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SPECIAL SECTION

Evolving wildlife management cultures of governance through Indigenous Knowledges and perspectives

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Abstract

Within governance agencies, academia, and communities alike, there are increasing calls to recognize the value and importance of culture within social-ecological systems and to better implement Indigenous sciences in research, policy, and management. Efforts thus far have raised questions about the best ethical practices to do so. Engaging with plural worldviews and perspectives on their own terms reflects cultural evolutionary processes driving paradigm shifts in 3 fundamental areas of natural resource management: conceptualizations of natural resources and ecosystems, processes of public participation and governance, and relationships with Indigenous Peoples and communities with differing worldviews. We broadly describe evolution toward these paradigm shifts in fish and wildlife management. We then use 3 case studies to illustrate the ongoing cultural evolution of relationships between wildlife management and Indigenous practices within specific historical and social-ecological contexts and reflect on common barriers to appropriately engaging with Indigenous paradigms and lifeways. Our case studies highlight 3 priorities that can assist the field of wildlife management in achieving the changes necessary to

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bridge incommensurable worldviews: acknowledging and reconciling historical legacies and their continued power dynamics as part of social-ecological systems, establishing governance arrangements that move beyond attempts to extract cultural information from communities to integrate Indigenous Knowledges into dominant management paradigms, and engaging in critical reflexivity and reciprocal, accountable relationship building. Implementing these changes will take time and a commitment to processes that may initially feel uncomfortable and unfamiliar but have potential to be transformative. Ethical and culturally appropriate methods to include plural and multivocal perspectives and worldviews on their own terms are needed to transform wildlife management to achieve more effective and just management outcomes for all.

KEYWORDS
culture, culture change, governance, Indigenous Knowledges, paradigm shift, social-ecological systems, stewardship, transformative change

There are increasing calls to understand the role of culture in natural resource conservation and management (Gavin et al. 2018, Manfredo et al. 2021*a*). These involve the cultures of governance agencies themselves (Berl et al. 2022), the social contexts in which they exist (Pascual et al. 2023), and how those cultures evolve (Manfredo et al. 2021*b*). Reflective of this trend are efforts to operationalize Indigenous Knowledges (IK) and perspectives in research, policies, and management (Tengö et al. 2017, Fisk et al. 2021, Reid et al. 2024). Indigenous Knowledges are the full knowledge-belief-practice systems of Indigenous Peoples, informed by and intertwined with Indigenous worldviews and cosmologies, are heterogeneous across and within Indigenous communities, and evolve over time (Cajete 2004, Houde 2007, Berkes 2012, Latulippe 2015, Jacobs et al. 2025). Efforts to operationalize IK thus far have often raised ethical concerns regarding approaches that seek to assimilate IK and paradigms into those of wildlife institutions based on dominant paradigms of natural science (Nadasdy 2005, Ramos 2018, Reid et al. 2021). This approach assumes the dominant conception of natural science is the standard for comparing all other forms of knowledge and worldviews, and that IK can be separated from the context in which it is situated (Houde 2007, Latulippe 2015). Such an approach can end up being more extractive and exploitative than collaborative, simply garnishing dominant paradigms and practices with examples of Indigenous culture (Fisk 2022).

Although dominant natural science approaches strive for objectivity, the enterprise of natural resource management, including institutions of wildlife management, is reflective of its cultural origins and built on a particular set of cultural viewpoints and assumptions (J. J. Fisk, University of Hawai'i at Mānoa, unpublished report). The history and development of institutions responsible for natural resource management can be viewed as a cultural evolutionary process driven by mechanisms of cultural inheritance and selection (Currie et al. 2021, Salerno et al. 2021). Changes in governance processes can be adaptive, in that they yield greater cooperation and regulatory compliance, greater collective welfare for humans and other environmental components, and enhance the long-term survival and resilience of governance institutions (Folke et al. 2005, Armitage et al. 2012, Ostrom 2014, Waring et al. 2015). Conversely, a failure to adapt to changing ecological and sociocultural conditions can lead to reduced relevancy, support, and trust, and suboptimal or inequitable outcomes across peoples and ecosystems (Manfredo et al. 2020, Sullivan et al. 2022).

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Many of the challenges to appropriately engaging with IK stem from the incompatibility of a wildlife management culture premised on the separation of humans and nature and cultures whose worldviews are instead based on the interconnectedness of people and nature (J. J. Fisk, unpublished report). This type of incompatibility is often referred to as incommensurable, where concepts or paradigms have no common measure and are fundamentally neither comparable nor compatible (Kuhn 1996, Pascual et al. 2023). In addition to core beliefs about the fundamental relationship between people and nature, a recent report identifies incommensurabilities in understandings of stewardship, design of institutions, and governance arrangements that have impeded effective support and implementation of IK in natural resource management (J. J. Fisk, unpublished report). Although not yet fully institutionalized, 3 current directions in the intentional adaptation of the governance of natural resources indicate potential for paradigm shifts that together may begin to bridge these incommensurabilities: 1) the acknowledgment and redressing of historical legacies and the power imbalances they continue to produce within social-ecological systems, 2) the creation and continual evolution of governance arrangements that move beyond attempts to extract cultural information from Indigenous communities to integrate IK into dominant management paradigms without institutional transformations, and 3) the engagement of agencies in critical reflexivity and investment in reciprocal, accountable relationship building with Indigenous Peoples.

In the past few decades, natural resource management goals have broadened from a focus on single species management to ecosystem-based management, including viewing ecosystems as coupled human and natural systems, or social-ecological systems (Leong et al. 2019, West et al. 2020). Similarly, approaches for systematically valuing facets of social-ecological systems originally focused predominantly on economic metrics, but broader approaches to valuations have emerged to account for diverse worldviews (Pascual et al. 2023, Hoelting et al. 2024). Typologies regularly include instrumental values (e.g., wild animals to sell or eat) or intrinsic values (e.g., the importance of animals existing in the wild), and attention is now turning to relational values—the meaningful relationships between people and nature and among people through nature, such as the reciprocity and care often central to Indigenous worldviews (Pascual et al. 2023). This cultural shift within natural resource management is characterized by a shift away from paradigms that separate humans from nature to relational paradigms that seek to understand connections between humans and nature and explore how Indigenous relationalities can influence this shift (West et al. 2020, Gould et al. 2023). Yet management institutions separated into silos by the type of resource, or even species, have made such integrated ecosystem-based management approaches difficult to define and implement (Long et al. 2015, Delacámara et al. 2020). Further, while some social values may be included in social-ecological systems models, uptake of relational values and diverse cultural meanings has been limited (Pascual et al. 2023) and values external to the institutions are still largely excluded from wildlife decision-making frameworks (Lake et al. 2018). In some instances, the importance of IK and its incommensurability with existing management practices is acknowledged (Fisk et al. 2021, Jacobs et al. 2022*a*). For example, narrative assessments of effects to Indigenous cultures have been offered in parallel to quantified natural science metrics of ecosystem condition (Office of National Marine Sanctuaries 2019). While this approach starts to elevate IK, it still does not create a clear pathway for IK to be implemented in natural science-based management processes or identify how cultural evolution within agencies could allow for greater commensurability with IK.

Public participation and governance in wildlife management have undergone similar stepwise evolutions. Historically, the reliance on scientific management resulted in the use of top-down technocratic approaches where managers using dominant natural science philosophies decided what was best for the public. Laws such as the National Environmental Policy Act (42 U.S.C. §§ 4321 et seq.) began including minimum requirements for public input within agency decision-making processes, often interpreted and institutionalized as consultation and public scoping sessions (Walesh 1999). More recently, governance arrangements that emphasize dialogue and collaboration have emerged because of an acknowledgment of the need to understand social processes, listen to diverse voices, and address conflicting value systems, morals, ethics, and philosophies (Berkes 2009, Leong et al. 2011, Winter et al. 2021). Such public engagement strategies emphasize possibilities for co-management and knowledge co-production that are more difficult to achieve in standard public engagement approaches (Leong et al. 2011).

