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Advancing Wildlife Policy of Eastern Timber Wolves and Lake Sturgeon through Traditional Ecological Knowledge

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Abstract: Traditional Ecological Knowledge (TEK) is becoming more prominent in wildlife management decisions and policy making. The cooperation of TEK and Western science paradigms have been beneficial for conserving our natural resources and wildlife populations. However, there are still concerns with accepting TEK as part of wildlife management, policy, and regulations. With increasing challenges to wildlife conservation, it is vital to implement Indigenous TEK to form more robust and holistic approaches to wildlife management. Here, we present two case studies in the upper Midwest region of the United States involving the Ojibwe tribe that show the importance of TEK collaboration and how that knowledge can be used for the betterment of ecologically sensitive species—lake sturgeon and eastern timber wolves.

Keywords: conservation; indigenous; lake sturgeon; management; Ojibwe; policy; tribal ecological knowledge; wildlife; wolves



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1. Introduction

Aldo Leopold is coined the “Father of Wildlife Management” due to his revolutionary ideas regarding relationships between ecosystem maintenance and human populations, i.e., Land Ethic [1]. His Land Ethic helped shape modern day wildlife conservation and redefined our relationships with the natural environment [2]. In Leopold’s “Land Ethic” essay, he describes the relationship between the land and man to be an interconnected community that must maintain cooperation in order to preserve ecosystem function and biodiversity [3]. This idea was groundbreaking to wildlife biologists with traditional backgrounds in Western science. However, similar stewardship ideas are found in Aboriginal cultures throughout North America. For example, the Yurok tribe, located in present-day northern California, developed the phrase “hlkelonah ue meygeytohl”. This translates to mean “to take care of the earth” which conceptualizes the relationship between the tribe and natural resources management [4]. This responsibility provides the foundation for Traditional Ecological Knowledge (TEK) through active participation in natural resource management [5].

The application of TEK has been increasing in the field of applied ecology and natural resource management [6] such as forestry [7–9], fire ecology [10], and fisheries [2,11]. These collaborations between Indigenous TEK and Western science have been beneficial for the preservation of invaluable natural resources. Moreso, wildlife biologists must adopt new wildlife management approaches by practicing the inclusion and co-production of social science methodology, TEK [12,13], and conservation. In the Great Lakes region of the United States, this collaborative approach can be seen through wild rice (*Manoomin*) (*Zizania* spp.) management, an important food resource for wildlife and Indigenous tribes. This resource is managed through partnerships between tribal members and state agencies which has helped build effective environmental science, policies, and stewardship [14]. Additionally, tribal members have provided local biologists with unique perspectives and

new avenues for scientific exploration [15] by identifying critical life history information of species [16]. In some instances, TEK has aided in providing important bioindicators for species cycles and declines [17,18], inferred population estimates [16], and provided local indicators of species health, illness, and diseases [18,19].

Despite these examples, there are still concerns about the integration of TEK and Western science [2,20] in wildlife conservation and policy. Some researchers identify that approaches to collecting information about wildlife species vary dramatically between the two paradigms and that the inherently qualitative approach to local TEK is difficult to validate, irrelevant, or insufficient [17]. Another area of contention stems from conceptual and practical challenges that prove to be controversial with tribal members' needs and subsistence use [2]. These reservations can be seen in one of the strongest covenants for wildlife management in North America: the North American Model of Wildlife Conservation (NAM). The NAM is a set of seven tenets that portrays and promotes conservation and hunting of the public domain [21]. However, these seven tenets of the NAM were created by Western wildlife biologists using colonial rhetoric and conservation values [22,23]; they are rooted in Western conceptions of property, human–animal relations, and science [24]. According to the sixth tenet of the NAM, science is the proper tool to discharge wildlife policy; however, Western science paradigms are the only formally recognized way of monitoring wildlife [25]. Since Western science is the dominating paradigm for wildlife research in the United States, wildlife professionals might be unfamiliar [26] or deterred from implementing TEK techniques. With growing concerns for wildlife species and related habitats, there is a need for new methodology and experimental designs that fulfill the needs of Indigenous communities [27]. Further, the seventh tenet which argues for the democracy of hunting, focuses on sport hunting and fails to reflect the other purposes for hunts [23,24]. Without these coordinations to the NAM, wildlife policy can alienate Indigenous tribes by infringing on their cultural practices and spirituality [28], causing a reluctance to share TEK information [2], and thus leading to less informed and collaborative wildlife management strategies [29].

