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RESEARCH ARTICLE

No Such Thing as Containment? Gene Drives for Conservation and the (Im)possibility of an Island

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Abstract
This article explores the use of islands as tools of geographical and intellectual containment - or what we call "islanding" - in the scientific and policy literature about gene drive technologies in conservation. In the first part of the article, we explore the narrative of contained gene drive use on islands and discuss how it juggles notions of localness and localization of gene drives and their (test) releases. We question the possibility and narrative of containing the spread of gene drives technologically or geographically, and argue that the gene drives for conservation literature strategically combines contradictory and reductive understandings of islands and containment. The second part of the article is devoted to reflection on nonlocal concerns about gene drives and the possibility of local gene drive decisions. We argue that attempts to legitimize local gene drives through local decision-making evade normative concerns about their nonlocalizability and risk instrumentalizing local communities for nonlocal agendas. Our overarching conceptual aim is therefore to open up a domain of thinking around the possibility of demarcation in our world – of our political, normative decisions, and of our reality – and to argue for the vital importance of reflection on this possibility in technological decision-making.

Keywords Gene drive technology · Island conservation · Islanding · (Non)local technology · The possibility of demarcation · Legitimacy of technology decisions

> '*there's no such thing as containment, whether it's an island that's far away or a place that is closed-in. […] There's no such thing as containment in this day and age.*'

(anonymous participant of stakeholder meeting on using gene drives for rodent eradication on islands, cited in Delborne et al., 2019: 18)

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1 Introduction

From anthrax experiments on the Scottish island of Gruinard to nuclear testing on Bikini Atoll, islands have been used countless times as sites for experimentation with unique conditions of containment. Located between in vitro and in vivo, islands have been framed as offering the controlled safety of a laboratory while simultaneously providing conditions of real-world complexity. Islands also serve the function of cognitive demarcation and idealization; and for that reason the island is also a popular trope in literature and film (Kinane, 2017). Thomas More's *Utopia* and Francis Bacon's *Nova Atlantis* are both islands.

This article explores the use of islands as tools of geographical and intellectual containment in debates about gene drive technologies in conservation. Gene drives can be considered a new step in the history of genetic technologies. Gene drive technologies are '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: 1) beyond the conventional 50% chance dictated by the rules of Mendelian inheritance, and potentially to all offspring. Because the relevant genetic element is passed on from generation to generation, gene drives could allow for the spread of genetic modifications through wild populations of organisms by releasing only a select number of gene-drive-modified specimens (Esvelt et al., 2014; Champer et al., 2016; NASEM, 2016). This inherently spreadable character of gene drives is both the essential characteristic of, and the biggest reason for risk and legitimacy concerns about, gene drives. As a result, islands have become the focus of creating spaces of contained spread in the context of conservation.

In gene drive debates, "conservation" is largely understood as safeguarding or restoring biodiversity by targeting invasive species[1] and their destructive effects on island ecosystems. The literature on the use of gene drives in conservation is predominantly concerned with invasive species (mostly rodents), and with islands. There are good reasons for this concern: island ecosystems provide attractive use cases for gene drives as endemic biodiversity is often threatened by invasive species while island geography promises containment. Targeting invasive species on islands therefore appears to provide a uniquely strong case for gene drives, combining low risk with high gain.

In the first part of the article, we explore this narrative of contained gene drive use on islands, including the typical representation of what is required to safely bring gene drives from lab to full field release, and discuss how it juggles notions of localness and localization – being local and making local – of gene drives and their (test) releases. The nonlocal nature of gene drives due to their intended spread is widely acknowledged in the literature, as is the unicity of islands and the human origin of the invasive species gene drives are meant to target. At the same time, the nonlocalness of gene drives is presented as something conditional, something which

[1] We acknowledge the animal-ethical question of invasive species and the problem of their designation as "invasive" (Simberloff, 2003; Larson, 2005; O'Brien, 2006; Inglis, 2020) but do not address them here.

can be bent towards localizability under the right conditions. In this move, the island plays a key role. "Islanding" is what occurs in the literature on gene drives for conservation: a form of demarcation in thinking that trades on the luxury provided by the island – the image of containment, of a piece of the world disconnected from the rest of the world – and which finds its way into material practices. We describe how the inherent spreadability of gene drives is supposedly contained, both internally by making localized gene drives, and geographically by testing and potentially deploying these drives on islands, and argue that the gene drives for conservation literature appears to knowingly combine contradictory and reductive understandings of islands and containment for strategic reasons.

The second part of the article is devoted to reflection on nonlocal concerns about gene drives and the possibility of local gene drive decisions. Whether or not a particular gene drive (test) release can actually be technologically or geographically contained, there are nonlocal and nonlocalizable dimensions of gene drives – for example those related to the technological nature of engagements with the nonhuman world – that need to be acknowledged. We point to a tension between the attempt to create a local gene drive that allows for local decision-making and their nonlocalizability due to the global context in which these technologies and decisions are being made. The notions of globalization (Albrow & King, 1990; Giddens, 1990; Robertson, 1992) and anthropocene[2] (Steffen et al., 2011; Waters et al., 2016; Hamilton, 2017) support views of our world as an interconnected system – and an end to the possibility of exclusively local problems. In this context, we argue that making gene drives local is also a normative-political move, as the use of gene drives is legitimized by not only containing gene drive spread in a technical and geographic way, but also by localizing the decision-making process. However, such attempts to legitimize gene drives through local decision-making risk evading normative concerns about their nonlocalizability and the instrumentalization of local communities for nonlocal agendas. It is vital to consider how the legitimacy of local decisions aligns with the reality of the world they are made in, and to reflect on the global connectivity of globalization and anthropocene and the multifarious "spread" of technology – physical, ideational, inspirational, institutional – in technological decision-making. Our overarching conceptual aim is to open up a domain of thinking around the possibility of demarcation in our world – of our political, normative decisions, and of our reality – and to argue for the vital importance of reflection on this "possibility of an island" in technological decision-making. "The (im)possibility an island" is a metaphor for demarcation and containment.

In exploring the (im)possibility of containment and its normative ramifications, this article contributes to recent scholarship in philosophy of technology on the implications and underlying assumptions of biotechnology (e.g. Dicks, 2016; Jebari, 2016; Gyngell & Savulescu, 2017; Siipi & Finkelman, 2017; Turner, 2017; Gerola et al., 2023), genetic engineering (e.g. Gyngell, 2012; Powell et al., 2012), GMOs

[2] The notion of the anthropocene is contested (e.g., Crist, 2013). We therefore use the concept non-capitalized (following the suggestion by Ruddiman et al., 2015), to indicate that we do not necessarily embrace the label while still wanting to talk about what it designates.

(e.g. Szántó, 2018), and synthetic biology (e.g. Holm, 2012; Schyfter, 2012; Rijssenbeek et al., 2022), zooming in on the relatively underexposed case of gene drives and the specific angle of attempts at *containing* technology. We also continue on existing debates about engagement and decision-making in relation to global vs. local technologies and values (e.g. Wong, 2016; Wong, 2020; Cruz, 2021, Friederich & Boudry, 2022). Finally, we contribute to scholarship attempting to broaden the range of what are considered relevant implications of technology, for example concerning the technologically mediated nature of our relation to the world or nature (e.g. Schyfter, 2012; Veraart et al., 2023) and technomoral change (e.g. Swierstra, 2013; Nickel, 2020; van de Poel & Kudina, 2022; Veluwenkamp et al., 2022).

