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Research Letters

Importance of non-journal literature in providing evidence for predator conservation

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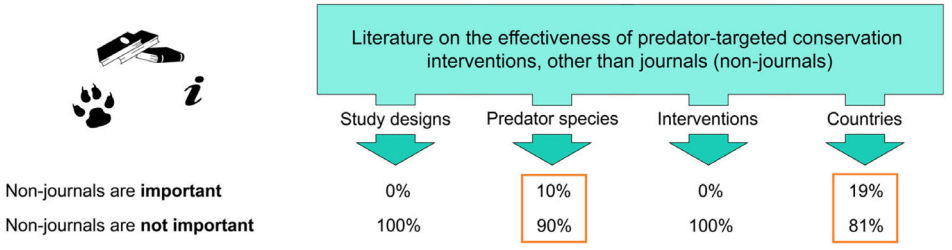
HIGHLIGHTS

- The literature other than scientific journals (non-journals) is a rarely explored resource in predator conservation.
- Non-journals are important for some predator species and countries.
- The use of non-journals should become a habitual practice to seek solutions for mitigation of human-predator conflicts.
- The list of publications and online resources with valuable non-journals is provided.

GRAPHICAL ABSTRACT



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ABSTRACT

The literature other than scientific journals (non-journals) is a valuable, but scattered and rarely used, source of evidence of the effectiveness of interventions applied for protection from mammalian predators. This study describes how journals and non-journals differ in relation to study designs, types of interventions, predator species, countries, and publication bias. I collected 411 journal cases (226 publications) and 97 non-journal cases (64 publications) covering the period 1955–2020, five study designs, six interventions, 28 species and 50 countries. Non-journals were important for two predators (leopard *Panthera pardus* and snow leopard *P. uncia*) and four countries (Canada, India, Russia and Sri Lanka). These species and countries have been affected by human-predator conflicts and the use of non-journals should become a habitual practice to mitigate conflicts. Information on other species and countries, and all study designs and interventions, was provided mostly or only in peer-reviewed journals. This study helps make the use of non-journals easier for researchers and conservation practitioners by providing and explaining a list of relevant literature and online resources.

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Introduction

Conservation interventions are required to reduce threats and improve the state of the environment and its components, such as biodiversity (Sutherland et al., 2020). To properly fulfill their goals, interventions should be practical, compliant with local social and ecological conditions, relevant and effective based on solid evidence (Walsh et al., 2019). Finding information on effective interventions is a complicated and time-consuming process because relevant data can be published in numerous professional periodicals, reports, dissertations and other products, which are scattered and seldom concentrated in repositories or databases. The time spent in literature search should be minimized considering the rapid pace of environmental degradation and an urgent need to react quickly (Xu et al., 2022). Specialized platforms (Livoreil et al., 2017; Sutherland et al., 2019; Downey et al., 2021), systematic reviews and meta-analyses (Moreira-Arce et al., 2018; Torres et al., 2018; van Eeden et al., 2018; Lozano et al., 2019; Khorozyan, 2022), and evidence prioritization (Malmer et al., 2020) boost the efficient search of the literature on conservation interventions.

Scientific literature is available in several forms. Most commonly, results of scientific studies have been published in professional journals which are periodical, peer-reviewed, widely available and visible (scholarly literature). Journal papers are traditionally believed to be more reliable (Adams et al., 2017) what makes scientists read and cite them much more frequently than non-journal materials. On the other extreme is a large amount of so called "gray literature" which includes conference proceedings, newsletters, reports, theses, dissertations, and other textual and visual information. They are usually produced only once (except for newsletters and institutional reports), not peer-reviewed, available to a narrow circle of people, poorly visible and rarely cited (Mahood et al., 2014; Paez, 2017). This classification creates a wrong impression that the gray literature is of poorer quality, but arguably it can be of high enough professional level but remain overlooked (Corlett, 2011). This neglect can be unintentional, when the gray literature is not known or not available, and intentional if scientists focus their research (mainly) on peer-reviewed publications, particularly in meta-analyses and systematic reviews (Moreira-Arce et al., 2018; Torres et al., 2018; Lozano et al., 2019). Division of publications into scholarly and "gray" appears to be not only derogatory regarding the quality of the gray literature, but it is also quite subjective because exceptions are not uncommon. For example, books and reports can be peer-reviewed (Deinet et al., 2013; Kulczycki et al., 2019; Superchi et al., 2019), and conference proceedings can be of high standard, periodical and peer-reviewed (Marsh, 2008). Therefore, in this paper I slightly change the terminology and divide the scientific literature into journals and non-journals (adapted from Christie et al., 2021).

