WAYS OF KNOWING, WAYS OF BEING: THE ROLE OF RELATIONAL CITIZEN SCIENCE IN THE CONSERVATION AND CARE OF LAYSAN ALBATROSS IN THE HAWAIIAN ISLANDS

by

LINDA MARIA KOSEN

(Under the Direction of Julie Velásquez Runk)

ABSTRACT

Citizen science (CS) is recognized as an important locus to produce knowledge at the interface of lay and professional scientists. Participants contribute to projects in ways that hasten and expand data collection at scales beyond normal research projects; in return, they benefit from improved scientific literacy, have a greater voice in conservation decisions, and participate in projects that address community-level concerns. Notwithstanding these benefits, there are growing concerns that in both theory and practice CS lacks reflexivity and gives insufficient attention to the ways in which power mediates peoples' engagements with science. As part of the positivist scientific tradition, CS is informed by a set of normative assumptions that determine certain truths about the world; the way we know those truths; and the values that shape how we apply our knowledge about the world. In this dissertation, advance scholarly understanding of these dynamics by bringing together theory from political ecology, ontology, and cultural geography to ask how relational frameworks shape peoples' engagements with CS.

I conducted this research by using a combination of ethnographic interviews; content analysis; and participant observation among citizen scientists pursuing conservation agendas related to Laysan albatross over a span of eighteen months in the Hawaiian Islands. Throughout two articles and a digital Storymap chapter, I trace how various discourses and material practices shaped citizen scientists' relationships to albatross and the ways in which CS programs brought together heterogeneous stakeholder groups. My results show that citizen scientists saw their work as bound within acts of care, reciprocity, and sociality that extended to albatross, the environment, and others in the community. This had the result of engaging a diverse group of stakeholders who mutually-supported one another and collaboratively managed the only colonies of Laysan albatross in the world that live among people. Given the growing interest in decolonizing research, this work offers lessons for more engaged and equitable ways of practicing CS and underscores that when done well, CS is fundamentally relational.

INDEX WORDS: Citizen science, Science and technology Studies, Integrative conservation, Participatory conservation, Wildlife monitoring

INTEGRATIVE CITIZEN SCIENCE WAYS OF KNOWING, WAYS OF BEING: THE ROLE OF RELATIONAL CITIZEN SCIENCE IN THE CONSERVATION AND CARE OF LAYSAN ALBATROSS IN THE HAWAIIAN ISLANDS

by

LINDA MARIA KOSEN

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by

LINDA MARIA KOSEN

Major Professor:	Julie Velásquez Runk
Committee:	Peter Brosius
	Nate Nibbelink
	John Schacke
	Trisha Kehaulani Watson

Electronic Version Approved

Ron Walcott

Vice Provost for Graduate Education and Dean of the Graduate School

The University of Georgia

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DEDICATION

I dedicate this dissertation to Leon and Anne Brenaman, who now fly with the albatross.

Kaua'i volunteers have a whale of a time counting

2-25-01

Staff Photo by DENNIS FUJIMOTO

EON BRENAMAN of Washington uses a makeshift distance measure he fashioned out of a ruler and calibrated
ing a home computer to calculate the distance of a whale spotted off the Kealia Point site. Once initial readings
done, he uses a table to calculate the distance. His wife Anne was the site leader at Kealia, and the couple
they've watched the gray whales from their Northwest residence.

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My whole family, including my anchor and sister, Tanya Kosen.

My hānai dad and best friend, George Thompson.

TABLE OF CONTENTS

TABLE OF FIGURES

LIST OF TABLES

ABBREVIATIONS AND ACRONYMS

CLO	Cornell Lab of Ornithology
CS:	Citizen Science
ESA:	Endangered Speices Act
HMS	Hawaiian Monk Seal
ICON	Integrative Conservation
IBA	Important Bird Area
IK/IKS/ILN:	Indigenous Knowledge / Indigenous Knowledge Systems/ Indigenous and Local Knowledge
IPLC	Indigenous People and Local Communities
IUCN	International Union for the Conservation of Nature and Natural Resources (IUCN)
LA	Laysan albatross
LHI	Lesser Hawaiian Islands
LINKS	Local and Indigenous Knowledge Systems
MHI:	Main Hawaiian Islands
NOAA	National Oceanic and Atmospheric Administration
PE:	Political Ecology
PMNM	Papahānaumokuākea Marine National Monument
STS:	Science Technology Studies
TEK:	Traditional Ecological Knowledge

CHAPTER ONE: INTRODUCTION

1.1 Vignette

Early on a winter morning in 2018, I sat among a line of volunteers at the Keālia lookout on the east shore of Kauaʻi. It was 8:00 a.m., and I sat directly in the path of whipping trade winds that swept damp clouds of salty mist in my direction. Rubbing my hands over the goosebumps on my legs, I looked up at a sky of stormy clouds. I accepted this would be a cold and damp morning and turned to the task of counting humpback whales. Working in tandem with a partner, we scanned the ocean for blows, tail slaps, breaches, and a handful of other whale behavior. To gauge distance, I held a horizonal ruler against the edge of the horizon while moving a cardboard slider down to the whale's location. After consulting a set of location-specific tables that translated the slider's location on the ruler to a distance measurement, we recorded our observations on a form (see Figure 1). Over four hours I would switch this task back and forth with my partner, before the sun finally warmed and I turned in my clip board and went home.

A month after the first whale count, I met with the program specialist for the Kauaʻi branch of the Sanctuary Ocean Count in Līhuʻe. The count is a yearly citizen science program that invites members of the public to use shore observations to collect data on the populations of humpback whales that migrate to the islands every winter. Beginning in 1996, each season has consisted of three counts across the months of January, February, and March. I was at the office to learn more about whale count data and the role of volunteer monitoring in whale conservation across the islands. As we made introductions, I mentioned my late grandparents were long-time volunteers with the program. From the next office over, another employee asked for their names. They had stopped participating after my grandfather passed in 2003, so I was doubtful anyone would remember them. After answering him, he excitedly replied, “Of *course* I remember him. He was the consummate citizen scientist, and that ruler was the best example of applied trigonometry I have ever seen!” The ruler he was describing was the same ruler, along with the distance tables, that I had used weeks before.

My grandparents had visited Kauaʻi every winter since the early 1990s, living at the Mokihana of Kauaʻi, a modest timeshare complex along the shoreline of Kapaʻa town, just minutes down from the Keālia lookout. Whale counts were one of the ways in which residents of Mokihana socialized, and at the time measurements were based on volunteer guestimates. Dissatisfied that estimations were unlikely to be accurate, my grandfather had designed a measurement protocol that has been used across 62 sites across Hawaiʻi since 1996.

The last count of the 2018 whale season was on March 31st, a gloomy day at the Kīlauea Point National Wildlife Refuge. Although rain was coming down hard, the partner I had been assigned was not at all deterred. I later learned she was a visitor who planned her trips to coincide with the whale counts and spent nearly every day of her vacation visiting the refuge. A few days later, she graciously took time off to sit down for coffee and tell me why she would come all the way from California to stand in the rain for hours—hardly anyone’s idea of a Hawaiian vacation.

When I had started this research, I had expected volunteers would couch their motivation in familiar discourses of ecological anxiety so common in the Anthropocene. However, what I found was that *why* was the question people often struggled to answer, which was what emerged when I interviewed my whale count partner. It was not that she and other people could not answer, but that they often seemed to be searching for words that do not exist in our common language. This has been discussed elsewhere as a form of ethical refusal, whereby people reject couching their motivations in conventional logic and discourses so common in science (Bird Rose 2017). How could I expect to understand why people participate in citizen science if people could—or would—not articulate it? This question has informed my approach to this research, which has fundamentally been about centering relationships in citizen science. In doing so, I have been fortunate enough to experience how citizen science is an act of care that connects people though time, including material objects like my grandfather’s ruler as well as the relationships I cultivated throughout my years working in citizen science projects and research.

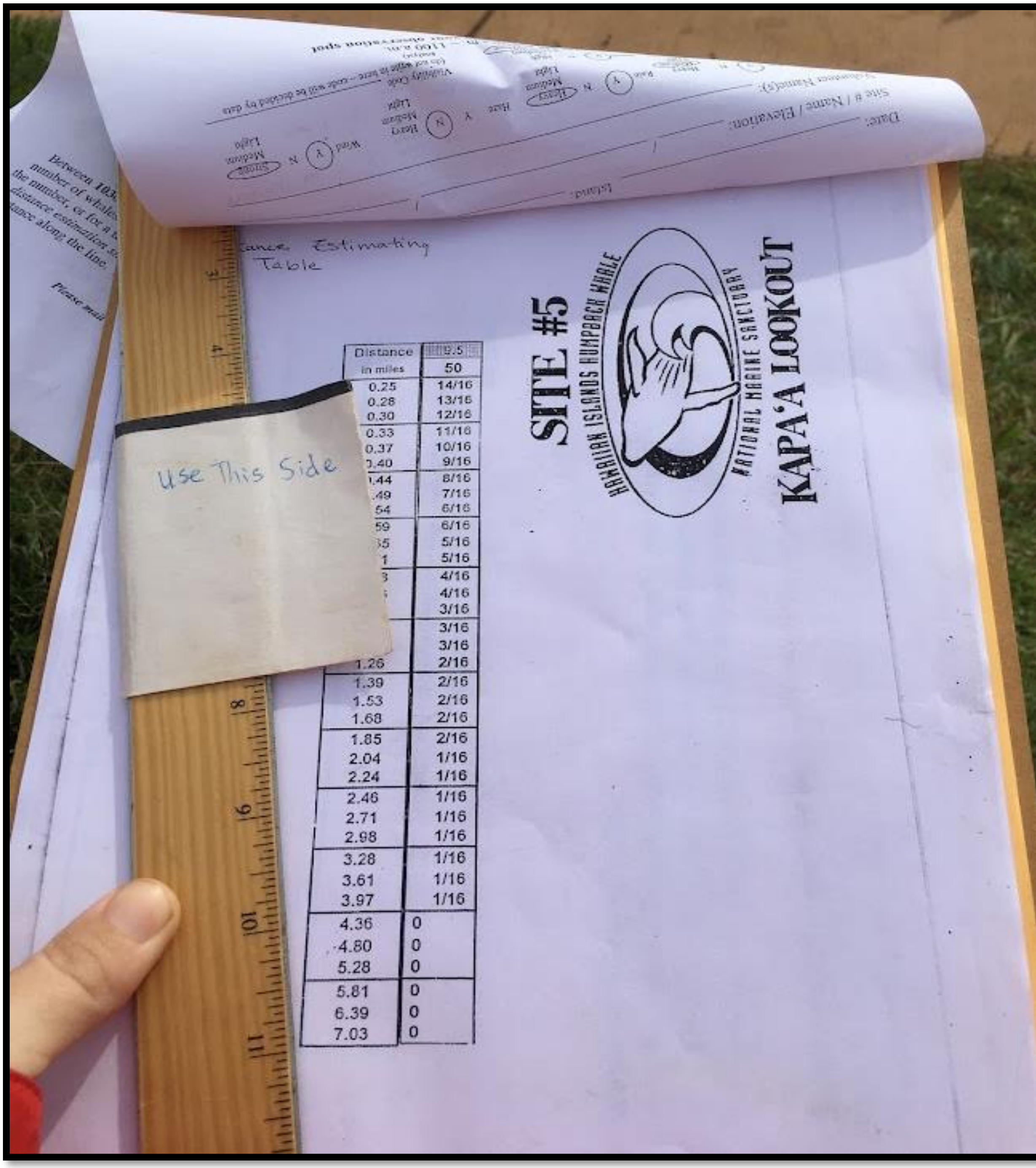

Figure 1 Tools provided to volunteers for whale counts (Photo Credit: L.Kosen Jan 28, 2018)

1.1 Background: Defining the Citizen Scientist

What does it mean to be a citizen scientist? How is this title defined, and who makes those determinations? Although lay science has existed across Europe and North America for over two-hundred years, the term “citizen science” (hereafter CS) came to parlance after Rick Booney established the first official CS program at the Cornell Lab of Ornithology in 1979 (Bonney, Mccallie, and Phillips 2009). While many definitions exist, it is most commonly understood as science utilizing networks of volunteers to contribute to scientific research under the supervision of professional scientists (Eitzel et al. 2017). Although CS has made major contributions across the sciences, it has been particularly salient in the field of ornithology. One of the earliest and most highly regarded examples of CS is the Audubon Annual Christmas Bird Count, which has been held every December since 1900 (B. L. Sullivan et al. 2009). Over a hundred years of volunteer observations have contributed to the science of bird migrations, population changes, and indicators of climate change (NABCI 2009; Daniel Kenneth Niven, Butcher, and Bancroft 2009; EPA 2017). Starting with just twenty-six observers in its inaugural count, it has grown to over eighty-thousand participants and has served as the foremost model in long-term ecological monitoring CS projects (Audubon n.d.). Still, the scientific contributions of programs like the bird count—which are likely in the hundreds—remain under-recognized in the scientific literature, owing to the relatively recent scholarly recognition of CS, as well as the tendency for non-hypothesis driven research to be limited to grey literature (Silvertown 2009).

The benefits of CS are often considered synergetic with other conservation practices. Research scientists benefit from large amounts of data that they would not be able to collect otherwise, and volunteers learn and apply new skills to projects that interest them. It also has educational benefits because participants gain hands-on experience, and their investment in projects leads to more public support for science (Bonney, Mccallie, and Phillips 2009). In a conservation context,the proposed benefits include protection of native wildlife (Dickinson et al. 2012a); improved scientific literacy (Brossard, Lewenstein, and Bonney 2005; Evans and Marra 2018); community participation in conservation decisions (Irwin 1995); and more equitable treatment of non-scientists in the process of creating and guiding science (Jasanoff 2004a; Leach and Fairhead 2002). Citizen science is constantly evolving with new questions and ways to volunteer, ranging from recruiting surfers to collect water monitoring data to online National Aeronautics and Space Administration (NASA) Earth observations that contribute to the science and understanding of climate change.

Citizen science also has its drawbacks. The quality and integrity of CS data are often questionable, therefore it is important when evaluating data that utilizes CS to consider different models and methods (Tonachella et al. 2012). Although CS typically relies on scientists to generate research questions, guide methodologies, and analyze results, the reality is that many projects allow volunteers to participate throughout all parts of the scientific process (Bonney, Cooper, and Ballard 2016; Dickinson et al. 2012a; C. B. Cooper et al. 2007). Regardless of the level of participant engagement, persistent problems include the reliability and usefulness of data, variable skills among volunteers (Tonachella et al. 2012), and balancing quality training with time and resource constraints (Dickinson et al. 2013). Thus, much of the volunteerism literature is focused on how to standardize training, methodologies, and research goals (Kimura and Kinchy 2016).

The democratizing potential of citizen science (Hoffman et al. 2016), perhaps its loftiest claim, is reflected in increased attention to how to attract a broader range of participants (Pandya 2012; Pandya and Dibner 2019). In Hawai‘i, where I conducted my research, discussions around citizen science also intersect with discussions around Indigenous epistomologies, specifically efforts to define how Indigenous knowledge or traditional ecological knowledge inform conservation science. However, CS programs often fail to attract participation from groups traditionally under-represented in science, which reflects the wider problem of a "disconnect between the norms and priorities of the research community and the values, aspirations, and cultures of many historically underrepresented communities" (Pandya 2012). Broad recommendations, like identifying values, interests, or incentives for potential participants (Dickinson et al. 2012a) are often made, yet there has been less attention on CS as a system with its own values, customs, and culture. Furthermore, attempting to organize CS around shared interests and values privileges consensus and erases difference (Selfa and Endter-Wada 2008; Turnhout, Van Bommel, and Aarts 2010) and also fails to recognize structural and power differences between the general public and expert scientists (Irwin 1995).

Science and Technology Studies (hereafter STS) scholars have been at the forefront of addressing these issues. Using a theoretical lens focused on the interface between science, society, and technology, this scholarship has contributed to general knowledge of CS by demonstrating how expert scientists and the general public negotiate what is accepted as scientific knowledge and how it is applied (Irwin 1995). Unfortunately, much of this work has been siloed within social science. Promisingly, organizations like the Citizen Science Association are increasingly including broader disciplines into these conversations and recognizing the value of integrating STS and other perspectives into mainstream CS research (Sullivan et al. 2009; Bonney, Cooper, and Ballard 2016).

This dissertation proposes that further progress in CS research requires widening the scope of what knowledge and practices constitute CS, as well as more attention to the positionality of participants, scientists, and other entities that are typically involved in CS projects. In the following literature review, I sketch out the broader discursive context of citizen science literature by bringing together scholarship in political ecology, STS, and traditional ecological knowledge. Given the wide scope of each of these literatures, I focus on three interlocking themes: 1) the concept of scientific citizenship and who and what makes citizen science; 2) boundary theory and the tensions between scientific gatekeeping and democratization; 3) the role of epistemology and relational frameworks in lay knowledges and how they inform the academic delineation of CS from traditional ecological knowledge (TEK).

1.2 Literature Review: The Rise of Citizen Science

Since at least the late 1980s, interest in Indigenous traditional ecological knowledge (TEK) (Agrawal 1995) has coalesced into increased calls for both quantitative and qualitative conservation scientists to reflect on how ways of knowing (epistemologies), beliefs about the nature of reality (ontology), and modes of investigating questions about the world inform research paradigms (Aliyu and Adamu 2015). This has opened conversations ranging from considering the relationships between researchers, colonialism, and citizenship (George and Wiebe 2020; Borrelle, Koch, Mackenzie, Ingeman, Mcgill, et al. 2021), frameworks and methodologies incorporating TEK into restoration efforts, and the conservation of endangered and threatened species (Serra et al. 2005; Chang, Winter, and Lincoln 2019; Gon, Winter, and Demotta 2021). Continuing in this vein, a growing body of theory variously known as “multispecies ethnography” (Kirksey and Helmreich 2010), “posthumanism” (Smart 2013), “anthropology of life” (Kohn 2007), and “more-than-human” (Whatmore 2006)—otherwise known as the so-called “ontological turn”—reflects broadening interest in the entanglements and agencies of human and non-human actors (Velásquez Runk 2014; de Castro 1998; Latour and Woolagar 2013). Despite burgeoning scholarly interest in ontology today, several critiques abound. First, the ontological turn has been criticized for presenting the idea of connectivity between different life-worlds as novel, even though these concepts are an inherent part of Indigenous thought and scholarship (Todd 2016). By failing to draw from Indigenous scholarship, ANT universally and uncritically assumes that a nature/culture divide is present across all cultures (Sundberg 2014). Furthermore, the emphasis on technology, lab spaces, and other spaces associated with modern science neglects other sites of encounter, flattens the complexity of other lifeforms, and fails to engage with theories of place (Bingham and Thrift 2000). Given its close relationship to STS, CS literature contains many of the same insights about science-society relations while also maintaining similar theoretical gaps. By putting ontological theory into conversation with political ecology, STS, and TEK, the following literature review provides the justification for what I will later argue is the need for greater consideration of relational theory in CS research.

1.2.1 Science and Technology Studies and its history in early CS scholarship

Although CS scholarship is most often associated with Rick Booney's work at the Cornell Lab of Ornithology beginning in 1996 (Bonney 1996), the first use of the term originated with sociology of science scholar Robert Irwin nearly a year before (Irwin 1995). Like other scholars at the time, Irwin was interested in linkages between expertise, trust, and risk and how relationships between the public and expert scientists changed over the latter part of the 20th century. The theory of Risk Society advanced by Ulrich Beck and Anthony Giddens was foundational to his work and argued that Enlightenment principles of progress, modernity, and universal knowledge created a new set of risks through advances in science and technology (Beck, Gidden, and Lash 1994; Beck and Heck 1994). This shifted risk as a concept originating external to society (e.g., an earthquake) to risks as produced by society itself (e.g., toxin exposure in the workplace).

Irwin used the concept of Risk Society to argue that the internalization of risk, combined with an increasingly scientifically literate public, progressively created tension between experts who largely control how science and technology are applied, and a public aware of the limitations and contingencies of science (Irwin 1995). These tensions reveal themes that make up much of the critical CS work today, which have been taken up among STS scholars investigating institutions, practices, meanings, and outcomes of science and technology and their multiple entanglements with the worlds people inhabit (Felt et al. 2017, 1). Thematically, this work has argued that: 1) science itself does not represent one cohesive body of knowledge, and it cannot be taken for granted that it is co-produced or co-practiced; 2) scientific recommendations are underlined by both "facts" and social assumptions and priorities; 3) the principle of replicability—which represents the desire for "broad" and "universal" knowledge—often precludes and erases important place-based and situational knowledges (1995, 50–51).

1.2.2 Scientific Citizenship

Many of the assumed benefits and virtues of CS rest on the concept of scientific citizenship—"the active and aware participation of citizens in the democratic process in the knowledge society"—a contested category shaped by the rise of scientization and boundary work that support the categorization of professional and lay knowledge, practitioners and volunteers (Irwin 1995; Kimura 2016). This concept has received pushback within STS, widely focused on critically examining ideas in CS widely considered axiomatic: 1) that participation is a benefit unto itself, 2) knowledge is co-produced between lay people and experts, 3) CS represents a democratization of knowledge. Mariah Cornwell and Lisa Campbell (2012a), through their work on sea turtle volunteers, argue that volunteers take advantage of their knowledge and physical proximity to spaces that expert scientists may not frequently access. Because of volunteers' local knowledge and the dependence on projects for volunteer labor, CS is more co-practiced across different social nodes of projects rather than knowledge co-production. Aya Kimura's (2016) work in post-Fukushima Japan has shown that women-led CS groups doing radiation testing on food were frequently derided by government officials because their work implicitly challenged gendered norms of who can have scientific authority. In these cases, rather than benefiting from participation, participants suffered discrimination and were stonewalled by government officials and other experts (2016). Both the aforementioned examples support deeper skepticism of CS potential to be democratic when it lacks awareness of the ways power, identity, and politics shape and constrain people's encounters with science (Akkerman and Bakker 2011; T. S. Gieryn 1995; Kimura and Kinchy 2016; Ottinger 2010; Ogden 2008).

