



Braiding Indigenous Knowledge and Western Science for Climate-Adapted Forests:

An Ecocultural State of Science Report

EXECUTIVE SUMMARY | OCTOBER 2023

THE PROBLEM: North American forests are experiencing unprecedented challenges due to extreme wildfires, pathogen and insect outbreaks, heat stress, drought, rapid development, and invasive species. Exacerbated by climate change, these threats collectively diminish economic values, cultural values, and habitat. Particularly because of fire exclusion, contemporary and historical management policies are root causes of current forest conditions.

Our report summarizes findings that braid together Indigenous Knowledge (IK) and Western Science (WS) to support climate adaptation of forest landscapes. Our writing team's cultural, geographic, and disciplinary diversity enables us to provide guidance that can enhance resilience and sustainability. This compendium builds on federal directives¹ to respectfully and intentionally braid IK and WS systems in a Two-Eyed Seeing approach² that informs climate-adaptation strategies to conserve forests. We conclude the Executive Summary of our report with five recommendations to catalyze proactive approaches to address threats to North American (NA) forests.

INTRODUCTION

Stewarded by Indigenous Peoples for millennia, forest landscapes contain diverse communities, including young, mature, and old forests, and shifting mosaics of meadows, shrublands, riparian areas, wetlands, and sparsely treed woodlands. Indigenous stewardship, based on reciprocity, shaped these systems and the values they provide.³

Today's forests continue to require respectful, proactive stewardship that fosters economic and ecological values such as clean water, fertile soil, food, material resources, and carbon sequestration.

Many forest landscapes face escalating threats. Wildfire extent and severity is increasing across western NA forests, with warmer, drier summers challenging tree regeneration. Non-native and native insects and pathogens threaten forests, warranting changes in adaptive forest stewardship and policy. Historical and contemporary forest management often contributed to these issues by focusing on short-term reactive solutions, such as fire suppression and disaster response, at the expense of longer-term investments in proactive management. Compounding challenges to NA forests need a different approach and underpinning worldview to address their scale and urgency. Given widespread departures from

WHO WE ARE

We are an intercultural, interdisciplinary team of Indigenous and Western scholars and practitioners. We focus on place-based strategies for adapting NA forest landscapes to climate change. As we consider the work of restoring resilience to forest landscapes for future generations, we believe it is essential to respectfully acknowledge the vital, longstanding role of humans in forest community sustainability.

historical conditions⁴ and rapidly advancing anthropogenic climate change, we cannot restore conditions to mirror the past. However, we can restore practices that contribute to adaptive stewardship and forest resilience.

Braiding IK and WS to inform adaptive stewardship offers the best chance of addressing threats to forest landscapes and conserving them for future generations. As we consider the importance of future forests, we acknowledge and account for the influential past, present, and future role of Indigenous Peoples and IK in shaping forest ecology. We also acknowledge that a strong body of scientific evidence supports restoring climate-resilient

¹Executive Order 14072, Strengthening the Nation's Forests, Communities, and Local Economies, 87 Fed. Reg. 24,851 (April 22, 2022).

²Bartlett et al. 2012. Two-Eyed Seeing and other lessons learned within a co-learning journey of bringing together indigenous and mainstream knowledges and ways of knowing. *Journal of Environmental Studies and Sciences*. doi.org/10.1007/s13412-012-0086-8

³Hoagland 2017. Integrating traditional ecological knowledge with western science for optimal natural resource management. *IK: Other Ways of Knowing*. doi.org/10.18113/P8ik359744

⁴Hagmann et al. 2021. Evidence for widespread changes in the structure, composition, and fire regimes of western North American forests. *Ecological Applications*. doi.org/10.1002/eap.2431

forest structure and function, including understory composition and biodiversity, through cultural and prescribed burning, forest thinning, meadow restoration, and hazardous fuel reduction treatments.⁵

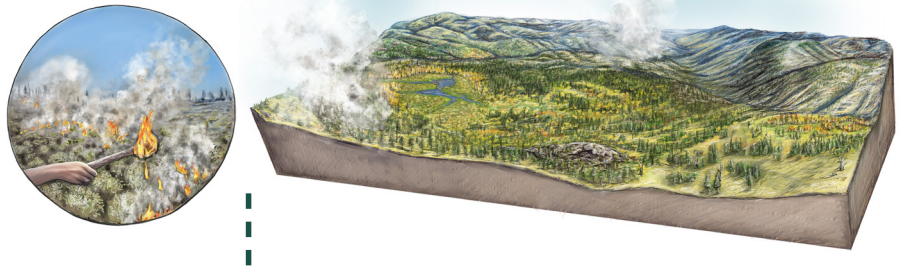
The complex problems humanity faces today make it difficult to imagine humans as other than an extractive or destructive force. However, knowledge systems associated with Indigenous oral tradition and application offer a vastly different perspective, one that created sustainable and resilient ecosystems over millennia. Forest landscapes co-evolved with people. Intentional human interactions with landscapes and fire broadly shaped forests and their rich species diversity.

