from parks specifically for broadening the beneficiary base (SANParks 2010a). In 2010, mopane worm harvesting from within the Kruger National Park (KNP) was identified as a new potential initiative. Mopane worms are a widely used source of protein in both rural and urban areas in southern and South Africa, both as a food supplement (providing limited seasonal food security) and as a source of cash income (Greyling and Potgieter 2004). Although popular, mopane worms can be expensive to buy and are not always available due to seasonality of outbreaks, sensitivity to climate conditions, habitat suitability and loss, and overharvesting. A pilot harvesting project was implemented, providing an opportunity for local residents living adjacent to the park to access benefits inside the KNP while also aiming to positively influence how local neighbours perceived the park (SANParks 2011). Prior to this, mopane worms had been harvested within the park by staff members only, normally under the restriction of 2 litres (L) of worms per person per day (SANParks 2015).

STUDY AREA

The KNP is situated in the Lowveld of South Africa, spanning the two provinces of Mpumalanga and Limpopo (Figure 1). Although having earlier predecessors, the park was officially proclaimed in 1926, from which time it has been perceived in a dual light (Carruthers 1995). On the one hand, the KNP is seen globally as a powerful symbol of conservation success; on the other hand, it is also perceived to be a symbol of segregation, inequality, and injustice to many living in close proximity to the park (Carruthers 1995). The history of forced resettlement of people beyond park borders from the interior of the park in the early years, as well as restricted access policies that only allowed entrance and use of facilities by certain sectors of society, fuelled a perception of segregation and injustice. However, the emergence of South African democracy in 1994 facilitated several processes of change in the context of transformation (Swemmer and Taljaard 2011).

With an annual rainfall between 400 mm and 750 mm, the 20,000 km^2 KNP is classed as semi-arid to arid wooded savanna vegetation, home to a large diversity of plants and animals that attract over 1.8 million tourists annually from around the world, resulting in a large regional economic impact (Saayman and Saayman 2006). The South African component of the 1,073 km perimeter of the KNP abuts seven South African municipalities covering land uses that include private and government conservation land, rural and urban towns, villages, agriculture and industry, and includes about 2 million people. Much of this land is of low agricultural potential (Lahiff and Cousins 2009) typified by high regional unemployment rates with residents being largely dependent on natural resources, subsistence agriculture, and social grants (Statistics SA 2015). The KNP employs over 3,000 people, and implements numerous projects and programmes aimed at benefitting local communities (Swemmer et al. 2017). However, the majority of neighbours do not visit the park nor do they receive any direct benefits from the park itself.

Figure 1
Location of the study area in the context of the Kruger National Park, in South Africa

THE MOPANE WORM HARVESTING PILOT PROJECT

The two-way engagement between KNP staff and community representatives facilitated planning and implementation of the project. The invitation was open to villages adjacent to the KNP where mopane worms are known to occur. Participating villages took part as a result of demand for worms and proximity to the park. In accordance with the harvesting protocol, access for mopane worm harvesting was limited to 10 people per village, per day with each participating village harvesting for only one day. Participants were allowed to harvest an unrestricted volume of worms, within a designated area, during an allocated harvesting period as stipulated in the Kruger Management plan at the time of the study (SANParks 2008).

Community representatives including traditional council and community forum representatives were responsible for

selecting participants with a maximum of one participant per household. The majority of the respondents heard about the mopane worm harvesting via the Traditional Council's office (48.07%), followed by the KNP community forum representatives (44.23%), a SANParks representative (5.77%) and word of mouth (1.92%). Selection of individuals within communities differed between areas. In three of the participating villages, Traditional Councils selected the participants, and in two of these, participants were selected based on being "poor". In one village, anyone could apply, and names were selected from "a hat". In another village, those that could afford the transport to participate were chosen, and in the last village, people submitted their names to the Traditional Council who chose a sub-group based on being "poor" and the remainder of the participants for that village were chosen based on their names being drawn from "a hat". Harvesters were responsible for their own transport, food, and equipment arrangements, but were provided with a permit, free entry and an armed guard to protect them from dangerous game while harvesting. Harvesting involved walking through the bush, plucking individual worms from trees, and storing them in containers. Two harvesting seasons took place within the first three years of starting the project (Table 1).

METHODS

A mixed methods data collection approach was used including focus groups and semi-structured questionnaires. With each group, a focus group was held first to discuss the research topic more broadly, followed by individual semi-structured questionnaires where participants were able to engage with the research in a more personal setting. Each participant, hence, took part in both a focus group and an individual semi-structured interview, with all data collection taking place between 15 February and 14 July 2011. A total of seven focus groups and 52 semi-structured questionnaire interviews were conducted with respondents comprising between 5 and 10 harvesters each from six participating villages from the first harvesting season, namely Mninginisi (9), Plange (10), Mashobye (7), Magona (6), Altein (7), Lombard (5) and one non-participating village (8). The non-participating village was planning to harvest but then was not able to participate due to road conditions at the time. The number of respondents in each village was based on how many of the harvesters that had participated in the mopane worm harvesting project during the first harvesting season (maximum of 10 per village) were willing to voluntarily participate in the research study.

Research assistants were selected based on their ability to provide translation and facilitation support, and were either members of SANParks staff or members of the Hlanganani Community Forum, the community forum responsible for communication and engagement between the KNP and local communities in the study area. Despite being registered as a formal research project with SANParks, further approval for the research by local authorities and subsequent entrance into the various communities was also facilitated through the Hlanganani Community Forum.

Participants were briefed about the purpose and scope of the research at the start of both the focus groups as well as the questionnaires, and they were also informed that participation in the research was voluntary and that their individual identities would be treated with confidentiality. Focus groups were loosely structured around a broad set of questions that prompted discussion on the context of living next to the KNP, mopane worm supply and demand, perceptions of the park and recommendations for KNP management. The semi-structured questionnaires comprised of an approximately 1 hour long interview that discussed multiple dimensions of human wellbeing; the impact of the project at individual, household, and community levels, the impact on perceptions of the park and management recommendations. Focus groups and questionnaires were conducted in XiTsonga and translated into English for the purposes of data collation and analysis.