Although non-journals are often hidden and poorly known, they are still likely to contain valuable information on the effectiveness of conservation interventions (Corlett, 2011). Their use is particularly favored by authorities, practitioners and local people because non-journals are usually written in a plain and understandable language with the minimum of professional jargon. Assuming the practice-oriented nature of research published in non-journals (Adams et al., 2017), the evidence it provides may reduce a wide research-implementation gap (Dubois et al., 2020). Also, non-journals can provide more balanced information than journals as they are less subjected to critical reviews and thus are more likely to disclose negative or neutral results, potentially reducing publication bias (i.e. prevalence of positive results; Adams et al., 2017; Paez, 2017). However, non-journals may also increase this bias if authors over-emphasize positive results, for example, by choosing only statistically significant results to avoid conflicts of interest (Corlett, 2011). Moreover, non-journals deliver information to the target audience much faster than journals (Christie et al., 2021). Meanwhile, conservation non-journals are difficult to find (Corlett, 2011). Unlike ecological and conservation journals which are easily searchable through the online repositories (e.g., Web of Science, BioOne, JSTOR and Scopus), there is no centralized database or library of the non-journal conservation literature, to the best of my knowledge. These characteristics increase the time and effort required to find and extract the information that users need from the non-journal literature.

In this study, I compared the content of journals and non-journals in regard to the effectiveness of interventions used to decrease damage from predators. I studied how differences between journals and non-journals are related to study designs and types of interventions, predator species and countries. I also tested the following hypotheses: (1) contributions of non-journals to conservation evidence are not biased by their smaller sample sizes, and (2) journals are more prone to the publication bias and they present interventions of higher effectiveness than non-journals. Conflicts with predators caused by their nuisance behavior and tangible damage to rural economies are widespread (van Eeden et al., 2018), and I considered anti-predator interventions as an example of globally relevant conservation actions to which the issue of non-journal use is broadly applicable.

Methods

I searched for the information about the effectiveness of interventions used to protect human assets (domestic animals, crops, orchards, tree plantations, beehives and neighborhood safety) from terrestrial mammalian predators. I also considered interventions applied in captive conditions because their study designs were developed to be applicable to the wilderness too. I searched for journals and non-journals using the same sources: 33 meta-analyses, reviews and books, eight online repositories specialized in predators and conservation evidence, Google Scholar and Web of Science. Full information about these sources and search terms is provided in Supporting Information S1. I compiled the database in 2018–2021 systematically and continuously, and collected study cases from journals and non-journals published through the end of 2020.

The literature search was systematic, standardized and unrestricted for geography, languages and publication types. I scanned titles and abstracts of retrieved publications for their thematic relevance and explored study results for the quantitative information (see below) about the effectiveness of predator-targeted interventions. This quantitative information was provided in the text, tables, figures or supplementary files, and it reported the effectiveness metric (relative risk, see below) directly or contained the data from which it could be calculated independently. I limited the search to the predator species known to cause damage to human assets ranging from the red fox (*Vulpes vulpes*, 4.84 kg) and Andean fox (*Lycalopex culpaeus*, 8.62 kg) to polar bear (*Ursus maritimus*, 375 kg) (Jones et al., 2009). I included the non-English literature which fit the selection criteria, but did not explore specific non-English repositories.

I excluded the cases which (1) contained insufficient data to calculate the relative risk; in cases where damage in control and treatment samples (see below) was reported, but sample sizes were not, I assumed that sample sizes were equal; (2) described effectiveness as it was perceived by people (e.g. very effective, effective or ineffective) and not assessed by treatment-control comparisons (e.g. Marker et al., 2005); (3) did not describe details of interventions; (4) described interventions out of the scope of this study (e.g. those related to the recovery of predator populations); (5) were non-independent (i.e. used the same data as the cases included in

this study); (6) derived from observational studies and not from treatment-control studies; and (7) used simulation modeling.

