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Review

Birds and people: from conflict to coexistence

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Negative interactions between humans and animals are becoming increasingly frequent, as wild habitats shrink and human presence and activities expand throughout the world. Conflicts between people over conservation are one of the outcomes of this increased interaction, with severe consequences for both wildlife and people. Globally, conflicts can arise across diverse ecosystems, species and circumstances. Even if most attention in wildlife-related conflicts has been on mammals, birds are also often at the centre of such conflicts, but conflict research is still not explicitly present in ornithological literature. Examples of such conflicts include those related to birds and agriculture, forestry, hunting, fishing and public health interests. Conflicts are often more complex than initial assessments might suggest, involving ecological, economic, cultural, social and political elements. Reflecting the complexity of these issues and their increasing relevance to bird conservation, a British Ornithologists' Union conference was organized in November 2021 that aimed to highlight examples of conflicts that exist between people over birds and their conservation. Building on this conference, we provide here a review of key themes relating to the understanding of conflicts, including the importance of conflict perceptions, the collaboration between multiple disciplines and the different types of knowledge needed to better understand conflicts. We then consider the management of bird conservation conflicts, including the key issues of dealing with uncertainty, the role of technical solutions and the importance of collaboration and building trust, illustrating each theme with real-world examples. Finally, we outline potential future conflicts around bird conservation and how best to address them proactively.

Keywords: agriculture, climate change, collaboration, fisheries, forestry, hunting, interdisciplinarity, invasive species.

As wild habitats shrink across the globe as the result of expanding human presence and activities, interactions between humans and wild animals are increasingly frequent (Redpath *et al.* 2013). This can lead to conflicts between people, often with different interests and goals around conservation (Young *et al.* 2010, Redpath *et al.* 2013, Lécuyer *et al.* 2022). For the purposes of this paper, we adopt the IUCN definition of conflicts as 'struggles that emerge when the presence or behaviour of

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wildlife poses an actual or perceived, direct and recurring threat to human interests or needs, leading to disagreements between groups of people and negative impacts on people and/or wildlife' (IUCN 2023). Research around such conflicts has frequently focused on conflicts related to mammals (e.g. large carnivores, ungulates, lagomorphs or rodents) but they often also include birds. In fact, the conservation of wild birds lies at the heart of many such conflicts, linked to agricultural interests (Henle *et al.* 2008, Ballejo *et al.* 2020, Lécuyer *et al.* 2022), forestry (Niemelä *et al.* 2005, Bonsu *et al.* 2019), hunting (Thirgood *et al.* 2000, Brochet *et al.* 2016, Cusack *et al.* 2021), fisheries (Sonntag *et al.* 2012, Marzano *et al.* 2013), energy production (Serrano *et al.* 2020) and public health (Dale 2009), among others. Due to the range of ecosystem services (e.g. seed dissemination, predator regulation, pollination, scavenging, cultural services and ecosystem engineering – see Whelan *et al.* (2008)) and disservices (e.g. vectors of zoonotic pathogens, livestock losses) involved, conflicts involving bird species can generate strong emotion and passion from multiple stakeholders (e.g. Thirgood *et al.* 2000, Carr & Reyes-Galindo 2017, Dayer *et al.* 2019). These can, when manifested through interactions that may have negative impacts on birds, people or both, severely threaten not just the conservation of birds, but also human livelihoods and well-being.

Conflicts can vary in their intensity. The lowest level of conflict intensity can be referred to as a dispute; in other words, the tangible manifestation of conflict around a material issue (Madden & McQuinn 2014, Cusack *et al.* 2021). Obvious manifestations of disputes include situations where the birds cause problems for humans, such as bird strikes on planes causing damage and, in some cases, human deaths (Dale 2009, Thorpe 2016), nuisance caused by gulls in urban environments (Rock 2005, Huig *et al.* 2016), dissemination of zoonotic pathogens from wild birds to livestock or humans (Reed *et al.* 2003, Battisti *et al.* 2020), birds producing damage (real or perceived) in farmland such as bird herbivory of crops (Fox *et al.* 2017) or predation by large raptors on livestock (Duriez *et al.* 2019, Lambertucci *et al.* 2021). In these cases, disputes may appear in relation to the extent of the damage (and the relationship between real and perceived damage) or its economic cost, and who should bear it. Conflicts also occur in those situations where human activities impede the conservation of bird species, such as where illegal or unsustainable hunting of migratory birds occurs (Brochet *et al.* 2016, Cusack *et al.* 2021), or where agricultural, forestry or development activities drive population declines (e.g. Gutiérrez 2015).