Quantitative data was captured and analysed in MS Excel, from which descriptive statistics were conducted. Content analysis was applied to qualitative data, by using open coding to identify themes emerging from the latent content of data recorded for individual questions (Vaismoradi et al. 2013). Human wellbeing impacts were clustered according to five wellbeing categories namely material (shelter, food, water), physical (being strong, well and looking good), social (care for children, self-respect, peace and good relations, dignity), security (civil peace, safe and secure environment, physical security and confidence in the future) and freedom of choice (including being able to help others in the community) (Narayan et al. 2000). Participation in both individual interviews and focus groups was voluntary, and participant and focus group identities and confidentiality have been protected by not including names of respondents nor names of villages linked to specific focus group responses in the data summaries

Table 1
Mopane worm harvesting statistics from two harvesting seasons Kruger National Park, South Africa

	Season 1	**Season 2**
Dates	29 Dec 2010 to 5 January 2011	17 to 26 December 2012
Participants	6 villages	15 villages (3 of whom sent 2 separate groups) and one mixed community group
Mean number of people per village	8.86 people (range=8-10 people; SD=0.90 people)	9.47 people (range=7-10 people; SD=0.97 people)
Number of harvesters	62	161
Worms harvested per village	Mean 217.14 L (range=80-320 L; SD=94.64 L)	Mean 186.39 L (range=46.4-285 L; SD=78.50 L)
Total volume of worms harvested (L)	1,520 L	3,168 L

or text (They are referred instead as "Focus group A, Focus group B etc."). A debriefing meeting in the form of a focus group was held with approximately 8 SANParks staff from various departments after the harvesting where operational aspects were interrogated as well as anecdotal observations noted and discussed.

RESULTS

Demographics and livelihoods of respondents and their households

Most (83.87%) harvesting participants from season 1 took part in the focus groups and semi-structured questionnaire interviews. Respondents and their families varied in age, gender, and household size (Table 2) with respondents being mostly married women, with a mean age of 46.94 years (range = 22 - 80 years; SD = 10.00). Households had a mean of 6.04 people per household (range = 2 - 11; SD = 2.43), with approximately even numbers of male and female household members. The majority of the people in the household were under the age of 29 years. Just under half of the household heads were female, with a mean age of 52.00 years (range = 30 - 80 years; SD = 31.11 years). Household incomes were a mean of R1,791 (range = R0 - R13,750; SD = R4,095), with a mean of 79.37% (range: 0 - 100%; SD = 37.69%) of household income coming from government social grants (59.05% child grants and 40.95% pension grants), an important additional source of income for poor households (Table 3). Most households used wood as a primary fuel source, but those households also using electricity, spent a mean of R71.68 (range = R20 - R400; SD = R81.13) per household, per month on electricity. Many households owned at least one type of livestock and planted a mean of 6.08 different crop species (Range: 1 - 11 crop species; SD = 2.77 crop species) at home, using livestock and crops for subsistence and/or income generation. Most respondents ate mopane worms at least once a week (92.2%), with fewer eating chicken feet (72.55%), fish (62.75%), chicken (50.98%), beef (13.75%) and pork (1.96%); with no respondents eating meat from goats or sheep.

Table 2
Individual and household demographics of respondents involved in mopane worm harvesting
Kruger National Park, South Africa

Group	Variable	Category	Percentage
Respondent	Gender	Women	84.62%
		Men	13.58%
	Marital status	Married	40.38%
		Single	38.54%
		Widowed	15.38%
		Divorced	5.77%
		Separated	1.92%
	Age	20-29	5.88%
		30-39	9.80%
		40-49	47.06%
		50-59	29.41%
		60-69	5.88%
		70-79	0%
		80-89	1.96%
Household	Size (no. of residents)	1-3	11.76%
		4-6	47.06%
		7-9	31.37%
		>9	9.80%
	Gender of household members	Females	52.27%
		Males	47.73%
	Age of household members	0-19 years	37.54%
		20-39 years	38.83%
		40-59 years	18.45%
		60-79 years	4.85%
		80-89 years	0.32%
Head of household	Gender	Females	49.02%
		Males	50.98%
	Age	20-39 years	15.68%
		40-59 years	76.47%
		60-79 years	5.88%
		80-89 years	1.96%

Impact on participant wellbeing

A baseline understanding of respondent's perceptions regarding the degree to which mopane worms contribute to wellbeing locally, despite the KNP mopane worm project, provides context for assessing the demand for and subsequent impact of facilitating access to additional sources of worms from the KNP. As indicated by a focus group from Altein Village, "*Everyone likes to collect worms…we learnt it from our parents….sometimes if we get a bag we eat them the whole year*". Respondents indicated that when they are available, mopane worms are collected for their material contribution to human wellbeing, both for household consumption and income generation, being desirable due to their taste, health benefits and long shelf life. Generally, respondents felt there were less worms available than in previous years, and this was attributed to harvester competition, habitat loss, rain, fire and inter-species competition. The reduced supply was perceived to have negative impacts on worm size, quality, and processing efficiency, and having to harvest elsewhere came with costs, both financial and security related. Consumption patterns varied ranging from eating worms all year round, to only eating during harvesting season, or in times of need. After harvesting, worms are degutted, and cooked with salt, then either dried or frozen. Some respondents indicated that in a normal season they would sell worms if they had managed to harvest a good amount, using the money for groceries and school related costs. Respondents generally expressed concern that there were less mopane worms in current times, mostly due to the role that the worms play as a food and revenue source.

Although we have anecdotal evidence of excitement and anticipation in the broader community on hearing about the project prior to participant selection, we recorded the direct impact that the mopane worm project had on human wellbeing from when participants and subsequently their families and their communities heard that they had been selected to be part of the project. As indicated by a focus group participant, "[*on*

Table 3
Livelihood strategies of households participating in mopane worm harvesting
Kruger National Park, South Africa

Livelihood strategy	Category	Type	Value
Income	Income earners	Portion of income earning household members	37.66%
	Source of income	Only income is child support grants	69.83%
		Only income is pension grants	11.20%
		Households with an ad hoc source of income	25.49%
	Income of head of household	No income	75.51%
		Income from social grants	16.32%
		Income from other sources	8.16%
Fuel use	Access to electricity	Yes	86.27%
		No	13.73%
	Expenditure on electricity	R0-R100	90.00%
		R101-R200	2.50%
		R201-R300	5%
		R301-R400	2.50%
	Primary cooking source	Wood	98.04%
		Electricity	1.96%
	Secondary cooking source	Households that use a secondary fuel source	11.76%
	Type of secondary fuel source	Electric stove	66.67%
		Wood	16.67%
		Paraffin stoves	16.67%
Livestock ownership	Ownership	Households owning at least 1 species of livestock	54.90%
	Number of species of livestock	1	64.28%
		2	25.00%
		3	7.14%
		4	7.14%
	Type of livestock	Chickens	43.14%
		Cattle	15.67%
		Pigs	13.73%
		Goats	9.80%
		Donkeys	5.88%
		Horses	1.96%
Livestock primary use	Chickens	Household consumption	88.89%
		Eating and selling	5.56%
		Savings/insurance	5.56%
	Goats	Eating in the household	60%
		Insurance/savings	40%
		Sell for cash if the children need something at school	1hh
	Cattle	Selling	37.50%
		Insurance	37.50%
		Milk	12.50%
		Eating at home	12.50%
		Meat for funerals and weddings	1hh
	Donkeys	Ploughing fields	2.00%
		Draught animal	1.00%
	Pigs	Personal consumption	100%

Contd...

