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Attitudes of local communities to wildlife conservation and non-consumptive, alternative income sources, near Kruger National Park, South Africa

T.P. Moorhouse [a,*,1], H. Ntuli [b,1], P. Nketiah [b], A. Elwin [c], N.C. D'Cruze [c]

[a] Oxford Wildlife Research, 64 Charles Street, Oxford, OX4 3AS, UK
[b] Department of Agricultural Economics, Extension and Rural Development, University of Pretoria, Agriculture Annex Building, Private Bag X20, Hatfield 0028, South Africa
[c] World Animal Protection (formally the World Society for the Protection of Animals), 222 Gray's Inn Road, London WC1X 8HB, UK

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ABSTRACT

Public pressure could end trophy hunting of wildlife, potentially negatively affecting species conservation and the human communities that depend upon the revenue hunting generates. Comparable revenue could be generated through other means (e.g. levies on tourists) and this money granted as subsidies to conserve wildlife and promote non-consumptive income streams. It is uncertain, however, whether communities near protected areas would accept such initiatives. We conducted face-to-face surveys in communities adjacent to Kruger National Park, South Africa, to examine attitudes towards, and perceptions of, wildlife conservation and levels of support for non-consumptive income sources.

We interviewed 1551 households across 12 communities. The vast majority of respondents supported protecting wildlife and non-consumptive wildlife use, and opposed consumptive uses of wildlife. We tested ten non-consumptive income alternatives, which were supported by >80.1 % of respondents. Where four of these had previously been implemented, 77.7–81.6 % of respondents rated their experience of them as "very good" or "good".

Respondents who were happier and had smaller households were more pro-conservation than those who were unhappier, with larger households. Household income and size may correlate with poverty levels, and therefore happiness, and serve as indices of respondents' capacity to support pro-conservation attitudes.

Attitudes to wildlife and willingness to accept novel income sources among communities adjacent to Kruger were sufficient to enact animal welfare and species conservation goals, were subsidies to be provided. We recommend further work implementing non-consumptive income streams in these communities to study how they influence people's happiness levels and wildlife conservation goals.

1. Introduction

Conflict between humans and wildlife is one of the most widespread and intractable issues facing conservation biologists today (Abas et al., 2025; Abrahms et al., 2023; Dickman, 2010). Such conflicts can be variable and complex. In some cases, relatively poor people can tolerate extreme losses from the presence of wildlife, while others experience few economic losses but are unwilling to live alongside a given species (Zimmermann et al., 2020).

Losses to humans from the presence of wildlife can arise from diverse sources (Dickman, 2010), e.g. through predation of livestock (Thirgood et al., 2005), crop-raiding or destruction of stored food (Pimentel et al., 2005; Perez and Pacheco, 2006; Dunham et al., 2010), direct attacks on humans (Loe and Roskaft, 2004; Packer et al., 2005; Dunham et al., 2010), disease transmission to stock or humans (Thirgood et al., 2005) or costs from the restriction of life choices that can result from people's proximity to conservation areas or the presence of wildlife (Woodroffe et al., 2005a, 2005b).

Conversely, the close proximity of human populations can have a series of negative impacts on wildlife populations (e.g. Macdonald et al., 2021), for example through retaliatory killings (Moreto, 2019; Swanepoel et al., 2014; Viollaz et al., 2021) and illegal harvesting of species

* Corresponding author.
[1] Joint first author.

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both inside and outside protected areas - for subsistence or commercial purposes, and as protest behaviour (Ntuli et al., 2021). The exploitation of wildlife for trade raises significant concerns due to its potential negative impacts on local ecosystems, species populations, and the well-being of indigenous communities whose livelihoods are dependent on the wildlife economy (Singh and Olofinbiyi, 2022). Furthermore, the illegal wildlife trade has been linked to organized crime networks and threats to global security (Anagnostou, 2021; Duffy, 2022; Wyatt et al., 2020). For these reasons meeting conservation objectives often requires measures to reduce forms of human-wildlife conflict, especially at the borders of national parks.

A subset of issues in human-wildlife conflict are raised by the practice of trophy hunting. Wildlife can be hunted for many purposes, including subsistence, wildlife population management, cultural and recreational reasons (Di Minin et al., 2021), but trophy hunting is a distinct form in which hunters (who can typically pay substantial sums to do so) target specific individual animals in order to keep body parts as "trophies" (e.g. Lindsey et al., 2007a, 2007b). The practice is increasingly at the centre of a number of contentious debates, within both the academic literature and the wider media and society in general (Yeomans et al., 2022; Batavia et al., 2019). While trophy hunting occurs for many species globally, in public discourse it has become particularly associated with charismatic African megafauna, and especially lions (*Panthera leo*) (e.g. Yeomans et al., 2022). As described in Moorhouse et al. (2024), the tenor of the current global debate surrounding trophy hunting is such that there exists a growing probability that trophy hunting could end in the near future in response to public pressure. Under current conditions – i.e. without measures to address any unintended consequences – many researchers and policy makers are concerned that the ending of trophy hunting could result in negative impacts, including on species conservation and on the livelihoods of communities that depend upon it as a source of income (Macdonald et al., 2017; Naidoo et al., 2016). They highlight that revenue generated by trophy hunting currently provides an incentive for rural communities (which are often relatively poor) and private landowners ('t Sas-Rolfes et al., 2022), and regional governments (e.g. Limpopo Provincial Government, 2023) to support conservation, and these financial incentives could be lost were trophy hunting to end (tsas't Sas-Rolfes et al., 2022). If financial incentives for conservation were to fall, a perceived risk is that local communities and private landowners may turn to alternative sources of income, such as poaching of wildlife (Mokgalo and van der Merwe, 2022) or transformation of natural habitats to other forms of land use (e.g. agricultural uses such as livestock ranging) that provide higher return on investments but with considerably lower conservation value (Di Minin et al., 2013). Some hunting revenue may be able to be replaced by ecotourism (Di Minin et al., 2013). Ecotourists, however, typically travel only to relatively accessible areas (Balmford et al., 2015). In Botswana, for example, only 22 % of the Northern Conservation Zone has intermediate or high potential for photographic tourism (Winterbach et al., 2015). A minimum of 1,394,000 km^2 of sub-Saharan Africa is used for trophy hunting, an area greater than currently encompassed by national parks (Lindsey et al., 2007a, 2007b).

Unintended negative consequences of ending trophy hunting for both wildlife and local human livelihoods could be avoided or ameliorated if the financial benefits were able to be replaced through other means. Payments to communities or landowners that are equal to or higher than revenue from trophy hunting would provide them with the option to keep trophy hunted species alive and receive payment for doing so, rather than eliminate those animals because of non-market values. The study by Moorhouse et al. (2024) of tourism and trophy hunting in South Africa suggested that such revenue replacement is possible. It established that given likely future trends in visitor numbers to South Africa, a modest levy on international travellers could entirely replace revenue that currently accrues from trophy hunting of targets species such as lions and elephants. As an example, a departure tax of $51 on air travellers should be sufficient to replace the entire revenue from trophy hunting in South Africa while remaining within the tolerance ($8.50 per day) of overseas travellers to pay (Moorhouse et al., 2024).

