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RESEARCH

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One Health, many perspectives: Exploring Indigenous and Western epistemologies

Michelle Pollowitz[1]*, Cole Allick (Turtle Mountain Band of Chippewa)[2], Keala B. Campbell (Native Hawaiian)[3], Nicole lee Kamakahiolani Ellison (Native Hawaiian)[2], Giselle Perez-Aguilar (Zapotec)[4], Melissa Vera (Tsm'syan and Yaqui First Nations)[2], Vickie Ramirez[1], Deborah Nadal[5] and Julianne Meisner[6]

Abstract

The One Health approach, which assesses the interconnectedness of animal, human, and environmental health, fails to include and amplify Indigenous knowledge and Indigenous scientists. To effectively center Indigenous knowledge next to and within the One Health approach, which is historically based in Western science, the similarities and differences between Indigenous science, specifically Traditional Ecological Knowledge (TEK), and One Health must be explored. The objective of this project is to identify values in Indigenous science that are unsupported or underrepresented in Western science and then collaboratively ideate recommendations that Western allies can take to center and support Indigenous scientists and elevate Indigenous knowledge. From January to March 2023, the study team conducted semi-structured interviews with Indigenous knowledge keepers via Zoom video calls. American Indian, Alaska Native, Native Hawaiian (Kānaka Maoli), and other Indigenous participants from the global diaspora residing in the continental United States and Hawaiian Islands were recruited through social media and referrals from Indigenous leaders who had participated in formative (phase 1) interviews completed in 2022. In those formative interviews, four themes emerged and called for further exploration of Indigenous perspectives on (1) the natural world, (2) cultural heritage, (3) value expression, and (4) reflection. These ideas were reframed into questions asked in subsequent (phase 2) interviews in 2023. Thematic identification methods were used to highlight key ideas throughout the interviews. Participants noted gaps between their Indigenous worldviews and the One Health model, particularly relating to contrasts with Western culture, holistic expression, power in action, identity and belonging, maintaining community and cultural practices, and sharing information/education. It was also noted that One Health must do more than just uplift Indigenous values to support Indigenous scientists and should instead collaborate with TEK keepers and foster practices that are inclusive and validating of other knowledge systems. Phase 2 interview responses highlighted Indigenous principles that are underrepresented in One Health practice. These principles were transformed into considerations specifically for Western-rooted scientists to improve allyship to Indigenous science and scientists. Adoption of the considerations would strengthen partnership between One Health practitioners and Indigenous scientists and promote collaboration across many ways of knowing.

One Health impact statement

The One Health theory encourages transdisciplinary collaboration to break down siloing and innovate solutions. Yet, One Health practice, and the Western scientific approach it takes, often excludes involvement with Indigenous ways of knowing and disclaims Indigenous knowledge keepers who have been conducting "One Health" work since time immemorial. Indigenous knowledge keepers who self-identified as cultural bridges between Native communities and Western communities were interviewed and asked to speak to values found in Indigenous science and research. The featured principles highlight some of the similarities and differences between Indigenous and Western scientific approaches. The identified values informed recommendations for Western scientists to be better allies to Indigenous scientists and to amplify Indigenous voices and science. One Health practitioners will benefit from these guidelines by navigating research in a more equitable way and by creating sustainable reciprocal partnerships with Indigenous scientists. This makes One Health more open and accessible to Indigenous and Western ways of knowing.

Keywords: One Health, Indigenous Science, Traditional Ecological Knowledge, American Indian/Alaska Native, Western Science, Two-Eyed Seeing, 4R's

Affiliations: [1]Center for One Health Research, Department of Environmental and Occupational Health Sciences, University of Washington, Seattle, WA, USA; [2]Washington State University, Pullman, WA, USA; [3]University of Hawai'i at Hilo, Hilo, HI, USA; [4]University of California, San Francisco, CA, USA; [5]Ca' Foscari University of Venice, Venezia VE, Italy; [6]Department of Global Health, University of Washington, Seattle, WA, USA

*Corresponding Author: Michelle Pollowitz. Email: michellepollowitz@gmail.com

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Introduction

A NOTE ON POSITIONALITY

The lead author and interviewer's positionality [MP] is that of a female, White, non-Indigenous researcher with a Master of science in environmental health and a concentration in One Health who has been trained within Western scientific institutions, particularly in the fields of ecology and public health. MP comes from settlers and European immigrants and does not have lived experience as an Indigenous person. MP's thesis committee members (co-authors VR, DN, and JM) come from diverse academic backgrounds but are all trained in Western scientific practice and do not identify as Indigenous. VR is a One Health researcher with a background in medical anthropology. DN is a cultural and medical anthropologist who specializes in work in South Asia. JM is a veterinarian with a PhD in epidemiology who leads research in One Health and global health.

To address the lack of Indigenous representation amongst the academic study team, we invited interview participants to be further involved as Indigenous advisors [authors GPA, CA, NE, MV, and KC] who co-developed aspects of the project, such as the interview guide and recruitment processes, and have contributed to the editing, direction, and approval of this manuscript. GPA is a PhD candidate in Medical Sociology, with Indigenous Zapotec roots, who collaborates with traditional healers in California and Oaxaca, México, on transmitting knowledge about traditional medicine across state-sanctioned borders in reciprocal ways. CA is a citizen of the Turtle Mountain Band of Chippewa Indians and recent PhD graduate from the Indigenous Health Program at the University of North Dakota where he focused on work with Indigenous Elders and aging. NE is a PhD candidate in Indigenous Public Health at the University of North Dakota. She is originally from Wai'anae, Hawai'i, and currently living in diaspora in the Pacific Northwest. NE is dedicated to promoting Indigenous food systems to address chronic health issues Native Hawaiians face. MV is a citizen of the Tsm'syen and Yaqui First Nations and has a PhD in nursing science. Her research program examines the intersections of Indigenous health and climate change and is grounded in Indigenous and decolonized methodologies. KC is a Native Hawaiian anthropologist and kinesiologist who presently serves as a mentor for Native Hawaiian and Indigenous students in STEM at University of Hawai'i (UH) at Hilo. She is also the advisor to Hui Keaomālamalama, the Hawaiian student RISO at UH Hilo, and a member of the Hanakahi Council, a campus-based caucus group of faculty and staff who are Native Hawaiian or associated with campus programs, colleges, or departments in Hawaiian Studies, Hawaiian language, or Hawaiian education or targeted to serve Native Hawaiian students.

