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# OPINION



# Actualizing Indigenous Knowledge in tribal wildlife management: basic preconditions

Tony Ciocco<sup>1</sup> | Stefan Tangen<sup>2</sup> | Chad Smith<sup>3</sup>

<sup>1</sup>U.S. Geological Survey, North Central Climate Adaptation Science Center, 4001 Discovery Drive, Suite S348, Boulder, CO 80303, USA

<sup>2</sup>Great Plains Tribal Water Alliance, PO Box 271, Pine Ridge, SD 57770, USA

<sup>3</sup>University of New Mexico, 705 Gurley Ave, Gallup, NM 87301, USA

#### Correspondence

Tony Ciocco, U.S. Geological Survey, North Central Climate Adaptation Science Center, 4001 Discovery Drive, Suite S348, Boulder, CO 80303, USA. Email: aciocco@usgs.gov

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USGS North Central Climate Adaptation Science Center

# Abstract

Indigenous Knowledge (IK) is increasingly involved in the contemporary management of natural resources. Tribal wildlife management programs in the United States may be uniquely positioned to effectively and ethically integrate their IK. While a narrow focus on the body of IK and a particular management activity may suffice for project-level integration efforts, herein we consider how IK integration at the programmatic level may be best supported. We propose a holistic conceptual framework of preconditions including sovereignty, the North American Model management, funding, cultural resources, stakeholder support, and programmatic leadership. We assess the current status and common challenges with each precondition and illustrate their potential roles for a more lasting and pervasive integration of IK into tribal wildlife management programs.

#### KEYWORDS

Indigenous Knowledge, Indigenous Knowledge framework, Indigenous Knowledge integration, Traditional Ecological Knowledge, tribal natural resource management, tribal wildlife management

Many Tribal Nations integrate their Indigenous Knowledge (IK) into contemporary management of natural resources in a variety of ways (Bussey et al. 2016, Hoagland 2017). Alongside increasing federal and scientific support (Executive Memorandum 2021, Brooks 2022, Pfaeffle et al. 2022), notable IK integration efforts into tribal wildlife management (TWM) programs have emerged (Gilchrist et al. 2005, Connor et al. 2022, Ramos 2022, Schley et al. 2022). While attention to IK and management activities may effectively enable IK integration at the project

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level, this narrow focus may not result in lasting changes to the wildlife management program. Substantial integration of IK at the programmatic level (see use of the terms programmatic level, vis-à-vis project level, in NEPA, Council on Environmental Quality 2014) can be supported by addressing the fundamental components that encompass and comprise the management program. We identify these components in the case of tribal wildlife management (TWM) and explore opportunities and challenges for their roles in the integration of IK.

The term Indigenous Knowledge has been used to refer to place-based knowledge accumulated and transmitted across generations within specific cultural contexts (Jessen et al. 2022). Closely related terms such as Traditional Ecological Knowledge (TEK; Berkes et al. 2000), Indigenous and Local Knowledge (ILK; Adade Williams et al. 2020, Kadykalo et al. 2021), and Indigenous Knowledges (IKS; Smith and Sharp 2012) are often used. For brevity, we use IK broadly throughout the paper as an umbrella term for all such concepts despite the limitations of such ambiguity (Green 2008). Our analysis focuses on Tribal Nations in the contiguous United States, though many aspects of our thinking may find applicability in indigenous natural resources management contexts across North America and globally.

Reyes-García (2015) identified 3 main drivers for the increased interest in IK since the 1980s: 1) the transnational Indigenous rights movement, 2) academic interest based on the belief that IK may provide unique solutions to conservation problems, and 3) international political response to both the transnational Indigenous rights movement and the hope for IK solutions in conservation. Efficacy in using IK has been well documented in numerous fields including forest management (Cheveau et al. 2008), ecological restoration (Uprety et al. 2012), climate change adaptation (Williams and Hardison 2013), and conservation biology (Drew and Henne 2006). In addition to containing ecological knowledge, IK is embedded within social and political contexts (Schareika 2014), providing alternative models for understanding social-ecological system dynamics (Waltner-Toews et al. 2003).