For the revenue generated from the above "lion levy" (Moorhouse et al., 2024), or any similar approach, to result in beneficial conservation and livelihood outcomes in South Africa (or at least to result in no net loss to either incomes or conservation status post the cessation of trophy hunting) it would be necessary for the money to be made available in the form of subsidies to South African landowners and communities. In particular these should go to those who currently make an income from involvement with trophy hunting concessions, accompanied by a binding directive to conserve wildlife and equitably distribute income among local communities that would otherwise be disenfranchised by the ending of an important source of income (Moorhouse et al., 2024). It remains unknown, however, whether communities in South Africa living adjacent to wildlife would be likely to support alternative income streams such as the lion levy, or to favour initiatives to conserve wildlife and make a transition away from using it consumptively. Human-wildlife interactions of local communities living adjacent to protected areas in Southern Africa can have disastrous consequences on both livelihoods and conservation outcomes (Abukari and Mwalyosi, 2020; Ntuli et al., 2019; Vedeld et al., 2012). In these communities benefits to humans of living adjacent to wildlife currently take the form of wildlife-origin meat and small amounts of income generated through trophy hunting, both legally and illegally (Ntuli et al., 2021; Ntuili and Muchapondwa, 2017). Interventions such as the lion levy, above, while sufficiently popular with overseas visitors to potentially replace revenue from trophy hunting, would ultimately fail to advance conservation objectives if rejected by local populations.

If local communities were to engage with conservation activities and non-consumptive wildlife uses (i.e. uses of that do not involve the killing or removal of animals), this could permit growth in wildlife populations. This in turn could risk an increase in human-wildlife conflict if wildlife became a nuisance to the community. If, however, proceeds from approaches such as the lion levy were invested in projects that divert effort from agricultural activities to alternative income sources - or to growing crops unlikely to be raided by wildlife, such as ginger (e.g. Gross et al., 2016) - such conflicts could be minimised.

In this study we employ face-to-face surveys with members of communities adjacent to Kruger National Park, South Africa - communities containing members who draw income from legal trophy hunting - to examine their attitudes towards, and perceptions of, wildlife, conservation and their level of support for non-consumptive income sources, in particular non-consumptive wildlife uses. Such alternatives would be adopted if their perceived benefits (financial and non-financial) were greater than their perceived costs and if those benefits were also perceived to be greater than persevering with the status quo (Biggs et al., 2017). We seek to understand whether local communities' attitudes are suitable to permit the adoption of alternative, non-consumptive livelihood choices, sufficient to decrease human-wildlife conflict in the region, and foster conservation and animal welfare objectives.

2. Methods

2.1. Study overview, context and location

We wished to study the perceptions of and attitudes towards consumptive and non-consumptive use of wildlife, and levels of acceptance of non-consumptive income sources, among respondents in 12 communities living adjacent to Kruger National Park in South Africa (Fig. 1). The study site is located in an arid region dominated by a mixture of savannah grasslands and woodlands with limited potential for crop cultivation, which makes livestock production the most dominant activity. The mean annual rainfall ranges from 210 mm to 500 mm while the mean annual temperature ranges from 32 °C to 40 °C. Development in the area varies between communities depending on

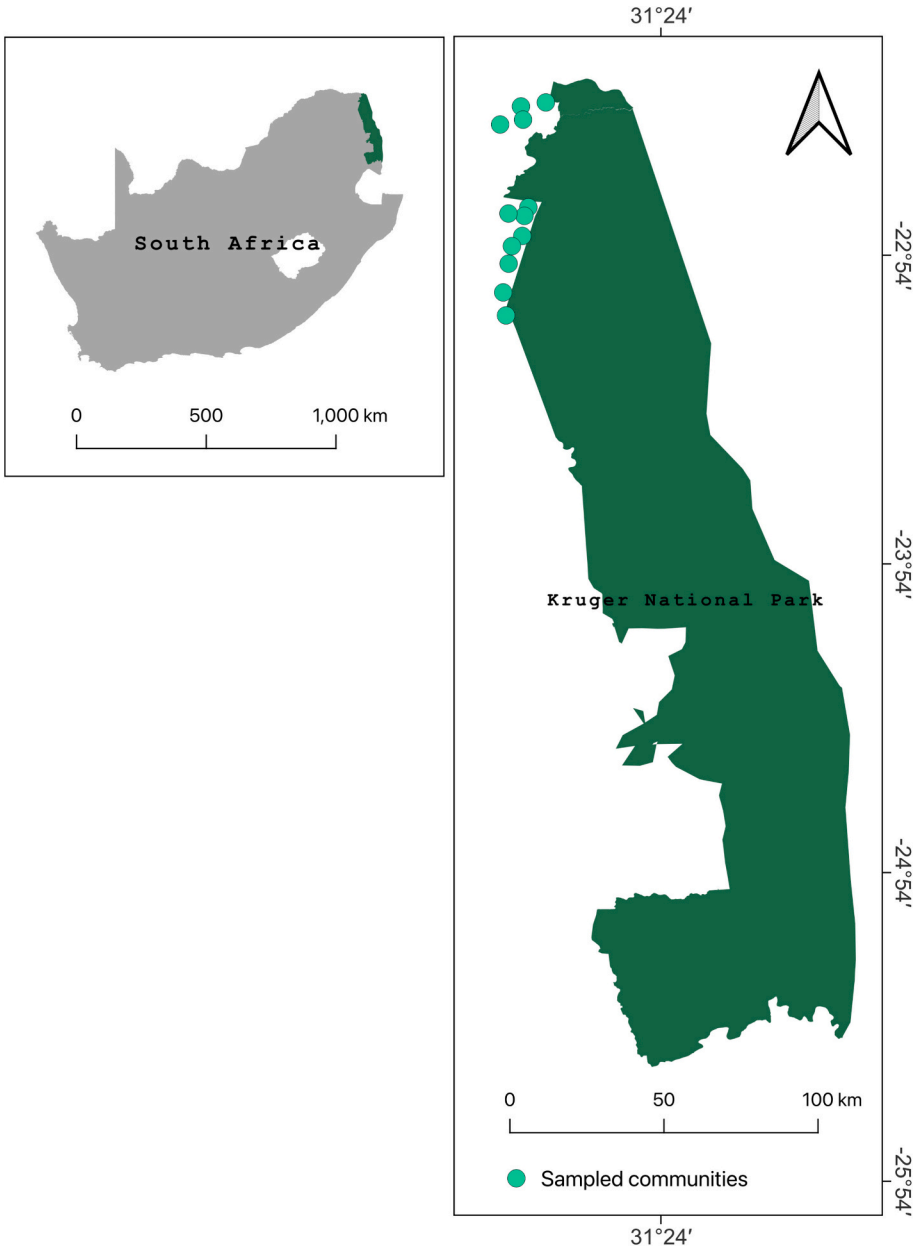

Fig. 1. Map of Kruger National Park, the study site and village communities surveyed.

their proximity to urban facilities such as shopping malls, schools and clinics. The region is characterised by very high unemployment and poverty due to limited livelihood opportunities. Human-wildlife conflict is increasing, exacerbated by the absence of a functional fence in some areas coupled with a decrease in the carrying capacity of protected areas - due to climate change and limited food availability - forcing large mammals to leave parks in search of food and water (Stoldt et al., 2020; Anthony et al., 2010; Ferguson and Hanks, 2012; Di Minin et al., 2021). In particular, elephants are known to be attracted to field crops during the agricultural season. Poaching is also rife in the area, particularly due to the destruction of household livelihoods (Ntuli et al., 2021; Sundström et al., 2019).