ONE HEALTH

One Health explores the interrelationship of animal, human, and environmental health, and aligns with values like *reciprocity* and *interconnectedness* that are central to Indigenous Traditional Ecological Knowledge (TEK), yet One Health is rooted in Western epistemology (Jack *et al*., 2020). One Health theory strives to create a transdisciplinary space in which diverse perspectives can come together to advance knowledge and break down scientific siloing. Therefore, the One Health lens can serve as a bridging framework to connect Western scientific understandings and practice and Indigenous scientific understandings and practice. One Health, which became popularized around the early 2000s, has been praised for its innovative interdisciplinary and systems-thinking approach that is often lacking in other Western scientific pursuits (Mackenzie and Jeggo, 2019). Yet, it is also criticized for upholding settler colonialist influences in Western science while failing to recognize the Indigenous values that are clearly being exploited by Western natural and physical sciences (Niahosa, 2019). Highlighting and centering Indigenous voices and TEK is urgently needed (Zinsstag *et al*., 2022). As more scientists and scientific fields adopt the One Health transdisciplinary approach into their practices, it is necessary to be mindful and intentional when connecting and collaborating with Indigenous peoples, local communities, and respective authorities. This approach aligns with the original transdisciplinary and multi-epistemological One Health theory of utilizing the strengths of multiple disciplines, worldviews, and lived experiences to identify options that may not be possible with one or few perspectives (Schelling *et al*., 2008). However, these goals are not always maintained in One Health practice.

INDIGENOUS KNOWLEDGE

Indigenous knowledge, described in English language terms, is the unique and diverse knowledge system that Indigenous peoples use to understand the workings and intricacies of the natural world. Indigenous peoples is a broad term that is loosely defined as individuals who are descendants of the peoples and land stewards who lived or resided in an area at the time when people of different ethnicities and cultures arrived and settled in that area. This definition includes many other groups that claim Indigenous identity from across the globe (Who are Indigenous Peoples? n.d.). This project specifically highlighted the voices of American Indian and Alaska Native people, as well as Native Hawaiian and other Indigenous people as a starting place for this work. These groupings, namings, and group distinctions are based in treaty language and are maintained for political consistency (Bird, 1999).

It is not the authors' intention to suggest that all Indigenous communities are a monolith and can be grouped into a single voice, but instead, we aimed to collect a number of voices across the diaspora to begin having these conversations, understanding that they are single representatives of their people. Indigenous knowledge is highly contextual and varies greatly in the methods of observation, categorization, compilation, and notation of information collected through personal experience or passed down over generations. Maintaining Indigenous knowledge ensures that Indigenous peoples will prosper not only in community health and cultural livelihood but also in Indigenous identity and determination (Whyte *et al*., 2016).

TRADITIONAL ECOLOGICAL KNOWLEDGE (TEK)

Within Indigenous knowledge, TEK exists as an environmentally focused area that includes topics of ecology, agriculture, and biology (Whyte *et al*., 2016) (Supplementary Materials: Appendix A). A cornerstone framework in TEK is that health includes the four vital dimensions of life: intellectual health, emotional health, physical health, and spiritual health (Cediel-Becerra *et al*., 2022). Further, TEK recognizes the reciprocal relationships and stewardship that exists between humans and the natural world, in which humanity and nature are connected and bi-directionally dependent (Ratima *et al*., 2019). TEK systems do not see a clear division between the health of the individual, the community, the ecosystem, and mother earth. The deep connection between humanity and the environment that TEK fosters has served Indigenous communities since time immemorial. It has also captured the attention of Western scientists which has led to the exploitation of Indigenous knowledge (Youdelis *et al*., 2021). For example, Western forest management services often adopt Indigenous forest stewardship and cultural burning practices during wildfire seasons, yet respect and reciprocity are not extended back to the Indigenous groups in which the knowledge was created (Kuhn, 2021). Further, the values found in One Health are taught in Western higher education, yet TEK is rarely mentioned.

WESTERN SCIENCE

Western science is derived from the principles of Western epistemology, which highlights and prioritizes science and technology that is verifiable and rationalizable (Baquero *et al*., 2021). The Western world, also referred to as the Global North, is an imperfect umbrella term used to broadly group and distinguish societies and

practices and will be used throughout this paper to represent non-Indigenous knowledge and customs (Khan *et al*., 2022). This is an epistemological and political designation, not a geographical one; many Indigenous individuals live and work within geographically Western locations and in Western-dominated societies. Western biomedical, psychological, physical, and natural sciences (hereafter, "Western science"), strives to measure metrics and identify universal truths. In many cases, Indigenous science cannot be evaluated by the criteria and standards that Western science demands, for example, methods of experimentation and documentation (Durie, 2004). Due to the requirements that have become standard in these fields in Western science, Indigenous science and scientists have been rejected, excluded, unacknowledged, and challenged. One example of this is the practice of classification in Western science, which extends to classifying and marginalizing people (Hardy and Stanley, 2022). This can provide a framework for colonialism and racism to be upheld, which necessitates demonstrations of strength and resilience in Indigenous groups (Baquero *et al*., 2021).