We surveyed literature that specifically discusses gene drives for conservation and/or conservation on islands. Conservation can be viewed as an underdeveloped theme in the gene drive literature regarding governance and ethics related questions (Hartley et al., 2022) – questions we broadly aim to contribute to. Furthermore, in addition to considerations of feasibility, we focus on conservation among the wider range of projected gene drive applications because islands figure so prominently in specifically this context, and this in turn provides an exceptionally informative entry-point into the questions of (non)localizability and (non)localness of both gene drives and technology more generally we want to raise in this article. While we focus on conservation for reasons just specified, islands also play a key role in other domains of proposed gene drive application, such as public health (e.g. Lanzaro et al., 2021)[3], and the central issues of (non)localizability and local decision-making apply to any gene drive decision (and, in a qualified sense, to technological decision-making in general).

The literature analysis was conducted in late 2022; the literature included thus reflects this cut-off point, while the recent emergence of gene drives as a technology of interest for conservation explains the relative recency of literature found. Some caveats about this literature need to be pointed out. First of all, many of the key articles referenced are produced by a collective of authors affiliated to the Genetic Biocontrol of Invasive Rodents (GBIRd) consortium, 'an interdisciplinary collaboration to develop and evaluate gene drive technology for eradicating invasive rodent populations on islands' (Campbell et al., 2019: 6). The reiteration of the shared story should therefore be seen in the proper light: there is a core group dominating the academic field regarding gene drives for island conservation, and this core group is committed to the actual realization of using gene drives for this purpose. Secondly, the emphasis in the related literature is on testing gene drives. In this sense, our analysis reflects a particular moment in time, when gene drives are still theoretical to an important degree, even if important progress is being made (e.g. Bier, 2022; Gierus et al., 2022). In terms of the "state of development", this moment in time involves *looking ahead to* field testing – currently, there have only been cage trials of gene drives in mosquitoes (e.g. Anderson et al., 2024). There are currently no full-fledged gene drive applications, nor field trial applications, in conservation or otherwise. However, examples of island application contexts mentioned in the literature

[3] We thank an anonymous reviewer for suggesting this particular reference to us.

are invasive rodents on Gough Island (Edwards et al., 2017; Leitschuh et al., 2018; Rohwer, 2020) and the Galápagos (Hall, 2017), invasive predators such as the Brushtailed Possum in New Zealand (e.g. Esvelt & Gemmell, 2017; Owens, 2017; Dearden et al., 2018; Campbell et al., 2019), and non-native mosquitoes spreading avian malaria on Hawaii (NASEM, 2016; Novak et al., 2018).

The aim of the reading of the central gene drives for conservation literature was to uncover the kind of story it tells about gene drives, why we need them, and what is needed to deploy them. This quickly led to the observation that a shared story tends to be told, and that islands and questions of demarcation infuse this story. A subsequent detailed reading of the literature with a particular eye to islands and demarcation was then conducted, leading to the depiction of the shared story and the central themes of islanding, localness and demarcation that are presented in what follows. In line with the aim of uncovering the story or narrative of the literature, the gene drives for conservation literature is presented in terms of two "Acts" and their respective themes and characters. Act I introduces the island conservation problem and gene drives as a solution, and culminates in recognition of the fundamental challenge of nonlocalness gene drives present. Act II revolves around the conditions required to address this nonlocal challenge. The division between the two acts is marked by a switch in the role of the island: from a main protagonist under threat in Act I to a supporting role in bringing gene drives – the main protagonist of Act II – to fruition. And in this role change, the gene drives for conservation story moves from real islands (in Act I) to fictional islands and back again (in Act II). The reading of the literature as a story also supports the recognition of gene drive trials as *performances* in the second part of the article.

As we move from the first to the second part of the article, the discussed themes (e.g. phased testing and NIMBY-based reasoning) become less indicative of the general story of the gene drives for conservation literature, and more reflective of what we consider to be particularly noteworthy exponents of the questions of demarcation and localness raised by said literature. Stylistically, we approach the subject by interweaving more descriptive observations of the gene drives for conservation literature with normative and interpretive reflections, including use of metaphor to open up the subject matter. We believe there is merit in using this approach because it reflects precisely what is our central observation in the article: that the island is both a real place and a thinking tool; that the isolation it appears to provide is both material and ideational and that we cannot neatly separate the two.

2 The Gene Drives for Conservation Story – Act I: The Island Conservation Problem and the Nonlocalness of Gene Drives

The gene drives for conservation literature has a standard narrative, wholly or partly reiterated in its publications (Campbell et al., 2015; NASEM, 2016; Edwards et al., 2017; Piaggio et al., 2017; Dearden et al., 2018; Leitschuh et al., 2018; McFarlane et al., 2018; Moro et al., 2018; Novak et al., 2018; Royal Society, 2018; Barnhill-Dilling et al., 2019; Campbell et al., 2019; Delborne et al., 2019; Godwin et al., 2019; Harvey-Samuel et al., 2019; Sudweeks et al., 2019; Reynolds, 2020; Serr

et al., 2020). The story begins with the *importance of islands*: 'Islands represent the greatest concentration of both biodiversity and species extinctions. Island species are often evolutionarily distinctive and highly vulnerable to novel disturbances, particularly invasive species' (Island Conservation, n.d.: n.p.). The import of the opening is clear: something must be done about this situation.

The unicity of islands is important to act I of the story. Isolation plays an important role here. Latin īnsulātus – from which isolation stems – literally means *made into an island*. Isolation is both the island's blessing and its curse. Isolation explains its unique biodiversity and its vulnerability to external stressors: 'high evolutionary distinctiveness is correlated with endemism […], which is itself correlated with greater vulnerability to extinction, all else equal' (Palmer & Fischer, 2021: 2293). Local landscapes and ecological conditions are unique and complex (Australian Academy of Science, 2017; Dearden et al., 2018; Kuzma et al., 2018; Redford et al., 2019), and some pests are particular to specific islands or island nations – e.g. possums to New Zealand (Dearden et al., 2018). This means that islands pose unique conservation needs, and have to be locally attuned (Russell & Holmes, 2015).

The story continues by describing the limitations of existing solutions, to arrive at the conclusion that new ones are needed (NASEM, 2016; Piaggio et al., 2017; Dearden et al., 2018; Leitschuh et al., 2018; McFarlane et al., 2018; Moro et al., 2018; Novak et al., 2018; Barnhill-Dilling et al., 2019; Campbell et al., 2019; Godwin et al., 2019; Serr et al., 2020). The current *intractability* of invasive species-related problems (Piaggio et al., 2017; Dearden et al., 2018; Novak et al., 2018; Harvey-Samuel et al., 2019) is a key notion here. And so, gene drives for island conservation enter the scene. Gene drives promise to provide the scalability and species-specificity lacking in existing conservation measures which mostly involve the use of poison (Leitschuh et al., 2018; McFarlane et al., 2018; Campbell et al., 2019) – in addition to promising improved cost-efficiency, "humaneness" compared to direct killing of targeted organisms, and safety for humans (NASEM, 2016). The species-specificity provided is considered novel, an innovation: '*For the first time*, we have the makings of a technology that could reduce or eliminate a pest population in a humane and species-specific manner' (McFarlane et al., 2018: 133, our emphasis). The perceived advantages of gene drives for conservation rely on their essential characteristics: a self-copying, inheritance-biasing genetic construct which, in frequently and prodigiously sexually reproducing organisms (such as mice), can theoretically spread a genetic modification – such as a biasing of maleness leading to populations that cannot reproduce anymore and eventually collapse – through populations of that organism via sexual reproduction, after a field release of a relatively small sample of gene drive-modified individuals. Species-specific because of sexual reproduction; scalable because of the spread of the inheritance-biasing mechanism.