We surveyed communities located in the northern part of Kruger National Park. This location was selected based on the researchers' experience working in the landscape, the need to recruit communities that represent a range of socio-economic conditions, distances from the park boundary and proximity to the borders of Mozambique and Zimbabwe - where cross border poaching of wildlife is known to exist - and because many of these communities are implicated in the poaching of wildlife (Ntuli et al., 2019). Nine of the sampled communities were Shangani-speaking communities while the remaining were Venda-speaking communities.

Our study selected 1551 households, surveying household heads via a 40-question survey, administered face-to-face via mobile-devices. The survey instrument was designed following a desk review of literature, focus group discussions and key informant interviews with members of these communities to provide qualitative information that was used to refine the survey instrument. The questionnaire was administered by enumerators who were recruited and trained from across all communities sampled, and conducted in the respondents' local, daily language. To preserve anonymity enumerators were permitted only to survey in communities in which they were not resident. Households were selected at random, and quotas were stratified by community size such that more households were surveyed in larger communities.

In the survey we presented respondents with 14 attitudinal statements and asked them to rate their agreement with each (see below for

details). The attitudinal statements are presented in Table 1, and were designed to provide a range of propositions (framed both as positives and negatives) to test attitudes across four broad categories: perceptions about costs of living near wildlife and actions to mitigate these; perceptions about conservation and non-consumptive use of wildlife; perceptions around consumptive use of wildlife and its benefits, and; perceptions around human's impacts on animal welfare (Table 1).

We also presented respondents with 10 non-consumptive income sources that could potentially be implemented in their community, four of which had already been trialled in some communities (see Table 2). We asked them to state how likely they would be to support each income source, or, if the alternative had already been trialled in their community, how valuable they felt it to be (see below).

These questions were embedded in a more extensive survey, full details of which are available in the Supplementary Materials.

2.2. Survey questions and implementation

Surveys were conducted by local field staff in communities on the northern boundary of KNP between the 12th and 27th of January 2024. Each respondent was informed about the objective of the study and that they could opt to not answer any question, or opt out of the interview as a whole at any time. Informed consent was derived for each participant. All responses were pseudo-anonymised on collection, and no key linking the identity of respondents with the resulting datasets was retained.

Respondents were asked a series of initial questions eliciting demographic information including age, sex, educational level, employment status, ethnicity, religion, household size, household income amount and income sources. The distance of their village to the park boundary was estimated using Google Earth. They were then asked: "Thinking about the last few years, on an average day, how happy have

Table 1
Attitudinal statements presented to respondent, and the broad category into which they fit.

Attitudinal statement	Statement category
Sometimes, killing wild animals that threaten us or our livelihood is necessary.	Perceptions about costs of living near wildlife and actions to mitigate these
Wildlife causes a nuisance in this area	
Efforts should be made to protect every wild animal in its natural habitat rather than trading them for money or hunting them for food.	Perceptions about conservation and non-consumptive use of wildlife
Hunting wildlife is inconsistent with Ubuntu because Ubuntu emphasises care and respect for nature rather than exploiting it.	
I would prefer that we could make money from wild animals without hunting or killing them.	
I'm worried that wildlife could disappear if we keep hunting for commercial use.	
Traditional communities are the natural stewards of wildlife.	
Wildlife conservation generates jobs for people in this area.	
Wildlife is part of our heritage, and we should protect it.	
Hunting wild animals for commercial trade isn't a problem because plenty exists.	Perceptions around consumptive use of wildlife, and its benefits
Hunting wild animals has always been part of our culture, and we should keep doing it.	
If we were allowed to hunt wild animals to sell, our community would be better off.	
Hunting has negative welfare and well-being outcomes for wild animals.	Perceptions around human impacts on animal welfare
Wild animals have the ability to experience feelings like pleasure and pain, they have value in their own right, and should not be killed for commercial gain.	

Table 2
The proposed alternative, non-consumptive income sources presented to respondents.

Non-consumptive income source	Description of income source provided to respondent	Income source implemented in some communities?
Non-ecotourism income streams	Alternative livelihoods to reduce pressure on wildlife. Non-consumptive alternative incomes beyond the local community level for tourists, e.g., training and support for tailoring, handicraft/goods production, organic gardening, and agroforestry.	Yes
Communal vegetable gardens	The communities are allocated land for communal gardening projects.	Yes
Community craft tourism	Community given space inside or close to the national park / on the ecotourism route to sell art and craft to ecotourism visitors. e.g., local food (non-wildlife), drink, dance	Yes
Conservancy creation and community based natural resource management (CBNRM)	Conservancy creation gives rights over wildlife and tourism directly to local communities (empowering), allowing them to generate revenue how they see fit. Can support engagement in non-consumptive use, including active wildlife and habitat protection (e.g., employing anti-poaching game guards, guided tours – Safari.	Yes
Ecosystem service payments (wildlife credits)	Direct payments, usually to community organisations, for the proven presence of wildlife, increases in wildlife numbers, habitat protection and/or improvement. NGOs and government work with tourism lodges to create performance payments. E.g., Community paid to protect a critical wildlife corridor (elephants), or payments are linked to camera-trap recordings of predators.	No
Lion levy	Visitors to local community managed wildlife reserve / or National Park (KNP) pay a "levy" for wildlife protection. Community receive income from the levy based on their commitment to not poach or kill lions for human-wildlife conflict (HWC) unless absolutely necessary. Direct payments to community for proven reduction in poaching or killing of wildlife for HWC.	No
Biodiversity stewardship	Biodiversity stewardship is an approach to entering into agreements with private and communal landowners to protect and manage land in biodiversity priority areas, often close to NPs, led by conservation authorities in South Africa. Biodiversity stewardship is based on voluntary commitments from landowners, who are supported in managing the	No

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Table 2 (*continued*)

Non-consumptive income source	Description of income source provided to respondent	Income source implemented in some communities?
	biodiversity stewardship sites.	
Payments for ecosystem services (land leasing)	Leasing land that would usually be used for agriculture/grazing and using it for wildlife conservation efforts.	No
Digital solutions (online tourism)	Digital app/platform users can remotely engage in tourism activities (e.g., local guides follow wildlife and stream/share findings), or remote wildlife watching, including reporting of illegal activities.	No
Digital solutions (online sales)	Online sales of goods such as handicrafts.	No

you been with your life here?" with response options of "Very unhappy", "Quite unhappy", "Neither happy nor unhappy", "Quite happy" and "Very happy".

Next, respondents were read text that stated, "Here are some things that other people have said about wild animals. Please could you say how much you agree or disagree with each statement? Please note, by "hunting", we specifically mean killing wild animals for food or to sell, not to protect people, homes, or crops." They were then shown 14 attitudinal statements, and for each selected their level of agreement from the options: "Agree", "Somewhat agree", "Neither agree nor disagree", "Somewhat disagree", and "Disagree". The attitudinal statements are shown in Table 1.

Respondents were then presented with text that read "Here is a list of potential non-consumptive alternative sources of income. For each, please indicate your level of support for the intervention and why." The list of non-consumptive alternative income sources comprised 10 items (see Table 2), and for each respondents were asked to select their level of support from: "Fully oppose", "Somewhat oppose", "Neither support nor oppose", "Somewhat support" and "Fully support".

Of the 10 non-consumptive income sources, four had already been implemented in some communities in the study area (see Table 2). For these, respondents were asked if the alternative had been implemented (with a binary yes / no response) and, if it had, were then asked what was the "current state" of the alternative, with response options of "Very good", "Quite good", "Neither good nor bad", "Quite bad" and "Very bad".

