UNIVERSITY OF CALIFORNIA SAN DIEGO

Editing Islands: (Re)Imagining Isolation in Gene Drive Science and Engagement

A dissertation submitted in partial satisfaction of the requirements for the degree of Doctor of Philosophy

in

Communication

by

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The dissertation of Riley Ilyse Taitingfong is approved, and it is acceptable in quality and form for publication on microfilm and electronically.

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DEDICATION

This work is dedicated to my mother and father:
Thank you for teaching me to value education, and to value justice even more.

EPIGRAPH

Just as the sea is an open and ever flowing reality, so should our oceanic identity transcend all forms of insularity, to become one that is openly searching, inventive, and welcoming.

Epeli Hauʻofa

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ABSTRACT OF THE DISSERTATION

Editing Islands: (Re)Imagining Isolation in Gene Drive Science and Engagement

by

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Westerners have long imagined, represented, and treated islands around the globe as "natural laboratories" given their perceived geographic isolation. It was on islands that colonizers first conducted "experiments" in imperial expansion via the establishment of plantation economies and maritime military infrastructure, and where scientists developed myriad ecological, evolutionary, and anthropological theories predicated on views of islands as enclosed systems containing human and nonhuman subjects amenable

to scientific observation. In this way, island isolation represents an enduring mythology fundamental to the entangled projects of settler colonialism, militarism, and scientific knowledge production. This dissertation examines the meaning-making processes that continue to uphold myths of isolation in contemporary scientific practice, focusing on an emerging genetic engineering technology known as gene drive.

This examination is organized into three chapters. Chapter 1 considers the historical basis of the myth of the isolated island laboratory, focusing on appropriations of Pacific Islands as military outposts and sites of nuclear weapons testing. Against this history, it considers the incommensurability of the conception of island isolation with Indigenous relations to islands as connected (not isolated) by the ocean. Chapter 2 examines presumptions of island isolation embedded in calls to trial genetically engineered organisms containing gene drives on remote islands. The third and final chapter provides an account of an ethnographic investigation of emergent community and stakeholder engagement practices meant to facilitate just decision-making surrounding the deployment of gene drive technologies, focusing on two Hawaiian Islands where gene drive research is underway. I identify isolation and containment as salient frames structuring scientific practices related to gene drives, and argue that these are ill-equipped to facilitate the just use of these technologies. I invite a reimagination of gene drive science and engagement through more oceanic and archipelagic ways of knowing that embrace connectivity and attend to history and power.

INTRODUCTION

This dissertation is an examination of widespread proposals to implement novel genetic engineering technologies known as *gene drives* on islands, and the challenges of adopting community engagement activities to facilitate local and Indigenous determination of the use of those technologies. This examination is driven by an interest in the meaning-making processes that undergird scientific imaginaries about islands and Indigenous knowledge, and a desire to identify opportunities to better align scientific practice to the interests of Indigenous Pacific Islanders on whose lands these technologies may one day be deployed. I analyze the scientific literature prescribing that gene drives be tested on islands to ensure their "safe" development, and draw on ethnographic methods to analyze the emergent community and stakeholder engagement practices on two islands where gene drive research is underway. The impetus for this project began with my everyday experiences studying the scientific discourses and practices surrounding gene drive technologies at UC San Diego (UCSD).

In recent years, scientists have developed genetic engineering techniques known as gene drives that have unprecedented capacity to alter wild species.[1] Gene drives make it possible to suppress or eradicate entire populations of species more rapidly than ever before, drawing notable interest and investment in their potential to mitigate vector-borne

[1] Gene drives push genetic alterations through populations of sexually reproducing organisms at higher-than-normal rates (NASEM, 2016). At the time of writing, no gene drive–modified organisms have been released outside the laboratory given the need for further technical development as well as regulatory and governance mechanisms to facilitate their ethical oversight. See Chapter 2 for a more in-depth introduction to gene drive technologies.

disease (e.g., malaria, Zika, dengue), or curb the impacts of "pest" species on ecological biodiversity or agricultural health (NASEM, 2016). As a graduate student at UCSD, one major site of gene drive research, I have seen the rapid growth of infrastructure to support the scientific development of gene drive technologies as well as to stimulate dialogue about the ethical issues surrounding their use.

While frequenting these spaces and discussions for my research, I have had the opportunity to hear from a global community of experts spanning the sciences, social sciences, philosophy, and policy who are grappling with the implications of technologies capable of modifying entire populations of nonhuman organisms, including in ways that could facilitate their extinction. Scholars question a number of underlying presumptions within proposals to release gene drive–modified organisms outside the laboratory. Is it ethical to eradicate an entire species of mosquito or rodent on the grounds that it causes suffering to humans or other animals? Whose definitions of *risk* and *benefit* will be reflected in assessments about whether it is safe to release gene drive–modified organisms in the wild? Within these important discussions, however, one prevailing presumption has gone almost entirely unexamined: that geographically isolated islands represent ideal sites for the first releases of gene drive–modified organisms.

Through my genealogical ties and lived relationship to the vast region known as Oceania, I have become attuned not only to the fact that *isolation* is just one (very narrow) way of viewing our island communities, but to the powerful consequences of such views, namely the configuration of our islands into a scatter of colonial and military outposts serviceable to the project of empire. Thus, this project is motivated in large part by unease with the regularity with which islands are conjured into collective imaginaries

as natural or logical *field sites* for gene drives. However, a deeper motivation is the strong connection and love I feel for Oceania as an expansive site of Indigenous history, futurity, and possibility, and a desire to see such an orientation better reflected in the scientific discourses that shape how a variety of actors imagine and relate to islands. For these reasons, my project is both an interrogation of the ways in which science, colonialism, and militarism work together to perpetuate mythical imaginaries of our islands as sites of experimentation, and an invitation to draw on oceanic ways of knowing to reimagine the limiting frames these systems provide for creating knowledge and relating to one another. The remainder of this introductory chapter details the interdisciplinary set of theories and methodologies on which I draw for this effort.

I.1 Oceania Is Vast, Oceania Is Expanding: Indigenous Pacific Theoretical Foundations

This project draws foundational conceptual and analytic frames from Indigenous Pacific Islander scholars who advance theory and practice rooted in the expansiveness of our Oceanic communities and histories. Tongan and Fijian scholar Epeli Hau‘ofa is a seminal voice in such efforts, with his classic essay “Our Sea of Islands” challenging Western imaginaries of Pacific Islands as tiny, far-flung dots in a distant sea, asserting Oceania instead as a sea of islands *connected* (not isolated) by the sea (Hau‘ofa, 1993). Like Hau‘ofa, numerous Indigenous Pacific scholars writing in the field of Native and Pacific Cultural Studies contribute to a “critical rethinking of islands from the standpoint of indigenous epistemologies,” emphasizing Indigenous cartographies and seafaring technologies to reanimate the sea as a site of Indigenous genealogy and mobility (Diaz,

2015, p. 90). My project is deeply informed by these and other aligned works in two significant ways.

First, I heed the calls of Native and Pacific Cultural Studies scholars to ground studies of Oceania in knowledges *from* Oceania. This offers an important intervention in longstanding tendencies of academic scholarship to study the Pacific and its peoples through theories from the continental US (and other Western perspectives). I draw on discourses generated *by* knowing Indigenous subjects belonging to Oceania, and mobilize my own standpoint as a diasporic CHamoru (Indigenous people of Guåhan/Guam) to acknowledge that while our shores have been met by many waves of imperialism, militarism, and colonialism, our sea of islands has always been a site of Indigenous mobility and resistance (Na'puti, 2020, p. 98).

Grounding in Oceanic knowledges also means forwarding the rhetorical practices generated by Pacific Indigenous scholars. Like many of these scholars, I prefer the term *Oceania* over *Pacific* when referring collectively to the regions colonially demarcated and named Polynesia, Melanesia, and Micronesia. As Hau‘ofa notes, *Pacific* suggests “small areas of land sitting atop submerged reefs or seamounts” while *Oceania* suggests “a sea of islands with their inhabitants” (1993, p. 153). In other words, Oceania better signifies the vastness of the planet’s single largest geographic feature and the island communities it connects. Oceania also resists the connotations of *passivity* associated with “Pacific.” As I-Kiribati and African American scholar and poet Teresia Teaiwa describes, “we use the term ‘Oceania’ instead of the ‘Pacific’ because we are not a tame and peaceful people” (2005, p. 23). Though I use Oceania and Oceanic to refer to our vast region and its peoples, I also use *Pacific Islander* to refer to all Indigenous peoples

of Oceania as it has been adopted as a meaningful collectivizing term through which Pacific Islanders self-identify.

Secondly, my project is informed by scholarship interrogating the logics through which islands come to signify *isolation.* Scholars spanning Native and Pacific Cultural Studies, Critical Island Studies, and Archipelagic American Studies contribute to these efforts, deconstructing the *isolated island* as an invention of colonial and continental thinking (DeLoughrey, 2012; Diaz, 2015; Hau'ofa, 1993; Roberts & Stephens, 2017). These works problematize the inherently landcentric logics that prefigure continents as the "center" (of power, significance), thereby marginalizing islands to periphery.[2] They trace the historic and ongoing ways that islands are imagined as tiny therefore disposable, and remote therefore akin to the contained space of the laboratory and amenable to various forms of experimentation. I join these works in their efforts to destabilize entrenched views of island isolation as an essential or commonsense truth, showing instead how they function as powerful *myths* in the maintenance of empire.

In focusing my analysis on the emergence and continued reproduction of the myth of the island laboratory, I contend thoroughly with a dominant epistemic claim that underpins these imaginaries: that ("valid") scientific knowledge production necessarily occurs in isolated or contained environments separated from the observer by physical distance. Across the three chapters of this dissertation, I demonstrate that the *laboratory* is a salient conceptual scheme through which islands are understood as "natural" sites of

[2] The impetus for the formation of the emergent field of Archipelagic American Studies is to disrupt those dichotomizing center-periphery dynamics, offering instead that we reframe geography (and studies of how power flows across geography) as *archipelagic.* In this understanding, power is not located or centralized on continents, but instead exists as a set of complex, interactive and constitutive relations *across* islands, oceans, and continents (Roberts & Stephens, 2017).

experimentation, and through which conventional boundaries between "expert" and "lay" knowledges are maintained. By drawing on scholarship that understands *all* knowledge as situated (i.e., embodied and produced within particular historical and cultural conditions), I am able to examine the value underpinnings of scholarly discourse and community and stakeholder engagement practices related to gene drives.

I.2 Situated Knowledges: Feminist Technoscience and Feminist Standpoint

The other major bodies of work that inform my theoretical orientation to this project are feminist technoscience and feminist standpoint theories. My interest is in their shared intervention into conventional epistemic standards that feminist technoscience scholar Donna Haraway has famously dubbed "the god trick" of objectivity: the notion that objective science is produced from a disembodied, transcendent gaze that claims to see everything from nowhere (Haraway, 1988, p. 581). Feminist contributions to science and technology studies or STS (later termed feminist *technoscience* to refuse the dichotomous separation between scientific theories and their practical or technological applications) offer a powerful counter to the disembodied gaze of Western empiricism by theorizing the intersections of science and technology with gender and other markers of identity (Åsberg & Lykke, 2010; Subramaniam, Weasel, & Mayberry, 2001; Subramaniam & Willey, 2017).

In this way, feminist technoscience understands science –and the knowledge claims and technologies to which it gives rise– as inherently entangled in social processes and interests that warrant political and ethical accountability (Åsberg & Lykke, 2010). In taking the scientific discourses and practices associated with gene drive technologies as

the object of my analysis, my project similarly orients to science as a social activity that embeds particular cultural values and worldviews which in turn shape material consequences. As I argue in this dissertation, in the same way that the "god trick" claims universality to present objective science as all-knowing, the seemingly common sense presentation of islands as ideal test sites for gene drives obscures the particular cultural logics through which associations of islands with isolation and experimentation have been produced.

I also follow feminist standpoint theorists in recognizing the value of women's situated knowledges to studies of power. Seminal contributors to this field such as Patricia Hill Collins, Dorothy Smith, Nancy Hartsock and Sandra Harding emphasize that the social locations of women – and other groups marginalized under intersecting dimensions of race, class, ability, sexuality, etc. – can offer epistemic advantage in analyses of power (Collins, 2000; Harding, 2004; Hartsock, 1998; Smith, 1987). In this view, perspectives expressed from the embodied social location (and attendant experiences and knowledge) of women and women of color are uniquely positioned to generate insights about social phenomena that are not available to those occupying dominant positions and perspectives. In a reconceptualization of conventional notions of objectivity, some standpoint theories suggest that feminist social locations offer *feminist objectivity* or *strong objectivity,* that is – "less partial and distorted accounts" of social phenomena (Harding, 1991, 138).

In this regard, writing from my standpoint as a Pacific Islander woman is valuable to the study of the ways gene drive technologies are being imagined and pursued for trials and implementation on islands. Indeed, my embodied, everyday experiences within

spaces where discussions about the ethical and social implications omitted deeper consideration of the implications of these technologies for Indigenous peoples including Pacific Islanders has shaped the very impetus for this dissertation. In the following section, I discuss my methodological and ethical orientation to this project.

I.3 Methodological Approach and Ethical Commitments

My methodological approach is informed by my ethical commitments within this project. I draw inspiration and practical guidance from the scholarship of Black and Indigenous feminists who reflect on the ways research can be a site of harm as well as social and political transformation (Collins, 2000; Goodyear-Kaʻōpua, 2016; L. T. Smith, 2012; TallBear, 2014). These scholars have proposed generative insights, questions and guiding ethical principles to pursue reflexive research practices committed to positive social change. This section offers an overview of my methodological choices as guided by engagement with some of these questions and considerations.

In a reflection on her feminist-Indigenous approach to inquiry, Native Studies scholar and Indigenous Science Studies co-founder Kim TallBear frames the following question to guide considerations of accountability within research: "whose lives, lands, and bodies are inquired into and what do they get out of it?" (2014, para. 2) Similarly, Kanaka Maoli (Native Hawaiian) scholar Noelani Goodyear-Kaʻōpua offers guiding methodological questions on how researchers can honor their *kuleana* (positionality and obligations) through their methodological choices, asking: "What is at stake in this research? How can I nurture reciprocal relationships? And how can I use the momentum from this research to catalyze positive social change?" (2016, p. 2) I bring these questions

to bear on the scientific research that is the subject of my inquiry, as well as my own research practices.

Considering the powerful (and potentially irreversible) ways that gene drives may impact the environments in which they are released, the stakes of decisions about their use are significant. I contribute to a growing conversation about the need for Indigenous peoples to be involved as key decision-making stakeholders in this context given their rights to determine the uses of their ancestral lands (Barnhill-Dilling, Rivers, & Delborne, 2020; Convention on Biological Diversity, 2017; Redford, Brooks, Macfarlane, & Adams, 2019; Taitingfong, 2020; Taitingfong & Ullah, 2021). Within this dissertation, I devote my examination to the discourses and practices that materially impact how gene drives are developed, and how decisions about whether to deploy them will be pursued. Specifically, I employ qualitative document analysis to assess presumptions within scholarly texts that the "safe" conduct of field trials necessarily involves the use of isolated islands, and I employ ethnographic analysis of the community and stakeholder engagement practices being pursued on two islands where gene drives are proposed for use as a tool for conservation. In both cases, my principal interest is in the degree to which prevailing claims and approaches align with the goal of Indigenous self-determination.

I identify engagement as an important site of study for multiple reasons. First, there is wide acknowledgment by scientists, ethicists, and policymakers alike that gene drives should not be released in the wild without some form of community engagement or authorization (Esvelt & Gemmell, 2017; NASEM, 2016; Neuhaus, 2018; Singh, 2019; Thizy et al., 2019). These calls for engagement generally espouse participatory values,

for instance: the building of relationships and trust between researchers and community partners; collaborative identification of local public health or conservation issues gene drives may mitigate; involvement of publics and communities as empowered decision-makers about the use of gene drives; and the engagement of local and Indigenous knowledges as forms of expertise valuable to such decisions. However, there is also recognition in this literature that it remains unclear how publics or particular communities will meaningfully inform decisions about gene drives given the nascent state of enforceable governance mechanisms to guide those decisions, and a general ambiguity surrounding the activities that ought to constitute engagement.

In summary, engagement is thoroughly imagined, discussed, and practiced as a way to inform actual decisions about the release of gene drives. For this reason, the activities that constitute engagement not only offer a rich site to study the ways in which decision-making power is negotiated and mediated in relation to these technologies, but to approach Goodyear-Ka‘ōpua’s invitation to identify ways to use research to catalyze positive social change. That is, if engagement is meant to afford opportunities for local and Indigenous communities to inform decisions about the use of gene drive technologies in their communities and on their ancestral lands, close study of the ways such practices are playing out can generate important insight into the challenges of meeting those goals.

As I describe in detail in Chapter 3, ethnographic methods provide a valuable window into the ways engagement activities are being designed and pursued in practice. My final chapter therefore draws on ethnographic fieldwork conducted between September 2018 and May 2020 to examine some of the practices and understandings of engagement taking shape in one island setting in Oceania where gene drive research is

currently underway. I detail ethnographic insights gained through: (1) situated observation of engagement activities on the island of Oahu, (2) interviews with conservationists and developers of gene drive (on Oahu and the Big Island of Hawai‘i) about engagement, and (3) interviews with Kānaka Maoli residing on the islands where gene drives are being developed about these technologies and potential modes of engagement to inform their use.

My analysis generates insight into the limitations of one orientation to engagement I observed in my ethnographic research, namely the conceptualization of engagement as a *strategic* activity aimed at persuading or influencing decision-makers toward authorization of mosquito control technologies, including gene drives. Because the limited set of activities I observed engaged small subsets of the public rather than specific groups or Indigenous communities, I organized interviews with a small group of Kānaka Maoli residents living on Oahu and the Big Island to prompt dialogue about proposals to use gene drives for local conservation efforts, and about how scientists and conservationists pursuing those efforts might go about engaging Kānaka Maoli.

In doing so I seek to uplift the insights of Kānaka Maoli I interviewed, but *not* to represent those insights through a normative lens of "objectivity." Kim TallBear describes her feminist-Indigenous research ethic as *standing with and speaking as faith,* informed in part by Neferti Tadiar's articulation of "Sampalataya," Tagalog for "act of faith" (2014). She describes hers as an ethic that divests from standard notions of distant objectivity as neutrality, and instead privileges research as an agent of change within communities:

> […] one speaks as an individual "in concert with," not silenced by one's inability to fully represent one's people. I read this to be a sort of co-

> constitution of one's own claims and the claims and acts of the people(s) who one speaks in concert with. Sampalataya involves speaking as faith—as furthering the claims of a people while refusing to be excised from that people by some imperialistic, naïve notion of perfect representation. ("Beyond the Politics of 'Giving Back, para. 1)

Following this ethic, I do not seek to speak for or objectively represent the views of Kānaka Maoli but rather to stand with these communities by amplifying their insights, expertise, concerns, and desires. In this way, I see my research not as an exercise in extrapolating my ethnographic data into a generalizable or statistically significant representation, but as an opportunity and commitment to learn from my interlocutors' situated expertise, and generate practical recommendations for engagement more equipped to honor that expertise.

I.4 Key Terms and Concepts

Before closing this introduction with a summary of the dissertation's chapters, I clarify some key terminology used throughout the dissertation, namely: myth; imperialism, settler/colonialism, and militarism; Indigenous; and genetic engineering.

I.4.1 Myth

I follow cultural and literary critic Roland Barthes in understanding myth most fundamentally as *modes of signification* (Barthes, 1972, p. 93). This definition underscores that rather than existing as natural objects or concepts, myths are systems of meaning that are *made* or *produced* through communication. Following Barthes, I also understand myth as *flexible* and *always motivated.* That is, while myths emerge in particular historical moments and contexts, their constant remaking means they are subject to shifts and transformations that reflect the dynamic ideological systems of

which they are part, and the material purposes they serve. As I demonstrate, the myth of the isolated island has functioned in some moments to fix islands as *peripheral* to continental centers of power and significance, and in others reconfigured them as *central* to projects of US empire and militarism.

Additionally, I find British philosopher Mary Midgley's definition of myth informative for my purposes as she emphasizes that myths are *imaginative patterns*: "networks of powerful symbols that suggest particular ways of interpreting the world" (Midgley, 2003, p. 1). My purpose in investigating the myth of the isolated island is not to simply expose it as "false," but rather to elucidate the *processes* through which this myth is continuously made, maintained, and mobilized toward particular ends. In other words, I aim to analyze the meaning-making processes through which imaginaries of isolated islands are produced, and characterize the consequences of unconscious internalizations of those imaginaries.

I.4.2 Imperialism (and Its Outposts)

I follow the definitions of imperialism, colonialism, and settler colonialism widely used in Indigenous Studies (Smith, 2012; Tuck & Gaztambide-Fernández, 2013; Wolfe, 2006). Focusing on the form of imperialism that became widespread with European expansion in the I adopt Māori scholar Linda Tuhiwai Smith's definition of *imperialism* as having four commonly used "layers" of analysis: "(1) imperialism as economic expansion; (2) imperialism as the subjugation of 'others'; (3) imperialism as an idea or spirit with many forms of realization; and (4) imperialism as a discursive field of knowledge" (p. 22). Her definition recognizes that beyond being an economic, political, and military phenomenon, imperialism is a complex *ideology* with widespread

expressions in culture, technology, and education (p. 23). Indigenous Studies frequently analyzes imperialism along these lines, locating it within the Enlightenment spirit, and recognizing it as crucial to the development of the modern state, of science, of ideas, and of the "modern" human person (p. 23). The advancement of imperialism, in all of its domains, required the exploitation and subjugation of Indigenous peoples, to secure European control over the markets, to ensure the spread of the Enlightenment ethos, to enforce a particular type of order over colonized societies.

I also follow Smith's definition of colonialism as "imperialism's outpost," noting the function of colonies in securing ports, enabling access to raw materials, and facilitating the efficient transfer of commodities from their point of origin to the imperial center (p. 24). She notes that colonies also served to enforce order over Indigenous and European subjects, to keep them "in service to the greater imperial enterprise." In this sense, colonies served as important cultural sites which reinforced particular ideas about what the "West" or "civilization" stood for.

Throughout this dissertation I emphasize the historic and ongoing impacts of settler colonialism on Pacific Islands (e.g., Hawai‘i, Guåhan). *Settler colonialism* refers to a distinct form of colonialism that functions through the replacement of Indigenous peoples with an invasive settler society, and the subjugation and forced labor of chattel slaves (Tuck & Yang, 2012, p. 6). In settler colonialism, the colonizer "comes to stay, making himself sovereign, and the arbiter of citizenship, civility, and knowing" (Tuck & Gaztambide-Fernández, 2013, p. 73). When writing about settler colonialism, Indigenous Studies scholars frequently draw on Australian historian Wolfe's article "Settler colonialism and the elimination of the Native" which describes settler colonialism as a

land-centered project that entails permanent settlement. In this sense, settler colonialism is understood "as a structure, not an event" (2006, p. 388). Tuck and Gaztambide-Fernández build on this, noting that "the violence of invasion is not contained to first contact or the unfortunate birthpangs of a new nation, but is reasserted each day of occupation" (p. 73). Given settlers' ongoing presence on Indigenous lands today (for instance in the US, Canada, New Zealand, Australia, South Africa, and others), settler colonialism is analyzed in Indigenous Studies as both an historical and contemporary structure.

In some instances throughout the dissertation, I use the phrase *settler militarism* to capture the interrelations of settler colonialism and militarism in Oceania. While militarism refers to "the ideology that a nation should maintain and be ready to use its strong military capabilities to advance its national interests" (Genz, Goodyear-Kaʻōpua, LaBriola, Morei, & Rosa, 2018), settler militarism emphasizes the ways in which settler colonialism and militarism have "simultaneously perpetuated, legitimated, and concealed one another" (Nebolon 2017). I draw on this definition of settler militarism from American Studies scholar Juliet Nebolon to emphasize the entwined logics of settler colonization and militarism on Pacific Islands like Hawaiʻi and Guåhan.

I.4.3 Indigeneity

Discussions regarding terminology used to refer to Indigenous peoples encompass a complex debate. Given the fraught histories through which colonizers have derived certain terms to name (and ultimately to subjugate) Indigenous peoples, some words that are used today to describe Indigenous peoples may reinscribe the colonial violence through which they were invented. The term *indigenous* is itself highly contested. Some

scholars point to the term's colonial history and damaging connotations. For instance, Foster (2017) writes that the term *indigenous* has been used in "derogatory ways to present people with historical connections to preinvasion societies as backward, less modern, and less human" (p. 22). Some Indigenous peoples have since made efforts to reclaim the word *indigenous,* capitalizing the *I* and using it as a collective term to build and organize global solidarities. In this dissertation, I aim to promote Indigenous peoples' own practices of self-naming by using the term *Indigenous* with a capitalized *I* to refer to Indigenous peoples in certain collectivizing contexts (e.g., global Indigenous peoples, Indigenous Pacific Islanders), and using terminology through which particular Indigenous groups self-identify for more specific contexts (e.g., CHamoru, Kānaka Maoli).

It is important to note that while *Indigenous* is widely used by Indigenous peoples as an empowered reclamation of Western/colonial instantiations of the word, the term is not without contestation. Scholars have simultaneously encouraged and problematized the use of terms that generalize indigeneity to form broader solidarities. On the one hand, Indigenous groups around the world can unite under umbrella terms, "transcending their own colonized contexts and experiences, in order to learn, share, plan, organize, and struggle collectively for self-determination on the global and local stages" (Smith, 2012 p. 7). Alternatively, the term *Indigenous* can also be seen as homogenizing of variation within and amongst groups that identify as Indigenous. As Māori scholar Linda Tuhiwai Smith argues, *Indigenous* "is problematic in that it appears to collectivize many distinct populations whose experiences under imperialism have been vastly different" (p. 6). Thus, she describes the final "s" in Indigenous *peoples* – arising from the 1970s American Indian Movement and Canadian Indian Brotherhood and preferred today by

many Indigenous activists– as a better (though still imperfect) attempt at acknowledging the real differences between Indigenous groups. In sum, terms that collectivize the Indigenous experience (e.g., Indigenous peoples, First Peoples, Native Peoples, Aboriginals, Fourth World Peoples) at once homogenize in ways that limit recognition of particular groups/cultures, and also offer important strategic opportunities for enabling collective voices in international arenas.

I.4.4 Genetic Engineering

Chapter 2 features a more in-depth introduction to the genetic engineering technology that is the topic of this dissertation (i.e., gene drives). Still, a general note on the terminology used to describe these techniques and technologies is warranted here. First, *genetic engineering* refers to the deliberate introduction of DNA, RNA, or proteins manipulated by humans to effect a change in an organism's genome or epigenome (NASEM, 2016, p. 182). *Genetically modified* is a broader term referring to an organism whose genotype has been altered by genetic engineering and nongenetic engineering methods alike (p. 182). Though genetic modification can be used to refer to genetic engineering, I prefer the term *engineering* to emphasize humans' deliberate efforts to alter the genetics of particular organisms. That said, "GMOs" (i.e., genetically modified organisms) are common vernacular so these terms appear as certain interlocutors use them (e.g., interviewees).

Finally, not *all* genetic engineering methods are *gene drives,* which represent a particular genetic engineering technique that can "bias inheritance," that is, spread a particular genetic element through a population of organisms at higher-than-normal rates. At the time of writing, genetically engineered mosquitoes have been released in several

areas across the globe (e.g., Cayman Islands, Malaysia, Panama, and most recently Florida), though none of these carry gene drives. To date, no gene drive–carrying organisms have been released outside the laboratory. I use the term *gene drive* or *gene drive–modified* to refer specifically to organisms that have been altered to carry gene drives (e.g., gene drive–modified mosquitoes).

I.5 Chapter Summaries

Chapter 1 argues that imaginations of islands as tiny, distant, and remote are rooted in an imperial myth that has long been mobilized to justify violent occupation, militarization, and experimentation on islands. Focusing my discussion on Oceania, I frame this imaginary as incommensurate with Indigenous Pacific Islander understandings of island space wherein the ocean is an expansive site of connection and mobility rather than isolation. I trace the emergence and maintenance of this myth in interconnected projects of scientific knowledge production and US settler militarism, giving most focus to Cold War–era nuclear testing in the Marshall Islands. The objects of analysis in this chapter include scientific literature (i.e., anthropology, ecology, island biogeography) and governmental media (i.e., Atomic Energy Commission films and photography).

Chapter 2 locates the myth of the isolated island laboratory within contemporary scientific discourse surrounding *gene drive* technologies. Analyzing a set of documents and published biosafety protocols meant to inform the "safe" and "ethical" use of gene drive technologies, I demonstrate the regularity with which islands are framed as ideal test sites for the first field trials of these technologies. By assessing how *containment* and *confinement* are operationalized at various stages of gene drive experimentation, I

observe that while laboratory-based containment of gene drive–modified organisms is thoroughly detailed as a *process* achieved and maintained through material infrastructure and stringent protocol, island-based confinement is mostly presented as a natural or self-evident *quality* of island geographies. I argue that this discrepancy points to an underlying presumption of island isolation and disposability that warrants critical investigation, and that these texts' rhetorical emphasis on *safety* and *security* obscures the degree to which they prescribe that risk be displaced onto island geographies.

Chapter 3 stays with gene drive technologies to explore what types of processes are emerging in efforts to facilitate just decision making about their deployment outside the laboratory. I investigate the salient topic of *community and stakeholder engagement,* using ethnographic methods to gain insight into how scientists, conservationists, and other "stakeholders" in gene drive development and decision-making are approaching the task of "engagement" with publics and communities. My ethnographic research takes place on two islands where gene drive research is underway (Oahu and the Big Island of Hawai'i) as a potential tool to conserve endangered birds. Through ethnographic observation and interviews I explore two key questions: (1) how are scientists and conservationists imagining, designing, and conducting engagement practices related to gene drive technologies?, and (2) how do local Indigenous residents wish to be engaged (or not engaged) in these activities?

The engagement activities that were the object of my study suggested notable deficits in terms of pursuing understanding of local knowledge and perceptions necessary for incorporation of community input to decisions about implementation of experimental practices. I observed a tendency among those designing and implementing engagement

activities related to gene drive at my site to employ "strategic" approaches to engagement aimed primarily at influencing decision-makers. While some scientists that I interviewed expressed interests in more participatory approaches to engagement, they described challenges of navigating infrastructural barriers to their development.

Notably absent from the engagement practices implemented by those involved with gene drives was consideration of how cultural and historical context experienced by island communities factor into participants' positions on experimental research. My discussions with Kānaka Maoli about gene drive technologies underscored this concern, as they prompted deeper consideration of historic and ongoing issues of Indigenous self-determination. Though my case study is limited in its generalizability, the wider adoption of strategic approaches to engagement warrant further examination about the epistemic norms these practices may embed, and consideration of these against the robust theoretical and practical models of community and stakeholder engagement developed in other fields such as education, the social sciences, and public health.

Taking these insights together I argue that the salient frames of *isolation* and *containment* that characterize gene drive science and engagement are ill-equipped to facilitate just decision making that is inclusive of local and Indigenous communities. I invite a reimagining of isolation through more oceanic and "archipelagic" frames that not only rethink presumptions of island isolation, but attend to the flows and relations power constituted by the development and proposed deployment of gene drives. In closing I propose "critical power mapping" as a tool to visualize those power relations, and through which local and Indigenous communities can bring their place-based knowledges and values to bear on decision making.

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CHAPTER 1

The Myth of the Island Laboratory: An Origin Story

> Western colonizers had long configured tropical islands into the contained spaces of a laboratory, which is to say a suppression of island history and indigenous presence.
>
> Elizabeth M. DeLoughrey

1.1 Introduction

Between 1946 and 1958, the United States (US) tested 67 nuclear weapons in the Marshall Islands, including the most powerful nuclear device ever deployed by the US: a 15-megaton hydrogen bomb code-named *Castle Bravo* (Genz, Goodyear-Kaʻōpua, LaBriola, Morei, & Rosa, 2018). Detonated at Bikini Atoll on March 1, 1954, *Bravo* yielded an energy 1,000 times the force of bombs dropped on Hiroshima and Nagasaki (Johnston & Barker, 2008). The blast formed a two-kilometer-wide crater in the coral reef at Bikini, pulverizing reef particles into an irradiated, snow-like dust that fell over 7,000 square miles and onto neighboring atolls (Cronkite, Conard, & Bond, 1997). Seventy-five miles from Bikini, the island of Rongelap was covered in two centimeters of irradiated debris within hours. Unaware the fallout was harmful, Rongelap residents consumed contaminated food and water and came into direct contact with the ash. US personnel in the area were advised to take shelter and avoid contact with the fallout and were evacuated within a day, yet three days would pass before officials evacuated the Rongelapese (DeLoughrey, 2012).