Project-level efforts to integrate IK into scientific research and management practices have been underway for decades (Nadasdy 2003, Gilchrist et al. 2005, Henri et al. 2010, Padilla and Kofinas 2014, Sidorova 2020), often revealing important ethical, philosophical, and practical concerns (Padilla and Kofinas 2014, Ramos 2018, Carroll et al. 2021) and elucidating the challenges of developing effective and replicable approaches (Tengö et al. 2014). Drawing from these developments, we consider a broader goal of connecting and expanding integration efforts to be more impactful and enduring. We term the general target of more substantive incorporation of Indigenous Knowledge as IK-imbued TWM. Specifically, we characterize IK-imbued TWM as integrating a greater depth of IK, more thoroughly across elements of the management program, in a way that is durable and long-lasting. In pragmatic terms, IK-imbued TWM entails integration at the programmatic level.

Tribal wildlife management programs occupy a unique position to more easily access and ethically integrate their IK. The degree to which TWM programs have already integrated IK varies widely (with little empirical data available) as does the degree to which such integration is sought as a fundamental objective. Yet, for TWM programs that wish to pursue IK-imbued TWM, we provide a pragmatic and generic framework to guide thinking towards such an objective.

Past efforts have revealed that contextual elements such as politicization and funding can heavily influence integration outcomes (Shackeroff and Campbell 2007). A similar analysis has been made of state wildlife management and the influence of funding, governance, science, and stakeholders (Jacobson et al. 2010). Although managers may be aware of the many practical factors that influence wildlife management programs, a comprehensive assessment of these factors, specific to IK integration, is currently lacking in the literature.

# THE IK SUPPORT MODEL

We propose a simple conceptual framework (IK Support Model; Figure 1) to convey key components necessary to achieving IK-imbued TWM. The stool design concept illustrates that sovereignty underlies and enables all other components of IK-imbued TWM, while funding, cultural resources, stakeholders, and North American Model (NAM) of management are each essential and tied together via leadership (Figure 1). The proposed framework is intended



**FIGURE 1** A conceptual framework (referred to as the Indigenous Knowledge (IK) Support Model) illustrates the primary preconditions for programmatic-level integration of IK into tribal wildlife management (TWM). Sovereignty forms the foundation, with components of funding, cultural resources (CULTURAL RES), stakeholders, and North American model (NAM) management brought together by leadership. With each component intact, IK has the potential to better integrate with and more thoroughly imbue TWM programs.

to help managers and stakeholders enhance holistic thinking, identify needs for programmatic development, conduct short and long-term planning, and evaluate and learn from past efforts. Below we describe each component of the IK Support Model in detail, demonstrating their integral roles in IK integration, and identify common challenges and misconceptions.

# Sovereignty

The term tribal sovereignty was not commonly used in describing Tribes in the U.S. until about 1965 (Cobb 2005), though the Commerce Clause of the U.S. Constitution recognizes Tribes as separate and distinct entities from federal, state, and foreign governments (U.S. Const. art. I, § 8). The term has since been used in reference to moral justice, cultural persistence, and legal authority (Coffey and Tsosie 2001). Sovereignty is applied here in the broad and classical sense, denoting legal power and autonomy from external control (Merriam-Webster.com).

Sovereignty to manage wildlife resources is a logical precondition to managing wildlife resources with IK. Sovereignty has become particularly contested not only for Tribes to manage their wildlife resources but to manage such resources as they see fit (Hoffmann and Mills 2020). Increasingly, tribal sovereignty entails a complex web of interrelated policies and jurisdictions (Coggins and Modrcin 1979; Wood 2000, 2001; Hoffman and Cliburn 2021). In particular, the land management activities of Tribes in the U.S. vary in their relationship to federal trust responsibility, often mediated by the Indian Self-Determination and Education Assistance Act (ISDEAA) of 1975 (25 USC 5301; though this policy is commonly referred to by its former Public Law number 93-638) enabling Tribes to enter into contract and compact agreements with the federal government to assume federal trust responsibilities (Johnson and Hamilton 1994).