Burgeoning interest in CS is evident in the myriad of journal issues dedicated to the topic, including in *Ecology and Society* (Ballard and Cooper 2015), *Biological Conservation* (Ellwood, Crimmins, and Miller-Rushing 2017), *The Journal of Science Communication* (Weitkamp and Lewenstein 2010) and *Diversity* (Cigliano et al. 2021). It is clear that there is interest in cross-disciplinary work in CS, with leaders in the field calling for more attention to the ways in which the practice of CS is embedded in broader science-society relations (Bonney, Cooper, and Ballard 2016). However, there has been less work that engages both the theoretical and practical realities of doing CS. For example, although boundary theory has demonstrated the ways in which expert science serves as a gatekeeper, it is impossible for the relationships between scientists and participants to be completely symmetrical. Participants are often uninterested in participating beyond data gathering, and it has been argued that overdependence on volunteers can be problematic because it a form of unpaid labor (Fischer et al. 2021). CS datasets are often the product of thousands of participant contributions, making it impossible for researchers using these data in research studies to recognize each individual.

1.2.3 Boundary Theory and Boundary Work

A central area of theory in STS is the concept of boundaries and boundary work. Loosely defined, boundary objects are an "analytic concept of those scientific objects which inhabit several and intersecting social worlds and satisfy the informational requirements of each of them" (Star and Griesemer 1989, 393). Maps, specimens, and citizen science monitoring protocols are examples of how "phenomena, objects, and ideas can occupy categories of 'social' and 'natural' 'simultaneously," and become sites of negotiation between different social worlds (1989). In short, boundary object theory helps us think through the way mutually intelligible objects come to have multiple meanings and uses across different users. Within conservation research, this has included concepts like stewardship (Enqvist et al. 2018), ecosystem services (Steger et al. 2018), connectivity (Wyborn 2015), and land trusts (Brownson et al. 2020).

Within CS scholarship, boundary theory has received relatively little attention, and even less so in conservation contexts. Much of the literature has focused on online projects and technologies as boundary objects, emphasizing CS as a collaborative mechanism that bridges participants and scientists (Neset et al. 2021; Huang et al. 2017). Other work has applied boundary object theory to study participant learning (Huang et al. 2017; Hoadley et al. 2019)

(Ekström 2022;), data validation and credibility (Ekström 2022), and the benefits of participants' membership in outside communities of practice on CS projects (Oswald 2020). Although this work has added to the CS literature, CS scholarship has largely focused on treating boundary objects as places for consensus building and a way to strengthen the scientific knowledge and agility of participants. In this way, CS is missing one of the key insights of boundary object theory, which is the different social worlds that coalesce around these objects and the various ways they can be applied.

1.2.4 Traditional Ecological Knowledge

The concept of scientific citizenship—regardless of where it falls in the spectrum of CS theory—has always been historicized as contemporaneous and in direct engagement with modern science, informing who and what are included. Thus, typologies of CS, while varied, are invariably organized by how they engage with scientific ways of knowing and doing (Wiggins and Crowston 2011). This has meant that the contributions of TEK (and other knowledge considered inconsistent with western scientific methodological standards in spite of the documented contributions of these knowledge systems to modern science (Agrawal 1995; Walajahi 2019). Furthermore, this gap means that there has been relatively little CS scholarship drawing from and contributing to literature on collaboration and knowledge co-production in conservation settings. Illustrative of this are decades of work in political ecology (PE), which brought attention to the ways in which participatory conservation often produced uneven power relations between experts and communities and failed to address local conservation needs, particularly in indigenous contexts (Agrawal 1995; Nadasdy 1999; Cooke and Kothari 2001; Jasanoff 2004a).

Today, the influence of this scholarship is evident as conservation science shifts away from participation to models of co-production, which seek to generate context-specific knowledge and pathways among those with diverse types of expertise (Norström et al. 2020, 183). The lack of CS engagement in these conversations can be in part attributed to agreement and engagement as defining attributes of CS. Although there are a growing number of STS scholars whose work has challenged these axioms (Kimura 2016; Cornwell and Campbell 2012b; Agrawal 1995; Lowe 2004), others argue that there are important differences between CS and TEK(Leach and Fairhead 2002).

A growing contingent of Indigenous and decolonial scholarship shows promise in reconciling some of these issues. A "Two-eyed Approach," which refers to "learning to see from one eye with the strengths of Indigenous Knowledges, and the other eye with the strengths of Western knowledges," has informed CS projects among Métis communities in Canada (Canitz and Scotia 2022; Bhawra 2022). Jasmin Bhawra (2022) describes how the shift from individual to *community-oriented* data collection, analysis, and knowledge imparted community control over data represents a way of decolonizing CS. In their study of Multiple Evidence Base (MEB) approaches, (2021b) argue that recognizing the differences between Indigenous and scientific knowledge systems can help them to support one another and that CS policy and practice would benefit from more consideration of the ways in which it can support Indigenous Knowledge Systems (IK/IKS). Describing his work reimagining the relationship between Aboriginal and settler Canadians, Aapaschase Cree scholar Dwayne Trevor Donald proposes "an ecological understanding of human relationality that does not deny difference, but rather seeks to more deeply understand how our different histories and experiences position us in relation to each other," (Donald 2009, 6).

In this dissertation, I ask how CS can deepen engagement with a body of literature increasingly focused on embodied practice, senses, and language as ways of knowing and being across human and non-human beings (Meyer 2001). Much of this work has been influenced by Epeli Hau'ofa's (1994) book *Our Sea of Islands*, which problematized how land-based geographies have framed islands and island people as fragmented, bound, and isolated from one another. Known under various terms like seascape relationality (George and Wiebe 2020), ocean epistemologies (Ingersoll 2016;), and ocean sovereignty (Bambridge, D'arcy, and Mawyer 2002; D'Arcy 2009; Zoysa 2021), scholars are increasingly reframing practices like surfing as ways of knowing (Ford and Brown 2005; Ingersoll 2016), while others have described practices like reclaiming place names connect people in the present to particular ways of feeling and knowing land (Kikiloi 2010a).

1.3 Site Background

One day in October 2018, I sat in a packed *hula hālau* (studio/school) on the east side of Kauaʻi to see the premier of *Kalama's Journey*, a documentary written and produced by members of the Kauaʻi Albatross Network (hereafter KAN) about a Laysan Albatross (*Phoebastria immutabilis)* (hereafter LA) chick raised on the north shore of Kauaʻi. As the lights went down and the documentary was about to start, a forest bird biologist leaned over to me and whispered, "I know who the KAN are, but what do they *do?"*

To be fair to the biologist, it would have been difficult to offer a precise definition of the KAN because the wide scope of things it does and the places it does them. Officially, it is a private organization that works with landowners, government entities, and the public to advance LA conservation on Kauaʻi. They do this by monitoring nest sites; working with private landowners and the Kīlauea Point National Wildlife Refuge (hereafter KPNWR); assisting biologists in activities such as albatross translocations; and, in the past, a collaborative camera project with the Cornell Bird Lab.

Organizations Providing Key Resource Individuals to KAN

Agreement on the Conservation of Albatrosses and Petrels; American Bird Conservancy' Hawai`i Department of Education, Hawaiian Studies Kupuna Component; Hawai'i Wildlife Center; Hawaiian Islands Land Trust; Island School, Hawaiian Studies; Kaua'i County Council Feral Cat Task Force; Kaua'i Endangered Seabird Recovery Program; Kaua'i Invasive Species Committee; Pacific Rim Conservation; Princeville at Hanalei Community Association; The Nature Conservancy-Hawaii; The Safina Center; US Geological Survey, Western Ecological Research Center; U.S. Navy Pacific Missile Range.

Figure 2 Individuals Providing Key Resource Individuals to KAN

The number of volunteers with the KAN is variable and depends on activities. In the 2018 season, about twenty people were signed up to participate in the Cornell Camera project, though I observed only about half of them regularly participate. Monitoring projects were more limited, with a core group of approximately between five and eight members regularly working on these projects. Many members also worked on other citizen science projects, including the Kaua'i Monk Seal Watch and the annual Sanctuary Ocean Count; additionally, others working in journalism, publishing, and art have been supporters of the KAN as well.

Hob Osterlund, KAN's founder, a decedent of six generations of missionary families in Hawaii, began her journey to Hawaii in 1979 when she encountered her great-aunt, whom she had never met, in a dream. In it, she was handed a copy of the text *Hawaiian Mythology*. Serendipitously, Hob's aunt and the book's author were one and the same: famed ethnographer and folklorist Martha Beckwith. *Hawaiian Mythology,* written almost 40 years before Osterlund discovered it, was the first of its kind to research and record Hawaiian oral narratives and is regarded as one of the seminal texts in Hawaiian religion and mythology today. Moved by the encounter, Hob felt the call to return to the islands. Months later while hiking the cliffs of the north shore of Kaua'i, she encountered her first albatross. Reflecting on Beckwith's text, she realized she had encountered her *aumakua,* a divine object of nature that may become a family's protector provided it is acknowledged so with prayers and offerings (Beckwith 1970).

The colonies of LA Hob would have encountered were small, but this has not always been the case. Fossil records show that LA were historically common across the Hawaiian Islands suddenly stopped nesting in the Main Hawaiian Islands (MHI) almost 1500 years (James 1982, Harrison 1993, Moniz-Nakamura 1999). This time period coincides with the arrival of the earliest Polynesians and it is likely that the introduction of new species as well as human consumption led to their decline in this part of the region (ibid). In the early 20th century, LA nearly went extinct due to the feather trade, with only eighteen-thousand breeding pairs remaining in 1922. Their population rebounded after subsequent bans, and today nearly six-hundred thousand pairs exist. Ninety-five percent of their nesting sites are in Midway Atoll and Laysan Island, located within the protected Papahānaumokuākea Marine National Monument.

In spite of the monument's isolation and prohibitions on fishing, albatross are not faring as expected. Because LA typically nest in dunes close to the water's edge, intense storm events and rising sea levels have destroyed critical nesting habitat (L. Young and Vanderwerf 2016) . In 2011, over forty-thousand nests were destroyed on Midway Atoll, putting a dent in the next generation of albatross. Other threats include chemical exposure from past military activity, plastics injection, and killing due to long-line fishing (Young 2009)While the birds are not yet threatened with extinction, the rapidly declining nesting habitat in the NWHI are cause for concern (Young et al. 2009).

1.4 Research Methodology

My interest in CS began when I was a student at Kauaʻi Community College and used my skills as a scuba instructor to participate in reef surveys and provide in-water safety support for other volunteers. During my first year of the ICON program at UGA, I participated in a seminar with others from my first-year cohort on a project with the Little Tennessee Land Trust where we assisted in developing a stream grading protocol and wrote a report on recommendations for implementing the program. Given my growing interest in CS, I applied for and was awarded an Innovative and Interdisciplinary Research Award from the UGA Graduate School to do a small research project on Kauaʻi in the summer of 2014. During this time, I also arranged an internship with Mālama Māhāʻulepū (hereafter MM), an organization dedicated to the ecological and cultural preservation of the Māhāʻulepū region on the south shore of Kauaʻi.

Over a period of six weeks, I focused my efforts on working as a participant observer in activities related to the MM/Surfrider internship as well as conducted interviews for the IIRG research study. I focused my interviews on community activists, educators, CS project leaders, and government officials, and anyone else with leadership experience in CS. Because the number of people who fit this profile, I drew from my prior connections within the community and also used snowball sampling to identify those with relevant experience (Bernard 2006). Thematically, my interviews focused on three broad areas:1) focal conservation issues on the island, 2) volunteer motivations and benefits of participation, 3) impacts of CS and ability for data to meaningfully affect positive conservation outcomes[1].

During the period of my internship, MM was at the forefront of community opposition to a proposal to construct a dairy near Māhāʻulepu because of concerns about water and air pollution. They were working in partnership with the organization Surfrider, which is an organization that focuses on water quality and beach access across the United States and incorporates CS into their research and advocacy (Meyers 2018). During the internship, I was trained on how to collect water samples from streams and near-shore waters in the area. After samples were collected, I worked with a representative from Surfrider to test various indicators of water quality as well as prepare samples to be tested for Enterococcus bacteria levels. I also designed a project where I recorded beach use observations, including subsistence and sporting activities, that were prepared into a summary report and given to MM at the conclusion of the internship.

Throughout the internship and during my interviews, I became curious about volunteers themselves and the role of knowledge co-production and multiple epistemologies in CS and these questions eventually informed my dissertation fieldwork, from fall 2017 to spring 2019

[1] UGA STUDY00001093 (Exempt)

(Figure 1.2). During this time, my research focused on participating in activities related to the conservation of Laysan albatross (*Phoebastria immutabilis*) colonies in an eleven-mile region on the north shore of Kaua‘i with KAN. I primarily participated in collecting nesting data and I also had the chance to observe translocated bird releases, visit homes with experimental habitat, and I participated in a joint project with the Cornell Lab of Ornithology in which volunteers took bird observations through live nest cameras. I carried out all research with the approval of UGA's institutional review board and informed consent protocols[2] (See Figure 1.2 Citizen Science Participation and Research Timeline).

During my initial interviews with the founder of the KAN, I inquired about the size of the group, which was described as between five and eight active volunteers at the time. There was no official way to "join" KAN per se, and I observed a variety of people who supported KAN in ways other than in-person monitoring, including volunteers who only participated in the Cornell Camera Project, landowners, and cultural practitioners. Because of this, I refer to KAN volunteers as those conducting monitoring activities on-island as "core" members and others as peripheral. Based on observations and with discussions with KAN leadership, there were approximately eleven landowners, four cultural practitioners, between twenty and thirty camera operators (including core KAN members), and various government and non-governmental

[2] Project ID: STUDY00004308 (Exempt)

agencies that in some capacity assisted or got assistance from KAN (see Figure 1.3: Organizations Providing Key Resource Individuals to KAN)

Given the small size of the KAN, I also secured institutional approval to act as a researcher in other CS settings, including the National Oceanographic and Atmospheric Administration (NOAA) Sanctuary Ocean Count and King Tides projects. I conducted a total of 26 interviews with CS volunteers, project leaders, scientists, landowners, and others affiliated with the CS projects. In addition to semi-structured interviews, I took informal notes, made video and audio recordings, and collected any materials relevant to CS projects (formal reports, pamphlets, etc.). All interviews and additional document and observational data were coded in Excel for salient themes using in-vivo coding (Bree and Gallagher 2016; Bernard 2006). Specific themes that emerged included grief; animal traits; anthropomorphizing; ecological change; genealogies; volunteering/helping; human/animal encounters; conflict; and the role of CS in volunteers' daily life.

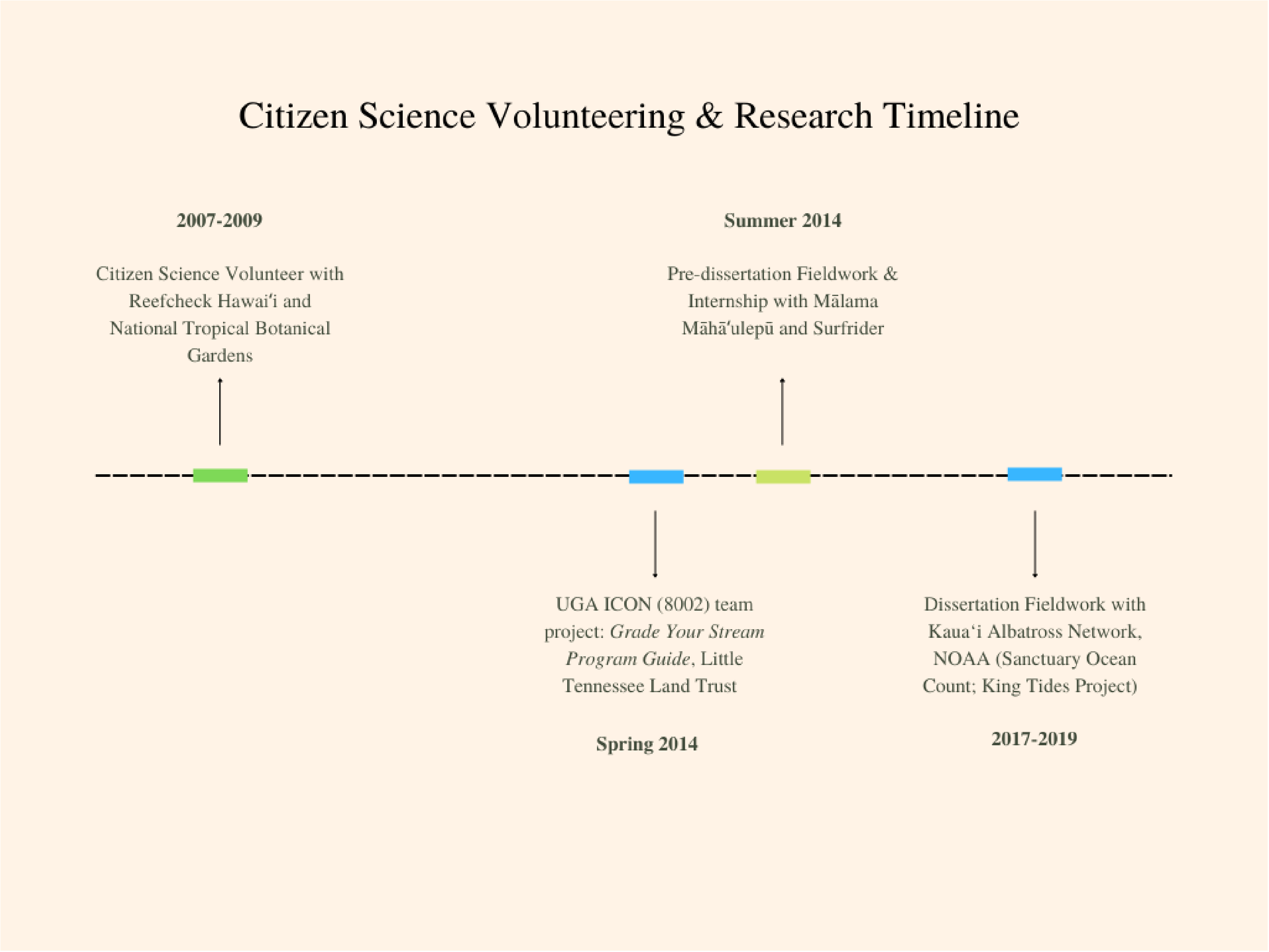

Figure 3 Research Timeline

1.5 The Biocultural Context of the Hawaiian Islands

1.5.1 Biogeography

The Hawaiian Islands are a focal area for biodiversity, and their isolation serves as a living laboratory for understanding processes like speciation, habitat fragmentation, and species dispersal (Kay 1994; Whittacker 1998, 1-6). They are considered "true" oceanic islands in that they formed on their own and were never connected to any larger landmass. Plants and animals that eventually made their home there arrived by long-distance dispersal, brought by the wind, ocean currents, and flight. Although the high rate of extant species also means the islands are ideal for studying processes that underlie extinction, the rapid rate of which species are disappearing—particularly birds—has led to the unfortunate moniker of "extinction capital of the world" (Farmer 2022; M. Phillips 2021; Kahn 2018).

Kauaʻi is the northwesternmost island of the inhabited islands known as the Main Hawaiian Islands (hereafter MHI), which include Niʻihau, Oʻahu, Maui, Lānaʻi, Molokaʻi, Kahoʻolawe, and Hawaiʻi Island. Today just over seventy-three thousand people live on the island, with approximately 100,000 additional visitors every month (" Kauaʻi County Census" 2021; "Annual Visitor Research Reports" 2020). At just over 500 square miles, Kauaʻi's verdant vegetation and nearly 500 inches of rain a year on Mt. Waiʻaleʻale has earned it the moniker of the "Garden Island." Mountain ranges cutting through what started as a shield volcano create an array of climate conditions, ranging from sub-tropical on the eastern windward side to the arid west side. Fringing reefs support a variety of tropical fish and marine invertebrate species, and off-shore areas host migratory mammals like humpback whales as well as other apex species (Inman, Gayman, and Cox 1964). The island is home to a large number of endemic species, many of which are endangered or threatened. In the past forty years, five of the island's thirteen native forest birds have gone extinct (Paxton et al. 2018) and seventy-two of its native plant species are currently threatened (Fricker et al. 2021).

1.5.2 Journeys

The Hawaiian Islands are situated within the larger region of Oceania, which is composed of subgroupings of Pacific islands within Polynesia, Melanesia, and Micronesia and includes twenty-thousand islands. These subgroupings represent both regions and culture areas and serve as reference points for the earliest human migrations into this region[3]. However, it should be noted that these groupings are hardly all-encompassing, and important linguistic, cultural, and biological markers of the people of this region are seen in Southeast Asia, New Guinea, and as far west as Madagascar (Palencia-Madrid et al. 2019)[4]. These people share languages from the Austronesian language family and originated from oceanic migrations from the area of present-day Taiwan circa 1500 to 1000 BCE (Blust 2019). Early dispersals were characterized by the spread of Lapita pottery, and later material culture like tattoo needles and ethnobotanicals like kava (*Piper methysticum*) spread through the region (2019).

[3] It needs to be noted that these subgroupings were first used in 1832 by French cartographer Dumont d'Urville (D'Urville 2003) to partition the region into racial and cultural classifications that situated people vis-à-vis one another on a ladder of evolutionary progress. Thus, it underscores the rootedness of colonial science and mapping practices in shaping peoples' understandings of the region and its people.