The US claimed an unexpected shift in winds caused fallout to spread to neighboring atolls, however, declassified documents later revealed that the Navy knew the wind was shifting toward Rongelap hours before the test and chose to proceed. Radiation exposure (both directly and through fallout in the soil and traditional food sources) has produced elevated rates of thyroid disease and cancer in Rongelapese and their descendants, and women have experienced a range of reproductive issues including miscarriages, stillbirths, and children born with birth defects (Genz et al., 2018; Hakewill & Dallemagne, 1995). Following *Bravo,* hundreds of Marshallese experienced dehumanizing treatment as subjects in studies of the effects of radiation exposure, none of which they properly consented to (Johnston & Barker, 2008). Today, Marshallese continue to fight for just compensation for the environmental degradation, health issues, and displacement[3] they face as a result of nuclear testing on their homelands.

Why were the Marshall Islands selected for nuclear weapons testing? How did government officials come to imagine Marshallese lands and bodies as sites of experimentation? Despite (disputed) claims that the wide spread of fallout was accidental, designations of *remoteness* and scientific ideas about *distance* and *isolation* were mobilized to justify *Bravo* as well as hundreds of other nuclear tests conducted throughout Oceania by the US, France, and Great Britain. Demonstrated perhaps most overtly by Former Secretary of State Henry Kissinger's comments on US military activities in Oceania, the disregard for Indigenous land and life is propped up by a spatial

[3] Bikinians and Rongelapese have experienced multiple re-evacuations and relocations due to continued high and dangerous levels of radioactivity from nuclear contamination. Virtually all 28 islands were severely contaminated from *Bravo* and other blasts, and several islands remain uninhabitable today (Johnston & Barker, 2008).

orientation to Pacific Islands as tiny and distant,[4] and therefore more disposable. In his words, "There are only 90,000 people out there; who gives a damn?" (McHenry, 1975).

Scientific logics also embed ideas about isolation as a necessary feature of rigorous study of experimental variables. From the view of the Atomic Energy Commission (AEC) that conducted *Bravo* with the Department of Defense, the geography of the Marshall Islands lent itself to experimental design, with the atolls providing a natural division of "test" and "control" groups (i.e., those exposed to radiation versus those not exposed) to establish the effects of radiation exposure (Johnston & Barker, p. 28). As Dr. Robert Conard – head of the medical surveillance team monitoring *Bravo's* radiological effects – wrote in a 1958 report, "The habitation of these people on Rongelap Island affords the opportunity for a most valuable ecological radiation study on human beings.... The various radionuclides present on the island can be traced from the soil through the food chain and into the human being" (Conard et al., 1958). Comments like these abound in declassified documents suggesting officials may have premeditated to involve Marshallese in long-term biomedical studies of radiation exposure,[5] and revealing the reduction of Marshallese survivors to data and statistics once studies were underway.

[4] See Figure 1.1 for an example of US representation of the Marshall Islands as small and remote.

[5] See *Consequential Damages* on "Project 4.1," described in a declassified 1953 memo as "The Study of Response of Human Beings Exposed to Significant Beta and Gamma Radiation Due to Fall-out from High Yield Weapons (Johnston & Barker, 2008).

Figure 1.1: A map of the Pacific in *Operation Crossroads: The Official Pictorial Record*, a 1946 book detailing a pair of nuclear weapons tests conducted at Bikini Atoll prior to Castle Bravo. The small size of the Marshall Islands is emphasized in the placement of a magnifying glass over the region and in the caption, which describes the atolls as "but a dot on the navigator's chart of the vast reaches of the Pacific." The remoteness of the region is also emphasized and described as a favorable quality in its selection for atomic bomb tests. Finally, Indigenous history and presence is erased by description of the islands as "discovered" by European explorers (United States Joint Task Force One, 1946).

Though largely taken for granted as truth in Western imagination, the association of distance and isolation with islands is not universal, but rather a particular, situated way of viewing island geographies. For many Indigenous Pacific Islander communities with historied relations to their ancestral islands and to the ocean that surrounds them, islands are *connected* by the ocean, not isolated. From this view, remoteness is not a "natural" quality of islands, but rather something constructed through colonial relations that extract resources and concentrate the wealth derived from them elsewhere. As this chapter will show, imaginations of islands as tiny, distant, and remote and therefore disposable are rooted in a myth that has long been fundamental to logics of Western imperial expansion into island spaces.

This chapter offers an origin story of the myth of the isolated island laboratory, tracing its birth (and continued perpetuation) to interrelated projects of colonialism, militarism, and scientific knowledge production predicated on the treatment of islands (and their inhabitants) as sites of experimentation. In telling this story, I embrace what CHamoru (Indigenous peoples of Guåhan/Guam) Communication scholar Tiara Na'puti has termed an *oceanic orientation*, "recogniz[ing] militarism and colonialism as entwined structures and ideologies of empire" and orienting to Oceania "where these issues converge with Indigenous perspectives and resistance" (Na'puti, 2020, p. 100). An oceanic orientation necessitates an unsettling of imperial orientations to island space that, though treated as universal or natural, have existed a relatively brief time compared to Indigenous Oceanic relations to (and views of) island space. It calls for a (re)centering of Indigenous orientations to islands, forged in deep relationship with and knowledge of the ocean. It also necessitates that in narrating colonial and military ruptures to Indigenous ways of knowing and being in relationship with the ocean, Indigenous acts of *resistance* and projects of recovery are honored and emphasized. For these reasons, I begin this story with an explication of what Indigenous Oceanic communities have long known and continue to assert through practices of resistance and reciprocity: the ocean is a site of expansive possibility engendering relationship, connectivity, mobility, and agency.

1.2 We Are the Ocean: Indigenous Relations to Islands

For the Indigenous peoples of Oceania, the sea is often understood as a site of genealogical origin (Hau'ofa, 1993). Numerous Oceanic mythologies and legends describe land and life as beginning in the ocean. The Kumulipo (Hawaiian creation oli, or

chant) tells of life originating with the coral polyp in the sea (Beckwith, 1972). Legends spanning the regions now called Polynesia, Melanesia, and Micronesia tell of gods fishing islands up from the sea, such as the demigod Maui in Tahitian, Hawaiian, and Māori mythology; the god Tangaloa in Samoan and Tongan mythology; the god Motikitik in Carolinian stories, and brothers To-Kabinana and To-Karvuvu in Papuan stories (Alkire, 1984; Dixon, 1932; Nunn, 2003). These and numerous other Oceanic stories portray the sea as a birthplace: the origin of islands and of life itself.

Legends like these also reflect a deep awareness of and connection to the oceanic environment. Details in these stories likely draw inspiration from the geologic phenomena that form islands, such as volcanic activity and tectonic plate movement. Stories of gods "fishing up islands" may reference island formation via submarine volcanic eruptions or large magnitude earthquakes, and stories of islands emerging as a thrashing fish, or being wrestled from the sea may reference volatile tectonic activities that occurred in the region (Nunn, 2003). The most epic of tales embed empirical observation about dynamic environmental processes. They also espouse cultural values and impart practical advice derived from experience: how to build a strong seafaring vessel, how to store provisions for long voyages, how to conduct voyages (Thompson, 2019).

The geographic distribution of legends with similar themes throughout Oceania are also testament to the vast and historied mobilities of Oceanic peoples. Instances where environmental details of local legends do not map neatly to the region's geologic features suggest that stories diffused over space and time as islanders made their transoceanic journeys. For instance, myths indicating the presence of shallow submarine

volcanoes are common in Tokelau where no such volcanoes exist, meaning those stories may have traveled along with islanders voyaging from volcanic regions of Polynesia. Islanders making those long journeys probably incorporated new experiences and environmental observations (e.g., witnessing volcanic eruptions or other dynamic weather events) into stories as they traveled, as well. In any case, the diffusion of these stories illuminates the key role of the ocean as a pathway enabling the mobility of Oceanic peoples.

As the first peoples to venture into open ocean some 4,000 years ago, transoceanic mobility is at the core of Oceanic indigeneity. For millennia, Pacific Islanders stewarded traditional voyaging techniques, reading the stars, moon, sun, waves, wind, and birds as navigational guides (Ingersoll, 2016, pp. 34-37). Kanaka Maoli (Native Hawaiian) scholar and surfer Karin Amimoto Ingersoll describes the embodied and relational knowledge that undergirds voyaging and other Oceanic practices like surfing and fishing as a "seascape epistemology," which she describes as:

> […] an approach to knowing presumed on a knowledge of the sea, which tells one how to move through it, how to approach life and knowing through the movements of the world. It is an approach to knowing through a visual, spiritual, intellectual, and embodied literacy of the *ʻāina* (land) and *kai* (sea) (Ingersoll, 2016, pp. 5-6).

Ingersoll describes the ways Indigenous islanders expertly read and interact with the ocean as a form of literacy that shapes a particular political and ethical relationship to the physical and spiritual world. It is through this seascape epistemology and attendant literacies that Oceanic peoples navigated more than four-fifths of the Southern Hemisphere using traditional methods (Diaz, 2015).

Indigenous Oceanic peoples crafted and skillfully navigated some of the most efficient sailing vessels in history. Designs varied by function, ranging from small fishing canoes for sourcing food from local reefs and lagoons, to seagoing vessels more than 100-feet in length and used for pelagic fishing and long – distance voyages. Micronesian outrigger canoes were known for their exceptional speeds, while Polynesian canoes featured double-hulled or catamaran designs used to navigate great distances. Following the lead of the community's master canoe builders, islanders sourced local materials – tree trunks, bamboo, mangrove – to craft the canoe's parts, and wove sails from pandanus fiber. They used tools like adzes to shape the sides and secured them together with twine braded from grass or coconut fibers, making for flexible and robust structures that could withstand the sea's varied textures and conditions.

Islanders throughout Oceania fished, traveled, engaged in trade, and migrated aboard these vessels, navigating them with diverse and sophisticated techniques. Oceanic voyagers read the environment – the land, waves, wind, stars, clouds, and birds – as a dynamic set of relationships rich with navigational information (Ingersoll, 2016). Voyagers created detailed celestial maps and committed them to memory. Using chants or poems to recall the positions of stars in the night sky, they could locate their position and chart their desired course. Seabirds flying out to sea and back to land could indicate the direction of and distance to land, and colors reflecting on the underside of clouds revealed the location of lagoons (Thompson, 2019). An oceanic literacy requires a holistic reading of the seascape, including the many beings surrounding and interacting with it. No single element (the cloud, the bird, a star) can be interpreted meaningfully without its broader context.

The Carolinian navigational concept of *etak* further demonstrates the relational notions of space characteristic of seascape epistemology (Diaz, 2015; Goodyear-Kaʻōpua, 2018; Ingersoll, 2016; Na'puti, 2019). Translating roughly to "moving islands," *etak* refers to a Carolinian wayfinding technique of triangulation in which the canoe is stationary, and the islands "move on the sea around it" (Thomas, 1972 as cited in Diaz, 2015, p. 98). Using *etak,* the wayfinder envisions the canoe and the stars as unmoving, while the island of departure moves away from the canoe and the destination island moves toward it. In other words, *etak* enables the navigator to determine their position in sea as a triangulation between the island of departure, the island of destination, and that of a third reference island, which all follow a fixed star course (Diaz, 2015, pp. 97-98). Though they cannot see the reference island at any time during the voyage, the act of envisioning its movement allows voyagers to keep track of progress made along their course. In this guidance system, islands are not static land masses, but mobile elements within an animate ecological formation.

For centuries islanders sustained and iteratively refined their Oceanic literacies. While these literacies are diverse and heterogenous as the local contexts in which they were cultivated, they share a common orientation to the ocean as a source of life, mobility, and connection. Though we may not know exactly how Oceanic peoples thousands of years ago viewed the ocean, it is clear from looking to the cosmologies and enduring traditions belonging to these communities that they orient toward the world through deep, embodied knowledges derived in relationship to the sea (Hauʻofa, 1993).

As waves of colonialism rupture those relations (beginning with the arrival of Europeans to the Mariana Islands in the 16th century) it also becomes clear that a

seascape epistemology is fundamentally distinct from Western worldviews. Colonial cartographies impose static and absolute notions of space onto island and ocean life, emptying it of Indigenous history and agency to conceptualize it instead as a site of colonial domination. Like colonial imaginaries of Indigenous lands as *terra nullius* ("nobody's land") to justify their seizure, the Pacific has been treated by colonial and military powers as *aqua nullius,* a passive, "blank space across which a diasporic masculinity might be forged" (DeLoughrey, 2020). In the act of assigning the world's largest geographic region a single name – something no Indigenous language of the region had done – colonizers collapse the expansiveness of Oceania into a conceivable bounded entity: the "Pacific."

Colonial mappings of the Pacific further fragmented it into discrete regions amenable to the racialized and gendered hierarchies of the West. In particular, the grouping of Pacific Islands into the regions known as Polynesia, Melanesia, and Micronesia reflects not only an arbitrary geographic bordering of the Pacific, but categorization of Pacific peoples according to fundamentally anti-Indigenous and anti-Black logics. As Kanaka Maoli scholar Maile Arvin demonstrates in *Possessing Polynesians: The Science of Settler Colonial Whiteness in Hawai`i and Oceania* (2019), Pacific peoples were generally represented as "primitive" in European accounts throughout the 18th and 19th centuries, yet they were subject to different racialization based on their perceived proximity to whiteness.

Polynesians were often described for their fairness and mythologized as descendants of classical Romans and Grecians; Polynesian women were portrayed at

times as sexualized sirens and nymphs reminiscent of "Europe's classical past" (p. 38).[6] In this view, the isolated Polynesians eluded civilization to remain in a more natural or "primitive" state. Melanesians were concomitantly racialized as Black, evident most readily in the naming of the region *Melanesia* – Greek for "black islands" – and the attribution of labels such as "dark," "violent," and "savage" to Melanesian peoples (p. 38). As naturalist Johann Reinhold Forster described in his popular 1778 travel account, *Observations Made during a Voyage Round the World,* there was a firm distinction between the "'exoticized primitivism' of nearly white Polynesians and the 'hard primitivism' of the dark, savage Melanesians" (Arvin p. 38). One the one hand, the imagined racial continuity between Polynesians and Europeans functioned to naturalize settler claims to Polynesian heritage and lands, while on the other, the denigration of Melanesians as the most primitive of the Pacific peoples maintained whiteness as a marker of superior, "civilized" society.

The imposition of settler colonial cartography and hierarchy onto Pacific Islands has a complex and lasting legacy in Oceania, yet Pacific Islanders have never been mere passive recipients of the treatment of their lands and waters as sites of colonial domination. Pacific peoples have always engaged in practices that reclaim their cosmologies and kinship ties to the ocean, and Oceanic literacies have continuously survived, adapted, and been reinvented over time through acts of resistance that reassert Indigenous relationships to the sea. As the next section discusses, by revitalizing navigational practices Indigenous Pacific Islanders refuse settler spatiotemporal logics

[6] For historic literary and artistic representations of Polynesians as comparable to white Europeans, see Johann Reinhold Forster's *Observations Made during a Voyage Round the World* (Forster, 1778), Dumond d'Urville's *Sur le iles du Grand Ocean* (d'Urville & Tardieu, 1831), or Joseph Dufour's *Les Sauvages de la Mer Pacifique* (c. 1804) (Museum of New Zealand, 2019).

that conceive of Pacific Islands as isolated by the sea, and cast Indigenous knowledge as a fading relic of a primitive past. By reclaiming militarized Oceanic spaces, Pacific Islanders refuse treatments of the ocean as a "seagoing Manifest Destiny" (Roberts & Stephens, 2017) for imperial expansion. Following Arvin's notion of *regenerative refusal,* I read these acts as refusals of settler logics that are not mere "negative challenges to settler colonialism but also positive, future-oriented acts aiming to realize a different way of being in and relating to the world" (p. 131). Through these and many other practices of refusal, Pacific Islanders regenerate relationships to the sea that affirm it as a site of mobility, invoking ancestral knowledge to chart an expansive future grounded in self-determination and the flourishing of Indigenous Oceanic lifeways.

1.3 Oceanic Regeneration

Following on the heels of numerous complex and heterogenous eras of colonial rule throughout Oceania, the ascendancy of American naval power in the late 19th and early 20th centuries played a significant role in remapping the Pacific as a site of military power. The US acquisition and subsequent militarization of islands like Hawai‘i, American Samoa, and Guåhan demonstrate the logics through which Indigenous Oceanic histories are denied under ongoing developments of transpacific militarism. Selected for their strategic geographic locations beginning with post Spanish-American War annexations from 1898-1900, these islands would become military outposts, providing stopping points for vessels and aircraft, training grounds for US troops, and generally forming a linked network of bases to symbolize the expansiveness of US military power.

For instance, early military interests in Hawai‘i identified the islands as an important naval base, coal refueling site, and defensive post against China (DeLoughrey, 2020). Pago Pago of eastern Samoa (now American Samoa) was originally identified by the US military as an ideal location to dock ships given its deep harbors, enabling later justifications of its rule by the US Navy as a coaling station (Genz et al., 2018, p. 6). Military discourses also represent the island of Guåhan as *the tip of the spear,* a strategic waterfront meant to protect the US from its perceived adversaries in Asia and the Pacific (Na'puti & Bevacqua, 2015, p. 844). In a glaring reminder of the ongoing nature of settler militarism in the Pacific, the US is currently pursuing a massive military expansion in the Mariana Islands including Guåhan and the Commonwealth of the Northern Mariana Islands (CNMI) that would relocate 5,000 US marines from Okinawa and use CHamoru lands and waters for military activities including the docking of nuclear-powered aircraft carriers and the establishment of a live-fire range on a wildlife refuge (Frain, 2017).

The orientation to islands as strategic points of military power is also reflected in the use of the term *insular* by US administrative bodies to refer to its island territories. Derived from the Latin *insula* meaning "island," the term insular has been used in explicit reference to maritime imperialism since at least 1808 when English writer Gould Francis Leckie called on British powers to extend their dominion to the sea in his influential treatise *An Historical Survey on the Foreign Affairs of Great Britain* (Leckie, 1808). In response to France's growing power over continental Europe, Leckie called for the conquest of particular Mediterranean islands in order to form an "insular empire," a

networked system of island bases or sea-surrounded "fortresses" sure to open "new fields of commerce, colonization, and riches" to Great Britain (D'Andrea, 2006; Leckie, 1808).

Upon US acquisition of island territories in the Pacific and the Caribbean including Guåhan, Puerto Rico, Cuba, and the Philippines at the end of the Spanish-American War, the US established formal administrative agencies charged with overseeing these so-called "insular" areas. First was the Division of Customs and Insular Affairs (1898), which was then replaced by successor agencies including the War Department's Division of Insular Affairs (1900), the Bureau of Insular Affairs (1902-1939), the Division of Territories and Island Possessions, and eventually the Office of Insular Affairs. Today, the Office of Insular Affairs oversees administrative activities in relation to its five major island territories including American Samoa, Guåhan, Puerto Rico, the Commonwealth of the Northern Mariana Islands (CNMI), and the US Virgin Islands.[7] Each of these island communities are designated as "unincorporated territories" of the US, a status that confers only some constitutional rights to its residents.[8]

Without context or critical analysis, the term *insularity* may appear merely to denote physical description of island space. However, considering both the historic uses of insularity in relationship to empire and the strategic military relationships between the US and its "insular" territories, insularity can be understood as connoting US imperial

[7] There are eight additional US insular areas, including Navassa Island in the Caribbean and Baker Island, Howland Island, Jarvis Island, Johnston Atoll, Kingman Reef, Midway Atoll, and Wake Atoll in the Pacific (US Department of the Interior, n.d.). Each have been used at various times for US military purposes such as nuclear testing, the establishment of military bases, or wartime occupation or observational posts.

[8] The Office of Insular Affairs defines an unincorporated territory as "a United States insular area in which the United States Congress has determined that only selected parts of the United States Constitution apply" (US Department of the Interior, n.d.). For instance, individuals born in the unincorporated territories of Guåhan, Puerto Rico, and US Virgin Islands are considered US citizens and can enlist in the US military, yet residents of these regions are ineligible to vote in the US presidential race and do not have voting representation in Congress.

appropriation of islands. Geographer Scott Kirsch has described the rhetorical use of *insularity* by the US in relation to the Philippines (an unincorporated US territory from 1901-1935) as "a physical geographic stand-in for describing, in more explicitly political terms, the relations between places that constituted the new US empire" (p. 4). The designation of insularity also does significant rhetorical work in framing island connectivity solely in relationship to military. Akin to Leckie's view of a networked system of British fortresses spanning the Mediterranean, insular US territories form a transpacific constellation of US military bases. In this view, isolated islands derive their value on the basis of their strategic value to US military power, rather than their genealogical and cultural significance to Indigenous peoples.

Pacific Islanders continuously resist the treatment of their ancestral islands as strategic sites in the maintenance of the US insular empire. By reasserting Oceania as an animate, historied, expansive site of possibility, they contest US framings of the Pacific Ocean as a mere backdrop to military domination, and of islands as tactical sites in the maintenance of transpacific militarism. By refusing the grammar and material conditions of settler militarism in Oceania, Pacific Islanders engage in acts that allow them to survive within – and pursue thriving beyond – the confines of settler militarism. Though acts of resistance take many forms, the revitalization of voyaging beginning in the mid 1970s serves as an exemplary refusal of settler military framings of time and space.

The revitalization of traditional navigational knowledge has occurred through transpacific solidarities that transcend colonial fragmentations of Oceania. Though some communities completely lost their traditional navigational knowledges due to colonial policies prohibiting Indigenous knowledge and practice and destruction of seafaring

vessels by colonizers, their reclamation of those knowledges has been enabled by the support of other Pacific communities. Such is the case of *Hōkuleʻa*, the first voyaging canoe built in the Hawaiian Islands in more than 600 years and an icon of Hawaiian cultural renaissance (Polynesian Voyaging Society, n.d.).

The Polynesian Voyaging Society (PVS) built *Hōkuleʻa* ("Star of Gladness") in 1975 under the lead of artist-historian Herb Kawainui Kāne, who had long dreamt of rebuilding a double-hulled canoe like the ones his ancestors used to sail to and settle the Hawaiian Islands. Because Polynesian voyaging knowledge had been lost under colonization, the first voyage of *Hōkuleʻa* was led by Satawalese grandmaster navigator "Papa Mau" Piailug (Genz et al., 2018). In 1976, Under Mau's leadership and teaching, *Hōkuleʻa* successfully retraced the ancient voyaging route between Hawaiʻi and the Tahitian island chains, thereby catalyzing and becoming a powerful symbol of Indigenous knowledge revitalization in Hawaiʻi and beyond (p. 38). Transpacific waves of inspiration were set in motion with the inaugural voyage of *Hōkuleʻa*. This great wave of Oceanic cultural revitalization transcended colonial borders, reaching the shores of the Western United States where many Pacific Islanders had resettled as the result of complex histories of US settler colonial and military occupation of their home islands.[9]

San Diego-based CHamoru master carver Mario Borja was first inspired to create a small CHamoru fishing canoe known as a galaide in 1995, as a tribute to the arrival of *Hōkuleʻa* in San Diego (Punzalan, 2018). Since then, CHamoru communities in Guåhan

[9] Emigration of Pacific Islanders to the U.S. was relatively small until the end of World War II, which prompted the movements of many American Samoans, CHamorus, and Tongans to the US. Major factors that shaped the outflux of islanders from their ancestral islands at this time included the granting of US citizenship to some islanders, and economic opportunity available via conscription in the US military or religious missionary work. Hawaiian statehood prompted an additional wave of emigration from Oceania to the US in the 1960s.

and throughout the diaspora have engaged in a variety of efforts to revitalize voyaging practices prohibited and ultimately lost under Spanish occupation. CHamoru community organizations including the Guåhan-based Traditions About Seafaring Islands or TASI (CHamoru for *ocean*) and San Diego-based Chamorro Hands in Education Links Unity or CHELU (CHamoru for *sibling*) have led collaborative projects to create sailable traditional seafaring vessels like the sakman, a single outrigger canoe used for long-distance voyaging and deep-sea fishing (see Figure 1.2) (Borja, 2013).

Figure 1.2: The *Sakman Chamorro* on its visit to Guåhan for the 12th annual Festival of Pacific Arts in 2016. Created in San Diego in 2011, the *Sakman Chamorro* is an important icon of cultural preservation in the CHamoru diaspora (Photo credit: Dan Lin, 2016).

As was the case with the creation of *Hōkule'a* and revitalization of wayfinding in Kānaka Maoli communities, CHamoru reclamation of maritime practices have involved intercultural collaboration and ingenuity. A master canoe carver from Yap was seminal in Borja's training as a canoe builder, and CHamorus derived the sakman's design from an

18th-century illustration known as “the Anson Drawing” (see Figure 1.3), a rare artifact of a history largely erased under colonial occupation (pp. 13-15).

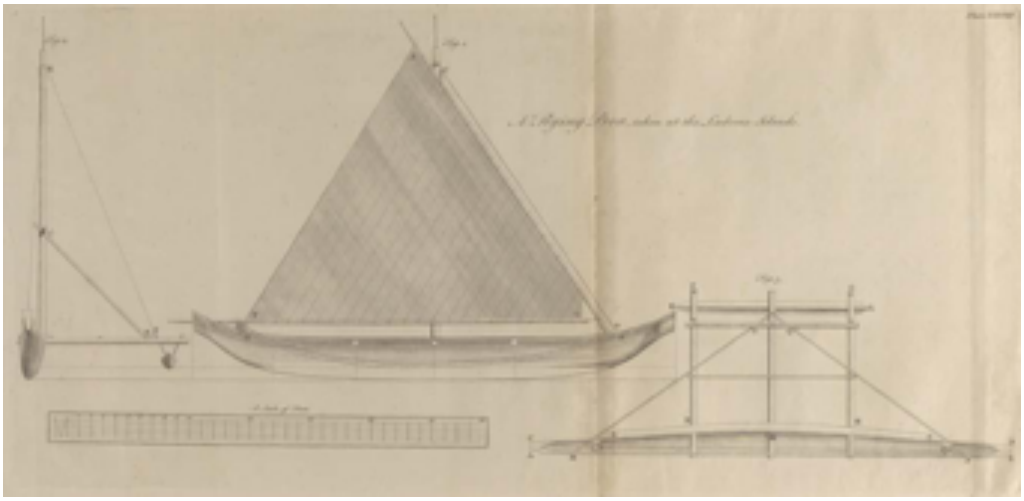

Figure 1.3: “Admiral George Anson’s drawing of a Chamorro proa. Courtesy of Pete Perez.” The English ship HMS Centurion encountered a CHamoru proa near the island of Tinian while on its “voyage around the world” in 1742. Fascinated by the watercraft’s design, Anson ordered a crewmember to produce a detailed rendering of the proa before destroying it (Uslander, 2016).

Even communities whose navigational knowledges survived colonial occupation found inspiration in the activities of *Hōkūle'a*. After learning of *Hōkūle'a’s* first voyage, leaders of the Marshallese canoe-building program known as “Waan Aelōñ in Majel” (Canoes of the Marshall Islands) initiated a project to document their voyaging traditions. Building on a rich local history of peaceful protest involving voyaging practices,[10] Waan

[10] Marshallese peoples from the Kwajalein Atoll have resisted US military occupation of their homelands in the form of “sail-ins” since the 1960s when the US Army established a ballistic missile testing facility at Kwajalein, thereby forcing 4,000 residents to relocate from their homes across two-thirds of the atoll to the 78-acre Ebeye Island. In response, landowners from Kwajalein organized a series of peaceful demonstrations protesting their displacement from their traditional lands and advocating for higher compensation and increased control over the terms of the land-use agreement with the military. These demonstrations grew over the years, eventually culminating with an event referred to as “Operation Homecoming” in 1982. Nearly 1,000 Kwajalein Marshallese navigated their canoes to multiple islands declared “off-limits” by the US military, peacefully reclaiming their lands and successfully disrupting planned missile tests, and pressuring the US to renegotiate its relations with the Marshall Islands under the Compact of Free Association (Dvorak, 2016; Genz et al., 2018).

Aelõñ in Majel organized projects working with nuclear refugees who stewarded the specialized knowledge of "wave navigation," or navigating by understanding wave patterns. Marshallese navigator Captain Korent Joel worked with Waan Aelõñ in Majel after his grandfather became too ill from radiation exposure (the result of environmental contamination from nuclear tests conducted by the US in the Marshall Islands) to continue his teachings. Captain Korent became a recognized navigator after successfully demonstrating his mastery of wave navigation in 2006, enabling him to lead voyages and perpetuate traditional wayfinding knowledge to other Marshallese apprentices (Genz et al., pp. 39-40).

Taking to the ocean aboard Indigenous-made canoes like *Hōkuleʻa, Sakman Cha–morro,* and the Waan Aelõñ in Majel, Indigenous islanders reassert mobilities and movement constrained by the colonial and military legacies of cultural erasure, forced displacement, and environmental contamination. As Ingersoll notes of *Hōkūleʻa*, these canoes "arous[e] memories and mak[e] indigenous knowledge visible and tangible, even for those Kānaka Maoli and Pacific Islanders who have never set foot on a boat" (p. 99). While these activities literally cultivate and revitalize seascape epistemology for those building and sailing the canoes, the visibility of the canoes also contributes to broader Indigenous knowledge revitalization, a movement comprised of islanders from the homelands to the diaspora.

These Oceanic demonstrations not only reaffirm the sophisticated knowledge systems stewarded by the Indigenous peoples of Oceania (doubted or outright denied by

some Western scientists[11]), but reassert an ethic and politics informed by embodied Oceanic knowledges. In her discussion of the ocean as a site of empowerment for Native Hawaiians, Ingersoll posits that seascape epistemology begets "an ethical reading of the ocean that exists outside […] dominant political and economic interests" (p. 95). Invoking the rhythms of the waves as enabling counter-hegemonic readings of (and relations to) ocean, she writes that, "knowledge of the sea breaks from an assimilated system and spills out, dis- and re-organizing definitions of literacy, as well as politics and ethics" (p. 98). If settler military developments of the Pacific render it an insular empire, Oceanic resistance reframes it as a historied and expansive site of Indigenous mobilities and sovereignty.

1.4 Mythmaking and the Island Isolate

Given this rich history of Oceanic knowledges, and the ways they persist across space and time, how do such reductive and static perceptions of islands emerge and even become dominant in Western imagination? Readers can no doubt conjure examples of Western cultural productions mobilizing the imagery of isolated islands to symbolize paradise and entrapment alike. Literary and filmic representations deploy the "desert island" trope as an essential plot device testing the survival skills and morality of characters in texts like *Lord of the Flies* and *Robinson Crusoe,* and popular media like *Castaway*, *Survivor,* and *Lost.* Tourism discourses deploy the remote island to summon

[11] Prior to *Hōkūle'a*'s successful journey to Tahiti, some Western scientists were skeptical that ancient Pacific Islanders could have intentionally and expertly navigated to and settled Pacific Islands. Instead, many hypothesized that islanders arrived as the result of an "accidental drift" (Arvin, 2019, p. 7).

images of a desirable tropical paradise teeming with exotic culture and inviting the visitor to take respite.[12]

Myth is flexible in this way, bending toward varied motivations while drawing on a common imaginary. As French literary critic Roland Barthes describes, myth operates as a multilevel communicative system, capable of taking on new meanings as its initial associations become more deeply entrenched as commonsense (Barthes, 1972). Once *island* and *isolation* become linked in an associative relationship that is accepted as mere truth (the first level of myth), a diverse range of secondary meanings and conceptual relationships can be attached to the island (the second level of myth). In the examples given above, the "fact" of island isolation reads variously as distance from the strenuous pressures or the vital resources of the modern world. The island is imagined as disconnected from "society" in ways that can either offer one sanctuary or render one stranded.[13]

In telling a story about this myth that literary scholar Elizabeth DeLoughrey (2012) has aptly termed "the myth of isolates," my goal is not to be comprehensive in detailing all its instantiations. Rather, I am interested in tracing its origin to elucidate how the interconnected projects of colonialism, science, and militarism were fundamental in the invention of images of islands as distant and isolated. Situating the birth of this myth in early 15th – century colonial expansion into island spaces, then tracing its material implications in Cold War – era nuclear colonialism exposes its role in justifying the

[12] For critical works on tourism discourses in the Pacific, see *Aloha America: Hula Circuits Through the US Empire* (Imada, 2012), Teresia Teaiwa's work on "militourism" (Teaiwa, 2016), and Duke University Press' decolonial tour guide series (Vicuña Gonzalez & Aikau, 2019).

