

Indigenous fire stewardship for fire management and ecological restoration in the Pacific Northwest

A literature synthesis and annotated bibliography



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About the Northwest Fire Science Consortium:

The Northwest Fire Science Consortium works to accelerate the awareness, understanding, and adoption of wildland fire science in Washington and Oregon. It connects managers, practitioners, scientists, local communities, and collaboratives working on fire issues on forest and range lands. The Northwest Fire Science Consortium is one of the 15 regional exchanges established by the Joint Fire Science Program's Fire Science Exchange Network to bring fire science users together to address regional fire management needs and challenges. Each regional exchange provides current and regionally relevant wildland fire science information to users in the region.

For more information: <http://www.nwfirescience.org/>

About the Ecosystem Workforce Program:

The Ecosystem Workforce Program is a program of University of Oregon's Institute for Resilient Organizations, Communities, and Environments (IROCE). We conduct applied social science research and extension services at the interface of people and natural resources. Our publications aim to inform policy makers and practitioners, and contribute to scholarly and practical discourse.

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Front Cover photo: A cultural burning at Baskett Slough National Wildlife Refuge, 2023.

Credit: David G. Lewis

Next Page photo: Fire maintained Bear-grass (*Xerophyllum tenax*) meadow, Oregon western Cascades.

Credit: Michael R. Coughlan

Back Cover photo: Cultural burn in the Sierra Nevada led by North Fork Mono Chairman Ron Goode.

Credit: Chris Adlam

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A cultural burning at Baskett Slough National Wildlife Refuge, 2023. Credit: David G. Lewis

Introduction

Resilience to wildfires is declining in forests of the western US, in part because of the loss of biodiverse forest structures that buffer the severity of fire impacts. Indigenous fire stewardship (IFS)¹ plays a critical role in the maintenance of North American forest resilience. The displacement and genocide of Indigenous peoples and their cultural practices, including the prohibition of IFS, have coincided with fire exclusion and suppression policies implemented by federal and state agencies, and have led to the diminishment of this management practice that has existed since time immemorial. Recently, the USDA Forest Service and its land management partners have formally recognized the wildfire problem as a “crisis” and acknowledged the need for a “paradigm shift in land management across jurisdictional boundaries” (USDA Forest Service, 2022). It is within this context that Indigenous fire stewardship, its history and current revitalization, has attracted increasing attention as a potential solution relevant to the restoration of the North American Pacific Northwest (PNW) landscapes.

This synthesis reviews literature on IFS in the PNW as represented in scholarly peer reviewed publications. We also conducted a systematic search of the internet to identify informational resources, networks, and organizations engaged with IFS in the PNW. We define IFS broadly as encompassing Indigenous peoples’

socioecological and spiritual relationships with landscape fire, and specifically focus this synthesis on cultural burning, i.e., the intentional use of broadcast and targeted fire (see formal definition below). This paper synthesizes information on ecological, social, and policy aspects of IFS that are relevant to fire managers and restoration practitioners in the PNW. We identify current knowledge and knowledge gaps, as well as policy opportunities and barriers relevant to the application of IFS to fire management and ecological restoration.

We employed a systematic review approach to answer the following broad questions as they apply to the PNW fire management context:

1. What is Indigenous fire stewardship and how has it been represented in peer reviewed literature?
2. What are the salient social issues, debates, and concerns about IFS and its application to restoration management?
3. What aspects of IFS has literature in fire ecology and ecological restoration included?
4. What does the literature say about the policy opportunities and challenges of integrating IFS into various fire management contexts across the PNW?

¹ Also known as “cultural fire” or “cultural burning”, see discussion of terms below.

Approach

The objective of this synthesis was to systematically review literature on IFS in the PNW and to provide an annotated bibliography of a sample of the most relevant articles (Appendix A: Annotated Bibliography). We organized articles according to their primary emphasis in three thematic areas: (1) social aspects, (2) ecological and management considerations, and (3) policy and governance aspects of IFS.

(1) **Social aspects** included social relations of cultural burning practices, discussions of cultural and religious significance, as well as ethical and political issues related to IFS and its history that have been documented using systematic social science approaches.

(2) **Ecological aspects** included scientifically documented spatial and temporal patterning of cultural burning as well as the effects of IFS on individual plant traits and the biogeographic distributions of plants and plant associations.

(3) **Policy aspects of IFS** concerned the current governance and institutional arrangements, as well as discussions of and recommendations for future pathways toward expanding IFS in public and private land management and practices across the PNW.

