Novel Natures – New technologies and conflicts in nature conservation.

An introduction to the Special Focus

Natural environments are undergoing significant changes due to human influences. At the same time, new technologies are emerging with the promise to provide solutions to environmental crises. This Special Focus on Novel Natures – New technologies and conflicts in nature conservation *emphasizes the need for in-depth debates about human relationships with natural environments and technologies. Under the heading of* novel natures, *we want to open the floor for cross-disciplinary debate, preparing the ground for conscientious, well-informed, and equitable decision-making in nature conservation and restoration.*

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In the past decades, an interdisciplinary debate about humanity's novel capacities to alter its planetary environment has coalesced around the concept of the "Anthropocene". The term has become a shorthand to describe accumulating anthropogenic environmental crises. Biodiversity loss and ecosystem deterioration advance rapidly, and climate change will alter ecosystems in ways that are difficult to predict (IPBES 2019). While these and other environmental issues are often the unplanned side-effects of human economic and technological endeavors, they are also the consequence of dominant ideas about the natural world as an exploitable resource. Anthropogenic environmental crises are not a new phenomenon. Nevertheless, the accumulation and acceleration of human-induced alterations have created a situation where it becomes necessary to rethink notions of stability in nature conservation. On a rapidly warming planet, traditional goals to preserve or restore historical "natural" conditions are being reassessed. In recent years, we therefore have seen the debate about the ideas of nature that guide nature conservation and restoration flare up, leading to calls to adjust management (e. g., Higgs et al. 2018).

Novel ideas about nature are also related to changes in knowledge regimes. Developments in scientific methods offer novel perspectives on the natural world. For example, genomic analyses have revealed human-induced processes in nature that previously went unnoticed, such as the ongoing hybridization of wild and domesticated cats, potentially leading to a "silent disappearance" of wild cats in their previous form (Quilodrán et al. 2020). In addition, technological advances open up new possibilities for intervening in nature. One example is de-extinction, that is, the "resurrection" of species using cloning techniques (e. g., Searle 2022). These new areas of research and possibilities for biotechnological intervention in turn raise significant questions about the aims and strategies of nature conservation. They also bring into focus the importance of carefully engaging with ideas of human agency in the Anthropocene. On the one hand, novel scientific findings reveal new aspects of the reach of human influence. In many cases, humans have directly or indirectly contributed to novel phenomena, but have not exercised active control over these developments. On the other hand, novel technologies promise to greatly expand the possibilities for management of the environment and thus of active human control over the natural world. These two aspects come together in changing perspectives on naturalness, and in concepts that highlight the ways in which humans are intertwined with non-human beings and their shared environments.

In this Special Focus, we aim to broaden interdisciplinary debates about the impact various forms and ideas of novelty have on nature conservation and restoration. The contributions are inspired by discussions at the symposium *Novel Natures? New technologies and conflicts in nature conservation* held in Hannover, Germany, in July 2022. The symposium brought together an interdisciplinary group of researchers from the social and natural sciences and the humanities, as well as stakeholders from NGOs

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and administration. As organizers, our intention was to stimulate transdisciplinary debates on the status and the future of nature conservation in the face of novelty and new technologies.

Novel natures, novel ecosystems, and invasive species

In the opening article, ***Montana et al. (2024, in this issue, pp. 146–151)*** propose *novel natures* as an umbrella term for considering the interconnections between novel phenomena, such as historically unprecedented combinations of species and abiotic conditions, and cultural and philosophical ideas that determine how novelty in the natural world is perceived and valued. In restoration ecology, the concept "novel ecosystems" is used to describe ecosystems that do not have historical analogues, such as ecosystems that spontaneously form on abandoned surface mines. The related concept of "ecological novelty" covers additional aspects of novelty occurring in nature, such as interactions between species which have not previously co-occurred. These concepts, however, are intended to address exclusively the ecological dimensions of environmental alterations. The term *novel natures* brings in perspectives that highlight that such novel states in natural environments are intertwined with societal processes. Novel phenomena in natural environments bring about shifts in social perceptions and normative evaluations, and vice versa, sociocultural processes can induce novelty in nature. The term *novel natures* suggested by Montana et al. is intended to add this missing layer of naturecultural[1] interactions. The introduction of this term, therefore, is meant to foster cross-disciplinary debates on different kinds of novelty – and changing notions of nature –, which prepare the ground for deliberate and equitable decision-making in nature conservation and restoration.