The database was comprised of independent cases, with each case describing an effect of a particular intervention on the protection of a particular human asset from a particular predator species in a site. As some publications contained more than one case, the total number of cases was higher than the number of publications. Several cases per publication were designed and applied independently. For each case, I recorded the publication type, study design of an intervention, predator species from which an asset was protected, intervention type, country where the study was conducted, and the effectiveness value. Publications were categorized as scientific journals (thereafter, journals) and other types (non-journals). Non-journals included books, book chapters, conference proceedings, newsletters, reports, Master's theses and PhD dissertations. Study designs included before-after, before-after-control-impact (BACI), control-impact, crossover and randomized controlled trial experiments (e.g., Treves et al., 2019; Christie et al., 2020; Khorozyan, 2022). Predator species were single species or several species mixed together, depending on how they were presented in original publications. Interventions included aversion, husbandry, invasive management, lethal control, non-invasive management, and mixed interventions when several interventions were used simultaneously in the same study and could not be disentangled. Aversion consisted of acoustic, chemical, physical and visual deterrents; husbandry included electric fences, enclosures, guarding animals and herding; invasive management was done with translocations, sterilization, geofence and shock collars; lethal control involved shooting, trapping and poisoning; and non-invasive management included the use of predator-proof garbage bins, removal of food remains, calving control, capacity building programs, crop management, replacement of livestock breeds or species, and supplemental feeding (Khorozyan, 2022).

The relative risk (RR) was the quantitative metric of the effectiveness of interventions. In the context of this study, RR is the probability of damage caused by predators in the treatment sample (with intervention) divided by the probability of that damage in the control sample (without intervention) (Khorozyan, 2020). When damage is an outcome, as in this study, the intervention is effective when damage is reduced and RR < 1, most effective when RR = 0 (damage reduced to nil), ineffective when RR = 1 (same damage in treatment and control) and counter-effective when it increases damage and RR > 1 (Khorozyan, 2020).

I used chi-square (χ^2) goodness-of-fit test, Mann-Whitney test and medians with their 99% confidence intervals (99% CI) in IBM SPSS Statistics v. 26.0 to explore differences in numbers and RR of journal and non-journal cases for each study design, predator species, intervention and country. Only samples with sizes larger than 4 were used in these analyses (Supporting Information S2). I measured the effect sizes of χ^2 test by Cohen's w = sqrt(χ^2/N) and of Mann-Whitney test by Cohen's r = |z|/sqrt(N), where χ^2 and z are the test statistics and N is the sample size (Cohen, 1988; Fritz et al., 2012). The effects were strong if r and w > 0.5, moderate if 0.3–0.5, and weak if 0.1–0.3 (Fritz et al., 2012). Confidence intervals for the medians were estimated as described by Conover (1999). Non-journals were considered as important sources of conservation evidence if the numbers of their cases were similar (p > 0.005) to those of journal cases, had weak to moderate effect size of difference in their numbers, made at least 25% of all cases, or all cases came from non-journals. A combination of significance level, effect size and an arbitrary, yet reasonable, threshold percentage was used to avoid misleading results from incorrect interpretations of p values alone, especially if the sample size was small (Benjamin et al., 2018). I selected a more conservative threshold of statistical significance (p = 0.005 vs. conventional p = 0.05) to minimize false positives and to determine the most distinct patterns only (Benjamin et al., 2018).

The percentages of non-journal cases for study designs, predator species, interventions and countries were represented by 100% stacked bars, and their association with the numbers of cases was checked by Spearman's correlation rho (ρ). Variation of estimates is given as ± standard error (SE).

Results

I compiled a database of 508 cases from 290 publications covering the period of 1955–2020, five study designs, six interventions, 28 predator species and 50 countries. Of these 508 cases, 411 (80.9%) came from 226 journals and 97 (19.1%) from 64 non-journals. Data on seven species and 29 countries were excluded from the analysis because of small sample sizes (n = 1–4; Supporting Information S2).

Non-journals were important for snow leopard (*Panthera uncia*; 8 out of 17 cases = 47.1%, χ^2 = 0.059, p = 0.808) and leopard (*P. pardus*; 9/32 = 28.1%, χ^2 = 6.125, p = 0.013; Fig. 1). The effect size of the difference between the numbers of non-journal and journal cases was weak for snow leopard (Cohen's w = 0.06) and moderate for leopard (w = 0.44). For snow leopard, non-journal cases came from five non-journal publications from a total of 11 publications (45.5%). For leopard, nine non-journal cases were over-represented by only two non-journal publications out of 19 (10.5%).

