

Ten considerations for conservation policy makers for the post-COVID-19 transition

S.J. Cooke, P. Soroye, J.L. Brooks, J. Clarke, A.L. Jeanson, A. Berberi, M.L. Piczak, C.H. Reid, J.E. Desforges, J.D. Guay, A.K. Drake, A.M. Jardine, J.P. Ethier, H.E. Keefe, A.M. Medd, B.P.M. Edwards, C. Reeve, A. Perkovic, A. Frempong-Manso, L. LaRochelle, S. Patterson, M. Roach-Krajewski, A. Howarth, B. Bard, E.J. Harmsen, J. Robichaud, S. Serré, C.J. Bihun, R.T. Buxton, V.M. Nguyen, L.C. Woodall, W.J. Sutherland, and J.R. Bennett

Abstract: Public health and safety concerns around the SARS-CoV-2 novel coronavirus and the COVID-19 pandemic have greatly changed human behaviour. Such shifts in behaviours, including travel patterns, consumerism, and energy use, are variously impacting biodiversity during the human-dominated geological epoch known as the Anthropocene. Indeed, the dramatic reduction in human mobility and activity has been termed the “Anthropause”. COVID-19 has highlighted the current environmental and biodiversity crisis and has provided an opportunity to redefine our relationship with nature. Here we share 10 considerations for conservation policy makers to support and rethink the development of impactful and effective policies in light of the COVID-19 pandemic. There are opportunities to leverage societal changes as a result of COVID-19, focus on the need for collaboration and engagement, and address lessons learned through the development of policies (including those related to public health) during the pandemic. The pandemic has had devastating impacts on humanity that should not be understated, but it is also a warning that we need to redefine our relationship with nature and restore biodiversity. The considerations presented here will support the development of robust, evidence-based, and transformative policies for biodiversity conservation in a post-COVID-19 world.

Key words: COVID-19, pandemic, conservation policy, biodiversity, transitions, Anthropause.

Résumé : Les préoccupations de santé et de sécurité publiques liées au nouveau coronavirus SRAS-CoV-2 et à la pandémie de COVID-19 ont considérablement modifié le comportement humain. De tels changements de comportement, notamment les modes de déplacement, la consommation et l'utilisation de l'énergie, ont des répercussions diverses sur la biodiversité au cours de l'époque géologique dominée par l'humain, connue sous le nom d'anthropocène. En effet, la réduction spectaculaire de la mobilité et de l'activité humaines a été appelée « anthropause ». La COVID-19 a mis en lumière la crise actuelle de l'environnement et de la biodiversité et a fourni l'occasion de redéfinir notre relation avec la nature. Les auteurs partagent ici 10 considérations à l'intention des décideurs en matière de conservation, afin de soutenir et de repenser l'élaboration de politiques percutantes et efficaces à la lumière de la pandémie de COVID-19. Il est possible de tirer parti des changements sociétaux résultant de la pandémie de COVID-19, de mettre l'accent sur la nécessité de la collaboration et de l'engagement, et de tenir compte des leçons tirées de l'élaboration des politiques (y compris celles liées à la santé publique) pendant la pandémie. La pandémie a eu des effets dévastateurs sur l'humanité qu'il ne faut pas sous-estimer, mais elle constitue aussi un avertissement que nous devons redéfinir notre relation avec la nature et restaurer la biodiversité. Les considérations présentées ici soutiendront le développement de politiques solides, fondées sur des preuves et transformatrices pour la conservation de la biodiversité dans un monde post-COVID-19. [Traduit par la Rédaction]

Mots-clés : COVID-19, pandémie, politique de conservation, biodiversité, transitions, anthropause.

Received 25 January 2021. Accepted 16 March 2021.

S.J. Cooke,* R.T. Buxton, V.M. Nguyen, and J.R. Bennett. Department of Biology and Institute of Environmental and Interdisciplinary Science, Carleton University, 1125 Colonel By Dr., Ottawa, ON K1S 5B6, Canada; Canadian Centre for Evidence-Based Conservation, Carleton University, 1125 Colonel By Dr., Ottawa, ON K1S 5B6, Canada.

P. Soroye, J.P. Ethier, H.E. Keefe, M. Roach-Krajewski, and B. Bard. Department of Biology, University of Ottawa, 75 Laurier Ave. E., Ottawa, ON K1N 6N5, Canada.

J.L. Brooks, J. Clarke, A.L. Jeanson, A. Berberi, M.L. Piczak, C.H. Reid, J.E. Desforges, J.D. Guay, A.K. Drake, A.M. Medd, B.P.M. Edwards, C. Reeve, A. Perkovic, A. Frempong-Manso, L. LaRochelle, S. Patterson, A. Howarth, E.J. Harmsen, J. Robichaud, S. Serré, and C.J. Bihun. Department of Biology and Institute of Environmental and Interdisciplinary Science, Carleton University, 1125 Colonel By Dr., Ottawa, ON K1S 5B6, Canada.

A.M. Jardine. Department of Geography and Environmental Studies, Carleton University, 1125 Colonel By Dr., Ottawa, ON K1S 5B6, Canada.

L.C. Woodall. Department of Zoology, University of Oxford, Mansfield Road, Oxford, OX1 2JD, U.K; Nektos, Begbroke Science Park, Oxford, OX1 2JD, U.K.

W.J. Sutherland. Conservation Science Group, Department of Zoology, University of Cambridge, Cambridge, CB2 3EJ, U.K.

Corresponding author: S.J. Cooke (email: steven_cooke@carleton.ca).

*S.J. Cooke served as an Editorial Board Member at the time of manuscript review and acceptance; peer review and editorial decisions regarding this manuscript were handled by Kathleen Rühland.

Copyright remains with the author(s) or their institution(s). This work is licensed under a [Creative Commons Attribution 4.0 International License](https://creativecommons.org/licenses/by/4.0/) (CC BY 4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author(s) and source are credited.

Introduction

The SARS-CoV-2 novel coronavirus (herein called COVID-19 recognizing that this is the resultant disease) pandemic has had an incredibly heavy human toll (from loss of life (Woolf et al. 2020), to mental health crises (Tandon 2020), to loss of livelihoods (Dev 2020), to changes in food security (Uddin et al. 2020)) and rapid and dramatic effects on the world and how it functions. Major changes in human behaviour spanning travel patterns, consumerism, and energy use, among others, have influenced local and global biodiversity (e.g., Gillingham et al. 2020; Rondeau et al. 2020; Zambrano-Monserate et al. 2020). These changes define the Anthropocene, a period characterized by unprecedented loss of biodiversity and global environmental change (Steffen et al. 2007), for which there is desperate need for action to stop this loss and restore ecosystems (Jeanson et al. 2020). The COVID-19 lockdown restrictions have created an unprecedented experiment termed the “Anthropause” in which nearly half of humans on the planet have been confined to their homes at various stages of the pandemic, resulting in major reductions in human disturbance on biodiversity (Bates et al. 2020; Rutz et al. 2020). Although there have been some obvious “wins” for the environment during the pandemic, there are also many trade-offs and paradoxes that we are just starting to understand. For example, in India, the rivers have benefitted from major reductions in pollution yet food-insecure peoples have turned to iconic endangered fish for food (Pinder et al. 2020). E-commerce has reduced localized public travel with associated emissions benefits but has led to a large amount of cardboard waste and other unforeseen costs (Tokar et al. 2021). What is clear is that COVID-19 has illuminated environmental and biodiversity crises while creating an opportunity to transition and redefine our relationship with nature and our planet (Steffen et al. 2020). Reducing the probability of future virulent disease outbreaks also hinges on abating the destruction of biodiversity (Gibb et al. 2020). In this sense, there are clear links between human and societal well-being and biodiversity (Díaz et al. 2006; Haines-Young and Potschin 2010).