Certain rights are intrinsic in the sovereign treaty relationship between Tribes in the U.S. and the U.S. government, as articulated in United States v. Winans 1905 and United States v. Wheeler 1978. These intrinsic Tribal rights include rights to hunt, fish and otherwise use and manage wildlife resources as exercised by Tribes before treaties were signed. As described in United States v. Winans, these rights are not derived from the U.S. and bestowed upon Tribes rather these rights are intrinsic to the Tribes regardless of existing treaties. Tribes have had to fight for centuries to maintain these rights and to prevent erosion of their sovereignty (Montana v. United States 1981, White Mountain Apache Tribe v. State of Arizona 1981, New Mexico v. Mescalero Apache Tribe 1983).

The Trust Doctrine is a "legal obligation that originates from the unique, historical relationship between the U.S. and Indian tribes... based on the U.S. Constitution, treaties, statues, Executive Orders, and other Federal laws" (Hoffman and Cliburn 2021:22, Secretarial Order No. 3335 2014). As the legal and philosophical basis of federal responsibility to Indian tribes, the Trust Doctrine has been described as an often-misunderstood foundational concept in Indian law that carries significant implications for the legal scope of tribal management of wildlife resources (Wood 1994, 2000, 2001; Hoffman and Cliburn 2021). Typically, the Trust Doctrine is couched in the guardian-ward concept, an antiquated view of Tribes as inferior dependent nations, rationalizing a paternalistic role of the U.S. (Washburn 2017), potentially misconstruing the role of the U.S. as original trustor rather than trustee (Ciocco 2022).

The guardian-ward concept, however, stands in contradiction to the legal basis of sovereignty and was corrected by Chief Justice John Marshall (Wood 2003). The dichotomy between the guardian-ward concept of trusteeship and the sovereign-trusteeship concept can be traced back to Johnson v. McIntosh 1823, Cherokee Nation v. Georgia 1831, and Worcester v. Georgia 1832 (Wood 1994, 2003; Hoffman and Cliburn 2021). Despite the greater legal basis for tribal sovereignty, the guardian-ward notion lingers today, and may limit the conceptual terrain of tribal self-determination, or as summarized by Rebecca Tsosie (1996):

"Although tribal values and norms regarding environmental use should serve as the basis for tribal environmental policy under the principle of 'self-determination,' tribal policy is in fact heavily impacted by the values and norms of Anglo-American society, embodied in federal environmental law and policy."

In addition to intrinsic Tribal rights to wildlife resources, many treaties include explicit provisions of perpetual harvests of wildlife for Tribes (Wood 2000, 2001). If not articulated in treaties, Tribes generally retain rights to wildlife resources through what is commonly known as the Doctrine of Implied Hunting Rights as established in Menominee Tribe of Indians v. United States 1968. Borrowing from concepts of economics, as a resource that extends across time, wildlife can be divided into both capital and yield components (Wood 2000). For Tribes to access their yield of wildlife resources, they must be able to protect and maintain the capital from which the yield is derived (Wood 2000). The biological sciences generally consider wildlife capital to emanate from 2 sources, minimum viable populations and natural production areas (Shaffer 1981, Traill et al. 2007). Recognizing the intrinsic provenance of wildlife capital carries important implications for federal trust responsibility if a Tribe does not exercise legal authority over animal populations and natural productions areas, such as the case with migratory species or shared watersheds. The well-known conflicts over salmon fishing in northwestern states of the U.S. (Blumm and Brunberg 2006) further illustrate problems stemming from shared capital resources, harvesting rights, and the right to diminish (or responsibility to protect) salmon populations.

In addition to the rights to capital and yield of wildlife resources, the scope of tribal management of these resources has been an issue of ongoing debate. The U.S. Bureau of Indian Affairs (BIA) has played a major managerial role in carrying out federal trust responsibility throughout much of the 20th century (McCarthy 2004, Danver 2013), with significant shifts to tribal management following ISDEAA (Novak 1990). Tribal wildlife resources have been historically and continue to be managed via complicated interactions between the BIA, Tribes, states, and

other federal authorities (Hoffman and Cliburn 2021). As such, these bureaucratic legacies have heavily influenced the character of TWM programs.

