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Transformative change for biodiversity requires more inclusive and participatory framing of research agendas

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Abstract

Science plays a crucial role in identifying transformative change trajectories that are positive for biodiversity and human well-being. The concept of transformative change for biodiversity is receiving increased attention both within the political as well as in the scientific arena, but what transformative change entails still remains scientifically unclear. In this paper we report on a research priority exercise undertaken at the 2022 Altnet conference in which conference participants within each session were asked to jointly propose research gaps relevant to transformative change. Thirteen research priorities are identified, emphasising the need to learn from doing through transdisciplinary participatory action research, involving multiple disciplines including social sciences and building on existing research on, for example, nature-based solutions, OneHealth and climate change. The identified research priorities were later analysed under the umbrella of transformative change principles as a proxy for science to act as a lever to realise transformative change for biodiversity. Mobilising scientific research, interdisciplinarity and co-construction with stakeholders and decision-makers is a necessary step forward to make transformative progress in developing the biodiversity research agenda. In this respect, transformative action by the scientific community to develop the research agenda in an all-inclusive participatory process can be seen as a lever of transformative change for biodiversity. Such an all-inclusive participatory process for the development of a long-term biodiversity research agenda is in accordance with building on an integrated and whole-of-society approach as included in the EU Biodiversity Strategy's aims and priorities around enabling transformative change.

Keywords Transformative change · Biodiversity · Research priorities · Science-policy interface · Transdisciplinary action research

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Introduction

“Give me a laboratory and I will raise the world” (Latour 1983) conveys the crucial role of science in helping humanity address its environmental, climate and social crises. The role of science is to increase our knowledge, improve education, tackle challenges and ultimately increase the quality of our lives. Science should play a key role in identifying transformative change trajectories that are positive for biodiversity¹ and human well-being. The challenge, however, is to identify the knowledge gaps needed for transformative change—and to reflect and address how those knowledge gaps are identified, in line with the ethos of transformative change. The aim of this paper is to present a set of research priorities proposed by participants at an Alternet conference on transformative changes for biodiversity and health in June 2022.

The need for transformative change for biodiversity was put forward in the IPBES Global Assessment Report on Biodiversity and Ecosystem Services (IPBES 2019), in which transformative change is defined as a fundamental, system-wide reorientation of technological, social, and economic structures that tackle not only direct but also indirect drivers of biodiversity loss (IPBES 2019). Although various other influential reports have also made a case for transformative change (EEA 2019; IPCC 2018; UNEP 2019), the concept of transformative change for biodiversity is receiving increased attention both within the political² as well as in the scientific arena.³ Transformative change is now recognised and integrated into many EU member states’ and the EU’s biodiversity strategies, as well as at the global level by IPBES, albeit to a lesser extent in the recently adopted Kunming-Montreal Global biodiversity framework decision submitted by the President of the Convention on Biological Diversity (CBD 2022). This attention has resulted in several new research initiatives on different understandings of the concept and on a variety of potential pathways and trajectories of transformative change to reach a positive outcome for biodiversity (Wyborn et al. 2020). What positive trajectories for transformative change for biodiversity actually entail, however, still remains scientifically intangible. International ambitions have moved beyond ‘mainstreaming’ biodiversity towards, among others, ‘transformative governance’ to unlock transformations for sustainable futures (Razzaque et al. 2019; Visseren-Hamakers et al. 2021), but little has been done on addressing the role of science in supporting these ambitions.

¹ Throughout this paper positive for nature or positive for biodiversity refers to the aim to halt the loss of biodiversity before 2030, reverse the loss of biodiversity, and live in harmony with nature by 2050 as described in both the Global Biodiversity Framework (CBD 2021) as the EU Biodiversity Strategy for 2030 (European Commission 2020).

² Transformative Change is for instance included in the EU Biodiversity Strategy for 2030 which was published within the framework of the EU Green Deal by the European Commission in May 2020. The publication is a key policy document for the future of Europe: the 2030 Biodiversity Strategy. It is the roadmap for the next 10 years regarding EU nature objectives (EUROPARC Federation, EU 2030 Biodiversity Strategy—EUROPARC Federation).

