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Exploring the Role of Traditional Ecological Knowledge in Climate Change Initiatives

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Abstract

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Indigenous populations are projected to face disproportionate impacts as a result of climate change in comparison to nonindigenous populations. For this reason, many American Indian and Alaska Native tribes are identifying and implementing culturally appropriate strategies to assess climate impacts and adapt to projected changes. Traditional ecological knowledge (TEK), as the indigenous knowledge system is called, has the potential to play a central role in both indigenous and nonindigenous climate change initiatives. The detection of environmental changes, the development of strategies to adapt to these changes, and the implementation of sustainable land-management principles are all important climate action items that can be informed by TEK. Although there is a significant body of literature on traditional knowledge, this synthesis examines literature that specifically explores the relationship between TEK and climate change. The synthesis describes the potential role of TEK in climate change assessment and adaptation efforts. It also identifies some of the challenges and benefits associated with merging TEK with Western science, and reviews the way in which federal policies and administrative practices facilitate or challenge the incorporation of TEK in climate change initiatives. The synthesis highlights examples of how tribes and others are including TEK into climate research, education, and resource planning and explores strategies to incorporate TEK into climate change policy, assessments, and adaptation efforts at national, regional, and local levels.

Keywords: Climate change, traditional ecological knowledge, American Indians, Alaska Natives.

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Introduction

Climate change may be a global phenomenon, but the impacts will not be evenly distributed among the world's population. Indigenous groups are projected to be among the communities most heavily affected by climate change (Parrotta and Agnoletti 2012). In Secretarial Order No. 3289, "Addressing the Impacts of Climate Change on America's Water, Land, and Other Natural and Cultural Resources," the U.S. Department of the Interior states that "climate change may disproportionately affect tribes and their lands because they are heavily dependent on their natural resources for economic and cultural identity" (USDI 2010: 4).

Many indigenous communities are beginning to experience the effects of climate change (IPCC 2001a, 2001b, 2007). As American Indians, Alaska Natives, and Native Hawaiians prepare to confront this threat, effective, culturally relevant strategies for climate change assessment and adaptation must be developed. Traditional ecological knowledge (TEK; See the "Traditional Ecological Knowledge and Western Science" section for a comparison of the two types of knowledge), is the primary indigenous way of understanding relationships among species, ecosystems, and ecological processes. Traditional ecological knowledge has the potential to play a vital role in climate change assessment and adaptation efforts that bridge human and environmental systems. Not only does it hold relevance for indigenous groups, it is also being recognized as an invaluable contribution to the larger climate change discussions occurring at regional, national, and international levels (Parrotta and Agnoletti 2012).

This synthesis of literature is specifically focused on TEK in the context of climate change. A significant body of literature exists describing the use of TEK in natural and cultural resource management, as well as the similarities and differences between TEK and Western science. As academics, governments, and communities build their understanding of climate change impacts, an understanding of the role of TEK in identifying impacts and planning for and adapting to climate change and its relationship to Western Science is needed. This synthesis identifies literature that has begun to explore this relationship between TEK and climate change.

This knowledge synthesis examines agency reports, science journals, indigenous natural resources and climate change initiatives, and reports by national and international organizations, to frame the applicability of TEK within a climate change context. It intends to summarize some of the ways TEK has historically been used in resource management and highlights the potential role of TEK in climate change assessment and adaptation initiatives. It also identifies some of the challenges and benefits associated with merging TEK with Western science, and

reviews how federal policies and administrative practices facilitate or challenge the incorporation of TEK in climate change initiatives.

This synthesis includes examples of indigenous groups, agencies, and organizations incorporating TEK into research, education, and resource planning efforts. These examples can serve as ideas for tribes and public and private partners with an interest in exploring the role of TEK in addressing climate change.

Although there is a growing body of literature related to TEK and climate change, TEK is not yet a mainstream consideration in climate change literature. There is also a gap in the literature describing culturally sensitive approaches to knowledge exchanges, collaboration, and communication between indigenous groups and federal agencies.

There are varying definitions of TEK given the significant body of literature on the subject. The Swinomish Climate Adaptation Action Plan defines TEK as the "holistic, evolving practices and beliefs passed down through generations about the relationships of living beings to their environment" (Swinomish 2010: 5). Author Fikret Berkes defines TEK as:

> A cumulative body of knowledge, practice, and belief, evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment (Berkes 1993, Berkes et al. 1995, Gadgil et al. 1993 as cited in Berkes 2008: 7).

This body of knowledge encompasses language, naming and classification systems, and sustainable practices for the use of resources. It also guides the use of rituals and defines the indigenous worldview and spirituality (Boven and Morohashi 2002).

> TEK can include diverse kinds of narratives or observations by an indigenous person or group (Menzies and Butler 2006). These narratives, in turn, can provide intergenerational observations of various kinds of natural resource phenomena (Alexander et al. 2011: 477).

Traditional ecological knowledge is sometimes referred to as a subset of indigenous knowledge, while in other cases it is considered synonymous with indigenous knowledge. In this document, traditional ecological knowledge, traditional knowledge, and indigenous knowledge are used interchangeably.

Traditional Ecological Knowledge and Natural Resource Management

Indigenous groups have historically relied on TEK to guide their interaction with natural resources (Berkes 2008). Traditional ecological knowledge "is acknowledged as having fundamental importance in the management of local resources, in the husbanding of the world's biodiversity, and in providing locally valid models for sustainable living" (Turner et al. 2000: 1275). In the United States, there are examples of indigenous groups that have included TEK guidelines in contemporary resource management plans for their tribes and communities. A few examples in the Pacific Northwest are profiled below.

Confederated Tribes of the Umatilla Indian Reservation: "First Foods" mission—

First foods are a central aspect of the traditions of the peoples of the Confederated Tribes of the Umatilla Indian Reservation (CTUIR). In 2007, the CTUIR Board of Trustees approved the adoption of the tribe's Department of Natural Resources (DNR) "First Foods" mission.

> Management of natural resources needs to be responsive to the unique values placed on the resources by tribal culture. The CTUIR DNR has adopted a mission based on indigenous foods served at tribal meals. These foods are served at ritual meals and are known to the CTUIR as "First Foods" (CTUIR 2010: 153).

Based off of the traditional first foods ceremonies of the CTUIR, this plan provides an indigenous framework for restoring culturally important foods; each branch of the program covers one of the first foods important to the people.

Coquille Indian Tribe: sustainable forestry initiative—

Congress awarded the Coquille Indian Tribe 5,400 acres of tribal forest in 1996, and the tribe has since developed a sustainable forestry initiative that combines Western science with TEK. The Coquille Tribe's forest-management plan calls for the tribe to manage "intensively for spiritual, cultural, biological, recreation, aesthetic, and economic values" (Wells 2011). Their approach is intended to balance "modern land-management tools and techniques" with tribal traditions. Some of the practices that reflect TEK values include the protection of wildlife habitat and ecologically valuable forest components, such as big trees and snags; the protection of nesting sites of culturally important birds; and management practices that promote the rapid regeneration of food and shelter for culturally significant wildlife after a timber harvest (Wells 2011).

The use of fire as an ecosystem management tool is an example of one of the contemporary applications of TEK, and illustrates the potential for TEK to influence changes in public land management processes.

Karuk Tribe: Eco-Cultural Resource Management Plan—The Karuk Tribe DNR drafted the tribe's Eco-Cultural Resource Management Plan in 2010. The plan is defined as "an integrated approach to adaptive problemsolving, in the interest of managing the restoration of balanced ecological processes utilizing Traditional Ecological Knowledge supported by Western Science" (Karuk 2010: cover). As the principle way of knowing, TEK guides the Karuk's resource management efforts in a culturally sensitive way and promotes the use and preservation of TEK in their community. This approach is guided by cultural environmental management practices specific to resources of interest.

Bridging traditional knowledge and agency management strategies—The use of fire as an ecosystem management tool is an example of one of the contemporary applications of TEK, and illustrates the potential for TEK to influence changes in public land management processes.

> Euro-Americans arrived in North America bearing their folk knowledge that held fire in forests to be destructive and hazardous to humans (Arno 1985, Lewis 1982). This view contrasted sharply with the traditional knowledge of the indigenous inhabitants, who embraced the benefits of burning and were skilled in application of fire technology (Kimmerer and Lake 2001: 36).

Colonizing Europeans and subsequent American forest policies that suppressed wildfires contributed to ecosystem change and other environmental consequences (Kimmerer and Lake 2001). In recent decades, however, the ecological role of fire has gained attention with Western scientists and federal land managers as a management tool. The significance of fire's influence on society and the environment is exemplified by the 2008 publication *Interagency Prescribed Fire: Planning and Implementation Procedures Guide*. This publication, which serves groups such as the U.S. Department of Agriculture (USDA) Forest Service and the U.S. Department of the Interior (USDI) Bureau of Indian Affairs and the National Park Service (among others) provides guidelines for prescribed fire planning and implementation.

> …prescribed fire is used to alter, maintain, or restore vegetative communities; achieve desired resource conditions; and to protect life, property, and values that would be degraded and/or destroyed by wildfire (USDA and USDI 2008: Executive Summary).

