

Data Submitted (UTC 11): 8/15/2022 4:00:00 AM

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Comments: Introduction: Our Nation's Forests under Fire

On April 22, 2022 President Biden issued Executive Order 14072: Strengthening the Nation's Forests, Communities, and Local Economies. Section 2(b) of this order instructs the US Forest Service (USFS) and Bureau of Land Management (BLM) to develop definitions for mature and old-growth forests and by April 23, 2023, conduct an inventory of these forests on US federal lands. As a Native American forest ecologist, I was asked to discuss the scientific basis for these definitions and the inventory process, including Indigenous values about forests. Herein I comment from a Native American perspective on the federal framework for defining and inventorying late-successional forests, defined as forest seral stages that include mature and old-growth classes, and next steps in management and restoration of these forests.

My comments are also informed by the October, 2021, America the Beautiful Initiative (White House CEQ 2021a), which calls for Tribal Nation and underserved community involvement in natural resource restoration, and the November, 2021, US White House Office of Science and Technology Policy (OSTP), Council on Environmental Quality (CEQ) memorandum to heads of departments and agencies stating that moving forward, Traditional Ecological Knowledge (TEK) could and should improve understanding of climate change and environmental sustainability. It also could help in the development of comprehensive climate adaptation and natural resource management strategies, to achieve mutually beneficial outcomes for Tribal Nations and federal agencies (White House CEQ, 2021b). Since publication of the OSTP CEQ memorandum, I have participated in OSTP CEQ consultations, provided Congressional testimony on the why and how of incorporating TEK into how the US federal government can partner with Tribal Nations legally and respectfully to restore and manage natural resources, and given an invited presentation to DOI leadership about TEK and partnering with Tribal nations.

Anthropogenic-induced global warming is leading to increasingly frequent severe and extensive drought, storms, wildfires, and floods (Grimm et al., 2013). Warmer temperatures, below-average winter precipitation, earlier snowmelt, and drier summers are creating longer wildfire seasons (Hessburg et al., 2021). Ecosystems managed for plantation forestry often lack the resiliency to recover from these disturbances and other environmental stressors (e.g., insect outbreaks), because such management involves eliminating or disrupting processes with which these ecosystems co-evolved, such as low-severity fires set by Indigenous people and mixed-severity wildfires (Grigal 2000; Kimmerer and Lake 2001; Bond et al., 2004; Bond and Keeley 2005; DeLuca and Aplet 2008; Crist et al., 2009; Micheloti and Meisel 2015; Merino et al., 2019; Haggmann et al., 2021; Lake 2021; Boyd 2022). Indigenous-set fires deposited Pyrogenic Carbon (PyC) in the soil, which increased soil nutrients (Bird 2015). Because of the recalcitrant nature of PyC, which can take millennia to decompose, this created valuable carbon stocks (DeLuca and Sala 2006; DeLuca and Aplet 2008; DeLuca et al. 2020; Bowring et al., 2022). Beyond reducing nutrient flow through fire-prone forest ecosystems, suppression of Indigenous-set fires also reduced diversity and abundance of species such as camas (*Camasia quamash*) and salmon (*Oncorhynchus* spp.) on which Indigenous Peoples have relied for millennia (Short 2016).

Spies and Franklin (1989) defined old-growth forests as "Ecosystems distinguished by old trees and related structural attributes . . . that may include tree size, accumulations of large dead woody material, number of canopy layers, species composition, and ecosystem function." (Spies et al. 2002). Such forests, which have been managed for conservation purposes per the 1994 Northwest Forest Plan and the 1976 National Forest Management Act (Thomas et al., 2006; Franklin and Johnson 2012; Spies 2019), are also succumbing to the effects of the anthropogenic-induced global warming described above, in part because of conservation practices created in an era when scientists and managers had little awareness of global warming or the important role of Indigenous fire stewardship in fire-prone forests. For example, in the Pacific Northwest, nearly 30 years of

protection to conserve species such as the Northern Spotted Owl (*Strix occidentalis*), combined with 100 years of federal fire exclusion policy have created unprecedentedly dense old-growth forests, increasing these forests' vulnerability to catastrophic fires (Spies 2019).