³ Within the Horizon Europe research and innovation funding programme until 2027 the work programme 2023/24 cluster 6 (Food, Bioeconomy, Natural Resources, Agriculture and Environment) uses the wording transformative change (incl transformative action) 36 times throughout the document (referring to transformative change in general 35 times and transformative arts, governance, research three times). The same document uses the wording transformation 77 times (varying from socioeconomic transformation, digital transformation, food system transformation etc.). see wp-9-food-bioeconomy-natural-resources-agriculture-and-environment_horizon-2023-2024_en.pdf (europa.eu).

The EU Commission's Directorate-General for Research and Innovation (DG-RTD) recognises that research on a societal and political framework is necessary to achieve the transformation needed and will therefore emphasise the role of the social sciences and humanities, gender, inter/transdisciplinary and systems approaches as well as building on existing research infrastructures (see Cluster 6: Food, Bioeconomy, Natural Resources, Agriculture and Environment (europa.eu)). The long-term biodiversity research agenda, mentioned in the EU Biodiversity Strategy (European Commission 2020), therefore needs to use its potential to contribute to a transformative agenda. However, the challenge for science to contribute to the transformative agenda is that transformative change is subject to normativity, where actions or outcomes are perceived as good and desirable versus other actions that are considered bad or undesirable based on existing worldviews.

In this paper we discuss a process of developing the biodiversity research agenda so that it can legitimately support the transformative change agenda while not losing credibility in leading to robust scientific progress. We highlight critical areas where the creation and implementation of the biodiversity research agenda could fundamentally be transformed for enhancing transformative change for biodiversity. In early 2022 the IPBES launched the Transformative Change Assessment which aims at offering practical options for concrete actions to foster, accelerate and maintain the transformative change necessary for a more sustainable future. Our paper contributes to these concrete actions in the context of setting the research agenda as a necessary pathway to gain knowledge on transformative change for biodiversity. It also contributes to the debate around which pathways of transformative change we need to take to achieve positive outcomes and how this could be incorporated into the development of the long-term biodiversity research agenda to enhance transformative change for biodiversity.

The role of the biodiversity research agenda and the research community for enhancing transformative change for biodiversity

The transformative change agenda aims to lead to positive outcomes for biodiversity and is embedded in the Global Biodiversity Framework of the Convention of Biological Diversity (CBD), with halting the loss of biodiversity by 2030 as overarching goal and living in harmony by 2050 as vision (CBD/COP/15/L.25). As such, developing the long-term biodiversity research agenda is essential for making progress in reaching this goal and vision. The success of the EU Biodiversity Strategy for 2030 is already acknowledged as being dependent on the effective implementation of science-based policies (European Commission Directorate-General for Research Innovation 2021). Science, taken here to mean the pursuit and application of knowledge and understanding of the natural and social world following a systematic methodology based on evidence, often proceeds while concepts and their practical applications remain rather unclear, as in the case of nature-based solutions (NBS) that have been promoted as a key tool for solving diverse environmental and societal problems (Sowińska-Świerkosz and García 2022). Thus, even though transformative change is unlikely to be fully planned or anticipated, effective governance (and thus policies and strategies) is needed to enable it (Bulkeley et al. 2020). However, changes in policy instruments and settings may not automatically result in paradigmatic, transformative change (Hall 1993). Mobilising biodiversity strategies should thus be seen as necessary, but not sufficient to instigate transformative change (Bulkeley et al. 2020) and a different approach to developing the science agenda and conducting science may be needed. Given

the inherently non-linear and unpredictable character of transformative change, a blueprint or recipe with clearly defined endpoints is neither possible nor, possibly, desirable (Turnhout et al. 2021). Alternatively, far-reaching transformative change could be nurtured, nudged and navigated by creating fertile ground for it, providing situation-specific stimuli, seizing opportunities and recognizing obstacles on the way (Wittmer et al. 2021). According to Turnhout et al. (2021) an inclusive and integrated approach is needed that accounts for complexity and uncertainty while tracking progress, impacts, and trade-offs. Thus the design, implementation and monitoring of strategies and actions for transformative change will require substantial research effort and support by the scientific community, including funding organisations.