2.3. Data analysis

Analysis of respondents' level of agreement with each attitudinal statement, and their degree of support for each non-consumptive income source, was conducted via ordinal logistic regressions, implemented in Program R (R Core Team, 2024) using the ordinal package (Christensen, 2015; Christensen, 2022), with the response variable derived from respondents' answers to create a five-point ordinal scale for each statement. In each analysis relevant explanatory variables were respondents' age (entered as a covariate), sex, village, distance from the border of the park (covariate), income amount (covariate), educational level (covariate), self-selected level of happiness (covariate) and the number of people living in their household (covariate). Distance from the border of the park was a property inherent to a given village, so these factors were confounded and unable to be entered into the same analysis. To permit analysis of the effects of distance from the border of the park, we constructed alternative models in which village was replaced by this factor.

3. Results

3.1. Overview, demographic and employment information

We gained full survey responses from 1551 respondents across the 12 communities surveyed. Of our respondents 976 (62.9 %) self identified as female, and 575 (37.1 %) as male. The average age of respondents was 44.5 years old (s.d. 15.5) ranging from 18 to 92. The majority of respondents identified as having Tsonga ethnicity (85.5 % of respondents) with 13.8 % identifying as Venda and 0.7 % identifying as other ethnicities. Regarding religion, 81.4 % identified as Christian, 10.6 % as non-religious, and 7.5 % as following a traditional African religion, with the remaining 0.5 % being "other" or Muslim. Mean household size was 4.9 people (s.d. 2.2).

Mean stated yearly household income was ZAR R48,333 (the equivalent of USD $2606), but with a substantial range (R0–2,160,000). Principal sources of income were social grants (e.g. disability or unemployment; 68.0 % of respondents), followed by private sector employment (e.g. working in retail, working on private farms; 12.2 %) and crops or livestock farming (10.8 %), firewood sales (8.4 %) and government employment (e.g. teacher, healthcare worker; 7.6 %). In addition 11.6 % of respondents stated that community members were employed in legal trophy hunting, 6.8 % stated that they personally hunted wild animals to sell, and 15.1 % that they hunted for subsistence.

Overall 34.2 % of the survey population derived some income from employment. Representing 27.3 % of female respondents and 45.7 % of males, and 184 (11.9 %) respondents were employed full time, of whom 96 (52.2 %) were female and 88 (47.8 %) were male. A further 111 (7.2 %) were employed part time, of whom 60 (54.1 %) were female and 51 (45.9 %) were male, and 234 respondents (15.1 %) were self employed, of whom 125 (53.0 %) were male and 110 (47.0 %) were female. By comparison, 838 (54.0 %) respondents were unemployed, of whom 620 (74.0 %) were female. The remaining 11.8 % of respondents comprised students (3.7 %), retirees and pensioners (6.2 %), and "other" (1.9 %, e.g. housewives).

3.2. Attitudes towards consumptive and non-consumptive use of wildlife

When asked to rate their level of agreement with attitudinal statements in Table 1, the vast majority of respondents indicated support for protecting and safeguarding wildlife, support for non-consumptive wildlife use, and opposition to the consumptive hunting of wildlife either for cultural reasons or commercial gain.

The highest levels of agreement were with the proposition that "Wildlife is part of our heritage and we should protect it", with 95.9 % of respondents agreeing (either stating that they agreed, 92.3 % or "somewhat" agreed, 3.6 %) and only 2.9 % of respondents indicating disagreement (Fig. 2). Similarly, agreement levels were above 90 % for the propositions that "Wild animals have the ability to experience feelings like pleasure and pain, they have value in their own right, and should not be killed for commercial gain" (94.3 %), "Efforts should be made to protect every wild animal in its natural habitat rather than trading them for money or hunting them for food" (92.3 %), and "Wildlife conservation generates jobs for people in this area" (90.7 %) (Fig. 2). Levels of agreement were above 85 % for the propositions that "Hunting wildlife is inconsistent with Ubuntu because Ubuntu emphasises care and respect for nature rather than exploiting it", "I'm worried that wildlife could disappear if we keep hunting for commercial use", "I would prefer that we could make money from wild animals without hunting or killing them", "Hunting has negative welfare and well-being outcomes for wild animals" and that "Traditional communities are the natural stewards of wildlife" (Fig. 2).

Two further propositions had majority, but more mixed, agreement and both involved human-wildlife conflicts: "Sometimes, killing wild animals that threaten us or our livelihood is necessary" (69.8 % agreement, 24.5 % disagreement) and "Wildlife causes a nuisance in this area"

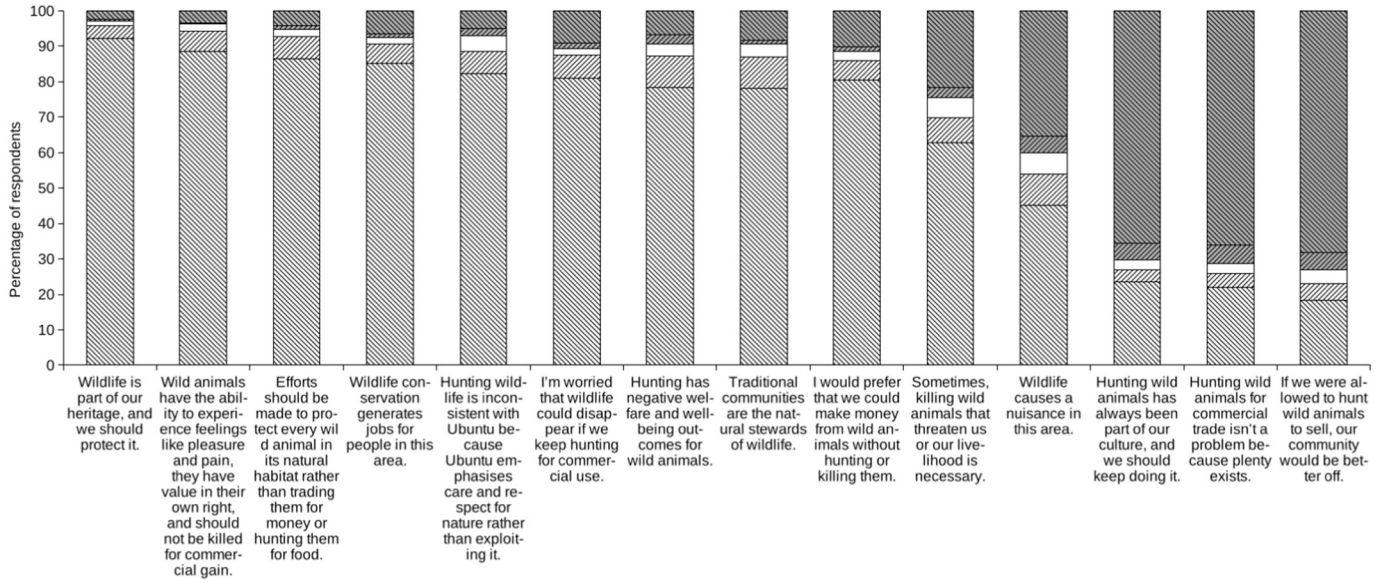

Fig. 2. The percentage of respondents agreeing with each attitudinal statement. From bottom to top each bar section represents "agree" and "somewhat agree" (hashed, unshaded), "neither agree nor disagree" (unhashed, unshaded), "somewhat disagree" and "disagree" (hashed, shaded).

(53.9 % agreement, 40.1 % disagreement") (Fig. 2).

