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Original research article

Drivers of hunting and photographic tourism income to communal conservancies in Namibia

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ABSTRACT

Hunting and photographic tourism provide ecosystem services that can facilitate conservation. Understanding factors influencing how tourism industries generate income is necessary to ensure sustainable community-based natural resource management. We evaluated effects of large mammal occurrence and landscape attributes on incomes from hunting and photographic tourism earned by communal conservancies in Namibia during 1998–2022. We compiled annual incomes and occurrence of 'Big 5' species (elephant [*Loxodonta africana*], buffalo [*Syncerus caffer*], black rhino [*Diceros bicornis*], lion [*Panthera leo*], and leopard [*P. pardus*]) using conservancy accounting and wildlife monitoring data. Hunting occurred in 70 of 86 conservancies and generated income almost twice as rapidly as photographic tourism (2.9 and 5.4 years after conservancy establishment, respectively). Hunting income increased with conservancy area and number of Big 5 species present but decreased with conservancy age and increasing mean elevation, topographic diversity, and distances to national parks. Photographic tourism occurred in 39 conservancies and generated 447 % greater median annual income than hunting for conservancies earning >$0. Big 5 species occurrence increased the probability conservancies earned >$0 photographic income but not the amount of photographic income. Photographic income increased with conservancy age and higher annual precipitation but decreased with higher mean elevation. Large mammals are an important driver of income to Namibia's conservancies and hunting and photographic tourism can provide complementary benefits. We recommend Namibia's conservancies, particularly those established more recently with smaller area, consider inter-conservancy wildlife co-management and collaboration with tourism industries to improve income potential and develop more sustainable community-based natural resource economies.

1. Introduction

A utilitarian approach to community-based conservation enables rural people to benefit from wildlife management through payment for ecosystem services (Naidoo et al., 2011a). Sustainable use of wildlife can accelerate development of community-based natural resource management (CBNRM) programs in southern Africa (Frost and Bond, 2008; Weaver et al., 2011). Tourist hunting provides localized socioeconomic benefits (Jones, 2009) and creates incentives for habitat conservation outside protected areas where

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there are limited alternative land uses for wildlife (Lindsey et al., 2006, 2007). Nature-based photographic tourism can also provide income to wildlife economies in some areas (WTO, 2014) with potential to support CBNRM's social and environmental objectives when local people are engaged (Mbaiwa and Kolawole, 2013).

Communities that rely on income from hunting and photographic tourism are vulnerable to wildlife trade policies and tourist market instability (Nattrass, 2021a). Importation bans on hunted wildlife are increasingly proposed and adopted in Euro-American jurisdictions (Lindsey et al., 2016). These trade restrictions are often justified morally (Horowitz, 2019) or as solutions to sustainability issues, but could adversely affect conservation funding (Di Minin et al., 2016), livelihoods of local communities (Mbaiwa, 2018), and biodiversity through land use change (Dickman et al., 2019). Novel zoonotic disease outbreaks also have increased calls to ban wildlife trade (Roe et al., 2020) and contributed to international travel restrictions which present further challenges to tourism that financially jeopardize communities (Hambira et al., 2021; Hulke et al., 2022).

Tourism benefits were volatile during the coronavirus disease 2019 (COVID-19) pandemic, emphasizing a need for improved information on CBNRM economic resiliency and income diversification strategies to reduce financial uncertainties (Lendelvo et al., 2020; Lindsey et al., 2020). Understanding factors that influence income from ecosystem services and implementation of tourism industries are necessary to ensure sustainability of CBNRM (Di Minin et al., 2021). Despite the importance of hunting and photographic tourism to conservation, few studies have investigated environmental drivers of income or compared relative economic performance across large spatial and temporal extents (Suich, 2010; Naidoo et al., 2016).

In Namibia, communal conservancies function as local wildlife governance institutions in a global resource-tourism network (Kalvelage et al., 2020) through leasing tourist concessions and forming joint venture partnerships with operators (Jones et al., 2015). Financial benefits from CBNRM generally increase with program age (Bandyopadhyay et al., 2009; Brooks, 2017), as older conservancies were often established in higher quality wildlife areas and had more time to build capacity, attract business partners, and develop tourist infrastructure (Humavindu and Stage, 2014). Larger conservancies could also benefit from economies of scale employing hunting and photographic tourism operations.

Large mammals, particularly high-value 'Big 5' species (elephant [*Loxodonta africana*], buffalo [*Syncerus caffer*], black rhino [*Diceros bicornis*], lion [*Panthera leo*], and leopard [*P. pardus*]; Di Minin et al., 2013), are an important income source for conservancies (Naidoo et al., 2011b), especially elephant and buffalo that yield high operator fees and hunting quotas on communal lands (Bond, 1994; Arntzen et al., 2003; Naidoo et al., 2016). Hunting fees are critical for funding conservancies' operational expenses (Naidoo et al., 2016) and efficient use of quotas optimizes wildlife-based income (Bollig, 2016). However, environmental factors like drought can reduce wildlife abundance and subsequent quota allocations (NACSO, 2021a). Black rhino and lion presence can increase photographic tourism (Muntifering et al., 2020, 2023a) and conservancies have recently received concessions within Namibia's national parks (MET, 2013), proximity to which could also increase wildlife abundance in nearby conservancies. Additional environmental attributes including topographic diversity and proximity to tourism infrastructure (Nattrass, 2021b; Kalvelage et al., 2021) can improve scenic value and tourist accessibility, respectively (Naidoo et al., 2011b).

We evaluated how incomes from hunting and photographic tourism earned by conservancies in Namibia during 1998–2022 were affected by large mammal occurrence and landscape attributes. We predicted both income sources would increase with years since conservancy establishment and be greater for larger conservancies with more Big 5 species present. We predicted that the number of Big 5 species present would have a stronger positive correlation with hunting income than with photographic income, while photographic income would have a stronger positive correlation with lower and more topographically diverse elevation and proximity to national parks and major roads. Finally, although precipitation can positively affect wildlife occurrence, we predicted that the mean amount of annual precipitation would not be correlated with either income source due to potential resilience of wildlife to drought years and competition with wildlife-based income from alternative land uses (e.g., agriculture, livestock) in conservancies receiving greater precipitation.

2. Study area

Namibia is a large (824,000 km^2) arid to semiarid country in southern Africa with desert to mixed savanna, shrubland, and woodland vegetation (Atlas of Namibia Team, 2022). Annual precipitation ranges from less than 50–650 mm and elevations are 0–2573 m above sea level (Atlas of Namibia Team, 2022). Namibia contains the world's largest free-ranging black rhino population (Muntifering et al., 2023b) and increasing elephant (Craig et al., 2021) and lion populations (Stander, 2019). Protected areas, communally managed wildlife areas, and private freehold lands used for wildlife ranching (Lindsey et al., 2013) combined represent about 46 % of Namibia's land area (NACSO, 2021b). Namibia is sparsely populated with 47 % of its 2.5 million people living in rural areas with high poverty and unemployment (NSA, 2021; WBG, 2023).

Economic potential for communal areas with high wildlife abundance was recognized in the 1990s (Ashley and Barnes, 1997) after commercialization of wildlife ranching on private lands (Republic of Namibia, 1975). Following Namibia's independence in 1990, progressive land use policies (e.g., MWCT, 1992; MET, 1995) led to the Nature Conservation Amendment Act (Republic of Namibia, 1996) which authorized communities to register customary landholdings as conservancies in 1998. Subsequent legislation enabled conservancy ownership and management of tourism enterprises (Republic of Namibia, 2002; MET, 2007). Conservancies are given conditional property rights and ownership over huntable wildlife and occur primarily in northwestern and northeastern Namibia (Jones, 1999). The conservancy program is managed by the Namibian Association of Community-Based Natural Resource Management Support Organizations (NACSO) and administered by the Ministry of Environment, Forestry and Tourism. The 86 registered conservancies represent about 20 % (166,179 km^2) of Namibia's land area and support more than 230,000 people (Fig. 1; NACSO, 2022).

3. Methods

We compiled data from NACSO including accounting records collected by conservancies during 1998–2022, years since conservancy establishment, and conservancy area. We used conservancy-led foot patrols, game counts, and wildlife monitoring data from NACSO to index annual occurrence of Big 5 species in each conservancy. We used a digital elevation model (30-m resolution) from the Shuttle Radar Topography Mission (RCMRD, 2017), national park boundaries and trunk roads (major roads for long distance travel) from the Environmental Information Service Namibia eLibrary (EISN, 2020; RAN, 2018), and annual precipitation data (5-km resolution) during 1998–2022 from the United States Geological Survey (Funk et al., 2015). We used conservancy boundaries from NACSO to estimate mean elevation, elevation standard deviation (SD), Euclidean distances to nearest national park border and trunk road, and annual precipitation for each conservancy in ArcGIS Pro (ESRI, 2022). Elevation data was spatially resampled to the resolution of annual precipitation data.