The next level of conflict intensity relates to underlying conflicts, where past interactions between, or decisions made by, parties involved intensify or aggravate the current situation. For example, the conflict between stakeholders over the conservation of Hen Harriers *Circus cyaneus* in forests in Ireland concerns land use priority. In other words, is protecting the nesting habitat of the bird species or the production of forest and forest products the priority? This stems from the way in which designation of Special Protection Areas for Hen Harriers, under the EU Birds Directive, was initially conducted over 10 years ago, with doubts remaining among stakeholders over the criteria and data used in the original designation process (Bonsu *et al.* 2019). This historical dimension is also apparent in the conflict between bird conservationists, farmers and crofters over the conservation of re-introduced White-tailed Eagles *Haliaeetus albicilla* in Scotland in the 1970s following their human-caused extinction in the early 20th century. Although this re-introduction is considered a conservation success by many, stakeholders including many farmers and crofters argue that the initial reintroduction was carried out without sufficient consultation, and this is now at the root of disputes over the extent to which White-tailed Eagles impact agricultural productivity and farmers' livelihoods (Young *et al.* 2016a). The origins of this conflict appear to have been mirrored in the reintroduction of White-tailed Eagle into Ireland (Burke *et al.* 2014, O'Rourke 2014). Although these examples represent underlying conflicts, their outcomes have implications for the population viability of threatened species if a workable solution is not found.

The highest level of conflict is a deep-rooted or identity-based conflict, where any compromise in the conflict is perceived as putting at risk the identity of individuals or groups involved (Madden & McQuinn 2014). In western North America, the conflicts around the conservation of the Spotted Owl *Strix occidentalis* highlight such a clash in ideologies between those wanting to preserve the aesthetic, spiritual and ecological values of old-growth forests and those who value trees as commodities that are the basis for livelihoods and community stability and believe that prioritizing owl conservation may put their community at risk (Gutiérrez 2015). Similar clashes in values occur in eastern and southern England between anglers and chalk river conservationists on the one hand, and groups who want to protect Mute Swans *Cygnus olor* on the other. The conflict arises because chalk rivers depend on Stream Water-crowfoot *Ranunculus penicillatus*, upon which swans feed. With the swan population nearly doubling over 30 years, the conservation of water crowfoot is now threatened, with negative impacts on the habitat of fish, invertebrates and other wildlife (Wood *et al.* 2014). The swan populations are valued by some conservationists and the general public, but other conservationists and anglers place greater value on the chalk river ecosystem reliant on the Stream Water-crowfoot, potentially including the human livelihoods from angling in that ecosystem. In such identity-based conflicts, the birds at the centre of the conflicts are often the manifestation of deeper and often complex issues that affect stakeholders. The recovery of the Mute Swan population is seen as less important than the conflict that has originated from that population recovery. In Eastern Europe, Carp *Cyprinus carpio* fisheries are part of the cultural heritage of the regions in which they occur. Strong regulations for the protection of Great Cormorants *Phalacrocorax carbo* have resulted in an increase in their population across Europe. Although many factors influence the reduction of catches in carp fisheries, including competition from fish-importing industries, overfishing, habitat modifications and eutrophication (Marzano *et al.* 2013), the added and very visible impact of cormorants is seen as a direct attack on the region's historical and cultural heritage (Marzano 2015). As such, the conflict highlights the clashes of values between those who want to conserve cormorants and those who feel that cormorants are affecting their heritage as well as their livelihoods (Carss 2021).

Conflicts, whether at the dispute or identity-based level, can have conservation and socio-economic implications and lead to antagonism between bird conservation and other human activities. To explore this further, a British Ornithologists' Union conference was organized in November 2021 that aimed to highlight examples of conflicts that exist between birds and people, as well as approaches that aim to understand the drivers of conflicts between birds and people and promote coexistence. Here we synthesize reflections from this conference, starting with key messages relating to the understanding of conflicts, namely the importance of recognizing the impact of the diversity of perceptions of conflicts, and the need for interdisciplinary and transdisciplinary approaches to understanding conflicts. We then highlight issues identified through the conference relevant to the management of conflicts related to birds, especially the range of technical solutions used in conflicts and their limitations, together with approaches used to build collaboration and trust, and reflect on the role of uncertainty in managing conflicts effectively. We end with a key component missing in many conflict management approaches, namely a consideration of possible future avian conflicts, in order to identify possible hotspots and management options to address future conflicts pro-actively.

