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Cultural impacts to tribes from climate change influences on forests

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Abstract Climate change related impacts, such as increased frequency and intensity of wildfires, higher temperatures, extreme changes to ecosystem processes, forest conversion and habitat degradation are threatening tribal access to valued resources. Climate change is and will affect the quantity and quality of resources tribes depend upon to perpetuate their cultures and livelihoods. Climate impacts on forests are expected to directly affect culturally important fungi, plant and animal species, in turn affecting tribal sovereignty, culture, and economy. This article examines the climate impacts on forests and the resulting effects on tribal cultures and resources. To understand potential adaptive strategies to climate change, the article also explores traditional ecological knowledge and historical tribal adaptive approaches in resource management, and contemporary examples of research and tribal practices related to forestry, invasive species, traditional use of fire and tribal-federal coordination on resource management projects. The article concludes by summarizing tribal adaptive strategies to climate change and considerations for strengthening the federal-tribal relationship to address climate change impacts to forests and tribal valued resources.

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1 Introduction

Climate change impacts, including increased frequency and intensity of wildfires, higher temperatures, extreme changes to ecosystem processes, forest conversion and habitat degradation are threatening tribal access to valued resources (Ryan et al. 2008). Climate change is affecting the quantity and quality of resources—such as water, minerals, and various plants, animals, and fungi—that tribes depend upon to perpetuate their cultures and livelihoods. In addition to providing sustenance, these resources and habitats have proven invaluable to cultural, economic, medicinal, and community health for countless generations.

Climate impacts on forests are expected to directly affect culturally important plant and animal species, in turn affecting tribal sovereignty, culture, and economy (Reo and Parker, submitted for this issue). Observed impacts include species losses and shifts in species ranges (Rose 2010; Swinomish 2010), including northward or elevational migration of some temperate forest species, contraction or expansion of other plant species, and changes in the distribution and population density of wildlife species (Trainor et al. 2009). Loss of biodiversity, impacts on culturally important native plants and animals, increases in invasive species or pathogens, bark beetle damage to forests and increased risk of detrimental wildfires have been observed in the Southwest (ITEP 2011), across much of the West, and in Alaska (Bentz et al. 2010; Hicke et al. 2012; Valachovic et al. 2011).

Increasing wildfires are projected to affect culturally valued resources. Rising temperatures, hotter and drier summers, and wildfires are projected to increase in frequency, intensity, and severity (Moritz et al. 2012; Flannigan et al. 2005). Droughts, as well as tree mortality and vegetation stress, will result in longer fire seasons by increasing fuel loading, insect outbreaks, and the spread of invasive species (NWF 2011). Rising temperatures are projected to affect tree ring growth and vegetation productivity in the Arctic (Andreu-Hayles et al. 2011). And just as climate change stands to affect forests and tribally valued forest resources, forests will play a role in affecting local climate responses (Mote et al. 2003).

This article examines the climate impacts on forests and the resulting effects on tribal cultures and resources. To understand potential climate change adaptation strategies, the article explores traditional ecological knowledge and historical tribal adaptive approaches to resource management, as well as contemporary examples of research and tribal practices related to forestry, invasive species, traditional use of fire and tribal-federal coordination on resource management. The article concludes by summarizing tribal climate change adaptation strategies and considerations for strengthening the federal-tribal relationship to address climate change impacts to forests.

1.1 Traditional ecological knowledge and climate impacts on forests

Climate impacts on tribal cultural resources will affect the formation and use of Traditional Ecological Knowledge (TEK). TEK, the indigenous way of understanding relationships among species, ecosystems, and ecological processes, can play a vital role in climate change assessment and adaptation efforts that bridge human and environmental systems (Whyte 2013; Hardison and Williams, submitted for this issue). Indigenous knowledge systems provide detailed information about ecosystems and spiritual and cultural identity (Grossman 2008; Parker et al. 2006; Turner and Clifton 2007). Native peoples use this knowledge to maintain and cultivate biodiversity, valued resources, and ecological health in their homelands (Jones et al. 2008; Salick and Byg 2007). Simultaneously, people adapt their knowledge base to changes in the environment (First Stewards 2012; Grossman 2008; Swinomish

2010; Turner and Clifton 2007). Many tribes are concerned about how climate change will affect their relationship with culturally significant species and ecosystems. They are also worried about the loss of TEK as climate change creates challenges for Native peoples to observe, experience and understand changes and how to strategically adapt (Parker et al. 2006). The loss of TEK coupled with especially rapid ecosystem alterations or redistribution of species populations resulting from climate change may cause indigenous peoples to become alienated from their traditional landscapes (Swinomish 2010; Turner and Clifton 2007). Many tribes will face challenges in regards to the migration of valued resources due to political and jurisdictional constraints, potentially making them climate refugees in their ancestral territories. Furthermore, climate change may reduce biodiversity in local ecosystems, making it more difficult for native peoples to use traditional adaptation strategies (Salick and Byg 2007).