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A study conducted in 2011 within the United States Department of the Interior identified the emerging paradigm shift toward dialogue-based approaches to public engagement; however, interviewees also indicated that "Somehow it hasn't yet gelled…the agencies are not quite believing in it enough to let it happen yet" (Leong et al. 2011:240). Instead, agencies still largely follow the top-down public input model wherein agency decisions are often defended against public comments rather than use comments to substantially modify decisions, falling short of engaging in the co-production of knowledge and decisions (Reed et al. 2018). Thus, while a need for transformation in public participation and governance has been recognized for decades, sufficient public engagement focused on mutual learning and collaborative deliberation is still not common practice. Further, public engagement approaches are largely premised on the assumed power structure of the agency as the main decision-maker and may not explicitly recognize Indigenous Peoples, including federally recognized Tribes and Nations, as rightsholders who must be consulted and collaborated with in nation-to-nation dialogues and diplomacy (Stark et al. 2022, Jacobs et al. 2022*b*). These culturally institutionalized power dynamics within dominant public participation models will need to be overcome to achieve real progress in addressing social inequities in management and bridging incommensurable worldviews.

Relationships between dominant wildlife management institutions and Indigenous Peoples in the United States have also evolved dramatically. The founding of the United States was based on ideologies, such as the Doctrine of Discovery and Manifest Destiny, that justified domination of European settlers over the environment and Indigenous Peoples, which resulted in active genocide, removal, and dispossession of the original stewards of the lands (Miller 2019). Native Peoples were often displaced to reservations and suffered cultural erasure and forced assimilation; many Indigenous children were removed to boarding schools and languages and cultural practices were outlawed (Ramos 2018). Although these ideologies of dominance manifested in different ways and evolved with changing contexts as the United States grew, many institutional structures and policies continue the subjugation of Indigenous lifeways (the practices, values, and paradigms that co-evolved with the environment for generations, premised on kincentric worldviews and reciprocal relationalities; Stark et al. 2022, Jacobs et al. 2022*a*, Oberholzer Dent et al. 2023).

The first few decades of the twenty-first century have seen growth in the United States government and the public at large formally acknowledging the legacies of harms to Indigenous communities, and the beneficial effects of Indigenous stewardship on the environment. Interest in Traditional Ecological Knowledge (TEK), a form of IK, emerged as a way to recognize IK and stewardship and to bring Indigenous practices back into ecology, but TEK was a term coined by academics that does not resonate with some Indigenous practitioners (Ramos 2018). Further, early experiences did not treat TEK as legitimate in its own right but attempted to distill IK into new data points to fit into established ecological models without addressing the power imbalances and social inequities against Indigenous Peoples (Nadasdy 2005). Indigenous scholars and practitioners have argued for methods that center IK in management discourse, recognizing that these knowledge systems are based on thousands of years of reciprocal, kincentric relationships with the environment (Salmón 2000) and have resulted in some of the healthiest wild areas in North America (Hoagland and Albert 2023).

This recognition of the significance of IK and the ethical imperative to support Indigenous lifeways is beginning to be expressed in high level policy. Most recently, the United States Government has developed implementation guidance for federal agencies recognizing the value of IK and setting expectations that IK will be included in federal decision-making (Prabhakar and Mallory 2022*a*, 2022*b*). But practices still tend to focus on how IK can be added to existing models, plans, and decision-making processes rather than bringing dominant wildlife management and Indigenous cultures into productive dialogue and synergy while addressing pertinent power imbalances (Latulippe 2015, Reid et al. 2021, 2024). Therefore, by examining 3 case studies presented here as examples of the intentional adaptation of governance institutions, we seek to address how natural resource management can evolve to achieve a full paradigm shift where Indigenous cultures and other incommensurable cultures are engaged with, accounted for, and achieve parity within environmental governance in respectful, effective, and ethical ways.

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METHODS

Positionality

We draw from our own lived and learned perspectives to detail how culture and cultural evolution relate to natural resource management and demonstrate how that relationship can be operationalized to systemically improve environmental governance and stewardship. The group of authors for this paper is composed primarily of social science or transdisciplinary research practitioners working within environmental governance agencies and institutes (particularly, but not exclusively, within the United States at the state and federal levels) and academics positioned within higher education institutions. The lead and several other authors are Indigenous (Taíno Boricua, N'dee [San Carlos Apache], Miwkoʔ, Karuk), although the majority are not. We have made concerted efforts to center the scholarship and perspectives of Indigenous Peoples.

Case studies

The authors of this paper were brought together as part of a working group to investigate potential applications of cultural evolutionary science (Mesoudi 2016) to natural resource management. The goal of this group is to improve decision-making and facilitate institutional adaptation through a better understanding of the processes of sociocultural change and associated impacts on current management and conservation challenges. We met regularly through 2022 and 2023 and identified an opportunity to provide cultural evolutionary context to ongoing efforts to operationalize and institutionalize IK in management and policy. We examined 3 case studies through the lens of cultural evolutionary theory to develop broader insights and identify key lessons that could be used to institutionalize transformative change. We drew the cases from areas of our own professional involvement and developed the cases and lessons analyses to distill core commonalities and synthesize concepts from diverse literatures including stakeholder engagement, adaptive governance, and critical Indigenous studies.

In this paper, we detail 3 cases that represent a variety of natural resource issues, United States geographies, and dynamics between Indigenous Peoples and wildlife management agencies: relationships with gray wolves (*Canis lupus*) in the Great Lakes, cultures of the seas in West Hawai'i, and fire stewardship in California. We describe the history of each case, including changing perceptions of natural resource agencies towards the resources and Indigenous Peoples, and highlight successes and challenges in moving forward together. We pay particular attention to drivers influencing institutional cultural shifts within each case study and the implications for improving the effectiveness and efficacy of endeavors to implement IK within wildlife management.

RESULTS

Relationships with wolves in the Great Lakes

The history of gray wolf (ma'iingan in the Ojibwe language; plurally ma'iinganag) management in the upper Great Lakes region of North America is long and complex. Prior to European colonization, wolves, including a number of subspecies of the gray wolf and other closely related canids, likely occupied the full breadth of suitable ecosystems on the continent (vonHoldt et al. 2024). State and federal governments attempted to extirpate wolves using bounties, poisoning, and policies that encouraged take and reduced perceived conflict with agriculture and other activities like deer (*Odocoileus* spp.) hunting (Hornaday 1913, Trefethen 1975). By the mid-1900s, the northeastern corner of Minnesota was potentially all that remained of the breeding range of gray wolves in the contiguous

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United States. Despite continued efforts through state-sponsored bounties, shooting, and trapping, wolves were never fully extirpated from this region (Erb and DonCarlos 2009).

Following protections afforded under legal precursors leading up to the passage of the United States Endangered Species Act of 1973 (ESA; 16 U.S.C. § 1531 et seq.), and under the care of Tribal Nations, wolves have seen recovery in the region. As of 2022, the wolf population in Minnesota remains stable at about 2,700 animals and has been well above federal recovery targets for several years (Erb and Humpal 2022). The Minnesota population has served as a source for natural recolonization through migration to other states including Wisconsin and Michigan that also now have resident wolf populations (Wydeven et al. 2009, Schley et al. 2022).

