Identifying and prioritising conflicts between human and wildlife interests in Great Britain: a scoping review

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Abstract

1. Where conflicts arise between wildlife and humans, there is often the need to mitigate the impacts. Identifying what conflicts are occurring is essential for informed decision-making.
2. A scoping review was conducted to identify conflicts associated with British mammals using Scopus, Web of Science and additional screening of citations from eligible articles and websites. Conflicts were classified as economic, health, environmental or social, divided into 32 subcategories and then ranked using a Generic Impact Scoring System (GISS).
3. The review utilised 289 articles to identify 200 conflicts involving 48 mammals. The highest ranked conflicts were all measurable on an economic scale (involving rabbit, badger, brown rat, grey squirrel). We estimated an annual economic cost exceeding £0.5 billion, which could exceed £1 billion if all conflicts could be monetarised. The most common conflicts were reservoirs of disease and zoonotic disease. There was no difference in impact score between native or non-native species except when considered by subcategory. Non-native species had a higher potential impact than native species but this effect was statistically similar when geographical distribution was considered. Our results highlighted the importance of ongoing monitoring for some species.
4. The review identified that although some mammals represent a cost to some, they provide a benefit to others and may require a holistic approach to management. We concluded that a scoping review and GISS approach are useful tools for identifying conflict species and could form part of a package of measures to ensure a balance between conservation and human interests.

Key words human-wildlife conflict, generic impact scoring system, economic impact, environmental impact, wildlife disease, management

Introduction

Co-habitation between humans and wildlife occurs on more than half of the earth's surface (Locke et al. 2019) and consequently human-wildlife interactions form an integral part of many ecosystems worldwide. Interactions between people and wildlife are often varied and complex and whilst the presence of wildlife may have beneficial impacts on human interests, there is a continued focus on conflict narratives that dominates how human-wildlife interactions are viewed (Hill 2021).

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Human-wildlife conflict is commonly described as conflict occurring between people and wildlife (Woodroffe, Thirgood, and Rabinowitz 2005), presence and/or actions of humans or wildlife that have an adverse effect on the other (Conover 2002) or threats posed by wildlife to economic activities, human life, recreation (Treves and Karanth 2003) or ecosystem services. Factors such as the intensification of agriculture and increasing human population have had major impacts on ecosystems worldwide (Tilman 1999). Wildlife damage to crops is often cited as a major global conflict (Woodroffe, Thirgood, and Rabinowitz 2005; Pérez and Pacheco 2006; Fang et al. 2021), which will continue to worsen as habitat loss precipitates an increase in human-wildlife encounters. Population growth and habitat encroachment may also increase the risk of disease transmission, which is of particular concern where wildlife pose zoonotic risks. For example, the first human cases of severe acute respiratory syndrome coronavirus (SARS-CoV) in Guangdong province, China, in 2002, were linked to wildlife found at a live animal market (Drexler, Corman, and Drosten 2014; Song et al. 2019). Subsequent serological surveys from residents living close to bat caves in Yunnan, China, which is geographically disparate to Guangdong, were found to be positive for SARS-related coronavirus (SARSr-CoV), indicating that spillover events may have occurred in zoonotic coronaviruses (Hao et al. 2022).

Conflict issues can arise with several types of problematic species, including native pests, invasive native species and invasive non-native species (Cassini 2022). These often induce debates on how or whether humans and wildlife can co-exist (Nyhus 2016), and may involve complex decisions where the conservation status of a species conflicts with its impacts on humans (Woodroffe, Thirgood, and Rabinowitz 2005). Addressing and categorising the adverse effects of human-wildlife conflicts is recognised as a challenging issue for conservation and development efforts (Gross et al. 2024). There is a general consensus that the negative effects created by some wildlife species, particularly invasive non-native species, have to be reduced (Nentwig, Künel, and Bacher 2010). Where conflicts arise between wildlife and human interests, there is often the need to intervene to reduce or mitigate the impacts and therefore identifying what conflicts are occurring and what their impacts are is essential for informing decision-making and resource allocation (Eschen et al. 2023). In 2022, the UK agreed to a global policy framework at the Conference of Parties (COP15) to the Convention on Biological Diversity that created a package of international measures to address the loss of global biodiversity and to restore natural ecosystems. One of the targets identified for reducing threats to biodiversity was managing human-wildlife conflicts, which in turn would feed into other elements of the framework, such as enhancing sustainability in agriculture, fisheries and forestry (The Wildlife Trust 2024). However, identifying which species are causing conflict and subsequently which should be targeted first can be challenging and controversial (Nentwig, Künel, and Bacher 2010).

Invasive non-native species are a major threat to biodiversity worldwide, severely impacting areas of high endemism (Dueñas et al. 2021), whilst also posing a serious threat to public health and economic activities. As of 2019, 3,224 plants and animals had been introduced to Great Britain, costing the UK economy almost £4 billion annually (Eschen et al. 2023); 10-15% of these are considered invasive with an estimated 188 invasive non-native animals recorded in 2020 (NNSS 2020). Tackling invasive non-native species is a key part of achieving the UK government's aims under its 25-year Environment plan (HM Government 2018) as well as the UK's obligation as a signatory of the Convention on Biological Diversity (https://www.cbd.int/convention/text/). However, even managing conflict caused by invasive non-native species can be controversial, resulting in debates on achievability, efficiency, social fairness and ethical implications (Crowley, Hinchliffe, and McDonald 2017). For example, the removal of hedgehogs from South Uist, where they were introduced to control garden pests but consequently contributed significantly to the decline of wading shorebirds (Jackson and Green 2000) resulted in widespread criticism and opposition, given that hedgehogs are a popular icon of British wildlife and are thought to be declining nationally (Crowley, Hinchliffe, and McDonald 2017).

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Much of the available literature on wildlife conflicts in the UK, both in terms of economic and biodiversity impacts, focuses on invasive non-native species (e.g. Manchester and Bullock 2000; Eschen et al. 2023). However, there is evidence to suggest that the most invasive non-native species are not necessarily the most damaging (Ricciardi and Cohen 2007; Ricciardi et al. 2013), therefore there is the need to consider also the impacts of native species, some of which can cause considerable human-wildlife conflict. For example, badgers are a known reservoir host of *Mycobacterium bovis*, the causative agent of bovine tuberculosis, which poses a risk to livestock health and is a serious economic problem for the UK cattle industry (Swift et al. 2021). Issues such as this highlight the challenge of conflict resolution for iconic British species, which can be both controversial and associated with complex legislative considerations. It is necessary, however, to consider all problematic species to address the UK's commitments to improving biodiversity as part of government plans or global policy frameworks.

Whilst policy frameworks are essential for providing goals and targets to reverse biodiversity loss, they do not necessarily incorporate a process by which these targets, such as managing human-wildlife conflict, can be identified in the first place, nor which should be prioritised. Assessing conflicts between species is further complicated by the fact that impacts are context dependent (Kumschick et al. 2015), which requires that the measure of impact is standardised to quantify and compare differences between species, taxonomic groups and localities (Nentwig, Bacher, and Pyšek 2016). When addressing the biodiversity impacts of invasive non-native species, Nentwig, Künel, and Bacher (2010) suggested prioritising actions against the alien species with a high impact potential of becoming established or spreading, using a method to quantify impacts in a way that could be compared among alien species within a taxonomic group. They devised a generic impact scoring system (GISS) to compare relevant impact categories that had been reported in the scientific literature, applying a scoring system to quantify impacts within the categories and rank species according to their impact scores. The GISS has since been modified and applied to a variety of classifications including alien fish (Van der Veer and Nentwig 2014), terrestrial arthropods (Vaes-Petignat and Nentwig 2014), aquatic invertebrates (Laverty et al. 2015), plants (Novoa et al. 2016; Sohrabi et al. 2021) and alien birds (Evans et al. 2020).