[13] The tendency for islands to be paradoxically conceived of as geographies that can either liberate or constrain has been theorized by scholars of the emerging field of American archipelagic studies. The introductory chapter of this thesis discusses this body of work in detail.

treatment of islands and islanders as sites of experimentation expendable to the "progress" of imperial expansion and scientific knowledge production. Historicizing this pervasive myth and grappling with its material implications allows us to denaturalize it, and to better interrogate its workings in contemporary discourses.[14]

As Barthes describes, myth can be understood most fundamentally as *communication* or "modes of signification" (Barthes, 1972, p. 93). In other words, rather than simply existing as a natural object or concept, myths are *made* or *produced.* They function through a system of meanings and associations, constructed and shared by a group of people in particular historical and cultural contexts. For Barthes, all myths have an historical foundation, and yet, the trick of the myth is that it obscures this fact. The myth *appears* natural, factual, or self-evident, concealing the conditions by which it was produced (and by which it is continuously reproduced) (p. 116). The myth of the isolated island is one such mode of signification. Though one may quickly associate ideas of isolation, remoteness, and distance with island space, those associations result from particular histories (originating and transforming over time within colonial, scientific, military, and popular culture discourses), then give rise to a second-order, "metalanguage" which renders the island "laboratory" (see Figure 1.3).

Barthes describes the semiotic operation of myth as a three-dimensional system, comprised of signifier, signified, and sign (p. 113). The first level of the myth involves the combination of signifier and signified (i.e., "the associative total of a concept and an image") to produce the *sign.* For instance, the word "island" (signifier) denotes a land mass surrounded by water (signified). Taken together, signifier and signified produce the

[14] Chapter 2 demonstrates extant mobilizations of the myth of island isolation in relation to emerging genetic engineering technologies.

sign: the island as a mass of land surrounded by water. Then, Barthes posits, that sign "becomes a mere signifier" at the second level of the system; treated as a single entity, it gets imbued with new associations. Notions of isolation, remoteness, boundedness, and containment get attached to the island, ultimately giving rise to the *myth* of the island as a suitable or natural laboratory. Those associations – island/remote, island/isolated, island/contained – arise through a range of communicative processes, becoming widely accepted or sedimented as "truth" over time.

Myths persist over time (indeed, the myth of the isolate is centuries old), but they are not static. As long as a particular myth survives, it is made and remade constantly, shifting and undergoing new iterations in alignment with the ideological system in which it occurs. To this end, Barthes asserts that the modes of signification at work in myth are neither arbitrary nor eternal, but always *motivated.* For Barthes, it is most disconcerting that myth presents as truth or "nature," despite the motivations from which it is derived:

> From the point of view of ethics, what is disturbing in myth is precisely that its form is motivated. For if there is a 'health' of language, it is the arbitrariness of the sign which is its grounding. What is sickening in myth is its resort to a false nature, its superabundance of significant forms, as in these objects which decorate their usefulness with a natural appearance. The will to weigh the signification with the full guarantee of nature causes a kind of nausea: myth is too rich, and what is in excess is precisely its motivation (p. 113).

In a prominent critique of the motivated origins of the myth of island isolation, Tongan and Fijian scholar and poet Epeli Hauʻofa notes that colonizers were the first to attach diminutive terms like "tiny," "remote," and "isolated" to Pacific Islands (Hauʻofa, 1993). He argues that colonizers adopted a narrow conception of size based on visible land surfaces alone, reflective both of Western orientations to land and water as separate entities, and of the colonial project of land seizure. Beginning with colonizers who first

projected constructs of isolation onto island space, the myth of the distant and remote island serves as the foundation for the myth of the island laboratory.

1.5 The Archipelagic Experiments of Empire

Early colonial exploits into island space were about more than mere territorial expansion; they were also interested in islands as test sites to derive knowledge about the most effective and profitable modes of expansion. Detailing the material practices of European expansion into the eastern Atlantic islands in the 15th century, DeLoughrey (2007) notes that it was largely through "*experiments* in deforestation, colonization, enslavement, and plantation monoculture" (p. 9, emphasis added) that the island becomes conceived as a key site and unit of analysis in the processes of knowledge production that undergird colonial expansionism:

> The archipelagoes of the Canary and Madeira islands were the first laboratories for European maritime imperialism and the first sugar plantations of the Atlantic. This experiment in island colonization, deforestation, plantocracy, and slavery was then repeated throughout the Caribbean. The use of one archipelago as an ideological and social template for the next reveals the ways in which the colonial discourse of islands repeated itself, rhizomatically, along a westward trajectory. (DeLoughrey, 2007, p. 9)

Repurposing Cuban writer Antonio Benítez-Rojo's concept of the repeating island,[15] DeLoughrey illustrates the processes through which the appropriation of island space into

[15] Benítez-Rojo developed concept of the "repeating island" to describe the ways in which Caribbean peoples maintain shared but fluid culture and identity throughout their diaspora (Benítez-Rojo, 1992). Akin to Hau'ofa's "sea of islands" (Hau'ofa, 1993), Benítez-Rojo reads against the land-centric colonial imaginary of the isolated island (and static notions of Caribbean culture) to emphasize the aquatic and archipelagic nature of the Caribbean. For Benítez-Rojo, Caribbean culture embodies its oceanic origins: flowing, fractal, and repeating asymmetrically like marine currents.

experimental sites of colonial expansion became a continuous practice, beginning with islands throughout the Atlantic, then repeating along a westward trajectory as Europeans traveled into the Caribbean and the Pacific. Motivated by colonial desires for possessable land, the myth of the isolate gets made and remade constantly across archipelagic geographies, undergoing – as myth does – complex iterations and transformations in different contexts. In other words, to say that the colonial perception (and treatment of) island space as a testing grounds "repeats itself" is not to flatten the complicated histories of colonial expansion, but to illuminate the significant role of myths of isolation within this expansion. In envisioning islands as small they become manageable, controllable, and maintainable, transforming into a replicable unit through which colonizers may derive and refine economic and political models to facilitate the growth of empire.

Environmental historian and geographer Alfred Crosby describes how early colonizers came to see and eventually treat island space as a laboratory (Crosby, 1986). According to Crosby, Europeans founding colonies throughout the Canary Islands and Madeira eventually identified a set of characteristics that seemed to enable successful colonization:

> First, the prospective settlement had to be placed where the land and climate were similar to those in some part of Europe. Europeans and their commensal and parasitic comrades were not good at adapting to truly alien lands and climates, but they were very good at constructing new versions of Europe out of suitable real estate. Second, the prospective colonies had to be in lands remote from the Old World so that there would be no or few predators or disease organisms adapted to preying on Europeans and their plants and animals. Also, remoteness assured that the indigenous humans would have no or few such servant species as horses and cattle; that is, the invaders would have the assistance of a larger extended family than the natives, an advantage probably more important than superior military technology – certainly so in the long run. Likewise, remoteness assured that the indigenes would be without defenses against the diseases the invaders inevitably would bring with them (Crosby, 1986, pp. 102-103).

In short, the absence or presence of particular types of life, as well as the capacity to eliminate Indigenous life, determined sites most amenable to the project of European expansion. Familiar ecological systems ensured the capacity to establish crops; remoteness offered a means to displace Indigenous peoples that ultimately hindered settler access to land. As DeLoughrey argues, it is with the lessons learned from these early experiments in expansion that "a grammar of empire" developed, in which *remoteness* and *isolation* come to represent island space and signify key features of successful colonization (DeLoughrey, 2007, p. 8). That colonial grammar continues to function across a multitude of discursive systems, toward various (always motivated) ends.

To more closely examine the motivations entrenched in the semiological systems connected to this grammar, it is informative to consider the relationships they confer. Terms like *remote* or *isolated* are inherently relational in that they can only be understood in context of their interaction with something else. To label a thing or a place *remote,* it must be distant from something or somewhere *else*; for something to be isolated implies it is disconnected from something else. In interrogating the mythical workings of these terms insofar as they are associated with island space, we might ask: from what are island spaces are considered distant? From what are they perceived to be disconnected? Finally, how do the interconnected and relational concepts of distance and disconnection confer notions of difference?

Evidently for the colonizers with whom this grammar originates, islands were experienced as distant from their continental posts in Europe, producing an imagined spatial formation in which the continent is centered as the metropole and islands are

marginal or peripheral. As the idea of the metropole confers ideas of power and modernity, island space may be perceived as disconnected from modernity, a myth that has long worked to discount Indigenous knowledge and equate indigeneity with "primitivity." Views of islands as isolated containers of primitive humans (and nonhuman flora and fauna) untouched by modern society motivate many scientific theories and even entire fields of study. A brief exploration of these reveals scientific discourse as a significant site in which the myth of the isolate is made and maintained. It also demonstrates the importance of myths of isolation to the very notion of Western scientific knowledge production.

1.6 Myth and Scientific Discourse

As philosophers and scholars of Science and Technology Studies (STS) have pointed out, we tend think of myths as the *opposite* of science, though science (like any social practice) is rife with mythical significations. Indeed, the myth of scientific objectivity and the modalities of experimentation and observation on which it is grounded has been the subject of inquiry for many scholars of STS. Scholars like Bruno Latour and Steven Woolgar (1979), Karin Knorr-Cetina (1981), and Michael Lynch (1985) have turned the ethnographic gaze onto the laboratory to demonstrate science as a situated, social process through which "truth" is actively constructed rather than passively discovered.

To recognize science as a site of mythmaking is not to dispel that which is "untrue" about science or knowledge production in service of discovering the "real" or "actual" truth. As British philosopher Mary Midgley has described, myths are not mere

lies but rather "imaginative patterns, networks of powerful symbols that suggest particular ways of interpreting the world" (Midgley, 2003). In short, we live in a world of myth, and science is no exception. What is worthy of analysis is the construction of the myths that shape particular ways of seeing the world, and the stakes of internalizing the interpretive schemes they engender. Having located the origins of the myth of the isolated island laboratory within Western projects of empire, following its uses in fields such as anthropology, biology, and ecology allows us to interrogate the invocation of this myth as it continues to appear as a powerful frame in contemporary scientific discourse.

Western biologists, naturalists, and anthropologists have long treated islands as ideal units of analysis given their mythical boundedness. From this view, the study of ecological or cultural phenomena on islands has been understood as holding distinct and valuable implications for scientific knowledge production. For 19th – century naturalists Charles Darwin and Alfred Russel Wallace, islands in the Galápagos and Malay Archipelago were their respective jumping-off points for demonstrating theories of natural selection. Though their work did not explicitly describe islands as laboratories, it was adopted in ways that ultimately popularized that very notion.

The field of insular biogeography (also referred to as island biogeography) is an informative site in which to observe this co-optation at work. Co-founders of the field, ecologists Robert MacArthur and Edward O. Wilson, open their seminal text *The Theory of Island Biogeography* (1967) with a quotation from Darwin's "Ornithological Notes," published over a century earlier:

> "The Zoology of Archipelagoes," Charles Darwin wrote at an early moment is his career, "will be well worth examination." And so it has proved. […] An island is certainly an intrinsically appealing study object. It is simpler than a continent or an ocean, a visible discrete object that can

> be labelled with a name and its resident populations identified thereby. In the science of biogeography, the island is the first unit that the mind can pick out and begin to comprehend. (MacArthur & Wilson, 1967, p. 3)

MacArthur and Wilson proceed to note that, because islands are high in quantity and highly diverse in their relative isolation, ecology, and size, they allow for "necessary replications in natural experiments" to test evolutionary hypotheses. By this logic, islands are advantageous to the scientific method insofar as they are not only "more numerous" than continents and oceans but represent a "simpler microcosm of the seemingly infinite complexity of continental and oceanic biogeography" (p. 3). If Darwin turned the scientific gaze to islands, MacArthur and Wilson multiplied it, assigning scientific value to islands not only for their isolation, but for their "repetitive" quality. As with the experimental practices of island colonization, the repeating-island imaginary is mobilized again. In this case, the island is continuously (re)made into an experimental site for the study of ecological phenomena.

Returning to MacArthur and Wilson's description of the value of islands to evolutionary studies: what does it mean to refer to experiments as *natural* or *necessary?* Such associations perform important work in mythmaking. As evinced by the works of MacArthur, Wilson, and the numerous other scholars they inspired across fields like island biogeography and evolutionary biology, there is a clear slippage between the rhetorical framing of the island as a site of "natural experiments" and its treatment as a "natural laboratory."

Many scholars have even made direct reference to islands as "natural laboratories" for studies of evolution (Emerson, 2002; Mayr, 1967; Román-Palacios & Wiens, 2018). If experimentation typically connotes the intentional manipulation of

variables to observe an outcome, the *natural* experiment facilitates the same opportunity for observation but involves no such interference. For biologists interested in understanding evolutionary processes, remote islands (and the archipelagoes of which they are part) represent unprecedented opportunity to understand how new and distinct species form through evolution, a process known as speciation. For instance, evolutionary biologists Rosemary Grant and Peter Grant elucidate the usefulness of island archipelagoes in studying speciation. Describing their continued study of the finches Darwin famously observed on the Galápagos Islands, they posit:

> Populations of the same species occur on different islands, and in some cases they have different ecologies. This allows us to investigate the reasons for their divergence. Closely related species occur together on the same island and differ. This allows us to investigate the nature of the reproductive barrier between them and the question of how and why species stay apart. Thus, considering populations across the entire archipelago, we can see all stages of the speciation process, from start to finish, at the same time. (Grant & Grant, 2003, p. 965)

From this vantage, it is as though nature *itself* conducts the "experiments" while the observer merely looks on. There are several overlapping presumptions embedded in this view, which I interrogate along two dimensions: (1) that the island represents an ideal scientific unit of analysis from which universal truths can be derived, and (2) that scientific observers *ought* to access island space to produce that knowledge. The imaginary of the island laboratory not only naturalizes island experimentation but naturalizes the observer's right to island space. Put another way, the acceptance of the idea of the island laboratory obscures the very presence and position of the observer.

Islands have been interpreted as ideal units of analysis in myriad scientific contexts. Recall MacArthur's and Wilson's assertions that islands are at once inherently simpler or more comprehensible than oceanic or continental geographies, and

microcosms of larger and more complex geographies (1967, p. 3). In this view, islands have qualities both distinct and universal: they represent smaller and less complex sites from which broader (or even universal) truths about the rest of the world may be derived. For MacArthur and Wilson, island ecology recapitulates "formerly continuous natural habitats" that existed prior to the "accelerating encroachment of civilization" (pp. 3-4). In effect, island space is treated as atemporal or existing in the past, an association that has been conferred onto inhabited and uninhabited island spaces alike.

Imaginaries of untouched nature resonate with what scholars have described as the myth of "pristine wilderness" (Denevan, 1992). European accounts of their arrival to the Americas often depicted a sparsely populated wilderness in spite of Indigenous presence and landscapes tended to and shaped by humans for millennia. The pristine wilderness myth relies on a dichotomous separation of humanity and nature, a division that historian Mark Dowie (2009) describes as deeply embedded in Western consciousness, dating back to manifest destiny desires for man to tame nature. He posits that Westerners revere nature as "a place to commune with the rest of the animal kingdom, discover themselves, and also, perhaps the purpose of life" (p. 92). In the imposition of the myth of pristine wilderness onto island space, biologists see opportunity to uncover universal truths about evolution, and scholars of other disciplines adapt the notion of the island laboratory to studies of human evolution, language, and culture under similar premises of atemporal island space.

Throughout the 1970s and 80s, anthropologists increasingly wrote of islands as "cultural laboratories" where studies of culture were supposedly simplified in the "controlled, isolated environments" that islands offer (DiNapoli & Leppard, 2018).

Though theirs were not the first articulations of islands as laboratories of culture,[16] archaeologists (Clark & Terrell, 1978; Evans, 1973; Keegan & Diamond, 1987; P. V. Kirch, 1986) as well as biological and cultural anthropologists (Dewar, 1997; Vayda & Rappaport, 1963) drew upon similar ideas (some even citing MacArthur and Wilson) in their own studies of human culture. Together, they contributed to a body of scholarship framing islands as important sites for the study of human culture, in some cases understanding that, the more "remote" the island, the more it may serve as a cultural "petri dish" (Held, 1989) or "pristine laboratory" for understanding the isolated evolution of culture (Dewar as cited in Fitzhugh & Hunt, 1997, p. 381).[17]

The (mythical) notion that the biologist or anthropologist can fully comprehend the island as a unit of analysis reveals particular ideas about the role of *distance* within knowledge production. As scholars of STS point out, Western notions of objectivity typically treat knowledge production as necessarily occurring from a distance. In this way, the island is apt for scientific study due not only to its distance from the mainland, but its supposed distance from the observer who renders it their object of study.

Feminist science studies and ecofeminist scholars contest the conflation of distance with "scientific objectivity" to problematize the alleged supremacy of Western knowledge systems over local and Indigenous knowledge. They call critical attention the ways in which *all* knowledge is situated and reflective of cultural epistemic norms. As ecofeminist scholar Vandana Shiva asserts, Western knowledge systems have maintained

[16] American cultural anthropologist Margaret Mead described Polynesia as a laboratory for studying cultural evolution as early as 1957. See Mead's "Introduction to Polynesia as laboratory for the development of models in the study of cultural evolution" in the *Journal of the Polynesian Society* (Mead, 1957).

[17] A number of scholars have also critiqued views of islands as laboratories. See Boomert and Bright (2007), Fitzhugh and Hunt (1997), Rainbird (1999), and Terrell et al. (1997), Fitzpatrick and Anderson (2008).

dominance via the negation and erasure of local and Indigenous knowledge, accomplished largely by presenting "objective" Western knowledge as *global* or universal when it is in fact also local and particular, having only spread worldwide through intellectual colonization (Shiva, 1993, p. 72).

Donna Haraway has described this as the "god trick" of objectivity: the understanding that objective science is produced from a disembodied or transcendent gaze that purports to see everything from nowhere (Haraway, 1988, p. 581). By upholding real or valid knowledge as that which is produced from the distanced "objective" vantage, embodied or place-based knowledges are made invisible, and thereby delegitimized. As Shiva writes, "the distance itself removes local systems from perception. When local knowledge does appear in the field of the globalizing vision, it is made to disappear by denying it the status of a systematic knowledge, and assigning it the adjectives 'primitive' and 'unscientific'" (p. 72). In the context of Western knowledge production about islands and islanders, the god trick lets the Western observer go unchecked as the arbiter of knowledge about island space and society. Consequently, Indigenous communities and knowledges are either rendered invisible or dehumanized in their treatment as objects of study.

1.7 Visualizing Mythical Isolates

The dominant, transcendent gaze has also been constructed through military media artifacts portraying islands from a distant, aerial view. This "aerial vision" mediates power-laden representations of Pacific Islands throughout the Cold War, particularly through the production of films by the Atomic Energy Commission (AEC):

> The airplane radically changed the perception of space and time, producing an 'aerial subjectivity', a cosmic view or aerial gaze born out of colonial mapping practices and tied to the often violent geopolitics of knowledge accumulation. […] This was particularly important for the large oceanic spaces of the Pacific, which were visualized aerially in US military films. (DeLoughrey, 2012, pp. 174-175)

The viewer of AEC films is interpellated in a panoptic aerial view of the Pacific. This was a powerful means through which American viewers with no relation to Pacific Island territories could come to imagine them as distant and isolated as they first became accessible for viewing. For instance, the 1951 film *Operation Greenhouse* features aerial footage of Enewetak Atoll (Figure 1.4) while the narrator describes the nuclear testing that will occur on the atoll as an imminent necessity: "The need for continuing tests of atomic weapons is self-evident. We need now, as never before, to expand our knowledge in the field of atomic weaponeering" (Nuclear Vault, 2010, 19:55–20:05).

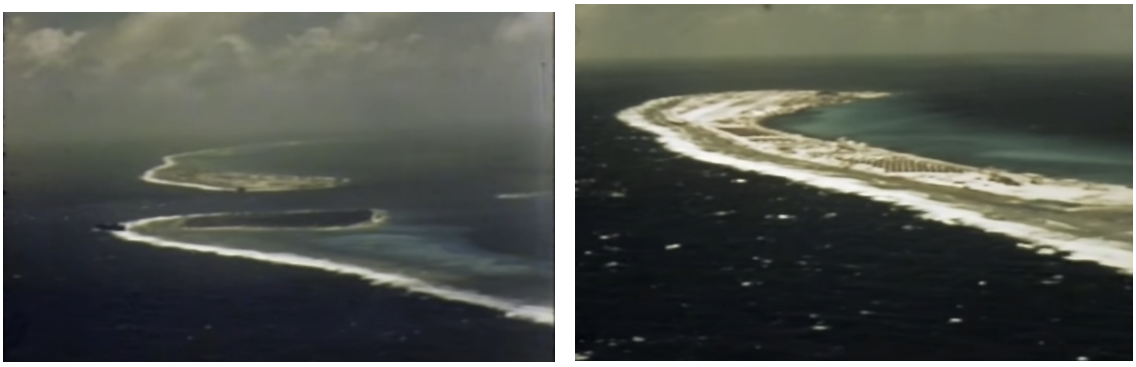

Figure 1.4: Aerial images of Enewetak Atoll in the 1951 film Operation Greenhouse (Nuclear Vault, 2010)

Americans viewed nuclear testing in the Marshall Islands through spectacular photographic and filmic representations that combined a transcendent gaze with narratives of inevitable progress. The production of this media was an important priority of government officials seeking to capture the tests: the 1946 Operation Crossroads tests at Bikini Atoll were recorded by over 1,500,000 feet of film and more than 1 million still

photographs (DeLoughrey, 2012). Officials setup ground and aerial cameras to record what would become iconic images of the blasts as they circulated widely in celebratory news media (Figure 1.5). For Americans consuming this media, the blasts were a symbol of scientific progress achieved in distant and isolated islands.

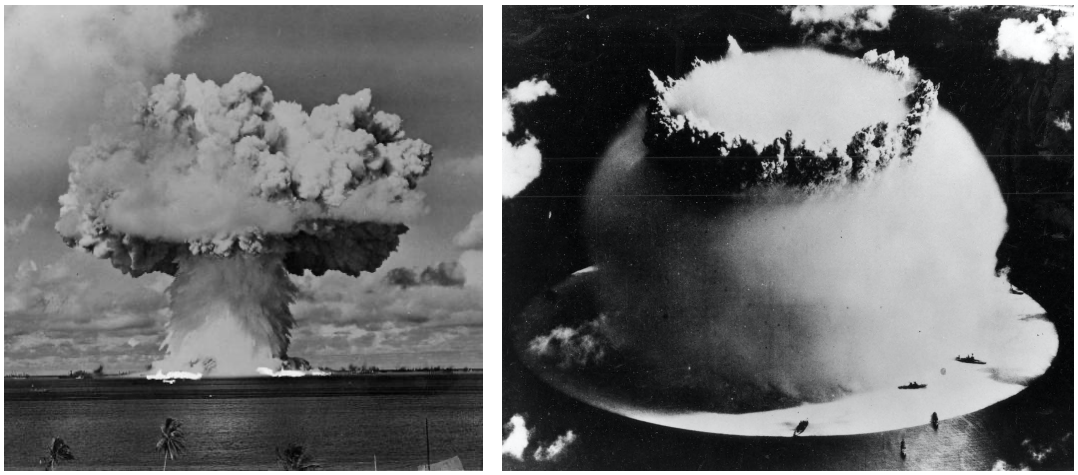

Figure 1.5: Left: Still photograph of the Operation Crossroads' "Able Shot" conducted July 1, 1946. Right: Still image taken micro-seconds into the second Operation Crossroads detonation, codename "Baker." (National Security Archive)

As was the case with all of the AEC's films, Marshallese were almost entirely absent from these representations which focused instead on American scientists and servicemen preparing for the blasts and of course, the spectacle of the blasts themselves.[18] In this way, the islands–turned–blast zone are decontextualized, floating land masses emptied of local history or life. The islands could be anywhere, and the atoll becomes a generic template for experimentation. Indeed, the imaginary of the isolated island was used to rationalize the hundreds of nuclear tests conducted beyond the Marshall Islands throughout the Cold War–era: in Mururoa and Fangataufa Atolls by the

[18] DeLoughrey writes that displaced Bikinians were featured momentarily in one government film wherein the narrator declares, "the islanders are a nomadic group, and are well pleased that the Yanks are going to add a little variety to their lives" (p. 176).

French government, in Australia and Kiritmati Islands by the United Kingdom, and in Kalama Atoll (or Johnston Atoll) and Kirimati by the United States (DeLoughrey, 2012; Genz et al., 2018). Together, scientific and popular media representations mediate practices of looking that emphasize distance, shaping powerful material implications for islands treated as disposable due to their perceived remoteness.

1.8 The Myth of Isolation Beyond the Pacific

I would be remiss to neglect the ways in which logics of isolation are applied beyond Oceania's islands. Notions of distance and disposability are often also extended to continental places selected for nuclear weapons testing, development, and toxic waste siting, further demonstrating the constructed and motivated (rather than pregiven) quality of perceptions of geographic "isolation." Looking to another AEC film, we can observe the adaption of the myth of isolation to continental geographies. A 1960s AEC film entitled "Guardian of the Atom" (Periscope Films, 2018) mobilizes the rhetoric of isolation against a terrestrial desert landscape. It opens with slow panning images of the Colorado Plateau as a male narrator sets the scene: "The rugged Colorado Plateau. Time: the early 1950s. This isolated area is about to influence the future of the world" (00:18–00:31). Less than a minute in, the film paints the picture of a pristine wilderness, describes the landscape explicitly as *isolated* and portrays it as such: a wild natural space void of human presence.

The opening scene of "Guardian of the Atom" continues with wide-angle shots of the rocky landscape, then cuts to a closeup shot of a hand scanning the terrain with a

Geiger counter.[19] The narrator continues: "Here, prospectors and geologists, equipped with strange new tools and spurred by government incentives, located one of the rare elements in the Earth's crust wealth never dreamed of. Uranium ore. Thus, nature gave mankind atomic energy, without directions how to find it, how to make it, how to use it. But scientists found the way" (00:38–00:54). As in the AEC's films in the Marshall Islands, the erasure of Indigenous presence functions to naturalize governmental appropriations of those lands, in the name of scientific progress.

Atomic energy is also presented as merely "given" to humans by nature, thereby obscuring the extractive practices (i.e., mining, milling) required to exploit it. Scientists are in turn described as the skilled and courageous "guardians" of this new discovery, erasing Indigenous guardianship to instead position settlers as the rightful stewards of nature and its untapped natural resources. The rhetorical move to frame settlers as guardians of resources on Indigenous lands is fundamental to broader projects of nuclear weapons production, given that roughly 70% of the world's uranium originates from Native communities, and some 66% of the known uranium deposits in the US are on reservation land (Endres, 2009, pp. 921-922). Uranium mining as well as aboveground nuclear testing occurred for roughly 50 years on and around Navajo and Hopi reservations and continue to shape adverse environmental and health effects in these communities,[20] and it is estimated that 90% of all uranium mining and milling occurred on or adjacent to Native American land (Grinde & Johansen, 1995).

[19] A Geiger counter is an instrument used to detect and measure levels of radiation.

[20] Due to mining on Navajo lands, at least 450 reported cancer deaths among Navajo mining employees (Endres, 2009), and some 500 abandoned uranium mines on Navajo nation continue to pollute water sources (Environmental Protection Agency, n.d.).

The selection of Native lands for nuclear activity was often tied to descriptions of the desert regions as a lifeless and therefore disposable "wasteland" (Endres, 2009).[21] Not unlike colonial perceptions of the ocean as negative space disconnecting islands, views of the southwest desert as lifeless are incommensurate with the historied relationships Indigenous peoples have to their ancestral lands in this region. As Navajo, Hopi, Lakota, Pueblo, Zuni, and many other tribal communities who descend from these regions know, life abounds in the desert. States with primarily desert ecologies have ranked high on surveys of the nation's plant and animal diversity, with Utah and Nevada ranking third and fourth (respectively) for plant diversity, and fifth and sixth for endemic species (Stein, 2002).

Just as perceptions of island spaces as remote and isolated do not constitute a universal or natural truth, neither is the desert a natural wasteland. Rather, a particular set of discursive moves grounded in static, reductive perceptions of land and water are deployed to justify extractive and harmful activities associated with nuclear weapons development and testing. Indigenous communities from Oceania to the continental US are still seeking justice for the prolonged effects of these activities, and resist the application of these familiar settler logics toward a number of other extractive projects on their lands.

[21] Communication scholar Danielle Endres (2009) analyzes rhetorical constructions of the desert southwest region as a "wasteland," arguing that perceptions of the southwest as barren, lifeless, uninhabitable, and remote influence and justify policies and practices that transform it into an "actual wasteland" sited for toxic waste.

1.9 Conclusion

As demonstrated in an exploration of AEC media, by omitting the Marshallese (their suffering as well as their resistance), photographic representations of nuclear testing tell a limited story about US experimentation in the Pacific. They also draw on (and reproduce) the myths discussed in this chapter: Oceania as a vacant and ahistorical space; islands as distant, remote, and expendable to the inevitable progress of US science and military. The myth of the isolate still persists in scientific imaginations, shaping taken for granted presumptions about islands, experimentation, and emerging technologies in new yet familiar ways.

In the next chapter, I locate the myth of isolation in contemporary scientific research. Following the logics embedded in scientific discourse surrounding a genetic engineering technology known as *gene drive,* I show how prevailing views of islands as distant and isolated justify their recommendation as ideal field trial sites for these contentious emerging technologies. By engaging in a close reading of the scholarly literature meant to frame the safe and ethical uses of genetic engineering technologies including gene drive, I continue to grapple with the semiotic processes that make the myth of the isolate, demonstrating the continued mobilization of island isolation to meet objectives of technological progress and biosecurity.

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CHAPTER 2

Gene Drive and the Myth of Isolation

2.1 Introduction

In the previous chapter I examined the myth of the island laboratory, a pervasive imaginary of islands as inherently isolated and bounded entities suited for experimentation. I traced the origins of the myth to 15th–century colonial expansion into island spaces then focused on its continuous reproduction (and consequences) through interconnected projects of settler militarism and scientific knowledge production in Oceania. This chapter demonstrates the ease with which islands continue to be readily imagined as sites of experimentation in contemporary scientific discourse, focusing on an emerging genetic engineering technology known as *gene drive,* and recommendations to test this technology on islands.

As I describe in more detail below, gene drive technologies have unprecedented capacity to alter the environment. As such, there exists a growing body of literature on the technical, social, and ethical issues related to their use. A common claim throughout this literature is that, due to their geographic isolation, islands represent ideal test sites for early trials of gene drive technologies. The purpose of this chapter is to investigate the ways such claims are presented in the literature: How are recommendations to test gene drives on islands articulated? What are the broader discussions and narratives within which these claims are embedded, and do they mobilize concepts or terms comparable to the logics of island experimentation detailed in Chapter 1?

To explore these questions, I conducted a two-part qualitative documentary analysis. The first part encompassed a close reading and analysis of documents featuring recommendations and discussions about the use of islands for gene drive field trials. Following a *theoretical sampling* approach informed by grounded theory and situational analysis (Clarke, 2015),[22] I selected five documents for initial analysis: (1) a consensus report on gene drive by the National Academies of Sciences, Engineering, and Medicine (NASEM) (NASEM, 2016); (2) a report from a workshop focused on the use of gene drive mice on islands (Farooque, Barnhill-Dilling, Shapiro, & Delborne, 2019); (3-4) two conference papers presented at the International Union for the Conservation of Nature's (IUCN) third annual conference on managing invasive species on islands (Campbell et al., 2019; Harvey-Samuel, Campbell, Edgington, & Alphey, 2019); and (5) the World Health Organization/Special Programme for Research and Training in Tropical Diseases' (WHO/TDR) guidance framework on Genetically Modified Mosquitoes (GMMs) (WHO/TDR, 2014).

I identified these documents as valuable to my analysis for the following reasons. The WHO/TDR guidance framework and NASEM consensus report are two widely-cited documents produced by interdisciplinary experts convened to offer recommendations and considerations related to the safe and ethical development and deployment of gene drive–modified organisms. They are valuable to my analysis because their recommendations are

[22] Adele Clarke describes *theoretical sampling* as "guided explicitly by *theoretical* concerns that have emerged in the provisional analysis" (Clarke, 2015). As opposed to typical modes of sampling that attempt to be "representative" of some phenomenon, theoretical sampling focuses on iteratively identifying *new data sources* "that are excellent for explicitly addressing specific theoretically interesting facets of the emergent analysis" (pp. 122-123). She describes this approach as implicitly feminist as it seeks to iteratively expand data based on emergent findings (i.e., "learning as you go") and is informed by the researcher's continuous mining of their own reflexivity.

frequently referenced within the broader gene drive literature, including the recommendation to trial gene drives on islands. The NSCU Workshop Report and IUCN Conference Proceedings focus more specifically on the use of gene drive on islands for invasive species management. These are rich for analysis because they feature explicit discussion of "island selection criteria," that is, criteria to guide the selection of particular islands for the trialing of gene drive–modified organisms.

