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Review

A systematic map of research on the conflict between humans and African savannah elephants

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A B S T R A C T

Globally, human population growth and unequal resource use are driving land use change, exacerbating resource competition between wildlife and people. Managing wide-ranging species with large dietary requirements including the African savannah elephant (*Loxodonta africana*) is especially challenging, with conflict over space and resources threatening conservation and human well-being. We systematically mapped peer-reviewed and grey literature to describe the evidence on conflict between people and African savannah elephants, identifying 136 eligible studies from 14,239 potential records. We determined temporal and spatial patterns in research effort, characterised the literature and described the conflict management interventions evaluated. Research effort was geographically uneven, with no studies identified in 13 of 24 range countries. Kenya and Tanzania accounted for 58% of the research, a frequency not explained by proportion of elephant range or elephant population density of either country, suggesting research effort may be influenced by other factors. Most studies focused on impacts of conflict on humans (89%), particularly crop damage (79%). Twenty-one different metrics for measuring conflict were recorded, most common was conflict event frequency (61%). Management interventions were evaluated in 55 studies across nine countries. Technical strategies (89%), including barriers and guarding, were the most commonly evaluated, followed by social strategies (20%) including promoting human behaviour change. The systematic map shows a growing body of human-elephant conflict literature that is uneven in geographic scope and the management interventions evaluated. Priorities for future research include broadening geographical coverage, applying socio-ecological systems frameworks, adopting standardised metrics for measuring conflict, and critically appraising management interventions.

1. Introduction

The global human population has grown at annual rates of 0.8–2.1% since 1970 (The World Bank Group, 2025) and is projected to rise from 8.2 billion people in 2024 to 10.3 billion people by the mid-2080s (United Nations, 2024). Population growth, combined with disproportionate resource consumption by wealthier nations, is driving increased demand for land and resources often resulting in large-scale habitat conversion and encroachment of natural lands (Foley et al., 2005; Tian et al., 2026). This process exacerbates competition between wildlife and people for space and resources, which can lead to conservation conflicts (Balmford et al., 2001). In turn, competition has the potential to increase the intensity of human-wildlife conflict (HWC) events with species capable of negatively affecting human well-being and livelihoods, such as through crop foraging and deaths, (McGregor, 2005; Agetsuma, 2007; Nyhus, 2016; Hill, 2018; IUCN, 2023) as well as humans negatively affecting wildlife through retaliatory killings (Viollaz et al., 2021). The International Union for Conservation of Nature (IUCN) Species Survival Commission (SSC) Human-Wildlife Conflict & Coexistence Specialist Group (HWCCSG) defines HWC as “struggles that emerge when the presence or behaviour of wildlife poses actual or perceived, direct and recurring threats to human interests or needs, leading to disagreements between groups of people and negative impacts on people and/or wildlife” (IUCN, 2023).

Between 2022 and 2050, over half of human global population growth is expected to occur in sub-Saharan Africa (UN DESA, 2022). Furthermore, the African continent is particularly rich in critical minerals sought after by global industries and economies (Boafo et al., 2024). These demographic and economic pressures mean that conflict between wildlife and people over space and resources is a notable challenge across the region (Gayo, 2025). The physical and ecological traits of the African savannah elephant (*Loxodonta africana*, referred to as “elephant” hereafter) make it a species particularly prone to negatively impacting people. Their large body size, substantial nutritional

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demands and wide-ranging behaviour means that contact with people in a fragmented landscape is likely, with 57% of elephant range existing outside Protected Areas (PAs; Wall et al., 2021). For instance, when people undertake activities such as natural resource collection, unexpected encounters with elephants can result in injuries and deaths (Buchholtz et al., 2019). Moreover, as agricultural activities encroach on natural habitats and natural food availability declines, elephants are more likely to graze on crops (Montero-Botey et al., 2024), especially when crops have higher nutritional value compared to natural forage (Chiyo et al., 2005; Branco et al., 2019). Crop foraging may also maximise foraging efficiency by reducing time spent and distance travelled to meet nutritional demands (Chiyo and Cochrane, 2005). As well as crop damage, elephants have also been found to damage water pipes and boreholes, affecting access to water for households and livestock (Ramey et al., 2013; Mariki et al., 2015). Such damage is of particular concern as droughts become more common due to climate change (IPCC, 2022). These issues facilitate “hidden costs” on people, including feelings of reduced safety and restricted mobility, which affects mental well-being and children's access to school (Sitati, 2003; Barua et al., 2013; Mayberry et al., 2017; Nyumba and Leader-Williams, 2022).

Elephants play vital ecological roles, shaping the environment through their foraging behaviour and seed dispersal (Valeix et al., 2011; Haynes, 2012; Bunney et al., 2017), and generate substantial economic benefits through tourism (Naidoo et al., 2016). Despite positive national population trends for elephants in Botswana, Kenya, South Africa, Malawi, Uganda, Zambia and Zimbabwe, the species is experiencing a continental population decline at a rate of 8% per year (Chase et al., 2016) and is now listed as Endangered on the IUCN Red List (Gobush et al., 2022). Although population declines are largely attributed to the increase in illegal killing for ivory (UNEP et al., 2013; Wittemyer et al., 2014; Schlossberg et al., 2020), human-elephant conflict (HEC) also contributes to mortality by eroding human tolerance, and sometimes provoking retaliatory killings (Dunham et al., 2010; Kansky et al., 2021; Usman et al., 2023). Habitat loss from agricultural expansion and human encroachment (Douglas-Hamilton, 1987; Geldmann et al., 2014) can exacerbate HEC, while climate change presents an additional long-term threat (Mpakairi et al., 2019).

There has been a growing body of HEC literature in recent years regarding crop foraging (Osborn, 2004; Chiyo et al., 2005), human injury and death, property damage (Gross et al., 2021) and hidden costs (Mayberry et al., 2017). Consequently, HEC research has adopted a variety of approaches, such as ecological methods to study elephant behaviour within human-dominated landscapes (Graham et al., 2009; Vogel et al., 2020; Tiller et al., 2025), but also social science frameworks to investigate aspects such as human tolerance towards elephants (Dickman, 2010; Usman et al., 2023). Additionally, interdisciplinary studies embrace a more holistic approach, often adopting both social and ecological methods (Sanare et al., 2022). More specifically, socio-ecological systems frameworks are used to investigate bidirectional feedback processes between the social factors of human societies and the biophysical factors of ecosystems (Ostrom, 2009; Milner-Gulland, 2012; Malley and Gorenflo, 2023). Given the endangered status of elephants (Gobush et al., 2022), the negative well-being pressures that people can face living alongside them (Mayberry et al., 2017; Nyumba et al., 2020), and the illustrated complexity of this research area, it is crucial to build a reliable resource that can be used to inform future research and subsequently, conservation management actions (Haddaway and Pullin, 2014; Xiao and Watson, 2019).

Narrative reviews and systematic assessments examining global trends and research gaps in HEC studies across Asian (*Elephas maximus*) and African savannah (*Loxodonta africana*) and forest (*Loxodonta cyclotis*) elephant species have been conducted (Shaffer et al., 2019; Saha and Soren, 2024). However, HEC dynamics and management effectiveness often depend on species ecology, behaviour and regional population size (Pozo et al., 2017; Matsuura et al., 2024). Aggregating species may therefore obscure patterns of research effort and intervention evidence across ecologically distinct systems. We undertake a species-focused systematic mapping approach to comprehensively describe the current evidence-base concerning conflict between humans and African savannah elephants. Because ranges of African savannah elephants and African forest elephants overlap in parts of Central Africa (Gobush et al., 2021, 2022) and studies do not always distinguish between species, this exclusion may underrepresent research effort in forest-dominated regions and limit generalisability to forested and mosaic landscapes. Our findings should therefore be interpreted within the African savannah elephant context. By following well-established guidelines (CEE, Collaboration for Environmental Evidence, 2022; ROSES, Haddaway et al., 2018) our systematic approach, eliminates reviewer bias and provides a repeatable method for cataloguing, describing and synthesising evidence. Consequently, we direct researcher attention to key knowledge gaps, as well as identify more specialised questions that can be addressed by systematic review (Pullin and Stewart, 2006; Xiao and Watson, 2019).