Some of the similarities between areas of Western science and Indigenous science, specifically related to TEK, exist within the One Health paradigm: the interconnectedness of humans, animals, and the environment, and the arbitrary division between these domains. Yet, many Indigenous lessons and practices, such as interconnectedness, are currently used by One Health practitioners without giving enough or any credit to the Indigenous scientists who first observed and recorded the science. Settler colonialists who stole Indigenous thoughts also rearranged the context in which TEK could be applied so that Indigenous science would be invalidated within the Western epistemological spaces (Durie, 2004). One Health, Western biomedical science, and Western public health typically view health as the *absence* of illness or disease rather than a composite measure of thriving spiritual, mental, emotional, and physical health as it is seen in many Indigenous practices (Hillier *et al*., 2021). Epistemological differences define the gaps between Western and Indigenous science, which challenges collaboration and stunts advancements that could be made synergistically using strengths in both approaches, just as the One Health approach promotes (Schelling *et al*., 2008). Merging and utilizing the advantages of both can center and amplify Indigenous knowledge in concert with Western technology and processes.

INDIGENOUS FRAMEWORKS

Two-Eyed Seeing is a framework that strives to connect Indigenous ways of knowing with Western ways of knowing, created by Elders Albert and Murdena Marshall from the Mi'kmaq community in Nova Scotia (Martin, 2012). Two-Eyed Seeing recognizes there are multiple forms of understanding, some of which come from Western epistemologies and some of which come from Indigenous epistemologies, and that they can coexist. Another Indigenous framework, the Four Rs, has been introduced into Western scientific practice as a way to guide collaboration with (1) respect, (2) relevance, (3) reciprocity, and (4) responsibility. Yet, partnership between Indigenous knowledge keepers and Western scientists must be carefully navigated to avoid exploitation of people and knowledge (Garnier *et al*., 2020).

Advancements are being made to center Indigenous voices and TEK within One Health, however, gaps remain, and strides need to be taken toward collaboration between Indigenous and Western ways of knowing. (Pete, 2016). (Re-)Indigenization has been defined as follows:

> The transformation of the existing academy by including Indigenous knowledges, voices, critiques, scholars, students and materials as well as the establishment of physical and epistemic spaces that facilitate the ethical stewardship of a plurality of Indigenous knowledges and practices so thoroughly as to constitute an essential element of the university. It is not limited to Indigenous people, but encompasses all students and faculty, for the benefit of our academic integrity and our social viability. (Peltier, 2018, p. 10).

Under this definition, One Health requires re-Indigenization as well as space in which TEK keepers can work with Western One Health practitioners to create strengthened efforts and relationships. As summarized:

> One Health research has to: (i) recognize and respect diversity regarding approaches to an understanding of health; (ii) acknowledge and appreciate social and cultural difference; (iii) analyze and take into account uneven power relations; and (iv) pay attention to how associations between disparate social worlds are configured. We affirm that research approaches also need to include consideration of the impacts and contributions of humans on human, animal, and environmental health. (Whittaker *et al*., 2021, p. 76).

This project sought to identify ways that Indigenous science, models, and language can inform actions that Western scientists should take to respect and support Indigenous science and scientists.

Methods

PRELIMINARY INTERVIEWS

This study takes a qualitative approach by using participant interviews to guide results and recommendations. Twelve formative (phase 1) interviews were conducted over Zoom in June–August 2022 in which 12 Indigenous scientists and knowledge keepers were asked to describe how the Four Rs (respect, relevance, reciprocity, and responsibility) related to their life, their worldviews, and to One Health. Responses from these interviewees indicated important values held in their Indigenous communities. Thematic identification was conducted using open coding and pile sorting methodologies (Yeh *et al*., 2014). Phase 1 participants determined that the themes which resulted following thematic identification represented principles and values held within their Indigenous knowledge systems that they felt were underrepresented or missing within their experiences with Western sciences. Identified themes included the natural world, cultural heritage, value expression, and reflection. We then convened a group of interview participants, referred to as the advisory group, to decide aspects of these themes we wanted to further explore. Together with this advisory group, we employed a co-creative process to transform these themes into semi-structured interview questions to inquire further. The advisory group provided guidance on the use of accessible and culturally attuned language for the questions to be used in the subsequent (phase 2) interviews. The advisory group also offered advice on how to develop relationships and respectfully conduct interviews with Indigenous individuals.

RESEARCH PARTNER POPULATION

The interviewee research partner population included 19 adult self-identified Indigenous scientists and knowledge keepers. In this context, knowledge keepers refer to individuals who practice, teach, and sustain the traditional knowledge and ways of their Indigenous communities and teachings. For both the formative and subsequent (phase 1 and 2) interviews, the participants were required to reside in the continental United States and the Hawaiian Islands. Participants were also required to speak fluent English and have access to the internet, email, and Zoom. Most or all research partners spoke English as their first language, and translation services for the interview guide and interviews were neither offered nor made available to research partners. Some research partners were trained in Indigenous scientific practices and knowledge systems, while others were trained in Western institutions while maintaining connection to their Indigenous cultural backgrounds. All research partners identified themselves as having lived experience as an Indigenous person. Career backgrounds of research partners varied, including ecology, midwifery, engineering, and psychiatry.

PARTICIPANT RECRUITMENT

Participants were recruited for the subsequent interviews (phase 2) using three recruitment strategies (Supplementary Materials: Appendix B). First, snowball sampling was conducted utilizing referrals from participants of the formative (phase 1) interviews. Snowball sampling follows Indigenous research methodologies by highlighting connectedness and relationality in research (Kennedy *et al*., 2022). Some interviewed participants also shared the interviewer's contact information with their personal network. Second, participants were also enrolled through convenience sampling, in which potential participants were directly contacted due to their interest in the project. Finally, study team members also reached out to individuals who indicated interest in the formative (phase 1) interviews of the project but did not complete a phase 1 interview. In recruitment outreach, all participants were provided with the interview questions and were informed that compensation would be given following their interview. Compensation is another important element in Indigenous research methods as it honors and provides reciprocity for knowledge that is gifted to the project.