Today, Tribes are generally subject to the same federal environmental regulations as are states (Warner 2014). While some federal environmental laws make no explicit mention of applicability to Tribes, and some tribal authorities may dispute the concept of federal control, Congress' plenary power as demonstrated in United States v. Kagama 1886 generally recognizes federal environmental regulatory authority over Tribes (Warner 2014). Moreover, the relationship of TWM programs to the U.S. federal government via ISDEAA contracts and compacts may further solidify the reach of both federal support and control (Delaney 2016).

Many Tribes in the U.S. today possess legal sovereignty to manage their wildlife resources, as is evidenced by the existence of TWM programs. Returning to the IK Support Model (Figure 1), it is not the breadth of sovereignty that appears to immediately limit the integration of IK in many cases. However, as extraconstitutional domestic sovereigns (United States v. Lara 2004) whose basis for wildlife management authority may be grounded in treaty rights, implied through doctrine, complex case histories with states (Hoffman and Cliburn 2021), and the ever-evolving notion of federal trust responsibility (Washburn 2017), TWM programs exist in a complex legal matrix. Indeed, the management context has been described as a legal house of cards (Hoffman and Cliburn 2021) and may pose a challenging environment for tribal managers to navigate and enact bold innovation.

#### Stakeholder support

We use the term stakeholders broadly to include relevant authorities, rights holders, constituents, and interested parties. It will be stakeholders that support or oppose new directions in TWM, allocate funding, and ultimately evaluate actions as successes or failures (Tangen 2017). It is possible that face-value professions of stakeholder support may dissipate when meaningful IK integration is undertaken. Consider the case of the 2018 effort by Navajo Nation Department of Fish and Wildlife (NNDFW) to address feral horse impacts (Wallace et al. 2021) by instituting a feral horse hunt (NNDFW 2018). Although the planned hunt was developed locally, outcry from nonlocal stakeholders quickly lead to halting the effort (Grover 2018, Pineo 2018).

Observed from a different cultural paradigm, some common contemporary natural resource management practices could be viewed as failures. Consider the worldwide socioeconomic debates around the value of hundreds of millions spent annually on invasive species management (Diagne et al. 2021) or endangered species conservation (Kellert 1985, Brown and Shogren 1998, Miller et al. 2002). Continued investments in these management practices, despite varying perceptions of success, suggests a degree of cultural conviction. Novel management pursuits that could emerge from IK integration may not garner the same cultural support from nonIndigenous society. For this reason, Davis and Wagner (2003) emphasized the need for IK-related research design capable of withstanding public scrutiny.

Romantic mythology of noble savages (Ellingson 2001) and contemporary progressive constructions of pan-Indigenous identity often exist in sharp contrast to the traditional mores of orthodox tribal cultures (Weaver 2001). As a result, culture-based work on the ground may not receive the same degree of local support as might be assumed from the national-level romanticization of Native American cultures. Paiute and Navajo traditions of pursuit hunting by chasing down antelope or deer on foot (Liebenberg 2006) could receive criticism from animal advocates if acknowledged as official methods of take (Loker and Decker 1994, Miller 2000). Gender roles of men and women are often emphasized in indigenous hunting and fishing traditions (Norgaard et al. 2017) yet may be viewed unfavorably by other cultural groups. As these examples suggest, systematic and thorough stakeholder analyses (Brugha and Varvasavszky 2000, Reed et al. 2009) may thus entail a critical step in the development of IKimbued TWM.

# The North American Model of wildlife management

The commonly cited foundation of management of wildlife resources in the U.S. is the North American Model (NAM; Organ et al. 2012). The North American Model was developed as the result of social, legal, and ecological events through the 19th and early 20th centuries, tracing back to wildlife refuges as early as 1832 and hunting conservation organizations such as the Boone and Crockett Club in 1887 (Organ et al. 2012). Federal policies (Lacey Act 1900, Migratory Bird Treaty Act 1918, Duck Stamp Act 1934, Pittman-Robertson Wildlife Restoration Act of 1937), along with the publication of An American Game Policy (Leopold 1930) played roles in the development of NAM (Organ et al. 2012). We use the term NAM broadly, referencing the 7 tenets and the institutional norms that characterize wildlife management as practiced by state wildlife management programs today including the bureaucratic structure (Merton 1963, Ahmady et al. 2016), the influence of cyclical funding sources, and a common repertoire of management activities.