To build on previous approaches, we collated literature from 1970 to 2023 on interactions between humans and African savannah elephants that result in negative impacts on people and/or elephants, and which may also lead to disagreements among people over wildlife management, consistent with the IUCN definition of human–wildlife conflict (IUCN, 2023). More specifically, we (1) identify country-level spatial patterns in research effort in relation to the proportion of each country covered by elephant range and its elephant population density, used here as coarse descriptive ecological indicators of elephant presence, (2) characterise the current HEC literature and (3) describe the HEC management interventions that were evaluated. Together, these objectives establish the current state of knowledge on HEC and highlight key routes for future HEC research.

We adopt the IUCN definition of HWC (IUCN, 2023), substituting the term “wildlife” for “African savannah elephants”. Retaliatory killing is included as a form of HWC, whereas illegal and legal hunting for subsistence or commercial purposes is excluded (Lindsey et al., 2013; Duffy et al., 2016). Although the term “conflict” has been critiqued as reducing complex relationships between wildlife and people to dichotomous antagonistic interactions (Redpath et al., 2015), the term “conflict” remains prevalent in the empirical literature and policy discourse. Therefore, in this systematic map we use the term “human-elephant conflict” to reflect the terminology that is often still used in the records we reviewed.

2. Methods

Following the principles of the RepOrting standards for Systematic Evidence Syntheses (ROSES) (Haddaway et al., 2018) and guidelines from the Collaboration for Environmental Evidence (2022) we undertook a systematic search of the peer-reviewed primary (hereafter scientific) literature and grey literature investigating HEC.

2.1. Search strategy

2.1.1. Scientific literature search

We conducted trial searches to establish the appropriate terms required to return relevant scientific literature whilst balancing sensitivity (returning all relevant records) with specificity (proportion of relevant records; Pullin and Stewart, 2006). A log of these searches recorded the database, search terms, number of results, and quality of the search regarding sensitivity and specificity. Thirty benchmark records were identified by three experts to assess performance of the final search string (Supplementary Material 1), which returned 29 of the 30 (97%) benchmark records. This confirmed strong performance of our search approach (Collaboration for Environmental Evidence, 2022). All terms were searched for in titles, abstracts and keywords to maximise the chance of locating relevant studies. Web of Science and Scopus were chosen as databases for the search because of their coverage of Natural

Sciences (Pranckutė, 2021).

We used the term **"elephant$"** to identify records on all elephant species, as species names are not always listed in titles, abstracts or keywords. To ensure that papers concerning human-*wildlife* interactions/conflict (HWI/HWC) and human-*elephant* interactions/conflict (HEI/HEC) were included, we used search terms "human-wildlife OR HWC OR HWI OR human-animal* OR human$ animal$ OR anthropogenic wildlife OR anthropogenic animal$" and "human-elephant* OR HEC OR HEI". Accounting for human-*wildlife* and human-*elephant* interactions in the search ensured identification of records concerning human-*wildlife interactions within the context of elephants* but do not explicitly mention human-*elephant* interactions.

We undertook the final literature search in April 2023. Date restrictions were not applied at this stage because HEC research is a relatively new field of study, with the systematic study of HEC only beginning in the mid-1990s (Hoare, 2012, 2015). Therefore, the amount of literature returned was likely to be manageable for screening. Due to resource constraints, we only included English-language records.

2.1.2. *Grey literature search*

We included grey literature from the African Elephant Library (African Elephant Specialist Group (AfESG) and Save the Elephants (STE), 2010) to reduce publication bias and identify relevant non-academic records (Paez, 2017). The database holds records relevant to the biology, ecology, behaviour and management of African elephants across the species range. We included conference papers, letters, theses and published reports with an ISBN from 1970 to April 2023. All other publication types were excluded, including journal articles (Supplementary Material 2) because scientific literature was already identified through a systematic search process.

2.2. *Screening process*

Records from scientific and grey literature were screened according to eligibility criteria. For scientific literature, screening was undertaken in CADIMA (Kohl et al., 2018) after automated duplicate removal. Titles, abstracts, and full texts were screened sequentially. Grey literature was screened manually at the title stage and then the full-text level following manual removal of duplicates. Where the *whole* of or *parts* of thesis chapters were duplicates of a scientific literature record, the *entire* chapter was discarded to avoid duplication. If it was unclear whether a record met these criteria, it was forwarded to the next screening stage so further details could be obtained. Where a single record contained multiple studies (e.g. PhD theses), individual studies were delineated before data extraction.

2.2.1. *Eligibility criterion (a): the study collected empirical data post-1970, or applied such data to a model for validation*

Records that collected data after 1st January 1970 were included. This was to eliminate historic and prehistoric records, for example in the Pleistocene, and was in accordance with the assertion that the biodiversity crisis and related threats began to be defined in the 1970s (Wilson, 1988).

2.2.2. *Eligibility criterion (b): species focus*

Records primarily focussing on HEC between humans and non-captive African savannah elephants were included. Records on Asian elephants (*Elephas maximus*) and African forest elephants (*Loxodonta cyclotis*) were excluded due to their distinct biology, ranges, and cryptic behaviour (Sukumar, 2003; Wrege et al., 2012; Turkalo et al., 2017; Williams et al., 2020; Gobush et al., 2022), which complicates comparison with African savannah elephants. Where species or location could not be reliably determined, especially prior to the recognition of two African elephant species in 2001 (Roca et al., 2001), records were discarded.

2.2.3. *Eligibility criterion (c): primary objective*

Only records where (one of) the primary objective(s) directly related to HEC were retained. If the primary research objective concerned general HWC, and elephants arose only in data collection, the paper was discarded. If explicit HEC data were collected, it had to be clearly distinct from any illegal hunting data also collected. To be eligible, papers involving management interventions had to be specifically targeting HEC. For example, it was not enough for a study to assess the effect of contraception on elephant population size; inclusion required also addressing issues of elephant population size associated with HEC. Although we use the term "human–elephant conflict" throughout this manuscript for consistency, eligible records could use a range of terminology, including "conflict", "coexistence", "interactions" and "relationships". Records were included based on their substantive focus rather than the specific terminology employed.

2.2.4. *Screening quality checks*

The same team member that screened records conducted two types of quality checks. First, a random 10% of records were re-screened at the title and abstract stage to evaluate within-reviewer consistency. A similarity of >90% was chosen to determine that relevant records were not missed between stages. Second, to provide independent verification of inclusion decisions and to minimise potential reviewer bias, 10% (14 records) of the final grey and scientific literature were reviewed for inclusion or exclusion by a second member of the review team. Agreement between reviewers was 93% (13 out of 14 studies).

2.3. *Data extraction*

We developed a data extraction protocol (Supplementary Material 3) with definitions of data variables and categories to code to avoid selection bias and ensure repeatability (Haddaway et al., 2015). Initial data categories were derived from previous systematic maps and reviews. We assessed data extraction consistency by having two team members independently extract data from a random 10% subsample of studies. Studies spanning multiple data categories were counted in each relevant group, so totals sometimes exceeded 100%.