However, at the same time gene drives pose a fundamental challenge. Because gene drives 'intentionally spread a genetic trait through a population, and their effects on ecosystems are potentially irreversible' (NASEM, 2016: 149), they involve 'a fundamental tension between the ability […] to spread locally within a target area and its ability to invade populations beyond that area' (Sudweeks et al., 2019: 7). From this tension emerges the dynamic that feeds the literature on gene drives for conservation. Gene drives provide specificity and scalability; but they are

also – in an important sense – an *inherently nonlocal technology* for relying on a self-copying and spreading mechanism. This is a captivating feature of gene drives. Gene drives are characteristically unspecific – uncontrollable spread, irreversible ecological consequences – but from the conservationist's point of view, gene drives provide specificity. A particular kind of specificity: they would only affect the targeted species, something current measures – poison, a blunt instrument – cannot provide. These are two kinds of specificity: one biological, genetic, evolutionary; the other geographic, spatial. And they do not necessarily imply each other: a gene drive release can be entirely species-specific but spread to every geographical nook of the earth.

2.1 The Nonlocalness of Gene Drives

The nonlocal nature of gene drives for conservation is widely acknowledged in the literature. Different dimensions can be distinguished here. First, and most importantly, there is the aforementioned nonlocal nature of the technology itself, often emphasized in the literature (Godwin et al., 2019; Harvey-Samuel et al., 2019; Serr et al., 2020; McFarlane et al., 2018; Redford et al., 2019; Hartley et al., 2022; Kuzma et al., 2018; Leitschuh et al., 2018; Min et al., 2018; NASEM, 2016; Delborne et al., 2019; Dearden et al., 2018; Novak et al., 2018; Barnhill-Dilling et al., 2019; Reynolds, 2020; Esvelt, 2018; Esvelt & Gemmell, 2017). The spread of a gene drive through a population from an initial release is referred to in terms of 'invasiveness' (Godwin et al., 2019), being 'forced' through a population and having an 'autonomous nature' (Harvey-Samuel et al., 2019), and 'designed to be self-sustaining' (Serr et al., 2020: 1237). Leitschuh et al. (2018) add that 'the deliberate release of gene drive biotechnologies subverts the very concept of 'containment,' given that the technology is designed to spread' (S129). While the notion of "spread" suggests that spatial dispersal is the core issue at hand, there is a temporal dimension to localizability as well: 'The biggest challenge is the rapidity with which gene drives can spread, because consequences could occur too quickly for any adaptive management scheme to halt them' (NASEM, 2016: 41).

Secondly, questions of nonlocalness relate to the particular application of gene drives in conservation. Invasive species are a reminder that entirely local ecosystems do not exist. Most invasive species have a human origin (Edwards et al., 2017; Dearden et al., 2018; Leitschuh et al., 2018; Redford et al., 2019; Barnhill-Dilling et al., 2019; Delborne et al., 2019; Godwin et al., 2019), and '[t]he increasing global complexity of transportation systems on land, air and sea has broken down the natural barriers to species movements formed by rivers, oceans and mountains, the barriers that isolated populations and allowed species diversity to evolve and be maintained' (Redford et al., 2019: 67).

Thirdly, the nonlocal nature of gene drives is reflected in the emphasis on governance and further research and development of the technology. Many commentators emphasize the need for *global* governance and coordination of gene drives (e.g. NASEM, 2016; Kofler et al., 2018; Novak et al., 2018; Barnhill-Dilling et al., 2019; Godwin et al., 2019; Reynolds, 2020). A strong admittance of the nonlocal nature

of gene drives is found in these responses to address their challenges. Here, we find the spreading propensity of gene drives expressed in terms of affecting the 'shared environment' (Min et al., 2018; Buchthal et al., 2019; Lunshof, 2019) and 'knowing no political boundaries' (NASEM, 2016; Barnhill-Dilling et al., 2019; Hartley et al., 2022). In the context of gene drive governance, Hartley et al. (2022: 37) define gene drives *as* a global technology: 'gene drive organisms are designed to spread through and possibly eliminate whole populations or species. This means gene drive is a global, transboundary technology'.

Finally, affirmation of the nonlocal nature of gene drives comes to the fore in the two main focuses of the literature on gene drives for conservation: the containment and highly controlled testing of gene drives. Together, these lead the gene drives for conservation story back to islands as the location of preference.

3 The Gene Drives for Conservation Story – Act II: Islands for Gene Drive Containment and Testing

After establishing the potential of gene drives for conservation as well as their fundamental nonlocal challenge, the story shifts in mood by focusing on ways of addressing this challenge, on the suitable conditions for their further development. *Containment* is the key theme here: how to make sure the gene drive is not only species- but also place-specific. And *trialing* is the central story arch: how to move from the laboratory to the actual application of gene drives for conservation purposes. For both, the island plays a key role. However, no longer is the island our main protagonist – the biodiversity hotspot, the extinction epicenter; it is now the gene drive that assumes this role.

3.1 Containment

Because of the nonlocal nature of gene drives, invasive species, and human mobility, containment is a core theme in the literature on gene drives for conservation. The emphasis on the vital importance of containment is arguably the strongest endorsement of the nonlocal nature of gene drives for conservation. Containment is isolation – an active kind, an isolation that needs to be created. While the geographic features of the island – 'the natural barrier of the sea' (Moro et al., 2018: 11) – provide a kind of naturally given, 'passive' form of containment, in Act II of our story they serve a wider, deliberate programme of containment of gene drives.

There are two kinds of containment in the gene drive story: extrinsic and intrinsic (Esvelt et al., 2014; Akbari et al., 2015; NASEM, 2016). Islands are the most prominent form of extrinsic containment, providing 'the strength of an ocean barrier' (Barnhill-Dilling et al., 2019: 6). However, many proposals for countering the perceived radicalness of the original gene drive proposal, that promised rapid, universal spread through populations (the *mutagenic chain reaction* (Gantz & Bier, 2015)), focus on limiting the gene drive intrinsically in terms of how far, long, or irreversibly its genetic effects reach by designing *local* drives (Min et al., 2018) or drives

with control mechanisms. Local drives are genetic or molecular containment to compensate for a lack of geographic containment (e.g. Barnhill-Dilling et al., 2019; Delborne et al., 2019). Reynolds (2020) refers to this as *technological* containment: containment *built into* the gene drive (or the drive designed to reverse a prior gene drive's effects).