INFORMATION SOURCES AND COLLECTION PROCESSES

All interviews began by obtaining consent to record the Zoom meeting, followed by an introduction to the interviewer and a description of the project. Then, the interviewee was prompted to introduce themself and, optionally, to share their age status (youth, adult, or Elder), their affiliation with academia (affiliated or non-affiliated), their Indigenous community affiliation(s), and their occupation. Then, the five interview questions were asked orally and typed in the Zoom chat (Supplementary Materials: Appendix C). Notes were taken during the interviews for later reference. After the interviews, participants were contacted through a follow-up email to express gratitude for sharing their time, information, and language and were provided with a US$40 e-gift card compensation. Compensation, gratitude, and personal connection heed best practices to show respect and reciprocity in Indigenous communities (Kennedy *et al*., 2022). Data saturation was neither considered nor discussed because each participant shared unique and personal experiences and perspectives.

INFORMATION STORAGE AND LOGISTICS

The interviews were conducted in English, and the interview guide was provided in English. With support from the advisory group, the interview guide was created to be comprehensible and linguistically accessible to multilingual speakers and speakers with first languages other than English, particularly of Indigenous languages. Information collection occurred via Zoom meeting recordings stored as .mp4 files.

The .mp4 files of each interview were individually uploaded into the Microsoft Word web browser transcription feature. To correct mistakes or misspellings that were made in the automatically generated digital transcript, the audio file was played while reading through the text document. Cleaned transcripts were not returned to participants for review or feedback; however, participants were later contacted for approval to use quotes.

CODING OVERVIEW

The first author of this paper [MP] served as the only coder for the thematic analyses due to limited resources and fulfillment of MP's master's thesis. The prepared transcripts were imported into ATLAS.ti software for coding and thematic identification (Supplementary Materials: Appendix D). Inductive open coding was used in which codes and rules for coding were created as needed throughout the coding process and no a priori codes, meaning codes that were created before the interviews based on previous knowledge, were established (Essential Guide to Coding Qualitative Data, 2024). While coding, the coder was reflective of their positionality as a white, Western-trained researcher attaching labels to Indigenous voices. In an effort to reduce bias, in vivo coding was utilized whenever possible. The advisory group supported coding by rewording codes to ensure culturally attuned phrasing. After all the transcripts were coded, the codes were reviewed to ensure accuracy and relevance across all interviews and were collected to form the codebook (Supplementary Materials: Appendix E). In the codebook, each code was given a description of its use in the coding process, as well as inclusion and exclusion criteria. Once the codes were created, they were grouped with related codes into broader categories. The categories were then synthesized into themes that explicated the messages identified throughout the interviews.

ADVISORY GROUP

Due to the positionality of MP as a white, non-Indigenous, Western-trained researcher, all interview participants were invited to join the advisory group. The advisory group ensured that Indigenous perspectives and voices were included and emphasized in all aspects of the project. The advisory group supported the creation and naming adjustment of transcript codes and categories by proposing new ideas and phrasing that better aligned with Indigenous research methodologies. Then, the advisory group worked with the coder to co-create new themes that bridged and were guided by Western and Indigenous practices. The advisory group also provided support regarding sharing information, permission, and consent with Indigenous collaborators. The advisory group met twice, one time prior to the start of the interviews and one time following completion of the interviews, after the codes, categories, and themes had been drafted. Advisory group members have maintained communication through email to provide feedback on quotes, manuscript sections, presentations, and other additional guidance.

ETHICAL CONSIDERATIONS

The Institutional Review Board (IRB) at the University of Washington determined that this project was not human subject research and therefore was IRB exempt (STUDY00015154). Additionally, another ethical consideration was the inclusion of Indigenous people throughout this project as it would be unethical as Western scientists to extract information from Indigenous communities without intentional inclusion of Indigenous advisors.

Results

RESEARCH PARTNER POPULATION

A total of 19 interviews were conducted for the subsequent (phase 2) research over an 8-week period from January to March 2023. Interview lengths ranged from 15 min to 2 hours with an average duration of 40 min. One interview was conducted over two sessions, but no repeat interviews were conducted. Amongst the participants, 57.4% (n = 11) identified as an adult, 10.9% (n = 2) identified as an Elder in their community, 0% identified as a youth, and 31.7% (n = 6) of participants did not provide an age status. With regards to academia, 67% (n = 12) of participants were a part of academia, 27.7% (n = 5) were not a part of academia, and 5.3% (n = 1) did not provide a response. Amongst the 19 individuals that participated in the subsequent (phase 2) interviews, those who chose to indicate their Tribal or Indigenous affiliations represented 13 Tribal nations and Indigenous groups.

THEMATIC RESULTS

During the formative (phase 1) interviews in 2022, Indigenous scientists and knowledge keepers were asked to describe how the Four R's (respect, relevance, reciprocity, and responsibility) related to their life, their worldviews, and to One Health. Following phase 1 thematic identification, four themed categories emerged: the natural world, cultural heritage, active values, and reflection (Fig. 1).

In the subsequent (phase 2) interviews which occurred in January–March 2023, 20 codes were identified throughout the

coding process (Supplementary Materials: Appendix E). The 20 codes were used a total of 608 times with 327 quotes throughout the 19 transcripts. The most used codes were *values* (n = 129), *connection to environment* (n = 84), and *knowledge keepers* (n = 43). The *values* code was the only code used in every transcript. *Connection to the environment* was used in 89.5% (n = 17) of the transcripts and *knowledge keepers* was used in 84% (n = 16) of the transcripts.

The 20 codes created were batched into six categories, and each of these categories were transformed into a theme in collaboration with the advisory group to encompass the important ideas and broader impact attached to the codes (Table 1). The six themes created by the advisory group highlight a few foundational principles that are common throughout Indigenous communities.