2.3.1. *Data extraction coding*

We recorded authorship, publication year, study title, publication type (e.g. thesis, report, or journal article), and study duration. Further data were also extracted and categorised according to the three research objectives. Categories and their descriptions can be found in Supplementary Material 3.

To identify spatial patterns in research effort (Objective 1), we recorded the study country and area (km^2) and obtained range data on all extant elephant populations from the IUCN Red List (Gobush et al., 2022). Range data were unavailable for Burkina Faso, which was excluded from this part of the analysis. Data on elephant population density per km^2 were acquired from the 2014/2015 Great Elephant Census (Chase et al., 2016), a standardised continent-wide survey conducted over the same time period. This dataset distinguishes between African forest and savannah elephants, and it is conservatively estimated that 93% of African savannah elephants were recorded. Elephant population density data were only available for 15 of 24 range countries (including Angola, Botswana, Cameroon, Chad, Ethiopia, Kenya, Malawi, Mali, Mozambique, South Africa, Tanzania, The Democratic Republic of the Congo (DRC), Uganda, Zambia, Zimbabwe; excluding Burkina Faso, Eswatini, Eritrea, Central African Republic (CAR), Namibia, Nigeria, Rwanda, Somalia and South Sudan).

To characterise the HEC literature (Objective 2), we extracted data on proximity of study areas to PAs, stakeholder types involved in HEC, primary study objectives, the direction of HEC investigated (negative elephant impact on humans, vice versa or both), primary conflict type, metrics used for measuring conflict (e.g. frequency, extent, probability, or economic cost of conflict events), correlates of HEC, and methodological approaches. Describing HEC management interventions (Objective 3) required extracting information on the intervention type and whether it was evaluated. An intervention was evaluated if it was assessed in accordance with the primary study objectives, HEC was measured, and the outcome of the intervention on HEC was measured. Evaluation of an intervention does not imply effectiveness of the strategy or a robust study design.

2.4. Data analysis

Analyses were conducted in R v4.3.2 (R Core Team, 2025). The number of studies in each data extraction category was calculated as a percentage of the total number of studies. We then tested for differences in research effort among countries by comparing observed study counts with expected counts based on each country's proportional elephant range and population density. A Fisher's Exact Test with Monte-Carlo simulation was used due to small sample sizes (less than 5) of some expected frequencies and a contingency table larger than 2 × 2 (Österling et al., 2010). For contingency tables larger than 2 × 2, Fisher's exact tests were used to assess overall associations; in these cases, a single odds ratio and corresponding 95% confidence interval cannot be meaningfully estimated and are therefore not reported. Comparing observed with expected research effort based on elephant range size and population density attempts to provide a broad heuristic for identifying countries that appear relatively under- or over-represented in the literature. Importantly, this approach does not imply an optimal level of research effort; rather, it reflects patterns arising from the distribution of existing studies. We do not account for factors operating at finer geographic scales, such as human population density, land use, fencing regimes and governance, which may strongly influence both HEC and research activity. Interpretation of these findings therefore requires consideration of these contextual factors. Compiling such fine-scale data was beyond the scope of this study, which aimed to provide a broad continental overview of HEC research.

Following Gross et al. (2022), we categorised management interventions found in the literature into six classes (Table 1). By building on an existing framework, we can ensure consistency in reviewing HEC interventions across the range of the African savannah elephant to reinforce recommendations and bridge the gap between science and practice. To see regional differences in research effort of various management interventions, we grouped Kenya, Tanzania and Uganda into "eastern Africa", and Botswana, Malawi, Mozambique, Namibia, Zimbabwe and Zambia into "southern Africa".

Table 1
The six classes of human-elephant conflict interventions and their definitions. Adapted from Gross et al. (2022).

Class of strategy	Definition
Technical	Strategies to prevent and decrease material damage from elephants, including deterrents and mitigation.
Social	Resolving conflicts through inclusion of relevant stakeholders using participatory methods, community outreach, and education.
Monitoring	Tools used to monitor HEC events, management interventions and elephant movement to develop early warning systems. For instance, using geo-fencing, or mobile phone technology to communicate movements with stakeholders.
Financial	Financial compensation or incentives to reduce the indirect or direct costs experienced by people living alongside elephants.
Legal environment	International, national and regional frameworks, guidelines and by-laws for HEC strategies and action plans.
Spatial management	Spatial organisation of landscapes through land-use planning and zonation. For instance, spatial population planning for elephants (e.g. corridor plans), defining agricultural practices for specific zones, and separating shared resources for elephants and people.

3. Results

A total of 14,239 records were returned from the scientific ($n = 5489$) and the grey ($n = 8750$) literature searches. For the scientific literature database, 4196 sources remained after filtering for publication type, English language and records post-1970. Removal of 1113 duplicates left 3083 records, of which 115 met the eligibility criteria. Seven were excluded due to incompatibility with the data extraction framework meaning data could not be extracted according to our pre-determined categories, leaving 108 records for analysis (Supplementary Material 1). From the African Elephant Library, 1063 grey literature records were screened after filtering for date and publication type, leaving 59 records. Of these, 38 were excluded, leaving 21 records containing 28 studies (Supplementary Material 2). In total, 136 studies from the scientific and grey literature were included in the analysis (Fig. S1).

3.1. Temporal and spatial patterns

From our final records, the first study investigating HEC was published in the grey literature in 1992 (Ngure, 1992); the first scientific paper was published in 1994 (Thouless, 1994). The most recent publications for both scientific and grey literature were from 2023. Almost twice as many studies were published between 2014 and 2023 (n = 87), compared to 1970–2013 ($n = 49$) where annual outputs ranged from zero to six. Overall, annual publications increased between 1992 and 2023, peaking at 14 in 2022 (Fig. 1a). Several studies spanned multiple countries, yielding 148 country-level study occurrences across 11 of the 24 elephant range countries: Botswana, Cameroon, Kenya, Malawi, Mozambique, Namibia, South Africa, Tanzania, Uganda, Zambia and Zimbabwe (Fig. 1b).

Research effort was highly concentrated, with Kenya (40%), Tanzania (18%), and Botswana (16%) accounting for 74% of all studies. None of the 136 studies were conducted in the remaining 13 range countries: Angola, Burkina Faso, CAR, Chad, DRC, Eritrea, Eswatini, Ethiopia, Mali, Nigeria, Rwanda, Somalia and South Sudan (Fig. 1b). Of the 136 studies, 7% were conducted across national borders. Studies across Mozambique and Zimbabwe, and across Kenya and Tanzania were the most common combinations accounting for 33% of trans-national studies. Two studies explicitly occurred within Trans-Frontier Conservation Areas (TFCA): the Great Limpopo (Mozambique-Zimbabwe-South Africa) and Kavango-Zambezi (Botswana-Namibia-Zambia).

3.1.1. Spatial distribution of research effort as a function of proportion of country covered by elephant range

There was a significant difference between observed and expected number of studies if research effort was based on the proportion of each country covered by elephant range (Fisher's Exact Test; $p < 0.001$). Research effort was greater than expected in Kenya, Tanzania, Botswana and Zimbabwe (Fig. 2a; Table S17; Fig. S2). Kenya showed the greatest deviation, with the observed number of studies exceeding the expected by 49 ($n_{expected} = 10, n_{observed} = 59$).In contrast, Zimbabwe had a similar number of observed and expected studies with only one paper more than would be expected ($n_{expected} = 9, n_{observed} = 10$). Research effort matched expectations in Nigeria, Somalia, South Africa and Eswatini, where number of studies corresponded to the proportion of country covered by elephant range. Research effort was lower than expected in the other 15 range countries (Fig. 2a; Table S17; Fig. S2). Of these range countries, Angola and South Sudan had the greatest deviation, with no observed studies despite large proportions of the country covered with elephant range (26% and 49%, respectively) and expected research effort of 12 and 22 studies, respectively. Cameroon, CAR, the DRC, Ethiopia, Malawi, Mali and Uganda had similar numbers of observed and expected studies with only one study fewer than expected.