Gene drive systems of this kind are a forceful response to the image of the inherently nonlocal gene drive. What they promise to provide is explicitly expressed in terminology pointing to locality: 'gene drive localization mechanisms' and 'spatially limited gene drive design' (Oh et al., 2021: 1421), 'localization of gene drives' and 'gene drives that exhibit spatial localization' (Sudweeks et al., 2019: 2), 'highly localized and targeted gene drive' (Novak et al., 2018: 14). The aim is 'to ensure responsibly that any wild-deployed drive stays local' (ibid.). Many suggest that the concerns that plagued the original gene drive proposals will be remedied by these local drives (e.g. McFarlane et al., 2018; Min et al., 2018; Campbell et al., 2019, Buchthal et al., 2019). In an important sense, local gene drives do seem to address fundamental worries about gene drives as they originally arose. Certain versions promise to provide strongly localizable technology, technology that would not even need the physical demarcation of the island to be contained. A variant of the local drive family particularly discussed in the context of island conservation is the *locally-fixed alleles* (LFA) approach (Campbell et al., 2019; Farooque et al., 2019; Godwin et al., 2019; Sudweeks et al., 2019; Oh et al., 2021). The approach targets genes that are found in all individuals of an island population, but not or hardly in mainland populations of the same species (Farooque et al., 2019). While geographic containment remains a major concern for most local drives, the LFA approach (and kindred approaches of "precision drives") promises to take away this concern. Because the gene drive would carry the genetic containment system, there appears to be a lot more openness to the possibility of escape beyond the boundaries of the targeted island in the literature proposing the LFA approach. In fact, it is precisely through showing how such an escape would not really be a problem with LFA that we recognize the technology's unique strength.

Local drives are clearly developed with a focus on actual future applications in conservation and beyond. However, the focus in the recent gene drives for conservation literature has been on conditions for gene drive trials. And for these gene drive trials, the geographic isolation of the island is a core condition (NASEM, 2016; Edwards et al., 2017; Moro et al., 2018; Barnhill-Dilling et al., 2019; Harvey-Samuel et al., 2019; Lunshof, 2019) – whether the gene drive being tested promises to provide genetic containment or not.

3.2 Islands as Ideal Testing Locations

A recurring suggestion in the literature on gene drives for conservation is that small, remote, humanly uninhabited islands are ideal testing locations (WHO/TDR, 2014; NASEM, 2016; Piaggio et al,, 2017; Moro et al., 2018; Buchthal et al., 2019; Campbell et al., 2019; Harvey-Samuel et al., 2019; Serr et al., 2020; Oh et al., 2021). Such islands allow maximization of containment and efficacy by limiting intra- and

interspecies gene transfer and providing the benefits of geographic isolation and small and genetically distinct target populations (Harvey-Samuel et al., 2019). The island's isolation again proves itself a multiheaded creature. Taitingfong (2019) observes a treatment of *islands as laboratories*. Harvey-Samuel et al. (2019) concur that 'open-field trials can be considered *extensions* of initial highly biocontained laboratory experiments where artificial biocontainment is 'relaxed' because aspects of efficacy and safety have previously been demonstrated' (618, emphasis added). The island is a necessary extension of laboratory conditions; it is *the closest thing we have* to a real-world laboratory.

Aside from ecological reasons, the main argument for idealizing small, uninhabited islands is the expectation that less *hassle* will be involved. Before the ecological barriers to a future gene drive release, there are the human barriers of opinion, value, interest, concern, and experience. Harvey-Samuel et al. (2019) suggest that '[l]evels of regulatory/engagement costs, risk assessment and societal objection are all likely to be more favourable if initial trials take place in uninhabited areas *which are not of great cultural value*' (623, emphasis added). Detailing the experiences of a conservationist working in the Galapagos, Hall (2017) tells how the biggest hurdle was to keep local inhabitants happy. Local humans create a complexity which can seem insurmountable, and the *ideal* island is thus imagined to be one without human habitation.

In all main parts of the gene drives for conservation story, the island plays a key role. The island is unique and valuable because of its isolation. The island is vulnerable to outside disturbance because of its isolation. And the island is vital to developing the solution to these disturbances because of the isolation it provides. However, it is a peculiarity of the gene drives for conservation story that, while the main characters remain the same, the island character changes roles abruptly. 'In addition to considerations of the specific ways gene drive may benefit islands, there is a broader discussion implying that islands may benefit the advancement of gene drive research overall' (Taitingfong, 2019: 182). While isolation explains both of the island's main roles, the reason for the appeal to the island in Act II – detailing the trials of the gene drive – is unrelated to the reasons that made it such a captivating protagonist in Act I: its conservation issues, the extinctions, its vulnerability. The story shifts perspective, invigorating the audience: the island is now an instrument to the gene drive, and instead of a rich, valuable but vulnerable character, the island's *lack* of vulnerability is emphasized. Islands are safe, protected – they provide geographic containment. Instead of a focus on the threat of being invaded, the island's capacity for preventing escape is made salient.

However, the comforting thought of remote, uninhabited islands as ideal testing locations cannot last long, and is quickly followed by a return to reality. When relevant publications move to proposing specific criteria for the actual selection of an island for testing (NASEM, 2016; Redford et al., 2019; Campbell et al., 2019; Farooque et al., 2019, Harvey-Samuel et al., 2019), they move from the idealization of the island back to their unruliness and particularity. Explaining why islands are ideal locations is easy, and compiling lists of selection criteria is still quite straightforward – but now, an actual island needs to be found to meet these criteria. Islands are ideal in the sense of "optimal", not "perfect". The NASEM report expresses this

clearly when they state that '[i]t is unlikely that one site will meet all of the [site selection] criteria that are initially considered, and so a set of core criteria may need to be agreed upon' (NASEM, 2016: 90). One criterion that stands out is that the first field trials should be conducted on islands with a proper – 'robust', 'credible', 'mature' – regulatory system in place (e.g. Campbell et al., 2019; Farooque et al., 2019; Harvey-Samuel et al., 2019; Serr et al., 2020). A *controlled* island is required, with a regime that enforces the ideal features of an island, including – notably – the very borders which define it: because of the main risk of human-mediated (re)introductions, the island and its 'borders and ports must […] be regulated or […] extensively monitored and managed in other ways' (Barnhill-Dilling et al., 2019: 6).

3.3 Conclusion on the Gene Drives for Conservation Story

We have outlined how the gene drives for conservation literature tries to address the problem of containing a technology which is inherently prone to spreading (and supposed to spread), and is aimed at addressing a problem (invasive species) that is inextricably bound up with the interconnected nature of our world. Materially, this involves efforts to localize gene drives and their application through technological and geographical containment. We also observe the enormous discursive effort that goes into conveying the localizability of gene drives and the localness of islands and – by implication – ecosystems and communities. "Islanding" is what we may call the forms of demarcation that occur in considerations of gene drives for conservation. Islanding is a way of responding to nonlocalness and can manifest itself in different ways. Examples we encountered are the representation of island conservation problems in terms of intractability, and the isolation of particular invasive-species issues from questions about their origin and possible perpetuation in light of a world of human mobility and global climate change. However, perhaps the most telling form of islanding is the focus on islands for gene drive testing and containment.