The islands people see today are the result of transformative change catalyzed when the first Polynesians arrived circa 1500 years ago (Burney et al. 2001). Having journeyed across the Pacific on canoes, the first people brought with them several species of plants and animals—including taro, sweet potato, and pigs—that provided the sustenance for them to live in a new environment (Abbott 1992). When they arrived, the islands would have appeared markedly different than they do today: plant species and birds found in upland forests would have spanned the entire island and would have lacked many of the plant species people associate with the Hawaiian Islands today.

The health of people and the land were linked through cultural values like *mālama* ‘*āina* (care for the land) and enforced through political oversight over resource use, including the enforcement of *kapu* (prohibitions) (Friedlander, Shackeroff, and Kittinger 2013). A system of *ahupua*‘a divided island watersheds into pie-shaped areas that contained all the sustenance people needed, spanning from ocean fishing grounds to upland forests (Gonschor and Beamer 2014). An ontology that tied people, land, non-human species together in reciprocal relationships is perhaps best known in the story of Hāloa, a child of gods who was still-born. From his grave grew the first taro plant, which is a staple food in the Hawaiian diet (Malo, 1898/1951, p. 244).

1.5.3 Colonialism and Contemporary Conservation

Arrival of Europeans in 1778 had dire consequences for the ecological health of the islands and political and social fabric of Indigenous Hawaiian life. Commercial enterprises like sealing, whaling, and guano mining nearly extirpated species like Hawaiian monk seals (*Monachus schauinslandi*), Humpback whales (*Megaptera novaeangliae*), and Laysan albatross *(Phoebastria immutabilis)* from the Hawaiian Islands by the end of the 19th century (L. Young et al. 2009; Harting et al. 2021). Plantation agriculture focused on sugarcane and pineapple introduced large-scale monocropping that replaced customary land use and also brought in laborers from Europe, Asia, and North America (Takaki 1983; Carroll-seguin 1988). During this period, Hawaiians fought to maintain political control and access to their lands. However, land titling schemes as well as the annexation of the islands in 1898 by the United States shifted the social and political structure of the islands and marginalized Hawaiian communities (Trask 2001).

An important period in Hawaiian history is a period in the 1970s known as the Hawaiian renaissance, which saw a resurgence in Hawaiian language, traditional ecological knowledge, and practices like traditional wayfaring (Boyko et al. 2022). During this time, Native Hawaiians became increasingly politically organized and lobbied to have a voice in conservation decisions. This informed what has increasingly become the standard for conservation science, which Hoku, a Native Hawaiian biologist, summarizes here:

> *Pono* (good, right) Science, a form of receiving free, prior, and informed consent by Indigenous people, became prevalent in Science, a form of receiving free, prior, and informed consent by Indigenous people, became prevalent in the realms of education and STEM. No longer was consent by Indigenous people, became prevalent in the realms of education and STEM. No longer was it acceptable to engage a community for their input; rather, participation of Hawaiians in science became a new standard (Boyko et al. 2022).

Today, practices like traditional wayfaring and feather making are considered important ways of connecting culture and conservation. Consequently, scientific frameworks for viewing environmental issues are increasingly drawing from biocultural frameworks, which emphasize the ways in which people, land, and non-human species have evolved together (Luat-Hūʼ Eu et al. 2021; Sterling et al. 2017; Ulalani Morishige et al. 2018)

Figure 4 Map of the Hawaiian Islands (Map by L. Kosen)

1.6 Dissertation Organization

Burgeoning interest in CS is evident in the myriad of journal issues dedicated to the topic, including in *Ecology and Society* (Ballard and Cooper 2015), *Biological Conservation* (Ellwood, Crimmins, and Miller-Rushing 2017), *The Journal of Science Communication* (Weitkamp and Lewenstein 2010),)and *Diversity* (Cigliano et al. 2021) .It is clear that there is interest in cross-disciplinary work in CS, with leaders in the field calling for more attention to the ways in which the practice of CS is embedded in broader science-society relations (Bonney, Cooper, and

Ballard 2016). However, there has been less work that engages both the theoretical and practical realities of doing CS. For example, although boundary theory has demonstrated the ways in which expert science gatekeeps, it is impossible for the relationships between scientists and participants to be completely symmetrical. Participants are often uninterested in participating beyond data gathering, and it has been argued that overdependence on volunteers can be problematic because it a form of unpaid labor (A. Fischer et al. 2021). CS datasets are often the product of thousands of participant contributions, making it impossible for researchers using these data in research studies to recognize each individual. Because it is impossible to reconcile all disciplinary perspectives, I put my ethnographic research into conversation with concepts of scientific citizenship, boundary theory, theories of knowing and being to ask how CS can be more integrative. Drawing from the ICON framework, I consider how CS can embrace social complexity and the types of iterative processes that can produce better conservation outcomes and equitable relationships between participants and practitioners (Vercoe et al. 2014).

1.6.1 Chapter Two

Chapter Two asks how CS is enacted and narrated to inform a sense of responsibility to reintroduced colonies of Laysan albatross among CS volunteers. Drawing from theories of place, I show how sense of responsibility toward albatross was driven by: 1) the recent phenomenon of albatross nesting among humans 2) the ways in which the practice of gathering data translates into awareness of global issues threatening bird survival 3) how place-based narratives of extinction and return are tied to interrelated migrations of people and non-human species across time and place in the Pacific. This chapter demonstrates the heterogeneity among volunteer experiences and how the practice of CS is embedded in deeper narratives of grief, time, biographies, and human-animal relationships. This chapter adds to the CS literature by demonstrating the heterogeneity of volunteer motivations and ways of knowing and understanding non-human species.

1.6.2 Chapter Three

In Chapter Three, I use boundary object theory to situate citizen science project as a site of heterogeneous engagement and meaning across different social worlds. I draw from my experience as a volunteer in the Cornell Lab 'Tross Cam project to show how the camera took on various representations across volunteers, private landowners, indigenous and local communities, and scientists. I use the case of the Hawaiian monk seal to foreground my analysis and contrast the role of CS volunteers in its management with that of albatross. I show that the camera was a successful bridging mechanism that invited multiple ways of knowing as well as included relational frameworks not normally addressed in CS literature. This chapter adds to boundary object theory in CS scholarship by shifting the emphasis away from boundary objects as consensus builders to boundary objects as spaces with interpretive flexibility that allows for multiple ways of knowing and enacting conservation.

1.6.3 Chapter Four

In Chapter Four, I use spatial, historical, and multimedia data to situate citizen science as a practice embedded in more-than-human networks. I draw from epistemological and ontological theory to question current paradigms in island restoration, which position land and seascapes as discrete from human lifeways. Using Esri StoryMaps, I use spatial data to show the ways in which humans and non-human species in Oceania have been connected throughout time and what these insights can contribute to developing better restoration paradigms.

CHAPTER TWO: CITIZEN SCIENCE AND RELATIONAL FRAMEWORKS[5]

[5] Kosen, L. To be submitted to *Pacific Conservation Biology*

Abstract

Conservation science is increasingly recognizing the value of local and traditional knowledge and its benefits to community-based research. However, research on citizen science (CS) has yet to fully embrace these principles, and critical scholars are calling for CS that is more reflexive, reciprocal, and recognizes the strengths of Indigenous ways of knowing (epistemologies) and being (ontologies). In this paper, I seek to build on this work by asking how citizen science can be more relational. I draw from semi-structured interviews, participant observation, and media analysis of Laysan albatross monitoring projects on the Island of Kauaʻi to show how new colonies of albatross have generated new ways of knowing and being with birds. This was achieved by conscientious engagements from citizen scientists with local and Indigenous communities and integrating practices into CS that reflected multiple epistemologies. This resulted in strong partnerships between project managers and a wide group of stakeholders across the community and serves as a model for how relational CS can inform projects that reflect the wants and needs of communities; are more equitable and diverse; and strengthen relationships between scientists and conservation stakeholders.

2.1 Introduction and Literature

2.1.1 Introduction

Members of the public are increasingly sought out to participate in conservation research (Theobald et al. 2015; Reyes-García et al. 2020; Dickinson et al. 2012b; Albagli and Iwama 2022; Daniel K Niven, Butcher, and Bancroft 2009). Often operating under the moniker of "citizen science" (hereafter CS), much of this work focuses on biodiversity monitoring (Cigliano et al. 2021) and conservation of endangered and threatened species (B. L. Sullivan et al. 2009).

There has been increased focus on understanding social embeddedness of CS participants and practitioners, particularly with respect to their lived-experiences in their local environments (A. Fischer et al. 2021; Cornwell and Campbell 2012a; Kimura 2016; Leach and Fairhead 2002; Riesch and Potter 2014). A small but growing contingent of CS scholars are engaging with these questions through Indigenous and decolonial lenses (Tengö et al. 2014b; Danielsen et al. 2019; S Hecker et al. 2018; Bhawra 2022; Reyes-García et al. 2020; Albagli and Iwama 2022; Pandya and Dibner 2019; Walajahi 2019), reflecting a broader shift in conservation science toward pluralistic and justice-centered ways of doing conservation research (Artelle et al. 2021; Trisos, Auerbach, and Katti 2021). However, this body of theory appears less often in mainstream CS research, which is still largely informed by mainstream management practices and assumptions about value-neutral science.

Given the salience of these issues in the Hawaiian Islands and broader interest in applying human and natural systems lenses to CS research (Crain, Cooper, and Dickinson 2014), I argue there needs to be more attention to the narratives and practices surrounding CS in the region, particularly as they relate to different epistemologies (ways of knowing) and ontologies (ways of being in the world). In this article, I draw from ethnographic research on citizen scientists and communities conserving colonies of Laysan albatross (*Phoebastria immutabilis*) on the Island of Kauaʻi to describe shifting relations between people and albatross over time. I show that CS volunteers recognized that the success of new colonies hinged on establishing socio-cultural linkages between people and birds and worked to forge these connections by drawing upon different domains of socio-cultural knowledge. I argue that this focus on relationality fostered collaborations with stakeholders often excluded in conservation decisions and also practiced CS in away that was attentive to volunteer positionality and the effects of issues like settler-colonialism in the Hawaiian Islands. This research offers lessons for how to increase stakeholder engagement in these kinds of projects as well as contributes to the growing body of literature seeking to decolonialize science.

2.1.2 *Literature Review*

2.1.2.1 Many Meanings of Citizen Science

It is taken for granted that citizen scientists contribute to the knowledge and practice of conservation science. These contributions are shaped by different scales of participation (individual versus community); driven and constrained by different social and political motivations; and are shaped by multiple ways of knowing the world. Today, much of the discourse around these engagements is informed by Richard Bonney's work at the Cornell Lab of Ornithology in the 1970s, which galvanized the concept and systematic study of CS and defined it as science practiced under the guidance and supervision of professional experts (Strasser et al. 2019; Bonney, Mccallie, and Phillips 2009). Practices falling under the banner of CS clearly predate it as a formal area of study as well as the professionalized standards that shape what it means to do science established in the 19^{th} century. Over hundreds—perhaps thousands—of years, people have engaged in systematic studies that were previously dominated by the fields of taxonomy, natural history, and crop and soil data (Miller-Rushing et al. 2020; Kalle et al. 2022; Prakofjewa et al. 2022) that now extends to nearly every scientific discipline. In the global environmental community, it is well established that citizen scientists contribute to the knowledge and practice of conservation science. But the mere phrase "citizen science" indicates how antithetical it has become that one cannot be both an average person and a scientist.

Over the last two decades of conservation science, there has been increased attention to developing context-based, iterative, and pluralistic models of collaboration, often described under various models of “co-production” (Jasanoff 2004b; Schneider et al. 2021; Norström et al. 2020; Wyborn 2014; Chambers et al. 2021; Caniglia et al. 2021). This work is often associated with terms like community-based research (and/or monitoring); participatory action research (PAR); and community-driven collaborative management. How community-based or collaborative research falls under the broader umbrella of CS is often contested. Traditionally, CS follows a model from which funding, research questions, methods, and dissemination flow in a top-down manner, in contrast to other forms of community-based science that are more aligned toward empowerment and social action (C. B. Cooper et al. 2021, as cited in Wilson 2014; Wilson et al. 2014). Others have suggested that what distinguishes CS from other forms of participatory science are a particular set of discourses that situate particular set of social and political relations that are predominant in late industrial contexts of Europe and North America (Leach and Fairhead 2002). The emphasis has thus been on citizen science as alternative science, conforming with its broad categories, more than on the ways in which public knowledge develops in embedded relationship with local social processes and differences, concepts, and moralities.

Scholarship within Science and Technology Studies (hereafter STS) as well as from Indigenous scholars are increasingly flagging the importance of considering local, institutional, and political contexts in which citizen scientists operate. Much of this work recalls decades of scholarship on participatory conservation and environmental governance, which has highlighted the relationships between power and knowledge production, particularly in local and Indigenous contexts (Nadasdy 1999; Velásquez Runk 2014; Brosius 1999). Many of the questions that inform this critical literature aim to deconstruct the values and assumptions that underlie science, including how we know what we know; what we believe to be fundamental truths; and what values and ethical concepts shape scientific undertakings.[6] This has work has been important to challenging ideas often considered axiomatic within mainstream CS research, including:1) CS as a product of *direct* engagement of lay people with experts; 2) participation as an apolitical activity; 3) CS belonging to industrialized, Westernized settings; and 4) agreement between volunteers and about what constitutes knowledge (epistemological agreement) (Leach and Fairhead 2002; Agrawal 1995; Kimura and Kinchy 2016; Cornwell and Campbell 2012b).

2.1.2.2 Indigenous and Anti-Colonial Citizen Science

Although Traditional Ecological knowledge (hereafter TEK) has received recognition in conservation science and various co-managed conservation projects, it often fails to ask why TEK is marginalized at all (Simpson 2004):

> This kind of Eurocentric analysis is unfortunate because it fails to recognize how and why Traditional Indigenous Knowledge systems became threatened in the first place, it undermines the inherently Indigenous processes involved in transmitting IK, and it devalues the rigor Traditional Indigenous Knowledge systems employed for millennia to transfer knowledge to younger generations. Elders have always passed into the next realm and IK systems have always been primarily oral, yet they sustained complex social, cultural, spiritual, and political systems long before the arrival of the Europeans (2004, 374–75).

[6] Known respectively as epistemology, ontology, and axiology. For more on these terms in qualitative and quantitative research, see Aliyu and Adamu (2015).

Additionally, researchers often miss that the ways that the ways in which knowledge is obtained and transmitted are as relevant as knowledge itself and are grounded concepts of place and relationships to non-human beings:

> From an indigenous perspective, Western research is more than just research that is located in a positivist tradition. It is research which brings to bear […] a cultural orientation, a set of values, a different conceptualization of such things as time, space, and subjectivity different and competing theories of knowledge, highly specialized forms of language and structures of power (Tuhiwai Smith 1999).

This type of knowledge is important for understanding how people perceive the environment, cultivate relationships with other humans and nonhumans, and develop perceptions, values, and attitudes about human–environment interactions (Haywood 2014, 66)—yet, it has received little attention in CS. Therefore, a small but growing number of CS scholars are working to explicitly address these themes in their work.

Recognizing the value of both Indigenous and positivist knowledge; utilizing decolonial methods; and bringing both into conversation with CS make up what Jasmine Bhwara (2022) calls a "Bridge Framework" for CS. At the center of this scholarship is recognition of the ways science often invalidates other systems of knowing (Tengö et al. 2014b), and acknowledging that research has had negative effects on marginalized populations (International Society of Ethnobiology Code of Ethics, 2006). Part of this is understanding norms about presentation and dissemination of knowledge, and Indigenous heritage management platforms are one example of where communities have started to take control over what knowledge is shared outside their communities ("The Ethno-Ornithology World Atlas" 2022; Ethnos Project, n.d.). Central to this is that CS researchers need to understand their own positionality in the communities where they work and study (Bhawra 2022), yet there has been little done to understand how these insights can be applied to mainstream CS. In this paper, I build on this work—particularly the Bridge

Framework being advanced in Indigenous CS (Bhawra 2022)—to argue for CS that is more attentive to relationships, positionality, and community norms.

2.2 Data Collection and Background

2.2.1 Methods

Research on CS and albatross conservation was carried out over a period of seventeen months between the fall of 2017 and spring 2019, which included participant observation and semi-structured interviews with the environmental non-governmental organization the Kauaʻi Albatross Network (hereafter KAN). Given the small size of active volunteers, a combination of snowball and convenience sampling were used to locate fifteen participants for semi-structured interviews, which included CS volunteers and practitioners, landowners (with and without nesting sites), conservation professionals, and community members. I also participated as a camera operator for a live-streaming albatross camera jointly managed by the Kauaʻi Albatross Network (hereafter KAN) and the Cornell Lab of Ornithology (hereafter CLO); assisted in albatross monitoring activities; volunteered at KAN events; attended social, scientific and educational events pertinent to conservation issues in Hawaiʻi. Across these contexts, questions and observations broadly focused on narratives surrounding albatross displacement; human-albatross cohabitation in the MHI; relational frameworks; and values and ethics surrounding the care of albatross and the environment. The analysis phase consisted of a grounded-theory approach that applied thematic coding and textual analysis of interview transcripts and field notes to identify salient themes (Bernard 2006).

2.2.2 Introduction to Albatross and the Hawaiian Islands

Laysan albatross (hereafter LA) are a species of seabird whose breeding and foraging grounds span the North Pacific. Ninety-five percent of the approximately six-hundred thousand breeding pairs of LA in the world are located on Laysan atoll and Midway Island, which are part of a chain on uninhabited islands and atolls that make up the Northwestern Hawaiian Islands (hereafter NWHI) (Powell 2014). Once common across the entire Hawaiian Island chain, LA shifted their colonies leeward as Polynesians initially settled the area commonly known as the Hawaiian Islands today, also referred to as the Main Hawaiian Islands (hereafter MHI), which consists of all the inhabited islands in the chain, including Kaua‘i (Olson and James1982, Moniz-Nakamura 1999, Burney et al. 2001 James 1982, Harrison 1993, Moniz-Nakamura 1999). By the early twentieth century, the feather trade, guano mining, and introduction of invasive species to the NWHI reduced their population to just 18,000 breeding pairs concentrated in the NWHI (Powell 2014; Rauzon 2001). Since then MHI populations slowly recovered, and by the 1970s small numbers of visiting birds began to reestablish colonies on Kaua‘i (Telfer 1980; Zeillemaker and Ralph 1992). Their nesting season of LA runs from mid-October to July, and today approximately five-hundred breeding pairs nest along a fourteen-mile stretch on the north shore, which includes the Kīlauea Point National Wildlife Reserve (hereafter KPNWR), as well as the US Navy's Pacific Missile Range Facility (hereafter PMRF) on the west side of the island.

The reasons LA are recolonizing the MHI are likely a combination of the effects sea-level rise in the low-elevation atolls of the NWHI and improved habitat in the MHI (Baker, Littnan, and Johnston 2006; Lindsey C. Young 2009). Although they are not listed federally, LA are currently listed by the International Union for the Conservation of Nature and Natural Resources (IUCN) as Near Threatened (IUCN 2018). Major threats include climate change; long-line fishing (Fischer et al. 2009); ingesting plastics (Nakatsuka et al. 2021); contaminant exposure (Finkelstein et al. 2009; L. Young et al. 2009); and introduced predators, including cats, dogs, mongoose, and mice (Pyle and Pyle 2017). Kaua‘i stands out against the other MHI because it lacks predators like mongoose and is also the only place in the world where LA nest among humans.

2.2.3 Managing Colony Sites: Citizen Science Volunteers and Partner Organizations

On Kaua‘i, the majority of LA are on its northeastern shore, which includes KPNWR; residential and private lands; and public and commercial properties. A single colony on the west shore is located on the PMRF, which is subject to ongoing translocation efforts because of the risk posed to aircraft. Several federal and state agencies work across these sites, including U.S. Fish and Wildlife Service (USFWS); U.S. Geological Survey (USGS) Bird Banding Laboratory; U.S. Department of Defense (DoD); and the U.S. Navy. These are all important sites for monitoring data, which includes recording nest locations; mating pairs; parent visits; hatching and mortality events; and fledging.

Private organizations and individuals also participate in monitoring and other activities related to LA conservation. The KAN is a local organization that coordinates with landowners, government entities, other nonprofits, and the public to advance LA conservation on Kaua‘i (Network n.d.). Aside from monitoring, their work includes banding; consulting private landowners interested in improving nesting habitat on their properties; participating in predator control efforts; assisting in PMRF translocations; and educating the public on issues affecting birds, such as climate change and invasive species (Adams, Felis, and Czapanskiy 2020; Network n.d.). Between 2014-2018, KAN also served as the island coordinator for a live-streaming nest camera done in conjunction with the CLO. In the 2018 season, approximately twenty people volunteered to participate in the camera project, approximately half of whom participated as regular volunteers. Monitoring activities were more limited, with a core group of approximately five to eight members regularly participating. Due to the online nature of the CLO project, volunteers were located across the MHI as well as continental U.S. Most camera volunteers were women, including the entire group of monitors. Several of these core members had traveled to Midway Atoll to count LA nests in the past and were actively involved as volunteers at the KPNWR.

Along with KAN, solitary volunteers also collected monitoring data. Many of these activities were conducted in tandem with governmental and NGO organizations, including KNWR; PMRF; the Division of Forestry and Wildlife (DOFAW); the State of Hawai`i Department of Land and Natural Resources (DLNR); the Safina Center; the Nature Conservancy of Hawaiʻi; and the Hawaiʻi Wildlife Center (Ibid). Both independent and KAN monitors were considered important contributors to these partnerships and have worked with biologists on published scientific papers and news articles on albatross and other conservation issues in the Hawaiian Islands (Lindsay C Young et al. 2014; Steutermann 2019).