We defined the PNW region using the EPA Ecoregion Level 1 Map² (Commission for Environmental Cooperation, n.d.) and included the Northwestern Forested Mountains (ecoregion 6.0), and Marine West Coast Forest (ecoregion 7.0) (Figure 1). Despite overlap within the conventionally defined political boundaries of the PNW, North American Deserts (ecoregion 10.0) was excluded. Therefore, in this study, the PNW refers to coastal and mountainous parts of Southeast Alaska, British Columbia, Washington, Oregon, California, Idaho, Montana, Utah, Wyoming, and Colorado. Although Intermountain West states and provinces such as Alberta, Wyoming, Utah, Colorado, and New Mexico were included in the literature search, we excluded sources dealing solely with those areas

from the annotated bibliography and overall synthesis.

Figure 1. Area and ecoregions included in the systematic review



We conducted a systematic review of peer reviewed literature on IFS (see Appendix B for a more detailed explanation of methods). Our search included 12 different Boolean statements applied to five reputable scholarly databases. We organized search results in a relational database that tracked individual searches and the articles they yielded. In addition to the article's citation, we recorded the topic area, key words, and geographic focus and summarized the

² <https://www.epa.gov/eco-research/ecoregions>

number of authors and citations they had received. To track findings and recurrence of articles across searches, we assigned a unique identifier to all peer reviewed articles.

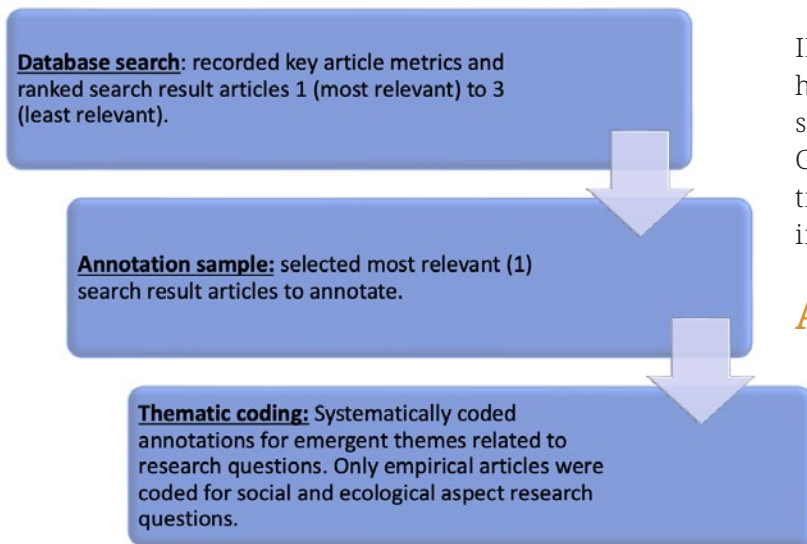
We ranked the relevancy of each article to our study objectives from 1 to 3 with “1” being most relevant and “3” being least relevant or not relevant at all. There were a small number of articles within the searches that did not pertain to fire or did not mention or address Indigenous use of fire at all. These articles were completely excluded from our reference list. To determine how relevant the articles were, we read through titles and abstracts and scanned the article sections to see if the article met the following criteria: (A) the information regarding IFS provided clear, significant, and novel contributions to the literature, (B) the research questions or paper objectives were directly related to IFS, or (C) IFS was discussed extensively in more than two sections in the paper. We ranked articles as “1” that focused partially in the PNW and met all the three criteria for relevancy to IFS. We ranked articles as somewhat relevant (“2”) if they met the three criteria but were outside of the study area (PNW) or, alternatively, if they focused on the PNW, met criteria C, but did not meet criteria A or B. For example, we gave articles a rank of “2” if they included some discussion of historical IFS for background or discussion context but did not include significant analysis or extensive focus on IFS throughout. We assigned a rank of “3” to articles that dealt with fire ecology or anthropogenic fire in the PNW but did not fully meet the three criteria. For example, an article would be ranked as least relevant (“3”) if it focused on human ignitions in the PNW but did not discuss IFS beyond a passing reference (e.g., failed to meet criteria C). Articles ranked as 1 were considered for inclusion in the annotated bibliography (i.e., the “annotation sample”), but those ranked as “2” or “3” were excluded. Citations and their rankings are included in the supporting information “Search-Results.csv”³