Underlying our exploration is a wider suspicion about the difficulty of conveying localness of a technology in today's world. The gene drives for conservation literature requires the image of the island to respond to this suspicion. We observe the work devoted to demarcation, specifically the selective, strategic use of the two sides of the island – the two sides of the same coin, resulting from isolation: their unicity, complexity, vulnerability; and their containment, safety. The two sides appear at odds with each other; but the gene drives for conservation literature requires both isolation-driven features of the island for its story: to legitimize the problem (unicity, complexity, vulnerability); to legitimize the technology and its testing (containment); to legitimize the details of the testing procedure (unicity, complexity). While the first and final role of the island are in partial acknowledgement of the nonlocal nature of islands, the middle role denies this – turning them into utterly localizable entities (and one may even argue that they are turned into "placeless" entities, having little real-world features other than geographic isolation). The island of the start and end of the story – the biodiversity hotspot and extinction epicenter, and the ecologically and socially complex context acknowledged for island selection for trials – reflects the real island; while the island of the middle of the story, the island

offering geographic containment to gene drives and their trials, is an idealization. We move from real to fictive, and back to real islands.

The aim of the first part of this article has primarily been to *reveal*, not criticize. If there is a point of criticism contained in it, it is that the science and development behind gene drives for conservation appears to knowingly combine contradictory and reductive understandings of islands and containment for strategic reasons. The vulnerability of islands emphasized to paint the scene suggests that it is actually very risky to test gene drives on islands. In the remainder of the article, we move to wider considerations of nonlocalness and nonlocalizability concerning gene drives and science and technology. Whether or not a particular gene drive (test) release can actually be contained – technologically, and/or geographically – to a local island context, there are nonlocal and nonlocalizable dimensions of gene drives which need to be acknowledged. We discuss the logic of phased testing (continuing the consideration of gene drive testing on islands) and concerns about gene drives that exceed the focus on particular releases, and subsequently the more reflective notions of care about nonlocal dimensions of gene drives and the possibility of truly local decisions about technology in today's world.

4 Phased Testing: Carrying Meaning between (Fictive and Real) Islands

If we recognize how individual island trials are also a form of localization, of conveying the localness of decision-context and conditions, the way such individual trials are connected to each other can also be viewed as a wider form of "nonlocalness" of gene drives. We have seen how the island serves an essential role in gene drive testing, providing the containment required to legitimize the trials. But gene drive researchers do not treat the island trial as *fully* local or isolated. These trials are not meant to be one-off events, unique case studies so to speak, relevant in themselves but not allowing for generalization towards other cases. They are intended to be part of a *pathway* of phased testing and release (NASEM, 2016; Hayes et al., 2018; Delborne et al., 2019)[4] and the first gene drive field trials involve taking the first careful steps into the field-based research phase. Of course, this phase is not over with one trial. However, the different individual island field trials follow their own phased testing pathway logic.

Moving from one trial to the next, we are *island hopping*. If one manages to create a route of islands in such a way that people can safely pass from one to the next, and by doing so travel from the familiar mainland to a distant, exciting destination, one can get a technology accepted. In this sense, a gene drive release on one island is never done in isolation.

We are expected to treat the outcomes of island trials as having meaning for other trials, on other islands. This requires reduction of the island to laboratory experimentation logic – the idea of *ceteris paribus* testing (changing one variable while

[4] 'A phased testing pathway […] can facilitate a precautionary, step-by-step approach to research on gene drives' (NASEM, 2016: 6). The phases of NASEM's pathway are: research preparation, laboratory-based research, field-based research, staged environmental release, and post-release surveillance.

keeping all others constant). The logic of case-by-case assessment is interspersed with a logic of carrying meaning between cases. We should treat particular cases of gene drive testing separately, but at the same time we should connect them by considering specific outcomes of prior tests as givens, like a chord connecting the beads to form a necklace. The step from one island to the next can never be seamless, given the unicity of real islands, but somehow the isolated trials need to be convincingly connected into what Latour (1999) refers to as a chain of inference for meaning to circulate through it.

4.1 The First Trial as a Performance

Hall (2017) summarizes the rule of thumb for gene drive testing as the smaller and the less inhabited, the better. Delborne et al. (2019) talk about moving from simple to more complex island environments in phased testing. 'Islands with relatively simple geographies and a resulting homogeneous invasive population […] will […] be most amenable to initial trials of these technologies' (Harvey-Samuel et al., 2019: 623). A field trial on a complex island would actually "prove" the advantages of gene drives, but the simple island makes success more likely. Small, humanly uninhabited, remote islands *are* the closest thing we have to real-world laboratory conditions (in the case of gene drives for island conservation). But they are that precisely because they are furthest removed from the real-world complexity of the islands where gene drives are projected to be employed. And so, of all real-world contexts imaginable, they tell us least about what we ultimately want to know: whether gene drives for conservation are as efficient and safe – and as *localizable* – as they are claimed to be.

This is deliberate, of course; it is how science and experimentation work, moving up the ladder of complexity only once a previous rung is deemed supportive after careful and repeated examination. But it is important to recognize that the efficiency and safety demonstrated in the first gene drive trials do more work than this logic of experimentation suggests. Harvey-Samuel et al. (2019: 618) remark that '[g]iven the transformative but also controversial nature of gene drives, it is imperative that their first field trials are able to successfully demonstrate that they can be used safely and efficiently' – and they devote themselves to discussing 'how to maximise the probability of this outcome' (ibid.). A similar point is reflected in the outcomes of expert interviews held by Delborne et al. (2019: 18): 'testing gene drives first on uninhabited islands provides a way to build confidence around gene drives. Interviewees suggested that beginning on uninhabited islands was necessary to show the efficacy of the technology, demonstrate the benefits and risks, and build the confidence of the public in gene drive eradications. It would offer a phased approach to gain acceptance to then scale up'. The first gene drive trials are *performances* of safety and efficiency – they convey a comfortable sense of safety and efficiency beyond strictly demarcated demonstration.

The first gene drive trial is a performance and a test. This should not surprise us: the history of modern science tells us that the experiment has often been about *public affirmation*, about people *witnessing* the empirical observation (Shapin &

Shaffer, 1985). The uninhabited island is like the stage on which this performance is held. Demonstrated is not the safety and efficiency of an actual future gene drive release on an actual island with a particular conservation problem, specific local biodiversity and human inhabitation, and all the relations and meanings this implies. What has been demonstrated most of all is *the idea* of gene drive safety and efficiency. The immersive experience of safety and efficiency triggered by the first field trial leads us to anticipate safety and efficiency throughout the show's run, until its final performance, its finale. In this way, the fictive, ideal island invoked for the first gene drives trials implicates the real, complex islands of potential future gene drive releases. They have symbolic, reassuring meaning.[5]

An essential part of island hopping is imagining a future aim to determine and then become motivated by. The island on the horizon motivates one to carry on, to travel further in order to reach it. The overarching conclusion of the NASEM report is that '[t]here is insufficient evidence available at this time to support the release of gene-drive modified organisms into the environment. However, the potential benefits of gene drives for basic and applied research are significant and justify proceeding with laboratory research and highly controlled field trials' (NASEM, 2016: 10). This passage reflects a particular kind of nonlocalness of technology: the effects a technology already has while in development, or even when still in the realm of imagination (e.g. Borup et al., 2006; Pollock & Williams, 2010; Bensaude-Vincent, 2014; Jasanoff, 2016). Gene drives are new, they are terra incognita. And so, we set out to explore them. But the islands we encounter are more like artificial islands – (re) claimed land. Contemporary science continuously recreates the explorer's dream: new islands to map and explore. Here, we are talking about *technoscience* (Hottois, 1984; Latour, 1988; Haraway, 1997; Barad, 2007; Pickering, 2008; Ihde, 2009); with bioengineering, we are talking about *making* as much as we are talking about *knowing*.