Table 3
Contd...

Crops	Planting	Households planting crops	100%
	Location of planting crops	Both household and community gardens	43.13%
		Household gardens	37.26%
		Community gardens	17.66%
		Project garden	1.96%
	Crop sales	Households not selling crops	78.43%
		Selling 1 crop	13.73%
		Selling 2 or more crops	7.84%

hearing that we were selected to participate] we were happy and excited with the news from the Chief". Happiness is an important indicator of overall wellbeing, and as such, it is important to note that happiness was broadly noted as the most common feeling expressed by respondents on hearing the news that they had been chosen to participate in the mopane worm project (Table 4 and Figure 2). The reasons behind the feelings of happiness were linked to the prospects of benefits from the harvest in terms of material (to get benefits from worms for food for self and family), social (going into KNP for the first time; received support from family members), and security (going to harvest with permission; knew that they would be looked after) dimensions of human wellbeing.

Some respondents had mixed feelings about participation anticipating danger from wild animals in the park. Respondents perceived the news of their forthcoming participation and its impact on their family's wellbeing, both positively and negatively (Table 5). Most families were perceived to be happy and hopeful of respondents receiving material benefits and being able to provide support for respondents to prepare to participate (social wellbeing) as indicated by a focus group respondent from Altein village who said, *"[our] families were very happy. They gave us money to go, they were not scared for us"*.

However, perceptions of negative impacts on family wellbeing were attributed to fear and concern of injury or death (security wellbeing). Some respondents perceived their families not to be concerned either way. Respondents perceived their communities to have mixed feelings about their involvement in mopane worm harvesting (Table 6). One focus group respondent from Mashobye village indicated, "*[before we went in to harvest] they [our communities] were worried about wild animals. We told them it is ok. They said maybe we will get eaten by dangerous animals, but we didn't even see a single animal. We only saw tracks."* Some respondents indicated that their communities were happy and hopeful on hearing the news of the respondents participation, while others perceived their communities to have experienced negative wellbeing impacts prior to the harvest as a result of the participant's selection, including feelings of jealousy, animosity, fear of danger and injury to participants (security wellbeing), and perceptions of unfair selection processes (social wellbeing).

The worms harvested in the park had the potential to contribute positively to the material dimension of human wellbeing, both through sales and direct consumption. Respondents harvested a mean of 27.83 L of fresh worms each (range = 5 L - 40 L; SD = 9.27 L) (Table 7). The economic value of the harvested worms per household was [1]R562.27 (range = R100 - R800; SD = R173.67), a noteworthy contribution of a mean of 50.34% of household income during the months of harvest (range = 4.48 - 100 %; SD = 31.74 %). Fewer than half of the respondents (38.46 %) collected worms in areas other than KNP during the harvesting season, with those that did collect in other areas, collecting a mean of 19.28 L per person (range = 1 - 62.5 L; SD = 21.69). Of those, 35% had to pay a "fee" to the local Traditional Authority to collect the worms, impacting negatively on material wellbeing with fees ranging between R10 and R20 each, and/or 2 L of cleaned worms. For all respondents, the harvested worms contributed to material (sales and consumption) and/or social (donations to friends and family) wellbeing. Most of the respondents (75 %) consumed all their harvested worms at home, while other households sold some of their worms (17.31 %). Some used the worms in their households and gave some away (5.77 %) while others sold all of their worms (1.92 %). Those that sold worms, sold a mean of 20.39 L each (range = 5 - 37.5 L; SD = 18.11 L), amounting to a mean of R517.14 per person (range = R120 - R1,000; SD = R308.85), with worms retailing at a mean of R42.40 per L (range = R20 - R100 per L; SD = R37.77 per L). At the time of the study, most of the respondents (66.67 %) no longer had any worms left from the harvesting season. Most respondents (97.73%) indicated that they were happy to have participated and that they wanted to participate again (Table 8). The reasoning was attributed to being able to get food and income (material wellbeing), the building of social connections by meeting new people (social wellbeing), seeing, visiting and learning about new places (mental and spiritual wellbeing) and feeling safe and looked after (security wellbeing).

Unintended consequences of actions can result in tangible and intangible costs which may outweigh benefits. As such, negative impacts associated with participating in the harvest were recorded. A direct impact on material wellbeing (cash) involved the payment of transport costs to and from the harvesting points, at a mean of R47.16 per person (range = R20 - R350; SD = R49.58). One participant spent R350, but she was a forum member who subsidised some of the transport costs for the other participants from her village. Other

Table 4

Individual harvester's reaction to hearing that they were chosen as participants in Mopane harvesting from the Kruger National Park, South Africa

Attitude	Theme	Sub-theme	Data source
Positive, happy	Hopeful about opportunity	Happy, interested, excited about opportunity	82.70%
		Happy, hopeful would get chosen	3.85%
		Happy and excited	A, G, D, E, F
	Benefits for self and family	Happy to get food/relish for self and family	5.77%
		Felt happy that the KNP was starting a new project that would benefit them	B
	Legal and safe access	Happy, glad going somewhere with permission, normally go to other reserves with no permission	1.92%
		Knew that they would be well looked after	E, G
	Will get more worms	Happy, better than private farms where lots of harvesting competition for worms	1.92%
	First access to KNP	Happy as it was the first time to the park	1.92%
		For many it would be the first time that they would be going into the park	C
Mixed feelings	Benefits but safety concerns	Had mixed feelings in the beginning including fear due to the potential risks of being threatened or injured by wild animals	C, E
		Happy and scared	1.92%

Where the data source is expressed as a %, the data is from semi-structured questionnaires (n=52), where the results are linked to a letter e.g., "C", the data is from focus groups, with the letter indicating the specific focus group where the data was collected (n=7)

