Hoʻomalu ʻĀina Maui: Land Stewardship, Kuleana, and Epistemic Justice in Environmental Education After the Lahaina Fire

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ABSTRACT

On August 8, 2023, a catastrophic wildfire devastated the town of Lahaina and severely impacted the broader Maui community. Thousands of structures were destroyed, and 102 lives were lost. It was the deadliest wildfire in Hawai‘i’s recorded history and the deadliest U.S. wildfire in over a century. This disaster was not simply a natural event but the culmination of settler-colonial land transformations that systematically displaced Kānaka ‘Ōiwi land management systems, introduced highly flammable invasive grasses, and disrupted integrated watershed systems. This study is grounded in a community-based participatory research (CBPR) project called Ho‘omalu ‘Āina Maui (protecting the land of Maui). Ho‘omalu ‘Āina Maui is a wildfire mitigation and land stewardship program that I co-developed in response to the 2023 Lahaina wildfire in partnership with a high school field ecology teacher, a Kānaka ‘Ōiwi biocultural conservation biologist, and a local nonprofit focused on watershed stewardship and cultural revitalization. Relational accountability to community is not only a principle of this project but a methodological commitment that has shaped every dimension of the research. This study asks: *How do high school students in Maui, Hawai‘i engage with and make meaning of multiple knowledge systems as they participate in land stewardship activities for wildfire mitigation?* To answer this question, this study draws on Kānaka ‘Ōiwi epistemologies, epistemic justice frameworks, decolonial science education, social-ecological systems resilience, and critical place-based education. Data were collected during the 2024-2025 school year through pre- and post-program surveys, ethnographic observations, pre- and post-program interviews, and a student-produced documentary film. Within this study, there are three interrelated sub-studies that explore: 1) what students bring to environmental learning in a post-wildfire context, explored through social-ecological systems resilience and Kānaka ‘Ōiwi biocultural knowledge frameworks, before any

formal programming; 2) how embodied practice shapes their developing relationships to ʻāina (land) and kuleana (relational responsibilities); and 3) what happens epistemologically when two knowledge systems with different ontologies and axiologies coexist in the same learning context. Findings reveal that: 1) students demonstrate strong systems thinking skills and critical consciousness about social injustices affecting Kānaka ʻŌiwi communities; 2) kuleana emerged not through instruction but through repeated engagement with a specific place, hands-on stewardship work, and relationships with kumu (teachers) who modeled kuleana; 3) students' grief about the Lahaina fire became the affective foundation for political analysis; and 4) epistemic authority was distributed across a constellation of knowledge holders whose collective expertise —spanning Kānaka ʻŌiwi cultural practice, biocultural conservation, and place-based ecology— created the conditions under which students could engage with multiple ways of knowing simultaneously and in relationship with one another. Overall, this study argues that centering Indigenous epistemologies in science education is not solely a matter of curriculum design but a relational and structural imperative. For educators, program designers, science education researchers, and policymakers, this requires sustained commitment to place, community, and the slow, necessary work of building the conditions under which genuine epistemic justice becomes possible. Implications argue that 1) epistemic justice requires structural attention to the ways in which knowledge is sequenced and validated across the full program arc; and 2) students arrive as knowledge holders whose expertise, grief, and relational accountability to place and community demand an authentic platform for them to teach, share, and build the futures they envision and deserve.

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Finally, I would be remiss not to name the many places that have shaped who I am as a researcher and as a person. I was raised on Nomlaki homelands in what is also referred to as Tehama County, Northern California, on a cattle and horse ranch within a multigenerational environment. My grandparents and great-grandmother lived next door to my parents, my three sisters, and me. My great-aunt and uncle lived just past my dad's saddle shop, and often a family

friend or two would stay for a while. My sisters and I experienced a childhood outdoors, where the land and animals were significant parts of daily life. That upbringing gave me a relationship to place, to seasons, and to the responsibility that comes with living close to the earth before I had the awareness to name what that meant. This relationship is the root of everything in these pages. I am grateful to have been raised there and to call this place home.

This dissertation was written on Patwin homelands in what is also referred to as Yolo County. UC Davis sits within the unceded homelands of the Patwin people. Today, there are three federally recognized Patwin tribes: Cachil DeHe Band of Wintun Indians of the Colusa Indian Community, Kletsel Dehe Wintun Nation, and Yocha Dehe Wintun Nation. Patwin people have remained committed to the stewardship of this land for many centuries. I have been incredibly fortunate to live here as a visitor and ally while in graduate school.

Finally, to Maui: the ʻāina and community. This dissertation was made possible by a land whose genealogy runs deeper than any research project, any institution, or any program. The fieldwork at the heart of this dissertation took place in the ahupuaʻa (land division) of Olowalu, on the Island of Maui, in the Moku (district) of Lahaina, land that Kānaka ʻŌiwi recognize as part of the body of their ancestral grandmother, Papahānaumoku. I recognize that her majesty Queen Liliʻuokalani yielded the Kingdom of Hawaiʻi under duress and protest to the United States to avoid the bloodshed of her people, and that Hawaiʻi remains an illegally occupied state. I recognize that each moment I have spent on this ʻāina, she has nourished me with her gifts, and that generations of Kānaka ʻŌiwi and their knowledge systems shaped Hawaiʻi in ways that allow me, as a guest, to receive those gifts today. This dissertation is an attempt to honor what this land holds and what this community makes possible. I hope it is worthy of the trust placed in

it, and I commit to continuing to work in solidarity with the varied strategies that Kānaka ʻŌiwi are using to protect their land, their knowledge, and their futures.

DEDICATION

I am grateful to dedicate this dissertation to the ʻāina and community of Maui, Hawaiʻi. To the valleys, streams, reefs, mountains, native forests, and to the species that call this Pacific Island home. This place has impacted me in ways that are indescribable.

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POSITIONALITY

I approach this research as an ally. I am a white, able-bodied, cisgender female scholar with deep gratitude for and accountability to the Maui community that shaped my understanding of ʻāina-based education and Kānaka ʻŌiwi Ways of Knowing. Prior to starting my PhD program, I spent five years teaching environmental education in Maui's public schools, including at the charter school where this research takes place. My relationship with the Maui community, including schools and students, spans nearly a decade and multiple roles. I first came to know some of the students in this study when they were in 3rd grade, during my earliest years teaching garden education at a school in Kīhei. By the time I was teaching 7th grade science at South Maui Charter School, the year before I began my PhD, some of those same students were in my classroom again. When I returned to conduct this research, several of them were participating in the Hoʻomalu ʻĀina Maui program through the Eco Club. In the year following my research, those same students, now juniors, were enrolled in the field ecology course as part of the Hoʻomalu ʻĀina Maui program. All this to say, I did not arrive at this research site as a stranger; I arrived as someone who had watched some of these young people grow up, whose teaching had in some small way been part of their formation, and who was being welcomed back by a community that had known me across many seasons of my own life as well. I hold this continuity with profound gratitude and with serious ethical responsibility.

My lived experiences shaped my commitment to community-based, culturally relevant work and brought me into a relationship with the kinds of epistemic tensions this dissertation explores. Returning to UC Davis to pursue a PhD in Science Education with a Designated Emphasis in Native American Studies gave me grounding in Indigenous research methodologies,

decolonial theory, and critical engagement with settler colonialism (Smith, 1999; Tuck & Yang, 2012; Wilson, 2008), frameworks I have tried to use thoughtfully.

My positioning, having established community relationships and being a white settler researcher affiliated with a mainland institution, has shaped every aspect of this work. I navigated this tension by maintaining relationships built over time, centering the voices of students and community members, and remaining reflexive and critical throughout the research process. This positioning is irreducibly complex. As a former teacher at this school, I return to this community carrying relationships built over nearly a decade, with students I watched grow up, with colleagues who trusted me, and with a place that has had a great impact on me. That continuity gave me access, context, and trust that I could not have built within a single research year. As a white settler researcher, I carry the structural weight of systems that have historically extracted knowledge from Indigenous communities while marginalizing Indigenous epistemic authority (Tuck & Yang, 2012; Latulippe & Klenk, 2020; Smith, 1999). Throughout this research, I have aimed to remain accountable to the community whose generosity made it possible by centering the voices and perspectives of students and partners and treating reflexivity as an ongoing ethical practice (Wilson, 2008). In practice, this reflexivity looked like ongoing negotiation. During initial conversations with partners at Kīpuka Malu, I became aware that certain terms I used to describe historical and present-day events were not used at their site. This was instructive and required me to recognize that this community had its own epistemological and political commitments. These moments, alongside regular check-ins with partners, were what reflexivity looked like in practice; a continuous negotiation of whose terms, whose questions, and whose knowledge were centered.

I have worked diligently and taken my ethical commitments seriously by centering community relationships, remaining accountable to the people and place that shaped my understanding, and treating this work as continuous with the responsibilities I hold as someone whose scholarship was made possible by this community's generosity.

CHAPTER 1. INTRODUCTION

INTRODUCTION AND BACKGROUND

On August 8, 2023, a catastrophic wildfire killed 102 people and destroyed thousands of structures in Lahaina, Maui (Rafferty, 2023). This fire was not simply a natural disaster but the culmination of settler-colonial land transformations, the replacement of traditional Kānaka ʻŌiwi land management systems with industrial monoculture agriculture, the proliferation of highly flammable invasive grasses, water diversions that disrupted integrated watershed management, and patterns of development that prioritized tourism over community resilience (Reed, 2023; Trauernicht et al., 2015; Brown, 2009; Morgan, 1986). In the aftermath of disasters such as this, young people are often left trying to make sense of what happened to their community and their role in preventing future disasters (Ronan & Johnston, 2005; Reimers, 2024).

What the Lahaina fire made visible, however, has long been true in Hawaiʻi's classrooms. K-12 science education in Hawaiʻi, like many places elsewhere, largely operates from Western epistemologies that separate humans from nature (Cajete, 2020b; Medin & Bang, 2014), meaning that students routinely learn about their environment without ever encountering the sophisticated Indigenous knowledge embedded in the places where they live (Morishige et al., 2018; Saffery, 2019). This erasure is not incidental. It reflects broader patterns in which traditional approaches to science education fail to connect scientific concepts with students' lived experiences (Minshew et al., 2017), contributing to disengagement at precisely the moment when environmental literacy is most needed (Roth, 2003; Sjöström & Eilks, 2018; Jones & Burrell, 2022). This study emerged from the convergence of these two crises.

I co-developed the Hoʻomalu ʻĀina Maui (protecting the land of Maui) program in direct response to the Lahaina wildfire through a partnership with a high school field ecology teacher, a watershed stewardship and cultural revitalization nonprofit, and a Kānaka ʻŌiwi biocultural conservation biologist. This project was designed from the outset to incorporate both Kānaka ʻŌiwi biocultural knowledge and Western science and to ensure that community partners held meaningful authority over how the work unfolded. This study explores how high school students engage with Kānaka ʻŌiwi biocultural knowledge and Western science (Kimmerer, 2013; Hatcher et al., 2009), through wildfire mitigation and land stewardship work. More fundamentally, this study asks the following questions:

1. *How do high school students engage with and make meaning of multiple knowledge systems when participating in land stewardship and wildfire mitigation activities?*
    a. *What are students' perceptions of social-ecological systems resilience and Kānaka ʻŌiwi biocultural knowledge one year after the Lahaina fire?* (Chapter 2)
    b. *How does participation in Hoʻomalu ʻĀina Maui shape students' sense of kuleana and connection to place?* (Chapter 3)
    c. *How do students engage with the ontological, axiological, and epistemic dimensions of Kānaka ʻŌiwi biocultural knowledge during ʻāina-based stewardship, and what role does epistemic authority play in shaping that engagement when multiple knowledge systems are present in the same learning context?* (Chapter 4)

The overarching question requires examination from multiple angles because engagement and meaning-making encompass cognitive, affective, relational, and political dimensions that no single framework can fully capture (Vossoughi et al., 2023). The three sub-studies are

deliberately sequenced: Chapter 2 establishes what students bring to the program; Chapter 3 explores how embodied practice shapes students' developing sense of kuleana; and Chapter 4 analyzes what becomes possible, and what remains constrained, once those relational conditions are in place. This structure reflects both the program's pedagogical sequence and the analytical progression needed to answer the questions shared above. Exploring these questions requires drawing on multiple theoretical perspectives, each of which is elaborated in the sections that follow.

Throughout this study, I use "Kānaka ʻŌiwi" rather than "Hawaiian" to refer to the Indigenous people of Hawaiʻi, following the usage of Kānaka ʻŌiwi scholars whose work grounds this study (Goodyear-Kaʻōpua, 2013; Meyer, 2008; Osorio, 2021). As Louis (2017, p. xv) notes, "Hawaiian" is not a word originating from ʻŌlelo Hawaiʻi (Native language of Hawaiʻi) and therefore reflects a Western colonial framing of Indigenous identity. I recognize that terminology is contested and that different scholars make different choices for principled reasons. Where I do make exceptions is in the survey and interview instruments that students engaged with, where "Hawaiian" and "Traditional Hawaiian Knowledge" were used because students are more familiar with that terminology. Throughout the program, "Kānaka ʻŌiwi" was used consistently by program partners and me, both to honor the Indigenous identity of the people of Hawaiʻi and to introduce students to the term as part of the program's broader epistemological commitments.

THEORETICAL AND METHODOLOGICAL THREADS

Understanding how students engage with and make meaning of multiple knowledge systems requires more than a single theoretical lens can alone provide. Therefore, this study

draws on five bodies of scholarship: decolonial science education (Bang, 2020; Cajete, 2020a; Smith et al., 2019), social-ecological systems resilience (Folke et al., 2010; Berkes & Folke, 1998), critical place-based education (Gruenewald, 2003; Tuck & McKenzie, 2015b; Johnson, 2012), Kānaka ʻŌiwi epistemologies (Meyer, 2008; Saffery, 2019; Goodyear-Kaʻōpua, 2013), and epistemic justice (Fricker, 2007; Kidd, Medina & Pohlhaus, 2017; Latulippe & Klenk, 2020). Decolonial science education provides the political and epistemological grounding for centering Indigenous ways of knowing. Social-ecological systems resilience theory offers tools for understanding how human and natural systems are intertwined and how communities navigate disturbance and change. Critical place-based education grounds learning in the specific histories, power relations, and relationships that shape landscapes and communities. Kānaka ʻŌiwi epistemologies provide the foundational ontological and axiological framework through which ʻāina, kuleana, and knowledge transmission are understood in this place. Epistemic justice frameworks highlight what is at stake when knowledge systems meet in contexts of unequal power, who is recognized as a credible knower, whose knowledge counts as evidence, and what structural conditions make genuine epistemic engagement possible.

This study presents three sub-studies (Chapters 2, 3, and 4) within this larger inquiry. Chapter 2 draws primarily on social-ecological systems resilience and biocultural knowledge frameworks to explore what students understand and believe about cultural, social, and ecological challenges facing their community prior to the program. Chapter 3 draws on critical place-based education, kuleana, and critical consciousness frameworks to explore how embodied practice supports students' developing sense of kuleana. Chapter 4 draws on Kānaka ʻŌiwi epistemologies and epistemic justice frameworks to explore what happens when two knowledge systems with different ontologies and axiologies coexist in the same learning context. Together,

the three studies provide a more complete account of how students engage with multiple knowledge systems than any single framework could offer. Methodologically, this study brings together critical place inquiry (Tuck & McKenzie, 2015a), community-based participatory research (CBPR) (Minkler & Wallerstein, 2011), and Indigenous research methodologies (Chilisa, 2019; Smith, 1999) in ways that position students as knowledge producers rather than research subjects, and community partners as co-investigators rather than consultants.

STUDY SITES

South Maui Charter School

This study takes place at South Maui Charter School in Kīhei, Maui, approximately 25 miles south of Lahaina. Like many communities across Maui, Kīhei residents navigate the complex realities of living in a tourism-dependent economy while facing intensifying environmental pressures. Situated on the south-facing shore of the island, students can directly observe interconnected environmental stressors, including invasive species abundance, wildfire risk, tourism impacts, water management challenges, coastal development, coral reef degradation, and toxic runoff (Pogue & Jr., n.d.). As a charter school with no geographic enrollment restrictions, students live in communities across Maui, bringing diverse relationships to place.

Figure 1.1

Landscape Surrounding South Maui Charter School, North of Kīhei, Maui

Figure 1.2

Map of Maui with Study Sites and Points of Reference

Kīpuka Malu

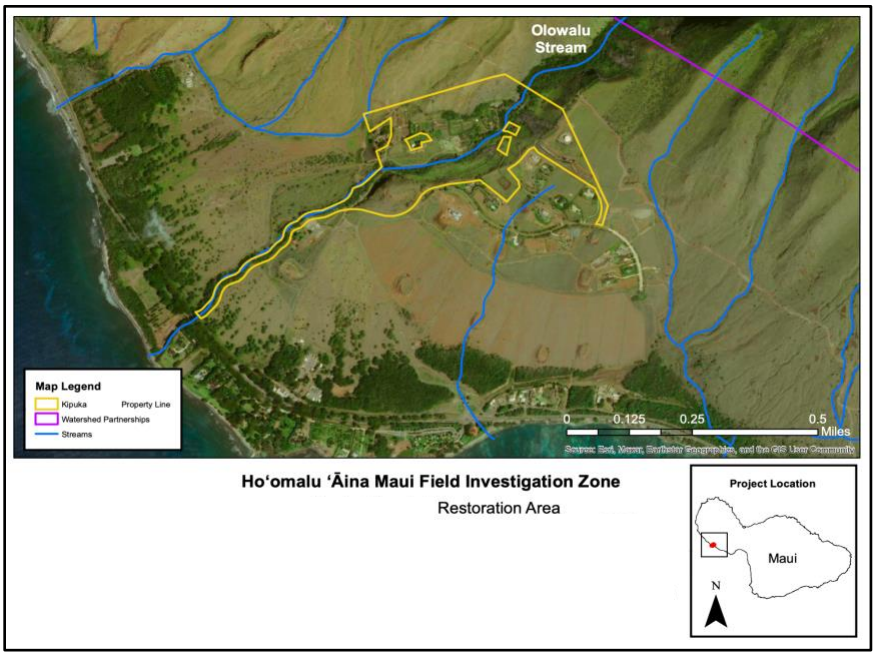
Fieldwork took place at Kīpuka Malu, located approximately 8 miles south of Lahaina and 17 miles north of the school, within the ahupua‘a (land division) of Olowalu and the moku (district) of Lahaina. To understand this site is to understand that its current ecological condition is inseparable from a much longer history of transformation.

Figure 1.3

Looking Toward Kīpuka Malu and Olowalu Valley, Olowalu, Maui

Figure 1.4

Kīpuka Malu property boundary within the Olowalu ahupua‘a, Olowalu, Maui



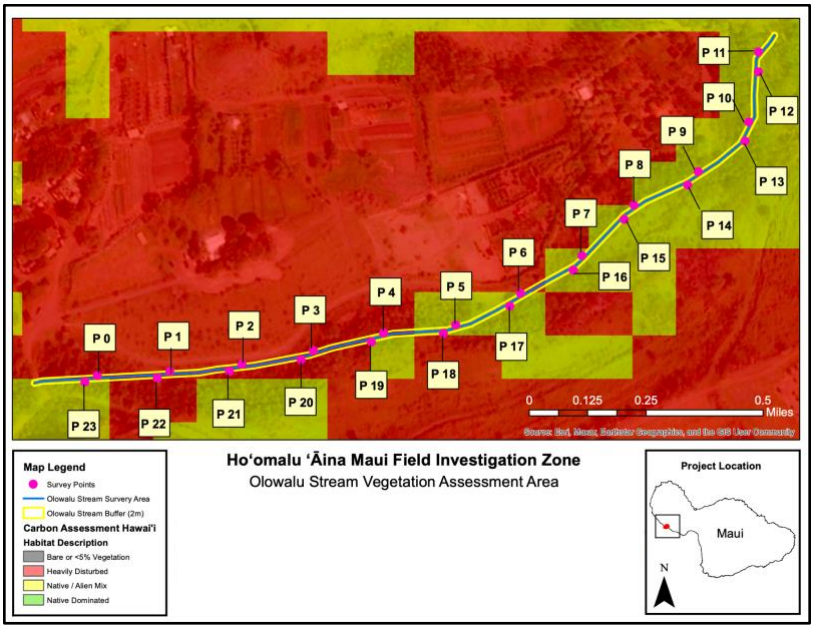
Olowalu has been inhabited and carefully tended for centuries. The valley was known as a pu‘uhonua (a place of refuge) where those fleeing conflict or kapu violation (breach of sacred law) could find refuge, and where the entire ahupua‘a functioned as a zone of peace (Kama‘ema‘e Smith, 2011). Kānaka ‘Ōiwi farmers cultivated the alluvial plain with kalo (taro), ‘uala (sweet potato), and ‘ulu (breadfruit), channeling the Olowalu Stream through a network of ‘auwai (irrigation ditches) that distributed fresh water across the valley basin. The stream itself connects Maui’s largest watershed, originating at Pu‘u Kukui, the highest peak of the West Maui Mountains, to the Olowalu Reef, a designated Hope Spot and of critical importance for oceanic and coastal health in the Pacific (Deakos, 2021). This mauka (mountain) to makai (ocean) flow means that how the land is managed above directly shapes the health of the reef below. Olowalu was also a site of deep political and genealogical significance. For example, High Chiefess Kalola Pupukahonokawailani ruled here in the late eighteenth century, presiding over Ka‘iwaloa Heiau, a major ceremonial site oriented toward Kaho‘olawe and the navigation lane to Tahiti.

Petroglyphs at Puʻu Kilea record centuries of travelers passing through the valley on the footpath connecting Lahaina and Wailuku (Kamaʻemaʻe Smith, 2011).

With the arrival of plantation agriculture in the nineteenth and twentieth centuries, this landscape was fundamentally altered. Sugarcane growers rerouted Olowalu Stream, redirecting its course to increase arable acreage and replacing the traditional ʻauwai system with concrete irrigation channels that contained rather than percolated water, disrupting the aquifer that had sustained the valley's moisture for generations (Evenhuis, 2007). The clearing of native hardwood tree species such as ʻiliahi (sandalwood), koa, and ʻōhiʻa from Olowalu's upper slopes had already significantly dried the valley by the early 1800s, setting the stage for the proliferation of invasive species that now dominate the landscape (Luat-Hūʻeu et al., 2021). Buffelgrass and haole koa, both highly flammable species whose spread accelerated through plantation-era land transformation, now cover most of the riparian corridor.

Figure 1.5

Olowalu Stream Vegetation Assessment Area, Olowalu, Maui



Students' vegetation assessment conducted as part of this study found buffelgrass present at nearly 80% of surveyed plots with high-density coverage across much of the assessment area, and haole koa at over 90% of plots (Miller et al., 2025). These findings represent not only an urgent wildfire hazard, but a legible record of colonial land transformation written into the landscape itself, both of which are closely intertwined.

Figure 1.6

Invasive Species Dominating the Riparian Corridor at Kīpuka Malu, Olowalu

Figure 1.7

Buffelgrass at Kīpuka Malu, Olowalu, Maui, a Primary Wildfire Fuel Introduced During the Plantation Era

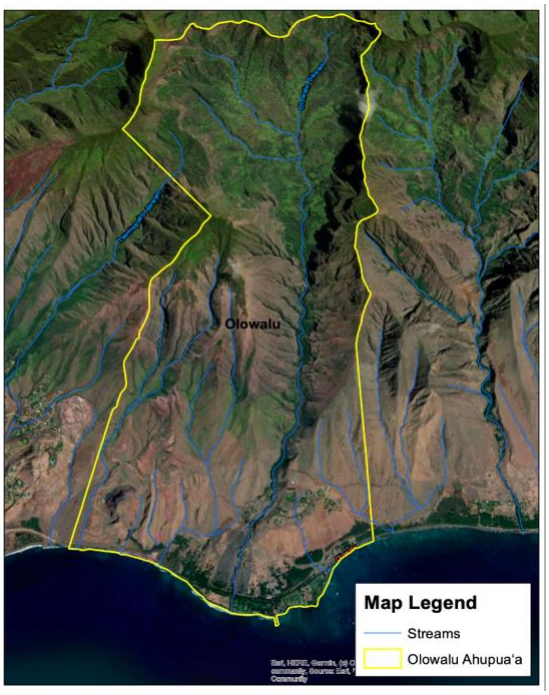
Kīpuka Malu was founded in 2020 by a group of individuals who were intent on protecting cultural resources through traditional Kānaka ʻŌiwi practices and protocols for the present and future. Kīpuka Malu was reorganized from the Olowalu Cultural Reserve, originally established in 1999, to protect cultural resources through traditional Kānaka ʻŌiwi practices and protocols. Despite this change, their mission has remained consistent: "*to perpetuate the traditional and customary practices of Kānaka Maoli* [Kānaka ʻŌiwi] *and to restore the spiritual connection of hānai ʻāina* [the practice of caring for land as one cares for a child] *for present and future generations*" (Kipuka Olowalu, n.d.). Since 2020, Kīpuka Malu has undertaken loʻi restoration, native plantings, invasive species removal, and the reestablishment of cultural protocols for all who enter the site. It was within this ongoing restoration effort that Hoʻomalu ʻĀina Maui students conducted their field visits not as visitors to a classroom extension site, but as participants in work already underway, consequential, and grounded in Kānaka ʻŌiwi relationships with this place.

Kīpuka Malu has experienced direct wildfire threat during and after the August 2023 fire, and the site continues to face elevated risk (Mass & Ovens, 2024). The same settler-colonial land transformations that made Lahaina vulnerable (e.g., the replacement of Indigenous land management with extractive agriculture, the spread of invasive fire-adapted grasses, the disruption of integrated watershed systems) are visible and ongoing at Kīpuka Malu. This is precisely what made it a generative site for the educational work this study explores: a place where the stakes of environmental stewardship are immediate, where Kānaka ʻŌiwi knowledge and Western science are present, and where students could engage with the deep entanglement of ecological and political history within a landscape (Ruiz-Mallén & Corbera, 2013).

Figure 1.8 shows the full extent of the Olowalu ahupuaʻa within which this restoration work takes place.

Figure 1.8

Map of Olowalu Ahupuaʻa, Olowalu, Maui



THE HOʻOMALU ʻĀINA MAUI PROGRAM PARTNERS

The Origins of the Partnership

The Hoʻomalu ʻĀina Maui program began as a phone call. In August 2023, in the immediate aftermath of the Lahaina wildfire, I called Ellie, the high school director at South Maui Charter School and a longtime friend. We had met years earlier through a shared morning surf routine, and our friendship had deepened over the years that I spent teaching and living on Maui. In that conversation, as the scale of the devastation was still becoming clear, we talked not only about the immediate crisis but about what students and the broader community would need in the long term. That conversation was the seed of what would become Hoʻomalu ʻĀina Maui, which the students in this study formally named.

Ellie connected me with Carrie, South Maui Charter School's high school ecology teacher, whose vision for place-based, hands-on environmental education aligned closely with the program we were beginning to imagine. Carrie and I spoke several times in the fall and winter of 2023, and it became clear quickly that she would be a central partner and a genuine co-architect of the program's design and implementation.

In January 2024, I reached out to Kīpuka Malu, the watershed stewardship and cultural revitalization nonprofit whose land would become the program's primary field site. As a 7th-grade science teacher, I had brought my students to Kīpuka Malu's site three times in a single school year, and those visits had established a working relationship with the organization, grounded in mutual respect and shared educational values. I contacted Debi, Kīpuka Malu's Executive Director, who was on board from the beginning. Her institutional endorsement made the partnership possible, and her trust in the collaboration's intentions shaped the terms on which it was built.

The partnership also included Waiola, a Kānaka ʻŌiwi biocultural conservation biologist affiliated with ʻĀina Momona Stewardship (his for-profit company where he performs environmental consulting), who brought deep expertise in botany, ecology, and biocultural conservation to the program. Waiola's involvement was grounded in genuine commitment to the program's goals independent of his connection to the research.

Table 1.1

Hoʻomalu ʻĀina Maui Program Partners and Roles

Partner	Organization	Role in program	Primary responsibility during field visits
Koa	Kīpuka Malu	Kanaka ʻŌiwi cultural practitioner	Led opening protocol, oli, moʻolelo, and other cultural teachings
Tara	Kīpuka Malu	Project manager	Led hands-on land stewardship and wildfire mitigation activities
Leilani	Kīpuka Malu	Communications and outreach specialist	Point person for communicating about the planning of field visits and supported land stewardship activities
Debi	Kīpuka Malu	Executive Director	Organizational partnership oversight
Waiola	Āina Momona Stewardship	Kanaka ʻŌiwi biocultural conservation biologist	Supported the students' vegetation assessments, gave in-class presentations, and supported field visits
Carrie	South Maui Charter School	Field ecology teacher	Supported all program activities; coordinated student participation, led all in-class instruction
Ellie	South Maui Charter School	High School Director	Ellie's long-standing relationships with both the researcher and ecology teacher helped bring the collaboration into focus

Jadda	University of California, Davis	Researcher	Supported all program activities while conducting ethnographic observations, surveys, and interviews

Twenty-four high school students participated in the Hoʻomalu ʻĀina Maui program and are included in this study's participant population, divided into two cohorts: a Field Ecology class (n=17) and an Eco Club (n=7). Four of the Field Ecology students joined the class in December 2024 following a schedule change and participated in all program activities from that point forward, including the final two field visits. Their pre-program interviews were conducted in January 2025 rather than September 2024, when the rest of the students had theirs. Of the 24 students, 22 completed individual or focus group interviews; two Eco Club students were unavailable during the interview window despite multiple scheduling attempts. Because coordinating one-on-one meetings outside of class time proved difficult for some students, I also conducted two small focus groups: one with two students and one with four students using the same interview protocol. One student did not complete the survey. Over the course of the year, four students left the program (three from Field Ecology and one from Eco Club) for various personal reasons, and 20 students completed the full program year. Pre-survey data reflects responses from 23 students, and interview data draws on responses from 22 students across both individual and focus group formats.

Table 1.2

Student Participants in the Hoʻomalu ʻĀina Maui Program (n=23)

Student Pseudonym	Gender Identity	Grade	Cohort (Field Ecology, Eco Club, or Both)	Race/ Ethnicity

Ali	Female	Junior	Field Ecology	White
Anna	Non-binary	Senior	Field Ecology	White
Anne	Female	Junior	Eco Club	White
Bella	Female	Junior	Eco Club	White
Bob	Male	Junior	Field Ecology	Hispanic or Latine, Other
Fall	Female	Junior	Eco Club	White
Helena	Female	Senior	Field Ecology	Native Hawaiian, Chinese, White
Janelle	Female	Senior	Field Ecology	Native Hawaiian, Filipino, Japanese, Chinese, Native American, Hispanic or Latine, White
Jessie	Female	Junior	Field Ecology	Pacific Islander (e.g., Samoan, Guamanian, Micronesian), Filipino, Hispanic or Latine, White, Other
Joy	Female	Junior	Eco Club	White
Kanoa	Male	Senior	Field Ecology	White
Kay	Female	Senior	Both	Hispanic or Latine
Keoni L.	Male	Senior	Field Ecology	Chinese, White
Kim	Female	Junior	Field Ecology	White
Li‘i	Female	Junior	Field Ecology	Native Hawaiian, Filipino, Japanese, Chinese, Native American, Hispanic or Latine, White
Lex	Female	Senior	Field Ecology	White

Max	Male	Senior	Field Ecology	Hispanic or Latine
Michael	Male	Junior	Field Ecology	White
Mundean	Female	Junior	Eco Club	Hispanic or Latine, White
Myrna	Female	Junior	Eco Club	Filipino, White
Sarah	Female	Senior	Field Ecology	White
Senai	Female	Junior	Eco Club	Black or African American, Hispanic or Latine
Solai	Female	Junior	Both	White

Figure 1.9

Students and Program Partners Walking to Opening Protocol at Kīpuka Malu, Olowalu, Maui

Community-Based Participatory Research in Practice

Community-based participatory research (CBPR) is often described in methodological terms as a set of principles about power-sharing, community ownership, and collaborative knowledge production (Israel et al., 2013). In this project, those principles took shape through relationships that preceded the research itself and through ongoing negotiation among partners about what the program would do, what questions it would ask, and whose priorities would guide it.

The partnership operated primarily through triads and dyads via regular informal check-ins among subsets of partners, rather than through a single governing structure. On field days, all partners were present and active, each contributing according to their role and expertise. Koa led opening protocols, oli, and moʻolelo, grounding each visit in Kānaka ʻŌiwi cultural practice. Tara led hands-on land stewardship and wildfire mitigation activities. Waiola supported vegetation assessments and connected students' fieldwork to broader biocultural conservation frameworks. Carrie coordinated all student participation and led all in-class instruction. Leilani managed communications, supported field activities, and shared cultural knowledge from her lived experiences and familial practices. I participated fully in all program activities, including driving students to and from field sites, preparing materials, helping plan field days, facilitating in-class and field-based activities, and conducting ethnographic observation, surveys, and interviews.

