FACETS
a multidisciplinary open access science journal

PERSPECTIVE

Understanding and avoiding misplaced efforts in conservation

Adam T. Ford[a*], Abdullahi H. Ali[b], Sheila R. Colla[c], Steven J. Cooke[d], Clayton T. Lamb[a], Jeremy Pittman[e], David S. Shiffman[f], and Navinder J. Singh[g]

[a]Department of Biology, University of British Columbia, Kelowna, BC V1V 1V7, Canada; [b]Hirola Conservation Programme, PO Box 1774, Garissa 70100, Kenya; [c]Faculty of Environmental and Urban Change, York University, Toronto, ON M3J 1P3, Canada; [d]Fish Ecology and Conservation Physiology Laboratory, Department of Biology and Institute of Environmental and Interdisciplinary Sciences, Carleton University, Ottawa, ON K1S 5B6, Canada; [e]School of Planning, University of Waterloo, Waterloo, ON N2L 3G1, Canada; [f]New College of Interdisciplinary Arts and Sciences, Arizona State University, Glendale, AZ 85051, USA; [g]Department of Wildlife, Fish and Environmental Studies, Swedish University of Agricultural Sciences, SE-901 83 Umeå, Sweden

*adam.ford@ubc.ca

OPEN ACCESS

Citation: Ford AT, Ali AH, Colla SR, Cooke SJ, Lamb CT, Pittman J, Shiffman DS, and Singh NJ. 2021. Understanding and avoiding misplaced efforts in conservation. FACETS 6: 252–271. doi:10.1139/facets-2020-0058

Handling Editor: Andrea Olive

Received: July 24, 2020

Accepted: November 23, 2020

Published: February 25, 2021

Note: This paper is part of a collection titled "Conservation in Canada: identifying and overcoming barriers".

Published by: Canadian Science Publishing

Abstract

Conservation relies on cooperation among different interest groups and appropriate use of evidence to make decisions that benefit people and biodiversity. However, misplaced conservation occurs when cooperation and evidence are impeded by polarization and misinformation. This impedance influences actions that directly harm biodiversity, alienate partners and disrupt partnerships, waste resources, misinform the public, and (or) delegitimize evidence. As a result of these actions, misplaced conservation outcomes emerge, making it more difficult to have positive outcomes for biodiversity. Here we describe cases where a failed appreciation for cooperation, evidence, or both have eroded efforts to conserve biodiversity. Generally, these case studies illustrate that averting misplaced conservation requires greater adherence to processes that elevate the role of evidence in decision-making and that place collective, long-term benefits for biodiversity over the short-term gains of individuals or groups. Efforts to integrate human dimensions, cooperation, and evidence into conservation will increase the efficacy and success of efforts to conserve global biodiversity while benefiting humanity.

Key words: conflict, evidence, prioritization, cooperation, fake news, decision-making, unintended consequences, communication

Introduction

Recent social trends have seen rising polarization in political affiliations and on key issues (Bail et al. 2018), along with the amplification of misinterpreted or false information in public discourse (Lazer et al. 2018). These two trends may have negative effects on many aspects of health, politics, science, and the conservation of biodiversity. For example, as early as the 1940s, and for decades after, the spread of misinformation overwhelmed scientific evidence suggesting a link between tobacco smoking and cancer (Proctor 2012). Today, similar misinformation regarding the efficacy of vaccinations (Lazer et al. 2018) or responses to the public health orders (e.g., the use of masks to reduce the spread of COVID-19) foments polarization and threatens public health (Paes-Sousa et al. 2020). The mere suggestion of human-caused climate change has become polarizing, impeding actions that could minimize harm to human health, livelihoods, and biodiversity (Biddle and Leuschner 2015). Polarization

threatens cooperative approaches to problem solving and decision-making (Barber and McCarty 2015; Maher et al. 2018), while misinterpreted or false information distracts the public and decision-makers from acting upon pressing needs and may waste resources in doing so (Oreskes and Conway 2011; Barnes et al. 2018). The conservation of biodiversity is a globally significant challenge, and inherently requires cooperation and evidence to be successful. However, success in conservation can be influenced by actions that undermine cooperation and evidence—i.e., polarization and misinformation.

To better understand how polarization and misinformation affects biodiversity, we define the term "misplaced conservation", which occurs when actions increase the scientific, financial, political, or social resources required to achieve a positive outcome for biodiversity in the present or future. Misplaced conservation is distinct from other human activities that are also direct threats to biodiversity, such as habitat loss or overexploitation. The concept of misplaced conservation focuses on activities where conservation resources are expended on an improper, unsuitable, or unworthy activity and the intended outcome of such activity was: (*i*) to maintain or restore biodiversity, but this outcome is impeded by lack of cooperation and evidence and (*ii*) to intentionally impede the use of cooperation and evidence in the context of doing conservation. For these reasons, misplaced conservation arises from the combined underlying influences of polarization and misinformation on conservation activities. By articulating the concept of misplaced conservation (**Fig. 1**), we hope to provide a framework to help overcome barriers to more effective conservation actions.

At its most benign, misplaced conservation may arise from genuine motivations to conserve biodiversity. These motivations may quickly give rise to incremental actions that appear as "baby steps" or "raising awareness". Too often, the success of these actions is not supported with evidence of their positive effect on biodiversity and may instead be distracting or otherwise placating people into a false sense of success (Hagmann et al. 2019). For example, "nudging" is a concept that alters the architecture of choice or the context in which choices are made to provide options that have smaller benefits, with lower costs, with quicker pay offs (Thaler and Sunstein 2009). While nudging has proven effective in many circumstances (Sunstein 2017), it can also lead to complacency that undermines support for more impactful policies and decision-making. Using an experimental approach, Hagmann et al. (2019) found that people overestimated the effectiveness of small gains in environmental policy, when a more costly but more effective alternative was presented. Similarly, simply "raising awareness" does not always lead to positive changes for conservation. In a behavioral experiment, Dunn et al. (2020) found that after watching a documentary about marine conservation, people increased their subject matter knowledge, but they did not change their behaviour with respect to ocean pollutants. While many impactful environmental movements began with smaller, incremental successes, nudges, and awareness campaigns, it should not be assumed that these are effective tools for conservation. The effectiveness of such interventions needs to be evaluated against the potential costs incurred by the fomentation of complacency.

Misplaced conservation also occurs when actions are intended to impede successful conservation. This malicious intent could, for example, involve attacking the credibility of an opposing scientist when competing lines of evidence are part of a conflict between stakeholders (Horton et al. 2016; Harvey et al. 2018; Loss and Marra 2018). For example, Hmielowski et al. (2014) found that when the mainstream media work to deliberately decrease trust in scientists, it increases uncertainty that global warming is happening. Giving equal weight to dissenting views, often a hallmark of journalism, without consideration of expertise may further exacerbate the credibility of science (Brown and Havstad 2017) and lead to policies that are inconsistent with the best available evidence to solve problems (Anderegg et al. 2010).