Unchecked, these challenges threaten tribal cultural resilience and well-being. In response, many tribes are emphasizing greater use of TEK and traditional adaptation methods (Jones et al. 2008; Swinomish 2010). TEK can help inform the dynamics of climate change by "teach[ing] what to look for and how to look for what is important" (Berkes 2009) in terms of ecosystem change. For example, alterations in the seasonality of indicator species (species whose presence or behavior provides information about the state of other species or ecological relationships) make it difficult to understand how other species will behave (Turner and Clifton 2007). TEK and native language may improve understanding of changes in ecological cycles (EPA 2011). When TEK is paired with Western science, a more comprehensive multi-scale strategy may result to better address climate change impacts on tribal cultural practices and traditional lifeways (EPA 2011).

1.2 Tribal adaptation to changing fire regimes and climate

Tribal cultures have adapted their subsistence strategies and socio-economic systems in response to climate and fire regimes for millennia (DeSantis et al. 2010; Moss et al. 2007; Williams 2002). Climate and bio-physical settings (e.g., weather, soils, topography, and vegetation) influence natural fire regimes (Gedalof 2011; Moritz et al. 2011). Tribal peoples observed and adapted to the effects of fire on ecological processes at various scales, from local habitats to landscapes encompassing diverse ecosystems (Nowacki et al. 2012; Stewart 2002).

Fire regime changes are currently being observed in North America (Cohen and Miller 2001). In particular, longer fire seasons and more frequent and severe wildfires are likely to impact cultural use and the availability of tribally valued resources.

In the Pacific West, wildfires have changed elk and deer forage and drought has reduced forage quality (DeVos Jr. and McKinney 2007). In the Midwest, Northeast, and South, changes in seasonal moisture have reduced forest nut crop abundance, stressing food webs and the dynamics of ecosystems utilized by tribes (McKenney-Easterling et al. 2000; Speer et al. 2009).

Fire regimes have evolved in response to natural and anthropogenic influences for millennia (Stewart 2002). Fire regimes directly influence vegetation composition and structure (Falk et al. 2011; Perry et al. 2011). Natural fire regimes differ from cultural fire regimes in that the latter depend on anthropogenic/tribal ignitions (Stewart 2002). There is also a difference between major wildfires in "natural" regimes that may be partially caused by human management and other fires that are not influenced by humans (Kofinas et al. 2010). Cultural fire regimes emerged as a result of time-tested tribal knowledge regarding the effects of climate and fire on culturally valued resources. Tribes utilized fire to increase the predictability of resources, as well as to increase ecosystem resilience. Tribes used fire for crop management, basketry, range-browse improvement, fire proofing around valued

resources, clearing travel routes, driving game/prey, clearing riparian areas, increasing water yield, communication/signaling, warfare, and rituals (Stewart 2002; Williams 2002). Tribes still value and apply many of the historical uses of fire today (Mason et al. 2012).

Projected climate change impacts in North America will result in alterations to most U.S. fire regimes, leading to changes in tribal adaptation strategies (Cohen and Miller 2001; Trosper et al. 2012). TEK and tribal practices can inform adaptation strategies to fire and contribute solutions to reduce climate change impacts on ecological services and culturally significant resources.

2 Climate impacts on tribally-valued forest resources

Indigenous peoples are culturally invested in specific values, meanings, and identities that are linked with the natural landscape (Daigle and Putnam 2009). Forest responses to climate change may alter tribal livelihoods and traditions and require unique adaptation strategies to ensure sustained access to tribally valued resources important for tribal economies and traditions.