The importance of debates about different ecological, social and normative notions of novelty is highlighted by persistent discussions about the evaluation of invasive species in nature conservation and restoration. In their contribution, ***Kung et al. (2024, in this issue, pp. 152–157)*** argue that longstanding discourses about invasive species as a threat need to be reconsidered, given that irreversible ecosystem changes become more common and resources for conservation remain limited. According to Kung et al., the concept of "novel ecosystems" offers a counter-narrative, which opens the space for rethinking the role of invasive species in nature conservation and restoration. The authors refer to the example of species which are beginning to inhabit cities while at the same time encountering a loss of their former habitats, for example due to pollution or climate change. The existence of "ecological refugees", they argue, indicates the importance of future-oriented concepts, which enable a change in attitudes towards novel species compositions, leading to more progressive policies and environmental management.

New technologies and nature conservation

As the example of genomic data highlights, the development of new technological apparatuses is closely connected to new forms of knowledge, which in turn are key aspects of how scientists and societies understand the natural world. In particular the production of novel living entities in the laboratory has challenged traditional binary distinctions, for example between human and non-human, and between natural and artificial (e. g., Karafyllis 2003, p. 16, Hinterberger 2020, Kelz 2020). Until recently, societal and academic debates about biotechnologies have focused mostly on biomedical and agricultural applications. While the agricultural use of genetically modified organisms (GMOs) has been a topic in nature conservation communities, the primary focus of these discussions has been on possible indirect or unintended consequences of agricultural GMOs on ecosystems, such as the possible outcrossing of GM crops to their wild relatives. In recent years, however, research into the possibilities of employing biotechnologies for nature conservation purposes has become more prominent. For example, gene modification has been employed in attempts to create novel strands of the American chestnuts *Castanea dentata* resistant to the blight caused by *Cryphonectria parasitica*, which has led to the functional extinction of the trees in the United States (Barnhill-Dilling et al. 2020).

Perhaps the most controversial emerging biotechnological tool, for which applications for nature conservation purposes are being proposed, however, are engineered gene drives. The term "gene drive" describes a process where a vertically transmitted genetic element spreads through a population of sexually reproducing organisms over generations, even if it provides no fitness advantage to the organism. With the advent of the genetic modification tool CRISPR/Cas9, the rapid and cost-effective development of engineered gene drives has become technically feasible (Esvelt et al. 2014). Currently, there are a variety of proposed designs for engineered gene drives under development. For example, research is aiming to develop engineered gene drives that would only spread for a specified time window or within a specific population. In addition, "suppression" and "replacement" drive designs are being developed, where the former aim to inhibit further reproduction, while the latter is designed to spread a new genetic trait through a target population or species. In particular suppression gene drives have been proposed for the control of animals, who are disease vectors, for agricultural pest control, but also for the control of invasive species for conservation purposes.

1 Terms like "natures-cultures" are used by many scholars in science and technology studies, anthropology, and geography to highlight the ways in which ideas of nature have been socially produced in Western thought and contemporary cultures. These debates are critical of a dualistic distinction between "nature" and "culture" and stress that human interactions with their environments create hybrid, or "naturecultural", things (see, e. g., Gesing et al. 2019, pp. 7–12). From the perspective of nature conservation, we would argue, however, that the insistence by some of these scholars that nature does not exist, is unproductive.

As the contributions to this Special Focus show, a broad societal debate about the development and use of engineered gene drives is urgently needed within and beyond the nature conservation community. The potential spatial and temporal reach of this technology, which could alter ecosystems far into the planetary future, requires the development of international governance structures (Rabitz 2019, Hartley et al. 2022). Like other biotechnologies, engineered gene drives raise complex ethical issues for the nature conservation community regarding shared normative ideas about naturalness and about how humans should interact with other species. These issues are interrelated with the ethics and politics of technology. For example, we have to ask whether a focus on technological solutions diverts attention from underlying causes of environmental degradation, which could be addressed by political means.