The majority of respondents disagreed with the remaining three propositions: "Hunting wild animals has always been part of our culture, and we should keep doing it" (26.9 % agreement, 70.3 % disagreement), "Hunting wild animals for commercial trade isn't a problem because plenty exist" (25.9 % agreement, 71.4 % disagreement), and "If we were allowed to hunt wild animals to sell, our community would be better off" (22.0 % agreement, 73.0 % disagreement) (Fig. 2). All three propositions with majority disagreement addressed positive aspects of hunting wildlife.

Mean levels of agreement with each proposition varied between villages (Table 3). Coefficients for the effect of villages, however, revealed no consistent patterns in levels of agreement with different propositions: there was no indication that members of a given village were consistently more likely to agree or disagree with particular types of proposition.

For all but two propositions respondents' level of agreement was associated with their self-described level of happiness (Table 3). For the nine propositions with which >85 % of respondents agreed (Fig. 2), levels of agreement were positively correlated with levels of happiness (Table 3). Odds ratios for the effect of happiness on agreement with these propositions indicated that respondents with the greatest levels of happiness were between 1.4 and 3.1 times more likely to select higher levels of agreement than were those with the lowest levels. For the two propositions concerning wildlife conflict, which had mixed agreement ("Sometimes, killing wild animals that threaten us or our livelihood is necessary" and "Wildlife causes a nuisance in this area"), there was no evidence of a relationship between respondents' happiness and their level of agreement. Finally, for the three propositions concerning positive aspects of the consumptive hunting of wildlife, which all had majority disagreement, respondents' levels of happiness were negatively associated with agreement (odds ratios indicate that those with the highest happiness were 2.1 to 3.1 times more likely to disagree with the proposition than were those with the lowest levels of happiness).

For eight of the nine propositions for which agreement was >85 % (see Fig. 2), level of agreement inversely correlated with the size of the household (Table 3). For these eight propositions, respondents with the highest number of people in the household (17) were between 2.1 and 5.2 times less likely to select higher levels of agreement than those with only a single household occupant. For one of the three propositions with majority disagreement level of agreement was correlated with household size (Table 3), such that those with the highest number of people in the household were 4.6 times more likely to select higher levels of agreement than those with a single occupant.

Respondents' level of education was significantly positively correlated with higher levels of agreement with eight of the 11 propositions that had majority agreements (Table 3). Odds ratios reveal that the effect of education was such that those with the highest levels of education were between 2.1 and 3.3 times more likely to select higher levels of agreement with these propositions than those with the lowest levels of education. Educational level was also significantly negatively correlated with one of the three propositions that had majority disagreement, such that respondents with the highest education were 2.0 times more likely to select lower levels of agreement.

For the majority of propositions levels of agreement were unaffected by respondents' age, sex, level of income or distance to a park boundary (Table 3).

3.3. Factors affecting respondents' level of happiness

Respondents' self-reported level of happiness was predicted by their village (LRT = 44.021, $P < 0.001$), their income (LRT = 5.321, $p = 0.0211$) and the number of people living in their household (LRT = 6.335, $P = 0.0118$), in a model that also included their age (LRT 0.034, $P > 0.854$), sex (LRT 1.252, $P > 0.263$), and level of education (LRT = 0.260, $P > 0.610$). There was no indication of an effect of distance from park boundary in a separate model in which this factor was entered (LRT = 0.0061 $P > 0.93$).

Odds ratios for the effect of income reveal that respondents with the highest incomes were 3.6 times more likely to select higher levels of happiness than were those with the lowest incomes.

Odds ratios for the effect of household size reveal that respondents with the highest number of people in the household were 2.6 times more likely to select lower levels of happiness than those with only a single resident.

3.4. Level of support for non-consumptive income sources

Support for different non-consumptive income sources among our respondents was high. Four of the proposed alternatives had already been implemented by respondents from communities in the study area, and these four alternatives had the highest support among respondents.

Table 3
The results of likelihood ratio tests of factors affecting the level of agreement with attitudinal statements concerning conservation and non-consumptive use, animal welfare, costs of living with wildlife and perceived benefits of consumptive use of wildlife. Shaded cells were statistically significant at $P \leq 0.05$. Statements are ordered by overall percentage of agreement across all respondents ($n = 1551$). Figures quoted for the effect of distance were derived from separate analyses in which village was replaced by this factor.

		Source															
		Age		Sex		Village		Income		Education		Happiness		Household		Distance (separate analyses)	
% agree	Statement	LRT	P	LRT	P	LRT	P	LRT	P	LRT	P	LRT	P	LRT	P	LRT	P
95.9	Wildlife is part of our heritage, and we should protect it.	0.013	>0.91	1.20	0.273	26.73	0.005	4.24	0.039	0.135	0.714	9.01	0.003	5.41	0.020	2.926	0.0872
94.3	Wild animals have the ability to experience feelings like pleasure and pain, they have value in their own right, and should not be killed for commercial gain.	0.556	0.456	7.81	0.005	35.0	<0.001	0.572	0.449	1.57	0.210	20.20	<0.001	6.98	0.008	0.400	0.527
92.6	Efforts should be made to protect every wild animal in its natural habitat rather than trading them for money or hunting them for food.	1.02	0.312	8.27	0.004	28.4	0.003	0.615	0.433	6.33	0.012	9.21	0.00	5.49	0.019	9.57	0.0020
90.7	Wildlife conservation generates jobs for people in this area.	0.238	0.626	1.81	0.179	65.9	<0.001	0.187	0.665	5.89	0.015	14.7	<0.001	4.56	0.033	3.00	0.0831
88.7	Hunting wildlife is inconsistent with Ubuntu because Ubuntu emphasises care and respect for nature rather than exploiting it.	0.021	0.884	2.77	0.096	14.0	0.235	1.18	0.277	6.34	0.012	34.9	<0.001	8.15	0.004	1.013	0.314
87.6	I'm worried that wildlife could disappear if we keep hunting for commercial use.	0.187	0.665	3.41	0.065	28.0	0.003	1.86	0.172	7.53	0.006	4.46	0.035	4.26	0.039	2.24	0.135
87.4	Hunting has negative welfare and well-being outcomes for wild animals.	0.037	0.847	2.09	0.149	35.8	<0.001	1.94	0.164	11.2	0.001	29.3	<0.001	13.8	<0.001	0.769	0.380
86.9	Traditional communities are the natural stewards of wildlife.	0.002	0.962	0.126	0.723	92.8	<0.001	0.745	0.388	2.81	0.094.	12.3	<0.001	0.24	0.624	17.48	<0.001
85.9	I would prefer that we could make money from wild animals without hunting or killing them.	1.50	0.222	6.09	0.014	58.5	<0.001	0.799	0.371	4.37	0.037	3.91	0.048	3.86	0.049	7.44	0.00638
69.8	Sometimes, killing wild animals that threaten us or our livelihood is necessary.	0.060	0.805	1.21	0.271	37.4	<0.001	0.007	0.995	17.4	<0.001	1.13	0.287	0.010	0.919	2.829	0.0926
53.9	Wildlife causes a nuisance in this area.	3.85	0.0497	3.40	0.065	80.1	<0.001	0.238	0.626	11.3	<0.001	1.95	0.162	0.189	0.663	16.36	<0.001
26.9	Hunting wild animals has always been part of our culture, and we should keep doing it.	0.67	0.412	6.88	0.009	43.1	<0.001	6.76	0.009	5.37	0.021	18.5	<0.001	4.70	0.301	0.0471	0.828
25.9	Hunting wild animals for commercial trade isn't a problem because plenty exist.	0.448	0.503	0.985	0.321	40.4	<0.001	0.711	0.399	1.77	0.183	15.9	<0.001	13.8	<0.001	1.92	0.166
23.0	If we were allowed to hunt wild animals to sell, our community would be better off.	0.667	0.414	3.14	0.076	29.4	0.002	0.162	0.688	1.66	0.198	37.6	<0.001	2.39	0.122	0.188	0.665