Our collaborative partnership was not merely structural. It had direct consequences for the research itself. Early in the planning process, I proposed a research focus oriented around climate anxiety. Carrie declined. She made it clear that she did not want the research to center on anxiety and redirected us toward resilience as the animating frame. That intervention shaped the

research questions, the program's pedagogical orientation, and ultimately the findings of this study. It is one of the clearest examples of what community accountability looked like in practice in this project, a community partner exercising genuine authority over the terms of the work.

There were other moments of negotiation and redirection throughout the research process. I came to this work with theoretical frameworks developed in my academic training, including language and conceptual tools drawn from critical Indigenous studies and decolonial theory. I learned, sometimes through direct feedback from partners, that not all of the language translated into or was welcome in this community context. Those moments were instructive and asked me to remain attentive to the epistemological and political commitments of the community I was working within.

Hoʻomalu ʻĀina Maui launched in the fall of 2024, with data collection occurring across the 2024-2025 academic year. The research and the program were constitutively intertwined, shaped by the same relationships, the same community priorities, and the same commitment to doing work that would be of genuine use to the students and place at its center.

Hoʻomalu ʻĀina Maui was designed from the outset to address two converging crises: the ecological and community devastation caused by the 2023 Lahaina wildfire and the systematic marginalization of Kānaka ʻŌiwi knowledge in K-12 science education. The program's design logic spans four interconnected dimensions (ecological, relational, epistemological, and political). Table 1.3 summarizes the program's theory of change across these dimensions.

Table 1.3

Hoʻomalu ʻĀina Maui Theory of Change

Dimension	Problem/Context	Program Response	Activities	Intended Outcomes
Ecological	The 2023 Lahaina wildfire resulted from settler-colonial land transformations that displaced Kānaka ʻŌiwi land management systems, introduced invasive species, and disrupted integrated watershed systems	A community-based participatory research program co-developed with a high school ecology teacher, a Kānaka ʻŌiwi biocultural conservation biologist, and Kīpuka Malu, a watershed stewardship and cultural revitalization nonprofit	Four field visits to Kīpuka Malu involving hands-on wildfire mitigation and land stewardship	Students develop kuleana through embodied engagement with ʻāina
Epistemological	K-12 science education in Hawaiʻi largely operates from Western epistemologies that marginalize Kānaka ʻŌiwi knowledge systems	Program design centers Kānaka ʻŌiwi epistemic authority through a constellation of knowledge holders with distinct and complementary forms of expertise	Cultural protocol, oli, and moʻolelo led by an ordained Kānaka ʻŌiwi cultural practitioner	Students engage with the ontological and axiological dimensions of Kānaka ʻŌiwi biocultural knowledge
Political	Young people in post-disaster contexts often lack the historical and political frameworks to understand what created conditions for disaster	Research design that foregrounds students' existing knowledge, lived experience, and critical consciousness as foundational rather than deficient	Pre- and post-program surveys and interviews, ethnographic observation, and student-produced documentary film	Students develop critical consciousness of the colonial forces that created conditions for the Lahaina fire
Relational	Environmental education programs often treat Indigenous knowledge as supplementary to Western science rather than as epistemologically	Relational infrastructure built through sustained, reciprocal partnership preceding and exceeding the program year	Collaborative data analysis, vegetation assessments, and student-led documentary film production	Students recognize Kānaka ʻŌiwi knowledge as foundational rather than supplementary to Western science

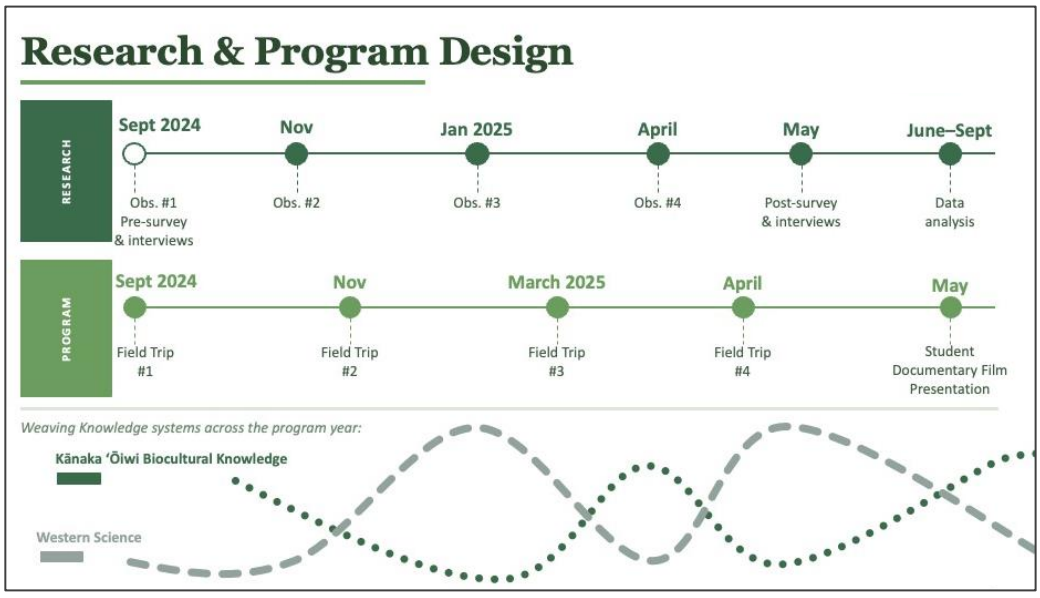
Dimension	Problem/Context	Program Response	Activities	Intended Outcomes
	distinct and authoritative			

Note. This theory of change reflects the program's pedagogical logic across cognitive, relational, epistemological, and political dimensions. Outcomes are not sequential but mutually reinforcing.

Figure 1.10 below shows the research and program design running in parallel across the 2024-25 academic year. The research track (top) documents pre- and post-surveys and interviews, four ethnographic observations, and data analysis. The program track (bottom) shows four field visits to Kīpuka Malu and the culminating presentation of the student documentary film. The intertwined lines at the bottom represent the conceptual architecture of the program: Kānaka ʻŌiwi Biocultural Knowledge and Western Science are not layered sequentially but interwoven throughout, with different knowledge systems foregrounded at different moments.

Figure 1.10

Hoʻomalu ʻĀina Maui Research and Program Design



ORGANIZATION OF THIS STUDY

This study consists of five chapters, which include this introduction. Primarily, this study consists of sub-studies chapters (2, 3, and 4) that draw on data from the Hoʻomalu ʻĀina Maui program. All community partners, student participants, and organizations have been given pseudonyms. Place names have retained their real names. Each of the three empirical chapters described above has its own theoretical and conceptual frameworks, method descriptions, findings, and discussions. While interrelated, each is written with the intent to stand alone, separately from the rest of the study. As a result, there is occasional repetition throughout. In the conclusion (Chapter 5), I outline key findings and implications for both theory and practice.

Throughout the writing of this study, I have grappled with the tension of representing this as a "single author's work." Dissertations, by institutional convention, require a single author, and yet this work was made possible through relationships, partnerships, and knowledge that belong to a community, not to me alone. Decolonial research methodologies (Smith, 1999; Chilisa, 2019) ask us to hold this tension honestly, to name whose labor and knowledge made the work possible, to resist the extraction of community knowledge for individual academic gain, and to remain accountable to the people and place at the center of the research. I have tried to honor both the collaborative nature of this work and my own contributions as the author of these pages, while recognizing that those contributions were made possible by the generosity of this community.

Throughout this study, ʻŌlelo Hawaiʻi (native language of Hawaiʻi) terms appear as primary, foundational conceptual and analytical grounding rather than as translations or supplements to English. Terms are defined upon first use and elaborated in greater detail in the

chapters where they are most central to the analysis. One term that recurs across all three empirical studies and warrants an introduction here is kuleana, a Kānaka ʻŌiwi concept encompassing relational responsibilities, rights, and privileges that emerge from genealogical connection to specific ʻāina (land) (Pukui & Elbert, 1986). Kuleana is explored in depth in Chapter 3 but shapes the conceptual architecture of this study as a whole.

In the paragraphs below, I provide a brief overview of each chapter and how they build on one another.

SUB-STUDIES

Chapter 2: "The Whole System Is Disrupted": How High School Students Understand Biocultural Knowledge and Social-Ecological Systems Resilience in Post-Wildfire Maui

This first empirical study, conducted exactly one year after the Lahaina wildfire, explores how high school students in Maui, Hawaiʻi, made sense of complex social-ecological challenges prior to engaging in the Hoʻomalu ʻĀina Maui program. I analyze their sensemaking through two frameworks: 1) Kānaka ʻŌiwi biocultural knowledge, which is essential for community resilience and rooted in Indigenous epistemologies, and 2) Social-ecological systems resilience (SESR), a Western science framework encompassing systems thinking and resilience thinking.

Using mixed methods, I collected survey data from 23 students (including one quantitative Likert-scale question and three qualitative open-ended questions) and conducted semi-structured interviews with 22 students at a charter school. I analyzed the Likert-scale question using descriptive statistics and the open-ended responses and interviews using hybrid deductive-inductive thematic coding. I found four patterns in how students engaged with these concepts that reflect both knowledge frameworks: (1) Students demonstrated significant systems

thinking skills when analyzing environmental problems, drawing connections across invasive species, fire risk, water diversions, and development; (2) Students drew extensively on direct experience with the wildfire to conceptualize resilience, applying lived knowledge of disaster response and community recovery; (3) Some students demonstrated critical awareness of social justice regarding Kānaka ʻŌiwi communities, articulating sovereignty issues and economic displacement; (4) Two students even showed integration of multiple dimensions of both biocultural knowledge and SESR when engaging with complex, place-based environmental challenges.

These findings point toward three directions for environmental education in post-disaster and Indigenous contexts: integrating political and ecological literacy, expanding how resilience is taught and understood beyond disaster response, and centering Indigenous knowledge through sustained, ethical, and accountable partnerships with cultural practitioners. These findings establish the conceptual baseline from which the subsequent empirical chapters build, demonstrating that the conditions students need are not more content but deeper relationships with place, community, and local Indigenous knowledge.

Chapter 3: "The Land Is Always First": Kuleana as Embodied Practice After the Lahaina Fire

This second empirical study explores how high school students in Maui, Hawaiʻi, develop kuleana (the Kānaka ʻŌiwi concept of relational responsibilities and rights) through participation in the Hoʻomalu ʻĀina Maui (protecting the land of Maui) program, a community-based participatory research (CBPR) initiative with a high school ecology teacher, a Kanaka ʻŌiwi (person Indigenous to Hawaiʻi) cultural practitioner, a Kanaka ʻŌiwi biocultural

conservation biologist, and myself, an education researcher. One year after the August 8th, 2023, Lahaina wildfire, high school students engaged in hands-on wildfire mitigation and land stewardship at Kīpuka Malu, a 75-acre ʻāina (land) and cultural preserve located 7 miles south of Lahaina. Drawing on semi-structured pre- and post-interviews, this research explores how participation in the Hoʻomalu ʻĀina Maui program shaped students' relationships to ʻāina, their understanding of the forces that created conditions for the fire, and their sense of kuleana to land and community. This study identifies three interconnected findings: (1) Kuleana emerged through repeated engagement with a specific place, through land stewardship work, and through relationships with kumu (teachers) who modeled kuleana, and for students with Kānaka ʻŌiwi heritage or deep community ties, this accountability was already present; the program created conditions to practice it more fully; (2) By the end of the year, most students could trace the fire's cause to colonial land management practices (plantation agriculture), and that understanding transformed grief from paralysis into motivation for action; and (3) students simultaneously refused extractive land relations and regenerated reciprocal relations, developing critical consciousness and land stewardship practice simultaneously. This research contributes to scholarship on critical place-based education, decolonial pedagogy, and post-disaster learning. Findings from this sub-study argue that the conditions under which students develop genuine environmental responsibility are irreducibly relational, place-specific, and grounded in Indigenous ways of knowing, conditions that curriculum alone cannot create. This is what Chapter 4 explores.

Chapter 4: "They Did Not Call It Science Back in the Day, It Was Just Being Kānaka": High School Students' ʻĀina-Based Learning and Epistemic Authority in Hawaiʻi

This third and final sub-study explores how students engage with the ontological and axiological dimensions of Kānaka ʻŌiwi biocultural knowledge during ʻāina-based stewardship, and how epistemic authority among program partners shapes students' experiences when two knowledge systems coexist in the same learning context. Science education in K-12 schools has long marginalized Indigenous ways of knowing, and in doing so, has worked to erase the land relationships and knowledge systems of the very communities whose homelands schools and their surrounding communities occupy. Hoʻomalu ʻĀina Maui (protecting the land of Maui) is a community-based participatory research (CBPR) project with a high school ecology teacher, a Kanaka ʻŌiwi cultural practitioner, a Kanaka ʻŌiwi biocultural conservation biologist, Kīpuka Malu (a nonprofit dedicated to land stewardship and cultural revitalization), and an education researcher. Hoʻomalu ʻĀina Maui was created in response to the August 8th, 2023, Lahaina wildfire. This program engaged twenty-four high school students in hands-on wildfire mitigation and land stewardship at Kīpuka Malu, located seven miles south of Lahaina. This study draws on audio-recorded field observations, pre- and post-program interviews with students, and a student-produced documentary film to share what they did, what they said, and how their understanding of land, knowledge systems, and accountability shifts across a program year. Scholars have long argued that ontological engagement with Indigenous knowledge requires relational conditions that curriculum alone cannot create (Bang, 2017; Bang, 2020; Marin & Bang, 2018; Cajete, 2020a; Goodyear-Kaʻōpua et al., 2014). This study contributes ethnographic evidence of what those conditions look like in practice in a public school context. This chapter argues that grounding science education in Kānaka ʻŌiwi biocultural knowledge is not a curricular design

challenge but a practice with its own relational logic that requires building the relational infrastructure first and sustaining it long after the program ends. Findings carry implications for ʻāina-based program designers, CBPR practitioners, and science education researchers working at the intersection of Indigenous knowledge and environmental stewardship in public school contexts. Ultimately, this study argues that another kind of science education is both possible and necessary, one organized not around what students need to learn but around what knowledge already exists in the land, the community, and the genealogical relationships that connect them, and what it would take to build the conditions under which that knowledge can be fully honored in educational settings.

CONCLUSION

Chapter 5: Synthesis Across Chapters

In this final chapter, I synthesize findings across the three sub-studies to address this study's overarching question: how do students engage with and make meaning of multiple knowledge systems in a post-wildfire environmental stewardship and public school context? This chapter explores cross-cutting themes that emerge when Chapters 2, 3, and 4 are read together: the role of embodied practice in knowledge integration (Pugh et al., 2019); the significance of relational accountability in shaping learning (Vaughn, 2022; Osorio, 2021); the tensions between frameworks that position resilience as adaptation versus transformation (Folke et al., 2010; Pelling, 2011; Allen et al., 2011); and the possibilities and constraints of educational partnerships that attempt to center Indigenous knowledge authority while operating within colonial institutions (Brayboy & Castagno, 2009). This chapter also explores implications for environmental education within Indigenous homelands (such as Hawaiʻi), particularly how

educators, cultural practitioners, scientists, and communities can collaborate in ways that honor sovereignty, support cultural revitalization, and practice reciprocity (Middleton Manning, 2023; Ross et al., 2011). It addresses who this research is intended to serve, particularly communities in Hawai‘i who are engaged in ‘āina-based education, educators seeking to decolonize science education broadly, and scholars developing frameworks for research-practice partnerships grounded in justice (Ghiso et al., 2019). This chapter concludes with methodological reflections on conducting community-based participatory research as a white settler scholar (Patel, 2015; Pillow, 2003), addressing questions of accountability, relationship, and the ongoing work of decolonization in educational research (Smith, 1999; Tuck & Yang, 2012). Finally, it proposes directions for future research on knowledge co-production in educational contexts (Norström et al., 2020; Yua et al., 2022; Zurba et al., 2022), youth empowerment in post-disaster settings (Ruiz-Mallén et al., 2022), and the role of environmental education in supporting both Indigenous resurgence (Goodyear-Ka‘ōpua et al., 2014) and social-ecological resilience (Krasny et al., 2010; Folke et al., 2010).

CHAPTER 2. "THE WHOLE SYSTEM IS DISRUPTED": HOW HIGH SCHOOL STUDENTS UNDERSTAND BIOCULTURAL KNOWLEDGE AND SOCIAL-ECOLOGICAL SYSTEMS RESILIENCE IN POST-WILDFIRE MAUI

INTRODUCTION AND BACKGROUND

On August 8, 2023, the deadliest U.S. wildfire in over a century devastated Lahaina, Maui, killing 102 people and destroying thousands of structures (Rafferty, 2023). This fire resulted from the complex interplay between climate change and settler-colonial land transformations. These land transformations include, but are not limited to, the conversion of traditional Kānaka ʻŌiwi[1] land management systems to industrial monoculture agriculture, the proliferation of highly flammable invasive grasses that replaced native ecosystems (Trauernicht et al., 2015), and the diversion of water. This catastrophe underscores an urgent challenge for environmental education: how do we prepare students to understand and address the interconnected social-ecological crises their communities increasingly face?

Traditional approaches to science education often fail to connect scientific concepts with students' lived experiences, contributing to disengagement and declining scientific literacy (Roth, 2003; Sjöström & Eilks, 2018) at a time when environmental literacy is critically needed. Moreover, most U.S. science education operates from Western epistemologies that separate humans from nature (Cajete, 2020b; Medin & Bang, 2014), marginalizing Indigenous knowledge systems that have sustained communities' relationships with land for generations. As climate change intensifies, there is growing recognition that environmental education must integrate multiple knowledge systems (Medin & Bang, 2014; Tuck et al., 2014) to address complex social-ecological challenges.

[1] I intentionally use "Kānaka ʻŌiwi" throughout this study rather than "Hawaiian," as the latter is an English term that represents a Western perspective of the Indigenous people of Hawaiʻi (Louis, 2017, p. xv).

Social-ecological systems resilience (SESR) emphasizes the interdependence of human and natural systems (Folke et al., 2010) and offers a framework for examining how communities and ecosystems adapt, learn from, and respond to change together. However, SESR emerged from Western scientific traditions and carries epistemological assumptions about how knowledge is generated and validated. Indigenous ways of knowing have long recognized the inseparability of human and natural communities (Charles & Cajete, 2020a), not as a precursor to Western science, but as foundational epistemologies with their own criteria for validity, form of knowledge sharing, and relationship to place. I employ both frameworks as distinct analytical approaches to explore students' understanding of social-ecological relationships.

In recent years, catastrophic wildfires have become a common occurrence globally (Pausas & Keeley, 2021), with devastating impacts on communities in their path. Duane et al. (2021) state that wildfires are influenced by factors related to climate change, with additional culprits being the impacts of settler colonialism (Martinez et al., 2023). Settler colonialism can be defined as a permanent occupation and claiming of Indigenous lands as a new homeland (Wolfe, 2006). It is an ongoing system that continues to shape society and is not just a historical event (Veracini, 2011). This process has involved both the genocide of Indigenous peoples and the transformation of their traditional lands into private property (Tuck and Yang, 2012; Spillers, 2003; Snelgrove et al., 2014). Settler colonialism has impacted the ability and capacity of Native and Indigenous people to steward landscapes at the scale they once used to (Domínguez & Luoma, 2020). As a result, landscapes have been severely impacted and transformed, reducing their resilience and ability to recover from disturbances and change (Summary Report, n.d.). Settler colonialism entails many transformations visible in Hawai‘i's landscape, including, but not limited to, development, invasive species abundance and distribution, water diversions, and

industrial-scale monoculture (single-crop) agriculture (Reed, 2023). These landscape transformations and vulnerabilities became visceral after the catastrophic wildfire that occurred in Lahaina, Maui, on August 8, 2023. Before the fire, highly flammable invasive grasses (Brown, 2009) surrounded the town of Lahaina, where loko iʻa (traditional fishponds) and loʻi kalo (taro) patches were once abundant (Morgan, 1986). These invasive grasses contributed to the rapid spread of the fire (NAISMA, 2023). This tragic event highlights the complex interplay between climate change, settler colonialism, and, as a result, altered landscapes. Analyzing these entangled forces requires theoretical frameworks that can account for both Indigenous and Western knowledge systems. This study responds to these conditions.

Conducted exactly one year after the Lahaina wildfire, I worked with high school students at South Maui Charter School in Kīhei, Maui, using surveys and semi-structured interviews to understand what students already knew and understood about the social-ecological challenges facing their community. I employed two frameworks: Kānaka ʻŌiwi biocultural knowledge and social-ecological systems resilience. I found that students arrived with significant systems thinking skills and critical consciousness about injustices affecting Kānaka ʻŌiwi communities but had not yet been given the educational conditions to connect that analysis to Indigenous ecological knowledge as a living framework for environmental problem-solving. These findings suggest that the most urgent task for environmental education in post-disaster and Indigenous contexts is not filling knowledge gaps but building the relational and structural conditions in which Indigenous knowledge can be recognized as relevant, living, and authoritative. The sections that follow elaborate the theoretical frameworks guiding this analysis, the methods used, the findings, and their implications for environmental education research and practice.

Approximately one year after the catastrophic Lahaina wildfire, this study explored the following research question:

How do high school students in Maui, Hawai‘i engage with and understand biocultural knowledge and social-ecological systems resilience one year after the Lahaina wildfire?

Exploring this question requires analytical frameworks that honor both Indigenous and Western knowledge systems. This study draws on two such frameworks.

THEORETICAL FRAMEWORKS

Two Knowledge Frameworks: Biocultural Knowledge and SESR

To explore how students make sense of social-ecological systems, this study attends to two knowledge frameworks: (1) Biocultural knowledge, rooted in Indigenous epistemologies that have sustained human-environment relationships for millennia, and (2) Social-ecological systems resilience (SESR), a Western scientific framework encompassing systems thinking and resilience thinking. I present biocultural knowledge first as it serves as the epistemological center of this study.

Biocultural knowledge

Biocultural knowledge, often termed Traditional Ecological Knowledge (TEK) in broader Indigenous scholarship (Morishige et al., 2018; Nemogá et al., 2022), integrates cultural practices, intergenerational wisdom, and place-based ecological understanding across generations (Berkes et al., 2000; Ens et al., 2015). In Hawai‘i, biocultural knowledge encompasses relationships between people and place, expressed through governance practices such as the ahupua‘a (traditional land division) system and kilo (observation), which guided

planting, harvesting, and ʻaina (land) stewardship (Morishige et al., 2018; Vaughan et al., 2017). These practices embody sophisticated understandings of relationships, reciprocity, and adaptation, distinct Indigenous epistemologies transmitted through practice since time immemorial (Kimmerer, 2013; Berkes et al., 2000). As Meyer (2008) argues in Kānaka ʻŌiwi epistemology, the memory of the land and the memory of the people are inseparable. Biocultural knowledge recognizes that humans and environments are not separate systems to be managed but reciprocal relationships to be tended to and cared for. Despite growing recognition that Traditional Ecological Knowledge offers essential insights for climate adaptation (Fernández-Llamazares et al., 2021), such knowledge remains largely absent from formal environmental education (Medin & Bang, 2014). In this study, biocultural knowledge serves as both an epistemological grounding and an analytical lens, directing attention toward whether and how students engage with Kānaka ʻŌiwi knowledge systems, cultural practices, and their relationship to land when reasoning about environmental challenges in their community. While biocultural knowledge grounds this study, SESR offers a complementary analytical lens for exploring students' perspectives on the systems in which they are embedded.

Social-ecological systems resilience (SESR)

Social-ecological systems resilience (SESR) provides the conceptual framework for understanding how coupled human-natural systems respond to disturbance, adapt to change, and reorganize when necessary (Bey, 2020; Folke et al., 2010; Gunderson & Holling, 2002). Unlike earlier Western ecological resilience concepts focused solely on ecosystem stability (Holling, 1973), SESR explicitly recognizes that human and natural systems are inseparable. Communities and ecosystems change through ongoing interactions that shape both social organization and

ecological processes (Berkes & Folke, 1998; Biggs et al., 2015). This framework is particularly relevant for environmental education in communities experiencing climate-driven disasters, where understanding system dynamics, adaptive capacity, and transformation potential becomes essential for future-oriented thinking and learning (Krasny et al., 2010; Ruiz-Mallén et al., 2022). This study employs SESR as an analytical framework while recognizing its limitations and Western origins.

SESR scholarship identifies three interrelated ways that systems respond to change: persistence (absorbing disturbances while maintaining system identity), adaptability (adjusting to changing conditions), and transformability (fundamentally reorganizing when existing configurations become untenable) (Folke et al., 2010; Walker & Salt, 2012). To explore how students engage with these concepts, I operationalize SESR through two analytical dimensions: "systems thinking" (understanding interconnections and relationships within coupled human-natural systems) and "resilience thinking" (understanding how systems respond to disturbance and change). These dimensions allow me to analyze students' reasoning and perspectives while remaining attentive to how they articulate these concepts in their own language and from their own experiences.

Systems thinking

Systems thinking reveals how social and ecological components interact within coupled systems. Students demonstrating systems thinking recognize interconnections, feedback loops, and emergent properties, such as tracing how changes in one domain cascade through entire systems (Cabrera & Cabrera, 2023; Wright & Meadows, 2008). For example, understanding Maui's wildfire requires systems thinking to connect invasive grass proliferation, altered and/or

new fire regimes, colonial land use changes, and community displacement as interrelated phenomena rather than isolated problems (Assaraf & Orion, 2005; Voulvoulis et al., 2022). Environmental education research suggests systems thinking develops through sustained engagement with complex, place-based problems rather than through abstract instruction (Yan et al., 2023). Western science education's articulation of systems thinking reflects concepts long understood within Indigenous epistemologies, though to describe these as 'parallels' risks suggesting they are equivalent when in fact they represent fundamentally different epistemological frameworks, and relationships to place (Medin & Bang, 2014; Cajete, 2000). I use systems thinking as one analytical lens.

Resilience thinking

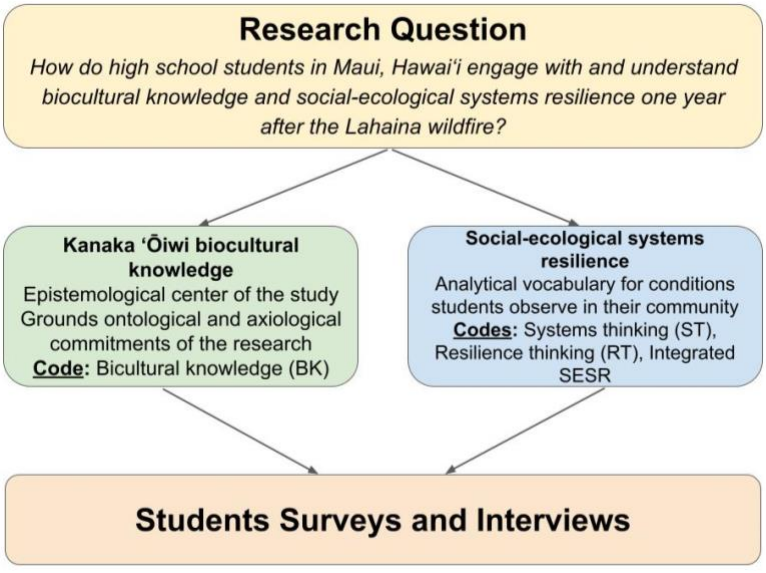
Resilience thinking explores how systems respond to disturbance and change. This dimension extends beyond the "bounce-back" capacity to encompass adaptive and transformative possibilities (Folke et al., 2010) as well. Students engaging with resilience thinking recognize that some disturbances require fundamental reorganization rather than restoration of previous conditions (Curtin & Parker, 2014). This is a critical insight for climate futures, where returning to what existed before may be impossible (Walker & Salt, 2012). Indigenous communities have long practiced adaptive and transformative stewardship in response to environmental change, though Western resilience scholarship has often failed to recognize these practices (Berkes & Ross, 2013). Critical scholars also caution that resilience frameworks can normalize crisis and shift responsibility for adaptation from structural causes to individual communities (MacKinnon & Derickson, 2013). This study attends to both the potential and limitations of resilience thinking in post-disaster educational contexts.

Biocultural Knowledge and SESR in Dialogue

Together, these two frameworks, biocultural knowledge and SESR, make it possible to ask the research question this study explores: *how do students in post-wildfire Maui engage with and make sense of the social-ecological challenges facing their community, and what role does Indigenous knowledge play in that sensemaking?* Biocultural knowledge directs attention toward what students carry from their cultural and community contexts, essentially the epistemological, ontological, and relational dimensions of their engagement with land and Indigenous knowledge. While SESR provides the analytical vocabulary for exploring how students reason about interconnections, disturbance, and adaptation within coupled human-natural systems. Together they make visible what neither could show alone. Figure 2.1 outlines how they inform this sub-study.

Figure 2.1

Conceptual Framework



METHODOLOGY

This study is most accurately characterized as a research-practice partnership (RPP) (Coburn & Penuel, 2016) between myself, a university researcher, and a high school field ecology teacher. This sub-study draws on a mixed-methods design (Creswell & Plano Clark, 2017) that combines quantitative survey data with qualitative interview and open-ended survey responses. Mixed methods were chosen to capture the range and depth of students' sensemaking about social-ecological challenges. Epistemologically, this study is grounded in the assumption that students, particularly those living in communities directly affected by environmental disaster and ongoing colonial land transformation, arrive with significant knowledge from lived experiences and, as a result, critical consciousness (Bang et al., 2012; Medin & Bang, 2014; Freire, 1970). Research questions, instruments, and analysis were all designed to surface and honor students' experiences and perspectives (Smith, 1999; Bang et al., 2012). I worked closely with the field ecology teacher, Carrie, to design, implement, and analyze the data. Our collaborative partnership had important implications for the research itself. Early in the planning process, I proposed a research focus oriented around climate anxiety. Carrie declined. She made it clear that she did not want the research to center on anxiety and redirected us toward resilience as the animating frame. That intervention shaped the research questions, the program's pedagogical orientation, and ultimately the findings of this study. It is one of the clearest examples of what community accountability looked like in practice in this project, a community partner exercising genuine authority over the terms of the work. More details about our collaborative process are provided in the Methods section.

Researcher Positionality

I approach this research as an ally. I am a white scholar with deep gratitude for and accountability to the Maui community that shaped my understanding of critical place-based education and Kānaka ʻŌiwi Ways of Knowing. I lived and worked in Maui for five years (2017-2022) as an environmental educator. Among the numerous educational institutions where I taught was the charter school where this research takes place. At the time of data collection (2024-2025 academic year), I was a doctoral student at UC Davis pursuing a PhD in Science Education with a Designated Emphasis in Native American Studies, which provided formal training in Indigenous research methodologies, decolonial theory, and critical engagement with settler colonialism. My positioning, as both a former teacher with established community relationships and a white settler researcher from a mainland institution, shaped every aspect of this work. I navigated this tension by remaining reflexive, maintaining relationships built over time, and by centering students' voices.

METHODS

Study Location

This study took place during the 2024-2025 school year at South Maui Charter School, a free, public K-12 charter school founded in the early 2000s in Kīhei, Maui, approximately 25 miles south of Lahaina. Situated on the south-facing shore of the island, the school serves a diverse student population drawn from communities across Maui, as it has no geographic enrollment restrictions. Approximately one-third of students qualify for the Free and Reduced-Price Lunch program. Like communities across Maui, Kīhei residents navigate the complex realities of living in a tourism-dependent economy while facing intensifying environmental pressures, and students can directly observe interconnected environmental stressors from their

daily lives, including invasive species abundance, wildfire risk, water management challenges, coastal development, coral reef degradation, and toxic runoff (Pogue & Jr., n.d.). South Maui Charter School's philosophy centers on project-based and community service learning, and its curricular flexibility as a charter school made this study possible. It is precisely this combination of demographic diversity, environmental stressors, and pedagogical openness that made South Maui Charter School a generative site for this research.

Participants

Twenty-four high school students participated in this study across two cohorts: a Field Ecology class (n=17) and an Eco Club (n=7). For this study, 23 students completed the survey, and 22 completed individual or focus-group interviews. Students were eligible to participate if they were enrolled in either the Field Ecology class or the Eco Club. All participation is voluntary, and written informed consent (Bloomberg, 2022) was obtained from both students and their parents/guardians. I use pseudonyms throughout this study when referring to participants to protect individuals' identities, in accordance with protocols for ethical research with human subjects and guidance from the UC Davis Institutional Review Board. This study received IRB approval from UC Davis and additional approval from the charter school administration. Table 2.1 presents select demographic characteristics of the student survey responses (n=23). Rather than selecting focal students, all 24 students from both groups were invited to participate in this study, and all of them did. One student from the field ecology class did not take the survey.