HISTORICAL CHANGES IN NORTH AMERICAN FOREST LANDSCAPES

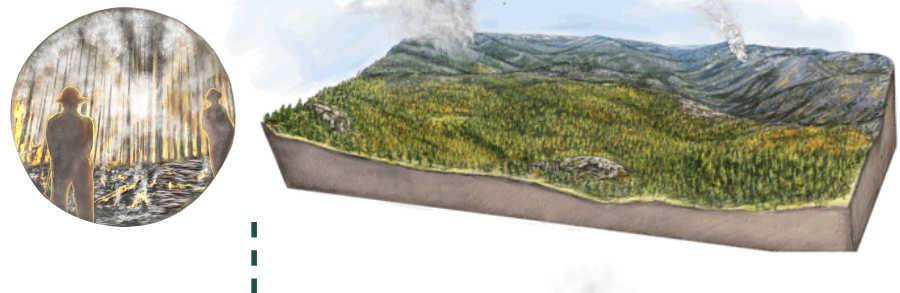
Prior to Euro-American colonization, Indigenous Peoples actively stewarded much of NA. From an Indigenous perspective, sustaining the health and vitality of forest understory vegetation, prairies, shrublands, and meadows generally supersedes maintaining overstory tree cover, frequently prioritized in Western forest management. Indigenous place-based reciprocal stewardship has often involved frequent cultural burning and maintaining open forests.

Some of today’s most threatened forest ecosystems were actively sustained by Indigenous stewardship practices. These include longleaf and shortleaf pine forests of the Southeastern US; extensive oak, pine, and hickory forests of the Northeast US, Central US, and Lake States; open grasslands and riparian areas of high-latitude boreal forests; open ponderosa pine and dry and moist mixed-conifer forests of the Interior West and Pacific Northwest (PNW); and oak and pine woodlands in Oregon, California, Arizona, New Mexico, and Texas. Open canopy forest mosaics in frequent-fire systems foster fire-dependent understory plants that provide wildlife habitat, food, material resources, and medicines, while also maintaining old trees.

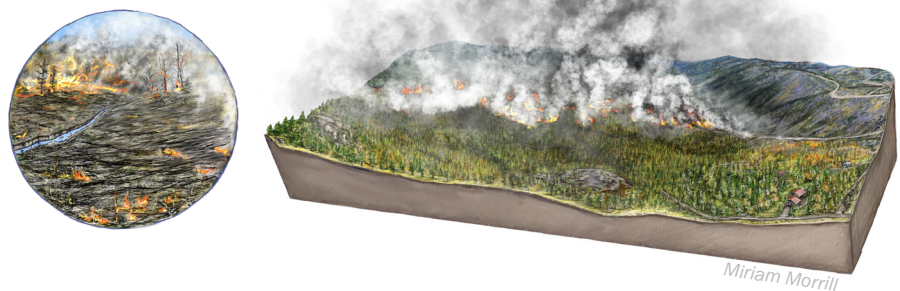
RECIPROCALLY STEWARDED LANDSCAPES: Historically, many forests occurred as mosaics of meadows, shrublands, and open woodlands. Fires were frequent because cultural burning was frequent, resulting in fires far less severe than those we see today.



CONTEMPORARY DEPARTED LANDSCAPES: Modern fire management suppresses most fires but does not effectively return proactive fire use. Without active stewardship through forest thinning, fuel reduction, and the intentional use of fire, forests grow dense.



EXTREME WILDFIRES: Under hot, dry, windy conditions, wildfires evade suppression, burning through dense forests, exploding in size and severity. Proactive stewardship restores forest landscape resilience to future wildfires.