In inverse order of levels of support these were non-ecotourism income streams (98.4 % support, comprising respondents who stated that they either supported or very much supported these initiatives), community craft tourism, communal vegetable gardens and community based natural resource management (CBNRM; 94.4 % support) (Fig. 3; Table 4). When analysing level of support for these four alternatives, responses were not recorded for those who had already implemented the measures - for such respondents we instead analysed levels of satisfaction with the implementation (see section below). The respective sample sizes for analyses of non-ecotourism income streams, community craft tourism, communal vegetable gardens and CBNRM were 974, 986, 608 and 832 respondents. The remaining six alternative income sources had not been implemented in any of the sampled communities, and the sample size comprised all 1551 respondents in each. In reverse order of support these were: ecosystem service payments (wildlife credits) (90.0 % support); digital solutions (online sales); digital solutions (online tourism); the lion levy; ecosystem services (land leasing), and; biodiversity stewardship (80.1 % support) (Fig. 3).

Mean levels of support for the non-consumptive income sources varied between villages for the six options not previously implemented (Table 4). We were unable, however, to control for an effect of respondents' village for the four options previously implemented, because the analysis was limited only to those respondents in communities in which the options had not previously been implemented.

The size of respondents' household was negatively correlated with levels of support for non-consumptive income sources in all ten analyses, significantly so in eight (Table 4). Odds ratios for the effect of household size across these eight analyses revealed that households containing the largest number of occupants (17) were between 2.5 and 10.6 times more likely to select lower levels of support than those with a single occupant.

Respondents' self-reported levels of happiness positively correlated with levels of support for non-consumptive income sources in all ten analyses, significantly so in six (Table 4). Odds ratios for the effect of happiness in these six analyses indicated that respondents reporting the highest happiness levels were between 1.6 and 4.0 times more likely to select higher levels of support than those with the lowest levels.

Respondents' age was inversely correlated with level of support for non-consumptive income sources in each analysis, but significantly so in six (Table 4). Odds ratios for the effect of age in these six analyses indicate that the oldest respondents (90) were between 1.5 and 8.2 times more likely to select lower levels of support for non-consumptive income options than were the youngest (18).

For the majority of propositions levels of support for non-consumptive income sources were not significantly affected by distance to the park boundary, respondents' sex, income or educational levels (Table 4).

3.5. *Levels of satisfaction with non-consumptive income streams where implemented*

When asked about the state of the four non-consumptive income streams that had been implemented in their communities, the vast majority of respondents expressed satisfaction (i.e. that the implementation was either “very good” or “quite good” for the community). Levels of satisfaction ranged from 77.7 % (for community craft tourism) to 81.6 % (CBNRM) (Fig. 4). Conversely the percentage of respondents reporting that the implementations were “quite bad” or “very bad” ranged from 10.1 % (non-ecotourism income streams) to 13.5 % (community craft tourism). Sample sizes for each were 565 (community craft tourism), 719 (CBNRM), 577 (non-ecotourism income streams), 943 (vegetable gardens).

4. Discussion

The overwhelming majority of respondents from villages adjacent to the boundary of Kruger National Park in South Africa indicated positive attitudes towards species conservation, non-consumptive wildlife uses and preserving animals' welfare, while indicating negative attitudes towards the consumptive hunting of wildlife (Fig. 2). The vast majority also indicated high levels of support for non-consumptive income sources, which would be consonant with the pursuit of biodiversity and animal welfare goals (Fig. 3). In communities in which four of the non-consumptive income sources had already been implemented (community crafts, CBNRM, non-ecotourism income streams and community vegetable gardens), levels of satisfaction with the schemes were high (in each case over three quarters of respondents expressing that the schemes were “quite good” or “very good”) (Fig. 4). This support for non-consumptive income sources is likely to reflect prevailing low levels of wage employment in the area (34.2 % of respondents derived income from working for paid wages, 11.9 % full time) and a concomitant reliance on government grants for income (68.0 % or respondents received either disability or unemployment benefit).

Combined, these findings strongly indicate that communities local to Kruger National Park would be highly likely to accept and support

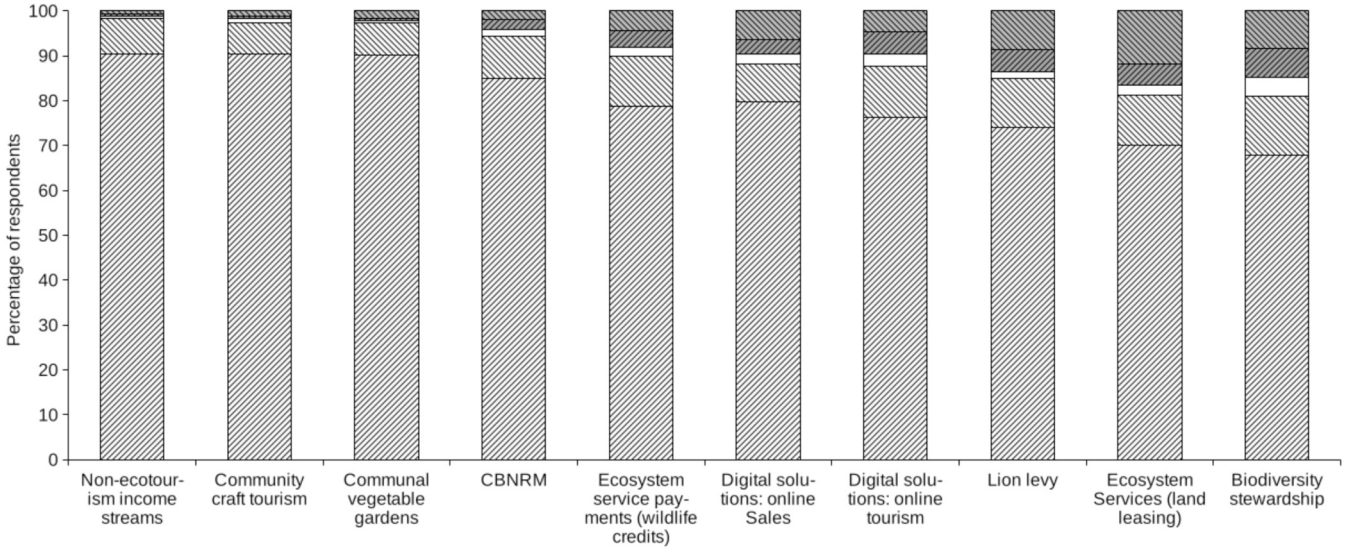

Fig. 3. The percentage of respondents stating each level of support for each non-consumptive income source. From bottom to top bar sections represent “fully support” and “somewhat support” (hashed, unshaded), “neither support nor oppose” (unhashed, unshaded), “somewhat oppose” and “oppose” (hashed, shaded).