The understanding of the different approaches in transformative change research (Avelino et al. 2017) and the different levers and leverage points (Bulkeley et al. 2020) have introduced us to a new era in which we can expect an increase in funding for research projects containing different uses and interpretations of what transformative change may entail. For example, the EU 2030 Biodiversity strategy (European Commission 2020) speaks of enabling transformative change through a new governance framework, stepping up implementation and enforcement of EU environmental legislation and building on an integrated and whole-of-society approach including different business models, pricing and valuation models and by improving knowledge, education and skills, all of which would be underpinned by sound science. The Horizon Europe research programme (the EU's key funding programme for research and innovation until 2027) will include a long-term strategic research agenda for biodiversity, combined with the development of a science policy mechanism for research-based options for ratcheting up the implementation of biodiversity commitments. This mechanism, or Science Service for biodiversity, is being developed by the Horizon Europe project BioAgora (<https://bioagora.eu/>). One potential function of the future Science Service will be horizon scanning and the type of exercise described here is a potential model for this function.

Transformative change requires us to address deep leverage points, i.e. the places for interventions in a system, which are deeply rooted in the causes of unsustainability, rather than shallow ones, i.e. the places for easily implementable interventions (Abson et al. 2017). In implementing such deep interventions and thus bringing about transformative change, the potential of the research agenda for transformative change requires pragmatic approaches to ensuring sound scientific progress along with the integrity and diversity of the politics to which research agendas are linked. One important challenge is that scientists are still broadly perceived—and perceive themselves—as being objective and value-free fact-producers for decision-makers (Ott and Kiteme 2016) something that collides with the normative character of transformative change, while policy plays a fundamental role in reorienting science and research toward, for instance, more participative, multi-stakeholder, and transdisciplinary approaches (Bulkeley et al. 2020).

Advancing transformative change through all-inclusive participatory processes in identifying and structuring the research agenda

As highlighted earlier in this paper, the call for transformative change is seen as necessary to halt the loss of biodiversity while also contributing to other societal challenges, such as health, climate and pollution. Furthermore, given the links between human health and biodiversity (Zinsstag et al. 2023), a radical transformation of socio-ecological structures

towards a vision of sustainability and resilience is needed—one that enhances the well-being of humans and the biosphere. This requires the support of a long-term biodiversity research agenda, which led Alternet (www.alterneteurope.eu) to contribute to identifying the scientific needs for transformative change. A major role of Alternet is to bring natural and social science researchers from a wide range of European countries together to integrate their understanding of biodiversity, ecosystems, and the services they provide to society, thereby creating a platform for meaningful communication with policymakers and the public. Furthermore, since 2021, Alternet hosts the management of the Eklipse mechanism (www.eklipse.eu) as part of its commitment to the science-policy interface where Eklipse supports governments, institutions, businesses, and NGOs to make better-informed decisions on biodiversity and ecosystem services in Europe (Watt et al. 2019).

In June 2022 the fifth Alternet conference entitled “Transformative Changes for Biodiversity and Health” took place in Belgium. The conference focussed on how interdisciplinary research can contribute to the transformative change agenda in biodiversity and health and what new perspectives on research and policy may advance our knowledge on biodiversity and health. Specific questions addressed during the conference were where and why do the benefits of biodiversity for ecological and human health arise and how can they be achieved? How and where can transformative change enable these benefits, including ensuring justice and equity? How can human-nature health solutions be developed? How can the adoption of these transformative biodiversity and human health solutions by society and communities be achieved, for example by transforming food systems?