KEY THEMES AROUND UNDERSTANDING CONFLICT

Perceptions of conflicts

Our relationships with wild and domestic animals have changed over time (Manfredo *et al.* 2003, 2009), paralleling transformations in human emotions associated with them (Kellert & Wilson 1993). Furthermore, emotions induced by animals may differ among individuals according to gender, age, cultural and natural environment, and perceived vulnerability to each species (Castillo-Huitrón *et al.* 2020), which can result in individuals (and sometimes whole stakeholder groups) having different sentiments towards different species. Understanding these feelings and emotions, as well as the social, economic or environmental factors influencing their variation among individuals, is relevant because they can shape the understanding of a conflict as well as the acceptability of conservation strategies.

Beyond emotions, values also shape perceptions. The impacts of human activities (e.g. hunting, farming, energy production) on the population status of a bird species may be perceived differently by those for whom nature protection holds higher value than economic development, compared with those for whom human economic development and stability hold higher value. The levels of damage caused by birds, for example, may be perceived as higher in the stakeholder group suffering them (farmers, fishermen or hunters) than quantified in scientific studies (e.g. Duriez *et al.* 2019).

The perception of a conflict by different stakeholders is embedded in their knowledge, experience and value system, which will impact on their view of the conflict and its possible management and will in turn influence their interpretation of scientific information (Hodgson *et al.* 2019). For example, the value attributed to wildlife may have different orientations, from domination (where human well-being is prioritized over wildlife, with the latter seen mainly in utilitarian terms) to mutualism (characterized by a desire for companionship with wildlife, which in this orientation holds equal rights to humans; Teel & Manfredo 2010). The influence of such value systems on interpretation of information may affect the way people frame conflicts and accept potential solutions (Hermann *et al.* 2013, Ganborg *et al.* 2016, St John *et al.* 2019, Carss 2021). For example, a domination-oriented person may have more acceptance of controlling populations of a species that creates damage to human livelihoods, whereas a mutualist would be strongly opposed to such a solution. More broadly, value systems may influence the place of biodiversity in societal priorities, and thus potentially in policy design or implementation (Manfredo *et al.* 2020).

Because information is usually interpreted through the value system and used to reinforce certain views (Hodgson *et al.* 2019, Lambertucci *et al.* 2021), spread and reinforcement of perceptions can occur through social networks (Muter *et al.* 2013). Media and social media can have a strong influence on the dynamics of conflicts by allowing people to transmit their mood and feelings to others, generating massive-scale contagions (Kramer *et al.* 2014). Media, including social media, can fuel conflicts but can therefore also potentially contribute to reducing or solving them, often by framing information positively or negatively (Arbieu *et al.* 2021, Correia *et al.* 2021). For example, livestock attacks by Griffon Vultures *Gyps fulvus*, partially explained by changes in food availability, have been very attractive to the media, facilitating the magnification of risk perception and conflict intensity (Margalida *et al.* 2014), with negatively framed vulture videos leading to more views than positively framed ones on a social media platform (Ballejo *et al.* 2021). In Dominica, education and conservation programmes were implemented in the 1980s to counteract a massive decline in their two endemic and globally threatened parrot species, the Imperial *Amazona imperialis* and Red-necked *Amazona arausiaca* Amazons. The conservation campaigns increasingly focused on the Imperial Amazon, re-constructing the species as an iconic national symbol or flagship species (Douglas & Veríssimo 2013). This process, however, led to the Red-necked Amazon being perceived as the 'other' species that could be blamed for crop losses, and was therefore expendable. Indeed, Dominican farmers used this framing to argue for government-sanctioned population management of Red-necked Amazons (Douglas & Winkel 2014). A recent review showed that the way a conflict is framed also influences management recommendations, with enforcement correlated with illegal resource use and stakeholder-based intervention correlated with human–human conflict framing (Baynham-Herd *et al.* 2018). Reframing may have benefits by allowing people to perceive conflicts from a different perspective (Carss 2021). Media play an important role in framing and reframing conflicts and the support people give to wildlife management and coexistence. It is therefore key for conflict management to understand and incorporate media as a stakeholder (Arbieu *et al.* 2021).