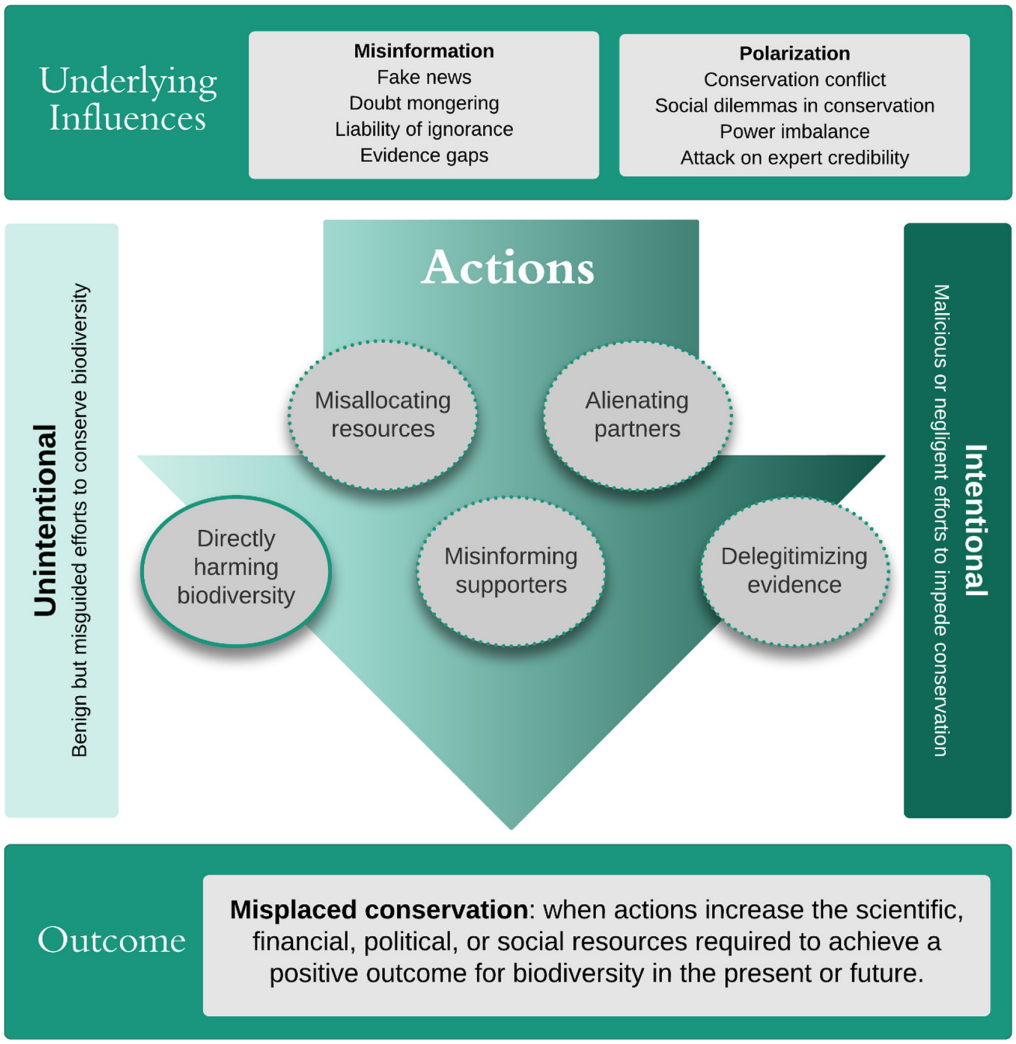

Fig. 1. A conceptual diagram illustrating how misplaced conservation emerges from underlying influences, through actions and intentions. Misinformation and polarization shape the types of actions people take in conservation and mediate the interactions between groups and between people and the environment. The resulting actions can be motivated by benign, but misguided, intent or something more malicious and negligent. Regardless of intent, misplaced conservation is the result of direct action (solid oval) and four indirect actions (dashed ovals) that increase the resources needed to achieve positive outcomes for biodiversity.

Whether people are motivated by truly benign outcomes and happen to be misguided or ignorant in their execution of conservation actions or they are motivated to be deliberately malevolent or negligent, we consider all of these intents to be part of misplaced conservation. The outcomes, rather than intentions, help determine misplaced conservation. Here, we describe some of the key actions that create misplaced conservation, supported by case studies to demonstrate this concept. We begin by describing five nonexclusive actions and then discuss solutions to better understand and resolve it—a critical step towards biodiversity conservation in an era of polarization and lies.

The five critical dimensions of misplaced conservation

Broadly speaking, there are direct (1) and indirect (4) pathways through which the actions of people lead to misplaced conservation (**Fig. 1**). Direct misplaced conservation has a proximate, negative impact on a wildlife population or biodiversity. In contrast, indirect, misplaced conservation impedes the ability of the public, conservation practitioners, stakeholders, or scientists to do conservation. The indirect impacts of misplaced conservation arise from (*i*) misallocating of resources, (*ii*) misinforming supporters, (*iii*) alienating partners, and (*iv*) delegitimizing evidence. These actions are not mutually exclusive and can combine to influence conservation outcomes (**Table 1**). For example, this misallocating resources can lead to a direct loss of biodiversity (Bottrill et al. 2008; Gilbert et al. 2020) or the misuse of evidence can entrench alienization of potential partners (Hodgson et al. 2019).

Directly harming biodiversity

Misplaced conservation can arise when an action intended to enhance biodiversity has a direct and negative impact on a wild population, species, or ecological community (**Table 1**). For example, domestic sheep (*Ovis aries*) were removed from a private ranch ahead of the area's forthcoming designation as Patagonia National Park, Chile (Wittmer et al. 2013). A primary motivation to create this protected area was to conserve populations of huemul deer (*Hippocamelus bisulcus*). However, by removing an important prey item (i.e., sheep) for local carnivores (*Vulpes* spp. and *Puma concolor*), predation rates on native deer species increased. The well-intentioned action of creating a more "pristine" environment to benefit huemel deer accelerated their decline.

In another case of direct harm, members of the public planted a species of milkweed to help provide habitat for monarch butterflies (Wade 2015). However, some people used a milkweed species that is not native to the temperate species range of monarch butterflies. As a result, monarchs interrupted their migration and were exposed to higher rates of egg parasites. Exposure to this non-native milkweed created a direct threat to monarchs (Satterfield et al. 2015).

Lastly, kokanee salmon (*Oncorhynchus nerka*) stocks in Okanagan Lake, British Columbia, were declining through the 1950s (Shepherd 1999). The planned introduction of the exotic mysid shrimp (*Mysis relicta*) in 1966 was intended to provide productive forage for the native salmon with the intention of bolstering the fishery. However, shrimp were able to escape predation from salmon through diel migration through the water column and then compete with juvenile kokanee for plankton. As a result, the introduction of mysid shrimp reduced forage for juvenile salmon, reducing recruitment, and directly hastening the decline of the salmon fishery. Consequently, there have been calls for the application of additional, costly control measures to lower mysid numbers (Shepherd 1999).

The well-intentioned but misplaced effort to conserve biodiversity may exacerbate declines. Efforts to bolster evidence through pilot studies and adaptive management and to improve the uptake of evidence in policy through cooperative approaches in decision-making are needed to minimize the prevalence of direct misplaced conservation.

Misallocating resources

It is a common experience for people working in conservation to operate with under-supported resources. These resources include funding, time, volunteer effort, media attention, or social or political capital. Misplaced conservation occurs when such fixed and limited resources are misallocated to issues that have minimal gains for biodiversity (**Table 1**). This misallocation of resources makes it more difficult to act upon higher priority action because fewer resources are then available.

Table 1. Case studies involving misplaced conservation.

System	Description	Actions leading to misplaced conservation					Reference
		Direct decline	Misallocated resources	Confused public	Alienated partners	Delegitimized evidence	
Bumblebees and honey bees	Policies to curb neonicotinoid use and promote managed honey bees will have negligible benefits and increase threats for at-risk bumblebees. Major threat not addressed.	■	■	■	■		Dicks 2013; Geldmann and González-Varo 2018; Alger et al. 2019
Grizzly bear hunting	Ban on bear hunting did not address the primary threats to bear populations.		■	■	■	■	Bellringer 2017
Shark petitions	Citizen-driven, nonexpert led petitions target issues peripheral to drivers of shark decline.		■	■			This paper
Huemul deer and national parks	Removal of domestic livestock led to increased predation on huemul deer—the species targeted for enhancement.	■					Wittmer et al. 2013
Proportional protected area targets	Areal-based protected area targets overlook the functional roles of the landscape/seascape. Areas of low productivity or weak governance contribute towards requirements of international treaties while failing to change the trajectory of human impacts within designated areas.		■	■			Barnes et al. 2018
Polar bears and climate change	Putative uncertainty in the effects of climate change on sea ice and the status of polar bears delegitimizes the science underpinning polar bear ecology.			■		■	Harvey et al. 2018
Wildlife tourism attractions	Putative conservation benefits of exposing tourist to captive animals are not borne out by data, leading to compromised animal welfare and greenwashing of conservation gains.			■		■	Moorhouse et al. 2015, 2017; White 2017
Feral cats and urban birds	Putative uncertainty in the effects of free-roaming cats on urban bird populations undermines evidence-based conservation action.			■	■	■	Loss and Marra 2018
Ocean pollution cleanup	Proposed approach to remove ocean garbage using a large collector machine may confuse the public as to its efficacy and destroy marine life.	■	■	■			Jambeck et al. 2015
Trophy hunting in Africa	Efforts to ban trophy hunting of lions for animal welfare conservation overlooks the economic benefits to local communities and diverts funding for population conservation.		■		■	■	Di Minin et al. 2016; Naidoo et al. 2016; Angula et al. 2018