Public health and safety have been important policy drivers influencing individual human behaviour during the COVID-19 response (Hartley and Perencevich 2020). Yet, there are opportunities to consider how conservation policy can be refined to benefit both humans and biodiversity during the post-COVID-19 transition. Conservation policy makers and their actions in the next several years will play major roles in addressing issues such as the global wildlife trade, climate change, biodiversity loss, pollution, and energy use in the coming decades (Pearson et al. 2020). Several recent papers have considered how environmental policy related to clean energy, transportation, and climate emissions can be refined (e.g., Amankwah-Amoah 2020; López-Feldman et al. 2020; Steffen et al. 2020) during what Schwab and Malleret (2020) call “the great reset”, and there are a number of emerging examples specific to biodiversity (Cooke et al. 2020; McElwee et al. 2020; Sandbrook et al. 2020).

Here, we present considerations for conservation policy makers intended to enable the development of more effective and transformative conservation policy recognizing that this may range from relatively small refinements to major rethinking of how economies and society function as part of a sustainable recovery and future. Specifically, we focus on policy changes that have the potential to bend the curve for biodiversity (Mace et al. 2018) — halting and reversing declines and restoring biodiversity for the benefit of humans and our planet — doing so in a way that is respectful and inclusive of stakeholders and rightsholders. This paper is intended to complement recommendations that have already been shared with conservation researchers in terms of how they can generate relevant science for COVID-19 transitions (see Buxton et al. 2020; Kadykalo et al. 2021). Our team includes a mix of early career and established conservation science

researchers based in Canada and the UK. The considerations presented here were derived from collaborative brainstorming and scanning of relevant literature with a focus on COVID-19 policy considerations for other sectors and issues (e.g., transportation, energy) and the policy sciences (see Weible et al. 2020). The lens used here may not be entirely relevant to all contexts or regions and reflects the lived experiences and perspectives of the authors. As such, there is inherent subjectivity to the considerations listed here. Nonetheless, all of the considerations are anchored in relevant literature and supported with timely examples. The considerations are not presented in order of importance.

1. Leverage interest in evidence-informed decisions

Health care experts discussing COVID-19 in the media frequently present findings that have emerged from evidence syntheses to help the public understand public health decisions, effectively mainstreaming evidence-based decision making. Behind the scenes, the evidence synthesis community is working to rapidly deliver robust syntheses (Bero 2020; Tricco et al. 2020) on topics such as the effectiveness of masks and mechanisms of viral spread. Moreover, these syntheses are being updated regularly, reflecting the emergence of new evidence (Tricco et al. 2020). The evidence synthesis community has also created hubs for sharing pandemic-related evidence (e.g., <https://www.mcmasterforum.org/find-evidence/covid-19-evidence>; LitCovid, <https://www.ncbi.nlm.nih.gov/research/coronavirus/>). Biomedicine has long been ahead of the environmental sciences in embracing evidence-informed and evidence-based decision making (Pullin and Knight 2001); however, the current interest and awareness in COVID evidence creates an opportunity for conservation policy makers to more fully embrace evidence synthesis (e.g., the Collaboration for Environmental Evidence, <https://www.environmentalevidence.org>) and evidence synopses (e.g., Conservation Evidence, <https://www.conservationevidence.com/>) to use when communicating to both politicians and the public (Kadykalo et al. 2021). Doing so may help to foster trust and understanding of conservation science and the scientific process. At the same time, dubious review processes (leading to subsequent retractions; Soltani and Patini 2020) and the proliferation of preprints (van Schalkwyk et al. 2020) have led to questions about scientific rigour and reliability that need to be addressed (or in the case of preprints, perhaps embraced; Vlasschaert et al. 2020). The concept of preprints is just starting to be adopted by researchers working in conservation science (e.g., we put this paper on the <https://www.ecoevorxiv.com/> preprint server). COVID-19 also revealed an opportunity to use evidence to counter misinformation as has been done with some success in the context of public health information during the pandemic (Ljungholm and Olah 2020). Indeed, the progression of COVID-19 has led to the most substantial public discussion of the scientific method in recent history (Agle 2020). The current interest in science (e.g., Agle 2020; Saitz and Schwitzer 2020; Feine and Jakubovics 2021) can be embraced as an opportunity to improve public support and understanding surrounding conservation policy notwithstanding the recognition that trust issues are pervasive in some regions.

2. Capitalize on positive human connections with nature

Travel restrictions and the shift to remaining at home have led to humans slowing their fast-paced lifestyles and becoming more engaged with natural environments close to home (Campbell 2020). This resulting increase in visitation to natural areas, green spaces, and parks near urban areas in some regions (Park People/Amis des Parcs 2020; Stinson and Lunstrum 2020) has led to some congestion but is also exposing new members of society to nature (Geng et al. 2021). This has coincided with a decrease in the use of wilderness and remote locations. In the Antarctic, for example, ecotourism will likely not rebound for years (Hughes and Convey 2020; Müller et al. 2020). This may be an opportunity to reclaim and redefine what wilderness is (Watson 2004) and rethink what

level of human disturbance is acceptable (Buckley 2020). Moreover, general reductions in human activity have benefitted wildlife. In the San Francisco Bay area, traffic noise levels dramatically decreased, leading to songbirds such as the white-crowned sparrow (*Zonotrichia leucophrys*) altering their songs into a more optimized frequency range (Derryberry et al. 2020). The so-called “Anthropause” creates a unique opportunity to share stories about how wildlife and nature function in the relative absence of humans. Sharing Anthropause stories (e.g., wildlife roaming the deserted streets in urban areas, <https://www.cnn.com/2020/04/10/coronavirus-empty-streets-around-the-world-are-attracting-wildlife.html>) highlights the resilience of nature and what is possible if we change human behaviour in ways that benefit biodiversity. This could lead to public buy-in for conservation policies that were previously regarded by some as being “unlikely to work”. Moreover, given that the Anthropocene is often viewed through a negative lens (Dalby 2016), the Anthropause provides a source of hope that is sorely needed (Bennett et al. 2016). Policy makers can capitalize on tangible examples and the potential for a stronger collective understanding and support of biodiversity, which can ultimately lead to conservation mobilization; however, it is also important to not misinterpret the Anthropause as indicating ultimate resilience of nature — some losses are irrecoverable.

3. Leverage the restructuring of society after COVID-19 to benefit biodiversity and people for today and tomorrow

The COVID-19 pandemic has had dramatic effects on humans (e.g., over 2 million deaths globally as of 25 January 2021 according to the WHO, <https://covid19.who.int/>) and has caused enormous hardship for many (e.g., loss of livelihoods, nutritional insecurity, mental health issues). Considering this, it is important to recognize the consequent societal changes that have led to some positive effects for both humans and wildlife. For example, restrictions on travel and trade to reduce the spread of COVID-19 have reduced global carbon emissions (Le Quéré et al. 2020) and improved air quality in cities (Connerton et al. 2020; He et al. 2020), with benefits for human health (see Ma and Kang 2020) and presumably biodiversity. Thus, policy makers should acknowledge and attempt to preserve societal changes that have simultaneously benefited human well-being and biodiversity. Moreover, it is well known that anthropogenic stress (e.g., arising from disturbance or climate change) on ecosystems and wildlife can promote disease outbreaks (Keesing et al. 2010), while loss of biodiversity can itself increase rates of infectious disease (Wood et al. 2014). Efforts to minimize human disturbance in ecosystems while protecting and restoring biodiversity may limit the ability of zoonotic diseases (such as COVID-19; for an acknowledgement that it may be premature to call it a zoonotic disease given that there is still uncertainty regarding source, see Haider et al. 2020) to spill over from wildlife to humans through a buffering effect (Johnson and Thielges 2010; Schmeller et al. 2020). Such investments in biodiversity benefit human well-being in both the short and long terms (Cunningham et al. 2017). A recent social science study revealed that linking human destruction of nature with COVID-19 is associated with increased support for conservation initiatives (see Shreedhar and Mourato 2020), which creates a unique opportunity for conservation policy makers to exploit. With financial stimulus spending and other social restructuring anticipated during post-pandemic recovery, this is an opportune time to make meaningful advances in biodiversity conservation today, while also protecting against future threats.