Traditional Ecological Knowledge, Ecocultural Restoration, and Two-Eyed Seeing

TEK (also known as Indigenous Traditional Knowledge[mdash]ITEK), is defined as knowledge and practices passed from generation to generation informed by cultural memories, sensitivity to change, and values that include reciprocity (Kimmerer 2000; Kimmerer 2011). TEK land-care practices include using prescribed fire and seasonal flooding to modify vegetation, conserving culturally significant species such as beaver (*Castor canadensis*) and bison (*Bison bison bison*), or adjusting timber use to create more sustainable communities of traditional plants that provide wildlife habitat, and in turn, food for humans (Kimmerer and Lake 2001). These processes increase biodiversity and ecological resilience by creating fine-grained, landscape mosaics that function within an ecosystem's range of natural variability. Further, TEK acknowledges that change is constant in an ecosystem. Because Indigenous Peoples see the world as always changing, their TEK is designed to observe and acknowledge change and act on it swiftly by adjusting Indigenous land-stewardship and subsistence practices. In this manner, TEK can optimize climate resiliency, as a form of adaptive management that has been use for millennia globally (Nadasdy 2007; Mason et al. 2012). This culture-based knowledge continues to evolve and grow to advance the health of Tribal lands and Tribal Nations.

The DOI defines adaptive management as a "systematic approach for improving resource management by learning from management outcomes." (Williams et al., 2009). Adaptive management is based on partnerships between managers, scientists, and stakeholders, who work together to create more resilient ecosystems to meet human needs. It reflects current understanding of ecological principles and needs of broader constituencies, such as farmers and people whose livelihoods are tied to the land, including Indigenous Peoples. It allows action in the face of uncertainty by implementing testable strategies that can be revised as needed. This enables managers and communities to improve policies and create more resilient ecosystems (Eisenberg, 2010, p. 205-206).

Adaptive management addresses the uncertainty embedded in ecosystems, via iterative discovery of what works best. In this manner, it resembles TEK, which assumes that the world is always changing, and that learning from what nature is telling us will enable humans to adapt to create more resilient ecosystems and subsist more sustainably on Earth (Berkes et al., 2000; Kimmerer, 2015; Wong et al., 2020). TEK intrinsically features systems thinking[mdash]a holistic problem-solving approach that examines connections between different parts of a system and how a system works within the broader context of larger systems (Bosch et al., 2007). It further acknowledges that problems cannot be solved without understanding and honoring these relationships (Long et al. 2003; Teixeira de Melo et al., 2020;).

TEK is about humans being part of nature. It is about constant change. TEK is how Indigenous Peoples have long adapted to that change gracefully and with intentionality. In other words, you cannot step into the same river twice, because the water is always moving. However, TEK values, regardless of place or Indigenous community, remain constant: reciprocity, humility, respect for the natural world and for other humans. This means that to Indigenous Peoples, what defines an old-growth forest will differ considerably from forest type to forest type, because there is no one-size-fits-all rubric to ecosystem management in TEK, beyond the basic moral principles described above.

Executive Order 14072, Section 2(b) is aimed at creating baseline data to address forest management issues we are facing today: drought, large, high-severity wildfires, disease and insect outbreaks, and human development (Stephens et al., 2019). Today TEK is beginning to be applied effectively on federal and tribal lands throughout the West in combination with Scientific Knowledge (SK), such as the work Frank Lake of the USFS is doing with the Karuk and Yurok Tribal Nations in reinstating Indigenous fire stewardship to create forests more resilient to wildfire, and best achieve management goals of both Indigenous sovereign nations and federal land managers.