National and International Interest in TEK

Many disciplines rooted in Western science now recognize the value of TEK (Trosper and Parrotta 2012). Various forms of TEK are commonly accepted in disciplines such as the social sciences as well as among scientists in fields such as agriculture and soil and water conservation (Alexander et al. 2011). Traditional ecological knowledge is also recognized for the contributions it can make to resource management. "In recent decades, resource managers have gradually begun to embrace the usefulness of applying TEK to contemporary stewardship issues in various parts of the world" (United Nations 2008, WCED 1987 as cited in Alexander et al. 2011: 478). Public agencies and nongovernmental organizations in the United States and around the world are beginning to incorporate TEK in climate change, planning, policies, education, and research.

The National Science Foundation has funded projects incorporating TEK in the study of climate change, including the development of indigenous-based math curriculum, the effects of contaminants on subsistence foods, and alternative technologies for waste disposal (Barnhardt and Kawagley 2005). In 2010, the USDA Natural Resources Conservation Service (NRCS) published a guidebook titled *Indigenous Stewardship Methods and NRCS Conservation Practices*, which "provides a sensitive process in which knowledge is shared, allowing employees to incorporate the indigenous knowledge into NRCS' assistance through its conservation practices" (USDA NRCS 2010: 1). According to the NRCS, "culturally diverse worldviews and ways of knowing are as important as genetic and biologic diversity in providing solutions to the ever growing daunting environmental issues we are facing" (USDA NRCS 2010: 4).

The United Nations University (the academic arm of the United Nations) has also addressed the importance of TEK by creating the Traditional Knowledge Initiative. The initiative "seeks to build greater understanding and facilitate awareness of traditional knowledge to inform action by indigenous peoples, local communities, and domestic and international policy makers" (United Nations University 2011). Their efforts include partnerships with other organizations to facilitate the inclusion of TEK into international endeavors.

The Convention on Biological Diversity (CBD) is also acknowledging the role of TEK and encouraging its responsible use. The CBD's Article 8j states:

> Each contracting Party shall, as far as possible and as appropriate: Subject to national legislation, respect, preserve and maintain knowledge, innovations and practices of indigenous and local communities embodying traditional lifestyles relevant for the conservation and sustainable use of biological diversity and promote their wider application with the

> approval and involvement of the holders of such knowledge, innovations and practices and encourage the equitable sharing of the benefits arising from the utilization of such knowledge innovations and practices (CBD 2011a).

The CBD's article 10c also promotes TEK by advocating that each contracting party "protect and encourage customary use of biological resources in accordance with traditional cultural practices that are compatible with conservation or sustainable use requirements" (CBD 2011b). Protecting and encouraging the traditional use of resources sets the stage for the preservation of knowledge associated with traditional activities.

TEK in a Climate Change Context

Traditional ecological knowledge is essential to the economic and cultural survival of indigenous groups and has proven invaluable to nonindigenous communities as a way of knowing that provides a renewed perspective. As indigenous and nonindigenous communities alike have benefitted from the application of TEK in natural and cultural resource management, there is increasing recognition of the value of TEK as it applies to climate change assessment and adaptation efforts.

Traditional ecological knowledge can help build an understanding of climate impacts on ecological processes and phenomena across spatial and temporal scales for different organisms, habitats, and various ecosystems (Nabhan 2010). It can also serve an important role in short- and medium-term weather forecasting (Parrotta and Agnoletti 2012). The applicability of TEK, associated with socioeconomic and adaptive human responses to environmental change can make an important contribution to understanding the impacts from climate change and strategies for adaptation.

Indigenous groups are projected to be among the most vulnerable in the face of climate change. This is in part because of their close ties with and reliance on ecosystem goods and services. Because of this, it is important that climate change impacts and adaptation strategies be examined through an understanding of Western science and place-based TEK. Internationally, organizations are progressively recognizing this need but continue to face challenges when attempting to incorporate TEK in their climate change initiatives. The foremost climate change authority, the Intergovernmental Panel on Climate Change (IPCC), is among these organizations.

In its fourth assessment report, the IPCC noted the importance of TEK as it pertains to climate change. Specifically, it stated that TEK is "an invaluable basis

for developing adaptation and natural resource management strategies in response to environmental and other forms of change" (Raygorodetsky 2011).

> Previous IPCC Assessments, however, were unable to access this type of information because, for the most part, traditional knowledge either appears in grey literature outside of peer-reviewed academic forums, or remains in oral form, thereby falling outside the scope of IPCC process (Raygorodetsky 2011).

To adress this issue, the IPCC is taking steps to make TEK a more prominent component of its fifth assessment, slated for publication in 2014 (Raygorodetsky 2011). One of these steps has been to partner with the United Nations University Traditional Knowledge Initiative to facilitate the incorporation of TEK into IPCC research and reporting. The two organizations are working "to ensure that the experience of indigenous and traditional peoples of climate change impacts and their adaptation and mitigation strategies are fully integrated in the next IPCC Assessment…" (Raygorodetsky 2011). Despite these efforts, there are claims that the IPCC's fifth assessment does not go to great enough lengths to include TEK as a significant component of the publication.

> There is no Indigenous population's chapter planned for WGII for example, and aside from the affirmation of the importance of Indigenous Knowledge at the 31st and 32nd Session of the IPCC, there is limited indication at an institutional level that this is a priority area for improvement or development. This is an important gap because Indigenous populations have been identified as a highly vulnerable subgroup, while their accumulated knowledge can help us understand how the climate is changing, characterize impacts, and provide valuable lessons for adaptation (Ford et al. 2010, Green et al. 2009, Salick and Ross 2009, Turner and Clifton 2009 as cited in Ford et al. 2011).

The IPCC's acknowledgement of the importance of TEK in a climate change context is indicative of the momentum that TEK is gaining as a knowledge system that has much to contribute to climate change research and political initiatives. The obstacles faced by researchers, policymakers, and others when attempting to incorporate TEK into climate change research illustrates some of the administrative and cultural challenges that must be addressed for TEK to be successfully incorporated into such efforts.

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The Role of TEK in Climate Change Adaptation

Traditional ecological knowledge is an invaluable way of knowing that has the potential to become instrumental in climate change assessment and adaptation efforts (Salick and Ross 2009). Indigenous communities have historically lived within the land's means and adapted to environmental changes. Climate change is likely to bring rapid environmental changes in many regions of the United States and require broad-scale adaptation strategies. The detection of environmental changes, the development of strategies to adapt to these changes, and the implementation of sustainable land-management principles are all important climate action items that can be informed by TEK (Parrotta and Agnoletti 2012). Researchers and scholars have already started to identify and categorize ways in which TEK and Western science can be used together in climate change-related research. As demonstrated above with international and national frameworks, this effort can be improved. Based on research carried out in the Arctic, Riedlinger and Berkes (2001 as cited in Berkes 2008: 164) identified five areas in which science and TEK can communicate and collaborate, through the use of TEK:

- As local-scale expertise
- As a source of climate history and baseline data
- In formulating research questions and hypotheses
- As insight into impacts and adaptation in communities
- For long-term community-based monitoring

Traditional ecological knowledge can make significant contributions in assessing the impacts of climate change and in identifying strategies for climate change adaptation.

Climate Change Assessment

> Indigenous cultures have centuries of experience with local natural resources. They may observe local environmental changes out in the field before Western scientists detect them and can develop ways to respond to these changes (Grossman 2008: 8).

Climate change assessments, approaches often guided by Western scientific frameworks, examine the potential changes that may occur to the environment, as well as community economies, infrastructure, public health, and other aspects of community livelihood as a result of climate change. Traditional ecological knowledge has the potential to inform various aspects of climate change assessments

(Parrotta and Agnoletti 2012). Specifically, TEK can provide baseline climate information and climate history, in identifying local climatic changes both short- and long-term, and in identifying the environmental and cultural impacts within ecological, spatial, and temporal scales.

Traditional ecological knowledge relies on the accumulation of long-term, land-based wisdom gained from experiences with organisms, habitats, ecosystems, and ecological processes. Consequently, this way of knowing can compare historical landscape conditions with present-day conditions (Parrotta and Agnoletti 2012). Indigenous narratives and traditions often include references to environmental conditions and events, giving TEK holders a fine-tuned sense of nature's temporality, diversity, and variability. Stumpff (2009) describes an example of how these traditions instill a keen sense of environmental awareness: "The Quileute know something is wrong because there are no smelt eggs in time for Honoring Elders Day to make 'stinky eggs,' so they know the smelt are out of balance often before scientists realize that this keystone species is faltering" (Stumpff 2009: 81). This knowledge can be useful when attempting to understand natural systems over time. As illustrated in the example below, research comparing information inferred from traditional narratives with scientific data reveals strong similarities and conclusions.

> In several Iñupiaq indigenous narratives, the changes in sea ice and whale migrations that have affected hunting success were described. This effect influences the Iñupiaq's spiritual and physical ties with the whale in relation to traditional musicmaking (Sakakibara 2009). These narratives were linked to NASA Earth Observations Records (NASA 2007). As time series of remotely sensed data become longer, further links between narrative and scientific observations may be found (Alexander et al. 2011: 482).

"The Quileute know something is wrong because there are no smelt eggs in time for Honoring Elders Day to make 'stinky eggs,' so they know the smelt are out of balance often before scientists realize that this keystone species is faltering."

