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Systematic Map Protocol

Title
What is the evidence of human-wildlife interactions with wild mesocarnivores in Africa? A systematic map protocol

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Keywords
Africa, mesocarnivores, human-wildlife interactions, human-wildlife conflict, ecosystem services

Background
Mesocarnivores are small and mid-sized carnivores with a body mass of <15kg (Roemer et al., 2009). A large and taxonomically diverse group, they play an important role in the ecosystem (Curveira-Santos et al., 2021). Despite this, they are understudied (Marneweck et al., 2022) and scientists have identified Africa, where ~30% of mesocarnivores are experiencing decreasing population trends (San et al., 2013), as an area where further research on mesocarnivores is particularly needed (San et al., 2022). Conflict with humans is one significant reason for the decline in mesocarnivore populations (Marneweck et al., 2022). They are persecuted by humans for real or perceived damage to anthropogenic resources such as livestock, crops and valuable game species (Streicher et al., 2021) and for their potential to transmit disease (Roemer et al., 2009). Although the literature has predominantly focused on human-wildlife conflict (Konig et al., 2020), human-wildlife interactions (HWIs) may also include neutral or positive interactions (Redpath et al., 2015). Positive HWIs may result from the cultural significance attached to the species (Bhatia et al., 2020) or the ecosystem services provided by them, such as waste removal, seed dispersal and pest control (Marneweck et al., 2022). Whilst HWIs with large carnivores have been well researched, much less scientific attention has been paid to mesocarnivores (Lozano et al., 2019). Almost one third of mesocarnivores are threatened with extinction (Marneweck et al., 2021). With the increasing frequency of HWIs due to changes in land use (Streicher et al., 2021), research is required to better understand HWIs with mesocarnivores in order to develop strategies to mitigate human-wildlife conflict and safeguard mesocarnivores. This systematic map will provide an overview of the existing research on HWIs with African mesocarnivores. The map is designed to inform future research to support landowners, conservation professionals and other decision-makers involved in mesocarnivore management.

Theory of change or causal model
The intention of this systematic map is to advance understanding of the interactions between humans and mesocarnivores in Africa. Outcomes for mesocarnivores and humans can be positive, negative or neutral depending on the nature of the interaction. Increased understanding of the nature and impact of these interactions can improve management to support human-animal coexistence. For example, increased understanding of the benefits of African mesocarnivores to

people, particularly their ecological value, can be used to harness community engagement in mesocarnivore conservation through social science methodologies, which has positive ramifications for species survival and human-animal coexistence.

Stakeholder engagement

The research question arose following fieldwork carried out with Wild Connection at Nambiti Game Reserve, KwaZulu-Natal, South Africa to investigate the presence and behaviour of aardwolf (Proteles cristata), a persecuted insectivorous mesocarnivore. Local stakeholders were involved in the development of the research question by highlighting misunderstandings about, and a lack of awareness of, mesocarnivore behaviour, local abundance and threat level. Informal discussions with South African conservation workers at Gap Africa and reserve managers at Alldays Wildlife and Communities Research Centre helped to refine the research question further, particularly with regard to the differences between farmer perceptions of the impacts of mesocarnivores and the actual impacts.

Objectives and review question

The primary review question is: What is the evidence of human-wildlife interactions with wild mesocarnivores in Africa? The secondary review questions are: (i). What are the types of human-wildlife conflict with wild African mesocarnivores? (ii). How do local people perceive wild African mesocarnivores? (iii). What is the value of wild African mesocarnivores to local people? (iv). What solutions are proposed to address human-wildlife conflict with wild African mesocarnivores?

Definitions of the question components

Based on the primary and secondary research questions, the review will be framed using the following Population Exposure Comparators Outcome (PECO) elements: Population(s): Wild extant mesocarnivores (body mass <15kg) in mainland Africa (compiled from the IUCN database of African carnivores (IUCN, 2024) see Additional File 1). Exposure(s): Direct or indirect interaction with humans/anthropogenic resources (real or perceived). Comparator(s): Within a paper: comparison between species, comparison between type of HWI, comparison between type of perception, comparison between type of location/situation, or studies with no comparator. Outcome(s): Any negative (e.g. conflict, hunting), neutral (coexistence with no explicit benefit or threat) or beneficial (e.g. ecosystem services, social/cultural value) HWI, type of conflict (e.g. damaging livestock, spreading disease, damaging crops), type of benefit (e.g. waste removal, seed dispersal, spiritual/religious), perception of species of interest, management solutions for conflict.