Another example is the Indigenous fire stewardship forest restoration work being implemented by the Confederated Salish and Kootenai Tribes in Montana in partnership with the USFS in Montana (Kimmerer and Lake, 2001; Mason et al. 2012; Lake et al., 2017; Lake 2021). These projects provide a strong conceptual foundation for addressing Executive Order 14072.

Respecting and applying TEK synergistically with SK advances social justice by healing some of the trauma in Indigenous communities caused by settler colonialism. Consequences of settler colonialism include land loss; significant population loss from genocide; oppression by criminalization for performing traditional cultural practices, including hunting, burning and occupation of usual and accustomed places; and relocation and forced removal to boarding schools, which led to loss of languages, cultures, and traditions (Wilkins and Lomawaima 2001; Yazzie 2007; Treuer 2019; Long et al., 2021).

Ecological restoration is the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed (Gann et al., 2019). Ecocultural restoration, defined as the process of restoring key historic pre-contact, pre-industrial ecosystem structures, processes, and functions, and the Indigenous cultural practices that helped shape ecosystems, increases resiliency to climate change and other stressors, while supporting Indigenous ecosystems and their cultures. (Kimmerer 2011; Dickson-Hoyle et al., 2011; Zedler and Stephens 2018; Martinez 2019;). Based on intercultural collaboration in partnership with Tribal Nations, federal agencies, and non-profit and academic institutions, ecocultural restoration can help conserve national forests (Reyes-Garcia et al., 2017; Zedler and Stevens 2018).

To braid together TEK and SK, called Two-Eyed Seeing, in forest inventorying, assessment, and management, it is necessary to recognize that natural resource management problems today are rooted in settler colonialism and the divergent world views and practices between Native American and European colonizers (Bartlett et al., 2012; Reid et al., 2020). This cultural difference is illustrated by the attitude about use of fire in forest landscapes. Evidence of Native American burning of forests to increase forest productivity, health, vigor, and diversity of structure and species, has been clearly documented in what is today the US, going back at least ten thousand years (Cronon 2003; Roos et al., 2018; Boyd 2022). Indigenous cultures are based on a strong link between human health and the health of the natural environment. Moreover, in the US, the decline of old-growth forest has been linked with the decline of Native American communities, as part of the process of Euro-American colonization, because of the related decline of cultural burning (Yazzie 2007).

Native American forest management is traditionally based on the principle of reciprocity and the understanding that fire is necessary to promote forest health (Eisenberg 2019; Lake 2021). This means that to Indigenous Peoples, forests are more than the sum of their parts, and are valued not just because of the economic worth of the timber they contain, but because of Indigenous Peoples' spiritual connection to these forests and understory plants, such as camas and beargrass (*Xerophyllum tenax*), that hold deep cultural significance. So for example, in today's world, members of a Tribal Nation who owns forest land often choose to not harvest a valuable stand of mature trees growing in a site used for many generations to harvest plant materials for medicine or basketmaking.

Historical and Policy Context

Starting in the 18th century, Euro-American colonizers brought with them values about the natural world and its resources based on exploitation for human gain (Cronon 2003). This shift, which was codified by Gifford Pinchot, involved fire exclusion to protect merchantable timber, and led to the degradation of forests throughout the US. It deprived Native Americans of their lands and traditional cultural practices, supported by the Doctrine of Discovery (Wilkins and Lomawaima 2001). Traditional use of fire became a criminal offense. Forests on Indian reservations continued to be prime targets for exploitation by non-Indigenous timber industries until very recently (Yazzie 2007).

Gifford Pinchot founded the USFS in 1905 and advanced the scientific model for natural resource management widely used in North America for forests as a progressive alternative to the unfettered lumbering of American landscapes applied in the 1800s. This model is based on sustained-yield of timber within a capitalist, profit-based system (Parry et al., 1983). After World War II, federal land managers sought maximum allowable yield, which exacerbated a wide range of environmental concerns on public lands.