The success of wolf recovery in Minnesota is juxtaposed with the broader context of wolf management across the Great Lakes region and the rest of the United States. While wolves likely occupy the full extent of their present habitat in Minnesota and other parts of the upper Midwest, they only occupy a small portion of the amount of land across their historical range because of a variety of factors, prominently including human land use (Erb and Humpal 2022, van den Bosch 2023). This situation has led to numerous legal challenges to the ESA status of different wolf metapopulations: gray wolves, both nationally and within the Great Lakes region have been removed and placed back on the threatened and endangered species list several times (Martin et al. 2020, Honig and Takacs 2023), with the most recent decision in 2022 resulting in federal relisting of the species as threatened in Minnesota and endangered in other contiguous states outside of the Northern Rocky Mountain region (U.S. Fish and Wildlife Service 2023). The fluctuating status of federal protections has had implications for policy at the state level, making effective management more difficult and wrought with conflict (Olson et al. 2015). When states have had authority for wolf management, they have at times instituted wolf hunting and trapping seasons. Minnesota held a wolf hunting and trapping season from 2012 to 2014 (Erb and Humpal 2022), and Wisconsin state law mandates a wolf hunting and trapping season in years that the species is not federally listed (Wisconsin Statutes § 29.185). States also administer contentious policies like lethal control programs, often in coordination with the federal government, to mitigate predation on livestock. Implementation of these policies differs in areas where wolves are federally endangered, rather than threatened as is the present status in Minnesota.

Alongside the history of relationships between state and federal governments and the wolves of the Great Lakes are the fluctuating relationships between government agencies and the Indigenous Peoples of the region. Most of the extant wolf range in the upper Great Lakes overlaps with the ancestral lands of the Ojibwe Peoples. Sixteen federally recognized Ojibwe Tribes, Bands, and Nations, in addition to other Native communities beyond the upper Great Lakes, have standing treaties with the federal government that describe their reserved rights to hunt, fish, gather, and exert influence over the management of fish and wildlife species and their habitats on ancestral lands, known in this region as ceded territories (Oberly 2014). These Tribes also possess sovereign reservation lands on which they express sole discretion over managing fish and wildlife, including wolves. The Voigt decision and Mille Lac decision, the rulings of Lac Courte Oreilles v. Voigt and Minnesota v. Mille Lacs Band, respectively, in the late 1900s affirmed their rights to hunt, fish, and gather on ceded territories (Loew and Thannum 2011). Through these court cases, Ojibwe Bands used legal mechanisms as a route to challenge unjust colonial power dynamics and drive a cultural shift regarding whose rights and relationships are deemed valid and protected within wildlife management. The Great Lakes Indian Fish and Wildlife Commission (GLIFWC), a Tribal entity composed of 11 Bands (but not all of the Ojibwe Bands in Minnesota and Wisconsin), was formed shortly after the Voigt decision to assist with conservation, management, and policy of Tribal resources (Oberly 2014). Additionally, the 1854 Treaty Authority, an inter-Tribal resource management agency, works to protect, preserve, and enhance the rights of Tribes to hunt, fish, and gather on lands within the 1854 Ceded Territory (Thompson 2020). Consequently, the Authority is another key part of wolf stewardship in the upper Midwest.

The natures of the relationships between Tribes and state fish and wildlife management agencies vary and have changed over time. While examples of collaboration between state agencies and Tribal governments abound, some issues rise to the courts for settlement. In spring of 2021, the Wisconsin Department of Natural Resources (WDNR) opened a wolf season, and had partnered with the GLIFWC to determine a sustainable yield of 200 wolves

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(ma'iinganag), of which 118 would be allotted to WDNR and 81 would be allotted to the Tribes. The Ojibwe chose not to harvest their allotted wolves, thus functionally lowering the effective harvest to 118. The state ultimately issued tags at a ratio of 10 permits per allotted wolf, which led to the overharvesting of 218 wolves (Schley et al. 2022). The lack of careful planning that led to the wolf overharvest ultimately led to a federal civil lawsuit between the Lake Superior Ojibwe Bands and WDNR in September 2021 to stop the 2021 hunt with the Bands arguing that the take by state-licensed hunters and trappers effectively consumed the Tribes' quota (violating the Voigt decision) in 2020 and could do so again in 2021. The federal court ultimately declined to issue a ruling because of a separate injunction in State Court; nevertheless, political trust was damaged between the WDNR and Tribes because of the perceived violation of Tribal rights, culture, and Knowledges (Schley et al. 2022). The wolves in Wisconsin were placed back on the endangered species list and the state designed a new wolf management plan in 2022, with increased co-managerial planning with Tribes, that created zones around reservations where hunting would be limited to reduce the chance of killing wolves from reservation packs.

Like Wisconsin, Minnesota has a unique, evolving relationship with Tribal governments regarding wolves. The governor of Minnesota issued an executive order (Executive Order 19-24 2019) on Tribal consultation, coordination, and cooperation in 2019. Among other provisions, the order directs Minnesota state agencies to consider the results of Tribal consultation in decision-making, and to seek mutually beneficial solutions to challenges of mutual interest. The order affirms the state's respect for Tribes' rights to sovereignty and self-determination, recognizing that diverse perspectives arising from relationships with Tribes are a benefit to all. Further, the order directs state agencies to develop plans for consultation and encourages state staff to coordinate with Tribal staff early and often. This sentiment is reflected in the approach of the Minnesota Department of Natural Resources (MNDNR) today, and the agency has evolved substantially in its efforts to understand, incorporate, and operationalize IK and perspectives in management.

In 2022, MNDNR revised its wolf management plan (MNDNR 2022) with the meaningful inclusion of Tribal perspectives. This occurred through several paths including 1) formal government-to-government consultation, 2) informal and routine staff-level collaboration on research and management, 3) inclusion of staff from Tribal government natural resource management agencies on a technical working group, 4) an invitation to Tribal community members to serve in an *ad hoc* basis on an advisory committee on the planning process, 5) an invitation to Tribal government resource managers to review and offer suggested edits to the draft plan, and 6) inclusion of a section regarding Tribal perspectives on wolves informed by conversation with Tribal community members and Tribal government natural resource management agency staff in the plan itself (MNDNR 2022:25). This illustrates how state wildlife management institutions and sovereign Tribal entities can work together to productively include and implement aspects of IK in complex planning efforts. In this case, the collaborative nature of and shared decision-making powers within the co-management arrangement reinforced reciprocity between state and Tribal governments and facilitated cultural change within wildlife management in the region. It is important to recognize that different Indigenous cultures within Minnesota, and individuals within those cultures, possess different relationships with wolves. Wolf range in the state currently overlaps the ancestral lands, reservation boundaries, and treaty resources of several Anishinaabe (including Ojibwe) Peoples. While the boundaries of Minnesota overlap other Indigenous cultures (e.g., Dakota Peoples), Ojibwe perspectives are reflected in the section of the plan because of the particular cultural significance of wolves for Ojibwe Peoples and the geographic distribution of wolves on the Tribal lands and ceded territories of the Ojibwe Bands.

To assist with the Minnesota co-managerial planning, GLIFWC staff held several conversations with Tribal members and natural resource management staff. Those perspectives were included directly in the plan. Not all of the positions preferred by Ojibwe Tribes in Minnesota are reflected in the plan, and while increased coordination represents a step forward from historical relationships between the state and Tribes, much work remains. Ojibwe participants wished to highlight several perspectives on wolves (ma'iinganag). First, that wolves hold a central role in the Ojibwe creation story where wolves are seen as brothers to humans. Consequently, the dominant scientific notion of wildlife management is incommensurable with the Ojibwe relationship to wolves, which centers the right

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of wolves to exist and people's responsibility to them, a kincentric relationship that contrasts with prevalent management paradigms of domination over the environment. Second, the Ojibwe have coexisted with wolves for centuries, which has led to the development of Knowledges to inform stewardship; the Ojibwe Peoples appreciate wolves for their role in the ecosystem and support maintaining populations in the state. Third, Ojibwe perspectives on relations to wolves inform their sovereign approaches to stewardship. These perspectives include the notion that wolves should determine their own population and range, and that taking the life of an individual is very serious and requires substantial justification; non-lethal techniques to reduce or prevent conflict should precede lethal ones. Finally, Indigenous Peoples' perspectives on wolves are varied and sovereign governments require independent consultation to best support stewardship. Importantly, these perspectives do not articulate the Ojibwe Peoples' deep meanings for wolves, but they do articulate some Ojibwe perspectives on human relationships with wolves as informed by IK.