The main aim of this scoping review was to identify and categorise human-wildlife conflicts associated with British mammals in order to summarise their magnitude and, where possible, their costs. The research augmented a review of human-wildlife conflicts produced over a decade ago (APHA, unpublished data) in response to a now withdrawn Defra policy framework on Wildlife Management in England (Defra 2010). The principal questions we aimed to address included: (1) are human-wildlife conflicts represented in the literature; (2) what conflicts have been reported; (3) can the evidence be used to assess the level of risk to human interests or the welfare or conservation status of an affected species? To determine the magnitude of wildlife conflicts, a modified GISS was applied to all conflicts so that mammals could be ranked according to their level of impact. Identifying species with the highest impact scores has the potential to assist policy development by enabling prioritisation of the most damaging species. In addition, the compilation of a comprehensive audit of British wildlife conflicts highlights where further areas of research might be required and identifies the early emergence of potential issues.

Materials and methods

Design

This review was conducted using the PRISMA extension for scoping reviews (PRISMA-ScR) checklist (Tricco et al. 2018), to explore the extent and nature of the evidence available on human-wildlife conflicts in Great Britain. The concept explored included compiling and analysing conflicts associated with economic, health, environmental and social impacts that

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could be reviewed and updated in future research. The context included terrestrial mammals (including bats) as they involve some of the most controversial and sensitive issues as well as complex legislative considerations. The types of sources eligible for the review included peer-reviewed articles, conference proceedings, theses, published books/chapters, government and non-governmental reports. No date range was applied to the searches.

Literature searches

Principal searches were undertaken using Web of Science and Scopus. Separate searches were carried out for each of the 66 terrestrial mammals using the search terms: [{common name} AND {Latin name}] AND [{England} OR {Scotland} OR {Wales} OR {Great Britain} OR] AND [{conflict} OR {pest} OR {damage} OR {impact} OR {management} OR {disease} OR {zoono*} OR {animal health} OR {health} OR {conservation} OR {predat*}]. Due to the large number of outputs generated, reports were exported to Microsoft Excel where an initial screening of the title for any likely relevance to the species concerned and potential conflicts was carried out by two reviewers (KP and DC). The minimum requirements for a literature resource to be included in the analysis were the presence of an accessible abstract and that the conflict occurred in Great Britain. Only articles written in English were included. Additional literature that was not captured in our initial search was sourced through screening the reference lists of eligible articles and relevant websites.

Data extraction and analysis

Extraction spreadsheets were developed in Microsoft Excel to assist with data collection. Data were extracted by two reviewers (KP and DC) by examining the abstracts in more detail and the full article. Data regarding study location, source type, date, conflict, species, duplication (i.e. the article was applicable to multiple conflicts and/or more than one species) were recorded. Articles that did not fit the criteria (i.e. the conflict was not occurring in Great Britain) but which were considered useful for compiling the review were retained but only conflicts that were reported as occurring in Great Britain were used in the analyses. A full list of screened references is included in Table S1.

The total number of species and conflicts identified using the extraction spreadsheets were used to compile a detailed report of the human-wildlife conflicts in Great Britain.

Categorising and scoring conflicts

Conflicts were categorised as either economic, health, environmental or social impact. Within these four main categories, conflicts were further assigned to 32 subcategories (economic=15, health=6, environmental=7, social=4). Subcategories were not weighted, therefore all subcategories were considered as of equal importance. Some species were involved in multiple conflicts within multiple categories, which were captured as distinct entities. An impact scale scoring system modified from Nentwig, Künel, and Bacher (2010) was applied to estimate the magnitude of each conflict at the national level for Great Britain, rated independently by three reviewers (KP, DC and GS). The level of impact was quantified on a scale of 1 (minimal impact known) to 5 (the highest possible impact: Table 1), with a value of confidence (low=1, medium=2 or high=3: Table 2) also assigned to each conflict (taken from Hawkins et al. 2015). Mammals for which no data were available, no impacts were known or impacts were not detectable were excluded from the analysis. The median of the three independent assignments of impact scale and confidence rating are reported for each conflict.

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Table 1. Criteria used to describe the scale of impacts in each of the four categories of conflict.

Scale of impact	A. Economic impact	B. Health impact	C. Environmental impact	D. Social impact
1	<£10K / yr	Local mild, short-term, reversible effects to individuals	Local, short-term, population loss, no significant ecosystem effect	Minimal social disruption
2	£10K – 100K / yr	Mild short-term, reversible effects to identifiable groups, localised	Some ecosystem impact, reversible changes, localised	Significant concern expressed at local level
3	£100K – 1M / yr	Minor irreversible effects and/or larger numbers covered by reversible effects, localised	Measurable long-term damage to populations and ecosystem, but little spread, no extinction	Temporary changes to normal activities at local level
4	£1M – 10M / yr	Significant irreversible effects locally or reversible effects over a large area	Long-term irreversible ecosystem change, spreading beyond local area	Some permanent change of activity locally, concern over a wider area
5	>£10M / yr	Widespread, severe, long-term, irreversible health effects	Widespread, long-term population loss or extinction, affecting several species with serious ecosystem effects	Long-term social change, significant loss of employment, migration from area

Table 2. Criteria used for the confidence ratings of the impact scale assignments.

Confidence level	Example evidence
High (3) (approx. 90% chance of impact scale assignment being correct)	There is direct relevant observational evidence to support the assessment; **and** Impacts are recorded at the typical spatial scale over which the conflict can be characterised; **and** There are reliable / good quality data sources on the impacts of the conflict; **and** The interpretation of the data / information is straightforward; **and** Data / information is not controversial or contradictory
Medium (2) (approx. 65-75% chance of impact scale assignment being correct)	There is some direct observational evidence to support the assessment but some information is inferred; **and/or** Impacts are recorded at a spatial scale, which may not be relevant to the scale over which conflict can be characterized, but extrapolation or downscaling of the data to relevant scales is considered reliable, or to embrace little uncertainty; **and/or** The interpretation of the data is to some extent ambiguous or contradictory
Low (1) (approx. 35% chance of impact scale assignment being correct)	There is no direct observational evidence to support the assessment, e.g. only inferred data have been used as supporting evidence; **and/or** Impacts are recorded at a spatial scale, which is unlikely to be relevant to the scale over which conflict can be characterized; extrapolation or downscaling of the data to relevant scales is considered unreliable potentially leading to significant uncertainties; **and/or** Evidence is poor and difficult to interpret, e.g. because it is strongly ambiguous; **and/or** The information sources are considered to be of low quality or contain information that is unreliable

Various species characteristics were also included in the analyses to determine whether they were associated with a conflict impact modified from Nentwig, Künel, and Bacher (2010). Impact scores were considered as the maximum impact for a particular species in Great Britain and did not account for their current distribution. Overall impacts were compared between species by summing the median scores of all conflicts and within each category ("potential impact"). To consider the distribution of a species, potential impact values were multiplied by the proportion of hectads (10 kilometre square resolution) each species occupies in Great

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Britain (derived from Crawley et al. (2020). The potential impact scores, corrected for the area occupied can be considered as the "actual impact" a species causes in Great Britain. Estimated population sizes were derived mostly from Mathews et al. (2018), typical body weights were taken mostly from Harris and Yalden (2008). Where information was missing, relevant online sources were used (see Table S3). The overall biomass for each species was calculated by multiplying population estimates and body mass. Population estimates and/or distribution data could not be reliably established for three species (feral cat, feral ferret, greater white-toothed shrew), therefore they were excluded from some of the statistical analyses.