I began with an initial reading of each document to locate discussions on islands as field sites, then analyzed those sections inductively, identifying emergent trends and themes in the data. This resulted in an initial set of 10 codes. I then grouped these codes into categories that capture substantive themes in the data: *biosafety, containment,* and *confinement*. My analysis paid close attention to the ways island geographies are figured in relationship to these concepts. I observe that islands are framed as capable of facilitating *biosafety* by *confining* gene drive organisms, absent the built structure of the laboratory. That is, while laboratories perform the work of *containment* in early stages of gene drive research, islands are imagined as performing the work of *confinement* in subsequent stages.

For the second part of my analysis, I sought to examine the material practices and protocols through which *biosafety, containment,* and *confinement* are operationalized. I expanded my sample to include three additional documents for analysis: (1) the Arthropod Containment Guidelines by the American Committee of Medical Entomology (ACOME, a subcommittee of the American Society of Tropical Medicine and Hygiene) (ACOME, 2019); (2) the Centers for Disease Control and Prevention's (CDC) Biosafety in Microbiological and Biomedical Laboratories manual (HHS, 2009); and (3) a scientific

publication entitled “Safeguarding gene drive experiments in the laboratory” (Akbari et al., 2015). These were selected based on their reference by the initial five documents as guiding recommendations and protocols to facilitate biosafety (ACOME, 2019; Akbari et al., 2015; HHS, 2009).

Overall, I observe that while laboratory-based containment is thoroughly detailed as a *process* achieved and maintained through material infrastructure and stringent protocol, ecological confinement is mostly presented as a natural or self-evident *quality* of island geographies. I also find brief acknowledgement in the literature that physical islands (i.e., land masses surrounded by water) are not the only types of “isolated” geographies that may facilitate containment. Yet, the recommendation to trial gene drives on islands remains the most readily prescribed and pursued path to containment. Taking my insights together, I argue that proposals to test gene drives on islands reflect entrenched associations of island geographies with isolation, and that emphasis on *safety* and *security* obscure the degree to which these proposals prescribe that risk be displaced onto island geographies.

After providing readers a brief introduction to gene drive technologies, including their potential applications and risks, I detail the insights gained in my documentary analysis. This discussion is organized along three sections. First, “Lab Containment (Phase 1)” demonstrates the thorough operationalization of containment for laboratory-based gene drive research; “Ecological Confinement (Phase 2)” examines the discussion surrounding the use of island isolation to confine of gene drive–modified organisms; and “Candidate Islands” examines the discussion about selecting islands for field trials.

2.2 A Brief Introduction to Gene Drive Technologies

The past decade has seen significant advancements in the precision with which scientists can make edits in the DNA of human and nonhuman organisms. Researchers and recent Nobel Prize recipients Jennifer Doudna and Emmanuelle Charpentier are credited with groundbreaking work on CRISPR/Cas9[23], a technology that has enabled researchers to more accurately and affordably add, remove, or change sections of an organism's DNA than ever before (Jinek et al., 2012; Sternberg & Doudna, 2015). In recent years scientists have used CRISPR toward the creation of additional, novel approaches to genetic engineering.

One such development is *gene drive*, a genetic engineering technique that can bypass typical rules of inheritance to push or "drive" genetic modifications through entire populations of sexually reproducing organisms. While offspring normally have a 50% chance of inheriting any particular trait from their parents, gene drives circumvent this rule, "biasing" inheritance by enhancing the transmission of a particular genetic element from parent to offspring (NASEM, 2016).[24] For instance, scientists might modify the genome of a mosquito so that it cannot vector a disease like malaria. Under normal patterns of inheritance, just half the offspring would inherit that modification. A gene drive can spread that modification through more than half of the offspring, and in some

[23] CRISPR (clustered, regularly interspaced, short palindromic repeats) are stretches of bacterial DNA that, when paired with a guide protein such as Cas9 (CRISPR associated protein 9), can make precise, targeted cuts in an organism's genome. The CRISPR/Cas9 system functions like a pair of scissors, cutting specific sequences of DNA so that it can be removed or so that new DNA can be inserted (NASEM, 2016, p. 13).

[24] While contemporary gene drive research utilizes novel methods in genetic engineering like CRISPR, gene drives themselves are not new. Scientists have been aware of "naturally occurring" gene drives (commonly referred to as *selfish genetic elements*) since the late 19th-century and have studied ways to co-opt gene drives to control natural populations since the 1960s (Burt & Trivers, 2006; Craig, Hickey, & Vandehey, 1960).

cases through nearly 100% of the population of mosquitoes. Gene drives using CRISPR do this by making precise cuts in the genome of the wild-type (i.e., unedited) organism then repairing it with an engineered version containing the "drive" so that all offspring will contain the drive allele (pp. 15-16; see also Figure 2.1).

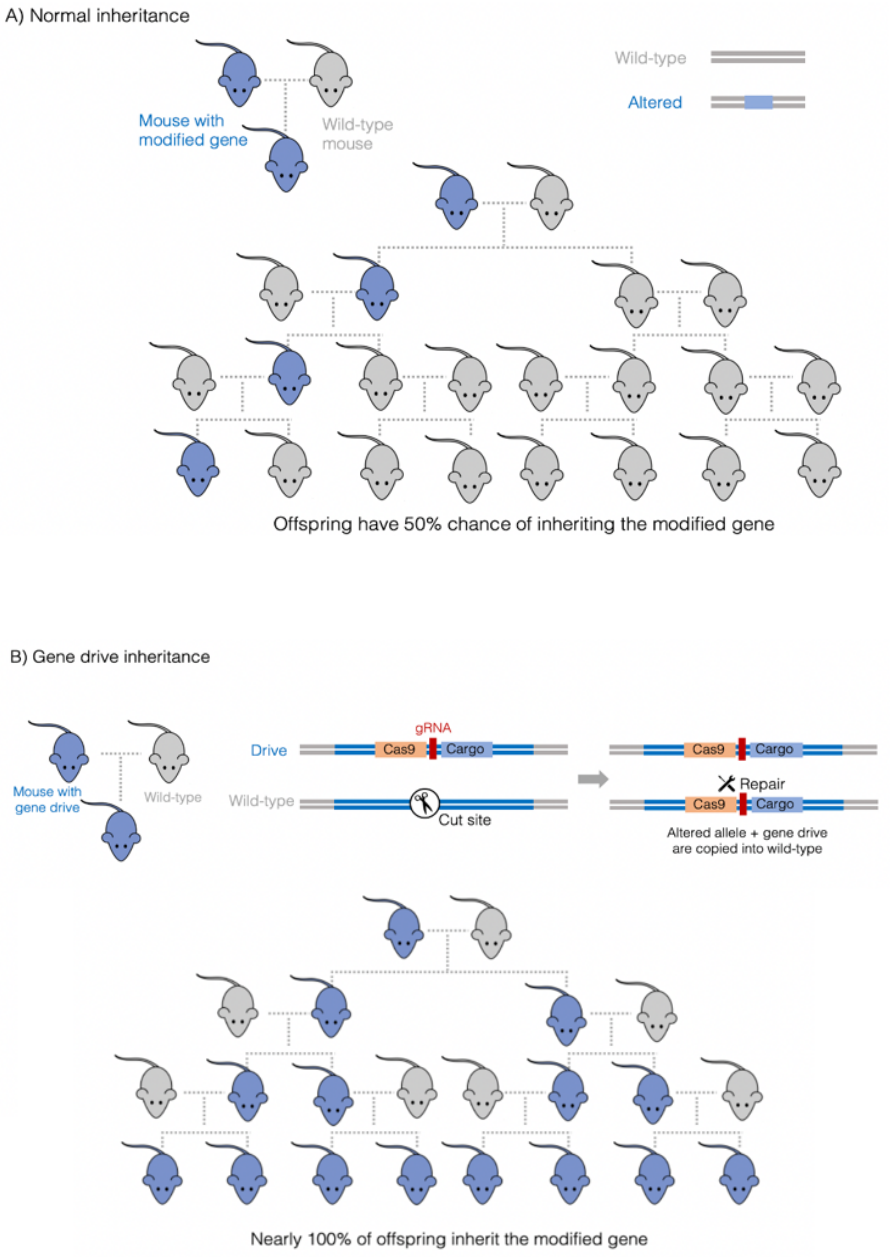

Figure 2.1: Normal inheritance versus gene drive inheritance (figure created by the author).

Though gene drive technologies are still being developed in the laboratory, they have garnered immense interest from scientists and funders for their possible applications across public health, agriculture, and conservation. Gene drives could be used to eradicate certain species of insects or other animals like rodents, for instance by biasing the sex of offspring to be all male (a population without females will decline or eventually crash), making gene drive an attractive tool to mitigate vector-borne diseases that are lethal to humans or other animals, or to manage pests associated with agricultural damage (see Figure 2.2).

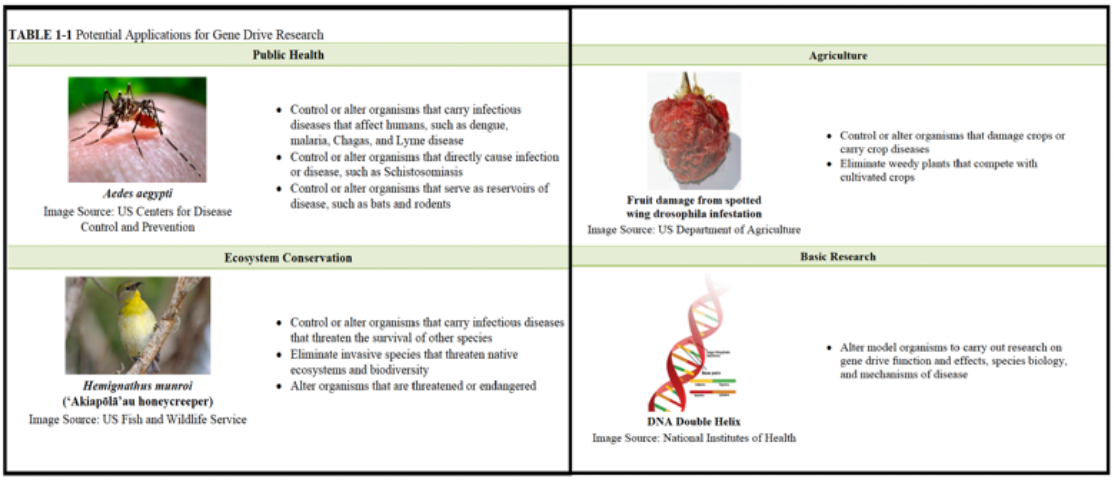

Figure 2.2: Potential applications of gene drives. Adapted from NASEM (2016, p. 19).

Such applications have attracted major funders including the Bill & Melinda Gates Foundation and the Tata Trusts of Mumbai, which invested a combined $140 million toward gene drive research for combating vector-borne disease and improving crop productivity between 2015-2017 (Courtier-Orgogozo, Morizot, & Boete, 2017). In

this way, entire populations of organisms can be modified, suppressed, or eradicated more rapidly than ever before.[25]

Because gene drives are in early stages of scientific development there remains considerable uncertainty surrounding the impacts they will have outside the laboratory, on wild ecosystems (Caplan, Parent, Shen, & Plunkett, 2015; Lunshof & Birnbaum, 2017; NASEM, 2016; Resnik, 2014). Will eradicating a species of mosquito or rodent disrupt the ecosystems of which they are part? What off-target effects (i.e., unintentional editing of DNA in the organism) might gene drives trigger, and will those effects produce undesired genetic changes? Compounding these issues is the fact that some gene drives are designed to endlessly self-propagate. That is, while some gene drive organisms require continuous release to sustain their populations, others are designed to continuously perpetuate themselves after the initial release of just a few modified organisms. Some scientists speculate that the escape of a single organism containing a self-propagating drive could prompt the spread of its modifications throughout wild mosquito populations on a global scale (J. P. Collins, 2018; Esvelt & Gemmell, 2017).

Enthusiasm that gene drives may mitigate intractable environmental and public health issues is thus met with apprehension about their potential to rapidly and irreversibly alter the environment. For these reasons, research is also underway to identify ways to contain, control, or reverse the effects of gene drives. The US military agency Defense Advanced Research Projects Agency (DARPA) is a major funder of such

[25] Alternative applications of gene drives include engineering the genomes of certain species to make them more resilient to diseases or other threats. For instance, some biologists are considering whether such an approach could be used to engineer defenses in coral reefs that would protect them from warming and acidifying waters contributing to their degradation (Redford, Brooks, Macfarlane, & Adams, 2019). However, these proposals remain largely speculative at this time, and gene drive research focuses predominantly on the suppression and eradication of certain organisms.

research, having invested at least $100 million toward gene drive research to date (Brown, 2017; Neslen, 2017). DARPA's "Safe Genes" program supports research meant to safeguard against intentional or accidental misuse of genome editing technologies and prevent and/or reverse "unwanted" genetic changes in a given biological system (DARPA, 2017). Some researchers funded by DARPA are working to develop "reversal drives," additional gene drives that could be deployed in an effort to restore populations or ecosystems to "baseline" states, should unwanted effects arise from accidental, unanticipated, or intentional uses of gene drive in the wild (DARPA, 2017). Experts have cautioned the use of reversal drives given that they may introduce their own unintended consequences, and may not be able to fully redress the impacts of the original drive (NASEM, 2016, p. 106).

Finally, a risk of gene drive development includes the potential for deliberate misuse of gene drives are referred to as "dual use" issues (i.e., the potential for gene drives to be used toward beneficial or purposefully harmful ends). Experts emphasize that this kind of weaponization of gene drive mosquitoes is unlikely from a technical standpoint, but "not inconceivable" (NASEM, 2016, pp. 160-161). For instance, a gene drive–modified mosquito could theoretically be developed to intentionally spread a pathogen or toxin. Again, the ability of certain gene drives to self-perpetuate intensifies concerns about the potential for their malicious use.

In sum, the research, development, and potential deployment of gene drives encompasses considerable uncertainty and risk. Still, as many scholars see it, the potential for gene drives to intervene in intractable issues – especially to mitigate human suffering associated with vector-borne disease – warrants the continued research and

development of gene drives. Some suggest that the risk of *not* developing gene drives ought to be weighed against the risk of developing them (Nuffield Council on Bioethics, as cited in WHO/TDR, 2014).

In an effort to manage the risks associated with the continued research and development of gene drives, experts emphasize the importance of strategies to *contain* and *confine* gene drive–modified organisms in the laboratory, and in the geographies that would serve as early field test sites. To understand how gene drives interact with real ecosystems, experts are recommending scientists undertake "confined field tests" to continue gene drive research and development without risking their global spread. As the National Academies of Sciences, Engineering, and Medicine (NASEM) writes in their widely-cited report on gene drive–modified organisms, "Gene Drives on the Horizon: Advancing Science, Navigating Uncertainty, and Aligning Research with Public Values":

> Some amount of uncertainty is unavoidable […] However, laboratory studies and confined field tests (or studies that mimic confined field tests such as large cage trials and greenhouse studies) represent the best approaches to reduce uncertainty in an ecological risk assessment, and are likely to be of greatest use to risk assessors. (NASEM, 2016, p. 7)

Confinement is expressed here in terms of the laboratory settings in which gene drive–modified organisms are developed, as well as the natural environments (or simulations of natural environments) in which those organisms may be released for continued scientific study. Upon closer reading of guidance framework literature from NASEM and other institutional bodies commenting on the safe development of gene drive–modified organisms, the challenge of confinement emerges as a key theme. The literature recommends a stepwise, phased approach that moves from highly contained to open settings (NASEM, 2016; WHO, 2020; WHO/TDR, 2014). In short, research (currently

underway) is first conducted in highly secure, contained laboratory settings, then pending sufficient scientific knowledge to justify it, research may advance toward less contained settings and eventually open release (See Figure 2.3).

Figure 1.1 Phased testing pathway for GMMs

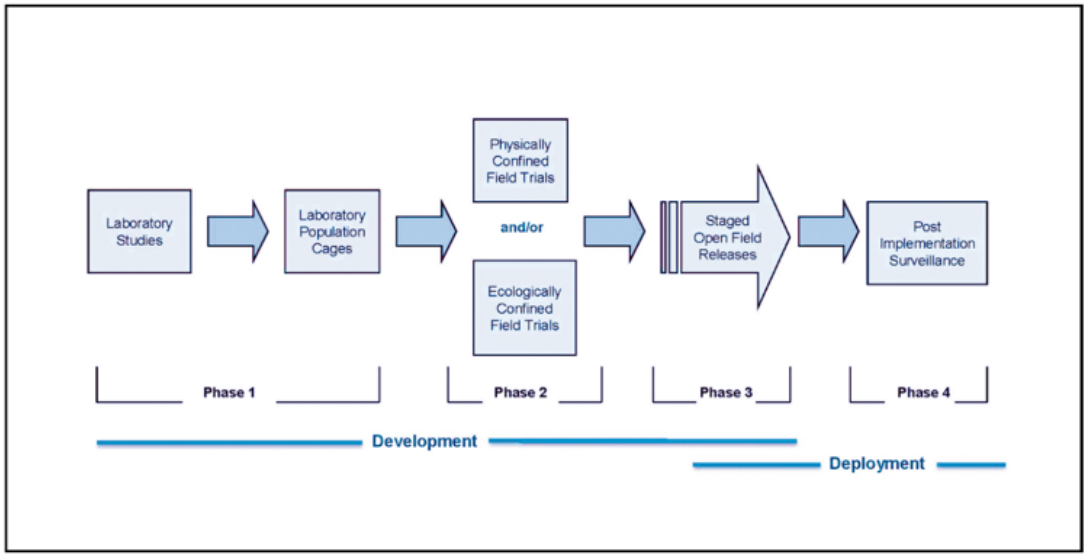

Figure 2.3: "Phased testing pathway for GMMs" by WHO/TDR from which NASEM's "Phased testing pathway for gene drive research" (NASEM, 2016) is adapted (WHO/TDR, 2014).

It is in the middle phase, between laboratory research and open releases, that islands get proposed as naturally confined settings suited for gene drive field trials. In 2014, WHO/TDR published a guidance framework for the testing of genetically modified mosquitoes (GMMs) (WHO/TDR, 2014). Acknowledging broad agreement in the scientific community that GMMs containing gene drive should be tested under physical confinement (p. xiv), the framework points specifically to physical or ecological islands as "ideal testing locations" for GMMs (p. 18). Similarly, following NASEM's (2016) recommendation of a phased testing approach, islands are described as "an ideal

geographically isolated contained setting" with "natural barriers" suited for the goal of restricting dispersal of gene drive-modified organisms during the confined field-testing phase (p. 92).

2.3 Laboratory Containment (Phase 1)

Discussions of containment of gene drive–modified organisms point to the importance of *biosafety,* "policies and practices intended to prevent harm to the health or safety of human beings, other living organisms, or the environment, especially those pertaining to safe handling and containment of infectious agents" (NASEM, 2016, p. 180).[26] The WHO/TDR and NASEM reports both emphasize the phased testing approach as fundamental to the pursuit of biosafety, given built-in considerations meant to help determine whether it is safe to progress to a subsequent stage of research or deployment (NASEM, 2016; WHO/TDR, 2014). At the core of this phased approach are those practices referred to as *containment* and *confinement:* measures taken to prevent potential escape of organisms into the environment as well as to monitor and control the degree to which organisms spread in the environment when released for field trials.

The definitions of containment and confinement vary somewhat – and are sometimes used interchangeably – within the gene drive literature. NASEM cites the US Department of Agriculture's Animal and Plant Health Inspection Service (APHIS) containment guidelines to distinguish the two:

> APHIS draws a distinction between "containment procedures," which are used to prevent exposure of modified organisms to the environment, e.g.,

[26] Biosafety is recognized as the domain related to *unintended* consequences or releases of gene drive–modified organisms, while biosecurity has to do with consequences related to the intentional misuse of research (NASEM p. 160).

> in laboratories, greenhouses, and during transport, and "confinement procedures" used during field trials to ensure the modified organism does not persist in the environment. (NASEM, 2016, p. 156)

In short, containment measures are meant to keep modified organisms out of the environment completely, while confinement measures are meant to limit the dispersal of organisms that have been released outside of the laboratory. Notably, APHIS' terms were first published over a decade before the development of CRISPR-based gene drives, so their notion of confinement (as restricting the persistence of an organism in the environment) is difficult to achieve, or perhaps irrelevant, in context of gene drives which are designed to indefinitely self-propagate upon release.[27]

Researchers rearing and managing arthropod[28] organisms containing gene drives follow stringent protocols reflected in the WHO and NASEM frameworks to minimize the risk of an organism escaping. This includes working in highly secure laboratories or insectaries. Securement of the physical laboratory involves everything from the location of the lab to careful design of the details of every entryway and surface by which an organism could escape or conceal itself. For instance, it is recommended that insectaries containing gene drive–modified organisms are located in low-traffic or secluded areas of a building, preferably in completely separate or relatively isolated wings of the larger campus of which it is part. Entrances to the space must feature multiple self-closing doors equipped with electronic or biometric door locks, insectary rooms must have well-sealed

[27] APHIS updated its guidelines in 2019 to address biosafety issues associated with recombinant DNA, but did not update their definition of confinement. Moreover, APHIS focuses predominantly on risks to human health, rather than ecological considerations relevant to the development of gene drive–modified organisms.

[28] Though there is gene drive research involving non-arthropod organisms underway (e.g., rodents), I choose to focus this discussion arthropod organisms, particularly insects like mosquitoes. Gene drive research is far more advanced and sought after in insect organisms, due both to the complexity of developing them in mammalian species and the appeal of gene drive mosquitoes to mitigate vector-borne disease.

or no windows, and ventilation systems must be fitted with appropriate filters or barriers to prevent escapes from the laboratory (Akbari et al., 2015; American Committee of Medical Entomology; American Society of Tropical Medicine and Hygiene, 2019).

Containment also encompasses policies and practices that shape the movement of humans and nonhumans through the space of the lab. These especially emphasize careful importation, handling, storage, and disposal of organisms involved in lab-based research. In the US, the management of non-native arthropods is subject to regulation by a number of governmental agencies[29] and follows increasingly stringent protocol depending on the diseases they vector to humans or other animals.

In addition to maintaining standard laboratory practices (e.g., wearing personal protective equipment and regularly cleaning and disinfecting all lab spaces and materials), technicians follow detailed procedures related to the management and surveillance of contained organisms. Organisms are to be kept in multiple levels of containers, such as tubes within a refrigerator or freezer, or a cage within a cage, and the design of containers must use materials to prevent escape such as properly sized mesh screens and shatterproof glass. All containers must be labeled with detailed information about the species, its origin or strain, date of collection, and researcher responsible for its safekeeping. Gene drive–modified organisms are to be clearly labeled and housed in separate containers and rooms from their wildtype counterparts to avoid unintended interbreeding. Disposal of arthropods or waste materials should use medical autoclave or

[29] In the US, obtainment and importation of non-native arthropods is subject to regulation by the Public Health Service/Centers for Disease Control and Prevention (CDC) and the Office of Health and Safety. In the case that those arthropods vector disease to humans or other animals, they may also be subject to USDA APHIS, and those containing recombinant DNA may be regulated by the US Environmental Protection Agency (EPA) and/or the Food and Drug Administration (FDA) (ACOME, 2019).

other incineration devices, and living, infected arthropods not being used in an experiment are to be killed by freezing or other methods, again followed by autoclaving or incineration (ACOME, 2019).

Lab procedures also target activities that present opportunities for organisms to escape. Technicians are instructed to take extra precaution when transporting arthropods, feeding them, or introducing additional organisms into a primary container. These processes are pertinent in instances which organisms require "live hosts" to feed. While some hematophagous arthropods – those that feed on blood – might feed on collected blood samples, some require live animals such as mammals, birds, or fish to feed (ACOME, 2019, pp. 162-163). In these circumstances, live host animals must be housed separately from the arthropods and inspected closely after feedings in case arthropods become concealed on their bodies, such as in their fur or ears. In other cases, human blood might be required to feed arthropods. Again, it may be possible to conduct feedings with pre-collected blood samples or with tools that simulate a human skin membrane. However, the use of simulated tools can require extensive training of arthropods, and some vectors have adapted in ways that make them unable to survive without blood acquired directly from a human and will not propagate otherwise. These processes require human volunteers and are subject to various research protections (e.g., Institutional Review Boards) and require extra precaution pertaining to the handling and management blood, which can be an additional inadvertent source of disease transmission.

These precautions are meant to minimize the probability of unintentional escape of an organism from the laboratory as close to zero as possible. Still, since some

arthropods jump or fly and are thus highly mobile, containment can be a challenge. Plans must be implemented in the case that escape does occur either within the laboratory or into the environment. Labs are to be equipped with traps that are regularly monitored, and any loose arthropods found in the lab must be handled with appropriate tools (i.e., not bare hands) and follow procedure for proper disposal. It is also recommended that the physical setup of the lab enables easier identification of escaped arthropods, such as a low ceiling, the use of light paint colors on walls or other surfaces, and the removal of any unnecessary furniture or clutter where organisms could hide or breed. Taken together, these strategies, policies, and procedures are meant to contain organisms entirely to the space of the laboratory.

Some investigators have recommended implementing certain confinement strategies to provide an additional layer of biosafety during phase 1 research, providing a backup in case primary containment methods fail. To do this, researchers might handle species in areas where the outside environment is inhospitable to the organisms' survival or reproduction. For instance, Akbari (2015) has suggested researchers choose cold-temperature regions and seasons to work with mosquitoes that require tropical climates; or that researchers work in areas where the modified species lack potential mates in the wild. NASEM notes that these approaches might not always be feasible, "as it could prevent research on gene drives from being conducted" (2016, p. 96), so gene drive research certainly occurs in regions where the escape of a gene drive–modified organism could lead to its propagation in the wild. In organisms with short generation times, it might not take very long for modified organisms to completely replace the wildtype population. Depending on the type of gene drive at work, this could give rise to

population crash or even eradication of the target species. Because it could prove very difficult or even impossible to reverse the impacts of gene drives on that species or the broader ecologies of which it is part, the risks of a potential breach of containment are substantial. Recommendations to layer confinement and containment strategies demonstrate the high stakes of failed containment.

The stringency of protocols surrounding escape also show the level of risk associated with failed containment. According to the Arthropod Containment Guidelines, in the event of an escape of infected arthropods it may be necessary to shut down and properly treat or disinfect the entire area with insecticide. Researchers may also be required to alert authorities, depending upon the hazard associated with the arthropod, the diseases it vectors, or materials with which it has been deliberately modified. For instance, the CDC's Select Agent Rule, established on the heels of 9/11 in response to concerns about bioterrorism, identifies a list of 38 "Select Agents:" microorganisms and toxins that "pose a severe threat to public health and safety" (HHS, 2009). The CDC regulates laboratories managing those agents and requires they be accounted for at all times. Should arthropods containing those agents escape, or should their escape merely be suspected, a federal investigation could be triggered under the Select Agent Rule. If researchers are unable to recover unaccounted arthropods, the situation would be considered a "release," prompting an emergency response that includes involving the appropriate institutional authorities and deliberating to identify next steps.

The containment and confinement measures discussed thus far – strategic choices pertaining to the design and location of the laboratory, as well as rigorous laboratory procedures for managing organisms within the laboratory – are *extrinsic*. That is, they

involve the manipulation or management of factors external to the organisms themselves. NASEM and WHO also recommend a number of *intrinsic* containment and confinement strategies that target the organism (e.g., molecular or reproductive factors) so that it cannot survive or propagate outside of the laboratory (NASEM p. 96). Intrinsic strategies become increasingly important as research progresses into phases beyond the laboratory, and researchers can no longer rely on the built space of the laboratory to provide control over the spread of organisms.

Some intrinsic confinement strategies target biological processes in ways that make it impossible for the organism to survive or propagate outside the laboratory. For instance, gene drive–modified organisms can be edited to develop dependence on substances not found in nature, ensuring they survive only when that particular compound is supplied to them in the laboratory (Wright, Stan, & Ellis, 2013). Additionally, strategies referred to as *reproductive confinement* work by ensuring that released organisms are unable to produce offspring in the wild. For instance, some strains of *Drosophila* (fruit fly) have genetic backgrounds that prevent them from producing viable offspring when mating with wildtype organisms; using these strains in gene drive research can diminish the chance of their establishment in nature (DiCarlo, Chavez, Dietz, Esvelt, & Church, 2015).

Some researchers are also developing a variety of "self-limiting" gene drives that would autonomously achieve confinement over space or time. In other words, these systems discourage the endless propagation of the drive by virtue of their design. Some self-limiting drives might work by requiring a particular threshold to successfully advance themselves, such as the release of a particular number of modified organisms.

Others can be designed to "self-destruct" upon the introduction of a certain chemical, after a designated number of generations, or under certain environmental conditions such as temperature (NASEM, 2016, p 36; p. 97). Research is still underway to evaluate the efficacy of these and other self-limiting mechanisms, to assess their vulnerabilities, and determine whether those vulnerabilities might give rise to other deleterious outcomes. As such, it is recommended that, whenever possible, researchers use a combination of extrinsic and intrinsic strategies to minimize the likelihood of escape and subsequent spread of modified organisms in the environment. Finally, it is recommended that researchers make gene drive–modified organisms visually distinguishable from wildtypes. For instance, researchers have used fluorescent proteins to engineer gene drive–modified fruit flies with brightly colored eyes (see Figure 2.4).

Figure 2.4: Three Drosophila Melanogaster fruit flies with gene drive and fluorescent eyes. Image by Craig Cutler for The New York Times. (Kahn, 2020)

In addition to helping researchers easily discriminate between modified and non-modified organisms when handling them in the lab, NASEM (2016) says this could also make it easier to identify organisms that have escaped containment, including by residents asked to report sightings in the surrounding geographic area (p. 92).

In sum, phase 1 strategies require significant investment in material infrastructure (as well as shared commitment to protocols and practice) to facilitate containment. The stringency of protocols demonstrates not only the seriousness of failed containment, but recognition that human error and unanticipated accidents are well within the realm of possibility. Looking to phase 2 reflects shifting expectations surrounding the conditions of experimentation as researchers are urged to adopt confinement strategies that enable observation of organisms in more "natural" settings, while still avoiding their uncontrolled spread.

2.4 Ecological Confinement (Phase 2)

If studies conducted in phase 1 meet all built-in safety considerations, researchers may be permitted to progress to phase 2, Field Research. At this stage, researchers focus on bringing organisms out of the laboratory and into the environment for field trials, though not yet under the conditions of fully open release. According to WHO, the purpose of phase 2 research is to provide evidence on the performance of genetically modified mosquitoes under more natural conditions, as well as "to provide an appropriate level of RA [risk assessment] and RM [risk management] before full implementation of open field trials in phase 3" (WHO/TDR, 2014, p. 53). Following WHO's definitions of risk and risk assessment, phase 2 is meant to identify hazards associated with the release

of modified organisms, and to estimate the "likelihood of each hazard occurring as well as the potential adverse impact of the hazard (harm)." In theory, information gathered about hazards and harm within phase 2 will then inform processes of risk management or "the process of identifying and implementing measures that can be expected to reduce risk to an acceptable level" (p. x). In sum, phase 2 represents a significant information-gathering step through which researchers and regulators will assess whether it is safe to advance to phase 3, open environmental release.

The primary challenge of phase 2 is establishing a study setting in which researchers can observe gene drive–modified organisms in nature while still ensuring their *confinement* – in other words, without letting them completely overtake the wild population. However, recall that the very purpose of gene drive is to replace its wild population with a modified, gene drive–carrying population. How, then, can field trials occur without gene drives spreading irreversibly into wild populations of organisms? Molecular methods such as self-limiting drives may help facilitate confinement, but research is still needed to determine whether these methods are truly safe and reliable. NASEM has also recommended that large cage or greenhouse trials may "mimic" confined field trials (2016, p. 88; see also Figure 2.5).