Honor and acknowledge your identity and belonging in your work

Many participants noted in their interviews that it was important for them to uphold their Indigenous identity and bring their lived experiences into their work. Participants noted how this contrasts from the desired subjectivity often found in Western physical, natural, psychological, and biomedical science. One participant who worked in Western academic spaces noted "*I feel like we need to infiltrate [research] in a sense. To make it more representative, make it more… look like me and I think me being here changes that dynamic."* This quote highlights the need to support people with diverse experiences within academia, particularly Indigenous identities. This individual also notes that their presence in research changes the dynamic typically consisting of white, Western, dominant voices. Another participant spoke to the importance of integrating identity in one's work, "*The work that we do as Indigenous people is so deeply relational that I can't just pull myself out of my research… it is an honor and it's a responsibility."* The quote demonstrates the importance of relationships in one's work, which differs from the impersonal, objective approach many Western scientists take. As one participant further explored:

> Standard objective science was very much like I'm this blank slate and positionality was kind of hidden… [Indigenous science] was very much the opposite, and that your position, your family, where you come from should be stated at the very beginning so your reader knows who you are talking to… people want to know who you come from so they can kind of gauge what school of thought you are coming from.

This quote provides an important example of drawing a parallel between one's family being similar to one's academic upbringing – both greatly influence work and worldview. The quote also introduces the importance of family-based identity in many Indigenous cultures. Another participant stated:

> In every community, in every family, there are cultures, there are beliefs, and there are morals that have to be followed for a family to identify itself. There are still families that have tried as much as possible to uphold their traditional cultural beliefs and heritage, despite all these modern issues that are coming up as time goes by.

In addition to supporting individuals with diverse identities within research and academic spaces, it is also necessary to create a space where Indigenous Peoples feel a sense of belonging. Several participants mentioned that representation matters, including encouraging youth to envision themselves in academic spaces. Moreover, representation extends to Indigenous researchers taking control of the Western narrative about Indigenous Peoples. As one participant said:

> The folks who were writing the history of Hawaiians and Hawaiian culture were not people of place…. It's really having a seat at the table, getting more Hawaiians…people of place, who are more invested in that community, in the people, to be doing the work.

These quotes work powerfully to broadcast the importance of representing one's identity and positionality clearly and proudly around their work.

Recognize community-based and land-based healing that takes care of us and needs care in return

One of the most prevalent themes to come out of the interviews, connection to the environment, made a clear statement of importance to Indigenous communities with nearly 90% of participants speaking of their connections to natural and social surroundings. Participants also noted that their relationship to

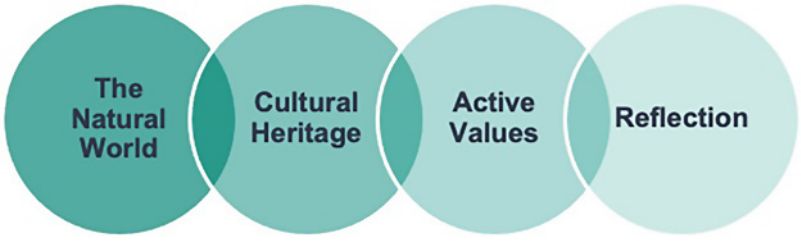

Fig. 1. Four themed categories that emerged from phase 1.

Table 1. Categories and themes created in collaboration with the advisory group.

Categories	Themes
Identity and belonging	• Honor and acknowledge your identity and belonging in your work.
Holistic expression	• Recognize community-based and land-based healing that takes care of us and needs care in return.
Contrast with Western culture	• Elevate Indigenous knowledge expression.
Sharing information – education	• Use storytelling to teach and educate, especially from Elders to youth.
Power in action	• Claim, revive, and protect your work and set it into action.
Maintaining community and cultural practices	• Participate in practices that contribute to community and identity.

land is closely tied to identity. One individual describes the deep connection their community has with taking care of the environment. They said *"Environmental stewardship and conservation is woven into who we are as a people. We live it in our everyday lives, and it is an integral part of who we are."* This quote serves as a great example of how environmental stewardship is intertwined to some Indigenous practices. However, not all participants held the perspective of stewardship being a culturally shared responsibility. As one participant said:

> I guess there is this whole notion of stewardship. It kind of comes from a different cultural lens than our traditional understanding of our role… We aren't really superior to any other being so this whole notion of stewardship suggests that maybe there's a hierarchy… Our superiority as humans and us being the only entities on the planet who can really have the ability and wherewithal to understand the dynamics and balance that exists in the ecosystem… We're very much in our traditional understandings of how we are co-located with all these other beings. We're just a part of the broader web or living things within our ecosystem.

This participant speaks of stewardship not as a responsibility that humans hold because they are capable of being caretakers of other species and their shared environment, but rather that humans are as integrated into the ecosystem as all other beings. Due to the connection that humans share with their environment, people are motivated to engage in practices that uphold environmental health such as stewardship initiatives. As another participant noted:

> I think the mental health, the spiritual health, and connection that is meant to happen between humans, animals, and the environment is definitely going to happen because it's just natural. It's something that lives deep within us, but we never give it the chance or time to feel it or be connected to our surroundings.

Other participants also noted the connection between humans and the environment including connection and kinship with animals. As one participant said:

> When you talk about mutualism, it's about both species or organisms benefiting from each other. So in our efforts to, for example, plant trees, we give home to animals like birds and humans benefit from our environment being cleaner due to removal of carbon dioxide… We are working together to ensure that the ecosystem is maintained.

This participant notes the importance of the shared environment and making sure that the ecosystem remains healthy. Another quote also highlights the foundational concept of the One Health approach that humans, animals, and the environment are all connected and must support each other to survive and thrive. As one participant who specifically mentions the One Health paradigm said, *"In terms of community,… [we] can come together and ensure that the environment is safe for humans and also animals just to bring that sense of belonging and togetherness in society when it comes to One Health."* The participant introduces another meaning of environment, extending past the physical landscape and encompassing the social relationships that are driven by community, togetherness, and feelings of belonging. Regarding the social environment, one participant explained:

> We engage in the community by supporting community relationships. We do have some tenants of community care with some values like reciprocity… of being able to support one another in ways you know are really needed… [we] learn healing modalities and be in community where youth and Elders are all attended to.

These quotes show that sustaining social environmental health is as important as natural environmental health. And, by recognizing that all beings are connected to humankind like a family network, supporting other life by extension upholds social environmental wellbeing.