Search strategy

The search string was formulated using the PECO elements above, coupled with keywords that are specific to the secondary questions. The search string includes two substrings: (i) population: the scientific and English common names of all extant mesocarnivore species (Additional File 1) found in mainland Africa, the taxonomic family group names for these species, and alternative terms used for mesocarnivores and (ii) exposure: terms relating to HWIs. We opted not to stipulate outcomes in the search string so that the search results would be open. We also opted not to include geographical restrictors because 59 species are found only in Africa and the volume of returned literature for the remainder (N=19) is manageable for us to screen out non-mainland African-based studies. This ensures that studies that do not mention country in the Title or Abstract will not be omitted. We chose to include all mesocarnivore species in mainland Africa (N=78, native and non-native) because of the potential for humans to interact with any of these species. When the search string was tested against each species individually, the volume of evidence for each species was relatively low and therefore it was feasible to include all of them to capture as much data on HWIs as possible. The search will be conducted in the English language with no date restrictions. Due to the length of the search string, it is set out in Additional File 5.

Bibliographic databases
We will conduct literature searches on the following bibliographic databases: 1). Web of Science using Topic search 2). CAB Abstracts using Abstract search and 3). EBSCO Open Dissertations.

Web-based search engines
We will conduct a literature search on Google Scholar. We will use a modified version of the database search string and use the first 200 records retrieved by the search for Title and Abstract screening. The search string is: mesocarnivore AND Africa AND conflict OR damage OR destruction OR “human-wildlife” OR "human-carnivore" OR HWC OR persecution OR interaction OR perception OR perspective OR attitude OR reaction OR benefit OR service OR advantage OR threat OR threats OR livestock OR farm OR agriculture OR crop OR community OR landowner OR smallholder OR stakeholder OR people.

Organisational websites
We will conduct literature searches of the following organisational websites: 1). Panthera 2). IUCN (human-wildlife conflict and coexistence library) 3). WWF 4). African Wildlife Foundation 5). Wildlife Conservation Society 6). Wildlife Conservation Network. The search strings for these sources will be adapted from the database search string and will reflect the search capabilities of each website.

Comprehensiveness of the search
To inform the search string, scoping searches of published literature were carried out in Web of Science using Topic search, and iterations of the search string were tested to explore relevance. Keywords were updated to ensure specificity and sensitivity. We tested a range of exposure terms relating to human-wildlife interactions (Additional File 2) and based on limited results, broadened the search terms to capture a comprehensive range of literature. During the iterative process to determine the search string, 17 articles relevant to the primary and secondary research questions surfaced. These were logged and used as benchmarking articles to test the relevance of the search string. The final search string captured each of these and validated the comprehensiveness of the search string (Additional File 3).

Search update
No search update is planned due to the restricted timeframe of the review.

Screening strategy
All articles will be exported into EPPI-Reviewer 6 and duplicates removed. The total number of articles and number of duplicates removed will be recorded using the ROSES flow diagram. Articles will be filed according to the inclusion criteria. This will enable us to sort evidence for different aspects of the primary and secondary questions. In the case where the volume of relevant articles remains too large to process in the available time, this will allow for a clearer understanding of where we may restrict the inclusion criteria to ensure that the project is feasible in the timeframe. Remaining articles will be screened by one person on Title and Abstract. ‘Priority Screening’ will be enabled in order to organise results by relevance. A random sample of 5% of total articles will be screened manually first, allowing the software to ‘learn’ relevant studies. This sample enables the software then to sort results by expected relevance. Progress will be monitored and when results begin to plateau and lose relevance, screening may cease based on agreement with the team. Where inclusion remains unclear based on screening by Title and Abstract, articles will be screened at full text. If full texts are unavailable, this will be noted and a second opinion sought based on Title and Abstract. All articles for second opinion will be screened by at least one other person to reach a decision. Existing reviews and meta-analyses will be included in a separate file to be coded separately.