The countries (Fig. 1) for which non-journals were important included Canada (nine out of 32 cases = 28.1%, χ^2 = 6.125, p = 0.013), India (5/15 = 33.3%, χ^2 = 1.667, p = 0.197), Russia (11/15 = 73.3%, χ^2 = 3.267, p = 0.071) and Sri Lanka (7/7, 100%). The effect size of the difference between the numbers of non-journal and journal cases was moderate for Canada (w = 0.44), India (w = 0.33) and Russia (w = 0.47). Proportions of non-journal publications were similar to proportions of non-journal cases for Canada (6/21, 28.6%) and India (4/12, 33.3%), but in Russia 11 non-journal cases were over-represented by four non-journal publications (4/7, 57.1%). An extreme case of over-representation was found for Sri Lanka where all non-journal cases (n = 7) came from one publication, and no journal cases were reported from this country.

Information on other species and countries and all study designs and interventions was provided mostly (χ^2 varied from 7.143 to 111.446, p from <0.001 to 0.008, w from 0.41 to 0.87) or only in journals, or their samples were too small to make reasonable judgments (n = 5–11; Fig. 1, samples sizes in Fig. 2). Thus, non-journals were found to be important for two out of 21 predator species (9.5%) and for four out of 21 countries (19.0%). I did not find evidence of significant relationships between the percentage of non-journals and sample size for study designs (ρ = 0.200, p = 0.747), species (ρ = 0.367, p = 0.102), interventions (ρ = −0.314, p = 0.544) and countries (ρ = −0.030, p = 0.897).

Cases from non-journals were marginally more effective than those from journals in non-invasive management (median RR = 0.000, 99% CI = 0.000–0.090 vs. 0.516, 99% CI = 0.111–0.762, Mann-Whitney U = 48.0, p = 0.005) and snow leopards (0.000, 99% CI = 0.000–0.000 vs. 0.125, 99% CI = 0.000–0.550, U = 12.0, p = 0.007) (Fig. 2). The effect size of the difference in RR was moderate for non-invasive management (Cohen's r = 0.41) and strong for snow leopard (r = 0.66). In all other cases, the effectiveness of journal and non-journal cases was similar (U varied from 0.0 to 4247.5, p from 0.044 to 1.000).

Discussion

This study shows that the non-journal literature can provide part of evidence of the effectiveness of predator-targeted inter-