4. Create conservation policies that are living and adaptive

Relevant and rigorous scientific evidence is the basis for well-constructed conservation policy (York et al. 2002). Timely conservation

policies in response to new sound science can increase conservation successes. Although such responses are still somewhat rare in the conservation sphere (for example, emergency listing and management orders for endangered species are severely underutilized; Bolliger et al. 2020), there are opportunities to learn from recent public health successes during the pandemic. For example, the quick implementation of emerging science-backed COVID-19 public safety protocols, recommendations, and policies (i.e., capacity limitations in public spaces and the use of face coverings) have reduced the impact of the virus in many countries (World Health Organization 2020); however, the process of generating rigorous and impactful scientific evidence, much like generating impactful policy, is continuous and iterative (Gluckman 2014). It is routine for scientific conclusions to shift with new evidence and as more knowledge in the field becomes available (as has occurred throughout the COVID-19 pandemic in the public health realm; Eibensteiner et al. 2021). It is also worth noting that social-ecological systems (which are central to conservation) are inherently dynamic such that it is unreasonable to think that static policy (Gavin et al. 2018) or governance systems (Young et al. 2008) will succeed. Flexibility that arises from “living policy and institutions” is key for dealing with the COVID-19 crisis (e.g., Fernandez Lynch et al. 2020) and will similarly be essential for dealing with pressing and complex conservation issues. The acceptance of this process should enable the creation of environmental policies that are living and adaptive by benefitting from updated scientific evidence (e.g., Keith et al. 2011). As with rapidly emerging policies such as public health policies on COVID-19, conservation guidance and policies should be dynamic to incorporate changing knowledge as the evidence base expands.

5. Consult and engage with stakeholders and rightsholders

Consultation and engagement with stakeholders and rightsholders is fundamental to achieving conservation success (Reed 2008). Traditionally, these activities occur during face-to-face meetings and workshops, but during the pandemic, they have largely ceased in an effort to maintain public health (Evans et al. 2020). This issue is amplified in Indigenous communities that are especially vulnerable to COVID-19 (e.g., due to lack of access to health care in remote communities and amplified food insecurity; see <https://www.wcsnada.org/Portals/96/Documents/Indigenous%20Peoples%20COVID%20and%20WCS%20Canada.pdf?ver=2020-05-15-193744-703>). Much progress has been made over the last several decades in adopting a co-production (Beier et al. 2017) or co-assessment (Sutherland et al. 2017) approach to conservation research and application, thus ensuring that diverse voices contribute to the development of conservation plans and policies as well as the establishment and prioritization of knowledge gaps (Reed 2008). It may be tempting to abandon or otherwise take shortcuts in engagement due to the uncertainty caused by the pandemic, yet it is essential to continue to move forward meaningfully and deliberately with co-production and co-assessment strategies where feasible as doing so has the potential to reduce conflicts (Redpath et al. 2013) all the while achieving more meaningful conservation outcomes that are context-specific (Nel et al. 2016). The pandemic creates an opportunity to rethink the process of engagement so that protocols and policies can be improved. For example, online engagement methods, which have been necessary during the pandemic, could be used to supplement and increase frequency of communication with stakeholders and rightsholders who may live in more remote areas (provided that they have access to the internet, which cannot be taken for granted). In fact, moving forward, it may be possible to have more sustained interactions enabled by technology to the extent that such methods are embraced by stakeholders and rightsholders.

6. Recognize the complexities involved in compliance and cooperation

Because of COVID-19, members of the public have been expected to alter their behaviour by repeatedly making decisions that conflict with their personal, immediate gains (Lunn et al. 2020). These decisions often must be made before the outcome is evident and before the effective value of the public good is known (Milinski et al. 2008). Research on social dilemma theories (see Dawes 1980) has shown that cooperation does occur in these circumstances, despite incentives that conspire against it (Johnson et al. 2020). An understanding of social dilemma theory should help policy makers understand why people cooperate (or not, including messaging fatigue that has occurred with COVID-19 in which individuals become tired of rules and guidance; Michie et al. 2020) and the ways in which cooperation in collective activities can be maintained or promoted (Van Lange et al. 2013; Johnson et al. 2020). Prior to embarking on social marketing initiatives related to conservation, it can be useful to consult relevant literature to determine what works (e.g., Salazar et al. 2019) and select actions using theory of change frameworks (Veríssimo et al. 2017). Conservation policy makers should consider the variety of behavioural responses in the community during this pandemic (for example, toilet paper hoarding and anti-mask behaviour) and consider the complexities of compliance, psychosocial research, and the mechanisms behind cooperation when attempting to overcome similar conservation social dilemmas.

7. Account for slow or reluctant adopters in policy design

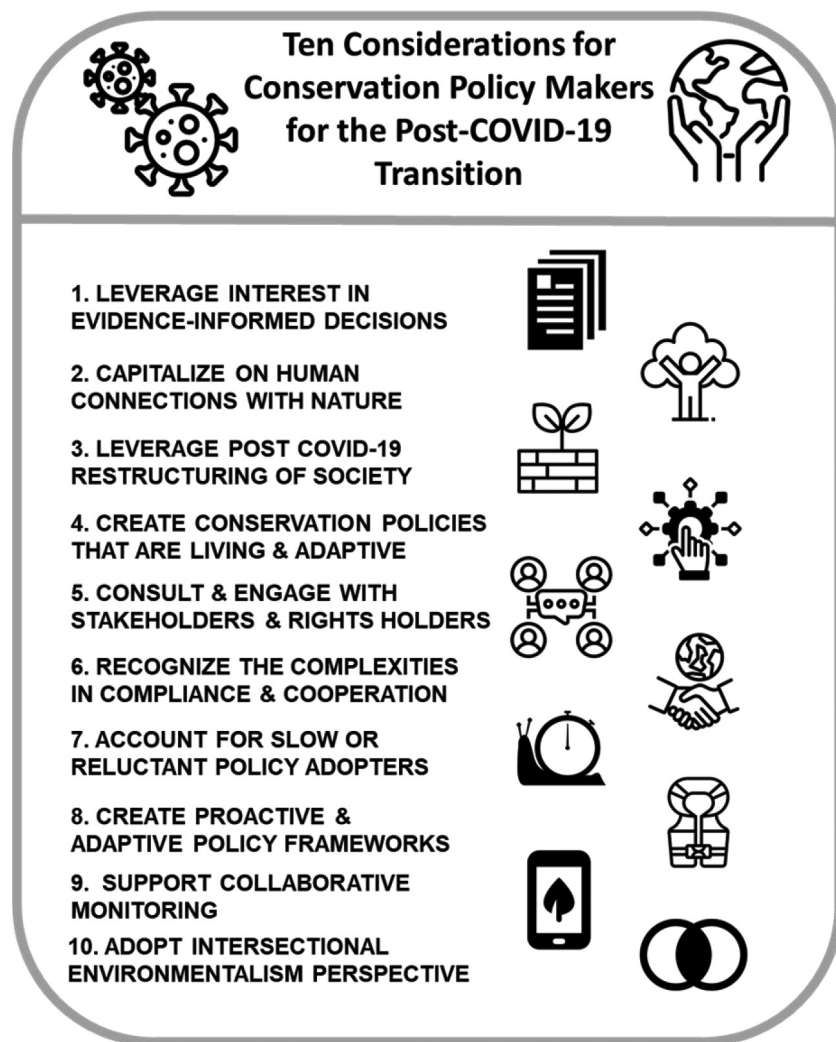
Significant effort is required to create new policy, but uncertainties related to adoption and public buy-in constitute additional hurdles. Change resistance is a major obstacle preventing the adoption of environmentally beneficial behaviours and policies on both individual and collective levels (Harich 2010), with many potential underlying causes (e.g., mistrust in authority; Piderit 2000). False and potentially damaging ideas (e.g., fake news) can increase resistance to discussion, engagement, and social change in the face of major issues (van der Linden 2015) such as climate change (Douglas and Sutton 2015). Resistant, slow, or reluctant adopters have become readily apparent during COVID-19 with issues such as wearing of masks (Howard 2020). Science denial transcends political and temperamental differences, and different groups of “slow adopters” require attention for different policies (Washburn and Skitka 2018). Given that public opinion is inextricably linked to policy and politics (Rose et al. 2018), understanding and addressing the drivers of slow adoption is crucial. Although various interest groups can have some influence on public opinion (and thus policy), there is evidence from the pandemic that core values developed during childhood remain relatively stable, even in the face of uncertainty and upheaval (Reeskens et al. 2021). As such, continued efforts to infuse conservation and environmental issues into early childhood education remain a high priority, especially given that such efforts can lead to intergenerational learning about conservation (Marchini and Macdonald 2020). The effectiveness of top-down, “hard” approaches to conservation are limited by noncompliance and limited governmental control, and policies that incentivize sustainable choices in a way that is consistent with societal objectives are more likely to receive support (Hilborn 2007). It is important to address the social drivers of denial, reluctance, and slow adoption early (e.g., by gaining the support of actors who share a common background with the target audience, making support more socially acceptable; Rosenau 2012). This has become especially apparent during the pandemic with much in the way of new research and understanding in the health care realm (e.g., Lunn et al. 2020; Van Bavel et al. 2020) that is transferrable to conservation.