The North American Model, in this broad sense, may provide a basic edifice upon which IK can be integrated. The use of NAM as a foundation for integrating IK in TWM reflects not only its predominance as the contemporary status quo, but also its successes in harmonizing competing social and ecological demands for wildlife resources in the modern era. A study of international wildlife management systems by Pack et al. (2013) rated NAM the highest overall performance across wildlife conservation, economics, social benefits, and protected area coverage. Even contemporary critiques of NAM (Peterson and Nelson 2017) use it as the fundamental basis upon which to map the influence of IK (Hessami et al. 2021).

In so much as IK-imbued TWM may advance NAM in new directions, managers may encounter resistance in the form of institutional inertia, or the resistance to change by organizations (Kingston and Caballero 2009). Institutional inertia is influenced both by external and internal factors, limiting organizations by "bounded rationality" and "organizational routines" (Kingston and Caballero 2009:10, 21). Achieving IK-imbued TWM may thus benefit from balancing reliance upon NAM's strengths with the boldness to innovate TWM in new directions.

## Funding

While funding could be conceptualized as a subcomponent of NAM, or as an outgrowth of stakeholder support, funding exerts such strong influence on the nature of TWM programs (McKinney et al. 2005) as to warrant assessment as a distinct component. Funding amount may be the primary limiter to program capacity and funding source may be a primary limiter to the scope of management activities. The feedback loop of receiving funding and managing to fulfill funders' objectives and thus receive more funding, is a predominant characteristic of wildlife management operations (McKinney et al. 2005). Accordingly, the objective of integrating IK into TWM thus becomes a question of funding amount and funding source.

Many TWM programs today receive funding from a variety of sources including their own tribal general funds, through selling hunting and fishing licenses, federal ISDEAA contracts and compacts, and grants such as the Tribal Wildlife Grants Program administered by the U.S. Fish and Wildlife Service (Hoffman and Cliburn 2021). Many TWM programs also piece together a patchwork of smaller and short-term funding sources from other federal and private grant programs (Hoffman and Cliburn 2021).

External funding typically comes with strings attached, enticing TWM programs to appeal to goals and priorities of the specific funders (Figure 2; Hoffman and Cliburn 2021). Such a funding environment may be prohibitive to forging innovative pathways in TWM such as integrating IK. Accordingly, TWM programs may evaluate the size, temporal span, and autonomy of various funding sources against their internal programmatic objectives to determine if a particular funding source should be pursued. In this funding environment, IK integration may be less likely to emerge as an objective of a TWM program itself than as an objective of one of the funders, or



**FIGURE 2** Example feedback loops in tribal wildlife management (TWM) funding that support program capacity and also constrain program activities. Indigenous Knowledge integration may be most practically achieved as an objective of a funding source or as a management approach to fulfilling the objectives of a funding source. This is in contrast to the common assumption that IK would emerge primarily as an objective of the TWM program. The federal funding (which could denote Indian Self-Determination and Education Assistance Act (ISDEAA) contracts or compacts (commonly known as 93-638 contracts) or other federal grants, tribal funding, and permit revenues are not indicative of all TWM programs as some may depend exclusively on only one of these sources or may draw from other funding sources not listed.

as a management strategy to fulfill a funder's objective. As a management strategy, TWM programs may compare the efficacy of a strategy involving IK integration against that of more standard NAM approaches.

State wildlife management programs receive the bulk of their funding from monies authorized by the Federal Aid in Wildlife Restoration Act (FAWRA; also known as the Pittman-Robertson Act of 1937), whereby the federal government collects taxes on permits, firearms and ammunition, and other recreational purchases and return a portion to the states (P-R Act 1937, Jacobson et al. 2007). Tribes have never been eligible to apply for these funds (National Congress of American Indians [NCAI] 2016). Many have voiced criticism that tribal fish and wildlife recreation activities contribute to this pot of funds, adhere to federal wildlife regulations, and help maintain shared wildlife resources, yet are left to manage for these activities without receiving any of this generated revenue (NCAI 2016).