Statistical analysis

All statistical analyses were performed using the R statistical programme version 4.2.2 (R Core 2022) and the RStudio Integrated Development Environment (IDE: version 2022.12.0, Posit Software, PBC). Given the nature of the response variables, initial analyses (to assess whether impact/confidence scores assigned by the three reviewers differed overall and in relation to the conflict species assessed) were performed using an ordinal logistic regression model fitted using the *ordinal::clm* function version 2023.12-4. (Christensen 2023). Species were aggregated based on status (native/non-native/feral) with reviewer ID included as an interaction term. Additional analyses were performed to assess whether impact scores assigned by the reviewers differed across impact categories (i.e. economic, environmental, health and social), across subcategories and between native/non-native species, including interaction terms. (N.B. feral species were removed from further analyses due to their low number of conflicts). Data were expanded to account for the disparity in the number of subcategories described for each species from the literature, so that for each species, a total of 32 subcategories were present, with an impact and confidence score of zero (0), representing no available data, assigned to absent subcategories.

Differences in potential and actual impact scores were analysed using generalised linear models (GLM), using the *glmmTMB* package version 1.1.10 (Brooks et al. 2017). Diagnostic testing of these analyses was performed using the *DHARMa* package version 0.4.7 (Hartig 2024). Prior to analysis, data were modified to account for species whereby an actual impact score could not be reliably established, with a score of zero (0) assigned to indicate insufficient evidence of impact. Feral ferret was subsequently excluded from the analyses, given a lack of data regarding population size and geographic distribution. Analyses assessed whether estimates of total impact (actual or potential) differed in relation to native/non-native status when modelled independently. Several covariate predictors were also specified independently in each model, including population size, body mass (kg) and biomass (kg). Models consisted of GLMs, fitted with a gaussian error distribution and "identity" link function, selected given that model residuals conformed to key assumptions (i.e. linearity, normality, homogeneity of variance), when total impact estimates were logarithmically transformed [$\log(n+1)$]. For each model, a two-way interaction term was specified between native/non-native status and each covariate predictor (population size, body mass, biomass). Due to issues with model performance, population size, body mass and biomass were also log-transformed [$\log(n+1)$].

Additional analyses examined how estimates of impact (actual or potential) might differ across the main impact categories (economic, health, environment, social); these were performed using a GLM fitted with a Tweedie distribution, which is appropriate when analysing a continuous response variable consisting of a combination of zeroes and positive values. These models compared impact across categories in relation to native/non-native status as well as population size, body mass and biomass. Interaction terms involving impact category, species status and each covariate predictor were included with respect to native/non-native species only.

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Results

General literature searches

A search of Web of Science and Scopus yielded 12,938 results for 66 terrestrial mammals in Great Britain. No conflict articles were identified for 18 of the mammals (1,017 results). A large proportion of the remaining article titles were deemed irrelevant to the search terms, thus a further 11,691 were removed prior to full article screening by KP and DC. A total of 230 database articles plus a further 247 articles identified from additional sources were retrieved and underwent full screening. Of these, 289 met the eligibility criteria (mammal conflicts specific to Great Britain); 79 were relevant to multiple species and/or conflicts resulting in a total of 558 articles used in the analyses. A PRISMA flow chart detailing the selection process is shown in Figure 1.

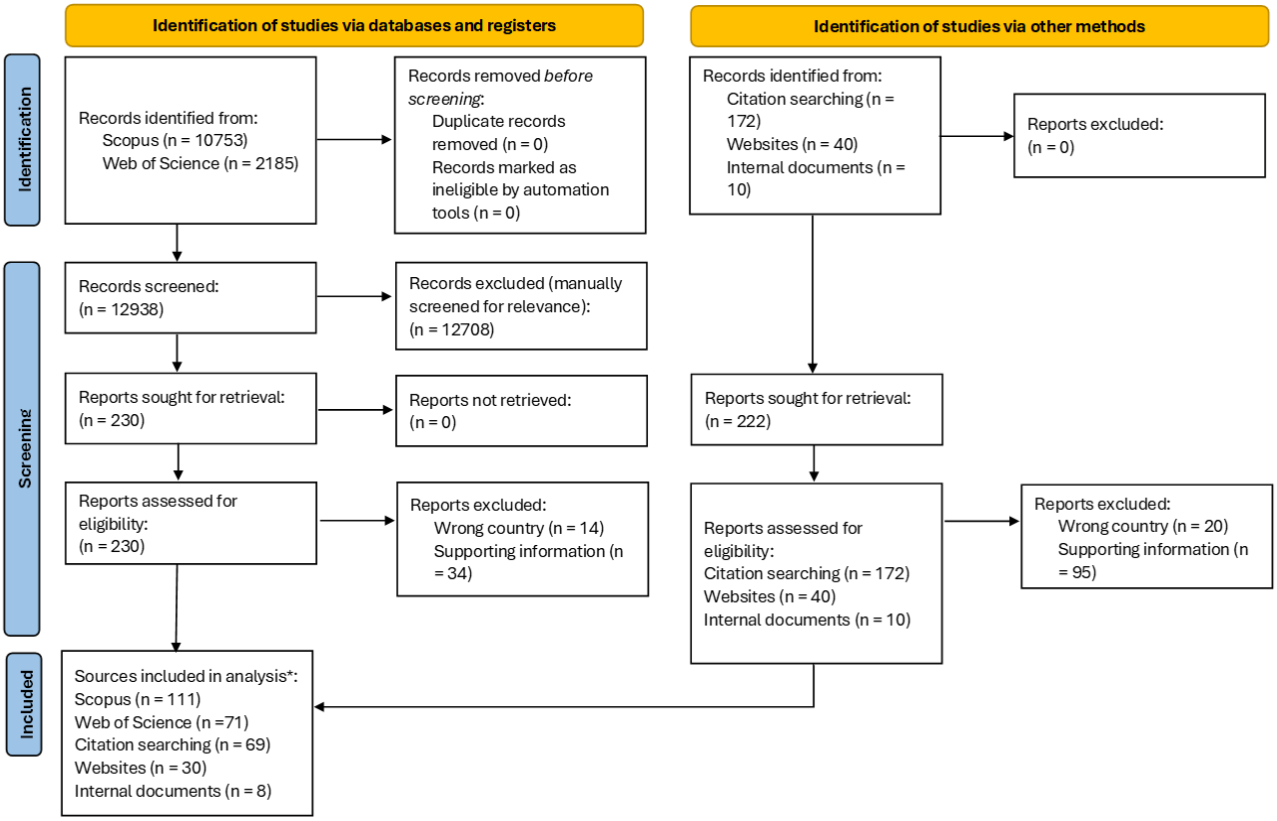

Fig. 1 PRISMA flow chart of the scoping review showing the number of records selected after each step. * Seventy-nine articles were relevant to more than one species and/or conflict.

The 48 mammals identified as causing conflict belonged to seven taxonomic groups (Rodentia: n=15; Carnivora: n=11; Artiodactyla: n=8; Chiroptera: n=6; Eulipotyphla: n=4; Lagomorpha: n=3; Perissodactyla: n=1). The first available record was from 1947 and the latest was from 2024. The majority of articles (n=367, 91%) were published within the last three decades (2014-2024: n=176, 44%; 2004-2013: n=110, 27%; 1994-2003: n=81, 20%).