We estimated annual hunting income for each conservancy by summing concession and hunting fee payments to respective management committees, salaries earned by conservancy members, direct household payments, and in-kind benefits from hunting operators (i.e., non-financial benefits [e.g., game meat, development projects, donations, training, meals]) included in NACSO's accounting records. We estimated annual photographic income for each conservancy by summing concession fees, salaries earned by conservancy members, direct household payments, and in-kind benefits from photographic operators (excluding game meat). We used values of game meat from hunting operators (excluding conservancy harvest) calculated by NACSO using replacement-cost shadow prices applied nationally each year (Naidoo et al., 2016), which was 27 Namibian dollars (NAD)/kg in 2022 (NACSO, 2023). We standardized all income values to 2022 United States dollars (USD) using the geometrically averaged annual NAD to USD exchange rate (Bank of Namibia, 2023) and USD consumer price index during 1998–2022 (USBLS, 2023). Median income values are reported

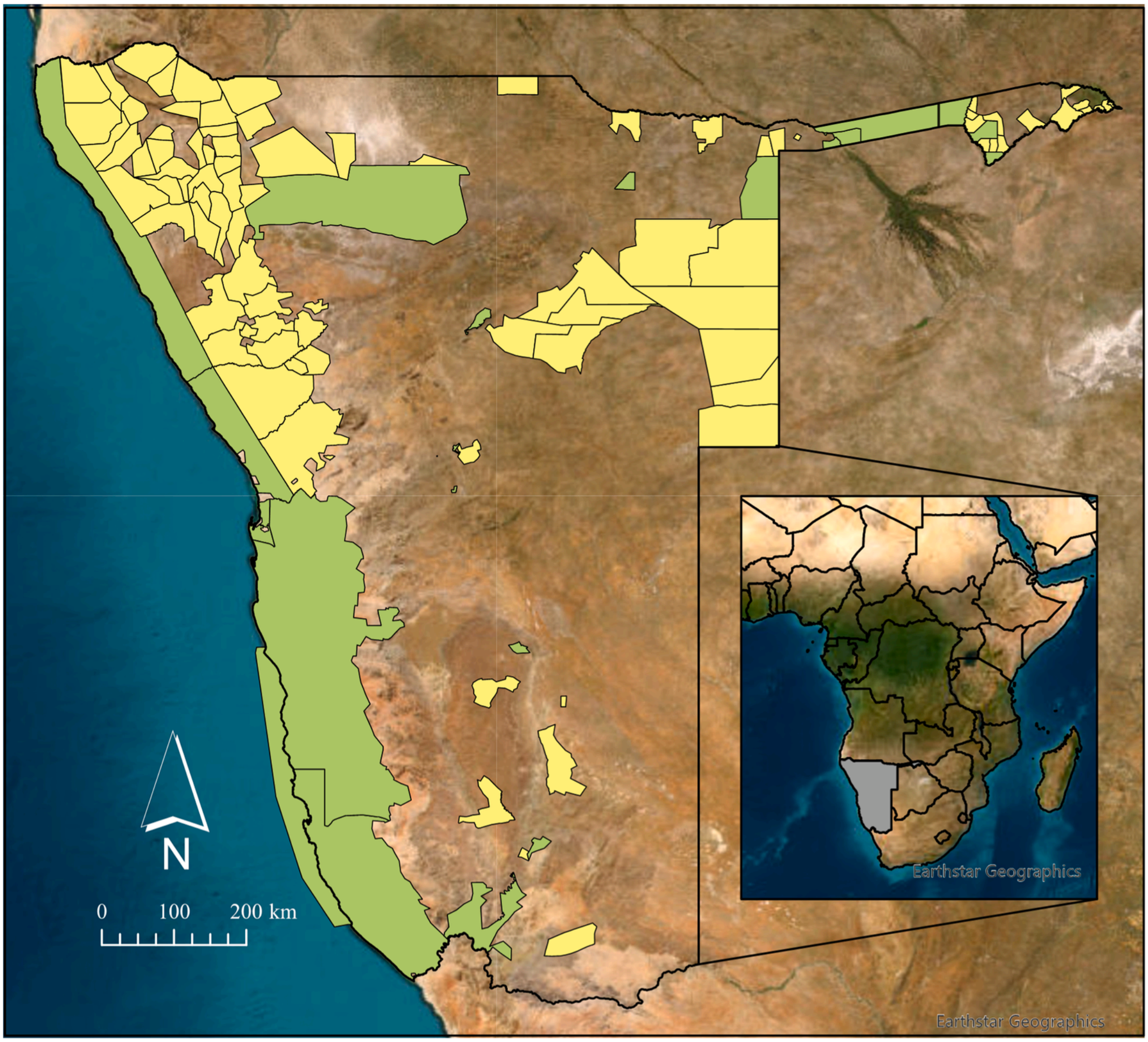

Fig. 1. Communal conservancies (yellow polygons) and national parks (green polygons) in Namibia, 2022 (NACSO).

due to skewed conservancy income earned from both tourism sources.

We used generalized linear mixed models to evaluate how incomes from hunting and photographic tourism earned by conservancies in Namibia during 1998–2022 were affected by large mammal community occurrence and landscape attributes. Distributions for both income sources were zero-inflated and skewed. Therefore, we ran two regression analyses for each income source. We used logistic regression to model a binary response (0 for conservancies earning no income, 1 for conservancies earning >\$0 income; Naidoo et al., 2011b) and linear regression to model log-transformed incomes >\$0.

We tested for dependence between hunting and photographic incomes using Pearson's product-moment correlation r and separate models that included the annual income from the other tourism source as a covariate. We identified a weak positive correlation ($r = 0.08$) between income sources, suggesting limited association. Hunting and photographic incomes were not correlated (95 % confidence intervals overlapped 0) when included as covariates in models testing for dependence. We calculated pairwise correlations r between continuous covariates and retained only the most relevant in our analyses when $|r| \geq 0.70$ (Dormann et al., 2013).

All final models included fixed-effect covariates for years since conservancy establishment, conservancy area (km^2), annual number of Big 5 species present, mean elevation (m), elevation SD (m), distance to nearest national park (km), distance to nearest major road (km), and annual precipitation (mm) (Table 1). We included random intercepts by conservancy to account for repeated annual measurements of the same conservancies across years in all models. We centered and scaled continuous covariates using a standardized z-score normalization (mean = 0, SD = 1). We tested for statistical significance of regression coefficients using $\alpha \leq 0.05$. We visualized regression coefficient estimates and uncertainty using dot-whisker plots with 95 % confidence intervals (CI). All analyses were performed in R version 4.2.2 (R Core Team, 2023) using the glmmTMB package for generalized linear mixed models (Brooks et al., 2017) and the DHARMa package for residual diagnostics (Hartig, 2022).

4. Results

Median number of years from conservancy establishment through 2022 was 8 (0–24) and median conservancy area was 1167 km^2 (43–9122 km^2; Table 1). Leopard had the highest annual mean proportional occurrence among Big 5 species recorded by conservancies, followed by elephant, lion, buffalo, and black rhino. Median mean elevation across conservancies was 1086 m (600–1624 m).

Hunting occurred in 70 conservancies (141,365 km^2, 85 % of total conservancy area; Fig. 2) and was the dominant (>70 % of combined income from both tourism sources) income source in 43 conservancies (78,432 km^2, 47 % of total conservancy area; Table 2). Photographic tourism occurred in 39 conservancies (81,797 km^2, 49 % of total conservancy area) and was the dominant (>70 % of combined income from both tourism sources) income source in 16 conservancies (49,161 km^2, 30 % of total conservancy area; Table 2). Neither tourism source represented more than 70 % of combined income in 12 conservancies, and 15 conservancies earned no income from either source. Conservancies that earned no income from either tourism source were 12 % smaller (median area of 1028 km^2) than the median area of all conservancies, 6 of which occurred in the northwest Kunene Region. On average, conservancies started earning income from hunting and photographic tourism 2.9 and 5.4 years after establishment, respectively.

Dispersion of observed binary and nonzero quantile-quantile income values deviated from expected, except for the probability of earning >\$0 hunting income (Appendix A). Nonparametric dispersion of the probability of earning >\$0 hunting income differed compared to simulated distributions ($P = 0.032$, Appendix A), but other income types did not. Outlier test plots suggested no model fit issues for income types from either tourism source.