(*continued*)

Table 1. (*concluded*)

System	Description	Actions leading to misplaced conservation					Reference
		Direct decline	Misallocated resources	Confused public	Alienated partners	Delegitimized evidence	
Militarization to reduce illegal harvest	Countering illegal wildlife harvest using a militarized "war on poachers" approach diverts resources from addressing the underlying socio-economic drivers that motivates the hunters.				■		Duffy 2014; Bocarejo and Ojeda 2016; Duffy et al. 2016
Ex situ rhino conservation	Proposal to conduct ex situ conservation of African rhinos in Australia diverts resources from community-involved in situ efforts and does nothing to enhance rhino population growth within the species range.		■	■		■	Hayward et al. 2018
Stream restoration for salmonids	Use of in-stream structural augmentation of streams does little to enhance population growth of salmonids and diverts resources from actions, like riparian management, that are more effective at enhancing habitat quality.		■	■			Stewart et al. 2009
Monarchs and milkweed	Monarchs require milkweed for habitat, but people have planted the wrong species, which increase the exposure of monarchs to disease. Attention to plight of Monarchs has increased people wanting to captive breed them, which has increased stressors.	■	■	■			Wade 2015
Captive monarch rearing	Amateur rearing and release of monarch butterflies is disrupting migratory behavior of wild populations.	■		■			Tenger-Trolander et al. 2019
Protected areas increase illegal hunting	Greater illegal harvest rates were observed inside parks than in surrounding areas.	■		■			Rauset et al. 2016
Alternative facts and vaquita conservation	Unsubstantiated claims about vaquita are delaying critical conservation efforts and distracting from real threats.	■	■	■	■	■	Rojas-Bracho et al. 2019
Ocean plastics	Pollution in the marine environment is seen as distracting attention from graver threats to biodiversity.		■				Bonebrake et al. 2019; Stafford and Jones 2019
Positive effects of habitat fragmentation	Forty years of evidence indicating that habitat fragmentation can lead to positive effects on biodiversity has be ignored, leading to misguided advice in conservation.	■				■	Fahrig 2017
Mysid shrimp introduction for salmon	Non-native shrimp were added to Okanagan Lake to bolster fish stocks, but ended up outcompeting juvenile fish and hastened their decline.	■					Shepherd 1999

Note: ■ = presence of action in the case.

Misallocating resources has often occurred when conservation agencies decide which species to prioritize for recovery or enhanced management. Species recovery efforts are often targeted at a subset of species under threat—this subset may have a higher "profile" (i.e., is more charismatic) and a lower threat profile than other species. Consequently, species with a lower public profile are under-resourced (Donaldson et al. 2016). In some cases, habitat protection for less-charismatic species can be far more cost-effective approach to restoring biodiversity than efforts focused exclusively on high-profile species (Neeson et al. 2018).

Similarly, the rise of individually focused conservation outcomes, or "compassionate conservation" (Ramp and Bekoff 2015) pulls resources away from more proximate causes of species or population decline to serve the welfare outcomes of individual animals, usually from a limited subset of large charismatic species (Hayward et al. 2019; Oommen et al. 2019). While animal welfare is embodied in many aspects of wildlife management and research, it is often unstated how attention given to the fate of individuals elevates the conservation of a species, population, or community. For example, many people were upset when "Cecil" the lion was killed by a hunter in 2015, yet policy reforms to support lion conservation have moved little since that time (Carpenter and Konisky 2019). Still, the legacy of Cecil's death remains a rallying cry for some conservation groups (Darimont et al. 2020). Efforts to address the negative impacts of habitat loss, invasive species, or human–wildlife conflict through compassionate conservation approaches would make unavailable some of the most cost-effective and successful tools developed to preserve and restore biodiversity (Callen et al. 2020).

To minimize the misallocation of resources, there either needs to be better use of existing allocations, or more resources, and preferably both (Bonebrake et al. 2019). To improve use of existing allocations, conservationists have put forward prioritization schemes to quantify tradeoffs in decision-making (Martin et al. 2018). In some cases, such priority allocation could lead to the loss of some components of biodiversity, but preserve a larger, more valued component (Gilbert et al. 2020). This so-called "conservation triage" has been hotly contested (Bottrill et al. 2008), but until resources are enhanced, there will likely remain a need to prioritize allocations in a world of finite resources.

While we argue there is no "most correct" conservation action that inherently deserves priority resource allocation, a more transparent, evidence-based and cooperative decision-making process should at least reveal tradeoffs in resource use. Questions of whose priority matters the most are critical to resolving allocation in a just and equitable manner. As such, the underlying human dimensions of conservation governance are central to mobilizing cooperative approaches to evidence-based decision-making (Decker et al. 2016).

Misinforming supporters

Misplaced conservation outcomes can arise when the public is misinformed about which threats are most pressing, which species are a priority for action, and (or) which actions are most beneficial for biodiversity (**Table 1**). A misinformed public also diverts resources away from actions that benefit conservation. For example, in the 2010s, a series of amateur-made online petitions to ban shark finning in Florida (USA) attracted tens of thousands of signatures. However, shark finning was banned in Florida in 1994, such that these petitions cannot possibly achieve their stated goal. These "finning" campaigns also contribute to the misunderstanding of threats facing sharks by incorrectly suggesting that the shark fin trade is the only threat these animals face (Shiffman and Hueter 2017). In contrast, government-sponsored (e.g., National Oceanographic and Atmospheric Administration (NOAA), a Federal agency that houses the National Marine Fisheries Service agency (NMFS)) petitions that would lead to tangible policy directions receive little attention. For example, three recent and evidenced-based proposals aimed to improve the sustainability of fisheries: an 2016 NMFS proposal to modify recreational angling regulations for threatened dusky sharks (81 FR 71672), a 2017

proposal to alter the US-Atlantic coast shark fishing season (82 FR 55512), and a 2017 proposal to require tuna fishing vessels to release threatened sharks that they capture (82 FR 56177). None of these petitions received substantial public support or commentary (only 87, 13, and 1 comment(s) were posted, respectively).

Similar to the case of using non-native milkweed to help monarch butterflies, recent awareness of pollinator conservation has focused largely on campaigns to "save the bees". However, confusion over how to best do this has been impeded by the conflation of native pollinators and managed, non-native bees (Dicks 2013). Managed bees contribute to the decline of native biodiversity via pathogen spillover and competition for floral nectar (Colla and MacIvor 2017). Broadscale policies to conserve pollinators, such as the US-based Pollinator Partnership Action Plan, focus on land uses and pesticide bans that will benefit non-native honey bees at the expense of native bumblebee species (Nicholls et al. 2020). While wild honey bee conservation is a concern within its native range (Requier et al. 2019), misinformed support for such "insect livestock" and feral, non-native species across North America threatens native pollinators which are truly at risk of extinction (Dicks 2013).

Ocean plastics have emerged as a central issue in marine conservation. For example, "straw shaming"—even at the cost of infringing on the needs of people experiencing physical disabilities—is one extreme outcome of the plastic pollution response (Krueger 2019). However, technological solutions to remove ocean garbage (i.e., through surface skimming) may not target the areas of the ocean where most pollution occurs (i.e., at depth) (Stafford and Jones 2019). Like the nudging of decarbonization policy (Hagmann et al. 2019), contemporary approaches to plastic pollution may have created a "convenient truth to distract environmental policy from more serious and urgent threats" (Stafford and Jones 2019). Overcoming these distracting discourses in conservation will not only require effective science but also effective communication of knowledge to support behavioral changes.