Table 4
The results of likelihood ratio tests of factors affecting the level of support for each proposed alternative, non-consumptive income source. Shaded cells were statistically significant at $P \leq 0.05$. Statements are ordered by overall percentage of agreement across all respondents. For the top four income sources, responses were limited to only those communities that had not already implemented them ($n = 577, 565, 943, 719$, respectively). Sample size for the bottom six was the full survey cohort (n = 1551). Figures quoted for the effect of distance for the bottom six alternative income sources were derived from separate analyses, in which village was replaced in the analysis by this factor.

		Source															
		Age		Sex		Village		Income		Education		Happiness		Household		Distance	
% support	non-consumptive income source	LRT	P	LRT	P	LRT	P	LRT	P	LRT	P	LRT	P	LRT	P	LRT	P
98.4	Non-ecotourism income streams	7.48	0.0062	0.1017	0.7498	–	–	0.0001	0.9934	1.1944	0.2745	10.0	0.0016	7.8042	0.005	1.06	0.303
97.5	Community craft tourism	1.90	0.1677	1.1698	0.2794	–	–	0.0478	0.8269	0.2402	0.6240	14.1291	<0.001	5.1813	0.0228	4.51	0.0338
97.4	Communal vegetable gardens	5.01	0.0252	<0.001	0.9957	–	–	0.5514	0.4577	0.4976	0.4806	1.0266	0.3110	1.4456	0.2292	0.538	0.463
94.4	CBNRM	3.09	0.0790	8.12	0.0044	–	–	9.1740	0.0025	0.2551	0.6135	15.0432	<0.001	11.64	<0.001	0.106	0.745
90.0	Ecosystem service payments	7.21	0.007	6.967	0.008	42.2	<0.001	0.063	0.801	1.155	0.283	6.407	0.011	4.094	0.043	5.57	0.0183
88.3	Digital solutions (online sales)	30.0	<0.001	3.487	0.062	52.7	<0.001	0.258	0.611	0.006	0.937	0.429	0.513	1.303	0.254	0.144	0.704
87.6	Digital solutions (online tourism)	42.0	<0.001	2.480	0.115	40.7	<0.001	0.083	0.773	0.191	0.662	0.921	0.337	5.387	0.020	<0.001	0.994
85.0	Lion levy	0.486	0.486	0.896	0.344	27.6	0.004	1.090	0.297	0.004	0.947	9.942	0.002	8.208	0.004	1.37	0.242
81.2	Ecosystem services (land leasing)	2.076	0.150	1.781	0.182	35.05	<0.001	1.125	0.289	0.791	0.374	5.593	0.018	5.115	0.024	0.0013	0.972
81.1	Biodiversity stewardship	13.03	<0.001	3.654	0.056	39.07	<0.001	0.066	0.797	1.535	0.215	2.188	0.139	8.533	0.003	8.37	0.00381

conservation and livelihood initiatives designed to provide income and minimise human-wildlife conflicts, including conflicts arising from issues surrounding trophy hunting and its potential cessation. These findings support the contention of Moorhouse et al. (2024) that revenue from a "lion levy" - envisaged as a levy on international travellers to South Africa, sufficient to replace income from trophy hunting and disbursed to landowners and local communities - could enable local communities to achieve conservation objectives. In the current study, when the concept of payments to protect and conserve wildlife was explained to respondents, overall support for it was expressed by 85.0 % of respondents, with 74.0 % stating that they would "very much support" the initiative (Fig. 3). Levies to replace revenue from trophy hunting in South Africa would therefore be likely to gain sufficient support both from international tourists (Moorhouse et al., 2024) and local communities to permit the conservation of lions, and by extension other wildlife living in lion range habitats, while benefiting local populations and mitigating human-wildlife conflicts. The latter would occur through providing a sustainable source of revenue to local communities, predicated on achieving and maintaining conservation standards. For such schemes to be effective would require support from a number of other stakeholders, including government and private landowners, but our findings demonstrate that support from local communities is likely to be high.

Respondents' attitudes varied with their household size and self-reported levels of happiness. For the nine attitudinal propositions with which >85 % agreed (Fig. 2) the correlation was positive. Conversely for the three propositions with which the majority of respondents disagreed (all of which referred to positive aspects of hunting; Fig. 2), the correlation was negative (i.e. greater happiness correlated with higher disagreement). Happiness was not correlated with the only two attitudinal propositions that yielded mixed agreement among our respondents, which were "Sometimes, killing wild animals that threaten us or our livelihood is necessary" and "Wildlife causes a nuisance in this area". These latter propositions were unique in not representing an attitude towards conservation and/or the consumptive use of wildlife, but rather referencing costs of living alongside wildlife (c.f. Table 1), which, along with the mixed levels of agreement, may explain the lack of correlation with happiness levels for these two statements.

Similar patterns of association were evident for levels of agreement with the above propositions and household size, in that for the nine propositions with 85 % agreement, levels of agreement were inversely correlated with household size - statistically significantly so in eight of nine cases - and for the three propositions with majority disagreement levels of agreement were positively correlated with household size - statistically significantly so in one case.

The above associations between happiness, household size and agreement were also evident in levels of support for the ten non-consumptive income streams, which were inversely correlated with household size and positively correlated with respondents' self-reported levels of happiness, albeit that these correlations weren't statistically significant in all cases (in eight of 10 and six of 10 analyses, respectively; Table 2).

Taken together the above indicates that respondents who were more satisfied with life in their community, and who had smaller household sizes, had attitudes that were more pro-conservation than those who were unhappier, with larger households. The relationship between household size and happiness levels in this analysis is highly likely to be confounded. In a separate analysis respondents' level of happiness were positively associated with their level of income, and negatively associated with the number of people living in their household. Household overcrowding can negatively affect people's mental health status, with higher levels being associated with depression (Ruiz-Tagle and Urria, 2022). Similarly, married and cohabiting households in South Africa have been shown to have high household well-being, whereas larger household sizes had significantly lower reported well-being (Anakpo and Kollamparambil, 2021). At least part of this effect is likely to have

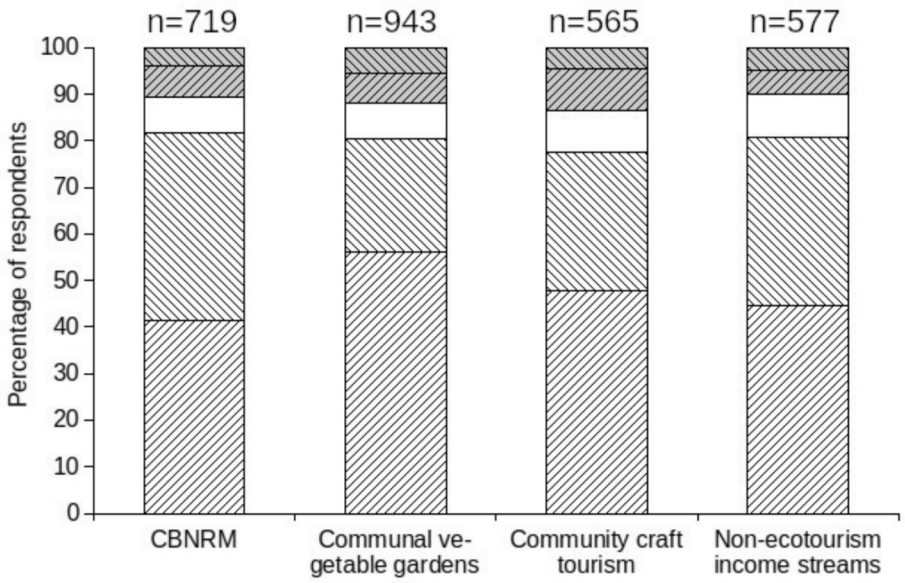

Fig. 4. The perceived state of four non-consumptive income sources where implemented by communities. From bottom to top bars represent "very good" and "quite good" (hashed, unshaded), "neither good nor bad" (unhashed, unshaded), "quite bad" and "very bad" (hashed, shaded).