A detailed description of all of the conflicts is in Supplementary Material S2. A summary of characteristics (native/non-native/feral status, population size, body mass, biomass) and conflicts for each species is in Table S3. The periods during which conflicts were reported in the scientific literature (i.e. identified during the original review only ("pre-2014"), during the original and current review ("pre-2014 and 2014 to present") and during the current review

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only ("2014 to present") are also shown. The median impact scores and confidence ratings are shown after each conflict in parentheses.

Overview of conflicts

Conflicts and status

Twenty-nine of the 48 mammals (61%) are native to the British Isles, 17 (35%) are non-native (which includes 10 that have been introduced in recent times and seven that are considered naturalised) and two (4%) are feral (species that are considered wild but are either managed or may have human dependence). Of the 48 mammals, 40 (83%) caused at least one economic conflict, 36 (75%) caused at least one health conflict, 23 (48%) caused at least one environmental conflict and eight (17%) caused at least one social conflict (Fig 2). When compared by status, 86% (25/29) of native mammals caused economic conflict, 66% (19/29) caused health conflict and 35% (10/29) caused environmental conflict. In comparison, 82% (14/17) of non-native mammals caused economic conflict, 88% (15/17) caused health conflict and 71% (12/17) caused environmental conflict. Social conflicts accounted for approximately 17% for both native (5/29) and non-native (3/17) species. The proportion of feral mammals causing conflict was either 50% (economic and environment) or 100% (health), although this was attributable to only two species (feral cat, Dartmoor/Exmoor pony).

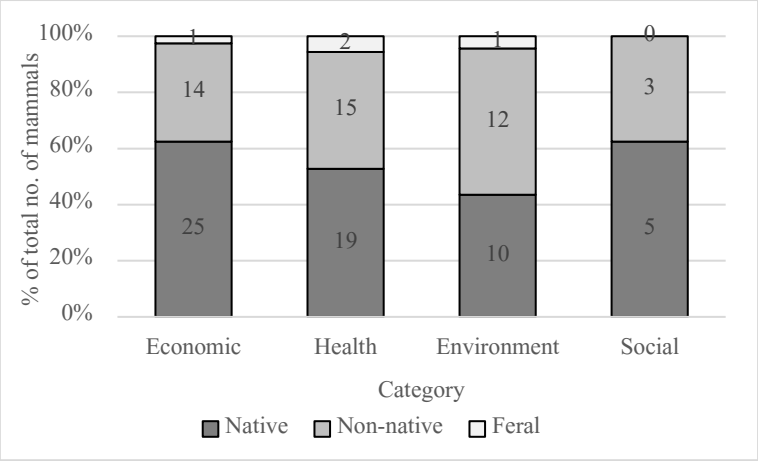

Fig 2. Percentage of mammals within each status causing conflict within the four main categories. Data labels denote the number of mammals within each status.

Frequency of conflicts

In total, 200 separate conflicts were identified, with 103 attributable to native mammals (52%), 92 to non-native mammals (46%) and five to feral mammals (3%). Ninety-one of the 200 conflicts (45%) were economic impacts (Appendix 1a), 71 (35%) were health impacts (Appendix 1b), 29 (15%) were environmental impacts (Appendix 1c) and nine (5%) were social impacts (Appendix 1d). A similar proportion of conflicts were recorded for both native and non-native species within all four categories (Fig 3). For native mammals, economic impacts accounted for 47% (48/103), health impacts accounted for 36% (37/103), environmental impacts accounted for 11% (12/103) and social impacts accounted for 6% (6/103). For non-native mammals, economic impacts accounted for 45% (42/92), health impacts accounted for 36% (32/92), environmental impacts accounted for 16% (15/92) and social impacts accounted for 3% (3/92). Feral mammals were involved in considerably less conflicts, mostly attributable to health and environmental impacts.

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The total number of mammals causing conflict within a particular subcategory ranged from one to 30 (Appendix 1a-1d), with the most common conflicts being reservoir of zoonotic disease (n=30) and reservoir of disease (n=22).

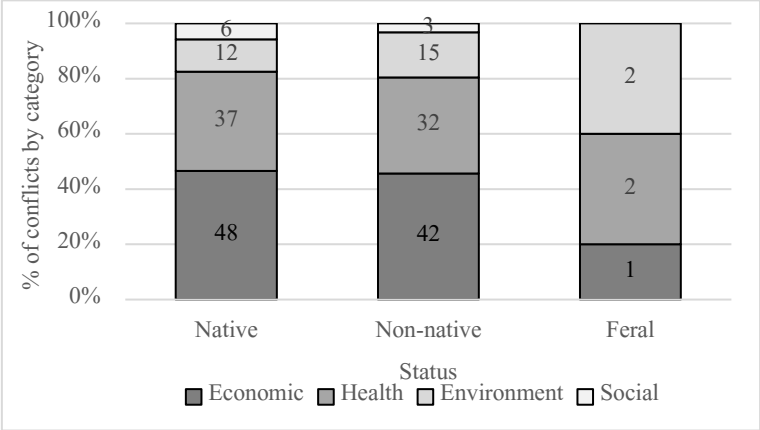

Fig 3. The percentage of conflicts within each category depending on status. Data labels denote the number of conflicts within each category. Native mammals: n=103; non-native mammals: n=92; feral mammals: n=5.

Impact scores and ranking of conflicts

Reproducibility of the scoring

Of the 200 conflicts, the three reviewers agreed on the impact score in 92 cases (46%); there was a maximum deviation of one score in 89 cases (44%), a maximum deviation of two scores in 18 cases (9%) and a maximum deviation of three scores in 1 case (1%). Overall, there was no statistically significant difference between the independently assigned impact scores ($\chi^2(2)=3.057$, $p=0.217$). However, confidence scores were found to differ statistically between reviewers ($\chi^2(2)=144.54$, $p<0.001$); all three agreed in 33 of the 200 conflicts (17%), two agreed in 131 cases (65%), with a deviation of one or two assigned by the third reviewer, and all three assigned a different confidence score in 36 cases (18%). This suggests that the reviewers were largely consistent in their impact scoring of British mammals but not necessarily in the confidence of the assignments.

Conflict scoring and ranking

Using the median impact scores across the three reviewers, seven of the 200 conflicts (4%) were assessed as impact score 5, 20 (10%) as impact score 4, 30 (15%) as impact score 3, 88 (44%) as impact score 2 and 55 (27%) as impact score 1 (Table 4a-4d). Six of the seven conflicts assessed as having the highest impact score of 5 (all with confidence rating of high) were economic and one was a health conflict. These were (in order of highest approximate economic cost): (1) rabbit damage to agricultural interests (£120 million), (2) badger involvement in the transmission of bTB to cattle (>£100 million), (3) brown rat damage to agricultural interests (£54 million), (4) rabbit damage to forestry (£43 million) (5) badger damage to agricultural interests (£39 million) (6) grey squirrel damage to forestry (£28 million, not including carbon capture estimates) and (7) brown rat damage to property (£14 million, based on local authority costs only). In all four categories, the majority of conflicts were scored as impact 2 (economic: 35% (32/91); health: 46% (33/71); environmental: 55% (16/29); social: 78% (7/9)). Despite two health conflicts being the most common amongst all mammals, generally, health conflicts were scored low, with over 90% (64/71) scoring either a 1 or 2.

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Table 4a. Total number of mammals causing conflict within the 15 economic subcategories and their median impact score. Status categories: Na=native; NN=non-native; Fe=feral.