Climate Change Adaptation

In reference to TEK, Fikret Berkes (2008) uses the phrase "knowledge as process" and defines it as "knowledge that undergoes continual generation and regeneration as people interact with the environment; observing, learning, and adapting." This definition suggests that TEK and "knowledge as process" refers to the ability of indigenous groups to be adaptive and resilient to change and offers a way of knowing that could be conducive to understanding impacts from climate change and strategies for climate adaptation. Salick and Ross (2009) suggest that indigenous peoples "interpret and react to climate change impacts in creative ways, drawing on traditional knowledge as well as new technologies to find solutions, which may help society at large to cope with the impending changes."

Indigenous groups have applied TEK to adapt to the changing environment through time, and there are already examples of groups applying TEK to adapt to the impacts of climate change. Such examples provide insight into potential adaptation strategies. In his research focused on the people of Sachs Harbour, Berkes (2008) breaks indigenous adaptive measures into two categories: (1) short-term or coping responses to environmental changes, and (2) cultural practices and adaptive responses to the broader environment.

Short-term responses include modifying the timing and location of harvest activity, adjusting the mix of species harvested, and monitoring for dangerous environmental conditions. Adaptive responses include intercommunity trade, hunting group mobility through seasonal settlements, sharing mechanisms and social networks, and flexibility of seasonal cycles of harvest and resources use (Berkes 2008). Knowledge exchanges between tribal communities are also occurring.

> At the Tribal Lands Climate Conference, a Haudenosaunee (Iroquois) woman reported that she had visited relations to her south to learn what was coming into her territories and then visited communities to her north to let them know what may be coming their way (Grossman 2008: 11).

Climate change is likely to affect the phenology and range of culturally important species. Information exchanges can help indigenous communities adjust their knowledge to prepare for these changes, and can be applicable to climate adaptation strategies.

Tribes Incorporating TEK Into Climate Change Initiatives

An increasing number of tribes and native groups throughout the United States are engaged in addressing climate change, and some explicitly mention the role of TEK in their efforts. In the Pacific Northwest, the Swinomish Indian Tribal Community has developed a strong climate change initiative, completing an impact assessment in 2009 and a climate change adaptation plan in 2010 that includes a section on the challenges of developing effective adaptation measures that consider tribal traditions. The plan also discusses “the need to have an ethical response that respects and preserves the sensitive nature of traditional knowledge and specifies ongoing work to connect elders with youth for intergenerational sharing of spiritual and other traditional environmental knowledge” (Swinomish 2010: 24).

The Swinomish plan (2010) includes a list of initiatives that are exploring ways in which TEK can be incorporated into adaptation planning. These include:

- The pursuit of a codification approach to institutionalizing traditional knowledge by creating an ethical construct that functions as an indirect representation of more sensitive knowledge concepts, in the interest of respecting and protecting such core knowledge.
- The creation of tribal review boards as a vehicle for formal screening and approval of traditional knowledge and sources. This would allow for and create a pathway for application of traditional knowledge, while providing a direct means of protecting such knowledge from misappropriation and misuse.

On a larger scale, the United Nations Permanent Forum on Indigenous Issues inspired indigenous groups to form the Indigenous Peoples' Biocultural Climate Change Assessment Initiative (IPCCA 2012) in 2008 as a platform to bring together TEK and Western science and incorporate indigenous perspectives into global climate change conversations (IPCCA 2012).

> As climate change is a global phenomenon, IPCCA is also undertaking a Global Assessment of indigenous peoples vis-à-vis climate change, producing reflections for policy development to support implementation of the United Nations Declaration on the Rights of Indigenous Peoples' and strengthen the role of indigenous knowledge in building appropriate solutions to the challenge of climate change. Part of the strategic policy goals of this indigenous initiative is to enable local voices to reshape the climate change debate (IPCCA 2012).

Martinez describes the IPCCA's approach as one that empowers local communities to do their own assessments.

> Our mission is to empower Indigenous communities to develop and use their own ecocultural realities and knowledge to assess the effects of climate disruption; the development and implementation of response options for building Indigenous resilience and "buen vivir" or wellbeing, and adaptive strategies to mitigate climate disruption impacts by enhancing ecocultural diversity for food sovereignty, security, and self-determined development (Martinez 2011: 7).

Tribal–Federal Partnerships

There are a growing number of examples of collaborations between indigenous groups and public agencies to incorporate TEK into climate change strategies. Examples of these collaborative efforts are provided below.

The 2010 Tribal Leaders Summit—
Tribal leaders and officials with the U.S. Environmental Protection Agency (EPA) worked together during the summit in Juneau, Alaska, to develop a report on climate change called "Visions for Action." The report (EPA 2010) included action items that highlighted the region's commitment to climate change within three categories:

- Education and communication
- Tribal leadership/consultation/co-management and policy development/ regulations
- Interagency tribal coordination/equitable funding/funding research

Each of these categories included the incorporation of TEK (or indigenous knowledge) in some capacity. For example, as it pertained to education and communication category, participants at the summit "proposed climate change education, informed by traditional ecological knowledge and science, targeted to schools, communities, and political leadership" (EPA 2010: 2).

Monitoring change using Aklavik (Inuvialuit) local ecological knowledge—
To effectively detect climatic changes, the Inuvialuit of Canada and Alaska developed the Arctic Borderlands Ecological Knowledge Co-op, joining forces with interested locals and officials to monitor various climate change indicators. In September 2011, the monitoring data were used to produce a report on 13 years of community-based monitoring by Inuvialuit harvesters in Aklavik, Northwest Territories (Robinson and Nguyen 2011). The Borderlands Co-op gathered local ecological knowledge from harvesters on topics related to subsistence harvesting and changes on the landscape and climate and helped illustrate how TEK can contribute to scientific understanding.

> The results of this study in some cases agreed with and other times corrected recent scientific conclusions, demonstrating the value and efficiency of such community-based ecological monitoring programs (Robinson and Nguyen 2011: Exec. Summary).

The Arctic Climate Impact Assessment (ACIA)—
Prepared by more than 300 participants from 15 countries, the ACIA (2005) was a scientific report including many examples drawn from the local traditional knowledge of Inuit, Sami, Athabaskans, Gwich'in, Aleut, and other Arctic indigenous peoples. "These publications demonstrate some of the possibilities for bringing diverse groups together to frame challenges related to climate change" (Alexander et al. 2011: 478).

In reference to TEK (or indigenous knowledge as it is referred to in ACIA), the report suggests that the ACIA utilized indigenous knowledge to an unprecedented degree (Huntington and Weller 2005).

The value of TEK as a climate change assessment and adaptation tool is quickly being realized. As the above examples demonstrate, local, regional, national, and international initiatives are relying on TEK to make important contributions. These types of collaborations are only bound to increase in frequency. In the United States, agencies and organizations can begin to consider financial and administrative strategies to incorporate TEK within climate change initiatives.

The Pacific Northwest Climate Change Network—
The Tribal Climate Change Project is a collaboration between the University of Oregon Environmental Studies Program and the USDA Forest Service Pacific Northwest Research Station. One of the Tribal Climate Change Project's central endeavors is the Pacific Northwest Climate Change Network, which serves as a platform for tribes to exchange information on climate change policy, grants, and programs. It provides a place for tribes and nontribal organizations to engage in climate change issues and share helpful resources and ideas. The network has over 50 organizations represented, including tribes, federal agencies, and nongovernmental organizations. A significant area of focus for the network includes exploring the role of TEK in climate change studies, vulnerability assessments, and adaptation plans, as well as the protection of TEK in cross-jurisdictional climate change initiatives.

Western scientists have an opportunity to reframe traditional perspectives on TEK (that may consider TEK as a subjective, informal, lesser way of knowing), and see TEK as a relevant, reliable knowledge system with strengths complimentary to those of Western science.

Traditional Ecological Knowledge and Western Science

As the value of incorporating TEK into climate change mitigation and adaptation plans is recognized, bringing TEK and Western science together will be indispensible. Successfully bringing together these two knowledge systems requires an understanding of any presumed incompatibilities and identification of how TEK and Western scientific approaches are compatible. Western scientists have an opportunity to reframe traditional perspectives on TEK (that may consider TEK as a subjective, informal, lesser way of knowing), and see TEK as a relevant, reliable knowledge system with strengths complimentary to those of Western science. Knowledge exchanges can be planned in a respectful way that will ensure the full protection of the knowledge systems and cultural practices of the tribe or native group contributing TEK. Finally, changes can be considered that would inform standard institutional practices and accommodate the unique nature of such knowledge exchanges.

Two Ways of Knowing

An obstacle to incorporating TEK into collaborative management and mitigation plans is the perceived incompatibility between TEK and Western science (Gamborg et al. 2012). Recent studies and collaborations have contested this notion and have shown that the two ways of knowing can be meaningfully used together, in part because of their inherent differences. The two knowledge systems differ most in the way facts are acquired and transmitted. Traditional ecological knowledge involves the accumulation of highly localized, experiential, placed-based wisdom over a long period, most often passed down orally from generation to generation. Western science, on the other hand, develops rapidly by testing the validity of hypotheses with experimental manipulation in a highly controlled setting via the application of standardized procedures, and is most often passed on via writing in an academic setting. The two knowledge systems also share some similarities. Both knowledge systems are founded on observations and critical evaluation of the phenomena, processes, or taxa of interest. Procedurally, they both rely on empirical observation in natural settings and on pattern recognition to refine their knowledge base (Gamborg et al. 2012). Both are subject to modification as initial facts and assumptions are disproven or improved upon through additional experience or testing, both relying on repetition to validate an assumed fact. The key differences and similarities between the two systems are highlighted in table 1 proposed by the Alaska Native Science Commission.