Early and late career scientists of all disciplines from 53 institutes (scientific and non-scientific) (Supplementary material, Table 1) attended the conference and over three days twelve sessions were held (Supplementary material, Table 1). Two to four specific research gaps relevant to transformative change were proposed in each session. During the final session, all research gaps were presented to the conference participants who, through Mentimeter (online interactive real-time voting platform and presentation software, <https://www.menti.com>) were asked to prioritise the research gaps according to their understandings and perceptions. Appendix 1 (Supplementary material) describes the process in detail and provides a full list of the research needs identified in each of the sessions (A to L) together with the results of the voting sessions. The twelve prioritised research gaps with the highest number of votes (in Appendix 1, highlighted in green for each session) were again given to the participants with the request to prioritise them from 1 being the highest priority to 12 the lowest priority. Finally, we asked the participants to come up with additional research gaps not previously addressed, which resulted in an additional research gap (number 13). Table 1 gives the research gaps in hierarchical order with the highest to lowest priority.

As the next and final step for this paper, we considered the six core principles of transformation according to Bulkeley et al. (2020), which need to be embedded through the Global Biodiversity Framework to achieve the kinds of transformative change required to advance goals for biodiversity on the ground. We assigned these six principles for transformative change to the 13 research gaps and analysed which of the principles were addressed in the specific research gap, as a proxy for science to act as lever to realise transformative change for biodiversity (Table 1). Three of the research gaps could not be assigned to one of the six principles (i.e. No 1 “Analyse transformative change processes and outcomes to better track and learn from experiments on transformative change”, No 12 “Understand the impacts of climate change, combined with biodiversity loss, on the emergence of zoonotic emergence”, No 13 “Exploring the real reasons/reasoning that push people to care about natural resources, including insights from behavioural economics, psychology etc.”, Table 1). However, both No 1 and No 13 are relevant to the work currently

Table 1 Overview of the research gaps with their priority rank (1 is highest prioritised, 12 is lowest prioritised, 13 is a research gap which hadn't been mentioned before and which received most of the votes

Priority	Research gap	Original session	Addressing the principles of transformative change (1–6) (Bulkeley et al. 2020), or contributing to the IPBES Transformative Change assessment (TC), IPBES Nexus assessment
1	Analyse transformative change processes and outcomes to better track and learn from experiments on transformative change	Actionize Scientific Knowledge	IPBES TC
2	Better understand the sociology of prevention, i.e. how do we convince people that prevention is better and cheaper than cure	Invasive species and their impact on Human and Ecosystem Health	E
3	Understand how nature-based solutions can be integrated into community wealth building/nature-positive economies in a way that is equitable, inclusive, and co-creative	Making Cities Biodiverse	B, C, D, E
4	Increase opportunities for transdisciplinary participatory action research beyond interdisciplinary research. Research must be co-constructed with the key actors of the food chains. In particular, as a lack of connection between actors willing to transform the food chains for sustainability has been identified as one of the main lock-ins, participatory action research must help reconnect these actors, in a variety of territories	Time for a change of food systems	E, F
5	Investigate how engaging citizens in science would empower their sense of agency to act on global challenges within their own area of influence? In particular, how can young researchers be included in this process?	Transdisciplinary Education	E
6	Develop ways to reinforce positive environmental attitudes to pave the way to transformative change, including citizen science schemes, environmental education and nature engagement which lead to the construction of environmental citizenship that can satisfy this need	Transforming our Perceptions of Human-Nature Relationships for Transformative Changes	E, F

Table 1 (continued)

Priority	Research gap	Original session	Addressing the principles of transformative change (1–6) (Bulkeley et al. 2020), or contributing to the IPBES Transformative Change assessment (TC), IPBES Nexus assessment
7	Instigate trans-disciplinary analysis of connecting human health with biodiversity to support governance, drawing on ecology, health science and political science/administrative studies/legal studies, and engaging land-use planning and natural resource management	Biodiversity and Human Health	C, D, E
8	Implement practical incentives for those involved in research on transformative change and investigate how to improve co-creation: Are the key actors of change-impact involved in transformative change? Are women adequately included? How much should people be paid for participation? How can we improve the narrative?	How to research transformative change?	E
9	Research messages and stories on the importance of sustainable food changes that resonate with all people regardless of their political associations, cultural background, or other parameters	Public Food Procurement as driver of Food Systems	E, F
10	Develop research that addresses the different components of one health in an integrated and systematic way, searching for general trends of interactions between all health (human health, ecosystem health etc.)	Biodiversity and Ecological Health	D
11	Analyse cascading risks that cross system boundaries and their governance at different levels (national, EU, global)	Governing System-Level Risks	B
12	Understand the impacts of climate change, combined with biodiversity loss, on the emergence of zoonotic emergence	Sustainable food system and Zoonotic diseases Emergence	IPBES Nexus
13	Exploring the real reasons/reasoning that push people to care about natural resources, including insights from behavioural economics, psychology etc	Chosen as additional research gap which was not addressed before in the different session	IPBES TC