Field Ecology is an upper-division class offered at the South Maui Charter School and serves as the alternative to Advanced Placement (AP) Environmental Science. Ecology Club is one of the many after-school clubs offered at South Maui Charter School dedicated to engaging

primarily high school students in everything from environmental activism to volunteer work like beach cleanups to snorkeling and hiking excursions.

Of the 23 students who completed the survey, three identified as Kānaka ʻŌiwi, which is consistent with the broader demographic reality of Maui County, where Kānaka ʻŌiwi represent a minority of the population (10.4%) despite it being their ancestral homeland (U.S. Census Bureau, 2024) (see Table 2.1).

Table 2.1

Demographic Characteristics of Hoʻomalu ʻĀina Maui Student Participants (n=23)

Category	Student Responses
Race	
Filipino	3
Japanese	1
Black or African American	2
Native American, Alaskan Native, First Nations	2
Chinese	3
Native Hawaiian (Kānaka ʻŌiwi)	3
Latinx/e	8
Pacific Islander (e.g., Samoan, Guamanian, Micronesian)	2
White	18
Gender	
Non-binary/third gender	1
Male	5

Female	17
Languages Other than English Spoken at Home	
Prefer not to say	1
Hawaiian (ʻŌlelo Hawaiʻi)	1
Only English	16
"Other" responses included:	
Spanish	3
Korean	1
Pidgin	1

Note. Students could select as many racial categories as they preferred.

Table 2.2 presents individual demographic information for the students whose voices and perspectives are featured prominently in this chapter's findings. While 23 students completed the survey and 22 completed interviews, the students represented here contributed particularly generative data for addressing the study's research questions.

Table 2.2

Demographic Profiles of Students Featured in Findings (n=10)

Student Pseudonym	Gender Identity	Grade	Cohort (Field Ecology, Eco Club, or Both)	Race/ Ethnicity	Languages Other than English Spoken at Home
Bella	Female	Junior	Eco Club	White	Only English
Bob	Male	Junior	Field Ecology	Hispanic or Latine, Other	Only English
Fall	Female	Junior	Eco Club	White	Only English

Helena	Female	Senior	Field Ecology	Native Hawaiian, Chinese, White	Only English
Joy	Female	Junior	Eco Club	White	Only English
Kanoa	Male	Senior	Field Ecology	White	Only English
Kay	Female	Senior	Both	Hispanic or Latine	Spanish
Myrna	Female	Junior	Eco Club	Filipino, White	Only English
Sarah	Female	Senior	Field Ecology	White	
Senai	Female	Junior	Eco Club	Black or African American, Hispanic or Latine	Spanish and Korean

Instrument Development

Instrument development for this sub-study was iterative and grounded in ongoing dialogue with Carrie, the field ecology teacher and program co-designer. Survey questions and interview protocols were developed by me and reviewed by Carrie, whose feedback shaped not only the wording of individual questions but the conceptual orientation of the study itself. Throughout the instrument development process, Carrie's grounded knowledge of her students, their community, and the specific environmental and emotional landscape of post-wildfire Maui ensured that the instruments were not only theoretically informed but contextually appropriate.

Survey Development

Drawing on established frameworks in environmental education and resilience scholarship (Dubois and Krasny, 2016; Krasny et al., 2010; Krasny & Roth, 2010), Carrie and I

co-developed the survey questions to elicit both students' conceptual understanding and their capacity to apply these concepts to their lived experiences. Questions addressing environmental observation were designed to build on research demonstrating that students can effectively identify and analyze local environmental changes when grounded in direct experience (Yan et al., 2023). Following Dubois and Krasny's (2016) framework, we asked open-ended questions about resilience that would allow students to define the concept from their own perspectives. Questions about community preparedness prompted students to evaluate their own community's adaptive capacity (Boon & King, 2016). We included questions designed to surface students' awareness of biocultural approaches to land stewardship (Berkes et al., 2000; Tengö et al., 2017). These questions were intentionally exploratory rather than evaluative, acknowledging that students' engagement with Indigenous knowledge would vary based on their backgrounds and educational experiences.

Interview Protocol Development

Our semi-structured interview protocol was designed to deepen the exploration of survey item themes and to create space for students to articulate perspectives that might not have been shared in survey responses. Carrie and I developed interview prompts organized around the three SESR dimensions, focusing on students' personal connections to place, understanding of system dynamics, and perspectives on resilience and adaptation. Questions were deliberately open-ended to encourage students to draw on personal observation, family knowledge, and lived experiences. For example, instead of asking students to define systems thinking abstractly, we asked them to describe relationships they observed in their local environment and trace connections between social, ecological, and political elements. Questions about biocultural knowledge explored

students' understanding of Kānaka ʻŌiwi land stewardship without assuming prior knowledge. The semi-structured interview format also allowed for responsive follow-up questions when students mentioned personal experiences, such as family members or friends affected by the Lahaina fire, or observations of invasive species in their neighborhoods, which could further highlight their understanding of social-ecological systems resilience.

Data Analysis

We employed an iterative, mixed-methods analysis (Creswell & Plano Clark, 2017) to explore students' understanding of social-ecological systems resilience. Analysis was conducted in Dedoose, a qualitative data analysis platform that supported systematic comparison across students. Analysis proceeded in two phases: first, descriptive analysis of survey responses (including one quantitative question and three qualitative open-ended questions); second, in-depth coding and thematic analysis (Braun & Clarke, 2021) of interview transcripts. This sequential analysis allowed survey data to inform interview interpretation while interview data provided rich context for understanding survey patterns. Throughout analysis, I documented interpretive decisions and moments of uncertainty in researcher memos in Dedoose. For example, I asked myself questions like: (1) Are there moments where my position as a former teacher, a white settler researcher, or a program co-developer is shaping what I am able to see or willing to claim?; (2) Am I representing this community in a way that serves them well?; (3) Am I honoring the trust this community placed in me? These questions did not resolve the tensions inherent in this kind of research, but they kept those tensions visible and productive across the full arc of analysis (Kovach, 2021; Pillow, 2003).

Collaborative Data Analysis

Two forms of community engagement shaped the analytical process. Carrie, the field ecology teacher and program co-designer, engaged in member checking, reviewing emerging findings and offering grounded feedback on their accuracy and resonance with her own observations across the program year. Additionally, as part of the program's participatory design, students engaged in a collaborative coding activity in which they reviewed and responded to anonymized excerpts from themselves and their peers, coding them using the same four analytical codes organizing this study (biocultural knowledge (BK), systems thinking (ST), resilience thinking (RT), and integrated social-ecological systems resilience (SESR)) (Ghiso et al., 2019; Sadd et al., 2014). This activity generated an additional layer of interpretive data about how students understood their own and each other's experiences, and honored students as knowers rather than only as participants (Smith, 1999; Israel et al., 2013).

Quantitative Survey Analysis

The survey included one Likert-scale question assessing students' perceptions of their community's preparedness for environmental changes. Response options ranged from "not at all prepared" to "extremely prepared" on a 5-point scale. Given the small sample size and ordinal nature of this question, I limited analysis to descriptive statistics, calculating frequency distributions and reporting both raw numbers and percentages for each response category (Creswell & Plano Clark, 2017).

Qualitative Analysis

Qualitative analysis included two data sources: open-ended survey responses and semi-structured interviews.

Open-Ended Survey Question Analysis

Survey analysis began with coding (Saldaña, 2021) students' responses to three open-ended questions addressing: (1) environmental changes students have observed in their community, (2) their definitions of what makes a community or environment resilient, and (3) their perspectives on community preparedness for environmental changes and potential solutions. Survey questions were developed in dialogue with Carrie and grounded in established frameworks in environmental education and resilience scholarship. For example, questions about environmental observation drew on research demonstrating that students can identify and analyze local environmental changes when grounded in direct experience (Yan et al., 2023), while open-ended questions about resilience followed Dubois and Krasny's (2016) study, allowing students to define the concept from their own perspectives rather than matching a predetermined definition. Questions about community preparedness drew on Boon and King's (2016) emphasis on community preparedness as a key indicator of resilience. I read all survey responses multiple times to develop familiarity with the data (Braun & Clarke, 2021) before applying any codes, noting initial patterns in how students described environmental challenges, conceptualized resilience, and assessed community capacity.

Semi-Structured Interview Analysis

Interview analysis employed a hybrid deductive coding approach (Fereday & Muir-Cochrane, 2006). I began with four a priori codes derived from the theoretical frameworks: Biocultural knowledge (BK), systems thinking (ST), resilience thinking (RT), and integrated social-ecological systems resilience (SESR). These codes were selected because they directly correspond to the two analytical frameworks organizing this study (Kānaka ʻŌiwi biocultural knowledge and social-ecological systems resilience) and allowed me to analyze how students engaged with each framework both separately and in combination. I applied these codes to the first five interview transcripts, coding line by line and marking segments where students demonstrated engagement with these concepts. During this initial coding phase, I maintained detailed analytic memos noting where codes overlapped, where student responses seemed to transcend single categories, and where the a priori framework felt inadequate for capturing what students were expressing (Saldaña, 2021). Table 2.3 presents each code, its definition, and a representative example from the data.

Table 2.3

Coding Framework and Representative Examples

Code	Definition	Representative Example
Biocultural Knowledge (BK)	Student engagement with Kānaka ʻŌiwi knowledge systems, cultural practices, and their relationship to land and environmental stewardship (Morishige et al., 2018)	"*Hawaiians truly did know what the land needed through observation and things like that…*" — Kanoa
Systems Thinking (ST)	Student recognition of interconnections, feedback loops, and relationships between ecological and social processes within coupled human-natural systems (Cabrera & Cabrera, 2023)	"*All the hotels and all the runoff from the hotels, the diversion of the water, it's not going where it should and all the concrete, the water can't seep down into the aquifer so definitely the whole system is disrupted.*" — Joy

Code	Definition	Representative Example
Resilience Thinking (RT)	Student understanding of how systems respond to disturbance and change, including persistence, adaptability, and transformation (Folke et al., 2010)	"*We definitely learned our lesson after the wildfires happened. We're seeing people are trying to start farming a lot more… being a little more smart about it, not so many pesticides."* — Kay
Social-Ecological Systems Resilience (SESR)	Student simultaneous integration of systems thinking and resilience thinking when engaging with complex place-based social-ecological challenges (Berkes & Folke, 1998)	"*The amount of invasive plants we have that's spread around Maui is tremendous… I think we need to direct our water system in a way that we are able to plant native plants and have them survive."* — Sinai

Our analytical process moved iteratively between deductive and inductive approaches, combining the structure of a priori coding with the flexibility of reflexive thematic analysis. Table 2.4 summarizes the full sequence of analytical procedures, from initial data preparation through collaborative validation.

Table 2.4

Overview of Analytical Procedures

Step	Procedure	Description
1	Transcription and immersion	Interview recordings transcribed verbatim. All transcripts and survey responses read repeatedly prior to formal coding to develop interpretive familiarity with the full data corpus (Braun & Clarke, 2021).
2	Quantitative survey analysis	Descriptive statistics calculated for the Likert-scale survey item, including frequency distributions and percentages for each response category (Creswell & Plano Clark, 2017).
3	Open-ended survey coding	Survey responses to three open-ended questions coded inductively, staying close to students' own language and resisting premature categorization (Saldaña, 2021).
4	Deductive construct coding	Four a priori codes derived from the theoretical frameworks; Biocultural Knowledge (BK), Systems Thinking (ST), Resilience Thinking (RT), and Integrated SESR; applied to interview transcripts line by line (Fereday & Muir-Cochrane, 2006). Codes were chosen because they directly correspond to the two analytical frameworks organizing this study.

Step	Procedure	Description
5	Inductive pattern development	As coding progressed, I moved iteratively between individual transcripts and emerging patterns, generating and refining themes through active interpretation. Themes are understood as constructed by the researcher rather than discovered in the data (Braun & Clarke, 2021). Analytic memos documented moments where the a priori framework felt inadequate for capturing what students were expressing.
6	Cross-case pattern development	Individual student responses read together to identify patterns across the cohort. Frequency of themes informed but did not determine the analysis; some patterns became analytically clear only through comparison across students rather than through code frequency counts alone.
7	Reflexive memo writing	Throughout analysis, interpretive decisions and moments of uncertainty documented in researcher memos in Dedoose, including reflections on how my positionality as a former teacher, white settler researcher, and program co-developer may have shaped what was visible or claimable (Kovach, 2021; Pillow, 2003).
8	Member checking	Member checking with Carrie, the field ecology teacher, whose feedback refined emerging findings. Students engaged in a collaborative coding activity using anonymized excerpts, honoring students as knowers of their own experience (Ghiso et al., 2019; Sadd et al., 2014; Smith, 1999; Israel et al., 2013).

FINDINGS

This study asked: *How do high school students in Maui, Hawai‘i engage with and understand biocultural knowledge and social-ecological systems resilience one year after the Lahaina wildfire?* To answer this question, I analyzed open-ended survey responses (n=23) and semi-structured interviews (n=22), which revealed four distinct patterns: 1) students demonstrated strong systems thinking and critical consciousness about the social-ecological challenges facing their community; 2) they conceptualized resilience through direct experience of the Lahaina fire and community response; 3) they engaged with Kānaka ʻŌiwi culture broadly through social justice and political-economic analysis; and 4) in some cases, integrated multiple analytical dimensions (biocultural knowledge, systems thinking, resilience thinking and SESR)

simultaneously. Table 2.5 summarizes these findings and the sections that follow elaborate on each in turn.

Analysis of open-ended survey responses (n=23) and semi-structured interviews (n=22) revealed distinct ways in which students engaged with core concepts in biocultural knowledge and social-ecological systems resilience (Table 2.5). I describe these four themes in detail below.

Table 2.5

Overview of Student Engagement with Biocultural Knowledge and SESR Concepts

Finding	Explanation
Finding 1: Systems Thinking in Environmental Reasoning	Students identified interconnections between ecological and social processes (invasive species, fire risk, water systems, development) but focused primarily on community-scale interventions (e.g., beach cleanups) rather than policy-scale actions
Finding 2: Resilience Conceptualized Through Experience	Students defined resilience through disaster-response frameworks emphasizing return to previous conditions, directly referencing Lahaina fire community response as exemplar of "bouncing back"
Finding 3: Missing and Emerging Connections to Biocultural Knowledge	Students engaged with Kānaka ʻŌiwi issues through social justice lenses (e.g., displacement and lack of affordable housing) but did not reference Kānaka ʻŌiwi biocultural knowledge (ahupuaʻa systems, mālama ʻāina) in environmental contexts
Finding 4: Integration Across Frameworks	Some students integrated multiple analytical dimensions when engaging with complex, place-based challenges (e.g., combining cultural knowledge with conservation efforts)

In the following sections, I elaborate on each finding, drawing on interview and survey data to illustrate how students engaged with systems thinking, resilience thinking, and biocultural knowledge across the study.

Finding 1: Systems Thinking in Students' Environmental Reasoning

Students frequently described environmental challenges as interconnected systems. Qualitative analysis of their responses demonstrated an emerging understanding of feedback loops, cascading effects, and human–environment connections. This was evident across the cohort: Nearly all students who responded to the open-ended survey question about environmental changes identified specific changes in their community. Students articulated connections between invasive species, fire risk, water diversions, and development. For example, Joy, a high school junior and member of the Eco Club, exemplified systems thinking when describing Maui's environmental challenges:

> *"Definitely the fountain grass, the kiawe... and the fires that those bring and especially those like down in Kihei. All the hotels and all the runoff from the hotels the divergent of the water, it's not going where it should and all the concrete, the water can't seep down into the aquifer so definitely the whole system is disrupted."*

Joy's response reveals something more than systems thinking as a cognitive skill. She is not reciting content learned in a classroom; she is tracing interconnections across ecological and social systems from her own embodied experience of living in Kīhei. She has observed how development, water diversion, and invasive species have affected the place she calls home. Joy's response also signals something beyond systems thinking as a technical skill. The phrase "*the*

whole system is disrupted" carries affective weight that purely cognitive frameworks cannot account for. She is not describing a problem to be solved analytically per se; she is naming a rupture in the relationships between human and natural systems that she has witnessed firsthand. This convergence of critical analysis and felt disruption is precisely the foundation on which environmental education in post-disaster contexts must build, not by filling knowledge gaps, but by creating the conditions under which students like Joy can connect what they already know and feel to the Indigenous knowledge frameworks that have long understood these relationships and long worked to restore them.

When students were asked, "If you were in charge, say you were the Governor of the State of Hawai‘i, what's one thing you would do to help the environment and your community in Maui?" their responses predominantly focused on actions they had direct experience with or could imagine implementing themselves. Bella, a high school junior and Eco Club president, offered a response that illustrated this: *"People litter a lot... I would like I don't know... set up a little crew go out on some days and just clean it up."*

Bella, proposes organizing a cleanup crew, a community-level intervention she could participate in directly. Other students made similar proposals, such as organizing restoration projects, planting native species, coordinating beach cleanups, changing personal consumption habits, and recruiting volunteers. These responses reflect patterns documented in youth environmental education research, in which students gravitate toward direct actions they can participate in. These patterns in how students reasoned about interconnected systems also shaped how they conceptualized resilience, as Finding 2 explores.

Finding 2: Resilience Conceptualized Through Experience

Analysis of students' open-ended survey responses and interviews revealed that definitions of resilience were shaped primarily by direct experience with the Lahaina fire, with most students emphasizing immediate disaster response and community cohesion over longer-term adaptation or transformation.

Joy's definition exemplified the natural disaster resilience framing: "A *resilient environment would be one that can withstand natural disasters as well as man-made ones. It should be able to return to its original state on its own within time.*"

Senai, a high school junior and the other Eco Club co-president, demonstrated similar thinking: "*A resilient community/environment means that if something would come to disturb us, we would not be heavily affected and if so affected, we would be able to solve it.*"

Myrna, a high school junior in the Eco Club, on the other hand, explicitly connected resilience to the Lahaina fire: "*When I think of a resilient community or environment, I first think of the community on Maui. Especially after the Lahaina fires, I think everyone showed a sense of togetherness and resilience.*"

Kay, a high school senior in the field ecology class, provided one example that did include adaptive elements:

> "*We definitely learned our lesson after the wildfires happened. We're seeing people are trying to start farming a lot more; we see where our old sugar cane plantations used to be, people are trying to restore these areas... being a little more smart about it, and not using so many pesticides.*"

What is most striking about students' definitions of resilience is that they didn't 'define' resilience; they described their lived experiences to make sense of the concept, resilience. Joy and Senai define resilience in terms of withstanding disturbance and returning to previous conditions, but their definitions are felt orientations toward a world that has already been disrupted. When Myrna says, "*I first think of the community on Maui,"* she is pointing to a specific place, a specific fire, and a specific moment of collective response. Her community, the Maui community, came together in the aftermath of August 8th, 2023, as the living evidence of what resilience looks like in action. Grief and community are not incidental to how these students understand resilience; they are constitutive of it. This is theoretically generative because it suggests that in post-disaster contexts, resilience is understood relationally and affectively before it is ever understood conceptually. Students are not blank slates waiting to receive frameworks; they are already working with frameworks forged in the experience of living through catastrophe. The limitation of those frameworks, their emphasis on returning to previous conditions rather than transforming the conditions that created vulnerability, is not a knowledge deficit. It is a reflection of what the Lahaina fire itself made visible: that communities can come together, survive, and rebuild, even when the structural forces that created the disaster remain intact. Kay's response gestures toward what lies beyond persistence. Her framing, "*we learned our lesson... people are trying to start farming... being a little more smart about it,"* suggests an adaptive orientation that has emerged not from instruction but from watching her community navigate the aftermath of disaster and begin to ask different questions about the land. What made this possible for Kay, but not yet for others, is a question this study cannot fully answer, but it

points to the relational and place-specific conditions under which resilience thinking expands beyond the immediate horizon of disaster response.

Quantitative analysis of the Likert-scale survey question found that approximately half of student (n=12) respondents rated their community as "somewhat prepared" for environmental changes, while none selected "extremely prepared," a pattern consistent with students' qualitative definitions of resilience as withstanding disturbance rather than transforming the conditions that created the vulnerability.

How students conceptualized resilience was inseparable from how they understood the communities most affected by the fire, a pattern Finding 3 explores through students' engagement with Kānaka ʻŌiwi knowledge.

Finding 3: Missing and Emerging Connections to Biocultural Knowledge

When students discussed Kānaka ʻŌiwi communities, most framed issues exclusively through social justice lenses rather than environmental or ecological contexts. One exception, however, was Kanoa. A high school senior in the field ecology class who identifies as a white male stated that he "*was raised by his one hundred percent Hawaiian uncle.*" Kanoa directly connects to Kānaka ʻŌiwi biocultural knowledge when asked, "How do you think combining different ways of understanding nature (like Traditional Hawaiian Knowledge and Western science) could help solve environmental problems?" In response, Kanoa said:

> ". . . *Hawai'i has its own issues compared to the Western world. Hawaiians truly did know what the land needed through observation and things like that… there*

are ways that others have come up with. . .But it should be more based off the Hawaiian way."

Kanoa's response is remarkable not only for what it says but for the certainty with which he says it. He does not hedge, qualify, or position Kānaka ʻŌiwi knowledge as one perspective among many; he centers it as foundational, asserting that environmental solutions "*should be more based off the Hawaiian way.*" This confidence is the product of intergenerational knowledge transmission: shared with Kanoa by his uncle, a Kānaka ʻŌiwi community leader from Lahaina, whose teaching gave Kanoa not just information about Indigenous land practices but an epistemological orientation toward the land. What Kanoa's response makes visible is precisely what the colonial disruption of Indigenous knowledge transmission has made invisible for most other students in this study. Considering that most students in this study could articulate the injustices affecting Kānaka ʻŌiwi communities without connecting those injustices to Indigenous knowledge as a living framework for environmental problem-solving is neither a failure nor a lack of curiosity. It is the predictable outcome when those transmission pathways are broken. Kanoa is the exception that makes the structure visible.

Alternatively, Sarah, a high school senior in the field ecology class, connected economic displacement to Kānaka ʻŌiwi communities. Sarah said:

"Housing and people not being able to buy every day needs, and taking Hawaiians out so they can just make a profit from tourists. Like my grandma's coworker. She is completely Hawaiian; she had to leave because they raised her rent."

Sarah's response articulates the displacement of Kānaka ʻŌiwi through tourism-driven gentrification. She traces a direct economic mechanism: tourism profits drive up housing costs and everyday expenses, making it impossible for some Kānaka ʻŌiwi community members to remain in their homes. Her example of her grandmother's coworker, "*completely Hawaiian,*" grounds this structural analysis in personal, observable displacement within her family's social network.

Another student, Bob, a high school junior in the field ecology class, identified infrastructure disparities. Bob said: *"Well, there's a lot of buildings made out of cane board and that stuff is bad for houses; I feel like we could try to get rid of that for Native Hawaiian houses."* Bob's response is modest in scope but significant in its logic. He has connected a colonial-era building material, cane board, a byproduct of the plantation economy which can harbor arsenic and is sensitive to moisture (Hawai'i Department of Health, 2018), to present-day structural harm in Kānaka ʻŌiwi homes. Like Sarah, he is reasoning from the observable to the structural, tracing a line between historical land transformation and its material consequences for the community most affected by it. This analysis arrived unprompted, grounded in specific local knowledge about building materials and their health implications, and reflects the same critical place-based awareness evident across this finding.

These responses share common features: students articulated injustices affecting Kānaka ʻŌiwi communities, demonstrated awareness of ongoing colonization, and connected these issues to observable community conditions. Their thoughtful, social, political, and economic analysis reflect**s** critical thinking about sovereignty, displacement, and structural inequality. While biocultural knowledge was largely absent from students' environmental reasoning, the

exceptions that emerged (outlined in Finding 4) occurred when students discussed challenges that held personal, cultural, or emotional significance.

Finding 4: Integration Across Frameworks

The previous three findings document what students brought to environmental learning separately —their systems thinking, resilience thinking, and emerging connections to Kānaka ʻŌiwi knowledge. In rare but significant moments, students drew on all of these simultaneously, revealing what becomes possible when multiple ways of knowing converge in a single response. These moments of integration were not evenly distributed across the cohort, nor were they identical in kind. Some were pragmatic, some were visionary, and some were deeply affective. Together they point toward the full range of what environmental education might cultivate and what students may already carry. Sinai exemplified this:

"The amount of invasive plants we have that's spread around Maui is tremendous... I think we have a great watershed system, but I think we need to direct it in a way that we are able to plant native plants and have them survive because currently we have dry conditions and if we would just plant native plants, they would die so I think directing our water system and feeding those plants would definitely help."

Sinai's response reveals something important about how systems thinking and resilience thinking operate together in student reasoning. She didn't start by listing what is broken and hopeless. She begins with what exists and what is possible, stating, "*I think we have a great watershed system,*" and builds on that perspective from there. Her proposal to redirect water to support native plant restoration is an adaptive strategy that works with existing system strengths

rather than against them. This orientation, seeing opportunity within complexity rather than only crisis, is precisely what resilience thinking, at its most generative, looks like.

Helena, a high school senior in the field ecology class, demonstrated similar knowledge integration:

"One thing that I would want to do is to create more sustainability in our community to focus on the environment and as well as people in general because if you have a flourishing community, that's going to impact everything around that community so I would start there and focus on environmental issues that are affecting that community the most and then from there you can work backwards until you have that sustainability and mindfulness in everything around you."

Helena's instinct to begin with a flourishing community and work outward until there is "*sustainability and mindfulness in everything around you,*" reflects a profound understanding that ecological health and human wellbeing are not competing priorities to be balanced but a single condition to be cultivated. The words she chooses — flourishing, sustainability, mindfulness — are her own language for something she has felt, watched, and lived. This is systems thinking and resilience thinking in their most expansive form: the capacity to imagine wholeness. To hold people, place, community, and ecosystems, present crisis and future possibility, in the same breath. Helena arrived with it.

In rarer instances, students drew on both biocultural knowledge and SESR concepts simultaneously. Fall, a high school junior in the Eco Club, demonstrated integration when discussing agricultural restoration:

"Traditional Hawaiian farming, but even we could just have food farms that are big ones, like I love seeing how, like every time I drive past over there, there's more and more farmland looking green because at least even if it's not native plants, if it's controlled and it's helping feed the community, I feel like that would help reduce fires."

Fall's knowledge integration is pragmatic and forward-looking, grounded in what she observes driving past farmland on her way to school. She is not drawing on deep cultural knowledge or genealogical relationship to place. She is reasoning across frameworks practically, asking what combination of traditional and contemporary approaches could actually reduce fire risk and feed her community. That this reasoning feels natural to her, that "*traditional Hawaiian farming*" and contemporary food production appear in the same sentence without tension, is itself significant. It suggests that for some students, the boundary between Kānaka ʻŌiwi and Western approaches to land management is already more permeable than formal science education assumes. For some students, however, knowledge integration runs deeper than pragmatic reasoning about land management.

Kay exemplified this when discussing ʻIʻwi birds (an endemic Honeycreeper, federally listed as threatened; U.S. Fish and Wildlife Service, 2024):

"...the cultural significance that they have; the fact that you know Native Hawaiian people... they [ʻIʻwi birds] *meant so much to them. You know the Aliʻi* [Chiefs] *and all of them, they worship them, to know that we have —not everyone— but a lot of people are unaware that they're still existing and that they're suffering and that they're fighting right now just to exist.*

It's a little sad and knowing that people are out there trying to actually save them and come up with things that's like the hopeful side... Sorry, I'm crying. I'm so embarrassed."

Kay's tears reveal a grief that has no boundary between the ecological and the social-cultural, between a species fighting to exist and a people whose identity is bound to it. The ʻIʻwi bird carries cultural significance for Kānaka ʻŌiwi people. It is kin. Its struggle to survive is inseparable from the struggle of the Kānaka ʻŌiwi people whose stories and relationships to place are woven into its existence, its stories, and its relationality. This is what genuine integration of knowledge systems, ways of knowing, and ways of relating to the natural world looks like. It's not a cognitive skill or a pedagogical achievement, but a form of knowing so deeply relational that its losses cannot be separated, quantified, or reconciled. Biocultural losses of this nature echo across decades and generations with ramifications in their wake. Begging the question: if environmental education does not recognize, honor, and actively work against the forces that sever biocultural relationships across generations, what exactly are we educating students for?

DISCUSSION

This study asked: *How do high school students in Maui, Hawaiʻi engage with and understand biocultural knowledge and social-ecological systems resilience one year after the Lahaina wildfire?* Findings reveal both the considerable strengths that students bring to environmental learning, and the educational conditions still needed to build on those foundations: not more content per se, but deeper relationships with place, community, and Kānaka ʻŌiwi knowledge systems.

What Students Bring

Students demonstrated multiple forms of environmental reasoning, providing strong foundations for deeper learning. Nearly all students identified specific environmental changes in their community, and many articulated connections between invasive species, water systems, development, and fire risk. Joy exemplified this when she traced connections from invasive species to wildfire risk, hotel development, water diversions, and aquifer recharge, concluding "*the whole system is disrupted*." Her explanation illustrates what systems thinking scholars term "dynamic thinking" (Assaraf & Orion, 2005; Adekola & Lamond, 2022), the ability to identify feedback loops, cascading effects, and interconnections across ecological and social systems.

Students' environmental reasoning was significantly shaped by lived experience, particularly their collective experience of the August 8th, 2023, Lahaina wildfire. When defining resilience, 9 students explicitly referenced disasters, and many drew directly on what they witnessed during their community's fire response. Myrna's statement, "*When I think of a resilient community or environment, I first think of the community on Maui. Especially after the Lahaina fires, I think everyone showed a sense of togetherness and resilience*," demonstrates how direct experience with crisis becomes the experiential foundation through which students understand resilience concepts. This pattern aligns with research demonstrating that communities experiencing catastrophic events define resilience primarily through immediate responses and social cohesion during crisis (Norris et al., 2008). This grounding in lived experience represents both a strength and a limitation: students possess deep, embodied knowledge of community response to acute disruption, but fewer frameworks for conceptualizing longer-term adaptation or transformation, a gap that becomes particularly significant as climate change requires

communities to navigate persistent rather than acute environmental challenges (Lehtonen et al., 2018; Walker & Salt, 2012; Pelling, 2011).

Additionally, students demonstrated critical consciousness of social justice issues affecting Kānaka ʻŌiwi communities. Sarah, for example, traced economic mechanisms of displacement: "*Housing and people not being able to buy every day needs and taking Hawaiians out so they can just make a profit from tourists.*" Her analysis exemplifies understanding of how tourism economies drive Indigenous displacement, a form of political-economic literacy that connects structural forces to observable community impacts. Students' capacity for critical analysis of power, injustice, and colonization represents a crucial foundation for environmental education that addresses root causes of ecological degradation (Gruenewald, 2003; Tuck et al., 2014). This critical consciousness reflects what scholars term political literacy or political clarity, the ability to identify structural forces shaping environmental outcomes (Bartolomé, 1994; Madkins & McKinney de Royston, 2019; Patterson Williams & Gray, 2021), and demonstrates students' capacity to connect social justice with ecological issues, though as findings reveal, this critical analysis remained largely disconnected from understanding how Indigenous knowledge systems offer alternative frameworks for land relations and environmental stewardship.

Finally, though rare, some students integrated multiple analytical frameworks when engaging with complex, place-based challenges. Kay's response to ʻIʻwi birds being threatened integrated cultural significance ("*Native Hawaiian people... they meant so much to them. You know the Aliʻi and all of them, they worship them*"), ecological understanding (species being threatened), and adaptive thinking (conservation efforts), suggesting these ways of knowing were not separate for her. Fall similarly integrated cultural knowledge with systems thinking when discussing how "*Traditional Hawaiian farming*" and contemporary food production both "*help*

reduce fires." These integrative moments demonstrate what scholars describe as "Two-Eyed Seeing," the capacity to draw on multiple epistemologies simultaneously without signaling that one is above the other (Bartlett et al., 2012; Tengö et al., 2017). Such integration reflects Indigenous epistemologies that have never separated cultural, ecological, and social dimensions of land relations (Meyer, 2008; Kimmerer, 2013), and points toward possibilities when students have access to multiple ways of knowing through sustained engagement with cultural practitioners and critical place-based learning (Gruenewald, 2003).

Three Implications for Environmental Education

Implication 1: Integrate Political Literacy with Ecological Literacy

Students readily applied systems thinking when analyzing environmental problems. When it came to governance structures, policy processes, and pathways for political intervention, however, their prior education had not yet given them frameworks for understanding how to act on that analysis at the scale of governance and policy. When asked what they would do as Governor of Hawai‘i, students overwhelmingly proposed community-scale interventions, for example, beach cleanups, native planting projects, and personal consumption changes, rather than policy interventions such as reforming land-use regulations, redirecting water rights, or supporting Indigenous land management.