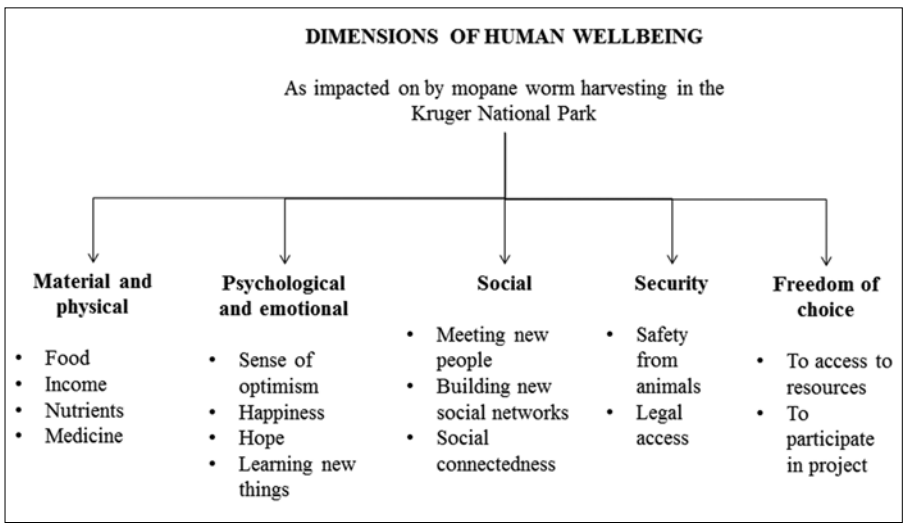

Figure 2

Contributions that mopane worm harvesting has made towards multiple dimensions of human wellbeing (Kruger National Park, South Africa)

arrangements included preparing food and water, a container for holding the worms, and protective clothing and shoes. The majority of respondents (56.81 %) indicated that they would have been doing domestic chores (including tending fields, collecting wood, and preparing food) had they not participated and these may have resulted in negative impacts on material, physical and social wellbeing dimensions at a household level. Others indicated that they would have done nothing/stayed at home (25 %), harvested elsewhere (11.36 %), harvested locally (9.09 %) or done other temporary work (2.27 %) on the day that they harvested. Some indicated that nothing else matters apart from mopane worm harvesting with others cancelling other planned trips in order to come and harvest in KNP.

Despite noting these costs, none of the respondents indicated that they perceived to have experienced a net negative impact on themselves or their families' wellbeing having participated in the harvesting. Respondents generally indicated that the operational part of the harvesting went well, with the only complaint being the challenges associated with driving on dirt roads in the rain (Table 9). Most respondents indicated that there was nothing they were unhappy with regarding the implementation and negotiation phases (82.61%), while some indicated that they would have liked more time to harvest (8.07%), more rangers (2.17%) and a different selection process as there were poorer households that were not chosen to participate (2.17%). The majority of respondents and focus groups suggested increasing the harvest time and the numbers of participants.

Perceptions of and impact on the conservation estate

Perceptions of the KNP are thought to be driven in part by direct or indirect interactions that neighbouring people have with the KNP and or the KNP staff. However, it is important to put these perspectives into the broader context of village life in order to provide insight into the relative impact that KNP has

Table 5

Respondent's perceptions of their family's reactions on being chosen to participate in the harvesting of mopane worms from the Kruger National Park, South Africa

Attitude	Theme	Sub-theme	Data source
Positive, happy	Supportive and helpful	Happy, supportive and helpful	64%
		Family members helped the harvesters to prepare for the harvesting process in some cases contributing to the travelling costs	A
		Helped to clean the worms afterwards	C
	Hopeful of benefits	Children happy and hopeful respondents would bring something home (eg. food/money for school fees)	2%
	Excitement about access to KNP	Most families of the harvesters expressed happiness and excitement at the prospect of their family member going into the park to harvest worms	A, B, C, E
		It was the first time they had ever visited KNP	F
Mixed feelings	Supportive and happy but concerned about safety	Happy, supportive, helpful, concerned about safety and injury	8%
		Mixed feelings of both joy as well as concern	D
	Happy but children concerned about safety	Happy, children concerned about parents safety from wild animals (eg. python)	2%
	Concerned about safety, but changed when saw benefits	Family warned participants to be careful but then changed their minds later once they saw the benefits that the participants had got	F
Negative, concerned, afraid	Safety and injury or death concerns	Concerned about safety and injury	16%
		Afraid respondents would not return	2%
		Afraid for the safety of the harvesters and told stories of dangerous pythons, elephants and lions that could injure or kill the harvesters	G
	Families fear made participants afraid, but they still participated	Families' concern elicited fear in participants, but they participated none the less	2%
Neutral	NA	Not concerned	4%

Where the data source is expressed as a %, the data is from semi-structured questionnaires (n=52), where the results are linked to a letter e.g., "C", the data is from focus groups, with the letter indicating the specific focus group where the data was collected (n=7)

Table 6

Respondent's perceptions of their community's reaction on hearing that they were chosen to participate in the harvesting of mopane worms (Kruger National Park, South Africa)

Attitude	Theme	Sub-theme	Data source
Positive, happy	Happy, hopeful	Happy and hopeful	21.57%
		Happy for the harvesters	D
	Encouraging	Wishing the harvesters well, emphasising that the worms outside the KNP were smaller and represented other species, not Mopane worms	A
Mixed feelings	Happy, hopeful but also envious	Happy and hopeful, jealous, envious	5.88%
		Mixed feelings but happy for harvesters	D
Negative, skepticism, jealousy, fear	Animosity, skeptical, envy, jealousy, fear of danger	Skeptical, animosity, jealous, fearful of danger	39.21%
		Skeptical and bitter suggesting to those chosen that they would get injured in the process	C, F
	Envy, jealousy	Wanted to go as well	15.69%
		Wanted to go as well, jealous were not chosen	A, B, F
		Jealous	9.80%
	Concerned	Concerned about logistics	1.96%
	Envy, jealous, skeptical about selection process	Jealous, skeptical and animosity, wanted to go, felt selection process was not transparent	3.92%
	Misunderstood financial implications	Misconception about being paid	1.96%
	Sad, hurt, disappointed	Sad and hurt	F
		Were upset, unhappy, frustrated and disappointed that they didn't get an opportunity	B, C, D, G
	Danger of wild animals	Concern about danger of wild animals, saying that the harvesters may be mauled by lions	C, E, G
		Threatened harvesters with stories of dangerous animals	C, F, G
		Afraid to go themselves	G
	Removed names due to fear	Afraid and asked to have their names removed	E, G
	Ancestors did not go	Said the grandparents had never gone so they should not either	F
Neutral	Did not have money	Were ok as they did not have money to go	G, E
	Envious but not unhappy	Also wanted to go but they were not unhappy	A
		Were not upset since the list had come from the *Nduna* (headman)	G

Where the data source is expressed as a %, the data is from semi-structured questionnaires (n=52), where the results are linked to a letter e.g., "C", the data is from focus groups, with the letter indicating the specific focus group where the data was collected (n=7)

on community wellbeing. We found that respondents all liked to live in their respective villages, with each area highlighting their own positive aspects and challenges of village life (Table 10). The best aspects of village life were associated with having access to benefits from the KNP (including visitation, employment, psychological benefits of living close to nature, and benefits from being able to harvest natural resources), access to natural resources more broadly and access to services such as electricity and water. One participant indicated *"…[because we live in this area we can] see wild animals, can show our children directly what animals such as impala look like*". Challenges associated with village life were either related to a lack of access to services (roads/transport, electricity, and water, education, and health care) or negative impacts associated with human-wildlife conflict (threats to human life, predation, herbivory, compensation, disease and livestock loss). As put by one respondent, "*…since the village is close to the KNP, we are not free to walk around, and especially when we are collecting fire wood we are scared of lions".*

Having good social relationships contributes positively to the social dimension of human wellbeing, and as such the perceptions of the respondents specifically regarding their relationship with the KNP was noted. Most respondents felt positive about their relationship with KNP as a result of the benefits associated with the park, the communication channels with the park and the changes in the park with regards to promoting new access opportunities. A respondent from a focus group indicated "*Our feeling is that the park is opening, unlike the old days*" (Table 11).