If the research gap addresses one or more principles of transformative change the number(s) of principle(s) are given in the final column with A = Address root causes, B = Take multiple paths, C = Expand action arena, D = Realise diverse co-benefits, E = Design deliberative and inclusive processes, F = Adopt proactive approach to resistance

undertaken in the IPBES Transformative Change assessment while No 12 is relevant to the work in the currently undertaken IPBES Nexus assessment. Of the nine remaining research gaps, seven address the co-creating, all-inclusive and participation principle (E) and two of these seven also address the proactive approach to resistance (F). The seven gaps all mention some form of nature-based solutions and/or citizen science and have an interdisciplinarity character. The two research gaps not addressing co-creating, all-inclusiveness and participation together or without the proactive approach to resistance both focus on interdisciplinary science combining different disciplines (D) and taking multiple paths including different sectors (e.g. health, energy, agriculture) (B) (Table 1).

Discussion

Transformative action by the scientific community to develop the research agenda in an all-inclusive participatory process can be seen as a lever of transformative change for biodiversity (Gosselin et al. 2020). However, according to Scholz (2017), working on normative societal missions (in his case sustainable transitions and in our case transformative change for biodiversity), scientists may promote and lobby for specific forms of this transition if they create certain real-world labs and promote certain types of transitions. Thus, scientists' values and social norms are an important factor if we look at the decision to participate in such a transition process where scientists become initiators of and catalysts for sustainable transitioning (Scholz 2017). In addition, when 'business as usual' pathways do not seem to provide the desired benefits, researchers, policy advisors and policy makers look for feasible solutions and potential pathways that would enable them to achieve their aspirations when it comes to contributing to the transformative change agenda. Advancing science using participatory processes thus requires diverse approaches and capacities towards not only securing scientific progress benefiting biodiversity but also human well-being and enhancing positive transformative change. So, the ultimate question is what constitutes positive transformative change at the level of biodiversity science?

In this paper we report on 13 research priorities, the top three being to: analyse transformative change processes and outcomes to better track and learn from experiments on transformative change; better understand the sociology of prevention, i.e. how do we convince people that prevention is better and cheaper than cure; and understand how nature-based solutions can be integrated into community wealth building/nature-positive economies in a way that is equitable, inclusive, and co-creative. An over-arching recommendation emerging from these and the other proposed priorities is that the long-term biodiversity research agenda should be built around a framework which emphasises sharing and promoting application of best practice and lessons learned to further develop and implement transformative change. A particular focus should therefore be on learning from doing through, for example, transdisciplinary participatory action research, and through innovation oriented to enhance biodiversity in and across different sectors. This could contribute to capturing the opportunities nature offers for alternative pathways and learning how resistance from vested interest can be overcome in addressing root causes. Such a framework opens up broader participation of the scientific community and emancipates knowledge gap creation for future production of actionable knowledge with transformative potentials. The challenge in the case of transformative change for biodiversity knowledge is that as it moves from generation and transmission to use this implies the need for democratic processes such as all-inclusive participation

processes to incorporate the exchange of lessons learned. By taking an all-inclusive participatory approach it may also help to solve the problem of the power plays of influential actors shaping the current science-policy interface by bringing them together with the broad scientific community in an equitable, transparent and inclusive manner. Because scientists alone cannot know what to do with the scientific knowledge gained, particularly how it could be used to develop and implement transformative change, we need an alignment with the policy arena and other users of scientific knowledge.