Multidisciplinary and transdisciplinary understanding of conflicts

Conflicts involving birds (along with other wildlife) are multidimensional, integrating the ecological relationships between species and their environment as well as human dimensions (including emotions, perceptions and ethical, political, economic and societal dimensions – as seen above). However, many decisions about wildlife management, especially those related to human–wildlife conflicts, are frequently dominated by one of those dimensions. For example, while objectivity in decision-making is desirable from the perspective of natural resource management agencies, human decisions about wildlife are frequently not based on facts alone, as most do not divorce rational from emotional perspectives. In fact, the affective component of decision-making is believed to occur before other cognitive functions, whereas the desire and ability to make deliberative and scientifically informed decisions occur secondarily, after the acquisition of specific knowledge (Slovic *et al.* 2002). Some decisions about wildlife management are dominated by emotions, a clear example being that of invasive animals that evoke strong affection. Invasive parrots such as the Ring-necked Parakeet *Psittacula krameri* and Monk Parakeet *Myiopsitta monachus* are a good example of these conflicts. In southern Spain, the Ring-necked Parakeet is threatening two species of conservation concern, the Great Noctule Bat *Nyctalus lasiopterus* and the Lesser Kestrel *Falco naumanni* by outcompeting them for nest-sites (Hernández-Brito *et al.* 2014). Moreover, both parakeets are known for their impacts on agriculture across their native and invasive ranges, with these impacts strongly related to their population sizes (Turbé *et al.* 2017). The eradication of both parakeets is feasible (Senar *et al.* 2021). However, these colourful and attractive species are often positively perceived by people in cities (Ribeiro *et al.* 2021), so many control campaigns in urban areas have been suspended or minimized in response to public opposition even though there is a case to persist with campaigns for the greater ecological good. On the other hand, when decisions about wildlife management in conflict situations are taken based solely on ecological criteria, this may exacerbate the conflict if it is seen by other sectors as the result of a power battle among groups rather than arising from ecological need. Here engagement is important to emphasize and ground the ecological arguments among stakeholders. This has been the case with the recent temporary moratorium of hunting of Turtle Doves *Streptopelia turtur* in western Europe based on population model results, which was contested by hunters who disbelieved the information on population status presented by conservationists or scientists, while considering that their efforts in habitat management for the species were more impactful than those of conservation organizations (https://circabc.europa.eu/ui/group/e21159fc-a026-4045-a47f-9ff1a319e1c5/library/072c941f-8cae-4b07-b072-8bc02dcb83b0/details).

Sometimes, the solution to disagreements is based on the design and implementation of education programmes to change beliefs, attitudes and behaviours towards wildlife conservation among the general public or affected stakeholders (Espinosa & Jacobson 2012). These programmes, however, may have varying levels of success (Bridson 2000), because knowledge by itself may not always have a direct or consistent effect on changes in beliefs, attitudes or behaviour (Heimlich *et al.* 2013, Ardoin *et al.* 2015), and it rarely affects values, which also influence attitudes and behaviour.

The reality is that conflicts are complex, with often large numbers of stakeholders involved directly or indirectly. Their effective management depends as much on understanding conflicts between stakeholders and their potential resolution, as it does on managing the species impacts themselves. In light of the complexity of the ecological, ethical, political and societal dimensions of conflicts, there is an acute need for more interdisciplinary approaches to the study and management of conflicts.

KEY THEMES IN THE MANAGEMENT OF CONFLICTS

Considering the potential negative impacts of conflicts for bird conservation and for human livelihoods and well-being, there is an increased focus on the need to better manage conflicts. Improved understanding of conflicts, as explored above, is essential to help identify the underlying issues, and therefore better tailor conflict management strategies (Redpath *et al.* 2013, Young *et al.* 2016a, 2022).

Dealing with uncertainty

Uncertainty arises because of inadequate characterization of all key steps in a conflict situation, inability to measure these steps accurately and challenges associated with describing them in a way that is understood by all parties. It operates at all levels and as a result makes conflicts more challenging to resolve. Uncertainty may be considerable in ecological evidence underpinning conflicts, where interactions are complex, involving multiple, interlinked processes. In conflicts involving birds, these processes include behaviour, energetics, demography and interspecific (e.g. trophic) interactions of wild birds in environments that vary spatially and temporally. There is an important distinction between uncertainty and variation, which is a natural property caused by differences, for example, between individuals, across space (e.g. habitat quality) or through time (e.g. inter-annual variation in weather conditions; Searle *et al.* 2023a). Uncertainty can be reduced through improved characterization, measurement and description, whereas variation can be quantified but not reduced. There is also uncertainty in how people respond to conflict situations linked to economic, cultural, social and political contexts, which shapes their responses. Here too, a clear distinction should be made between uncertainty in the influence of these contexts in these processes and variation between people or stakeholder groups. To minimize conflicts, it is important that uncertainty is presented to all parties in a transparent way by setting out the full set of possible outcomes incorporating uncertainty that is propagated through all steps in a conflict situation. This is especially important in cases where a yes–no decision is required, where such transparency ensures that the most informed choice can be made, and key approaches that are proportional to the extent of uncertainty, such as the precautionary principle, are adopted in the most appropriate way. In many situations to date, uncertainty appears to be low only because certain aspects of a conflict have been excluded or underestimated. However, to benefit conflict management, uncertainty needs to be reduced through stronger evidence, based on a more comprehensive process-based understanding and more accurate measurement of these processes (Searle *et al.* 2023a). For example, the effects on marine birds of harvesting of forage fish has proved challenging to quantify because of the mismatch in temporal and spatial scales of data on fish, birds and fisheries, the inability to adequately incorporate additional factors that are simultaneously driving marine bird populations, such as climate impacts, and the lack of causal evidence because of the reliance on correlative approaches (Sydeman *et al.* 2017).

