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Novel organisms and the ethics of conservation.

Divergent views on gene drives reflect divergent ideas about humans and nature

What concepts of nature, humans, and their relationships underpin the debate about gene drives for conservation? To provide some answers to this question, the eradication of invasive rodents on islands is used as an example. While current debates mostly weigh the potential benefits for conservation against the potential ecological risks, it is worthwhile to move beyond such a risk-benefit perspective. Ethical issues that are more specific to conservation are: the significance of "natural", the normative goals of conservation, and the ideal of living in harmony with nature.

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Novel organisms and the ethics of conservation. Divergent views on gene drives reflect divergent ideas about humans and nature
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Understanding conflicts in nature conservation

In July 2022, the symposium *Novel Natures? New technologies and conflicts in nature conservation* took place in Hannover, Germany. Its aim was to better understand how "[d]ebates about novel technological interventions are intertwined with longstanding disagreements about the objects, aims and ethical commitments of nature conservation".[1] Using the controversy about the application of gene drives to eliminate invasive alien species from islands as an example, this paper provides some answers from the perspective of conservation ethics[2].

Genetic tools for conservation?

In controversies about genetic engineering, nature conservationists have traditionally tended to side with the critics. Ecologists countered the promises of increased or improved agricultural yields with a systemic perspective, giving greater weight to unintended side effects and associated ecological risks. This habitual scepticism was challenged by the prospect of using genetic tools for conservation purposes. In view of the ongoing loss of biodiversity, calls for a closer cooperation between synthetic biology and conservation biology were raised (Piaggio et al. 2017). In 2019, the International Union for Conservation of Nature (IUCN) issued a report on "genetic frontiers for conservation" (Redford et al. 2019) that met with criticism from several IUCN members (AAO et al. 2019). To this day, "the issue is highly polarised across the conservation community" (IUCN 2024, p. 4).

One particularly contested tool is the use of engineered gene drives. These are defined as "systems of biased inheritance in which the ability of a genetic element to pass from a parent to its offspring through sexual reproduction is enhanced" (NASEM 2016, p. 15). The intention of using gene drives is to spread genetic modifications through populations of wild organisms rapidly and effectively (Esvelt et al. 2014). However, the effective spread of genetic alterations through wildlife populations is at the same time a promise for efficiency and a reason for concern (Esvelt and Gemmel 2017). Accordingly, the application is controversial. Initiatives like Genetic Biocontrol of Invasive Rodents support the development of gene drive technology because they expect that gene drives have the "potential to scale up efforts to protect island communities and prevent island species extinctions" (GBIRd 2017). On the opposing side, nongovernmental organisations like Save Our Seeds use mottos that declare "gene drive organisms are perhaps one of the most dangerous environmental applications of genetic engineering ever developed".[3] The concerns range from ecological risks (Dolezel 2019), to social acceptance and legal affairs (Mitchell and Bartsch 2019), to dual use (Gurwitz 2014), and to questions of governance (Reynolds 2020, Hartley et al. 2022).

Invasive rodents on islands

The control of invasive rodents on islands is among the most auspicious applications of gene drives in conservation. It suggests a solution to a major threat to global biodiversity and has therefore served as a case study in various horizon-scanning reports (NASEM 2016, Redford et al. 2019, Brandt et al. 2019).

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1 Symposium program: *Novel Natures? New technologies and conflicts in nature conservation.* July 20 to 22, 2022, Hannover, DE.
2 My perspective on conservation and ethics is a German one. It reflects debates within the German conservation community and ties in with the tradition of Kant and Habermas.
3 *www.stop-genedrives.eu/en*

Islands are of particular relevance for conservation as 90 % of the global extinctions attributed to invasive alien species have occurred on islands (IPBES 2023). To prevent extinctions, rodent eradication is a common conservation practice involving the distribution of rodenticides. These toxins lead to death from internal bleeding when ingested. This practice is challenged for ethical and practical reasons, as animal rights supporters resist the approach of "killing for conservation" (Predavec et al. 2019) and the amount of suffering involved. On inhabited islands, residents are concerned about the safety of their children, pets, and farm animals, which limits the social feasibility of rodenticides (Russell et al. 2018). Moreover, rodent populations increasingly become resistant to conventional toxins (McGee et al. 2020).

In this situation, gene drives are being discussed as a potential new tool (Campbell et al. 2019). Instead of using rodenticides, the plan is to genetically modify mice so that their reproductive success is reduced. A synthetic gene drive is used to effectively spread the deleterious modification through the whole population. This method claims to eliminate the mouse population "without causing animals to suffer" (Esvelt and Gemmell 2017). Whether or not the technology can ever safely and reliably meet this expectation is contested. Knowledge gaps make the use of gene drives unlikely in the near future (Moro et al. 2018, Godwin et al. 2019). In particular, the line between premature termination of the drive and its spread to non-intended targets seems narrow and difficult to control (Noble et al. 2018). If and how such gene drives should be developed and applied is controversial in regard to their technical feasibility and ecological risks, as well as their governance and responsibility.