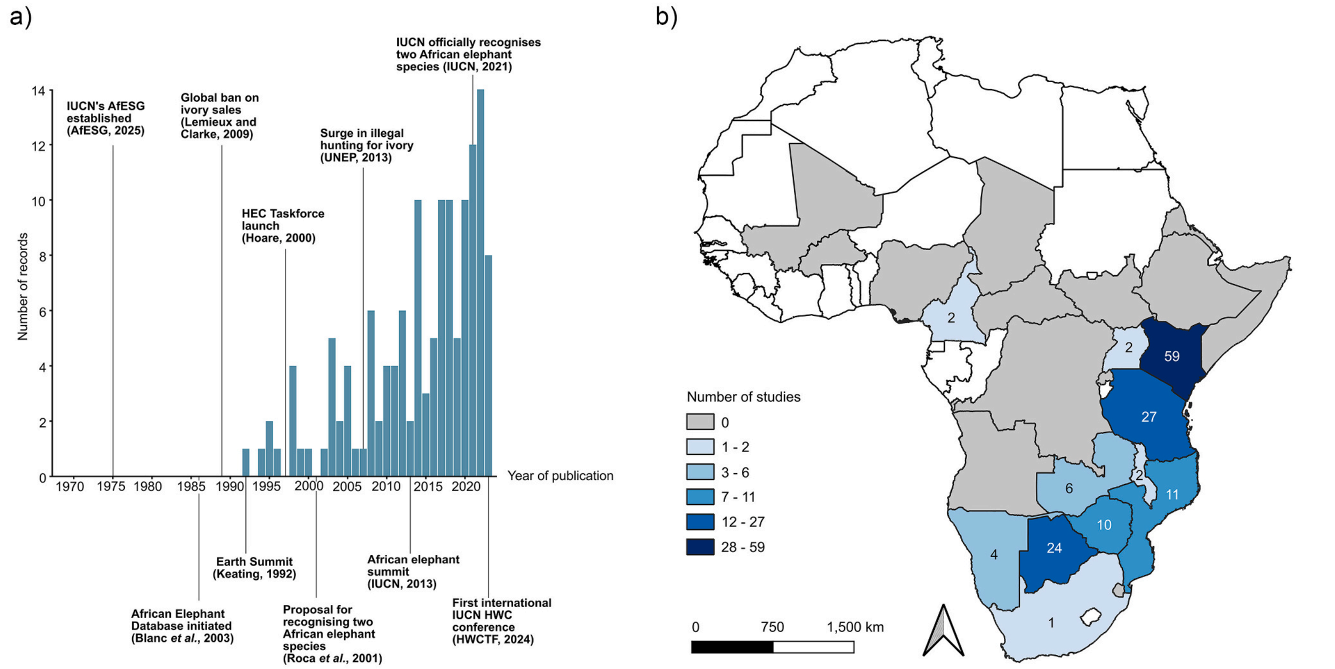

Fig. 1. (a) Timeline showing key dates in human-wildlife and human-elephant conflict research, and the number of published human-elephant conflict studies per year up to April 2023 (b) Geographical distribution of country-level study occurrences. Shades of blue indicate the number of studies. Grey countries indicate African savannah elephant (*Loxodonta africana*) range countries where no studies were identified.
AfESG: African Elephant Specialist Group; HEC: human-elephant conflict; HWC: human-wildlife conflict; IUCN: International Union for Conservation of Nature. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

3.1.2. Spatial distribution of research effort as a function of elephant population density

Across the 15 countries with elephant population density data, 144 studies were identified. Namibia was the only country with published studies ($n = 4$) for which elephant population density data were unavailable. There was a significant difference between the observed and expected number of studies if research effort was based on country-level elephant population density (Fisher's Exact Test; $p < 0.001$). Research effort exceeded expectations in Kenya, Tanzania, Mozambique and Cameroon (Fig. 2b; Table S18). Kenya showed the greatest deviation, with 51 more studies than expected ($n_{expected} = 8,\ n_{observed} = 59$). Cameroon had a more similar number of observed and expected studies ($n_{expected} = 0,\ n_{observed} = 2$).

The remaining 11 range countries had fewer studies than expected (Fig. 2b; Table S18). South Africa and Zimbabwe had the greatest deviation, with 23 and 22 less studies than expected, respectively. Botswana had a slightly lower deviation of 10 studies less than expected. Five countries with available elephant population density data (Angola, Chad, The DRC, Mali and Ethiopia) had no observed studies. Of these, Angola, Chad, Mali and Ethiopia had the lowest elephant population densities (0.02–0.08 km^{-2}) compared to the ten other countries for which elephant population density is available (aside from Cameroon, 0.01 km^{-2}), with 1–2 studies expected per country. In comparison, the DRC had a higher elephant population density (0.21 km^{-2}), based on which, six studies were expected. (Fig. 2b; Table S18).

3.2. Study characteristics

Most studies (82%) occurred within or directly adjacent to PAs while 38% occurred outside PAs (Fig. 3; Table S19). The most frequently studied stakeholder type was farmers (82%), of which over one-third were explicitly identified as subsistence farmers (35%). Residents (26%) were the second most frequently studied, followed by government and Non-Government Organisation (NGO) personnel (each, 2%) and researchers (0.7%; Fig. 3; Table S20). The most common primary study objective was assessing HEC interventions (44%), followed by identifying correlates of HEC (39%; Table S21). Concerning the direction of HEC investigated, most studies assessed the negative impact of HEC on humans (89%), with fewer investigating negative impact on both humans and elephants (5%) or on elephants (4%) (Fig. 3; Table S22).

Of the nine primary conflict types investigated, most studies focussed on elephant damage to human livelihoods, assets and well-being ($n = 182$), with the majority focusing on crop damage (79%). In comparison, seven (5%) studies investigated human damage to elephant physical health and connectivity (Table S23). Across 136 studies, we found a total of 21 different metrics for measuring HEC, with conflict event frequency being most common (61%), followed by spatial extent of impacts, such as crop damage area (23%; Table S24). Over half of the studies (56%) statistically investigated the relationship between a metric for measuring HEC (e.g. human death) and correlates (e.g. land use change). Of these studies, spatial correlates, such as distance from water sources (10%) or PAs (9%), and study location (9%), were most common (28%). HEC intervention characteristics were the second most studied correlate (22%), followed by temporal, biological and human socio-demographic correlates (18%, 16%, 15%, respectively; Table S25). Interdisciplinary methods were more common than single-disciplinary approaches. A socio-ecological approach (using both social and ecological methods) was used in 44% of studies, whereas 33% and 20% of studies used only social or ecological methods, respectively. Two (1.5%) studies used a socio-ecological systems framework, investigating bidirectional ecosystem-human behaviour feedbacks (Fig. 3; Table S26).