The contemporary conservation movement, which arose in the mid-1800s in response to degradation caused by excessive harvest of trees, wildlife, and minerals, assumes that humans can control nature and that nature works best without humans in it (Martinez 2007). This is yet another form of the settler colonialism mindset. Conservation informed by SK often involves separation of humans and nature; e.g., restoring nature by creating protected "natural" areas from which human traditional subsistence practices are excluded (Cronon 1996; Martinez 2007; Mace, 2014). This strongly contrasts with Indigenous ontologies in which humans are intrinsic to nature and cannot be separated from nature (Kimmerer 2015; Burrow et al., 2018). In the US, the deep divide between the conservation movement and Indigenous management and TEK-informed use of natural resources such as forests, continues today.

Since the 1970s, policies that emphasize sustainability and conservation of biodiversity guided changes in natural resource management (Thomas et al., 2006; Spies et al., 2019). This included establishment of legislation that governed forest management, such as the 1976 National Forest Management Act. The 1994 Northwest Forest Plan defined old-growth forests and called for their protection (Thomas et al., 2006; Franklin and Johnson 2012; Spies 2019). Nevertheless, contemporary forest management is generally ineffective at maintaining ecologically resilient, productive forest ecosystems that can reliably and sustainably supply the ecosystem services on which humans rely for survival, such as fertile soil, plants, pollination, and clean water (Parry et al., 1983; Noss et al., 2006; Havstad et al., 2007; Crist et al., 2009; Muir et al., 2010; Franklin et al., 2012; FAO, 2021). This has led some ecologists to suggest that natural resource management could benefit strongly from being informed by older, more traditional ways of knowing the natural world (Kimmerer 2000; Wong et al., 2020; Lake 2021).

In 2004, the Tribal Forest Protection Act (TFPA) enabled stewardship agreements between federal agencies and Tribes managing Tribal forest lands to reduce the threat of wildfire and other stressors (e.g., disease, insects) on Tribal forests. This entails a government-to-government relationship that honors sovereignty rights. TFPA recognizes that federal management policies for federal forests adjacent to reservations greatly affect Tribal Nations. Further, the law acknowledges that federal agencies have a fiduciary trust to protect Tribal assets, and that this includes sovereignty rights, federal consultation, and government-to-government relationships. TFPA enables Tribes that have expertise and resources to contribute to forest management across boundaries (Lucero and Tamez 2017; Tamez 2012). The 2018 Good Neighbor Authority is further advancing partnerships in adaptive management of federal land between Tribal Nations and federal natural resources agencies.

Using Two-Eyed Seeing to Define, Measure, and Restore Mature and Old-Growth Forests

By braiding together TEK and SK ontologies in defining and managing old-growth forest one gains binocular vision that enables people to find solutions to the challenge of old-growth forest conservation and management. Because forests in the US had been managed for thousands of years by Indigenous Peoples, and then stolen from Tribal Nations by the US federal government, often involving forced removal and genocide, today the descendants of these Indigenous Peoples have strong interest in the restoration and management of these lands for improved forest resiliency to climate change and wildfire, and sustainable timber production that also provides habitat for wildlife, pollinators, and culturally significant plants for harvest by Tribal members per treaty rights (Yazzie 2007; Nie 2008; Boyd 2022).

Reid et al. (2020) created a stepwise, circular framework for intercultural collaborative partnerships with Indigenous Peoples that applies to any type of natural resource (Figure 1). This framework begins by identifying

mutual research interest (e.g., a knowledge gap or need), and then identifying tools required, co-developing research, co-evaluating the research, and validating the results by the community. This results in shared recognition of the value of the research and co-benefits and can build long-term relationships between all involved for co-management of public lands.

FIGURE - See page 6 of 12 Figure 1. Conceptual model for adaptive management using a Two-Eyed Seeing framework (Reid et al., 2020).

So what would a Two-Eyed Seeing definition of mature and old-growth forests in the US look like? Arriving at place-based definitions of old-growth will require partnerships between Tribal Nations and the US federal government, as part of government-to-government consultation (Nie 2008; Lake 2021). These partnerships would involve co-creating policies to define and develop methods for inventorying mature and old-growth forests efficiently.