Years since conservancy establishment positively affected the probability conservancies earned >\$0 hunting income (ß = 0.66, CI = 0.46–0.86, Fig. 3a, Appendix B) but conservancy age decreased the amount of hunting income (ß = −0.18, CI = −0.26–-0.10, Fig. 3b). Increasing median years since conservancy establishment by 5 increased the probability conservancies earned >\$0 hunting income from 46 % to 60 % but decreased the amount of hunting income by \$1498 with all other covariates held at median values. The amount of hunting income increased with conservancy area (ß = 0.37, CI = 0.02–0.72, Fig. 3b) and number of Big 5 species present (ß = 0.28, CI = 0.17–0.38), which also positively affected the probability conservancies earned >\$0 hunting income (ß = 0.88, CI = 0.60–1.16, Fig. 3a). Hunting income increased by \$3332 when median conservancy area increased by 2000 km^2 with all other covariates held at median values. Increasing median number of Big 5 species present by 1 and 2 increased the probability conservancies earned >\$0 hunting income from 46 % to 62 % and 77 %, respectively, and increased the amount of hunting income by \$2399 and \$5387, respectively, with all other covariates held at median values. The probability conservancies earned >\$0 hunting income and amount of hunting income decreased with increasing mean elevation (ß = −0.33, −0.63–-0.02, Fig. 3a; ß = −0.53, CI = −1.03–-

Table 1
Variables potentially affecting hunting and photographic tourism income earned by communal conservancies in Namibia, 1998–2022.

Variable	Median	Range
Years since establishment	8	0–24
Area (km^2)	1167	43–9122
Annual Big 5 species occurrence	1	0–5
Mean elevation (m)	1086	600–1624
Elevation SD (m)	70	0–327
Distance to nearest national park (km)	38	0–230
Distance to nearest major road (km)	83	0–320
Annual precipitation (mm)	241	31–1037

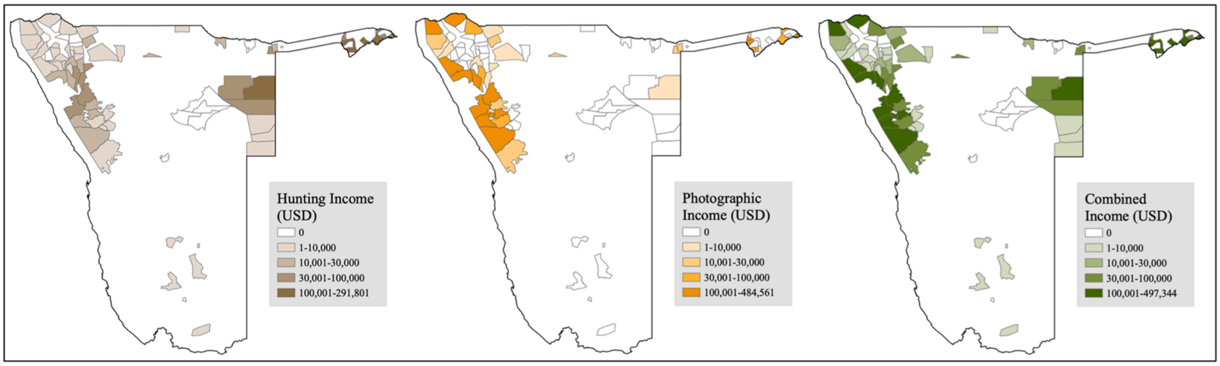

Fig. 2. Annual mean income from hunting, photographic tourism, and combined income from both sources earned by communal conservancies in Namibia, 1998–2022.

Table 2
Summary of annual income estimates (2022 United States dollars) from hunting and photographic tourism earned by communal conservancies in Namibia, 1998–2022.

Statistic	Hunting	Photographic Tourism
Mean	$32,622	$56,212
Median income >$0	$26,863	$120,081
Maximum	$491,768	$1135,747
Total	$45,964,012	$79,203,315
Conservancies earning income >$0	70	39
Area (km^2) earning income >$0	141,365	81,797
Percent total area earning income >$0	85	49
Conservancies by dominant income source (>70 % of combined income from both tourism sources)	43	16
Area (km^2) by dominant income source	78,432	49,161
Percent total area by dominant income source	47	30
Average years from conservancy establishment to initial income	2.9	5.4

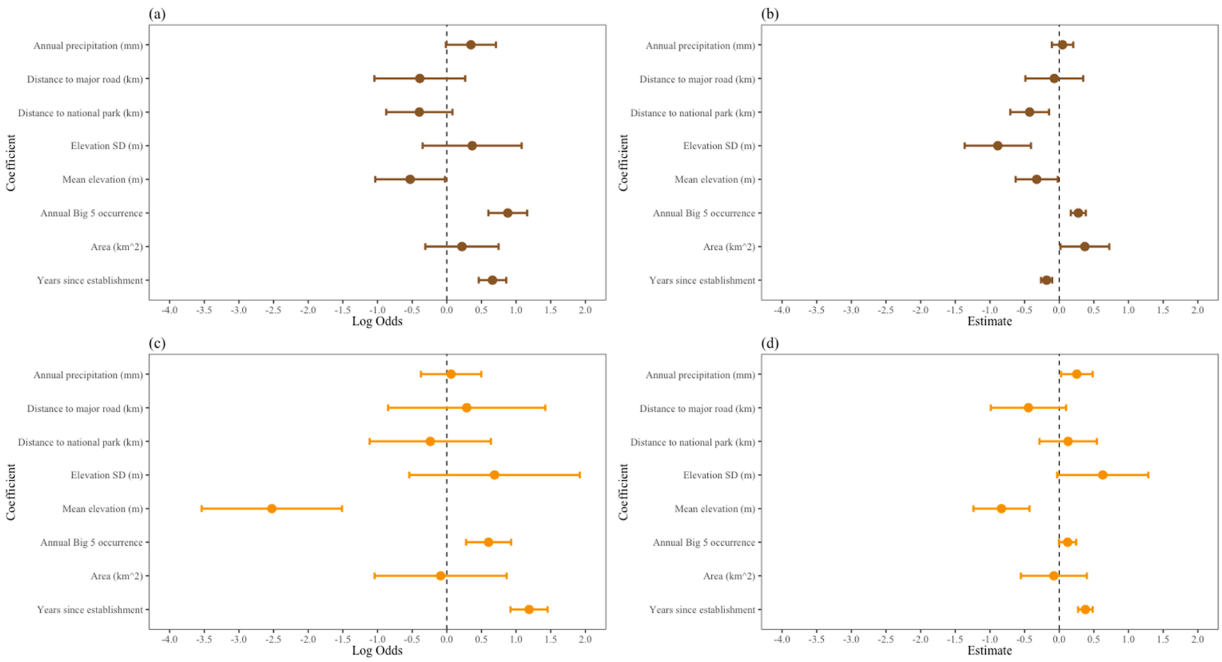

Fig. 3. Standardized regression coefficient estimates with 95 % confidence intervals (i.e., whiskers) for generalized linear mixed models fit to the (a) probability of earning >$0 hunting income, (b) amount of hunting income, (c) probability of earning >$0 photographic income, and (d) amount of photographic income earned by communal conservancies in Namibia, 1998–2022.

0.03, Fig. 3b; respectively). The amount of hunting income also decreased with greater topographic diversity (ß = −0.89, CI = −1.37–-0.41, Fig. 3b) and distances to nearest national park (ß = −0.43, CI = −0.71–-0.15).

Years since conservancy establishment increased the probability conservancies earned >$0 photographic income and amount of photographic income (ß = 1.19, CI = 0.92–1.46, Fig. 3c; ß = 0.38, CI = 0.27–0.48, Fig. 3d; respectively, Appendix B). Photographic income increased by $5627 when median years since conservancy establishment increased by 5 with all other covariates held at median values. Big 5 species occurrence positively affected the probability conservancies earned >$0 photographic income (ß = 0.60, CI = 0.28–0.93, Fig. 3c) but was not correlated with the amount of photographic income. Increasing median number of Big 5 species present by 1 and 2 increased the probability conservancies earned >$0 photographic income from 2 % to 3 % and 4 %, respectively, with all other covariates held at median values. The probability conservancies earned >$0 photographic income and amount of photographic income decreased with increasing mean elevation (ß = −2.52, CI = −3.54–-1.51, Fig. 3c; ß = −0.83, CI = −1.24–-0.43, Fig. 3d; respectively). The amount of photographic income also increased with greater annual precipitation (ß = 0.25, CI = 0.03–0.48, Fig. 3d).