A persistent problem in management of threatened and endangered species is making management decisions when there is a lack of data. This is particularly important when it comes to understanding species distributions (Guisan et al. 2013), and CS participants on Kauaʻi have become recognized contributors to the growing body of LA data in the MHI (Bakker et al. 2017; Lindsay C Young et al. 2014). These include monitoring data, maintaining direct relationships with colony landowners, and amassing hours of local observations. While these may contribute to tracking several data points like breeding success, local threats, and population distribution, the growing issue of people and albatross co-existing in proximity also necessitates attention. In the following section, I describe the evolution of LA conservation in the MHI as well as spaces where people and birds frequently come into contact. I show that CS is not simply a process of data collection, but also a place where the lives of people, birds, and other species are becoming increasingly entangled. These interactions support the need for management strategies that consider the changing nature of human-bird relationships and the potential for volunteers to collect data that will inform these decisions.

2.2.4 Living with Albatross

2.2.4.1 Crumbling Atolls & High-Islands

Fossil deposits suggest LA were present in the MHI when early Polynesians arrived, although their populations likely dropped because of habitat loss; predation from newly-introduced animals; and consumption[7] (Burney et al. 2001). After European arrival, populations concentrated in the NWHI were nearly extirpated by the feather trade; guano mining; and egg collection for albumin used in early photography (L. Young et al. 2009; Safina 2003). Since then, El Nino events and hurricanes have already made entire sections of the NWHI disappear overnight, including Whale-Skate Island in the French Frigate Shoals (Reynolds et al. 2015; Eagle 2018). Given predictions of continued sea-level rise, establishing and protecting colonies located in high islands of the MHI has become one of the most important conservation strategies

[7] Paleoecologists believe destruction of lowland habitat had more of an impact than predation (Olson and James 1982)

of LA and will likely become more so as the NWHI continue to be impacted by climate change (Baker, Littnan, and Johnston 2006). These strategies include social attractants and egg translocation; predator fencing; invasive species management; habitat restoration; and population monitoring (Lindsay C Young et al. 2014; L. Young and Vanderwerf 2016; VanderWerf et al. 2019). As ground-nesting birds, LA in the MHI are vulnerable to a variety of predators, and fenced reserves like the KPNWR on Kauaʻi and James Campbell National Wildlife Refuge on the Island of Oʻahu (JCNWR) have been successful in keeping invasive species out. Still, restoration efforts are complicated by the fact that desired pre-human states are impossible and difficult to approximate and that ad-hoc management often exacerbates existing problems (2010, 203)[8].

On Kauaʻi, these issues are compounded because albatross occupy habitat that is often in proximity to humans. In the town of Princeville, approximately forty nesting pairs reside with just under two-thousand residents as well as a portion of the 1.2 to 1.3 million visitors that come to the island annually (ACAP 2022; "Kauaʻi Destination Management Action Plan 2021-2023" 2021). Because of their relative tolerance toward people, LA are opportunistic nesters and can be seen at golf courses; resorts and condominium properties; residential backyards and driveways;

[8] Recent predation of LA by house mice on LA (*Mus musculus*) at Midway Atoll has been hypothesized to be due to increasing populations after elimination of several species of rats, otherwise known as *mesopredator release*(Work, Duhr, and Flint 2021).

and swaths of land adjacent to roadways. An independent monitor[9] who had overseen these sites for over ten years expressed exasperation at their choices of nesting sites:

> I'm responsible for the counts in the Princeville neighborhoods and the golf course. I keep track of the fledglings and count down to the exact moments when they will leave. I constantly worry about getting hit by a golf ball on the course (…) it's inconvenient they nest there, but what can you do?

Although homeowners generally understood the necessity of keeping their distance from birds, at times interventions were necessary. “Normally we leave them to build their own nests, but this year we built a small shed for one, because it kept going under our house,” said one homeowner. Although certain nesting sites were not always ideal, monitors often attributed relatively wide support from homeowners and the resort community for the success of these nest sites. Due to LA philopatry[10], homeowners—many of whom participate in monitoring themselves—often have the same nesters return to breed as well as several visiting non-breeders. The close relationship between people and “their” birds were evidenced by homemade signs many homeowners placed in their yards, which often displayed viewing directives as well as the birds' names. Aware of the hazards birds face in these areas, they were often pragmatic about the tradeoffs involved in urban nesting sites, including the lack of free-roaming domestic pets (i.e., dogs and cats) and community support:

> “This area has everything going for it. We are lucky we have the support of this community (Princeville). We don’t have the problem of feral pigs and dogs

[9] This monitor was independent of KAN
[10] Tendency to remain in or return to the area of its birth

> running loose that you see in other places. The homeowners in this neighborhood like them. It definitely makes buying a home here more attractive for people."

Discourses around the causes and effects of LA colonies in the MHI differed between some CS volunteers and biologists. Population structure studies suggest that a strong driver of LA expansion may be due to dispersal because improved habitat—rather than solely displacement—and the MHI are commonly situated as refugia in the case that sea-level rise continues to destroy habitat in the NWHI (Young et al. 2009). This often contrasted with homeowners and monitors across nesting sites, who often conveyed a sense of themselves and islands being "chosen" by LA. Much of this discourse was grounded in relational narratives that displayed awareness of human incursion and changes to the ecology in the NWHI. "Everything is connected by climate change," said one monitor, "Midway is their mothership, but Kauaʻi is now their Noah's Arc. Nowhere else do they nest in people's yards." In a similar conversation with a Princeville homeowner-monitor, they said, "We know Midway is crumbling. They are here because humans have abused the Earth." These discourses often emerged in tandem with monitors' observations about LA behavior. In one case, a monitor described the ways in which proximity to nests provided insight into the role of humans in the precarious nature of LA survival:

> "Year after year they come back. And when they don't you have to watch while their mate waits […] The moment they show up is so exciting. But then there are the times when they don't come back. Sometimes you find out they have been caught by longlines. Other times you never really find out what happened."

This comment reflected the ways in which the NWHI and ocean were often framed as precarious spaces for albatross and challenged discourses around the isolation, protection, and pristine environments. Many volunteers had visited Midway in the past and witnessed for themselves the abundance of plastics littering the shores as well as the persistent dangers posed by environmental pollutants; ground contamination; invasive species; and airplanes.

2.2.4.2 Not Another Lawn Ornament: Ethics of Living Amongst

The first flights of LA begin often begin with a walk to the cliffsides and bluffs that trace the northeastern shore of Kauaʻi. In many cases, this requires them to walk through winding streets and pathways that cut across residential and resort properties. Once they leave the island, LA will spend four to five years at sea before returning to land. Homeowners were often pleased to have return nesters, and relished the novelty of having their own birds and regarded them as a status symbol. Others, however, held a more skeptical view of human-bird interactions, noting that affinity for birds was not necessarily in birds' interest:

> They aren't lawn ornaments. […] I don't think most people understand their significance, they just see an exotic giant bird. Especially those in vacation rentals. […] We can't possibly be around to monitor what's happening 24/7. It's going to take cooperation between the resorts, the homeowners, and everyone else to educate these people.

In these conversations, the longevity of LA often came up. Decades of banding at in the NWHI have found they can live and produce young for at least seventy years, as long or longer than many humans (Cooper 2022). Research on "backyard" or "urban" wildlife has found that urban spaces can successfully provide good habitat and resources for a variety of species, but doing so often requires landowners to engage in activities that foster a connection to place (Fardell, Pavey, and Dickman 2022). This is complicated with LA because of the transient nature of their interactions with visitors and part-time residents as well as their long lifespan. Regarding the latter, questions surround the ethics of having nesters on property that could be sold or transferred for other uses. Nesting on PMRF have been a persistent problem, with the Navy[11] working seasonally with biologists as well as organizations like KAN to translocate eggs and birds off base. After observing a translocation of adult birds from the base to a private property south of Princeville, a KAN monitor remarked:

> We have had cases where we let them out, they walk straight to the cliff, and then fly right back to PMRF. It takes hours to get them here (translocation sites) and within a few minutes we're back where we started.

The difficulty of translocations is one example of albatrosses' drive to return to sites that they have imprinted on and underscores the thorny questions of what will happen if people no longer wish to cohabitate. Although LA are protected by the Migratory Bird Treaty Act and state laws, most property owners are not required to make improvements to their lands and properties with LA continue to be bought and sold (Hob Osterlund, personal communication 2018).

An additional area of concern monitors cited were interactions with visitors. Although there has been little evidence of LA being regularly harassed, there have been ongoing issues with other species such as Hawaiian monk seals (*Monachus schauinslandi*), which are suggestive of these possibilities, particularly at isolated nesting sites. Monk seals have experienced similar

[11] The Navy has authority to shoot albatross but have not used it to date, and are regarded as supportive partners in LA conservation (Savre 2015).

displacement in the NWHI as LA and are critically endangered. In the past, various volunteer programs were coordinated between the community, the DLNR, and National Oceanographic and Atmospheric Administration (NOAA), using volunteers to assist in education efforts; monitor beach haul-outs; erect barriers around seals; and also share their knowledge of seals at conferences and directly with managing organizations (Robinson and Bernard 2003). Interviews with past seal monitors found that seals were vulnerable because they move to different beach sites and there is a lack of volunteers to observe people-seal interactions. A 2019 study supports these worries, and found that 17.8% of social media posts by visitors using the hashtag "#monkseal" displayed behaviors known to disturb seals, such as approaching closer than posted limits (Sullivan, Robinson, and Littnan 2019). Although visitors most frequently harass seals, there have been high-profile incidences of human-wildlife conflict locally as well (Watson et al. 2011; Walters and Heacock 2003).

While it has been suggested that volunteers may act as a buffer against common sources of conflict, this also carries the risk of exacerbating community tensions. LA monitors were aware of the ways in which seal monitors have often been thrust in the middle of conflicts arising from conservation measures that impose on beach access and subsistence fishing (Robinson and Bernard 2003), and have sought to avoid these tensions by actively promoting "respectful cooperation" between community stakeholders. In a conversation about social attractants, one monitor said:

> "You can't just "plug" them [LA] into the landscape. It takes a lot of work to get people on board, and you can't treat every community the same. You can't talk to every community the same. Because not everyone trusts us.

In the following section, we dig deeper into the social complexities that underlie LA conservation and the tensions that emerged as volunteers observed the impacts of anthropogenic change on albatross.

2.2.4.3 Citizen Science as an Act of Witnessing

The most high-profile KAN project has been its work as the island coordinator of the Cornell Lab of Ornithology "Tross Cam" project, which operated from 2014 to 2018. This was one of many live bird cameras Cornell has managed Cameras coincided with LA nesting season and were broadcasted from private properties where KAN also performed monitoring. As the island coordinator, KAN acted as a liaison to these property owners and worked with Cornell to recruit and train volunteers as remote camera operators. Volunteers consisted of a mix of KAN-affiliated monitors as well as non-KAN members who only participated in the camera project. Camera operation took place in hourly shifts, where operators would simultaneously track albatross with the camera while logging bird activities. This would begin from the time LA pairs began to nest and provided minute-by-minute tracking of events like hatching and fledging.

In contrast to KAN monitors who had physical access, those who were strictly camera monitors only knew albatross through what they saw on camera. Because cameras ran twenty-four hours a day during the camera season, operators had to be prepared to encounter the myriad hazards LA contend with, including avian pox, starvation, and predation. Training sessions had emphasized the importance of not anthropomorphizing birds, and the official policy when a bird was injured was to avoid interference. At times this resulted in conflicts, particularly young chicks were injured or dying. One case embedded in the memories of many was the death of a young chick who was observed having difficulty standing after being banded days earlier. He was eventually diagnosed with a fractured leg and received reparative surgery, but ultimately deteriorated and was euthanized. Although it was inconclusive if the banding had been the source of the injury, some operators and public viewers strongly believed that human intervention was necessary because it had been injured by unnatural causes and were angry the chick had not been treated sooner. Opinions were divided, and some operators expressed persistent sadness after this event. “When I saw the chick die, I was devastated,” one camera operator said, “it was traumatic.” Others monitors expressed mixed opinions, often questioning the effects of camera on the nest sites. “We infringe on their world,” one practitioner said, “Is the camera the natural world or human world?”

Human impacts were also evident through absences on camera. Early in a nesting season mated pairs would consistently switch between nesting and foraging trips, which have been documented to last as long as twenty-nine days with a range up to sixteen-hundred miles (Adams, Felis, and Czapanskiy 2020). In 2018, camera operators noticed that a parent had failed to return from a trip and were informed shortly after that the National Marine Fisheries Service (NMFS) had reported it killed in a bycatch incident with a long-line fishing vessel. Because it was clear that the chick would eventually starve while the remaining parent was foraging, a local bird rehabilitation facility agreed to perform feedings and camera operators assisted by carefully tracking when feedings needed to take place.

2.2.5 Knowing Albatross

2.3.4.1 The Social Capital of Citizen Science Monitoring

Situated southeast of Princeville are approximately eleven miles of nesting sites located on private and semi-private rural lands. Some sites sit empty, with large plastic decoys meant to attract new nesters dotting open landscape. KAN handles monitoring data at many of these sites and assists property owners with and without nesters on predator-control efforts; habitat restoration; installing social attractants, including decoys and sound machines; and conservation easements. In some cases, these efforts have been successful, and homeowners using social attractants have had LA successfully nest at those sites. In contrast to Princeville, these sites are often isolated and inaccessible by visitors and the local community, in many ways making them ideal spots for long-term colonies. While control over access theoretically translates to more protection for birds, the power to access and manage these spaces is tied up in the history of settler colonialism. In this section, I describe how spatial distribution of people and birds and access to conservation spaces are tied up in the epistemic privilege of science.

One of the proposed benefits of CS participation is an increase in "social capital," which in monitoring literature is variously described in context of strengthening relationships between stakeholders (Whitelaw, Vaughan, and Craig 2003; Bliss et al. 2001). The common trope of "knowledge is power" often underlies mainstream CS, with some proposing monitoring data can catalyze "shifts in the locus of power" (Bliss et al. 2001, 147). Given CS research on volunteer demographics consistently finds that most participants are white, college educated, and earn above-average income (Pateman, Dyke, and West 2021; Allf et al. 2022), I disagree in part with these statements, instead proposing that the ability to leverage these data into action is a result of the existing social capital volunteers bring with them to projects. Members of KAN had backgrounds in tech, medicine, and business, and had published scientific publications both independently and in conjunction with leading bird biologists. Additionally, their demographic profiles fit that of typical citizen scientists.

The spatial distribution of monitors close to bird nesting areas also supports my claims. Many monitors lived close to or on major nesting sites on the north shore, which is one of the wealthiest and least diverse areas on the island. In Princeville, seventy-four percent of the population is white and is also home to a large population of transient population of part-time "mainlanders" who live in transient vacation rentals and condominiums part time. In contrast, the area of Anahola, at the lowest border of nesting sites, has a population of fourth-five percent Pacific Islanders and twelve percent of the population are below the poverty line. Most of the land in Anahola is leasehold under management of the Department of Hawaiian Homelands (DHHL), which is meant to provide permanent land for Native Hawaiians. However, prime areas of coastline are privately owned and their home value is generally more than that of leaseholds. This pattern of wealth inequality consistently maps across the island—particularly in areas were communities use local resources for subsistence (Vaughan and Ardoin 2014). Coast-adjacent properties often consume large amounts of acreage, which creates physical barriers between the local community and the high net-worth individuals who occupy these homes. Given the propensity of LA to nest close to cliffsides, interactions between people and birds are therefore shaped by colonial histories that have shifted land and resources as things held in common to being privately owned.

2.3.4.2 Ways of Knowing, Ways of Being

The ways in which LA are now becoming integrated in the MHI are informed by epistemological and relational lenses. Relationships between birds, communities, monitors, other species, and land are not just a product of natural coincidence, but also by the way successive waves of human arrivals have shaped landscapes. Political organization and sophisticated resource-management systems of early Hawaiians supported large populations of people, and practices that would now be labeled "sustainable" today were informed by beliefs that human and non-human worlds were reciprocal and connected (Gomes 2020). The political, social, economic systems later introduced by Europeans quickly severed the connections between people and land, the social and ecological consequences of which endure today. Although management has moved to repair the effects on land, an epistemological bias toward Western ways of knowing still informs many restoration frameworks and turns the islands into isolated masses through theories like Island Biogeography. In what follows, I describe the ways in which monitors grapple with the nature-culture divide; their interactions with Indigenous and local communities; and the ways in which Native Hawaiian forms of embodied knowledge are important to supporting biocultural frameworks.

Integral to KAN's methods and philosophy was involving local and Native Hawaiian communities in various aspects of their work. Although albatross had cultural significance for Hawaiians, birds had not nested in MHI for centuries and new colonies were geographically limited and often isolated. KAN saw value in forging discourses and practices that framed the birds' connections to the MHI in ways that reflected Hawaiian epistemologies and relational frameworks. One way they did this was by inviting Hawaiian cultural practitioners to give the birds on camera Hawaiian names. This affected a set of discourses around LA that situated them genealogically in relation to one another as well as the sites where they nested and hatched.

Genealogical connections are particularly salient in Hawaiian culture. In the Hawaiian creation chant the *Kumulipo*, the genealogy of all humans can be passed back to taro (*Colocasia esculenta*), which is considered the older brother of all mankind (Greenwell 1947). This representation underscores the important cultural relationship with taro, which Hawaiians brought with them on their original journeys and was a staple food in their diet and the ways in which they organized their land (1947). By giving birds Hawaiian names and describing the ways they were connected to particular places, KAN invoked traditional concepts of place in which human and non-human worlds were genealogically connected and bound by reciprocal relationships (Beckwith 1970; Kikiloi 2010b; Gon, Winter, and Demotta 2021; Luat-Hū'Eu et al. 2021; Winter, Lincoln, and Berkes 2018).

The time of the year LA nest on Kauaʻi also coincided with an important period in the Hawaiian calendar known as *makahiki*, which was traditionally a time of tribute and sport (Malo 1898). Albatross played an important role in makahiki ceremonies, and their pelts were used in special standards that traversed the island collecting offerings to petition akua (deities) for a season of successful harvesting (Boyko et al. 2022). KAN also showed support for traditions of Hawaiian feather work and gathered under the direction of Hawaiian practitioners to process feathers for cultural uses. This was part of a larger trend in the Hawaiian Islands of using of using salvage permits through the Migratory Bird Treaty Act (MBTA) to honor the cultural uses of birds in Hawaiian culture (Boyko et al. 2022). These practices became a time to engage in dialogue, reflection, and honor traditional ways of knowing birds, a process that Marcelo Leguia-Cruz et al. have described as "doing together" (2021, 105). This emphasis on tying LA to seasons and sociality was significant because seasonality has been identified as playing an important epistemological role in Hawaiian culture and observational conservation practices as is known as *huliʻia:*

> It is an observational process documenting natural changes over time, identifies dominant cycles within certain species or occurrences (flowering, fruiting, presence/absence of flora/fauna, cloud formations, spawning, or recruiting of fish species, etc.) and assists in identifying correlations between species and/or occurrences as indicators of the other. […] It allows natural cycles to support and guide our management practices, allowing the

> flexibility needed to ensure the best times to rest areas or species from cultivation and harvest—or vice versa. Huliʻia stems from traditional management systems driven by an intimate understanding of the natural environment and the ability of communities to adjust and adapt their activities as best management practices to support these systems of nature.(Andrade and Morishige 2022, 310).

In their work, KAN recognized that ways of knowing and being within Hawaiian culture were manifested through material practices, social relationships, and observations over time. This reflects one of the ways in which relationality came to be a foundational principle in the philosophy and practices that guided their approach to LA conservation.

2.3 Discussion and Conclusion

Conservation researchers are increasingly attentive to the impacts of settler-colonialism, which has resulted in the growth of scholarship in knowledge co-production, decolonial science, and Indigenous methods (Borrelle et al. 2021; Velásquez Runk 2014; Luat-Hū'Eu et al. 2021; Price, Winter, and Jackson 2021; Vallino et al. 2021). Despite this, there has been surprisingly little attention to this in the CS literature. I suggest part of this may be because CS scholarship tends to emphasize the virtues of CS as universally positive (Kimura and Kinchy 2016), leaving scant research on the ways in which it impacts those with different epistemological and ontological frameworks (Walker, Smigaj, and Masakazu 2021; Mahmoudi et al. 2022).

In this context, KAN provides an exceptional example of multiple epistemologies and ontologies in CS, showing a broad attention to relationality, which spanned across human and non-human worlds. First, they viewed their relationships to people and LA as reciprocal. The concepts of reciprocity and sociality are foundational concepts in many cultures (Velásquez Runk 2014, 6; Todd 2016; Tengö et al. 2021a), and have recently received increased attention in CS research (Tengö et al. 2021a). KAN intentionally incorporated this type of sociality into their work, for example when members gathered to process feathers. This is particularly important within the social context of Hawai‘i, where the quality of one’s relationships is an important component of self. Karen Ito’s (1999) ethnographic research has explored these dynamics through a Native Hawaiian lens, describing how her subjects’ internal sense of self was linked to social relationships:

> The Hawaiian concept of self is grounded in affective social relations. The structure and dynamics of interpersonal relations are provided by the interpersonal network linking individuals and the emotional tenor of those relationships. Therefore, the Hawaiian self is tied to the quality and quantity of one’s relationships. Not only are the bonds of emotional affect the ties that support and protect each member, but they define one. One’s affect with others illuminates both self and other (1999, 80).