	Mammal impact scores within each subcategory					**Total per status**
Conflict (total mammals)	**Impact 5**	**Impact 4**	**Impact 3**	**Impact 2**	**Impact 1**	
Damage to forestry (15)	Grey squirrel, rabbit	Roe deer, red deer, fallow deer	Japanese sika, brown hare, edible dormouse, field vole	Muntjac, feral goat, mountain hare, beaver, bank vole	Chinese water deer	**Na - 6** **NN - 9**
Damage to agricultural interests (19)	Badger, rabbit, brown rat	Roe deer, fallow deer, mole, house mouse	Red deer	Japanese sika, Chinese water deer, muntjac, wild boar, brown hare, mountain hare, grey squirrel, beaver, wood mouse	Edible dormouse, field vole	**Na - 9** **NN - 10**
Damage to vehicles (RTAs) (9)	-	Roe deer, fallow deer, badger	Red deer, muntjac	Japanese sika, Chinese water deer, wild boar, Exmoor/Dartmoor pony	-	**Na - 4** **NN - 4** **Fe - 1**
Competition with livestock (3)	-	-	-	-	Red deer, Japanese sika, feral goat	**Na - 1** **NN - 2**
Predation of game species (11)	-	Red fox	-	Stoat, badger, American mink, hedgehog, brown rat	Wild cat, pine marten, feral ferret, weasel, polecat	**Na - 8** **NN - 3**
Predation/impact on commercial fisheries (3)	-	-	-	Otter, American mink	Beaver	**Na - 2** **NN - 1**
Predation of poultry (4)	-	-	-	American mink	Pine marten, feral ferret, polecat	**Na - 2** **NN - 2**
Damage to property (6)	Brown rat	Badger, grey squirrel, house mouse	Edible dormouse	Natterer's bat	-	**Na - 2** **NN - 4**
Damage to amenities and domestic grassland (4)	-	Rabbit	American mink, mole	Badger	-	**Na - 2** **NN=2**
Conflicts with construction, infrastructure and development (9)	-	Badger	Natterer's, serotine, common pipistrelle, soprano pipistrelle, brown long-eared bat	Beaver, hazel dormouse, water vole	-	**Na - 9**
Predation of livestock (1)	-	Red fox	-	-	-	**Na - 1**
Conflicts with transport (2)	-	-	Rabbit, brown rat	-	-	**NN - 2**
Sustaining predators harmful to game (2)	-	-	-	-	Field vole, Orkney vole	**Na - 1** **NN - 1**
Damage to property as a result of poaching (2)				Brown hare	Mountain hare	**Na - 1** **NN - 1**
Conflicts with utilities (1)	-	Brown rat	-	-	-	**NN - 1**
Total per impact score	**6**	**18**	**17**	**32**	**18**	**91**

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Table 4b. Total number of mammals causing conflict within the six health subcategories and their median impact score. Status categories: Na=native; NN=non-native; F=feral.

	Mammal impact scores within each subcategory					**Total per status**
Conflict (total mammals)	**Impact 5**	**Impact 4**	**Impact 3**	**Impact 2**	**Impact 1**	
Health risks from RTAs (9)	-	-	Roe deer, wild boar	Red deer, Japanese sika, fallow deer, muntjac, badger	Chinese water deer, Exmoor/Dartmoor pony	**Na - 4** **NN - 4** **Fe - 1**
Reservoir of disease (22)	-	-	Rabbit, grey squirrel	Roe deer, red deer, fallow deer, muntjac, wild boar, feral cat, badger, red fox, field vole, wood mouse, house mouse	Japanese sika, Chinese water deer, feral goat, stoat, Daubenton's, hedgehog, brown hare, red squirrel, beaver	**Na - 12** **NN - 9** **Fe - 1**
bTB transmission (8)	Badger	-	-	Fallow deer, muntjac, wild boar	Roe deer, red deer, Japanese sika, red fox	**Na - 5** **NN - 3**
Reservoir of zoonotic disease (30)	-	Brown rat	House mouse	Roe deer, red deer, fallow deer, muntjac, American mink, red fox, Daubenton's, serotine, hedgehog, rabbit, bank vole, field vole, wood mouse	Japanese sika, Chinese water deer, feral goat, polecat, common shrew, greater white-toothed shrew, brown hare, mountain hare, red squirrel, grey squirrel, beaver, edible dormouse, yellow-necked mouse, Skomer vole, black rat	**Na - 15** **NN - 15**
Threat to livestock where ground is undermined (1)	-	-	-	Mole	-	**Na - 1**
Threats of branches falling (1)	-	-	-	-	Grey squirrel	**NN - 1**
Total per impact score	**1**	**1**	**5**	**33**	**31**	**71**

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Table 4c. Total number of mammals causing conflict within the seven environmental subcategories and their median impact score. Status categories: Na=native; NN=non-native; F=feral.

	Mammal impact scores within each subcategory					Total per status
Conflict (total mammals)	**Impact 5**	**Impact 4**	**Impact 3**	**Impact 2**	**Impact 1**	
Damage to conservation habitats (9)	-	-	Roe dee, red deer	Japanese sika, fallow deer, muntjac, feral goat	Chinese water deer, wild boar, bank vole	**Na - 4** **NN - 5**
Threat to biodiversity (6)	-	Grey squirrel	-	Roe deer, red deer, Japanese sika, fallow deer, greater white-toothed shrew	-	**Na - 2** **NN - 4**
Threat to genetic integrity (3)	-	-	Feral cat	Japanese sika, feral ferret	-	**NN - 2** **Fe - 1**
Competition with or predation of wildlife (including protected or conservation species) (7)	-	-	Badger, American mink, red fox	Feral cat, otter, pine marten, stoat	-	**Na - 5** **NN - 1** **Fe - 1**
Predation of important ground-nesting birds and island ecosystem damage (2)	-	-	Hedgehog, brown rat	-	-	**Na - 1** **NN - 1**
Sustaining predators harmful to important conservation species (1)				Rabbit	-	**NN - 1**
Damage to island ecosystems (1)	-	-	-	-	Black rat	**NN - 1**
Total per impact score	**0**	**1**	**8**	**16**	**4**	**29**

Table 4d. Total number of mammals causing conflict within the four social subcategories and their median impact score. Status categories: Na=native; NN=non-native; F=feral.

	Mammal impact scores within each subcategory					Total per status
Conflict (total mammals)	**Impact 5**	**Impact 4**	**Impact 3**	**Impact 2**	**Impact 1**	
Public nuisance (4)	-	-	-	Muntjac, feral goat, rabbit	Wild boar	**Na - 1** **NN - 3**
Domestic nuisance (2)	-	-	-	Pine marten	Red fox	**Na - 2**
Predation of domestic pets (1)	-	-	-	Red fox	-	**Na - 1**
Domestic nuisance & hygiene (2)	-	-	-	Natterer's, serotine	-	**Na - 2**
Total per impact score	**0**	**0**	**0**	**7**	**2**	**9**

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Analysis of impact scores in relation to native/non-native status and conflict category, found a statistically significant effect of category, when considered as a main order effect ($\chi^2(3)=62.90$, $p<0.001$) but not status ($\chi^2(1)=0.421$, $p=0.516$). Reviewers assigned a greater score in relation to economic impacts, followed by environmental, health and then social impacts (Fig 4). When conflict category was considered in relation to status, there was no statistically significant interaction term between the two ($\chi^2(3)=4.839$, $p=0.184$)

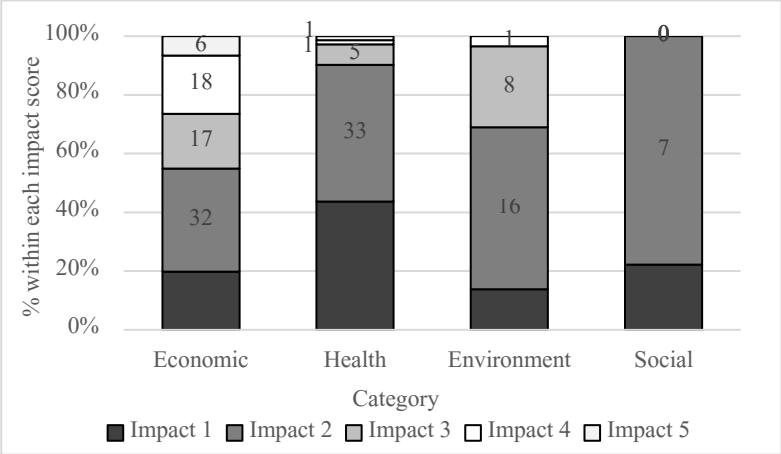

Fig 4. The proportion of conflicts depending on impact score (1-5) within the four categories. Data labels denote to total number of conflicts within each impact score. Economic: n=91, health: n=71, health: n=29, social: n=9.