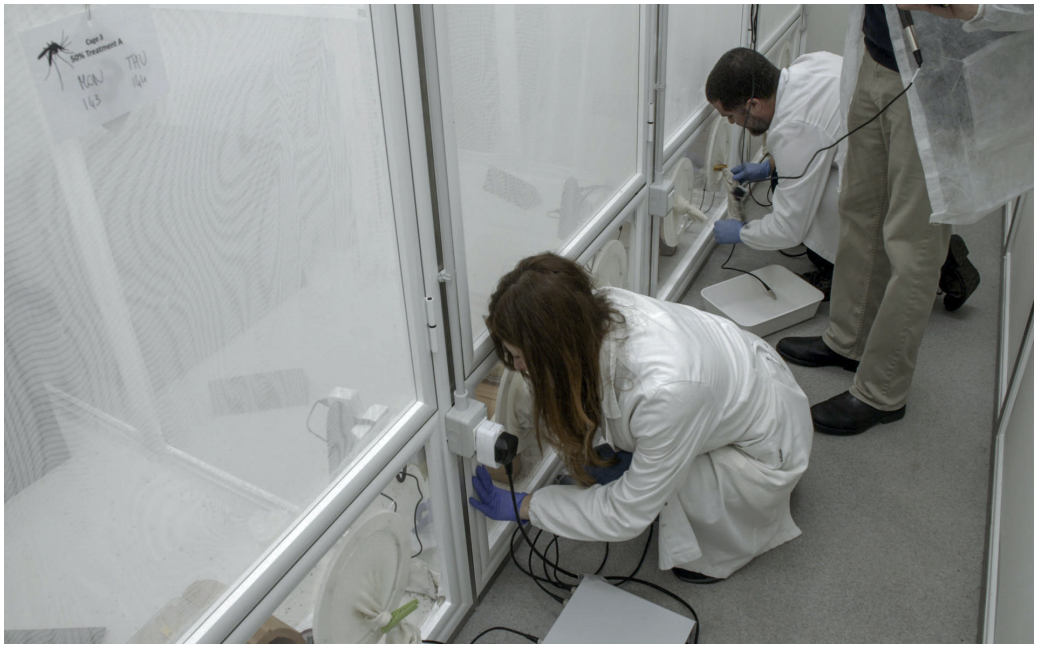

Figure 2.5: Technicians in Terni, Italy initiate a yearlong experiment monitoring mosquitoes containing gene drives. (Stein, 2019)

These allow researchers to observe the dynamics of gene drive–modified organisms in simulated, "fieldlike" conditions while still ensuring containment. Still, according to the prescribed phased approach, the progression toward open field trials requires an intermediate step between containment and open release. Unable to rely on the built space of the laboratory to enclose organisms in phase 2, researchers turn rely increasingly on qualities of the physical environment to facilitate confinement.

Recommendations surrounding ecological confinement almost exclusively point to the use of physical islands (i.e., islands surrounded by water), though there is acknowledgment that *ecological* islands might facilitate containment. According to definitions in recent ecology scholarship, ecological islands are "small and isolated habitat patches produced by landscape features" (Cartwright, 2019). Unlike a physical island, an ecological island is not necessarily surrounded by water but arises from distinct landscape features that produce smaller, micro-habitats within broader ecosystems, such as rock outcrops, sinkholes, cliffs, or springs (p. 331, See also Figure 2.6).

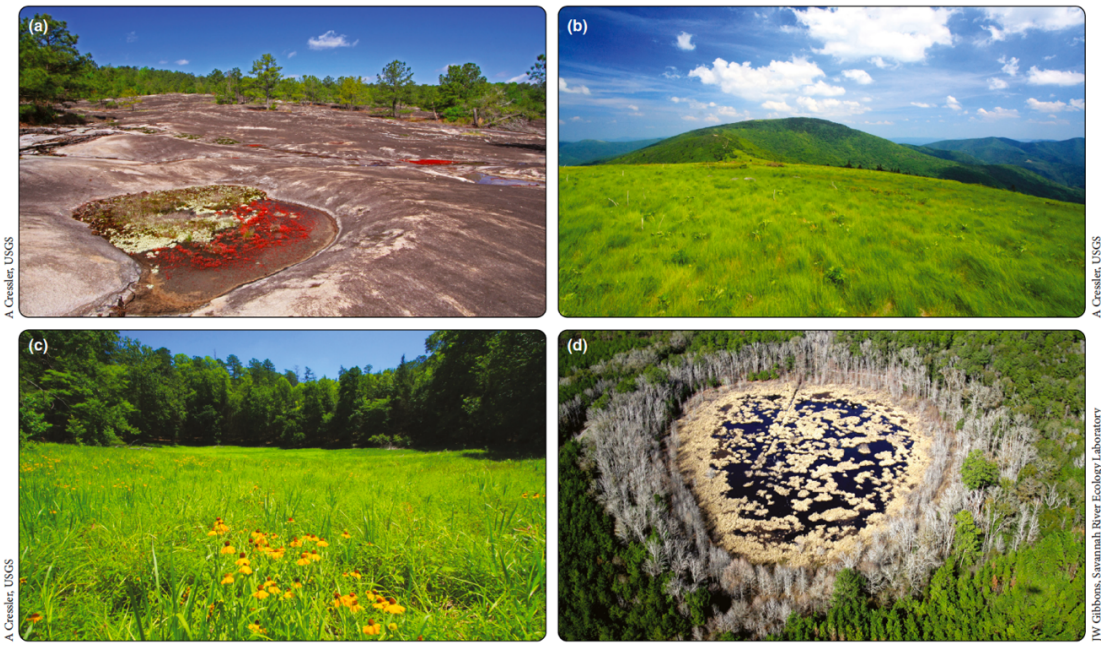

Figure 2.6: Examples of "ecological islands:" granite, outcrop, high-elevation grassy bald, sinkhole wetland, Carolina bay wetland (Cartwright 2019).

WHO/TDR's recommendations on confinement mention that *ecological islands* could be used to confined trials, though only briefly: "…it is anticipated that ideal testing locations for GMMs will be chosen in part for their confinement characteristics

(ecological or physical islands)" (2014, p. 18). In the section on phase 2 trials, the document mentions ecological islands once more: "'Ecologically confined' refers to those trials conducted in delimited areas from which escape is unlikely due to some ecological or geographical isolating factor. These include ecological or physical islands" (p. 31). No further explanation is given as to how ecological islands could be used for trials, however, as the remainder of discussion in WHO/TDR and NASEM focus on the use of physical islands for confined experiments.

The recommendation to use islands for confined field trials of gene drive spans two major gene drive research contexts. First, it is widely presumed that islands offer a useful proxy for continental geographies that are the target of phase 3 open releases. As NASEM suggests:

> Field-based research can take place in areas with natural barriers, such as islands which constitute an ideal geographically isolated contained setting, where climatic and environmental conditions are similar from where the organism would normally thrive while physically limiting the dispersal of the organisms (O'Connor, 2012 in NASEM, p. 92).

In this scenario, the recommendation is to use islands solely for the purpose of experimentation. The suggestion to identify islands with similar environmental and climactic qualities "to where the organism would normally thrive" implies that islands used for field trials are *not* the intended site of the gene drive intervention to be facilitated in phase 3, open releases. For instance, researchers on the UC Irvine Malaria Initiative (UCIMI) are engineering *Anopheles gambiae* mosquitoes to intervene in the high rates of human malaria in countries throughout sub-Saharan Africa (UCI Malaria Initiative, n.d.). Researchers of the UCIMI collaboration have considered using oceanic islands for field trials since at least 2013, when one lab conducted research to identify whether the

Bijagó's archipelago or Comoro Islands would be more suitable for trials of genetically modified mosquitoes. Most recently, they have identified the island nation of São Tome and Príncipe as well as the Comoro Islands as "optimal candidate field sites" for trials of their mosquitoes, which they now modify to contain gene drive (Vector Genetics Laboratory, 2019; See also Figure 2.7). Under this plan, phase 2 confined field trials would occur on islands to inform phase 3 releases, which would occur at continental sites.

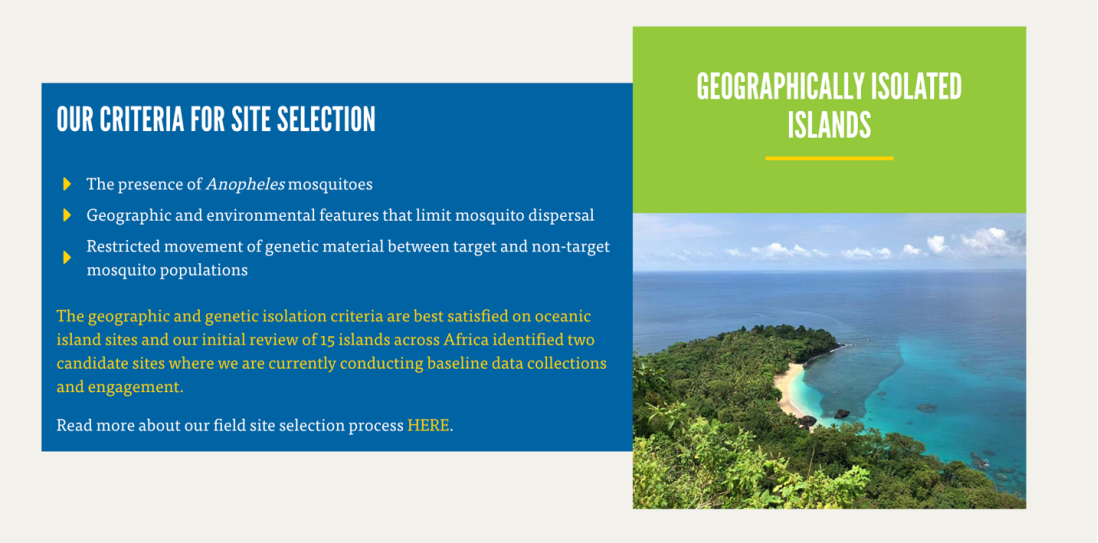

Figure 2.7: A screenshot from the UCIMI website's "Where We Work" tab (UCIMI, n.d.)

In alternative scenarios, islands may represent the target site or endpoint of the gene drive intervention. For instance, biologists in Hawai'i are exploring mosquito control technologies including gene drives to prevent the transmission of avian malaria to local endemic birds (Redford et al., 2019). Researchers with the organization known as Island Conservation also hope to use gene drive to protect biodiverse island ecosystems by eradicating invasive rodent populations. While the intention is to ultimately deploy the

gene drives on islands, researchers may still express a preference to conduct phase 2 field trials on different islands, for instance those that are smaller or more geographically isolated than the target island, or those that are uninhabited by humans (Campbell et al., 2019).

In either case, the central presumption is that isolated geographies will necessarily do the work of *confinement*. But how isolated is isolated *enough* to prevent the unwanted spread of gene drive–modified organisms? The NASEM guidance framework lacks specificity regarding what constitutes an appropriate level of isolation. Though it offers multiple statements that islands are ideal geographically isolated settings for gene drive trials (NASEM, p. 88; 90; 92), no evidence is offered to support this claim or elaborate on *why* islands are suitable geographies for gene drive trials.

WHO offers some operationalization of confinement, though in relation to questions of effective scientific knowledge production rather than risks related to ecological or human health. A section entitled "Careful site selection increases the likelihood of detecting significant results" addresses the challenge of confining transgenic mosquitoes from wild populations in order to maintain the divisions between the test and control groups that are fundamental to typical experimental designs (pp. 19-20). In other words, confinement in this context has to do with keeping transgenic and wildtype mosquitoes separate enough that data gathered on the modified mosquitoes are not "contaminated" by integration of wildtypes.

Still, this discussion defies specificity and relies on limited evidence with respect to what constitutes sufficient remoteness. WHO cites a 1997 study on mosquito dispersal to support their claim that "two kilometres will probably be sufficient" to confine

organisms modified with self-limiting mechanisms, and that organisms with other types of drives will simply require "greater distances" of separation (Service, 1997, p. 20). The two-kilometer figure comes from data (typically treated as common knowledge today) that suggest mosquitoes are capable of flying only very short distances, typically a few meters and in rarer cases up to a few kilometers. However, many studies –including the 1997 study cited by WHO/TDR – note that mosquito dispersal can be facilitated over longer distances via wind and much longer distances human-assisted transportation such as ships or planes. Indeed, the arrival of mosquitoes to many Pacific Islands happened via ships, such as the European whaling ships believed to have brought *Culex quinquefasciatus* and later *Aedes aegypti* to Hawai'i throughout the 19th-century (Redford et al., 2019).

The two IUCN conference papers posit that islands "1 km or more" from other land masses are "remote enough" to avoid unassisted migrations of gene drive–modified mice (Campbell et al., 2019; Harvey-Samuel et al., 2019). They cite one study which states that *Mus musculus* (house mouse) have been observed to swim up to 500 meters between land masses, and that they are more likely to be moved via human assisted transport (Campbell et al., 2019, p. 619). Given that organisms like mosquitoes and rodents can be redistributed beyond their typical range by weather events or carriage on humanmade structures, geographic distance alone cannot ensure their confinement to a designated region such as a trial area.

In spite of evidence that confinement requires considerable planning and monitoring or may prove very difficult to predict or control (for instance in the case of unforeseeable weather events), the guidance framework literature offers little in the way

of clarifying *how* organisms will be confined to a particular trial area, particularly in comparison to the level of detail provided to describe securitization of the laboratory. Moreover, despite some acknowledgment that physical islands are not the only "naturally confined" geographic settings, the recommendation to use them for gene drive trials persists. The next section explores the discussion about selecting specific islands as field trial sites.

2.5 Candidate Islands

The initial five documents in my dataset each consider "site selection," or the identification and pursuit of specific field sites for the conduct of gene drive research. It is at this stage that NASEM's recommendations incorporate considerations of justice in addition to practical guidance, noting that "site selection [for field trials and open releases] should be guided by many considerations, including the balance of benefits and harms, both in terms of public health and the environment and as understood in collaboration with the stakeholders in the community" (NASEM, 2016, p. 77). Site selection for eventual open releases will thus depend upon a range of complex factors such as regulatory infrastructure and public acceptance.

Multiple documents in my dataset identify "mature" regulatory mechanisms as a key criterion in the selection of a trial island (Campbell et al., 2019; Farooque et al., 2019; Harvey-Samuel et al., 2019). Though this was not explicitly stated in my dataset, other literature on gene drive governance suggests that island isolation may represent an attractive quality for gene drive trials from a regulatory standpoint. One 2020 article on gene drive governance made this point, arguing that while coordinated governance for

large-scale releases has yet to be established, geographically isolated releases may be possible under existing regulatory mechanisms (Kelsey et al., 2020). They note that:

> […] current international and local governance is likely capable of proceeding with controlled field trials and releases in well-demonstrated geographically isolated areas. Anticipating release in larger, less-defined disease-endemic areas poses greater issues for governing bodies because of the capacity of drive organisms to expand beyond geopolitical borders, infringing on the consent of governments and communities alike. In an attempt to better equip the current international governance. (Kelsey et al., 2020, p. 976)

In this view, geographic isolation may allow for the circumvention of challenges associated with gene drives that may span borders with different governance structures and preferences regarding the release of gene drive–modified organisms. It may therefore be possible to conduct contained trials on islands sooner than on continental geographies.

Site selection will also be driven in large part by the problem being targeted. Open releases are envisioned for regions facing disproportionate burdens of issues gene drives are meant to mitigate, such as vector-borne disease and biodiversity decline caused by introduced or invasive species. Alternatively, it is implied that site selection for *field trials* depend more upon features like the remoteness of the site, as well as the degree to which it might simulate the conditions of the intended site of open release. While regulatory and social factors will determine site selection at the field trial stage there is emphasis on using this stage as another information-gathering exercise, "continu[ing] the assessment of biological and functional activity of GMMs" (WHO/TDR, 2014, p. 9). Islands are thus seen as providing important opportunities for knowledge production that must precede broader releases of gene drive–modified organisms.

The IUCN conference papers and Gene Drive Mouse Workshop Report offer the most specific discussion of criteria for island selection. In their article entitled "Trialling

gene drives to control invasive species: what, where and how?" Harvey-Samuel et al. reference the WHO/TDR guidelines to assert that "in order to maximize containment and efficacy, small, isolated islands are ideal locations for the first trials of gene drives" and list a number of geographic and biological "advantages" of island locations to trial safety (2019, pp. 621-623). These reflect familiar logics of isolation that frame them as amenable to experimentation given their "simple" and numerous quantity.

One point made is that the genetic homogeneity of populations of organisms on islands may enable the development of geographically confinable gene drives. Harvey-Samuel et al. note that, "the potential genetic homogeneity of an island invasive population and simplicity of island communities (reducing the number of hybridizing congeners) may prove advantageous in designing sequence-specific molecular safeguards to limit this risk [of transgene escape]" (p. 622). In other words, developers may be able to create gene drive systems that would only work on the unique genetic sequences of organisms on a given island, providing a backup safety measure in the case of their unintended travel beyond the trial area. This implies that the organisms living on islands possess unique biological characteristics that make them capable of containing biosafety risks associated with gene drives.

The authors also note that atolls and archipelagoes offer an opportunity to study the dispersal of gene drive–modified organisms, stating that, "where multiple islands occur in close proximity, these areas could be used to test assumptions on the spread of a drive technology within/between populations depending on the dispersal of the target (e.g., coral atolls/archipelagos for short/longer distance dispersal, respectively)" (p. 623). In this view, atolls and archipelagoes provide natural experimental settings with value for

continued knowledge production about gene drives, namely measurements of how far they will spread after an initial release. This resonates with the repeating-island logics detailed in the previous chapter, wherein islands are understood as facilitating opportunities for numerous "experiments" to develop models of imperial expansion, or as providing naturally divided "test" and "control" groups for nuclear experimentation in the Marshall Islands.

Harvey-Samuel et al. also briefly address desirable social criteria for island trials of gene drives. They identify two key criteria for site selection: "the existence of a credible regulatory structure and an enthusiastic local participant (e.g. academic researcher or wildlife management agency) with expertise regarding the invasive being targeted" (p. 623). They emphasize that the selection of islands that are uninhabited (by humans) may curb societal objection, particularly if those islands are not of "great cultural value" (p. 623). Finally, they add that "a local participant with knowledge of the regional, ecological, social, economic, political, and cultural context of deployment is invaluable" (p. 623). In sum, these criteria seem to strive for settings with less likelihood for social opposition, and forego deeper consideration of any relevant political or cultural considerations.

The "Exploring Stakeholder Perspectives on the Development of a Gene Drive Mouse for Biodiversity Protection" workshop report details a set of exercises meant to prompt discussion about the use of gene drive mice on islands, including an activity specifically about the selection island field trial sites. The workshop was held at North Carolina State University (NCSU) in March 2019, "aiming to convene a diverse group of stakeholders, scientists, funders, and leaders for an exploration of perspectives on the

development of a gene drive mouse for restoring biodiversity on islands" (Farooque et al., 2019, p. 1). Participants included about 20 scholarly experts spanning science, ethics, and policy (Figure 2.8 shows a full list of participant expert areas represented in the workshop). Funded by DARPA's Safe Genes Program, the workshop also intended to supply NCSU's Safe Genes researchers with information about gene drive research, engagement activities, and potential deployment. To initiate discussion about selection of an island field site for future trials, organizers facilitated an activity based on "fictional island scenarios" (p. 6).

1.4 Participants

- Evolutionary biologists
- Invasive species experts
- Ethicists
- Mouse biologists
- Conservation experts
- Animal welfare experts
- Wildlife biologists
- Biotechnology policy experts
- Population geneticists
- Population modelers

Figure 2.8: Participants in the "Exploring Stakeholder Perspectives on the Development of a Gene Drive Mouse for Biodiversity Protection on Islands" Workshop (Farooque et al., 2019).

Workshop organizers presented participants with four hypothetical island scenarios, each with varying geographic, ecological, societal and regulatory characteristics (See Figure 2.9). Participants were then split into groups to discuss each scenario independently before selecting their top two preference for an "imagined first field trial" (Farooque et al., 2019, p. 6; p. 18). As authors of the report described, fictional scenarios prompted discussion about perceived risks, benefits and concerns as well as

complex ethical issues associated with each scenario, without recommending any actual islands as field sites (p. 3).

Authors reported on those characteristics deemed more suited to field trials, as well as those that raised concerns. Islands viewed more favorably for trials were those further from the mainland, with government buy-in, uninhabited by humans, lacking endangered species, and demonstrating a need for a gene drive mouse (i.e., places where mice negatively impact local ecosystems). Less preferable qualities included smaller distance to the mainland, proximity to a mainland region with strong environmental activism, ownership by a foreign company, and presence of native mice (p. 19). Some participants also raised concerns about whether there was access to information about local or Indigenous communities' preferences and values, and histories through which they may have been excluded from weighing in on decisions affecting their community. Ultimately, "Island C" was chosen as the most favorable candidate island, reflecting a combination of the qualities listed above:

> The following benefit considerations made Island C the top choice (8/20) for first-release candidate island: proximity to a university, good understanding of population and genetic data, well controlled access, little human traffic, established research station, government buy-in, and no native mice. Concerns included proximity to a mainland location with strong environmental activism and accidental transport of the gene drive mice to the mainland by a predator. (p. 19).

Island Selection Criteria	Island A	Island B	Island C	Island D
Size	5 ha	10 ha	100 ha	400 ha
Distance from mainland	10 km	1000 km	1 km	100 km
Presence of native mice	No	Yes	No	Yes
Human activity on island	Small-scale Eco-tourism	Lighthouse	Research Station	Indigenous agriculture
Geography	Sandy beaches		Steep Cliffs	
Accessibility - Public	Yes	Yes	No	No
Accessibility - Research team	1 hr boat ride	flight to landing strip	10 min boat ride, with crane access	1 day boat ride
Regulatory Oversight	U.S.	AU	US	AU
Number of land managers involved	Wealthy Conservationist	Petrochemical Company	Government (Fish & Wildlife)	Tribal government, Federal government
Knowledge of invasive mouse population (behavior, genetics, ecology)	N/A	1 sampling event	20 years of studies	1 year of study
Livestock & other animals	None	feral goats	None	llamas, pigs, chickens
Prior eradication efforts	Succeeded in 2009	historical baiting around barracks	None	None
Non-targets of concern	None	native mouse	endangered raptor	None
Presence of M*us musculus*	No, would be introduced	Yes	Yes	Yes
Feasibility of eradication with toxicants	Highly feasible	Feasible	Unclear	Difficult
Organisms threatened by mice	bat spp that is rebounding	an extirpated lizard that could be reintroduced	several endangered birds	Mice spread human disease as a vector for tick-borne illness

Figure 2.9: Fictional Island Scenarios in the "Exploring Stakeholder Perspectives on the Development of a Gene Drive Mouse for Biodiversity Protection on Islands" Workshop (Farooque et al., 2019).

Beyond the specific considerations raised in the workshop (which are reviewed in limited detail here), the workshop report serves as an interesting artifact of the types of imaginative activities that take place in formal deliberative spaces, as well as everyday activities associated with gene drive development. Frequently this involves the abstraction of situated, real-life contexts in which these technologies would be deployed into scenarios or thought experiments. As the authors of the NCSU workshop admit, this may risk flattening the complexity of "real candidate islands" (p. 19). This is a critical

point, but there is another important type of imaginative work being performed here. The very task of imagining islands as "candidates" reinscribes the mythical logics that presume and frame their isolation as serviceable to experimentation, and the containment of risk. In other words, these are precisely the types of taken for granted discursive moves that further sediment the imaginary of the isolated island laboratory.

2.6 Conclusion

The growing literature on the ethical complexity of gene drive technologies calls on experts to think deeply about the norms emerging in considerations about how to safely and ethically advance gene drive research. Such analyses warrant critical attention to the underlying presumptions and values present in discourses that will ultimately shape decisions about gene drive research and deployment. The analysis conducted in this chapter reveals one such norm in the literature: the conflation of island geographies with isolation, and attendant conclusions that islands represent ideal test sites for gene drives.

Building on Chapter 1 which deconstructed the seemingly universal truth of island isolation, this chapter sought to examine the logics undergirding calls to test gene drives on islands. My analysis revealed that while laboratory containment of gene drive–modified organisms is achieved through built structures and rigorous protocol, islands are imagined as facilitating the confinement of gene drive organisms (and the risks associated with their deployment) primarily by virtue of their geographic isolation. I also observed that the literature identifies other types of isolated geographies that may be amenable to gene drive trials, yet physical islands continue to be the most readily pursued for this purpose. For these reasons, it is difficult to avoid the conclusion that this reflects

commitments to the protection of continental geographies at the expense of places viewed as distant and isolated.

Chapter 3 employs ethnographic methods to examine how people are grappling with proposals to implement gene drives in an actual island setting. I focus my analysis on the activities that constitute *community and stakeholder engagement* on two islands where gene drive is underway, given that engagement is widely understood as requisite to the trial or implementation of gene drives at any site, and identified as a means to facilitate just decision-making about the use of gene drive technologies. I consider the limitations of extant orientations to engagement as a "strategic" activity, and consider how engagement may facilitate more meaningful inclusion of local and Indigenous communities.

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CHAPTER 3

Containing Engagement: Ethnographic Insights on Strategic Approaches to Gene Drive Engagement in Hawai'i

3.1 Introduction

In the previous chapter, I analyzed a set of documents related to the safe and ethical use of an emerging genetic engineering technology known as *gene drive*.[30] I interrogated widespread claims in this literature that islands make ideal test sites for gene drives given their perceived geographic isolation, and argued that these claims reflect colonial myths of islands as natural laboratories amenable to experimentation.[31] While the last chapter focused on the ways islands are *imagined* in the abstract as test sites for gene drive, this chapter utilizes an ethnographic approach to consider an actual island setting where these technologies are being developed and considered for deployment. Moreover, given that myths of island isolation have long been mobilized to justify settler occupation, militarization, and experimentation on islands without consulting or gaining the consent of local communities and Indigenous peoples, this chapter investigates what efforts are being made in the gene drive space to ensure that communities whose environments would be impacted by these technologies have a say decision-making surrounding their use.

[30] Gene drives are genetic engineering techniques that work by spreading genetic modifications through an entire population of sexually reproducing organisms. For a more detailed introduction to the technology see Chapter 2.

[31] Chapter 1 discusses the myth of the isolated island laboratory at length.

I turn my focus toward the popular yet nebulous topic of *community and stakeholder engagement,* which is presented in the gene drive literature as requisite to any decisions to release gene drive–modified organisms, and understood as a way to "open up" decision making to local and Indigenous communities. My investigation focuses on two broad, interrelated questions about emergent engagement practices related to gene drive technologies: (1) how are practitioners of engagement imagining, designing, and conducting engagement activities?, and (2) what sorts of values and epistemic norms are embedded in these practices? Given my interest in the ways in which gene drive technologies are being pursued for deployment in Oceania (and my own relationship to this region), I explore these questions through ethnographic observation and interviews conducted on two Hawaiian Islands where gene drive research is underway.

After providing a brief introduction to community and stakeholder engagement in the context of gene drive technologies, and an overview of my methodological approach, I frame several key insights drawn from my ethnographic research in Hawai‘i. In sum, I observe that an emergent approach to engagement is informed by "strategic communication" which orients to engagement as a persuasive practice informed by marketing research methods. I see this approach as *containing* rather than opening up engagement, foreclosing opportunities for relationship-building and mutual learning, and strategically withholding information in the hopes of cultivating approval of novel technologies.

While some scientists working on gene drive express desires to facilitate more open and participatory approaches to engagement, they find these difficult to pursue given limited infrastructure and resources to sustain such activities, and institutional

pressures that disincentivize them. Finally, I argue that strategic practices are misaligned not only to calls to open up engagement, but to meet Kānaka Maoli desires to bring history to bear on decisions regarding the use of technologies on their ancestral lands.

3.2 Brief Background on Community and Stakeholder Engagement in Gene Drive Research

Though *community, stakeholder,* and *engagement* are each broad terms for which no single, shared understanding exists, the National Academies of Sciences, Engineering and Medicine's (NASEM) popular 2016 report on gene drives[32] offers definitions that reflect their typical use in the gene drive literature (NASEM, 2016). These definitions orient around the different relationships individuals have to the technology itself. For instance, NASEM defines *communities* as those living in geographic proximity of a potential field trial or release site, while *stakeholders* refer to individuals with "professional or personal interests sufficient to justify engagement" (e.g., scientists, researchers, technologists, conservationists, policymakers), but not necessarily living in proximity to a release site. Additionally, *publics* are defined by NASEM as groups of people who may not have a direct connection to or interest in gene drives but may nevertheless contribute to democratic deliberation and decision-making if engaged (pp. 131-132; see also Figure 3.1).

[32] NASEM's 2016 publication, *Gene Drives on the Horizon: Advancing Science, Navigating Uncertainty, and Aligning Research with Public Values* is a roughly 200-page report summarizing the "current understanding of the scientific discoveries related to gene drives and their accompanying ethical, legal, and social implications" (p. vii). It was produced by 16 experts spanning the natural and social sciences, ethics, and law, to analyze scholarly works and presentations on gene drives and present a "consensus report" on the state of gene drive science, and expectations for its responsible development and use. At this time, the report has been cited 265 times (according to Google Scholar).

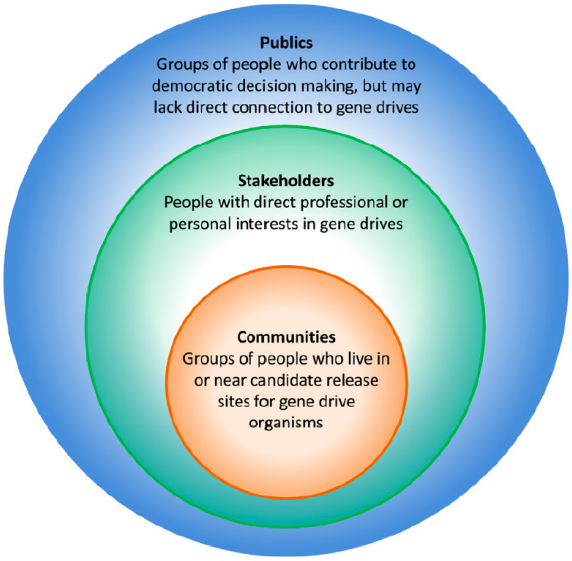


Figure 3.1: NASEM's definitions of communities, stakeholders, and publics (2016, p. 132).

NASEM acknowledges that individuals can (and often do) belong to more than one of these groupings. For instance, scientists developing gene drives in the United States (US) with the intention of trialing or implementing them in other countries would be stakeholders but not community members. Alternatively, scientists residing in the places where they are developing and proposing to implement gene drives are considered both stakeholders and community members, under NASEM's definitions (such is the case for scientists I interviewed for this project).

There is wide agreement in the gene drive literature that communities, stakeholders, and publics must be engaged in some way prior to the release of any gene drive–modified organisms outside the laboratory. NASEM underscores this point, stating that the "outcomes of engagement may be as crucial as the scientific outcomes to decisions about whether to release a gene-drive modified organism into the environment" (2016, p. 7). Commenters calling for engagement generally invoke *participatory* models of engagement, emphasizing community members as collaborative partners with valuable

expertise that may shape and direct research and decision-making. For instance, NASEM defines engagement as "seeking and facilitating the sharing and exchange of knowledge, perspectives, and preferences between or among groups who often have differences in expertise, power, and values," and asserts that engagement "requires attention to multiple types of communication, deliberation, relationship building, reflection, and empowerment" (p. 131).

Scholars have recommended that engagement be used toward a number of participatory endeavors in the gene drive space: to communicate openly and transparently to communities and publics about gene drive technologies under development (Esvelt & Gemmell, 2017; Farooque et al., 2019; Resnik, 2018); to build relationships and mutual trust among various stakeholders and communities (Kormos et al., 2021; Singh, 2019); to co-develop technology with local communities (Buchthal, Weiss Evans, Lunshof, Telford, & Esvelt, 2019); and to prompt public deliberation about the value considerations raised by gene drives, such as the human capacity to alter or eradicate nonhuman species (Caplan et al., 2015; Jasanoff, Hurlbut, & Saha, 2015). Overall, this literature thoroughly addresses the need for participatory engagement in order to grapple with the ethical complexity of gene drive technologies, and to challenge conventional power dynamics that may otherwise exclude communities and publics from meaningfully informing research and decision-making about their use.

However, moving these recommendations to practice proves challenging for several reasons. Questions remain about who should be engaged, when, and in what ways. Commenters also caution that without clear guidelines or mechanisms of oversight, practitioners of engagement may forego participatory engagement for more instrumental

or unidirectional activities aimed at obtaining authorization, particularly if such activities are undertaken by proponents of the technology (Kofler et al., 2018). Moreover, calls to value community knowledge and input may be met with resistance by practitioners unaccustomed to seeing "lay" members of the public or community as possessing valuable insight or expertise. Indeed, some experts have expressed preferences to limit the decision-making power of "lay" communities or publics who may lack knowledge on genetic engineering. As researchers from North Carolina State University observed of a workshop conducted in 2016 on gene drive governance:[33]

> Some participants operated under the premise that the main goal [of public engagement] should be to educate the public, as they perceived a current lack of public knowledge about gene drives and, thus, were hesitant to include the public as full partners in decision-making for fear that this lack of understanding would lead to fear of anything that is genetically engineered (GE). (Kuzma et al., 2018, p. S24)

Such beliefs reflect a "deficit model" which presumes that a lack of education or literacy on gene-editing technologies gives rise to fear or opposition, and that those fears can be dispelled through education. Engagement organized around deficit model views privilege one-way transmission of information in efforts to manage skepticism. Not only do these approaches prove ineffective in subduing opposition,[34] they foreclose opportunities for "lay" stakeholders or community members to share their own situated expertise.