One of the reasons KAN has been able to be attentive to these issues is their own recognition of their positionality as non-indigenous people working in a settler-colonial context. Jasmin Bhawra’s (2022) research is a particularly compelling example of a CS researcher who has explicitly addressed these dynamics in her work. Sociality and acts of reciprocity were integral to both her rapport within the community in which she worked, but also in shaping her research methodology and theoretical orientation:

> These experiences emphasized the importance of acknowledging the extent to which our systems—and therefore our ways of thinking and doing—are colonized, so that we may begin to reimagine how our approach to health research and community engagement could shift if we took a decolonized approach (2022, 4).

Likewise, part of KAN’s DNA has been engaging with the community, which has informed both their methods and priorities.

Jasmin Bhawra’s (2022) research is also one of the best examples of a CS project that has taken steps to develop methodologies for a more relational CS. Working among Métis communities in Canada, she adopted a “Two-eyed Seeing Approach,” originally proposed by Mi’kmaw Elders Albert and Murdena Marshall (Martin 2012). The metaphor of two-eyes refers to seeing problems with one eye on Indigenous knowledge and the other on Western knowledge, recognizing that both have their own unique strengths (2012, 45–47). KAN's approach to LA conservation reflected this framework for thinking about knowledge. They contributed recognized the value of science and conservation biology of LA conservation through their monitoring work; observations collected through the camera project; as well as contributions to scientific publications and presentations. But they also spent an equal amount of energy into supporting the generation of contemporary local and Indigenous relational knowledge about LA through both in how they practiced CS as well as in highlighting the role of Indigenous knowledge in peoples' contemporary understandings of LA.

Although conservation scientists may not always realize it, relational frameworks play an important role in many conservation issues. In recent years, this has become more apparent with the attention to relationships among people and other beings, whether albatross, spirits, plants, landscapes or others. For conservationists, such relationality is well established in the issue of feral pig (*Sus scrofa*) management in the Hawaiian Islands. Pigs are considered an important part of Hawaiian culture and subsistence, having traveled among them on canoes when they first settled the islands (Luat-Hū'Eu et al. 2021). Since then, researchers have recently argued that pigs and Native Hawaiians have been involved in a long-standing co-evolutionary relationship that was interrupted by settler-colonial land management practices (2021). However, to biologists they are one of many "invasive" species threatening Hawaiian ecosystems and their impacts on species like albatross is an ongoing concern. These competing discourses reflect many of the central concerns within an emergent body of scholarship concerned with peoples' relationships to invasive and uncharismatic species/beings including toxins (Todd 2017); cats (Zelinger 2017); squirrels (Crowley, Hinchliffe, and McDonald 2018) ; coyotes (Draheim et al.

2021) and others. How people care for a particular species affects what other species suffer—also known as the "violence of care"—and it is peoples' particular relational frameworks that influence how these decisions are made. These insights are important to consider within CS research, which often bases assumptions about what species are important through a non-Indigenous lens.

KAN offers important lessons for how to cultivate relational citizen science for conservation. First, scholars, practitioners, and participants must consider their own positionality and the heterogeneous effects of science on certain communities. In order to do this, they need to recognize that no knowledge claim is ever truly objective and that all epistemologies offer situated and partial truths about the world (Haraway 1988). Next, doing CS relationally requires time, effort, and investing in personal relationships. For many communities, these relationships extend to non-human beings, and researchers should be attentive to their own assumptions about how their research is guided by assumptions about nature and culture. Finally, changing our ideas of what knowledge production is (i.e., publication and data) benefits conservation science. Local and Indigenous communities have the benefits of site-specific knowledge that many scientists do not, and sharing that knowledge requires scientists recognize its value and view communities as important partners in developing projects that are culturally-relevant. Additionally, urgent conservation problems often require iterative and evidence-based knowledge, making them more effective than long-term research when issues need to be addressed quickly. Within CS research, greater attention to helicopter or parachute research, knowledge co-production, and collaborative research is likely to address the positionality of citizen scientists and, like, KAN address multiple epistemologies in CS.

There is an attraction in the natural sciences to research at scale, and in CS research this is reflected in the preoccupation with developing various types of typologies in projects. However, as with any typology, they reflect normative ideas about the values and hierarchies that mediate engagements with science (Strasser et al. 2019, 55). These ideas are often not shared across all communities, which suggests that attempting to map CS projects across different contexts may produce sub-par benefits for both communities and science. In this article, I have made the case for a CS that moves past typologies, and is instead informed by understandings of local knowledge frameworks and maintained through reciprocal relationships. KAN's success in engaging a diverse range of stakeholders suggests a relational approach to CS can better inform projects that reflect the wants and needs of communities; are more equitable and diverse; and strengthen relationships between scientists and Indigenous communities.

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CHAPTER THREE: CITIZEN SCIENCE AS A BOUNDARY OBJECT: THEORY AND APPLICATIONS[12]

[12] Kosen, L. To be submitted to *Ecology and Society*

Abstract

All citizen science (CS) projects share the common goal that expert scientists and members of the public will work collaboratively to produce knowledge that can address real-world problems. In this way, CS assumes that a certain degree in homogeneity among participants exists and that those involved will share a common understanding of project goals and reasons for participating. In this article, we question these axioms by applying the concept of boundary objects to a collaborative wildlife camera project between the Cornell Lab of Ornithology and a local Laysan albatross monitoring group on the Island of Kaua‘i. Over a period of one and a half nesting seasons, we conducted twenty-six semi structured interviews as well as acted as participant observers to study the discourses and knowledge-making practices that emerged between scientists, citizen scientists, and local communities. We found that through its interpretive flexibility, the camera facilitated participation between the Cornell lab, local wildlife agencies, citizen scientists, and the local community and produced knowledge about albatross that was relevant to these distinct communities. By holding space for different ways of knowing, the camera facilitated connections across stakeholder groups and attracted participation from groups typically underrepresented in CS.

3.1 Introduction and Literature

3.1.1 Introduction

Amateur scientists have contributed to the collection of scientific data in Europe and North America for at least two-hundred years, evolving into what is now known as citizen science (hereafter CS) (Bonney 1996). The collaborative nature of CS is seen as mutually beneficial: universities, government agencies, and others laud CS as a cost-effective way to gather large amounts of data that would otherwise be expensive and time-consuming (2011), while volunteers get the opportunity to collaborate on "authentic" research projects and deepen their knowledge of science (Evans and Marra 2018; McKinley et al. 2017; Conrad and Hilchey 2011). Though this work spans multiple disciplines, it has been particularly impactful in conservation science (Conrad and Hilchey 2011). By inviting the public to participate in these projects, data on individual species are collected at scales and speeds often unfeasible or expensive (MacPhail and Colla 2020). CS volunteers also have the capacity to contribute to complex conservation issues, including identifying areas of high likelihood of human-animal encounters (Rychyk and Alexander 2019); priority conservation areas (Bonnet-Lebrun et al. 2019); and assessing the effectiveness of proposed management strategies (Bonnell and Breck 2017).

Some of the most persistent issues for CS researchers and practitioners are the quality, applicability, and impact of volunteer-derived data (Cohn 2008; T. Phillips, Bonney, and Shirk 2012). Researchers seeking to address these problems have to contend with the fact that CS inherently "shakes up the traditional science paradigm of how we produce knowledge, who is legitimate in doing science, what counts as research, who "owns" data or can legitimately use them, and who should be credited with findings" (Storksdieck et al. 2016, 3). Complicating this is that CS projects can take myriad forms, ranging from highly supervised "top-down" projects where experts verify data, to those that are entirely volunteer-directed and often operate at community levels (Eicken et al. 2021). Given these facts, there are a growing number of investigations into the work arrangements that characterize research in CS settings, which largely draw from a science and technology studies (hereafter STS) framework. Much of this work has upended common assumptions about work in collaborative settings by decentering many of the typically assumed virtues of CS (e.g., scientific outcomes; public participation), instead focusing on social and material processes that dictate how knowledge is reached, retained, and abandoned particular CS settings (Kimura and Kinchy 2016; Kimura 2016; Cornwell and Campbell 2012a; Irwin 1995; Strasser et al. 2019).

In this paper, I aim to further this conversation by asking CS how can allow for collaboration without consensus. By drawing from Star and Griesemer's concept of boundary objects (1989), I examine Laysan albatross (*Phoebastria immutabilis*) monitoring projects based on the island of Kaua'i as sites where different stakeholders engaged for different ends. I focus on a period time where the Kaua'i Albatross Network (hereafter KAN) collaborated with the Cornell Lab of Ornithology on a streaming nest camera project, which facilitated participation between the lab, local wildlife agencies, citizen scientists, and the local community. The camera acted as a boundary object by offering interpretive flexibility to heterogeneous social groups; maintained a common identity even while it was tailored to group-specific needs; and owed its material and infrastructural properties to the interactions within and across these groups (Star 2010; Star and Griesemer 1989). Using semi-structured interviews and observational data, I tack between three primary sites of knowledge production across the project: ex-situ observations of birds by camera operators; in-situ monitoring by the KAN; and local and Indigenous knowledge practices.

I found that the camera anchored a diverse array of groups that spanned from local to institutional scales. Although groups could tailor the camera to meet their specific needs, its common form allowed for collaborations as well as iterative decision-making across groups. Peoples' motivations for engaging in the camera project were diverse and many of the strongest cross-group partnerships did not necessitate agreement about long-term LA conservation goals. We end this paper by offering several ways the conceptual framework of boundary objects can be of use within conservation CS, including the potential to mediate common sources of conflict in settings with heterogeneous stakeholders; strengthen collaborations; and accommodate different epistemologies (ways of knowing).

3.1.2 Boundary Theory

Interest in the creation, development, and consequences of science and technology in relation to their historical, cultural, and social contexts has coalesced into an interdisciplinary field known as STS. A central characteristic in this work has been avoidance of giving primacy to material or social worlds, instead focusing on the way they are co-constitutive, which is often described under the idiom of co-production[13] (Jasanoff 2004a). Key to this work has been the concept of boundary objects, which are either material or immaterial objects that facilitate cooperation without consensus (Star 2010). While any one group has its own tailored way of interacting with a boundary object, it will also maintain a common identity across groups and can also be used to share information and increase common understandings across disparate social worlds (Fox 2011). Specimens, field notes, and maps are often cited as common examples, although it should be noted that it is the work processes, scales of work, and work done across heterogenous groups that characterize boundary objects, not static categories.

[13] Note the term "co-production," has a markedly different meaning than the way the terminology is typically employed in conservation literature. For further reading see Jasanoff 2004c.

3.1.1 Boundary Theory in CS Research

The influence of boundary theory is apparent in both conservation research and STS, and there is a small but growing contingent of scholars using a boundary object lens to study collaborations in CS projects. Research on co-designed citizen science climate service applications has shown how collaborative development of apps created space for different informational needs and dialogue across different social groups, and also facilitated learning and communication across an inclusive and diverse group of stakeholders (Neset et al. 2021). Similarly, studies of online scientific modeling projects have shown that they serve as constantly-changing artifacts that allow users to reevaluate their knowledge of ongoing environmental management projects as well as facilitate communication between citizen scientists and project leaders (Huang et al. 2017). Researchers have also applied boundary object theory to understand credibility and data validation in CS settings. Ekström's (2022) research on biodiversity CS examined the various information practices that existed within an online species portal, showing that validity was often an iterative process shaped by the continuous monitoring, examining and judging the data of online participants (2022, 15–16). Ottinger's (2010) work on CS air monitoring engaged with both boundary objects and a similar node of boundary theory literature interested in standards and standardized practices in science. Although air monitoring devices known as "buckets" had the capacity to organize the disparate communities employing them, their standardization also limited the ways in which they were used and who could use them. Thus, while boundary objects offer flexibility, this work has shown how standardization can also limit the ways in which different communities can innovate them to meet their particular needs (Fujimura 1992; Star 2010).

In what follows, I advance boundary object theory by situating a CS wildlife camera as a muti-scalar object that attended to the informational and work needs of those conducting ex-situ observation; in-situ monitoring; and community outreach. While each group used the camera to attend to their own needs, they often worked collaboratively and iteratively on conservation decisions. This paper contributes to CS research by calling attention to boundary objects as key sites where groups with diverse and sometimes conflicting views on environmental management decisions can successfully collaborate as well as suggesting new ways to think about the organization and infrastructure of CS projects.

3.2 Case Study and Methods

The Hawaiian Island chain is divided geographically into the Main Hawaiian Islands (MHI) and the Northwestern Hawaiian Islands (NWHI). The former includes all major inhabited islands, including Kaua‘i, while the latter represents a collection of small low-lying islands and atolls that begin in the westernmost edge of the MHI and span twelve-hundred miles into the Pacific. Due to their isolation, the NWHI are considered a focal conservation area for several species and includes over ninety-seven percent of Laysan albatross (hereafter LA) breeding sites (Baker, Littnan, and Johnston 2006). In the MHI, LA were extirpated circa 1,500-1,900 years ago (Burney et al. 2001), limiting their range to the NWHI. Over the past century, NWHI populations have struggled with the effects of hunting, feather and egg collecting, and introduction of invasive species, going from the brink of extinction recovering to over five-hundred thousand breeding pairs today (Olson and James 1982; Rauzon 2001). Following this population rebound, small numbers of birds started returning to sites in the MHI, likely driven by the effects of sea-level change as well as improved conditions in the main islands (Baker, Littnan, and Johnston 2006). Laysan albatross are classified as Near Threatened by the IUCN (VanderWerf 2012), and in addition to habitat loss, warming ocean temperatures are also altering foraging patterns and producing poor breeding outcomes (Thorne et al. 2015). They are vulnerable to being caught as bycatch in North Pacific fisheries and commonly ingest plastics mistaken for traditional food sources (Gilman and Freifeld 2003; Gray, Lattin, and Moore 2012).

Laysan albatross are pelagic seabirds that spend most of their time foraging in the Pacific Ocean (Young et al. 2009). They only return to land during breeding season, which spans from approximately late November through mid-July (2009). High cliffs on the islands of Kauaʻi and Northwestern Oʻahu offer high habitat safe from inundation, and Kauaʻi is particularly ideal because it is the only of the main islands to not have invasive mongoose, which are particularly destructive to ground-nesting birds (L. Young et al. 2009). Kauaʻi also has the distinction of being the only site in the world where LA nest among humans, and there are several nesting sites along its northeastern shore. Given their narrow foraging range and continuing destruction of nesting habitat, colonies in the MHI are increasingly tied to their long-term survival (Arata et al. 2009). The Kīlauea Point National Wildlife Refuge (hereafter KPNWR) is the largest LA colony in the state, with approximately one-hundred seventy mating pairs. Another approximately two-hundred other pairs are spread across private and public lands adjacent near KPNWR as well as a small population on the Pacific Missile Range (PRMF) (Adams, Felis, and Czapanskiy 2020; VanderWerf et al. 2019).

3.2.2 The KAN, CLO, and the Albatross Camera

The diversity of nesting sites on Kauaʻi requires coordination across various government agencies, conservation groups, and community members. Outside the refuge and base, the

Department of Fish and Wildlife (DOFAW) monitors colonies on public and private lands with the aid of individuals and private conservation organizations (Adams, Felis, and Czapanskiy 2020; VanderWerf 2012). The most prominent LA volunteer group is the Kaua‘i Albatross Network (KAN), which is a volunteer-led organization seeking to advance albatross conservation on the island through a mix of bird monitoring, community outreach, and collaboration with landowners and government agencies. At the time of this research, a core group of approximately five to eight KAN volunteers regularly collected nest data on private land, participated in banding, and assisted with bird translocations. They also maintained relationships with landowners upon whose lands many LA nested and eventually served in an advisory role to those desiring to attract more birds to their properties. Cognizant of the lack of human-LA interactions in the MHI historically, they also worked among local and Hawaiian communities, promoting activities that highlighted the importance of traditional ecological knowledge of birds.

The Cornell Lab of Ornithology (hereafter CLO) has hosted a variety of live-streaming bird cameras since 1988, which have allowed the public into the intimate spaces of multiple bird species. Cameras also operate as a forum for CS projects; repository of natural history observations; educational tool; and collaborative space that includes scientific institutions, conservation organizations, and the public. Viewing has become increasingly immersive, with site visitors able to view various bird species twenty-four hours a day in high resolution streaming video. Cornell Lab cameras have collectively recorded over a billion minutes of bird observations and have proven to be efficient and impactful vehicles for gathering CS data (“Birdwatching Goes Hi-Def with Axis. The Cornell Lab of Ornithology Uses Axis Network Cameras Creating an Intimate Bond with Birds.” 2012). In addition to providing important biological data on birds, these projects have also provided insights into the use of streaming cameras in CS projects. For example, in 2021 the National Science Foundation (NSF) provided funding to Cornell for several CS investigations using archived video footage of four different bird species captured on CLO cameras (Mady et al. 2021).

Beginning in 2014, KAN acted as the island coordinator on a project with Cornell to host a streaming camera for LA nests. The project operated seasonally until 2018 and was conceived to bring awareness to LA conservation as well as gather data on the growing colonies in the MHI. The camera became instantly popular, logging over a million different viewers in its first season ("Bird Cams FAQ: Laysan Albatross Nest" 2012). During the period of this research, a mix of approximately twenty volunteers from within and outside KAN had signed up as volunteer camera operators, with an average of ten participating regularly. Volunteers included a combination of full and part-time residents as well as people living on the continental United States. Training for these positions included a Cornell-led seminar that included basic bird biology, the logistics of operating the camera, and managing the social media associated with the camera project. Volunteers then signed up for shifts where they would both operate the camera from their computers. Operation was done by logging in remotely through the internet to Axis Communications P5635e cameras with both pan/tilt/zoom (PTZ) and infrared (IR) capabilities. Volunteer logs and communication between volunteers, Cornell, and KAN were managed via RingCentral team collaboration software. While Cornell managed the physical infrastructure of the camera and streaming platform, KAN located nesting sites ideal for the camera and provided some of the volunteers who would operate them remotely. KAN also performed in-person monitoring at these sites and responded when there were issues that threatened nest safety, such as feral animals. The camera featured one nest in 2017-2018 and three in 2018-2019. A variety of other birds, including nest parents, potential mating pairs, and unmated adults were also commonly seen on camera.

3.2.3 Methods

The results in this article cover a period of fieldwork carried out from December 2017 and May 2019—a period of approximately one-and-a-half nesting seasons. I conducted twenty-six semi-structured interviews and participant observation to study three primary modes of knowledge production in the project: ex-situ observations of birds by camera operators, in-situ monitoring by the KAN, and local an Indigenous knowledge practices. Interviews took between one and two hours to complete, and when feasible employed video-queued methodology (VCE), where the participant was asked to view the camera stream from a laptop in order to deepen the richness of responses to the interview questions (Adair and Kurban 2019). Interviewees were located through a combination of purposeful and snowball sampling, and included KAN leaders, camera volunteers, landowners, conservationists, government officials, and others from similar citizen science projects[14]. Participant observation included volunteering as a camera operator; participation in field monitoring; and attending social events and scientific talks associated with KAN. In total, interviews, participant observation, and other activities took approximately 123 hours to complete.

[14] Purposeful—or judgement—sampling is particularly-well suited to case-studies of small populations. This study included project leaders and participants from other CS projects that employed similar methodologies (i.e., simple monitoring) and had similar objects of study (i.e., migratory humpback whales).

Analysis employed a grounded-theory approach, where notes collected through participant observation and interviews were coded for salient themes (Bernard 2006). Throughout my analysis, I was attentive to three major themes: First, I focused on instances of conflict and anxieties, both about how CS was practiced as well as how people perceived environmental and human impacts on LA. This sometimes manifested within the actual events observed during participant observation, and at other times anxieties were reflected in peoples' discourses and practices. Next, I examined the role of positive affect in volunteering as well as toward non-human animals. I paid particular attention to the discourses of camera operators as well as observations of who spent time on the camera as well as how long and how often. Last, I investigated where themes of cooperation and collaboration emerged in the KAN/CLO camera project. This was done by studying the various institutions and actors connected to the project at various scales as well as the ways in which project leaders and volunteers articulated the value of collaborative work. I also applied a similar approach to two sources of media related to KAN for similar themes, with an emphasis on Native Hawaiian epistemologies and ontologies. The first was a thirteen-minute audio recording of Shad Kane, a Hawaiian cultural practitioner, speaking about the cultural significance of birds at the Pacific Seabird Group conference. The other was a nine-minute KAN produced documentary, *Kalama's Journey*.

3.3 Results

3.3.1 Ex-situ Observation

KAN and Cornell were jointly responsible for the coordination as well as the physical and infrastructure of the LA camera, although their myriad other organizational responsibilities meant much of the camera operation was left to other volunteers. Over five seasons of the CLO camera, operators logged their observations into hundreds of spreadsheets, which included banding data that went to the USGS Bird Banding Laboratory (USGS BBL). Scientists currently use these data to understand LA population dynamics, movements, and threats to survival. For example, The National Marine Fisheries Service Pacific Island Regional Office Fisheries Observer Program requires observers to be present on Hawaii-permitted longline fishing vessels and record when LA have with vessels and become accidental bycatch (NOAA 2014; 2018). Recovered banding numbers are then reported to the USGS BB, which in turn helps biologists on Kauaʻi understand the impacts of things like fishing on local LA populations.

In addition to their scientific contributions, operators were also responsible for engaging the public via the camera's Twitter feed and documenting LA on a camera in a way that considered the aesthetics of their shots. They often captured events that could take hours or even days to observe such as hatchings—which last anywhere from 48 to 72 hours—and regular occurrences such as feedings; the arrival and departure of nesting parents; and other behaviors. In some cases, operators were the first witness novel observations, such as when LA interacted with species not found in the NWHI, including feral chickens and endemic nēnē geese (*Branta sandvicensis*).