5. Discussion

Our predictions on how large mammal community occurrence and landscape attributes affected incomes from hunting and photographic tourism earned by conservancies in Namibia during 1998–2022 were partially supported. The amount of hunting income decreased with conservancy age, which could reflect drought-related quota reductions (NACSO, 2021a), a limited hunting market, or market declines caused by trophy importation issues (Nyamayedenga et al., 2021). That the amount of hunting income increased with larger conservancy area indicates that conservancy size is important for consumptive land use planning. On average, larger conservancies could have more Big 5 species present and potential harvest of other species (e.g., Hartmann's mountain zebra [*Equus zebra hartmannae*], greater kudu [*Tragelaphus strepsiceros*]; Naidoo et al., 2016). Inter-conservancy co-management of wildlife could increase income, particularly for smaller conservancies with less tourism opportunity. For example, the amount of hunting income increased by an equivalent 12 % (i.e., $3332) of median hunting income for conservancies earning >$0 annual income when median conservancy area increased by 2000 km^2 (i.e., about the median size of 2 conservancies earning no income from either tourism source, 6 of which occurred in northwest Kunene Region).

The probability conservancies earned >$0 hunting income and amount of hunting income were positively correlated with Big 5 species occurrence, which likely reflected high operator fees paid to conservancies from elephant and buffalo (Naidoo et al., 2016). Greater topographic diversity likely decreased hunter accessibility. The amount of hunting income decreased with greater distances to national parks likely because greater wildlife abundance in national parks increases wildlife abundance in nearby conservancies, supporting the idea that conservancies serve as conservation buffers around protected areas (Meyer et al., 2021).

The probability conservancies earned >$0 photographic income and amount of photographic income increased with conservancy age, which likely reflected development of tourist infrastructure over time and subsequent increases in salaries of conservancy members employed by operators (NACSO, 2021a). The amount of photographic income was not correlated with Big 5 species occurrence despite the importance of black rhino and lion for tourism (Muntifering et al., 2023a; NACSO, 2023). Photographic tourism could offer income alternatives for Namibia's conservancies without Big 5 species present despite international tourists' interest in primarily viewing large mammals (Di Minin et al., 2013).

Conservancies with lower mean elevation earned more income, particularly from photographic tourism, which could reflect that conservancies established earlier occurred in lower elevation areas with higher tourist accessibility or habitat quality for Big 5 species. Greater topographic diversity was not correlated with photographic income despite possible improved scenic value and mountainous terrain on popular tourism circuits (Naidoo et al., 2011b). The spatial resolution of elevation SD also could have been too coarse to reflect local variation in conservancy elevation. That photographic income was not correlated with proximity to national parks (e.g., Etosha National Park) likely reflects tourist preference for exclusively visiting national parks with better tourism infrastructure. Also, recently awarded concessions are likely not yet operational. For example, 23 conservancies shared 19 concessions in national parks in 2020 (NACSO, 2021a), but photographic tourism started generating income after 5 years on average. We were unable to assess income earned by these specific concessions but they could be expected to generate photographic income soon. Conservancies adjacent to national parks earned less income from photographic tourism than the median income of conservancies generating income from this source.

Large mammals remain an important driver of ecosystem services to Namibia's conservancies (Naidoo et al., 2011b), although community benefits can be reduced by associated human-wildlife conflicts (Tavolaro et al., 2022). Our data for recording annual Big 5 species occurrence provides an index of large mammal community occurrence including other species that could increase tourism (e.g., giraffe [*Giraffa camelopardalsi*], hippopotamus [*Hippopotamus amphibius*]). Namibia's conservancy-led monitoring system could be used to encourage additional conservation investment by further demonstrating biodiversity occurrence to the private sector and donors (Stuart-Hill et al., 2005). This monitoring system is also used to establish quotas and manage harvests with the Ministry of Environment, Forestry and Tourism. Conservancies used only 37 % of their total quota for huntable Big 5 species (excluding black rhino) during 2006–2022 (NACSO, unpublished data), further indicating a limited market altough some quotas are allocated across multiple years. More efficient quota use could increase hunting income, assuming there is adequate hunting demand and quotas are sustainable and not reduced in response to climate-change induced drought (Carpenter, 2022).

Hunting and photographic tourism in Namibia appear to be complementary ecosystem services (Naidoo et al., 2016). While income from photographic tourism could equal or exceed income from hunting (e.g., 447 % greater median annual income for conservancies earning >$0, 172 % greater total income across conservancies during 1998–2022), income from hunting occurred in more conservancies and generated income more rapidly, suggesting that hunting cannot be easily replaced. Previous analysis simulating a tourist hunting ban revealed negative impacts to conservancy operational budgets (Naidoo et al., 2016; NACSO, 2021a). While there is unlikely a risk of a tourist hunting ban considering that Namibia's domestic policy supports sustainable use of wildlife (Republic of Namibia, 1990; cf., Botswana during 2014–2019; Mbaiwa, 2018), importation restrictions on hunted wildlife in consumer countries are likely to reduce community benefits from lower hunter visitation, spending, and quota use (Nyamayedenga et al., 2021). For example, elephant import permitting by the United States Fish & Wildlife Service has been challenged by new regulation and subject to litigation for economic harm to Namibia's conservancies (DSC vs. Bernhardt, 2021). Namibia's conservancies are especially susceptible to wildlife importation policy in the United States given reliance on American hunters targeting high-value species (e.g., elephant; MacLaren et al., 2019). Importation restrictions on hunted wildlife could threaten livelihoods and habitat conserved by Namibia's conservancies (MacLaren et al., 2019), along with similar CBNRM programs in southern Africa (e.g., Communal Areas Management Program for Indigenous Resources Association in Zimbabwe; MECTHI, 2023), unless alternatives to hunting are available (White and Belant, 2015).

Community benefits from tourist hunting also depend on effective international regulation of wildlife trade (e.g., Convention on International Trade in Endangered Species of Wild Fauna and Flora; Abensperg-Traun, 2009; Carpenter, 2011; Cooney et al., 2021). Hunting could be more resilient than photographic tourism to global market dynamics (e.g., COVID-19 pandemic; MEFT, 2021; 2008 Great Recession; Naidoo et al., 2016) and has widespread support from Namibia's conservancies (Angula et al., 2018), which have more positive attitudes toward wildlife when benefiting from hunting (Störmer et al., 2019). Wildlife trade policies that consider potential impacts to indigenous people and local communities could improve benefits from tourist hunting and reduce costs (Houdt et al., 2021; Clark et al., 2023; Challender et al., 2023).

Income varied markedly across conservancies in Namibia and is dominated by hunting and photographic tourism (estimated 97 % of total income, excluding grants, across conservancies in 2022; NACSO, unpublished data), compared to other activities available (e.g., plant harvesting [e.g., Devil's claw {*Harpophytum spp.*}; Lavelle, 2023], craft sales). Conservancies' reliance on hunting and photographic tourism suggest diversification strategies could improve income potential by including development of additional tourist markets (MacLaren et al., 2019; MEFT, 2021), mixed agriculture production (e.g., small-scale horticulture; Hulke et al., 2021), and carbon or biodiversity credits (Smith et al., 2022), which are being developed in some of Namibia's conservancies (NACSO, 2023). Namibia had 46 community forests and 20 fishery reserves shared by 7 conservancies in 2022 (NACSO, 2023), which can generate income from sale of natural plant products (e.g., timber, Devil's claw) and fishing tourism. Wildlife-based income on communal lands could also be improved through higher tourist willingness to pay for conservation and community benefits (Fischer et al., 2015; Naidoo et al., 2021), direct community participation in the private sector (e.g., negotiating quota price; Rigava et al., 2006; marketing; Child and Weaver, 2006; shared business ownership models; Hoole, 2009), national investment in sustainable tourism (MET, 2016), and strengthening governance (Child and Barnes, 2010; Ullah and Kim, 2020).

Financial sustainability is critical to building resilient community-based natural resource economies. Our results support development of emerging conservancies in Namibia's northeast Zambezi Region that have high tourism potential from Big 5 species presence, low elevations, and high annual precipitation (NACSO, 2021a). We recommend that Namibia's conservancies, particularly those established more recently with smaller area and adjacent to other conservancies (e.g., northwest Kunene Region), consider implementing inter-conservancy wildlife co-management or shared land use zonation plans and collaborate with tourism industries to improve income potential from hunting and photographic tourism.

Ethics Statement

Not applicable: This manuscript does not include human or animal research.

Declaration of Competing Interest

The authors declare no conflict of interest.