3.3. Management interventions

3.3.1. Management interventions evaluated

HEC management interventions were evaluated in 40% of studies ($n = 55$). All percentages are expressed as a proportion of these 55 studies. Technical strategies were most frequently evaluated (89%), followed by social strategies (20%; Table 2). The remaining four management

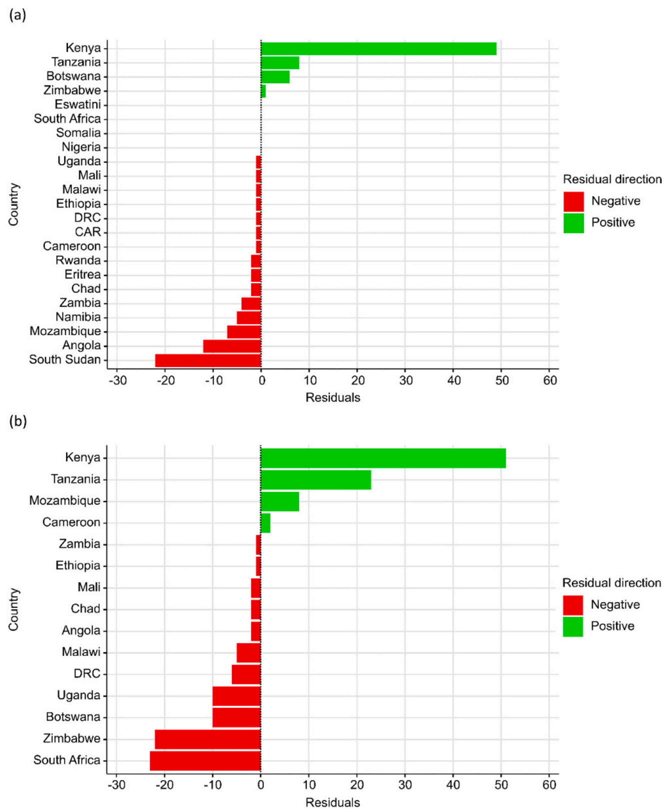

Fig. 2. The deviation of actual number of studies per elephant range country from the expected number of studies: (a) according to proportion of each country covered by elephant range; (b) according to elephant population density per range country. Red bars indicate fewer studies were conducted than would be expected. Green bars indicate more studies were conducted than would be expected.
CAR: Central African Republic; DRC: Democratic Republic of the Congo. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

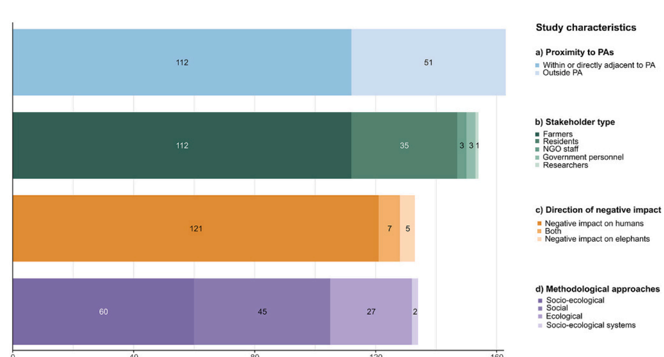

Fig. 3. Number of studies according to (a) proximity of the study to Protected Areas (PA), (b) stakeholder type, (c) direction of human-elephant conflict investigated and (d) methodological approaches. Stacked bars indicate number of studies. Categories within study characteristics a-d are not mutually exclusive meaning, for example, that within stakeholder type, a single study can be recorded as collecting data from both farmers and researchers. Consequently, totals across a-d differ.
n = 136 studies
NGO: Non-Governmental Organisation; PA: Protected Area.

intervention classes (financial, n = 5; monitoring, n = 2; legal environment, n = 1; and spatial management, n = 1) were evaluated in 16% of studies and were not further categorised. The most frequently

Table 2
Categorisation of technical and social management intervention strategies evaluated in studies.

Management Intervention		Description
Category	Subcategory	
TECHNICAL (n = 49)		
Barriers (n = 35)	Chilli-Beehive Fence	Fencing material soaked with chilli, and beehives on fences along the boundary of human areas
	Beehive Fence	Beehives along the boundary of human areas
	Chilli-Based Fence	Fencing material soaked with chilli
	Chilli Plant Buffer	Chillis planted on the boundary of crop fields
	Electric Fence	Electrified fence
	Unfamiliar Items on Fence	Items hanging from fence, e. g. metal strips that reflect light and create loud noises, cow bells/tin cans hanging from fence that create loud noises, and coloured cloths
	Soft Virtual Boundary (SVB)	Foreign, flimsy visual items, e.g. bottles, deployed across short distances across multiple routes into human areas
	Traditional Barrier	Barriers traditionally used by communities e.g. trenches, moats, wire fences, non-vegetative buffer
	Strobe Lights	Solar-powered strobe lights enclosing an area
Guarding (n = 15)	–	Keeping watch e.g. using watchtowers, dogs, torches
Acoustic Deterrents (n = 14)	Playback of Negative Audio	Audio recordings of elephant warning calls or gun shots played aloud
	Trip Alarm	Sound alarm triggered by elephant tripping a cord
	Traditional Acoustic Deterrents	Includes banging drums, hitting sticks, and yelling
Chilli Methods (Excluding Chilli Barriers) (n = 9)	Chilli Briquettes	Burning chilli objects such as dung mixed with chilli
	Chilli-Based Spray	Unpleasant olfactory spray made up from mostly chilli and sometimes also multiple bad smelling ingredients
	Unspecified Chilli Method	Any chilli-based method that is not specified
Other (n = 11)	Non-Chilli Briquettes	Burning non-chilli objects such as tyres, dung
	De-Tusking	Removing tusks from elephant
	Injure or Cull Elephant	Culling or injuring elephants e.g. using guns
	Translocation	Relocating elephants
	Unmanned Aerial Vehicle (UAV)	Herding elephants away from human areas using drones with whirring noises and blinking red and green lights
	Projectiles	Gas dispensers with ping pong balls filled or not filled with chilli oil, fired at elephant and making a noise
	Any Unspecified	Any technical strategy that is not specified
SOCIAL (n = 11)		
Promoting Change in Human Behaviour (n = 7)	Cultivating Alternative Unattractive Crops	Changing crop composition by growing crops that are less palatable to elephants
	Relocating Human Activities	Moving people or their livelihoods to other areas
	Change in Timing for Farming Practices	E.g. early ploughing or synchronised farming activities

(continued on next page)

Table 2 (*continued*)

Management Intervention		Description
Category	Subcategory	
Promoting Knowledge Exchange Between People (*n* = 6)	Local Cooperation Within Community	Collaborate on implementing human-elephant conflict solutions within local communities, e.g. among farmers
	Awareness, Education, Knowledge (AEK) Exchange and Training Programmes	Awareness campaigns, environmental education programmes and farmer-to-farmer exchange programmes
	Government-Led Group Offering Conflict Intervention	Government group providing elephant guarding
	Involve Technical Support	Support or advice using vertical (non-governmental organisations, government, local communities) and horizontal cooperation strategies (rangers across regions)
Other (n = 1)	Unspecified Social Strategy	Any social strategy that is not specified

evaluated technical management intervention category was barriers (64%) followed by guarding (27%). The most frequently evaluated social management intervention category was promoting changes in human behaviour (13%), followed by knowledge exchange between people (11%).

3.3.2. *Management interventions evaluated per country*

Of the 55 studies evaluating management interventions, some spanned multiple countries; therefore, country-level study occurrences differ from the overall number of studies for some management intervention types. The spatial distribution of studies evaluating management interventions reflects wider spatial patterns in the overall literature (Fig. 4 and S5). Management interventions were evaluated in 80 studies across nine elephant range countries (Kenya, Tanzania, Botswana, Mozambique, Zimbabwe, Malawi, Namibia, Uganda and Zambia; Fig. 4). The following percentages are expressed as a proportion of these 80 studies. Social and technical strategies were most frequently evaluated across eastern Africa (n = 11, 14% and n = 55, 69%, respectively; Fig. 4a, b) compared to southern Africa (n = 4, 5% and n = 35, 44%, respectively; Fig. 4a, b). Distinct categories of management interventions were evaluated in 118 studies across nine elephant range countries. The following percentages are expressed as a proportion of these 118 studies. Barriers were the most evaluated category of technical strategy (n = 38, 32%), primarily in Kenya (n = 18, 15%, Fig. 4b).