The focus group comprising people who had not participated in the project, were more neutral regarding their perceptions of their relationship with the park, yet still expressing hope that their relationship with KNP will grow stronger with one respondent indicating, "*Our relationship with KNP is not strong enough. But lately it does look as though the KNP is reaching out. We want to build strong relations with Kruger".* More specifically, respondents indicated that they felt differently about the KNP as a result of participating in the mopane worm project with one group stating, "*We feel that relations have improved, previously when we were collecting firewood and we heard the parks vehicle we would hide, but now we feel more relaxed*." Respondents attributed this change in their perceptions about the KNP to be as a result of a number of improvements to their wellbeing induced through the project, namely being granted access to the park resulting in them being able to see, experience, and benefit from the park directly themselves, something that they never thought was possible (social and material wellbeing). Respondents indicated that their perceptions of the park changed in that they were no longer afraid of either the people or the animals in the park (security wellbeing) and that their perceptions had changed as a result of improved relationships with the park (social wellbeing).

Anecdotal feedback from KNP staff after the harvesting suggested that the project had stimulated improved communication and relationships between park staff and neighbouring communities, with examples given of neighbours contacting park staff on occasions when they noticed something suspicious in their villages, post participation in the mopane worm project. Staff also reported a more positive attitude towards the park during community meetings as a result. Despite the overwhelmingly positive reactions of participants and their families to the project, also noteworthy were the reactions from the broader public on hearing about the mopane worm project via an official KNP news article (SANParks 2010b). At the time of the harvesting, interested parties could make public comments via the SANParks Forum that had an interactive link on the SANParks website. Although some of

Table 7
Mean volumes of worms harvested per person, per village, (Kruger National Park, South Africa)

Village	Mean volumes (liters) harvested per participant (range; Standard deviation)
Mninginisi	35.56 L (range=30-40 L; SD=5.27 L)
Plange	31.11 L (range=30-40 L; SD=3.33 L)
Mashobye	30.00 L (range=20-30 L; SD=4.88 L)
Magona	30.00 L (range=20-30 L; SD=6.32 L)
Altein	28.57 L (range=20-35 L; SD=3.54 L)
Lombard	12.40 L (range=10-15 L; SD=2.51 L)
Combined	**27.83 L (range=5-40 L; SD=9.27 L)**

Table 8
Rationale for future participation in mopane worm harvesting from the Kruger National Park, South Africa

Theme	Sub-theme	Data source
Opportunity to get food for self and family	Need the worms (eat or sell) to help my family	74.29%
	More worms than elsewhere	2.86%
	It was the only opportunity to harvest worms	2.85%
	Need the worms (eat or sell) to help family	A, D
Social interactions and new experiences	To see animals, to meet and spend time with the staff (ranger)	11.43%
Personal satisfaction	Felt good	5.71%
New experiences	First visit to the park	C, E
	Was a new place to visit, was the first time to see KNP from the road	E
Felt safe and secure	Felt safe, were looked after and treated well	8.57%
	Felt safe, were looked after and treated well	C, D
	Would come again despite not getting many worms, as felt secure	B, C

Where the data source is expressed as a %, the data is from semi-structured questionnaires (n=52), where the results are linked to a letter e.g., "C", the data is from focus groups, with the letter indicating the specific focus group where the data was collected (n=7)

Table 9

Perceptions of project operations and suggestions for improvement for mopane worm harvesting from the Kruger National Park, South Africa

Perceptions on operational side of harvesting		
Theme	**Sub-theme**	**Data source**
Positive-general	Operational part of the harvesting went very well	B, C, D, E
Positive-experience	When the harvesting was over, they did not want to come out as it had felt like they were on a touring trip	C
Positive-staff	The rangers were commended as being very friendly	C, E
Positive-safety	Good, staff looked after the harvesters well	A, F
	Make the harvesters feel safe and not scared	B
	Harvesters obeyed the rules	A
Negative-road conditions	Harvested during the rain, which made it difficult to drive on the roads	A
Suggestions for improvement		
Theme	**Sub-theme**	**Data source**
None	None	9.80%
More time	A longer harvesting time and/or more harvesting days	62.75%
	Allow sleep over for more time	5.88%
	More time to harvest in the park	A, B, D, E, F
	Including overnight stays	C, F
Different time	Later in season (worms small)	1.96%
More participants	More participants/villages per day	7.84%
	Increasing the number of participants	B, C, D, E
More rangers	More rangers specifically to allow harvesters to cover more ground, to not get left behind and to not get lost	7.84%
	More rangers	B, C
	Having a consistent number of rangers per group (there were perceptions that some groups got more rangers which would have allowed them to harvest more)	C
Earlier communication	Earlier communication	5.88%
	Improved, earlier communication regarding harvesting operations	F
Place to process worms	Place for cleaning and drying	5.88%
Repair fence	Repair fence	5.88%
Secondary benefits	Exploring the option of using a local temporary security company	A
Harvesting area	Not taking people to areas that have already been harvested	C

Where the data source is expressed as a %, the data is from semi-structured questionnaires (n=52), where the results are linked to a letter e.g., "C", the data is from focus groups, with the letter indicating the specific focus group where the data was collected (n=7).

the comments were neutral or positive, there was a strong theme of concern and negativity from people on the electronic forum on hearing about the harvesting, with comments such as, *"Is this a joke? I cannot believe this…KNP is losing focus here in a big way*" dominating the thread.

DISCUSSION

Our study demonstrated that facilitating access to small scale resource use from within a protected area contributes positively to local livelihoods in areas where natural resources are in demand and competition for resources is high (Matsika et al. 2013). We illustrated that while net benefits are accrued at an individual and household level, there is potential for communities at large to feel aggrieved about the process if they are not included, with the specific selection process playing a role in driving these perceptions. Randomly selected participation (eg. names being "drawn from a hat") seemed more broadly acceptable than when participants were chosen based on their economic status (poorest of the poor). These results suggest that scale and local context (i.e., level of engagement with the project/or conservation area) are important to consider when conducting social and economic impact assessment and perception studies in and adjacent to conservation areas.