This pattern reflects what Jensen and Schnack (1997) term the gap between systems understanding and action competence, knowledge not only of environmental problems but of political pathways to address them. This gap could reflect multiple dynamics: students may appropriately recognize they have more immediate agency at community scales, or may hold well-founded distrust of state governance given Hawai‘i's history of U.S. occupation and

ongoing sovereignty struggles (Goodyear-Kaʻōpua, 2013). Students witnessed community mutual aid, not government intervention, as the effective response to the Lahaina fire. There may also not have been prior education on the political process and how students or young people, in general, could intervene.

In Maui, where land-use policy, water management decisions, and fire prevention infrastructure directly shaped wildfire vulnerability, connecting ecological literacy with frameworks for political action is not academic but urgent.

Implication 2: Expand Resilience Frameworks Beyond Disaster Response

Students conceptualized resilience primarily through disaster-response frameworks that emphasize the capacity to withstand disturbance and return to previous conditions, a quality resilience scholars call persistence (Holling, 1996). This reflects both their direct experience with the Lahaina fire and patterns documented in community disaster resilience research, where those who experience catastrophic events define resilience through immediate response capacity and social cohesion (Norris et al., 2008).

Kay's response offered a glimpse of what adaptive resilience thinking looks like: "*We learned our lesson after the wildfires... people are trying to start farming... being a little more smart about it.*" Her framing emphasizes learning from disturbance and changing practices rather than simply restoring what existed before. As climate change intensifies and returning to previous conditions becomes less possible, frameworks that span the full spectrum of resilience responses (e.g., persistence, adaptation, and transformation) become increasingly necessary (Walker et al., 2004).

Implication 3: Center Indigenous Knowledge Through Sustained Partnerships

While students demonstrated sophisticated political-economic analysis of the injustices affecting Kānaka ʻŌiwi communities, biocultural knowledge was largely absent from their understanding of environmental change. Students could trace how colonization dispossessed Kānaka ʻŌiwi of land and housing but had not yet been given the educational conditions to connect those impacts to environmental vulnerability or to encounter Indigenous knowledge systems as living, relevant frameworks for addressing the challenges they could so clearly see.

This absence is not surprising. The colonial land transformations documented throughout this study did not only alter the physical landscape. They systematically disrupted the intergenerational transmission of the very knowledge systems students are not referencing. The 1896 language ban, which prohibited ʻŌlelo Hawaiʻi instruction in schools for nearly a century, severed intergenerational transmission of Kānaka ʻŌiwi knowledge encoded in language, story, and practice (Wilson & Kamanā, 2001; Warner, 1999). Structural separation of cultural content from scientific content in schools ensures students rarely encounter Indigenous knowledge as relevant to environmental problem-solving (Bang et al., 2012). What Kanoa's example makes visible is what becomes possible when that transmission happens, through family, through community, through sustained relationship to place.

Addressing wildfire vulnerability in Maui requires not simply adding technical fixes but fundamentally rethinking land relations and management paradigms. Biocultural knowledge offers precisely such alternatives, and centering it in environmental education requires not better curriculum design but sustained, accountable partnerships with cultural practitioners who hold the authority and the relationships to share it.

Contributions, Limitations, and Future Directions

The three implications outlined in the section above, identified in this study, are not merely pedagogical recommendations. They are a political argument: that environmental education plays a role in shaping how young people understand the causes of disasters like the Lahaina fire, imagine possible futures, and see themselves as actors in creating those futures. This requires recognizing that environmental education is never neutral. Therefore, the question becomes whether we engage with it explicitly toward justice or implicitly reproduce injustice through claims of neutrality.

Important limitations include my positionality as a non-Indigenous researcher analyzing biocultural knowledge engagement, a small sample size, a single-point-in-time data collection, and instruments that may not have adequately surfaced students' perspectives. Future research could center Kānaka ʻŌiwi scholars and explore how youth in Hawaiʻi engage with Kānaka ʻŌiwi knowledge systems across multiple contexts.

CONCLUSION

Students in post-wildfire Maui bring insightful perspectives, lived experiences, and critical consciousness to environmental learning. They need education that helps them understand how to address those problems through civic engagement, integrating political literacy, adaptive thinking, and multiple ways of knowing that center Indigenous knowledge, essential for biocultural and social-ecological resilience. This requires integrating project-based learning that emphasizes real-world problem-solving through sustained, accountable partnerships with Kānaka ʻŌiwi cultural practitioners and community members, ensuring that students not only learn but also contribute to the restoration of ʻāina and the resilience of the communities

whose homelands they occupy. As climate change intensifies, the question is whether educational systems will build the relational conditions necessary to draw on all available sources of knowledge to support students in understanding and acting on the challenges their communities face, and in building more just and resilient futures.

CHAPTER 3. "*THE LAND IS ALWAYS FIRST*": HIGH SCHOOL STUDENTS ENGAGING WITH KULEANA AS EMBODIED PRACTICE AFTER THE LAHAINA FIRE

"Hawai'i has and always will be the Indigenous homeland of Hawaiians; therefore, if you want to learn about the places of Hawai'i, you must include Kānaka 'Ōiwi [Native Hawaiian people], *their stories, histories, cultural practices, and Ways of Knowing. In doing so, it encourages each of us to explore our unique positionality and kuleana in relation to the Native land and people of Hawai'i and then develop our own relationship accordingly"* (Saffery, 2019, p. 11).

INTRODUCTION AND BACKGROUND

A wildfire devastated the town of Lahaina, Maui, on August 8, 2023, claiming 102 lives and destroying thousands of structures, making it the deadliest U.S. wildfire in over a century (Rafferty, 2023). This fire was not simply a natural disaster but the culmination of historical forces: colonial land dispossession, flammable invasive grasses (the result of plantation agriculture) and ongoing patterns of land abandonment that have transformed Maui's landscapes (Trauernicht et al., 2015; Whyte, 2018). In the aftermath of such a catastrophic event, young people are often left trying to make sense of what happened to their community and of their role in preventing similar events in the future (Ronan & Johnston, 2005; Tidball & Krasny, 2012). Understanding what created the conditions for this fire and how young people might envision their role in preventing future disasters requires examining not just immediate causes but the fundamental relationships between people and land. This means grappling with how land relations have been disrupted, severed, and maintained across generations, particularly in places

like Hawai‘i where colonial forces have systematically worked to disconnect Kānaka ‘Ōiwi[1] ‘āina relations (Kana‘iaupuni & Malone, 2006). This study explores those questions through the Ho‘omalu ‘Āina Maui (protecting the land of Maui) program, a community-based participatory research project developed in response to the 2023 Lahaina wildfire, in which high school students engaged in wildfire mitigation and land stewardship.

In Hawai‘i, the intentional severing of Kānaka ‘Ōiwi relations with ‘āina has unfolded across more than 200 years of colonization and continues to this day (Kame‘eleihiwa, 1992). However, Kānaka ‘Ōiwi communities have fought to maintain and restore kuleana (the rights and responsibilities that emerge from genealogical connection) to specific ‘āina (Cupchoy, 2024; Goodyear-Kaopua et al., 2014). ‘Āina was traditionally “entrusted to community as the source of all life and a direct connection to kūpuna (ancestors) and akua (gods), never to be owned or coveted” (Barger et al., 2024, p. 3). This relationship was violently disrupted through the Māhele (division) of 1845 and the subsequent Kuleana Act of 1850. Under pressure from American business interests seeking to establish plantations, these laws imposed Western property systems onto Kānaka ‘Ōiwi land tenure, requiring Kānaka ‘Ōiwi to survey, register, and prove ownership of lands their families had cared for across generations. The result was massive dispossession. Only 7,500 Kānaka ‘Ōiwi families received land awards totaling 28,600 acres, less than 1% of Hawaiian Kingdom lands (Barger et al., 2024).

Relationships between Kānaka ‘Ōiwi and ‘āina are both metaphysical and material (McCubbin et al., 2021). ‘Āina, translating to “that which feeds,” embodies reciprocal relationships cultivated across generations between people and place (Barger et al., 2024). These sustained connections provide physical, mental, spiritual, and emotional nourishment to kupa

[1] I intentionally use “Kānaka ‘Ōiwi” throughout this study rather than “Hawaiian,” as the latter is an English term that represents a Western perspective of the Indigenous people of Hawai‘i (Louis, 2017, p. xv).

ʻāina ʻohana (people descended from and enduring in place), who, in turn, fulfill their kuleana to care for and transmit ʻike (knowledge) about specific ʻāina. Understanding if and how students living in Hawaiʻi today develop these relationships, especially in a post-disaster context, requires examining kuleana not as an abstract concept but as a lived practice, one that is both pedagogical and deeply political.

This study is centered within the Hoʻomalu ʻĀina Maui (protecting the land of Maui) program, a community-based participatory research (CBPR) initiative I co-developed with a high school ecology teacher, a Kanaka ʻŌiwi biocultural conservation biologist, an education researcher, and Kīpuka Malu, a 75-acre ʻāina stewardship and cultural revitalization nonprofit whose staff includes an executive director, a program manager, a cultural practitioner, and a communications coordinator, who were all integral to the design and facilitation of each field visit. We developed Hoʻomalu ʻĀina Maui in response to the 2023 Lahaina wildfire. Drawing on pre- and post-program semi-structured interviews, I explore what processes and experiences shaped students' developing relationships to ʻāina, and how students made meaning of their responsibilities to land and community in the aftermath of the fire.

This chapter begins with theoretical frameworks that draw on kuleana, ʻāina, and critical place-based education scholarship before presenting the methodology, methods, findings, and discussion. Research questions guiding this study are:

(1) *How do high school students develop kuleana through participation in a critical place-based education program focused on wildfire mitigation and land stewardship in a post-wildfire context?*

(1a) *What processes and experiences shape students' developing relationships to ʻāina through participation in land stewardship and wildfire mitigation work?*

(1b) *How do students make meaning of their responsibilities to ʻāina and community in the aftermath of the Lāhainā fire?*

THEORETICAL FRAMEWORKS

Kuleana and ʻĀina: Genealogical Rights, Responsibilities, and Relationships

Kuleana is translated as "right, privilege, concern, responsibility" (Pukui & Elbert, 1986, p. 179). This translation, however, barely captures the concept's complexity. In Kānaka ʻŌiwi philosophy, rights and responsibilities are inseparable. Rights are earned only by first fulfilling responsibilities, and every right or privilege entails increased levels of responsibility (Blaich, 2003). Thus, the "right for any student or individual to participate in Hawaiian educational programmes comes with responsibilities" (Kaomea, 2009, p. 89). This philosophical principle fundamentally differs from Western frameworks that position rights as individual possessions separate from obligations (Lingenfelter, 2007). Vaughn (2022) emphasizes that "kuleana usually derives from a specific place or land where a family originates. Kuleana is a Kānaka ʻŌiwi cultural tenet predating settler colonialism that centers on personal and collective responsibility" (p. 151). Kuleana's culturally relevant and place-specific origin establishes it as fundamentally relational, emerging from genealogical connections to specific ʻāina.

Understanding kuleana at this depth requires understanding ʻāina not merely as land but as the genealogical foundation from which kuleana itself emerges. Saffery (2019) explains: "Defining our relationship with our ʻāina as one of family, yet clearly making the generational distinction between the land and people, helps to not only clarify our kuleana as younger siblings to mālama ʻāina (care for the land) but also to reinforce our worldview that we belong together" (pp. 10-11). This relationship is expressed in the ʻŌlelo noʻeau [Kānaka ʻŌiwi proverb] recorded

by Mary Kawena Pukui: “Hānau ka ʻāina, hānau ke aliʻi, hānau ke kanaka (Born was the land, born were the chiefs, born were the common people)” (Pukui, 1983, p. 56). As Saffery elaborates, this saying “explains that both Kānaka Hawaiʻi [Kānaka ʻŌiwi] and our ʻāina are alive and have been born into this world. It expresses that we are intimately tied to each other through our shared genealogy, in which the ʻāina is our elder sibling” (2019, pp. 10-11). This genealogical relationship positions care for land not as environmental stewardship but as fulfilling familial obligations to an elder sibling, a fundamentally different ontological and ethical relationship that Western frameworks of land management cannot fully account for (Bang, 2017).

In Remembering Our Intimacies: Moʻolelo, Aloha ʻAina, and Ea (2021), Jamaica Heolimeleikalani Osorio argues that kuleana is a Kānaka ʻŌiwi concept that colonization has systematically flattened and commodified. While commonly translated as “responsibility,” kuleana encompasses a dynamic web of rights, privileges, and obligations that arise from pilina (relationship), particularly with respect to land and community. Drawing on moʻolelo (stories), Osorio demonstrates that kuleana is something you practice through lived relationship, not something you possess. Ultimately, Osorio calls for a return to kuleana as decolonial praxis[2], a way of challenging settler control by insisting on Kānaka ʻŌiwi frameworks for understanding authority, responsibility, and relationship to ʻāina and lāhui (Nation of Hawaiʻi). These frameworks for kuleana as relational practice and decolonial praxis find resonance in critical place-based education, which similarly positions land and community as sites of both learning and political contestation.

[2] Cyclical, inseparable relationship between critical reflection and transformative action (Freire, 1970).

Critical Place-Based Education and Critical Consciousness

Place-based education has emerged as both a theoretical orientation and a pedagogical practice that centers local landscapes, communities, and issues as primary contexts for learning and inquiry (Orr, 1994). However, not all place-based education challenges the structures that shape relationships to place. Gruenewald (2003) distinguishes between place-based education, which celebrates connection to place without interrogating issues of power, and *critical* place-based education, which explicitly examines how colonialism, capitalism, and other systems of oppression shape landscapes and communities. Critical place-based education begins with questions that do not presume colonization is over (Johnson, 2012). It asks: Who has been displaced from this place? Whose labor has shaped this landscape? What stories are told about this place, and whose stories are erased? These questions position place not as a neutral backdrop for learning but as a contested terrain shaped by historical and ongoing violence (Tuck & McKenzie, 2014).

In the context of Hawai‘i, critical place-based education must reckon with the realities of settler colonialism and its material impacts on ‘āina and Kānaka ‘Ōiwi communities. Taira and Maunakea (2022) argue that place-based education in Hawai‘i requires centering Kānaka ‘Ōiwi epistemologies and practices rather than merely incorporating them as cultural supplements to Western curricula. This means organizing learning around ahupua‘a[3], seasonal cycles, and genealogical relationships to place, frameworks that position Kānaka ‘Ōiwi as knowledge authorities rather than cultural consultants (Taira & Maunakea, 2022). Porter and Cristobal (n.d.) build on this argument, demonstrating how ‘āina-based education serves as a form of cultural perpetuation and political resistance by maintaining relationships to land. When students engage

[3] Traditional land division system that consisted of vertical landscape segments from the mountains to the near-shore ocean environment, and into the ocean as deep as a person could stand in the water (Evenhuis, 2007).

in practices like loʻi kalo (taro) restoration or kilo (observation), they are not learning about Kānaka ʻŌiwi culture as a historical artifact but participating in living traditions that assert continued Kānaka ʻŌiwi presence and authority on ancestral lands.

Critical place-based education intersects with Freire's (1970) concept of critical consciousness, which encompasses the development of awareness of social, political, and economic contradictions and the capacity to act against oppressive systems. Freire argues that education is never neutral: it either domesticates students by encouraging them to accept existing social arrangements or liberates them to critically analyze and transform unjust conditions. Critical consciousness develops through praxis, the cyclical process of reflection and action (Diemer & Li, 2011; Jemal, 2017). Students do not develop critical consciousness by being told about injustice, but rather by engaging with contradictions in their own lived experiences and taking action to address them. bell hooks deepens this framework by connecting critical consciousness to practices of care and community. She argues that education as the practice of freedom (hooks, 1994) must be rooted in love, not sentimental emotion, but "a combination of care, commitment, knowledge, responsibility, respect, and trust" (hooks, 2001, p. 131). This perspective resonates with kuleana, suggesting that critical consciousness emerges not only from intellectual analysis but from embodied practices that can more fully reveal the political dimensions of care and relationships.

In this post-disaster context, critical place-based education takes on an urgent significance. The Hoʻomalu ʻĀina Maui program positions students to develop critical consciousness of these connections through embodied engagement. When students engage with ʻāina stewardship at Kīpuka Malu, they are not simply performing environmental service but confronting the material legacies of plantation agriculture and ongoing patterns of land

abandonment. When they learn from a cultural practitioner and a biocultural conservation biologist about stewardship practices that have maintained healthy ecosystems for generations, they encounter a contradiction between Indigenous knowledge systems, proven effective across centuries, and Western land management approaches that have contributed to catastrophe.

Importantly, critical place-based education in this context does not position students as lacking knowledge. Rather, following Tuck and McKenzie (2015), it recognizes that young people already possess significant knowledge of their communities and the forces that affect them. The pedagogical task is creating conditions for students to deepen, articulate, and act on this knowledge. This positions students as knowledge producers engaged in what Smith (1999) describes as the decolonization project, not simply learning about the past but actively participating in "the long-term struggle for self-determination" (p. 142).

Yet critical questions remain about how these theoretical frameworks translate into students' lived experiences. How do young people, particularly those navigating post-disaster trauma, develop kuleana through embodied engagement with ʻāina? What forms of relational accountability emerge when students practice responsibilities in contexts where colonial structures remain firmly in place? Existing research has not explored how practicing kuleana through wildfire mitigation and land stewardship work influences students' critical consciousness of the systems that created conditions for the fire to occur in the first place. Nor has scholarship explored what it means for students to deepen their relationships to ʻāina in post-disaster contexts, or how grief, loss, and transformation shape processes of learning to care for ʻāina.

METHODOLOGY

This study is grounded in community-based participatory research (CBPR), an approach that positions community members as co-investigators and treats the research process itself as a form of community benefit (Israel et al., 2013; Minkler & Wallerstein, 2011). CBPR shaped this study from the outset, beginning with the research questions themselves. Early in the planning process, I proposed a research focus oriented around climate anxiety. Carrie declined. She made it clear that she did not want the research to center on anxiety and redirected us toward resilience as the animating frame. That intervention shaped the research questions, the program's pedagogical orientation, and ultimately the findings of this study. It is one of the clearest examples of what community accountability looked like in practice in this project, a community partner exercising genuine authority over the terms of the work.

All program partners signed memoranda of understanding outlining their roles and received financial compensation for their contributions, reflecting a genuine commitment to equitable partnership. In practice, however, CBPR partnerships rarely achieve perfect symmetry across all dimensions of the research process (Israel et al., 2013). In this study, nonprofit staff were deeply engaged as co-facilitators of the program itself; their cultural knowledge, land stewardship expertise, and relationships with students were irreplaceable and central to everything the program made possible. A full research partnership was the intention from the outset, and financial compensation was provided to support participation. In practice, the demands of running a nonprofit engaged in active land stewardship meant that partners' engagement with the formal dimensions of the research process was more limited than originally envisioned. This is not a reflection of their commitment but of the real capacity constraints that community-based organizations navigate alongside research partnerships. This distinction

between program partnership and research partnership is one this study holds honestly, recognizing that different partners contributed different forms of expertise at different stages, and that the relational trust built through program collaboration was itself a form of research infrastructure.

Hoʻomalu ʻĀina Maui was a collaborative effort involving multiple program partners, each bringing distinct expertise and relational responsibilities to the work at Kīpuka Malu. Table 3.1 describes each partner's role across the four field visits.

Table 3.1

Hoʻomalu ʻĀina Maui Program Partners and Roles

Partner	Organization	Role in program	Primary responsibility during field visits
Koa	Kīpuka Malu	Kanaka ʻŌiwi cultural practitioner	Led opening protocol, oli, moʻolelo, and other cultural teachings
Tara	Kīpuka Malu	Project manager	Led hands-on land stewardship and wildfire mitigation activities
Leilani	Kīpuka Malu	Communications and outreach specialist	Point person for communicating about the planning of field visits and supported land stewardship activities
Waiola	Legacy Land Stewardship	Kanaka ʻŌiwi biocultural conservation biologist	Supported the students' vegetation assessments, gave in-class presentations, and supported field visits
Carrie	South Maui Charter School	Field ecology teacher	Supported all program activities; coordinated student participation, led all in-class instruction
Jadda	University of California, Davis	Researcher	Supported all program activities while conducting ethnographic observations, surveys, and interviews

Researcher Positionality

I approach this research as an ally. I am a white scholar with deep gratitude for and accountability to the Maui community that shaped my understanding of critical place-based education and Kānaka ʻŌiwi Ways of Knowing. I lived and worked in Maui for five years (2017-2022) as an environmental educator. Among the numerous educational institutions where I taught was the charter school where this research takes place. At the time of data collection (2024-2025 academic year), I was a doctoral student at UC Davis pursuing a PhD in Science Education with a Designated Emphasis in Native American Studies, which provided formal training in Indigenous research methodologies, decolonial theory, and critical engagement with settler colonialism. My positioning, as both a former teacher with established community relationships and a white settler researcher from a mainland institution, shaped every aspect of this work. I navigated this tension by remaining reflexive, maintaining relationships built over time, and by centering students' voices.

METHODS

Study Location

This study takes place at South Maui Charter School in Kīhei, Maui, approximately 25 miles south of Lahaina. Like communities across Maui, Kīhei residents navigate the complex realities of living in a tourism-dependent economy while facing intensifying environmental pressures. Situated on the south-facing shore of the island, students can directly observe interconnected environmental stressors, including invasive species abundance, wildfire risks, tourism impacts, water management challenges, coastal development, coral reef degradation, and toxic runoff (Pogue & Jr., n.d.). As a charter school, there are no geographic enrollment restrictions, meaning the charter students live in various communities across Maui.

Fieldwork took place at Kīpuka Malu, located approximately 8 miles south of Lahaina and 17 miles north of the school. Kīpuka Malu sits within the ahupuaʻa of Olowalu and the moku (district) of Lahaina. It is a landscape that has experienced the direct threat of wildfire during and after the August 2023 fire and carries deep cultural and genealogical significance for Kānaka ʻŌiwi communities (Colorado & Hurd, 2023).

Students in the Hoʻomalu ʻĀina Maui Program are enrolled in high school Field Ecology, an upper-division class offered at the South Maui Charter School, and serves as the alternative to Advanced Placement (AP) Environmental Science. Or, student participants are members of the Ecology Club, one of the many after-school clubs offered at South Maui Charter School dedicated to engaging primarily high school students in everything from environmental activism to volunteer work like beach cleanups to snorkeling and hiking excursions.

Hoʻomalu ʻĀina Maui was developed in direct response to the 2023 Lahaina wildfire and is grounded in the understanding that developing kuleana and critical consciousness in a post-disaster context requires more than content delivery; it requires placing students inside living relationships through embodied engagement with ʻāina, with kumu (teachers), and with the historical and political frameworks that give grief a productive object.

Table 3.2 summarizes the program's theory of change. This study focuses specifically on the relational and political dimensions of this theory of change, examining how embodied land stewardship shaped students' developing kuleana and critical consciousness.

Table 3.2

Hoʻomalu ʻĀina Maui Theory of Change

Dimension	Problem/Context	Program Response	Activities	Intended Outcomes
Ecological	The 2023 Lahaina wildfire resulted from settler-colonial land transformations that displaced Kānaka ʻŌiwi land management systems, introduced invasive species, and disrupted integrated watershed systems	A community-based participatory research program co-developed with a high school ecology teacher, a Kānaka ʻŌiwi biocultural conservation biologist, and Kīpuka Malu, a watershed stewardship and cultural revitalization nonprofit	Four field visits to Kīpuka Malu involving hands-on wildfire mitigation and land stewardship	Students develop kuleana through embodied engagement with ʻāina
Epistemological	K-12 science education in Hawaiʻi largely operates from Western epistemologies that marginalize Kānaka ʻŌiwi knowledge systems	Program design centers Kānaka ʻŌiwi epistemic authority through a constellation of knowledge holders with distinct and complementary forms of expertise	Cultural protocol, oli, and moʻolelo led by an ordained Kānaka ʻŌiwi cultural practitioner	Students engage with the ontological and axiological dimensions of Kānaka ʻŌiwi biocultural knowledge
Political	Young people in post-disaster contexts often lack the historical and political frameworks to understand what created conditions for disaster	Research design that foregrounds students' existing knowledge, lived experience, and critical consciousness as foundational rather than deficient	Pre- and post-program surveys and interviews, ethnographic observation, and student-produced documentary film	Students develop critical consciousness of the colonial forces that created conditions for the Lahaina fire
Relational	Environmental education programs often treat Indigenous knowledge as supplementary to Western science rather than as epistemologically	Relational infrastructure built through sustained, reciprocal partnership preceding and exceeding the program year	Collaborative data analysis, vegetation assessments, and student-led documentary film production	Students recognize Kānaka ʻŌiwi knowledge as foundational rather than supplementary to Western science

Dimension	Problem/Context	Program Response	Activities	Intended Outcomes
	distinct and authoritative			

Note. This theory of change reflects the program's pedagogical logic across cognitive, relational, epistemological, and political dimensions. Outcomes are not sequential but mutually reinforcing.

Participants

Twenty-four high school students participated in the Hoʻomalu ʻĀina Maui program across two cohorts: a Field Ecology class (n=17) and an Eco Club (n=7). Four Field Ecology students joined in December 2024 and completed pre-program interviews and pre-program surveys in January 2025. Over the course of the year, four students left the program for personal reasons, and 20 students completed the full program year. For this study, 23 students completed the pre-program survey, and 22 completed individual or focus-group pre-interviews. At the close of the program year, 19 students completed individual post-program interviews; one Eco Club student was unable to meet due to scheduling constraints. Sixteen students completed the post-program survey; three Eco Club students and one Field Ecology student did not. Pre-post interview comparison therefore draws on 19 students, while pre-post survey comparison draws on the 16 students who completed both pre- and post-surveys. Students were eligible to participate in Hoʻomalu ʻĀina Maui if they were enrolled in either the Field Ecology class or the Eco Club. All participation is voluntary, and written informed consent (Bloomberg, 2022) was obtained from both students and their parents/guardians. I use pseudonyms throughout this study when referring to participants to protect individuals' identities, in accordance with protocols for ethical research with human subjects and guidance from the UC Davis Institutional Review Board. This study received IRB approval from UC Davis and additional approval from the

charter school administration. Table 3.3 presents selected demographic characteristics of the student survey respondents (n=23). Rather than selecting focal students, all 24 students from both groups were invited to participate in this study, and all 24 did.

Critically, this study must account for the diverse positionalities students bring to the program. Students participating in the Hoʻomalu ʻĀina Maui program, reflect the broader demographic diversity of Maui with only three students identifying as Kānaka ʻŌiwi (see Table 3.3). This raises important questions about what it means for non-Indigenous students to engage in a program grounded in Kānaka ʻŌiwi epistemology and cultural practice. Kaomea (2009) argues that non-Indigenous participants in Indigenous education programs carry their own distinct kuleana that emerge not from genealogical connection but from their presence on and relationship to Indigenous land. This study attends to that distinction throughout, recognizing that pathways to kuleana are not uniform across students with different relationships to place, ancestry, and community.

Table 3.3

Demographic Characteristics of Hoʻomalu ʻĀina Maui Student Participants (n=23)

Category	Student Responses
Race	
Filipino	3
Japanese	1
Black or African American	2
Native American, Alaskan Native, First Nations	2
Chinese	3
Native Hawaiian (Kānaka ʻŌiwi)	3

Latinx/e	8
Pacific Islander (e.g., Samoan, Guamanian, Micronesian)	2
White	18
Gender	
Non-binary/third gender	1
Male	5
Female	17
Languages Other than English Spoken at Home	
Prefer not to say	1
Hawaiian (‘Ōlelo Hawai‘i)	1
Only English	16
“Other” responses included:	
Spanish	3
Korean	1
Pidgin	1

Note. Students could select as many racial categories as they preferred.

Table 3.4 presents individual demographic information for the students whose voices and perspectives are featured prominently in this chapter’s findings. While all 24 students participated in the program, the students represented here contributed data that was particularly generative for addressing the study’s research questions.

Table 3.4

Demographic Profiles of Students Featured in Findings (n=18)

Student Pseudonym	Gender Identity	Grade	Cohort (Field Ecology, Eco Club, or Both)	Race/ Ethnicity	Languages Other than English Spoken at Home
Anna	Non-binary	Senior	Field Ecology	White	Only English
Bob	Male	Junior	Field Ecology	Hispanic or Latine, Other	Only English
Fall	Female	Junior	Eco Club	White	Only English
Helena	Female	Senior	Field Ecology	Native Hawaiian, Chinese, White	Only English
Janelle	Female	Senior	Field Ecology	Native Hawaiian, Filipino, Japanese, Chinese, Native American, Hispanic or Latine, White	
Jessie	Female	Junior	Field Ecology	Pacific Islander (e.g., Samoan, Guamanian, Micronesian), Filipino, Hispanic or Latine, White, Other	Only English
Joy	Female	Junior	Eco Club	White	Only English
Kanoa	Male	Senior	Field Ecology	White	Only English
Kay	Female	Senior	Both	Hispanic or Latine	Spanish
Keoni L.	Male	Senior	Field Ecology	Chinese, White	Only English
Kim	Female	Junior	Field Ecology	White	Only English
Lex	Female	Senior	Field Ecology	White	Only English
Michael	Male	Junior	Field Ecology	White	Only English

Mundean	Female	Junior	Eco Club	Hispanic or Latine, White	Only English
Myrna	Female	Junior	Eco Club	Filipino, White	Only English
Sarah	Female	Senior	Field Ecology	White	Only English
Senai	Female	Junior	Eco Club	Black or African American, Hispanic or Latine	Spanish and Korean
Solai	Female	Junior	Both	White	Only English

Data Sources

Data collection occurred from August 2024 through May 2025. This study specifically analyzes pre-post semi-structured interviews to capture how students understood and articulated their developing kuleana through participation in the program.

Semi-structured interviews

Semi-structured interviews (Seidman, 2019) and two small focus groups (Morgan, 1997) explored students' understanding of kuleana, their relationships to ʻāina, their critical consciousness of social-ecological issues, and their reflections on the Lahaina fire. Individual interviews were conducted at both the beginning and end of the program year. The pre-program interview protocol included questions such as: "What does kuleana mean to you?" "How would you describe your relationship to the land here in Maui?" and "If we were to make a positive change in the community through this project, what kind of change would you hope to see?" The post-program protocol repeated these questions and added: "What do you think needs to be healed or restored in the relationship between people and the land here in Maui?" and "How do

you feel about your kuleana to ‘āina and community now?” Interviews ranged from 20 minutes to 2 hours, were audio-recorded with participant permission, and transcribed verbatim. The pre-post design allowed me to trace shifts in students’ thinking and explore how their articulations of kuleana evolved through participation in stewardship work.

Analysis

Data analysis followed a reflexive thematic analysis approach (Braun & Clarke, 2021), adapted to honor the pre-post structure of the dataset. Analysis was conducted in Dedoose, a qualitative data analysis platform that supported systematic comparisons across students and time points. Pre- and post-program interviews were uploaded and coded separately to preserve the integrity of each time point before comparison. Initial coding was inductive and exploratory, staying close to students’ own language and resisting premature categorization (Saldaña, 2021). As coding progressed, I moved iteratively between individual transcripts and emerging patterns, generating and refining themes through active interpretation consistent with Braun and Clarke’s (2021) perspective that themes are constructed by the researcher rather than discovered in the data.

To conduct the pre-post comparison, I constructed student profiles with support from two undergraduate research assistants, both trained in qualitative data analysis and recruited through the UC Davis Center for Community and Citizen Science. Research Assistants traced individual student trajectories throughout the program year and then identified patterns across the cohort. Research assistants completed training in the study’s coding framework and confidentiality protocols prior to engaging with data, and their involvement was limited to profile construction and pattern identification rather than interpretive analysis. Identifying individual student

trajectories first, then cross-cohort patterns, kept the analysis accountable to the specificity of each student's experience while generating findings with sufficient scope to be theoretically meaningful. Frequency of themes across pre- and post-program data informed but did not determine the analysis. For instance, some patterns became analytically clear only through longitudinal comparison of individual trajectories, not through code frequency counts alone.

Validity within this study was strengthened through several complementary practices. Preliminary findings were shared with the ecology teacher, whose feedback refined the analysis. Students engaged in a collaborative in-class coding exercise using their own anonymized quotes, a form of ground-truthing that embraces collective sense-making as a validation practice (Ghiso et al., 2019; Sadd et al., 2014; Sharkey & Horel, 2008). Throughout analysis, I documented interpretive decisions and moments of uncertainty in researcher memos in Dedoose. For example, I asked myself questions like: (1) Are there moments where my position as a former teacher, a white settler researcher, or a program co-developer is shaping what I am able to see or willing to claim?; (2) Am I representing this community in a way that serves them well?; (3) Am I honoring the trust this community placed in me? These questions did not resolve the tensions inherent in this kind of research, but they kept those tensions visible and productive across the full arc of analysis (Kovach, 2021; Pillow, 2003).