Appendix A

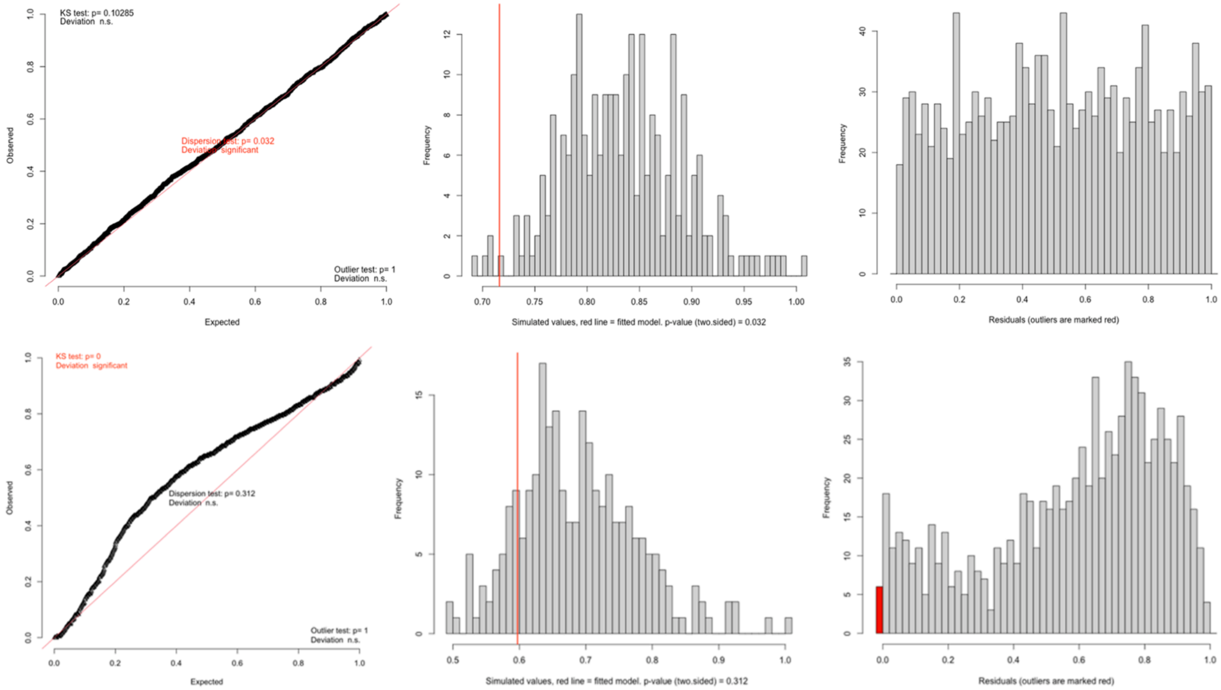

Figure A1. Kolmogorov-Smirnov (left column), nonparametric dispersion (center column), and outlier (right column) test plots for generalized linear mixed models fit to the probability of earning >$0 hunting income (top row) and amount of hunting income (bottom row) earned by communal conservancies in Namibia, 1998–2022.

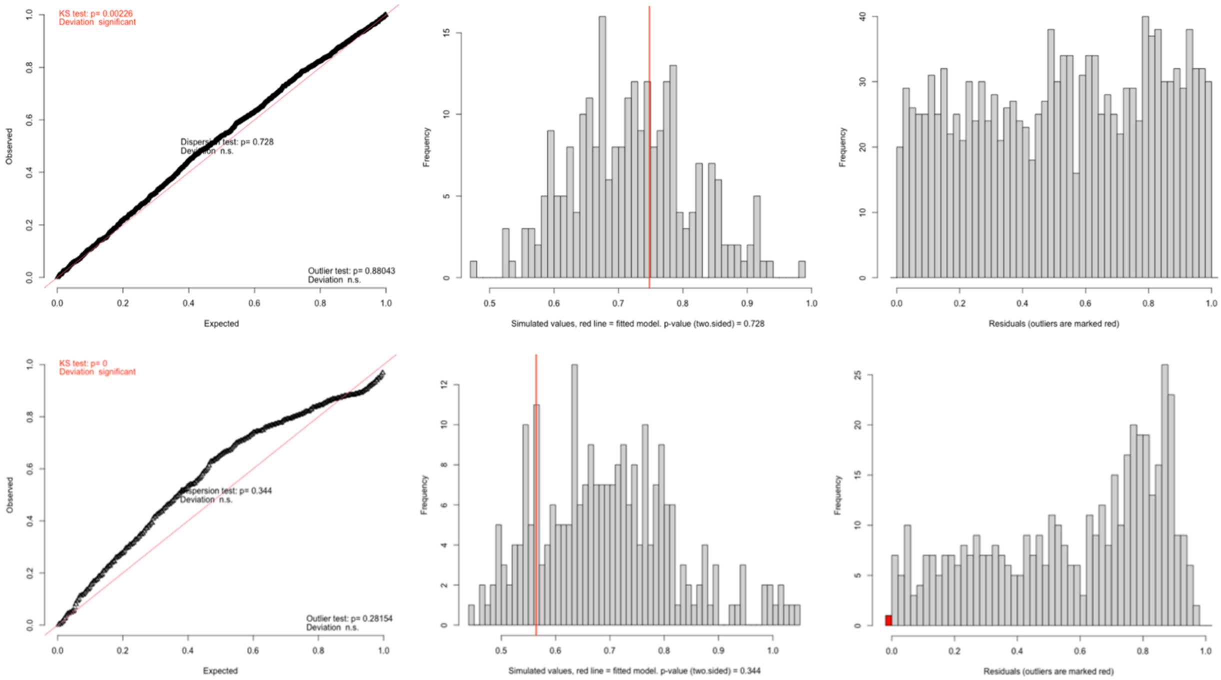

Figure A2. Kolmogorov-Smirnov (left column), nonparametric dispersion (center column), and outlier (right column) test plots for generalized linear mixed models fit to the probability of earning >$0 photographic income (top row) and amount of photographic income (bottom row) earned by communal conservancies in Namibia, 1998–2022.

Appendix B

Table B.1
Regression coefficient log odds or estimates with 95 % confidence intervals (CI) and *p*-values (< 0.05 bolded) for generalized linear mixed models fit to the probability of earning >$0 hunting income and amount of hunting income earned by communal conservancies in Namibia, 1998–2022.

	Probability of Earning >$0			**Amount of Hunting Income**		
Coefficient	Log odds	*CI*	*p-value*	*Estimate*	*CI*	*p-value*
Intercept	0.56	0.08 – 1.04	**0.022**	4.91	4.59 – 5.22	**<0.001**
Years since establishment	0.66	0.46 – 0.86	**<0.001**	−0.18	−0.26 – −0.10	**<0.001**
Area (km^2)	0.22	−0.31 – 0.75	0.417	0.37	0.02 – 0.72	**0.040**
Annual Big 5 species occurrence	0.88	0.60 – 1.16	**<0.001**	0.28	0.17 – 0.38	**<0.001**
Mean elevation (m)	−0.53	−1.03 – −0.03	**0.039**	−0.33	−0.63 – −0.02	**0.036**
Elevation SD (m)	0.37	−0.35 – 1.08	0.316	−0.89	−1.37 – −0.41	**<0.001**
Distance to nearest national park (km)	−0.40	−0.87 – 0.08	0.104	−0.43	−0.71 – −0.15	**0.003**
Distance to nearest major road (km)	−0.39	−1.04 – 0.27	0.243	−0.07	−0.49 – 0.35	0.736
Annual precipitation (mm)	0.35	−0.01 – 0.71	0.060	0.05	−0.11 – 0.20	0.539

Table B.2
Regression coefficient log odds or estimates with 95 % confidence intervals (CI) and *p*-values (< 0.05 bolded) for generalized linear mixed models fit to the probability of earning >$0 photographic income and amount of photographic income earned by communal conservancies in Namibia, 1998–2022.

	Probability of Earning >$0			**Amount of Photographic Income**		
Coefficient	Log odds	*CI*	*p-value*	*Estimate*	*CI*	*p-value*
Intercept	−3.01	−4.04 – −1.97	**<0.001**	6.34	5.94 – 6.73	**<0.001**
Years since establishment	1.19	0.92 – 1.46	**<0.001**	0.38	0.27 – 0.48	**<0.001**
Area (km^2)	−0.09	−1.04 – 0.86	0.854	−0.08	−0.55 – 0.40	0.749
Annual Big 5 species occurrence	0.60	0.28 – 0.93	**<0.001**	0.12	−0.00 – 0.24	0.054
Mean elevation (m)	−2.52	−3.54 – −1.51	**<0.001**	−0.83	−1.24 – −0.43	**<0.001**
Elevation SD (m)	0.69	−0.54 – 1.92	0.273	0.63	−0.03 – 1.29	0.061
Distance to nearest national park (km)	−0.24	−1.11 – 0.64	0.594	0.13	−0.28 – 0.54	0.541
Distance to nearest major road (km)	0.29	−0.85 – 1.42	0.620	−0.44	−0.99 – 0.10	0.109
Annual precipitation (mm)	0.06	−0.37 – 0.50	0.781	0.25	0.03 – 0.48	**0.029**

Data availability

Data is not publicly available but can be shared upon reasonable request by contacting M. P. Louis.