Climate impacts on forest resources may have direct effects on traditional foods important to tribes (Lynn et al. 2013). Projected changes in climate for California's forest-oak dominated (*Notholithocarpus* and *Quercus* sp.) ecosystems include dryer and warmer conditions in the next 50–100 years (Kueppers et al. 2005). Paleoclimate reconstructions and fire ecology studies show that oaks are resilient to drought conditions and increased fire frequency (Holmes et al. 2008). Despite these adaptive traits, oaks may experience costs in the reduction of acorn-mast production (Pérez-Ramos et al. 2010). As historical tribal burning gave way to fire suppression and exclusion, the increased density of other vegetation has decreased the ability of oaks to resist additional climate-related stress. Precipitation changes coupled with cooler temperatures may predispose oaks to diseases (e.g., exotic pathogen *Phytophthora*), while warmer conditions may predispose diseased or environmentally stressed oaks to greater fire risks (Dale et al. 2001). Reductions in acorn production, coupled with water stress, increases acorn susceptibly to insect damage. Less resilient oak trees, reduced acorn production, increased fire threat and insect pests synergistically combine to make lower quality and quantity of acorns available for tribal and wildlife food consumption.

2.1 Climate-related impacts from invasive species and pests

Climate change will exacerbate the risks posed by invasive species to forest resources (Reo and Parker, submitted for this issue). The threats of urbanization, unsound management, and exotic pathogens (e.g., Sudden Oak Death-*Phytophthora ramorum*) to oak-dominated ecosystems will diminish tribal opportunities to utilize acorns and other food plants (e.g., Evergreen huckleberry, salal, California myrtle) (Ortiz 2008). Unfortunately, few mitigation or adaptation strategies exist for tribal acorn gatherers. Current policies and land management practices do not adequately address tribal concerns (Seppälä et al. 2009; Cordalis and Suaġee 2008; Krakoff 2008). To promote production of higher quality acorns, tribes who rely on acorns for ceremonial and dietary uses could work with local land managers to prioritize access and contribute tribal knowledge to the design of restoration treatments.

Compounding climate change impacts to tribes are the multi-scale effects of invasive species as animal and plant pests, pathogens, and diseases directly affect subsistence and ceremonial practices, health and safety. Pests are increasing forest mortality and reducing the

quality and quantity of forest products valued by tribes. Pathogens and diseases are affecting habitat quality, plant health, and pose a direct threat to humans (Dukes et al. 2009; Sturrock et al. 2011).

The relationship between invasive species and climate change is increasingly important to understand as environmental changes create more suitable conditions for the spread of invasive species and an acceleration of landscape-level change. Invasive species can outcompete, displace or colonize habitats occupied by native species. Invasive species can alter nutrient, hydrologic, or fire regimes, changing the quality or quantity of valued forest resources. Tribes may be forced to alter subsistence or ceremonial practices in response to the compounded stressors of climate change and invasive species. Specific impacts involve the loss of traditional resources and changes in the geographical range of species. Invasive insects, pathogens and fungal diseases can kill trees valued for food or materials, and restructure the composition, structure and function of forests (Dukes et al. 2009; Sturrock et al. 2011).

Sudden Oak Death, or SOD (*Phytophthora ramorum*), first detected in coastal northern California in the mid-1990s, is now threatening oak-dominated forest ecosystems (McPherson et al. 2010; Valachovic et al. 2011). As SOD spreads, it will diminish tribal opportunities for utilizing forest resources. Many of the pathogen's hosts are trees or shrubs utilized by tribes for foods, materials, and medicines (Ortiz 2008). In addition to the increased mortality of culturally valued plants, heightened fuel loading will elevate the threat of wildfire. As trees and shrubs die, fuel accumulates, threatening life, property and resources. Some current treatments, such as herbicides, used to prevent or limit the spread of SOD (Valachovic et al. 2011) can also degrade tribally valued forest resources (Ortiz 2008). The current and expected climate change impacts on SOD-infected forests will likely increase the vulnerability of coastal redwood and mixed conifer-hardwood ecosystems (Frankel et al. 2008).

In the Midwest and eastern U.S., the invasive emerald ash borer (EAB) is creating landscape-level change and impacting the cultural practices of indigenous peoples who use black ash (*Fraxinus nigra*). The EAB (*Agrilus planipennis* Fairmaire) is an invasive beetle from Asia that has caused widespread ash (*Fraxinus* spp.) mortality. Despite aggressive eradication efforts, EAB, first discovered in Michigan in 2002, has spread to 18 states and two Canadian provinces (Kovacs et al. 2010).[1] EAB dispersal occurs when adult beetles fly to a new host tree or, more significantly, when people unknowingly transport infested trees, logs, or firewood. EAB is projected to spread across much of the natural range of ash in the Northeast by 2019 (Kovacs et al. 2010). The economic impact of EAB-related street tree removal and replacement in a 25-state region is estimated at $10.7 billion—a cost that does not include community amenity values associated with the loss of landscape trees, losses to forest landowners and the forest products sector and falling stumpage values as markets respond to a glut of dead trees (Kovacs et al. 2010).