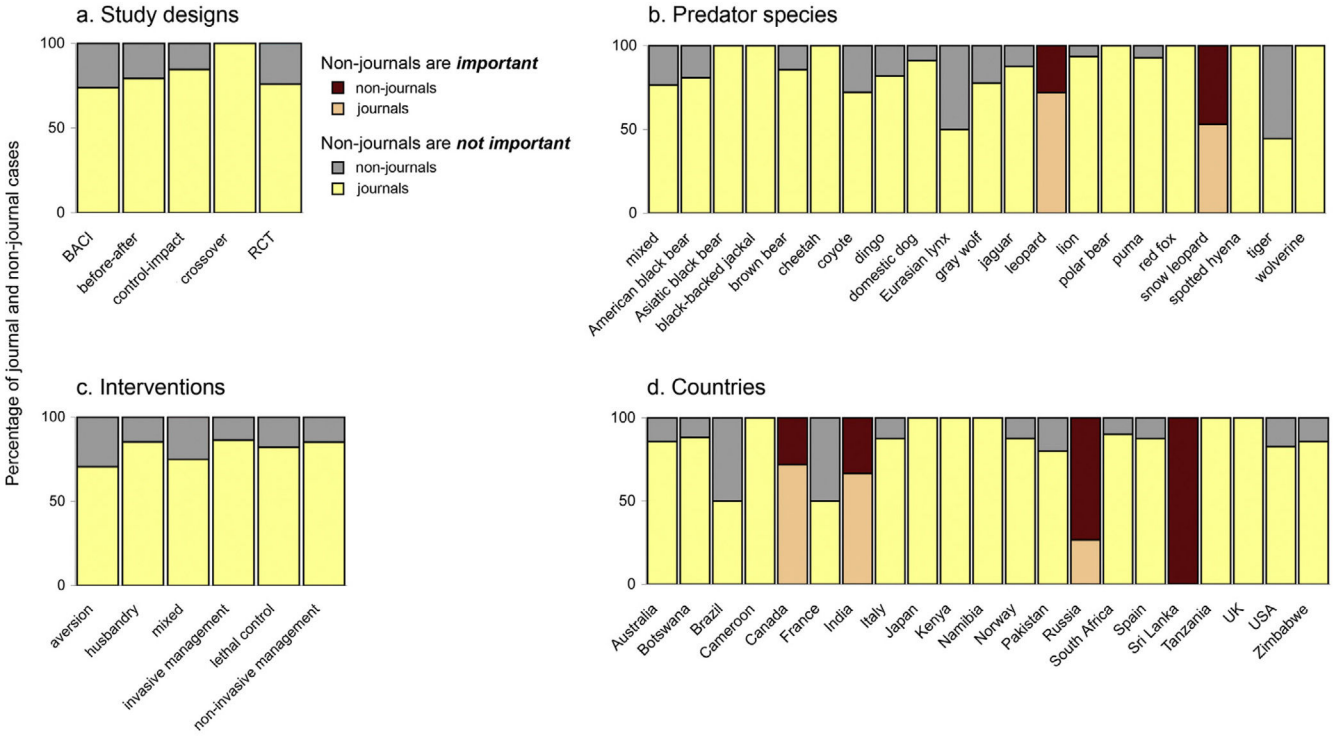

Fig. 1. Contributions of journals and non-journals to the information on the effectiveness of predator-targeted interventions across the study designs (a), predator species (b), interventions (c) and countries (d) when non-journals are important and not important. Abbreviations: BACI – before-after-control-impact, RCT – randomized controlled trial.

ventions, regardless of sample size (support of hypothesis 1). Non-journals were found to be important for two predator species (leopard and snow leopard) and four countries (Canada, India, Russia and Sri Lanka), with no apparent effects among study designs and interventions. Leopard and snow leopard cause serious damage to domestic livestock and thus provoke active retaliatory or preventive killings of these big cats, making man-caused mortality one of the main threats to survival of these globally vulnerable species (Loveridge et al., 2010). Minimization of such conflicts and promotion of co-existence between humans, leopards and snow leopards requires the knowledge on how to effectively protect livestock from these predators (Khorozyan and Waltert, 2021), and this information can be provided by non-journals, especially on snow leopard and to a lesser extent on leopard.

All four countries for which non-journals appeared to be important have been affected by human-predator conflicts, especially India (Torres et al., 2018). Parts of India, Sri Lanka and Russia are covered by the world's biodiversity hotspots (Marchese, 2015) where making the use of non-journals a habitual conservation practice may lead to the transfer of knowledge and experience from human-predator conflicts to other fields of biodiversity and landscape conservation.

Some predators and countries showed signs of the importance of non-journals, but their small samples (Fig. 2) preclude making firm conclusions. The species with small samples included Eurasian lynx (*Lynx lynx*), jaguar (*P. onca*), domestic dog (*Canis familiaris*), dingo (*C.f. dingo*) and tiger (*P. tigris*), while the countries with small samples were Brazil, France, Pakistan, South Africa, Spain and Zimbabwe. As more information is published or found on these species and countries, particularly in non-English languages which I did not specifically search for, the role of non-journals in providing evidence may increase. The database of this study shows that non-journals published in German, French, Spanish, Russian and Norwegian served the unique sources of information on lynx in Switzerland and France, brown bear (*Ursus arctos*) in Norway, puma (*Puma concolor*) and jaguar in Paraguay and Brazil, and snow leopard in Russia (Krogstad et al., 2000; Angst et al., 2002; Kuksin and Kuksina, 2009; Landry and Raydelet, 2010; Hoogesteijn et al., 2016; Villalba et al., 2016). Therefore, the use of information published in non-journals in non-English languages should become a good practice for predator conservation.

Not all non-journals are equal in their content, as some of them can contain disproportionally high amount of information on conservation evidence. In this study, such information-rich non-journals were found for leopard, Russia and Sri Lanka, but they also can occur for any other species or country. Increased use of data from non-journals is expected to reduce over-representation and a geographical bias in research synthesis.

I did not find evidence of publication bias in journals (rejection of hypothesis 2). In contrast, for snow leopard and non-invasive management non-journals described slightly more effective interventions than journals did. This may imply that (1) effective interventions are described not only in scientific journals but also in non-journals, and/or (2) non-journals may select the most significant results (so called "cherry picking") to inflate positive effects (Corlett, 2011). Different motivations drive these two biases, which can be reduced through more intense and diversified literature searching efforts.