Diseases introduced by European colonization killed up to 80-90% of the Indigenous population. In the early stages of colonization, rapid changes in forest ecosystems occurred through initial land clearing and burning. Post-colonization, federal policies of forced removal, displacement, and genocide further reduced the Indigenous population.^{6,7} In many places, a period of fire exclusion spanning 100 to 170 years or more followed.⁸ Sharply diminished Indigenous presence led to the perception

⁵Prichard et al. 2021. Adapting western North American forests to climate change and wildfires: 10 common questions. Ecological Applications. doi.org/10.1002/eap.2433

⁶Treuer. Heartbeat of Wounded Knee. (NY: Penguin, 2019)

⁷Heart and DeBruyn 1998. The American Indian holocaust: Healing historical unresolved grief. American Indian and Alaska Native Mental Health Research. doi.org/10.5820/aian.0802.1998.60

⁸Eisenberg et al. 2019. Out of the Ashes: Ecological Resilience to Extreme Wildfire, Prescribed Burns, and Indigenous Burning in Ecosystems. Frontiers in Ecology and Evolution. doi.org/10.3389/fevo.2019.00436

KEY TERMS

We offer the following definitions to suggest common language that can inform policy that respectfully braids IK and WS.

RECIPROCITY is the fundamental awareness that humans and ecosystems have mutually shared needs. It involves mutually beneficial relationships between cultural stewards and the land, plants, and animals they live among and rely on. In a reciprocal culture, people have a strong connection to a place and a moral responsibility to care for that place and its living beings.

PLACE-BASED RECIPROCAL STEWARDSHIP is an ethical value that grounds responsible planning and management and applies that value to stewarding nature, the economy, health, and cultural resources, property, and information. Indigenous Peoples, their practices, and their culture exemplify place-based reciprocal stewardship. An essential component of climate adaptation today, this approach emphasizes learning by doing and local connection of people to the places that sustain them and are sustained by them. Examples include intentional burning, forest thinning, other fuel reduction treatments, integrated pest management, postfire management, and collecting the seeds of native species to assist forest community regeneration.

ECOCULTURAL RESTORATION is the process of creating and maintaining diverse and healthy landscapes that are adapted to climate change and wildfires by restoring stewardship practices, ecological processes, and relationships. WS provides powerful tools for learning but

alone is insufficient to address challenges associated with anthropogenic climate change, human development, and increasingly severe disturbances. Restoring these forests requires honoring and understanding IK, the relationships with the land it embodies, and weaving it with WS to guide land stewardship ethics and planning.

CO-STEWARDSHIP AND CO-MANAGEMENT

In the United States, the Federal Government has promulgated **co-stewardship** as encompassing a variety of arrangements with Tribal Nations, Tribal consortia, and Tribal-led entities to steward lands on a cooperative basis.

Co-management describes arrangements to manage natural resources with shared authority and responsibility. While treaty rights, legislation and other legal mechanisms have fostered such arrangements, co-management is more generally the result of extensive deliberation and negotiation to jointly make decisions and solve problems.

To support meaningful Tribal participation in decision-making, Executive Order 13175 of November 6, 2000 (Consultation and Coordination With Indian Tribal Governments) charges all executive departments and agencies with engaging in “*regular, meaningful, and robust consultation with Tribal officials in the development of Federal policies that have Tribal implications.*” The US Departments of Agriculture and Interior, with their Offices of the Solicitor, are advancing the establishment of co-stewardship agreements with Tribal Nations and identification of authorities to support implementation of Joint Secretarial Order 3403. Co-stewardship agreements can be an important mechanism to guide inclusion of IK in management of federal lands.

of NA as *terra nullius* (“nobody’s land”), an ideology that informs modern land conservation and protection and enables ongoing Euro-American erasure of Indigenous Peoples and their stewardship.

MATURE AND OLD GROWTH DEFINITIONS AND STATIC RESERVES

In 1989, the USDA Forest Service defined old-growth forest as “. . . *dynamic systems distinguished by old trees and related structural attributes. Old growth encompasses the later stages of stand development that typically differ from earlier stages in a variety of characteristics, which may include tree size, accumulations of large dead woody material, number of canopy layers, species composition, and ecosystem function.*” The 2023 Mature and Old Growth Inventory Assessment similarly defines it and adds “. . . *old-growth forests are distinguished by their ecosystem services and social, cultural, and economic values. Old-growth forests have place-based meanings tied to cultural identity and heritage; local economies and ways of life; traditional and subsistence uses; aesthetic,*

spiritual, and recreational experiences; and Tribal and Indigenous histories, cultures, and practices. Dialogue with stakeholders and Tribal Nations and integration of local and Indigenous Knowledge with evolving scientific understanding are critical in identifying and stewarding old-growth forests.”