As with the other dimensions of misplaced conservation, supporters become misinformed when evidence is not communicated clearly or used appropriately. Such misinformed support can be the outcome of conservation leadership failing to "do their homework" for how to best focus the efforts of people invested in positive outcomes for biodiversity. Efforts to better connect conservation biology and conservation social science (including communication science) are critical to channeling clear and accurate information to supporters (Kareiva and Marvier 2012; Bennett et al. 2017).

Alienating partners

Misplaced conservation can occur when the partners (groups or individuals) become alienated from a shared vision of success that was caused by, or results, in greater polarization. Alienation occurs when short-term gains are elevated over long-term benefits and when individual gains are elevated over collective benefits, giving rise to conservation social dilemmas (Cumming 2018) or conservation conflict (Redpath et al. 2013). While alienation may result from different value systems held by conservation partners and the perceptions of inequity (i.e., superiority) in those value systems relative to others (Saunders et al. 2006; Manfredo et al. 2017), the outcome is disrupted partnerships. For example, hunting, animal welfare, and conservation organizations may not share the same ethical, instrumental, or utilitarian values towards wildlife, yet all of these groups advocate for better conservation outcomes for wildlife (Butler et al. 2003; Treves 2009; Dickman et al. 2019). When these groups are pitted against one another over a subset of values (e.g., consumptive use of wildlife; evidence vs. anecdote; science vs. emotion), it generates conflict and weakens their collective ability to affect change on commonly shared values (e.g., the persistence of wildlife populations) (Redpath et al. 2017). Given the importance of partnerships in achieving conservation success (McNeely 1995; Cooke et al. 2020), efforts that disrupt partnerships can have dire and long-lasting consequences.

One common way alienation manifests is through geopolitical structures that are decoupled from diverse value systems and worldviews. As in many countries, people in rural Sweden had a more favorable view of lethal approaches to human–wildlife conflict than people in urban areas (Gangaas et al. 2013). Urban populations can influence policy on human–wildlife conflict policy without facing the proximate consequences of loss of safety, interruption of livelihood, or damage to property (Ericsson and Heberlein 2003). Rural residents may therefore act outside of regulations (Gangaas et al. 2013) unless given more appropriate tools and resources to resolve conflict with wildlife (König et al. 2020). Similarly, Indigenous perspectives in conservation often are alienated by colonial governments. Recently, The Tahltan Nation in British Columbia offered bounties for grizzly bear and wolf harvest following a province-wide ban on grizzly bear hunting—which the Tahltan had vocally opposed (Simmons 2020). The persistence of stakeholder conflict, unregulated actions, and centralized or colonial decision-making makes it more difficult to conserve biodiversity for rural, urban, and Indigenous people.

The emergence of alienated partners speaks clearly to the role of cooperation as an antidote to polarization. In some cases, evidence can help support or bring together groups in a cooperative manner and reduce polarization (Baynham-Herd et al. 2020; Williams et al. 2020). However, science can also become "weaponized" by all sides in public debate, such that more information will not always generate better decisions (Peery et al. 2019). Instead of conflating conservation with a "data gap" per se, efforts to improve processes that lead to better decisions (i.e., in a manner the improves stakeholder or public support) may be needed to overcome the alienation of partners and increase the success of conservation actions.

Delegitimizing evidence

Misplaced conservation can arise when the products (i.e., facts) and generators (i.e., scientists) of evidence are delegitimized in the political or decision-making realm (**Table 1**). Here, we refer to evidence in the context of biological and social "western science", and recognize that there are other systems that create, hold, and share knowledge (e.g., Indigenous knowledge) that make important contributions towards conservation (Garnett et al. 2018) and also face delegitimization.

Delegitimization may arise when scientists representing different world views, or interpretations of data, come into debate over a policy. The perception of scientific uncertainty is then exploited to undermine conservation outcomes. When decision-makers or the public perceive a lack of scientific consensus, it undermines the value of evidence and confidence in evidence-based decision-making (Lewandowsky et al. 2013). For example, special interest groups may inflate perceptions of uncertainty, via doubt mongering, in a practice that has been seen in polar bear conservation (Harvey et al. 2018), the impact of free ranging cats on biodiversity (Loss and Marra 2018), and responses to climate change (Oreskes and Conway 2011).

In some cases, delegitimization may arise from competing interests in the uptake of certain types of information, rather than a lack of information per se. "Whose science matters" becomes central to these debates and evidence may reinforce, rather than neutralize, polarization among groups (Hodgson et al. 2019). Such debates have been documented in raptor conservation (Hodgson et al. 2019), deer management (Freddy et al. 2004), bear hunting (Majić et al. 2011), and climate change (Hayhoe 2018). Peery et al. (2019) described the challenge of agenda-driven science in conservation: "because conservation conflicts in an increasingly polarized world might tempt some to engage in agenda-driven science to win a conflict."

Finally, scientists may delegitimize their own contributions to positive conservation outcomes. Unlike fundamental scientific disciplines, conservation sciences actively encourage the blending of

curiosity-driven, basic research with mission-oriented applied research and advocacy (Horton et al. 2016; Smol 2018). Conservation scientists often engage in public discourse and play an important role in disseminating facts to the public, stakeholders, and decision-makers (Chan 2008; Smol 2018). However, conservation scientists risk depleting the credibility of the research community in general if values and facts are conflated (Horton et al. 2016; Redpath et al. 2017). Indeed, as Baynham-Herd et al. (2020) showed, trustworthiness of intervenors is seen as a key predictor of cooperation in conservation with integrity ranking as a key dimension of how trust is built. For this reason, transparency in the facts (i.e., scientific consensus) vs. the expressed values of the scientist require clear articulation. As Chan (2008) argued, conservation scientists must clearly communicate where the facts stop and where their own values begin, or they risk abusing goodwill and trust towards science and its practitioners.

What people can do to avoid misplaced conservation

To avoid or mitigate misplaced conservation efforts, we recommend that more effort be made to adopt an intentional, transparent process of decision-making that accounts for the gains and losses to both cooperation and biodiversity (Saunders et al. 2006). While this effort may at first appear to be conservation dictum, we underscore that cooperation has too often taken a back seat to short-term gains in biodiversity. Finding pathways cooperation, in spite of knowledge gaps and differences in attitudes or beliefs, remains an essential and yet understudied tool in formal conservation education and training (Cinner 2018). Rather than try to change or undermine the values of potential partners, it is usually more effective to find alignment with the existing values of conservation partners (Decker et al. 2016; Manfredo et al. 2017; Hayhoe 2018). Seeing conservation efforts as a push towards better cooperation and use of evidence is one way to suppress the negative effects of polarization and misinformation.

Scientists and managers should invest in (and be supported to do so) efforts to monitor the outcomes of conservation action, then interpret, share, and respond adaptively to evidence as it accrues. Such an "adaptive management" approach is often discussed in conservation but not clearly executed (Keith et al. 2011). For example, recent efforts to ban (British Columbia, Canada in 2017) or restore (in Wyoming, USA) grizzly bear hunting have focused on ethics and individual welfare; however, there has been little or no advocacy by conservation groups to create processes that quantify the impacts of these policy changes on bear populations and the people who must co-exist with them. Adaptive management as a means of understanding and solving conservation problems is vulnerable to many of the same challenges faced in misplaced conservation writ large, with self interest, conflicts, and deliberate overconfidence in data serving to undermine management goals (Walters 1997).

Reducing uncertainty is a central goal of evidence-based decision-making, yet progress in science is often nonlinear and unpredictable. Debate and paradigm shifts are a normal and important part of the scientific process (Kuhn 2012). Conservation science is no different, with some debates unresolved after decades of research (Young et al. 2010). As such, we do not suggest that conservation scientists should abandon productive and civil debates about science generally or conservation specifically, but we hope that such debates will focus on critical and transparent analysis of data, analyses, techniques, and interpretations, rather than a critique of scientists or the inferred motivations or values of potential conservation partners.