8. Create proactive and adaptive policy frameworks that consider unintended negative consequences

The high degree of uncertainty associated with the COVID-19 pandemic accelerated the typical policy-making framework as most governments prioritized public health over potential short-term economic repercussions. This response can serve as a template to address the biodiversity crisis. The exponential rates of biodiversity loss around the world are a direct cause of human-induced threats, namely habitat loss and degradation, pollution, invasive species, accelerated climate change, and exploitation (Vitousek et al. 1997; Rosser and Mainka 2002; Fukushima et al. 2020). Reductions in population sizes of wild organisms, localized extirpations, and species extinctions are increasingly prevalent around the world as extinction rates are 1000 times higher than natural background extinctions and are projected to increase in the future (De Vos et al. 2015; WWF 2020). Considering that biodiversity is intrinsically linked to human health (both physically and mentally), well-being, and wealth, conservation of biodiversity must be prioritized to achieve sustainable economic growth (Costanza et al. 1997; Hough 2014). While scientists have been calling for action for several decades, decision makers must recognize the urgent need to bend the curve of biodiversity loss before irreversible consequences arise. As exemplified during the COVID-19 pandemic, immediate global awareness and action has the potential to flatten the curve of global trends. By emphasizing urgency in conservation-related issues, perhaps the curve in biodiversity loss could be bent as well. At the same time, it is important to consider unintended adverse effects of policies on environmental and human health (Corlett et al. 2020; Pearson et al. 2020) and realize that policies may backfire in precarious times of misinformation (Schwab and Malleret 2020). COVID-19 has highlighted the ways in which there can be unintended consequences that arise from policy (e.g., public health lockdowns led to decreased funding and effort for fish and wildlife enforcement, which enables illegal activity; Cooke et al. 2020; Lendelvo et al. 2020), especially when forced to act quickly and in a reactive manner, which is an important consideration even during non-COVID times.

9. Support collaborative monitoring by both scientists and communities to allow for better decisions in the face of unexpected events

Data gathered voluntarily by local community members have been crucial in tracking the spread of COVID-19 and making timely policy adjustments to reduce transmission (Budd et al. 2020). Governments actively encourage communities to use smartphone apps that can track potential exposure to COVID-19 and alert both users and health authorities to spreading risk. Conservation can also greatly benefit from data gathered by volunteers using digital technology. Community (aka citizen) science offers opportunities for generating more comprehensive and robust data, particularly at spatial and time scales necessary for many decisions (Chandler et al. 2017). Incentivizing citizens to fill in knowledge gaps and embracing community-collected data may provide policy makers with the opportunity to mobilize public involvement in making better ecosystem protection decisions. In some Indigenous communities, the concept of “Indigenous Guardians” has become popular with benefits for the environment (especially for monitoring to inform decisions) and self-determination (Reed et al. 2021). With a continued emphasis on the importance of long-term monitoring from both scientific and citizen or community groups, further discoveries can be made regardless of obstacles such as COVID-19. In fact, COVID-19 has highlighted how community science plays a key role in generating essential data to inform public health decisions — a model that accelerated during the pandemic but is expected to

Fig. 1. Ten considerations for conservation policy makers for the post-COVID-19 recovery.

become normalized (Provenzi and Barello 2020). Continued scientific research and long-term monitoring would refine projections and result in better, more insightful recommendations, ultimately leading to more effective biodiversity policy recommendations (Parr et al. 2002).

10. Refocus conservation action and policy through the lens of intersectional environmentalism

Disadvantaged communities have been disproportionately affected by COVID-19, both in terms of infection rates and in terms of economic fallout. Similarly, black, Indigenous, and people of colour are disproportionately affected by the impacts of biodiversity loss and are most likely to be excluded from or negatively impacted by decisions on conservation. For example, in many areas with colonial histories (e.g., Serengeti, Maghreb, Nepal), people and animals have been extirpated from regions or deprived of its resources to achieve a political goal, often in the name of the preservation of biodiversity or access to a particular resource (Shrestha 1995; Robbins 2015). Despite this, conservation decision making and long-term success benefit from including local communities and diverse voices and perspectives (Brooks et al. 2012; Díaz et al. 2018). The global “Anthropause” presents a unique opportunity to restructure and develop intersectional policies that create sustainable conservation solutions that reflect the rights and voices of marginalized people. Beginning by meaningfully considering

colonial histories of conservation and scientific institutions (Chaudhury and Colla 2020), evaluating “objectivity” and considering positionality (Baker et al. 2019), and supporting diverse and inclusive communities (Maas et al. 2020), conservation should work towards engaging historically excluded communities, as how it has begun to engage with Indigenous communities. This would be beneficial both to people and biodiversity and is especially timely as we begin to set new international conservation and sustainability targets through the new United Nations 2030 targets to be set later in 2021 (<https://sdgs.un.org/2030agenda>; Schleicher et al. 2019; Thomas 2020).

Conclusion

Here we present 10 considerations for conservation policy makers and decision makers focused on development and refinement of conservation policy during the post-COVID-19 transition (Fig. 1). The pandemic has dramatically altered our relationship with nature and is regarded as a time of transition globally (Habersaat et al. 2020). Much can be learned from the pandemic, particularly related to the social and behavioural sciences (Van Bavel et al. 2020), as we work collectively towards addressing the biodiversity crisis. Scholars have already charted pathways to navigating clean-energy transitions driven by the pandemic (Steffen et al. 2020), yet similar scaffolding has yet to occur for biodiversity and conservation policy. The attention that biodiversity has received as a result

of the Anthropause has amplified the realization that humans have had a dramatic effect on biodiversity, and it is time for change. Our audience here are conservation policy makers recognizing their critical role; however, we also acknowledge that they cannot do it alone and require robust evidence (Buxton et al. 2020), input, and assistance from diverse stakeholders and rightsholders to guide them. Moreover, natural science alone will be wholly insufficient to generate the evidence needed to develop effective conservation policy (Schultz 2011). There is much need to bring together natural scientists with legal scholars, economists, psychologists, and social and behavioural scientists (Bennett et al. 2017), along with other ways of knowing (Gadgil et al. 1993). The pandemic has had devastating impacts on humanity that should not be understated, but it is also a warning (see Nematchoua 2020) that we need to redefine our relationship with nature and restore biodiversity. We recognize that policy makers and their institutions are presumably forming their own perspectives on opportunities and challenges for conservation during the post-COVID-19 transition. The considerations that we provide here are not intended to supplant those perspectives but rather to supplement them. Indeed, it is our intention that the considerations presented here will enable the development of robust, evidence-based, and transformative conservation policies to guide us during this transition (Lundquist et al. 2020) at a variety of scales (from local to international; Burgass et al. 2020).

Conflict of interest statement

The authors declare no conflicts of interest.

Acknowledgements

Funding was provided by the Natural Sciences and Engineering Research Council of Canada, Carleton University, and the Ottawa-Carleton Institute of Biology. We thank several reviewers for their thoughtful input on the paper.