An all-inclusive participatory process for the development of a long-term biodiversity research agenda is in accordance with building on an integrated and whole-of-society approach as included in the EU Biodiversity Strategy's aims and priorities around enabling transformative change. According to this Strategy, action against biodiversity loss must be underpinned by sound science and the future Horizon Europe programme will include a long-term strategic research agenda for biodiversity (European Commission 2020). In addition, IPBES is working on the thematic assessment of the interlinkages among biodiversity, water, food and health (i.e. the Nexus Assessment) which will have strong links to IPBES's thematic assessment of the underlying causes of biodiversity loss, determinants of transformative change and options for achieving the 2050 vision for biodiversity (i.e. the currently undertaken Transformative Change Assessment). For both assessments our recommendations offer practical options for concrete action to foster, accelerate and maintain the long-term biodiversity research agenda, including the necessary societal transformation for biodiversity to a more sustainable future. Future effort is also needed on the monitoring of the impact of research on the actual achievement of transformative change for biodiversity.

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Declarations

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References

- Abson DJ, Fischer J, Leventon J, Newig J, Schomerus T, Vilsmaier U, von Wehrden H, Abernethy P, Ives CD, Jager NW, Lang DJ (2017) Leverage points for sustainability transformation. *Ambio* 46:30–39. <https://doi.org/10.1007/s13280-016-0800-y>
- Avelino F, Wittmayer JM, Kemp R, Haxeltine A (2017) Game-changers and transformative social innovation. *Ecol Soc*. <https://doi.org/10.5751/ES-09897-220441>
- Bulkeley H, Kok M, van Dijk JJ, Forsyth T, Nagy G, Villasante S (2020) Moving towards transformative change for biodiversity: harnessing the potential of the post-2020 global biodiversity framework. An EKLIPSE Expert Working Group report. UK Centre for Ecology & Hydrology, p 48
- CBD (2021) First draft of the post-2020 global biodiversity framework. CBD/WG2020/3/3
- CBD (2022) Final text of Kunming-Montreal Global Biodiversity Framework. CBD/COP/15/L25
- EEA (2019) Sustainability transitions: policy and practice. European Environment Agency, Luxembourg
- European Commission (2020) Communication from the commission to the European Parliament, the Council, Eht European Economic and Social Committee and the Committee of the Regions. EU Biodiversity Strategy for 2030—Bringing nature back into our lives
- European Commission Directorate-General for Research Innovation (2021) Science at the service of biodiversity. Publications Office
- Gosselin F, Galanaki A, Vandewalle M, Van Dijk J, Varumo L, Ventocilla J, Watt A, Young J (2020) Key messages from the scientific community for the EU post 2020 biodiversity strategy—elaboration of the multi-phased, iterative and consultative elicitation of scientific expertise (MICESE) method. *Sustainability* 12:2385
- IPBES (2019) Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. In: Brondizio ES, Settele J, Díaz S, Ngo HT (eds) IPBES secretariat. Bonn, Germany, p 1148
- IPCC (2018) Global warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty. In: Masson-Delmotte V, Zhai P, Pörtner H-O, Roberts D, Skea J, Shukla PR, Pirani A, Moufouma-Okia W, Péan C, Pidcock R, Connors S, Matthews JBR, Chen Y, Zhou X, Gomis MI, Lonnoy E, Maycock T, Tignor M, Waterfield T (eds) Summary for policymakers. World Meteorological Organization, Geneva, p 32
- Latour B (1983) Give me a laboratory and i will raise the world. SAGE Publications Ltd, New Delhi
- Ott C, Kiteme B (2016) Concepts and practices for the democratisation of knowledge generation in research partnerships for sustainable development. *Evid Policy* 12:405–430. <https://doi.org/10.1332/174426416x14700793045951>
- Razzaque J, Visseren-Hamakers I, Gautam AP, Gerber LR, Islar M, Karim MS, Kelemen E, Liu J, Lui G, McElwee P, Mohammed AJ, Mungatana ED, Muradian R, Rusch GM, Turnhout E, Williams M, Chan I, Fernandez-Llamazares A, Lim M (2019) Chapter 6. Options for decision makers. In: Brondizio ES, Settele J, Díaz S, Ngo HT (eds) Global assessment report of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. IPBES secretariat, Bonn, pp 880–964
- Scholz RW (2017) The normative dimension in transdisciplinarity, transition management, and transformation sciences: new roles of science and universities in sustainable transitioning. *Sustainability* 9:991
- Sowińska-Świerkosz B, García J (2022) What are nature-based solutions (NBS)? Setting core ideas for concept clarification. *Nat-Based Solut* 2:100009. <https://doi.org/10.1016/j.nbsj.2022.100009>
- Turnhout E, McElwee P, Chiroleu-Assouline M, Clapp J, Isenhour C, Kelemen E, Jackson T, Miller DC, Rusch GM, Spangenberg JH, Waldron A (2021) Enabling transformative economic change in the post-2020 biodiversity agenda. *Conserv Lett* 14:e12805. <https://doi.org/10.1111/conl.12805>
- UNEP (2019) Global Resources Outlook 2019. Natural resources for the future we want. United Nations Environment Programme
- Visseren-Hamakers IJ, Razzaque J, McElwee P, Turnhout E, Kelemen E, Rusch GM, Fernández-Llamazares Á, Chan I, Lim M, Islar M, Gautam AP, Williams M, Mungatana E, Karim MS, Muradian R, Gerber LR, Lui G, Liu J, Spangenberg JH, Zaleski D (2021) Transformative governance of biodiversity: insights for sustainable development. *Curr Opin Environ Sustain* 53:20–28. <https://doi.org/10.1016/j.cosust.2021.06.002>
- Watt A, Ainsworth G, Balian E, Cojocarú G, Darbi M, Dicks L, Eggermont H, Furman E, Goudeseune L, Huybrecht P, Kelemen E, Koch F, Konstantinou Z, Livoreil B, Locher K, Lux A, Mehring M, Nesshoever C, Paloniemi R, Saarikoski H, Pinto IS, Vandewalle M, Varjopuro R, Varumo L, Wittmer H, Young J (2019) EKLIPSE: engaging knowledge holders and networks for evidence-informed European