Technical solutions

Technical solutions to help solve disputes can sometimes be identified. Because these disputes are likely to differ vastly between species, regions and human contexts, technical solutions are likely to be unique and not necessarily appropriate in other contexts. However, examples may give ideas for potential solutions that could be tried in different contexts. For example, diversionary feeding has been tested as a means to reduce predation of Red Grouse *Lagopus lagopus scoticus* by Hen Harriers in the UK (Redpath *et al.* 2001, Ludwig *et al.* 2018). These studies showed that providing laboratory rats close to nests significantly reduces the number of grouse chicks brought to the nest by breeding harriers. Such a technical solution could potentially be used in the context of maintenance of the high densities of grouse required for driven shooting (which in turn necessitates maximizing production and minimizing predation of grouse chicks) on estates where the density of Hen Harriers is high and may therefore help to reduce the conflict between Hen Harrier conservation and Red Grouse shooting.

Similarly, various technical solutions have been proposed to control expanding populations of invasive species. The use of reproductive inhibitors such as diazacon in treated sunflower seeds has been proven to successfully reduce nest productivity of Monk Parakeets in the USA (Avery *et al.* 2008), thus potentially minimizing their population expansion and their ecologically negative impact. Other methods such as destroying eggs, providing chemosterilants or destroying nests, however, have been proved to be ineffective in reducing population growth in this species (Senar *et al.* 2021). On the other hand, lethal control of breeders, including shooting, has been suggested as more effective than nest or productivity control to reduce both Monk Parakeet (Conroy & Senar 2009) and Rose-ringed Parakeet *Psittacula krameri* populations (Klug *et al.* 2019).

A variety of solutions can be used to avoid collision of birds at windfarms (Cook *et al.* 2011), including selective stopping of certain rotors when approaching birds are detected (de Lucas *et al.* 2012). Predictive modelling can also be used to inform zoning strategies for renewable projects in areas where the impact on birds is minimized (Serrano *et al.* 2020). Technical approaches to aid the development of solutions can be based on accurate spatial–temporal information on the movements of bird species. These data can potentially be used to manage problematic species and individuals, such as gull species in urban environments (Spelt *et al.* 2019). The International Cooperation for Animal Research Using Space tracking system onboard the International Space Station is an example of such a tool (Jetz *et al.* 2022). This tool can inform management of conflicts by highlighting specific hotspots with potential increased interface between humans and gulls.

Similarly, experimental procedures have shown that Conditioned Food Aversion can be used to reduce nest predation of ground-nesting species by

Red Foxes *Vulpes vulpes* (Tobajas *et al.* 2020), so preventing conflicts between bird conservationists and mammalian predators of endangered species. This study showed that the use of thiram (a slightly toxic product that acts as an emetic for foxes after ingestion) used on artificial Red-legged Partridge *Alectoris rufa* nests increased wild partridge productivity and density in comparison to control areas, despite compensatory predation by other predators. This method could be used as a non-lethal tool to reduce nest predation by foxes, reducing the need for carrying out lethal fox control, which is a controversial management practice that is frequently used by hunting estates (Arroyo *et al.* 2012). Another study demonstrated that sensory misinformation tactics can be used to deter invasive mammalian predation of endangered ground-nesting species with results demonstrating that the methods were as effective as lethal control (Norbury *et al.* 2021). These methods could also be considered when it is important to reduce nest predation of other declining ground-nesting birds (McMahon *et al.* 2020). These methods could prevent conflicts between individual conservationists, who aim to protect ground-nesting bird species, and meso-predators, mainly mammals, which can impact on their numbers.