A Two-Eyed Seeing definition of mature and old-growth forest would acknowledge that each forest type is unique. Moreover, that each location is unique. It would not be based on a static diameter-at-breast-height metric, or other silvicultural metrics such as basal area and canopy cover, applied uniformly across US forests. Neither would it be based on static remote-sensing metrics.

In practicing Two-Eyed Seeing, the cross-cultural definition of old-growth forest should be place-based. For example, the definition of old-growth forests (e.g., diameter of trees, stand structure) will differ in a moist forest in western Oregon, versus a dry forest in eastern Oregon, or a forest in Arizona in an arid or semi-arid region. It would braid the best SK with TEK, which today both define old-growth forest not as a static forest type, but by its ecological characteristics and site characteristics, including soil types, precipitation, slope, and aspect, which vary geographically and by dominant tree species and related plant associations. Further, a new definition of old-growth forests would reinforce SK and TEK findings that understory characteristics are as important as overstory characteristics. The understory sustains forests, because certain understory plants are critical to soil stabilization, soil nutrient cycling, and the provision of resources trees need to grow into mature forests (Turner 2015; Oldfield et al., 2019; Lake 2022).

After the initial inventorying phase, next steps include establishing partnerships between Tribal Nations and the US federal government in co-management and ecocultural restoration of the nation's mature and old-growth forests, in a manner that honors Tribal sovereignty, data sovereignty, and self-determination rights, supported by Memoranda of Understanding (MOUs) and Data Sharing Agreements (DSAs) (Long et al. 2003; Kenney 2012; Lake 2021). Ecocultural restoration treatments may include prescribed burning and thinning of mature and old-growth forests, and would also include ethnobotany (Turner 2015; Lake 2021). Understanding how different management practices and fire history influence soil PyC stock, dynamics, and soil biogeochemical properties at various spatial scales will be of great importance in designing nature-based solutions and treatments to improve forest resilience. To be effective, forest management will include all the components of ecological restoration, from assessment, to identifying a reference site, to planning a treatment including all types of knowledge, including TEK, to application and monitoring (DeLuca and Aplet 2008; DeLuca et al., 2010; Gann et al., 2019; Thompson et al. 2020). This will build on the baseline data on mature and old-growth forests to be collected under Presidential order 14072.

Conclusion

To create mature and old-growth forests more resilient to climate change and other stressors, the first step is to rethink and redefine the concept of mature and old-growth reserves and restore human relationships with forests that once maintained forests and people in good health. This new paradigm is not an invitation to revert to the unfettered silviculture practices (e.g., clearcuts) broadly applied to old-growth forests during the first half of the 20th century, nor is it an invitation to eliminate policies such as stream buffers, but rather redefine them to

support watershed health and conserve Threatened and Endangered species, by helping restore these streams and associated plant communities to historical (e.g., pre-Euro-American settlement) conditions. This new paradigm will begin to address the grievous damage done by settler colonialism to Tribal Nations and mature and old-growth forests in a more holistic manner, using ecological forest management practices (e.g., Franklin et al. 2018), and acknowledging that protection that excludes humans from nature does not work in the long-term. Additionally, federal policy solutions must be based on the concept of reciprocity—the ethics of taking what one needs, but not more, honoring the needs of future generations, and treating the natural world with respect (Houde 2007; Yazzie 2007; Cassons 2015; Grey and Kuokkanen 2020; Fernandez-Llamazares 2021). The second step is the sort of inventory described in Executive Order 14072, Section 2(b) informed by SK and TEK. The third step is to acknowledge that command-and-control US forest management practices used since these lands were colonized by Euro-American settlers do not work, and to create an ecocultural plan for forest restoration and management. Going beyond the Pinchovian sustained-yield philosophy of forest management involves realizing that expedient approaches that do not consider all ways of knowing will not work in today's world. Cultural humility and reciprocity will enable us to create healthy forests for future generations of Americans.

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