Historically, the differences between these two ways of knowing often hindered collaborative effort. There are many examples now, however, of those who view these differences as complementary to each other rather than mutually exclusive (Parrotta and Agnoletti 2012). Traditional ecological knowledge can contribute qualitative, historical field data that Western science may lack, while Western science typically provides more quantitative data. As it pertains to climate change, contributions from both knowledge systems are imperative. Traditional ecological knowledge can identify on-the-ground climate-related changes occurring at a local level and contribute traditional management practices that have been time-tested. Additionally, as ecosystems experience increased fluctuations and former extremes in variability become more common, TEK of the “extreme” or “atypical” can be used to increase predictability of current and future change. Western science can quantify and document the changes that are occurring and test the validity of assumptions and potential solutions. Climate change mitigation and adaptation plans, frameworks, or strategies, especially for regions within or surrounding lands

Table 1—Comparisons between traditional and scientific knowledge in use[a]

Indigenous scientific knowledge	Western scientific knowledge
Holistic approach	Compartmentalized approach
Lengthy acquisition	Rapid acquisition
Long-term wisdom	Short-term prediction
Prediction in local areas	Predictability in natural principles
Weak in predictive principles in distant areas	Weak in integrated, local areas of knowledge
Models based on cycles, accepting variablity	Linear modeling as first approximation
Explanations based on examples, anecdotes, parables, and experiential familarity	Explanations based on hypothesis, theories, laws, and scientific judgment

[a] Modifed from Alaska Native Science Commission 2011a.

critical to tribes and native groups, have an opportunity to include TEK, along with Western science, to address the challenges in a holistic way that will maximize the positive outcomes for all parties involved.

Protection of Native Knowledge Systems and Culture

The holders of TEK have often been hesitant to collaborate with Western scientists because TEK is closely linked with each native group's and native individual's identity, lifestyle, intellect, and spirituality, and disclosing such information could be detrimental to cultural preservation.

> Many Natives view the extraction of their traditional knowledge from its broader cultural context as a form of theft and, understandably, have been reluctant to share the depth and breadth of what they know with outside interests. They also fear that, because many wildlife managers and decision-makers do not understand their culture, customs or values, their traditional knowledge will somehow be used against them (e.g., setting quotas and other hunting regulations). At best, piecemeal extraction of traditional knowledge from its larger cultural context invites misrepresentation and misinterpretation. At worst, it represents a form of misappropriation and cultural exploitation (Alaska Native Science Commission 2011b).

Many legal systems have historically treated TEK as part of the public domain once it leaves the indigenous community to which it belongs. For example, researchers have acquired TEK from indigenous groups and published it in their research, which then became public domain and open for use by private corporations that could capitalize on profits without benefitting the indigenous community that contributed the TEK (Posey and Dutfield 1996,1997 as cited in Berkes 2008).

An indigenous individual's inheritance of TEK comes with a responsibility to one's family, elders, and community, and especially to mentors who have entrusted or shared the information (Johnson 1992, Lake 2007). Unethical behavior on the part of some scientists and private entities can deteriorate TEK holders' trust and willingness to participate in future collaborations for fear that their TEK will be misappropriated (Mason et al. 2012). For scientists and TEK holders to enter into a long-term collaboration, native knowledge systems and culture must be protected from exploitation and misapplication.

An indigenous individual's inheritance of TEK comes with a responsibility to one's family, elders, and community, and especially to mentors who have entrusted or shared the information. Unethical behavior on the part of some scientists and private entities can deteriorate TEK holders' trust and willingness to participate in future collaborations for fear that their TEK will be misappropriated.

Perceptions of Western Scientists

Because TEK is produced and disseminated differently than Western science, Western scientists have sometimes viewed TEK not as science, but as folklore (Mason et al. 2012). "Throughout history, marginalization of alternate perspectives as 'unscientific' has been a pervasive characteristic of Western science" (Bala and Joseph 2007, Nader 1996, as cited in Mason et al. 2012: 188). Such attitudes have at times negatively impacted the collaborative process, the quality of the knowledge resulting from such processes, and even the willingness of TEK holders to participate, the latter of which is described in a publication by the U.S. Global Change Research Program:

> Desires on the part of some Native peoples not to air their concerns publicly, not to have their sacred knowledge revealed to the uninitiated, not to have their wisdom and stories dismissed as mere folklore, or not to have their participation become overly romanticized by those who may wish to focus on quaint pageantry while ignoring the vital message carried by the seasoned wisdom of these traditions, sometimes influences the willingness to participate (Maynard 1998: 5).

To find ways to use these two knowledge systems to address climate change, practioners of Western science have an opportunity to reframe the way they view TEK and strengthen their interactions with tribes and native groups in discussing TEK. Scholars have proposed strategies to bring TEK and Western science together. Among these scholars are Anthony Davis and Kenneth Ruddle, who suggest that TEK and Western science can be brought together more easily by systematizing TEK research to strengthen its validity within the scientific community and increase its applicability.

> Despite notable exceptions, much of the most cited IEK/LEK/TEK literature lacks even the notion of subjecting IEK/LEK/TEK claims to systematic examination. Skeptical study is so uncommon that much

> presented as ‘‘knowledge’’ amounts to little more than statements of either belief, faith, or preference (Davis and Ruddle 2010: 892).

In addition, guidelines to ensure an ethical and equitable knowledge exchange can be established when initiating collaboration between scientists and TEK holders. An example of such an undertaking can be found in the NRCS' *Indigenous Stewardship Methods and NRCS Conservation Practices Guidebook*, a thorough compilation of guidelines to help both the agency and the tribes understand each other and improve communication in an effort to facilitate knowledge exchange. The guide's introduction sets a collaborative, equitable tone:

> This guide will help NRCS employees gain an understanding of the indigenous perspective of natural resources conservation, indigenous stewardship methods (ISM), and intellectual property rights. Further, it will guide NRCS employees through a process to incorporate or implement the ISM into their conservation planning process. This guide will help both the NRCS employee working with Tribes as well as our Tribal partners to make the NRCS list of conservation practices stronger, more comprehensive, and more culturally relevant to Tribes across the United States. It will allow NRCS and Tribes to work on a professional level to achieve their common goal—helping each other help the land (USDA NRCS 2010: 1).

The guide's contents promote respectful communication, the acceptance of differing cultural values, the equal importance of both indigenous and Western science contributions, and the protection of tribal culture and intellectual property.

Bringing TEK and Western Science Together

Various agencies are taking steps to overcome some of the hurdles listed above in order to bring TEK and Western science together. This is demonstrated in the EPA Region 10 Tribal Leaders Summit 2010 Action Plan, which states, "…within the next year, the federal agencies in collaboration with tribes in Region 10, will sponsor a workshop to explore the connections between indigenous knowledge, citizen science and western science" (EPA 2010: 6).

Similarly, the National Oceanic and Atmospheric Administration's National Marine Fisheries Service addressed collaboration and inclusion of TEK into scientific processes in the 2010 Tribal Consultation Recommendations, which state: "Allow tribal entities to participate in the scientific analysis stage of the decision making. Allow for traditional ecological knowledge to be used in this phase of the process" (NOAA NMFS 2010: 5).

Fire is a critical ecological component of many ecosystems. Climate change is affecting fire behavior and landscape disturbance patterns caused by vegetation/fuel dynamics affecting natural resources of sociocultural importance. In the United States, regarding wildland fire management, an interdisciplinary collaborative approach to fire and fuels research and management acknowledges the importance of community values and TEK. Various initiatives are taking place to facilitate strategies to coordinate the use of Western science and TEK as it pertains to fire management.

One such initiative took place during a 2-day workshop in June 2010. Seven tribal elders and 20 native and nonnative scientists (including USDI Bureau of Indian Affairs and U.S. Forest Service employees) partook in a workshop on the Flathead Indian Reservation of the Confederated Salish Kootenai Tribes in Western Montana. The process, was documented and published in the Journal of Forestry (Mason et al. 2012). The purpose of the workshop was to "explore ways to integrate Native American stewardship practices, traditional knowledge, and philosophies with western science to address contemporary forest health and wildfire challenges" (Mason et al. 2012: 187).

The National Cohesive Wildland Fire Management Strategy's Western Regional Assessment also acknowledges the importance of TEK in the section "Honoring tribal heritages and land uses."

> Preserving and respecting traditional uses and practices is of vital importance. Wildland fire management policies and practices need to take into account cultural values and beliefs, related historic and spiritual sites and resources, and the relevant lessons to be gleaned from traditional ecological knowledge (National Cohesive Wildland Fire Management Strategy 2011: 18).