References

Abensperg-Traun, M., 2009. CITES, sustainable use of wild species and incentive-driven conservation in developing countries, with an emphasis on southern Africa. Biological Conservation, 142 (5), 948–963. https://doi.org/10.1016/j.biocon.2008.12.034.

Angula, H.N., Stuart-Hill, G., Ward, D., Matongo, G., Diggle, R.W., Naidoo, R., 2018. Local perceptions of trophy hunting on communal lands in Namibia. Biological Conservation, 218, 26–31. https://doi.org/10.1016/j.biocon.2017.11.033.

Arntzen, J. W., Molokomme, D. L., Terry, E. M., Moleele, N., Tshosa, O., Mazambani, D., 2003. *Main findings of the review of CBNRM in Botswana*. CBNRM Support Programme, Occasional Paper, No. 14. Gaborone, Botswana. https://portals.iucn.org/library/node/8629.

Ashley, C., Barnes, J., 1997. Wildlife Use for Economic Gain: The Potential for Wildlife to Contribute to Development in Namibia. In *Environmental Sustainability*. CRC Press. https://doi.org/10.1201/9780429117411-10.

Atlas of Namibia Team, 2022. *Atlas of Namibia: Its Land, Water and Life*. Namibia Nature Foundation, Windhoek, Namibia.

Bandyopadhyay, S., Humavindu, M., Shyamsundar, P., Wang, L., 2009. Benefits to local communities from community conservancies in Namibia: an assessment. Development Southern Africa, 26 (5), 733–754. https://doi.org/10.1080/03768350903303324.

Bank of Namibia, 2023. *Bilateral Exchange Rate*. Windhoek, Namibia. http://www.bon.com.na/.

Bollig, M., 2016. Towards an Arid Eden? Boundary making, governance and benefit sharing and the political ecology of the "new commons" of Kunene Region, Northern Namibia. International Journal of the Commons, 10 (2), 771–799. https://doi.org/10.18352/ijc.702.

Bond, I., 1994. The importance of the sport-hunted African elephant to CAMPFIRE in Zimbabwe. TRAFFIC Bulletin 14 (3), 117–119.

Brooks, J.S., 2017. Design Features and Project Age Contribute to Joint Success in Social, Ecological, and Economic Outcomes of Community-Based Conservation Projects. Conservation Letters, 10 (1), 23–32. https://doi.org/10.1111/conl.12231.

Brooks, M.E., Kristensen, K., van Benthem, K.J., Magnusson, A., Berg, C.W., Nielsen, A., Skaug, H.J., Mächler, M., Bolker, B.M., 2017. glmmTMB balances speed and flexibility among packages for zero-inflated generalized linear mixed modelling. The R Journal, 9 (2), 378–400. https://doi.org/10.3929/ethz-b-000240890.

Carpenter, S., 2011. The Devolution of Conservation: Why CITES Must Embrace Community-Based Resource Management. Arizona Journal of Environmental Law and Policy, 2, 1. https://heinonline.org/HOL/Page?handle=hein.journals/arijel2&id=1&div=&collection⟩=.

Carpenter, S., 2022. Exploring the impact of climate change on the future of community-based wildlife conservation. Conservation Science and Practice, 4 (1), e585. https://doi.org/10.1111/csp2.585.