- policy on biodiversity and ecosystem services. *Evid Policy* 15:253–264. <https://doi.org/10.1332/174426418x15314036194114>
- Wittmer HBA, Büttner L, Chakrabarty R, Förster J, Khan S, König C, Krause G, Kreuer D, Locher-Krause K, Moreno Soares T, Muñoz Escobar, M., Neumann, M., Renner I, Rode J, Schniewind I, Schwarzer DTU, Zingrebe Y, Spiering S (2021) Transformative change for a sustainable management of global commons—biodiversity, forests and the ocean. Recommendations for international cooperation based on a review of global assessment reports and project experience. UFZ, Leipzig, Germany, pp 154
- Wyborn C, Davila F, Pereira L, Lim M, Alvarez I, Henderson G, Luers A, Martinez Harms MJ, Maze K, Montana J, Ryan M, Sandbrook C, Shaw R, Woods E (2020) Imagining transformative biodiversity futures. *Nat Sustain* 3:670–672. <https://doi.org/10.1038/s41893-020-0587-5>
- Zinsstag J, Kaiser-Grolimund A, Heitz-Tokpa K, Sreedharan R, Lubroth J, Caya F, Stone M, Brown H, Bonfoh B, Dobell E, Morgan D, Homaira N, Kock R, Hattendorf J, Crump L, Mauti S, del Rio VV, Saikat S, Zumla A, Heymann D, Dar O, de la Rocque S (2023) Advancing one human–animal–environment Health for global health security: what does the evidence say? *The Lancet*. [https://doi.org/10.1016/S0140-6736\(22\)01595-1](https://doi.org/10.1016/S0140-6736(22)01595-1)

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