been related to relative levels of wealth, in that extended households or households headed by females and grandparents in South Africa often have lower overall income and higher rates of consumption (Anakpo and Kollamparambil, 2021). Similarly, a report for the African Development Bank group highlighted that in Nigeria household size correlates with levels of poverty, with one-person households typically having reduced levels of poverty while each additional household member progressively increases the probability of being poor (Anyanwu, 2013). A number of studies have demonstrated that large families often do not support conservation initiatives, because they are typically poorer households and more likely to be dependent on natural resources for subsistence (Ntuli et al., 2021; Ntuli et al., 2019; Sundström et al., 2019). In our present study, therefore, it is highly plausible that respondents' household income and household size are inextricably linked with their levels of poverty and, by extension, happiness, which in turn serve as an index of respondents' capacity to support pro-conservation attitudes, and their likelihood of supporting non-consumptive income streams.

It is important to note that the background for the above relationship between happiness, household size, pro-conservation attitudes and support for non-consumptive income streams was that the vast majority (typically three quarters or more in all cases; Figs. 2,3) of respondents exhibited attitudes in favour of non-consumptive use of wildlife, and in favour of non-consumptive income streams. Our work therefore suggests that while levels of support were already high, they could be made higher still if levels of happiness among respondents were able to be increased, most probably through providing better opportunities, increased incomes or through reducing household sizes. Anakpo and Kollamparambil (2021) state that improving household well-being in South Africa is likely to require women to be provided with equal opportunities to work or earn income to reach a state of economic autonomy. Similarly, women's education and family planning programs have been shown to be the dominant determinants of fertility rates in sub-Saharan Africa (e.g. Bongaarts, 2020), with such programs operating by reducing both wanted and unwanted fertility. Similar education and family planning schemes could be expected to reduce household sizes in these communities. The implementation of non-consumptive income streams may well provide increased income to local communities, which should result in positive reinforcement of conservation benefits. In addition, we provide a tentative, initial recommendation that such schemes may be most beneficial if accompanied by interventions to permit the reduction of household sizes, through education and family planning initiatives.

Our study has a number of limitations. Our findings have value in demonstrating that in principle attitudes and dispositions in communities local to Kruger National Park create conditions appropriate to diminish human-wildlife conflict and work towards improvements in livelihood, biodiversity, conservation and animal welfare objectives. There may, however, prove to be a gap between respondents' stated attitudes and their real-life probability of desisting from consumptive uses of wildlife, engaging in pro-conservation activities or accepting/pro-actively participating in alternate income streams. We have no data to argue against this possibility. Our data do, however, test the hypothesis that these interventions would be acceptable in principle, assuming that if such propositions were unattractive in the abstract then they would be much less likely to be acceptable in real-world scenarios. These findings provide evidence that such alternatives are worth trialling. Sensible follow-ups may include workshops in different communities to investigate the practicalities of how alternatives could be implemented and what support is required, and/or to trial further non-consumptive income sources in a small number of communities, in order to ascertain whether the degree of uptake will be as large as indicated by the present survey, and whether the purported conservation benefits are realised.

Interpretation of our analyses is complicated by the non-experimental nature of our study, in which several factors were unavoidably correlated and therefore statistically confounded. As an example, respondents' levels of happiness co-varied with their village, their income and their household size, and all of these factors were entered as explanatory variables in our analyses of attitudinal statements and acceptance of non-consumptive income sources. An alternative approach to the analysis could have sought to reduce the multiple factors to a single representative factor (e.g. through exploratory factor analysis), or to undertake model selection through information-theoretic approaches (e.g. Akaike's Information Criterion; Anderson, 2008). We opted to avoid such approaches because the relationship between happiness, household size and attitudes and/or support of non-consumptive incomes was well delineated and consistent across analyses.

Each of our analyses revealed a strong effect of respondents' village, with this factor influencing their self-stated level of happiness, their

attitudes towards non-consumptive use of wildlife and - in the analyses in which village was able to be entered as an explanatory variable - their level of support for the non-consumptive income streams. The effect of village was, however, inconsistent across all propositions tested: respondents from a given village did not have consistently raised or lowered probabilities of agreement with similar propositions, but rather varied on an individual basis. We therefore draw no conclusions from the effect of village in the analyses, but rather include the term to control for a potentially extraneous source of error.

4.1. Conclusions

Our study was designed to reveal what attitudes residents of villages adjacent to the boundary of Kruger National Park in South Africa had towards non-consumptive use of wildlife, species conservation and animal welfare outcomes, and whether they would be likely to support the local implementation of initiatives aimed at providing income sources that do not involve the consumption of wildlife. Our results were derived from 1551 respondents across 12 communities and clearly indicate that the vast majority viewed their local wildlife as a resource to be protected and respected. Respondents did highlight that wildlife can cause a nuisance and that lethal control of animals that threaten lives of livelihoods may be viewed as legitimate by many, but outside of these circumstances consumptive use of animals (e.g. through hunting for sale) garnered majority disapproval. The overwhelming majority of respondents also stated that they would highly support initiatives to provide alternative, non-consumptive income sources in the area.

Respondents' attitudes towards wildlife and their support for non-consumptive income initiatives were strongly related to their level of happiness, which in turn was correlated with household income (as a positive) and household size (as a negative). Increasing incomes in the area, particularly for female household heads, and providing initiatives to increase education and family planning options may be expected to further increase happiness and well-being within the population and in turn the proportion holding pro-wildlife attitudes.

In the context of trophy hunting, our work provides a vital counterpoint to previous studies, by showing that not only are attitudes and willingness-to-pay among international visitors to South Africa sufficient to replace the revenue from trophy hunting (Moorhouse et al., 2024), but that attitudes to wildlife and willingness to accept novel income sources among the local populations are sufficient to permit such revenue to enact animal welfare and species conservation goals in areas adjacent to lion habitats. These findings are also highly relevant for South Africa's National Biodiversity Economy Strategy, which emphasises that: “South Africa promotes a diverse biodiversity-based economy that includes both non-consumptive and consumptive uses of all the benefits and services of biodiversity” (DFFE, 2023), demonstrating the acceptability of such ambitions among populations local to protected areas.

On the strength of the above evidence, we recommend that future work should seek to implement a selection of the above non-consumptive income streams in selected communities and monitor changes in residents' attitudes and feelings of contentedness with daily life, in tandem with wildlife population and conservation metrices.

CRediT authorship contribution statement

T.P. Moorhouse: Writing – original draft, Visualization, Formal analysis, Writing – review & editing, Methodology, Conceptualization. **H. Ntuli:** Writing – review & editing, Methodology, Project administration, Investigation, Writing – original draft. **P. Nketiah:** Methodology, Data curation, Writing – review & editing, Investigation. **A. Elwin:** Writing – review & editing, Writing – original draft, Conceptualization, Project administration. **N.C. D'Cruze:** Writing – review & editing, Methodology, Project administration, Conceptualization, Writing – original draft, Funding acquisition.

Ethics statement

The research was approved by the University of Pretoria's Faculty of Natural and Agricultural Sciences Ethics Committee on 02.10.23, reference number NAS201/2023.

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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Data availability

Data will be made available on request.

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