Our analytical process moved iteratively between inductive coding and longitudinal comparison of individual student trajectories across the program year. Table 3.5 summarizes the full sequence of analytical procedures.

Table 3.5

Overview of Analytical Procedures

Step	Procedure	Description
1	Transcription and immersion	Interview recordings were transcribed verbatim. All transcripts read repeatedly prior to formal coding to develop interpretive familiarity with the full data corpus (Braun & Clarke, 2021). Pre- and post-program transcripts uploaded and coded separately to preserve the integrity of each time point before comparison.
2	Inductive initial coding	Initial coding was inductive and exploratory, staying close to students' own language and resisting premature categorization (Saldaña, 2021).
3	Iterative theme development	As coding progressed, I moved iteratively between individual transcripts and emerging patterns, generating and refining themes through active interpretation. Themes are understood as constructed by the researcher rather than discovered in the data (Braun & Clarke, 2021).
4	Student profile construction	Student profiles constructed with support from two trained undergraduate research assistants to trace individual student trajectories across the program year. Research assistant involvement was limited to profile construction and pattern identification rather than interpretive analysis.
5	Longitudinal trajectory analysis	Pre- and post-program transcripts compared per student to trace developmental arcs across the program year. Individual trajectories identified first, then cross-cohort patterns. Frequency of themes informed but did not determine the analysis, some patterns became analytically clear only through longitudinal comparison rather than code frequency counts alone.
6	Reflexive memo writing	Throughout analysis, interpretive decisions and moments of uncertainty documented in researcher memos in Dedoose, including reflections on how positionality as a former teacher, white settler researcher, and program co-developer may have shaped what was visible or claimable (Kovach, 2021; Pillow, 2003).
7	Collaborative analysis	Preliminary findings shared with Carrie, the field ecology teacher, whose feedback refined the analysis. Students engaged in a collaborative in-class coding exercise using anonymized quotes, honoring collective sense-making as a validation practice (Ghiso et al., 2019; Sadd et al., 2014; Sharkey & Horel, 2008).

FINDINGS

This study has three findings. First, students developed kuleana through embodied engagement with ʻāina, through hands-on stewardship work, repeated site visits, and relationships with kumu (teachers) who modeled kuleana. Second, students developed critical consciousness of the colonial forces that created conditions for the Lahaina fire; their grief found

a historical object and this became the foundation for political analysis. Third, students simultaneously refused extractive land relations and generated reciprocal relations. The sections that follow elaborate each finding in turn, drawing on pre- and post-program interview data to trace how students' relationships to ʻāina, their understanding of the forces that shaped the fire, and their orientation toward land and community shifted across the program year. Each finding is presented through the students' own words, with interpretive analysis woven throughout.

Kuleana as Embodied Practice: Students' Developing Relationships to ʻĀina

Before beginning fieldwork, students articulated their understanding of kuleana during pre-program interviews in September 2024. Definitions varied in framing but shared a core orientation of reciprocity. Joy explained, "*To me, it* [kuleana] *means your responsibility to like wherever it is that you are, to your family, to yourself, your environment, to the place where you live. And so, like when you take care of the land and the people around you, it's because it gives to you, so you should be giving back.*" Helena offered a distinctly intergenerational framing: "*It's your responsibility to do what others can't do anymore. Like if someone's older, you can take on that responsibility for yourself… it's everyone's due diligence to give back versus just take, take, take*." Keoni L. framed kuleana not as action but as orientation: "*It's just your responsibility, your duty, whether it's to the land or to people. It's very much just a way to live.*" For Jessie, the concept had been transmitted directly by her grandmother in third grade: "*She was teaching us what kuleana meant. It was her responsibility to pick us up from school and take care of us, and it was our responsibility to do good in school.*"

Joy locates kuleana in place and relationship, "*you give back because the land gives to you.*" Helena grounds it in intergenerational obligation, "*you take on what others can no longer*

carry." Keoni L. strips it to its essence, not an action but "*a way to live*". Jessie received it at age eight, from her grandmother, in the most ordinary of circumstances: picking up children from school. Four students, four pathways, one convergence. What is theoretically significant here is not that students could define kuleana but that they arrived at reciprocity independently, through different relationships, different family contexts, and different life experiences, without formal instruction in Kānaka ʻŌiwi ways of knowing. Kuleana was already alive in them. The language students used across pre-interviews — "should," "try," "would like to," "need to" — marked kuleana as something understood but not necessarily enacted. That distinction between knowing and doing is what the program aimed to address.

This began to change throughout the Hoʻomalu ʻĀina Maui program. Across four field visits to Kīpuka Malu, students were not taught about kuleana so much as placed inside its practice. Twelve students described the hands-on stewardship work itself (removing invasive species, outplanting native species, conducting vegetation assessments) as generating a new relationship to land that was contextually different from what they had known before. Jessie described the planting protocol specifically: "*We chanted before planting the plants. I thought that was a really good traditional way to do it. Because you're also giving. I believe that if you put your love into something, it actually works out for the best.*" Jessie's reflection reveals something significant about what embodied cultural practice makes possible. She is describing a shift in how the act of planting and chanting was understood as an offering and a kind of relationship. "*Because you're also giving,"* she says, and in that phrase the entire logic of Western land management, i.e., 'do X, get Y,' dissolves. Jessie is not a technician executing a conservation protocol. She is a person bringing her love, intention, and presence into a relationship with the land. That this shift happened through a cultural practice transmitted by a

kumu with years of training is not incidental. Embodied cultural practice reached something in Jessie that a classroom-based Western science lesson plan could not have designed for.

Figure 3.1

Students and Community Partner Removing Invasive Species at Kīpuka Malu, Olowalu, Maui

Fourteen students named learning from the cultural practitioner as formative in shaping their sense of responsibility. Rather than teaching kuleana as curriculum content, he modeled it through practice. Through oli (chant), moʻolelo (stories), and working alongside students. Mundean, who described having no prior experience with Kānaka ʻŌiwi cultural knowledge, reflected on what made the cultural practitioner's teaching distinctive: "*He taught us in a way that wasn't boring. He'd tell us all of his stories. It was almost like a lecture, but it wasn't boring, because he was able to tie in culture with science, which was really interesting. Not a lot of people can do that well.*" Mundean's perspective carries particular theoretical weight precisely

because of what she had no prior experience with Kānaka ʻŌiwi cultural knowledge. She had no existing framework through which to recognize or validate what Koa was sharing. And yet, she names his teaching as impactful. "*Not a lot of people can do that well,"* she says, an evaluative claim that carries more force coming from someone engaging with this form of teaching for the first time than from someone already steeped in its tradition. What reached Mundean was not cultural familiarity. It was the integrity of Koa's weaving of two knowledge systems, culture and science held together, neither subordinated to the other, arriving with such authenticity that even a student with no prior point of reference could feel its power. Students learned kuleana by watching someone demonstrate it. For Mundean, that demonstration did not require prior knowledge to land.

Figure 3.2

Cultural Practitioner Demonstrating Haku Lei Making at Kīpuka Malu, Olowalu, Maui

Repeated visits to the same site deepened students relationship with ʻāina in ways that a single field trip could not. Helena explained, "*Going back to Kīpuka multiple times, you start to*

recognize individual plants, you notice what's changing, what needs attention. It becomes your place in a way it wasn't before." Students witnessed seasonal changes, saw the effects of their prior work, and developed an intimacy with a specific place. They were not rotating through different environments accumulating ecological knowledge; they were returning to the same ʻāina, watching it change, and being changed by it. This is the condition under which kuleana moves from concept to embodiment.

By May 2025, 15 of 20 students showed the pattern that most clearly marked the program's impact: kuleana had moved from something they talked about doing to something they simply did. For example, descriptions of enacted responsibility, specific care practices, and concrete commitments had become more prevalent. Solai's trajectory across the program year is one of the most striking in the dataset. In September 2024, she described having "*always wanted to*" participate in land stewardship but never having found an opportunity. By May 2025, she was leading her peers through vegetation monitoring protocols at Kīpuka Malu. Her goal was not personal learning alone but authentic contribution: "*My goal for the outcomes of the vegetation assessment is to help show the restoration efforts being made at Kīpuka.*" The distance between those two moments is not measured in content learned or skills acquired. It is measured in the shift from wanting to belong to a practice to holding authority within it. Solai did not just develop kuleana across the program year. She grew into a person who leads others in enacting it.

Sarah's reflection captures what became possible over four field visits to Kīpuka Malu, during which students removed invasive species, planted native species, conducted vegetation assessments, and engaged in cultural protocols and practices. These experiences positioned students not as learners receiving content but as participants in restoration work that was simultaneously ecological and cultural; removing what colonialism introduced and regenerating

what it displaced: "*This class gave us a chance to really feel empowered in what we were doing, and that we had the chance to make a difference. We did it in this class, which made me feel that we really can in any other aspect of our lives, because we have so much ahead of us.*" For both students, kuleana had moved from an orientation they held to a practice they inhabited.

Kay, who was moving away from Maui at the end of the school year, captured kuleana's broader applicability beyond Hawai'i*: "Educating myself on what these environmental issues in this area may be, because everywhere is going to have environmental issues, no matter where we are nowadays. Just finding certain organizations or groups and stuff like that, volunteering, trying to continue that on."*

Kay's reflection raises a theoretically generative question about the relationship between kuleana and place. Kuleana is rooted in genealogical connection to specific 'āina, it derives its meaning from belonging to a place. And yet Kay, who is leaving Maui, describes carrying kuleana with her wherever she goes finding organizations, volunteering, continuing the work. This is an extension of kuleana. What Kay internalized at Kīpuka Malu was not attachment to a specific restoration site but a practice of reciprocal responsibility that now travels with her as a way of being in relationship with any place she inhabits. Kuleana, when genuinely practiced, rather than merely taught, has the capacity to exceed the boundaries of the program. Kay's year of sustained relationship with 'āina, with cultural practitioners, and with the living history of a place still recovering from catastrophe did not stay in Olowalu. It became a way of moving through the world.

From Grief to Political Clarity: Critical Consciousness After the Lahaina Fire

In pre-program interviews conducted one year after the Lahaina fire, students recognized environmental problems but typically described them as discrete, unconnected issues. Kim identified "*a lot of old fields from sugar cane that are just left empty with nothing in them, and it gets really dusty. And then the invasive species, like there's always like a lot of deer and mongoose.*" Naming abandoned plantation lands, invasive grasses, and invasive animals as separate concerns without connecting them. Eight students made partial connections between one or two elements of the social-ecological system, but none yet articulated a full systems-level understanding of what created conditions for the fire. The emotional texture of these pre-program interviews was one of grief and fear alongside genuine motivation to act. They felt the weight of what had happened without yet having the historical and political frameworks to explain it. When asked how she felt about the environmental challenges facing Maui, Solai captured this complexity:

"*Scared honestly, but also motivational because I wanna do stuff but also like because of world politics play so much into that that scares me and so that's why like a big motivational factor like why I'm trying to do all this and take all these classes and stuff to try and help because I think it is the biggest problem facing me, but also my generation because not having a place to live is the number one thing."*

Solai's response is striking in its political clarity. She is not describing a vague environmental anxiety; she is naming the entanglement of world politics, housing insecurity, climate crisis, and generational stakes. "*Not having a place to live is the number one thing*," she

says, connecting ecological vulnerability to the most material of human needs. And yet alongside that fear sits an equally powerful motivation. She is taking classes, seeking knowledge, looking for ways to act. Solai is not waiting for someone to tell her what to do. She is already moving toward the problem, even without yet having the historical and political frameworks to fully name its causes. Most environmental education teaches facts without pathways for authentic engagement, leaving students like Solai, who arrive with genuine political clarity and motivation to act, with nowhere to put it. Anna names what that looks like:

"*Some teachers — not Miss* [Carrie], *but in middle school — we learned about climate change and it was all very 'The planet's dying, there's nothing we can do,' always hopeless. Miss* [Carrie] *is actually the first person that has said, no, there's something we can do — it's not entirely hopeless, and it's bad, but it's not as bad as we thought, because we can make a difference.*"

Grief, in other words, had been taught as a terminal condition rather than a starting point. When environmental education presents ecological crisis as inevitable and irreversible, it does not prepare students to act with empowerment and agency; it convinces them there is nothing they can do about it. For students already carrying the weight of the Lahaina fire and living with the consequences of unchecked land transformation, that message is not abstract. What Carrie offered was not false optimism, but what Anna calls the possibility of difference: "*it's bad, but it's not as bad as we thought, because we can make a difference.*" That reframing did not erase the grief. It gave it somewhere to go. And it is precisely that space between feeling the weight of

crisis and believing action is possible that the Hoʻomalu ʻĀina Maui program was designed to inhabit.

Even before formal program participation began, the September 2024 focus group discussion showed students beginning to find an object for their grief through collective analysis. Janelle described watching "*the island go from a beautiful green flourish to a sad brown*," and Sarah completed the systems-level connection: "*It used to rain so much more and it doesn't anymore, and it's just fires and dry and it's just the sadness behind everything.*" Janelle followed with "*yeah, like. . .you grew up hearing that like the land is the most important thing the one thing that you're supposed to cherish forever and it's hard to cherish something when it's falling apart."* What is theoretically significant about this exchange is not only what Janelle and Sarah say but how they arrive at it together. Sarah completes Janelle's thought. Janelle extends Sarah's. The systems-level historical analysis that emerges, from land abandonment to ecosystem collapse to changed rainfall to fire to grief, is not the product of either student alone. It is produced in the space between them, through the act of thinking collectively. This happened before the program began, which is significant. It suggests that the capacity for historical and ecological analysis was already present in these students, waiting not for instruction but for the conditions and, in this case, collective dialogue, under which it could surface. Grief, shared in a group, found its first foothold in historical causality.

By May 2025, 16 of 20 students demonstrated systems-level understanding of how historical forces and present conditions are interconnected. The plantation-era-to-fire connection became a central through line. Helena articulated it directly:

"*When we had cane sugar — using all of that water all the time — you have water to water your crops, but then a whole section is just, there's no water, your stream's gone. If you're diverting water for so long and you just have all this dry brush, then it opens things up to the fire. It all comes back together when you don't think about it.*"

Helena is naming the colonial architecture of a landscape she has lived inside of her entire life. Water diverted for sugarcane. Streams gone. Dry brush spreading. Fire. Each element she traces is not simply an ecological fact; it is the material implications of decisions about who controls land, who profits from it, and who is left to live with the consequences. What Helena has arrived at, through a year of working and learning at Kīpuka Malu, is an understanding of how power moves through place. How the choices of plantation owners a century ago are still visible in the soil's dryness, the spread of invasive grasses, and her community's vulnerability to fire. She says, *"It all comes back together when you don't think about it."* In that phrase, she is describing the understanding that did not arrive through analysis alone. It arrived through a relationship with a place that holds its history in its ecology, and through being present and attentive long enough for that history to become visible. Helena is doing the intellectual and political work that environmental education has long claimed as its highest aspiration, and she is not alone.

Solai connected historical water diversion to contemporary water scarcity, plantation-era invasive species introduction to present fire fuel, and plantation closure to land abandonment:

"*So much of Maui's environment ties back to water and precipitation and all these things that were affected by the plantations. They diverted water for sugarcane and when they left, they just left the land abandoned with all these invasive grasses.*"

Solai extends this from ecological understanding into political naming. The word "*they*" is important. She is not describing an impersonal historical process. She is identifying actors, decisions, and consequences. This transforms what might have been experienced as a natural disaster into a story of specific choices made by specific people with specific interests. Historical analysis gave grief a structure, a set of causes that were neither natural nor inevitable, but the result of decisions that could be named, contested, and changed.

By the end of the school year, that structure extended from historical causality to present political analysis. Thirteen of 20 students developed explicit awareness of who makes current decisions about land, who benefits, and who bears the costs. Bob articulated this directly:

"*They're always people with tons of money that can really make a difference, but they don't and they just hoard it. Because like the wildfires, they gave people in Lahaina only $700 per household, and then they're giving the airport and stuff millions of dollars to rebuild.*"

Bob then connected this to infrastructure politics he had learned through his uncle's involvement in the Carpenters Union: "*We have the technology to do better, but it comes down to who's willing to pay for it, and usually that means who profits from keeping things the way they are.*"

Bob is shining a light on something very important; he is naming a political choice, one that reveals whose recovery is considered worth funding and whose is not. In Hawai‘i, where Kānaka ‘Ōiwi families have watched their land and their futures be purchased by outside wealth, and where the communities most devastated by the fire are the same communities that have always borne the costs of decisions made without them, this is not an abstraction. It is the lived reality of what economic disparity looks like when disaster strips away whatever buffer or illusion of justice and equality remained.

Bob's second observation cuts even deeper. "*We have the technology to do better, but it comes down to who's willing to pay for it, and usually that means who profits from keeping things the way they are.*" He is not just describing inequality. He is naming the mechanism that reproduces it. Inaction, in Bob's analysis, is not a failure of imagination or capacity. It is a deliberate structural condition maintained by those who benefit from it. Bob arrived at this understanding through his uncle's involvement in the Carpenters Union and through watching working people navigate decisions made without them; this is significant. Like Kanoa, he is carrying knowledge that no formal curriculum provided. In this case, a clear understanding of how economic interests shape not just disaster recovery but the conditions under which justice becomes possible or impossible.

For some students, political analysis extended beyond land use and disaster response to the institutions shaping their own capacity to act. Keoni L. turned a critical lens onto schooling itself:

"*I think schools generally don't really encourage protesting or anything that disrupts peace. When they teach you how to be a member of society, most people aren't encouraging you*

to make a ruckus and just get people's attention. I think that's a big thing most schools are like, don't do that."

Keoni L. extends Bob's analysis from economic structure into institutional reproduction. If Bob named who profits from keeping things the way they are, Keoni names the machinery through which that arrangement is sustained and upheld. Schools teach compliance. They teach students to be good members of society, not to make a ruckus or disrupt the peace. For students from low-income communities, from communities that have watched their land and their water get taken from them by people with more power and more money, that lesson lands with particular force. Do not cause trouble. Do not demand accountability from those who hold power over your life and opportunities. Keoni is naming this problem. Systems that have produced the conditions for the Lahaina fire —concentrated wealth, political inaction, the maintenance of arrangements that benefit the powerful at the expense of everyone else— are reproduced every day in schools that teach young people to work within these systems rather than challenge them.

For others, political clarity landed closest to home in the specific experience of watching people lose their land. Five students critiqued land acquisition as a political problem with identifiable beneficiaries and victims. Jessie connected this directly to personal stakes: "*A lot of locals are getting their homes taken away because they can't afford it. It's being given to people who don't really belong here, who aren't aware. I want to just give them their homes back.*"

Jessie is doing two things simultaneously. She is naming displacement as a political choice made by people "*who don't really belong*" to this place and don't understand what they are taking. She then goes further. "*I want to just give them their homes back."* That sentence is a vision of repatriation, the active return of what was taken, offered with the simplicity of someone

who cannot understand why it hasn't already happened. In a state where land dispossession has been ongoing for over two centuries, where the people most devastated by the Lahaina fire are the same people whose land has been steadily purchased out from under them, Jessie's desire to simply give homes back is not naïve. It is moral and political clarity that cuts through every economic and political justification offered for why things must remain as they are.

Six students moved beyond critique to propose structural interventions: changes to water law, land use policy, and disaster recovery funding rather than individual behavioral solutions. Four explicitly named themselves as implicated in the dynamics they were critiquing, recognizing their own positionality within the systems they were analyzing rather than standing outside them as observers. Political analysis had given grief a target: not the fire itself, not nature, not bad luck, but decisions that could be named.

For most students, this analytical grounding transformed grief from a paralyzing condition into a generative one. Solai, who had described paralyzing fear in September, proposed water law reforms by May, identified structural causes of fire risk, and described landscape restoration work she would continue. Fall articulated the transformation most directly: "*The cure for depression is action. Learning of issues should make you upset because they're concerning, but when you're that upset, don't just let it linger in your mind, use that to help make the world better.*" Fall's insight arrives with the force of something that feels lived rather than taught: "*The cure for depression is action*." She is making a claim about the relationship between grief and agency. Ecological grief, in Fall's framing, is not a psychological obstacle to be managed or minimized; it is an appropriate and necessary response to injustice, and its appropriate outlet is not resolution but action. She is speaking to others who are upset, saying that being upset is not

only acceptable but encouraged, because that emotional response, when given direction and purpose, becomes the foundation for doing something about the conditions that produced it.

Myrna described what the program itself had done for her sense of possibility: "*It did give me hope. Even if it's such a small project on an island in the middle of the ocean, it shows that, okay, in my community, there are people that aren't going to back down.*" Myrna's words are powerful, and they connect to Bob's, who named who profits from keeping things the way they are, and to Keoni, who named how institutions teach young people to accept that arrangement. Myrna names the idea: what if they don't? "*There are people that aren't going to back down."* She is describing a kind of defiance that both Bob and Keoni alluded to— the specific, grounded, place-based refusal of a community that has already lost so much. For Myrna, hope is not a feeling that arrived because things got better. It is evidence she collected by watching people do the work anyway, on a small island in the middle of the ocean, against odds that would justify giving up. That evidence is now hers to carry. In a world that has given communities like this every reason to believe that nothing they do will matter, Myrna is saying: try and stop us.

However, not all students underwent dramatic shifts. For some, change was more tentative or provisional. Keoni L. described a modest but genuine motivation at the year's end:

"*I think I do feel motivated, not massively, but there is some motivation there, just living on this island and seeing the problems it has. That's a little kick in the pants to just do something, even if it's a smaller change.*"

Keoni's honesty is its own form of data. When he said, "*I think I do feel motivated, not massively, but there is some motivation there,*" he is not engaging in socially desirable responding by telling a researcher what she wants to hear. He is describing exactly where he is. He is moved by living on this island and seeing its problems, but not yet on fire about it. That this sits alongside Bob's structural analysis and Myrna's defiance in the same dataset is not a contradiction. It is the truth of what happened across this cohort. Not every student left the program transformed. Some left with a small but genuine shift in orientation, a little more motivated than before, a little more aware of what is at stake.

Jessie described similarly mixed feelings: "*I still do feel hopeless sometimes... but there's still a lot of people and communities trying to make everything better.*" Their cases serve as an important reminder that participation in ʻāina-based stewardship does not automatically convert grief into critical analysis for all students, and that the conditions under which that conversion happens warrant further investigation. For most students, grief had not disappeared by May 2025; it had been absorbed into the ongoing work of caring for land and community, informing why that work mattered in ways that no longer required constant naming. How students channeled that orientation into practice is what the following section explores.

Regenerative Refusal: Practicing Refusal, Regenerating Relationships

Not all epistemological refusal stemmed from the program; some students brought it with them. In a pre-program focus group, an exchange between Kanoa and Janelle made this visible. Kanoa began the program by positioning Kānaka ʻŌiwi and Western knowledge as complementary:

"*Hawaii has its own issues compared to the Western world, and the Hawaiians truly knew what the land needed from observation and things like that. And there are definitely ways that other people have come up with to help it go faster so it's good in that sense that we have better ways to help but I feel like. . .*"

Before he finished, Janelle interrupted: "*It's not the right way.*" Kanoa paused, then reformulated and said: "*It should be based more off of Hawaiian knowledge.*" Her interruption refused the framing that Western approaches simply accelerate what Kānaka ʻŌiwi knowledge already knows, insisting on a difference in kind rather than speed, and on epistemological priority rather than parallel contribution. By the end of the school year, this position had become more widely held and more confidently articulated: 11 of 20 students demonstrated increasingly assured assertion of Kānaka ʻŌiwi knowledge as foundational rather than supplementary to Western science. Solai articulated this hierarchy directly:

"*I think a lot of the traditional approaches, they know so much about the land already and how to treat it, because Hawaiians lived for so long without a Western point of view. So, I think we can use that so much, and then we can use new Western technology to help and actually put them into place.*"

Solai's framing reflects a meaningful shift in how she understands the relationship between knowledge systems. Kānaka ʻŌiwi knowledge is not a supplement to Western science; it is the foundation from which Western technology takes direction. She arrives at this understanding not through genealogy but through a year of embodied engagement with ʻāina,

with kumu, and with the living history of this place, which speaks directly to what the program set out to do.

However, not all students framed this as a strict hierarchy. Michael offered a more contextual integration: "*Bringing back some of the traditional stuff is very important, back then it was healthy and growing, and everyone was very aware. But today the world has changed, and you can't go back exactly. You have to adjust*." Michael wrestles honestly with how Indigenous knowledge lives in a changing world. Not dismissing it. Not romanticizing it. Asking what it means to bring it back when you can't exactly go back.

Mundean extended this toward questions of scale: "*Traditional Hawaiian knowledge just needs to get out there more… combining it with Western science could probably make a lot of impact on a bigger, broader scale.*" Mundean, who entered the program with no prior experience with Kānaka ʻŌiwi cultural knowledge, is now advocating for its wider recognition. *"Traditional Hawaiian knowledge just needs to get out there more."* From someone encountering this knowledge for the first time is a remarkable statement.

Together these positions, from Janelle's sharp refusal of Western knowledge to Michael's contextual integration, capture a range of epistemological stances, all of which positioned Kānaka ʻŌiwi knowledge as essential rather than supplementary to Western science.

Koa's teaching was inseparable from the embodied work, and for many students, it was transformative. Koa led students through E Hō Mai, the teaching of the genealogy of kalo as the elder sibling of Kānaka ʻŌiwi people, grounding the restoration work in its cultural and genealogical significance. Before any seed went into any pot, he taught the planting chant Ke Kanu Nei Au, asking students to bring their intention and mana into the act of planting. His teaching arrived as the ontological frame within which the ecological work became more

significant. Fourteen students named his teaching as the most formative part of the program year. Not the field visits themselves, not the vegetation assessments, not the documentary film, but the specific experience of learning from someone who carried this knowledge in his body, his lineage, and his practice.

Kanoa described what his Kānaka ʻŌiwi uncle from Lahaina had taught him, knowledge the cultural practitioner's teachings may have reinforced and deepened:

"*Hawaiians believed that they came second to the land. The land is always first, land revolves around them. So if they did something to mess it up, they go back and they fix it because the impact that they have on the land really did make a difference.*"

This ideology positions humans not as stewards managing land for sustainability but as younger siblings with obligations to an elder sibling, a fundamentally different ontology of human-land relationship. For students who had spent a year removing invasive species, planting native species, and working alongside kumu (teachers) who embodied this relationship, the teaching did not arrive as an abstract philosophy. It arrived as a description of what they had already been practicing.

That ontological reorientation extended into explicit refusal of the extractive historical and political systems students could now name. Fifteen students demonstrated critique of extractive land relations alongside commitment to reciprocal alternatives, positioning these as two dimensions of the same project. The refusal operated most visibly through a critique of tourism and land acquisition. One of the focus groups named the displacement pattern directly: "*Housing and people buying, just to make profit from tourists. Taking Hawaiians out.*" This

statement names the essential logic of land dispossession in Hawai‘i with a clarity. There is no hedging, no acknowledgment of economic complexity, no diplomatic framing. Just the bare structure of what is happening and who it is happening to. These students have been watching this their entire lives. This is what happens when the evidence is all around them: in the housing prices, the presence of tourists, and the absence of the people who used to live next door. What it demands of environmental education is a reckoning. If students arrive already carrying this analysis, already seeing clearly what is being done to this place and its people, then the question is not how to teach them to ‘think critically’. The question is what we are going to do with the clarity they already have. Fall extended this critique to her own positionality as a settler transplant:

“*I don’t feel I should be here; to be honest, I think this land belongs to the Native Hawaiians. . . It’s more the economy that wants us here, and Maui needs to be self-sustainable anyway, so I’m planning to move away, especially as someone who’s using the resources that the island does not have, and I don't have any cultural connection. . . I would love to have one, and I try to immerse myself wherever I can, but I don't have any ancestral connection here, so I don’t think I should live here.*”

Her framing represented the most explicit refusal of settler presence itself; a position she had arrived at through conversation with a kumu and through her own analysis of resource use. Where most students proposed managing or limiting extractive practices, Fall’s refusal went to the root: not how extraction should be regulated but whether the conditions that make it possible should be allowed to continue.

Against these extractive patterns, students enacted reciprocity through restoration work, and the specific practices they described reveal what regeneration looked like in material terms. When they removed buffelgrass (introduced during the plantation era as cattle forage and now the primary fire fuel on Maui), they refused the extractive land use that introduced it, the abandonment that let it spread, and the ongoing neglect that maintains the fire risk. When they planted native species, they regenerated relationships severed by that same history: between plants and pollinators, forests and birds, people and the places some of their ancestors had stewarded. Solai described a teaching from her auntie about using all resources without waste: "*Don't cut down trees and then not use that as compost. Use all the resources.*" Utilizing invasive species as mulch and propagating native species from saved seeds, these practices enacted a philosophy of reciprocal relationship in which nothing is simply discarded. Lex articulated the connective logic underlying this work: "*For a community, it's like if we all help, it will become stronger. We all learn together. It's not a single journey. It's a lot more togetherness… Our environment outside, we're also in it, it's all so connected.*" Refusal and regeneration were not sequential; students did not first refuse extractive relations and then build reciprocal ones. They practiced both simultaneously, in the same gesture of removing what harms and restoring what sustains through embodied practice.

Seven students extended this reciprocity explicitly into an intergenerational frame, understanding their restoration work as a contribution to ongoing collective practice rather than a discrete intervention. Kay, whose family was preparing to leave Maui at the end of the school year, explained: "*This year my goal is to do as much as I can before I leave because I want to make an impact and leave something behind for the next group of students.*" She positioned herself not as a contributor to ongoing work but as one who enacted reciprocity through

intergenerational knowledge sharing. Mundean articulated a parallel orientation toward return: "*Coming back here after college, I think, would probably be one of the most impactful things."* Both students named return and continuation as forms of reciprocity: giving back to the place and community that had shaped them. Joy described seeing peers working in parallel (one on fire prevention education, another organizing loʻi kalo (taro) restoration in Lahaina, another on invasive deer management) and positioned herself within that network: "*Now I'm seeing all these other people doing things and it feels like there's so many people that don't know this information and they need to know.*" Regeneration, for these students, was not a project with a completion date. It was a practice they had entered, and one they understood themselves as responsible for carrying forward.

Taken together, these three patterns: 1) Kuleana moving from articulated concept to embodied practice; 2) Grief becoming the foundation of political clarity, and 3) Practicing refusal for regenerating relationships, actually describe a single process— what it looks like when students are placed inside living obligations rather than solely taught about them. In the following discussion section, I explore these findings in relation to the literature and explain their implications for how we understand critical place-based learning in post-disaster contexts, with particular relevance to decolonial education, science education, and environmental education.

DISCUSSION

This study asks: How do high school students develop kuleana through participation in a critical place-based education program in a post-wildfire context? Two sub-questions guided this inquiry: what processes and experiences shape students' developing relationships to ʻāina, and how do students make meaning of their responsibilities to ʻāina and community in the aftermath

of the Lahaina fire. Three findings address these questions. In response to the first sub-question, kuleana did not develop through instruction but through conditions: repeated visits to a specific site, hands-on stewardship work, and relationships with kumu who embodied what they were asking students to practice.

In response to the second sub-question, students' grief over the Lahaina fire served as the affective ground from which critical thinking and political analysis grew. Together, these findings answer the overarching question: students developed kuleana by being placed inside conditions that allowed them to practice what they already felt. A third finding cuts across both sub-questions; students simultaneously refused the extractive land relations they could now name and practiced reciprocal relations through stewardship work. Together, these contributions argue that the conditions under which students develop genuine environmental responsibility are irreducibly relational, place-specific, and grounded in Indigenous ways of knowing.

Kuleana as Pedagogy: From Concept to Embodied Practice

Students in this study arrived with meaningful understandings of kuleana. They could define it, situate it in their families and communities, and articulate their obligations to land and people. This challenges a foundational assumption in environmental education: that developing environmental responsibility requires transmitting values or knowledge students lack. Bang et al. (2012) identify this deficit framing as endemic to science and environmental education, positioning students as empty vessels (Freire, 1970) rather than already embedded in knowledge traditions with epistemological authority. What the program created were conditions for that understanding and care to be practiced through repeated visits to a specific place, hands-on stewardship work that positioned students as collaborators rather than observers, and kumu who

modeled kuleana rather than taught it. Kuleana emerged from these conditions rather than being transmitted through them, confirming what Osorio (2021) and Saffery (2019) each communicate, that kuleana is enacted through sustained relational practice, not acquired through instruction.