Conservation actions often are motivated by perceptions of scarcity and imbue a sense of urgency—the time to act is "now". However, the risks that come from passionate, but misinformed, people advocating for preferred policy outcomes that misalign with evidence can be high. Cooperation, as antidote to extinction, needs to transcend the roles played by people concerned with biodiversity, of which scientists are but a limited sector. Many groups (e.g., public, experts, scientists, governments,

Table 2. Research needs to identify the causes of and approaches to reduce misplaced conservation.

Theme	Understanding the causes of misplaced conservation	Mitigating the occurrence of misplaced conservation
Evidence-related process	• How does misinformation related to conservation issues arise and spread? • How much evidence and of what quality is enough to make sound decisions? • What are the reasons that individuals and organizations engage in deliberate efforts to disrupt conservation actions?	• How can scientists communicate competing lines of evidence to the public without undermining credibility or "doubt mongering"? • How do we communicate failures and uncertainty in conservation without undermining credibility? • What can be done to prevent or correct the spread of misinformation? • How can scientists develop better social and ecological "pilot studies" to minimize risk of unintended outcomes for biodiversity?
Cooperation-related processes	• How does the psychology of polarization and misinformation contribute to decision making? • What prevents people from seeking appropriate or updating new evidence in the decision-making process? • Where does proximate and ultimate responsibility for decision making rest for complex, multi-actor processes?	• What are the best ways of achieving consensus or reasonable compromise related to conservation problems? • What are the best strategies for preventing partners from becoming alienated, given that not all groups share the same degree of legitimacy in decision-making? • How can diverse ethical or moral dimensions of conservation be brought together for a common vision of success?

and conservation organizations) are responsible for promoting the importance of biodiversity and acting to averting loss. For this reason, it is not necessary for every concerned member of the public to know every technical detail and nuance of complex environmental problems, nor the policies that can help address them. Nonexperts can help by joining, or working to amplify the message of, expert-led and evidence-based conservation campaigns. Nonexperts can also volunteer their time or help raise funds for expert-driven campaigns, or they can write to decision-makers expressing support for (or opposition to) policies as recommended by experts. Ultimately, people should consider that without specific knowledge, training, or experience, that there are real risks to people and biodiversity if ineffective solutions are promoted to resolve complex problems.

In addition to cooperation across levels of "expertise", efforts to promote cooperation across backgrounds and identities has demonstrated positive outcomes for science. Conservation actions stemming from diverse and inclusive processes that include a variety of views and experiences should produce the best outcomes. For example, greater gender diversity on research teams leads to more productive scientific outcomes, in addition to the benefits of creating more equitable workspaces (Nielsen et al. 2017). Likewise, integrating local and macro-scale institutions is a critical step towards recognizing the diversity of power, scope, and governance structures that affect biodiversity (Berkes 2007; Popp et al. 2019). Including local peoples in decision-making increases their agency over resources and should increase acceptance of any changes to their daily lives that come from conservation actions.

An important vehicle for cooperation is open, transparent, and respectful communication with all relevant partners (Lundquist and Granek 2005). Stakeholders and rights holders who believe that

regulations were developed in a reasonable, fair manner that incorporates collective priorities are more likely to follow resulting regulations and laws (Kennedy 2010; Dressel et al. 2020). Likewise, when stakeholders feel like they and their concerns are being ignored, they are more likely to ignore the resulting regulations (Suman et al. 1999; Freddy et al. 2004). Shiffman (2020) documented how strategically communicating key scientific facts and science-based policy solutions resulted in passing new environmental regulations while minimizing inter-stakeholder conflicts.

Social media has transformed how people communicate with one another, a transformation that has important implications for both environmental advocacy and for conservation scientists who wish to engage in public outreach (Parsons et al. 2014; Lamb et al. 2018; Smol 2018). This transformation may not always result in positive gains for biodiversity (i.e., via the spread of misinformation; Vosoughi et al. (2018)); nonetheless, social media is a powerful form of intervention and feedback. When used well, social media also has the potential to infuse public discourse with expert-supported approaches to conservation and pushback on misinformation (Thaler and Shiffman 2015; Shiffman 2020). In addition, scientists can now hear the concerns people are expressing on social media about biodiversity-related policies and this, in turn, can help design more cooperative approaches to conservation and nuanced communication strategies. This insight needs to be contextualized of course, as the media channels available to a scientist are constructed through the same biased algorithms as the information leading from the scientist to the public.

The liability of misinformation in conservation

As much as there are positive steps people can take to reduce misplaced conservation, acting poorly can make a bad situation worse. There is a need for conservation scientists to acknowledge that people trying to help is not the same as helping, and good intentions do not excuse easily foreseen or managed harm. Case studies of misplaced conservation often highlight people who wanted to help but may have not foreseen the myriad outcomes of their actions. However, conservation decisions affect the existence of species, peoples' livelihoods, or the intactness of cultures—the onus on better decision-making leaves little room for error (Foote and Wenzel 2009). Misplaced conservation asks scientists and stakeholders to acknowledge that outcomes—rather than intentions—are the arbitrator of conservation success.

Society has enshrined into law the concept of negligence to help guide responsible behaviour when the outcomes were reasonably anticipated. For example, driving while intoxicated is against the law in many places because it is a known and well-established risk to public safety—the intentions of the driver (e.g., to get home) are not at issue. There often are no explicit laws to protect against misplaced conservation (i.e., excluding environmental regulations) and this is unlikely to occur. However, there is a need to better hold people involved in making conservation decisions accountable for their role in promoting polarization and misinformation.

Conclusion

The benefits of cooperative and evidence-based approaches to conservation are well described and are generally regarded as essential for achieving conservation gains (Keith et al. 2011). These approaches build policy with evidence and integrate wholistic dimensions of conservation practice—including the roles of governance, politics, social justice, and fundamental ecology. Yet, the adoption of these concepts is far from universal practice. There is a need to better understand and then address the practices that run counter to the body of knowledge that has described pathways to effective conservation practice (**Table 2**).

Society is witnessing one of the largest and most rapid mobilizations of scientific focus and public policy in history in response to the COVID-19 pandemic. Along with the urgency and scope of this crisis, lessons are quickly emerging about the critical role of scientific integrity and accountability and the need for accurate communication between science, policy, and the public (Piller 2020). Conservation science will benefit from these lessons as society continues to cope with accelerating global extinctions. Articulating the mechanisms of, and solutions, to misplaced conservation will help ensure that efforts to restore and protect biodiversity are successful.

Acknowledgements

ATF and SJC were supported by the Canada Research Chairs Program. CTL was supported by a Vanier Canada Graduate Scholarship and a Wildlife Conservation Society W. Garfield Weston Fellowship. The National Sciences and Engineering Research Council (NSERC) supported contributions by ATF, SJC, and SRC. The SSHRC supported JP. NJS was supported by the "Beyond Moose" programme of the Swedish Environmental Protection Agency—Naturvårdsverket. The Liber Ero Fellowship Program supported DS and JP. We thank S. Otto and A. Derocher for comments on an earlier version of this paper.

Author contributions

ATF, AHA, SRC, SJC, CTL, JP, DSS, and NJS conceived and designed the study. ATF, AHA, SRC, SJC, CTL, JP, DSS, and NJS drafted or revised the manuscript.

Competing interests

The authors have declared that no competing interests exist.

Data availability statement

All relevant data are within the paper.

References

Alger SA, Burnham PA, Boncristiani HF, and Brody AK. 2019. RNA virus spillover from managed honeybees (*Apis mellifera*) to wild bumblebees (*Bombus* spp.). PLoS ONE, 14: e0217822. PMID: 31242222 DOI: 10.1371/journal.pone.0217822

Anderegg WRL, Prall JW, Harold J, and Schneider SH. 2010. Expert credibility in climate change. Proceedings of the National Academy of Sciences of the United States of America, 107: 12107–12109. PMID: 20566872 DOI: 10.1073/pnas.1003187107

Angula HN, Stuart-Hill G, Ward D, Matongo G, Diggle RW, and Naidoo R. 2018. Local perceptions of trophy hunting on communal lands in Namibia. Biological Conservation, 218: 26–31. DOI: 10.1016/j.biocon.2017.11.033

Bail CA, Argyle LP, Brown TW, Bumpus JP, Chen H, Hunzaker MBF, et al. 2018. Exposure to opposing views on social media can increase political polarization. Proceedings of the National Academy of Sciences of the United States of America, 115: 9216–9221. PMID: 30154168 DOI: 10.1073/pnas.1804840115

Barber M, and McCarty N. 2015. Causes and consequences of polarization. *In* Political negotiation: a handbook. Vol. 37, pp. 39–43.