For each article included in the annotation sample, we coded for its primary topic area (ecological science, social science, or policy) and created codes to indicate whether the article presented empirical research or non-empirical scholarship (Figure 2). Articles that fit into more than one topic area were assigned to one primary topic based on judgmental assessment by the authors. We also assessed Indigenous authorship for all articles in the annotation sample. We conducted internet searches for public-facing author profiles provided by websites managed by their institutional affiliations. If authors’ website profiles included statements of enrollment in a Native American Tribe or First Nation or included specific identity statements expressing Indigenous heritage, we made note of this in our database. Lastly, we systematically assessed the relative impact and importance of each article based on two metrics: the number of co-authors and citations by other authors per year (i.e., the number of times the article had been cited divided by the number of years the article has been in publication). We used Google Scholar to obtain the number of times the article has been cited. If articles appeared more than once on Google Scholar, we selected the entry with the highest number of citations by other authors. We calculated the percentile rank for both metrics, summed them, and ranked this composite variable.

To avoid biases in our annotation sample introduced by the timing of our study and our search methodology, we judgmentally selected additional articles that we were aware of for consideration in the review: these articles were either too new to be indexed, were in journals that are not included in the online databases, or were not captured by our searches for other reasons. These articles are included in Appendix C: Further Readings.

³ Available by searching for this title at the University of Oregon Scholar’s Bank: <https://scholarsbank.uoregon.edu/xmlui/>

Figure 2. Article selection and synthesis process



Review of current IFS practices

IFS is undergoing active revitalization by Tribes and Indigenous-led organizations and, in some areas, it is being actively supported by land management agencies and conservation organizations. Consequently, the scholarship lags behind developments within this field. Further, for a variety of reasons related to histories of attempted genocide and generations of political oppression and exploitation as well as issues related to Tribal sovereignty (including control over the ownership of data), some Tribes are reluctant to engage with non-Native scholars, specifically on topics that touch on traditional cultural practices. Many Tribal Nations are also in the process of restoring traditional practices and are not in a place or do not have the capacity to publish about their efforts. Finally, there are still many people in the non-Native scientific and lay communities that lack understandings of Indigenous people and cultures, and this creates barriers for the revitalization of Indigenous-led cultural practices. These factors contribute to significant gaps between the historical and current practice of

IFS and its representation in academic literature. To help fill this gap between practice and the scholarship, we systematically searched the internet using Google search engine to identify current informational resources, support networks, and programs involved in this revitalization effort.

Article annotation

We systematically reviewed articles for annotation and organized our annotations around six subject areas pertaining to each article:

- (1) Explicitly stated research questions and objectives.
- (2) Terms and definitions of IFS used by the authors.
- (3) Article framing and intended audience.
 - (a) Author training and disciplines (first three authors, or if there was a statements of author roles, all authors involved in conceptualizing the work)
 - (b) Production context (i.e., Was the article an outcome of a funded research project, a workshop or conference session, or was the article responding to a specific event or scholarly need?)
 - (c) What are the aims and scope of the journal and who is its intended audience?
 - (d) Beyond research questions and objectives, what additional information is important about the main argument or logic?
- (4) Research methods or synthesis framework.
- (5) Results.
- (6) Significance to the study, communication, or application of Indigenous fire stewardship.

Each article was reviewed by at least two reviewers (one of the co-authors on this report) and the annotations were collectively edited. Next, we systematically coded the annotations for emergent themes related to our research questions. While all articles were coded for the first research question (what is IFS) and the last research question (policy

discussions and recommendations), only articles presenting empirical research were coded for the second and third questions (ecological and social aspects) (Table 1). Themes were determined iteratively, and we tested for intercoder reliability by comparing independently coded annotations across two or more researchers (Appendix D: Codebook).

Table 1. Annotated articles included in the social and ecological empirical analysis.