In this paper we present historical background and examples of TEK incorporation into wildlife management and how we can utilize TEK to better understand ecological relationships to improve wildlife policies. We define TEK and discuss how the Ojibwe tribe, located in the Great Lakes Region of the United States, use their traditional knowledge to help manage wildlife species with state agencies. To illustrate our points, we are reviewing two case studies: lake sturgeon (*Acipenser fulvescens*) in Michigan and eastern timber wolves (*Canis lupus lycaon*) in Wisconsin. Each case study represents how proper TEK implementation can result in interdisciplinary and comprehensive approaches to wildlife management, but, if not considered, it can result in poor, inadequate management, and policy decisions.

2. What Is TEK?

TEK refers to the vast knowledge of land and resource management that Indigenous people have gathered over hundreds and thousands of years—preserving and living with the land. This basis of knowledge is acquired through the experience, tradition, and sharing of information among tribal members [30]. By having a direct connection to the land, groups of Indigenous people have been successful in gaining a multitude of invaluable skills in relation to the environment. This knowledge continues to evolve and grow as it is further passed down through generations of tribal members. Like Western science, TEK is founded on a collection of observations of the natural world but is fundamentally different in other aspects. It is primarily subjective, qualitative, and passed down from generation to generation orally by tribal elders whereas Western science uses a technical approach of quantitative data [31].

Akin to TEK, cultural-based conservation is the active involvement of local communities and their cultures in conservation efforts that affect them. In places such as Africa, Asia, and Latin America, cultural-based conservation rose to prominence in the 1980s.

This occurred after the Western model of conservation based on separation of nature from culture and people, i.e., the fortress model, did not succeed in protecting biodiversity from substantial loss [32]. This was a key starting point in the creation of a new movement—one that unifies nature and culture to conserve biodiversity and the environment. This emergent movement continues to be increasingly recognized as a significant step in enhancing sustainable land and resource management internationally [33].

Historically, TEK policies were discredited by non-Indigenous groups but have recently gained recognition and high regard due to the relevance and long history of the management practices [30]. Similarly, cultural-based conservation takes an approach to preserve traditional practices and should be considered when developing TEK policies to avoid controversy with Indigenous and native cultures. When implementing these two strategies alongside scientific management methods, relationships strengthen, and they build a sense of community with Indigenous wildlife users [34]. When it comes to how these methods can be used to manage the environment, TEK improves the general understanding of the human connection to the environment [2].

The definition of TEK is not a uniform concept across tribes [29]. Each nation provides their own diverse reflection on ecological diversity that seeks to understand and appreciate the environment [35]. This is contrary to traditional Western science agendas that aim to define [36] natural resources and wildlife management objectives and assure management fits within the constraints of established policy and law. Given these core differences, creating management and policy collaborations that include both TEK and Western science may seem difficult, but similarities are seen in both paradigms [2,37]. Concepts of ecosystem balance, environmental stewardship, and ethics are core foundations in both TEK and Western science [2–4] that help humans and wildlife coexist [2,3]. Reconciling knowledge-sharing systems and existing policy through Indigenous and non-Indigenous collaboration and promoting co-production between scientific and Indigenous knowledge are the most productive approaches to conserving wildlife and the environment [13,23]. Therefore, when constructing and administering wildlife policies, a combination of TEK and Western science can and should be used to promote respectful partnerships and empower local decision-making efforts [13].

3. History of the Ojibwe Tribe

The Anishinaabe tribe believe themselves to be the “Original People” that were placed on Earth [38]. After arguments and fights between one another, the Creator sent a great flood upon Earth, leaving only the animals and one survivor: Nanabozho. Through connection and cooperation, they reconstructed Earth into what it is today. According to their oral histories, the Anishinaabe originated on the northeast coast of present-day Canada and the United States and migrated to the shores of the Great Lakes [39,40]. The “Great Migration” resulted in settlements and the establishment of three First Nations—each having their own unique traditions, language, and culture—the Ojibwe, also known as Chippewa, Ottawa, and Potawatomi [41]. The formation of these three nations is known as The Council of the Three Fires [42].