Challender, D., Sas-Rolfes, M. 't, Dickman, A., Hare, D., Hart, A., Hoffmann, M., Mallon, D., Mandisodza-Chikerema, R., Roe, D., 2023. Evaluating key evidence and formulating regulatory alternatives regarding the UK's Hunting Trophies (Import Prohibition) Bill. bioRxiv. https://doi.org/10.1101/2023.06.13.544826.
Child, B., Barnes, G., 2010. The conceptual evolution and practice of community-based natural resource management in southern Africa: past, present and future. Environmental Conservation, 37 (3), 283–295. https://doi.org/10.1017/S0376892910000512.
Child, B., Weaver, C., 2006. Marketing hunting and tourism joint ventures in community areas. In *Participatory Learning and Action 55: Practical tools for community conservation in southern Africa*. International Institute for Environment and Development, London, UK. https://www.iied.org/g02926.
Clark, D.A., Brehony, P., Dickman, A., Foote, L., Hart, A.G., Jonga, C., Mbiza, M.M., Roe, D., Sandbrook, C., 2023. Hunting trophy import bans proposed by the UK may be ineffective and inequitable as conservation policies in multiple social-ecological contexts. Conservation Letters, 16 (2), e12935. https://doi.org/10.1111/conl.12935.
Cooney, R., Challender, D.W.S., Broad, S., Roe, D., Natusch, D.J.D., 2021. Think Before You Act: Improving the Conservation Outcomes of CITES Listing Decisions. Frontiers in Ecology and Evolution, 9, 631556. https://www.frontiersin.org/articles/10.3389/fevo.2021.631556.
Craig, G.C., Gibson, D.S.C., Uiseb, K.H., 2021. Namibia's elephants-population, distribution and trends. Pachyderm, 62, 35–52.
Dallas Safari Club (DSC), et al., Plaintiffs, v. David Bernhardt, et al., Defendants, 518 F. Supp. 3d 535 (United States District Court for the District of Columbia 2021).
Di Minin, E., Clements, H.S., Correia, R.A., Cortés-Capano, G., Fink, C., Haukka, A., Hausmann, A., Kulkarni, R., Bradshaw, C.J.A., 2021. Consequences of recreational hunting for biodiversity conservation and livelihoods. One Earth, 4 (2), 238–253. https://doi.org/10.1016/j.oneear.2021.01.014.
Di Minin, E., Fraser, I., Slotow, R., MacMillan, D.C., 2013. Understanding heterogeneous preference of tourists for big game species: implications for conservation and management. Animal Conservation, 16 (3), 249–258. https://doi.org/10.1111/j.1469-1795.2012.00595.x.
Di Minin, E., Leader-Williams, N., Bradshaw, C.J.A., 2016. Banning Trophy Hunting Will Exacerbate Biodiversity Loss. Trends in Ecology & Evolution, 31 (2), 99–102. https://doi.org/10.1016/j.tree.2015.12.006.
Dickman, A., Cooney, R., Johnson, P.J., Louis, M.P., Roe, D., signatories, 218, 2019. Trophy hunting bans imperil biodiversity. Science, 365 (6456), 874. https://doi.org/10.1126/science.aaz0735.
Dormann, C.F., Elith, J., Bacher, S., Buchmann, C., Carl, G., Carré, G., Marquéz, J.R.G., Gruber, B., Lafourcade, B., Leitão, P.J., Münkemüller, T., McClean, C., Osborne, P.E., Reineking, B., Schröder, B., Skidmore, A.K., Zurell, D., Lautenbach, S., 2013. Collinearity: a review of methods to deal with it and a simulation study evaluating their performance. Ecography, 36 (1), 27–46. https://doi.org/10.1111/j.1600-0587.2012.07348.x.
EISN, 2020. *Protected Areas*. Environmental Information Service Namibia, eLibrary. http://the-eis.com/elibrary/.
ESRI, 2022. *ArcGIS Pro, Version 3.0.4*. Environmental Systems Research Institute. Redlands, California, USA.
Fischer, A., Tibebe Weldesemaet, Y., Czajkowski, M., Tadie, D., Hanley, N., 2015. Trophy hunters' willingness to pay for wildlife conservation and community benefits. Conservation Biology, 29 (4), 1111–1121. https://doi.org/10.1111/cobi.12467.
Frost, P.G.H., Bond, I., 2008. The CAMPFIRE programme in Zimbabwe: Payments for wildlife services. Ecological Economics, 65 (4), 776–787. https://doi.org/10.1016/j.ecolecon.2007.09.018.
Funk, C., Peterson, P., Landsfeld, M., Pedreros, D., Verdin, J., Shukla, S., Husak, G., Rowland, J., Harrison, L., Hoell, A., Michaelson, J., 2015. The climate hazards infrared precipitation with stations–a new environmental record for monitoring extremes. Scientific Data, 2 (1), 150066. https://doi.org/10.1038/sdata.2015.66.
Hambira, W.L., Stone, L.S., Pagiwa, V., 2021. Botswana nature-based tourism and COVID-19: transformational implications for the future. Development Southern Africa, 39 (1), 51–67. https://doi.org/10.1080/0376835X.2021.1955661.
Hartig, F., 2022. *DHARMa: Residual Diagnostics for Hierarchical (Multi-Level/Mixed) Regression Models*. R package version 0.4.6.
Hoole, A., 2009. Place-power-prognosis: Community-based conservation, partnerships, and ecotourism enterprises in Namibia. International Journal of the Commons, 4 (1), 78–99. https://doi.org/10.18352/ijc.112.
Horowitz, A., 2019. Trophy hunting: a moral imperative for bans. Science, 366 (6464), 435. https://doi.org/10.1126/science.aaz3315.
Houdt, S. van, Brown, R.P., Wanger, T.C., Twine, W., Fynn, R., Uiseb, K., Cooney, R., Traill, L.W., 2021. Divergent views on trophy hunting in Africa, and what this may mean for research and policy. Conservation Letters, 14 (6), e12840. https://doi.org/10.1111/conl.12840.
Hulke, C., Kairu, J.K., Diez, J.R., 2021. Development visions, livelihood realities – how conservation shapes agricultural value chains in the Zambezi region, Namibia. Development Southern Africa, 38 (1), 104–121. https://doi.org/10.1080/0376835X.2020.1838260.
Hulke, C., Kalvelage, L., Kairu, J., Revilla Diez, J., Rutina, L., 2022. Navigating through the storm: conservancies as local institutions for regional resilience in Zambezi, Namibia. Cambridge Journal of Regions, Economy and Society, 15 (2), 305–322. https://doi.org/10.1093/cjres/rsac001.
Humavindu, M.N., Stage, J., 2014. Community-based wildlife management failing to link conservation and financial viability. Animal Conservation, 18 (1), 4–13. https://doi.org/10.1111/acv.12134.
Jones, B.T.B., 1999. Policy lessons from the evolution of a community-based approach to wildlife management, Kunene Region, Namibia. Journal of International Development, 11 (2), 295–304. https://doi.org/10.1002/(SICI)1099-1328(199903/04)11:2<295::AID-JID583>3.0.CO;2-U.
Jones, B.T.B., 2009. Community Benefits from Safari Hunting and Related Activities in Southern Africa. In *Recreational Hunting, Conservation and Rural Livelihoods*. Wily-Blackwell.v, West Sussex, UK. https://doi.org/10.1002/9781444303179.ch10.
Jones, B.T.B., Diggle, R.W., Thouless, C., 2015. From Exploitation to Ownership: Wildlife-Based Tourism and Communal Area Conservancies in Namibia. In *Institutional Arrangements for Conservation, Development and Tourism in Eastern and Southern Africa: A Dynamic Perspective*. Springer, Netherlands. https://doi.org/10.1007/978-94-017-9529-6_2.
Kalvelage, L., Revilla Diez, J., Bollig, M., 2020. How much remains? Local value capture from tourism in Zambezi, Namibia. Tourism Geographies, 24 (4–5), 759–780. https://doi.org/10.1080/14616688.2020.1786154.
Kalvelage, L., Revilla Diez, J., Bollig, M., 2021. Do Tar Roads Bring Tourism? Growth Corridor Policy and Tourism Development in the Zambezi region, Namibia. The European Journal of Development Research, 33 (4), 1000–1021. https://doi.org/10.1057/s41287-021-00402-3.
Lavelle, J-J., 2023. Towards Pro-poor or Pro-profit? The governance framework for harvesting and trade of devil's claw (*Harpagophytum spp.*) in the Zambezi Region, Namibia. In *Conservation, Markets & the Environment in Southern and Eastern Africa*. James Currey.
Lendelvo, S.M., Pinto, M., Sullivan, S., 2020. A perfect storm? The impact of COVID-19 on community-based conservation in Namibia. Namibian Journal of Environment, 4, B-15. https://nje.org.na/index.php/nje/article/view/volume4-lendelvo.
Lindsey, P., Allan, J., Brehony, P., Dickman, A., Robson, A., Begg, C., Bhammar, H., Blanken, L., Breuer, T., Fitzgerald, K., Flyman, M., Gandiwa, P., Giva, N., Kaelo, D., Nampindo, S., Nyambe, N., Steiner, K., Parker, A., Roe, D., Tyrrell, P., 2020. Conserving Africa's wildlife and wildlands through the COVID-19 crisis and beyond. Nature Ecology & Evolution, 4 (10), 1300–1310. https://doi.org/10.1038/s41559-020-1275-6.
Lindsey, P.A., Alexander, R., Frank, L.G., Mathieson, A., Romañach, S.S., 2006. Potential of trophy hunting to create incentives for wildlife conservation in Africa where alternative wildlife-based land uses may not be viable. Animal Conservation, 9 (3), 283–291. https://doi.org/10.1111/j.1469-1795.2006.00034.x.
Lindsey, P.A., Balme, G.A., Funston, P.J., Henschel, P.H., Hunter, L.T.B., 2016. Life after Cecil: channelling global outrage into funding for conservation in Africa. Conservation Letters, 9 (4), 296–301. https://doi.org/10.1111/conl.12224.
Lindsey, P.A., Havemann, C.P., Lines, R.M., Price, A.E., Retief, T.A., Rhebergen, T., Waal, C. van der, Romañach, S.S., 2013. Benefits of wildlife-based land uses on private lands in Namibia and limitations affecting their development. Oryx, 47 (1), 41–53. https://doi.org/10.1017/S0030605311001049.
Lindsey, P.A., Roulet, P.A., Romañach, S.S., 2007. Economic and conservation significance of the trophy hunting industry in sub-Saharan Africa. Biological Conservation, 134 (4), 455–469. https://doi.org/10.1016/j.biocon.2006.09.005.
MacLaren, C., Perche, J., Middleton, A., 2019. The value of hunting for conservation in the context of the biodiversity economy. In *The Development of Strategies to Maintain and Enhance the Protection of Ecosystem Services in Namibia's State, Communal and Freehold Lands*. Namibia Nature Foundation, GiZ, Department of Environmental Affairs.
Mbaiwa, J.E., 2018. Effects of the safari hunting tourism ban on rural livelihoods and wildlife conservation in northern Botswana. South African Geographical Journal, 100 (1), 41–61. https://doi.org/10.1080/03736245.2017.1299639.
Mbaiwa, J.E., Kolawole, O.D., 2013. Tourism and biodiversity conservation: the case of community-based natural resource management in Southern Africa. CAB International Reviews, 8 (10), 1–10. https://doi.org/10.1079/PAVSNNR20138010.

Meyer, M., Klingelhoeffer, E., Naidoo, R., Wingate, V., Börner, J., 2021. Tourism opportunities drive woodland and wildlife conservation outcomes of community-based conservation in Namibia's Zambezi region. Ecological Economics, 180, 106863. https://doi.org/10.1016/j.ecolecon.2020.106863.

MECTHI, 2023. *Zimbabwe Biodiversity Economy: Status Report, Investment Blueprint and Framework for Natural Capital Accounting.* Ministry of Environment, Climate, Tourism and Hospitality Industry. Government of Zimbabwe. Harare, Zimbabwe.

MEFT, 2021. *Tourist Statistical Report 2021. Ministry of Environment, Forestry and Tourism. Gove*rnment of Republic of Namibia. Windhoek, Namibia.

MET, 1995. *Wildlife management, utilization and tourism in communal areas.* Ministry of Environment and Tourism. Government of Republic of Namibia, Policy Document. Windhoek, Namibia.

MET, 2007. *Policy on tourism and wildlife concessions on state land.* Ministry of Environment and Tourism. Government of Republic of Namibia, Policy Document. Windhoek, Namibia.

MET, 2013. *National Policy on Protected Areas' Neighbours and Resident Communities*. Ministry of Environment and Tourism. Government of Republic of Namibia. Windhoek, Namibia.

MET, 2016. *National Sustainable Tourism Growth and Investment Promotion Strategy 2016–2026: Executive Summary*. Ministry of Environment and Tourism. Government of Republic of Namibia. Windhoek, Namibia.

MWCT, 1992. *The Establishment of Conservancies in Namibia*. Ministry of Wildlife, Conservation and Tourism. Government of Republic of Namibia, Policy Document. Windhoek, Namibia.