Camera operation required considerable time and dedication of many volunteers, who often spent time watching the camera and interacting with other volunteers while off-shift. During an interview with a volunteer who lived part-time on Kauaʻi, she described the personal connection she had forged over years as a volunteer and propensity to check on the camera at all times of the day and night:

> I can't even describe them (LA); I fell in love the first time I saw one; I love watching how they take care of each other. It's kind of like an obsession, I'll even wake up in the middle of the night to check the cam and see how they are doing […] I know people

> might get annoyed with me sometimes for hogging the camera shifts (laughs), but I can't help it.

Other volunteers living off-island often took time to visit Kauaʻi during next season as well. While observing the camera live steam on a laptop, one volunteer from the west coast of the U.S. described how her work as a wildlife illustrator informed her experiences and motivations as a volunteer:

> To me, they (LA) represent love. Their dedication to one another, to their chicks. Life is so fast paced; when I watch it feels like I can leave that world (human) and just let go and be in the moment. It feels like a drama, and I'm honored to witness it […] I worry about them. They're like lots of species today. People don't pay enough attention; they don't watch what's going on around them and how it affects other species. People can deny things like climate change because it's not affecting them yet. But we know how it's affecting other species. We can see it. We can see when they throw up plastic. If one of the parents leaves and doesn't come back, we know why. And then we're left with the consequences of a chick possibly starving to death.

Her comments underscored the difficult emotional terrain volunteers often had to navigate as observers and documentarians of the struggles of LA to survive in a changing world. Enjoyment derived from easy access to the inner world of the nest sites as well as familiarity with specific birds was frequently cited as a key motivator and benefit of volunteering. While volunteers had been trained that all communications via social media as well as shift logs were to be conveyed in factual and scientific language, chat-logs within the RingCentral app often contained emotionally charged language as well as observations or comments deemed extraneous and unscientific. At times this pitted Cornell and KAN-affiliated volunteers against other operators, resulting in a demarcation of scientific versus unscientific discourse within the camera project. This represented what Thomas Gieryn terms "boundary work" (T. Gieryn 1983), which is the construction of a social boundary that delineates certain intellectual activities as "non-science."

Cameras are often promoted to experience nature from the leisure of one's living room, but their site-specificity and observers' intimacy with animals can also be a barrier to understanding big-picture issues. Within the camera project, volunteers' propensity to anthropomorphize birds strained relationships between the KAN members who were motivated by science in the service of conservation and operators motivated by the sheer love of birds. Managing events such as when a bird was sick or injured required clinical decisions that often required coordination with government agencies and licensed wildlife rehabilitators. At times, this erupted into tensions over operators' negative reactions to these events. In an interview with a KAN leader, she described her concern about these events and volunteers' dramatizing observations:

> When an animal lets you in their world, you see something different. Cameras give you insight into things you may not want to see. Not just things like sickness. Maybe a chick is out in a storm and standing there all wet. That's a normal thing. But then people put on their own feelings: "It's lonely." "Its cold." You can't do that […] The camera has been valuable […] It brought out a connection and good heartedness in people. But it can also give a false sense of distance. You need to ask: is this infringing on their world?

The contrast between operator and KAN discourses demonstrates that volunteer motivations about participation differed. While some people cited things like climate change as motivating factors, others did it simply for enjoyment. At times, volunteers' propensity to anthropomorphize birds caused conflicts, although the time they invested in camera ultimately supported the production of scientific data. I return to this point later in the paper, where I discuss the ways in which camera operated at different scales.

3.3.2 In-situ Monitoring

In order to sustain and expand LA colonies on Kaua'i, social attractants (decoys and sound boxes playing bird vocalizations), habitat restoration, predator fencing, invasive species management, and safe areas for translocations are priority conservation strategies (VanderWerf et al. 2019; Savre 2015; Adams, Felis, and Czapanskiy 2020). Translocation projects have been particularly important to managing both bird and human safety. Adult mating pairs on PMRF colonies often nest close to large Navy runway area, and eggs are taken from the original parents and given to nesters on the north shore to discourage further colony growing at the PMRF.

KAN leadership recognized the value of private property owners early on, and had built a reputation for a thoughtful and balanced approach to LA management on these lands, which the founder described in an interview:

> It's amazing but also a challenge that this is the only place in the world albatross nest among humans. I became aware of landowners early on and focused a lot on engagement. A lot of it really hinges on what kinds of connections you can make, and also not making mistakes that lead to distrust. This isn't just habitat, it's where people live. You can't just come in and start telling people what to do. It's a partnership.

Their work as the island coordinator for the camera project was one example of the trust they had built through a strategy of "non-confrontational habitat management" and their ability to build relationships between stakeholders such as Cornell and individual landowners. Although cameras only occupied one property per year, the rural and close-knit characteristics of these communities meant KAN increasingly gained rapport with other site owners because of their existing work within these communities.

One of the benefits for those hosting cameras was that it required little from homeowners. The camera was provided and operated by Cornell and volunteers and KAN performed in-person monitoring. This was because “on-cam” nests made up only a portion of the birds on camera properties at one time. An interview with the owner of a former camera site illustrated this point: “Do you identify as a conservationist?” they[15] were asked. Letting out a laugh, they rebutted: “No, not really. Not that I don’t care, but that’s not my thing and not why I like them. It’s their personalities, how different they are.” Still, they conveyed considerable affection for the birds, relaying with bubbling excitement witnessing a bird that had hatched on their property fledge from the side of their pool:

> We were all in awe. I mean, it just walked out and did its thing like we weren’t even here. Everyone had their cell phone out waiting for it to finally take off. That’s not the kind of thing you expect in your yard.

Following up about why they had agreed to host the camera, they said:

> It’s an easy thing to do, and we like (Name redacted). They are always respectful of our space and if what they’re doing makes it easier for the birds, I’m happy to help. It’s a unique thing to have this bird in your yard that people all over the world want to see it.

In this case, the initial buy-in to host the camera did not necessarily need to stem from holding any conservation goals per se, and their willingness to help stemmed from KAN’s investment in relationship building and work on creating flexible sites for community engagement.

When landowners were interested in doing more, KAN worked as a consultant and adviser on how to improve existing nest habitat as well as how to attract mating pairs to properties with no established nest sites. In some cases, KAN helped individuals gain approval

[15] We are using a gender-neutral pronoun to protect the identity of the individual who was interviewed.

for the PMRF translocation chicks to be moved to their properties. Other common methods included installing decoy attractants as well as educating people about the importance of native vegetation:

> It was because of KAN we got involved […] All the things we learned about safe habitat was from them […] We have had albatross visit, but none nesting yet. That's why we have those decoys and planted native vegetation, to hopefully attract them.

This owner, who did not yet have established nesters on their property, went on to describe KAN's influence at the neighborhood-level for dealing with the pervasive issue of feral animals:

> Now there's a neighborhood consensus about trapping feral cats and dog-proof fencing. Because it really can't just be one property. There needs to be community awareness, but also sincere motivation because a lot of this requires money and time. […] What's good about (Name redacted) is she is a really good listener, which is so important. I think most people when you ask them want to help with these kinds of things, but they also want to make sure they won't be negatively impacted. If you're only concerned about the birds, but not about people, people sense that.

Managing animals on private lands is often difficult to coordinate even when there is high support for conservation goals (Cooper et al. 2007; Thompson et al. 2004), and KAN leaders were also cognizant of the heterogeneous conservation attitudes and knowledge across the community:

> Many of these people aren't from here, but they have some of the most valuable, safe habitat for birds. You can't keep predators out of a lot of places, but you can here. People from Kaua‘i know all about feral cats because it's such a big thing. But you can't assume people from the mainland[16] do, and you have to educate them without being patronizing.

[16] Continental United States

KAN recognized that meeting landowners on their own terms was the best strategy for engagement. At times, this meant simply hosting a camera. At other times, landowners desired more involvement and even took the initiative to make changes at the community-level. Overall, this underscored KAN's flexibility in understanding that the needs and desires of those with whom they partnered could not be assumed to be uniform. We expand on this point in the following section, where we describe the ways in which the camera became a site to produce Indigenous knowledge as well as fostering relationships across stakeholder groups.

3.3.3 Representations and Knowledge Production

The camera also was a place that bridged Indigenous communities and conservation organizations and held space for Indigenous representations of LA. Early in 2018, two CLO project managers visited Kauaʻi to assist in the launch of a new camera. During their trip, there was a blessing ceremony co-organized by KAN and CLO and hosted by the property owner whose home sat on a bluff above the nest sites. Kauaʻi Albatross Network invited Native Hawaiian cultural practitioners and members of a local *hālau hula* (hula school) named Studio Ha`a, who all assembled around the area of the camera and its nests. During this ceremony, they conducted ceremonial rites including traditional *mele oli* (chants) and mele hula (dance) in front of observers that included KAN members, camera operators, members of local conservation organizations, the CLO managers, and others living on the north shore.

Events like blessings were one of the many examples in which KAN sought to bridge Indigenous communities and scientists. For example, in 2019 the Pacific Seabird Group (PSG) conference was held on Kauaʻi, and KAN served on its organizing committee. The opening plenary included Indigenous speakers as well as a special blessing ceremony by Studio Ha`a.

Indigenous speakers were also invited to hold talks at the conference, and KAN arranged for a well-known cultural practitioner from the island of Oʻahu to present on the cultural significance of seabirds in Hawaiian culture, including their traditional uses in *nā hulu aliʻi* (royal Hawaiian feather work) (Kane 2019).

KAN also included Indigenous and local people in creating media about LA. In 2018, KAN published a short documentary called *Kalama's Journey*. Kalama was one of the chicks that had been translocated from PMRF and had been given to a pair of nesters featured on the CLO camera. The documentary charted its life from hatching until the moment it fledged, and described the role of cooperation between the various stakeholders on Kauaʻi in the long-term success of these colonies. The documentary included several testimonials about the importance of LA for the community, which centered Indigenous and local voices. These included several prominent cultural practitioners, members of Studio Ha`a, and community leaders who were shown in the film at the camera site. Most Laysan albatross colonies on Kauaʻi are inaccessible, and many of the discourses contained in the documentary reflected that people saw the experience as a way to learn both about birds as well as human roles as stewards:

> Maybe what the *mōlī* (Laysan albatross) is doing is actually talking to us, teaching us. Inspiring us that out of all the places they could choose they're here…maybe its reminding us of how special this place is, reminding us that we need to care for it.

This statement echoed a common theme in KAN's discourses about birds, which was that Kauaʻi and its people had a unique relationship with LA. Speaking with one of the leaders of KAN, they said:

> People and albatross haven't lived together before, and we have to recognize that there is no roadmap for how to co-exist with an animal […] The albatross are the ones that chose to come back, but we obviously played a role in that. We know that they once lived here and that they nearly went extinct because of people. So we can either choose do what we

> usually do, which is ignore what we're doing to the Earth, or we can take this as a sign that we have a role to play in this.

Later, they addressed the importance of TEK and the concept *malama* '*aina,* which is a Hawaiian concept of care for the land.

> If you think about it, the words you use reflect the things you think are important […] There's no word in our culture like mālama[17], but I think it's a concept people need to learn. […] That's why it's so important to acknowledge our shortcomings and what we can learn from Hawaiian people.

KAN were particularly attuned to how they crafted their messaging around LA and the impacts narratives can have on peoples' perceptions of species, which was one of the reasons involving local and Indigenous people in the camera project was so important. For example, Hawaiian Monk seals (hereafter HMS) (*Monachus schauinslandi*) had been the subject of ongoing human-wildlife conflict in Hawaiʻi, and common narratives about the conflict often pitted Native Hawaiian communities against the government (Sprague and Draheim 2015). KAN leaders were aware of the way this perception affected the arc of HMS management and its possible implications for new LA colonies:

> Unlike albatross, seals are perceived as class and race issue. There's a lot of blame and it causes people to take sides. It doesn't help that volunteers are mostly white; people saw who killed seals and suddenly it was made out to be locals versus the government. Even though people are now admitting it's about deeper issues, that idea is entrenched.

Consequently, KAN recognized that the recent phenomenon of LA nesting among people required discourses that situated birds within the broader human community. However, because

17

people and birds had never lived among one another contemporaneously, learning how to do this was a process that would require conservationists being attentive to the ways in which people come to know and relate to other species. The camera served as a space where various stakeholders could come together to learn about and share their knowledge iteratively, which speaks to the many forms it took.

3.4 Discussion

The CLO/KAN partnership was a key example of how the camera acted as a boundary object by offering a site for flexible knowledge production and widening engagement across stakeholder groups across scales, even when they did not share common goals. For example, although operators were integral to collecting data, some volunteered without any overarching goals other than they enjoyed participating. This included many hours observing cameras off-shift and dedicating a great deal of time to providing detailed shift logs and social media posts. In contrast, while KAN members participated in cameras, they were also interested in establishing relationships across different stakeholders, contributing to long-term data sets, as well as gaining iterative knowledge through monitoring work and translocations. The camera also served as a boundary object by bridging conservation partners with local and Indigenous communities at the camera sites, which was an example of how the camera was a place where ill and structured uses coalesced.

Previous research in collaborative research settings has found that boundary objects, while providing spaces for the exchange of information, also facilitate reciprocal relationships that cross cultural and organizational boundaries (Di Marco, Alin, and Taylor 2012, 33), although this has received less attention in mainstream CS research (Hetland 2008; Tengö et al.

2021b). My findings support that data exchange across the project was indeed reciprocal. Landowners were willing to work with KAN because they had a positive relationship, which often later extended to their properties being used for cameras, translocations, and new nest colonies. Likewise, while operators derived enjoyment from watching cameras, their observational data benefited LA conservation at local, regional, and international scales, including organizations like KAN and CLO, who performed the work of maintaining the camera.

3.5 Conclusion

Table 1 Boundary Objects and CS: Benefits and Outcomes

BOUNDARY OBJECTS AND CS

Benefits/Outcomes	Example from Article
Widen and strengthen connections across stakeholder groups	Academic institutions; governmental/NGO/volunteer orgs.; landowners; community groups; etc.
Beneficial in situations that require iterative decision-making	Experimental habitat; decoys; translocations
Can help mitigate sources of HWC	Understanding socio-cultural context
Mitigate issues of volunteer turnover/loss of project knowledge	Production of various physical and discursive artifacts
Increased diversity and inclusion; knowledge pluralism	Respect for local and indigenous knowledge; volunteer/practitioner reflexivity

Boundary object theory offers several benefits for CS, which extend past the regional focus of this paper. For one, boundary objects have recently been proposed as a way to address transience in volunteer settings (Pedersen 2019) because of their properties to produce discursive and material artifacts that are easily understood across groups (Star 2010), which were present throughout the camera project. Volunteer retention is one of the biggest challenges facing CS projects (Frensley et al. 2017), and the majority of contributions in CS projects are made by a small fraction of the volunteers in an overall project (Schulwitz et al. 2018), which was the case with the KAN and camera volunteers. In addition to data, thousands of volunteer chat logs and posts on Twitter feed documented important details about the natural history of LA on the island, while naming and genealogies tied to important Native Hawaiian cultural practices ensured that future generations of people on Kauaʻi would understand LA's connection to the island. Additionally, documentaries as well as KAN publications were important for documenting the work of volunteers and the on-the-ground knowledge they gained through their monitoring work over the years, which were shared across a variety of stakeholders.

The camera as a boundary object also served as a space for people unaccustomed with LA to interact with them in positive ways. The amount of public land on Kauaʻi where a person can encounter has been LA limited, and it is the only island of the MHI where they can be found nesting among humans, leaving no definite road map for how to manage potential conflict. The KAN was aware that in the past, peoples' unfamiliarity with species like Hawaiian monk seals had caused conflicts that pitted people against seals as well as against one another. *Kalama's Journey* offered an excellent example of how the camera provided space to share and circulate Native Hawaiian TEK about LA, which played an important role in circulating the narrative of people, place, and LA as interrelated. Past research supports that peoples' familiarity and types of media coverage play a role in managing community relationships with unfamiliar species (Delibes-Mateos 2020; Mckenzie, Leong, and Robinson 2020). This is supported by the literature on nature-related webcam viewing, which has shown that these activities are effective at fostering emotional connections and generating support for conservation (Skibins and Sharp 2019; Richardson and Lewis 2022). KAN's work with local and Indigenous communities offers an important lesson for why integrating pluralistic knowledge into CS can translate to direct conservation benefits like prevention of conflict as well as increase diversity and engagement in these programs.

In this article, I have used boundary object theory to understand the work arrangements and heterogeneous knowledge that emerged from the CLO-KAN camera project. In part one, I described how camera operators became skilled observers and biographers of LA life. After months of observations, operators often formed strong attachments to birds and were left negotiating discursive boundaries set upon them by project managers. On the other side of the camera, KAN leveraged the project to connect with landowners and access properties for monitoring purposes. My interviews found that conservation values were not necessarily predictive of participation in the project, and even minimal involvement on the part of homeowners was still beneficial to LA conservation. Finally, I described how the camera became part of the partnership between KAN and local and Indigenous communities. This was accomplished in part by KAN's willingness to practice reflexive volunteering, which I suggest deserves further attention in CS research. This research has contributed novel insights into the collaborative dynamics of multi-stakeholder CS projects and has also called attention to collaborations with Indigenous communities as an area that is currently under-theorized in boundary object and CS research.

CHAPTER FOUR: SUMMARY OF THE STORYMAP PROJECT[18]

[18] Kosen, L. To be submitted to ArcGIS Storymaps: https://arcg.is/K1quP

Abstract

In this chapter, I use maps, multimedia, and narrative to situate Laysan albatross (LA), citizen scientists, the communities of Kaua‘i within a larger history of migrations in the Pacific. I ground the Storymap in a framework of various ocean epistemologies and ontologies, which re-orient the Hawaiian Islands from an isolated landmass to a place that is connected to the larger region of Oceania. My approach to telling this story is informed by a body of critical theory that includes critical GIS and decolonial scholarship (Mahmoudi et al. 2022; Vierros et al. 2020; Pearce and Louis 2008; Runk 2015). In doing so, this project reflects multiple epistemological lenses and speaks to different communities.

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4.1 Research Summary

In this chapter, I use a framework of ocean epistemologies and ontologies to connect citizen scientists, land, Laysan albatross, and communities on the island of Kaua‘i. I apply maps, multimedia, and narrative to trace out intersecting migrations, reorienting the Pacific as a place of connectivity. I situate citizen scientists within these migrations as many of the first people to observe and record observations of LA and as those who frequently observe the environmental impacts of humans in the Northwestern Hawaiian Islands. By drawing from multiple epistemologies and ontologies, I engage with increasing calls to decolonize geospatial research and incorporate both Indigenous and positivist knowledge into mapping (Vierros et al. 2020; Pearce and Louis 2008; Runk 2015). In what follows, I describe the methods that informed this research before presenting images of the maps embedded in the published Storymap.

4.2 Methods

ArcGIS Storymaps is an online platform that integrates maps, visual and recorded media, and text to author stories. I used ArcGIS Pro and ArcGIS online, which both have functionalities for data maintenance, visualization, and advanced analysis in 2D, 3D, and 4D. Although they shared similar mapping capabilities, they were distinctly different to operate and consequently required different workflows when constructing maps. Additionally, I used Canva to create my own clip art that was applied directly within the maps as well as in other areas of the Storymap. For images, videos, and audio recordings, I drew from my research data as well as images available via public archives. I edited images and video in Adobe photoshop to improve picture quality and achieve a cohesive aesthetic throughout the Storymap. For audio, I used Audacity software to produce clips as well as enhance sound quality.