The point of this section was to highlight how the logic of scientific and technological development forms a specific kind of nonlocalness for gene drives. Contained are the "ecological" effects of the trial, but not its symbolic meaning, so to speak, nor the trajectory of development already imagined and outlined for gene drives. The more implicit criticism of the first part of the article returns more explicitly here: gene drive science strategically combines contradictory and incomplete conceptions of islands and containment. The "simplest" of islands is used to create a symbolic value of confidence that is to drive the whole further trajectory forward. The gene drive for conservation literature employs the idea of the contained island only for those dimensions that suit its purposes. Gene drive researchers are aware that hopping from one island to the next can never be seamless. The performance of the initial trials is the glue that keeps them together, perceptually.

[5] However, the image of the island supporting the gene drive for conservation literature can perhaps be considered a more general form of "hyperreality", a reality mediated by various cultural lenses and institutions detached from engaged experience and specific context (Borgmann, 1984, 1995. See also Higgs, 2000). The involved notion of the island may be a fictive island far beyond the first field trial – that is, including its projected "end-point", the actual island of the actual full field release.

Localizing gene drives is not only done by geographically and technologically *isola*ting them; it is also done by separating the trial from the actual release and by assessing each specific gene drive on a case-by-case basis. As we will argue next, making gene drives local is also a normative-political move: the use of gene drives is legitimized by not only containing gene drive spread in a technical and geographic way, but also by localizing the decision-making process.

5 Crossing Borders and Care about the Nonlocal

We saw how the nonlocal nature of gene drives is acknowledged in terms of their spreading propensity. Notably, this feature is often expressed as the potential for gene drives to *cross borders* (NASEM, 2016; Esvelt & Gemmell, 2017; Kofler et al., 2018; Kuzma et al., 2018; Min et al., 2018; Barnhill-Dilling et al., 2019; Hartley et al., 2022). This particular emphasis implies that gene drives become a matter of concern for people only if they find them in their vicinity. A NIMBY or not-in-my-backyard logic (e.g. Aitken, 2009; Feldman & Turner, 2010; Batel & Devine-Wright, 2015; Ryghaug et al., 2018; Macht et al., 2023) underlies the gene drives for conservation debate, specifically the sensibility that NIMBY implies a reasonable claim to the likelihood of IMBY: you are a relevant stakeholder if the gene drive actually *reaches you* – arrives in your backyard. The admitted nonlocal nature of gene drives crucially relies on an effect- or causality-based understanding of influence. The (non)local nature of a gene drive is determined by following its actual physical spread, traced from the point of original release. Whether or not gene drives are a local technology depends on the diaspora resulting from *specific* releases.

Clearly, this is an indispensable way of looking at gene drives; those in whose backyards a gene drive will be released should have a strong say in this decision – importance of voice should reflect extent of being affected (Fraser, 2010). However, this focus has particular implications for how we think about relevant concerns about gene drives. When discussing the importance of *engagement* for gene drive development, the typology provided by the influential NASEM-report (2016) is often referenced (e.g. Barnhill-Dilling et al., 2019; Campbell et al., 2019; Delborne et al., 2019). The report distinguishes communities, stakeholders, and publics to indicate the range of relevant audiences that ought to be engaged. While the reasonable claim to IMBY is not all-determining – spatial proximity *and interests* are the two key variables – even in this nuanced typology the force that drives the engagement of the three audiences originates from the location of the gene drive release. The particular object of their concern and therefore reason for their engagement is the *particular* gene drive release. For communities, proximity in terms of interests is derivative of spatial proximity – and spatial proximity relates to *impact*, to 'direct connection' and 'tangible and immediate interest'. Stakeholders are defined by the proximity of interests *in spite of* a lack of spatial closeness; publics lack both spatial and interest-related proximity. The nearness of the community implies the actual point of release, and the same applies to the lack of spatial proximity of stakeholders and publics.

Should direct connection and tangible and immediate interest be defined by spatial proximity? The report's category of "publics" consists of people who lack 'the

direct connection' to gene drives 'but nonetheless have [contributing] interests, concerns, hopes, fears, and values' (NASEM, 2016: 132) – in other words: who *care* about gene drives. That these people care about gene drives even though it is not – presumably – their backyard into which they will be released reveals a deep connection to gene drives. Their concern travels to the backyards of others. The object of their care is nonlocal. The report states that 'publics do not just exist; they are constructed through procedures of engagement' (NASEM, 2016: 136). Engagement here means: *actively being* engaged. But to be engaged can also mean: to be emoted by something, triggered, made attentive. The concept of engagement captures precisely the tension between the potential limitlessness of engaged as *caring*, and the demarcated nature of engaged as actively, procedurally involved. Viewing concern as spatially and locally constituted – by a particular release, in our case – does not do justice to the fact that the object of concern or care may be of a nonlocal nature. Care about the nonlocal involves matters exceeding the local level, but also care about the locales – the contexts and situations – of others, the *backyards* of others. In this regard, we could say that the demarcation of gene drive releases occurs not only through technically and geographically containing the spread of gene drives, but also through the compartmentalization of care into isolated domains of evaluation. The NASEM report (2016) recommends assessing the desirability of gene drives on a case-by-case basis. The Royal Society statement on gene drives repeats this emphasis on the importance of case-by-case evaluation (Royal Society, 2018). Isolation is of methodological value for scientific experimentation but can also create political legitimacy. Isolation is required for treating particular gene drive releases as stand-alone ethical cases, instead of partly being determined by some nonlocal normative nature of the use of gene drives.

What people object to in a proposal to develop or release a gene drive may not be that gene drive initiative itself, but what it represents to them: for example, the technological nature of our society's engagement with the nonhuman world (Swierstra & Rip, (2007); Macnaghten et al., (2015) indicate the recurrence of this concern in public responses to emerging technologies; substantive examples of this concern are Katz (1992), Higgs (2000) and Preston (2017, 2018)) or how technology changes our values and moral framework (Swierstra & Rip, 2007; Swierstra et al., 2009; Verbeek, 2011; Swierstra, 2013; Nickel, 2020: Nickel et al., 2022). If we imagine the perspective of someone who objects to gene drives for their riskiness, the hubris or will to control they reflect, the way they appear to intervene into the fundamental process of evolution, or how they artificialize local populations, inheritance, and ecosystems (De Graeff et al., 2019, 2021; examples of such concerns regarding biotechnology more broadly are: Gyngell, 2012; Schyfter, 2012; Turner, 2017; Veraart et al., 2023), we can see how the control of the spread of *particular* releases is perhaps not the only or most important issue (Boersma, 2022; Boersma et al., 2023; Bovenkerk & Boersma, 2023). Regarding local drives, Min et al. (2018: S42) remark that they 'exclusively affect local but not global populations'. But the better the localization of gene drives works, the likelier their widespread (wide*spread*) adoption becomes (through inspiration, and through an active search for outlets because of time, effort, resources and reputations invested). A world riddled with highly controlled and localized individual gene drive releases is still a world full of

gene drive spread. Successful gene drive use on a particular island is likely to lead to further use on other islands. It is incomplete to imagine the phased testing pathway to end at full release, for after the first successful full release, many others are likely to follow.