References

- Agle, J. 2020. Assessing changes in US public trust in science amid the COVID-19 pandemic. *Public Health*, **183**: 122–125. doi:10.1016/j.puhe.2020.05.004. PMID:32405095.
- Amankwah-Amoah, J. 2020. Stepping up and stepping out of COVID-19: New challenges for environmental sustainability policies in the global airline industry. *J. Clean. Prod.* **271**: 123000. doi:10.1016/j.jclepro.2020.123000. PMID:32834564.
- Baker, K., Eichhorn, M.P., and Griffiths, M. 2019. Decolonizing field ecology. *Biotropica*, **51**(3): 288–292. doi:10.1111/btp.12663.
- Bates, A.E., Primack, R.B., Moraga, P., and Duarte, C.M. 2020. COVID-19 pandemic and associated lockdown as a “Global Human Confinement Experiment” to investigate biodiversity conservation. *Biol. Conserv.* **248**: 108665. doi:10.1016/j.biocon.2020.108665. PMID:32549587.
- Beier, P., Hansen, L.J., Helbrecht, L., and Behar, D. 2017. A how-to guide for coproduction of actionable science. *Conserv. Lett.* **10**(3): 288–296. doi:10.1111/conl.12300.
- Bennett, E.M., Solan, M., Biggs, R., McPhearson, T., Norström, A.V., Olsson, P., et al. 2016. Bright spots: seeds of a good Anthropocene. *Front. Ecol. Environ.* **14**(8): 441–448. doi:10.1002/fee.1309.
- Bennett, N.J., Roth, R., Klain, S.C., Chan, K.M., Clark, D.A., Cullman, G., et al. 2017. Mainstreaming the social sciences in conservation. *Conserv. Biol.* **31**(1): 56–66. doi:10.1111/cobi.12788. PMID:27334309.
- Bero, L.A. 2020. Producing independent, systematic review evidence: Cochrane's response to COVID-19. *Am. J. Public Health*, **110**(7): 952–953. doi:10.2105/AJPH.2020.305734. PMID:32407142.
- Bolliger, C.S., Raymond, C.V., Schuster, R., and Bennett, J.R. 2020. Spatial coverage of protection for terrestrial species under the Canadian Species at Risk Act. *Écoscience*, **27**(2): 141–147. doi:10.1080/11956860.2020.1741497.
- Brooks, J.S., Waylen, K.A., and Borgerhoff Mulder, M. 2012. How national context, project design, and local community characteristics influence success in community-based conservation projects. *Proc. Natl. Acad. Sci. U.S.A.* **109**(52): 21265–21270. doi:10.1073/pnas.1207141110.
- Buckley, R. 2020. Pandemic travel restrictions provide a test of net ecological effects of ecotourism and new research opportunities. *J. Travel Res.* 0047287520947812. doi:10.1177/0047287520947812.
- Budd, J., Miller, B.S., Manning, E.M., Lampos, V., Zhuang, M., Edelstein, M., et al. 2020. Digital technologies in the public-health response to COVID-19. *Nat. Med.* **26**: 1183–1192. doi:10.1038/s41591-020-1011-4. PMID:32770165.
- Burgass, M.J., Larrosa, C., Tittensor, D.P., Arlidge, W.N., Caceres, H., Camaclang, A., et al. 2020. Three key considerations for biodiversity conservation in multi-lateral agreements. *Conserv. Lett.* e12764. doi:10.1111/conl.12764.
- Buxton, R.T., Bergman, J.N., Lin, H.Y., Binley, A.D., Avery-Gomm, S., Schuster, R., et al. 2020. Three lessons conservation science can learn from the COVID-19 pandemic. *Conserv. Biol.* **34**: 1331–1332. doi:10.1111/cobi.13652. PMID:33044011.
- Campbell, A. 2020. Canadian nature expert doubts we're seeing more wild-life during pandemic. *Pique Newsmagazine*. Available from <https://www.piquenewsmagazine.com/whistler-news/canadian-nature-expert-doubts-were-seeing-more-wildlife-during-pandemic-2510407>.
- Chandler, M., See, L., Copas, K., Bonde, A.M., López, B.C., Danielsen, F., et al. 2017. Contribution of citizen science towards international biodiversity monitoring. *Biol. Conserv.* **213**: 280–294. doi:10.1016/j.biocon.2016.09.004.
- Chaudhury, A., and Colla, S. 2020. Next steps in dismantling discrimination: Lessons from ecology and conservation science. *Conserv. Lett.* e12774. doi:10.1111/conl.12774.
- Connerton, P., Vicente de Assunção, J., Maura de Miranda, R., Dorothée Slovic, A., José Pérez-Martínez, P., and Ribeiro, H. 2020. Air quality during COVID-19 in four megacities: lessons and challenges for public health. *Int. J. Environ. Res. Public Health*, **17**(14): 5067. doi:10.3390/ijerph17145067.
- Cooke, S.J., Twardek, W.M., Lynch, A.J., Cowx, I.G., Olden, J.D., Funge-Smith, S., et al. 2020. A global perspective on the influence of the COVID-19 pandemic on freshwater fish biodiversity. *Biol. Conserv.* **253**: 108932. doi:10.1016/j.biocon.2020.108932.
- Corlett, R.D., Primack, R.B., Devictor, V., Maas, B., Goswami, V.R., Bates, A.E., et al. 2020. Impacts of the coronavirus pandemic on biodiversity conservation. *Biol. Conserv.* **246**: 108571. doi:10.1016/j.biocon.2020.108571. PMID:32292203.
- Costanza, R., d'Arge, R., de Groot, R., Farber, S., Grasso, M., Hannon, B., et al. 1997. The value of the world's ecosystem services and natural capital. *Nature*, **387**: 253–260. doi:10.1038/387253a0.
- Cunningham, A.A., Daszak, P., and Wood, J. 2017. One Health, emerging infectious diseases and wildlife: two decades of progress? *Philos. Trans. R. Soc. B Biol. Sci.* **372**(1725): 20160167. doi:10.1098/rstb.2016.0167. PMID:28584175.
- Dalby, S. 2016. Framing the Anthropocene: The good, the bad and the ugly. *Anthropocene Rev.* **3**(1): 33–51. doi:10.1177/2053019615618681.
- Dawes, R.M. 1980. Social dilemmas. *Annu. Rev. Psychol.* **31**(1): 169–193. doi:10.1146/annurev.ps.31.020180.001125.
- Derryberry, E.P., Phillips, J.N., Derryberry, G.E., Blum, M.J., and Luther, D. 2020. Singing in a silent spring: Birds respond to a half-century sound-scape reversion during the COVID-19 shutdown. *Science*, **370**: 575–579. doi:10.1126/science.abd5777. PMID:32972991.
- Dev, S.M. 2020. Addressing COVID-19 impacts on agriculture, food security, and livelihoods in India. Chapter 7. In *COVID-19 and global food security*. Edited by J. Swinnen and J. McDermott. International Food Policy Research Institute. pp. 33–35.
- De Vos, J.M., Joppa, L.N., Gittleman, J.L., Stephens, P.R., and Pimm, S.L. 2015. Estimating the normal background rate of species extinction. *Conserv. Biol.* **29**(2): 452–462. doi:10.1111/cobi.12380. PMID:25159086.
- Díaz, S., Fargione, J., Chapin, I.I.F., and Tilman, D. 2006. Biodiversity loss threatens human well-being. *PLoS Biol.* **4**(8): e277. doi:10.1371/journal.pbio.0040277. PMID:16895442.
- Díaz, S., Pascual, U., Stenseke, M., Martín-López, B., Watson, R.T., Molnár, Z., et al. 2018. Assessing nature's contributions to people. *Science*, **359**(6373): 270–272. doi:10.1126/science.aap8826. PMID:29348221.
- Douglas, K.M., and Sutton, R.M. 2015. Climate change: Why the conspiracy theories are dangerous. *Bull. Atomic Sci.* **71**(2): 98–106. doi:10.1177/0096340215571908.
- Eibensteiner, F., Ritschl, V., Stamm, T., Cetin, A., Schmitt, C.P., Ariceta, G., et al. 2021. Countermeasures against COVID-19: how to navigate medical practice through a nascent, evolving evidence base — a European multicentre mixed methods study. *BMJ Open*, **11**(2): e043015. doi:10.1136/bmjopen-2020-043015. PMID:33597140.
- Evans, K.L., Ewen, J.G., Guillera-Aroita, G., Johnson, J.A., Penteriani, V., Ryan, S.J., et al. 2020. Conservation in the maelstrom of Covid-19 — a call to action to solve the challenges, exploit opportunities and prepare for the next pandemic. *Anim. Conserv.* **23**: 235–238. doi:10.1111/acv.12601.
- Feine, J., and Jakubovics, N. 2021. Science in the spotlight: A crisis of confidence? *JDR Clin. Transl. Res.* **6**: 4–7. doi:10.1177/2380084420976358. PMID:33346728.
- Fernandez Lynch, H., Dickert, N.W., Zettler, P.J., Joffe, S., and Largent, E.A. 2020. Regulatory flexibility for COVID-19 research. *J. Law Biosci.* **7**(1): lsa0057. doi:10.1093/jlbb/lsa0057.
- Fukushima, C.S., Mammola, S., and Cardoso, P. 2020. Global wildlife trade permeates the Tree of Life. *Biol. Conserv.* **247**: 108503. doi:10.1016/j.biocon.2020.108503. PMID:32454527.
- Gadgil, M., Berkes, F., and Folke, C. 1993. Indigenous knowledge for biodiversity conservation. *Ambio*, **1**: 151–156.
- Gavin, M.C., McCarter, J., Berkes, F., Mead, A.T.P., Sterling, E.J., Tang, R., and Turner, N.J. 2018. Effective biodiversity conservation requires dynamic, pluralistic, partnership-based approaches. *Sustainability*, **10**(6): 1846. doi:10.3390/su10061846.
- Geng, D.C., Innes, J., Wu, W., and Wang, G. 2021. Impacts of COVID-19 pandemic on urban park visitation: a global analysis. *J. For. Res.* **32**: 553–567. doi:10.1007/s11676-020-01249-w.
- Gibb, R., Redding, D.W., Chin, K.Q., Donnelly, C.A., Blackburn, T.M., Newbold, T., and Jones, K.E. 2020. Zoonotic host diversity increases in human-dominated