Eligibility criteria
Articles will be screened according to the inclusion and exclusion criteria. This may be updated based on regular discussions between the research team regarding relevance during the screening process. Population(s): any extant African mesocarnivore (Additional File 1); relating to mainland Africa only; relating to wild animals only; native or introduced species; terrestrial or semi-terrestrial animals. Exclude: large carnivores (>15kg); studies outside of mainland Africa; feral animals; captive animals; rehabilitated animals; re-releases. Exposure(s): any type of HWI (direct or indirect) which leads to negative, neutral or positive outcomes (realised or perceived); relates to human attitude/perception towards species of interest. Exclude: interactions between animals/species/family groups; relates to mesocarnivore behaviour/behavioural ecology; relates to land use; relates to land occupancy. Comparator(s): comparison of different types of HWIs; comparison of species and HWIs; comparison of location/situation and HWIs; comparison of different types of perception; studies that have not used a comparator. Exclude: comparison of mesocarnivore with large carnivore; comparison of mesocarnivore with non-target species. Outcome(s): positive/negative/neutral effect of HWI; type of conflict; type of benefit; any management solution for HWC; perception of species of interest. General: any date range; any empirical study, meta-analysis or review. Exclude: not in English language; not available at full text.

Consistency checking
To check for consistency, 5% of total articles (before Priority Screening is enabled) will be selected at random and screened by one other member of the research team at Title and Abstract level. Articles will only be double screened at full text if both members agree that this is necessary. Disagreements for inclusion will be discussed with the wider project team where they cannot be resolved by the two screeners. If the consistency rate does not reach 80%, inclusion criteria will be discussed with the wider team and may need to be amended. If the final volume of returned articles is deemed too large to allow enough time for double screening, a lower percentage of articles will be double screened. This will be decided by consultation with the project team.

Reporting screening outcomes
Outcomes of the screening process will be documented using a ROSES flow diagram. All articles excluded on Title and Abstract will be included in a separate file. Any articles removed after full text review will be filed separately and a reason for exclusion provided.

Study validity assessment
As this is a systematic map, critical appraisal of individual studies will not be carried out. However, we will capture details of study design as part of the coding process and highlight potential validity issues.

Consistency checking
N/A

Data coding strategy
The full data coding strategy is set out in Additional File 4.

Meta-data to be coded
The meta-data to be extracted from all eligible studies includes bibliographic and background information and data relating to the PECO elements defined above. See Additional File 4.

Consistency checking
Coding will be performed by one member of the research team. To check for consistency, 5% of total articles will be selected at random and coded by one other member of the research team. If the

consistency rate does not reach 80%, coding will be discussed with the wider team and may need to be amended.

Type of mapping
A systematic map database created in Excel will be produced alongside a full written report.

Narrative synthesis methods
We will interrogate the metadata in the systematic map database and, using descriptive statistics, produce a narrative summary describing the volume, characteristics and trends of the evidence base, including knowledge gaps and clusters, to address the primary and secondary questions, and to identify priority areas for future research. The narrative will be accompanied by graphs, tables, heatmaps and other infographics wherever possible. For example, a geographic map showing the number of studies in each country. As we are looking at a high volume of species, we may spotlight species of particular interest and provide greater in-depth analyses of these species.

Knowledge gap identification strategy
The systematic map database will be used to produce simple numerical accounts of frequencies in each category and more complex crosstabulations to enable trends, knowledge gaps and clusters to be identified. Heat maps, descriptive tables and other infographics will be used to illustrate themes, knowledge gaps and knowledge clusters, to guide future research.

Demonstrating procedural independence
The authors do not have previous published work relevant to this research.

Competing interests
Authors have no competing interests.

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Author’s contributions
NR and EW conceptualised the project. KH, NR and EW devised the research questions and acquired funding. VH and LE performed the scoping searches and wrote the first draft of the manuscript, with comments and edits from KH, KJ, NR and EW. All authors read and approved the final manuscript.

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