The black ash, one of three ash species in addition to green (*Fraxinus pennsylvanica*) and white ash (*Fraxinus americana*) in Maine, is a highly important "cultural keystone species" (Garibaldi and Turner 2004) for the Wabanaki peoples (*"people of the dawnland"*) of Maine and the Maritimes. The ecological idea of a "keystone" species has been thought of, variably, as a species that "holds the system in check," or "whose impact on its community or ecosystem is large," or that "performs roles not performed by other species or processes" (Garibaldi and Turner 2004). Cultural keystone species play a similar role in the functioning and resilience of culture. Something is deemed a cultural keystone species by: the intensity

[1] Cooperative Emerald Ash Borer Project—USDA-APHIS Map: http://www.emeraldashborer.info/files/MultiState_EABpos.pdf

and multiplicity of use, naming and terminology in a language, role in narratives or ceremonies, persistence and memory of use, level of unique position in culture, and the extent to which it provides opportunities for resource acquisition beyond the territory (Garibaldi and Turner 2004).

For the Wabanaki nations of Maine (the Penobscot Indian Nation, Passamaquoddy Tribe-Pleasant Point, Passamaquoddy Tribe-Indian Township, Aroostook Band of Micmacs, and the Houlton Band of Maliseet Indians), the black ash serves critical roles in the social, cultural and economic spheres of contemporary life. The impact of invasive species on, as well as indigenous peoples' efforts to protect, cultural keystone species, is an important issue largely ignored in the literature on invasive species (Pfeiffer and Voeks 2008). The cultural impacts of invasive species is especially important in light of climate change, which will bring other stressors to ecosystem services that will also greatly impact tribal cultures (Kofinas et al. 2010).

The cultural importance of black ash is reflected in Wabanaki origin stories, wherein Gluskabe, the Wabanaki trickster hero, shot an arrow into the basket tree (the black ash), giving rise to the people who came into the world singing and dancing. Given this context, there is no substitute for the ash in Wabanaki culture. Moreover, baskets made of black ash are the oldest art form in New England and represent an original "green," value-added, sustainable forest product. The loss of ash and the associated basketry tradition would have deep economic, cultural and spiritual effects on tribes. Sales of ash basketry exceed $150,000 each year and many tribal household incomes are partially dependent upon this resource (Daigle and Putnam 2009). More than 95 % of tribal basketmakers in Maine live on or near reservations—many at or below the poverty level. Indigenous basketmakers and ash harvesters are working collaboratively with university researchers, state and federal foresters, landowners, and others to prevent, detect, and respond to the invasive EAB (Ranco et al. 2012).

3 Tribal adaptation in response to forest changes and wildfire threats

3.1 Tribal engagement in Landscape Conservation Cooperatives

Tribes are working with diverse partners to develop climate adaptation strategies. Amongst these partners are Landscape Conservation Cooperatives (LCCs), collaborative networks designed to coordinate conservation science and better address local and regional concerns related to conservation problems.

The North Pacific Landscape Conservation Cooperative (NPLCC) has collected tribal input for adaptation to identify and prioritize tribal responses to climate change. The NPLCC's Science and TEK sub-committee, with input from American Indians, Alaska Natives, and Canadian First Nations, has identified "effects of change in air temperature and precipitation on forests" (Jenni et al. 2012) as a priority, acknowledging fire as a secondary mechanism in response to climate.

The Upper Midwest and Great Lakes LCC has supported research to identify climate-vulnerable terrestrial species and natural communities, such as white-tailed deer and boreal and hardwood forests. Transitions in precipitation and temperatures threaten forest resources that tribes depend upon. Changes in the length of the spring fire season will likely increase stress or affect competition between different trees. In particular, a warmer climate could result in greater forest fires that degrade or reduce sugar maples (food) and black ash (basketry). Droughts coupled with extreme weather events could impact conifer germination and result in shifts in the range of tree species (Hoene 2010; Rose 2010). Changes in climate and fires would result in forest species compositions that tribal communities have not

historically encountered. These broad geographic changes in forests directly affect wildlife, plants and other culturally significant resources.