Given the importance of forest and grassland resources to indigenous communities, and the cultural reliance on fire-managed landscapes by many indigenous groups, fire-related TEK pertaining to climate change has utility to Western scientists and managers. Natural resource-based indigenous organizations representing indigenous interests, such as the Intertribal Timber Council, facilitate the incorporation of TEK into forestry and fire management with indigenous governments and practitioners. These efforts provide mechanisms for the equitable inclusion of TEK with Western science (Trosper et al. 2012)

There are several cases in which the two ways of knowing have been used together. As illustrated in Berkes (2009), indigenous groups in Canada worked with scientists to use traditional knowledge to inform resource management and

planning, address environmental contaminants, and identify issues related to public health, development, climate change, and biodiversity and conservation, among other areas.

> Non-indigenous researchers have played a major role in knowledge co-production in these areas, always preceded by trust-building, development of working relationships, and respect for areas that should not be researched (Berkes 2009: 153).

The Alaska Traditional Knowledge and Native Foods Database (2000) is another example of a successful collaborative effort.

> The database serves as a clearinghouse for data and observations concerning contamination and other adverse changes in the environment, in order to assist Native communities in facing these impacts. This project is one example of how Alaska Natives, scientists, government entities and others can work together to seek solutions to the effects of climate change on Native communities (Hanna 2007: 48).

Traditional ecological knowledge holders and scientists are beginning to recognize the mutual benefits that can result from collaborating. When asked why his people share TEK, Richard Glenn, an Iñupiat who has served on the Arctic Research Consortium and the Alaska Native Science Commission, responded:

> Why do Iñupiat share traditional knowledge? Despite the stigma our community is proud of a long history of productive, cooperative efforts with visiting researchers, hunters, travelers, scientists, map makers and others. We share when we consider others close enough to be part of Iñupiat culture and share when it is in the best interest of a greater cultural struggle (Barnhardt and Kawagley 2005: 14).

Policy Considerations: Including TEK Within Climate Change Initiatives

The successful incorporation of TEK into climate change efforts depends not only on bridging TEK and Western science; ultimately, it calls for institutional practices and policies to accommodate knowledge exchanges, and the development of a framework that guides federal agencies and organizations toward the culturally sensitive incorporation of TEK into climate change planning and policy (Parrotta and Agnoletti 2012). This section explores areas that may be included in a culturally sensitive process for the exchange and use of TEK:

- Mechanisms for knowledge exchange
- Protection of TEK
- Funding and compensation
- Continued involvement and communication
- Inclusion of TEK in climate change research and management

Mechanisms for Knowledge Exchange

Through consultation, federal agencies have an opportunity to discuss the use of the TEK in addressing climate change and to create formal mechanisms to share and utilize TEK in federal and tribal climate change assessments, plans, and implementation strategies.

There are various federal laws and principles in place to encourage meaningful collaboration and knowledge exchanges between federal agencies and federally recognized tribes. In 1994, President Clinton signed a presidential memorandum for heads of executive departments and agencies, entitled "Government-to-Government Relations with Native American Tribal Governments." The memorandum describes the unique government-to-government relationship between the federal government and federally recognized tribes, and encourages close communication and collaboration through principles such as:

> Each executive department and agency shall assess the impact of Federal government plans, projects, programs, and activities on Tribal trust resources and assure that Tribal government rights and concerns are considered during the development of such plans, projects, programs and activities (U.S. Presidential Memorandum 1994).

One important component of the government-to-government relationship is consultation. As part of its trust responsibility to American Indians and Alaska Natives, the federal government must consult with tribes on federal actions, policies, rules, or regulations that will directly affect them. Through consultation, federal agencies have an opportunity to discuss the use of the TEK in addressing climate change and to create formal mechanisms to share and utilize TEK in federal and tribal climate change assessments, plans, and implementation strategies. These mechanisms may include development of memorandums of understanding or agreements that help formalize strategies for sharing and utilizing information.

Beyond consultation, many public agencies and nongovernmental organizations are working to improve communication with indigenous groups and foster more meaningful collaboration. These initiatives may involve meetings with tribal representatives to discuss opportunities for improving consultation and collaboration.

Examples of collaboration between tribes and public agencies using TEK in climate change initiatives include the 2010 EPA Tribal Leaders Summit. This summit resulted in action items and long-term objectives, including some related to tribal leadership, consultation, comanagement, and policy development and regulations.

Specific objectives related to climate change included sponsoring local, national, and international forums on climate change and researching, collecting data, and sharing information related to TEK (EPA 2010).

The USDA Forest Service has also taken recommendations from tribal leaders in an effort to improve tribal-agency communication and collaboration. In response to tribal requests asking that the role of science in the agency's planning process account for traditional tribal knowledge, the Forest Service passed rule 219.4(a)(3) "Requirements for public participation: Native knowledge, indigenous ecological knowledge, and land ethics," stating that, "the responsible official shall request information about native knowledge, land ethics, cultural issues, and sacred and culturally significant sites." (USDA Forest Service 2012: 21196).

In addition to improving the consultation process to better accommodate the exchange and use of TEK, federal agencies and organizations may consider modifying institutional standards as they pertain to accepted forms of knowledge and literature. Presently, many agencies and organizations accept only peer-reviewed literature, which may exclude TEK. Standards will have to be modified if TEK is to be considered an acceptable source of information that can be incorporated into climate change assessments and adaptation plans.

Protection of TEK

A process to incorporate TEK into climate change assessment and adaptation planning should also include appropriate measures to protect the sensitive information shared through traditional knowledge. Traditional ecological knowledge is closely linked with each native group's identity, and disclosing such information could be detrimental to cultural preservation.

The 2008 United Nations Declaration on the Rights of Indigenous Peoples addresses the indigenous right to control and protect TEK in article 31, which states:

> Indigenous peoples have the right to maintain, control, protect and develop their cultural heritage, traditional knowledge and traditional cultural expressions, as well as the manifestations of their sciences, technologies and cultures, including human and genetic resources, seeds, medicines, knowledge of the properties of fauna and flora, oral traditions, literatures, designs, sports and traditional games and visual and performing arts. They also have the right to maintain, control, protect and develop their intellectual property over such cultural heritage, traditional knowledge, and traditional cultural expressions (United Nations 2008: 11).

Many public agencies are taking action and developing guidelines to ensure that native knowledge systems are protected when tribes or native groups collaborate with the agency. The Bureau of Reclamation's 1998 Protocol Guidelines: Consulting with Indian Tribal Governments document, illustrates their strategies to address the protection of native knowledge systems. (See sidebar 1.)

The USDA Farm Bill (2008) has also taken measures to protect TEK by including a statement limiting the need to disclose information related to traditional site and resource uses among tribes. Specifically, the bill limits disclosure of information "concerning the identity, use, or specific location in the National Forest System of a site or resource used for traditional or cultural purposes by an Indian tribe" (USDA 2008: 1261).

Tribes and native groups have also been proactive in the development of guidelines for government agencies and scientists wanting to collaborate with them or carry out research on tribal or native lands. The guidelines are meant to ensure an equitable interaction that keeps the tribe or native group's best interests in mind. The Alaska Federation of Natives Board released an example of such guidelines in 1993. (See sidebar 2.)

In addition, tribes and native groups have also taken initiatives to protect TEK as intellectual property.

> In addition to sponsoring a day-long symposium on "Native Science at its 2003 annual meeting in Denver, the AAAS, has published a Handbook on *Traditional Knowledge and Intellectul Property* to guide traditional knowledge holders in protecting their intellectual property and maintaining biological diversity (Hansen and VanFleet 2003, as cited in Barnhardt and Kawagley 2005: 11).

Funding and Compensation

Lack of funding is often a barrier that prevents indigenous groups from developing climate change initiatives or participating in initiatives led by others. The Department of the Interior noted the consequences of inadequate funding in the Tribal Recommendations for the fiscal year 2012 Climate Change Adaptation Initiative:

> Many Native communities are proactively addressing climate change, demonstrating great resilience and adding unique knowledge and practices of value both within and beyond tribal communities. Due to a lack of financial resources, only a few of the 565 federally recognized tribes, such as the Swinomish Tribe, have developed or are developing adaptation plans, calculating their carbon footprints, and collaborating with states, local governments and federal agencies in joint climate

Sidebar 1

Bureau of Reclamation's 1998 Protocol Guidelines: Consulting with Indian Tribal Governments

Tribes are particularly sensitive about the disclosure of certain kinds of information about religious practices and sacred sites, traditional knowledge, intellectual property, and cultural resources. In order to minimize the likelihood that sensitive material may be released, Reclamation staff are encouraged to refrain from acquiring sensitive information. Tribes should be informed that they should only submit to Reclamation information or material that the tribe is willing to release as part of the public record. If tribally sensitive information is discussed or collected during consultation, Reclamation staff should be mindful of the following:

- Tribal information that has been disclosed or collected should be protected to the maximum extent practicable.
- Information obtained from tribes may become part of the public record and be released as a result of requests made under the Freedom of Information Act (FOIA).
- When FOIA requests are made for the disclosure of tribal information, Reclamation offices are encouraged to notify and consult with the affected tribe.

Source: USDI Bureau of Reclamation 1998: 34.