The details given above of a range of potential technical solutions provide a glimpse of the extensive research resources devoted to trying to find such solutions across many cases of conflict. However, these technical approaches are often not a definitive solution, because, in many cases, they do not consider the social aspects of the conflict. For example, invasive species such as parakeets may be positively perceived by the public, whereas their negative ecological impacts may not be recognized (Ribeiro *et al.* 2021). Additionally, there is usually strong negative perception of any lethal control of animals viewed by some as overabundant (Martínez-Jauregui *et al.* 2020) and this may result in opposition to lethal control of invasive species (Crowley *et al.* 2019). In fact, the acceptability of population management tools is usually associated with the legitimacy of the goal (Garrido *et al.* 2017), and sometimes the acceptability of solutions aiming to reduce human economic losses is higher than that of solutions aiming to improve conservation value (Martínez-Jauregui *et al.* 2020). It is also important to match the level of intensity of a conflict with the right conflict management approach. For example, while a dispute may be settled through a technical solution (e.g. using falconry to minimize bird collisions with planes around airports; Roca-Gonzalez *et al.* 2020), it is less likely that such a strategy will adequately address an underlying or deep-rooted conflict. Indeed, managing a deep-rooted conflict with a technical solution may exacerbate the conflict, with stakeholders perceiving their concerns to be slighted (Young *et al.* 2016a).

In more complex situations involving underlying or deep-rooted conflicts, participatory and deliberative processes that can improve relationships and trust between stakeholders and reduce the intensity or negative impacts of conflicts may need to be used to help stakeholders engage in and manage the conflict jointly (Young *et al.* 2016a, Rakotonarivo *et al.* 2020, Saif *et al.* 2022). Effective integration of all stakeholders and explicit considerations of social aspects of the conflict may be more important, in most cases, than the technical solutions to address the ecological aspects of the conflicts, and we highlight this fact to emphasize that more research is necessary in these respects to both test these propositions and be able to advance more efficiently in reducing those conflicts.

Collaboration and building trust

Increasingly, efforts to manage conflicts are focusing on building trust and collaboration between stakeholders. This trust-building can target different stages of the conflict understanding and management process. For example, a recent Scottish project gathered stakeholder knowledge of ground-nesting birds' status and trends as a contribution to a wider conflict management aim, which was building dialogue and trust between stakeholders through reaching a consensus on the knowledge underpinning the conflict (Ainsworth *et al.* 2020). Trust-building can also happen later in the process, for example in the selection of conflict management strategies. In Ireland, Eurasian Curlews *Numenius arquata* have seen a continued decline in population and range over the last 30 years (Balmer *et al.* 2013, O'Donoghue *et al.* 2019), which reflects population declines across Europe (Keller *et al.* 2020). To address this decline in Ireland, a workshop was organized in 2016 bringing together 80 stakeholders from the government, conservation, forestry, non-governmental organizations, agriculture, energy production and academia to examine the curlew decline and seek to bring about solutions in the Irish context. The stakeholders jointly identified and agreed 20 short-, medium- and long-term actions needed to prevent the extinction of Eurasian Curlews, allocated to specific groups, and regularly evaluated and adapted (Young *et al.* 2020). Seven years on there is an active Curlew Conservation Programme, co-ordinated by the Irish National Parks and Wildlife Services and other local schemes such as the Curlew European Innovation Partnership in the west of Ireland, so the workshop did help focus the minds and has delivered some positive outcomes. Ultimately, of course, the viability of the breeding population will be the definitive test of these conservation actions.

Collaborative and trust-building efforts can take the form of participatory processes. The decision to implement participatory approaches, however, needs careful reflection, design and evaluation, and an understanding of the current governance structure and potential power dynamics between stakeholders (which should be determined during the conflict understanding phase). Indeed, if a conflict is acute and involves participants with important power asymmetries, it might be useful to start with smaller meetings with separate groups of stakeholders before embarking on a multi-stakeholder process (Young *et al.* 2016a, 2016b). It is also increasingly clear that involving stakeholders earlier – even in the understanding of conflicts – can be highly beneficial in terms of identifying solutions that will be acceptable to all (Ainsworth *et al.* 2020). These solutions can include a range of different options that can be used synergistically, for example technical solutions, educational programmes and legislative instruments, or financial incentives such as compensation, insurance, or payments for conservation or ecosystem services. Jointly agreed solutions need to then be regularly evaluated and adapted to reflect any lessons learned or changes in the context of the conflict indicating the requirement for continuous co-management of the solutions with stakeholders.