One cultural practice that may have contributed to kuleana development and is worth theorizing specifically was students' repeated engagement with E Hō Mai[4], the oli (chant) led by the cultural practitioner and recited by everyone in the group before fieldwork at Kīpuka Malu. E Hō Mai is an "oli commonly used at the start of an event or small gathering to focus a group's energies and ultimately carry out the *kuleana* they have undertaken" (Kamehameha Schools. (n.d.). Several students named cultural protocols such as engaging in oli as especially meaningful for their field experiences at Kīpuka Malu. E Hō Mai is an act of giving a relational orientation to place that intends to shape how people engage with and understand the work that follows. If the oli created that orientation at the beginning of each visit, it represents a pedagogical mechanism that works through repeated relational practice.

However, not all students moved from articulating kuleana to enacting it with equal depth or pace. Students who showed minimal shift shared a pattern. They had the fewest existing community-cultural connections and the least prior experience with hands-on ecological work. This suggests that the conditions the program created, including repeated site visits, cultural practitioner mentorship, and hands-on stewardship work, as epistemological practice, are necessary but not always sufficient, particularly for students navigating the compounding disruptions characteristic of post-disaster contexts (Ronan & Johnston, 2005).

[4] E Hō Mai is an "*oli* (chant) commonly used at the start of an event or small gathering to focus a group's energies and ultimately carry out the *kuleana* (responsibility) they have undertaken" (Kamehameha Schools, n.d.).

From Grief to Political Clarity

How grief functioned as a vehicle for critical consciousness development in the Hoʻomalu ʻĀina Maui program is one of the most significant findings. In scholarship on young people's psychological and emotional responses to climate change and environmental crisis, Clayton (2020) documents the paralysis climate anxiety can produce; Ojala (2012a) shows that constructive hope develops through collective action. Both position the pedagogical task as converting distress into agency. What students in this study did was different: grief integrated rather than transformed, becoming the affective foundation of political analysis.

Understanding why requires the ontological framework Kameʻeleihiwa (1992) provides: ʻāina as elder sibling, humans born into accountability to land rather than educated toward it. Kanoa articulated this directly, drawing on what his uncle from Lahaina had taught him: "*Hawaiians believed that they came second to the land. The land is always first... So if they did something to mess it up, they go back and they fix it."* Within that framework, grief as a result of the harm inflicted on the ʻāina is not an emotional obstacle to overcome; it is the younger sibling's appropriate response to witnessing harm to the elder. When students understood the fire as the culmination of colonial land management, grief found its location within a relationship to ʻāina that predated the disaster and will outlast it. It did not need to be converted. It needed an outlet for action, and the program provided the historical and political analysis that gave it one (Ojala, 2012b). Hazlewood et al.'s (2023) concept of "hope-in-action," enacted through reciprocal obligation to land rather than generated through reassurance, captures this more precisely than frameworks that treat grief as a problem to be solved.

Freire's (1970) account of critical consciousness developing through praxis, the cyclical process of reflection and action in which understanding and doing are inseparable, describes a

related structure, but the route students traveled was specifically relational. For example, students felt grief at the harm being done to ʻāina, which led to the historical analysis of cause, and ultimately the reciprocal practice/action as response. The land was the through-line, not an abstract political system and that distinction matters for understanding the conditions under which critical consciousness develops in place-based Indigenous contexts.

Watts et al.'s (2011) sociopolitical development theory offers a useful framework for understanding the progression students demonstrated across the program year from accepting environmental conditions as natural and inevitable to naming their structural causes to orienting their action toward changing them. What this study contributes to that framework is evidence of what drives that progression in place-based Indigenous contexts: not formal instruction in critical theory but grief, embodied practice, and sustained relationship with a specific ʻāina and community. Land was the catalyst for sociopolitical development.

Diemer and Li (2011) distinguish between critical reflection, the capacity to analyze structural forces shaping one's community, and political efficacy, the belief that one can actually act on that analysis to change those conditions. Both are necessary components of critical consciousness development, and both are visible in this cohort. The students who proposed structural interventions, changes to water law, land use policy, and disaster recovery funding, were demonstrating political efficacy: the conviction that the decisions Bob named, the structures Keoni identified, and the displacements Jessie witnessed are not fixed features of the world but conditions that can be contested and changed. That this conviction emerged through embodied engagement with ʻāina rather than through civic education instruction is significant. It suggests that political efficacy, like kuleana, develops not through being taught but through being placed inside the conditions that make it necessary.

Relational Accountability as Regenerative Refusal

In the previous section, kuleana was established as a form of accountability constituted through relationship rather than produced through pedagogy. For students with Kānaka ʻŌiwi heritage or deep community ties, the epistemological refusal that deepened across the cohort started before the program began. Janelle's interruption in the September focus group, refusing the framing of Kānaka ʻŌiwi and Western knowledge as complementary before formal program participation, was not the program's product. It was already present. That it spread and deepened across the cohort points to something the program made possible to practice more widely, but the authority for that refusal was relational and genealogical, not pedagogically produced by the program. Vaughn (2022), a Kānaka ʻŌiwi feminist scholar, writes about building educational pathways for Pacific Islander students in higher education and argues that kuleana derives from relational and genealogical accountability rather than institutional design. She states that kuleana does not generate accountability so much as express the accountability that genealogical relationships already require. Programs that treat kuleana as something to be uniformly developed risk flattening this distinction and reproducing the universalism they intend to resist (Osorio, 2021).

The physical land stewardship work enacted what Chazan and Baldwin (2021) call regenerative refusal: simultaneously refusing settler-colonial logics and regenerating Indigenous relationships, knowledges, and futures. Critically, refusal and regeneration were not staged sequentially; students did not first develop critical consciousness and then act on it. They practiced both simultaneously, removing what harms the land and restoring what sustains the land. Simpson (2014) argues that land-based resurgence is the practice of decolonization, not its

aspiration. Tuck and Yang (2012) insist that decolonization requires material enactment, not metaphor. The findings demonstrate this at the level of student experience: critical consciousness of colonial land relations and practice of reciprocal stewardship developed as one movement, each requiring and deepening the other.

Figure 3.3

Students and Community Partners Planting Native Species at Kīpuka Malu, Olowalu, Maui

Regenerative refusal positions students as inheritors of responsibilities with authority, people already embedded in obligations that predate them, whose agency consists not in acquiring new consciousness but in practicing what those obligations require. Students who

understood themselves as younger siblings to ʻāina, carrying kuleana, were not recipients of a critical place-based education program. Students were part of something larger than any education program, or any disaster for that matter, can contain.

Implications for Critical Place-Based Education, Policy, and Indigenous Contexts

Existing frameworks for critical place-based education and post-disaster learning share a foundational assumption, that the educational program's work is to develop something students currently lack: critical consciousness, environmental responsibility, and a sense of place. This study complicates that assumption. When accountability to land is ontologically constituted rather than pedagogically produced, and when grief is a relational response rather than an obstacle to agency, the frameworks that treat programs as the source of students' environmental consciousness miss what is actually happening. What is needed, and what this study begins to theorize, is a framework that asks not what students need to develop but what obligations already exist, in the land, in the community, in genealogical relationships, and what it would take for students to practice them more fully.

The Hoʻomalu ʻĀina Maui program's effectiveness was inseparable from its relational structure, a Kānaka ʻŌiwi cultural practitioner teaching from Kānaka ʻŌiwi epistemology, a biocultural conservation biologist working across knowledge frameworks, a nonprofit rooted in cultural revitalization and land stewardship, and a teacher who modeled hope and possibility for students navigating disaster's aftermath. These are not replicable design features. They are relationships between people, place, and knowledge that took years to build. The curriculum is inseparable from the community within which it operates.

What this study ultimately argues is that critical consciousness and regenerative land relationship are not two outcomes a program can aim to integrate. They are the same thing. Kuleana is consciousness. Consciousness is practiced through relationship. Relationship is the ground from which refusal and regeneration grow. The Hoʻomalu ʻĀina Maui program did not teach this. It created conditions in which students could discover what was already alive within them.

A longitudinal curriculum design sustained over multiple years, with ongoing mentorship from cultural knowledge holders, is likely required for the deepest transformations. The question of the extent to which relational engagement is needed, and what prior conditions facilitate or impede it, remains an important direction for future research.

Findings from this study also carry implications that extend beyond program design into policy. When students like Bob can identify that disaster recovery funding flows toward infrastructure that serves commercial and tourism interests rather than communities, when students like Helena can trace plantation-era water diversion to present fire risk, and when students like Jessie can name housing displacement as a political choice rather than an economic inevitability, they are demonstrating a level of structural analysis that environmental and education policy has not yet learned to honor or act on. These findings demand that policymakers take seriously the following: that disaster recovery funding must be accountable to the communities most devastated, not the infrastructure most profitable; that water law in Hawaiʻi must reckon with the colonial history of diversion and its ongoing ecological consequences; that affordable housing and Indigenous land rights are environmental justice issues inseparable from wildfire vulnerability; and that civic education must create genuine pathways for young people to act on the political clarity they already carry, rather than teaching them, as Keoni so precisely

named it, "*not to make a ruckus*". Environmental education that stops at ecological facts and never reaches these structural realities is not neutral. It is complicit in maintaining the conditions that produced the Lahaina fire in the first place.

While the Hoʻomalu ʻĀina Maui program cannot be replicated, as its effectiveness was inseparable from the specific relationships, place, and community that made it possible, the orientations that shaped its design and implementation can be carried over to other contexts. Table 3.6 offers not a replication guide but a set of commitments that educators, program designers, and researchers working toward community-engaged land-based education can orient themselves around, regardless of place or context.

Table 3.6

Orientations for Educators Moving Toward Community-Engaged Land-Based Education

Orientation	What this looks like in practice
Build relationships before curriculum	Seek out and compensate cultural practitioners, community members, and knowledge holders as genuine partners before designing any program activities. Relationships are the infrastructure and the condition under which the work becomes possible.
Start with what students already carry	Design from students' existing knowledge, lived experience, grief, and political consciousness. These are the most generative raw material for learning.
Create conditions for embodied practice	Create opportunities for students to fully engage with real work in specific places rather than solely delivering content about those places.
Commit to the long work	Sustained engagement across multiple years is needed for the deepest transformations.

CONCLUSION

This study set out to understand how high school students develop kuleana through participation in a critical place-based education program in a post-wildfire context. What we found was that kuleana did not develop through instruction but through repeated visits to a specific place, hands-on stewardship work that positioned students as collaborators in ongoing restoration work, and relationships with kumu who modeled kuleana rather than taught it. Students' grief about the Lahaina fire became the affective foundation for political analysis rather than an obstacle to it, and students simultaneously refused extractive land relations and practiced reciprocal ones. Together these findings argue that the conditions under which students develop genuine environmental responsibility are irreducibly relational, place-specific, and grounded in Indigenous ways of knowing.

What this study ultimately argues is that another kind of environmental education is both possible and necessary; one organized not around what students lack but around what obligations already exist in the land, the community, and the relationships that connect them, and what it would take to build the conditions under which students can practice those obligations more fully.

CHAPTER 4. "*THEY DID NOT CALL IT SCIENCE BACK IN THE DAY, IT WAS JUST BEING KĀNAKA*": HIGH SCHOOL STUDENTS' ʻĀINA-BASED LEARNING AND EPISTEMIC AUTHORITY IN HAWAIʻI

INTRODUCTION AND BACKGROUND

"*They did not call it science back in the day. Just being Kānaka was science.*"

— Koa, cultural practitioner, Kīpuka Malu, November 2024

What students learn to see when they look at the natural world depends on what their education has taught them to notice, value, and ask (Bang et al., 2012; Bang & Medin, 2010; Tuck et al., 2014). In the United States, K-12 science education has been shaped by, and largely continues to serve, the same colonial, capitalist, patriarchal, white supremacist structures that dispossessed Indigenous peoples of their lands, suppressed their languages, criminalized their practices, and systematically dismantled the knowledge systems and governance structures through which they sustained relationships with their homelands across generations (Smith, 2012; Tuck & Yang, 2012; Wynter, 2003). Science education has not simply failed to include Indigenous ways of knowing in curricula; it has been intentionally designed, alongside boarding schools, land seizures, and language bans, as a mechanism for replacing those ways of knowing with ones that served extraction, accumulation, and colonial control (Cajete, 2020b; Medin & Bang, 2014). Colonialism is not historical. It continues in every science classroom that treats Western knowledge as the dominant framework for understanding the natural world (Ladson-Billings, 1995a; Kayumova & Strom, 2023; Charles & Cajete, 2020b; Deloria & Wildcat, 2001).

Because science education sits at a complex intersection of culture, history, justice, and power, it has perpetuated exploitative paradigms by failing to challenge dominant Western assumptions or disrupt colonial narratives that separate humans from nature. This human-nature

disconnect has constrained science curricula from effectively preparing students not only to address intensifying climate crises but also to cultivate the ontological and axiological orientations necessary to understand the environment as more than a resource to extract or a landscape to be managed (Beery et al., 2023). Hawai‘i offers a particularly stark example of how these dynamics have unfolded.

This study centers on the Ho‘omalu ‘Āina Maui (protecting the land of Maui) program, a community-based participatory research (CBPR) (Israel et al., 2013) initiative I co-developed with a high school ecology teacher, a Kanaka ‘Ōiwi[1] biocultural conservation biologist, an education researcher, and staff members at the nonprofit Kīpuka Malu (described below) which include a Kanaka ‘Ōiwi cultural practitioner, a program manager, a communications and outreach coordinator, and an executive director. Ho‘omalu ‘Āina Maui was co-created in response to the August 8th, 2023, Lahaina wildfire. During the 2024-2025 school year, high school students engaged in hands-on wildfire mitigation and land stewardship at Kīpuka Malu, a 75-acre ‘āina stewardship and cultural revitalization nonprofit located 7 miles south of Lahaina. Drawing on audio-recorded field observations, pre- and post-program interviews, and a student-produced documentary film, this study explores the following research questions:

1. *How do students engage with the ontological and axiological dimensions of Kānaka ‘Ōiwi biocultural knowledge during ‘āina-based stewardship, and how do those engagements shift over the course of a one-year program?*
2. *In what ways does the epistemic authority and modes of knowledge sharing among program partners shape students’ experiences, and what tensions emerge when Kānaka ‘Ōiwi and Western knowledge systems are present in the same learning context?*

[1] I intentionally use “Kānaka ‘Ōiwi” throughout this study rather than “Hawaiian,” as the latter is an English term that represents a Western perspective of the Indigenous people of Hawai‘i (Louis, 2017, p. xv).

Findings reveal that students' ontological and axiological orientations shifted meaningfully across the program year; that epistemic authority was distributed across a constellation of knowledge holders whose collective presence created conditions no single educator could have produced alone; and that even within this carefully designed, relationally grounded program, structural tendencies toward Western epistemic legitimation persisted in how knowledge was sequenced and validated. These findings argue that centering Indigenous epistemologies in science education is not a curricular design challenge but a relational one; the infrastructure must be built first. Implications follow for ʻāina-based program designers, CBPR practitioners, and science education researchers.

THEORETICAL FRAMEWORKS

ʻĀina, Knowledge, and Colonial Disruption in Hawaiʻi

Kānaka ʻŌiwi scholars and practitioners have long argued that the health of ʻāina (land) cannot be separated from the health of Kānaka ʻŌiwi knowledge systems; that the displacement of one has historically enabled the degradation of the other (Kameʻeleihiwa, 1992; Goodyear-Kaʻōpua et al., 2014; Whyte, 2018). Colonial restructuring of Hawaiʻi — the Great Māhele of 1848[5], the overthrow of the Kingdom of Hawaiʻi (1893), plantation agriculture, the forced diversion of waterways — did not only dispossess Kānaka ʻŌiwi of land. It systematically dismantled the conditions under which biocultural knowledge is generated, transmitted, and kept alive. Suppression of ʻŌlelo Hawaiʻi (the native language of Hawaiʻi) in schools severed a language that encodes ontological relationships to land (Oliveira & Wright, 2015). Additionally,

[5] The Great Mahele of 1848 dismantled the feudal system and gave rise to an allodial system of land tenure. Private ownership of most of the property in Hawai`i began with the Great Mahele (Chinen, 1978).

the displacement of ʻāina-based practices including loʻi kalo (taro) cultivation, lokoʻia (fishpond) stewardship, and ahupuaʻa (traditional division of land that typically extends from the mountain to the sea) water management, eliminated the embodied contexts through which axiological orientations toward land are transmitted across generations (Goodyear-Kaʻōpua, 2016). What colonial institutions targeted was the relational, epistemological, and ethical frameworks through which Kānaka ʻŌiwi understand themselves as accountable to land, water, and other-than-human kin **(**Kameʻeleihiwa, 1992; Meyer, 2008; Saffery, 2019). Considering these frameworks have survived through deliberate resistance, language revitalization, and the continuity of cultural practice across generations, is itself a testament to the depth of Kānaka ʻŌiwi knowledge sovereignty and the strength of the resistance (Goodyear-Kaʻōpua et al., 2014; Kameʻeleihiwa, 1992).

This disruption was intentionally epistemic. Colonial institutions, including schools, actively positioned Western ways of knowing as universal and Kānaka ʻŌiwi knowledge as local, supplementary, or pre-scientific, embedding epistemic hierarchy into the very structures through which the next generation learned to see the world (Goodyear-Kaʻōpua, 2016; Wynter, 2003; Bang et al., 2012; Silva, 2004). When the August 8th, 2023, Lahaina wildfire occurred, it made the consequences of this layered dispossession visceral. This disaster was shaped not only by drought and hurricane-level winds but by a century of colonial land management (Trauernicht et al., 2015). This fire was the result of the same colonial processes that separated land from knowledge, and knowledge from the communities whose survival depended on both.

Indigenous and Western Knowledge in Conversation: Existing Scholarship and Its Limits

A growing body of scholarship has explored how Indigenous and Western knowledge systems can be integrated in K-12 science and environmental education (Chinn & Nelson-Barber, 2023; Kimmerer, 2002). Barnhardt and Kawagley (2005) established that Indigenous knowledge systems represent complete and sophisticated sciences in their own right, not supplements to Western science but epistemologically distinct ways of knowing that deserve equal credibility. Two-Eyed Seeing (Bartlett et al., 2012; Hatcher et al., 2009) is a framework that has offered one model for holding Indigenous and Western knowledge in parallel, drawing on the strengths of each without undermining either. Marin and Bang (2018) showed how land-based, relational learning contexts activate ways of knowing that western science instruction cannot grasp. In Hawai‘i specifically, scholarship has documented how biocultural and ‘aina-based education supports Kānaka ‘Ōiwi students’ academic engagement and cultural identity (Goodyear-Ka‘opua, 2013; Kana‘iaupuni & Malone, 2006), and how ‘āina-based education functions as both cultural perpetuation and political resistance (Saffery, 2019; Taira & Maunakea, 2022; O’Neill et al., 2023). This body of work has been generative for building frameworks for curriculum design and documenting outcomes for Indigenous learners (Goodyear-Ka‘opua, 2013; Wooltorton, 2023).

Yet most of this scholarship explores knowledge integration at the level of curriculum, pedagogy, or measured outcomes; e.g., what is designed, what is taught, what students demonstrate having learned (Miller et al., 2018). Far less attention has been paid to the ontological and axiological dimensions of what happens when students actually engage with Indigenous knowledge in practice (Bang, 2017). For example, how their relationships to knowledge itself shifted, what it felt like to navigate between frameworks that carry different

assumptions about what is real and what structural forces shaped that navigation, even in contexts explicitly designed to honor multiple ways of knowing. This study enters that space.

Epistemology, Ontology, Axiology, and Epistemic Authority: A Conceptual Framework

This study analyzes student engagement with Kānaka ʻŌiwi biocultural knowledge across three analytically distinct but inseparable dimensions. *Epistemology* asks how we know what counts as evidence, what forms knowledge takes, and who produces it. *Ontology* asks what kind of world we inhabit, what entities within it have standing and agency, and what relationships are real. *Axiology* asks what values shape how we act on what we know (Kayumova & Strom, 2023). These three dimensions cannot be examined in isolation. As Escobar and Frye (2020) argue through the concept of pluriversality, different knowledge systems do not simply offer different perspectives on one shared world; they carry different worlds, structured by different ontological assumptions and enacted through different values and relationships. This is what Cajete (2020) means when he writes that Native science is born of lived and storied participation with the natural landscape: not an alternative methodology for investigating the same reality, but a way of being in relationship with a reality that Western science, in its dominant forms, does not recognize as real. Bang (2020) argues that genuine transformation in science education requires engaging this heterogeneity (diversity of perspectives) at all three levels rather than domesticating Indigenous knowledge into epistemological terms alone; a move that preserves the appearance of inclusion while limiting deeper engagement.

In Kānaka ʻŌiwi practice, these three dimensions are transmitted through forms such as Moʻolelo (story, genealogical account, narrative of place) (Oliveira & Wright, 2015; Lipe, 2018; Wilson-Hokowhitu, 2019), protocol (asking permission to enter a space), and oli (for example

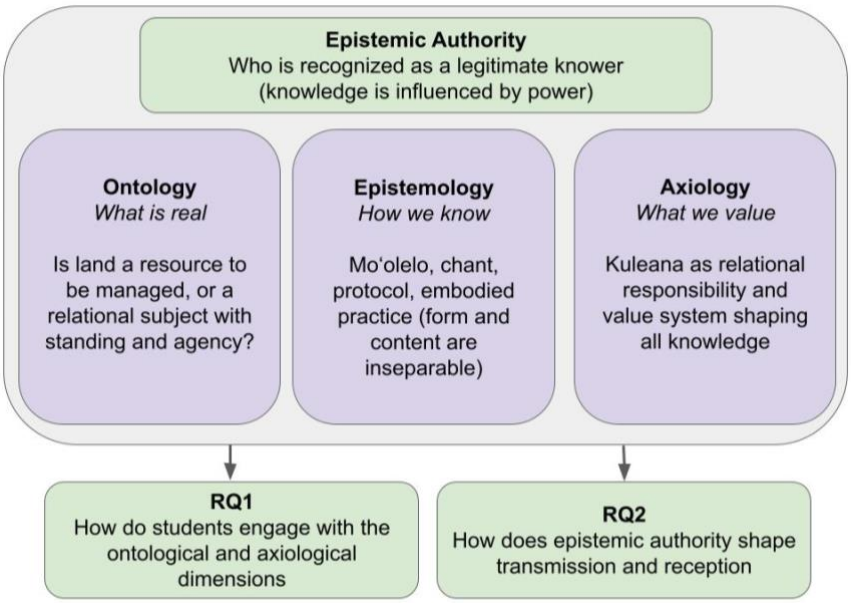
chanting while planting a seed). Lopes (2018) describes this as knowledge that must be inhabited rather than acquired, a distinction with direct consequences for what cultural practitioners do when they teach and what students are able to receive.

This is where epistemic authority becomes important. Epistemic authority names the recognized right to transmit particular knowledge, in particular contexts, to particular people (McCready & Winterstein, 2017). In Kānaka ʻŌiwi culture, that authority is not conferred by institutional credentialing; it is earned through decades of embodied practice, cultural ordination, and relational accountability to a lineage of knowledge holders (Goodyear-Kaʻōpua, 2013; Lopes, 2018). When that authority enters a formal educational setting, it meets a structure built around entirely different criteria of legitimacy, credentialed teachers, academic degrees, and peer-reviewed knowledge (Latulippe & Klenk, 2020). Fricker (2007) identifies testimonial injustice as what occurs when a knower's epistemic authority is not seen as credible. When they are not recognized as a credible source and the knowledge they carry is rendered invisible as a result. In formal educational settings, this is a structural condition: schools recognize credentialed teachers, degrees from academic institutions, and peer-reviewed knowledge, while the authority of cultural practitioners operates through entirely different criteria of legitimacy (Latulippe & Klenk, 2020). Kidd, Medina, and Pohlhaus (2017) name this hermeneutical injustice the condition in which the conceptual resources available in a given context are inadequate to recognize or make sense of a particular kind of knowing. Most high school students attending a public school in the U.S. do not arrive on a field trip fully equipped to receive what an ordained cultural practitioner carries. Understanding what that transmission involves and what structural conditions shape whether and how students can receive it requires analytical tools that can account for the epistemological, ontological, and axiological dimensions

of what is being shared, as well as the question of whose knowledge is recognized as credible and authoritative in a given context. These four concepts — epistemology, ontology, axiology, and epistemic authority — together structure the analysis that follows (see Figure 4.1).

Figure 4.1

A Framework for Analyzing Epistemic Authority and Knowledge Engagement in Kānaka ʻŌiwi ʻĀina-Based Education



Note. Conceptual framework draws on Kayumova & Strom (2023), McCready & Winterstein (2017), Fricker (2007), and Tuck & McKenzie (2015a).

Key terms essential to this analysis include the following:

Table 4.1

Key Terms

KEY TERM	DEFINITION

Kānaka ʻŌiwi Epistemologies	Kānaka ʻŌiwi epistemology encompasses the ways knowledge is attained, retained, and communicated within Kānaka ʻŌiwi culture. Knowledge has a spiritual, ʻāina-based, and relational dimension; learning is an active, oral, and experiential process in which thinking and feeling are not separate, and intelligence is grounded in relationship to land, ancestors, and community (Meyer, 1998, pp. 22-26).
Biocultural Knowledge	Interconnected knowledge, practices, and beliefs of Indigenous peoples regarding their reciprocal relationships with the natural environment, acquired through generations of place-based interaction (Morishige et al., 2018; Dudgeon & Berkes, 2003).
Epistemology	Knowledge is influenced by power, and there are multiple ways of knowing that hold value. (Tuck & McKenzie, 2015a, pp. 77-78; Lather, 2006, pp. 37-39).
Ontology	The truth is that reality is structured by arrangements of power that require social change. (Tuck & McKenzie, 2015a, pp. 77-78; Lather, 2006, pp. 37-39).
Axiology	Knowledge and values are inextricably linked. (Tuck & McKenzie, 2015a, pp. 77-78; Lather, 2006, pp. 37-39).
Epistemic Authority	The credibility and standing we grant speakers as sources of knowledge. It's not just about whether someone *has* knowledge, but whether they are *recognized* as having it by others (McCready & Winterstein, 2017; Fricker, 2007).
Relational Epistemologies	Relational epistemologies recognize all entities, human and more-than-human, as related and interconnected in mutually reciprocal, dynamic, and always-becoming, relationships that shape the sources, scope, and validity of knowledge and knowledge making (Cajete, 1999; Pugh et al., 2019)

METHODOLOGY

This study is grounded in community-based participatory research (CBPR), an approach that positions community members as co-investigators and treats the research process itself as a form of community benefit (Israel et al., 2013; Minkler & Wallerstein, 2011). CBPR shaped this study from the outset, beginning with the research questions themselves. Early in the planning process, I proposed a research focus oriented around climate anxiety. Carrie declined. She made it clear that she did not want the research to center on anxiety and redirected us toward resilience as the animating frame. That intervention shaped the research questions, the program's pedagogical orientation, and ultimately the findings of this study. It is one of the clearest examples of what community accountability looked like in practice in this project, a community partner exercising genuine authority over the terms of the work.

All program partners signed memoranda of understanding outlining their roles and received financial compensation for their contributions, reflecting a genuine commitment to equitable partnership. In practice, however, CBPR partnerships rarely achieve perfect symmetry across all dimensions of the research process (Israel et al., 2013). In this study, nonprofit staff were deeply engaged as co-facilitators of the program itself; their cultural knowledge, land stewardship expertise, and relationships with students were irreplaceable and central to everything the program made possible. A full research partnership was the intention from the outset, and financial compensation was provided to support participation. In practice, the demands of running a nonprofit engaged in active land stewardship meant that partners' engagement with the formal dimensions of the research process was more limited than originally envisioned. This is not a reflection of their commitment but of the real capacity constraints that

community-based organizations navigate alongside research partnerships. This distinction between program partnership and research partnership is one this study holds honestly, recognizing that different partners contributed different forms of expertise at different stages, and that the relational trust built through program collaboration was itself a form of research infrastructure.

Hoʻomalu ʻĀina Maui was co-developed in response to the 2023 Lahaina wildfire as a CBPR initiative grounded in the conviction that centering Kānaka ʻŌiwi biocultural knowledge in a public school science context is not a curricular design challenge but a relational one that requires building infrastructure first.

Table 4.2 presents the program's theory of change across four interconnected dimensions (ecological, relational, epistemological, and political).

Table 4.2

Hoʻomalu ʻĀina Maui Theory of Change

Dimension	Problem/Context	Program Response	Activities	Intended Outcomes
Ecological	The 2023 Lahaina wildfire resulted from settler colonial land transformations that displaced Kānaka ʻŌiwi land management systems, introduced invasive species, and disrupted integrated watershed systems	A community-based participatory research program co-developed with a high school ecology teacher, a Kānaka ʻŌiwi biocultural conservation biologist, and Kīpuka Malu, a watershed stewardship and cultural revitalization nonprofit	Four field visits to Kīpuka Malu involving hands-on wildfire mitigation and land stewardship	Students develop kuleana through embodied engagement with ʻāina

Dimension	Problem/Context	Program Response	Activities	Intended Outcomes
Epistemological	K-12 science education in Hawai‘i largely operates from Western epistemologies that marginalize Kānaka ‘Ōiwi knowledge systems	Program design centers Kānaka ‘Ōiwi epistemic authority through a constellation of knowledge holders with distinct and complementary forms of expertise	Cultural protocol, oli, and mo‘olelo led by an ordained Kānaka ‘Ōiwi cultural practitioner	Students engage with the ontological and axiological dimensions of Kānaka ‘Ōiwi biocultural knowledge
Political	Young people in post-disaster contexts often lack the historical and political frameworks to understand what created conditions for disaster	Research design that foregrounds students' existing knowledge, lived experience, and critical consciousness as foundational rather than deficient	Pre- and post-program surveys and interviews, ethnographic observation, and student-produced documentary film	Students develop critical consciousness of the colonial forces that created conditions for the Lahaina fire
Relational	Environmental education programs often treat Indigenous knowledge as supplementary to Western science rather than as epistemologically distinct and authoritative	Relational infrastructure built through sustained, reciprocal partnership preceding and exceeding the program year	Collaborative data analysis, vegetation assessments, and student-led documentary film production	Students recognize Kānaka ‘Ōiwi knowledge as foundational rather than supplementary to Western science

Note. This theory of change reflects the program's pedagogical logic across cognitive, relational, epistemological, and political dimensions. Outcomes are not sequential but mutually reinforcing.

Researcher Positionality

I approach this research as an ally. I am a white scholar with deep gratitude for and accountability to the Maui community that shaped my understanding of critical place-based education and Kānaka ‘Ōiwi Ways of Knowing. I lived and worked in Maui for five years (2017-

2022) as an environmental educator. Among the numerous educational institutions where I taught was the charter school where this research takes place. At the time of data collection (2024-2025 academic year), I was a doctoral student at UC Davis pursuing a PhD in Science Education with a Designated Emphasis in Native American Studies, which provided formal training in Indigenous research methodologies, decolonial theory, and critical engagement with settler colonialism. My positioning, as both a former teacher with established community relationships and a white settler researcher from a mainland institution, shaped every aspect of this work. I navigated this tension by remaining reflexive, maintaining relationships built over time, and by centering students' voices.

METHODS

Hoʻomalu ʻĀina Maui was a collaborative effort involving multiple program partners, each bringing distinct expertise and relational responsibilities to the work at Kīpuka Malu. Table 4.3 describes each partner's role across the four field visits.

Table 4.3

Hoʻomalu ʻĀina Maui Program Partners and Roles

Partner	Organization	Role in program	Primary responsibility during field visits
Koa	Kīpuka Malu	Kanaka ʻŌiwi cultural practitioner	Led opening protocol, oli, moʻolelo, and other cultural teachings
Tara	Kīpuka Malu	Project manager	Led hands-on land stewardship and wildfire mitigation activities
Leilani	Kīpuka Malu	Communications and outreach specialist	Point person for communicating about the planning of field visits and supported land stewardship activities

Waiola	Legacy Land Stewardship	Kanaka ʻŌiwi biocultural conservation biologist	Supported the students' vegetation assessments, gave in-class presentations, and supported field visits
Carrie	South Maui Charter School	Field ecology teacher	Supported all program activities; coordinated student participation, led all in-class instruction
Jadda	University of California, Davis	Researcher	Supported all program activities while conducting ethnographic observations, surveys, and interviews

Participants

Twenty-four high school students participated in the Hoʻomalu ʻĀina Maui program across two cohorts: a Field Ecology class (n=17) and an Eco Club (n=7). Four Field Ecology students joined in December 2024 and completed pre-program interviews and pre-program surveys in January 2025. Over the course of the year, four students left the program for personal reasons, and 20 students completed the full program year. For this study, 23 students completed the pre-program survey, and 22 completed individual or focus-group pre-interviews. At the close of the program year, 19 students completed individual post-program interviews; one Eco Club student was unable to meet due to scheduling constraints. Sixteen students completed the post-program survey; three Eco Club students and one Field Ecology student did not. Pre-post interview comparison therefore draws on 19 students, while pre-post survey comparison draws on the 16 students who completed both pre- and post-surveys. Students were eligible to participate in Hoʻomalu ʻĀina Maui if they were enrolled in either the Field Ecology class or the Eco Club. All participation is voluntary, and written informed consent (Bloomberg, 2022) was obtained from both students and their parents/guardians. I use pseudonyms throughout this study when referring to participants to protect individuals' identities, in accordance with protocols for

ethical research with human subjects and guidance from the UC Davis Institutional Review Board. This study received IRB approval from UC Davis and additional approval from the charter school administration. Table 4.4 presents selected demographic characteristics of the student survey respondents. Rather than selecting focal students, all 24 students from both groups were invited to participate in this study. Students participating in the Hoʻomalu ʻĀina Maui program, reflect the broader demographic diversity of Maui with only three students identifying as Kānaka ʻŌiwi.