4.3 Results

4.3.1 Hawaiian Islands World Map

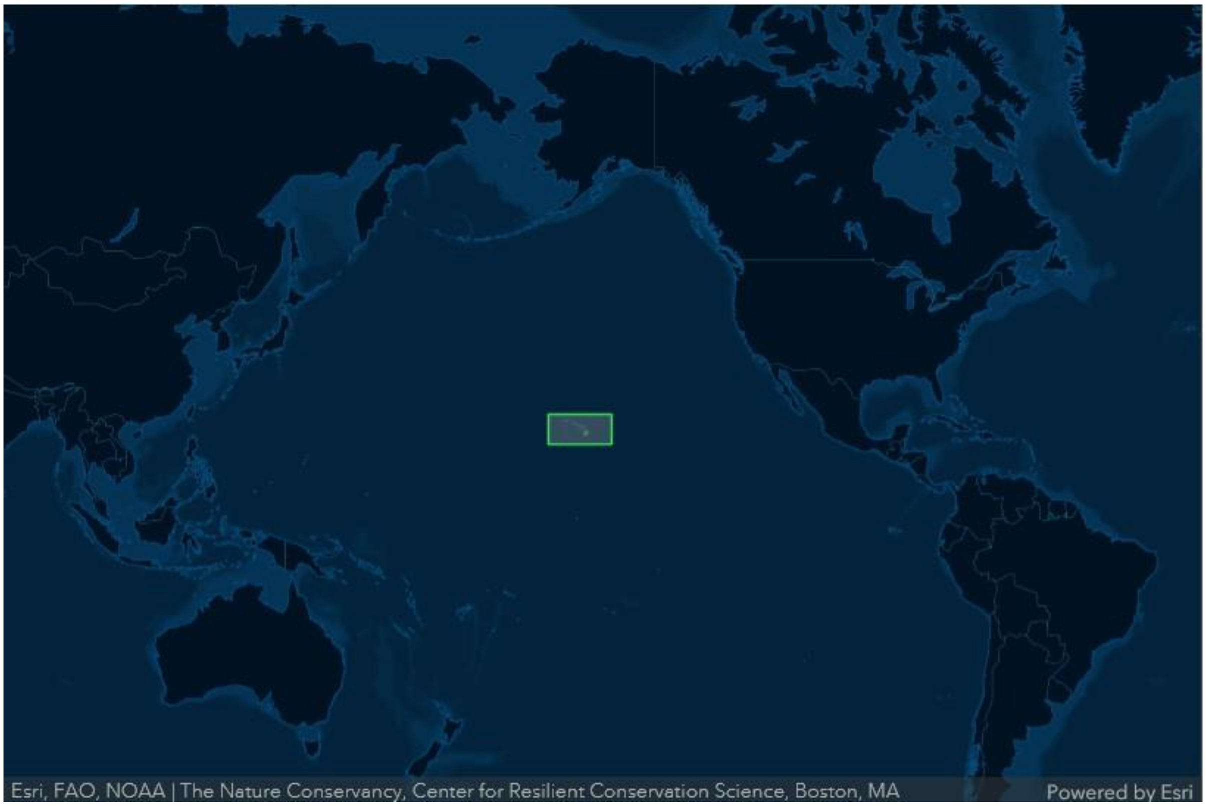

Figure 5 Hawaiian Islands World Map

4.3.2 Biodiversity Hotspots

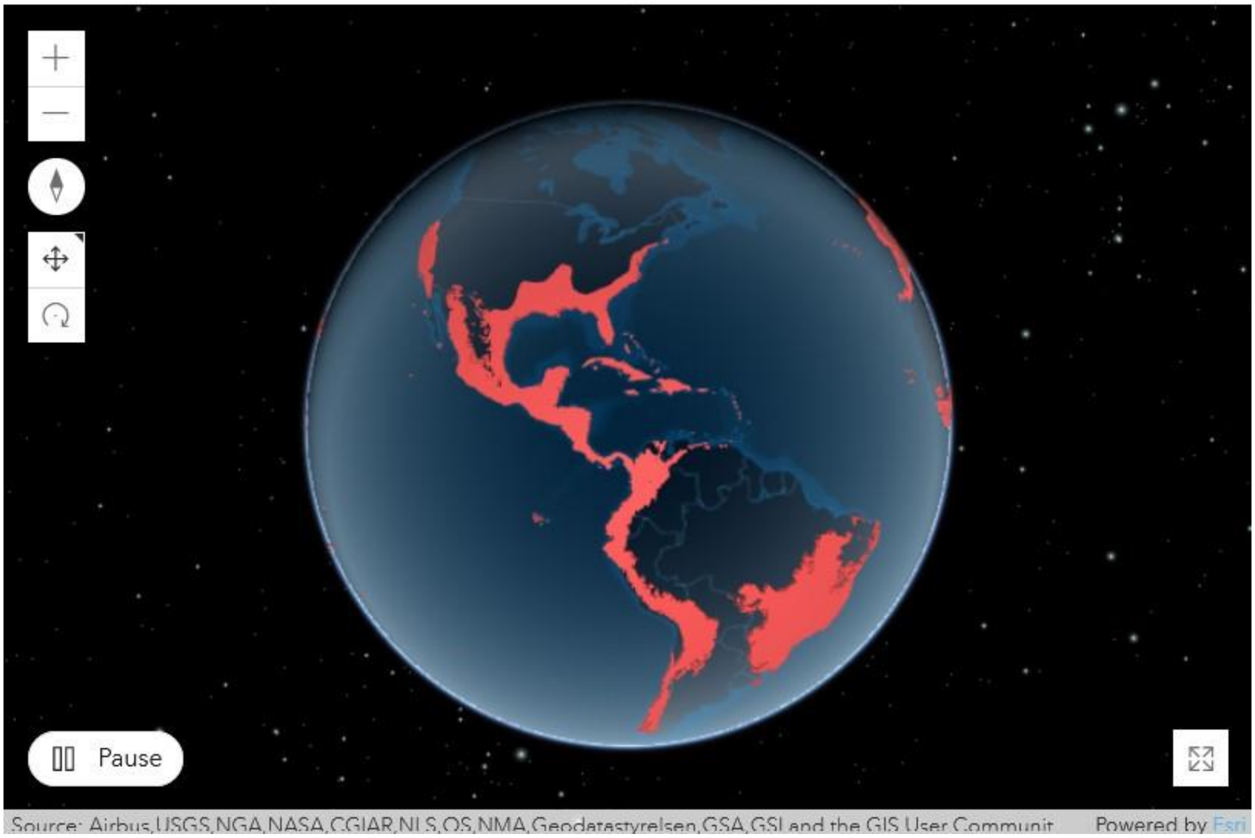

Figure 6 Biodiversity Hotspots

4.3.3 Biodiversity in the Hawaiian Islands

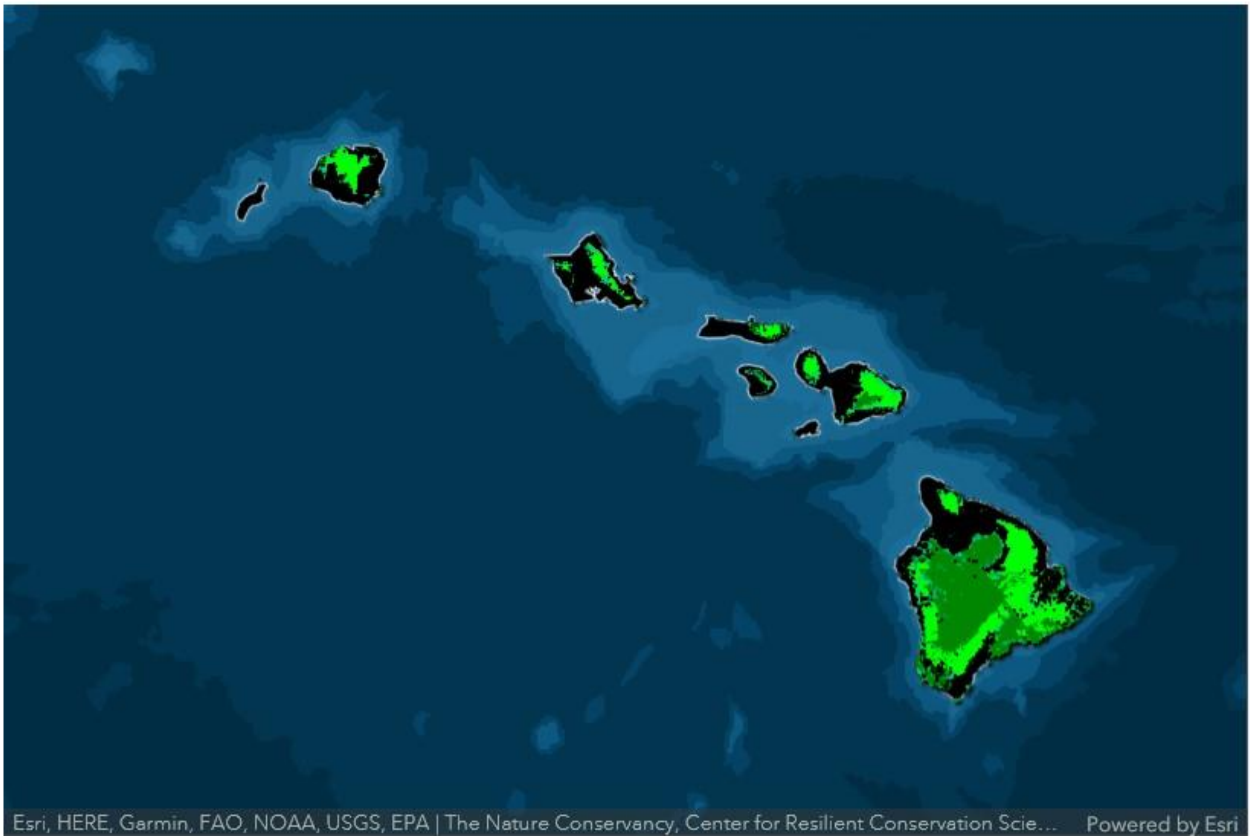

Figure 7 Biodiversity in the Hawaiian Islands

4.3.4 The Hawaiian Islands

Figure 8 The Hawaiian Islands

4.3.5 Oceania

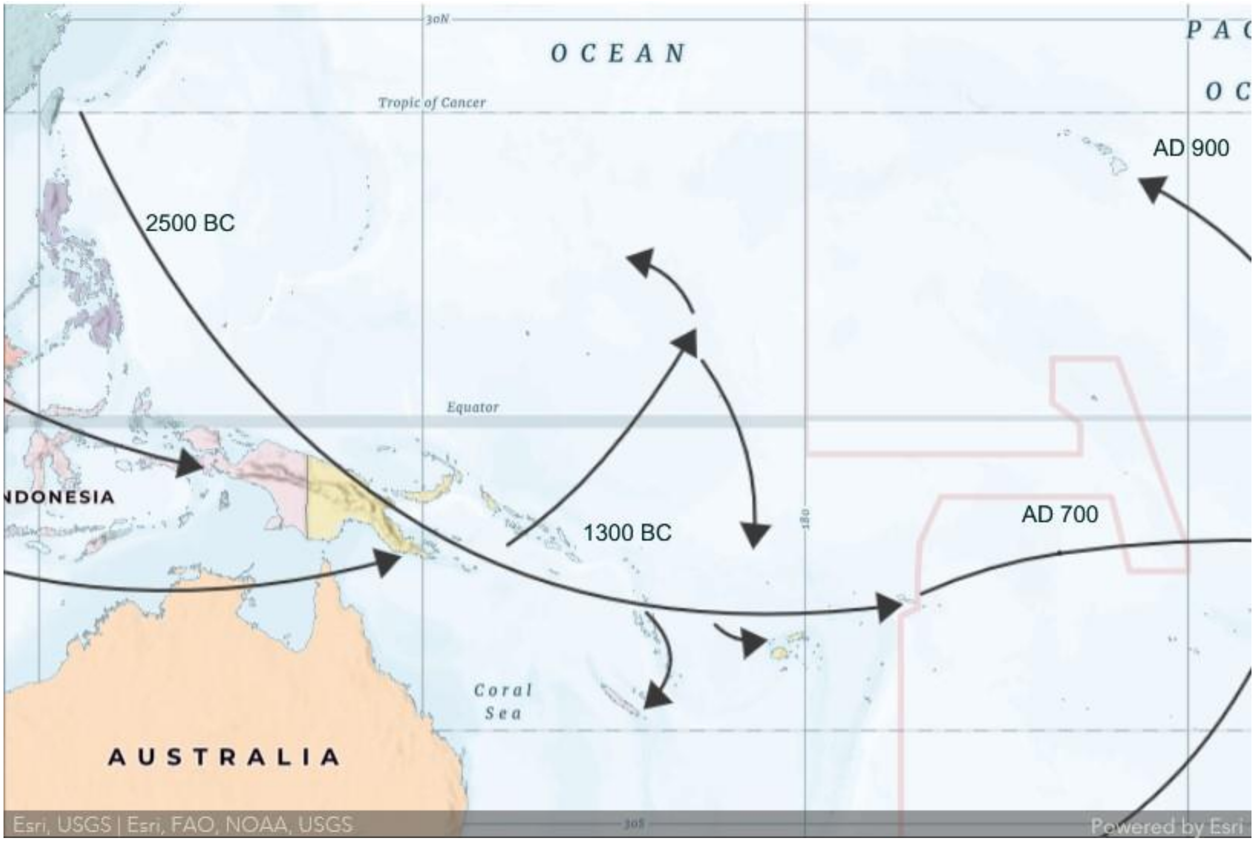

Figure 9 Oceania

4.3.6 Currents and Winds of the Pacific

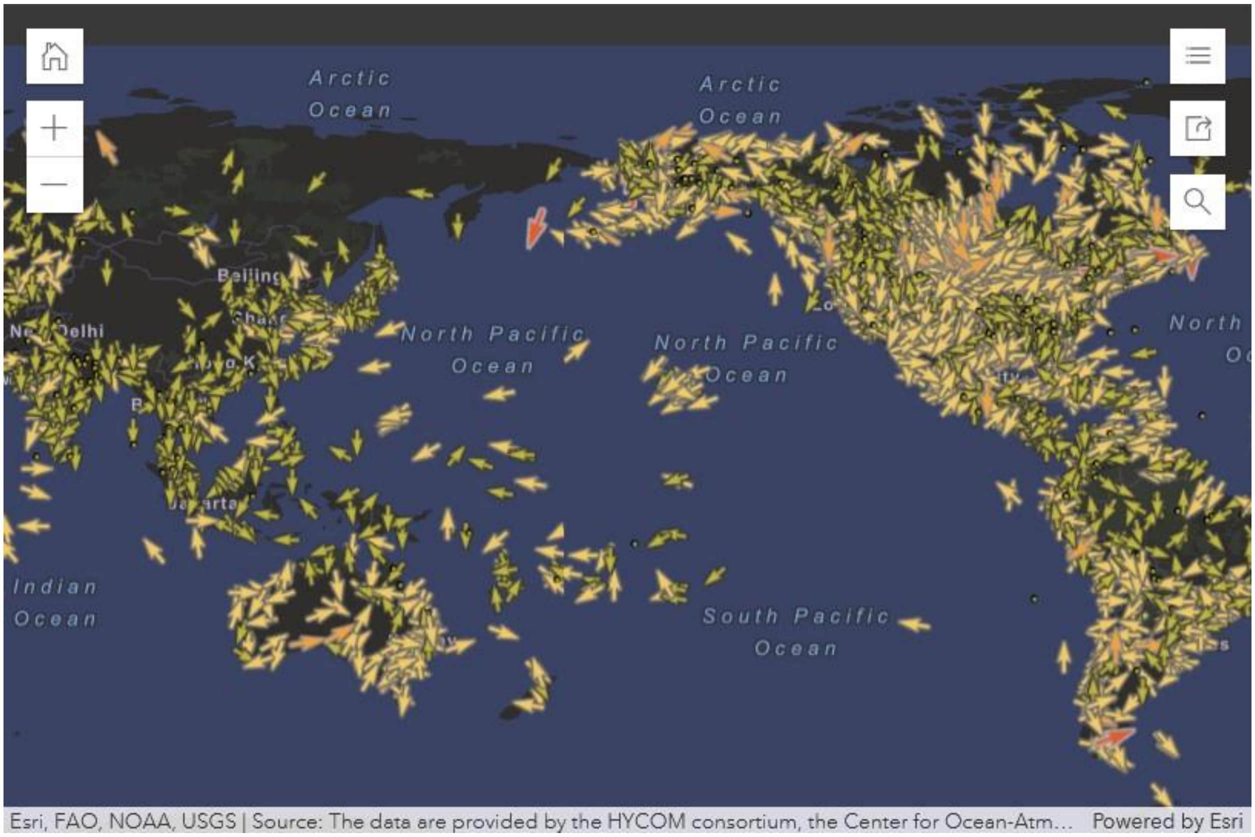

Figure 10 Currents and Winds of the Pacific

4.3.7 Kaua'i

Figure 11 Kaua'i

4.3.8 Kauaʻi Ahupuaʻa

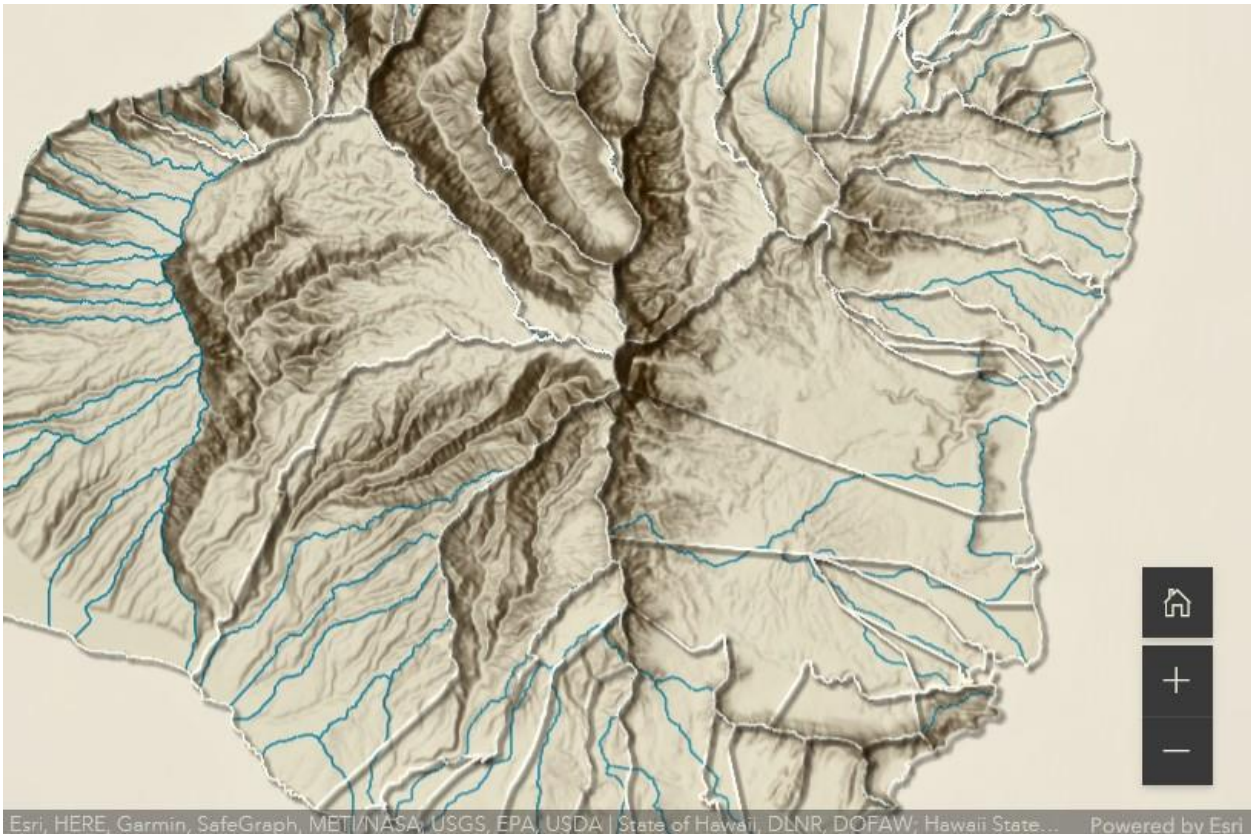

Figure 12 Kauaʻi Ahupuaʻa

4.3.9 Ahupua‘a of Kalaheo (3-D)

Figure 13 Ahupua‘a of Kalaheo

4.3.10 Albatross Nesting Colonies (interactive tour)

Figure 14 Albatross Nesting Colonies

4.3.11 Albatross Telemetry (3-D)

Figure 15 Albatross Telemetry

4.3.12 Housing Density

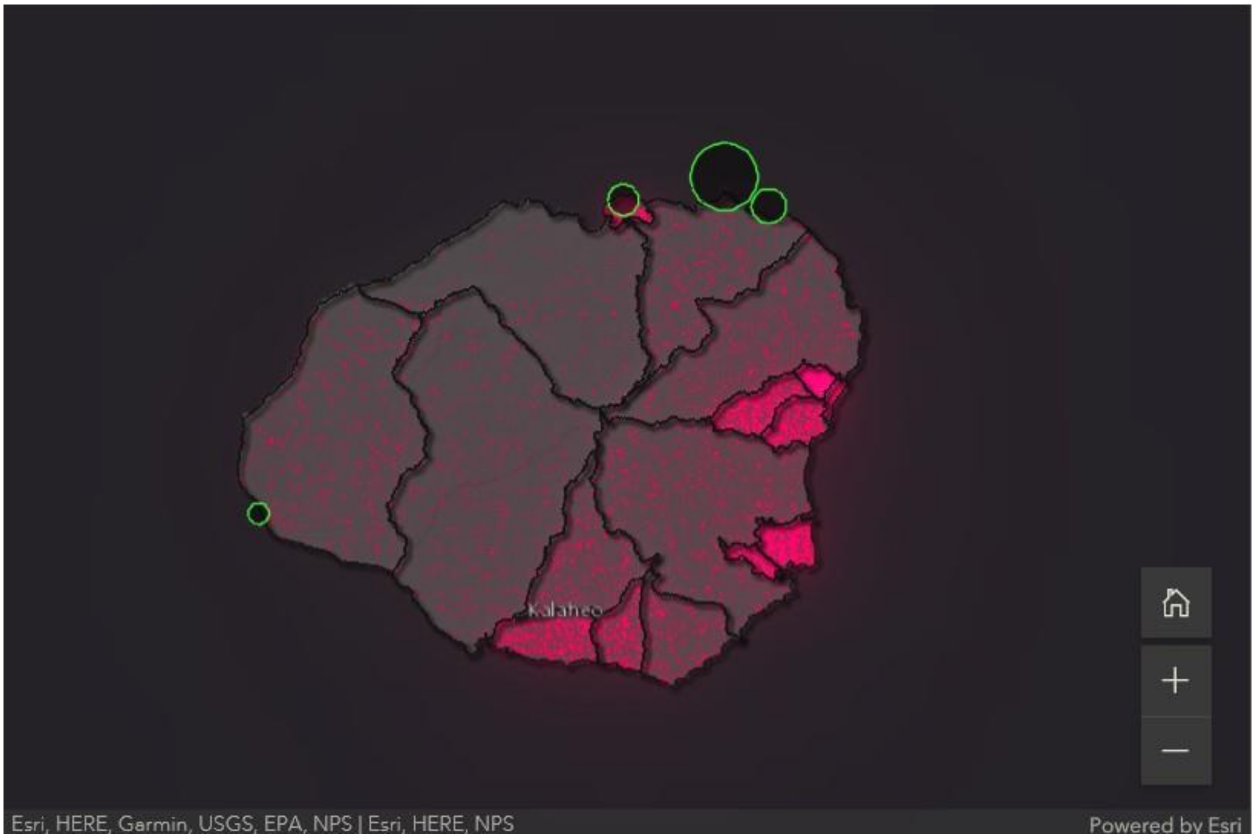

Figure 16 Housing Density

4.3.13 Map Tour of the Hawaiian Islands (animated tour)

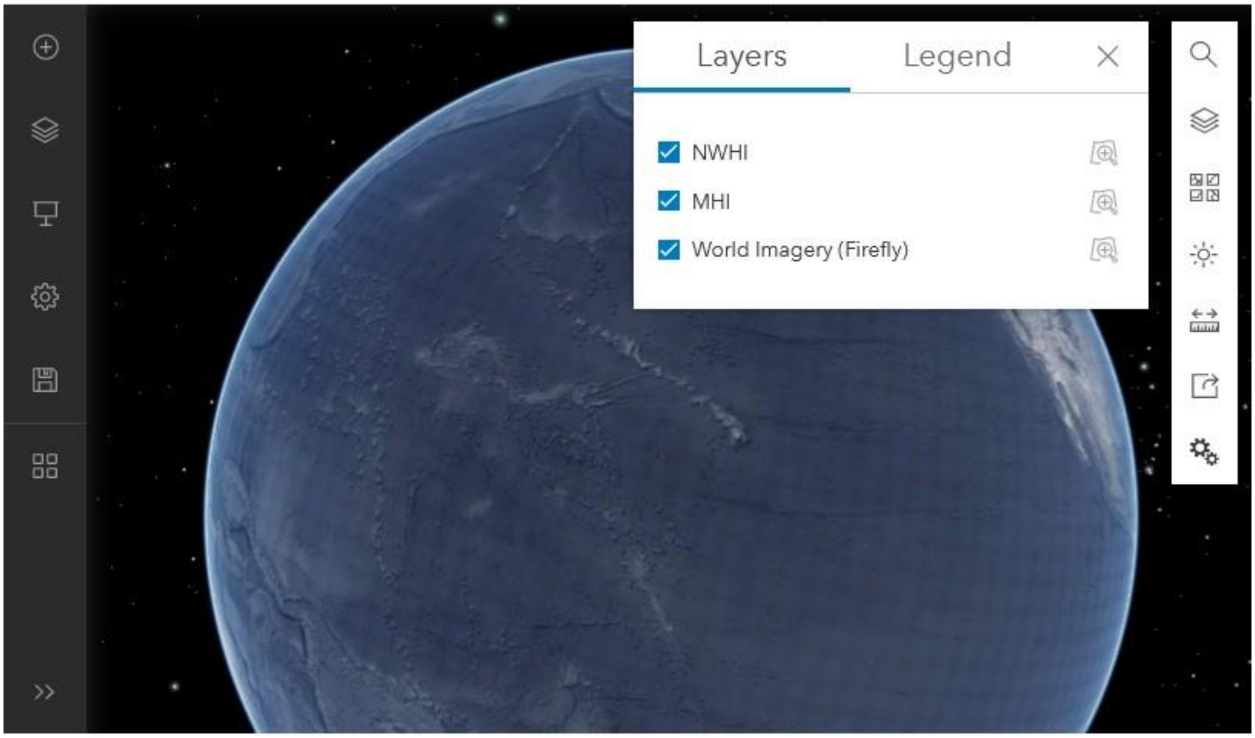

Figure 17 Map Tour of the Hawaiian Islands

4.3.14 2-Meter Sea-Level Rise Midway (slider map)

Figure 18 2-Meter Sea-level Rise Midway

4.3.15 CLO Citizen Science Data (graph and timelapse animation)

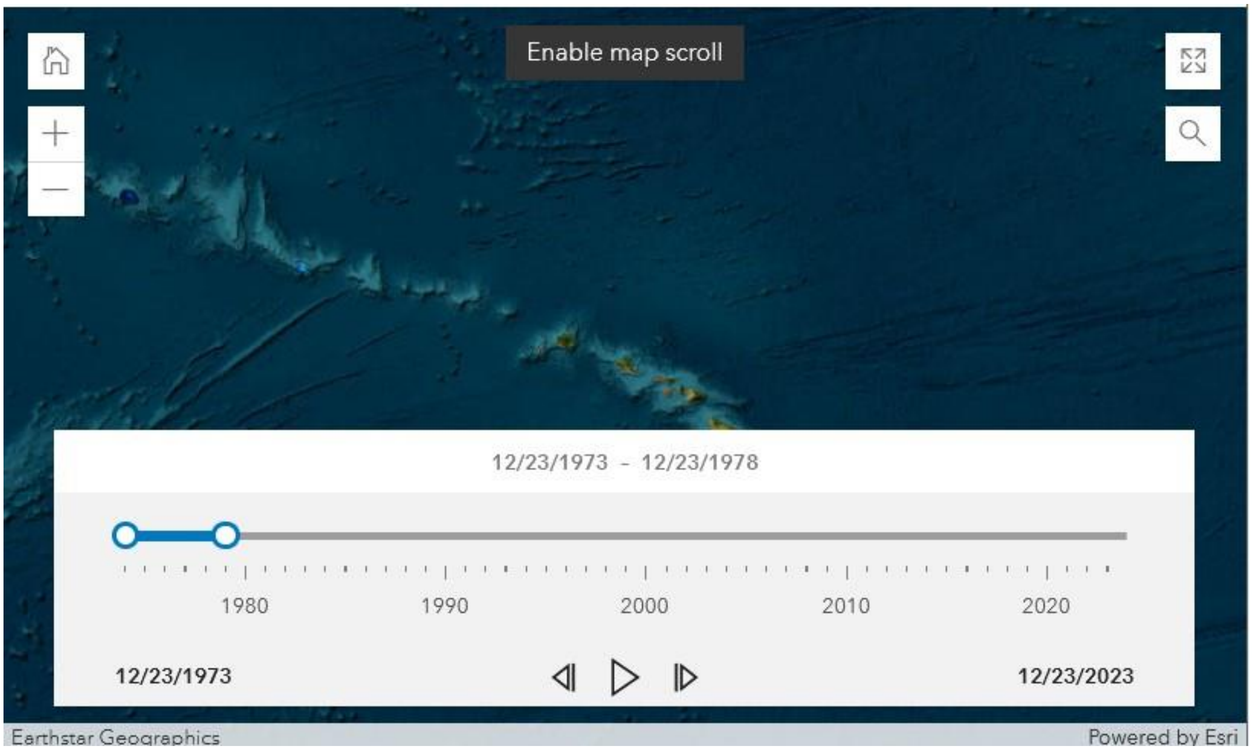

Figure 19 CLO Citizen Science Data

4.3 Discussion

The Storymap chapter aligns with several goals of the ICON program, including research that draws form multiple epistemologies as well as can communicate research across stakeholder groups (University of Georgia 2021; Gunnell et al. 2021). Several 3-D and interactive maps were included in the story as well as videos and audio recordings. In sum, this makes it an engaging form of communicating research and is particularly ideal as a strategic communication tool given its accessibility online as well as its interactive qualities.

CHAPTER FIVE: CONCLUSION

5.1 Chapter Summaries

5.1.1 Chapter Two: Citizen Science and Relational Frameworks

In this dissertation, I explored the epistemological and ontological assumptions of CS; its organizational structure and collaborative mechanisms; and the political geographies that shape peoples' relationships to Laysan albatross. Starting with chapter two, I investigated how human-albatross relations have shifted through time and the role of citizen scientists in creating new ways of living with and knowing albatross. The first section situated albatross within the larger arc of their relationship to different cultures over time and described the tensions volunteers negotiate working with albatross nesting among humans. A plurality of epistemological and ontological perspectives shaped volunteers' perspectives of albatross conservation, and although they viewed the MHI and people as essential to the birds' long-term survival, they also grappled with the ethics and questions about the of long-term care of birds nesting in human communities. Additionally, proximity and access to birds was shaped by colonial histories and categories of privilege, facts that called upon volunteers to reflect upon their positionality vis-à-vis a larger network of land, people, and non-human species. The KAN regarded Native Hawaiian traditional knowledge as a key component of forging connections between people and albatross and incorporated discourses and practices into CS that reflected Hawaiian epistemologies and ontologies.

Critical researchers have criticized typical CS typologies for failing to take into account volunteers' embeddedness in larger power structures (Kimura and Kinchy 2016) and have challenged the idea that the end-result of CS projects is the co-production of knowledge between scientists and volunteers (Cornwell and Campbell 2012a; Ottinger 2010). Given the increasing calls across the sciences for conservation researchers to reflect upon their positionality and the role of research in colonial histories (Borrelle et al. 2021; Price, Winter, and Jackson 2021; Sammler and Lynch 2021; Todd 2016; Velásquez Runk 2014), this article makes a timely intervention in CS scholarship and suggests the need for increased reflexivity across the domains of scholars, practitioners, and volunteers. Conservation projects often fail to meet their goals due to a lack of understanding of locally-situated knowledge (West 2006; Li 2007; Leach and Fairhead 1994) and fail to take into account that grounding conservation in culturally-appropriate ways of knowing and relating to the environment has positive impacts on human well-being (Andrade et al. 2022; Andrade and Morishige 2022). These results suggest a relational approach to CS can better inform projects that reflect the wants and needs of communities; are more equitable and diverse; and strengthen relationships between scientists and Indigenous communities.

5.1.1 Chapter Three: Citizen Science as a Boundary Object

The concept of participation in CS often assumes volunteers share common understandings of the issues under study and what outcomes should look like. In this way, participation is often organized around homogenous groups of people and situates non-participants on the periphery while privileging consensus over difference (Turnhour 2010; Selfa and Endter-Wada 2008 Turnhour et al. 2010). Chapter three called these assumptions into question by applying boundary object framework to investigate the organizational structures of CS projects. I situated the Cornell Lab of Ornithology/KAN camera project as a boundary object that linked the discrete activities of camera operators, monitors, the CLO, biologists, and local and Indigenous communities. Camera volunteers used the camera to document fine-grained accounts of albatross life and facilitate connections with individual birds across the world through social media and private communication platforms. Their discourses reflected a volunteer ethos motivated by the "love of birds" rather than a scientific or policy-oriented agenda. In contrast, access to private land was essential to monitoring individual colonies as well as building relationships with homeowners, and KAN and Cornell often tacked between managing the camera and doing on-the-ground monitoring work. Across this space, there was considerable heterogeneity across landowners: some only hosted the camera while others with no birds worked closely with KAN to attract new nesters. These sites were often used for translocations, which required cooperation between homeowners, KAN, biologists, and the PRMF. In many cases, this informed neighborhood-wide agreements on conservation issues like feral animal control. The last form of the camera was as a place for iterative knowledge production about LA. The KAN recognized that peoples' lack of familiarity with LA was a potential site of HWC and worked intentionally to engage with Indigenous and local communities and situate the organization as a site where traditionally and scientific knowledge intersect. In sum, the camera bridged connections across individual, community, and institutional scales. It served big-picture conservation agendas of Cornell, KAN, and conservationists; the project-specific desires of camera monitors; informational and support needs of homeowners; and promoted Hawaiian TEK.

Critical scholars are increasingly upending assumptions about collaboration in CS projects. Volunteers—who often have the benefit of locally-situated knowledge and experience—sometimes have to push back against project managers in pursuit of their own agendas (Cornwell and Campbell 2012a; Ottinger 2010). Additionally, citizen scientists pursuing so-called "activist" projects may lack support or even encounter hostility if their work threatens the status-quo (Kimura 2016). These dynamics underscore that model-oriented CS may over-simplify the social dynamics that are integral to all collaborative projects and may impede the success of certain projects. There is no one recipe for a successful CS project, and boundary objects are a useful way of thinking about how to allow for multiple epistemologies, conservation goals, and types of engagement in CS projects.

5.1.2 Chapter Four: Flying with Albatross: Space and Relationality Across the Pacific

In chapter four, I used ocean epistemologies and ontologies to connect people, land, albatross, other species across time and space in the Pacific. Using maps, multimedia, and narrative, I traced out intersecting migrations of people and albatross in the past and the ways in which a resurgence of interest in Hawaiian knowledge and traditions also coincided with the return of LA to the MHI. I showed that citizen scientists also have a place in these migrations as many of the first people to observe and record observations of LA. My results showed that citizen scientists were among the first people to collect observations of albatross and have been among the few people who live directly among nesting sites. I also demonstrated how plastics were both material and discursive objects that occupied the same migratory paths traveled by Native Hawaiians and birds as well as fueled volunteer anxieties about the long-term health of LA.

This chapter responded to increasing calls to decolonize geospatial research and incorporate both Indigenous and positivist knowledge into mapping (Vierros et al. 2020; Pearce and Louis 2008; Runk 2015). Given the increased emphasis on sharing results with local communities (University of Georgia 2021; Gunnell et al. 2021), the accessibility and interactive qualities of the Storymap make it an ideal strategic communication tool that fits into the larger goals of the ICON program. Additionally, publishing the Storymap in addition to the two journal articles is aligned with the ICON goal that diverse audiences—including scholars, practitioners, citizen scientists, and community members—can engage with this research.

5.2 Discussion and Synthesis

5.2.1 Citizen Science is Relational

Across all three chapters, I described how different sets of ecological imaginaries cross-cut LA monitoring and the ways humans, albatross, land was situated relationally. An example of this was the different discourses surrounding albatrosses' expanding their nesting range to the MHI. Although there was clear agreement across stakeholder groups that that establishing colonies on the high islands was imperative, their perspectives differed. Citizen scientists and others in the community situated the MHI within a material and discursive "arc" that brought LA under the care of local communities, while biologists have typically positioned the MHI as potential refugia that require humans to address anthropogenic disturbances that have contributed to the vast amount of bird extinctions (Reynolds et al. 2015; L. Young et al. 2009; Baker, Littnan, and Johnston 2006). In sum, the former perspective depended on people to care for albatross while the latter aimed to erase their impacts as much as possible. Meanwhile local and Indigenous communities in the islands also had their own sets of relational frameworks, which have often not received recognition among conservation scientists. The reason KAN was successful with these communities was that they recognized discourses and practices that resonated with Hawaiian communities and also engaged in social practices that reflect culturally-appropriate ideas of reciprocity. This supports the first insight of this dissertation, which is that when done well, **citizen science is relational**.