We demonstrated that the worms harvested from the KNP contributed positively to the physical components of participant and household wellbeing. The worms were mostly used for household consumption, but were equivalent to approximately half the financial value of one month's income for participating households, a significant amount if one considers the costs of replacement items (Shackleton and Shackleton 2004). Those that sold worms, accrued about R517 each (9.58 times the minimum daily wage for farm workers in South Africa at the time of the study) (DOL 2008). Other studies have shown that although the number of households that sell wild harvested products (as opposed to using them in the household) is relatively small, the relative contribution that this form of income makes towards poorer household livelihoods is significant (Shackleton and Shackleton 2004). For most participants the worm harvest in the park was their only source of worms, with worms being the primary source of protein (together with fish and chicken feet) for many respondent households.

Consumption of 100g of mopane worms is estimated to contain up to 76% of a humans daily protein requirements

Table 10
Most positive and most challenging aspects of village life according to participants in mopane worm harvesting from the Kruger National Park, South Africa

Positive aspects of village life		
Theme	**Sub-theme**	**Focus group**
Access to benefits from KNP	Opportunities to benefit from the KNP through visitation, employment or resource use	C, D, F
	Access to meat from animals that escape from the park/are shot	C, F
	Opportunities to see wild animals and/or to show them to the younger generations	A, C
	Being close to nature, living close to KNP	D, F
	Opportunities for learners to access KNP free of charge	F
	Well maintained fence between KNP and the village	C
Access to natural resources	An ability to grow crops due to land and/or water access	A, E, G
	Opportunities to own livestock due to grazing land	A, D, E
	Access to natural resources e.g., wood, thatching grass and marula's to make beer	E
Access to services	Having access to electricity (although not everyone has access)	B
	Presence of dams	E
	Access to drinking water	E
Most challenging aspects of village life		
Theme	**Sub-theme**	**Focus group**
Access to roads and transport	Lack of transport during rainy season	A, E
	Bad roads	D, E
	Difficulty in getting public transport from secondary roads	E, G
	No bridges	E
	Dangerous roads due to animals	E
Access to electricity and water	Lack of access to electricity (although some in village do have)	B
	Lack of access to water	B
Access to education	No high school	E
Access to health care	No clinic	E
	Mosquitoes and malaria	E
Human wildlife conflict	Livestock predation	A, B, C, F
	No compensation for HWC	C, F
	Losing cattle that wonder into KNP through broken fences and then get shot	C
	Large herbivores raiding crops	C
	Foot and mouth disease	E
	Crocodile predation on livestock and people (children)	E

Data from focus groups, A-G (n=7)

(Makhado et al. 2014) suggesting that the worms harvested in KNP would have contributed the equivalent protein requirements for 114.21 "people protein days" per household. Mopane worm harvesting is a short season, but dried worms can contribute nutrition and income over a longer period when available in large enough quantities and the December/January harvest season coincides with additional expenditure on school related costs just after Christmas (Shackleton and Shackleton 2004). Most harvesters in our study were women, despite the invitation being open to both genders, many of whom were single household heads, over the age of 40 with no additional source of income. Insect collecting and processing by women is common (Hunter et al. 1990; Munthali and Mughogho 1992) with insects in some cases contributing a higher proportion of the diets of women and children in comparison to men (Illger and Nel 2000) suggesting that sustainable resource use opportunities have the potential to benefit marginalised and vulnerable groups more who are less likely to have other opportunities such as those linked to youth development (youth are defined as between the ages of 18 and 35).

Our study further highlighted that apart from the important material benefits of the harvested worms (food, income, nutrition, medicine), additional impacts included the psychological (sense of optimism, hope, happiness and learning new things), social (meeting new people, building new networks and social connections), security (safety from animals and having legal access to a resource), and freedom of choice (to access resources) dimensions of human wellbeing (Figure 3). Although it has been suggested that basic human needs must be met before higher level, intangible needs are prioritised (Maslow 1943), some suggest that the psychological components of wellbeing can contribute a larger fraction of overall wellbeing (Bartels et al. 2019). Although the wellbeing dimensions can be assessed separately, their linkages are also important, with increased levels of physical health widely recorded as a driver for increased psychological wellbeing among various age groups (Edwards et al. 2005). Also relevant is the engagement with nature through direct exposure and connectedness which has shown a positive impact on psychological wellbeing (Kamitsis and Francis 2013).

Table 11
Mopane worm harvester's broad perceptions of the Kruger National Park, and the specific influence of mopane worm project on harvesters relationships with the KNP

Broad perceptions of harvesters' relationship with the KNP			
Attitude	**Theme**	**Sub-theme**	**Focus group**
Positive	Broadly positive	Good	A, B, E, F
		See the KNP positively	A, B, D, E
	Aesthetic	KNP is a beautiful place	F
	Linked to benefits	Receive temporary and permanent job opportunities from the park	D, E
		Are beneficiaries of the park	C
		Glad that the KNP wants to share the park's resources	C
	Linked to communication	Strong and positive due to community forum (Hlanganani)	C
		Are informed by everything done in the KNP	D
		Have good communication including on DCA's and this was said to be in contrary to that of LEDET	D
	Linked to KNP changing	KNP is opening up and changing in comparison to previous times	B
		Previously harvesters could only see worms on trees through the fence, now they have access to those worms	C
Neutral	Need for improvement	There remains a need for jobs and more donations for special events	G
		Not strong enough, but looks like KNP is reaching out, we want to build strong relations with KNP	G
Influence of Mopane worm harvesting on perceptions			
Attitude	**Theme**	**Sub-theme**	**Focus group**
Positive, improved relationship	Broadly positive	Perceptions of the park have been influenced in a positive way	C, E, F
	Access to KNP for getting worms	Opened up their eyes expressing a need to want to come again	A
		Having been allowed to enter the park resulted in them seeing the park differently	G
		Perceive that the park is opening up unlike previous times	B
		Enabled harvesters to realise how beautiful the park is on the inside	B
		Initially thought they would never get access to KNP to walk around	G
	Safety	Need not be afraid of the animals there	D
	Improved relationship	Relationship with the park has improved as a result	C

As determined during focus groups, with the letter indicating the specific focus group where the data was collected (n=7)

The psychological impacts of learning linked to the harvesting included visiting the park (for the first time in some cases), seeing animals, and spending time with and getting to know the park staff. Learning new things promotes greater satisfaction and optimism, can boost self-confidence and can help build a sense of purpose in so doing contributing positively to mental wellbeing (NHS 2019). Informal learning processes (such as those associated with the learning experiences of being part of the mopane worm harvesting project) have been associated with higher wellbeing (Jenkins and Mostafa 2015), while learning amongst older adults promotes an active and engaged lifestyle (Merriam and Kee 2014).