[33] The workshop, "Road Map to Gene Drives," convened an international group of more than 70 experts spanning academia, business, government, and nonprofit organizations (Kuzma et al., 2018).

[34] Scholars studying science communication surrounding climate change, nanotechnology, genetically modified foods, and synthetic biology have observed that deficit approaches to engagement (i.e., presenting scientific information and facts in efforts to "educate" laypersons) are more likely to intensify polarization than produce favor (MacDonald et al., 2020).

Finally, without coordinated or enforceable governance mechanisms to guide decision-making processes about the release of gene drive–modified organisms,[35] it remains unclear how any insights gained in engagement will actually be applied. Various international organizational bodies are weighing in on the need for decisions to reflect local authorization, with some calling for the consent of local and Indigenous communities. For instance, the International Union on the Conservation of Nature (IUCN) has noted that decision-making about synthetic biology technologies (including gene drive) "can implicate rights of indigenous peoples and local communities in relation to natural resources and culture," citing international law and policy protecting Indigenous self-determination (Redford et al., 2019). Similarly, the United Nations Convention on Biological Diversity's[36] (CBD) Ad Hoc Technical Expert Group's (AHTEG) report on synthetic biology in 2017 commented:

> Given the current uncertainties regarding engineered gene drives, a precautionary approach and cooperation with all countries and stakeholders that could be affected, taking into account the need for the free, prior and informed consent of indigenous peoples and local communities, might be warranted in the development and release of organisms containing engineered gene drives, including experimental releases, in order to avoid potential significant and irreversible adverse effects to biodiversity. (Convention on Biological Diversity, 2017, p. 5)

While these statements make headway on issues of Indigenous self-determination, they deploy ambiguous language open to interpretation (e.g., "*can* implicate" Indigenous

[35] Scholars note that the scientific development of gene drives currently outpaces the development of mechanisms to guide the legal-ethical aspects of their oversight (Barnhill-Dilling, Serr, Blondel, & Godwin, 2019). The capacity of certain gene drive systems to self-propagate presents unprecedented challenges for their regulation, given their potential to spread beyond geopolitical borders demarcating heterogenous governments and community preferences regarding the use of gene drives (Kelsey et al., 2020).

[36] The Convention on Biological Diversity (CBD) is an international legal instrument "for the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources" (Convention on Biological Diversity, n.d.-a).

rights, consent "*might* be warranted"),[37] and raise questions about various frameworks of *consent.* Some scholars have questioned whether individual consent is feasible or even possible to achieve in the context of gene drive releases (Singh, 2019), and others have problematized the free, prior and informed consent (FPIC) framework, arguing that it is vulnerable to narrow interpretations that limit collective autonomy and self-determination (George, Kuiken, & Delborne, 2019). Māori (Indigenous people of Aotearoa/New Zealand) scholars have further noted that frameworks like FPIC ultimately operate in a Western paradigm and as such, may exclude Māori preferences and processes for decision-making (Palmer, Ripeka Mercier, & King-Hunt, 2020).

At present, practitioners around the globe are actively organizing engagement activities related to genetically engineered organisms (including gene drives). These vary immensely in form and purpose, and are not always well documented. For instance, in a study analyzing 14 published accounts of community and stakeholder engagement projects related to novel vector control technologies (e.g., genetically engineered mosquitoes), my colleagues and I found that engagement activities ranged from public notice and comment periods to expert working groups, interview studies, surveys, media coverage, community meetings, face-to-face canvassing, meetings with government officials, and public relations efforts (Schairer et al., 2019). We also found that documents associated with engagement efforts generally omitted or included vague description of activities and were often unclear on the goals or motivations for conducting a given activity (pp. 7-9).

[37] It is also of note that while the US is a signatory to the Convention on Biological Diversity, it has not yet ratified this international treaty. At the time of writing, 196 states have ratified the CBD, with the exception of the US and the Holy See (Vatican) (Convention on Biological Diversity, n.d.-b).

Some engagement practitioners have access to established infrastructure to guide their efforts. For example, nonprofit organizations such as Target Malaria[38] have dedicated stakeholder engagement teams with experience conducting engagement in relation to other mosquito control activities (Barry et al., 2020; Target Malaria, n.d.). For others, engagement will be a new undertaking, and may not be well resourced. Thus, it is valuable to investigate what engagement looks like in practice to provide clarity into the actual activities that constitute engagement, and to understand how practitioners are navigating the challenges of organizing and sustaining those activities.

Several scholars have undertaken such investigation. These efforts generally draw on social science methods to explore emergent challenges and successes of engagement activities and generate recommendations to guide future engagement. They deploy a variety of methods to do so: reviewing published documents about engagement activities (Schairer, Taitingfong, Akbari, & Bloss, 2019); soliciting comment from individuals with experience organizing stakeholder engagement activities (Thizy et al., 2019); interviewing community members or leaders who attended engagement activities (Barnhill-Dilling, 2018; Barnhill-Dilling, Rivers, & Delborne, 2020; Barry et al., 2020); interviewing and surveying expert stakeholders who attended engagement activities (Costantini, 2020); participant observation of engagement activities with community members and stakeholders (Barnhill-Dilling, 2018; Barnhill-Dilling et al., 2020; Costantini, 2020). This small but growing body of literature lends important insight into the on-the-ground experiences and dynamics of engagement activities that frequently

[38] Target Malaria is a multinational research consortium working in Burkina Faso, Ghana, Mali, and Uganda and exploring genetic technologies to eradicate mosquitoes that transmit malaria (Target Malaria, n.d.). Target Malaria is funded primarily by the Bill and Melinda Gates Foundation ($75 million) and the Open Philanthropy Project ($17.5 million) (Hartley et al., 2021).

represented in limited detail (or omitted entirely) from published reports about those activities.

Ethnographic studies of engagement can thus offer a valuable window into the ways engagement plays out in practice, and perhaps better characterize any gaps and misalignments between abstract calls and aspirational intentions of engagement on the one hand, and the on-the-ground realities and material consequences of engagement on the other. Moreover, if engagement is meant (as NASEM describes) to convene and prompt communication among groups with "differences in expertise, power, and values," engagement is a rich site to explore how power and difference are mediated, contested, and negotiated. As I describe in the next section, I see these explorations as benefitting from feminist and Indigenous approaches to ethnography attuned to the situated quality of all knowledge and embodying a reflexive ethic of accountability.

3.3 Site and Methodological Approach

This chapter reflects on ethnographic insights gained through situated observation and interviews with community members and stakeholders on Oahu and the Big Island of Hawai‘i. The Hawaiian Islands are a vast archipelago of 132 islands, atolls, reefs, banks, shoals, and seamounts in the North Pacific Ocean first settled by seafaring Polynesians more than one thousand years ago (P. V. Kirch, 2011). Prior to the islands' colonization by the US, the eight major Hawaiian Islands (Hawai'i, Maui, Koho'olawe, Moloka'i, Lana'i, O'ahu, Kaua'i and Ni'ihau) functioned as independent states, and then as a unified monarchical Kingdom in the late 18th century. The Kingdom of Hawai‘i was illegally overthrown in 1893 by foreign businessmen and sugar planters backed by the US

military, leading to the dissolution of the monarchy, its annexation as a territory of the US and eventual statehood (Trask, 2000). The overthrow marks the outset of a long and lasting legacy of US settler colonization and militarization in the Hawaiian Islands. As prominent Kanaka Maoli scholar and activist Haunani-Kay Trask has described:

> When the United States military invaded our archipelago in 1893 and overthrew our constitutional monarchy, our fate as an outpost of the American empire was sealed. Entering the U.S. as a Territory in 1900, our country became a white planter outpost, providing missionary-descended sugar barons in the islands and imperialist Americans on the continent with a military watering hole in the Pacific. (2000, para. 2)

US settler military expropriations of Hawaiian lands and waters for the establishment of military infrastructure, plantation agriculture, and resorts undermine Indigenous relations to ʻāina (land, translated as "that which feeds us" in ʻŌlelo Hawaiʻi[39]) as a living ancestor rather than an extractable resource. As Kanaka Maoli scholar and educator Noelani Goodyear-Kaʻōpua has described, "'āina is not *something,* but *someone"* (N. Goodyear-Kaʻōpua, 2013).

As Chapter 1 described, settler militarization of Pacific Islands is mutually constituted with mythical spatial imaginaries of Pacific Islands as *isolated* and therefore amenable to myriad projects of scientific and military experimentation. In Hawaiʻi, the myth of island isolation has deep implications for the islands' treatment as a strategic military site and testing grounds, as an exotic tourist destination, and as a "living laboratory" for the study of human and nonhuman evolution and culture. In the realm of environmental sciences and conservation, Hawaiʻi's geographic remoteness has also

[39] ʻŌlelo Hawaiʻi is the Hawaiian language.

attracted global attention as both a biodiversity "hotspot"[40] and "the extinction capital."[41] A speaker at the International Union for Conservation of Nature (IUCN) World Conservation Congress in 2016 captured this attraction in comments lauding Hawai'i as "a microcosm for the practice and science of global biocultural conservation challenges" (DLNR, as cited in Gugganig, 2021). Efforts to study, conserve, and protect Hawai'i's biodiversity thus attract a variety of sectors and communities such as state and federal agencies, university-based researchers and scientists, community-based organizations, NGOs, as well as Kānaka Maoli with lived and ancestral relations to certain species including as 'aumākua (family or personal deities) (Walters, 2006).

The focus of this chapter is the conservation of endemic bird species that are threatened by mosquito-borne disease, namely avian malaria. In particular, the *Culex quinquefasciatus* mosquito (or southern house mosquito) vectors avian malaria to Hawai'i's honeycreepers, a group of endemic forest birds of which more than two-thirds have gone extinct (Pyle & Pyle, 2017). Hawaiian honeycreepers are revered for their impressive adaptive radiation (i.e., evolutionary development of features specific to their ecological niche), and recognized as contributing important ecological functions like seed dispersal and pollination (Lovette, Bermingham, & Ricklefs, 2002; USFWS, 2019). Honeycreepers and other native birds are also attributed significant cultural value given their traditional use for food, ceremony, and, most famously, spectacular feather work worn by Hawaiian ali'i (nobility) (Gomes, 2016; see also Figure 3.2). Gene drive is now

[40] The Hawaiian Islands are home to more than 10,000 endemic species (DLNR, 2010), and the Big Island is one of the most climatically climatic diversity diverse regions on the planet, with four of the five major climate groups present (i.e., humid tropical, arid and semi-arid, temperate, and ice or alpine climates) (Island of Hawaii Visitors Bureau, n.d.).

[41] An estimated 40% of endangered species recognized by the US Fish and Wildlife Service existing in Hawai'i (Perry, 2016).

being considered as a potential tool to suppress or eradicate populations of *Culex*, with developments of the gene drive–modified mosquitoes taking place locally on Oahu and the Big Island.

Figure 3.2: Above left: An illustration showing several Hawaiian honeycreepers. Laysan finch (center) and (clockwise from top) Hawai‘i ‘akepa, Maui parrotbill, po‘ouli, ‘i‘iwi, Maui creeper, and ‘akiapōlā‘au. Artwork by H. Douglas Pratt (Current Biology, 2011). Above right: A *Culex quinquefasciatus* mosquito on the eye of an ‘i‘iwi. Image by Chris Johns/National Geographic (Newbern, 2015). Below: ‘Ahu ‘ula (Hawaiian feather cloak) (The British Museum, n.d.)

Given the complex sociopolitical context surrounding genetic engineering and land use in Hawai‘i, those interested in exploring gene drive as a conservation tool recognize the challenging task of engagement that lies ahead. My project seeks to understand what types of engagement activities are emergent and underway in relation to proposals to use gene drive to conserve endangered Hawaiian birds, and the degree to which those practices might facilitate participatory involvement of local communities and Indigenous peoples. Though engagement practices related to gene drive were largely nascent at the time of my research, stakeholders were nevertheless anticipating, imagining, organizing, and in some cases conducting engagement activities in ways that make for rich ethnographic analysis.

In September 2018 I attended a series of focus group activities about mosquito control technologies (including gene drive) at a market research firm, and between March 2019 and May 2020, I conducted 18 semi structured in-depth interviews with individuals living on two islands where gene drives are being developed.[42] Interviews were evenly split across individuals with professional interests in gene drives (and other novel mosquito control technologies) for bird conservation, and Indigenous residents in areas where gene drive–modified mosquitoes are being developed and considered for release for conservation purposes.[43]

Interviewees working directly on conservation projects included employees of conservation NGOs, state agencies, federal agencies, and faculty and students at universities, namely: the US Fish and Wildlife Service (USFWS), the American Bird

[42] Interviews conducted after March 2020 (n= 5) were conducted via Zoom due to the COVID-19 pandemic.

[43] Interviewees were recruited through snowball or chain referral sampling (i.e., asking participants to identify additional participants).

Conservancy (ABC), the Coordinating Group on Alien Pest Species (CGAPS), the University of Hawai‘i at Mānoa, the University of Hawai‘i at Hilo, and the Mauna Kea Forest Restoration Project. These interviewees have academic training spanning conservation genetics, invasive species biology, Hawaiian Studies, and environmental sciences. Interviewees residing in regions where gene drive–modified mosquitoes are being considered for release (but do not work on projects with any relation to gene drive) included Kānaka Maoli educators, caretakers, community organizers, mothers, fathers, and kupuna (elders).

My ethnographic approach is informed by feminist technoscience, feminist standpoint, and Indigenous feminist theories. This methodological orientation (described more thoroughly in the introductory chapter) shapes the material ways in which I conducted this ethnographic research, as well as how I seek to represent it here. In short, I treat all knowledge as *situated,* meaning socially produced and embedded within particular cultures and worldviews (Åsberg & Lykke, 2010). With respect to engagement, this means I aim to understand how the very design and conduct of engagement activities embed particular values and worldviews, and how those may affect the degree to which a given activity will align to its participatory aspirations, namely "empowering" communities and stakeholders to voice their own diverse, situated knowledges.

With respect to my own ethnographic practice, this means embodying a reflexive approach that accounts for the situated conditions through which I arrive at the insights and conclusions represented in this chapter, and being intentional about how I represent those insights. In this way, I approached my interviews as an exercise of deep and active listening with a small sample of individuals with valuable insights, expertise, concerns,

and desires that I seek to explore here. This is intentionally *not* an exercise in extrapolating data into a generalizable or statistically significant representation, but rather a purposeful reflection on my embodied experience conducting ethnographic observation and interviewees around topics of science, indigeneity, engagement, and genetic engineering for bird conservation in Hawai‘i.

Following feminist standpoint theorists who see situated observation as a resource for critical analysis (P. H. Collins, 2000; Harding, 2004; Hartsock, 1998),[44] I narrate key moments and insights gained in ethnographic observation as I experienced them. These descriptions appear as vignettes woven throughout the chapter and written in the style of ethnographic writing known as *sudden anthropology* or *flash ethnography*, moments of ethnographic clarity or insight that emerge in a brief or instant moment from fieldwork.[45]

3.4 Flash Ethnography 1: Viewing Room

It’s 4:45 pm and I’m walking through the concrete jungle that is downtown Honolulu. I round a corner onto a main road, squinting at the map on my phone in hopes of orienting myself to my destination. *Harris*[46] *Research… Where is Harris Research?* One nondescript gray building after another towers over the palms and potted ferns that line the walkways. I’m looking for the marketing research firm where focus groups will

[44] Feminist standpoint theorists like Patricia Hill Collins, Sandra Harding, and Nancy Hartsock argue that women’s standpoints (i.e., embodied, situated knowledges and perspectives) are a valuable resource for studies of power (Harding, 2004). For more on standpoint theory see the introductory chapter.

[45] Anthropologists David Syring and Julian Offen (Syring & Offen, 2017b) note that “anthropological knowledge or ethnographic clarity sometimes requires a lengthy article or book to develop, but sometimes these things emerge in an instant insight” or rich vignette from fieldwork (p. 5). For examples of sudden anthropology and flash ethnography see works by Caroline Osella (Osella, n.d.), *Anthropology and Humanism’s* special issue on sudden anthropology (Syring & Offen, 2017a), and Nomi Stone and Carole McGranahan’s introduction to Flash Ethnography on the American Ethnologist website (Stone & McGranahan, 2020).

[46] Pseudonyms used

be conducted with Oahu residents to talk about mosquito control techniques, including one that involves genetic engineering. I was sent an email with detailed instructions about where to go (and how to conduct myself) once inside the building, but the directions for getting there were less developed.

> Please arrive at least 15 minutes before and enter the CLIENT VIEWING ROOM, not the focus group room itself (needless to say, refrain from chatting with others and discussing why you are there, and please don't wear your conservation logo gear). From the elevators, take two lefts and look for a door with a sign that reads "Focus Group in Progress." Knock and open the door slowly.

Finally, I come across the correct building. Once inside, I consult an attachment in the email for a rudimentary rendering of the office space. A rectangle labeled "CLIENT VIEWING ROOM" is highlighted and indicated with several arrows. I chart my path accordingly, arriving at the door with the Focus Group sign posted. As instructed, I knock twice and open the door slowly to a quiet, dimly lit room. Inside, I am greeted by folks from various conservation-focused agencies and NGOs. I'm making my rounds to introduce myself when I notice the large one-way mirror behind me. On the other side, people are filing into a small conference room with a large table in the center. Microphones hang from the ceiling, casting the sound of shuffling feet and small talk into the viewing room. Noticing my surprise, one of the conservationists chuckles. *Ah, your first time!* she says, grinning. *You're in for a treat! Clients of Harris Research are invited to observe the focus groups. We learn a lot from watching the conversations live, instead of just reading the report or transcripts afterwards.*

The viewing room looks like a small movie theater, with three rows of fold-up auditorium-style seats facing the mirror. Several people are already seated with notepads in hand. A participant on the other side of the glass appears to look directly at us. She

adjusts her hair. *They must know…* I begin, addressing no one in particular. *That we're in here?* my earlier interlocutor finishes my sentence, then reassures me. *Yes, she's going to tell them.*

It's 5:00 pm. A woman walks in and takes a seat at the head of the table, introducing herself as Linda Harris. She's there to facilitate the group. Several of the conservationists shift eagerly in their seats, their whispers falling into silence as they wait for the show to begin. I take a seat in the top row and settle in with my own notepad in hand. The excitement is palpable as Linda begins to speak. *Here we go!* someone in the viewing room whispers audibly for the group to hear. *Here we go,* I think to myself, taking note of the energy in the room. A double feature.

3.5 Finding the Movable Middle: Engagement as Strategic Communication

The focus group activity raises a number of questions I grapple with in this chapter: Why would conservationists use a marketing research firm to find out what local residents think about mosquito control technologies? What type of knowledge will be produced (and not produced) from this activity? What sorts of relationships does this activity shape? Foreclose?

I explored the impetus for this approach through an interview with one of its organizers, who described the focus groups as generating knowledge about public awareness and perception, then using that knowledge to inform the design of strategic communication plans targeting broader publics. Our conversation then led me to a deeper examination of a particular approach to engagement activities that she described as "strategic communication."

This interviewee works for a University of Hawai‘i research unit and holds a leadership position in a voluntary group of partners from non-governmental organizations (NGOs), state agencies, and federal agencies interested in invasive species management in Hawai‘i. In our conversation, she described a central aspect of her work as coordinating outreach and engagement related to invasive species and "crafting strategic communications plans" to do so. She explained that because her team has experience assessing public awareness and organizing strategic communication around invasive species issues, the Department of Land and Natural Resources (DLNR) and the US Fish and Wildlife Service (USFWS) solicited them to assist with engagement related to mosquito control tools, including (but not limited to) genetic engineering:

> This is one of those things that may not have risen to the top of my pile when I look at invasive species issues to work on. But it is clearly important for the agencies and the birds really do need this help. [We were brought on] as that knowledge base because we've been the only group that has worked on consistently assessing public awareness and figuring out how to do strategic communication around invasive species issues. And this is an invasive species issue. (E[employee]1, personal communication, March 27, 2019)[47]

For her, the motivation to conduct the focus groups is driven primarily by state and federal agencies' needs in relation to invasive species management, namely the need to identify publicly acceptable methods of mosquito control to protect endangered birds. As a result, the engagement of local residents in discussions of gene drive and other forms of mosquito control are incorporated into existing engagement practices, in this case strategic communication.

[47] Personal communications with interviewees are indicated according to three categories: (1) Employees (i.e., individuals working for or collaborating with state agencies, federal agencies, and nonprofits with some interest in gene drive mosquitoes), (2) Developers (i.e., University scientists and students contributing to the development of gene drive technologies in Hawai‘i), and (3) Kānaka Maoli residents (i.e., local Indigenous residents in regions where gene drive development is underway).

Strategic communication represents a communicative approach and a field of study with broad interpretations and heterogenous uses. In the inaugural issue of the *International Journal of Strategic Communication,* scholars seeking to characterize strategic communication as a unified academic field of study defined it as "the purposeful use of communication by an organization to fulfill its mission" (Hallahan, Holtzhausen, van Ruler, Verčič, & Sriramesh, 2007). Writing in 2007, Communication scholars Kirk Hallahan and colleagues described strategic communication as an emerging paradigm spanning the fields of management, marketing, and advertising, and gaining international acceptance and application in universities, human resources groups, non-profits, governmental health campaigns, diplomacy, military intervention, and public relations. In describing the diverse settings and actors that use strategic communication, they emphasized that "it is not only corporations, but also activist organizations and social and citizen movements, use strategic communication to reach their goals" (p. 4). In sum, the authors describe all organizations as engaging in communicative actions to gain the attention or support of particular constituents or broader publics, and strategic communication refers to the *intentional* and *purposeful* actions through which an organization presents and promotes itself, and through which that organization seeks to influence behavior (pp. 7-10).

The deliberate influence of behavior is a central aspect of strategic communication. In examples provided by Hallahan et al., elections campaigns, public health campaigns, fundraising, marketing, and the promotion of particular social causes all involve strategic communicative acts aimed at influencing behavior: gaining votes for a particular candidate, discouraging "risky" health behaviors, gaining support (monetary

or otherwise) for particular causes, or getting people to purchase products (pp. 7-9). In the realm of environmental conservation, strategic communication has been used to encourage behavioral compliance to practices that prevent the spread of invasive species (Dalrymple, Shaw, & Brossard, 2013). Hallahan et al. describe these acts as fundamentally *persuasive,* noting that "persuasion is the essence of strategic communication" (p. 24).

Terms like *persuasion* and *strategic* can carry negative connotations of manipulation or signify military activity. Indeed, the word *strategy* derives from *stratēgia,* the Greek word for "generalship" (i.e., military general) (Merriam-Webster.com Dictionary, 2021), and early uses of *strategic* in organization theory emphasize strategic planning as "controlling the environment and maintaining the organization's autonomy" (Hallahan et al., p. 12). Acknowledging the etymological origins and early uses of the term, Hallahan et al. observe that "the mere mention of the term *strategic* thus evokes a one-sided approach to organizational management that is based in asymmetrical or top-down communication" (p. 11). However, they challenge the association of strategic communication with manipulative or asymmetrical communication, arguing instead that such views are reductive and foreclose consideration of the emergent or alternative practices through which a variety of actors use strategic communicative acts to advance their goals.

Considering the many ways in which strategic communication can be construed and practiced, my goal is not to offer any broad or sweeping conclusions about strategic communication as a discipline or approach to organizational activities. Rather, I am interested in exploring what it means to orient to public outreach and engagement as a

strategic or *persuasive* endeavor in the context of genetic engineering technologies, and to identify the underlying epistemic and value norms present in the types of practices being taken up within this approach and context. As my colleagues and I found in our analysis of published accounts of engagement in relation to novel vector control, engagement is quite commonly treated as an activity meant to *influence* communities, publics, or particular stakeholders who hold some level of decision-making power, or from whom approval of a technology might be warranted (Schairer et al., 2019).[48] Though this approach is commonly practiced by governmental agencies, non-profit organizations and for-profit companies carrying out engagement for a variety of purposes, it marks a misalignment from the more empowering forms of engagement called for in the literature on novel vector control and especially gene drives. As we note in our co-authored article detailing the findings from our analysis,

> In theory, engagement is an opportunity for future users to influence technological development and for developers to better understand the public's interests and make more ethical design choices. In practice, engagement is motivated by strategic needs for information about field testing sites or potential markets, political credibility, or compliance. (p. 3)

As such, closer examination of persuasive and strategic approaches to engagement is valuable to identify and improve upon gaps between the theories of inclusive engagement and their translation to practice.

Looking to my own ethnographic data, the concept and practice of persuasion resonates with my interviewees' descriptions of the focus group activities. They serve as important knowledge-generating activities to inform broader strategic plans aimed at

[48] This study used qualitative analysis of published documents featuring 28 distinct activities across 14 engagement projects related to novel vector control. We identified three categories that capture the types of engagement taken up in novel vector control: engagement to *inquire*, engagement to *influence*, and engagement to *involve* (Schairer et al., 2019).

persuasive ends, such as cultivating public acceptance of certain technologies to suppress mosquito populations. One interviewee communicated this when she framed key takeaways from the focus groups: “The summary of our focus group work is there's a lot of need for storytelling. People aren’t aware of the birds and they've got Jurassic park as their basis for understanding genetics” (E1, personal communication, March 27, 2019). She explained that, from previous research, they have found storytelling to be an effective strategy to get people on board with invasive species issues, but they anticipated this to be even more challenging with the contentious topic of genetic engineering entering the conversation:

> People are coming from a lot of different places. People are definitely 100% not aware of what [genetic modification] means. There's all of these buzz words and just GMO [genetically modified organisms] and anti-GMO. People get on these bandwagons and as we know with human nature, it is really difficult to bring in new information. We see it with everything, right? We see it with vaccinations. We see it with political views. It just gets proven again and again and again. And so part of that is hopefully getting out a little bit in advance, having the right people go in through the storytelling, or this other door where the guards aren't necessarily up. (E1, personal communication, March 27, 2019)

Her comments suggest a deficit model view associating a lack of understanding of genetics with “anti-GMO” stances, but recognizes that the presentation of additional information does not necessarily facilitate acceptance, suggesting instead that storytelling is a powerful vehicle of persuasion. She noted the power of storytelling another time in our conversation, commenting that,

> [Mosquito borne avian disease] is something that people are not aware of. We know that storytelling works really well and in order to protect something you have to really know it and already love it. You have to be engaged with it. So instead of going in and doing our focus group work on just simply asking, “how do you feel about gene drive?” If we were to ask questions in that way, we know the response we would get. But we also know that if we build up a little bit of story, if we tell them why and start

> building those natural links then they would be more willing to accept it. (E1, personal communication, March 27, 2019)

Again, opposition is anticipated and even pre-empted through strategic communication within the focus group activities.

Her comments also convey a tactical approach that seeks to identify and engage with segments of the community less likely to express opposition, or most amenable to influence. She invoked marketing terminology, explaining that there is a *movable middle,*[49] people who may not have particularly strong feelings toward or against a given intervention, and may therefore be more open to persuasion:

> There's people that are resistant, there's people we consider the movable middle and then there's people that are already doing the work. It would be really difficult to go and work with activists because they're not the movable middle. You start through the people that are already somewhat open, and definitely get the people that are open and they can help you. Then you go to the movable middle and you start with laying that groundwork. (E1, personal communication, March 27, 2019)

In this view, engagement is best conducted as an activity reserved for target audiences based on their likelihood to be supportive (or become supportive) of a particular intervention.

The anticipation of opposition to genetic engineering was another theme to emerge from my interviews with conservationists. Some characterized anticipated opposition as based in fear driven by media, consumption of misinformation, or general lack of education around genetics. One conservationist lamented the influence of films like Jurassic Park on public perception of genetic engineering:

[49] A definition from the Mobile Marketing Association describes the *movable middle* as consumers "who are neither very likely nor very unlikely to buy" a given product, adding that research finds these consumers "five times more responsive to a brand's advertising" (WARC, 2021).

> Every time we have this discussion [about gene drives] Jurassic Park gets mentioned. As much as that movie was a fun movie, it has not done wonders for conservation or gene drives. […] While there is a lot of uncertainty with gene drives, a lot of the concerns are the worst movie sci-fi fantasy sort of elaborations that are not even biologically realistic, like they can't happen. (E3, personal communication, March 19, 2019)

An employee working for the State of Hawai‘i Natural Area Reserve System expressed concerns about the impact of misinformation on perceptions about mosquito control techniques. He recalled reading an article that confused *Wolbachia* (a mosquito control technique that does not use genetic engineering) with gene drives, noting that "so far there hasn't been another article that's come out to refute that. False information is already being circulated. That's a major concern that I have" (E2, personal communication, April 7, 2020). He was also one of a few interviewees to characterize public skepticism to gene drives or other genetic engineering techniques as "valid," citing controversies on Kaua‘i where agricultural biotechnology companies have conducted experimental field trials with genetically engineered crops[50] (E2, personal communication, April 7, 2020).

One invasive species biologist who works for the USFWS spoke of engagement as a necessary task for decision-making about conservation interventions but also expressed frustration that communities sometimes raise opposition late in the decision-making process:

> This one probably gets me in trouble, but the community has to also take a little bit of responsibility on themselves […] I'm a government official. I work on endangered species conservation. That is something that society

[50] Hawai‘i is major site of experimentation for genetically engineered crops, with some 90% of the United States' industrial GMO corn originating there (Pala, 2015). Kaua‘i has been described by local activists and media as "Ground Zero" for GMO testing, and for grassroots activism responding to the biotech/seed industry's indiscriminate pesticide use and occupation of Hawaiian lands (Brower, 2016).

> has deemed important. We value our biodiversity and our species, and we want the environment to be healthy. […] We've had working groups and meetings. There's publications. It's out there that [endangered native birds] has been a problem and there's people working on it for some time. Then you get to the point where there's the ability to move forward and do something. There's a process of starting to let people know, "Hey, we're going to do this intervention," then you get people in the community that will be like, "why wasn't I part of this decision?" when the decision is now. Society entrusted these kinds of experts to come up with a solution. […] They're kind of mad that they're entering the conversation now, but that opportunity was always there. They could have engaged, it is just that birds wasn't their thing. (E5, personal communication, March 28, 2019)

His comments express frustration both at public unawareness about conservation issues like mosquito borne avian disease, and perceived lack of deference to experts who work on these issues. There is also an underlying presumption that information (about conservation issues and about the proposed interventions) is available to communities, and that they ought to be responsible for engaging with it. His subsequent comments resonate with framings of communities as potential barriers to progress:

> I think that's what can be frustrating is too, you get people that spent their whole life trying to solve this problem. And then right when you're getting really close, then all of a sudden people come in [with opposition]. You cannot be a roadblock when people come with solutions. I think that's the problem because then a lot of things don't move forward, and they don't happen. (E5, personal communication, March 28, 2019)

This interviewee recounted experiences working to remove rats or the introduced coqui frog when members of the public suddenly "become experts" by suggesting alternative solutions that are not feasible or discount the expertise of government officials who have been working on invasive species management for years. At this point he acknowledged cultural differences as a potential counterpoint to his own views: "On the other side of it, I think a lot of these things haven't taken in consideration either cultural considerations or

that there are different ways of doing things. There can potentially be a middle ground or way of doing things" (E5, personal communication, March 28, 2019).

Though interviewees differed on whether public opposition is "valid," it is evident that *anticipated* opposition plays a powerful role in governmental communication and decision-making in relation to mosquito control. One conservationist reflected on the need to "be really careful with communications so there isn't public mistrust in the technology and how it's going to be used" (E4, personal communication, April 6, 2020), and another commented that governmental agencies minimize the sharing of information about mosquito control technologies for fear that they may prompt public opposition:

> Unfortunately, I don't think there's a whole lot going on to try and raise awareness about [mosquito control technologies]. That's one of the bigger problems. Part of it is because people in conservation who are aware of these things are trying to tread on thin ice. Because there has been a lot of negativity associated with genetic modification in Hawai'i in the past. So that's why people are being cautious about how to approach this. State and other agencies that have come down on how they want to engage the public, get people to learn about this, they've kept a lid on it until they can come up with a unified approach. (E2, personal communication, April 7, 2020)

This interviewee was sympathetic to this approach, adding that while it is important to disseminate information to communities, a risk of doing so is the spread of misinformation. He noted that, "[agencies] still should be putting out some information. The level of information to the community is lacking but it's hard to figure out that balance of getting information out without spurring fear or misinformation campaigns from people who may oppose it" (E2, personal communication, April 7, 2020).