6 The Possibility of an Island: Local Decisions about Local Affairs

In this concluding section, we want to briefly reflect on *the possibility of an island* in today's world, and what we – in light of our particular case of gene drives for island conservation – may do to support this possibility. By "possibility of an island" we mean the possibility of localities where local decisions can be made about local affairs. The preceding discussion has suggested that decisions have two dimensions or sides – which we may term "political" and "ontological" – which can be more or less aligned or "in-tune" in terms of their localness. Supporting the possibility of an island means attempting to bring those two dimensions into closer alignment. We can and should support local decision-making on normative-political grounds. But it is vital to also think about ways of protecting or retrieving the localness of the things these decisions aim to address. And so, as illustrated by our example of gene drives for conservation, we need to reflect on the global connectivity of globalization and anthropocene, and on technology and its multifarious "spread" – physical, but also ideational, inspirational, and institutional. A decision on using – for example – a gene drive to address an invasive species problem could never be *devoid* of local matters. But there are dimensions to such decisions which defy localness, such as the instrumentalization of the local island for the distinctly nonlocal goal of legitimizing gene drives beyond a specific locality, that need to be acknowledged and addressed in order for local decisions to be as "legitimate" as possible. We have a particular (and thus partial) form of legitimacy in mind: the alignment of the localness of the matter decided on and the localness of those deciding; a conviction that *we should decide* because *it concerns us*. The decision to use a gene drive to address a local conservation problem would be "legitimate" in two ways: local communities decide, in a fair and inclusive process (normative-political); and the thing that is decided can be viewed as a local matter (ontological).

Islands would be impossible if they presupposed absolute isolation. Local cultures and ecosystems have been 'shaped and transformed in long histories of regional-to-global networks of power, trade, and meaning,' as Tsing (2005: 3) puts it. Linking localness to absolute isolation is not only empirically dubious, but also potentially politically harmful as it has often contributed to framing Indigenous communities as static remnants of the past (Peddi et al., 2023) and ecosystems as untouched wilderness that needs to be separated from any human influence (Büscher & Fletcher, 2020). "The island" of which we discuss the possibility is not the pristine or absolute island, and the same applies to the ideas of isolation and localness on which this conception of islands would rely. As our discussion of the gene drives for conservation literature suggests, the images of pure island and isolation are fictions. What we have in mind is a *qualified* localness, isolation and unicity. While the pure island has never existed, we do believe that anthropocene and globalization

on the one hand and contemporary technologies of the anthropocene such as gene drives and their development on the other hand pose a unique challenge or threat to localness and unicity – a difference or change in the possibility of qualified localness. The ubiquity of connections threatens absolute but not *qualified* localness, it does not invalidate local cultural traditions, the unicity of threatened ecosystems, or the political import of self-determination in the sense of local control over local issues. Part of affirming the possibility of an island therefore entails challenging its framing as absolute isolation.

We do not mean to imply that the difficulty of exclusively local decisions is a generalization that follows from the specific case of gene drives and the difficulty of their containment we examined alone. It is the anthropocene and globalization, and what they imply in terms of technology and the interconnectivity of natural systems, that explain this state of affairs; even if gene drives do exceptionally reveal it. Gene drives illustrate how some contemporary technologies may uniquely challenge that intricate balance of embracing both connection and localness.

6.1 What is at Stake

In emphasizing the limitations of islanding regarding gene drives, our discussion brings into view a more general concern for the fate of local unicity in light of the fundamentally interconnected nature of our world, and the observation that the legitimacy of local decisions does not necessarily correspond to the condition of our world. Globalization – of people and of "nature" and climate in their wake – challenges islands' condition of existence: their relative isolation from the rest of the world. Perhaps the physical manifestation of the island is misleading, therefore: islands are caught up in global interconnectivity, and only their rising from the sea or representation on a map is there to remind us of a previous world where localness seemed achievable. We should not pretend that the world of legitimated local gene drive decisions coincides with our natural world, our world of human mobility of movement, ideas and innovations. Exclusive reliance on "isolated" conservation efforts, local drives and local community engagements – of localities trying to keep things the way they were – would be in denial of the interconnected nature of our world, and fighting a steep uphill battle. To treat local communities and decisions as isolated entities and events does little to address the underlying forces that have destroyed the possibility of an island in our world.

Islanding reflects ambiguities between the more technical and the more normative sides of containment. By making the case for *technical* containment, the gene drives for conservation literature shifts attention to local evaluations that run the risk of sidelining normative concerns about nonlocal aspects of technologies. Local evaluations of technologies including gene drives are of crucial importance, but need to complement rather than substitute engagement with nonlocal aspects such as creating precedents of technology implementation or strengthening global technology acceptance through local success stories. The relevance of these considerations presents itself most clearly in relation to the widely expressed commitment to the involvement of local and often Indigenous communities in decision-making

about gene drive applications in local environments (e.g. Esvelt & Gemmell, 2017; Dearden et al., 2018; Barnhill-Dilling et al., 2019; Campbell et al., 2019; George et al., 2019; Taitingfong, 2019; Hartley et al., 2022; Palmer et al., 2022. Similar emphasis is expressed for CRISPR and biotechnology more broadly, e.g. Kofler et al., 2018; Novak et al., 2018; Buchthal et al., 2019; Palmer et al., 2021; Wise & Borry, 2022). Given the stage of gene drive development, this commitment mainly concerns recommendations for future practice.

Indigenous perspectives highlight the need for decision-making in accordance with local people and territories. Local decision-making is at the center of self-determination as enshrined in the *United Nations Declaration on the Rights of Indigenous Peoples*, and crucially involves self-determined choices about the use of technologies and adoption of aspects of techno-scientific modernity. But embracing the importance of Indigenous self-determination and local decision-making should not lead to the evasion of normative questions about technologies beyond local scales. While the gene drives for conservation literature displays clear sensitivity to the inclusion of Indigenous worldviews in decision-making, it should be mindful of two pitfalls related to its "islanding" tendencies. First, the risk of outsourcing normative burdens and of instrumentalizing Indigenous communities for advancing nonlocal goals of legitimizing gene drive technologies by pointing to local approval. And second, the risk of reducing Indigenous perspectives to being of "merely local" relevance rather than also recognizing their relevance for normative engagement with technologies and conservation at global scales, as important voices also in global debates about socio-environmental crises (Cariño & Ferrari, 2021; *M'sit No'kmaq* et al., 2021) and technological shaping of environments (Gumbo, 2020; Cruz, 2021).

Gene drives are the product of global knowledge production, are positioned as solutions to global challenges such as biodiversity loss, and raise global concerns about technological shaping of environments. Avoiding responsibility for these nonlocal aspects by outsourcing technological legitimization would not do justice to the technologies or the communities expected to locally evaluate them.

6.2 Supporting the Possibility of an Island

How can we support the possibility of an island? We end by highlighting four challenges for the design of and decision-making about technologies that emerge from our previous discussion. First, the care about the nonlocal we outlined earlier can be seen as a precondition for attempts at reclaiming the possibility of an island. As feminist scholarship (e.g. Plumwood, 1993) tells us, care is locally and relationally constituted. This is why a focus on local communities, like we saw advocated for gene drives, is vital. However, the local constitution of care does not mean that the object of care needs to stay local. Local care makes caring for the nonlocal dimensions of technology and the localities of others possible. As Plumwood (1993: 183) argues: 'The feminist suspicion is that no abstract morality can be well founded that is not grounded in sound particularistic relations to others in personal life, the area which brings together in concrete form the intellectual with the emotional, the sensuous and the bodily'. Nonlocal concerns regarding technology – e.g. interventionism, the

human presence on earth, anthropocentrism, global climate change and ecological crises – always find their expression in concrete locales, in concrete interventions, decisions, practices, and relations. But a concern with for instance intervening into evolutionary mechanisms, or releasing inherently spreading biotechnologies based on part-idealizations of island contexts, can be closely felt by someone even if these actions are not expected to occur nearby. NIMBY implies a reasonable claim to IMBY. But what about NIABY: not in *anyone's* backyard?