Sidebar 2

Alaska Federation of Natives Board Policy Guidelines for Research

- Advise those native people who will be affected by the study of the purpose, goals and time frame of the research, the data-gathering techniques, the positive and negative implications and the impacts of the research.
- Obtain informed consent of the appropriate governing body.
- Fund the support of a native research committee appointed by the local community to assess and monitor the project and ensure compliance with the expressed wishes of native people.
- Protect the sacred knowledge and cultural/intellectual property of native people.
- Hire and train native people to assist in the study.
- Use native languages whenever English is the second language.
- Include native viewpoints in the final study.
- Acknowledge the contributions of native resource people.
- Inform the native research committee in a summary report, in nontechnical language, of the major findings of the study.
- Provide copies of the study to the local people.

Source: Alaska Native Science Commission 2011b.

> adaptation efforts. By comparison, at least 36 of the 50 states have climate action plans (USDI 2010: 2).

The Department of the Interior further noted that:

> Tribal peoples are sharing their traditional knowledge with other tribal peoples, providing invaluable insights to scientific efforts to understand climate change, and reviving ancestral practices that are time-tested, climate resilient, and are inherently effective adaptation techniques. Through an extensive intertribal outreach effort, tribes have managed to secure seats at the table in developing the National Fish, Wildlife, and Plants Climate Adaptation Strategy led by the U.S. Fish and Wildlife Service, National Oceanic and Atmospheric Administration, and Association of Fish and Wildlife Agencies. However, this strategy effort only supplies minimal travel funding for tribal participants and no resources to cover staff time. There are huge demands for tribal participation on at least ten federal climate planning strategies, but none of these processes provide adequate, dedicated funding to support tribal involvement (USDI 2010: 2–3).

To remedy this lack of adequate funding, the 2012 Indian Country Budget Request included a request to the Department of the Interior for $15 million for a Climate Change Adaptation Initiative (NCAI 2011). Pending appropriation, this funding could significantly increase the number of tribes and native groups able to fund climate change initiatives, increasing the opportunities for the inclusion of TEK in climate change assessment and adaptation plans. These funds would also "support tribal participation in interagency workshops to incorporate traditional knowledge into climate adaptation strategies…" (USDI 2010: 7). This would increase collaborative efforts between indigenous groups and federal agencies, as well as opportunities to include TEK in climate change assessment and adaptation plans on native and nonnative lands.

If TEK is to form part of climate change assessment and adaptation efforts, agencies and organizations must plan for and allocate adequate funding. The National Science Foundation and North Pacific Research Board, for example, allocated $1 million for the TEK component of their Bering Sea Integrated Ecosystem Research Program (BSIERP) (NOAA NMFS 2010). The BSIERP project summary is available online at http://www.nprb.org/science/ltk.html.

Compensation for TEK holders is another aspect that should be addressed when incorporating TEK into climate change assessment and adaptation planning. In at

least one meeting between tribal representatives and a federal agency, tribal representatives have addressed the topic of payment in exchange for information. Under the Presidential Executive Order 13175, the National Oceanic and Atmospheric Administration's (NOAA's) National Marine Fisheries Service (NMFS) brought together a group of representatives from Alaska tribes in November 2009 to discuss strategies to improve the tribal consultation process. Among the recommendations was one stating that NMFS should fund tribes' participation in consultations, and that such consultations "can't be an unfunded mandate or a low priority in the budget" (NOAA NMFS 2010: 4).

Forms and quantity of payment for TEK contributions are not well documented. In one Canadian case study described in a joint publication by Nuffic and UNESCO's Management of Social Transformation Programme (Boven and Morohashi 2002), tribal elders transmitted indigenous knowledge to members of their own tribe who work with children. In this case, TEK holders were paid in either cash or gifts equal to an approximate value of CAD 50 (about $48 US) for a half hour session (Boven and Morohashi 2002). In some cases, institutions may be unable to fund TEK holders owing to internal barriers, such as lacking the structural flexibility to fund small-scale practitioners. If compensation in exchange for TEK is to become a standard, institutions could consider amending their standards to make payment to small-scale practitioners an accepted practice.

Historically, public agencies have met the minimum requirements for consulting with tribes but have missed opportunities for meaningful communication and collaboration with indigenous groups.

Continued Involvement and Communication

A culturally sensitive process to incorporate TEK into climate assessment and planning should ensure continued involvement of and communication with the indigenous entities contributing TEK. Historically, public agencies have met the minimum requirements for consulting with tribes but have missed opportunities for meaningful communication and collaboration with indigenous groups. As the Karuk Tribe writes in the Eco-Cultural Resources Management Plan, "National Forest interaction with the Karuk Tribe at times has been confined to 'we have notified the Tribe and we have fulfilled our legal obligation'" (Karuk 2010: 6–7). The Karuk make clear their desire to establish more meaningful partnerships with public agencies in an effort to collaboratively address their respective needs as they pertain to planning, policy, and forest management (Karuk 2010).

Inclusion of TEK in Climate Change Research and Management

Academic institutions, federal research entities, and professional societies can play an important role in including TEK in climate change research and management. The Ecological Society of America (ESA), for example, has a TEK section. The efforts of the ESA-TEK section members work to bring the value of TEK to the

many disciplines of ecology, including climate change. The goals of this section are to (1) promote the understanding, dissemination, and respectful use of TEK in ecological research, application, and education; (2) encourage education in TEK; (3) stimulate research that incorporates the traditional knowledge and participation of indigenous people; and (4) increase participation by indigenous people in the ESA.

Other professional organizations have adopted or developed TEK working groups or committees. The Wildlife Society has a Native Peoples' Wildlife Management Working Group, "which promotes improved relationships between state/provincial/federal wildlife managers and tribal wildlife managers through improved communications" (USFWS 2011). These are mechanisms in which the inclusion of TEK to various disciplines working on climate change adaptation and mitigation strategies foster collaboration with indigenous and tribal people.

Conclusion

Traditional ecological knowledge has the potential to play a vital role in indigenous climate change assessment and adaptation efforts, as well as make important contributions to the climate change efforts of federal agencies, institutions, and organizations at local, national, and international levels. Many indigenous groups, agencies, and organizations are taking steps to facilitate the incorporation of TEK into various climate change initiatives. A key example of this is the resolution on Traditional Knowledge and Climate Change passed in September 2011 by the Affiliated Tribes of Northwest Indians. This resolution illustrates the potential for significant impacts to tribal rights and resources from climate change, establishes the role of TEK in governance and decisionmaking, and emphasizes tribal capacity to be "co-managers in any government climate planning, or mitigation or adaptation measures that affect tribal resources, lands or well-being" (ATNI 2011).

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References

Affiliated Tribes of Northwest Indians [ATNI]. 2011b. Resolution No.11-77. Traditional knowledge and climate change. http://www.atnitribes.org/PDF%20Docs/resolutions/2011/annual/11-77_Amen%20an%20ff%20the%20Flr_ATNI_2011_TEK_an_Climate_Change%20Final.pdf. (June 27, 2012).

Alaska Native Science Commission. 2011a. Comparisons between traditional and scientific knowledge. http://www.nativescience.org/html/traditional_and_scientific.html. (November 11, 2011).

Alaska Native Science Commission. 2011b. What is traditional knowledge? http://www.nativescience.org/html/traditional_knowledge.html. (November 11, 2011).

Alaska Traditional Knowledge and Native Foods Database. 2000. http://www.nativeknowledge.org/start.htm. (September 27, 2012).

Alexander, C.; Bynum, N.; Johnson, E.; King, U.; Mustonen, T.; Neofotis, P.; Oettlé, N.; Rosenzweig, C.; Sakakibara, C.; Shadrin, V.; Vicarelli, M.; Waterhouse, J.; Weeks, B. 2011. Linking indigenous and scientific knowledge of climate change. BioScience. 61(6): 477–484.

Arno, S.F. 1985. Ecological effects and management implications of Indian fires. In Proceedings: symposium and workshop on wilderness fire. Gen. Tech. Rep. INT-182. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station: 302–303.

Bala, A.; Joseph, G.G. 2007. Indigenous knowledge and Western science: the possibility of dialogue. Race and Class. 49(1): 39–61.

Barnhardt, R.; Kawagley, A.O. 2005. Indigenous knowledge systems and Alaska native ways of knowing. Anthropology and Education Quarterly. 36(1): 8–23.

Berkes, F. 1993. Traditional ecological knowledge in perspective. In: Inglis, J.T., ed. Traditional ecological knowledge: concepts and cases. Ottawa: Canadian Museum of Nature/International Development Research Centre: 1–9.

Berkes, F. 2008. Sacred ecology. New York: Routledge. 336 p.

Berkes, F. 2009. Indigenous ways of knowing and the study of environmental change. Journal of the Royal Society of New Zealand. 39(4): 151–156.

Berkes, F.; Folke, C.; Gadgil, M. 1995. Traditional ecological knowledge, biodiversity, resilience and sustainability. In: Perrings, C.; Mäler, K.-G.; Folke, C.; Holling, C.S.; Jansson, B.-O., eds. Biodiversity conservation. Dordrecht, The Netherlands: Kluwer Academic Publishers: 281–299.

Boven, K.; Morohashi, J., eds. 2002. Best practices using indigenous knowledge. Nuffic, The Hague, The Netherlands and UNESCO/MOST, Paris, France. http://www.unesco.org/most/Bpikpub2.pdf. (June 27, 2012).

Confederated Tribes of the Umatilla Indian Reservation [CTUIR]. 2010. Comprehensive plan. http://www.umatilla.nsn.us/Comprehensive%20Plan.pdf. (June 27, 2012).