Elevate Indigenous knowledge expression

As the participants mentioned in Theme 1, Indigenous scientists exist in Western-dominated scientific spaces. Thus, Western scientists should amplify Indigenous researchers who work in Western scientific places and live in Western-dominated cultures. As one participant described:

> There's so much information that lies among [Indigenous] people and maybe most of them are afraid to come forward and give all this information because they are afraid that they will not get enough support. So I think it's essential for all this information to come to light, whichever possible. Just to make sure that the current generation of people or the young children grow up knowing that they need to respect animals, they need to respect the environment.

In this quote, the participant makes clear that Indigenous knowledge is not elevated due to the fear that Indigenous ideals will not be supported by Western scientists, or that it will be misused. However, it is critically important to ensure the safety of sharing Indigenous knowledge so that current and future generations can learn and maintain that intergenerational information, especially relating to stewarding animals and the environment. The contrast with Western approaches was brought up as another participant provided the example, *"Evidence-based medicine is a tool but it does not embody a holistic Indigenous perspective whatsoever… I can easily see the link between how evidence-based medicine is weaponized against people… and that's done with the environment as well."* This quote highlights the danger of focusing only on physical health (for example, evidence-based health concerns) while ignoring mental, emotional, and spiritual health, as well as the health of the environment. It also notes that evidence-based and Western-based medicine and science does not always work within Indigenous communities. As another participant stated, the most effective way to make a difference in an Indigenous community is to create the solution within that community. They explained:

> We're adapting a Western tool for an Indigenous community. What we need to do is start in the Indigenous community and build the tool, because then it's going to be effective because it's based in Indigenous knowledge… We need to start thinking Indigenously… I'm not discounting Western ways because we have to bridge, we have to come to the middle. That Two-Eyed Seeing approach so that we take the best of both worlds because we are living in that world.

Therefore, Indigenous methods and tools must be created for Indigenous communities by and for Indigenous communities with the assistance of Western resources and networks to elevate Indigenous knowledge.

Use storytelling to teach and educate, especially from Elders to youth

The themes of storytelling and education were significantly present, with 74% (n = 14) of participants speaking about storytelling in their interviews and 63% (n = 12) talking about teaching youth. Three key values of storytelling emerged from the participant transcripts: education, intergenerational connection, and cultural teachings. Storytelling can be a powerful tool for education, as one participant explained, *"We can find meaning in stories from the old days and things that have been passed down through the centuries that is science. That's not just some fairytale story book."* This quote describes the Traditional Ecological Knowledge teachings that storytelling can hold and how it can relate with Western science which also practices storytelling as a way to educate youth and share teachings. Another participant touched on this while relating it to the current (or "now" generation), urging:

> It's high time that you bring these things together, these things back and we involve the storytellers and all these people, all these traditional Indigenous communities. We have to bring them back to life because sometimes they just feel like they are not being

> appreciated, yet they are literally the ones that are making our environment healthy for us to live in. That is why I think it's just time to bring all the traditional concepts and everything back to the now society and train all or give all this information to the now generation, the current generation. Because I think they do not understand the connection between the environment, themselves, and the animals as well.

This quote introduces the second idea of using storytelling to connect generations of community, to appreciate those who hold traditional knowledge, to emphasize the importance of preserving knowledge, and to provide teachings to the youth. As one participant summarized:

> In a nutshell, it's acknowledging the depth of our ancestral knowledge, understanding and practicing it in a way that we can then share it with the next generation without it getting lost in translation. The passing of our ancestral knowledge to the next generation is how I uphold my responsibility in maintaining the bridge between the past and the future.

Another participant touched on the importance of honoring Elders and traditions, saying:

> We're losing our relationship with our Elders, our knowledge keepers… it allows us to call out and honor and respect the histories, the histories of research, the histories of environmental injustice… the biggest thing is reconnecting and making sure that those ties are there while we still have Elders here.

The quote above introduces how storytelling also carries and teaches traditional practices, the third concept to emerge from quotes related to storytelling. Moreover, participants shared how storytelling is used to educate and share culturally important knowledge. As another individual put it, *"Storytelling is one of my favorite ways to just share information, to transit from, to embody it, and to share it, just to bring our stories and our songs to life."* Bringing to life, revival, and longevity are all values that highlight the necessity of using storytelling in culture and education. To underline the importance of supporting cultural and scientific education through stories and storytellers, a participant urged, *"The biggest thing that brings power is education. Especially to people that are underrepresented. So to know your history and to respect that."* These quotes speak to the reasons that education, cultural knowledge, and intergenerational connection to community are empowering and nourishing.

Claim, revive, and protect your work and set it into action

Just as Indigenous knowledge should be sustained through intergenerational education, interview participants also called for bringing back cultural practices through teachings and actions. Yet once knowledge is recognized, many participants noted that it must be protected from misuse, misinterpretation, and intellectual theft. In one interview, a participant said, *"I can't talk with you about many issues because I need permission of the community."* Asking for permission and consent to share and use information was raised as an issue of high importance, especially in research contexts such as this project. On this topic, the same participant noted, *"Many people [say] only 'I want the information' and they don't [give] back the results of that investigation with their community. [They] keep the information."* Further, some non-Indigenous researchers may not see the complexity and cultural value of the information they seek to gain. Another participant raised the concern of extractive and manipulative research, saying, *"I know as an Indigenous person and researcher that a lot of our communities have mistrust because of historically being taken advantage of. So I think any researcher could learn that there should be more community involved, always."* This quote introduces the critical consideration of involving the community and not taking information away from the individuals who are sharing their knowledge. Another individual spoke to the sensitivity they feel about sharing information. They said:

> I think it directly relates to being incredibly protective of what we nearly lost. In our case, the erasure of our culture and traditional practices, our sense of identity, our language, and our ways of being. As far as permission goes, that is really important. Ensure that the people you are speaking to and getting information from are comfortable sharing and being very aware of that. Additionally, some information simply will not be shared, because it is not meant to be shared.