Historically, the Ojibwe tribe was most notable for their birch bark canoes and scrolls, copper mining, fishing, and cultivation of wild rice, maize, and maple syrup [40,43]. Having access to natural resources was essential to their survival and way of life. To protect their harvest, particularly wild rice, they fought numerous wars with both the Dakota and Fox Nations [40]. These battles for natural resources and land continued throughout history, especially when the first European settlers arrived with the intention of starting a colony in 1620 [44].

The present-day Ojibwe reside near the Great Lakes in Canada, Minnesota, Michigan, and Wisconsin. Here, they make use of the land by fishing (Figure 1), hunting, foraging, and gathering materials. Specifically, the Wisconsin Lake Superior Ojibwe and Michigan Lake Huron and Lake Michigan Ojibwe tribes have bands that each strive to preserve and share their history, culture, and language [45]. In 1854, Treaty negotiations of the Indian

Removal Act in 1830 and Treaties of 1837 and 1842 established the Ojibwe band reservations and allowed them rights to traditionally hunt, fish, and gather for ceding their land to the government [46]. The Voigt Decision and Inland Consent Decrees in the late 1900s intensified their treaties, allowing them to exhibit their rights on ceded lands and harvest significant percentages of the sustainably allowable resources in ceded areas, excluding timber [47,48]. These bands worked tirelessly to gain sovereignty and recognition from the state and federal governments to maintain their historical land and culture. Although the law states that tribes have the right to exhibit traditional methods for subsistence use of wildlife, conflicts between Indigenous and non-Indigenous wildlife users and managers still arise. Below are two case studies that display examples of conflicts and the importance of creating alliances amongst each other for the betterment of wildlife species.

Flow Chart Highlighting the Major Steps of Applying Traditional Ecological Knowledge (TEK) Methods to Wildlife Management

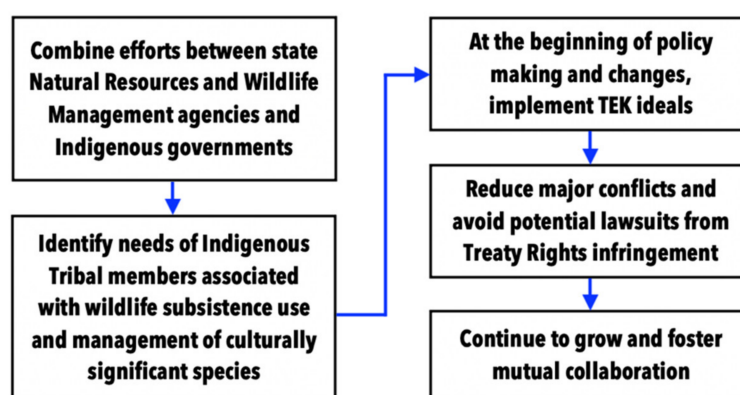


Figure 1. The major steps to applying TEK methods to wildlife management and policy.

4. Case Study 1: Successfully Conserving Lake Sturgeon through TEK Implementation in Michigan

The connection between the Ojibwe and lake sturgeon is one that spans multiple generations and centuries. The belief shared among tribal members is that the lake sturgeon is “ogimah namé”, which translates to “king of all fish” [49,50]. The fish was one of a few unique animals included in the early Ojibwe clan system which satisfied the needs and teachings of the larger tribal nation [49]. The sturgeon clan was comprised of scholars, professors, philosophers, and mediators that were involved in ensuring moral governance of the tribe [49,51]. Before spawning runs, tribal leaders would consult with the sturgeon clan to discuss strategies for sustainable take and avoidance of overharvest [49]. Coinciding with these notions, the Ojibwe treasured and revered the fish for its abundant products and byproducts, including versatile skin, isinglass derived from dried swim bladders, and sustenance in the form of meat, oil, and roe for consumption, storage, and trade [52]. When it came to the harvest of lake sturgeon, the Ojibwe subsisted and followed approaches derived from generations of accumulated TEK [49,53]. Additionally, they viewed and continue to view the harvest of lake sturgeon as something that solely requires simple and sustainable practices [49]. This provides them not only with long-term benefits but harmony with the fish as well—a balanced give and take.