The aim of this study was not only to demonstrate the value of non-journals, but also to show where they can be found. Supporting Information S1 contains the list of publications and online repositories, which I used in this study and highly recommend to researchers and practitioners in their work. All these resources are freely available for downloads, except for the digital library of the IUCN/SSC Cat Specialist Group (CSG) and its newsletter Cat News (http://www.catsg.org), and for some publications which are not open-access. Publications from the first sources can be obtained by becoming a member or Friend of the CSG, or requesting copies from CSG members whose list is available on the website. Although non-journals naturally differ in their quality, they may give good

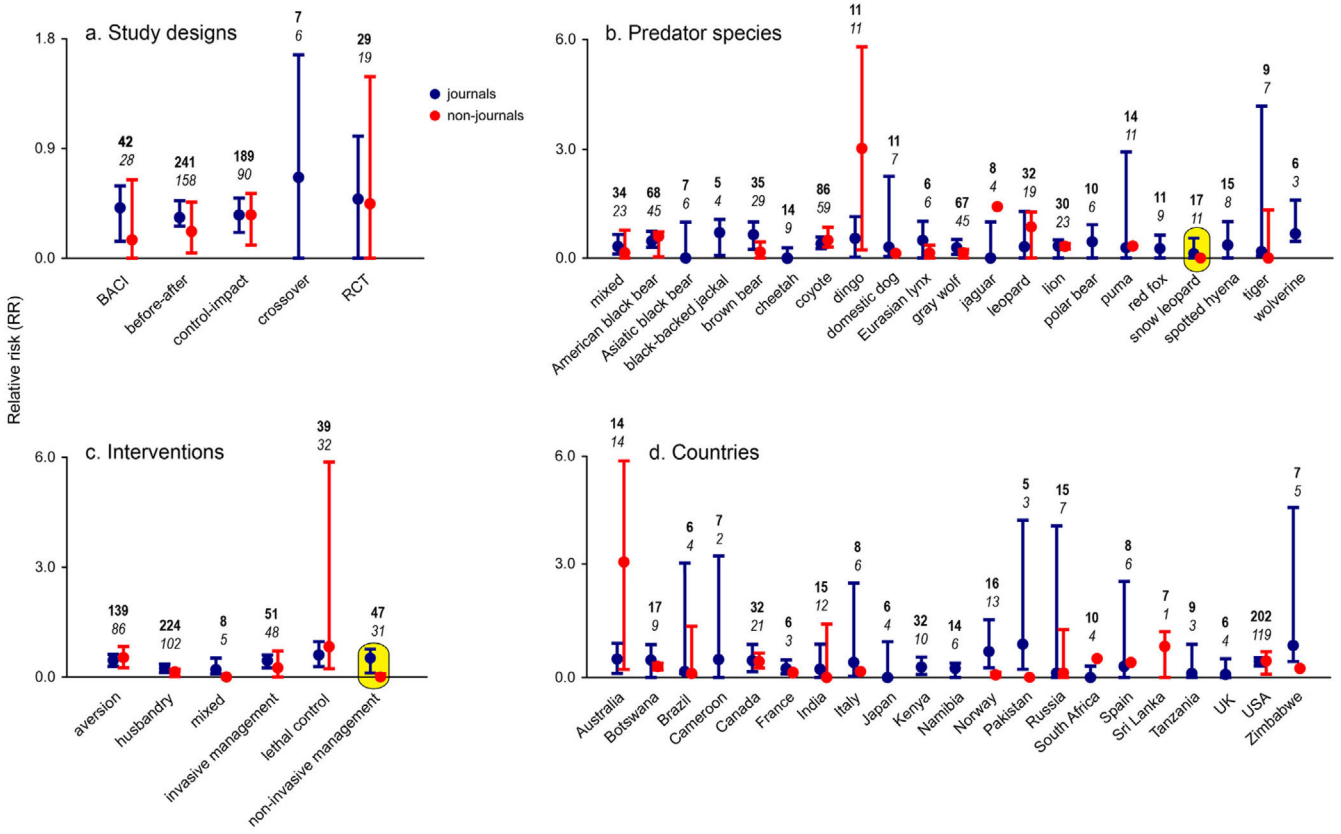

Fig. 2. Effectiveness of interventions (median ± 99% confidence interval) described in journals and non-journals in relation to study designs (a), predator species (b), interventions (c) and countries (d). A lower relative risk of damage inflicted by predators indicates a higher effectiveness of interventions. The numbers of cases (bold) and publications (italic) in samples are indicated above the graphs. The samples where journals and non-journals contain (marginally) significantly different estimates of the relative risk are encircled. Abbreviations: BACI – before-after-control-impact, RCT – randomized controlled trial.

insights into practical considerations, improvements and replications of interventions used to protect human assets from predators.

Conflict of interest

The author declares no conflict of interest.

Author contributions

IK is solely responsible for the manuscript.

Data accessibility statement

The original data of this study is openly available in Figshare repository at https://doi.org/10.6084/m9.figshare.20000912.

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.pecon.2022.08.003.

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