Collaborative and participatory approaches that aim to build trust and joint solutions can, however, take time and resources (Ainsworth *et al.* 2020). They also require all stakeholders to be willing to find joint solutions, that may of course entail making concessions – an outcome that is not always acceptable (Redpath *et al.* 2013). In the conflict between Hen Harrier conservation and Red Grouse shooting, for example, the conflict and levels of distrust between stakeholders persist despite numerous attempts to better understand the social and ecological dimensions of the conflict (e.g. Thirgood *et al.* 2000, Thompson *et al.* 2009, Hodgson *et al.* 2018, St John *et al.* 2019), and multiple attempts to bring the stakeholders together to address the conflict (Redpath *et al.* 2004, Ainsworth *et al.* 2020).

LOOKING TO THE FUTURE

There are major challenges facing birds currently (Lees *et al.* 2022) and solutions to these challenges must be found and delivered within our global community. An important initial action should be the proactive management of potential conflicts. We illustrate this need with some examples of conflicts that are predicted to become more complex and acute in the future, and describe some of the tools and models now available to undertake this interdisciplinary work.

Conflicts involving birds and people are increasingly embedded in global issues such as climate change, land use change, food and energy security, and global biodiversity loss. Scotland's western and northern isles provide ideal habitat for geese with a steady increase in improved grassland and winter temperatures over the last 20 years in this area (Mason *et al.* 2018). At the same time, both protection from hunting (e.g. Barnacle Geese *Branta leucopsis*) and a loss of the culture of shooting geese (e.g. Greylag Geese *Anser anser*) have led to further pressure being taken off these populations (Tullock *et al.* 2017, Mason *et al.* 2018). For example, Barnacle Geese and Greylag Geese over-wintering in Scotland have dramatically increased in numbers, damaging agricultural grasslands (McKenzie & Shaw 2017, Mason *et al.* 2018), and Greylag Geese in the Orkney Isles, north of mainland Scotland, are now staying over summer, creating substantial impacts on valuable agricultural crops, such as barley (Tullock *et al.* 2017). There is a need, however, to take into consideration the global conservation obligation which both Britain and Ireland have in supporting populations of these geese in these locations (Bainbridge 2017). Assessing the perceived impacts compared with the real impacts of geese on agricultural production remains a contested issue because measuring perceptions as well as real impacts are both resource intensive, requiring effort and expertise (Simonsen *et al.* 2017). All in all, legislative, cultural and societal change, in addition to climate and agricultural change, have contributed further to the increase of goose numbers in Scotland. The recent dramatic effect of avian influenza on certain wildfowl populations, in particular the Barnacle Geese on the Solway coast and the island of Islay, may further alter the dynamics of this conflict by elevating conservation measures for the Svalbard and Greenland Barnacle Goose populations (e.g. pausing or reducing culling), which in turn is in conflict with those stakeholders focused on agricultural production.

New conflicts are also emerging as the result of pressures put on farming communities because of international developments and climate agreements (Lécuyer *et al.* 2022). At the same time, the willingness to pay a fair price for farming products is limited and further complicated by the knock-on effects associated with the current war in Ukraine and the 'cost of living' crisis (World Economic Forum 2023). Farmers are, however, seen as a key group that can contribute significantly to tackling the biodiversity crisis (Hallgren *et al.* 2020, Reay *et al.* 2020). With these new issues playing out already, mitigation of conflicts around bird conservation needs to consider the multiple pressures perceived by key stakeholder groups such as farmers and devise ways of integrating them as partners in conservation (Lécuyer *et al.* 2022).