3.2 Collaboration in tribal forest management

Many tribal and agency resource managers are using silvicultural treatments and fire to strategically mitigate the effects of climate change and wildfire (Rose 2010; Wotkyns 2010). Interagency-tribal partnerships are utilizing timber harvesting, hazardous fuels reduction, and prescribed burning as restorative treatments (Mason et al. 2012). In the U.S. Southwest, agencies, organizations, and Pueblo tribes are integrating restoration treatments to mitigate climate change and wildfire impacts (Bradley 2012; Wotkyns 2010).

Collaboration among groups with disparate perspectives but common goals are invaluable to increase investment and sense of ownership, enhance social capital and cooperation, and disrupt power dynamics that in the past have led to the exclusion of some groups—especially indigenous peoples (Bliss et al. 2001; Fernandez-Gimenez et al. 2008; Reo 2010; Wondolleck and Yaffee 2003). In the Northeast, work is underway to involve tribes in Emergency Response Planning efforts with invasive species such as the EAB. Collaborative efforts to address EAB as it approaches Maine have resulted in four areas of research and actions that are being employed: mapping ash resources, developing policy guidance, public education and stakeholder engagement, and seed collection (Ranco et al. 2012). Research is underway to quantify annual radial growth of black ash using dendrochronological techniques to identify trees best able to tolerate climatic variability and that possess the growth characteristics that make suitable Native American basket-trees. This effort will help characterize sites where black ash is ecologically important and be utilized to develop a quantitative model to identify areas likely to support high-quality basket-trees. The quantitative model may also be combined with U.S. Department of Agriculture Forest Service Forest Inventory and Analysis (FIA) data to identify the occurrence and proportion of high-quality black ash stands that are at most risk for EAB infestation. A major outcome of this effort is to integrate spatial, scientific and indigenous knowledge to create statewide suitability maps for Maine's black ash, indicating sites associated with basket-quality trees and vigorous growth. Ultimately, this knowledge will be used to guide EAB monitoring, detection, and response activities that may contribute to collaboration for addressing future climate change and invasive species. Another goal is to provide regional responses to invasive species within the contours of indigenous resource management values (Pfeiffer and Voeks 2008). Figure 1 llustrates a map of the Cooperative Emerald Ash Borer Project.

A 2011 report evaluating the federal-tribal relationship under the Northwest Forest Plan found that improving consultation through Memorandums of Understanding (MOU) resulted in strengthened government-to-government relationships. In 2000, the Quileute Tribe developed an MOU with the Olympic National Forest acknowledging the Tribe's right to hunt, fish, and gather within the ceded lands outlined in the 1855 Treaty of Olympia. In 2008, the National Park Service (NPS) Olympic National Park and eight Olympic Peninsula tribes signed an MOU defining the trust responsibilities of the federal government, clarifying responsibilities and expectations of the NPS and the tribes, and establishing a framework for stronger government-to-government consultation (Harris 2011). MOUs demonstrate pathways to uphold the trust responsibility, while fostering productive partnerships between agencies and tribes.

The Tribal Forest Protection Act (TFPA) of 2004 offers another example of federal policy fostering federal-tribal partnerships in restoration and natural resource management. The TFPA authorizes the Secretaries of Agriculture and Interior to give consideration to tribally-