This participant brings up the importance of permission, which became a recurrent theme throughout the interviews. Another participant added, "*If you were in Indigenous spaces or trying to center Indigenous voices, then that information and that permission needs to come directly from the source. It needs to stay there and never move."* This quote included the importance of not extracting knowledge, rather keeping it with the source of information. Amplifying and centering Indigenous voices, a key intention of this project, also presented in several interviews. One individual noted:

> [This] is such deep emotional work because we lose a lot, we are not listened to a lot, we are not heard a lot. And so a lot of times it's going to be specific people who can be those in-between voices… Unfortunately it means that those who are the most quiet are not going to ever be heard, let alone listened to.

Not being listened to or heard is highlighted in the preceding quotes and in the interviews of several participants. Participants brought up that some community members are more separated from Western society and therefore less heard by outsiders. These individuals may also be protected by that separation, which prevents their knowledge from being taken or misused. Due to the historic exploitation of Indigenous information, understanding how and why permission and information is protected in Indigenous communities is necessary for working with Indigenous Peoples and working closely with Indigenous knowledge.

Participate in practices that contribute to community and identity

For many of the individuals interviewed, being active and engaged in their communities and traditional practices was a core part of their described experiences. However, some participants described challenges they face in participating in cultural activities. As one individual said, *"I've seen that busyness of life. We can lose sight of practicing and upholding these values."* Another participant similarly spoke of the need to revive the presence of traditional actions into daily life. They said, *"Maybe [Mother Earth] sent that pandemic to make us stop and realize that we're taking her so much for granted and that we need to start implementing some of these practices into everyday life."* Other participants described ways that they remember their traditions and history and how that relates to community identity. One participant explained:

> If we do not know our ancestor's history, we cannot be good in our present for us. So history, memory, are always important for us to be remembering…You know your identity, and [if] your grandparents did good things or bad things. You have the responsibility to improve, to be better.

This quote introduces the key principle of responsibility, which was a value brought up throughout the interviews. Another participant expands on the actions they take to support the community and culture. They said, *"I feel like my role on the earth, doing the research that I do, is how I uphold responsibility and accountability within the stewardship of Mother Earth."* This quote, and the quotes above, carries the interwoven message that supporting and upholding traditions is personally and communally important. Another participant added:

> We want to support one another in maintaining our unique Tribal traditions, and we are able to join in in whatever way is appropriate… We're able to really come together as a larger community and to be able to continue to support and maintain that knowledge and those

> relationships… That definitely varies from Tribe to Tribe, depending on what folks have gone through. I think there's a real strong need and interest in maintaining those traditions… I think we are kind of in a renaissance period right now, actually over the last 20 years and still the case moving forwards, of being able to bring those practices into research settings in a way that is respectful and that is appropriate and that is with community input and oversight so that way we can maintain those traditions and also leverage them as a way to improve overall public health and population health.

This quote excellently summarizes the critical concepts of supporting one another, protecting traditions and knowledge so that they can be honored and shared, and using relationships to maintain community. Every interview participant shared their practices and knowledge that they use to contribute to their personal and community identity.

Discussion

The goal of this project is to learn from Indigenous leaders about Indigenous models, values, and practices – such as Two-Eyed Seeing, earth stewardship, and compensation as reciprocity – that can be honored and supported by Western scientists in One Health practice. We believe that all the Indigenous lessons, values, and methods shared throughout the paper, particularly in the interview quotes, would benefit One Health topics. The effort of Western scientists honoring and amplifying Indigenous science and scientists aims to create reciprocal and sustainable collaboration that centers and uplifts Indigenous voices in partnerships within One Health. To achieve this goal, interviews were conducted to explore aspects of Indigenous knowledge systems that are underrepresented, and therefore unsupported, in Western scientific approaches in One Health. The idea of amplifying Indigenous ways of knowing within and outside of One Health recognizes that whether or not Indigenous peoples participate in Western science, academia, or customs, they maintain Indigenous perspectives and can serve as knowledge holders of diverse Indigenous epistemologies.

The partners who participated in interviews highlighted Indigenous values of identity and belonging, holistic expression, contrast with Western culture, sharing information-education, power in action, and maintaining cultural and community practices. Following the direction of Indigenous leaders and these identified areas, Western scientists can show up as allies to support Indigenous principles and peoples.

The themes explored in this paper are expressed as action items that Western scientists and One Health practitioners can and should take to support Indigenous ways of knowing (including TEK), and to amplify Indigenous voices (Table 2). These directives were created with the advisory group to specifically guide Western scientists to fill the gaps that separate Indigenous and Western approaches.

This project commenced with a call to listen, unlearn, and learn. Then, a guiding question emerged: in what ways are Indigenous science and Western science, or TEK and One Health, respectively, similar and different? One Health is specifically evaluated here as it is seen as an area of Western epistemology that shares core considerations with some Indigenous scientific practices, particularly related to TEK. Though ideals that bridge One Health and TEK were brought up in the interviews such as connection to the environment and being part of a larger system, the themes call attention to Indigenous values that must be further supported in Western scientific practice.

As mentioned in the introduction, some work has been started to investigate shared values amongst TEK and One Health practitioners. The Four Rs – respect, relevance, reciprocity, and responsibility – represent points of connection and collaboration. For example, it is a central feature of One Health practice to work in strong transdisciplinary partnerships, connecting local leaders to academics to participatory community members and all in between who uphold these values within One Health efforts (Zinsstag *et al*., 2023). Further, literature demonstrates that centering Indigenous values, such as the Four Rs and others recognized in this paper, in higher education and Western-educated spaces could lead to better work and education outcomes for students (Kirkness and Barnhardt, 1991). Lastly, another outcome of this work is that operationalizing the values and themes which emerged from the interviews lays the groundwork for creating One Health research, programs, and broader community settings that uplift other epistemologies in the current Western-dominated One Health landscape (Jacobs *et al*., 2022).