Barnes MD, Glew L, Wyborn C, and Craigie ID. 2018. Prevent perverse outcomes from global protected area policy. Nature Ecology & Evolution, 2: 759–762. PMID: 29556080 DOI: 10.1038/s41559-018-0501-y

Baynham-Herd Z, Redpath S, Bunnefeld N, and Keane A. 2020. Predicting intervention priorities for wildlife conflicts. Conservation Biology, 34: 232–243. PMID: 31237026 DOI: 10.1111/cobi.13372

Bellringer C. 2017. An independent audit of grizzly bear management. Auditor General of British Columbia, Victoria, British Columbia.

Bennett NJ, Roth R, Klain SC, Chan K, Christie P, Clark DA, et al. 2017. Conservation social science: understanding and integrating human dimensions to improve conservation. Biological Conservation, 205: 93–108. DOI: 10.1016/j.biocon.2016.10.006

Berkes F. 2007. Community-based conservation in a globalized world. Proceedings of the National Academy of Sciences of the United States of America, 104: 15188–15193. PMID: 17881580 DOI: 10.1073/pnas.0702098104

Biddle JB, and Leuschner A. 2015. Climate skepticism and the manufacture of doubt: can dissent in science be epistemically detrimental? European Journal for Philosophy of Science, 5: 261–278. DOI: 10.1007/s13194-014-0101-x

Bocarejo D, and Ojeda D. 2016. Violence and conservation: beyond unintended consequences and unfortunate coincidences. Geoforum, 69: 176–183. DOI: 10.1016/j.geoforum.2015.11.001

Bonebrake TC, Guo F, Dingle C, Baker DM, Kitching RL, and Ashton LA. 2019. Integrating proximal and horizon threats to biodiversity for conservation. Trends in Ecology & Evolution, 34: 781–788. PMID: 31130317 DOI: 10.1016/j.tree.2019.04.001

Bottrill MC, Joseph LN, Carwardine J, Bode M, Cook C, Game ET, et al. 2008. Is conservation triage just smart decision making? Trends in Ecology & Evolution, 23: 649–654. PMID: 18848367 DOI: 10.1016/j.tree.2008.07.007

Brown MJ, and Havstad JC. 2017. The disconnect problem, scientific authority, and climate policy. Perspectives in Science, 25: 67–94. DOI: 10.1162/POSC_a_00235

Butler JS, Shanahan J, and Decker DJ. 2003. Public attitudes toward wildlife are changing: a trend analysis of New York residents. Wildlife Society Bulletin, 31: 1027–1036. DOI: 10.2307/3784448

Callen A, Hayward MW, Klop-Toker K, Allen BL, Ballard G, Broekhuis F, et al. 2020. Envisioning the future with 'compassionate conservation': an ominous projection for native wildlife and biodiversity. Biological Conservation, 241: 108365. DOI: 10.1016/j.biocon.2019.108365

Carpenter S, and Konisky DM. 2019. The killing of Cecil the Lion as an impetus for policy change. Oryx, 53: 698–706. DOI: 10.1017/S0030605317001259

Chan KMA. 2008. Value and advocacy in conservation biology: crisis discipline or discipline in crisis? Conservation Biology, 22: 1–3. PMID: 18254846 DOI: 10.1111/j.1523-1739.2007.00869.x

Cinner J. 2018. How behavioral science can help conservation. Science, 362: 889–890. PMID: 30467154 DOI: 10.1126/science.aau6028

Colla SR, and MacIvor JS. 2017. Questioning public perception, conservation policy, and recovery actions for honeybees in North America. Conservation Biology, 31: 1202–1204. PMID: 27624856 DOI: 10.1111/cobi.12839

Cooke SJ, Rytwinski T, Taylor JJ, Nyboer EA, Nguyen VM, Bennett JR, et al. 2020. On "success" in applied environmental research—what is it, how can it be achieved, and how does one know when it has been achieved? Environmental Reviews, 28: 357–372. DOI: 10.1139/er-2020-0045

Cumming GS. 2018. A review of social dilemmas and social-ecological traps in conservation and natural resource management. Conservation Letters, 11: e12376. DOI: 10.1111/conl.12376

Darimont CT, Genovali C, and Paquet PC. 2020. Takaya the grey wolf will become B.C.'s Cecil the lion. Globe Mail.

Decker D, Smith C, Forstchen A, Hare D, Pomeranz E, Doyle-Capitman C, et al. 2016. Governance principles for wildlife conservation in the 21st century. Conservation Letters, 9: 290–295. DOI: 10.1111/conl.12211

Di Minin E, Leader-Williams N, and Bradshaw CJA. 2016. Banning trophy hunting will exacerbate biodiversity loss. Trends in Ecology & Evolution, 31: 99–102. PMID: 26746807 DOI: 10.1016/j.tree.2015.12.006

Dickman A, Cooney R, Johnson PJ, Louis MP, and Roe D. 2019. Trophy hunting bans imperil biodiversity. Science, 365: 874. PMID: 31467215 DOI: 10.1126/science.aaz0735

Dicks L. 2013. Bees, lies and evidence-based policy. Nature, 494: 283. PMID: 23426287 DOI: 10.1038/494283a

Donaldson MR, Burnett NJ, Braun DC, Suski CD, and Hinch SG. 2016. Taxonomic bias and international biodiversity conservation research. FACETS, 1: 105–113. DOI: 10.1139/facets-2016-0011

Dressel S, Johansson M, Ericsson G, and Sandström C. 2020. Perceived adaptive capacity within a multi-level governance setting: the role of bonding, bridging, and linking social capital. Environmental Science & Policy, 104: 88–97. DOI: 10.1016/j.envsci.2019.11.011

Duffy R. 2014. Waging a war to save biodiversity: the rise of militarized conservation. International Affairs, 90: 819–834. DOI: 10.1111/1468-2346.12142

Duffy R, St John FAV, Büscher B, and Brockington D. 2016. Toward a new understanding of the links between poverty and illegal wildlife hunting. Conservation Biology, 30: 14–22. PMID: 26332105 DOI: 10.1111/cobi.12622

Dunn ME, Mills M, and Veríssimo D. 2020. Evaluating the impact of the documentary series *Blue Planet II* on viewers' plastic consumption behaviors. Conservation Science and Practice, 2: e280. DOI: 10.1111/csp2.280

Ericsson G, and Heberlein TA. 2003. Attitudes of hunters, locals, and the general public in Sweden now that the wolves are back. Biological Conservation, 111: 149–159. DOI: 10.1016/S0006-3207(02)00258-6

Fahrig L. 2017. Forty years of bias in habitat fragmentation research. *In* Effective conservation science: data not dogma. *Edited by* P Kareiva, M Marvier, and B Silliman. Oxford University Press, Oxford, UK. pp. 32–38. DOI: 10.1093/oso/9780198808978.003.0005

Foote L, and Wenzel GW. 2009. Polar bear conservation hunting in Canada: economics, culture and unintended consequences. *In* Inuit, polar bear and sustainable use: local, national and international perspectives. *Edited by* MMR Freeman and L Foote. CCI Press, Edmonton, Alberta. pp. 13–24.