The 1989 definition was strongly influenced by observations of wet forests of the Pacific Northwest in which Indigenous influence on forest development was not readily apparent to Western scientists. Older forests were believed to develop without human influence, leading to dense stands of large trees and snags and large quantities of downed logs. The 2023 addition was an important acknowledgement of the reciprocal ecocultural relationship between older forests and people. Many older forests owe their existence to Indigenous cultures.

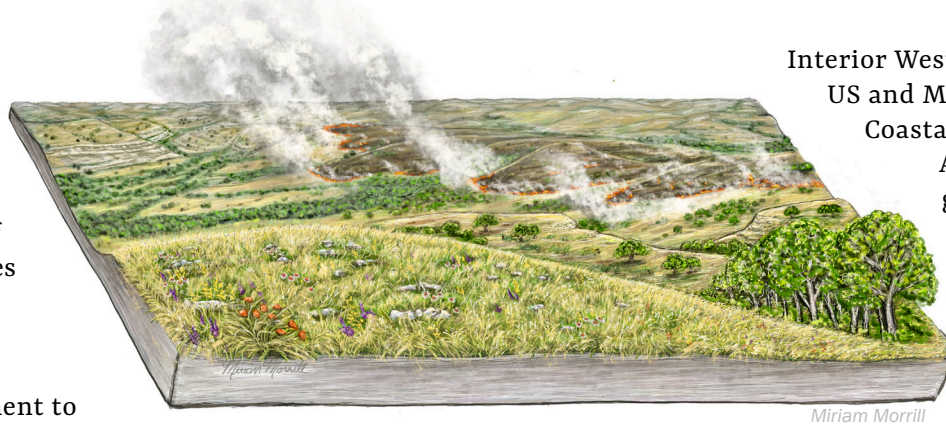
Over the historical extent of many forest landscape types, cultural fires regularly shaped vegetation patterns. Within these fire-maintained landscapes, old trees and patches of old forests developed and persisted for a time within dynamic and highly diverse assemblages of open

forests, woodlands, grasslands, and shrublands. Old forests and old trees were an emergent property of ecocultural landscapes created by cultural burning, lightning ignitions, and forest growth and development to support Indigenous lifeways.

Because old-growth forests were long perceived to develop without human influence, a commonly proposed policy for their conservation has been to designate an area for their protection and to leave it alone forever – the so called “inviolable” or “static” reserve. Although designations that protect forests from development and overharvesting are a necessary tool essential to their conservation, treating forests as though they are static, unchanging entities both ignores their dynamic nature and severs ecocultural linkages. This is especially true in dry, fire-prone forests, where flexibility in stewardship, including active forest management, is critical given climate change.⁹ Attempting to maximize and preserve mature and old forest conditions in static reserves will often fail under projected climate change, drought, wildfire, and other disturbances. Proactive and adaptive stewardship is needed to re-create and maintain resilient forest landscapes, including old trees.

ECOCULTURAL SYSTEMS

In this report, we describe forests as being part of ecological and cultural (“ecocultural”) systems. For example, open pine and/or oak forests are not only composed of fire-adapted trees, but also diverse understory plant assemblages that depend on frequent fire and open light conditions. And in moist mixed-conifer forests that host edible berry-producing shrubs, partial shading by overhead canopies is desirable. Place-based stewardship of these ecocultural forest systems also includes culturally valued resources sustained by these practices. Based on geographical, floral, and faunal diversity of forests and the human communities within them, our report presents shared understanding, strategies, and actionable examples of adaptive place-based stewardship. We focus on major forested regions of NA, including the Northern Boreal and Hemiboreal; eastern temperate region of Canada and the US; Southeastern US;



ECOCULTURAL SYSTEMS: In this report, we describe forests as being part of diverse ecocultural systems, such as gallery forests within the tallgrass prairie illustrated above. Indigenous fire use stewarded these landscapes, thereby maintaining mosaics of forests and grasslands.

Interior West Montane; Southwestern US and Mexico; and Pacific Coastal.