Ethical perspectives on gene drives

The "ethical landscape of gene drive research" (Callies 2019) is complex: both the problems that give rise to ethical reflection and the theories for tackling them are diverse. Disputed topics are the treatment of animals (De Graeff et al. 2019), matters of inclusion and power (Kormos et al. 2022), and a code of conduct for the research (Annas et al. 2021). Regarding conservation, the use and meaning of "nature" in this debate is of particular interest (De Graeff et al. 2022). Why do some people regard the use of gene drives as *good* and *right* for conservation reasons, while others regard it as *bad* and *wrong* for the same reasons?

The attributes *good* and *right* refer to two different ethical traditions. While *good* denotes "ethically desirable" regarding (differing) conceptions of a good life, *right* refers to universally applicable moral rights and duties. If and how we can know what's *good* and *right* is a disputed matter within ethics. Three main approaches can be distinguished that use different criteria for judgements. Consequentialist ethics judge an action by its *outcomes,* deontological approaches ask whether the underlying *principles* are justified, and virtue ethics focus on the *attitudes* expressed in an action (Eser et al. 2014). Currently, the debate focuses mostly on outcome: the use of gene drives is regarded as acceptable if (and only if) the consequences are acceptable. Accordingly, questions where the outcomes are realistic, probable, or possible, and how the potential detrimental outcomes are to be weighed against potential benefits play a dominant role. To complement the consequentialist approach, it is worthwhile to shed light on the meaning of "natural", rival goals of nature conservation, and conflicting ideas about the relationship between humans and nature.

"Naturalness" is used both to defend and question gene drive technology. For ethics, the question of naturalness is irrelevant. What is natural is not necessarily good.

The concept of "natural"

Views on nature affect both the valuation of non-native species (Eser 2016) and the valuation of gene drives (De Graeff et al. 2021). Whether a change is considered natural or not is a relevant factor in its assessment. Appeals to "naturalness" are used as an argumentative strategy by both advocates and critics of gene drive technology. By stating that "gene drives occur naturally and are not recent phenomena" (Campbell et al. 2019) proponents emphasise the naturalness of gene drives, indicating that this makes them more acceptable. In contrast, critics suggest that the technology is "unnatural" when they highlight that engineered gene drives could "drive" a new trait through a wild population more effectively than according to the Mendelian law. But what exactly does "natural" mean and how do these interpretations reconcile?[4]

The ancient philosopher Aristotle (384 to 322 B.C.) defined "natural" as follows: "Each of [the things that exist by nature] has *within itself* a principle of motion and of stationariness" (Aristotle 2009). As such, an entity is natural if the cause for any changes lies "within itself". This is clearly not the case for invasive species, nor for engineered gene drive organisms. The migration of the former and the alteration of the latter have their cause in human activities, not in themselves. From this perspective, both appear as unnatural.

A different understanding of nature comes from Immanuel Kant (1724 to 1804). For Kant, nature referred to "the existence of things insofar as it is determined by general laws"[5] (Kant 1977, >

4 To avoid exceeding the scope of this article, my explanations remain simplistic and are directed at conservationists who are interested in ethical issues.

5 „Natur ist das Dasein der Dinge, sofern es nach allgemeinen Gesetzen bestimmt ist."

p. 159; translated by author). As such, nature comprises everything that can be explained by natural laws. In this understanding, both invasive species and gene drive organisms are natural. Their existence, spread, and behaviour are in line with the laws of nature.

With regard to “naturalness”, both invasive species and gene drive organisms are hybrids – they are “natural” and “unnatural” at the same time. However, while invasive species spread by themselves (without human intention), the spread of gene drive organisms is intended by humans. Nevertheless, these novel organisms are not mere artefacts. Although their genome was altered by humans, they grow, move, and behave in their own ways. To acknowledge this specificity of engineered living beings, Karafyllis suggested the term “biofact” (Karafyllis 2007). It “refers to a being that is both natural and artificial. It is brought into existence by purposive human action but exists by processes of growth” (Karafyllis 2007, p. 145). Like the concept of *novel natures,* the term “biofact” aims to provide a neutral term that leaves room for different value judgements and deliberation (Montana et al. 2024, in this issue).

Objects and objectives of conservation

Nature as state and process

Nature is both a process and a product. Baruch de Spinoza (1632 to 1677) differentiated between the active, productive aspect of nature, *natura naturans,* and that which is produced and sustained by it, *natura naturata* (Nadler 2023). This dual character of nature is reflected in nature conservation, where there is an ongoing debate about whether certain states, or rather their processes, are the appropriate objects for conservation.

On the one hand, conservationists are concerned with *natura naturata:* particular species, communities, or ecosystems. In order to prevent the extinction of native species, some are willing to consider all possible means of eliminating alien species. In this case, responsibility is understood as retrospective: humans must remedy the damage they have caused to nature. The objects of this responsibility are the products of natural evolution.

On the other hand, conservationists are concerned about *natura naturans:* the inherent dynamics of nature. In order to prevent future damage, some caution that human intentions and nature’s own ways may differ, as demonstrated by the spread of invasive species. In this case, responsibility is understood as prospective: humans must prevent causing future, unintended damage. The objects of this responsibility are the consequences of human actions.