Convention on Biological Diversity [CBD]. 2011a. Article 8j. Traditional knowledge, innovations and practices. http://www.cbd.int/traditional/. (December 18, 2011).

Convention on Biological Diversity [CBD]. 2011b. Article 10c. Sustainable use of components of biological diversity. http://www.cbd.int/convention/articles/?a=cbd-10. (June 26, 2012).

Davis, A.; Ruddle, K. 2010. Constructing confidence: rational skepticism and systematic enquiry in local ecological knowledge research. Ecological Applications. 20(3): 880–894.

Ecological Society of America [ESA]. ESA traditional ecological knowledge section. http://www.esa.org/tek/. (February 16, 2012).

Ford, J.D.; Berrang-Ford, L.; King, M.; Furgal, C. 2010. Vulnerability of aboriginal health systems in Canada to climate change. Global Environmental Change-Human and Policy Dimensions. 20(4): 668–680.

Ford, J.D.; Vanderbilt, W.; Berrang-Ford, L. 2011. Authorship in IPCC AR5 and its implications for content: climate change and indigenous populations in WGII. Climate Change. http://www.springerlink.com/content/g473nu2t726l5640/fulltext.pdf. (June 27, 2012).

Gadgil, M.; Berkes, F.; Folke, C. 1993. Indigenous knowledge for biodiversity conservation. Ambio. 22(2/3): 151–156.

Gamborg, C.; Parsons, R.; Puri, R.K.; Sandøe, P. 2012. Chapter 14: Ethics and research methodologies for the study of traditional forest-related knowledge. In: Parrotta, J.A.; Trosper, R.L., eds. Traditional forest-related knowledge: sustaining communities, ecosystems and biocultural diversity. Dordrecht, The Netherlands: Springer: 535–562.

Green, D.; King, U.; Morrison, J. 2009. Disproportionate burdens: the multidimensional impacts of climate change on the health of indigenous Australians. Medical Journal of Australia. 190(1): 4–5.

Grossman, Z. 2008. Indigenous nations' responses to climate change. American Indian Culture and Research Journal. 32(3): 5–27.

Hanna, J.M. 2007. Native communities and climate change: protecting tribal resources as part of national climate policy. Boulder, CO: the Natural Resources Law Center, University of Colorado Law School. In conjunction with, the Western Water Assessment at the University of Colorado. http://www.colorado.edu/law/centers/nrlc/publications/ClimateChangeReport-FINAL%20_9.16.07_.pdf. (June 27, 2012).

Hansen, S.; VanFleet, J. 2003. Traditional knowledge and intellectual property: a handbook on issues and options for traditional knowledge holders in protecting their intellectual property and maintaining biological diversity. American Association for the Advancement of Science. http://shr.aaas.org/tek/handbook/handbook.pdf. (June 27, 2012).

Houde, N. 2007. The six faces of traditional ecological knowledge: challenges and opportunities for Canadian co-management arrangements. Ecology and Society. 12(2): 34. http://www.ecologyandsociety.org/vol12/iss2/art34/. (June 27, 2012).

Huntington, H.; Weller, G. 2005. Introduction to the ACIA. In: Symon, C.; Arris, L.; Heal, B., eds. Arctic climate impact assessment. New York: Cambridge University Press: 1–20.

Indigenous People's Biocultural Climate Change Assessment [IPCCA]. Welcome to the portal of the indigenous peoples' biocultural climate change assessment initiative. http://ipcca.info/. (February 9, 2012).

Intergovernmental Panel on Climate Change [IPCC]. 2007. Chapter 15: Polar regions (Arctic and Antarctic)-15.2.2.4. Human populations. Contribution of working group II (impacts, adaptation, and vulnerability) to the fourth assessment report of the Intergovernmental Panel on Climate Change. http://www.ipcc.ch/publications_and_data/ar4/wg2/en/ch15s15-2-2-4.html. (June 27, 2012).

Intergovernmental Panel on Climate Change [IPCC]. 2001a. Chapter 16: Polar regions (Arctic and Antarctic)-16.2.8.1. Impacts on indigenous peoples. Contribution of working group II (impacts, adaptation, and vulnerability) in the third assessment report of the Intergovernmental Panel on Climate Change. http://www.ipcc.ch/ipccreports/tar/wg2/index.php?idp=612#16281. (June 27, 2012).

Intergovernmental Panel on Climate Change [IPCC]. 2001b. Chapter 19: Vulnerability to climate change and reasons for concern: a synthesis-19.3.4.2. Indigenous communities. Contribution of working group II (impacts, adaptation, and vulnerability) in the third assessment report of the Intergovernmental Panel on Climate Change. http://www.ipcc.ch/ipccreports/tar/wg2/index.php?idp=671. (June 27, 2012).

Johnson, M., ed. 1992. LORE- Capturing traditional ecological knowledge. Dene Cultural Institute and International Development Research Centre. http://web.idrc.ca/openebooks/644-6/. (June 27, 2012).

Karuk Tribe Department of Natural Resources [Karuk]. 2010. Eco-cultural resources management plan (draft). http://www.karuk.us/karuk2/images/docs/dnr/ECRMP_6-15-10_doc.pdf. (June 27, 2012).

Kimmerer, R.W.; Lake, F. 2001. The role of indigenous burning in land management. Journal of Forestry. 99(11): 36–41.

Lake, F. 2007. Traditional ecological knowledge to develop and maintain fire regimes in Northwestern California, Klamath-Siskiyou bioregion: management and restoration of culturally significant habitats. Corvallis, OR: Oregon State University. Ph.D. dissertation. http://hdl.handle.net/1957/6222. (June 27, 2012).

Lewis, H.T. 1982. Fire technology and resource management in aboriginal North America and Australia. In: Williams, N.M.; Hunn, E.S., eds. Resource managers: North American and Australian hunter and gatherers. American Association for the Advancement of Science Selected Symposium Series No. 67. Boulder, OR: Westview Press: 45–67.

Martinez, D. 2011. Indigenous ecosystem-based adaptation and community-based ecocultural restoration during rapid climate disruption: lessons for Western restorationists. http://www.scribd.com/doc/76322289/Dennis-Martinez-2011. (June 27, 2012).

Mason, L.; White, G.; Morishima, G.; Alvarado, E.; Andrew, L.; Clark, F.; Durglo, M.; Durglo, J.; Eneas, J.; Erickson, J. 2012. Listening and learning from traditional knowledge and Western science: a dialogue on contemporary challenges of forest health and wildfire. Journal of Forestry. 110 (4): 187–193.

Maynard, N.G., ed. 1998. Native peoples-native homelands climate change workshop. U.S. Global Research Program. http://www.usgcrp.gov/usgcrp/Library/nationalassessment/native.pdf. (June 27, 2012).

Menzies, C.R.; Butler, C. 2006. Introduction: understanding ecological knowledge. In: Menzies, C.R., ed. Traditional ecological knowledge and natural resource management. Lincoln, NB: University of Nebraska Press: 1–17.

Nabhan, G.P. 2010. Perspectives in ethnobiology: ethnophenology and climate change. Journal of Ethnobiology. 30(1): 1–4.

Nader, L., ed. 1996. Naked science: anthropological inquiry into boundaries, power, and knowledge. New York: Routledge. 340 p.

National Aeronautics and Space Administration [NASA]. 2007. Ice in the Beaufort Sea: natural hazards. http://earthobservatory.nasa.gov/NaturalHazards/view.php?id=17067. (June 27, 2012).

National Cohesive Wildland Fire Management Strategy. 2011. Western regional assessment and strategy. http://www.forestsandrangelands.gov/strategy/documents/reports/1_CohesiveStrategy03172011.pdf. (June 27, 2012).

National Congress of American Indians [NCAI]. 2011. Indian country budget request (fiscal year 2012). http://www.ncai.org/resources/ncai-publications/indian-country-budget-request/fy2012/FY2012_Budget.pdf. (June 27, 2012).

National Oceanic and Atmospheric Administration National Marine Fisheries Service [NOAA NMFS]. 2010. Additional response to November 2009 recommendations about the Alaska region's tribal consultation process. http://www.fakr.noaa.gov/tc/workgroup/nmfs_response_to_nov09.pdf. (June 27, 2012).

Parrotta, J.A.; Agnoletti, M. 2012. Chapter 13: traditional forest-related knowledge and climate change. In: Parrotta, J.A.; Trosper, R.L., eds. Traditional forest-related knowledge: sustaining communities, ecosystems and biocultural diversity. Dordrecht, The Netherlands: Springer: 491–534.

Posey, D.A.; Dutfield, G. 1996. Beyond intellectual property: toward traditional resource rights for indigenous peoples and local communities. Ottawa, Canada: International Development Research Centre. 250 p.

Posey, D.A.; Dutfield, G. 1997. Indigenous peoples and sustainability: cases and actions. Utrecht: International Union for the Conservation of Nature and International Books. 367 p.

Raygorodetsky, G. 2011. Why traditional knowledge holds the key to climate change. United Nations University. http://unu.edu/articles/global-change-sustainable-development/why-traditional-knowledge-holds-the-key-to-climate-change. (December 13, 2011).

Riedlinger, D.; Berkes, F. 2001. Contributions of traditional knowledge to understanding climate change in the canadian arctic. Polar Record. 37(203): 315–328.