- ecosystems. *Nature*, **584**(7821): 398–402. doi:10.1038/s41586-020-2562-8. PMID: 32759999.
- Gillingham, K.T., Knittel, C.R., Li, J., Ovaere, M., and Reguant, M. 2020. The short-run and long-run effects of Covid-19 on energy and the environment. *Joule*, **4**(7): 1337–1349. doi:10.1016/j.joule.2020.06.010. PMID:32835174.
- Gluckman, P. 2014. Policy: The art of science advice to government. *Nat. News*, **507**(7491): 163–165. doi:10.1038/507163a. PMID:24627919.
- Habersaat, K.B., Betsch, C., Danchin, M., Sunstein, C.R., Böhm, R., Falk, A., et al. 2020. Ten considerations for effectively managing the COVID-19 transition. *Nat. Hum. Behav.* **4**: 677–687. doi:10.1038/s41562-020-0906-x. PMID:32581299.
- Haider, N., Rothman-Ostrow, P., Osman, A.Y., Arruda, L.B., Macfarlane-Berry, L., Elton, L., et al. 2020. COVID-19 — zoonosis or emerging infectious disease? *Front. Public Health*, **8**: 763. doi:10.3389/fpubh.2020.596944. PMID:33324602.
- Haines-Young, R., and Potschin, M. 2010. The links between biodiversity, ecosystem services and human well-being. In *Ecosystem ecology: a new synthesis*. Edited by D.G. Raffaelli and C.L.J. Frid. Cambridge University Press. pp. 110–139. doi:10.1017/CBO9780511750458.007.
- Harich, J. 2010. Change resistance as the crux of the environmental sustainability problem. *Syst. Dyn. Rev.* **26**: 35–72. doi:10.1002/sdr.431.
- Hartley, D.M., and Perencevich, E.N. 2020. Public health interventions for COVID-19: emerging evidence and implications for an evolving public health crisis. *JAMA*, **323**(19): 1908–1909. doi:10.1001/jama.2020.5910. PMID:32275299.
- He, G., Pan, Y., and Tanaka, T. 2020. The short-term impacts of COVID-19 lockdown on urban air pollution in China. *Nat. Sustain.* **3**: 1005–1011. doi:10.1038/s41893-020-0581-y.
- Hilborn, R. 2007. Managing fisheries is managing people: What has been learned? *Fish Fish.* **8**(4): 285–296. doi:10.1111/j.1467-2979.2007.00263.2.x.
- Hough, R.L. 2014. Biodiversity and human health: evidence for casualty? *Biodivers. Conserv.* **23**: 267–288. doi:10.1007/s10531-013-0614-1.
- Howard, M.C. 2020. Understanding face mask use to prevent coronavirus and other illnesses: Development of a multidimensional face mask perceptions scale. *Br. J. Health Psychol.* **25**(4): 912–924. doi:10.1111/bjhp.12453. PMID:32588949.
- Hughes, K.A., and Convey, P. 2020. Implications of the COVID-19 pandemic for Antarctica. *Antarct. Sci.* **32**(6): 426–439. doi:10.1017/S095410202000053X.
- Jeanson, A.L., Soroye, P., Kadykalo, A.N., Ward, T.D., Paquette, E., Abrams, A.E.I., et al. 2020. Twenty actions for a “good Anthropocene” — perspectives from early-career conservation professionals. *Environ. Rev.* **28**(1): 99–108. doi:10.1139/er-2019-0021.
- Johnson, P.T.J., and Thielges, D.W. 2010. Diversity, decoys and the dilution effect: how ecological communities affect disease risk. *J. Exp. Biol.* **213**: 961–970. doi:10.1242/jeb.037721. PMID:20190121.
- Johnson, T., Dawes, C., Fowler, J., and Smirnov, O. 2020. Slowing COVID-19 transmission as a social dilemma: Lessons for government officials from interdisciplinary research on cooperation. *JBPA*, **3**(1). doi:10.30636/jbpa.31.150.
- Kadykalo, A.N., Haddaway, N.R., Rytwinski, T., and Cooke, S.J. 2021. Ten principles for generating accessible and useable COVID-19 environmental science and a fit-for-purpose evidence base. *Ecol. Solutions Evidence*, **2**(1): e12041. doi:10.1002/2688-8319.12041.
- Keesing, F., Belden, L.K., Daszak, P., Dobson, A., Harvell, C.D., Holt, R.D., et al. 2010. Impacts of biodiversity on the emergence and transmission of infectious diseases. *Nature*, **468**(7324): 647–652. doi:10.1038/nature09575. PMID:21124449.
- Keith, D.A., Martin, T.G., McDonald-Madden, E., and Walters, C. 2011. Uncertainty and adaptive management for biodiversity conservation. *Biol. Conserv.* **144**: 1175–1178. doi:10.1016/j.biocon.2010.11.022.
- Lendelvo, S.M., Pinto, M., and Sullivan, S. 2020. A perfect storm? The impact of COVID-19 on community-based conservation in Namibia. *Namibian J. Environ.* **4**: 1–15.
- Le Quéré, Q., Jackson, R.B., Jones, M.W., Smith, A.J.P., Abernethy, S., Andrew, R.M., et al. 2020. Temporary reduction in daily global CO₂ emissions during the COVID-19 forced confinement. *Nat. Clim. Change*, **10**: 647–653. doi:10.1038/s41586-020-0797-x.
- Ljungholm, D.P., and Olah, M.L. 2020. Regulating fake news content during COVID-19 pandemic: evidence-based reality, trustworthy sources, and responsible media reporting. *Rev. Contemp. Philos.* **19**: 43–49. doi:10.22381/RCP1920203.
- López-Feldman, A., Chávez, C., Vélez, M.A., et al. 2020. Environmental impacts and policy responses to covid-19: a view from Latin America. *Environ. Res. Econ.* doi:10.1007/s10640-020-00460-x. PMID:32836838.
- Lundquist, C., Hashimoto, S., Schoonenberg, M., et al. 2020. Transformative scenarios for biodiversity conservation and sustainability. *Conserv. Lett.* **e12772**. doi:10.1111/conl.12772.
- Lunn, P.D., Belton, C.A., Lavin, C., McGowan, F.P., Timmons, S., and Robertson, D.A. 2020. Using behavioral science to help fight the Coronavirus. *JBPA*, **3**(1): 1–15. doi:10.30636/jbpa.31.147.
- Ma, C.J., and Kang, G.U. 2020. Air quality variation in Wuhan, Daegu, and Tokyo during the explosive outbreak of COVID-19 and its health effects. *Int. J. Environ. Res. Public Health*, **17**(11): 4119. doi:10.3390/ijerph17114119. PMID:32526996.
- Maas, B., Grogan, K.E., Chirango, Y., Harris, N., Liévano-Latorre, L.F., McGuire, K.L., et al. 2020. Academic leaders must support inclusive scientific communities during COVID-19. *Nat. Ecol. Evol.* **4**: 997–998. doi:10.1038/s41559-020-1233-3. PMID:32493950.