Incorporating these perspectives in the plan led the plan authors to critically reflect on elements of the broader document, including how the presentation of the issues fits with IK (MNDNR staff, personal communication). The term wolf management, for instance, is value-laden and reflects the implicit cultural assumptions of the MNDNR and the people that operate under its authority. Staff revised the plan to consider the long-term goals of the document and used terms to best reflect them. Ultimately, the term wolf stewardship is used in many instances in the document and directly reflects learnings from engagement with Ojibwe collaborators and IK. Yet stewardship remains human-centric and does not fully account for the relational nature of human–wolf interactions from Ojibwe perspectives.

There have been increasing efforts to engage in co-managerial planning for wolves in Wisconsin and Minnesota. While their paths have been slightly different, the continued cultural evolution within agencies and engagement with diverse communities, stakeholders, and rightsholders has led to more inclusive solutions and a steady cultural shift within wildlife management institutions. This evolution reflects a growing pressure from scholars and practitioners in wildlife management to critically evaluate whether traditional wildlife management principles of the early to mid-twentieth century (primarily focused around a limited stakeholder base) are representative of the diverse values surrounding nature (Decker et al. 1996, Gavin et al. 2018, Manfredo et al. 2021*a*, Pascual et al. 2023). By reframing the managerial frameworks and engaging in shared power within co-management arrangements and decision-making processes, natural resource managers may build greater partnerships to enhance wildlife management decisions and policies, support an evolving Land Ethic (Leopold 1920), and sufficiently engage all stakeholders and rightsholders, particularly Indigenous environmental stewards, to benefit the long-term sustainability of ecological communities.

Cultures of the seas in Hawai‘i

In the era preceding European contact and influence, fisheries in Hawai‘i belonged to the people and were governed on behalf of the chiefs by konohiki—a class of people responsible for overseeing and governing the stewardship and use of resources, such as loko i‘a (fishponds) and fishing. Konohiki were often responsible for resources at the ahupua‘a (social-environmental divisions often corresponding to watershed boundaries) or ‘ili (subdivisions within ahupua‘a) scale, accountable to the ecologies and communities of those places and the ali‘i (chiefs) they answered to, mirroring principles of place-based, nested governance arrangements (Winter et al. 2018). Konohiki governance was premised on deeply intergenerational relations and kinship with the ‘āina (the land, or that which provides), with their responsibilities borne of those relations and cultural norms of kuleana (rights and responsibilities) to ‘āina and community, particularly to ensure the cultivation and perpetuation of abundance through the generations (Kosaki 1954). Even wild capture fishing included stewardship practices such as caring for the ko‘a (fishing grounds) by feeding fish or resting areas, which continue today.

In an attempt to protect the land from harmful foreign interests, King Kamehameha III divided the lands among the people of Hawai‘i in 1848, introducing private land ownership through what is now known as the Great Māhele

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(Beamer 2014). After the overthrow of the Hawaiian Kingdom by a coalition of Euro-American businessmen and the United States military in 1893 and the subsequent annexation in 1898, rights to govern seascape relationalities (e.g., fishing, recreation, infrastructure) were taken over by federal and territorial governments, and eventually state government after Hawai'i became the fiftieth state in 1959. Coinciding with missionary-driven ethnocide, disease-driven decimation of Kānaka 'Ōiwi (Native Hawaiian) communities, and social upheaval preceding and following the coerced instatement of United States rule over Hawai'i, cultural and social infrastructure was degraded and actively replaced with colonial approaches to governance and natural resource management (Kosaki 1954, Trask 1999). As with other Native cultures across the United States, many aspects of Hawaiian culture were almost lost to colonialism. Coincident with social movements across the United States, the Hawaiian Renaissance in the 1970s renewed attention to traditions such as Polynesian voyaging and revitalized the use of 'Ōlelo Hawai'i, the Hawaiian language. Although there remained kīpuka (refugia) wherein Hawaiian cultural values and practices, including fishing traditions, continued to be practiced (McGregor 1995), the violent dispossession of cultural lifeways, including traditional fisheries governance, has been a source of deep hurt for Hawaiian communities that continues to fester given the entrenching and perpetuation of imposed government institutions (Higuchi 2008, Akaka et al. 2019).

The last century of seascape governance in Hawai'i has replicated the evolution of the set of values, norms, and practices that characterize the North American Model of Wildlife Conservation (Eichler and Baumeister 2021), with state and federal agencies following practices developed and standardized in the continental United States. The positioning of federal fisheries management within the Department of Commerce in the 1970s reiterated a focus on fish as a commodity, with optimization of economic value and jobs as the priority for managers while maintaining sustainable stocks. This contrasts with strong local traditions of sharing and gifting fish that continue today (Vaughan and Vitousek 2013), influenced by Kānaka 'Ōiwi and people from diverse Asian heritages who were brought to Hawai'i to work on plantations (Leong et al. 2020). Seascape governance has also conformed to the institutionalized standards of top-down public engagement models that meet required minima via familiar practices such as listening sessions and public meetings. While efforts are made to reach conventional constituents, typically centering the fishing industry and conservation organizations, processes are less aligned with and generally do not allow for the place-based governance that many kūpuna (elders) and local families still remember and advocate for (Ingram et al. 2020), thus perpetuating the denial of community agency over the stewardship and governance of their seas.

Since the Hawaiian Renaissance in the 1970s, the desire to see Hawaiian values and norms restored within seascape governance in Hawai'i—for Hawai'i to be governed in accordance with the cultures born of the 'āina—has fueled bottom-up advocacy and organizing. This has resulted in pockets of innovation where culture and community guidance have been pushed to the forefront, driving the cultural evolution of agencies in Hawai'i through direct pressure and by demonstrating modes of seascape governance and stewardship grounded in Hawaiian culture, Knowledges, and values. At the state level, this has been exemplified by Community-Based Subsistence Fishing Areas (CBSFAs) in which communities are given greater agency to define place-based fishing regulations and monitoring strategies based on the cultures and values of those communities. Communities such as Hā'ena on the island of Kaua'i and Mo'omomi on the island of Moloka'i have pushed to be designated as CBSFAs to attempt to bring Hawaiian values into dominant marine governance structures, although there have been grievances around the lack of true decentralization and sharing of decision-making powers to communities and the coerced contorting of culture to fit into state structures and processes (Higuchi 2008, Vaughan et al. 2016). Because of this lack of power sharing and institutional rigidity, with dominant seascape governance culture persisting as the core paradigm, CBSFA "legislative mandates [have been] insufficient to ensure meaningful integration of indigenous knowledge without [first] changing inequitable policies, reorganizing agency structure, and devolving decision making" (Vaughan et al. 2016:42). Despite these hurdles, some communities, such as Mo'omomi, have engaged in informal governance of their seas through strategies like discouraging fishing during spawning season and in nursery habitats and encouraging gatherers of limu kohu (*Asparagopsis taxiformis*) to spread

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spores while they collect the prized macroalgae, leading to far higher local abundance of desired species compared to similar coastal waters throughout Hawai'i (Poepoe et al. 2007, Hui Mālama O Mo'omomi 2017).

The State of Hawai'i Department of Land and Natural Resources (DLNR) has also initiated the Holomua Marine Initiative, which is working with communities to achieve shared nearshore management goals founded on pillars of place-based planning, pono (a Hawaiian cultural value that entails being appropriate, correct, and just) practices that encourage responsible behavior, monitoring, and restoration (Department of Land and Natural Resources 2022). These efforts of DLNR have been largely prompted by recognition from community and agency members of the incompatibility between dominant, centralized management approaches and the place-based, culturally rich and heterogenous relationships communities in Hawai'i have with the seas. Therefore, the Holomua Marine Initiative is being conducted in collaboration with navigation teams composed of local community members and an advisory network of scientific experts (including members of other local agencies) and cultural practitioners to develop management regulations and monitoring plans that are congruent to local cultures, particularly Hawaiian culture.