Ecological	Social	Policy	
Johannessen, 1971	White, 1975	Anderson, 1996	Brookes, 2021
Shinn, 1980	Shinn, 1980	Kimmerer, 2001	Mucioki, 2021
Keeley, 2002	Gottesfled, 1994	Wray, 2003	Vinyeta, 2021
Weisberg, 2003	Anderson, 1996	MacDougall, 2004	Nicolakis, 2021
Macdougall, 2004	Levy, 2005	Levy, 2005	Hoffman, 2022a
Storm, 2006	Diekmann, 2007	Storm, 2006	Hoffman, 2022b
Trusler, 2008	Tveskov, 2007	Diekmann, 2007	O’Gorman, 2022
Shebitz, 2009	Trusler, 2008	Murphy, 2007	Christianson, 2022
Christy, 2011	Deur, 2009	Shebitz, 2009	Nicolakis, 2022
Derr, 2014	Carroll, 2010	Carroll, 2010	Dickson-Hoyle, 2022
Hoffman, 2017	Lewis, 2010	Turner, 2011	Connor, 2022
Roos, 2018	Turner, 2011	Hamman, 2011	Dockry, 2023
Marks-Block, 2019	Ray, 2012	Ray, 2012	
Hart-Fredeluces, 2020	Lightfoot, 2013	Mason, 2012	
Klimaszewski-Patterson, 2020	Anderson, 2013	Eriksen, 2014	
Marks-Block, 2021	Eriksen, 2014	Norgaard, 2014	
Brookes, 2021	Norgaard, 2014	Anderson, 2015	
Barlow, 2021	Anderson, 2015	Long, 2017	
Knight, 2022	Long, 2018	Anderson, 2018	
O’Gorman, 2022	Nicolakis, 2020	Long, 2018	
Connor, 2022	Long, 2021	Marks-Block, 2019	
Armstrong, 2023	Adlam, 2021	Klimaszewski-Patterson, 2020	
	Mucioki, 2021	Nicolakis, 2020a	
	Copes-Gerbitz, 2021	Nicolakis, 2020b	
	Marks-Block, 2021	Hart-Fredeluces, 2020	
	Dickson-Hoyle, 2022	Adlam, 2021	
	Christianson, 2022	Prichard, 2021	
	Nicolakis, 2022	Barlow, 2021	
	Vinyeta, 2022	Copes- Gerbitz, 2021	
	Dockry, 2022		



Fire maintained oak (*Quercus* spp.) meadow, Oregon Coast Range. Credit: Michael R. Coughlan

Below, we provide a descriptive summary of our literature and internet searches and present a synthesis of thematic findings that address our research questions. We suggest that this synthesis, along with the article annotations we provide in the Appendix, can be used as a resource for managers and practitioners interested in IFS. While we designed our review of the peer reviewed literature to be comprehensive, it is in no way exhaustive. We further acknowledge that our methodology is biased by

the nature of the databases we searched and by the structural limitations inherent within the conventions of Western scholarly traditions. For example, our categorization of ecological versus social aspects of IFS are Western constructs that contrast with more holistic understandings often present in Indigenous worldviews. We suggest that individuals interested in learning more about IFS should seek to develop mutually rewarding relationships with Indigenous communities whose ancestral landscapes they work in.

Results

Web-based resources and Tribes active in IFS

Our search for web-based informational resources, support networks, and programs surrounding IFS in the PNW region resulted in the identification of 16 websites (Table 2). Seven websites listed informational resources, including newsletters, descriptions of current IFS revitalization partnerships, and links to webinars, videos, podcasts, events, and other resources related to Indigenous knowledge and fire. Seven websites described programs, interagency partnerships, or councils that currently plan, conduct, or participate in cultural burns and cultural fire workshops. For example, the Cultural Fire Management Council facilitates cultural burning on the Yurok reservation and traditional lands through cooperative, family, and demonstrative burning projects. The Chico Traditional Ecological Stewardship Program offers Traditional Ecological Knowledge (TEK) certification and workforce devel-

opment trainings and collaborated with Mechoopda Tribal and community members to conduct a cultural burn in Chico, California. One website listed a support network, the Indigenous Peoples Burning Network, which is led by Native American elders and fire practitioners and supports Indigenous communities that are revitalizing IFS. The network currently works with the Klamath Tribes in Oregon, the Karuk-Yurok-Hoopa Tribes in California, the Washoe Tribe of California and Nevada, the Pueblos of northern New Mexico, the Alabama-Coushatta Tribe of Texas, and the Leech Lake Band of Ojibwe. Lastly, one website described a project led by the USGS Climate Adaptation Science Centers that aims to develop “(1) a series of collaborative traditional burning efforts, (2) an evaluation of preliminary sociopolitical and ecological outcomes from the burning, (3) a broader synthesis of outcomes that draws upon recent burning efforts by the same team of practitioners, and (4) documentation of lessons learned and best practices.”

Table 2 Organization, page title, summary, and resource type for web-based informational resource search results.