In Ojibwe history, lake sturgeon were so bountiful that legends tell of the waterways teeming with fish to the point where a person could walk across the water on their backs [51]. When European settlers expanding westward arrived in the 1800s, however, the species was pushed to the edge of extinction. Initially, the settlers traded with the Ojibwe in exchange for dried sturgeon to eat [51]; these were important deals for their growing tribal economies and trade practices [51,52]. Shortly thereafter, the commercial fishing industry arrived at the Great Lakes and began targeting herring and lake trout instead [51]. Considered a nuisance, sturgeon were flagrantly slaughtered because of the damage they caused to

fishing nets intended for other species [54–56]. When the settlers expropriated the Ojibwe, decades of suffering and decline for the lake sturgeon were further enabled. The fish were stacked on the shorelines, used to power steamships due to their high oil content, and overexploited for the use of their roe in the caviar industry [51,54]. Furthermore, they endured the destruction and pollution of their habitat through the construction of dams and disposal of paper mill waste into the Great Lakes [51]. With all the previous confounding factors, along with lengthy reproduction and spawning cycles [56–58], the lake sturgeon populations crashed by the early 1900s.

In response to the 1900s crash, Ojibwe tribal members saw reviving the species as being completely intertwined with strengthening their own community and recognized the important link between healthy human communities and healthy ecological communities [51]. With the help of tribal members and TEK, the restoration of the lake sturgeon became their objective moving forward. During the 1970s, conflicts over inland fishing, hunting, and gathering began between the state of Michigan, five sovereign tribes (including the Ojibwe), and the United States over inland fishing, hunting, and gathering tribal regulations on ceded land from the 1836 Treaty of Washington [49,55]. The tribes believed they still retained the rights to harvest natural resources by their own rules on approximately 37% of Michigan's inland acreage [53]. As it was done for centuries before the conflicts, tribal members would wait for warmer weather and more favorable conditions to harvest their annual portion of Michigan lake sturgeon [53]. This was met with disagreement and backlash from the non-Indigenous public, prompting the Ojibwe to adopt and practice their own natural resource management regulations [53]. After a series of court orders and expired consent decrees on tribal harvest rights, including those from 1985 and 2000 [48,59,60], the dispute was finally settled legally in *United States v. State of Michigan* [61].

While it was previously ruled that tribes reserved their right to fish in the Great Lakes, the scope of Treaty rights with respect to the inland portion of their ceded lands was not yet resolved [59]. This was due to the text found in Article 13 of the 1836 Treaty which stated that Indigenous tribes reserved the right to harvest and follow usual privileges of occupancy only until the land was required for settlement [59]. The tribes believed that their usual privileges were still valid and that they did not need to adhere to state harvest regulations; however, the Article was upheld. To remove legal uncertainty and confusion completely, the state of Michigan filed a claim to resolve the issue [59,61]. The result of this settlement was the 2007 Inland Consent Decree (ICD) [59,61]. The ICD is a legal document that defines and solidifies the extent of tribal rights and describes the necessary collaboration of tribal governments and the state of Michigan to successfully manage natural resources. Particularly, they work inside the jurisdiction of the state with the Michigan Department of Natural Resources (MDNR) to decide on regulations of harvest and take [53]. In the case of the Ojibwe, this is the management of the lake sturgeon.

Apart from legal entities, the Ojibwe have their own Indigenous wildlife and fisheries biologists, conservation officers, and hatcheries for management that work alongside the MDNR Tribal Coordination Unit [53]. Together they tag lake sturgeon, locate individuals through radio telemetry [62], model and monitor populations, and evaluate growth and mortality [53]. Furthermore, they implement and utilize Ojibwe TEK bioindicators to foretell the beginning of the lake sturgeon spawning each year, including the appearance of the eastern tiger swallowtail butterfly (*Papilio glaucus*), the size of poplar tree leaves, and the timing of various amphibian calls at dusk [62]. This application of TEK helps in better understanding the natural history of the lake sturgeon in the Great Lakes region and strengthens Indigenous and non-Indigenous wildlife managers' ability to resolve concerns with species population declines. Though they have faced numerous challenges in gaining recognition and building cooperative relationships with the state of Michigan and general public [53], the Ojibwe now serve as an active constituent of the regulating bodies that manage lake sturgeon on their own ancestral lands—further illustrating the importance of implementing TEK in natural resource management [63].