Freddy DJ, White GC, Kneeland MC, Kahn RH, Unsworth JW, deVergie WJ, et al. 2004. How many mule deer are there? Challenges of credibility in Colorado. Wildlife Society Bulletin, 32: 916–927. DOI: 10.2193/0091-7648(2004)032[0916:hmmdat]2.0.co;2

Gangaas KE, Kaltenborn BP, and Andreassen HP. 2013. Geo-spatial aspects of acceptance of illegal hunting of large carnivores in Scandinavia. PLoS ONE, 8: e68849. PMID: 23894353 DOI: 10.1371/journal.pone.0068849

Garnett ST, Burgess ND, Fa JE, Fernández-Llamazares Á, Molnár Z, Robinson CJ, et al. 2018. A spatial overview of the global importance of Indigenous lands for conservation. Nature Sustainability, 1: 369–374. DOI: 10.1038/s41893-018-0100-6

Geldmann J, and González-Varo JP. 2018. Conserving honey bees does not help wildlife. Science, 359: 392–393. PMID: 29371456 DOI: 10.1126/science.aar2269

Gilbert SL, Broadley K, Doran-Myers D, Droghini A, Haines JA, Hämäläinen A, et al. 2020. Conservation triage at the trailing edge of climate envelopes. Conservation Biology, 34: 289–292. PMID: 31348540 DOI: 10.1111/cobi.13401

Hagmann D, Ho EH, and Loewenstein G. 2019. Nudging out support for a carbon tax. Nature Climate Change, 9: 484–489. DOI: 10.1038/s41558-019-0474-0

Harvey JA, Van Den Berg D, Ellers J, Kampen R, Crowther TW, Roessingh P, et al. 2018. Internet blogs, polar bears, and climate-change denial by proxy. BioScience, 68: 281–287. PMID: 29662248 DOI: 10.1093/biosci/bix133

Hayhoe K. 2018. When facts are not enough. Science, 360: 943. PMID: 29853662 DOI: 10.1126/science.aau2565

Hayward MW, Ripple WJ, Kerley GIH, Landman M, Plotz RD, and Garnett ST. 2018. Neocolonial conservation: is moving rhinos to Australia conservation or intellectual property loss. Conservation Letters, 11: e12354. DOI: 10.1111/conl.12354

Hayward MW, Callen A, Allen BL, Ballard G, Broekhuis F, Bugir C, et al. 2019. Deconstructing compassionate conservation. Conservation Biology, 33: 760–768. PMID: 31206825 DOI: 10.1111/cobi.13366

Hmielowski JD, Feldman L, Myers TA, Leiserowitz A, and Maibach E. 2014. An attack on science? Media use, trust in scientists, and perceptions of global warming. Public Understanding of Science, 23: 866–883. PMID: 23825287 DOI: 10.1177/0963662513480091

Hodgson ID, Redpath SM, Fischer A, and Young J. 2019. Who knows best? Understanding the use of research-based knowledge in conservation conflicts. Journal of Environmental Management, 231: 1065–1075. PMID: 30602230 DOI: 10.1016/J.JENVMAN.2018.09.023

Horton CC, Peterson TR, Banerjee P, and Peterson MJ. 2016. Credibility and advocacy in conservation science. Conservation Biology, 30: 23–32. PMID: 26041036 DOI: 10.1111/cobi.12558

Jambeck JR, Geyer R, Wilcox C, Siegler TR, Perryman M, Andrady A, et al. 2015. Plastic waste inputs from land into the ocean. Science, 347: 768–771. PMID: 25678662 DOI: 10.1126/science.1260352

Kareiva P, and Marvier M. 2012. What is conservation science? BioScience, 62: 962–969. DOI: 10.1525/bio.2012.62.11.5

Keith DA, Martin TG, McDonald-Madden E, and Walters C. 2011. Uncertainty and adaptive management for biodiversity conservation. Biological Conservation, 144: 1175–1178. DOI: 10.1016/j.biocon.2010.11.022

Kennedy AL. 2010. Using community-based social marketing techniques to enhance environmental regulation. Sustainability, 2: 1138–1160. DOI: 10.3390/su2041138

König HJ, Kiffner C, Kramer-Schadt S, Fürst C, Keuling O, and Ford AT. 2020. Human–wildlife coexistence in a changing world. Conservation Biology, 34: 786–794. PMID: 32406977 DOI: 10.1111/cobi.13513

Krueger A. 2019. Do you really need a straw with that? New York Times.

Kuhn TS. 2012. The structure of scientific revolutions. 50th anniversary edition. University of Chicago Press, Chicago, Illinois.

Lamb CTCT, Gilbert SLSL, and Ford AT. 2018. Tweet success? Scientific communication correlates with increased citations in Ecology and Conservation. PeerJ, 6: e4564. PMID: 29666750 DOI: 10.7717/peerj.4564

Lazer DMJ, Baum MA, Benkler Y, Berinsky AJ, Greenhill KM, Menczer F, et al. 2018. The science of fake news. Science, 359: 1094–1096. PMID: 29590025 DOI: 10.1126/science.aao2998

Lewandowsky S, Gignac GE, and Vaughan S. 2013. The pivotal role of perceived scientific consensus in acceptance of science. Nature Climate Change, 3: 399–404. DOI: 10.1038/nclimate1720

Loss SR, and Marra PP. 2018. Merchants of doubt in the free-ranging cat conflict. Conservation Biology, 32: 265–266. PMID: 29377342 DOI: 10.1111/cobi.13085

Lundquist CJ, and Granek EF. 2005. Strategies for successful marine conservation: integrating socioeconomic, political, and scientific factors. Conservation Biology, 19: 1771–1778. DOI: 10.1111/j.1523-1739.2005.00279.x

Maher PJ, Igou ER, and van Tilburg WAP. 2018. Brexit, trump, and the polarizing effect of disillusionment. Social Psychological and Personality Science, 9: 205–213. DOI: 10.1177/1948550617750737

Majić A, Marino Taussig de Bodonia A, Huber D, and Bunnefeld N. 2011. Dynamics of public attitudes toward bears and the role of bear hunting in Croatia. Biological Conservation, 144: 3018–3027. DOI: 10.1016/j.biocon.2011.09.005

Manfredo MJ, Bruskotter JT, Teel TL, Fulton D, Schwartz SH, Arlinghaus R, et al. 2017. Why social values cannot be changed for the sake of conservation. Conservation Biology, 31: 772–780. PMID: 27757996 DOI: 10.1111/cobi.12855

Martin TG, Kehoe L, Mantyka-Pringle C, Chades I, Wilson S, Bloom RG, et al. 2018. Prioritizing recovery funding to maximize conservation of endangered species. Conservation Letters, 11: e12604. DOI: 10.1111/conl.12604

McNeely JA. 1995. Expanding partnerships in conservation. Island Press.

Moorhouse TP, Dahlsjö CAL, Baker SE, D'Cruze NC, and Macdonald DW. 2015. The customer isn't always right—conservation and animal welfare implications of the increasing demand for wildlife tourism. PLoS ONE, 10: e0138939. PMID: 26489092 DOI: 10.1371/journal.pone.0138939

Moorhouse TP, D'Cruze NC, and Macdonald DW. 2017. The effect of priming, nationality and greenwashing on preferences for wildlife tourist attractions. Global Ecology and Conservation, 12: 188–203. DOI: 10.1016/J.GECCO.2017.11.007

Naidoo R, Weaver LC, Diggle RW, Matongo G, Stuart-Hill G, and Thouless C. 2016. Complementary benefits of tourism and hunting to communal conservancies in Namibia. Conservation Biology, 30: 628–638. PMID: 26537845 DOI: 10.1111/cobi.12643

Neeson TM, Doran PJ, Ferris MC, Fitzpatrick KB, Herbert M, Khoury M, et al. 2018. Conserving rare species can have high opportunity costs for common species. Global Change Biology, 24: 3862–3872. PMID: 29654612 DOI: 10.1111/gcb.14162

Nicholls AA, Epstein GB, and Colla SR. 2020. Understanding public and stakeholder attitudes in pollinator conservation policy development. Environmental Science & Policy, 111: 27–34. DOI: 10.1016/j.envsci.2020.05.011

Nielsen MW, Alegria S, Börjeson L, Etzkowitz H, Falk-Krzesinski HJ, Joshi A, et al. 2017. Opinion: gender diversity leads to better science. Proceedings of the National Academy of Sciences of the United States of America, 114: 1740–1742. PMID: 28228604 DOI: 10.1073/pnas.1700616114

Oommen MA, Cooney R, Ramesh M, Archer M, Brockington D, Buscher B, et al. 2019. The fatal flaws of compassionate conservation. Conservation Biology, 33: 784–787. PMID: 30977162 DOI: 10.1111/cobi.13329

Oreskes N, and Conway EM. 2011. Merchants of doubt: how a handful of scientists obscured the truth on issues from tobacco smoke to global warming. Bloomsbury Publishing USA.