At the federal level, National Oceanic and Atmospheric Administration (NOAA) Fisheries, the body within the Department of Commerce responsible for marine fisheries management, has begun to transition from more conventional single-species fisheries management to ecosystem-based management (Levin et al. 2009). The National Integrated Ecosystem Assessment Program was developed to implement ecosystem-based management for fisheries and has been working to develop social indicators, such as cultural ecosystem services indicators. Cultural ecosystem services frameworks have been criticized for missing many crucial biocultural relationships and misrepresenting the underlying cultural paradigms of those relationship (Fish et al. 2016, McElwee et al. 2022); thus, the West Hawai'i Integrated Ecosystem Assessment has initiated work with local communities to expand beyond typical approaches to include holistic and reciprocal ways of relating to the ocean (Leong et al. 2019). Similarly, NOAA Fisheries is coordinating with DLNR and NOAA's Office of National Marine Sanctuaries and the Coral Reef Conservation Program to collectively improve social and cultural monitoring efforts in culturally grounded ways, although these efforts are just beginning.

These pockets of innovation have been highly correlated with the formal inclusion and involvement of Kānaka 'Ōiwi in related management design and decision-making processes, particularly those who have deep, accountable relationships with cultural practitioners and local communities, Hawaiian and otherwise. These people often act as cultural bridges within management structures and processes, translating and implementing culture within seascape governance in far more adaptive and meaningful ways than through standard public participation strategies, therefore functioning as drivers of cultural evolution within agencies. Such was the case of the 'Ōiwi NOAA employees who, over a process that lasted >10 years, applied Hawaiian culture and values toward marine protected areas with the development of Mai Ka Pō Mai, a Native Hawaiian guidance document for the management of Papahānaumokuākea Marine National Monument (Quiocho et al. 2023:2):

> "The Mai Ka Pō Mai framework is a structured visual representation of Hawaiian cosmology and worldview as it relates to the geography of Hawai'i. This framework also represents the culmination of key experiences from co-management and co-governance, and the co-generation, co-production, and co-application of knowledge. The framework supports the balanced and unified development of collaborative management systems and decision making among the co-managing agencies and the Native Hawaiian community."

Agents of cultural shift often face deeply ingrained institutional rigidity, bureaucracy, and jurisdictional siloing that prevent transformative change. As well-intentioned as those efforts are, the lack of institutional will to transform in accordance with Indigenous and local cultures can lead to overburdening the public for input that is only nominally included within management structures without any deeper paradigm shifts. Therefore, these efforts ultimately still treat IK as mere add-ons to dominant natural science information, further exacerbating community

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grievances while allowing for the perpetuation of inequities surrounding whose cultures get centered or marginalized within seascape governance.

Because the cultures of management agencies remain largely unchanged, the degree to which ʻIke Hawaiʻi (Hawaiian Knowledges) can be foundationally operationalized in seascape stewardship is severely limited ethically and practically. As reflected by CBSFAs, even when culture is permitted to become legally ratified, governance structures require cultural norms and practices to conform to dominant structures rather than transforming institutional cultures and policies to be more commensurable with the cultures and biogeography of Hawaiʻi. Even when sought out for programmatic and policy considerations, Hawaiian culture is often treated as an addendum or a supplementary feature or as data points included within dominant models; it is rarely regarded as a foundation upon which governance agencies in Hawaiʻi can build, although there have been recent exceptions such as Mai Ka Pō Mai (Office of Hawaiian Affairs et al. 2021, Quiocho et al. 2023). ʻIke Hawaiʻi, as with other IK, is a living, evolving body of Knowledges that is inseparable from the practices, paradigms, and practitioners who actualize and tend to them. As such, operationalizing and institutionalizing ʻIke Hawaiʻi sufficiently and ethically would fundamentally require foregrounding Hawaiian culture, including the communities who hold and live those Knowledges, instead of the dominant environmental governance cultures that are often treated as acultural baselines and institutional givens rather than cultural products and projects in and of themselves (J. J. Fisk, unpublished report).

A fundamental step towards transformative cultural change of seascape governance in Hawaiʻi is investing ample time and resources into cultivating reciprocal and accountable trust with communities, particularly cultural practitioners whose expertise and relations will be pivotal for the cultural transformation of management agencies (Quiocho et al. 2023). Such an investment was essential for the development of Mai Ka Pō Mai and has been vital for ensuring the cultural alignment and ethical quality of the Holomua Marine Initiative. These relationships, like all generative relationships, will require building trust, particularly to overcome hesitancy and tensions born from histories of dispossession and community exclusion associated with dominant environmental governance structures. In our professional and personal interactions, community members often stress how building this trust will take time and a demonstrated track record that agency partners can be trusted, which itself requires continual commitment and accountability to the community. The aspect of accountability is key for multiple reasons, not least of which is that there is no singular cookie-cutter guideline or procedure to follow when engaging and partnering with communities. Furthermore, the continual transformation of management agencies to follow community guidance will be paramount for accountability to the communities and cultures of Hawaiʻi, lest structural inequities be perpetuated, as has been the case with CBSFAs.

New ways of interfacing with communities are necessary to ensure culture, particularly ʻIke Hawaiʻi, guides Hawaiʻi seascape governance in a place-based manner. Just as an ʻōlelo noʻeau (Hawaiian proverb) states that i ulu nō ka lālā i ke kumu (the branches grow because of the trunk), programs and policies will need to foreground a solid foundation in Hawaiian culture and ʻIke Hawaiʻi both in structure and in process. This includes hiring, resourcing, and granting greater agency to the communities of Hawaiʻi, particularly people deeply rooted in Hawaiian cultural practices and communities of practice, as these strategies have been demonstrated drivers of cultural shifts and failure to invest in these strategies has impeded the success of pockets of innovation. Collaborating and synergizing transformative efforts across jurisdictions in accordance with nested governance principles, including with community groups who are often the frontline for monitoring and stewarding the Hawaiʻi seascape, will be imperative for implementing ecosystem-based management that is place-based and rooted in the cultures of Hawaiʻi such that efforts compound rather than compete.

Fire stewardship in California

For hundreds of generations, fire stewardship has been integral to the lifeways of Indigenous Peoples across the region now known as California (Lake 2007, Marks-Block et al. 2019, Adams 2023*b*). Native cultures adapted to

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local landscapes and ecological processes by developing sophisticated fire stewardship practices linked to climate and environmental conditions, evolving to become fire-dependent cultures, in which people rely on fire to sustain critical elements for their societal well-being (Lake 2007). For example, >75% of Karuk traditional food and cultural use species are enhanced by fire (Lake 2007, Norgaard 2014). A focus on what flourishes in response to burning (e.g., plants, fungi, animals) rather than merely focusing on what is taken away by fire (e.g., fuel and hazard reduction) is a fundamental aspect of Indigenous fire stewardship that distinguishes it from typical prescribed burning by government agencies in California (Hankins 2021). Indigenous Peoples have viewed cultural use of fire as a right and a responsibility, with deep connections to spiritual beliefs (Eriksen and Hankins 2014, Clark et al. 2021, Lake 2021).