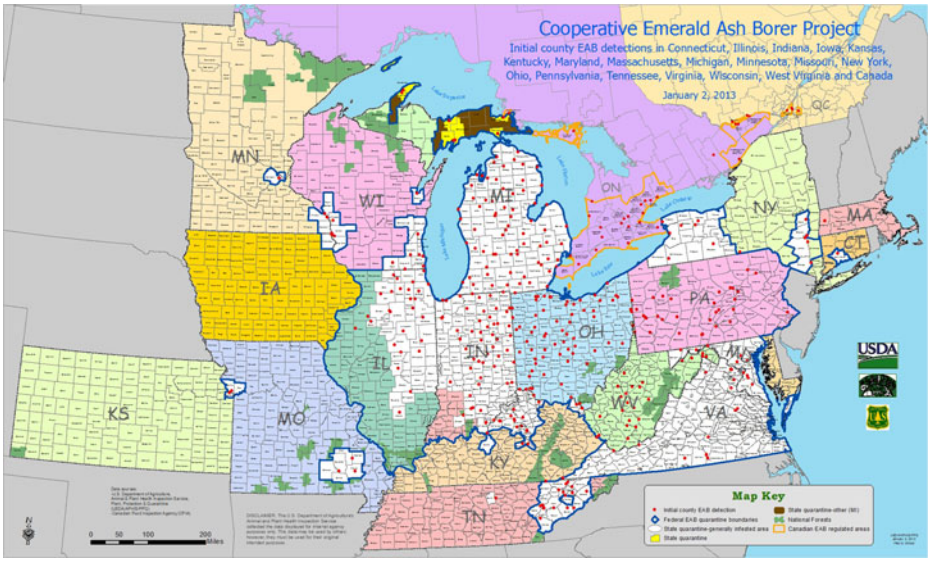

Fig. 1 The Emerald Ash Borer (EAB) beetle has destroyed tens of millions of ash trees in 18 states and continues to expand to other states. http://www.aphis.usda.gov/plant_health/plant_pest_info/emerald_ash_b/index.shtml

proposed stewardship contracting or other projects on Forest Service or Bureau of Land Management (BLM) lands bordering or adjacent to Indian trust land (PL 108–278, 2004). TFPA projects must protect tribal trust resources from fire, disease, or other threats coming off of Forest Service or BLM lands, and offer a mechanism for federal-tribal partnerships to address climate change on tribal lands.

4 Conclusion

Forest disruption and changes in species composition resulting from climate change could lead to the loss of culturally important resources, negatively impacting tribal subsistence, culture, and economy. To address these challenges, robust federal-tribal relationships are needed, particularly when changes affect treaty rights, tribal lands, and resources held in trust. Collaboration, knowledge-sharing, and joint action by tribes and nontribal stakeholders can lead to more effective and sustainable planning efforts around climate change and invasive species.

Climate change impacts on forests will not only affect tribal traditions and access to wildlife and plants; it will affect tribal sovereignty and the treaties, federal policies, and federal trust responsibilities that support tribal access to cultural resources (Whyte 2013). Treaties establish the basis for the Government-to-Government relationship between tribes and the United States government, which is grounded in the U.S. Constitution, and elaborated through statutes, federal case law, regulations and executive orders. The impacts of climate change on tribal sovereignty and indigenous peoples more broadly are described in greater detail elsewhere in this special issue (Whyte 2013; Hardison and Williams, submitted for this issue). Climate change impacts on tribally valued forest resources will require an understanding of how treaty and reserved rights may be affected. Strong Government-to-Government relationships will ensure help that tribes, state and federal agencies and other partners work together to sustain tribal access to culturally important forest resources and habitat.

Tribal involvement in agency resource management and climate change initiatives could include monitoring for species changes in forest habitats, using TEK to understand how culturally-important species may be shifting in composition or distribution, and developing adaptive strategies for fire and forest management. TEK is as much about what to look for, what questions to ask, and how to go about research in a collaborative manner, as it is an additional form of data. While non-indigenous researchers have played a major role in advancing our knowledge about climate change, this must "always [be] preceded by trust-building, development of working relationships, and respect for areas that should not be researched" (Berkes 2009:153). This requires scientists to become more accepting of other kinds of knowledge (Berkes 2009). Bringing together traditional Western science and TEK requires scientists and TEK practitioners to recognize that "indigenous knowledge systems seem to build holistic pictures of the environment by considering a large number of variables qualitatively, while science tends to concentrate on a small number of variables quantitatively" (Berkes 2009:154).

TEK and tribal involvement in climate research, assessments and policy formation can foster and inform strategies to address climate impacts to forests. The current gap in studies on the cultural impacts to tribes from climate change affects on forests requires meaningful tribal engagement in research and dedicated support to investigate these issues for tribes. Tribal engagement has made climate impacts on forests a priority for the NPLCC. And tribes have offered specific guidance to the NPLCC on the needs and potential priorities specific to tribes in managing ecosystems, habitats, species, and resources in light of current and projected climate change effects (Tillmann and Siemmann 2012). Tribal engagement in national climate initiatives such as the National Fish, Wildlife and Plants Climate Adaptation Strategy, Climate Science Centers and Landscape Conservation Cooperatives are critical to building an understanding of how tribes may be affected by climate change, and to inform tribally-appropriate climate strategies. The 2013 National Climate Assessment, a report on the impacts of climate change in the U.S. coordinated by the U.S. Global Change Research Program, provided tribes with such an opportunity through direct tribal input and the inclusion of a chapter on climate impacts to tribal communities, resources, and the value of TEK in identifying adaptation strategies. This will help inform the efforts of resource managers across the nation and provides an example of the type of engagement tribes should have in climate policy and programs.

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