The conservationist who helped organize the focus groups also commented on the importance of clarifying to the public that the agencies are not currently pursuing gene drives, explaining that, "every time somebody brings it up and says, "you guys are

working on gene drive," our response that we've all agreed on is that "no, actually we're not, but it's a tool in the toolbox and we should be open to considering it'" (E1, personal communication, March 27, 2019). Her comments point to the strategic use of communication to pre-empt public opposition to gene drives. A scientist who works for one of the University of Hawai‘i (UH) campuses observed this as a trend she has encountered through suggestions to adopt more "palatable" terms to communicate about gene drives:

> We have experienced suggestions in workshops, where people are like, "well how about, you know, couching the language?" As in, "should we use a different word than gene drive?" We've seen this. If you look at some of the mosquito control techniques – I don't want to name specific ones– but changes in names of what the specific modification is to make it a little more palatable. We have point blank always refused to do that. (D[developer]1, personal communication, March 20, 2019)

She affirmed her own stance, which prioritizes transparent communication:

> We're calling this a gene drive because it's a gene drive. We're not going to call it something else, even if it sounds a little more pretty. That was the most basic agreement for us, with any kind of community engagement. That we would be very open blunt and that we won't try to couch language. We try to avoid jargon as much as possible and talk big picture, but not to hide what we were doing in different terms. (D1, personal communication, March 20, 2019)

Another UH scientist framed the hesitation to associate with gene drive or other genetic engineering technologies, observing from meetings with state and federal agencies that, "they're very averse to talking to the public about any kind of genetic modifications, including gene drive with mosquitoes. There's a common perception that there would be a big public backlash and it would slow things down and create a lot of problems, block you" (D2, personal communication, October 4, 2019).

He added that the agencies are just as cautious with how they represent the strategies they *are* currently pursuing, namely the *Wolbachia* Incompatible Insect Technique (IIT) which does not involve genetic engineering but works by releasing lab-reared mosquitoes carrying the *Wolbachia* bacteria that, when released, cannot produce viable offspring with wild females (Redford et al., 2019). He shared that the agencies pay close attention the language used to describe the *Wolbachia* method: "So they termed it. What was it called? 'Mosquito birth control.' They said 'don't mention bacteria. Don't mention these other things.' And they think that would be a lot more acceptable" (D2, personal communication, October 4, 2019; see also Figure 3.3). As the mindful branding of the technology suggests, the agencies have a stake in managing public perception around *Wolbachia.* This reflects both a sense of urgency around implementing a new mosquito control technique in the short-term, and a longer-term goal to garner public support for mosquito control by other, more effective techniques.

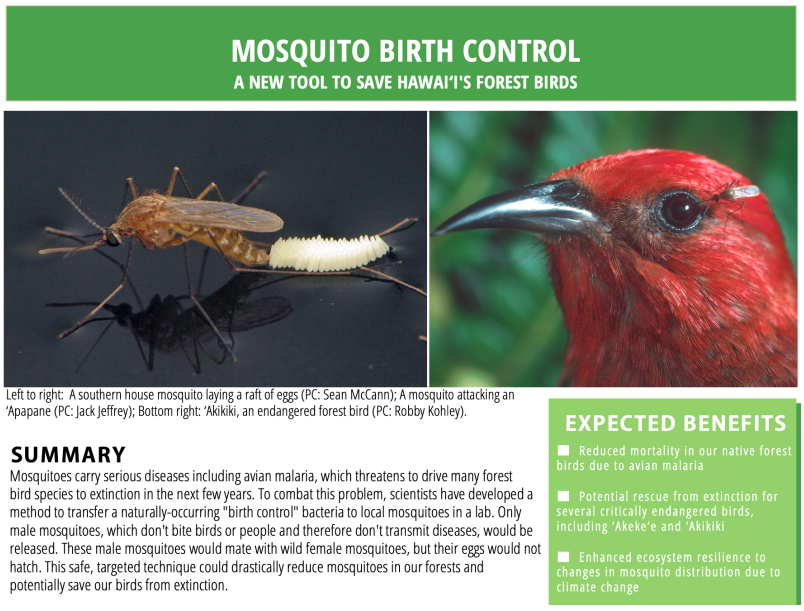


Figure 3.3: Part of a fact sheet on the *Wolbachia* IIT mosquito control method by the Department of Land and Natural Resources (DLNR, 2020).

As a conservationist from the American Bird Conservancy explained, one reason for the interest in *Wolbachia* is that it is an established technique in use in several countries including the US:

> The interest had been on *Wolbachia* because it is a known and proven technique for reducing mosquito populations for human health, in places such as Australia, the United States, Singapore, several places in the Caribbean. It's been used worldwide safely. So, we can use that, we hope relatively soon. (E3, personal communication, March 19, 2019)

In this sense, *Wolbachia* represents a more feasible approach than gene drives which require several more years of technical and regulatory development before they can be considered for implementation. If there was any consensus across all state, federal, NGO, and university-employed conservationists and scientists I interviewed, it was that the need to take action to prevent extinctions of the most vulnerable forest birds is extremely urgent. Existing strategies are regarded as costly, ineffective, and labor-intensive, such as the use of non-specific pesticides and the removal of feral pigs that dig cavities that catch water and become productive larval mosquito habitats (Liao, Atkinson, LaPointe, & Samuel, 2017). As such, interviewees described *Wolbachia* as a potentially important improvement on existing methods, with one conservationist estimating that it could help prevent as many as 17 species of birds from extinction in Hawai‘i (E3, personal communication, March 19, 2019).

Others agreed while also acknowledging its long-term limitations. As one interviewee noted, "*Wolbachia* is the thing for now, because we have to do something now. But it is intensive where you have to continue to release and release and release. […] We're going to need something more sustainable" (E1, personal communication, March 27, 2019). She and one other interviewee pointed out that the cost of continuously

rearing and releasing *Wolbachia*-infected mosquitoes is not sustainable, drawing comparison to the relatively low cost of gene drive techniques:

> It would take massive releases. So you need rearing facilities and you would need to release several times more mosquitoes to suppress the population than you would with the gene drive techniques. If funding runs out or interest shifts, you stop making the releases and the mosquitoes will be back. (D2, personal communication, October 4, 2019)

With general agreement that gene drives offer a more effective strategy at a lower cost and burden of labor, some interviewees saw *Wolbachia* as a good short-term option until other strategies become available. As one conservationist shared, "if we can suppress mosquito populations in the habitat of ʻakikiki and ʻakekeʻe we can buy time until gene drive comes online or, captive rearing[51] becomes more successful" (E4, personal communication, April 6, 2020).

Some felt that *Wolbachia* may also present a direct opportunity to cultivate public acceptance of (potentially more controversial) technologies that may work more effectively to suppress mosquitoes. As my first interviewee noted, the urgency of adopting new strategies for mosquito control is met with an urgency to start building public acceptance toward new mosquito control techniques:

> If we don't start working on this, we'll have a really hard time when there's other tools available that are more sensible than *Wolbachia*. Ultimately *Wolbachia* gets people engaged, gets the research going, gets the discussions going, and helps make people feel more comfortable about discussing these topics and makes it a priority. (E1, personal communication, March 27, 2019)

[51] Captive rearing or captive breeding refers to a conservation strategy wherein wild species are captured, then raised and bred in facilities in an effort to prevent extinctions. As a challenging and resource-intensive technique, captive breeding is typically considered a stopgap measure (Paxton, Laut, Vetter, & Kendall, 2018).

These comments presume that *Wolbachia* will indeed be more widely accepted by the public, a view with which some interviewees disagreed. As one scientist noted, "[*Wolbachia*] has the perception among a lot of the agencies here that it's more acceptable to the public, than genetic modification. I'm not sure that's completely true. But you know, the perception of perception also matters" (D2, personal communication, October 4, 2019). Indeed, the "perception of perception" appears to play an important role in the strategic ways certain stakeholders communicate about and engage the public on mosquito control in and beyond Hawai'i.

Some scholars studying public outreach and engagement in relation to emerging biotechnologies have observed the degree to which "fear of public fear" can foreclose meaningful or more participatory public engagement (Barnhill-Dilling, 2018; Marris, 2015). As Forestry and Environmental Resources scholar and engagement practitioner Katie Barnhill-Dilling has argued, "scientists imagine and construct audiences as phobic about their technology, and the scientists' engagement efforts are rooted in a fear of public phobia" (Barnhill-Dilling, 2018). Studying public engagement around forest biotechnology, she describes this phenomenon as "forest biotechnology phobia-phobia"[52] and observes that deficit model communication is often a product of scientists' phobias (p. 37). Based on my own ethnographic data, those stakeholders orienting to engagement as a strategic activity similarly construct a fearful public that can be influenced with the right branding. In the next section, I take a closer look at the tendency for mosquito control outreach and engagement to be incorporated into marketing research and strategy

[52] Barnhill-Dilling adapts Emma Marris' concept of synbiophobia-phobia (i.e., imaginaries of publics as a threat to synthetic biology) to derive her concept of forest biotechnology phobia-phobia (Marris, 2015).

(at my site and more broadly) and consider the particular relationships this structures among stakeholders and publics.

3.6 Flash Ethnography 2: Save Our Birds!

The first focus group is underway. In the viewing room, observers are equipped with a detailed chart featuring the demographics of each participant: name, age, number of children, ethnicity, occupation, income, gender. They scribble notes onto a template indicating who is who around the table.

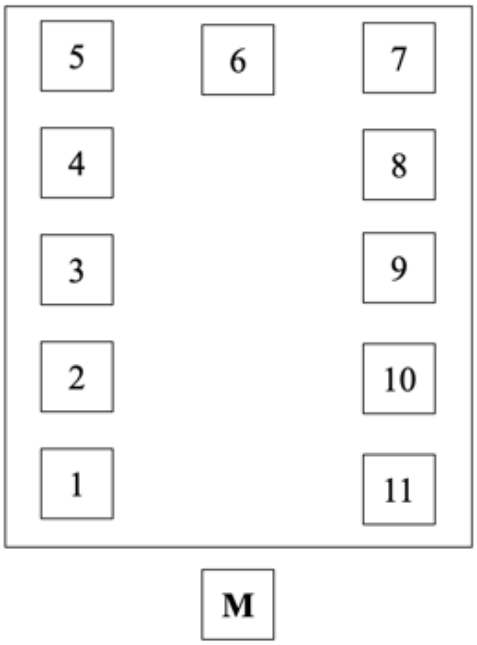


Figure 3.4: Focus group seating chart provided to observers (image by the author, based on the original).

Linda asks some questions from her script: *What comes to mind when I say native species? Can you name any native birds? What comes to mind when you hear invasive species? What are some invasive species?* The viewing room fills with quiet cheers when participants accurately distinguish between native and invasive species, or express their

disdain for mosquitoes. Linda introduces four potential techniques to manage mosquitoes that vector avian malaria to Hawaiian forest birds: "a birth control technique," and three kinds of "genetic modification" techniques. The session closes with "message testing." Linda reads some mock commercial scripts about avian disease to the participants. *Which slogan do you prefer?: Save our Birds! or Mosquito-Free Forests!*

3.7 Marketing Mosquito Control

It is common to see marketing techniques mobilized for environmental conservation efforts. There is no shortage of examples of media campaigns targeting individual level behaviors in the name of sustainability, for instance adopting more energy-efficient practices or discontinuing personal use of plastics. Some scholars have critiqued the use of marketing to promote conservation, pointing out that the overall purpose of marketing – to get consumers to purchase a product – seems incompatible with environmental conservation, a goal or practice threatened in many ways by consumerism. As Psychology scholar P. Wesley Schultz notes,

> […] most marketing activities are designed to attract and retain an audience with the goal of selling a product. Achieving conservation objectives, by contrast, often involves a level of cost or sacrifice to the individual, such as reducing consumption or abstaining from a previous behavior. Indeed, consumerism is often cited as one of the chief causes of many environmental problems, and it seems unlikely that conservation and sustainability can be achieved by buying certain products. (Schultz, 2011)

However, in the realm of mosquito control, it may very well be the case that marketable products are framed as facilitating conservation goals, the product being the laboratory-reared mosquito itself. Indeed, *Wolbachia*-infected and genetically engineered mosquitoes are treated discursively and materially as *products*. This is evident in the

processes through which they are regulated in the US, as well as the adoption of marketing and branding techniques to promote their uptake by consumers, both of which embed neoliberal[53] values of global market innovation and competitiveness.

There is longstanding debate over whether GMOs ought to be regulated through *product-based* or *process-based* approaches, a distinction any jurisdiction hoping to regulate GMOs must contend with. Law scholars Marchant and Stevens note that "a product-based approach bases regulatory requirements on the characteristics of the final product, regardless of the process by which it was made," whereas a process-based approach bases regulation on the *process* used to make the product (Marchant & Stevens, 2015). For instance, the European Union has adopted a process-based approach that some have argued imposes unnecessarily strict regulations on GMO foods despite evidence that the process through which they are made is no less risky than conventionally produced foods (Breyer et al., 2009). The US endorses a product-based approach (though some note the US applies a *de facto* process-based approach through the subjection of GM foods to additional regulations) (Marchant & Stevens, 2015). Some propose that regulation of gene drives be based on *function* (Oye et al., 2014), which NASEM describes as a "product-based approach that embraces case-by-base risk assessment of gene drive technologies" (2016, p. 152).

In addition to the insistence on product-based approaches to the regulation of genetically engineered organisms in the US, the classification of current mosquito control technologies further demonstrates their discursive figuring as *products.* For instance,

[53] Scholar David Harvey describes neoliberalism as a hegemonic political economic theory that favors free market competition, private property rights, and reduction of government intervention in economy and individual freedom of choice (Harvey, 2005).

Wolbachia-infected mosquitoes and the biotechnology company Oxitec's genetically engineered OX513A mosquitoes are regulated by the Environmental Protection Agency (EPA) on the grounds that they are pesticide products.[54] Many developers of gene drive also adopt a process known as "Target Product Profile," derived from the context of pharmaceutical development and meant to aid in the development of predefined standards to determine what constitutes safe and effective "candidate products" (NASEM, 2016, p. 89).

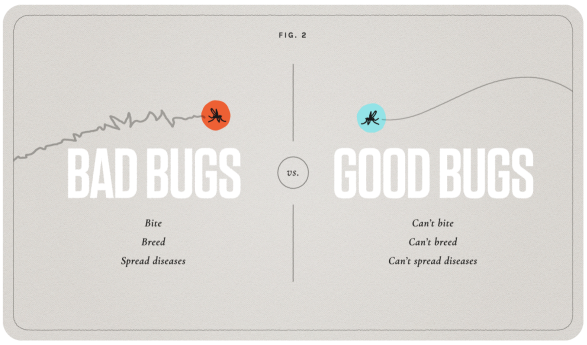
Mosquito technologies are also treated as products of biotechnological innovation that carry economic value, demonstrative of the deeper neoliberal logics characteristic of the biotechnology industry. Philosophy scholar Zahra Meghani and Public and International Affairs scholar Jennifer Kuzma have argued that US regulatory systems also reflect neoliberalization with regard to biotechnology. They observe that the Food and Drug Administration (FDA), the agency that will likely have regulatory authority over gene drives, has been particularly influenced by neoliberal reforms prioritizing innovation and trade competitiveness at the expense of attention to human and environmental health (Meghani & Kuzma, 2017). They argue that the push for innovation and market entry favors the development of genetically engineered mosquitoes (regardless of whether their sponsors are for-profit or non-profit entities) and argue the FDA's current risk assessment framework lacks the rigor that will be necessary for emerging gene drive technologies (p. S207).

[54] Initially it was thought that the OX513A mosquitoes might be subject to oversight by the Food and Drug Administration (FDA) as an "animal drug" because they contain recombinant DNA (i.e., DNA formed artificially with genetic material from a variety of sources and then inserted into a target organism) (Khan et al., 2016; Meghani & Kuzma, 2017). Ultimately the FDA ceded authority to the EPA, recognizing the mosquitoes as having a pesticide function.

The market orientation to the development of mosquito control technologies is evident looking to existing biotechnology companies like the UK-based Oxitec and US-based Verily and MosquitoMate, and the ways they develop brand images to appeal to consumers. A challenge for their particular products (mosquitoes) is the frequency with which typical media framings of mosquitoes draw on militarized and xenophobic rhetoric commonly mobilized in invasive species narratives (Subramaniam, 2001).[55] Headlines call for *war* on mosquitoes (Boston Herald, 2019; Green, 2017), and represent them as *aliens* and *invaders* "arriving in droves" to vector disease (Conaughton, 2015; Littlejohn, 2019). The biotechnology companies rearing lab-made mosquitoes make clear the negative impact of wild mosquitoes that vector diseases to humans.[56] But they also employ much friendlier framings of mosquitoes considering that the product used to control wild populations of mosquitoes is, in fact, more mosquitoes. Oxitec's OX513A and OX5034 mosquitoes are branded (and trademarked) as "Friendly™" mosquitoes; Verily's Debug marketing distinguishes the "bad" (wild) mosquitoes from the "good" (*Wolbachia*-carrying) mosquitoes, MosquitoMate describes their "ZAP" mosquitoes as "environmentally friendly and innovative" (Debug, n.d.; MosquitoMate, n.d.; Oxitec, n.d.; see also Figure 3.5).

[55] In "The Aliens Have Landed! Reflections on the Rhetoric of Biological Invasions," Banu Subramaniam analyzes parallels in the rhetoric surrounding human immigration and invasive species, demonstrating how xenophobic rhetoric is extended to plant and animal species (2001, p. 29).

[56] Oxitec, MosquitoMate, and Verily target two species of mosquitoes in the genus *Aedes* (i.e., *Aedes aegypti* and *Aedes albopictus*) that vector diseases like dengue, Zika, chikungunya, Eastern Equine Encephalitis, among others.



MOSQUITO mate®

Environmentally Friendly
Innovative Mosquito Control

Figure 3.5: Left: An image from the home page of Verily's Debug website (Debug, n.d.). Right: MosquitoMate's Logo (MosquitoMate, n.d.).

Most of these programs require trained staff to release the mosquitoes, or to interface with residents to install and monitor data-gathering equipment to survey the technology over time. However, Oxitec is now making it possible for residents to release the mosquitoes themselves. Their new "just-add-water" technology ships cardboard boxes pre-filled with Friendly™ eggs that will develop with a small quantity of water (Oxitec, 2020; see also Figure 3.6). In either case, the successful deployment of mosquito technologies requires buy-in from local residents–social acceptance of the technology, willingness to communicate with staff or let them into their home, or in some cases the actual purchase of products– further motivating their branding as "safe" and "friendly."

Figure 3.6: Oxitec's just-add-water technology, via the Florida Keys Mosquito Control District (FKMCD) Website. Oxitec is currently partnering with FKMCD to pursue releases of their Friendly™ mosquitoes throughout the Florida Keys (Florida Keys Mosquito Control District, n.d.).

In sum, the orientation to mosquito control technologies as marketable products is demonstrative of the broader neoliberal logics and mechanisms that guide their development, regulation, and use. The available (and in some cases dominant) frameworks for imagining and relating to these technologies embed market values and techniques. Perhaps it is less surprising then, that public outreach and engagement can also be oriented to through the strategies and values of marketing.

In my ethnographic observation of the focus groups, engagement was treated primarily as an exercise in gathering knowledge for the sake of informing and influencing. When framed and pursued as a marketing activity, the focus groups interpellated organizers in the subject position of *client,* and participants in the subject position of *consumer* of the products (technologies). In my analysis, fixing members of a given community or public to the role of *consumer* effectively forecloses opportunities

for *mutual* sharing of expertise, ethical concerns, or value-based considerations. Instead, engagement is approached as a scripted and circumscribed activity aimed primarily at informing strategic plans to influence potential decision-making stakeholders.

The built space of the engagement activities also reinforced and made visible the divisions between expert stakeholders and the "lay" public or community. The setting of the focus groups I observed has been described in focus group literature as a "white room," a "well-demarcated, closed space, designed to facilitate the interaction of research subjects and their observation by researchers, while isolating all of them from external influences" (Lezaun, 2007). Efforts to protect the controlled, isolated quality of the focus groups were affirmed in multiple ways: the directive for observers to avoid contact with participants, the moderator's use of a premade script and standardized approach to facilitation, and perhaps most notably, the presence of a one-way mirror separating viewers from those being viewed. The mediation of the activity through the mirror upholds conventional boundaries between experts and the "lay" public by structuring particular forms of looking: the experts are those *doing* the looking whereas the participants are the ones observed and analyzed. While this arrangement may serve an epistemological function within focus group and marketing methodology, it is in tension with visions of engagement as a way to facilitate and sustain relationships and dialogue across communities and stakeholders.

The maintenance of conventional boundaries not only fall short of the aspirational goals of engagement as prescribed in the literature on gene drive, they are also misaligned with the stated desires and lived experiences of some scientists and conservationists I interviewed. For instance, two UH scientists shared their disinterest in

activities that seek to influence or pressure communities into authorization of a gene drive. As one noted:

> This is Hawai‘i, if the people that live in Hawai‘i decide, “no, we don't want this technology,” that’s it. That’s their decision. You can appeal with democracy and those things, but just respecting people as people, they’re adults, they can make decisions. We need to be a part of that. We can't just say, “we know what's best and we're going to do it right.” […] I do believe the technology has a tremendous of potential. I wouldn’t have tried working on this so many years if I didn't, but I'm also a little worried about overselling. (D2, personal communication, October 4, 2019)

The other UH scientist affirmed an interest in the autonomy of local residents and communities over strategic efforts aimed at influencing publics, “hopefully we’ll engage people into making that choice about whether they want to use this gene drive system or another gene drive system or no gene drive system” (D1, personal communication, March 20, 2019).

Several interviewees also challenged conventional boundaries between experts (e.g., those situated in particular institutions) and communities or the public. This was expressed both explicitly as desires for engagement practices that open up boundaried spaces like laboratories and universities, and implicitly through the sharing of experiences and everyday practices that reveal the porousness of these categories. One UH scientist recounted an experience at a public seminar that both questions definitions of *community* and acknowledges the boundaries maintained by institutions like universities:

> I had a woman get quite angry at me at a conference one time. It was the Hawai‘i Conservation Conference and there was a talk story session about these types of types of new technologies. She was angry about the type of research that we were doing. She felt we were forcing onto the community, which we were not doing at all, of course. And what I had to remind her of was I live here, so I'm also part of the community here. I’ve got my family here, got friends here, I work here, my house is here. And

> so, this separation of an institution versus the community is something that I would like to see broken down a little bit better –that wall between the two. (D1, personal communication, March 20, 2019)

This reflection raises an important consideration about researcher positionality and relationship to risks and benefits of a given technology. Hawai‘i is a unique context for gene drive development given that scientists on the islands are considering applying these technologies in the regions where they reside. It is more common to see gene drives developed in laboratories situated in economically wealthier nations, with plans for trial and eventual deployment on remote islands or in economically poorer regions. Of course, concepts like risk and benefit are culturally contingent, so while it may be argued that scientists living in a region where they propose to deploy a gene drive "share" its attendant risks and benefits, it is important to recognize that what may constitute harm can look different to members of the same geographic region. Nevertheless, the locality of researchers developing technologies like gene drives stands in stark contrast to dominant spatial patterns of development and deployment.

Some interviewees also recognized the university classroom as a sort of "community" space, in that their students are locals who live in Hawai‘i, and some are Indigenous to Hawai‘i. They described prompting discussion about the interconnected scientific and ethical issues related to gene drive in the classroom as an important way to establish transparent communication about their work. One interviewee considered whether the university or even the laboratory could become a site that is more open to community members:

> I would love to bring members of the community in [to the lab] that are not necessarily our students. We're not sure how to do that yet, because you can only fit so many people in the lab at one time, but I think that will be really neat. I would like to be able to make the community feel like it's

> more theirs. As they get more informed about the types of research that we're doing, and others are doing, and technologies that are available, we can bring their specific concerns into the research. We can't do that without the communication. (D1, personal communication, March 20, 2019)

These comments rethink the boundaried quality of the university as well as the laboratory, reimagining them as open spaces of collaboration and co-development.

While the demarcated space of the focus groups replicated conventional boundaries, some conservationists' reflections on their everyday professional practices indicate that such isolation is not characteristic of their work. In fact, for conservationists who work on a variety of islands throughout the archipelago, their work regularly brings them into collaboration with local residents and Indigenous communities, experiences they recounted as valuable learning opportunities.

For instance, a few conservationists explained that their conservation work often involves Hawaiian cultural protocol. The conservationist with the American Bird Conservancy explained that several projects have connected him with Native Hawaiian cultural practitioners and conservationists on the Big Island, Maui, Kaua'i, and Papahānaumokuākea Marine National Monument, sharing that the work is often very grounded in Hawaiian cultural practice, particularly at Papahānaumokuākea. He noted that "Native Hawaiian stewardship of the islands is critical. So everything we do out there is integrated pretty closely with that" and shared that:

> We go out to Nihoa which is incredible, magical, spiritual spot. There is a cultural representative there. You do a welcoming and departing oli [chant]. You think about what you're doing. Though I'm there for the bird work and also some plant work – basically biological work – there's usually people there doing archaeology, doing opihi [a type of limpet] work, doing other things that they are leading with the cultural framework. So we have those conversations at night on the boat, and see the context and understanding of what their motivations are. I've had lots of those

> conversations. When it takes a day and a half or three to four days on a boat, you have a lot to talk about. (E3, personal communication, March 19, 2019)

Another conservationist reflected on his experiences observing cultural protocol, admitting that it took him some time to appreciate its significance. He shared a memory from doing conservation work in a forest reserve on the Big Island, when someone gave some insight into the purpose of the opening oli:

> They did a chant in the beginning. But it was the first time that the person explained why. [They said] "you know, we're all new and we're coming into a really powerful area. There's a lot of energy and you're coming in here with energy. So we take a step back and slow down." It gave me goosebumps and really connected. Before, I wasn't seeing the real intention, understanding the purpose of the protocol and how it can like ground you. I totally see its value and it's more meaningful for me now, whereas before it was just a process. (E5, personal communication, March 28, 2019)

Both interviewees reflected on the *slow* temporality of experiences that raised their awareness and appreciation of cultural protocol, and helped ground them in *place*: taking time for an oli before engaging in conservation tasks, traveling by boat to the Northwestern Hawaiian Islands.

Engagement practitioner and scholar Tina Cook has commented on the value of the slow pace of participatory engagement practices, arguing that in order for collaborative involvement to take place among partners, the research process must allow for a significant amount of time and energy to "just talking" (Cook, 2012). She notes that talk is invaluable to the establishment of open dialogue, negotiation and co-development of shared meanings within the project, and practitioner reflexivity that questions "expert" understandings. In this way, talk can be understood as an invaluable precursor to more engaged action, and a practice through which agency can be more equitably shared.

Cook also reflects on the incommensurate temporality of grant cycles and academic pressures with participatory community-engaged practices (2012, "Organisational space," para. 4). Similarly, one scientist reflected on the challenge of conducting engagement in institutional settings that do not provide the time or resources to do so. She shared that she felt her lab could be doing much more to engage Kānaka Maoli, noting that "while we're making good progress in the lab right now, we are failing at community engagement. We are in Hawai'i where there are strong cultural values, there are a lot of local people, and local people that are Native Hawaiian. So I want to try to bridge that gap" (D1, personal communication, March 20, 2019). She also made reference to the pressures associated with her faculty position, and how these prevent time for the design and conduct of engagement:

> I wish we all had more time to work on these kinds of things. A lot of us right now at the university level are quite stressed because there's a lot of talk about the metrics of what we do. Right now, our teaching is only measured by our face-to-face classroom time. Those hours are underestimated. So mentoring students, graduate students, undergraduate research projects, none of those are counted right now so a lot of us are overworked, stressed. There's a senator in Honolulu who is thinking about cutting 120-200 faculty positions. And the metric again being how many hours are you teaching as opposed to the quality of the teaching. I'd love to sit down more with [my colleagues] to talk about engagement but there's so many limitations put on us that it's frustrating. (D1, personal communication, March 20, 2019)

Taken together, these interviewees' reflections on the value of slow, place-based approaches to conservation and desires for more time to pursue engagement demonstrate a misalignment between existing, institutionalized frameworks and local preferences for engagement.

In the following and final section, I offer insights from my interviews that focus on the engagement of Kānaka Maoli in relation to emerging gene drive technologies. Key

themes to emerge from my interviews with Kānaka Maoli include the importance of Hawaiian self-determination, and desires to make decisions about the future through deep engagement with the past.

3.8 Engaging Kānaka Maoli in Gene Drive Decisions

In response to my questions about how scientists, conservationists, or others involved in decisions about the release of gene drive–modified organisms in Hawai‘i might go about engaging Kanaka Māoli, one kupuna from Kaneohe, Oahu responded: “The most honorable thing is to involve the community. If not, that’s hewa [wrong], and we know about that” (K[Kanaka Maoli]1, personal communication, July 23, 2019). Her comment succinctly captures the most widespread theme to emerge from my interviews with Kānaka Maoli: desires for Hawaiian self-determination, and the importance of the past as a resource for decisions about the future. Though I went into my interviews planning to talk about specific proposals to genetically engineer mosquitoes that vector avian disease to the endemic birds of Hawai‘i, I spent much these conversations listening to stories that had to do more broadly with colonial and military decisions and developments that have threatened Hawaiian self-determination and harmed ‘āina (land, translated to “that which feeds us”). Interviewees also framed historic and ongoing grassroots efforts to restore, reassert, and regenerate Hawaiian knowledge, culture, and relations to land.

A woman from Waimānalo who asked to be referred to as Aunty Kapua began to talk about the overthrow of the Hawaiian Kingdom at the outset of our conversation. She introduced herself as we sat in her backyard, expertly weaving lei as she spoke: I’m a 56

year-old mother of three, and grandmother of six little girls." She told me about her family, how she comes from a long genealogical line of lei makers, and about her deep passion and experience advocating for Hawaiian language immersion programs in her community. She explained the joy she gets from hearing her children speak fluent Ōlelo and lamented pressures to assimilate to American culture and to speak English, changes she situated in connection to the overthrow:

> We have to look at [our cultural knowledge base] before we make changes in our society. Is it pono or is it proper to make those kinds of changes? When the overthrow happened, it turned our whole nation into turmoil as a people and families, especially the Royal family that was in power at that time. And they had a kuleana [responsibility] to take care of their people and they couldn't because they were forced out of that position. And it has lasting effects on the family that we see today, that we're slowly coming out of. (Aunty Kapua, personal communication, March 26, 2019)

Aunty Kapua refers to the 1893 coup that dethroned Queen Liliuokalani and ultimately set the stage for the annexation of Hawai‘i as a US territory, and later a US state and site of military occupation. As scholar Aikau Hokulani describes, the coup marked the beginning of the long and continuing US "military project" in Hawai‘i (Aikau, 2001). Like other US-occupied Pacific Islands such as Guåhan and American Samoa, Hawai‘i is a densely militarized region with US military controlling about 22% of the land on the island of Oahu (Kajihiro, 2000). Across the Hawaiian Islands, the armed services have "21 installations, 26 housing complexes, 8 training areas, and 19 miscellaneous bases and operating stations" (para. 7), making militarism both a historied and everyday experience for residents. It is not surprising, then, that discussion about decision-making processes affecting Hawaiian lands prompted examples of military occupation, as well as Hawaiian resistance to it.

One kupuna talked about the annexation of Hawaii by the US, which followed the overthrow. She highlighted Hawaiian resistance through the Kū'ē petitions of 1897, in which the majority of Hawaiians registered strong objections to the annexation of their nation, explaining that "Kū'ē means to stand up for what is right, and that is the heart of our Hawaiian sovereignty movement" (K3, personal communication, March 26, 2019). She also recounted the effects of US militarization on the island of Kahoʻolawe, which was used as a bombing range by the US military for decades, and where Kānaka Maoli activism and restoration projects continue today.[57]

One Kanaka Maoli resident of Big Island who coordinates a bird conservation project on Mauna Kea noted that there is a direct relationship between military and conservation in Hawaiʻi. He described the creation of the Oahu Army Natural Resources Program (OANRP), an environmental program organized by the Army in Hawaiʻi with which he worked in the past:

> A lot of the military areas, training areas, especially on all Oahu are home and host to a lot of endangered species on Oahu Island. The training they do was resulting in a lot of take of these species, so the military was sued and organizations that sued the military were successful. […] Basically, they're training in these ecosystems that these endangered species rely on. So a lot of funding was set aside. They created a program of natural resource managers, that would be the OANRP. I think they manage over 200 different endangered species. […] The work that they do is absolutely amazing. And I learned a lot [in my time there] and I attribute where I am now to how much I learned there at that project. (K7, personal communication, May 18, 2020)

[57] Following the Japanese attack on Pearl Harbor, the US Army began using Kahoʻolawe Island for military training and bombing exercises. These practices continued for more than thirty years, causing significant ecological degradation and desecration of the sacred site which represents the physical embodiment of Kanaloa (god of the sea). Native Hawaiian activism at Kahoʻolawe took the form of physical occupation, legal action, and cross-movement solidarity with the Nuclear Free and Independent Pacific Movement. Kahoʻolawe remains a rich symbol of cultural revitalization and decolonial resistance in Hawaiʻi (Genz et al., 2018; Kajihiro, 2000).