The federal Tribal Wildlife Grants Program awards grants on a competitive basis, having awarded over \$94 million by 2020 (USFWS 2020). In 2018, 25% of applications were awarded, while 32% were awarded in 2019, with award amounts limited to \$200,000 expenditures that may include staffing, equipment, and other operational costs (USFWS 2020). The Tribal Wildlife Grants Program has also been applauded for its no-strings-attached approach, funding a wide array of potential projects, free from many of the administrative requirements of other tribal-federal arrangements (Hoffman and Cliburn 2021). Nonetheless, the limited funding amount, one-time allocation, and competitive awarding make this funding less than ideally suited for IK integration that may require on-going funding and may diverge from normative management activities. The Recovering America's Wildlife Act (RAWA 2019) was introduced to the House of Representatives Natural Resource Committee in July of 2019 and could become the tribal equivalent of FAWRA, providing Tribes with \$97.5 million annually, enabling a significant shift in TWM. Title II of the Act addresses tribal conservation and restoration, with broad provisions for the use of funds that could provide opportunity for Tribes to pursue IK-imbued TWM.

Revenue from the sales of hunting and fishing licenses varies widely between Tribes, ranging from nonexistent to comprising a meaningful portion of annual funding. The feedback loop of managing for permitting, and using

permit revenue to fund management, may constrain the scope of management to only the most cost-effective activities. Such activities may diverge from, and may even directly contradict, Indigenous cultural values. Nonetheless, license sales, particularly from trophy hunting, has proven a valuable revenue source in many wildlife management contexts (Lindsey et al. 2007, Cooney et al. 2017, Dickman et al. 2019). Creatively designing new revenue-generating strategies that align with cultural values is a growing focus of TWM today (Hoagland 2017).

The most lucrative and autonomous funding model, commonly referred to as the Missouri Model, may be useful for Tribes. In 1976, Missouri enacted an indefinite sales tax, the proceeds of which go into a fund for wildlife conservation, with over \$2 billion having been raised as of 2004 (McKinney et al. 2005). The model has made Missouri the most well-funded state wildlife management program in the country (McKinney et al. 2005). In 1996 Arkansas similarly enacted a 1/8<sup>th</sup> cent sales with 45% going to the Arkansas Game and Fish Commission (Arkansas Game and Fish Commission 2020). Despite the complexities and differences between tribes in the enactment of sales taxes on tribal and non-tribal members within reservation boundaries, and the potential legal contestation that such taxation could create (Goldberg 1976), given its potential return, the Missouri Model could warrant consideration for tribal contexts.

There is a wide range of small and short-term grants that can be applied to TWM. For example, support for climate change adaptation, such as the BIA Tribal Climate Resilience Program (BIA TCR), can support TWM activities (BIA TCR 2022). Climate change funding has already shown a precedent for being used in new and creative ways (Poiani et al. 2011). Funding sources designed for protecting cultural resources, revitalizing cultural knowledge, practices, and language, could also be used, as these are closely intertwined with IK and wildlife management activities (Ramos 2022).

While the funding arrangements and relative funding capacities vary widely between Tribes, many Tribes remain underfunded when compared to their state wildlife management counterparts (Canaga-Retna 2015, Hoffman and Cliburn 2021; Figure 3). For example, federal appropriations for state wildlife management programs are roughly 10 times that provided to tribes via the Tribal Wildlife Grant Program (Hoffman and Cliburn 2021). Higher levels of funding and greater organizational capacity do not supplant the specific role of innovation capacity (Prajogo and Ahmed 2006), knowledge management capacity (Chen and Huang 2009, Santoro et al. 2018), or



Funding Comparison State versus Tribal Wildlife Management

**FIGURE 3** A comparison of funds per acre between the Navajo Nation Department of Fish and Wildlife (NNDFW; Tom 2019), wildlife departments in nearby states of New Mexico and Arizona (New Mexico Department of Game and Fish 2017, Arizona Game and Fish Department 2018), and 2 of the most well-funded states, Texas and Missouri (Missouri Department of Conservation 2019, Texas Parks and Wildlife Department 2019).