We therefore suggest that the learning experiences associated with the mopane worm harvesting clustered under the theme of 'seeing new places and things' contributed positively to psychological and mental wellbeing of participants, over and above the worms being a source of food and income. In addition to the learning that already took place, such projects can provide an additional space for more structured 'social learning', described as learning by all stakeholders to manage the issues in which they have a stake (Ridder et al. 2005). Outcomes from social learning processes include knowledge, improved relationships, and a change in values, all of which have the potential for positive protected area benefit sharing outcomes (Lumosi et al. 2019). Learning with others increases social capital by helping to develop social competencies, extending social networks and promoting shared norms and tolerance of others (Field 2009). Meeting new people and building social connections with SANParks staff was perceived by participants to be an additional benefit, and we suggest that this is due to the contribution that building social connections (and social cohesion) make towards the social wellbeing of individuals and groups (Narayan et al. 2000). We feel that these observations are particularly relevant in rural contexts adjacent to parks where people do not necessarily have opportunities to leave the area, to find work, nor to learn new things nor to meet people from outside of their own local settings.

Our study highlighted that participants perceive good communication and engagement with park personnel to be an important driver of relationships between themselves and the KNP, both prior to and as a result of participation in the mopane worm harvesting. People-parks relationships are defined as historical and current connections with "the people" and "the place" of protected areas (Allendof 2010), hence this is an important observation as it is often assumed that positive perceptions and relationships can be built through the sharing of tangible benefits alone. This suggests that by promoting access for people to enter and harvest resources from land that they had been denied access to previously can play a role in reconnecting people to the land, and in so doing to building relationships between people and natural and cultural resources inside of protected areas.

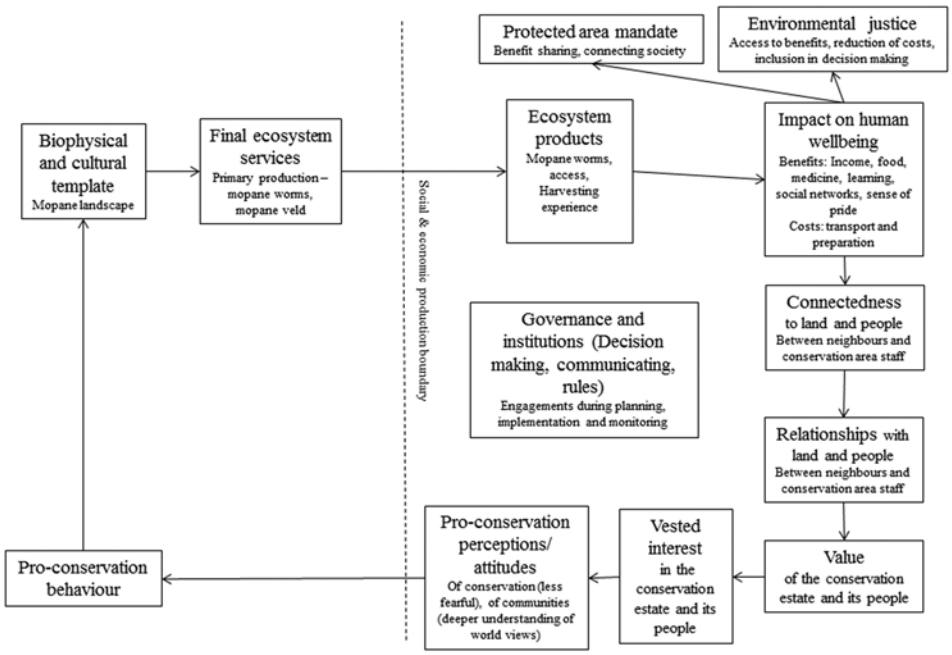

Figure 3

Ecosystem service cascade interpreted in the context of mopane worm harvesting from the Kruger National park, South Africa Adapted from Swemmer et al. (2017)

Also broadly referred to as social capital, social bonds or connections are networks of relationships among people that enable society to function effectively and to access resources (Lin 2001). Social capital can be bonding (within homogenous groups) or bridging (between groups) (Smith 2000-2009), and we suggest that mopane worm harvesting contributed to the building of bridging social capital between harvesters and SANParks staff, something that is often missing in disadvantaged communities contributing to them being caught in the poverty trap (Villalonga-Olives and Kawachi 2015). Where social capital exists, it is assumed that the benefits of working together would outweigh the costs (Villalonga-Olives and Kawachi 2015), with trust and reciprocity, key components of social capital, facilitating further cooperation, reducing transactional costs, enhancing long term agreements and promoting collective action (Smith 2000-2009). Hence, in the absence of social capital, individuals tend to act in an asocial manner, in their own interest with low levels of collaboration and at the expense of the larger group.

Social bonding (between conservation and societal actors) resulting from people-people engagement throughout the benefit sharing governance processes (including planning, implementation and monitoring) stimulates social connectedness that results from mutual understandings between groups and leading to the building of positive relationships and trust seemingly regardless of the tangible benefits (e.g. worms harvested).

Although we did not explicitly measure behaviour, we suggest that social connectedness between people working in conservation areas (as opposed to the agency itself) and people living alongside these conservation areas provide an opportunity for, as well as stimulate a willingness to work together towards relevant, common goals while reducing the likelihood of one party making decisions that may not be in the other's best interest (some examples could include poaching and social unrest from a neighbouring community perspective, and human wildlife conflict, and/or communication and level of engagement in decision making from a conservation perspective). An important acknowledgement that needs to be highlighted is that despite the benefits of building social capital between conservation agency staff and participants through engagement opportunities created through data collection processes such as this, there remains a potential for bias in situations where respondents may choose to respond to questions in a manner that will be in their favour for future engagement with the conservation area, as opposed to otherwise. It would be difficult for the researchers to assess whether or not this was the case for this case study, however, it was clarified that responses would be treated as confidential and respondents were asked to respond as truthfully as they could so that the process accurately reflected their perceptions, in order to monitor effectively and subsequently adapt the project where necessary.