5. Case Study 2: Wolf Hunt Causes Ojibwe Tribe to Sue the Wisconsin Department of Natural Resources

The eastern timber wolf, or ma'iingan, is a symbolic creature to the Ojibwe because their history is intertwined and reflected in one another. In Ojibwe heritage, the Creator sent Nanabozho: a brother in the form of ma'iingan. They were told that they would travel separate paths, but their lives would be forever linked, forever being feared and misunderstood [64]. For example, times where wolves were being persecuted coincided with times tribal members were most persecuted, and the rebirth of the tribal culture mimics the rebirth of wolf populations [65]. The wolf appears throughout Ojibwe oral histories as a companion or guardian and symbolizes protectiveness and perseverance [47].

During the European settlement of North America, predators were perceived as competitors, threats to human health and safety [66–68], and economic liabilities regarding livestock depredation [68,69]. One of the most targeted predators was the wolf [69]. By the 1900s, the wolf was eradicated over a large portion of their North American range, and the extermination of the wolf was a prime objective of the federal government [70,71]. Bounties and poisoning campaigns led to the rapid decline of wolf populations throughout the country [71,72]. Unfortunately, wolves residing in the state of Wisconsin, located in the northern Midwest, also fell victim to overharvest leaving only a few scattered remnant lone wolves spread across the state in the late 1950s [73,74].

In 1977 and 1978, Thiel and Welch [75] documented breeding packs of wolves in the northern area of the state [74]. Wildlife biologists and researchers in Wisconsin believe wolves recolonized the state from a large western population on the border of Minnesota [74]. Although wolf populations were starting to expand to their historic territories, the species was listed as endangered by the US Fish and Wildlife Service (USFWS) under the Endangered Species Act (ESA) in 1973 [76]. This listing provided federal protection and regulations to help grow populations [77]. By 1998, the wolf population in Wisconsin grew high enough to enable them to be delisted from the ESA [78]. During this time, Wisconsin residents and property owners reported an increase in negative encounters with wolves that resulted in domestic animal depredation [79]. Although <50% of these reports were deemed related to wolves, calls for lethal control measures increased and granted in 2003. [78,79]. Between 2003 and 2020, wolves were relisted under the ESA three times causing confusion, frustration, and conflict between the state and its constituents [78]. Amid this time period in 2012, the Wisconsin state legislature passed Assembly Bill 502 into law, calling for mandated hunting and trapping of wolves through regulated harvest seasons [78]. It was not until 2020, when wolves were delisted from the ESA leaving the management of wolf populations up to state agencies and collaborators once again.

The Great Lakes Indian Fish and Wildlife Commission (GLIFWC) was formed shortly after the Voigt decision to assist with conservation and management of tribal resources on ceded and tribal territories [47]. This agency has helped the Ojibwe utilize their Treaty rights and support wildlife conservation through natural resource management expertise, conservation enforcement, legal and policy analysis, and public information services [80]. Specifically, the GLIFWC has a representative on the Wisconsin Wolf Management Plan Committee (WWMPC), a charter that assists in the development of wolf management plans by providing input and guidance of wolf management [81]. Bands of the Lake Superior Ojibwe tribe have established their own wolf relationship plan that collaborates with the Wisconsin Department of Natural Resources (WDNR), USFWS, and United States Department of Agriculture—Animal and Plant Health Inspection Service (USDA-APHIS) agencies that will support the recovery and management of wolves in their territories [82]. In one relationship plan, Fergus and Hill [82] outlined methodology to monitor and research wolves including winter track surveys, howling surveys, observation and trail camera reports, scat analysis, creating buffers around den sites, and monitoring radio-collared individuals. Additionally, citizen outreach and education will remain a continued effort to build coexistence relationships and more knowledge about the packs [82].