Paes-Sousa R, Millett C, Rocha R, Barreto ML, and Hone T. 2020. Science misuse and polarised political narratives in the COVID-19 response. The Lancet, 396: 1635–1636. PMID: 33091363 DOI: 10.1016/S0140-6736(20)32168-1

Parsons ECM, Shiffman DS, Darling ES, Spillman N, and Wright AJ. 2014. How twitter literacy can benefit conservation scientists. Conservation Biology, 28: 299–301. PMID: 24372742 DOI: 10.1111/cobi.12226

Peery MZ, Jones GM, Gutiérrez RJ, Redpath SM, Franklin AB, Simberloff D, et al. 2019. The conundrum of agenda-driven science in conservation. Frontiers in Ecology and the Environment, 17: 80–82. DOI: 10.1002/fee.2006

Piller C. 2020. Two elite medical journals retract coronavirus papers over data integrity questions. Science. DOI: 10.1126/science.abd1697

Popp JN, Priadka P, and Kozmik C. 2019. The rise of moose co-management and integration of Indigenous knowledge. Human Dimensions of Wildlife, 24: 159–167. DOI: 10.1080/10871209.2019.1545953

Proctor RN. 2012. The history of the discovery of the cigarette–lung cancer link: evidentiary traditions, corporate denial, global toll. Tobacco Control, 21: 87–91. PMID: 22345227 DOI: 10.1136/tobaccocontrol-2011-050338

Ramp D, and Bekoff M. 2015. Compassion as a practical and evolved ethic for conservation. BioScience, 65: 323–327. DOI: 10.1093/biosci/biu223

Rauset GR, Andrén H, Swenson JE, Samelius G, Segerström P, Zedrosser A, et al. 2016. National parks in northern Sweden as refuges for illegal killing of large carnivores. Conservation Letters, 9: 334–341. DOI: 10.1111/conl.12226

Redpath SM, Young J, Evely A, Adams WM, Sutherland WJ, Whitehouse A, et al. 2013. Understanding and managing conservation conflicts. Trends in Ecology & Evolution, 28: 100–109. PMID: 23040462 DOI: 10.1016/J.TREE.2012.08.021

Redpath SM, Linnell JDC, Festa-Bianchet M, Boitani L, Bunnefeld N, Dickman A, et al. 2017. Don't forget to look down—collaborative approaches to predator conservation. Biological Reviews, 92: 2157–2163. PMID: 28338282 DOI: 10.1111/brv.12326

Requier F, Garnery L, Kohl PL, Njovu HK, Pirk CWW, Crewe RM, et al. 2019. The conservation of native honey bees is crucial. Trends in Ecology & Evolution, 34: 789–798. PMID: 31072605 DOI: 10.1016/j.tree.2019.04.008

Rojas-Bracho L, Brusca RC, Álvarez-Borrego S, Brownell RL Jr, Camacho-Ibar V, Ceballos G, et al. 2019. Unsubstantiated claims can lead to tragic conservation outcomes. BioScience, 69: 12–14. PMID: 30647475 DOI: 10.1093/biosci/biy138

Satterfield DA, Maerz JC, and Altizer S. 2015. Loss of migratory behaviour increases infection risk for a butterfly host. Proceedings of the Royal Society B: Biological Sciences, 282: 20141734. PMID: 25589600 DOI: 10.1098/rspb.2014.1734

Saunders CD, Brook AT, and Eugene Myers O. 2006. Using psychology to save biodiversity and human well-being. Conservation Biology, 20: 702–705. PMID: 16909560 DOI: 10.1111/j.1523-1739.2006.00435.x

Shepherd BG. 1999. A case history: the kokanee stocks of Okanagan Lake. Kamloops, British Columbia.

Shiffman DS. 2020. Recreational shark fishing in Florida: how research and strategic science communication helped to change policy. Conservation Science and Practice, 2: e174. DOI: 10.1111/csp2.174

Shiffman DS, and Hueter RE. 2017. A United States shark fin ban would undermine sustainable shark fisheries. Marine Policy, 85: 138–140. DOI: 10.1016/J.MARPOL.2017.08.026

Simmons M. 2020. Tahltan president explains why his nation is paying members to hunt bears and wolves in northwest B.C. The Narwhal.

Smol JP. 2018. A crisis in science literacy and communication: does reluctance to engage the public make academic scientists complicit? FACETS, 3: 952–957. DOI: 10.1139/facets-2018-0022

Stafford R, and Jones PJS. 2019. Viewpoint—ocean plastic pollution: a convenient but distracting truth? Marine Policy, 103: 187–191. DOI: 10.1016/J.MARPOL.2019.02.003

Stewart GB, Bayliss HR, Showler DA, Sutherland WJ, and Pullin AS. 2009. Effectiveness of engineered in-stream structure mitigation measures to increase salmonid abundance: a systematic review. Ecological Applications, 19: 931–941. PMID: 19544735 DOI: 10.1890/07-1311.1

Suman D, Shivlani M, and Walter Milon J. 1999. Perceptions and attitudes regarding marine reserves: a comparison of stakeholder groups in the Florida Keys National Marine Sanctuary. Ocean & Coastal Management, 42: 1019–1040. DOI: 10.1016/S0964-5691(99)00062-9

Sunstein CR. 2017. Misconceptions about nudges. SSRN Electronic Journal. DOI: 10.2139/ssrn.3033101

Tenger-Trolander A, Lu W, Noyes M, and Kronforst MR. 2019. Contemporary loss of migration in monarch butterflies. Proceedings of the National Academy of Sciences of the United States of America, 116: 14671–14676. PMID: 31235586 DOI: 10.1073/pnas.1904690116

Thaler AD, and Shiffman DS. 2015. Fish tales: combating fake science in popular media. Ocean & Coastal Management, 115: 88–91. DOI: 10.1016/J.OCECOAMAN.2015.04.005

Thaler RH, and Sunstein CR. 2009. Nudge: improving decisions about health, wealth, and happiness. Penguin.

Treves A. 2009. Hunting for large carnivore conservation. Journal of Applied Ecology, 46: 1350–1356. DOI: 10.1111/j.1365-2664.2009.01729.x

Vosoughi S, Roy D, and Aral S. 2018. The spread of true and false news online. Science, 359: 1146–1151. PMID: 29590045 DOI: 10.1126/science.aap9559

Wade L. 2015. Plan to save monarch butterflies backfires. Science. DOI: 10.1126/science.aaa6337

Walters C. 1997. Challenges in adaptive management of riparian and coastal ecosystems. Conservation Ecology, 1: 1.

White TI. 2017. Dolphins, captivity, and seaworld: the misuse of science. Business and Society Review, 122: 119–136. DOI: 10.1111/basr.12112

Williams DR, Balmford A, and Wilcove DS. 2020. The past and future role of conservation science in saving biodiversity. Conservation Letters, 13: e12720. DOI: 10.1111/conl.12720

Wittmer HU, Elbroch LM, and Marshall AJ. 2013. Good intentions gone wrong: did conservation management threaten Endangered huemul deer *Hippocamelus bisulcus* in the future Patagonia National Park? Oryx, 47: 393–402. DOI: 10.1017/S0030605312000531

Young JC, Marzano M, White RM, McCracken DI, Redpath SM, Carss DN, et al. 2010. The emergence of biodiversity conflicts from biodiversity impacts: characteristics and management strategies. Biodiversity and Conservation, 19: 3973–3990. DOI: 10.1007/s10531-010-9941-7