Across these varied geographies, we found the following common attributes of ecocultural stewardship and restoration:

- 1) Material culture, livelihoods, and responsibility based on law and ceremony drive stewardship;
- 2) Stewardship shapes

the structure, composition, and processes across each forested region; 3) Reciprocal relationships maintain sustainable conditions over space and time; and 4) Adapting and adjusting practices to address changing climate, environments, and disturbance processes is ongoing and incremental.

CARBON SEQUESTRATION

In NA, forests currently store substantial carbon that could be quickly and drastically reduced under continued warming and associated changes in wildfire extent and severity. Above-ground carbon stores in many fire-excluded forests are inflated due to forest densification and encroachment into non-forest areas. Indeed, many forest landscapes historically maintained by fire have exceeded their carbon carrying capacity, destabilizing existing sinks. Restabilizing them requires a more comprehensive approach that considers the importance of both above-ground and below-ground carbon stores. Low- and moderate-severity fire, such as cultural burning, produces below-ground carbon (e.g., charcoal), a key component of forest carbon stores. While soil carbon is generally resilient to wildfire and other disturbances, high-severity fires can cause significant losses. Adaptive stewardship can prioritize forest carbon stabilization by reducing the likelihood of uncharacteristically large and severe fires. Cultural and prescribed burning can increase and stabilize soil carbon, which persists for hundreds to thousands of years. Maintaining this carbon pool is an important part of incorporating IK into adaptive forest stewardship.

WORKING WITH TRIBAL NATIONS

In response to growing awareness of the importance of IK, in November 2022 the US White House issued directives

⁹Gaines et al. 2022. Climate change and forest management on federal lands in the Pacific Northwest, USA: Managing for dynamic landscapes. *Forest Ecology and Management*. doi.org/10.1016/j.foreco.2021.119794

that “agencies should recognize and, as appropriate, apply IK in decision making, research, and policies” across the Federal Government. This has led to rapid growth of opportunities to partner with Tribal Nations and Indigenous Peoples, while being mindful to not appropriate their cultural knowledge. By incorporating multiple ways of knowing across cultures, these partnerships represent a critical shift in how the Forest Service stewards public lands and promotes climate resilience.¹⁰

Tribal and Indigenous Peoples’ co-stewardship, including both federally recognized and unrecognized communities, is a high priority for effective adaptive stewardship and environmental justice. Co-stewardship with federal agency partners braids together IK and WS. Sovereignty Rights require that agencies and their partners honor and respect the rights of all Indigenous Peoples. We summarize key principles for working with Tribal Nations and Indigenous Peoples:

1. Acknowledge historical injustices including genocide, ethnocide, and ecocide.
2. Practice early and ongoing engagement with Tribal Nations and Indigenous knowledge holders.
3. Earn and maintain trusting relationships by being transparent, open, and honest.
4. Co-produce knowledge and practice.
5. Provide needed funding to Indigenous Peoples for involvement at each step.
6. Share power and decision-making authority with Tribal Nations and Indigenous Peoples.
7. Support Indigenous sovereignty, autonomy, and self-determination.

¹⁰Executive Office of the President Memorandum on Guidance for Federal Departments and Agencies on Indigenous Knowledge. Nov. 30, 2022. [whitehouse.gov/wp-content/uploads/2022/12/OSTP-CEQ-Indigenous-Knowledge-Guidance.pdf](https://www.whitehouse.gov/wp-content/uploads/2022/12/OSTP-CEQ-Indigenous-Knowledge-Guidance.pdf)

¹¹Menominee Tribe Forest Management Plan. [mtewood.com/Content/files/ForestManagementPlan.pdf](https://www.mtewood.com/Content/files/ForestManagementPlan.pdf)

¹²Western Klamath Restoration Partnership. [wkrp.network](https://www.wkrp.network)

¹³Stan et al. 2022. Reduced forest vulnerability due to management on the Hualapai Nation. Trees, Forests and People. doi.org/10.1016/j.tfp.2022.100325

¹⁴Victor, Jr. 2014. Fire Management of the San Carlos Apache Tribe: A Case Study in Southeastern Arizona. Northern Arizona University.

ECOCULTURAL RESTORATION IN ACTION

PINE-HARDWOOD FORESTS OF NORTHERN WISCONSIN



Prescribed burning in an eastern white pine stand. Photo Credit: Forest Management Plan, Page 99.