Analysis of impact scores, in relation to native/non-native status and conflict subcategories, showed both as having a statistically significant effect ($\chi^2(1)=33.63$, $p<0.001$; $\chi^2(31)=640.18$, $p<0.001$, respectively), with a significant two-way interaction term also identified ($\chi^2(31)=155.56$, $p<0.001$). Across all economic impacts, non-native species received a statistically significantly greater impact score than natives in relation to damage to woodland, damage to agricultural interests, damage to property, conflict with transport and conflict with utilities (all $p<0.05$). Conversely, native species received a significantly higher score due to conflicts with construction and development and the predation of livestock (both $p<0.001$). Across health impacts, the model predicted a statistically greater impact score for non-native species as reservoirs of zoonotic diseases only ($p=0.008$). With regards to the environment, non-native species received a statistically significant greater impact score for damage to conservation habitats and their threat to biodiversity and genetic integrity (all $p<0.05$). In terms of social impacts, non-native species received a greater impact than natives with respect to public nuisance only ($p<0.01$).

Potential impact

The number of separate conflicts per species ranged from one to eleven (Table 5), with sika deer involved in the most conflicts. Species scoring highest in potential total impact (i.e. the sum of all median conflict scores for a particular species) were badger, rabbit, roe deer, fallow deer and red deer. Generally, these species also scored highly within the separate categories (except for social conflicts), with badgers scoring highest in both potential economic and health impacts. The highest potential environmental impact was produced by sika deer, followed by roe deer, red deer and feral cat. The highest potential social impact was observed in the red fox, followed by rabbit, wild boar, pine marten, Natterer's and serotine bat.

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Table 5. Distribution (i.e. the proportion of Great Britain each mammal is found, based on presence in 10x10km squares), total number of conflicts and impact scores (potential and actual) in total and within each of the four categories (economic, health, environmental, social) for all conflict mammals. Mammals are listed in order of highest total actual impact. – denotes missing data.

			Potential impact					Actual impact				
Species	**Distribution**	**No. conflicts**	**Total potential impact**	**Economic**	**Health**	**Environment**	**Social**	**Total actual impact**	**Economic**	**Health**	**Environment**	**Social**
Badger	0.746	10	33	21	9	3	0	24.624	15.670	6.716	2.239	0
Rabbit	0.833	8	26	17	5	2	2	21.649	14.155	4.163	1.665	1.665
Roe deer	0.726	9	25	12	8	5	0	18.151	8.713	5.808	3.630	0
Red fox	0.800	8	19	8	5	3	3	15.207	6.403	4.002	2.401	2.401
Grey squirrel	0.583	7	20	11	5	4	0	11.653	6.409	2.913	2.331	0
Brown rat	0.529	7	21	14	4	3	0	11.105	7.403	2.115	1.586	0
Red deer	0.412	10	23	11	7	5	0	9.480	4.534	2.885	2.061	0
Fallow deer	0.347	9	24	12	8	4	0	8.317	4.158	2.772	1.386	0
American mink	0.533	6	14	9	2	3	0	7.457	4.794	1.065	1.598	0
Mole	0.807	3	9	7	2	0	0	7.266	5.651	1.615	0	0
Hedgehog	0.824	4	8	2	3	3	0	6.592	1.648	2.472	2.472	0
Brown hare	0.680	5	9	7	2	0	0	6.119	4.759	1.360	0	0
Muntjac	0.334	9	17	7	8	2	0	5.673	2.336	2.669	0.667	0
Field vole	0.564	5	9	5	4	0	0	5.075	2.819	2.256	0	0
Wood mouse	0.560	3	6	2	4	0	0	3.360	1.120	2.240	0	0
Otter	0.782	2	4	2	0	2	0	3.126	1.563	0	1.563	0
House mouse	0.235	4	13	8	5	0	0	3.060	1.883	1.177	0	0
Stoat	0.597	3	5	2	1	2	0	2.983	1.193	0.597	1.193	0
Natterer's	0.411	3	7	5	0	0	2	2.880	2.057	0	0	0.823
Sika deer	0.134	11	19	8	5	6	0	2.540	1.069	0.668	0.802	0
Bank vole	0.446	3	5	2	2	1	0	2.229	0.892	0.892	0.446	0
Common pipistrelle	0.674	1	3	3	0	0	0	2.021	2.021	0	0	0
Soprano pipistrelle	0.619	1	3	3	0	0	0	1.858	1.858	0	0	0
Brown long-eared bat	0.600	1	3	3	0	0	0	1.799	1.799	0	0	0
Serotine	0.246	3	7	3	2	0	2	1.721	0.738	0.492	0	0.492
Daubenton's	0.491	2	3	0	3	0	0	1.472	0	1.472	0	0
Pine marten	0.171	4	6	2	0	2	2	1.025	0.342	0	0.342	0.342

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Table 5 cont.

			Potential impact					Actual impact				
Species	**Distribution**	**No. conflicts**	**Total potential impact**	**Economic**	**Health**	**Environment**	**Social**	**Total actual impact**	**Economic**	**Health**	**Environment**	**Social**
Mountain hare	0.162	4	6	5	1	0	0	0.973	0.811	0.162	0	0
Water vole	0.425	1	2	2	0	0	0	0.850	0.850	0	0	0
Polecat	0.269	3	3	2	1	0	0	0.807	0.538	0.269	0	0
Weasel	0.530	1	1	1	0	0	0	0.530	0.530	0	0	0
Common shrew	0.502	1	1	0	1	0	0	0.502	0	0.502	0	0
Red squirrel	0.247	2	2	0	2	0	0	0.494	0	0.494	0	0
Feral goat	0.023	6	13	4	7	1	1	0.209	0.070	0.047	0.047	0.047
Hazel dormouse	0.199	1	2	2	0	0	0	0.397	0.397	0	0	0
Chinese water deer	0.042	7	9	5	3	1	0	0.375	0.208	0.125	0.042	0
Wild boar	0.031	7	9	3	2	2	2	0.402	0.124	0.216	0.03	0.031
Beaver	0.018	6	9	7	2	0	0	0.166	0.129	0.037	0	0
Yellow-necked mouse	0.129	1	1	0	1	0	0	0.129	0	0.129	0	0
Edible dormouse	0.008	4	8	7	1	0	0	0.064	0.056	0.008	0	0
Wildcat	0.039	1	1	1	0	0	0	0.039	0.039	0	0	0
Exmoor/Dartmoor pony	0.005	2	3	2	1	0	0	0.016	0.011	0.005	0	0
Black rat	0.006	2	2	0	1	1	0	0.011	0	0.006	0.006	0
Skomer vole	0.004	1	1	0	1	0	0	0.004	0	0.004	0	0
Orkney vole	0.003	1	1	1	0	0	0	0.003	0.003	0	0	0
Feral cat	-	3	7	0	2	5	0	-	-	-	-	-
Feral ferret	-	3	4	2	0	2	0	-	-	-	-	-
Greater white-toothed shrew	-	2	3	0	1	2	0	-	-	-	-	-

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Analyses identified a statistically significant difference between native/non-native species ($\chi^2(1)=4.235$, $p=0.040$), with the latter predicted as having a higher potential impact overall ($\beta=0.513$, z ratio=2.058, $p=0.046$). When specified as main order effects, total potential impact was found to increase as a function of body mass ($\beta=0.335$, t ratio=3.598, $p<0.001$) and biomass ($\beta=0.184$, t ratio=4.706, $p<0.001$) but not population size ($\beta=0.040$, t ratio=1.012, $p=0.311$). However, no statistically significant interaction term was identified ($p>0.05$), suggesting that differences in the rate of change for total potential impact were comparable between native and non-native species, relative to changes in population size, body mass and biomass.