As governments develop policies on energy security and biodiversity net gain, conflicts between green energy and bird conservation are predicted to increase in the years ahead (Ermgassen *et al.* 2019). Such developments have the potential to affect seabirds through displacement from important habitat, barrier effects to movements and collisions with turbine blades (Drewitt & Langston 2006, Masden *et al.* 2010). Similarly, proposed development of renewable energy in Spain for the next few years is thought by scientists to be likely to have strong effects on raptors and steppe birds (Serrano *et al.* 2020). However, a review by Ermgassen *et al.* (2019) calculated that around half of all new infrastructure projects fall within countries with environmental laws stressing that such energy production must be delivered in a sustainable manner, whereby there is no significant negative impact on protected species. Furthermore, they estimate that 47% of the ranges of infrastructure-threatened bird species falls within countries with mandatory compensation policies towards achieving no net loss. In the case of offshore wind developments, a range of compensatory measures have been proposed (MacArthur Green 2021) that have the potential to alleviate these impacts and, ultimately, deliver biodiversity gain. Compensation approaches suggested in this report for a range of UK seabirds include no-take zones to boost fish populations on which birds feed, eradication of invasive mammal predators to increase seabird breeding success and artificial colonies to offset lost breeding habitat. Given the magnitude of compensation anticipated, large-scale measures that address the requirements of multiple developments in a coordinated way are being considered, especially in fisheries management, with the objective of increasing the availability of key fish prey for seabirds, with benefits for their survival and productivity (Cury *et al.* 2011, Searle *et al.* 2023b). However, compensation schemes that involve other sectors, such as fisheries management in the case of offshore wind developments, must consider the wider socio-economic implications including the livelihoods and culture of fishermen. As such, conflicts associated with green energy are expected to become more complex as these non-ecological factors are incorporated. In many of these conflicts around compensation and no net loss, decision-makers continue to struggle with a lack of empirical evidence of impacts and whether measures taken in response reduce those impacts. A closer collaboration between decision-makers and scientists is crucial here to complete the iterative loop of actions and evidence.

The tools available to combine ecological and social information and better understand the impacts of stakeholder conflicts on bird populations are ever increasing. These include models that combine data collected through citizen science, such as Population Viability Analyses and stakeholder modelling (Balmer *et al.* 2013, Keller *et al.* 2020, García-Antón & Traba 2021) or modelling specific cohorts within the bird community that may be increasing or decreasing rapidly, for example ground-nesting bird species in farmland or corvids (Ainsworth *et al.* 2020, McMahon *et al.* 2020). Models that deal with conflicts as a stakeholder decision-making process in conservation are important tools and help predict the outcome of these decisions (e.g. new policies) on conflicts, livelihoods and species conservation (Bunnefeld *et al.* 2017). Recent models have incorporated goal-oriented behaviour of multiple stakeholders with competing objectives, effectively creating a modelled conflict (Duthie *et al.* 2018). For example, conflicts between conservation success in the form of increasing Common Crane *Grus grus* populations and farming in Sweden were modelled to test the empowerment of farmers to contribute to crane population control and so limit agricultural damage. The model highlighted the challenges of increasing stakeholder (i.e. farmer) involvement for managers: how to set policies and management actions that balance increasing stakeholder numbers through engagement while avoiding overexploitation and ensuring sustainable population management of cranes (Nilsson *et al.* 2021). These brief examples demonstrate how the incorporation of the experiences from stakeholder modelling from similar scenarios into providing management solutions for bird conflicts can be an important tool, to inform both the thinking and the proactive actions. However, the uptake of stakeholder models to understand complex stakeholder relationships and decision-making, and the effects of these decisions on conflicts are still underused in bird conservation practice. Examples from fisheries and protected area management demonstrate that modelling stakeholder decisions increases management effectiveness but long-term commitment from managers, scientists and funders is needed to enable the iterative process of modelling and actions to work (Bunnefeld *et al.* 2017).

CONCLUSION

Conflicts between birds and people are ever present. As highlighted at the British Ornithologists' Union conference in November 2021, there are a range of contexts for these conflicts, often with a unique set of circumstances. As ornithologists and bird conservationists who often deal with these situations, we must endeavour to understand better the origins of these conflicts and to predict potential new conflicts in order to proactively manage them. The ongoing management of conflicts together with stakeholders is another important philosophy to appreciate given that there are rarely absolute or quick solutions. Finally, given the correct approach and engagement, there is a need to work more closely with other disciplines and sectors to empower ornithologists and bird conservationists to input knowledge of conflicts more effectively, but more importantly, to facilitate the engagement of relevant stakeholders to bring about more long-term and effective conflict management for birds and people. However, conflict management must clearly separate conflicts involving native species and those associated with non-native invasive species. While management measures should promote coexistence with native species, in the case of invasive species, priority should be given to the conservation of biodiversity and ecosystem services, including decisions that may not be supported by all the stakeholders involved.

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AUTHOR CONTRIBUTIONS

Barry J. McMahon: Conceptualization; writing – original draft. **Beatriz Arroyo:** Conceptualization; writing – original draft. **Nils Bunnefeld:** Conceptualization; writing – original draft. **Martina Carrete:** Conceptualization; writing – original draft. **Francis Daunt:** Conceptualization; writing – original draft. **Juliette C. Young:** Conceptualization; writing – original draft.

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The authors declare that they have no conflicts of interest.

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