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absorptive capacity (Todorova and Durisin 2007). That is to say, increasing funding in TWM may enable, but not necessarily lead to, greater innovation such as IK integration.

#### Cultural resources

Integrating IK into wildlife management requires extant cultural resources, which vary widely between Tribes (Stapp and Burney 2002). Such resources may include anthropological and ethnographic material, documented or still spoken languages, traditional cultural properties, traditional political structures, living orthodox religious communities, and subsistence lifestyles that include hunting and fishing, gathering, farming, and pastoralism (King 2013). There is a natural tendency to avoid quantification of a resource that is so deeply intertwined with identity (Weaver 2001, Tsosie 2005). Nonetheless, the condition of cultural resources may heavily influence the potential for IK-imbued TWM. Indigenous Knowledge integration may be approached differently for a Tribe that has no living speakers of the traditional language or extant traditional cultural practice, from one with a distinct traditional government, language, and subsistence lifestyle.

Cultural resources departments (sometimes referred to as Tribal historic preservation offices) are a logical interdepartmental collaborator for accessing tribal cultural resources. Rather than *ad hoc* cultural advisors, these programs operate under section 106 of the National Historic Preservation Act (NHP Act) of 1966 and possess professional skills and resources to access, interpret, and convey IK for TWM integration purposes. Nonetheless, many potential alternative arrangements exist (Davis and Wagner 2003).

## Leadership

Leadership refers to the individual(s) who would catalyze, organize, and sustain the pursuit of an IK-imbued TWM program. As with most organizational innovation, individual leadership is critical (Hogan and Kaiser 2005). Effective leadership in innovation has been linked to the ability to toggle between exploring and exploiting new opportunities (Rosing et al. 2011). In the case of IK-imbued TWM, this goes beyond coalescing the fundamental pillars of the IK Support Model to creatively brainstorming opportunities for their integrated deployment as well as skill in bringing such efforts to fulfillment.

In pursuing IK-imbued TWM, it is logical that leadership stem from the TWM program itself. However, IK integration is highly transdisciplinary involving IK-holders, scientists, and managers. Robards et al. (2018) detailed 7 Alaskan case studies involving managers actively seeking IK involvement, IK-holders forming councils and asserting influence on management programs, and scientists using co-production methods to foster IK integration into management decision making. These cases exemplify the potential for leadership catalyzing the actualization of IK in TWM to emerge from diverse sources.

# DISCUSSION

A systematic assessment of IK in TWM programs could help fill a critical knowledge gap in this field. Such information may enable further analysis of common challenges, best practices, and other lessons learned. An organization such as the Native American Fish and Wildlife Society (NAFWS) may be well positioned to facilitate such an effort in similar fashion to the Indian Forest Management Assessment Team (IFMAT) coordinated by the Intertribal Timber Council (Gordon et al. 2013).

The IK Support Model considers a holistic view of TWM, illustrating how each of the components of sovereignty, funding, cultural resources, stakeholders, NAM management, and leadership, may support or constrain

IK-imbued TWM. This holistic perspective may support IK-integration efforts beyond individual projects' add-ons to an intrinsic component of the character of a TWM program.

Imbuing TWM with IK entails a paradigmatic shift in tribal natural resource management, possibly leading to what Schot and Kanger (2018) termed a deep transition, or a long-term, connected, radical shift in a particular direction. In a broader historical view, we currently stand at a rare opportunity. While invaluable cultural resources are lost with each passing tribal elder, the convergence of these various preconditions may facilitate a deep transition to IK-imbued TWM. The incoming generation of TWM leadership possesses a unique opportunity to actualize ancestral knowledge in this regard. Capitalizing on this opportunity may provide new insights to scientific fields (Jessen et al. 2022) and renewed vitality to the cultural resources themselves (lanni et al. 2015).

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#### CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

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No ethical information provided.

#### DATA AVAILABILITY STATEMENT

Data sharing not applicable to this article as no datasets were generated or analyzed during the current study.

#### ORCID

Tony Ciocco D http://orcid.org/0000-0002-5849-888X

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