European colonization left legacy effects including genocide, forced displacement of Native Peoples, and environmental devastation from mining and timber harvest (Norgaard 2019). The seizure of Native lands by European and Euro-American governments led to the denial of rights to hunt, fish, gather, and burn, which are all components of responsible land stewardship that have maintained Indigenous cultural identities (Adams 2023*b*). One of the foundations of this process is the historical and current disruption of Native land tenure through broken and unratified treaties. In California, colonial governments imposed laws that affected these Indigenous cultural practices. As early as 1793, a Spanish Governor introduced a prohibition on Indigenous burning (Anderson 2006). After the United States Government admitted California to become a state, its emissaries negotiated 18 treaties with Tribes across California, with a promise to reserve 3 million hectares of land, but at the behest of California officials, the Senate refused to ratify them and even kept them hidden for decades (Miller 2013). In 1850, the California state legislature passed the Act for the Government and Protection of Indians, which sanctioned the removal of Indigenous Peoples from their traditional lands and the abduction and forced servitude of Native children, and criminalized the setting of fires and failure to extinguish fires in prairie lands (Beitzel 2013). Early European and Euro-American perspectives viewed Indigenous burning as a threat to economic interests (e.g., property, timber, agricultural production) and dismissed it as being rooted in superstition or only as a tool for hunting animals (Crouse 1902, Harley 1918, Leopold 1920). Letters written over a century ago in a California Game and Fish magazine laid out some of the tensions between Native interests in frequent burning to promote desired plants and animals, including elk (*Cervus elaphus canadensis*), American black bears (*Ursus americanus californiensis*), grizzly bears (*U. arctos horribilis*), and mule deer (*Odocoileus hemionus*), and the concerns of non-Indigenous wildlife managers for displacing timber and grass for deer and cattle with brush after fires (Editor 1916).

Fire suppression within national forest reserves in Northwest California began in 1905, followed by broader state and federal prohibitions (Anderson 2006), including the 10 a.m. policy, which stipulated control of all forest fires by 10 a.m. (Pyne 1981). But some Euro-American foresters, several of whom had formative experiences working on Indian reservations where fire practices were either recently evidenced or being continued by Tribal members, reported the valuable effects of burning in reducing fuels and protecting larger trees from damage (Arno and Fiedler 2005). Nevertheless, suppression remained the dominant policy and Indigenous Peoples were subject to persecution, including arrests and threats of violence, for attempting to maintain their fire practices (Norgaard 2014).

Fire governance shifted earlier in the southeastern United States, where traditions of cultural burning had become more deeply rooted in Euro-American culture. Forest Service prohibitions on prescribed burning were rescinded earlier in the twentieth century (Murphy and Cole 1998). The Tall Timbers Research Station in northern Florida emphasized the critical role of fire in sustaining bobwhite quail (*Colinus virginianus floridanus*), longleaf pine (*Pinus palustris*) forests, and other associated biodiversity. In a 1965 treatise considering how humans came to recognize the importance of fire, one the founders of Tall Timbers, E. V. Komarek, made a point of highlighting how Indigenous Peoples such as Hopi, “succeeded in that hostile climate because of this [cultural system of passing down IK] and because they were on intimate terms with their total environment including weather, soils, plants, and animals” (Komarek 1965:207). Agency culture and governance in the western United States began to shift significantly in the 1960s, as the National Park Service began to embrace the role of fire and greatly increase the

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use of prescribed burning in California (Leopold et al. 1963, Vinyeta 2022). However, prescribed burning was used as a professional activity with heavy regulation rather than drawing from long-standing cultural practices informed by place-based traditions (Biswell 1999). Although many Tribes regularly employ prescribed burning for fuel reduction, often following practices standardized across federal and state governments (Figure 1), Indigenous cultural practitioners emphasize the differences in worldview and objectives when applying fire in a deeper cultural context (Tom et al. 2023). Consequently, while Yosemite National Park became a key demonstration area for the value of restoring naturally ignited wildfires and prescribed fires, there remained key tensions in restoring the Indigenous stewardship practices that had maintained the iconic groves of pines (*Pinus* spp.), oaks (*Quercus* spp.), and sequoias (*Sequoiadendron giganteum*) in the Park (Deur and Bloom 2020).

Many Tribes and Indigenous communities in California are working to overcome the trauma and legacies of colonialism, including fire suppression, as they revitalize their land stewardship roles using cultural fire (Aldern and Goode 2014; Eriksen and Hankins 2014, 2015; Long et al. 2017, 2021; Maclean et al. 2023; Tom et al. 2023). These efforts have to overcome continuing institutional barriers to cultural burning, including continuing imposition of burn bans (Norgaard 2014), and regulation and certification systems that are inconsistent with Indigenous cultures of governance (Clark et al. 2021, Marks-Block and Tripp 2021). Burning practices are regulated to protect air quality, reflecting a cultural norm in agencies that views smoke as primarily a pollutant and hazard to be avoided, while Tribal practitioners recognize that smoke is a medicine that has purifying and rejuvenating effects for the land and its people (Hankins 2021, Long et al. 2021). According to traditional Karuk dipnet fisherman and former cultural biologist for the Karuk Tribe Ron Reed: "Knowledge hierarchies that exclude Indigenous [P]eoples can assert narrow definitions of expertise that privilege Western scientific knowledge systems over Indigenous knowledge systems, and delegitimize Indigenous land management authority on the basis of disputed historical and legal frameworks" (Reed and Diver 2023).

Eriksen and Hankins (2014, 2015) describe the gendered roles of cultural practices and among Native California communities and colonial impacts on these roles. Traditionally, men usually maintained responsibilities for fire, although women assumed large roles owing to a variety of factors including the removal of men from their communities (Eriksen and Hankins 2015). Native women used fire to tend patches of plants for food, medicine, and fiber for weaving. Basketry materials are a primary motivator for burning, and many of the fine baskets used in food preparation and clothing have been made by women; consequently, the art of basketweaving strongly symbolizes the contributions of

FIGURE 1 Melinda M. Adams leading a cultural burn at the Tending and Gathering Garden (Woodland, California, USA). Photo by Jonathan Long.

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Indigenous women to society (Risling Baldy 2018). Native women in California have led many of the recent efforts to uphold these cultural traditions (Adams et al. 2023*a*), including through the efforts of the California Indian Basketweavers' Association to negotiate agreements with state and federal agencies to support safe gathering and use of fire (Oberholzer Dent et al. 2023). Agencies have responded by actively supporting Indigenous cultural fire in important policies and programs (California Wildfire and Forest Resilience Task Force 2022), including training opportunities led by and for Indigenous women (Adams 2023*b*). The state of California has explicitly included cultural burning by practitioners in recent legislation (SB 332 and AB 642), has provided funding to support Indigenous burning through grants from the Regional Forest and Fire Capacity Program to the Indigenous Stewardship Network, and has initiated discussions for establishing prescribed fire training centers that explicitly include cultural burning and Tribal engagement. Awareness of the broader complexities of relationships centered around fire have led to calls for new institutions and new language, including explicit inclusion of cultural practitioners and burners (Goode et al. 2022) rather than limiting frameworks to professional firefighters.

Some of the institutional challenges to expanding use of fire are directly connected to wildlife conservation. To conserve threatened species such as spotted owls (*Strix occidentalis*) and fishers (*Pekania pennanti*), standards were established that require high levels of tree canopy cover, although subsequent research has challenged such metrics in favor of maintaining presence of tall and large trees rather than smaller trees and shrubs that can increase wildfire risks (North et al. 2017) and can inhibit Indigenous stewardship. Indigenous Knowledges of the dependencies of certain ecosystems and associated cultural values on fire and smoke has been particularly important in resolving perceived tensions with wildlife conservation. For example, Tribal experts highlighted complex food webs that centered on production of quality acorns from oaks, and maintenance of large hardwoods that form cavities used by various old-forest associated animals (Long et al. 2017). Tribal practitioners explained that maintaining open-grown hardwoods in areas favored for acorn gathering could complement maintaining more decadent hardwoods in less accessible areas for wildlife trees (Long et al. 2017). Another issue involved spring burning, which can be an important tool for restoring degraded forests, but such burns often fall outside the historical cultural burn season for Tribes (Long et al. 2023). Both Tribal cultural practitioners and wildlife biologists have raised concerns about ecological impacts, especially to birds, mammals, and plants, from some spring burning (Thompson and Purcell 2016, Halpern et al. 2022, Long et al. 2023). These understandings have been incorporated into revised federal management plans that prioritize large hardwoods for supporting Tribal cultural practices and wildlife (U.S. Department of Agriculture Forest Service 2023).