Initial discussions of introducing a wolf harvest in 2021 were refused after a 4–3 majority vote propagated by concerns regarding time constraints and lacking input from Wisconsin's Native American tribes [83]. When Wisconsin refused to immediately reinstate a wolf harvesting season, Hunter Nation Inc., a Kansas-based hunting organization, sued the WDNR on the basis that refusing to establish an immediate wolf hunt was infringing on their constitutional rights [84]. After this lawsuit, officials opened a wolf season that led to tribal, state, and federal agencies working together to collaborate on wolf management to determine sustainable yields. Furthermore, the decision was made that the Ojibwe tribe would be granted 50% of the sustainable wolf harvest thus upholding Treaty rights and the Voigt Decision. Members of the GLIFWC acted as representatives on the WWMPC that worked together to establish sustainable yield harvest limits of the newly delisted gray wolf.

In February of 2021, a harvest quota of 119 individuals was set for a limited lottery style wolf hunt season [85] with the expectation that the Ojibwe tribe would harvest approximately 60 wolves. Considering TEK and cultural-based conservation principles, the Ojibwe choose not to harvest their allotted wolves to maintain cultural ideals and to maintain the ecological health on their land. With this decision, the Ojibwe also assumed the total State harvest would be half of the quota. Despite the expectation that only approximately 60 wolves would be harvested, an overharvest of 218 wolves were removed by non-tribal hunters causing concern for the state's sustainable wolf population [85] and questioning the Treaty rights which allowed the tribe to protect the wolf population. The inconsistency in management authority over wolf populations throughout the past decades has caused a decline in local support for wolf protection, more backlash, distrust in the WDNR, and higher potential for illegal kills [78,86]. Additionally, some local hunters believe that white-tailed deer (*Odocoileus virginianus*), a common prey species for wolves and an important game species, populations have decreased and suggest that deer behavior has changed due to wolf predation [86]. This produces less opportunities for harvesting deer and the increasing frustration may lead hunters to shoot wolves illegally [86]. Furthermore, the feeling of powerlessness is evident amongst local farmers regarding domestic animal protection against wolf predation [86]. While these are not the feelings of every person that took part in the wolf hunt, these could be potential factors resulting in the overharvest.

Despite negotiations and pleas to the state agency to stop a fall wolf hunt, the Natural Resources Board decided to *increase* the quota and disregard the 1837 and 1842 Treaties and the Voigt Decision [64]. This led to a civil lawsuit between the Lake Superior Ojibwe Bands and the WDNR in September 2021 [64]. In this court case, the Ojibwe identified the nullification of the Treaty rights and the state's refusal to honor their 50% harvest guaranteed from the Voigt Decision [64]. For the maleficence of the WDNR, the Ojibwe requested the fall wolf hunt be closed until further scientific data and cooperation between stakeholders could be undertaken. In October 2021, a federal judge found that the hunt was unconstitutional and that the WDNR acted against the Ojibwe Treaty rights [64] proving that tribal rights, culture, and knowledge are crucial components to the maintenance and prosperity of wildlife species.

6. Discussion

Applying TEK methods to wildlife management (Figure 1) and policies must first start with joint efforts between agencies and Indigenous people and identifying the unique needs associated with wildlife management and harvest. Understanding TEK will foster creative relationships between Indigenous governments and state and federal agencies [23,87,88] which will lead to updated and improved policies and management goals [23]. In most instances, TEK is potentially complementary and parallels to adaptive management goals that are built upon Western scientific methods [31]. Seeking this collaboration can be a difficult step to undertake; however, initial involvement between parties will reduce major conflicts [89] and avoid legal actions. Not incorporating tribal needs and knowledge during the beginning stages of policy changes and management can be seen in both case

studies. In the case of the lake sturgeon, conflict arose when the non-Indigenous peoples and state and federal agencies tried to inhibit the rights of the Ojibwe to use traditional harvesting methods that were legally granted to them. This led to arguments, legal battles, and distrust between the tribes and agencies [90]. Likewise, the WDNR moved forward with a wolf hunt without proper insight from the Ojibwe leading to similar consequences and eventually closing the season to all parties.