This interviewee observes that the OANRP is engaged in valuable conservation work that informs his own efforts on Mauna Kea. I admitted my surprise to learn that the Army oversees so many conservation efforts in Hawai‘i, something I became aware of while attending the 2018 Hawai‘i Conservation Conference in Honolulu. I recounted coming across OANRP's booth in the expedition hall, donning the familiar US Army Logo. He explained that the use of recognizable military imagery is a relatively recent shift in their branding:

> Well, they're a lot different now. Their interface has changed to reflect the military lately more than it has in the past. In the past the PCSU [Pacific Cooperative Studies Unit] research side represented things. But now you can definitely tell that they're a quote-unquote "military" project or program, you know, down to having a spokesperson that does interviews and stuff like that. (K7, personal communication, May 18, 2020)

He acknowledged this rebranding as a strategic move, observing that "it's smart for the military to showcase the awesome work OANRP is doing. They can show the type of work they're doing that offsets their training and the damage of the training" (K7, personal communication, May 18, 2020). His comments acknowledge the entanglement of military and conservation, and the strategic use of conservation to positively brand the military. Some scholars identify the alignment of military to conservation as a broader phenomenon known as "greenwashing," described as the disguising of militarism as environmentalism (Harris, 2015).[58] While interviewees discussed the impact of the

[58] Some scholars and governmental officials have argued that the creation of geographically delineated spaces for military purposes (e.g., bases, training areas, live fire ranges) provides natural reserves for animals whose habitats would otherwise be affected by encroaching human development (Gazenbeek, 2005). Political science scholar Peter Harris problematizes such framings as obfuscating the destructive aspects of militarism, adapting the term *greenwashing* from 1990s environmentalists problematizing the "public relations efforts to portray an organization, activity, or product as environmentally friendly" (Harris, 2015). An article entitled "Bombing for Biodiversity—Enhancing Conservation Values of Military Training Areas" demonstrates the paradoxical logics through which the greenwashing of militarism functions, arguing that military training areas "can maintain high habitat value because they

military on Hawaiian communities and ecologies in a variety of ways, the presence of militarism as a theme demonstrates its salience to local residents within discussions of conservation and environmental decision-making.

Some interviewees cited examples of events undermining Hawaiian self-determination that connected specifically to proposed scientific projects. Three interviewees recalled UH researchers' proposals to genetically engineer kalo (the taro plant) in the early 2000s, a project undertaken in efforts to engineer resistance to leaf blight and increase crop yields (Kagawa-Viviani et al., 2018). The proposals prompted strong concerns from Kānaka Maoli for whom taro represents the sacred embodiment of the first Hawaiian ancestor. As one kupuna described:

> Our first Hawaiian was Hāloa, and came from the kalo. Hāloa came from the Oha [shoots], of the kalo. To genetically modify that is a big issue in Hawai‘i. […] So that's the kind of stuff that I think about when I think about genetically modified foods, animals, anything genetically modified. (K4, personal communication, August 20, 2019)

She then questioned whether genetic engineering was really "necessary" to increase crop yields as suggested by researchers, noting that shortages were later remedied with the revitalization and creation of taro fields, as opposed to genetic engineering. As she described, this was preferable not only as a means to protect Hāloa, but to encourage Kānaka Maoli and others around the archipelago to revitalize relationship to Hāloa through kalo cultivation. This suggests that opposition to the genetic engineering of Hāloa reflects a desire to maintain active kinship relations to Hāloa. Kanaka Maoli scholars Maile Arvin and Noelani Goodyear-Ka‘ōpua have also described Hawaiian

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are not subject to pressures like logging, land clearing, agriculture, and urbanization which are degrading the formal reserve systems of many nations" while acknowledging this is often because they contain unexploded ordnance (Zentelis & Lindenmayer, 2014).

protests of the genetic engineering of kalo as part of broader resistances to the encroachment of commercial agricultural practices by large biotechnology corporations like Monsanto in Hawai‘i, and the treatment of mana (life force) contained in genetic material as a commodity (Arvin, 2019; N. Goodyear-Ka‘ōpua, 2013).

Two interviewees also cited the Thirty Meter Telescope (TMT), a massive telescope proposed for construction atop Mauna Kea on the Big Island of Hawai‘i, as an ongoing example of a scientific proposal violating Hawaiian self-determination. As one kupuna from the Big Island described,

> The Mauna Kea issue is massive because yeah, we want the UH students to have a learning center and learning tools but does it have to come at the cost of treasures in our land? Up on Mauna Kea is Lake Waiau. When they put that new observatory up there, they're going to totally wipe that out. It's something you can never capture ever again. So yes, we want them to have all of this great stuff, but we don't want it at the expense of our land, our spirit, our culture. (K5, personal communication, August 23, 2019)

Mauna a Wākea, or Mauna Kea, is the highest mountain in the Hawaiian archipelago and "a sacred *piko* (umbilicus; convergence)" for Kānaka Maoli (Goodyear-Kā‘opua, 2017, p. 184). This interviewee elaborated on what would be lost if Kānaka Maoli were no longer able access Lake Waiau, a sacred site historically visited by Hawaiian royalty and priests and described as the realm of Hawaiian gods: "If we were to remove [Lake Waiau], we could hear about it in song and in stories, but we wouldn't be able to experience it. And it possesses something that we need in life" (K6, personal communication, August 23, 2019).

As I read them, the concerns shared about genetically engineered kalo and TMT do not represent simple or outright opposition to genetic engineering or "science." Nor can they be reduced to mere "cultural" difference or preference, though they are

frequently framed this way by mainstream media (Arvin, 2019). First, the very description of Kānaka Maoli responses to these projects as "opposition" discursively centers the technology, often positioning it as a solution or marker of "progress," and casting Indigenous "opponents" as standing in the way of that progress. As Kānaka Maoli scholars Noelani Goodyear-Kāʻopua and Bryan Kuwada have written of Native Hawaiian activism on Mauna Kea, Kānaka Maoli and their allies are often dismissed as "relics of the past" rather than by their self-described relationship to Mauna Kea as kiaʻi or protectors (N. Goodyear-Kaʻōpua, 2017; Kuwada, 2015). Opposition in these cases might be better read as commitment to the protection of sites and entities that represent sacred history and ongoing kinship relations. In Goodyear-Kaʻōpua's words, kiaʻi are protectors of the future, rather than protestors of the past (p. 184).

Secondly, the representation of kiaʻi desires to protect Hawaiian lands as a "science versus culture" debate reflects a binary separation of science and culture that is not only incommensurate with Indigenous onto-epistemologies but denies that, as Indigenous STS scholar Kim TallBear has cogently stated, "all peoples do science, and all science is cultural" (TallBear, 2021). Indeed, Kānaka Maoli have been engaging in sophisticated scientific practice for millennia, though often Indigenous knowledge practices are not read as "scientific" because they do not dichotomously separate "the material from the spiritual, nature from culture, and humankind from all other life" as Western systems of knowledge tend to (Nakashima & Roué, 2002, p. 314). Thus, to frame opposition to proposals like genetically engineered kalo or TMT as cultural (i.e., not scientific) dismisses that Indigenous culture *is* scientific, in relations to land afford the continued creation and sharing of knowledge.

Like all knowledge, that which is produced in accordance with epistemic norms of Western empiricism is also situated and cultural, despite its persistent claims to that which is really true or objective. Ecofeminist and feminist technoscience scholars Vandana Shiva and Donna Haraway deploy metaphors of vision to describe the ways in which the dominant imperial, masculinist gaze comes to be designated as "empirical" and "universal" thereby dismissing all other epistemological positions. According to Shiva, despite its refusal to situate itself, Western knowledge is neither disembodied nor all-knowing. Though, its claim to supremacy over other ways of knowing invokes such qualities:

> […] local knowledge is made to disappear by simply not seeing it, by negating its very existence. This is very easy in the distant gaze of the globalizing dominant system. The Western systems of knowledge have generally been viewed as universal. However, the dominant system is also a local system, with its social basis in a particular culture, class, and gender. It is not universal in an epistemological sense. It is merely the globalized version of a very local and parochial tradition. Emerging from a dominating and colonizing culture, modern knowledge systems are themselves colonizing. (Shiva, 1993, p. 71)

Again, all knowledge is produced from a particular, embodied position. Donna Haraway describes the supposedly omniscient gaze of Western knowledge systems as the "god trick," claiming to see everything from nowhere (Haraway, 1988, p. 581). Discursive framings of Indigenous knowledge as *cultural* and Western knowledge as *scientific* thus deny the situated and value-laden nature of Western knowledge claims, including those that position the genetic engineering of kalo as a necessary solution, or of the construction of TMT as a marker of scientific progress.

Following one interviewee's comment that the honorable thing to do is to "involve the community" in decisions about whether to release genetically engineered

organisms in Hawai‘i, I asked what that might look like in practice. Her response was that scientists should “try to talk to as many different people, with different opinions, as possible” (K1, personal communication, July 23, 2019). She and other interviewees listed a variety of potential groups to be engaged: cultural practitioners like kumu hula (hula teachers) and halau (hula schools), Hawaiian Civic Clubs, local residents, farmers, hunters, conservationists, and students. Aunty Kapua echoed similar sentiments and invoked her own experiences engaging communities on Hawaiian language immersion:

> It seems like it would be important for scientists who don't have that cultural knowledge to talk to people who do so they don't miss other opportunities. It's valuable to the project, and to the outcomes to have as many ideas that you can add to the pot that will help. I know working with people and parents, you get all kinds of people. Most positive, some are negative, but everyone brings something to the table, even the negativity. So just keeping them there, not shunning them, but trying to hear them out. Let everyone know they're important to the mission and the vision. (Aunty Kapua, personal communication, March 26, 2019)

Aunty Kapua’s comments reflect a strengths-based approach to engagement that values local input and openness to disagreement. She also speculated about how Hawaiians in her own community would respond. Though she felt people might be more open to the use of genetic engineering to protect Hawai‘i’s endemic birds, she also anticipated concerns:

> I think it’s something that people will be more open to because it’s going to protect the ‘i‘iwi [a type of Hawaiian Honeycreeper]. I think there's still going to be a lot of people with concern who want to find a different way. […] We've had it in our past, so many times, where we're doing it in conservation’s name and then it turns out to be a disaster. So, I don't know how it would go for the scientists’ project because people still don’t trust outsiders and government […], and Hawaiians haven’t come to see any kind of resolution to the problems we are already dealing with. To add any more problems to that, we just don’t want it. (Aunty Kapua, personal communication, March 26, 2019)

Rather than claim any clear or specific stance on genetic engineering technologies, Aunty Kapua anticipated concerns surrounding "disasters" of conservation projects (likely in reference to past failed pest control efforts),[59] and a general mistrust of outsiders and government. Again, most salient are those historic events that have challenged Hawaiian sovereignty and amounted to environmental and cultural harm, much of which continues today.

Interviewees also articulated desires to restore relationships and cultural practice in direct relationship to native birds. One Kanaka Maoli researcher on the Big Island shared his complicated feelings about the limited knowledge and relationship Kānaka Maoli have with native bird species, and what that means for how they could be engaged on issues related to their conservation. Though he agreed Kānaka Maoli should be able to make decisions about how their lands are used, he expressed concern that Hawaiians' lack of relationship to native birds may make them less informed as decision-makers. When we talked about who should get to make decisions about the release of genetically engineered mosquitoes for conservation purposes in Hawai'i, he said:

> It should be the people who are from that place and who are invested in that place. […] But sometimes I feel we, as Hawaiians are not in a position right now to make good decisions about the maintenance of our resources. We might've been a hundred, 200 years ago. We do not interact with these things in the same way that we used to. I think about my teachers at UH Hilo. They're masters of Hawaiian language, of a lot of stuff. But if you ask them, what's an 'apapane versus what's an 'amakihi, our two most

[59] The introduction of mongoose by the sugarcane industry in the late 19th-century is popularly cited as a failed pest control effort. Though the hope was that they would predate on populations of rats damaging sugarcane crops, mongoose and rats are diurnal and nocturnal respectively, meaning they are active at opposite times of the day. Instead, mongoose fed on other small mammals as well as birds, reptiles, insects, fruits, and plants, and preyed on the eggs and hatchlings of native ground nesting birds and endangered sea turtles, and they continue to be widely regarded as pests in Hawai'i today. Conservation experts challenge the framing of the mongoose as "biocontrol gone wrong," distinguishing biological control as an established field that did not inform decisions to introduce mongoose to Hawai'i (DLNR, n.d.).

> abundant native forest birds, they cannot tell you. They don't know the difference. And you know, if you don't know the basics like that, then you shouldn't be making decisions about whether this thing lives or dies. It's not our fault that this is how things are, but we need to make those connections again. That also means that the scientists need to be willing to let go of some of the power and bring us into the fold and, and allow us to reconnect with the land. (K5, personal communication, May 13, 2020)

While this interviewee frames the lack of relationship to native forest birds as a potential deficit or limiting factor in informed decision-making about the use of gene drive or other vector control technologies, he also frames a desire for scientists who have more access to Hawaiian lands and native species to share that access with Kānaka Maoli.

Another resident of the Big Island observed the loss of relationship to native birds, noting that the "Native Hawaiian community needs to be more educated about our native species" (K7, personal communication, May 18, 2020). He talked about the importance of Hawaiian language, sharing that his children and wife attend and work in a Hawaiian immersion school, and noting that despite cultural revitalization by way of improved access to Hawaiian language resources, awareness of native species is lacking in his community:

> I absolutely did not learn a thing about our native birds. We learned a little bit about our Hawaiian culture growing up, but definitely not even close to what we needed to learn. One of the things that I'm trying to do is grow Native Hawaiians' support and education of our native and endangered species. So we can help our people realize how valuable they are. (K7, personal communication, May 18, 2020)

These interviewees' comments express desires for restoring relationship to native birds, and point to a need for improved education as well as access to the birds. The lack of relationship to native birds was also mentioned by scientists and conservationists, with one noting that, "you really have to get up high and you have to get away from the city to see many of our native birds, so the vast majority of people are unaware of them" (E3,

personal communication, March 19, 2019), and another that "my grandpa grew up on Oahu and lived there his whole life and never saw ʻiʻiwi. It's difficult to get people engaged when these things are so far away" (E2, personal communication, April 7, 2020).

Some identified risks associated with bringing people up into those bird habitats, citing the vulnerability of native ecosystems to human activity and an ongoing problem of human-assisted spread of the fungal disease Rapid ʻŌhiʻa Death (ROD) affecting the keystone ʻŌhiʻa tree (E7, personal communication, March 29, 2019). However, the Kanaka Maoli researcher from Big Island acknowledged these risks as warranted in order to rebuild relationships to native birds, asserting that "we need as much as possible to get people to where nature is. There's a risk involved in that. You know, we have ROD and there's all kinds of invasive species, but I think it needs to be done" (K5, personal communication, May 13, 2020). For the two interviewees that spoke to the need for education surrounding native birds, the emphasis was not on educating Kānaka Maoli on genetics or genetic engineering technologies, but re-establishing relationship to native birds.

Though I interviewed a relatively small group of residents (n=9), I was struck by the repetition of similar themes in their responses. It seems reasonable to suspect that practitioners of engagement can anticipate similar such conversations in their efforts to organize engagement practices on the topic of conservation biotechnologies, particularly the salience of history as an important lens through which to think about the future. This resonates with Hawaiian orientations to time that flip conventional Western notions of the past and the future. Hawaiian scholar and filmmaker Lilikalā Kameʻeleihiwa has

described this through reference to a Hawaiian proverb, “ka wā ma mua, ka wā ma hope,” which is often interpreted as using the past to inform the future. In its literal translation, the *past* is “the time in front,” and the *future* “the time behind:”

> It is as if the Hawaiian stands firmly in the present, with his back to the future, and his eyes fixed upon the past, seeking historical answers for present-day dilemmas. Such an orientation is to the Hawaiian an eminently practical one, for the future is always unknown, whereas the past is rich in glory and knowledge. (Kameʻeleihiwa, 1992; Chapter 2, para. 16)

Heeding the wisdom shared by my interviewees and by Kameʻeleihiwa, the past will be a valuable resource for engaging Kānaka Maoli in future decision-making about the use of genetic technologies in Hawaiʻi.

3.9 Conclusion

Considering the significant uncertainty associated with gene drive technologies, the literature on community and stakeholder engagement calls for forms of engagement that “open up” processes of dialogue and decision making to publics and communities. However, the ethnographic insights gained in this chapter suggest that engagement may also function as an act of *containment* when approached as a strategic or persuasive activity. For instance, efforts to pre-empt anticipated opposition and cultivate approval led to the strategic containment or withholding of information, and the adoption of market research strategies prevented mutual learning and dialogue by isolating “lay” participants from their expert observers. Such acts of containment also seem misaligned to the interests of local scientists and Kānaka Maoli who expressed interests in forms of engagement that facilitate relationship-building, consider history, and value diverse forms of expertise.

In the conclusion of this dissertation, I synthesize findings generated across last the three chapters to argue that *isolation* and *containment* are limiting frames for inclusive engagement and decision making related to gene drives. I invite a reimagining of these practices through an "archipelagic" analytic that not only rethinks presumptions of island isolation, but considers power and history as vital information for decision makers. To provide a concrete recommendation to guide practices that might better embody an archipelagic approach, I propose an exercise I am calling *critical power mapping* that can serve as a tool for a variety of decision makers to visualize patterns of power emerging through the development and proposed deployment of gene drives, and empower local and Indigenous communities to map the stakes of these decisions as they see them.

3.10 References

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CONCLUSION

This dissertation examined proposals to implement emerging gene drive technologies on islands. It interrogated presumptions of island isolation undergirding recommendations to use islands for the first outdoor field trials of gene drives, and provided an ethnographic account of community and stakeholder engagement practices in Hawai‘i where gene drives are being considered as a tool to mitigate local conservation issues. Given widespread deliberation over how to ensure the safe and ethical development of gene drive technologies, my primary interest was in exploring the degree to which the processes that will inform their use are equipped to include local residents and Indigenous peoples as key decision-making stakeholders, including in Oceania where my examination was focused.

In this concluding chapter, I synthesize this project's key insights, reflect on its limitations, and generate recommendations that can be applied to practice. My main finding is that the salient frames of *isolation* and *containment* that currently structure scientific imagination and practice in relation to gene drive are ill-equipped to approach more just and inclusive processes to guide their use. As such, I invite a reimagining of gene drive science, engagement, and decision-making through the analytic framework of the *archipelago* that emphasizes connectivity and attends to history and power to understand the constitutive relations among ocean, island, and continent. Within this discussion I present some practical recommendations for future engagement and decision-making related to gene drives that I see as embodying an archipelagic approach.

C.1 Each Island Is an Opening: Rethinking Gene Drives Through the Archipelago

Themes of isolation, containment, and in particular the figure of the laboratory were recurrent throughout this study. I demonstrated that major organizational bodies like the World Health Organization (WHO) and the National Academies of Sciences, Engineering, and Medicine (NASEM) claim that geographically isolated islands present ideal trial sites for gene drives with minimal attention to what constitutes "enough" isolation to ensure the containment of gene drive–modified organisms, and no consideration of the histories through which islands have been used for experimentation with deleterious effects (WHO/TDR, 2014; NASEM, 2016). I showed that islands are prefigured as an analog for the biosecure laboratory, "containing" risk while still enabling necessary knowledge production for the continued development of these technologies.

In this way, proposals to use islands as field trial sites for gene drives echo colonial myths of isolation that have long been mobilized to justify imperial, military, and scientific experimentation on islands. Such proposals are generally framed as enabling the *safe* development of gene drives, thereby obscuring the *displacement* of risk onto island geographies. This is not to say that practices aimed at safeguarding against the unintended or indefinite spread of gene drive organisms are not warranted. Rather, it is a call to assess the presumptions underlying definitions and attendant practices associated with *safety*, particularly whose safety is privileged, and at whose expense.

The themes of containment and isolation also proved relevant to my ethnographic analysis of community and stakeholder engagement practices in Hawai‘i. This site was unique in that scientists and conservationists are pursuing *local* use of gene drives for conservation, rather than using the island(s) as a trial site prior to continental release. Thr-

ough interviews and observation of a limited set of engagement activities, I learned that some conservationists are orienting to engagement as a *strategic* activity that embeds market research techniques aimed at influence and persuasion of decision-makers. These activities configured engagement within a controlled, laboratory-like setting, clearly demarcating and maintaining conventional boundaries between "experts" and the "lay" public or community, and treating engagement as an exercise in knowledge assessment and message testing. Counter to calls for engagement about gene drive and other genetic engineering technologies to "open up" dialogue and deliberation, this strategic approach to engagement effectively foreclosed opportunity for the mutual sharing of expertise, values, and local conceptions of risk and benefit. As such, I read this approach to engagement as a practice of *containment* in itself, strategically withholding information in order to pre-empt opposition, and keeping valuable forms of expertise in isolation from one another.

In sum, this case study presses us to consider how current conceptions of *safe* and *ethical* gene drive science and engagement are limited by their reliance on frames of containment and isolation. Following Archipelagic American Studies scholars' calls to divest from myths of insularity that orient to continental space as *central* and islands as *peripheral*, I call for a shift from logics of insularity (connoted in gene drive discourse through frequent reference to *containment*, *confinement,* and *isolation*) to more archipelagic thinking.

Scholars contributing to the "archipelagic turn" in Island Studies and the "decontinentalizing" of American Studies have proposed a reconceptualization of geography as *archipelagic assemblages*: interrelated networks of island–ocean–continent

formations that span the planet (DeLoughrey, 2001; Roberts & Stephens, 2017; Stratford, 2017). Such a view is akin Indigenous Pacific Islander ontologies discussed in this project, wherein land and sea exist in continuous relationship, and islands are connected by the sea. Whereas dominant insular imaginaries index isolation, disconnection, and marginality, the archipelago emphasizes connectivity and relationship, and reimagines – as Martinican writer Éduoard Glissant has cogently stated– that "each island is an opening" (Glissant, as quoted in Roberts & Stephens, 2017, p. 29). To embrace archipelagic thinking thus unsettles the seemingly self-evident logics of isolation that frame the island as a closed and bounded entity, and calls attention to the ways insular logics are constitutive of colonial appropriations of island territories.

What might it look like to adopt an archipelagic orientation to gene drive science? How might scientific discourses engage with conceptual frames that better account for the cultural and historical relations among the geographies and communities where these technologies are proposed for use? Might these shifts in imagination and discourse foster more accountability and responsibility within choices about the distribution of risks across geography? While these are questions that I hope to explore more deeply through expanded study of the practices that surround the conception and pursuit of these forms of biotechnological experiments, I suggest here that archipelagic thinking is better equipped than the narrow and static frames of isolation and containment to grapple with the technical and ethical complexity associated with gene drives. My hope is that further study would involve a set of collaborations that consider how the elaboration of research agendas (and their attendant practices of community engagement) are generated across distributed practices. In this way it becomes possible to consider links between the

imaginaries as work at these experimental testing sites and those in other sites contributing to the promotion of genetic technologies.

Geographer Elaine Stratford proposes the archipelago as a valuable analytic for articulating *relationships* "along the continuum inferred by the terms 'local' and 'global'" (p. 78). This holds useful import to analyses of the technical, ethical, and legal challenges associated with the "transboundary" potential of gene drives which bring the local and global into tension. As I discussed in Chapter 2, the emphasis on containment emerges largely from concerns that the release of a few self-perpetuating gene drive–modified organisms could theoretically spread their genetic alterations through wide (and potentially global) populations of that species, spanning not only ecosystems but political boundaries and governance systems (Kelsey, 2020). Consequently, the majority of policy discussions take shape in international and national fora despite the fact that local communities at any site of release would bear the most immediate impacts of a gene drive in their environment (Kofler et al., 2020).

I propose a tool I am calling *critical power mapping* as a potential way to bridge the local and global in gene drive decisions by (1) visualizing power dynamics taking shape across geography, and (2) providing local and Indigenous communities the opportunity to represent their own values, concerns, or insights related to technological proposals. In both cases, the idea is for the "map" to clarify relevant issues for consideration within gene drive decisions and create a product that can be shared with policymakers, regulators, or risk assessors who will ultimately inform those decisions.

C.2 Critical Power Mapping

Power mapping is a visualization tool that "identifies key actors within a particular field of action, defines the power that these actors have in relation to particular decisions or resources, and assesses the relationships of these actors with each other and with oneself" (Noy, 2008). It has been adopted across a variety of fields including clinical and community psychology (Hagan & Smail, 1997); community-based natural resource management (Schiffer, 2007); project management (Bourne & Walker, 2005); participatory action research (Littman et al., 2021); and community, labor, and social movement campaigns (Noy, 2008).

Power mapping has long been mobilized as a strategic tool within project and "stakeholder management" to identify powerful stakeholders most amenable to influence in order to advance project goals (Walker, Bourne, & Shelley, 2008). This approach to power mapping has been applied specifically within the realm of genetically engineered insects by researchers in Brazil who used it as a technique to "navigate political tensions" and identify "science based" stakeholders to facilitate the regulatory approval of local releases of Oxitec mosquitoes (Andrade et al., 2018). Such approaches recall the strategic approach to engagement I observed in my fieldwork for this project, pursuing targeted communication aimed at influence and the cultivation of approval of particular technologies.

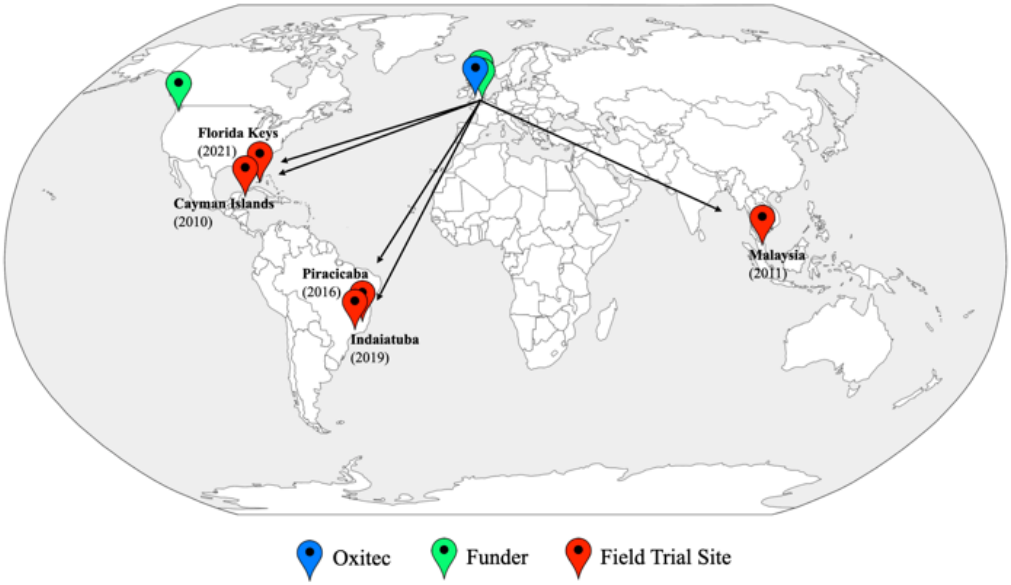
What I am proposing is a *critical* approach to power mapping that facilitates the visualization of geospatial patterns and relationships of power, and/or locally defined considerations relevant to decisions about gene drives. I use the word "critical" to signal a departure from power mapping practices aimed at the identification of persuadable

decision-makers, and suggest that instead it be used as an open-ended exercise to facilitate reflection, collaboration, and self-representation. I offer a few examples of how this activity could be used to represent global as well as local relationships with relation to gene drive technologies.

As a tool to visualize global power dynamics, critical power mapping might be used to represent the flows of capital and technology within gene drive science and experimentation. Figure 1 provides an example of this by visualizing the British biotechnology company Oxitec's trials of genetically engineered mosquitoes over the past decade. For application to emerging gene drive technologies, one interesting approach would be to pinpoint the source(s) of funding, the location of laboratory-based development of gene drive–modified organisms, the intended trial site, and (if it is different from the trial site) the intended endpoint for implementation of gene drive technologies. This can help rethink disparate points within the network of gene drive funding, development, and deployment as *in relation* to one another, and represent emergent geopolitical patterns. For instance, this might make clear dominant North/South or continent/island patterns among the locations where capital and resources are concentrated and where technologies are intended for use.

By making visible the flows of capital and technology constituted in gene drive development and experimentation, maps like this can help to clearly present information that currently exists across several different papers, reports, and websites, or that may be difficult to access. Some experts are calling for an international tiered registry to provide information about gene drive research and releases in a centralized database and to

increase public transparency, which may make the creation of these types of visualizations more accessible (Kofler et al., 2018; Warmbrod, 2020).



Funder	Location (HQ)	Type of Organization	$
Bill & Melinda Gates Foundation	Seattle, USA	Nonprofit Organization	$4.1M (2018)
Wellcome Trust	London, UK	Charitable Foundation	$6.8M (2021)
Oxford Capital Partners	Oxford, UK	Venture Capital	$10M (2014) £8M (2012)

*This is a non-exhaustive list of Oxitec's recent funders. Information was gathered from Crunchbase.com (Crunchbase, n.d.)

Figure C.1: Example of a Power Map visualizing UK-based biotechnology company Oxitec's genetically engineered mosquito trials. Locations of field trials (through April 2021) are indicated in red (and listed in the table), funders in green, and the site of development in blue. The information represented is non-exhaustive and serves only to offer an example of critical power mapping.

Critical power mapping may also provide a generative activity within community engagement. One possibility is to present maps like the one above when providing information about a gene drive or other genetic engineering technology. This can facilitate the introduction of a given technology within the broader social, political, and economic

contexts in which they are developed and in which they would be deployed. Such an approach departs from deficit models of engagement that focus exclusively on technical literacy or introduce the technology in isolation from the wider systems of which it is part.

In a more participatory approach to critical power mapping, participants of an engagement activity may also generate power maps themselves. This can offer an exercise to clarify relevant considerations in relation to a given proposal, such as local values or definitions of risk and benefit. Recalling my own experiences interviewing Kānaka Maoli (Native Hawaiians) about proposals to use gene drive to conserve endemic birds in Hawai‘i, a variety of historic and ongoing events related to Hawaiian self-determination were prompted by interviewees as salient to discussions about genetic engineering. Critical power mapping could be used to represent these (through text, images, or otherwise) as key considerations to decisions about gene drives.

Alternatively, participants may wish to map out who they view as members of their community, in order to allow for self-definition of who or what should be considered in risk assessment and decision making. As I learned through my interviews, some Kānaka Maoli raised examples of nonhuman organisms and cultural sites that represented important living members of their community; these could be clarified and indicated through visual representation, thereby expanding conventional definitions of the *community* or *stakeholders.* Prompting participants to collectively identify these types of relationships can elucidate place-based values and create opportunities for local communities to meaningfully drive the agenda of research and technology development (e.g., identifying particular applications of gene drive that may be of local interest). Such

practices better approach calls for co-development forwarded in the literature on inclusive engagement related to gene drive and other genetic engineering technologies (Delborne et al., 2020; Hartley et al., 2019; James & Tountas, 2018; NASEM, 2016).

The examples raised here offer a preliminary set of suggestions of how critical power mapping might be used to prompt dialogue and reflection within an engagement activity. Participants and practitioners of engagement can surely imagine a number of other ways to use this approach. Importantly, critical power mapping helps to orient to engagement as an epistemically flexible practice, inviting participants to contribute their own expertise and views, and identify preferred modes of representation that are meaningful and accessible to them. Power maps may also be disseminated to policymakers, regulators, risk assessors or other decision-makers to see that local inputs better inform those processes.

This study has grappled with the meaning-making processes that surround the justification and negotiation of approval of gene drive technologies. Beginning with the question of why islands are so readily imagined as ideal trial sites for gene drives, I explored the entrenched myths of isolation that motivate these recommendations. Through investigation of a set of community and stakeholder engagement practices meant to guide decisions about the deployment of gene drives I considered shortcomings and opportunities for these to better align to local and Indigenous self-determination. Given the nascent state of engagement activities at my site, particularly those involving Indigenous communities, this case study can only offer limited and provisional analysis of the ways in which community engagement around gene drive research will unfold. However, despite this limitation in scope, it generated insight into one pattern of

orientation to engagement that enabled deeper consideration of how these activities can work to isolate and contain rather than bridge valuable expertise. Moreover, my discussions with local scientists and Kānaka Maoli have allowed me to frame some considerations for future engagement that inspired the recommendations presented in this concluding discussion.

Significant work lies ahead to establish just decision making processes related to gene drives and other genetic engineering technologies. I am encouraged by the difficult questions these efforts inspire about the values and knowledges that underpin science and engagement, as these should always be asked of emerging technologies and the systems of governance that guide their use. If this study can offer any lessons in navigating these challenging questions, it should be that our greatest resources for innovation will be found through deeper engagement with history and openness to multiple ways of knowing.

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