Protection of species versus transformation

Different assessments of gene drives relate to two objectives of conservation: the protection of species and the pursuit of societal transformation. Proponents tend to compare new genetic tools with existing technical alternatives (so-called downstream solutions), critics rather compare new technical tools to systematic changes (upstream solutions; De Graeff et al. 2021). In view of the unabated loss of biodiversity, some conservationists perceive a dilemma: to either agree with the genetic modification of wild populations or to give up on protecting endangered species (Kahn 2020). To evade this dilemma, others suggest that nature conservation should not be limited to species protection but should also address the social and economic drivers of global change. Safeguarding global biodiversity requires a major social-ecological transformation (IPBES 2019). From this transformation-oriented perspective, the development of repair techniques is criticized because it prevents, rather than enables, necessary fundamental transformations (Brandt et al. 2019).

The role of humans in nature

Whether gene drives are regarded as a legitimate tool for conservation depends on how the role of humans in nature is understood (De Graeff et al. 2021). In contrast to the modern distinction between humans and nature, many conservationists adhere to a relational ontology (Wickson 2015). Against this background, the technological ideal of prediction and control may appear as human hubris.

Living in harmony with nature

Regardless of the consequences for the environment and society, the use of gene drive technology might affect the identity of the conservation community. In this vein, Sandler (2020) argues for a “form-of-life perspective”: how would conservation itself change if it agreed to the use of gene drives? At this point, the above distinction between *good* and *right* becomes relevant. An action is *right* if it is in line with universal ethical principles and it is *good* if it expresses an attitude that the actors consider desirable. From the latter perspective, the release of engineered gene drives may collide with conservationists’ idea of what kind of people they want to be (Wickson 2015). In this case, judgements about the technology are less a matter of (general) obligations and more about (personal) ideals (Kaebnick 2014).

The ideal of living in harmony with nature is prevalent in nature conservation. It is the overarching aspiration of global biodiversity policy, as recently expressed in the *New Global Framework for Managing Nature Through 2030* (CBD 2021). Living in harmony with nature is a conception of the good life that humans are entitled to realise. It entails emotional bonds between humans and nature such as awe, respect, and care. Such an attitude includes a concern for the other that does not consider nature merely as a means to human ends but respects it as an end in itself (Jax et al. 2018). Engineered suppression gene drives turn living beings into tools for eradication. Such an instrumentalist approach conflicts with the ideal of harmony with nature. From a relational perspective, this course of action may be considered undesirable, even if it were for a respectable purpose and did not violate any universal principles.

Human hubris

Are humans allowed to interfere with the genetic material of living beings? Critics of genetic engineering answer this question in the negative. Early on, manipulations of the nucleus of the cell were accused of transgressing a boundary that should be respected (Chargaff 1978). On the other side, it is argued that humans have always influenced the genetic make-up of plants and animals through targeted breeding. The advent of engineered gene drives has taken this debate to the next level. Do humans have a right to engineer evolution? Or even a duty to do so (Esvelt 2019)? Or is the idea of steering evolution in itself a matter of hubris?

Again, answers to these questions depend on the perspectives of nature, and the role of humans in it. In the Aristotelian tradition, nature is a cosmos of which humans are part. Their role is to fit in harmoniously. Modern concepts of nature in the Kantian tradition emphasize the special position of humans and their right to care for themselves and their own kind. While one side adheres to a nature-knows-best ideal, the other believes in the idea that nature can be perfected. Neither of these views can claim sole validity. Both bear some truth. Humans are part of nature, and they differ from it in ethically relevant ways. The dual nature of humans as beings of nature and beings of reason causes an ambiguity that does not allow a one-sided resolution. However, conservationists tend to emphasize human dependence on nature and argue for greater human humility, while engineers are inclined to emphasize the human capacity for improvement. When it comes to genetic engineering for conservation purposes, the views of these two fields collide (Redford et al. 2014).

Conclusion

The aim of this paper was to shed light on some of the philosophical questions underlying the controversy over gene drives in conservation. Whether gene drives are considered as *good* or *right* depends not only on the hoped-for or feared material consequences, but also on principles and attitudes that are specific to nature conservation.

“Naturalness” is used both to defend and question gene drive technology. For ethics, the question of naturalness is irrelevant. What is natural is not necessarily good. To invite deliberation, terms like “biofact” or *novel natures* that acknowledge the hybrid character of engineered organism are more appropriate.

Likewise, responsibility for nature is used in favour of and against gene drive technology. While retrospective responsibility focuses on anthropogenic threats to natural entities and their remediation, prospective responsibility respects the intrinsic dynamics of nature, acknowledges non-human agency, and shies away from incalculable risk. Those who focus on the defence of local species are more likely to consider gene drives than those who aim for global transformative change.

Attitudes towards gene drive technology reflect conflictive views on the role of humans in nature: the harmony with nature versus the mastery of nature. These perspectives are not mutually exclusive but are opposite ends of a spectrum. Those who are committed to a harmonious relationship with nature are less likely to consider gene drives than those who believe in mastering nature. Even if such subjective ideas of a good life cannot justify general restrictions, they do explain why gene drives are still so controversial in the conservation community.

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