Muntifering, J.R., Clark, S., Linklater, W.L., Uri-Khob, S., Hebach, E., Cloete, J., Jacobs, S., Knight, A.T., 2020. Lessons from a conservation and tourism cooperative: the Namibian black rhinoceros case. Annals of Tourism Research, 82, 102918. https://doi.org/10.1016/j.annals.2020.102918.

Muntifering, J.R., Guerier, A., Beytell, P., Stratford, K., 2023b. Population parameters, performance and insights into factors influencing the reproduction of the black rhinoceros *Diceros bicornis* in Namibia. Oryx 57 (5), 659–669. https://doi.org/10.1017/S0030605322001065.

Muntifering, J.R., Malherbe, A., Dax, L., Beytell, P., 2023a. From seeing to saving: How rhinoceros-based tourism in north-west Namibia strengthens local stewardship to help combat illegal hunting. Frontiers in Sustainable Tourism 1, 1090309. ⟨https://www.frontiersin.org/articles/10.3389/frsut.2022.1090309⟩.

NACSO, 2021a. *The state of community conservation in Namibia (Annual Report 2020)*. Ministry of Environment, Forestry and Tourism, and Namibian Association of CBNRM Support Organizations. Windhoek, Namibia.

NACSO, 2021b. *The state of community conservation in Namibia (Annual Report 2019)*. Ministry of Environment, Forestry and Tourism, and Namibian Association of CBNRM Support Organizations. Windhoek, Namibia.

NACSO, 2022. *The state of community conservation in Namibia (Annual Report 2021)*. Ministry of Environment, Forestry and Tourism, and Namibian Association of CBNRM Support Organizations. Windhoek, Namibia.

NACSO, 2023. *The state of community conservation in Namibia (Annual Report 2022)*. Ministry of Environment, Forestry and Tourism, and Namibian Association of CBNRM Support Organizations. Windhoek, Namibia.

Naidoo, R., Beytell, P., Malherbe, A., Middleton, A., Perche, J., Muntifering, J.R., 2021. Heterogeneous consumer preferences for local community involvement in nature-based tourism drive triple-bottom-line gains. Conservation Science and Practice, 3 (6), e425. https://doi.org/10.1111/csp2.425.

Naidoo, R., Weaver, L.C., Diggle, R.W., Matongo, G., Stuart-Hill, G., Thouless, C., 2016. Complementary benefits of tourism and hunting to communal conservancies in Namibia. Conservation Biology, 30 (3), 628–638. https://doi.org/10.1111/cobi.12643.

Naidoo, R., Weaver, L.C., Longcamp, M.D., Plessis, P.D., 2011a. Namibia's community-based natural resource management programme: an unrecognized payments for ecosystem services scheme. Environmental Conservation 38 (4), 445–453. https://doi.org/10.1017/S0376892911000476.

Naidoo, R., Weaver, L.C., Stuart-Hill, G., Tagg, J., 2011b. Effect of biodiversity on economic benefits from communal lands in Namibia. Journal of Applied Ecology 48 (2), 310–316. https://doi.org/10.1111/j.1365-2664.2010.01955.x.

Nattrass, N., 2021a. Conservation and the Commodification of Wildlife in the Anthropocene: A Southern African History. South African Historical Journal 73 (1), 95–116. https://doi.org/10.1080/02582473.2021.1909117.

Nattrass, N., 2021b. Differentiation in Economic Costs and Returns from Living with Wildlife in Namibian Community Conservancies. South African Journal of Economics 89 (2), 282–300. https://doi.org/10.1111/saje.12265.

NSA, 2021. *Namibia Multi-Dimensional Poverty Index (MPI) Report 2021*. Namibian Statistics Agency. Windhoek, Namibia.

Nyamayedenga, S., Mashapa, C., Chateya, R.J., Gandiwa, E., 2021. An assessment of the impact of the 2014 US elephant trophy importation ban on the hunting patterns in Matetsi Hunting Complex, north-west Zimbabwe. Global Ecology and Conservation, 30, e01758. https://doi.org/10.1016/j.gecco.2021.e01758.

R Core Team, 2023. *R: A language and environment for statistical computing.* R Foundation for Statistical Computing. Vienna, Austria.

RCMRD, 2017. *Namibia SRTM DEM 30 meter.* Regional Centre for Mapping of Resouces for Development. SERVIR-Eastern and Southern Africa. Nairobi, Kenya.

Republic of Namibia, 1975. *Nature Conservation Ordinance*. Government Gazette of The Republic of Namibia, Windhoek, Namibia.

Republic of Namibia, 1990. *The Constitution of the Republic of Namibia*. Government Gazette of the Republic of Namibia, Windhoek, Namibia.

Republic of Namibia, 1996. *Promulgation of Nature Conservation Amendment Act.* Government Gazette of The Republic of Namibia. Windhoek, Namibia.

Republic of Namibia, 2002. *Communal Land Reform Act*. Government Gazette of The Republic of Namibia, Windhoek, Namibia.

Rigava, N., Taylor, R., Goredema, L., 2006. Participatory wildlife quota setting. In: *In Participatory Learning and Action 55: Practical tools for community conservation in southern Africa*. International Institute for Environment and Development, London, UK, pp. 62–69. https://www.iied.org/g02929.

RAN, 2018. *National Road Network version 12*. Roads Authority Namibia. Windhoek, Namibia. https://www.ra.org.na/Pages/index.aspx.

Roe, D., Dickman, A., Kock, R., Milner-Gulland, E.J., Rihoy, E., 't Sas-Rolfes, M., 2020. Beyond banning wildlife trade: COVID-19, conservation and development. World Development, 136, 105121. https://doi.org/10.1016/j.worlddev.2020.105121.

Smith, J., Samuelson, M., Libanda, B.M., Roe, D., Alhassan, L., 2022. Getting Blended Finance to Where It's Needed: The Case of CBNRM Enterprises in Southern Africa. Land, 11 (5), 637. https://doi.org/10.3390/land11050637.

Stander, P.E., 2019. Lions (*Panthera leo*) specializing on a marine diet in the Skeleton Coast Park, Namibia. Namibian Journal of Environment, 3 (A), 1–10.

Störmer, N., Weaver, L.C., Stuart-Hill, G., Diggle, R.W., Naidoo, R., 2019. Investigating the effects of community-based conservation on attitudes towards wildlife in Namibia. Biological Conservation, 233, 193–200. https://doi.org/10.1016/j.biocon.2019.02.033.

Stuart-Hill, G., Diggle, R., Munali, B., Tagg, J., Ward, D., 2005. The event book system: a community-based natural resource monitoring system from Namibia. Biodiversity & Conservation, 14 (11), 2611–2631. https://doi.org/10.1007/s10531-005-8391-0.

Suich, H., 2010. The livelihood impacts of the Namibian community based natural resource management programme: a meta-synthesis. Environmental Conservation, 37 (1), 45–53. https://doi.org/10.1017/S0376892910000202.

Tavolaro, F.M., Woodgate, Z., Brown, C., Redpath, S.M., O'Riain, M.J., 2022. Multispecies study of patterns and drivers of wildlife impacts on human livelihoods in communal conservancies. Conservation Science and Practice, 4 (9), e12773. https://doi.org/10.1111/csp2.12773.

Ullah, I., Kim, D.-Y., 2020. A model of collaborative governance for community-based trophy-hunting programs in developing countries. Perspectives in Ecology and Conservation, 18 (3), 145–160. https://doi.org/10.1016/j.pecon.2020.06.004.

USBLS, 2023. *Consumer Price Index for All Urban Consumers*. United States Bureau of Labor Statistics. Washington, D.C., USA. https://www.bls.gov/.

WBG, 2023. *Namibia – data World Bank Group*. Washington, D.C., USA. https://data.worldbank.org/country/NA.

Weaver, C.L., Hamunyela, E., Diggle, R., Matongo, G., Pietersen, T., 2011. The catalytic role and contributions of sustainable wildlife use to the Namibia CBNRM Programme. In *CITES and CBNRM. Proceedings of an international symposium on "The relevance of CBNRM to the conservation and sustainable use of CITES-listed species in exporting countries*". International Union for Conservation of Nature, Gland, Switzerland.

White, P.A., Belant, J.L., 2015. Provisioning of game meat to rural communities as a benefit of sport hunting in Zambia. PloS One, 10 (2), e0117237. https://doi.org/10.1371/journal.pone.0117237.

WTO, 2014. *Towards Measuring the Economic Value of Wildlife Watching Tourism in Africa, Briefing Paper*. World Tourism Organization, Madrid, Spain. https://doi.org/10.18111/9789284416752.