Actual impact

Species scoring the highest actual impact were badger, rabbit, roe deer and red fox (Table 5). Generally, these species also scored highly within the separate categories, with badgers scoring highest in both actual economic and health impacts. Roe deer scored the highest actual environmental impact, followed by hedgehog, red fox, grey squirrel, badger and red deer. The highest potential social impact was observed in the red fox, followed by rabbit and Natterer's bat.

Analysis of actual impact estimates showed no statistically significant difference between native/non-native species ($\chi^2(1)=0.056$, $p=0.813$). When considered as main order effects, total actual impact was predicted to increase significantly in relation to population size ($\beta=0.094$ t ratio=1.980, $p=0.048$) and biomass ($\beta=0.215$, t ratio=4.691, $p<0.001$). When considered in relation to status, there was no statistically significant interaction for biomass ($\chi^2(1)=0.298$, $p=0.585$) suggesting that the rate of increase was comparable across native and non-native species. Body mass was found to have no statistically significant effect on total actual impact when considered as a main order effect ($\chi^2(1)=1.741$, $p=0.187$) or through interaction with status ($\chi^2(1)=0.088$, $p=0.767$). A statistically significant interaction term was identified between status and population size, with total actual impact predicted to increase, relative to population size, at a significantly higher rate for non-native species when compared to natives ($\beta=0.179$, t ratio=2.120, $p=0.034$).

Conflict change over time

For many mammals, a conflict occurring before 2014 was still being reported in the scientific literature within the last decade (Table S3). Twenty-seven of the 46 (59%) conflicts reported only before 2014 were economic, followed by 10 (22%) health, 5 environment (11%) and 4 social (8%). In contrast, 25 of the 45 (55%) conflicts reported from 2014 to 2024 were health (55%), mostly attributable to reservoir of disease or reservoir of zoonotic disease, followed by 9 environment (20%), 8 economic (18%) and 3 social (7%).

Discussion

This scoping review compiled conflicts associated with British terrestrial mammals to assess their level of risk to human interests. A total of 289 articles were identified for the conflict analyses, including 194 primary research articles, 51 non/government reports, 20 books/articles, 22 website guidance/media and two PhD theses. A further 163 articles (Table S1) were used to provide supporting conflict or ecological information (Supplementary Material S2 and Table S3). Two-hundred separate conflicts were identified and successfully attributed with a risk level to help understand the scale of human-wildlife conflicts occurring within Great Britian.

Negative interactions between people and wildlife are more often than not viewed as human–wildlife conflict, with socio-economic factors cited amongst the issues influencing people's perception of wildlife (Bhatia et al. 2020). In this paper, we estimated a conservative total annual economic cost of human-wildlife conflicts in Great Britain (as reported in

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Supplementary Material S2) in excess of £0.5 billion, which would likely exceed £1 billion if all conflicts could be monetarised. All but one of the seven conflicts assessed as having the highest impact score of 5 involved economic conflicts. The one health conflict scored as impact 5 (the involvement of badgers in the transmission of bTB), was also measurable on an economic scale, suggesting that conflicts associated with a monetary value are inherently easier to quantify compared with those that are not. To account for potential bias associated with individual conflicts, we applied a prioritisation approach (generic impact scoring system (GISS)) to evaluate the overall impact of conflict mammals. In some cases, mammals causing the greatest economic damage, such as rabbit and badger, were ranked highest overall for their actual impact. However, this approach also identified species that did not necessarily cause the highest individual impacts; for example, roe deer and red fox were ranked third and fourth overall, respectively, for actual impact despite neither receiving the highest impact score of 5 for any of their identified conflicts.

The emphasis of legislation associated with wildlife in the UK has moved from protecting human economic interests (e.g. Prevention of Damage by Pests Act 1949 and Pests Act 1954), to promoting animal welfare (e.g. Wildlife and Countryside Act 1981 and Animal Welfare Act 2006) and protecting biodiversity (e.g. Habitats Directive 1992, Environment Act 2021). There is likely to be an increasing trend for conflicts arising between promoting biodiversity and human economic interests, as human activities continue to expand into existing wildlife habitats. Four of the five mammals identified as causing the greatest actual economic and health impact (badger, rabbit, roe deer), environmental impact (roe deer, hedgehog, red fox), and social impact (red fox, rabbit) are native, which leads to increasing conflict where specific legislation applies to a protected species. For example, badgers are protected under the Protection of Badgers Act 1992 but are the focus of ongoing controversy regarding management options for controlling the spread of *Mycobacterium bovis* to cattle in the UK, which is estimated to cost the taxpayer over £100 million annually (Defra 2024). Likewise, some bat species are widely distributed throughout Great Britain and often associated with conflicts with buildings or construction; as bats and their roosts are legally protected under the Wildlife and Countryside Act 1981 and the Conservation of Habitats and Species Regulations 2010, this can lead to potentially complex and costly resolution.

Although native mammals were ranked amongst the highest scoring impacts in all four categories, overall, there was no statistical difference in the reviewer assigned impact scores or actual impact scores between native and non-native species. However, there was a disproportionate amount of conflict in specific areas, with non-native species perceived as causing significantly more damage to woodlands, conservation habitats and agricultural interests, and a greater reservoir of zoonotic disease compared to native species. Rabbits caused the highest economic conflict compared to all other mammals with their impact on agriculture, and ranked second overall for total actual impact. As such, this may highlight rabbits as a priority species for human-wildlife resolution. However, rabbit populations have declined significantly in the UK in recent years, with severe local population reductions reported (Petrovan, Ward, and Wheeler 2011), which have led to concerns regarding the impact of such population reductions on other species, such as carnivores, that rely on them as a food source (Sainsbury et al. 2019). In contrast, grey squirrel abundance and distribution has expanded rapidly since they were introduced to Great Britain in the late 19th century (Gurnell and Hare 2008). They are considered a pest species in the UK and as such are afforded no protection under the Wildlife and Countryside Act 1981. As part of its 25-year Environment plan (HM Government 2018), the government has committed to managing grey squirrels to protect woodlands and red squirrel populations in the UK. While the general consensus is that grey squirrels must be managed to protect biodiversity within the UK, removing healthy wildlife can be controversial and may face opposition from pressure groups, which can be key to the success or failure of an eradication project (Bremner and Park 2007).