These insights may have practical application in how citizen scientists and biologists can craft messages about albatross. Cultural uses of non-human species are an important part of Hawaiian relational frameworks (Kittinger et al. 2012), and KAN's engagements with indigenous communities highlighted birds' role in feather work. However, it should be noted that feather collection was done through a salvage permit and did not injure or affect living birds. This is not the case with species like monk seals, which offer no contemporary cultural uses (Kittinger et al. 2012). Although the research on press coverages' effects on species perceptions (Delibes-Mateos 2020) suggests cameras may be a positive tool for generating positive affect, researchers also need to be prepared to accept that peoples' relational frameworks are context and culturally-specific, and that management perspectives might be incommensurable (W. Smith 2020).

5.2.2 Citizen Science is Heterogeneous

The promises of CS have evolved past scientific discoveries and democratization. Many are now demanding for CS to account for its embeddedness structures that shape encounters with science as well as recognize these encounters as heterogeneous and locally-situated (Kimura and Kinchy 2016; Irwin 1995; Cornwell and Campbell 2012a). Working in this vein, I have used theories of boundary objects to show that **CS is heterogeneous** and can accommodate diverse stakeholders with goals and worldviews that are divergent.

It is important to understand the reasons maintaining divisions between traditional or "mainstream" CS and locally based participatory science might be necessary. Doing so acknowledges that relationships to science are embedded in various social and institutional relations that have varied through time (2002, 229) and that categories of Indigenous and “citizen” participants is often necessary to account for the various ways in which colonialism, power, and identity shape peoples’ relationships with science and other ways of knowing (2002, 300). Not all participatory science can provide the broad, fine-grained data scientists need to address large-scale problems and project design at times may require centralized, top-down approaches (Haywood, Parrish, and Dolliver 2016; C. B. Cooper et al. 2021). Likewise, applying CS as a blanket category runs the risk of homogenizing participants with diverse values, goals, and belief systems (Tengö et al. 2021a; 2014b) and may also open the way for large science organizations to control what should be community-led projects (C. B. Cooper et al. 2021, as cited in Shirk et al. 2012; Shirk et al. 2012). Given the many modes of structuring participation—from completely decentralized to highly local—this chapter supports that participatory science exists on a continuum with varying levels of overlap. This is supported by several studies, which have found that deliberate project design can accommodate different knowledge systems (Tengö et al. 2021a); benefit diverse interests (Bonney et al. 2014); and accomplish social and scientific impacts (Danielsen et al. 2019).

5.2.3 Citizen Science is Embodied and Discursive

Finally, I have described the ways in which citizen **science is embodied and discursive.** Citizen science is inherently practice-based, and the future of an integrative CS will hinge on developing practical tools for scholars, practitioners, and volunteers to translate these concepts in ways that are impactful. A growing literature on “citizen social science” (CSS) seeks to use ground-up approaches to address social-scientific problems (Fischer et al. 2021), and offers a possible way in which CS can be leveraged to understand the sociocultural dynamics that shape local conservation problems. Early studies suggest it has the potential to draw from lived experience to shape research perspectives as well as draw in those who would not normally take part (2021), although more empirical studies needed to understand its benefits (Heiss and Matthes 2017).

The Multiple Evidence Base Approach (MEB) has been gaining traction as a method to identify synergies between CS projects and local and indigenous knowledge systems (Tengo et al. 2021). In contrast to CSS, MEB is a process that guides collaborations across different knowledge systems and emphasizes rights, representation, and power dynamics (Tengö et al. 2014a). However, both approaches require longer-term commitments and deeper engagement than contributory CS. This reflects that one model of co-production that is unlikely to work across all sites, scales, and project goals, and tradeoffs will have to be considered.

It must be acknowledged that there were unique factors that shaped the findings in this dissertation. First, KAN leadership had a large amount of knowledge of the community and an established network of connections, which undoubtedly shaped the success of the camera as a bridging mechanism. It is likely that in most CS projects, participants and leaders may arrive with less or no knowledge of communities and may not have the resources or time to build these kinds of deep relationships. The second caveat applies to peoples' perceptions of albatross. Although colonies in the MHI are growing, albatross are not living in spaces where people commonly engage in subsistence practices, they are relatively inconspicuous in comparison to species like monk seals, and they are not the subjects of any intense management plans. Therefore, the results presented in this study should be considered specific to LA and the communities in which I carried out my research.

5.3 Take-home Messages and Conclusion

It is widely known in conservation science that trust is required for effective collaborations between scientists, practitioners, and local communities. Yet, this has received scant attention in mainstream CS, likely due to the perception that it is universally beneficial. In fact, the topic of trust in CS literature is primarily addressed in terms of trustworthiness of data, giving primacy to the priorities policy makers and scientists, rather than local communities. Both practitioners and scholars in CS need to be attentive to the fact that in many contexts there are long histories of scientific research having adverse effects on marginalized communities, which have undermined confidence in scientific authority (Smith 2015; Kay-Trask 1991; Silva and Fernandez 2006; Brandt 1978). The emphasis on scalability and "big-data" within CS and science more generally means little attention is paid attention to local contexts and histories of the places in which CS is practiced and the ways in which these have informed the arc of conservation in these areas. For example, concepts like *mālama* ʻ*aina* (care for land) (Holmes 2000), though historically part of Hawaiian culture, became increasingly salient in the period of the Hawaiian Renaissance as part of the resistance against settler-colonialism and was at the center of debates over the authority of non-Indigenous scholars to define and historicize local and Indigenous peoples (Briggs 1996)[19]. The importance of local and Indigenous communities defining their own conservation priorities as well as the values that inform them is evident in both the scholarship and practice of

[19] As Briggs (1996) points out, concepts like "invention of tradition" extended beyond the Hawaiʻi/Pacific region

conservation in the region today, and has informed the successes and failures of conservation projects (Watson et al. 2014). Yet, these are unlikely to be considered if CS continues to focus on research at scale. Therefore, scholars and practitioners need to be attentive to local histories as well as actively seek out ways to understand them. There are many ways in which this can be done, including intentionally working across disciplines (with particular attention to local and Indigenous scholarship); considering positionality and histories and impacts of science; as well as ways in which trust has been broken with communities in the past.

Taking the aforementioned issues into account, there needs to be reconceptualization of the concepts of consensus and cooperation in CS. This means moving away from superficial concepts of participation and assumptions about shared goals and benefits. Otherwise, “collaborative relationships and coalitions are made precarious and risk depoliticizing shared concerns when they are bound by […] attention to sameness and the bracketing of difference and political disagreement” (Goldensher 2021). Although stakeholders may have common concerns, they also can engage these problems through different units of analysis as well as diverse ways of identifying with their object of study (Star 1993; 2021). Not only can this improve the robustness of knowledge production (1993), it also has implications for addressing common sources of conflict. The KAN’s approach to community engagement was exemplary in this sense because of their attention and respect for different stakeholder concerns as well as using an iterative approach to LA conservation that was informed by context rather than models. In sum, these lessons are not meant to imply that CS needs to do away with all models or interests in particular scientific questions. Rather, they suggest that CS has unique potential and capacity to advance how conservation science is studied and practiced.

The current direction of CS research necessitates developing theoretical and practical strategies for cross-disciplinary engagement. This means considering problems as simultaneously ecological and social and leveraging multiple epistemologies to highlight different areas of research problems (Vercoe et al. 2014; Mcshane et al. 2011). Avoiding common impasses that emerge when different theoretical orientations aim for complete reconciliation requires accepting that there will always be points of incommensurability and that conservation research requires choices about trade-offs (2014; 2011). By using these goals to orient this dissertation theoretically and methodologically, I hope to advance theory well as provide insights into what it means to study and practice integrative CS.

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