Debates about gene drives in nature conservation

The first contribution on the topic of gene drives in this Special Focus presents the perspective of Save Our seeds, an NGO advocating for a "GMO free nature".[2] ***Couto Pilz et al. (2024, in this issue, pp. 158–164)*** highlight the risks associated with engineered gene drives and caution against the excitement about its potential application for conservation purposes. The authors focus on the societal issues associated with the prospected field testing and application of engineered gene drives, pointing to injustices and imbalances involved in the development and application of this technology. They call for stringent regulations and appropriate risk assessment frameworks as a basis for well-grounded and equitable decision-making. Since none of these seem to be in sight, the authors call for a global moratorium on the release of engineered gene drive organisms into the wild.[3]

Rabitz et al. (2024, in this issue, pp. 165–169) examine engineered gene drives as one example of emerging high-impact technologies. They argue that the development of engineered gene drives does not represent an incremental step in genetic modification techniques, but a significant change in the depth of intervention, compared to conventional GMOs. Gene drive technology, in their opinion, can be more fruitfully compared to other emerging high-impact technologies, like solar radiation modification for climate engineering. Consequently, they argue for broadening the debate about gene drives to include other technologies with comparable depth of intervention. Ensuring public participation and deliberation is paramount in all of these cases, and it is key to foster ethical reflection on underlying values and goals as well as underlying notions of human-nature relations. The international governance framework of the United Nations could provide the necessary international platform for the establishment of respective deliberation infrastructures.

The Special Focus concludes with ***Eser's (2024, in this issue, pp. 170–174)*** contribution, which addresses ethical dimensions in the debate on engineered gene drives in nature conservation. She focuses on plans to use this technology for eliminating invasive rodents on islands. Conservationists disagree on such proposals, Eser argues, because they differ in what they understand as key objectives for conservation. For example, conservationists who focus on local species conservation are more likely to be in favor of gene drive technology than those conservationists who argue for the necessity of global transformative change. Eser demonstrates that these debates have their roots in conflicting philosophical views on the concept of nature and the roles of humans in nature.

Missing perspectives from the Global South

Many current proposals for the field-testing and use of engineered gene drives focus on regions in the Global South and on the territories of Indigenous communities. At the same time, voices from these regions and communities tend to be underrepresented in international policy- and academic debates. Unfortunately, we were also not able to adequately include these perspectives at the symposium and in this Special Focus. There are various structural issues that impede international academic collaborations and in particular transdisciplinary forms of knowledge production. For example, scholars from the Global South often face limited resources and visa-restrictions for travel, and non-academic actors at times have more pressing obligations. Thus, in many respects, the debate on engineered gene drives perpetuates well-known issues of global social inequality that affect international nature conservation governance and academic research.

Some scientists involved in early engineered gene drive research have sought to develop their own community engagement strategies in the early stages of field-testing planning (Buchthal et al. 2019). These approaches can be viewed as responses to criticisms of existing frameworks on the ethical, legal and social implications (ELSI) of emerging genomic technologies, which have been criticized for not providing potentially affected communities with enough access to decision-making processes. There have also been calls for "free, prior and informed consent" (FPIC) of affected Indigenous peoples and local communities at international governance levels (George et al. 2019, pp. 1 f.). Recent community engagement efforts, however, have been criticized for not taking sufficient account of the complexities of global social inequalities, international and local power-structures, and other factors that complicate processes of community engagement (see, e. g., Mark-Shedtbolt 2017). This is particularly the case in regions of the Global South where regulatory structures are weak and governments depend on funding from international institutions, and on NGOs and private sector actors based in the Global North. In addition, community engagement

2 *www.saveourseeds.org/en/about-us.html*
3 *www.stop-genedrives.eu/en*

planned and initiated by actors with a vested interest in the technology in question could be seen as problematic.[4] Such processes are often framed in terms that imply local communities lack adequate scientific understanding of genetics and biotechnology. Community engagement then becomes an exercise in unidirectional knowledge transfer, where the scope and type of knowledge deemed important is limited from the outset. This diminishes the possibility to explore diverging ideas about what constitutes relevant knowledge of natural environments and what constitutes appropriate human-nature relationships.

Political and ethical debates on the development and use of new (bio-)technologies have to be more attentive to the pervasive influence of colonial histories and contemporary global inequalities in resources, including international political influence. For example, as Taitingfong (2020) points out, current proposals for field testing engineered gene drives on islands reiterate colonial and post-colonial perspectives on Pacific Islands as remote from the rest of the world, and therefore ideal testing grounds for dangerous technologies. Such an understanding, she writes, suppresses the presence, perspectives and histories of Indigenous island populations. International nature conservation and restoration face similar criticisms, and calls for profound changes in the general attitudes, structures and policies abound (e.g., Büscher and Fletcher 2020). It is high time to deepen the debate, and we hope that this Special Focus will help to stimulate this.

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4 See, e. g., expert interviews with Gbeyehu, Ntambirweki, Tapsoba, and Yaméogo, representatives of NGOs in Africa, conducted as part of the Save Our Seeds campaign *Stop Gene Drives* at *www.stop-genedrives.eu/en/experts*.