Table 4.4

Demographic Characteristics of Hoʻomalu ʻĀina Maui Student Participants (n=23)

Category	Student Responses
Race	
Filipino	3
Japanese	1
Black or African American	2
Native American, Alaskan Native, First Nations	2
Chinese	3
Native Hawaiian (Kānaka ʻŌiwi)	3
Latinx/e	8
Pacific Islander (e.g., Samoan, Guamanian, Micronesian)	2
White	18
Gender	
Non-binary/third gender	1

Male	5
Female	17
Languages Other than English Spoken at Home	
Prefer not to say	1
Hawaiian (ʻŌlelo Hawaiʻi)	1
Only English	16
"Other" responses included:	
Spanish	3
Korean	1
Pidgin	1

Note. Students could select as many racial categories as they preferred.

Table 4.5 presents individual demographic information for the students whose voices and perspectives are featured prominently in this chapter's findings. While all 24 students participated in the program, the students represented here contributed data that was particularly generative for addressing the study's research questions.

Table 4.5

Demographic Profiles of Students Featured in Findings (n=14)

Student Pseudonym	Gender Identity	Grade	Cohort (Field Ecology or Eco Club)	Race/ Ethnicity	Languages Other than English Spoken at Home
Ali	Female	Junior	Field Ecology	White	Only English
Bella	Female	Junior	Eco Club	White	Only English

Fall	Female	Junior	Eco Club	White	Only English
Helena	Female	Senior	Field Ecology	Native Hawaiian, Chinese, White	Only English
Joy	Female	Junior	Eco Club	White	Only English
Kanoa	Male	Senior	Field Ecology	White	Only English
Kay	Female	Senior	Both	Hispanic or Latine	Spanish
Kim	Female	Junior	Field Ecology	White	Only English
Lex	Female	Senior	Field Ecology	White	Only English
Michael	Male	Junior	Field Ecology	White	Only English
Mundean	Female	Junior	Eco Club	Hispanic or Latine, White	Only English
Myrna	Female	Junior	Eco Club	Filipino, White	Only English
Sarah	Female	Senior	Field Ecology	White	Only English
Solai	Female	Junior	Both	White	Only English

Data Collection

Data for this study were collected across the 2024–2025 academic year (August 2024 through May 2025) through three primary sources: audio-recorded field observations, pre- and post-program semi-structured interviews (Seidman, 2019) with students, and student-produced documentary film interviews. Students and their guardians were provided informed consent prior to data collection. I use pseudonyms throughout this study when referring to participants in order

to protect individuals' identities in accordance with protocols for ethical research with human subjects and guidance from the UC Davis Institutional Review Board.

Twenty-four students participated in the Hoʻomalu ʻĀina Maui program across two groups: a field ecology class and an Eco Club, both at South Maui Charter School. Four students joined partway through the year, completing pre-interviews in January 2025 rather than September 2024. Nineteen students completed both pre- and post-program interviews, providing the primary comparative dataset for examining how students' engagement with Kānaka ʻŌiwi biocultural knowledge shifted over the course of the program.

Pre- and Post-Program Semi-Structured Interviews

I conducted pre-program semi-structured interviews (Seidman, 2019) in September 2024 (and January 2025 for four students) prior to students' first field visit to Kīpuka Malu. Interviews were conducted individually or in small focus groups (Morgan, 1997) and asked students about their existing relationships to land, their prior knowledge of Kānaka ʻŌiwi cultural practices and ecological systems, and their understanding of if and how Kānaka ʻŌiwi and Western knowledge systems relate to and communicate with each other if at all. Post-program interviews were conducted in May 2025 following the completion of all four field visits, designed to surface shifts in students' ontological and axiological orientations, their recognition of epistemic authority, and their navigation between knowledge frameworks.

Example questions included:

1. How do you think combining different ways of understanding nature (like Traditional Hawaiian Knowledge and Western science) could help solve environmental problems?

2. How have historical practices on Maui, such as water diversion and plantation agriculture, shaped the environment and communities we see today, and what connections do you see between these past land management decisions and recent events like the Lahaina fire?
3. What knowledge or experiences do you bring from your family, culture, or community that might help us understand environmental issues differently?
4. Do you think there are important ways of knowing about the environment that aren't usually included in school? If so, what are they?
5. What do you think needs to be healed or restored in the relationship between people and the land here in Maui?
6. How do you feel about working with cultural practitioners like Koa on environmental projects? What do you hope to learn from these types of collaboration?

Interview questions were developed prior to the first field visit. As is common in qualitative research, the theoretical framework deepened through engagement (Braun & Clarke, 2021). Question 1's framing of Indigenous and Western knowledge as "combinable" reflects the analytical starting point rather than the argument the study ultimately develops.

Field Visit Audio Recordings and Ethnographic Observations

Four field visits to Kīpuka Malu were conducted across the academic year. Audio recordings captured the full arc of each field visit, from opening protocol to closing oli, providing a continuous record of practitioner teachings, student engagement, and the relational dynamics between knowledge holders and learners. Ethnographic observations (Emerson et al.,

2011) were written following field visits to document interpretive observations and emerging analytical questions.

Student-Produced Documentary Film

A fourth data source in this study emerged from within the program: a student-produced documentary film developed through a partnership with Maui Huliau (a local nonprofit dedicated to supporting youth with climate literacy and producing media). Students crafted their own narratives about the program, conducting on-camera interviews with each other and with program partners during the third field visit. Entire recorded interviews, not only the footage that made the final film, were included in the data corpus for this study. Some interview content analyzed here appears in the final documentary; other content was recorded during the same sessions but was not selected for the final cut. In both cases, the interviews were student-directed and self-authored, provided a voice and perspective that was distinct from my researcher-led interviews; participants were choosing what to say, to whom, and for what purpose.

Data analysis

Data analysis proceeded in four stages, moving between deductive framing and interpretive thematic development across the full data corpus: field visit audio recordings, pre- and post-program interview transcripts, documentary film interviews, and ethnographic observations.

Field audio and interview recordings were transcribed by myself and GoTranscript (a human-transcribed transcription service). Initial engagement with the data involved repeated reading of transcripts alongside listening to audio recordings, attending not only to what was said

but to tone, pacing, and the relational dynamics between speakers. This process of immersion in the data (Braun & Clarke, 2021) preceded any formal coding and was essential for developing the interpretive familiarity that thematic analysis requires.

Prior to coding (Saldaña, 2021), three analytical constructs were developed deductively from the conceptual framework. Construct 1 attended to ontological and axiological positioning, and to how students understood land, stewardship, and their obligations to the more-than-human world. Construct 2 attended to epistemic authority and how students perceived the knowledge their kumu (teachers) shared, what pedagogical approaches he used, and what students were able to connect to. Construct 3 attended to how students navigated between Kānaka ʻŌiwi biocultural knowledge and Western science when both were present in the same learning context. These constructs functioned as sensitizing concepts (Blumer, 1954), orienting the analysis toward dimensions of student engagement without ignoring what the data might show within or across them.

All transcripts were coded in Dedoose, a qualitative data analysis platform. Pre- and post-program transcripts for all nineteen students were read in full before coding began to ensure that each transcript was interpreted as a whole before individual passages were assigned constructs. Field audio transcripts were coded using the same construct framework, with particular attention to moments in which protocol, moʻolelo, oli, or moʻokūʻauhau (genealogy) teachings were shared and to how Koa and Tara framed the same site and the restoration work through different knowledge frameworks across field visits. Documentary film transcripts were coded using the same approach.

A supplementary analysis spreadsheet was maintained alongside Dedoose to track patterns across the full student dataset at pre- and post-program stages and noting the

developmental arc across the program year. This cross-case structure allowed for both within-case analysis (tracing a single student's trajectory) and cross-case comparison (identifying patterns across students with different prior relationships to Kānaka ʻŌiwi knowledge and ʻāina).

Throughout analysis, I documented interpretive decisions and moments of uncertainty in researcher memos in Dedoose. For example, I asked myself questions like: (1) Are there moments where my position as a former teacher, a white settler researcher, or a program co-developer is shaping what I am able to see or willing to claim?; (2) Am I representing this community in a way that serves them well?; (3) Am I honoring the trust this community placed in me? These questions did not resolve the tensions inherent in this kind of research, but they kept those tensions visible and productive across the full arc of analysis (Kovach, 2021; Pillow, 2003).

Collaborative Data Analysis

Two forms of community engagement shaped the analytical process. Carrie, the field ecology teacher and program co-designer, engaged in member checking, reviewing emerging findings and offering grounded feedback on their accuracy and resonance with her own observations across the program year. Additionally, as part of the program's participatory design, students engaged in a coding activity in which they reviewed and responded to anonymized excerpts from the dataset, coding them for constructs related to biocultural knowledge. While the constructs students used in this activity were not identical to the three analytical constructs organizing this study, the activity generated an additional layer of interpretive data about how students understood their own and each other's learning, and honored students as knowers of their own experience rather than only as participants.

Figure 4.2

Students and Carrie Collaboratively Coding Anonymized Interview Excerpts at South Maui Charter School, Kīhei, Maui

Findings are presented in the section below through a combination of thick description (Geertz, 2008) of key situated episodes and interpretive analysis tracing ontological, axiological, and epistemic dimensions. I present rich, contextualized accounts of what students and teachers said and did during field visits and interviews. Alongside this, I share an interpretive analysis that traces the ontological, axiological, and epistemic dimensions of those encounters across the program year.

My analytical process is summarized in Table 4.6 below (Harry et al., 2005).

Table 4.6

Overview of Analytical Procedures

Step	Procedure	Description
1	Transcription and immersion	Field audio and interview recordings transcribed by myself and GoTranscript a transcription service. Repeated reading and listening prior to formal coding to develop interpretive familiarity with the full data corpus (Braun & Clarke, 2021).
2	Deductive construct development	Three analytical constructs developed from the conceptual framework prior to coding, functioning as sensitizing concepts (Blumer, 1954) to orient analysis while not ignoring emergent patterns.
3	Construct coding in Dedoose	All transcripts coded at the construct level following reflexive thematic analysis procedures (Braun & Clarke, 2021).
4	Supplementary cross-case tracking	Analysis spreadsheet maintained to record construct presence and strength across all nineteen students at pre- and post-program stages, enabling within-case and cross-case comparison (Miles et al., 2014).
5	Cross-case pattern development	Pre- and post-interview data read together per student to trace developmental arcs (Stake, 2006). Students grouped across cases to identify patterns and contrast cases.
6	Community engagement	Member checking with Carrie (Creswell & Miller, 2000); participatory coding activity with students honoring them as knowers of their own experience (Smith, 1999; Israel et al., 2013).

FINDINGS

This study set out to answer two research questions: (1) How do students engage with the ontological and axiological dimensions of Kānaka ʻŌiwi biocultural knowledge during ʻāina-based stewardship, and how do those engagements shift over the course of a one-year program?; and (2) In what ways does the epistemic authority and modes of knowledge sharing among

program partners shape students' experiences, and what tensions emerge when Kānaka ʻŌiwi and Western knowledge systems are present in the same learning context? Findings reveal that students' ontological and axiological orientations toward ʻāina and knowledge shifted meaningfully across the program year, that epistemic authority was distributed across a constellation of knowledge holders whose collective presence created conditions no single educator could have produced alone, and that even within this carefully designed and relationally grounded program, structural tendencies toward Western epistemic legitimation persisted in how knowledge was sequenced and validated. Findings are organized around three constructs drawn from the conceptual framework: ontological and axiological positioning, epistemic authority and transmission, and navigating between knowledge systems. The findings section opens with an extended ethnographic vignette from the first field visit that places the reader inside the relational and pedagogical world the analysis then explores. Constructs 1 and 3 are each introduced through situated episodes drawn from field observations, while Construct 2 opens with an analytical overview of the five knowledge holders whose collective presence shaped students' experiences.

Vignette taken from ethnographic observations

It is early September 2024, and the high school students have arrived at Kīpuka Malu for the first time. Kīpuka sits seven miles south of Lahaina, in the Olowalu valley, where the Olowalu stream runs year-round, rare on this side of Maui, rarer still after a century of plantation-era water diversions. The students are mostly quiet. Some look up at the valley walls where the heiau (temple or place of worship) exist.

Our partners at Kīpuka Malu gather them before any other learning happens.

Figure 4.3

Koa, Tara, and Debi, Gather Students Around the Loʻi to Begin Protocol at Kīpuka Malu, Olowalu, Maui

Koa is a Kanaka ʻŌiwi cultural practitioner, ordained through thirty-six years of hula training under his kumu. He does not begin with an agenda or a safety briefing. He begins with protocol. He explains, simply, what they are about to do and why:

"*We always do protocol to start our day. We ask permission to do things. That is the one thing, from ancient times, that separates them from modern day. We used to always ask permission before we did everything. It shows being humbled and being willing to learn."*

Koa blows into a conch shell in the four cardinal directions, and the wind suddenly picks up. Koa then leads students through *E Ho Mai,* an oli commonly used at the start of an event or small gathering to focus a group's energies and ultimately carry out the kuleana (responsibility) they have undertaken (Kamehameha Schools, n.d.). Some students have a printout of the words. Some students mouth the words carefully. Some sing out. Some stand quietly, holding the paper, and just listen.

When it is over, Koa points to the valley walls. He names the heiau visible from where they stand: Luakini Heiau dedicated to Kū, and Lono Heiau dedicated to fertility and agriculture. He explains that the students will not be working near those sacred spaces today. But the work they are about to do — clearing invasive plants and restoring the stream corridors — is itself a form of honoring those nearby sacred places. "*We are improving the riparian corridors, so in other words we are honoring those spaces by making the area better."*

Then he tells them about kalo. He traces a genealogy: the stillborn child of sky father Wākea and earth mother Papahānaumoku, buried in the ground, becoming the first kalo plant. The next child born from that same union becoming the first human being. He explains ʻaumākua are ancestors who, when they pass, are deified into the natural world around them. Into waterfalls. Into certain rains. Into sharks and turtles. "*That means we all have ʻaumākua,* he says. *We have ancestors that are part of the natural world around us. That means that no longer is the Earth just a commodity."* Later, standing at the edge of the loʻi kalo (taro), he teaches them a

phrase: *He wai ola.* Living water. He asks them to say it together. They do. Some quietly, some with more confidence. He invites them to look at the water, to see how alive it is. Around them, damselflies move across the surface. Tadpoles. Algae. Snails. The stream that was diverted for sugarcane for sixty years is running again into the loʻi all the way down to the Olowalu reef.

At the end of the day, students fill pots with soil in preparation for planting native seeds. Koa teaches them a planting chant "*Ke kanu nei au*" which roughly translates to "I plant you in the ground" and has them perform it before any seed goes into any pot. He chuckles and frames this oli as an invitation by saying: "*My kumu* [teacher] *loves to make everyone feel invited to have culture in their life."* The students repeat the words back to him, voices uneven but trying nonetheless. Then they plant.

This is what the students walked into. The analysis that follows explores what they did with it.

Figure 4.4

Students Planting Native Species After the Ke Kanu Nei Au Chant at Kīpuka Malu, Olowalu, Maui

"Land is not a commodity. It is kin": Students' Ontological and Axiological Shifts

This vignette above shows what the field visits to Kīpuka Malu were like. What it does not show are the years of schooling, family practice, community knowledge, and political consciousness that each student carried with them into the program, the very factors that shaped how they engaged with the ontological and axiological dimensions of Kānaka ʻŌiwi biocultural knowledge, and how those engagements shifted across the program year. These factors are explored in the findings below, which highlight the students' and teachers' voices and perspectives.

At the second field visit in November 2024, Koa said, "*They did not call it science back in the day. Just being Kanaka was science."* This sentence makes the claim that Kānaka ʻŌiwi knowledge is not a different method for investigating the same reality. It is a different reality. One in which knowing and belonging to the land are not separate. This creates a different ontology when engaging in land stewardship compared to Western science.

Kanoa, a high school senior in field ecology, brought this ontological orientation with him to the program. Kanoa explained in his pre-program interview that he was *"[R]aised by my one-hundred percent Hawaiian uncle from Lahaina and his grandpa is from Niʻihau… he taught me the proper ways of the Hawaiian and what is right for Hawaiʻi"*. His uncle is a Kanaka ʻōiwi community leader whose foundation works to preserve traditional land and cultural practices for future generations. Before the program began, Kanoa said he had restored a heiau with his uncle over the course of a month. He knew the logic of giving and receiving not as a concept but as a lived practice.

Kanoa was a high school intern at Kīpuka Malu last summer. In his interview, he describes native forests as the following: "*Native plants, it's literally just harmony and peaceful. Invasive species make the ground toxic for each other, and they just fight it out."* When asked by his peers on camera during the student documentary why this work matters to him, he said:

"*The land around us is all taken over by invasive species right now, and bringing back the native species will help bring life back to our oceans and the rest of our land. Since the fires, I feel like a lot of people have come together more and started planting more native plants and realizing what our island truly needs."*

Restoration, according to Kanoa, is not habitat management. It is the recovery of a relational order that has been disrupted.

Joy, a high school junior in the Eco Club, arrived to the program with a particular view of how knowledge systems relate. In September 2024, during her pre-program interview, she valued Kānaka ʻŌiwi land practices and understood kuleana as a reciprocal obligation, but her

framework positioned the two knowledge systems in a clear hierarchy. She acknowledged the value of *"people tending the land and plant the loʻi and do all that and spend their lives doing that,*" but framed these practices as meaningful for "*people that want to take care of the land like that...because it's what's been in their family"* and "*it's their passion."* For Joy, Kānaka ʻŌiwi land practices were culturally significant and personally meaningful, something families carry forward by choice. Western science, by contrast, was where real problem-solving lived: *"if we actually want to solve issues, we need bigger solutions."* However, Joy's axiological orientation changed over the course of the year. By May 2025 in her post-program interview, she said: "*In Hawaiian culture, they didn't have to come up with solutions. It wasn't a solution. It was just how it was, and they knew what would be bad, and they didn't do that. They were sustainable from the beginning."* She is no longer describing Kānaka ʻŌiwi knowledge as a complement to Western problem-solving. She is recognizing that it operated in an entirely different ontological mode.

Kay, a field ecology high school senior, more directly names what Joy's framing was alluding to: "*How ahead Native Hawaiians were of their time... why did we ever lose sight of that? They* [colonists] *saw how well everything looked and chose to take over without noticing how well it was working."* The word "*chose*" is significant. She is not describing a gap in Western knowledge or an unfortunate historical accident. She is naming a decision, the active colonial *choice* to displace a knowledge system that was working.

Fall, a high school junior in the Eco Club, enters the program already processing Kānaka ʻŌiwi knowledge through a Western scientific frame. In her pre-program interview, discussing the willy willy tree and tiger shark phenological correlation, she says: *"They didn't know the science explanation behind it, but they knew what they needed to know."* She respects Kānaka

‘Ōiwi knowledge. She makes room for it by noting that Western science can now explain the mechanism. This is her pre-program perspective. By May 2025, this framing had shifted. She says: “*The ancient Hawaiians knew so many things that science today is now discovering and backing up.”* Here we can see that the direction of authority has shifted. Knowledge that Fall once understood as meaningful but in need of scientific validation now stands on its own terms. Not because Western science has been discarded, but because it is no longer the sole arbiter of what matters. This is what ontological reorientation looks like in practice: not a rejection of Western science, but a recognition that Kānaka ‘ōiwi knowledge has always been equally valid and rigorous on its own terms.

“*The Ecology of a Place Really Is the People”:* Stewardship as Kuleana

At the field visit in September 2024, Koa names what Western science lacks: “*When you have these ecological knowledges as part of your ancestry, there is a value system to that and that’s different. Science doesn’t necessarily have the value system, which is really important now than ever.”* This is not a critique of Western science’s methods. It is a critique of its axiology, or rather, of its absence of one. Additionally, it is what Koa named explicitly when interviewed by students for their documentary film, connecting the axiological claim directly to the Lahaina fire:

“*The ecology of a place really is the people. It’s really important that we get people to engage, go do something to make it a better world. The fire of Lahaina was a perfect example of this; my entire neighborhood was impacted severely, and the entire community below me is gone. We are bringing it back one person at a time. It’s not about the buildings; it’s the people coming back.”*

Koa is naming the axiological core of what he teaches. When he says, "*the ecology of a place really is the people,"* he is stating an ontological fact that Western science education, in its separation of human and natural systems, has systematically obscured. In his framing, the Lahaina fire is not primarily an ecological event that affected people. It is a rupture in the relationship between people and place, and restoration means the return of that relationship, not the reconstruction of buildings. This is what distinguishes Kānaka ʻŌiwi stewardship from Western land management at its most fundamental level: the goal is not solely about ecological stability but the relational wholeness of these acts of care.

He then teaches the students the word kokua (cooperation or support):

"*kua is your spine, ko is the long whistle of eternity, and that means you are honoring the calls of your ancestors when you step up and help those around you. And to kokua, it feeds you. It makes your soul feel better."*

By tracing kokua to its roots as the spine and the call of eternity, he is demonstrating that ʻŌlelo Hawaiʻi encodes ontological relationships within everyday language. To help others is not a civic virtue or a prosocial behavior. It is an act that connects the individual body to ancestral time. When he says, it "*feeds you*" and "*makes your soul feel better,*" he names what Western frameworks of service learning and volunteerism cannot. In this context, reciprocal obligation is not sacrifice but sustenance and stewardship, in this teaching, is not ecological management. It is the act of ancestral kuleana.

Figure 4.5

Koa Leading Students and Community Partners in a Mo'olelo (story) at Kīpuka Malu, Olowalu, Maui

Joy arrives at the axiological claim from the direction her ontological shift opened: *We shouldn't be having to fix these things. We should just be working with nature and not against it.* Not a management strategy. A prior value system, one in which the ecological crisis is not the problem but the symptom of an ontological orientation that treated the Earth as something to extract from rather than something to be in relationship with.

Helena, a high school senior in field ecology, articulates kuleana without using the word:

"*To me, this project means being able to give back to some place that you call home, some place I've lived my entire life. You might think you are not doing anything but you are doing something. We've been here* [at Kīpuka Malu] *for at least six months, you see all the changes that you've made. That one tree that I planted, now it's getting bigger. Or the stream is looking different. Those little things are going to add up to a bigger ecological change."*

The relational obligation she describes, "*giving back to a place that gave to you,"* is kuleana.

Leilani's teaching of the three piko at the program's close teaches that the human body holds three sites of relational connection: the crown connecting to Akua and the heavens, the navel to lineage and the present, and the groin is connected to offspring and the future. Students remove their hats during protocol so the crown piko stays open, permeable, and grounded from above to below. Leilani is not an ordained cultural practitioner, but she carries this teaching from her own genealogical relationship to Kānaka ʻŌiwi knowledge. She carries epistemic authority rooted in belonging to a place, community, and culture.

Bella, a high school junior and Eco Club co-president, arrived at the program with genuine curiosity about Kānaka ʻŌiwi knowledge but had no prior educational experiences where she had learned cultural knowledge. *"I want to see how they* [Kānaka ʻŌiwi] *see the islands,*" she said in September 2024. "*I've been here all my life, and I've never learned anything about it."* By May 2025, she described the field visits excitedly and named the educators collectively as people she learned a lot from. When asked what she learned that was most interesting from Koa specifically, she paused: "*I can't really remember since it was a while ago."* She described the two knowledge systems as "*complementary*" and noted they "*touched on a lot of similar things.*" Bella's experience is worth sitting with. She arrived with genuine curiosity and left with positive feelings about what she had experienced. And yet, when asked what she learned specifically from Koa, her description of the two knowledge systems as "*complementary*" and as having "*touched on a lot of similar things*" suggests a different kind of engagement than that demonstrated by other students. What made the difference is not something this study can answer definitively. What I can say is that not every student who participated fully

in the program emerged with the same capacity to differentiate, name, or carry forward what Koa shared. That variation is itself a finding and points toward questions about prior scaffolding, program duration, and the conditions under which ontological engagement with Indigenous knowledge becomes possible that future research must consider. A one-year program, such as Hoʻomalu ʻĀina Maui, cannot undo what years of schooling have built into a student's sense of what is real and what is legitimate. What Koa and Leilani shared was a different world. What each student was able to do with that is what the next two constructs explore.

A Constellation of Knowledge Holders: Epistemic Authority Across the Program Partnership

This finding introduces the construct of "Epistemic Authority and Transmission", which explores how epistemic authority and modes of knowledge sharing among program partners shaped students' experiences, and what epistemic hierarchies emerged when Kānaka ʻŌiwi and Western knowledge systems were present in the same learning context. This program did not have a single knowledge holder. It had five, each carrying a different form of authority, each reaching students through different means. Students spent the year learning from all of them.

Carrie, the field ecology teacher, made the program possible institutionally speaking. Her authority is pedagogical and curricular in nature; she knows how to design learning experiences, how to coordinate a school partnership, how to facilitate twenty-four students engaging in field-based learning across an academic year. In her documentary film interview, she names the program's purpose in terms that bridge the scientific and the relational:

"*Our goal for this project is to build resilience; how do we come back from some of the natural disasters we have faced like the Lahaina fire? And how do we have hope going forward? Be bioculturally aware; to do things that are good for the land and to be part of the solution."*

It cannot be emphasized enough how instrumental Carrie was to the whole program. She coordinated, designed, planned, collaborated with myself and partners at Kīpuka Malu in order to make this program happen. This was its own form of knowledge work, and without her nothing else could have happened. Additionally, students named her more than any other adult in the program. For Sinai, Carrie's ecology class was identity-transforming; she described moving from disengagement to environmental purpose because of it. For Bella, it was Carrie's class that first made her want to pursue environmental science as a major in college. For Ali, who entered the program saying she didn't think she could make a difference, Carrie remained the primary epistemic anchor even after a full year of field visits at Kīpuka Malu. For Anna, when asked what resilience meant, she thought immediately of what Carrie had taught her about native plants and fire, that "*[R]esilience meant bouncing back from environmental disaster in the way that native plants do after a wildfire."* Across both cohorts, the class and the club, her name surfaced repeatedly as a person who had changed how students saw themselves in relation to the natural world. Carrie did not just teach ecology. She made students feel like the kind of people who could care about it and *do* something about it.

Waiola, the biocultural conservation biologist, holds epistemic authority that sits between Koa's and Tara's. As a Kanaka ʻŌiwi biocultural conservation biologist, he carries both a master's degree in Tropical Conservation Biology and cultural grounding. In the documentary film, he describes his role in the program in scientific management terms:

"*My role is to support* [Soleria] *with her junior project and provide Kīpuka Malu with baseline information for the field conditions they are seeing to help inform management. This data will allow them to better understand the abundance and distribution of different weed targets that they are looking to remove and then track restoration progress over time.*"

This language is scientific. But it captures only one dimension of what Waiola brought to the program.

In two classroom-based guest lectures, one on native plants and one organized around a konohiki (stewardship) assignment, a different picture emerges. In the konohiki lecture, Waiola opened by telling students that mele (song) and moʻolelo (stories) are legitimate data sources alongside peer-reviewed academic journals, positioning them as equal methodological frameworks rather than cultural supplements to *real* science. He then tasked students with becoming konohiki stewards of a specific wao (socio-ecological zones) within the ahupuaʻa of the Olowalu Valley, asking them not just to learn about traditional land stewardship but to inhabit its logic, to think from within it. The goal he named for their stewardship was not in terms of ecological metrics but in ʻāina momona (a state of abundance and fertility that is simultaneously ecological, relational, and cultural). This is not the language of a scientist describing a management objective. It is the language of someone who holds both knowledge systems and knows how to move between them fluently.

What is not visible in Waiola's documentary interview but is present in the program record is a Kanaka ʻŌiwi scientist modeling what it looks like to hold both knowledge systems with equal respect. Students conducting vegetation assessments alongside Waiola, and students

becoming konohiki under his guidance, were receiving that modeling, whether or not they could name it. That students did not name him as prominently as Koa or Carrie in their post-program interviews is a pattern worth examining. Most of his contributions to the program were classroom-based. For example, he gave guest lectures on native plants and led the konohiki assignment in class. These forms of knowledge transmission, however sophisticated in content, resembled what students are accustomed to receiving in school. His field-based contribution to the vegetation assessment was significant, but by the time students were conducting that work, Solai was leading it in the field. Waiola's form of epistemic authority may have been less visible to students not because it was less significant but because it arrived through registers, they already knew how to receive. For students with no prior experience of cultural practice, Koa's teaching arrived through forms such as protocol, oli, mo'olelo, and genealogy, which were likely striking precisely because they were unfamiliar to many students.

Tara, the project manager, holds scientific and conservation authority. She has environmental expertise and land restoration experience. In her field audio, she explicitly negotiates the distribution of epistemic authority in the program, telling students, *"Koa is going to cover the historical parts and the cultural significance of this area because that is also really amazing."* In a single sentence, she defines her domain and defers the other to Koa, not dismissively but respectfully, acknowledging that different knowledge requires different knowledge holders.

Her restoration philosophy extended this respect into practice: "*Kīpuka Malu operates chemical-free —no pesticides, no herbicides— using cardboard mulching, worm castings, and vinegar in their place."* And when asked what she would tell the Maui community, she didn't

reach for a scientific prescription. She went straight to the everyday choices that most people don't connect to the coral reef ecosystems:

"*Stop using commercial fertilizers. Compost. Don't grow grass lawns, or if you do, make them smaller; those things are hurting our coral. They're hurting our land. They're infiltrating our water sources underneath us.*" And then, almost as an afterthought, she says: "*Hang out in nature. Get regrounded. Go barefoot a little bit, go in the ocean. Be aware of your surroundings; once you realize what your environment around you is doing, it's a lot easier to work with it.*"

For Tara, knowing the land begins with being in it and being a part of it.

Leilani, the communications and outreach specialist, holds a form of authority that is distinct from all the others. She is not an ordained cultural practitioner and does not hold degrees in a science discipline. However, she carries epistemic authority rooted in genealogical belonging, in being Kanaka ʻŌiwi, in her relationship to this land and this community. Her three piko teaching at the program's close, described above, is the clearest expression of this: knowledge transmitted not through ordination or higher education but through who she is and where she comes from.

Koa's authority is of a different order than any of these. When students interviewed him for the documentary, they asked how he feels about education. He said:

"I think that very much, education is the most important component for our society, and if people forget about taking care of the next generation, we're going to end up with a really big problem down the line — if we don't give time, we have to give time to do so. I grew up in the hālau,

which is a group that we practice our hula and our culture, and we learn about cultural norms. We're dancing hula, sure, and it's a story from long ago, and we learned about its relevance to where we are today, and also where our kūpuna, where our ancestors come from. And it took me 36 years of being a dancer and chanter to graduate — it's not something accredited. We don't get that on a diploma. We don't get that on a piece of paper ever. I don't have any documents from it. At the end, we were practicing six hours a day, six days a week, to do this one graduation ceremony, the pass or fail. And I did pass to be a practitioner. And in that realm, it was easily the most important journey in my life. By educating with the classroom of the world, we have a much better chance of getting people to be excited about the world around them."

What Koa is describing is a fundamentally different theory of knowledge transmission from the one that formal schooling operates on. His thirty-six years in the hālau hula were not measured in credits or credentials but in embodied practice, relational accountability to a lineage of knowledge holders, and a single high-stakes graduation ceremony that could not be retaken. The fact that he has no documents, no diploma, no piece of paper to show for it is not a limitation of his training. It is the point. His authority cannot be conferred by an institution because it was never produced by one.

When students asked him to describe his role, he said:

Here I am the cultural practitioner known as the Kahu [caretaker] *of this space, as a guardian of the space and educator from this village as a youth. And I'm here to help share our culture and add the cultural component to what we're doing. Biocultural conservation is a lot, much more, a lot deeper ingrained into us as a cultural heritage space where we can combine the science and*

the culture. So, I'm in there to kind of make sure the two are married and not leaving one or the other as separate entities.