- Mace, G.M., Barrett, M., Burgess, N.D., Cornell, S.E., Freeman, R., Grooten, M., et al. 2018. Aiming higher to bend the curve of biodiversity loss. *Nat. Sustain.* **1**: 448–451. doi:10.1038/s41893-018-0130-0.
- Marchini, S., and Macdonald, D.W. 2020. Can school children influence adults' behavior toward jaguars? Evidence of intergenerational learning in education for conservation. *Ambio*, **49**(4): 912–925. doi:10.1007/s13280-019-01230-w. PMID:31435880.
- McElwee, P., Turnout, E., Chiroleu-Assouline, M., Clapp, J., Isenhour, C., Jackson, T., et al. 2020. Ensuring a post-COVID economic agenda tackles global biodiversity loss. *One Earth*, **3**: 448–461. doi:10.1016/j.oneear.2020.09.011.
- Michie, S., West, R., Amlôt, R., and Rubin, G.J. 2020. Slowing down the covid-19 outbreak: Changing behaviour by understanding it. *BMJ Opinion*. Available from <https://blogs.bmj.com/bmj/2020/03/11/slowing-down-the-covid-19-outbreak-changing-behaviour-by-understanding-it>.
- Milinski, M., Sommerfeld, R.D., Krambeck, H.J., Reed, F.A., and Marotzke, J. 2008. The collective-risk social dilemma and the prevention of simulated dangerous climate change. *Proc. Natl. Acad. Sci. U.S.A.* **105**: 2291–2294. doi:10.1073/pnas.0709546105.
- Müller, D.K., Carson, D.A., de la Barre, S., Granås, B., Jóhannesson, G.T., Øyen, G., et al. 2020. Arctic tourism in times of change: dimensions of urban tourism. Available from <https://pub.norden.org/temanord2020-529/#>.
- Nel, J.L., Roux, D.J., Driver, A., Hill, L., Maherry, A.C., Snaddon, K., et al. 2016. Knowledge co-production and boundary work to promote implementation of conservation plans. *Conserv. Biol.* **30**(1): 176–188. doi:10.1111/cobi.12560. PMID:26041340.
- Nematchoua, M.K. 2020. Coronavirus covid-2019: Is this really an invisible enemy or a warning to humanity? *Health Environ.* **1**(2): 48–61. doi:10.25082/HE.2020.02.001.
- Park People/Amis des Parcs. 2020. The Canadian City Parks Report. Available from <https://cityparksreport.parkpeople.ca>.
- Parr, T.W., Ferretti, M., Simpson, I.C., Forsius, M., and Kovács-Láng, E. 2002. Towards a long-term integrated monitoring programme in Europe: network design in theory and practice. *Environ. Monit. Assess.* **78**: 253–290. doi:10.1023/A:1019934919140. PMID:12374392.
- Pearson, R.M., Sievers, M., McClure, E.C., Turschwell, M.P., and Connolly, R.M. 2020. COVID-19 recovery can benefit biodiversity. *Science*, **368**(6493): 838–839. doi:10.1126/science.abc1430. PMID:32439784.
- Piderit, S.K. 2000. Rethinking resistance and recognizing ambivalence: A multidimensional view of attitudes toward an organizational change. *Acad. Manage. Rev.* **25**(4): 783–794. doi:10.5465/amr.2000.3707722.
- Pinder, A.C., Raghavan, R., Britton, J.R., and Cooke, S.J. 2020. COVID-19 and biodiversity: The paradox of cleaner rivers and elevated extinction risk to iconic fish species. *Aquat. Conserv.* **30**(6): 1061–1062. doi:10.1002/aqc.3416. PMID:32834706.
- Provenzi, L., and Barelli, S. 2020. The science of the future: establishing a citizen-scientist collaborative agenda after Covid-19. *Front. Public Health*, **8**: 282. doi:10.3389/fpubh.2020.00282. PMID:32582619.
- Pullin, A.S., and Knight, T.M. 2001. Effectiveness in conservation practice: pointers from medicine and public health. *Conserv. Biol.* **15**(1): 50–54. doi:10.1111/j.1523-1739.2001.99499.x.
- Redpath, S.M., Young, J., Evelyn, A., Adams, W.M., Sutherland, W.J., Whitehouse, A., et al. 2013. Understanding and managing conservation conflicts. *Trends Ecol. Evol.* **28**(2): 100–109. doi:10.1016/j.tree.2012.08.021. PMID:23040462.
- Reed, G., Brun, N.D., Longboat, S., and Natcher, D.C. 2021. Indigenous guardians as an emerging approach to indigenous environmental governance. *Conserv. Biol.* **35**: 179–189. doi:10.1111/cobi.13532. PMID:32378218.
- Reed, M.S. 2008. Stakeholder participation for environmental management: a literature review. *Biol. Conserv.* **141**(10): 2417–2431. doi:10.1016/j.biocon.2008.07.014.
- Reeskens, T., Muis, Q., Sieben, I., Vandecasteele, L., Luijkx, R., and Halman, L. 2021. Stability or change of public opinion and values during the coronavirus crisis? Exploring Dutch longitudinal panel data. *Euro. Soc.* **23**(Suppl. 1): S153–S171. doi:10.1080/14616696.2020.1821075.
- Robbins, P. 2015. How can political ecology change policy? The role and limitations of the social scientist. *Universitat Autònoma de Barcelona*. Available from <https://www.youtube.com/watch?v=h6T-2nze7ig&feature=youtu.be>.
- Rondeau, D., Perry, B., and Grimard, F. 2020. The consequences of COVID-19 and other disasters for wildlife and biodiversity. *Environ. Resource Econ.* **76**: 945–961. doi:10.1007/s10640-020-00480-7.
- Rose, D.C., Sutherland, W.J., Amano, T., González-Varo, J.P., Robertson, R.J., Simmons, B.L., et al. 2018. The major barriers to evidence-informed conservation policy and possible solutions. *Conserv. Lett.* **11**(5): e12564. doi:10.1111/conl.12564. PMID:31031821.
- Rosenau, J. 2012. Science denial: A guide for scientists. *Trends Microbiol.* **20**(12): 567–569. doi:10.1016/j.tim.2012.10.002. PMID:23164600.
- Rosser, A.M., and Mainka, S.A. 2002. Overexploitation and species extinctions. *Conserv. Biol.* **16**(3): 584–586. doi:10.1046/j.1523-1739.2002.01635.x.
- Rutz, C., Loretto, M.-C., Bates, A.E., Davidson, S.C., Duarte, C.M., Jetz, W., et al. 2020. COVID-19 lockdown allows researchers to quantify the effects of human activity on wildlife. *Nat. Ecol. Evol.* **4**: 1156–1159. doi:10.1038/s41559-020-1237-z. PMID:32572222.
- Saitz, R., and Schwitzer, G. 2020. Communicating science in the time of a pandemic. *JAMA*, **324**(5): 443–444. doi:10.1001/jama.2020.12535. PMID:32749498.