Importantly, such deeply felt care-at-a-distance can concern the local self-determination of communities. It is not just an ivory tower concern with 'the human-nature relation' which can travel across waters; a concern with the possible plight of others and their ability to decide locally about their own local situation can do this too. And so, these two forms of "nonlocal care", care about the locales of others in light of nonlocal concerns, come together in a commitment to the possibility of local decisions. The first challenge is thus to cultivate and provide room for nonlocal care in decision-making about technologies.

A second challenge is how to address, in concrete technologies and decisions about them, the interconnectivity of our social and natural world (globalization; anthropocene) and concerns about nonlocal dimensions of technology which subvert local unicity and decisions. This challenge can be illustrated by asking whether there is a place for gene drives in attempts at supporting the possibility of an island. There are reasons for viewing gene drives favorably in this regard. First, the locally-fixed alleles approach (Sudweeks et al., 2019; Oh et al., 2021) we introduced earlier is in a sense an ultimate island technology. Against the global tendencies of technological development, it targets what makes the island unique – not its geographic isolation per se, as is the case for other local drives and gene drives for conservation more broadly, but its tendency towards unicity due to geographic isolation. The invasive species have been incorporated into this tendency, to the point where they can now be specifically genetically targeted. Secondly, it can be argued that we should embrace technologies such as gene drives because they promise to intervene for the sake of ending the existing practice of *continuous* intervention; the promise is that once a gene drive has successfully eradicated a population, no more pesticides need to be used. Finally, when we view spatially limited gene drives from a "value-sensitive design" (Friedmann, 1997; Nissenbaum, 2001; Van den Hoven, 2007) point of view, we can consider whether the design choice for spatial limitation should be considered as itself expressive of value. Perhaps, in light of doing something to address the interconnectivity of our world, limitability – localizability – is not instrumental to other values (e.g. "safety"), but itself something we come to cherish?

However, there are also reasons for viewing gene drives as lacking the appropriate characteristics to support the possibility of an island, being too prone to non-localness. Considerations supporting this position interspersed our analysis. Their inherent spreading propensity, contained in the design itself, may bear too strong a resemblance to the movements of globalization and anthropocene towards interconnectivity and the erasure of local unicity. Gene drives can be understood as a technology of denial of local unicity in important regards. Gene drives may erase the importance of unique local geographical conditions for success. And local drives relate ambiguously to the island: on the one hand, they trade on the genetic effects of

isolation for their design (e.g. LFA) and/or testing, but at the same time they make the geographic isolation of the island less important.

Moreover, in the language employed around gene drive testing, the absolute importance of patrolling the island is emphasized (e.g. Barnhill-Dilling et al., 2019): monitoring the boundaries of the island, limiting travel, a cordon sanitaire. The realization of containment during testing stands in stark contrast to the real world to which the island returns after a gene drive release. What happens after the gene drive monitoring apparatus leaves? The island goes back to being intricately caught up in the flux of the world of which it is a part. The island has not been given back its condition of existence; the improved conditions were merely a temporary state of exception. In this regard, gene drives do not appear to be a 'disruptive technology' (Hopster, 2021) first and foremost, but an *appeasing* technology, a technology which allows for the continuation of existing practices instead of the consideration whether a more fundamental change is what is truly warranted. Human mobility and connectivity have erased natural barriers (Redford et al., 2019). When it comes to most invasive species, we cannot imagine the situation without overlaying the mobility of humans – and our own "invasiveness". The human origin behind the particular conservation issue is not a one-off incident but a reflection of a pervasive state of the human-nature relation. In this sense, the deployment of gene drives is symptom-control, not a solution of the underlying problem.[6] Thus, for every conservation decision involving bringing back a specific local ecosystem into a prior state, we should perhaps ask whether we are also doing something to "give back" to the possibility of an island – whether it is not just symptom control in a deeply interconnected world we leave as it is.

These reflections on gene drives bring us to our third, closely related challenge: how to develop technologies which invite explicit, careful consideration of (non)localness and (non)localizability. Gene drives can be viewed favorably in this regard. One of the "advantages" of gene drives is that there is a clear source or origin of the technology, and therefore a clear decision on introducing a technology to the "shared environment". It is precisely because gene drives are an inherently nonlocal technology (even if designed for localization) that they stimulate or "afford" (e.g. Klenk, 2021) such a concrete and considered decision; they emphasize that the decision to release them is a release of control. In light of the particular challenge we propose here, this is perhaps a good thing. Gene drives force those pondering their (future) application to consider questions which are often less easily considered regarding other technologies, but arguably should. Contrary to a gene drive and its 'potential for unilateral alteration of the shared environment' (Min et al., 2018: S59), the smartphone would be an example of an opt-out technology: the choice to purchase and use one is the individual's, and deciding not to means not "having" the technology. However, the general use of smartphones by others very much affects the lifeworld of those without one. You can opt out of the purchase and use of a smartphone, but you cannot opt out

[6] There are of course profound animal-ethical, ecological and cultural arguments for protecting local species against invasive ones.

of living in a smartphone society. Technologies constitute forms of life (Winner, 1989): they have the potential to fundamentally alter the societal practices into which they are introduced, to structure the content of everyday life around them. Gene drives may not be unique in their nonlocalness, but they do extraordinarily reveal it because of their inherent spreading property.

The final challenge is how to take seriously the performativity of local decisions. Local decisions can be a form of activism, of saying no to a world of interconnectivity and to the undermining of local determination. In this regard, the choice to fix a certain historical state in the case of conservation of island ecosystems – often criticized for arbitrariness (Hobbs et al., 2011; Higgs et al., 2014; Lee et al., 2014; Rohwer & Marris, 2016) – may be understandable if we recognize that "pre-disturbance" and "pre-globalization" share a meaning. This suggests that invasive species eradications on islands can be more explicitly understood and evaluated in terms of the motive of fighting back against the interconnectivity of the world that has subverted the possibility of truly local decisions – and that those promoting conservation efforts could explicitly couch their aims in terms of this consideration. The historical reference point *is* arbitrary – ecologically speaking – but in terms of supporting the possibility of an island in an interconnected world, it is *deliberate*. "Island restoration" would acquire a double meaning: restoration of local biodiversity, and restoration of localness.

Furthermore, humanly uninhabited islands can be viewed as reminders of a different world – a world before global human mobility. In considering gene drive trials, these islands appear to be treated as if the downtrodden among the places on earth: *no one cares* about them, so they are more suitable for human experimentation. Uninhabited islands are no one's backyard. Perhaps they should be treated differently, as reminders of unicity, as symbols of the possibility of a different world. Despite everything we have discussed, islands still represent the occurrence of unicity in our world. And they suggest how isolation is a precondition to unicity. If left alone, they become more unique.

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