Governance systems at state and federal levels have shifted to embrace co-stewardship and consideration of IK in the use of fire. Drivers influencing this shift include scientific demonstrations of the many beneficial effects and relatively low risks of using fire, agency awareness of ecological changes that intensified those beneficial effects and the risks of fire exclusion, and greater public and agency recognition of the rights and expertise of Indigenous cultural practitioners to burn. That understanding and appreciation advanced in the mid-twentieth century through the work of Euro-American scientists who had been influenced by their experiences in landscapes long stewarded by Indigenous Peoples and often working directly with Indigenous experts. But it was not until the late twentieth century, when scientists began publishing research conducted with Tribal elders, that the importance of Indigenous fire stewardship became more widely recognized in agency science and management discourse in California (Anderson 1999). That foundational work was followed by additional research, increasingly conducted through participatory research with Indigenous communities, that revealed the profound influence of Indigenous stewardship within California social-ecological systems (Anderson 2006, Long et al. 2021).

Indigenous-led efforts to institute policy changes at state and federal levels have also been drivers of adaptive change. Tribes and Indigenous leaders in California have established new institutions such as the Indigenous People's Burning Network and the Indigenous Stewardship Network, which spread knowledge of cultural burning under contemporary constraints (Maclean et al. 2023). The Indigenous People's Burning Network, a program established by The Nature Conservancy, has supported training and peer-learning nationwide (Marks-Block and Tripp 2021). The Indigenous Stewardship Network, an Indigenous-led organization, has focused on advancing

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practice and policy in California through convenings, intergenerational knowledge exchanges, and demonstration projects led by traditional practitioners. Programs of the California Indian Basketweavers' Association, such as Following the Smoke II, on United States Forest Service lands have strengthened traditional burning practices used to care for basketry plants (Oberholzer Dent et al. 2023). Additionally, Tribes have exercised their rights to self-determination and have fostered partnerships through National Wildfire Coordinating Group training opportunities to build fire adaptive capacities in their homelands (Adams 2023*b*).

DISCUSSION

Each of our 3 cases illustrate different drivers of institutional cultural shift that have helped address the incommensurabilities between dominant wildlife management practices and Indigenous stewardship: legal and policy mechanisms in the Great Lakes case, formal community involvement guided by bottom-up activism in the Hawai'i case, and the continual development of accountable collaborative stewardship in the California case. All cases illustrate the cultural evolution of thought and practice within wildlife management and strategies of Indigenous communities as they strive to perpetuate cultural lifeways and values and to be recognized by governance systems that have often ignored and devalued their interests. Our case studies highlight 3 areas of opportunities to help wildlife managers in achieving the transformative, systemic evolution needed to bridge incommensurable worldviews: acknowledging and reconciling historical legacies and their continued power dynamics as part of social-ecological systems, realizing governance arrangements that move beyond attempts to extract cultural information from communities and to integrate IK into dominant management paradigms, and engaging in critical reflexivity and reciprocal, accountable relationship building.

While wildlife management has broadened to consider ecosystems as social-ecological systems, the legacies of active erasure of Indigenous Peoples from those systems are still largely unaddressed. Beliefs about the superiority of colonizer cultures became ingrained in governance systems, resulting in the dismissal of Indigenous Peoples' influence on natural systems in favor of a romanticized goal of pristine nature, protected against human interactions (Pettorelli et al. 2019). Yet all of our cases illustrate that active stewardship was fundamental to Indigenous relationships with the environment, and that imposed natural resource governance systems inhibited continuation of these practices. Reinstating these relationships conceptually and physically has yielded multiple benefits. For example, in California, renewing Indigenous stewardship practices is fostering social benefits for Indigenous communities and is achieving broad benefits in terms of biodiversity and reduced risk of destructive wildfires (Long et al. 2021, Tom et al. 2023). Similarly, in Hawai'i, biocultural approaches to conservation such as those demonstrated in Mai Ka Pō Mai can begin to reconcile cultural erosion and result in more ethical and equitable involvement of Kānaka 'Ōiwi that lead to more just ecological and social outcomes and more appropriate implementation of 'Ike Hawai'i within management (Quiocho et al. 2023). In the Great Lakes, legal and policy mechanisms were necessary to force the consideration of these issues in management and have begun to lead to active dialogue and the development of trust between wildlife management agencies and Native Nations.

As wildlife management has evolved to implement Indigenous perspectives, long-standing management customs, including investing most heavily in game species and a small set of endangered species, have come under greater scrutiny (Hoagland and Albert 2023). These points of friction reflect the ongoing nature of social inequities perpetuated by prevalent wildlife management approaches and highlight the necessity of paradigm-level cultural shifts to address the current incommensurabilities between dominant wildlife management practices and Indigenous Knowledges and perspectives. In this regard, Indigenous values and stewardship regimes will continue to be pivotal for advancing conservation and restoration goals toward broader and more inclusive conceptions of social-ecological health and well-being.

A common theme across the case studies is that re-establishing Indigenous stewardship regimes will depend on continued evolution of governance systems to value Indigenous Knowledges and values, and to relinquish more

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authority to local Indigenous practitioners. Rather than attempting to simply catalog and consider IK, governance systems need to provide space for Indigenous cultures and practices to evolve in the face of changing climate and novel ecosystem assemblages, as exemplified by highly altered fire regimes. This evolution can occur despite distinct legal relationships and drivers affecting different regions; for example, changes in the Great Lakes case study were prompted by treaty obligations to federally recognized Tribes, but key policy changes in California have not been limited to federally recognized Tribes.

Our cases reveal the active evolution of governance systems in ways that implement worldviews and values that have typically been excluded from dominant wildlife management practices. The CBSFAs in Hawai'i institutionalize a growing emphasis on empowering local communities and cultures to develop place-based regulations and monitoring strategies. The formation of Tribal organizations and collaborations with agencies in the Great Lakes are less formalized changes to typical management planning but could lead to stable, enduring shifts in governance structures. In California, Indigenous practitioners have navigated a patchwork of different policies to resume their practices across federal and state jurisdictions. These different strategies have in common a dissatisfaction with mainstream institutional arrangements and can be viewed as a type of institutional bricolage, renegotiating and blending formal and informal rules and norms to achieve change in ways that are socially, relationally, and historically contingent (Cleaver 2012). Cleaver (2012) identifies this institutional bricolage as a proposed corrective to the shortcomings of institutions predicated on rational choice and economic theory but also cautions that it may still reproduce social inequities, as we saw echoed in our cases, such as with the continued power imbalances associated with CBSFAs in Hawai'i. Indigenous communities have long noted that acknowledgments of historical injustice are feckless without attempts to dismantle those same legacies (Fisk et al. 2021). Environmental governance systems that have been imposed onto these lands, seas, and airs at the expense of Indigenous lifeways serve to maintain Indigenous dispossession and cannot be inclusive without intentional transformative change (Lake et al. 2018). The calls for improved co-governance and co-production of knowledge (King 2007, Marks-Block and Tripp 2021, Jacobs et al. 2022*b*)—where agencies work with peoples from non-dominant worldviews to ensure they understand problems in the same way, agree on shared knowledge needs, and identify appropriate processes for shared governance and accountability (Fisk et al. 2021, Jacobs et al. 2022*b*)—will only succeed by critically reflecting on the continuously evolving governance needs of all parties.