This project is motivated by the use of Indigenous and Western perspectives simultaneously to create a new way to look at a problem, solution, or situation. The action items and themes represent efforts for Western scientists to be more respectful and intentional collaborators when working with Indigenous people. This work is important because it checks co-opting TEK in One Health and encourages strengthened co-creation between Western and Indigenous scientists.

LIMITATIONS

There are limitations that have impacted this project. One main limitation is that the primary author and members of the study team identify as non-Indigenous and cannot contribute personal lived experiences as Indigenous people, nor can they personally provide Indigenous perspectives, to this body of work. To mitigate the continuation of Western scientists maintaining dominant

Table 2. Themes and action items for Western scientists created in collaboration with the advisory group.

Themes	Action items for Western scientists
• Honor and acknowledge your identity and belonging in your work	Acknowledging personal identity within one's work, situating power, privilege, and marginalization, when appropriate
• Recognize community-based and land-based healing that takes care of us and needs care in return	Respecting the reciprocal caretaking of the social and natural environments
• Elevate Indigenous knowledge expression	Centering Indigenous science and scientists
• Use storytelling to teach and educate, especially from Elders to youth	Supporting storytelling as a way to share information and strengthen intergenerational relationships
• Claim, revive, and protect your work and set it into action	Claiming and promoting your work and setting it into action to have a lasting impact on communities from past, present, and future
• Participate in practices that contribute to community and identity	Contributing to identity by partaking in community activities with cultural humility

voices, the Indigenous partners were involved in decisions made throughout the progression of this project following their interview. Further, Indigenous partners also participated in the editing of this paper. Another limitation within the study team was that only one coder was used. As this was a Master's thesis project, there were limitations to having multiple coders on the team due to lack of resources, coder availability, and time. This led to potential biases and lack of reflection, though this was slightly mitigated by the support of the advisory group. Because there was only one coder, it was not possible to perform inter-coder consensus assessments and inter-rater reliability checks.

Several limitations affected participant enrollment and subsequently whose voices were amplified. The participant population was restricted to individuals who had internet connection, email addresses, and Zoom capabilities. Further, it is typical in One Health work to approach language diversity by allowing research participants to communicate in their native or first language and then translate and back translate the transcripts. However, limitations in time, resources, and personnel restricted the interviews and subsequent collaboration with the advisory group to occur in English, which the authors recognize is a language that represents and is of colonial domination and power. In this project, most of the participants use English as their first language.

As with many aspects of this work that stemmed from preliminary interviews, phase 2 participants were referred or directly contacted which meant those who were recruited had a relationship with a previous participant or a member of the study team. The authors made a cognizant choice to interview those working at the intersection of Indigenous and Western worldviews (e.g. those in academia or those teaching Indigenous principles to Western audiences) as a first point of learning, trust building, and collaboration. This approach led to results where the voices of youth, some Elders, and non-academic knowledge keepers were not amplified in this project, but this approach was considered a necessary first step for the authors. Future studies will prioritize building relationships to connect with additional perspectives.

The partners that were interviewed shared stories, traditions, and teachings relevant to their communities; however, it is critical to recognize that the participants cannot speak on behalf of the beliefs and experiences of everyone in their community or Indigenous group, nor to the perspectives of all Indigenous peoples. Rather, the objective of this work is to be guided by shared values of the participants, while avoiding oversimplification, to create objectives for Western scientists.

Finally, one limitation that impacted the richness of information was the lack of time and resources available to build relationships with individuals and communities. Throughout the interviews, participants shared testaments to the importance and power of relationship building in Indigenous communities. However, with the limited time and resources available, members of the study team were not able to devote necessary time toward fostering relationships, trust, respect, and reciprocity with interviewed partners and with communities. It is difficult to assess how lack of relationship development affected this project and how it would have benefitted from relationship-based research methods.

CONCLUSION

Through the process of meeting with Indigenous leaders, knowledge keepers, and scientists, study team members and participant-partners were able to identify both similarities and differences between TEK and the Indigenous knowledge systems it comes from and One Health along with the Western knowledge systems it is tied to. Due to common core values in One Health and in TEK, the One Health approach exists as a point of connection to TEK which brings together Western and Indigenous sciences. The action items that were co-created by Western and Indigenous scientists represent accessible and immediate ways that Western scientists can support Indigenous values and science. This must be done in and out of One Health work without assimilating and appropriating Indigenous knowledge into Western dominated sciences. This is important because it can help Western scientists be better collaborators with Indigenous scientists, and it can make One Health more inclusive of Indigenous ways of knowing. In addition to the ideals and beliefs identified by partners during their interviews, this work highlighted the need to build relationships within scientific and social spaces. Finally, this paper serves as the first step in a process to educate Western scientists on One Health and Indigenous principles to include diverse perspectives into all efforts.

CONFLICT OF INTEREST

The authors have no conflicts of interest to declare.

ETHICS STATEMENT

The authors confirm that the research meets any required ethical guidelines. The Internal Review Board (IRB) at the University of Washington has deemed this project exempt. Participants were asked to provide consent on the use of quotes in the manuscript and related presentations. Participants were also invited to review the manuscript and provide input and feedback.

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AUTHOR CONTRIBUTIONS

JM and VR made substantial contributions to phase 1, as well as the conception and design of phase 2. MP performed the thematic identification process for phase 1 interviews and coordinated all aspects of phase 2, including developing the interview guide, recruiting and enrolling participants, conducting interviews, performing the thematic analysis, and drafting the manuscript. JM, VR, and DN edited the manuscript and provided guidance for interpretation of themes and development of action items. GPA, CA, KC, MV, and NE guided the development of the interview questions, provided feedback on quote use, supported thematic identification, and edited the manuscript. All authors have read, edited, and approved the submitted version of the manuscript.

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DATA AVAILABILITY

Data such as interview recordings and coded transcripts are stored on a password-protected computer. Interview transcripts contain personal identifying information and are therefore not available for public use.

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