The Menominee Tribe is implementing inspiring ecocultural restoration practices in pine-hardwood forests that have experienced widespread change since Euro-American colonization.¹¹ Their forest stewardship includes even- and uneven-aged silvicultural prescriptions and prescribed burning to mimic historical and human-influenced disturbance regimes and moderate fire severity. Restoration is based on reciprocity and multi-resource stewardship, to provide sustained timber products to the Menominee people of today, while maintaining wildlife habitat, enhancing aesthetics, protecting cultural resources and archaeological sites, and improving soil and water. The diverse forest types managed by the Tribe, as well as demonstration sites used to test alternative treatments, ensure the adaptability of these forested landscapes under climate change and shifting disturbance regimes.

OAK-PINE WOODLANDS OF NORTHERN CALIFORNIA



Fire used to restore oak-pine woodlands in the Klamath Mountains Region of Northern California. Photo Credit: Frank Lake.

The Western Klamath Restoration Partnership provides an example of how ecocultural restoration uses thinning and intentional burning to restore oak woodlands.¹² By strategically harvesting encroaching Douglas-fir and applying cultural burning, the Yurok, Karuk, Hoopa, and Klamath Tribes, guided by IK and WS, favor large and old oak trees and fire-resistant conifers, oaks, and redwoods. Ecocultural restoration practices also promote culturally significant berry-producing shrubs, basketry materials, and many other culturally valued plants and fungi. Restored woodlands are less susceptible to high-severity fires and insect outbreaks and better adapted to a warming climate.

MIXED-CONIFER FORESTS OF ARIZONA



Fire burns through a past treatment during the 2015 Sawmill Fire in Arizona. Photo Credit: Inciweb.

The Hualapai Nation in western Arizona and the San Carlos Apache Tribe in southeastern Arizona work to restore the ecological and cultural integrity of mixed-conifer forests in their ancestral homeland.^{13,14} They have restored fire-receptive mixed-conifer landscapes using uneven-aged silvicultural treatments, prescribed burning, and managed wildfires, guided by fire history research and IK. Proactive forestry and fire stewardship programs have increased ecosystem resilience, while promoting important cultural values such as improved habitat for large game species, sustainable timber supplies for local economies, and higher understory biodiversity.

FIVE RECOMMENDATIONS

Coupling Indigenous Knowledge (IK) with Western Science (WS) can catalyze proactive approaches to address threats to NA forests at meaningful scales. We recommend the following adaptive strategies to restore forest landscape resilience.¹⁵

1. Adopt proactive stewardship. Invest intentionally in the expanded use of cultural and prescribed burning, forest thinning, and other active forest management at the pace and scale needed to address the broad influence of modern destructive wildfires, restore resilience, and reduce reliance on fire suppression and disaster response.

2. Provide the flexibility to steward for dynamic landscapes and navigate uncertainties under rapidly changing conditions. Managing for static landscape conditions has been ineffective on many fronts. Especially under climate change, high-severity fire, drought, and other disturbances cannot be prevented in areas prioritized for mature and old-growth forest conservation. All landscapes, even those in designated reserves, are dynamic.

3. Ground agency planning and land and resource stewardship policies in ethics of reciprocity and responsibility to future generations. Through active stewardship, people benefit from and provide for the ecosystems that support them for generations.

4. Catalyze innovative approaches to forest stewardship by effectively funding adaptive forest stewardship and long-term monitoring at stand to landscape scales. This is at the heart of adaptive stewardship: learning what works best as conditions change to inform the modification of best practices.

5. Recognize and respect Tribal Sovereignty and Indigenous Knowledge. Establish and support Government-to-Government co-stewardship partnerships with Tribal Nations at all stages of policy development, planning, monitoring, decision-making, and adaptive stewardship. Common elements of co-management include: (1) recognition of Tribes as sovereign governments; (2) incorporation of the federal government's trust responsibilities to Tribes; (3) legitimation structures for Tribal involvement; (4) meaningful integration of Tribes early and often in the decision-making process; (5) recognition and incorporation of Tribal expertise; and (6) dispute resolution mechanisms.¹⁶

¹⁵Resilience is a measure of a forest landscape's ability to adapt to a range of interacting disturbances, while maintaining climate-adapted fire regimes and vegetation patterns.

¹⁶Mills and Nie 2021. Bridges to a New Era: A Report on the Past, Present, and Potential Future of Tribal Co-Management on Federal Public Lands. Public Land & Resources Law Review. scholarworks.umt.edu/plrlr/vol44/iss1/2

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