4. Discussion

4.1. *Overview and key findings*

Our systematic map collated existing literature on conflict between humans and African savannah elephants to establish the current state of knowledge, identify research priorities and identify more refined questions for detailed evidence syntheses. A total of 136 studies from 11 of 24 elephant range countries met our eligibility criteria. These were analysed to identify spatial patterns in research effort, characterise HEC literature, and describe HEC management interventions. There was a general increase in the frequency of studies published per year, with notable reductions during periods of increased illegal elephant hunting. Research effort varied by country and often differed from expectations based on elephant range or population density. The final 136 studies predominantly focused on the impacts of HEC on humans rather than effects on elephants, and metrics used to measure conflict were inconsistent across studies. Fewer than half of studies evaluated HEC management interventions, and these were all within nine elephant range countries. Technical strategies, namely barriers (such as electric fences), were most frequently evaluated.

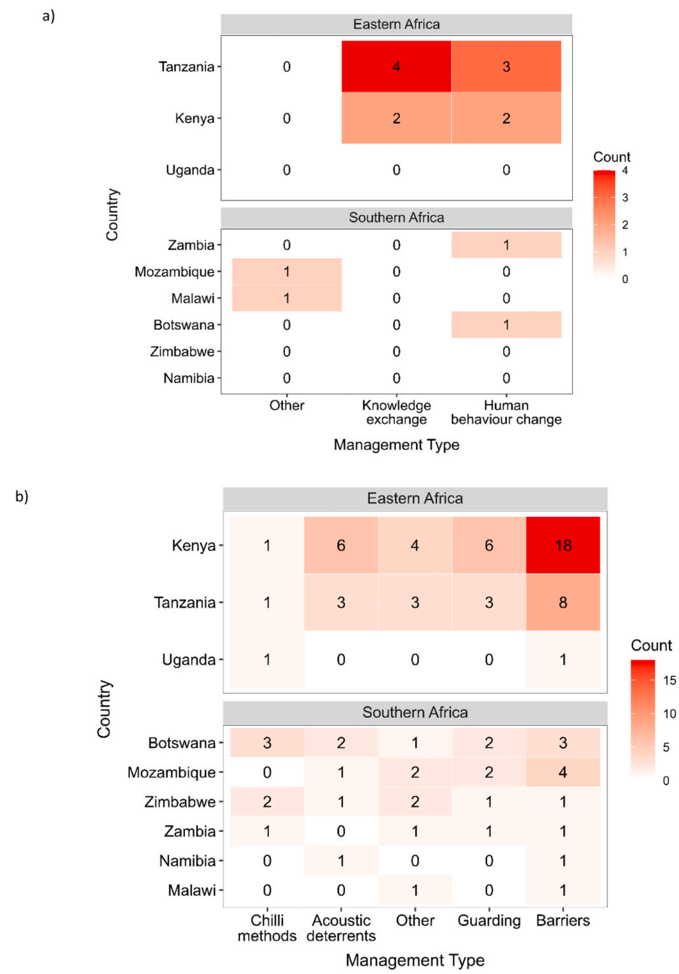

Fig. 4. Structural matrices of the distribution and frequency of studies reporting on the linkages between country and (a) social intervention strategies, and (b) technical intervention strategies. Darker shaded cells indicate higher number of studies. Lighter shaded cells indicate lower number of studies.

4.2. *Temporal patterns*

Temporal patterns in HEC studies aligned with growing international government interest in environmental issues. HEC studies that met our eligibility criteria began in 1992, the same year as the Earth Summit (Keating, 1992), which led to the Convention on Biological Diversity (CBD), a legally binding international agreement between 168 signatories to safeguard biodiversity (UNEP, 1992). After 1992, there was a general increase in studies, likely reflecting wider academic publishing trends (Thelwall and Sud, 2022), and human population growth (UN DESA, 2022) increasing the probability of human-wildlife contact. A noticeable peak in studies occurred in 1998, one year after the launch of the HEC Taskforce of the IUCN African Elephant Specialist Group, which promotes collaborative HEC mitigation, continent-wide technology harmonisation and data-sharing between practitioners and researchers (IUCN SSC AfESG, 2025).

Despite the establishment of the African Elephant Specialist Group in 1975 and the African Elephant Database in 1986, no studies met our eligibility criteria between 1970 and 1991. This absence perhaps reflects other research priorities during this period, including the illegal hunting for ivory, culminating in the 1989 global ban on international ivory trade (Lemieux and Clarke, 2009). We identified temporal variation in the number of HEC studies published across the review period, including two notable reductions in HEC studies that broadly coincide with a surge in illegal elephant hunting in 2006–2007 (UNEP et al., 2013; Wittemyer et al., 2014; Schlossberg et al., 2020) and the African Elephant Summit held in 2013 to address the escalating crisis (IUCN, 2013). During these periods, data collection for illegal wildlife trade research increased globally, with a peak in 2014 followed by a general decline (Kemp, 2025). However, since 2013, we found that almost twice as many HEC studies were published compared to all previous years. Although our results do not imply a causal link between HEC and illegal hunting research, it does highlight the possible lack of investigation of potential connections between the two topics. Previous research has shown that where people have negative experiences with wildlife, it is likely that they will have less support for conservation and towards efforts to reduce illegal hunting (Kansky et al., 2014; Montanheiro Paolino et al., 2024). Therefore, future research examining connections between the two topics would be useful for informing effective strategies to both mitigate HEC and reduce illegal hunting.

4.3. Spatial patterns

4.3.1. Spatial distribution of research effort

Spatial patterns of research effort might be expected to reflect a range of ecological, social, and institutional factors within a country. We examined whether research effort aligned with two ecological proxies, the proportion of a country covered by elephant range and the elephant population density. Greater elephant range coverage increases the likelihood of human–elephant spatial overlap and thus the potential for conflict (Sitati et al., 2003). Higher elephant population densities may increase the frequency of elephant presence in shared landscapes and potentially lead to greater competition between elephants and people for space and resources (Pozo et al., 2017; Supanta et al., 2025). Consequently, HEC research in such areas could be particularly important for informing land use decisions, conservation planning and conflict management interventions. However, we found that research effort often deviated from expectations, potentially suggesting the relevance of other social and institutional factors in determining research effort. Gross and Heinsohn (2023) reported similar findings of geographic publication bias towards countries such as Kenya.

One explanation is that much of the research in the Global South is conducted by institutions based in the Global North (Miller et al., 2023), and so research effort could be attributed to a nation's accessibility for international researchers, including perceived safety and proportion of English-speakers to enable research collaboration (Amano and Sutherland, 2013). For example, research effort in the three most studied countries of Kenya, Tanzania and Botswana, exceeded expectations based on elephant range size. All three countries are English-speaking, perceived as relatively safe, as demonstrated by high tourism (World Bank Group, 2019), and host well-established elephant conservation NGOs. However, compared to Kenya or Tanzania; Angola, South Sudan, and Mozambique had higher proportions of elephant range, and the DRC, Uganda, Malawi and Zimbabwe had higher elephant population densities, but all received less research attention in our final records than expected based on these respective ecological proxies. The lower research output in these countries could be due to perceptions of reduced safety from political and economic instability, including civil conflict (Pearce, 2012; Rapanyane and Tirivangasi, 2020; Dendere and Taodzera, 2023), which could reduce research effort. Furthermore, it is possible that the search restrictions to English-language records did not capture as many records from countries where English is not an official national language, such as Angola, Mozambique, and the DRC.