While the lake sturgeon conflict with the MDNR resulted in a legal battle, it was one of the initial steps that helped with the application of successful Ojibwe TEK for sturgeon management and policies. The settlement of the ICD led to the cooperative management of natural resources which included lake sturgeon management and regulation [59]. Thus, modern Ojibwe TEK is one of the leading ways lake sturgeon are monitored in the state of Michigan, and state biologists are able to gain valuable knowledge about their natural history. This has provided new biological insights and opportunities for comparing and validating scientific hypotheses while providing links between wildlife and cultural conservation [2,88]. A similar example of this can be seen with beluga whale (*Delphinapterus leucas*) harvest and management in Alaska. Inuit TEK has helped shape beluga monitoring and provided health monitoring [17], general behavioral traits, feeding behavior, description of movements, and interactions between species [91]. Not only did this provide needed information for a vulnerable species, but it also helped build understanding and appreciation of the knowledge and skills of Indigenous and non-Indigenous researchers [92]. Maintaining partnerships between these stakeholders will sustain lake sturgeon population levels and give Ojibwe members the ability to practice their traditions.

Ways in which the lack of collaboration between the two groups resulted in negative ramifications can be seen with the wolf case study. Because of moving forward with a wolf hunt without the TEK of the Ojibwe, the Wisconsin wolf population suffered from illegal and over harvest. This was followed by a ruled violation of Treaty laws that ended in closing future wolf hunting seasons until WDNR could design a management plan that promoted sustainable wolf populations while honoring the cultural-based conservation of the Ojibwe. According to the 1999 Wisconsin Wolf Management Plan, no surveys were conducted to determine attitudes towards wolf management [93]. To gain insightful perspectives for wildlife related decisions, keeping an open dialogue amongst parties can aid with resolving this conflict [94] or identify differences in ideology that can help mediate the controversy. The WWMPC has been one way that the state has incorporated TEK and Ojibwe ideals to wolf harvest management, but long-term solutions are necessary to sustain [95] wolf populations. However, until the cultural significances of wolves are considered, the wolf harvest and management will not be a collective partnership [96]. Yet, the court's decision to pause wolf hunts has brought needed time to establish sound wolf management plans that can administer regulations in alignment with the Ojibwe beliefs [97]. With the latest decision made in February 2022 to relist wolves under the ESA [98], the Wisconsin wolf hunt has halted until further notice. With this new added time, the WDNR can look towards advisement from Ojibwe members regarding wolf management on both strategic and operational levels allowing for greater representation at higher decision-making levels [99].

It is pertinent to make sure that the Indigenous voices are heard when creating and implementing wildlife policies and management. Allowing for participation throughout the entire policy and management process leads to increased resourcefulness, multidisciplinary objectives, new indicators, and effective outcomes [100]. In response to immediate involvement in wildlife species management, relationships between the Indigenous people and wildlife agencies fosters adaptation from strict colonial legacies to the co-production between parties [13]. Examples of this can be universally seen in many wildlife and restoration efforts [101]. Interdisciplinary and holistic theories have been used in Canadian natural resource management to address issues associated with climate change such as wildlife subsistence use, food security, and past and current land use [101–105]. The re-emergence of cultural burning [101] in Australia has helped restore critical habitats for sensitive wildlife

and preserve native plant species [101,106,107]. In addition, many countries in Africa exhibit the integration of community-based and cultural practices with modern natural resource management to promote habitat restoration, wildlife conservation and sustainability, and biodiversity [108–110]. These examples exemplify the capabilities that integration of TEK into Western science can have on overall wildlife conservation and biodiversity.

The two case studies presented convey the significance of cooperating with Indigenous tribes for sustainable wildlife management practices. We can advance our understanding of our biological world and the roles we have in the ecosystem by expanding Western science and the NAM with TEK and cultural-based conservation [23]. Complex wildlife conservation solutions benefit from diverse stakeholder input and problem-solving approaches that incorporate the intricate connections between wildlife and humans [2,13,88,111]. Furthermore, this partnership will enhance wildlife management decisions and policies and guarantee that Aldo Leopold's "Land Ethic" and Indigenous philosophies of ecosystem balance, environmental stewardship, and ethics are withheld throughout time. Adapting these holistic philosophies and practices can warn against pollution, habitat fragmentation, climate change, and predicting and safeguarding against geological events such as floods and earthquakes [2,13,88]. By working together, wildlife professionals in all sectors can help redefine our relationship with wildlife and nature that will ultimately benefit the long-term sustainability of ecological communities and lead to greater knowledge, sense of responsibility, and engagement from all stakeholders [2,88,112].

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