Robinson, P.; Nguyen, L. 2011. Monitoring change using Aklavik (Inuvialuit) local ecological knowledge. ParcsCanada. http://www.taiga.net/coop/ABEKC-Report-2011-Final.pdf. (June 27, 2012).

Sakakibara, C. 2009. 'No whale, no music': Iñupiaq drumming and global warming. Polar Record. 45(4): 289–303.

Salick, J.; Ross, N. 2009. Traditional peoples and climate change. Global Environmental Change. 19(2): 137–139.

Stumpff, L.M. 2009. Climate change and tribal consultation: from dominance to détente. http://www.georgewright.org/0914stumpff.pdf. (June 27, 2012).

Swinomish Indian Tribal Community [Swinomish]. 2010. Swinomish climate change initiative climate adaptation action plan. http://www.swinomish-nsn.gov/climate_change/Docs/SITC_CC_AdaptationActionPlan_complete.pdf. (June 27, 2012).

Trosper, R.L.; Parrotta, J.A. 2012. Chapter 1: Introduction: the growing importance of traditional forest-related knowledge. In: Parrotta, J.A.; Trosper, R.L., eds. Traditional forest-related knowledge: sustaining communities, ecosystems and biocultural diversity. Dordrecht, The Netherlands: Springer: 1–36.

Trosper, R.L.; Clark, F.; Gerez-Fernandez, P.; Lake, F.; McGregor, D.; Peters, C. M.; Purata, S.; Ryan, T.; Thomson, A.; Watson, A. E.; Wyatt, S. 2012. Chapter 5: North America. In: Parrotta, J.A.; Trosper, R.L., eds. Traditional forest-related knowledge: sustaining communities, ecosystems and biocultural diversity. Dordrecht, The Netherlands: Springer: 157–203.

Turner, N.J.; Clifton, H. 2009. "It's so different today": climate change and indigenous lifeways in British Columbia, Canada. Global Environmental Change-Human and Policy Dimensions. 19(2): 180–190.

Turner, N.J.; Ignace, M.B.; Ignace, R. 2000. Traditional ecological knowledge and wisdom of Aboriginal peoples in British Columbia. Ecological Applications. 10(5): 1275–1287.

United Nations. 2008. United Nations declaration on the rights of indigenous peoples. Resolution adopted by the General Assembly, March 2008. http://www.un.org/esa/socdev/unpfii/documents/DRIPS_en.pdf. (June 19, 2012).

United Nations University. 2011. Traditional knowledge initiative. http://www.unutki.org/. (October 6, 2011).

U.S. Department of Agriculture [USDA]. 2008. Food, Conservation, and Energy Act of 2008. http://www.gpo.gov/fdsys/pkg/BILLS-110hr6124eh/pdf/BILLS-110hr6124eh.pdf. (June 6, 2012).

U.S. Department of Agriculture and U.S. Department of the Interior [USDA and USDI]. 2008. Interagency prescribed fire: planning and implementation procedures guide. http://www.nwcg.gov/pms/RxFire/rxfireguide.pdf. (June 27, 2012).

U.S. Department of Agriculture, Forest Service [USDA FS]. 2012. National forest system land management planning; final rule and record of decision. Federal Register. 77 FR 21196. https://www.federalregister.gov/articles/2012/04/09/2012-7502/national-forest-system-land-management-planning#p-503. (June 19, 2012).

U.S. Department of Agriculture, Natural Resources Conservation Service [USDA NRCS]. 2010. Indigenous stewardship methods and NRCS conservation practices. Native practices work group. http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1045245.pdf. (June 27, 2012).

U.S. Department of the Interior [USDI]. 2010. Order No. 3289, Amendment No. 1. ELIPS: Electronic Library of Interior Policies. http://elips.doi.gov/app_so/act_getfiles.cfm?order_number=3289A1. (December 14, 2011).

U.S. Department of the Interior, Bureau of Reclamation. 1998. Protocol guidelines: consulting with Indian tribal governments. Native American Affairs Office. http://www.usbr.gov/native/naao/policies/protguide.pdf. (June 27, 2012).

U.S. Environmental Protection Agency [EPA]. 2010. EPA region 10 action plan from 2010 tribal leaders summit. http://www.epa.gov/region10/pdf/tribal/2010_tribal_leaders_summit_action_plan.pdf. (June 27, 2012).

U.S. Fish and Wildlife Service [USFWS]. 2011. Traditional ecological knowledge for application by service scientists. http://www.fws.gov/nativeamerican/graphics/TEK_Fact_Sheet.pdf. (June 27, 2012).

U.S. Presidential Memorandum. 1994. Government-to-government relations with Native American tribal governments. Federal Register. 59 FR 22951. http://www.gpo.gov/fdsys/pkg/WCPD-1994-05-02/pdf/WCPD-1994-05-02-Pg936.pdf. (June 26, 2012).

World Commission on Environment and Development [WCED]. 1987. World Commission on Environment and Development: our common future. Oxford, UK: Oxford University Press. 400 p.

Wells, G. 2011. Native American forestry combines traditional wisdom with modern science. Solutions. Issue 6: 107–114. http://www.thesolutionsjournal.com/node/1012. (December 1, 2011).

The Wildlife Society. Native peoples' wildlife management working group. http://joomla.wildlife.org/Native/. (February 16, 2012).

Appendix: Considerations for Incorporating TEK Into Climate Change Initiatives

Following is a list of considerations for incorporating traditional ecological knowledge (TEK) into climate change policy, assessments, and adaptation efforts at national, regional, and local levels.

National Policy Considerations

- Establish formal recognition of the value of TEK in a climate context and inclusion of TEK within the National Climate Assessment.
  - Clarification of TEK as an accepted form of literature in the National Climate Assessment.
  - Protection of disclosed TEK.
- Examine the role of TEK in the Intergovernmental Panel on Climate Change assessments.
- Establish support for TEK (including funding) within Climate Science Center initiatives and processes where Landscape Conservation Cooperatives are establishing science priorities.

Formal Recognition of TEK by Federal Agencies and Public Officials

- Educate agency managers, scientists, and public officials on the nature of TEK and its role in climate change research and planning through publications, training sessions, and roundtables or meetings with indigenous groups.
- Modify institutional standards for accepted formats of information to allow nonpeer reviewed literature and information to be considered acceptable. If need be, this can be an exception applied only in regards to TEK.

Protection of TEK

- Ensure that all agency representatives understand the United Nations Declaration on the Rights of Indigenous Peoples adopted by the General Assembly in 2007, as well as the international law of Free Prior and Informed Consent, and use these international regulations to guide the process of protecting the sensitive information that forms part of TEK.
- Consider the pursuit of a codification approach to institutionalizing TEK by creating an ethical construct that functions as an indirect representation of more sensitive knowledge concepts, in the interest of respecting and protecting core knowledge.

Future Research

- Carry out or promote research that can inform the inclusion of TEK in climate change initiatives.
- Examine additional areas where TEK is relevant in climate change discussions, such as the effects of climate change on plant and animal phenology, and the implications of these effects on the foundations of TEK.

Funding and Compensation

- Identify the need for TEK early in the process and include it in formal planning documents so as to ensure that adequate funding is secured for the TEK portion of the climate change initiative.
- Modify rules to allow for compensation of small-scale practitioners, such as may be the case for TEK holders.

Incorporating TEK in Climate Change Assessments and Adaptation Plans[1]

Establish the role of TEK in climate change efforts

- Identify the scope of the climate change initiative, including the boundaries of the assessment and tribal resources and interests that may be affected (on and off-reservation.)
- Determine how TEK will inform and guide the objectives of the climate change initiative.
- Establish formal recognition among all partners of the value and use of TEK in the climate assessments and plans.

Foster strong collaboration with tribal and nontribal partners

- Identify tribal and nontribal collaborators that should be involved in the initiative.
- Identify potential TEK holders that can contribute knowledge or establish a process by which TEK will be acquired.
- Communicate results, findings, and plans to all partners, including TEK holders.
- Consider developing a standard knowledge exchange template or set of guidelines that can be used in future endeavors.

[1] A list of resources for tribal climate change adaptation planning can be found at http://www4.nau.edu/tribalclimatechange/resources/adaptation.asp#tools.

Protection of TEK

- Create a review board for the purpose of screening and approving the received TEK and its sources.
- Establish a strategy that ensures that protection of TEK when it is used to inform climate change assessments and adaptation plans.
- Ensure that collaborators understand the United Nations of the Rights of Indigenous Peoples adopted by the General Assembly in 2007, as well as the international law of Free Prior and Informed Consent, and use these international regulations to guide knowledge exchange.

TEK and Government-to-Government Relationships

- Tribes and public agencies should exercise the government-to-government relationship by forming partnerships and collaborations around federal climate change initiatives.
- Public agencies should strive to engage tribes in climate change initiatives and ensure that TEK has a role in informing such initiatives.
- When government action has tribal implications, public agencies should initiate a formal consultation with involved tribal groups. During this consultation, the following topics may be addressed:
    - What the knowledge exchange is intended to accomplish
    - How TEK will be used in the given climate change initiative
    - How culturally sensitive information that forms part of TEK will be protected
    - How funding or compensation will be addressed
    - What the long-term role of the indigenous groups and TEK holders will be in the initiative

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