Although South Africa and Botswana have well-established research centres and international research attention, as well as relative political stability and security (Zikalala, 2021; Reiter, 2024), both countries exhibited lower research effort than expected based on elephant population density. This is notable for Botswana, which has the highest elephant population density in Africa (Chase et al., 2016). However, elephant populations are unevenly distributed in Botswana, with higher elephant population densities concentrated in northern regions where HEC has been extensively documented (Pozo et al., 2018; Buchholtz et al., 2023; Songhurst, 2023). Therefore, the apparent underrepresentation of Botswana likely reflects a concentration of research effort at the regional scale relative to country-level ecological indicators, rather than a lack of research activity in areas where elephants and people interact. Furthermore, recent elephant range expansion into southern areas of Botswana (Thouless et al., 2016; Evans, 2019; Statistics Botswana, 2022), could be leading to emerging HEC dynamics that are not yet reflected in the literature. South Africa's use of fenced reserves limits human-elephant contact and resultant HEC (Taylor et al., 2021; Wagner et al., 2024; Burudi et al., 2025), and likely explains the lower-than-expected research effort based on elephant population density. The low number of studies from South Africa may also result from our eligibility criterion excluding general HWC research in which elephants were only incidental. Consequently, the observed research effort reflects how studies are framed, and our systematic map highlights a particular scarcity of research focused on HEC in South Africa.

4.3.2. Geographic coverage

Mozambique-Zimbabwe was the most common country combination for transnational studies, followed by Kenya-Tanzania, the latter of which likely reflects transboundary elephant populations in the Amboseli-Kilimanjaro and Serengeti-Mara ecosystems (Osipova et al., 2018; Kinyanjui et al., 2019; Hahn et al., 2022). Despite extensive cross-border elephant movement (Thouless et al., 2016), we found only a few transboundary HEC studies, potentially due to complex permit processes, financial cost, and differing research priorities depending on political contexts and national management goals. Our finding aligns with elephant ecology research where most research occurs within states rather than across borders (Gross and Heinsohn, 2023).

Transboundary research is crucial in shaping national and international policy decisions that impact elephants and people both within and beyond state boundaries (KAZA-TFCA, 2016). For instance, it is believed that warfare and illegal hunting have reduced elephant populations in Angola and Zimbabwe, displacing many elephants into Botswana (STE, 2020; MENT, 2021; Schlossberg and Chase, 2024), potentially increasing chances of HEC in this country. Although eight TFCAs in Africa have been set up to collaboratively manage ecosystems across borders, only two studies explicitly took place within a TFCA. More HEC research within TFCAs would facilitate international collaboration between academics, governments and NGOs to achieve successful cross-border HEC management.

4.4. Study characteristics

Our results show a strong anthropocentric focus, with most studies assessing HEC impacts for people compared to elephants. This bias is further supported by the prevalence of studies primarily investigating elephant damage to human livelihoods, assets and well-being. The prioritisation of human dimensions is not unexpected. The widespread use of the term “conflict” in academic and political discourse portrays people as victims and wildlife as conscious antagonists towards people (Peterson et al., 2010; Pooley et al., 2017). This framing could be driving research priorities into HEC impacts on human well-being because it is perceived as urgent. Nevertheless, there is evidence that HEC has a substantial negative impact on elephants, such as physiological stress (Ahlering et al., 2011; Chiyo et al., 2011), which could result in behavioural changes such as increased aggression (Poole et al., 2023). In turn, heightened aggression in elephants could exacerbate HEC through increased risk of elephant attacks on humans, but it remains unclear whether more aggressive elephants tend to engage more readily in high-risk conflict behaviours, such as crop foraging. A socio-ecological systems framework seeks to investigate possible bidirectional feedback loops such as this one, concerning human and elephant behaviour (Milner-Gulland, 2012). However, we found a distinct lack of studies adopting this methodological framework. Greater use of socio-ecological systems frameworks in future research would situate negative human-elephant interactions within the broader contexts of human societies and biological and behavioural processes of elephants (Ostrom, 2009; Milner-Gulland, 2012; Malley and Gorenflo, 2023).

We identified 21 distinct metrics used to measure HEC across the 136 studies. These metrics differed in what they measured (e.g. frequency, severity and rate of conflict event, or human perception of damage) and the units of reporting. This diversity indicates inconsistency in how HEC is measured, which could hinder cross-site comparison of HEC management needs and limit the ability to synthesise evidence to inform resource allocation and area prioritisation (Daly et al., 2018; Carroll et al., 2025). To address this, previous work has called for spatially and temporally comparable continental-scale metrics used to measure conflict, such as “number of HEC incidents per square kilometre of human settlement area per year” (Hoare, 1999).

Related efforts are now underway through the IUCN Species Survival Commission Human-Wildlife Conflict & Coexistence Specialist Group. The group is undertaking a participatory and collaborative process to develop context-specific metrics for monitoring progress towards the CBD target to “effectively manage human-wildlife interactions” (CBD, 2022; IUCN SSC HWC Task Force, 2022). We recommend that future HEC studies consider adopting appropriate standardised metrics such as those suggested by this group if deemed suitable. Importantly, this suggestion does not eliminate the utility of past studies. Data on conflict event frequency could be incorporated into standardised density metrics using available spatial and temporal data. Moreover, building on our findings, a systematic review or meta-analysis could be conducted to assess the reliability, replicability and common elements across existing metrics, thereby laying the groundwork for a standardised metric used to measure HEC and support continental-scale conservation prioritisation.

4.5. Management interventions

Several previous and ongoing efforts have synthesised and evaluated HEC management interventions, offering valuable resources for practitioners. These syntheses have typically focused on a single conflict type (e.g. crop foraging; Montgomery et al., 2022), compiled current methods without formal evaluation of effectiveness (e.g. Human-Elephant Coexistence Toolbox; King et al., 2022), or used a Delphi process to rapidly evaluate effectiveness of conservation and conflict management strategies (Sutherland et al., 2021). While prior resources and studies provide valuable overviews of HEC management interventions, they offer limited insight into how current research is distributed across intervention types and regions within sub-Saharan Africa. Our study complements the existing syntheses by systematically characterising the evidence base, allowing us to examine which intervention types are most frequently evaluated, in which contexts, and where important gaps remain.

Technical strategies were the most commonly evaluated management intervention, perhaps due to their perceived effectiveness and accessibility compared to social, financial, monitoring, spatial and legal methods, making them appealing to funders, policymakers and communities. Technical strategies can provide immediate visible results and are easily implemented, often independently or alongside local NGOs. This offers farmers agency and control over HEC, which in turn can reduce negative attitudes towards elephants and foster co-existence (Nkansah-Dwamena, 2023). For example, farmers can build chilli fences using readily available materials, such as engine oil, tobacco, homegrown chillies, ropes and wooden poles (Sitati and Walpole, 2006). This aligns with our finding that most studies focussed on subsistence farmers, a group that can be vulnerable to food insecurity due to elephant crop-foraging. On the other hand, social, financial, monitoring, legal and spatial strategies can involve technical expertise (Treves et al., 2009), considerable coordination efforts and time to build trust between parties for stakeholders to consider supporting such interventions (Baynham-Herd et al., 2020), such as community-based insurance schemes (Sherchan et al., 2022). Overall, this makes them less appealing to funders, policymakers and communities who seek immediate results for conflict mitigation. Nevertheless, studies evaluating financial strategies exist, but these often focus on broader HWC rather than specifically on elephants (Bulte and Rondeau, 2007). Therefore, the apparent lack of research into financial mechanisms in our systematic map should be interpreted as a consequence of how research is framed, rather than a true absence of evidence.