Although we have been able to demonstrate that the mopane worm project has had positive impacts on human wellbeing, positive impacts on perceptions and subsequent attitudes towards conservation, and has built social capital between actors, it is important to acknowledge that the link between perceptions, attitudes, and behaviour are complex, non-linear, and dependent on various additional factors (Freymier and Nadler 2017). The greater the level of specificity (the link between the type and scale of attitude, and type and scale of behaviour being measured), the stronger the predictability of attitude influencing behaviour (Freymier and Nadler 2017). Equally important is the perception

of control over behaviour (greater perceived control resulting in greater likelihood of attitude influencing behaviour), how the attitude and perceptions were formed in the first place (direct experience being more likely to directly influence behaviour), how often the attitudes are accessed from the brain (spoken about and or engaged with), and the situational context within which the behaviour is performed (personal setting providing individual opportunity to act on and be responsible for behaviour, whereas a group setting provides anonymity) (Freymier and Nadler 2017). A more in depth study would be needed to specifically track the links between attitudes and behaviour in the context of resource use inside the park, especially if such studies were to inform how sharing benefits in this manner could have an impact on the degree to which people living adjacent to parks would play a role in the illegal wildlife trade.

Participants in the focus groups seemed broadly content living in their villages, with about half of the positive aspects of village life mentioned, being linked to the presence of the KNP (e.g. the opportunity to benefit from the park, to see wild animals and to live close to nature). The most commonly mentioned negative aspects of village life was human-wildlife conflict (HWC) which has been recorded as having a significant negative impact on livelihoods and subsequently a source of discontentment in communities living adjacent to the park (Rademan 2004; Anthony 2007). Noteworthy was that less than half of the negative impacts mentioned could be directly attributed to the KNP, with many respondents listing lack of access to services such as transport, water, electricity, sanitation, health and education as significant challenges of living in the area. In other studies, people living adjacent to the KNP have reported the frequency of household shocks experienced over a 5 year time frame as being mostly linked to climatic conditions, disease, lack of capital, and unemployment as opposed to being linked to their proximity to the KNP (Parent et al. 2012). Although this would need more careful exploration, this does suggest that despite being a very emotive issue, the perceptions that conservation areas have firstly an overall negative impact on neighbour wellbeing, and secondly, are responsible for the majority of the challenges faced by people living in these areas, may be overestimated.

Since the data was collected between 2 and 7 months post-harvest, it is unlikely that the positive feelings recorded are only temporary euphoria associated with the harvesting event. The one focus group that was held with the group of people whose harvesting day was cancelled, perceived their relationship with the KNP to be weak, but they indicated that they did feel that as a result of the engagement that the KNP was starting to reach out to them, and were hopeful that their relationship with the park would improve. Noteworthy is that despite not having participated, this focus group indicated that just having had the possibility of harvesting worms made the potential participants realise that they might get the chance to go into the park, and this had changed how they viewed the park. One focus group indicated that even if they didn't get many worms, they would still like to participate again. Normally, due to both ecological and economic sustainability principles, harvesting only takes place when mopane worm outbreak sizes are large based on the assumption that participants would only want to participate when they would have a good chance of harvesting enough to outweigh the costs (transport, opportunity costs, and preparation).

However, our research has shown that the benefits of participating go beyond just the worms harvested, including the learning opportunities of seeing new places, reconnecting to land as well as the social interactions and connections between new people that are built along the way. This suggests that potential harvesters should be part of the process of deciding whether it would be in their interests to harvest or not, not only for the positive outcomes that arise from effective governance (including co-decision making) (Ostrom 1990) but in order to provide access to benefits including the harvesting experience and social capital between harvesters and park staff. It is important to acknowledge that positive relationships require on-going positive and repeated engagement events, and these need to be maintained if relationships are to be nurtured and sustainable. The challenge with most protected areas is that they lack sufficient resources to allocate towards this task which can be time consuming and resource heavy.

The negative comments observed on the SANParks forum regarding the news of the mopane worm harvesting suggests a broader public resistance to such projects, most likely due to contrasting value systems, perceptions of protected areas being 'no-take zones' and perceptions that the harvesting of worms will have negative impacts on the conservation estate. A second media address was shared in response to the negative outcry, emphasising that the project was a pilot, would be implemented at a small scale, and that the impacts were being closely monitored and as such would not negatively impact the environment. Anecdotal observations subsequent to this suggest that the content of the second release (clarifying the small scale and scope of the project) alleviated many of the broader publics concerns in this regard. However this would need to be investigated further.

It is important to acknowledge that positive relationships leading to social capital are built over time as a result of multiple positive connections between people and places. As such, on-going engagement is required for such relationships to be sustained. It has been suggested that increased law enforcement in reaction to increased rhino poaching may lead to a hardening of boundaries between parks and neighbouring areas (Lunstrum 2014; Annecke and Masubulele. 2016). However, at the time of the study, rhino poaching had just started to escalate as had the subsequent responses by the KNP, and as such it is unlikely that there would have been significant negative, poaching related impacts on local neighbours. However, relationships are built on trust and reciprocity, and as such, any actions between conservation area staff and local communities that breaks trust could result in reduced relationship potential, further highlighting the potential positive role that such resource use projects can play in promoting access, softening borders, building conservation support and contributing to sustainability in a climate of increasing illegal wildlife trade.

Our findings are relevant to conservation agencies that aim to share conservation related benefits for human wellbeing and for building relationships, growing positive perceptions and in so doing, building long-term support for conservation. Our results are especially relevant where benefit sharing arrangements have an environmental justice focus, specifically regarding promoting access to tangible resources within protected areas through processes that aim to address the negative impacts of historical practices involving forced removals of people, and restricted access policies based on race. Globally, protected areas are facing challenges of illegal wildlife trade especially where social relationships with nearest neighbours may be fragile, and we suggest that projects such as the one described in this study have the potential to reduce conflict by acting as a catalyst for enhancing people and parks relationships at a small cost to conservation.

CONCLUSION

Our study demonstrates that despite the mopane worm harvest volumes being relatively small, and the harvesting seasonal, facilitating access for local neighbours to collect natural resources from protected areas such as the KNP has the potential to contribute positively to material (food and income), psychological (learning), social (connections) and security (safe and legal) dimensions of participant and household wellbeing. We further highlight that such processes can positively influence perceptions of and relationships between protected area staff and neighbours through the building of social capital between actors and we believe this to have mutually beneficial outcomes. We further suggest that broad stakeholder perceptions can be managed with transparent communication. In order to further understand project induced change in conservation related perceptions, attitudes and actions, future research could explore multi-scale indicators, focussing on behaviour measurement specificity and including a deeper investigation of social learning and connectedness over a longer time frame. More specifically, our study has the potential to inform global debate on consumptive resource use from protected areas by demonstrating that when done sustainably (ecologically, economically and socially), such initiatives could be used as a tool leading to environmental and social sustainability. We view this in the context of catalysing restorative and distributional justice processes in and around parks such as the KNP, with a history of unjust access, benefit sharing policies and practices.

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NOTES

1. The street value of mopane worms at the time of the study was R40/ L. At the time of writing this article, the street value was estimated to have doubled, with worms retailing at approximately R80/ L at main markets.

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