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Although the majority of reported conflicts were economic, the two most common conflicts were health related (reservoir of zoonotic disease and reservoir of disease). More than 60% of human pathogens are zoonotic in origin (Taylor, Latham, and Woolhouse 2001) with urbanisation and anthropogenic factors, amongst others, thought to have greatly influenced the emergence and distribution of zoonoses (Rahman et al. 2020). Generally, though, the impact score of health conflicts were deemed low (mostly 1 or 2), therefore we assumed that most health impacts were likely local, mild, short- to mid-term and with reversible effects (see Table 1). This highlights the importance of surveillance, which is crucial to preventing and controlling the spread of disease, in particular zoonotic disease (Rahman et al. 2020). This is also pertinent to exotic diseases, which are not reported here as only current diseases causing conflict in Britian were assessed. Whilst there is extensive research on the pathology and epidemiology of disease in a wide range of British mammals, as reported in Supplementary Material S2, it is evident that for some mammals, there is an inference of disease presence and/or zoonotic potential or a general lack of information (e.g. some hantaviruses (Vapalahti et al. 2003) and Ljungan virus (Salisbury et al. 2014; Rossi et al. 2021) in rodents; *Babesia* spp. in badgers (Guardone et al. 2020)), which suggests further research may be warranted. Understanding disease dynamics in British wildlife is intrinsically linked to biodiversity conservation, as anthropogenic activities such as urbanisation and habitat destruction, are likely to lead to increased interaction between humans and wildlife (Bedenham et al. 2022).

In many cases, mammals that caused the most conflict were amongst the most widely distributed throughout the British Isles, e.g. badger, rabbit, roe deer and red fox. Our analyses identified that total actual impact tended to increase as a function of biomass and population size, therefore a GISS approach may be particularly beneficial for monitoring recently introduced species, whether native or non-native, which have the potential to expand beyond their current range. For example, beavers were reintroduced to Great Britain around 20 years ago and are considered keystone species due to their ability to alter ecosystem structure and function through their engineering activities (Puttock et al. 2017; Auster, Puttock, and Brazier 2019). Whilst beavers are generally considered as having a positive impact on biodiversity, we identified six potential conflicts of interest with humans; although they ranked 38th overall based on total actual impact, likely owing to their current limited distribution, they ranked joint 12th overall based on potential impact. Whilst the reintroduction of beavers across Great Britain is currently carefully managed, highlighting and monitoring potential issues at this stage is essential for ensuring the status of this species remains positive rather than possible future perception as a pest species.

Human-wildlife conflict has long been associated with negative impacts on human interests, although it is evident that interactions between people and wildlife are more varied and complex (Hill 2021). More recently, the emphasis has shifted from conflict between humans and wildlife and its mitigation, to a coexistence approach (Gross et al. 2024), or at least one that constrains conflict or adapts shared spaces to mitigate conflict. Whilst there is a general consensus that some species must be managed or even eradicated (e.g. invasive non-native species: Nentwig, Künel, and Bacher (2010)), for others, particularly native species, a more holistic approach may be required. In some cases, mammals that represent a conflict and cost to some, may also provide a benefit to others. In Great Britain, the red fox has been widely persecuted due to its perceived status as a pest species (Macdonald and Johnson 2015). Their impact on agriculture has been estimated to cost £20 million annually, most of which is attributable to direct and indirect effects of livestock predation (Baker, Harris, and White 2006). However, fox predation on rabbits, which have a much more significant impact on agriculture, is estimated to create an indirect economic benefit to farmers of at least £11 million annually and may even be approaching an economically neutral impact on agriculture (Baker, Harris, and White 2006).

The findings reported here must be viewed in light of several limitations. Although an extensive literature search was conducted to identify conflicts associated with British wildlife, it

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is likely that some conflicts were not identified or cost estimates were not available, and therefore not reported. Whilst the conflict descriptions given in Supplementary Material S2 are not exhaustive and based only on the searches returned, they likely represent reasonable overviews and are sufficiently robust to provide an overall audit of the current national importance of conflicts between human and wildlife interests in Great Britain. However, individual assignments of scale may need to be revised as further information emerges. Conflicts that were identified before 2014 only are more than likely still occurring or may not be reported as frequently in the scientific literature. Likewise, conflicts reported after 2014 only may have been occurring prior to this and again, either missed in the original literature searches or less frequently reported. The majority of "new" conflicts we identified were disease related, which may reflect a shift of focus leading to increased reporting in this area, possibly in light of several international public health emergencies of zoonotic origin within the last ten years, such as Middle East respiratory syndrome (MERS), Ebola and Covid-19 pandemics (Sun et al. 2024).

Another limitation of our findings is the lack of data for some species. Feral species were excluded from some of the analyses due to the small number of conflicts in Great Britain, although their impacts can be significant. Data regarding feral cats are limited due to the difficulty in differentiating between feral and domestic cats (Hand 2019), the uncertainties of feral cat population estimates (based mostly on urban populations) and the lack of known distribution within Great Britain. Cats are one of the most ubiquitous mammals globally (see McDonald & Skillings (McDonald and Skillings 2021)) and one of the most destructive, with free-ranging cats suggested as having a major impact on the mortality of several bird species in the UK (Baker et al. 2008). They are also the biggest threat to the survival of Scottish wildcats due to introgression (Fredrikson 2016). Given their domesticated origins, feral cats have no native range and their ubiquitous adverse impacts on native wildlife around the world has led to them being labelled amongst the world's worst invasive species (Lowe, Browne, and Boudjelas 2000). From a biodiversity conservation perspective, a wealth of evidence suggests that feral cats should be controlled and ideally removed from places where their impact is detrimental, often as an urgent priority (Trouwborst, McCormack, and Camacho 2019).

When applying the GISS in this paper, none of the conflicts were weighted, i.e. they were all considered of equal importance. This follows Nentwig, Künel, and Bacher (2010), who stated that in the absence of objective scientific criteria to consider one impact category more important than the other, selective weights were not applied. They also stated that deciding relative impact weights is a social process rather than a scientific one. It is possible to apply individual weights to conflicts, for example, by considering stakeholder values (e.g. Kumschick et al. (2012)), which will likely differ according to the relevance of a particular conflict to a particular group. The scoring system applied here is thus considered robust to the uncertainty of impact knowledge but could be adjusted with weight scores to account for specific social values, such as stakeholder interests, in the future (Nentwig, Künel, and Bacher 2010).

Conclusions

The prioritisation approach we applied here is a useful tool for identifying individual conflicts for individual species but also provides a broader assessment of where human-wildlife impacts may be affecting socio-economic and biodiversity interests. It is clear that it should not be relied upon in isolation to identify priority species for mitigation purposes, and all other available evidence or opinion from conservation groups, stakeholder groups, public perception and other interested parties, should be considered. Ideally, any decision making, whether relevant to government policies or conservation organisations, should consider ensuring a balance between the need to conserve and enhance biodiversity, the interests of the general public and the interests of those directly affected (Defra 2010).

Conflict of interest

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The authors declare no conflicts of interest.

Data availability statement

The data that support the findings of this study are available as supplementary material.

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Supporting information

Table S1. Comprehensive list of articles included in the conflict review and analyses, including study location, source type, date, conflict, species, duplication (i.e. the article was applicable to multiple conflicts and/or more than one species).

Supplementary material S2. Detailed description of all of the conflicts identified in the scientific literature for 48 mammals of the British Isles.

Table S3. List of species causing conflict, including order, status, population size, body mass, biomass and type of conflicts recorded over time (pre-2014 only; both pre-2014 and 2014 to present; 2014 to present only). The median impact score (1=minimal known impact to 5=highest known impact) and confidence rating (1=low; 2=medium; 3=high) are shown after each conflict [x,x]. The highest impact scores are shown in bold.

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