Koa's self-description as "Kahu" or "caretaker and guardian," positions his role not as an instructor but as keeper of the relationship between people and place. His insistence that the two knowledge systems be "married and not leaving one or the other as separate entities" is a statement about what knowledge integrity requires. For Koa, separating cultural knowledge from ecological practice is a form of epistemic violence, the same kind of severance that colonial institutions enacted when they displaced ʻāina-based practices from the contexts in which they were transmitted and kept alive. His presence at Kīpuka Malu is itself a form of resistance to that severance.

At the third field visit, in conversation with students at Kīpuka Malu, Koa named what his form of knowledge transmission reaches that Western science instruction does not: "*Your brain is engaged and it is nice to feel your spirit being nurtured at the same time, which is a rarity because there are two different subjects."* The brain and the spirit are not addressed by the same pedagogical form. The institutional form of a school is typically built for only one of them.

At the last field visit in April 2025, returning to the planting chant months into the program year, Koa teaches a fuller version: "*Ke kanu nei au ʻaia iā ʻoe ka ulu"* (I plant you in the ground to grow, now grow). Leilani extended the teaching further, connecting the chant to intention, mana (lifeforce or energy), and the responsibility each person brings to the act of planting:

"*Think of speaking life and putting good mana into the plants. When you speak life into it — I plant you into the ground to grow now grow — put your pu'u wai* [heart] *into it. Really have that good energy, have good mana'o* [thought] *thinking about your intention, so things prosper and grow. If you have that good energy, everything will be pono* [good]*."*

Together, Koa and Leilani were teaching students that the act of planting is relational, a conversation between the person, the plant, and the living world they are both part of. The planting chant is not a ritual performed once and set aside. It accumulates. Each time students plant with it, they are being asked to bring more of themselves, their intention, their energy, their heart, into a relationship with what they are putting in the ground. By the last field trip, students who had first received the chant awkwardly at the first field visit, voices uneven, paper in hand, are now being asked to understand what they were doing and why.

Across these six students, what emerges is not a uniform response to Koa's teaching but a convergence from six different directions toward the same recognition. Michael names it as the difference between information and presence. Kay names it as the difference between the head and the heart. Lex names it as an awareness that now travels with her into every cultural place she enters. Mundean names it as a rare capacity to hold two knowledge systems together. Myrna names it as a depth of knowledge so vast it humbles her. Sarah names it as something worth carrying forward and sharing. None of them use the same words but all of them are describing the same engagement. What Koa's teaching made visible, across students with vastly different prior relationships to Kānaka 'Ōiwi knowledge, is that there are forms of knowing that schooling has never offered them access to and that when those forms arrive, students recognize them, even when they cannot fully name what they are recognizing.

What Grew from "*Ke Kanu Nei Au*"

The planting chant at the first field visit is the clearest single episode in the field audio of what it looks like when Koa teaches. The vignette shows it: before any seed goes into any pot, Koa teaches students *ke kanu nei au* and has them perform it together. The knowledge lives in the doing together, not in the description of it. By May 2025, multiple students named the planting chant as one of the most significant lessons of the entire program year. What each of them carried from it was different.

Michael had known about traditional oli (chanting) before the program but had never received it as embodied practice:

"*I never really knew too much on that. I knew about it and stuff, but I did not know how to properly do it.*" When asked what made Koa's teaching distinct, he said: "*Yes, I can maybe go watch a YouTube video or take a college class* [about chanting/oli]*, but it is the deeper connection you get with just meeting different people and learning new things that way— that is really cool."*

YouTube delivers information. What Koa offers is his presence and ordination. What yields is a relationship between teacher and learner that YouTube cannot replicate.

Kay reflects on the difference between knowledge systems: "*The traditional Hawaiian knowledge connects to the heart a lot more than Western science."* The cultural significance of the place became clear through moʻolelo in a way ecological data alone had not made possible.

Lex, who moved to Maui from Minnesota and had no prior experience with Kānaka ʻŌiwi cultural practice, said by May 2025:

"*He* [Koa] *slows it down and puts more meaning into it for us... you leave feeling more uplifted after talking to him. You feel so much more aware. You're like, I want to know a lot about every cultural place I go into, and what the protocol should be."*

As Lex's reflection shows, the exposure to Koa's pedagogy facilitated an awareness of protocol beyond the specific context of Kīpuka Malu.

Mundean, who also experienced learning from a cultural practitioner for the first time, said: "*He was able to tie in culture with science, which was really interesting. Not a lot of people can do that well. I think he did it really well."* What Koa did is recognized as rare, even by a student with no prior framework for understanding why.

As Myrna, said at the program's close: "*I am a little intimidated by it* [cultural knowledge] *just because I feel like where I am now, I know so little, but I need to remind myself that everyone started at the bottom."* Myrna had learned that Koa trained for 36 years before his uniki (graduation). This intimidation she describes is recognition of the depth of knowledge.

Sarah left the program with plans to carry what she had received:

"*I am going to UH* [University of Hawai'i] *Mānoa, and there are going to be a lot of students from the mainland who do not know anything about Hawai'i, and to be able to share his* [Koa's] *knowledge and reference him to other people is enough for me."*

Sarah has internalized Koa's epistemic authority to the point of positioning herself as a conduit for it.

What each student was able to receive from the program and what happened when two knowledge systems made different claims about the same world, is what the third construct explores.

Figure 4.6

Carrie Planting Native Species Alongside Students and Community Partners at Kīpuka Malu, Olowalu, Maui

"There Is Science Backing for That": The Persistence of Epistemic Hierarchy

On the morning of the first field visit, Koa gathered students around the loʻi and invited them to look at the water. He pointed out the damselflies moving across the surface. "*Everyone say pinau!"* he said, teaching students the ʻŌlelo Hawaiʻi word for dragonfly or damselfly. He explained that their presence signals living water, a healthy ecosystem. Then he said, *"everyone say, 'he wai ola!'"* This translates to "living water," connecting the ecological observation to an ontological claim: that the water is not a resource to be monitored but a living relative to be in relationship with. Meanwhile, Tara had described the same stream in terms of turbidity, sedimentation, dissolved oxygen, and coral reef health downstream. The same water. Two entirely different ways of understanding what it is and what it asks of the people standing beside it. Students received both framings without being asked to reconcile them. This is what the third construct explores, not what students learned about two knowledge systems, but what happened when those systems made different claims about the same world, and how students made sense of that for themselves.

At the last field visit, Tara introduces the Kānaka ʻŌiwi moon calendar to students preparing to plant. She explains which lunar phases are most favorable for getting plants established, then adds: *There is science backing for that.* She goes on to explain the mechanism, *"the moon's gravitational pull on groundwater, roots chasing water as it rises and falls with the lunar cycle."* Later in the same visit she teaches the willy willy/tiger shark phenological correlation: "*When the willy willy tree blooms red, it signals tiger shark mating season, a Hawaiian proverb that predates Western science by centuries*." She tells students: "*It has been scientifically proven. Look into the proverbs. I guarantee you a lot of them still stand true."* In both cases, Tara introduces Kānaka ʻŌiwi knowledge first, as a proverb, observation, and

practice, and Western science follows as confirmation. This is not a failure of intention but a reflection of the structural pull that shapes how knowledge gets framed.

Koa navigates this differently, but not always in the direction one might expect. In his documentary film interview, explaining why the planting chant matters, he says:

"*When you have that intensity as you're adding water to things, you're actually adding your vibration to the water and into the plants, and they've already proven that with science. They're starting to prove that these cultural norms make sense and actually do have value."*

He then describes what the chant does beyond what is scientifically provable: "*If you add your mana to the space, you can actually upgrade the whole daily relevance to things, and also help your cup to be filled, your inner cup."* In this public-facing documentary context, Koa reaches for confirmation before moving to what confirmation cannot hold; the structural pressure toward Western legitimation is not only in Tara's teaching or in students' thinking. It operates even for the knowledge holder most deeply rooted in a different epistemological world, when he is speaking for a camera, for an audience that may not share that world.

What Koa does not do in this same interview is stop at confirmation. He moves through it toward something else entirely. He says:

"*It's a bigger concept than just cut, dry, plant, and it grows. When we chant, we call on* archaeoacoustics*; we engage the space by chanting and clapping, starting our day off to be at the exact same moment, in the same breath."*

Archaeoacoustics is the study of how sound interacts with sacred spaces and is a Western scientific field (Navas-Reascos et al., 2023). Koa names it deliberately, bridging his cultural practice and scientific vocabulary in the same breath, not to subordinate one to the other but to show that the two are in conversation.

Students' Epistemic Navigation

Students navigated this in ways that reveal as much about the structural conditions of the program as about individual students.

Fall describes Kānaka ʻŌiwi biocultural knowledge in her post-program interview this way: "*The ancient Hawaiians knew so many things that science today is now discovering and backing up."* She goes further, describing something Waiola taught the students in class: sacred prohibitions against living above certain elevations on the mountain, prohibitions that encode an ecological relationship between summit restoration and watershed health that Western science is only now mapping.

Solai's pre-program framing positioned Kānaka ʻŌiwi knowledge as the source of ideas and Western technology as the vehicle for implementation. By May 2025 that hierarchy has become more explicit:

"*Traditional knowledge knows so much about how the land works and how they have been able to make it run for hundreds of years. We need to use that, but then we can use Western science, modern technologies, to reinforce it."*

Kānaka ʻŌiwi knowledge is foundational; Western science is a tool that serves it. She is not resolving the tension between the two systems so much as ordering them. In the first field trip audio, Solai moves from performing the protocol with Koa to leading scientific data collection (e.g., percent coverage, phenology, and species identification).

Kanoa, who entered the program already holding a Kānaka ʻŌiwi ontology through his uncle and community, is also the student who most explicitly names the tension rather than resolving it. In his post-program interview, he said: "*They* [referring to knowledge systems] *can mix, yes, and there are ways they work together, but there are also some ways they fight each other."* He does not specify which ways. He does not need to. Kanoa, who came to the program already holding a Kānaka ʻŌiwi ontology, recognizes that the two systems are not always reconcilable. He names that honestly rather than smoothing it over.

Joy noticed something in her post-program interview: "*[R]esilience is not a neutral word. When applied to a human community recovering from disaster it means one thing. When applied to kiawe* [a resilient invasive species], *it means something ecologically harmful*." The same word does different work depending on what world you are standing in. She did not arrive at this through abstract reasoning. She arrived at it by conducting four field visits in a landscape where the distinction between native and invasive is not a classification but something students were asked to act on with their hands every time they went out.

Kim said in her post-program interview: "*I still don't know the specifics, what is traditional Hawaiian, and what is Western science. The lines are a little bit blurred for me*." Kim's blurred lines are worth sitting with. They could signal that years of schooling that position Western science as the default framework for understanding the natural world have made it difficult for her to perceive a distinct alternative. Or, they could signal something more

generative, that for Kim, the two knowledge systems are beginning to feel less separate, less hierarchical, more continuous with each other. The data cannot resolve which interpretation is more accurate. What it can say is that blurriness, in either case, is not the same as indifference. Kim engaged genuinely. The boundary between two epistemological worlds remaining unclear to her after a full program year is not a failure of the program. It is a reminder that the work of epistemic justice is measured in the slow, uneven, student-by-student process of engaging with ways of knowing that their schooling has never offered before.

DISCUSSION

Scholars have long argued that ontological engagement with Indigenous knowledge requires relational conditions that no curriculum alone can create (Bang, 2017; Bang, 2020; Marin & Bang, 2018; Cajete, 2020a; Goodyear-Kaʻōpua et al., 2014). This study contributes ethnographic evidence of what those conditions look like in the specific, situated experience of this specific group of high school students over one program year in the aftermath of the 2023 Lahaina wildfire. Most existing scholarship in this area has explored what is designed, what is taught, and what students demonstrate having learned, the curricular and pedagogical dimensions of bringing these knowledge systems into relationship (Barnhardt & Kawagley, 2005; Kanaʻiaupuni & Malone, 2006; Saffery, 2019). This study provides an account of what it looks like when two knowledge systems with different ontologies are engaged in a formal schooling context. In doing so, it extends existing scholarship in two directions: by theorizing the constellation of epistemic authority as a structural feature of ʻāina-based education that makes ontological engagement possible, and by documenting how epistemic hierarchy persists even

within programs explicitly designed to honor Indigenous knowledge, a finding that has implications for how the field understands the limits of program design.

A constellation of epistemic authority

One of the most significant structural features of Hoʻomalu ʻĀina Maui, and one that existing scholarship on ʻāina-based education has not yet fully theorized in ethnographic detail, is that epistemic authority was distributed across a constellation of knowledge holders rather than centered on a single kumu or practitioner. While existing scholarship has documented the importance of cultural practitioners in Indigenous education contexts (Goodyear-Kaʻōpua, 2013), it has paid less attention to what becomes possible when multiple knowledge holders with distinct and complementary forms of authority work together in the same program. This study contributes to that account. Carrie, Waiola, Tara, Leilani, and Koa each carried a different form of authority, reached students through different means, and together created something that no single knowledge holder could have accomplished alone. Through member checking, Carrie reflected in a post-field trip conversation with me that "*this program would not have happened without these partnerships.*" These relationships between specific people are built across a specific history in a specific place. Carrie's observation is itself an important finding.

This is the CBPR argument Israel et al. (2013) make: genuine partnership, shared ownership, and mutual benefit across the full arc of a project take time to build. Our constellation grew through a sustained, reciprocal, trust-based relationship between a public school, a nonprofit, a biocultural conservation biologist, an education researcher, and a community of practitioners, across months of design before, during, and after the program. This is what Pugh, McGinty, and Bang (2019) mean by relational epistemologies: knowing is not something

individuals do in isolation, it emerges from relationships between entities, human and more-than-human, that are mutually reciprocal, dynamic, and always-becoming. Our constellation of knowledge holders in this program was itself a relational epistemological structure that had to be built before we could do anything.

Bang (2020) argues that genuine transformation in science education requires engaging Indigenous knowledge at the ontological and axiological level rather than solely in epistemological terms. This study suggests that such engagement is not something a single educator can design. It requires a web of relationships, authorities, and forms of knowing working together. Carrie's motivational and pedagogical authority likely created the conditions under which students arrived open enough to receive what Koa offered; students who came to the program already feeling like the kind of people who could care about the environment were more prepared to engage with what a cultural practitioner had to share. Marin and Bang (2018) show how family-based land knowledge creates the relational foundation on which formal learning about the natural world can build; Carrie's ecology class functioned as that relational foundation for many students in this program, particularly those who arrived without prior cultural or ecological knowledge of place. Waiola modeled what it looks like to hold both knowledge systems with equal respect, a living demonstration of what Cajete (2020) describes as Native science born of lived and storied participation, enacted not in opposition to Western science but alongside it. Tara's respectful deference, explicitly naming Koa as the knowledge holder for the historical and cultural dimensions of Kīpuka Malu, made the division of epistemic labor visible to students. Fricker (2007) identifies testimonial injustice as what occurs when a knower's epistemic authority is not recognized as credible. Tara's deference was a structural refusal of that injustice, enacted in front of students. Leilani carried genealogical belonging and a

form of authority that neither ordination nor credentialing could confer, and one that Kidd, Medina, and Pohlhaus (2017) would recognize as operating through a different set of epistemic criteria than formal educational institutions are equipped to recognize.

Koa's authority was of a different order than any of these. His thirty-six years of hula training, his self-description as "*kahu or guardian and sharer of cultural knowledge*", these are the epistemic conditions under which his teaching was possible. What he transmitted required his presence, his lineage, and a relationship between teacher and learner that no textbook or other medium of learning Kānaka ʻŌiwi culture could substitute for. McCready and Winterstein (2017) argue that epistemic authority is always negotiated within communities of knowing. The constellation surrounding him, Carrie's motivational groundwork, Waiola's biocultural modeling, Tara's respectful deference, and Leilani's genealogical belonging, created the conditions under which his teaching had the best possible chance of reaching students across a wide range of prior relationships to land, culture, and knowledge. After the first field visit, Carrie reflected simply: "*It's a good group of people, and that makes such a big difference.*" That observation underscores the assertion by Marin and Bang (2018) that relational contexts shape what kinds of knowing become possible in land-based learning environments. Similarly, Goodyear-Kaʻōpua (2013) shows that the quality of relationships between educators, cultural practitioners, and students is inseparable from what students can internalize in Indigenous education contexts.

The implication for the field, therefore, is not a design prescription. It is a relational imperative. If ʻāina-based education is to create the conditions for genuine ontological engagement with Kānaka ʻŌiwi knowledge in school contexts, it requires the kind of long-term, reciprocal, community-embedded partnerships that made this constellation possible, partnerships

that precede the program, exceed it, and cannot be reduced to a model or a replicable curriculum. That is what this program demonstrates.

The structural persistence of epistemic hierarchy

Our constellation of knowledge holders created the conditions for ontological engagement with Kānaka ʻŌiwi knowledge. And yet, the structural conditions of schooling did not disappear. Even within a program designed to honor Kānaka ʻŌiwi knowledge, the structural tendencies Latulippe and Klenk (2020) identify in knowledge co-production contexts were visible in the pedagogy. Tara's teaching during the last field visit, introducing Kānaka ʻŌiwi phenological knowledge and the Kānaka ʻŌiwi moon calendar with the assurance that "*there is science backing for that,*" is a window into the structural conditions that shape even the most committed science educators. Tara is a deeply knowledgeable educator who transmits Kānaka ʻŌiwi knowledge with genuine respect and care. What her teaching reveals is a structural pull that operates even among the most committed science educators: the institutional context of a science class tends to position Western science as the framework that confirms, validates, and/or makes room for Indigenous knowledge. Kānaka ʻŌiwi knowledge arrives as proverbs or practice; Western science arrives as proof. The sequence is not neutral. It positions Kānaka ʻŌiwi knowledge as something that turns out to be true rather than something that was always true on its own terms, what Latulippe and Klenk (2020) call the structural tendency to subordinate Indigenous knowledge to Western legitimating frameworks. Significantly, this dynamic was evident not only in Tara's teaching but also in Koa's documentary film interview, where he seeks Western scientific confirmation. The structural pressure toward Western legitimation does not

spare even the knowledge holder most deeply rooted in a different epistemological world; it shapes how knowledge is framed whenever the audience may not share that world.

Bang and Medin (2010) describe this as the challenge of supporting students' navigation of multiple epistemologies, a challenge that, these findings suggest, cannot be met by relational infrastructure or curriculum design alone when the structural conditions of schooling persistently reinscribe Western science as the unmarked default (Wynter, 2003; Bang et al., 2012). It is representative of what years of schooling build into a student's sense of what counts as legitimate knowledge (Little Bear, 2000), and what one program year, however carefully designed and however relationally grounded, cannot fully undo. That is not an argument against such programs. It is an argument for understanding them as one part of a much larger project of epistemic justice (Fricker, 2007), one that requires sustained, structural attention to how knowledge is sequenced, framed, and validated across K-12 science education broadly, not only within the contexts of individual partnerships or programs.

Implications for ʻāina-based Education, CBPR Practice, and Educational Policy

The findings of this study do not yield a program model. They yield something more foundational: an argument that the conditions of possibility for ontological engagement with Kānaka ʻŌiwi knowledge in school contexts are relational rather than curricular, and that understanding those conditions requires a different set of questions from those the field has typically asked.

For ʻāina-based program designers, the most pressing implication is not about what to teach or how to sequence field visits. It is about what students bring before the first field visit and what the program does with that. The findings show that students arrived with vastly

different prior relationships to land, culture, and knowledge, and that those differences shaped what each student was able to receive from the program in ways that curriculum design alone can not compensate for. Kanoa arrived already holding a Kānaka ʻŌiwi ontology transmitted through his uncle and community. Joy arrived with a strong environmental and political consciousness. Bella arrived with genuine passion and curiosity for the subject matter and no prior cultural framework. All three participated fully. What each carried from the program was shaped as much by what they brought as by what the program offered. This does not mean educational programs should screen students for prior knowledge; it means programs need to ask what kinds of scaffolding different students need to engage more fully, and build that scaffolding intentionally before, alongside, and after the program itself (Minshew et al., 2017). For some students, a single program year may not be sufficient for the deepest teachings to take root. This is a reason to think carefully about what sustained engagement over multiple years might make possible that one year cannot.

Figure 4.7

Students and Community Partners Preparing a Restoration Site for Native Species Planting at Kīpuka Malu, Olowalu, Maui

For CBPR practitioners working in similar contexts, the most important finding to sit with is this: the relationships are the program. Therefore, the question a practitioner must ask before building a program like this one is not "how do we design the curriculum?" It is "do we have the relationships that make this possible, and if not, how do we build them, genuinely, over time, with accountability to the community whose knowledge we hope to honor?" As Carrie observed through member checking with me, this program would not have happened without these partnerships. That observation is a design principle. Programs built on transactional partnerships, hire a cultural practitioner, design a curriculum, and measure outcomes are likely to reproduce the epistemic hierarchies they intend to challenge because the web of trust, accountability, and sustained relationship that makes genuine epistemic engagement possible was not established first. This study documents what building that infrastructure can look like in practice. Genuine relational partnerships can create conditions for epistemic engagement that more transactional approaches cannot.

Taking seriously what Latulippe and Klenk (2020) call Indigenous knowledge sovereignty means recognizing that the right to determine the conditions, forms, and purposes of knowledge transmission belongs to the knowledge holder, earned through decades of embodied practice and relational accountability. What a CBPR partnership can do is create the structural conditions under which that transmission is possible: real-time at a real place, with real work to do, led by kumu with the epistemic authority to lead it. The restoration work at Kīpuka Malu was not a vehicle for delivering Kānaka ʻŌiwi cultural content to students. It was the occasion through which students entered into a relationship with land, with Koa, Leilani, Waiola, Tara, and Carrie, and with each other, and it was through those relationships that certain kinds of knowing became possible.

Finally, the structural visibility of epistemic hierarchy, even within this carefully designed and relationally grounded program, is perhaps the most important implication for practitioners to sit with. Good intentions and explicit commitment to honoring Kānaka ʻŌiwi knowledge are necessary but not sufficient. Designing for epistemic justice in a school partnership means creating explicit space for students to engage with Kānaka ʻŌiwi knowledge on its own terms, not only in relation to what Western science can confirm. It means attending to how knowledge is sequenced, framed, and validated across the full arc of the program, not only in the cultural practitioner's teaching but in the science educator's teaching, in the researcher's framing, and in the questions the program asks students to answer. Epistemic justice, as Fricker (2007) argues, is not achieved by including Indigenous knowledge in a curriculum. It requires structural attention to the conditions under which that knowledge is recognized as credible, transmitted with integrity, and received with the conceptual resources necessary to understand what it carries.

Findings of this study also carry implications for educational systems, institutions, and policymakers. The structural conditions that made this program possible and the constellation of epistemic authority described in this study do not exist by default in public schooling. Creating them requires deliberate policy attention across several dimensions. First, educational institutions must develop mechanisms for recognizing and compensating the epistemic authority of cultural practitioners whose credentials are not conferred by academic institutions but earned through decades of embodied practice, cultural ordination, and relational accountability to a lineage of knowledge holders. Second, the funding structures that govern educational partnerships must be redesigned to support the long-term, trust-based relationship-building that genuine epistemic partnership requires. Grant cycles of one to three years are structurally incompatible with the kind of relational infrastructure this program demonstrates as necessary. Third, as long as K-12 science curricula position Western science as the default framework and Indigenous knowledge as a supplement, a guest speaker, or a field trip, the epistemic hierarchies this study documents will persist regardless of how carefully individual programs are designed. Structural curriculum reform is needed, in addition to program innovation. Finally, teacher preparation programs must equip educators to work alongside cultural practitioners as genuine partners, to recognize and defer to Indigenous epistemic authority in science learning contexts, and to understand that the relational work of building such partnerships is itself a form of professional practice that deserves institutional recognition and support to create and uphold.

CONCLUSION

On the last day of the program year, students sang Oli Mahalo, a chant of gratitude composed to thank their kumu for the ʻike (knowledge) and manaʻo (thoughts) they have shared.

They had practiced it consistently over the last few weeks of the program, even during the van ride to Kīpuka Malu on the last day. At the close of the last field visit, they performed it with confidence. Their voices were no longer uneven, no longer dependent on the paper in their hands. The oli gives thanks from east to west, from sunrise to sunset, to the akua (gods), to the kūpuna (ancestors), and to all who are present, both seen and unseen. It is an acknowledgment that the exchange of knowledge is never between individuals alone but between generations, between the living and the ancestral, between people and place (Smith & Nobriga, 2008). That moment is what this paper has tried to document: not what the program taught, but what it made possible. Grounding science education in Indigenous knowledge systems and ways of knowing is not a curricular add-on. It is the roots, trunk, and branches of the learning process; the living structure that must be grown before any curriculum can take hold. Students are the leaves: what the whole structure exists to sustain, and what makes the tree's work visible to the rest of the world.

CHAPTER 5: CONCLUSION

SYNTHESIS ACROSS THREE STUDIES

This study began with a conversation in the aftermath of one of the deadliest U.S. wildfires in over a century and the deadliest in Hawai‘i’s recorded history. Our impetus for this work came from the desire to support our community, its youth, and the ‘āina, not just in the immediate aftermath of the fire, but in the long term. And, as most community-engaged practitioners and researchers know, working toward solutions to complex social-ecological issues takes time and, therefore, patience, and requires the engagement of diverse collaborators, including but not limited to cultural practitioners, scientists, educators, researchers, and young people. As Koa said in his documentary interview, “*work arm in arm as laulima, a tree of hands.”* This study takes that suggestion seriously, as methodology: knowledge produced in relationship, accountable to community, and oriented toward the long work of restoration that no single voice, institution, or program year can complete.

This study is grounded in the overarching question: *How do high school students engage with and make meaning of multiple knowledge systems as they participate in land stewardship activities for wildfire mitigation?* My three sub-studies unpack this question by revealing its full complexity, including its cognitive, relational, epistemological, and political layers. Ultimately, this study reveals something more fundamental: a record of what happened to young people across a year of engaging with a landscape and community still recovering from catastrophe, working alongside kumu who carried knowledge in their bodies and their lineages, and being asked to bring their own intention, grief, and love into the act of restoration. Each of the three sub-studies has its own distinct arc and a single point of convergence. What emerges when you read the three sub-studies together is not a program model but a portrait of what young people

are capable of when education creates the conditions for what they already carry to surface, deepen, and find its purpose. This is what the three sub-studies together document: not what the program produced in students, but what students were able to become when the relational conditions were right.

Cross-Cutting Themes

Across the three sub-studies, the strongest finding is about the conditions under which certain kinds of knowing become possible, and what those conditions reveal about what science education, in its current form, continues to systematically leave out.

Ens et al. (2015) define biocultural knowledge as knowledge that encompasses people, language, and culture and their relationship to the environment. Central to this framework is the concept of ecological memory, the repository of knowledge, maintained through cultural practice and intergenerational transmission, that enables both biological and social systems to recover after disturbance (Aitken et al., 2021; Folke et al., 2004). When ecological memory is depleted, systems become vulnerable to permanent regime shifts rather than returning to previous functional states (Johnstone et al., 2016). The same is true of social systems: without ancestral memory, maintained through oral and written traditions and living relationships to place, communities lose the capacity to understand what created their vulnerability and imagine alternative futures (Aitken et al., 2021; Smith, 1999). The Lahaina fire was not only an ecological event. It was the consequence of what happens when ecological memory, stored in Kānaka ʻŌiwi land management practices, water systems, and biocultural knowledge, is systematically displaced over generations (Fernández-Llamazares et al., 2021; Price et al., 2021).

What the three empirical studies together document is what became possible when a program created the conditions for that memory to be shared, practiced, and carried forward.

Figure 5.1

Student Removing Invasive Species at Kīpuka Malu, Olowalu Maui

To know ʻāina, in this framework, is not to possess information about it. It is to belong to it, to carry obligations toward it, and to be in relationship with it across generations. When formal education separates ecological knowledge from cultural practice, scientific content from relational accountability, and land from the people whose genealogies are written in it, it does not simply omit something valuable. It actively reproduces the colonial severance that made that separation possible in the first place (Wynter, 2003; Tuck & Yang, 2012). What the three

empirical studies together document is what became possible in this place, with these people, across this particular year. That is the primary finding. The structural conditions that made this work difficult to build and harder to sustain are not evidence of what the program failed to achieve. They are evidence of why achieving epistemic justice in science education, building the relational conditions under which Indigenous knowledge is genuinely honored, and sustaining the partnerships between schools, communities, and cultural practitioners that make that possible required what it did, and why our work cannot stop here.

Justice-oriented science education has long argued for bringing Indigenous knowledge into curricula, for representing Indigenous students' lived experiences in science, and for designing learning experiences that are culturally relevant and place-specific (Ladson-Billings, 1995b; Barnhardt & Kawagley, 2005; Bang & Medin, 2010). This work has been necessary and generative. However, inclusion, as Goodyear-Ka'ōpua (2013) cautions, can become its own form of containment. When the epistemological assumptions built into schooling remain intact, including what counts as evidence, who holds epistemic authority, and what kinds of knowing deserve institutional recognition, Indigenous knowledge becomes a unit, a guest speaker, and a field trip. This study argues that the conditions for genuine epistemic transformation are irreducibly relational and place-specific, meaning they cannot be scaled, templated, or assessed using a rubric. This is not a limitation but a structural reality the field must contend with, and a condition that genuine partnership and practice demand.

IMPLICATIONS

For environmental educators, these findings argue that the most urgent work is not curricular design but relational infrastructure. Before asking what to teach, educators must ask:

Who holds epistemic authority over the knowledge we hope to center, and have we created the structural conditions under which that authority is recognized and honored? The Hoʻomalu ʻĀina Maui program offers one model of what this kind of collaboration can look like.

For science education researchers, this study argues for frameworks that attend to the ontological and axiological dimensions of knowledge integration, rather than solely epistemological dimensions. Bang's (2020) call to engage Indigenous knowledge at the level of the kind of world we inhabit, not only how we know it, is confirmed and extended here. This work is in conversation with scholarship developing humanizing, justice-centered approaches to science instruction that attend to students as whole people across intellectual, emotional, and relational dimensions (Patterson Williams & Gray, 2021). In post-disaster and Indigenous contexts, especially, these dimensions are imperative to teaching and learning.

Finally, these findings argue for creating genuine opportunities for students to assume the role of educator, not as a performance to demonstrate what they have learned, but as a meaningful extension of kuleana. When students in this program produced their own documentary film and directed interviews with program partners and each other, they were not summarizing what they had been taught. They were making claims about what mattered, in their own voices, for an audience beyond the classroom. Sarah, who was mentioned earlier, plans to share what she learned from Koa with students at UH Mānoa who have never encountered Kānaka ʻŌiwi knowledge, pointing to the same orientation that teaching and learning are a reciprocal process and experience. Students are carriers and transmitters of knowledge. Environmental education, and education more broadly, must take students' roles as knowledge producers seriously and thus must create structural conditions for them to have their voices heard

in front of and for real audiences, with real stakes, and real recognition of students' authority to teach and share what they know, think, and feel.

A FINAL WORD

An episode I would like to revisit here, which was partially described in Chapter 4, was when the students sang Oli Mahalo. What I didn't mention was what Leilani told them after their performance. She gathered the students together one last time and said:

"*this is a place that you can come to just be, or if you know of anybody that needs a place to go, maybe they're dealing with a lot of stuff and just need to get into nature. Bring your o'hana, come to our community workdays; the door is always open for anyone to come up to Kīpuka Malu. That is what this Pu'uhonua* [place of refuge] *is here for.*"

Figure 5.2

Students Walking Toward Kīpuka Malu, First Field Visit, September 2024, Olowalu, Maui

Then, the school year ended. Yet, our work still lies ahead. For students who carried something from this program year into the years beyond it, for researchers willing to follow what was planted rather than only measure what bloomed, and for practitioners ready to ask not "*how do we design this program?*" but "*do we have the relationships that make this program possible?*"

This study is, in some ways, an attempt to document what becomes possible when an education program functions like a pu'uhonua, not a place where students are filled with knowledge, but a space where they are placed inside their kuleana, given the historical and political frameworks to understand those responsibilities and trusted to carry them forward in whatever directions their lives take them.

This study ultimately argues that another kind of science education is both possible and necessary. A science education that draws on all available sources of knowledge and the embodied wisdom students carry from their families and communities, and that organizes that knowledge around the question not of what students need to learn, but of what knowledge already exists: in the land, in the community, and in their genealogical relationships (Rusoja, 2022). The door that Leilani left open at Kīpuka Malu is the same door this research is asking science education researchers and science education more broadly to walk through. It opens not into a curriculum but into a commitment, to place, to community, to the slow and necessary work of building the relational conditions under which another kind of knowing, and another kind of world, becomes possible.

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