To engage in these types of conversations, natural resource managers will need to engage in critical reflexivity about their core assumptions regarding the nature of resources and governance processes, aided by relationship building with those who can facilitate this type of reflection. For example, in the Great Lakes case, long histories of policies that required consultation, coordination, and cooperation still resulted in lawsuits, in part because agencies failed to redress historical power dynamics that often dismiss the sovereignty of Indigenous communities and failed to understand the Indigenous perspectives that led to their harvest decisions. Recent changes resulted in co-managerial approaches that included a commitment to longer-term relationships, more informal and regular interactions, and efforts to implement Indigenous perspectives in management and stewardship plans. The inclusion of a section on Tribal perspectives in Minnesota's wolf management plan revealed key differences in the fundamental objectives for wolf management and stewardship: while agencies assumed the goal was to maximize wolf harvest, the Ojibwe strove to harvest the fewest necessary. Similarly, in Hawai'i, Mai Ka Pō Mai was only realized after a > 10-year commitment to a process establishing a collaborative approach for management planning grounded in traditional Hawaiian values. The presence of Kānaka 'Ōiwi staff was instrumental as a driver of cultural shift for this and other various initiatives in Hawai'i that are working to institutionalize 'Ōiwi cultural foundations. Advocates for reform of fire governance in California have frequently pointed to examples from parts of the southeastern United States and Western Australia where traditions of cultural burning had already been incorporated into land management policy (Sneeuwjagt et al. 2013).

Greater exposure to new ideas and unfamiliar people results in greater openness and understanding (Mrkva and Van Boven 2020); exposure during informal interactions has also proved to be important for successful collaborative processes (Wondolleck and Yaffee 2012). As demonstrated in all 3 case studies, hiring more

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Indigenous staff and consultants and engaging in collaborative long-term planning processes can help improve exposure to previously unfamiliar worldviews and opportunities for more frequent informal interactions that build relationships, trust, reciprocity, and accountability. Such exposure and subsequent reflexivity are necessary to achieve a deep consideration of which cultures are at the foreground of natural resource governance systems, the power dynamics and potential social inequities associated with the relative prioritization and exclusion of different cultures, and the degree to which the cultures embodied by wildlife management agencies reflect and are congruent with the cultures and communities of the lands being managed. Only after such reflexivity within agencies can paradigm-level transformations be used to guide the cultural evolution of natural resource management beyond the bounds of shallow reformations that leave the paradigms and power imbalances within governance systems relatively unperturbed. Achieving such transformations also addresses recent concerns about equity and environmental justice, improving the ability and relevance of natural resource management to appropriately serve all publics, regardless of the degree to which their worldviews reflect those of the dominant natural resource management institution.

The compartmentalized understandings within federal and state agencies of relationships with the environment, as compared to more holistic and kincentric understandings by Indigenous Peoples, has been a long-standing critique (Salmón 2000, Houde 2007). Wildlife managers can often struggle to understand and implement holistic Indigenous worldviews given legal mandates, jurisdictional limits, and other institutional silos that often focus only on 1 part of the environment at a time. Our cases illustrate how these divergent cultural conceptions of relationships with the environment can result in goals as starkly divergent as maximizing versus minimizing the lethal control of wolf populations; although it is still too soon to know the population-level effects of the shift to minimizing lethal control, the change has already been substantial for the welfare of the individual wolves who continue to survive and for the Ojibwe Peoples who cherish wolves as kin. Kuhn (1996:150) describes the insight needed to understand this type of incommensurability:

> "The proponents of competing paradigms practice their trades in different worlds…Both are looking at the world, and what they look at has not changed. But in some areas they see different things, and they see them in different relations one to the other…it is why, before they can hope to communicate fully, one group or the other must experience the conversion that we have been calling a paradigm shift. Just because it is a transition between incommensurables, the transition between competing paradigms cannot be made a step at a time, forced by logic and neutral experience. Like the gestalt switch, it must occur all at once (though not necessarily in an instant) or not at all."

This phenomenon can be visually illustrated by images that are perceptually ambiguous, such as Rubin's well-known face-vase (Figure 2). By focusing on different elements of the image, viewers can see either a vase or 2 people engaged in dialogue. Both perspectives are correct, but each is associated with different understandings about the meaning. Similarly, incommensurable worldviews about the environment cannot be reconciled simply by using facts relevant to one worldview to help another party adopt that vision. Instead, our cases illustrate the importance of sustained relationships in creating the space for the dialogue and accountability necessary to help each party understand how the other views and values the big picture, allowing them to see more clearly how and why they each have different ways of understanding the same environment, influenced by distinct cultural values and knowledges. When parties achieve the ability to understand how the other sees the problem, the experience can be transformative (Forester 2009, Leong et al. 2009), as when managers learned to see wolves as kin to protect, seascapes as places to cultivate and care for, and fire as a cultural practice that sustains the forest rather than destroying it. Previously intractable conflicts based on incommensurable paradigms can then be recognized as different ways to view the same environment, allowing for the possibility of identifying areas of common ground and future cooperative evolution.

Pearce and Littlejohn (1997:97) illustrate how incommensurable worldviews can also affect productive discourse: parties in conflict default to the normal discourse associated with their worldview, yet "participants not

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FIGURE 2 Ambiguous face-vase adapted from Rubin (1915). By focusing on different elements, the viewer can see 2 very different subjects. Figure art by Amanda Merritt.

only differ about what they want, believe, or need but also lack shared procedures for arguing their claims and standards for judging the validity of those arguments." Peace and Littlejohn suggest that insisting on normal patterns of discourse of one group (e.g., institutionalized top-down public engagement processes) may lead participants to fall into prescribed adversarial roles. Instead, they suggest creating what they call abnormal patterns of discourse focused on mutual understanding where participants can learn from each other to see with a different vision. Institutions such as the GLIFWC, CBSFAs, Indigenous People's Burning Network, and Indigenous Stewardship Network can help elevate IK and perspectives to have space at the table for these discussions.

Communities and their cultures are heterogeneous, so being accountable to that diversity, particularly as communities and cultures continue to evolve, will help ensure that agency conduct is most congruent with the specific cultural contexts of the communities they serve and engage with. In a similar vein, Indigenous community members frequently request genuine reciprocity and treatment as rightsholders rather than typical stakeholder engagement processes where input or insight, including treasured cultural knowledges, is collected from communities in extractive ways then often sidelined or ignored within policies and management action. Community members often note that such genuine reciprocity would include the explicit consideration and prioritization of community concerns and afford greater agency to communities within governance processes, the timely implementation of culturally commensurable strategies to alleviate community concerns and actualize input, and the greater resourcing of communities to steward the seascapes with which they are intimate (Ingram et al. 2020, Jacobs et al. 2022*a*).

The innovation of new patterns of discourse will be necessary to reconcile wildlife management and Indigenous worldviews. As we have illustrated, it will require managers to shift fundamental thinking about natural resources and ecosystems, public participation and governance, and relationships with Indigenous Peoples and other people with differing worldviews. As noted by Leong et al. (2011), moving towards collaborative, public engagement governance will require investments by agencies including capacity building, diagnostic tools, and rewards and incentives for internal staff and external communities. A decade later, these needs are echoed in our case studies that illustrate the pitfalls of continuing to conduct business as usual (e.g., lawsuits, community opposition, conflict, loss of support) and the synergistic benefits of fully realized co-management that result in improved stewardship outcomes and serve as a step toward healing past harms and building trust with communities. Such transformations will help the wildlife management profession to effectively reflect more plural and multivocal perspectives and

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worldviews while also redressing the ongoing legacies of historical power imbalances and social-ecological injustices, resulting in more effective and just management outcomes for all.

MANAGEMENT IMPLICATIONS

Through our case studies, we have illustrated how better implementing and institutionalizing IK in wildlife governance systems will require paradigm shifts in multiple areas of management practice such as planning, staffing, policy, and public engagement. Critical reflexivity will be needed on how to reconcile deep divisions between dominant wildlife management and Indigenous cultural systems, including historical harms and power imbalances. Realizing these shifts will require embracing multivocal perspectives and worldviews in ways that may be uncomfortable but have potential to achieve more effective and just social-ecological outcomes. Transforming wildlife governance systems will likely require different approaches to discourse and engagement, and support for Indigenous communities in reestablishing and further cultivating active stewardship relationships.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

ETHICS STATEMENT

This study did not directly involve vertebrate animals or human subjects; no ethics approvals were necessary.

DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

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