There was a higher frequency of technical and social management interventions evaluated in eastern Africa, namely Kenya and Tanzania, compared to southern Africa. This mirrors general research effort patterns, and it is likely this variation aligns with explanations for geographic patterns in general research effort, including accessibility and perceived safety. This is further supported by barriers being the most evaluated management intervention, not only across Africa, but most notably in Kenya. Kenya contains the well-established NGO, Save The Elephants, that pioneered beehive fences as a management strategy and continues to conduct studies evaluating their effectiveness to mitigate HEC (King et al., 2009, 2024). The high number of studies evaluating barriers is also likely influenced by the historic and socio-political context of Kenya. Following colonial land reforms and a transition from mobile pastoralism to sedentary agriculture, fences became a prominent method of separating people from wildlife (Evans and Adams, 2016). Although we acknowledge that much of the country remains unfenced, this legacy may be shaping current HEC intervention strategies.

4.6. Limitations

Screening and data extraction were conducted by a single reviewer, introducing potential subjectivity, however the eligibility criteria were applied consistently. Bias was mitigated through comprehensive searches using benchmark records and rigorous quality checks, although not conducting chain citation searches may have led to some omissions. Furthermore, nine of the 13 countries with no studies do not have English as an official language, so restricting the review to English-language sources may have contributed to their underrepresentation. Importantly, we acknowledge that a lack of HEC research in certain countries may reflect search framing and eligibility criteria and should not be understood solely as evidence of limited HEC research taking place. Therefore, geographic gaps found in our systematic map are indicative of gaps in the accessible and eligible evidence base.

Many elephant range countries have national HEC strategies or elephant action plans that guide intervention strategies. Financial, monitoring, spatial, and legal-based interventions may be embedded within policy instruments but remain underrepresented in peer-reviewed literature. We attempted to account for this through a grey literature search that was sourced exclusively from the African Elephant Library, an ongoing project collating records on African elephant biology, ecology, and management. While this approach ensured transparency and reproducibility, it may have excluded internal NGO reports, national action plans, or consultant evaluations not yet incorporated into the database. Limiting published reports to those with an ISBN may have further restricted available records. The apparent scarcity of financial, monitoring, spatial, and legal-based intervention types in the mapped evidence should be interpreted in the context of existing policy frameworks. Publication time-lags may also have influenced the evidence base. Final searches were conducted in 2023, so recently implemented management interventions, particularly those requiring longer evaluation periods, may not yet be published. To support future efforts, we provide data extraction guidelines (Supplementary Material

3) so larger, multi-lingual teams can expand this literature database as additional grey literature becomes accessible.

Our exclusion of broader HWC research in which elephants were only incidental may have contributed to the observed geographic gaps and the limited identification of financial interventions. These interventions are often embedded within wider HWC frameworks and may therefore have been under-detected due to our search terms, classification decisions, and eligibility criteria. Consequently, studies addressing HEC in practice may not have been captured. We emphasise that our findings reflect not only underlying HEC research activity, but also how studies are framed, indexed, and selected within systematic mapping processes.

Inferences regarding spatial patterns in research effort as a function of elephant population density may be more accurate if we tracked national elephant population trends alongside number of studies per year. However, we do not believe doing so would alter our conclusions. We also assumed that spatial extent of elephant range increased proportionately to level of spatial overlap with human areas, affecting chances of HEC (Sitati et al., 2003). In reality, elephant range may overlap with areas of low or zero human population density as in the Okavango Delta (Statistics Botswana, 2022). Future studies could conduct regional analyses with fine-scale spatial data on human settlements and livelihood activities.

4.7. Research gaps

4.7.1. Geographic patterns

Our results show that studies were conducted in only 11 of 24 elephant range countries, with distributions that deviate from expectations based on ecological proxies. This uneven coverage highlights a geographic bias in the evidence base, limiting its applicability across Africa. Researchers should aim to address country-level differences in HEC studies to build a more equitable and effective evidence base for supporting HEC management across Africa. Fine-scale regional analyses would also allow for inclusion of factors that might impact geographical patterns in research effort, such as human population density, accessibility and management strategies (e.g. fenced reserves), which were not captured in our broad systematic map. Such analyses would provide greater explanatory power to differences in research effort.

4.7.2. Conceptual frameworks

Our synthesis indicates that the HEC literature is predominantly anthropocentric and reveals a lack of integrated approaches capable of capturing the dynamic interactions between human and elephant behaviour. Adopting socio-ecological systems frameworks would help address this gap by explicitly incorporating feedbacks between human and ecological components of HEC.

4.7.3. Metrics for measuring HEC

We identified 21 distinct metrics used to measure HEC across the evidence base, indicating substantial inconsistency in how conflict is quantified. This lack of standardisation limits comparability across studies and regions. The development and adoption of standardised, continent-wide metrics for measuring HEC would improve cross-study comparisons and enable strong decision-making of policy and management practice.

4.7.4. Evaluation of management interventions

Our results suggest that technical interventions are most frequently evaluated, while social, financial, monitoring, legal and spatial approaches are underrepresented. This imbalance constrains understanding of the full range of management options. Future systematic reviews should critically appraise the effectiveness of HEC interventions across technical and non-technical approaches, including policy instruments such as legal, financial and governance-based interventions. Explicitly evaluating the alignment between published evidence and the priorities articulated in national HEC strategies and action plans would help identify gaps between research and implementation, enabling practitioners to select management tools with greater confidence and contextual relevance.

4.8. Conclusion

Our systematic map summarises HEC research conducted across Africa, which uses varied conceptualisations and methods to address complex challenges. We provide evidence that the current scope of HEC research identified in our final records shows strong geographical patterns, as well as being focused on impacts to humans and on the evaluation of technical conflict management interventions. We reveal insight into how national contexts and a need for immediate conflict mitigation to improve human well-being could be shaping these observed patterns in research effort. Research into conflict between people and the African savannah elephant has grown in recent decades to address the pressing conservation issue of increasing human-wildlife contact. Our overview highlights critical research gaps, while providing an extensive database to support future syntheses that inform policy and guide the implementation of effective mitigation strategies essential for human-elephant coexistence.

CRediT authorship contribution statement

P.L.A. Downes: Conceptualization, Methodology, Formal analysis, Investigation, Data curation, Writing - original draft, Writing - review & editing, Visualization, Project administration. **F.A.V. St John:** Writing – review & editing, Supervision, Project administration, Methodology, Funding acquisition, Conceptualization. **K.E. Evans:** Writing – review & editing, Validation, Supervision, Methodology, Funding acquisition, Conceptualization. **S. Willcock:** Writing – review & editing, Supervision, Methodology, Funding acquisition, Conceptualization. **G. Shannon:** Writing – review & editing, Validation, Supervision, Project administration, Methodology, Funding acquisition, Conceptualization.

Declaration of Generative AI and AI-assisted technologies in the writing process

During the preparation of this work the authors used Google Gemini and ChatGPT to check for spelling errors and verify whether references were cited in the text and reference list. After using this tool/service, the authors reviewed and edited the content as needed and take full responsibility for the content of the published article.

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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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.biocon.2026.111853.

Data availability

Data is publicly available in a Zenodo repository: https://doi.org/10.5281/zenodo.17455113.

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