- Salazar, G., Mills, M., and Veríssimo, D. 2019. Qualitative impact evaluation of a social marketing campaign for conservation. *Conserv. Biol.* **33**(3): 634–644. doi:10.1111/cobi.13218. PMID:30178894.
- Sandbrook, C., Gómez-Baggethun, E., and Adams, W.M. 2020. Biodiversity conservation in a post-COVID-19 economy. *Oryx*, **29**: 1–7. doi:10.1017/S0030605320001039.
- Schleicher, J., Zaehring, J.G., Fastré, C., Vira, B., Visconti, P., Sandbrook, C., et al. 2019. Protecting half of the planet could directly affect over one billion people. *Nat. Sustain.* **2**: 1094–1096. doi:10.1038/s41893-019-0423-y.
- Schmeller, D.S., Courchamp, F., and Killeen, G. 2020. Biodiversity loss, emerging pathogens and human health risks. *Biodivers. Conserv.* **29**: 3095–3102. doi:10.1007/s10531-020-02021-6.
- Schultz, P.W. 2011. Conservation means behavior. *Conserv. Biol.* **25**(6): 1080–1083. doi:10.1111/j.1523-1739.2011.01766.x. PMID:22070255.
- Schwab, K., and Malleret, T. 2020. Covid-19: The great reset. In *World economic forum*. Forum Publishing, Switzerland.
- Shreedhar, G., and Mourato, S. 2020. Linking human destruction of nature to COVID-19 increases support for wildlife conservation policies. *Environ. Resource. Econ.* **76**(4): 963–999. doi:10.1007/s10640-020-00444-x.
- Shrestha, N. 1995. *Becoming a development category*. University of Toronto. Available from http://www.math.toronto.edu/mpugh/Shrestha_1995_Becoming_a_development_category.pdf.
- Soltani, P., and Patini, R. 2020. Retracted COVID-19 articles: a side-effect of the hot race to publication. *Scientometrics*, **125**(1): 819–822. doi:10.1007/s11192-020-03661-9. PMID:32836531.
- Steffen, W., Crutzen, P.J., and McNeill, J.R. 2007. The Anthropocene: are humans now overwhelming the great forces of nature? *Ambio*, **36**: 614–621. doi:10.1579/0044-7447(2007)36[614:TAAHNO]2.0.CO;2. PMID:18240674.
- Steffen, B., Egli, F., Pahle, M., and Schmidt, T.S. 2020. Navigating the clean energy transition in the COVID-19 crisis. *Joule*, **4**(6): 1137–1141. doi:10.1016/j.joule.2020.04.011. PMID:32352076.
- Stinson, J., and Lunstrum, E. 2020. Coronavirus closures could lead to a radical revolution in conservation. *The Conversation*. Available from <https://theconversation.com/coronavirus-closures-could-lead-to-a-radical-revolution-in-conservation-137050?fbclid=IwAR0fL67k3oPSMmyEakCZ9sOA1-TGaFMo1kozZUASfjdpyty6UO9BYvnRE0>.
- Sutherland, W.J., Shackelford, G., and Rose, D.C. 2017. Collaborating with communities: co-production or co-assessment? *Oryx*, **51**(4): 569–570. doi:10.1017/S0030605317001296.
- Tandon, R. 2020. COVID-19 and mental health: preserving humanity, maintaining sanity, and promoting health. *Asian J. Psychiatr.* **51**: 102256. doi:10.1016/j.ajp.2020.102256. PMID:32586624.
- Thomas, L. 2020. Intersectional environmentalism: Why environmental justice is essential for a sustainable future. Available from <https://www.thegoodtrade.com/features/environmental-justice>.
- Tokar, T., Jensen, R., and Williams, B.D. 2021. A guide to the seen costs and unseen benefits of e-commerce. *Business Horizons*. doi:10.1016/j.bushor.2021.01.002.
- Tricco, A.C., Garrity, C.M., Boulos, L., Lockwood, C., Wilson, M., McGowan, J., et al. 2020. Rapid review methods more challenging during COVID-19: commentary with a focus on 8 knowledge synthesis steps. *J. Clin. Epidemiol.* **126**: 177–183. doi:10.1016/j.jclinepi.2020.06.029. PMID:32615209.
- Uddin, M.N., Alam, B., Islam, S.S., Arif, M., Alam, M.M., and Kabir, S.L. 2020. Impact of COVID-19 on food safety and security in low and middle income countries. *Asian J. Med. Biol. Res.* **6**(2): 130–137. doi:10.3329/ajmbr.v6i2.48043.
- Van Bavel, J.J.V., Baicker, K., Boggio, P.S., Capraro, V., Cichocka, A., Cikara, M., et al. 2020. Using social and behavioural science to support COVID-19 pandemic response. *Nat. Hum. Behav.* **4**: 460–471. doi:10.1038/s41562-020-0884-z. PMID:32355299.
- van der Linden, S. 2015. The conspiracy-effect: Exposure to conspiracy theories (about global warming) decreases pro-social behavior and science acceptance. *Pers. Individ. Differ.* **87**: 171–173. doi:10.1016/j.paid.2015.07.045.
- Van Lange, P.A., Joireman, J., Parks, C.D., and Van Dijk, E. 2013. The psychology of social dilemmas: A review. *Organ. Behav. Hum. Decis. Process.* **120**(2): 125–141. doi:10.1016/j.obhdp.2012.11.003.
- van Schalkwyk, M.C., Hird, T.R., Maani, N., Petticrew, M., and Gilmore, A.B. 2020. The perils of preprints. *BMJ*, **370**: m3111. doi:10.1136/bmj.m3111. PMID:32816814.
- Veríssimo, D., Vaughan, G., Ridout, M., Waterman, C., MacMillan, D., and Smith, R.J. 2017. Increased conservation marketing effort has major fundraising benefits for even the least popular species. *Biol. Conserv.* **211**: 95–101. doi:10.1016/j.biocon.2017.04.018.
- Vitousek, P.M., Mooney, H.A., Lubchenco, J., and Melillo, J.M. 1997. Human domination of Earth's ecosystems. *Science*, **277**(5325): 494–499. doi:10.1126/science.277.5325.494.
- Vlasschaert, C., Topf, J., and Hiremath, S. 2020. Proliferation of papers and preprints during the COVID-19 pandemic: Progress or problems with peer review? *Adv. Chronic Kidney Dis.* **27**: 418–426. doi:10.1053/j.ackd.2020.08.003. PMID:33308508.
- Washburn, A.N., and Skitka, L.J. 2018. Science denial across the political divide: liberals and conservatives are similarly motivated to deny attitude-inconsistent science. *Soc. Psychol. Person. Sci.* **9**(8): 972–980. doi:10.1177/1948550617731500.
- Watson, A.E. 2004. Human relationships with wilderness: The fundamental definition of wilderness character. *Int. J. Wildern.* **10**(3): 4–7.
- Weible, C.M., Nohrstedt, D., Cairney, P., Carter, D.P., Crow, D.A., Durnová, A.P., et al. 2020. COVID-19 and the policy sciences: initial reactions and perspectives. *Policy Sci.* **53**: 225–241. doi:10.1007/s11077-020-09381-4.
- Wood, C.L., Lafferty, K.D., DeLeo, G., Young, H.S., Hudson, P.J., and Kuris, A.M. 2014. Does biodiversity protect humans against infectious disease? *Ecology*, **95**(4): 817–832. doi:10.1890/13-1041.1. PMID:24933803.
- Woolf, S.H., Chapman, D.A., Sabo, R.T., Weinberger, D.M., and Hill, L. 2020. Excess deaths from COVID-19 and other causes, March–April 2020. *JAMA*, **324**(5): 510–513. doi:10.1001/jama.2020.11787. PMID:32609307.
- World Health Organization. 2020. World Health Organization's epidemic information network. Available from <https://www.who.int/teams/risk-communication/employers-and-workers> [accessed 2 November 2020].
- WWF. 2020. *Living Planet Report 2020 — Bending the curve of biodiversity loss*. Edited by R.E.A. Almond, M. Grooten, and T. Petersen. WWF, Gland, Switzerland.
- York, R., Rosa, E.A., and Dietz, T.D. 2002. Bridging environmental science with environmental policy: Plasticity of population, affluence, and technology. *Soc. Sci. Q.* **83**(1): 18–34. doi:10.1111/1540-6237.00068.
- Young, O.R., King, L.A., and Schroeder, H. 2008. *Institutions and environmental change: principal findings, applications, and research frontiers*. MIT Press, Cambridge, Mass., USA.
- Zambrano-Monserrate, M.A., Ruano, M.A., and Sanchez-Alcalde, L. 2020. Indirect effects of COVID-19 on the environment. *Sci. Total Environ.* **728**: 138813. doi:10.1016/j.scitotenv.2020.138813. PMID:32334159.