Organization	Page Title	Summary	Resource Type
Northern Rockies Fire Science Network	TK & Fire Aug 2023 Newsletter	Provides links to videos, webinars, podcasts, story maps, news, events, and other resources related to Indigenous knowledge and fire.	Informational resource
National Park Service	Indigenous Fire Practices Shape our Land	Provides an overview and definition of cultural burning. While cultural burning was an integral practice to Indigenous ways of life for millennia, it was halted in the 20th century. More recently, there have been efforts to revitalize cultural burning. Describes partnerships with contemporary fire practitioners, including the Southern Sierra Miwuk Nation, the Tuolumne Band of Me-Wuk, the Red Cliff Band, Bad River Band, and other Great Lakes Indian Fish and Wildlife Commission member Tribes.	Informational resource
British Columbia Wildfire Service	How Cultural Burning Enhances Landscapes and Lives	Provides an overview and definition of cultural burning, as well as several cultural objectives and an overview of the role of fire in Indigenous lifeways. It additionally shares links to resources on cultural burning revitalization.	Informational resource

Table 2, cont. Organization, page title, summary, and resource type for web-based informational resource search results.

Organization	Page Title	Summary	Resource Type
KCET	Tending the Wild: Cultural Burning	Provides a video on the history and contemporary revitalization of cultural burning in California.	Informational resource
OSU Extension Service	Prescribed Fire: Why We Burn	Describes the history of prescribed burning in Oregon, objectives of prescribed fire, and regional objectives for burning in Oregon.	Informational resource
Blue Forest Conservation	The importance of Indigenous cultural burning in forested regions of the Pacific West, USA	Provides a newsletter from July 2022 that defined cultural burning as “the purposeful use of fire by a cultural group (e.g., family unit, Tribe, clan/moiety, society) for a variety of purposes and outcomes and is distinct from prescribed fire use or controlled burning.” Describes the findings of a literature review (Long, Lake, and Goode, 2021).	Informational resource
California Wildfire and Forest Resilience Task Force	Prescribed Fire	Provides links to resources including a dashboard to track wildfire resilience projects in California, a pilot project to fundraise for liability coverage, and a wildfire smoke forecasting app.	Informational resource
Chico Traditional Ecological Stewardship Program	Verbena Fields Cultural Burning	Highlights a partnership between the Mechoopda Tribe, Chico State University, Chico Wildland Management students, and Chico Ecological Reserves to expand the use of prescribed fire, revitalize cultural resources, control invasive plants, and exchange knowledge.	Program
Karuk Climate Change Projects	Good Fire	Lists current barriers to the expansion of cultural burning and prescribed fire in California. Recommended solutions include addressing risk aversion, rewarding intentional fire activities, and developing both the human and financial capital necessary to burn on the scale necessary to burn on the scale needed to protect California’s ecosystems and public health.	Program
British Columbia FireSmart	Cultural Burning & Prescribed Fire	Defines cultural burning as “the controlled application of fire on the landscape to achieve specific cultural objectives.” Lists case studies of cultural burning done by the Lil’wat Nation, members of the Pent-icton Indian Band/Syilx Nation, and the First Nations’ Emergency Services Society’s Fuel Management Department in partnership with Shackan Indian Band members.	Program (BCFS)
Firefighters United for Safety, Ethics, and Ecology	Indigenous Cultural Burning	Describes cultural burning revitalization efforts being carried out by the Karuk tribe.	Program (FUSEE)

Table 2, cont. Organization, page title, summary, and resource type for web-based informational resource search results.

Organization	Page Title	Summary	Resource Type
Cultural Fire Management Council	Fire Program Projects	Lists projects undertaken by the Cultural Fire Management Program that aim to expand IFS, including family burning, cooperative burning, demonstrative burning, and fuels reduction.	Program/council
Southwest Climate Adaptation Science Center	Traditional Burning	Partners with Indigenous fire practitioners in California to plan and participate in cultural burning workshops. A summary of the 2020 workshop is provided, along with resources.	Program/partnership
Southwest Fire and Climate Adaptation Partnership	Cultural Burning	Describes a “cultural burning roundtable” that is working to expand knowledge and the practice of cultural burning in the interior Southwest and introduces the roundtable members. Links an annotated bibliography on cultural burning written by the roundtable members.	Program/partnership
USGS Climate Adaptation Science Centers	Cultural Burning as a Climate Adaptation Strategy	Provides an overview of a project, currently ongoing, that aims to develop (1) a series of collaborative traditional burning efforts, (2) an evaluation of preliminary sociopolitical and ecological outcomes from the burning, (3) a broader synthesis of outcomes that draws upon recent burning efforts by the same team of practitioners, and (4) documentation of lessons learned and best practices.	Project
Nature Conservancy / IPBN	Indigenous Peoples Burning Network	Operates as a support network, led by elders and IFS practitioners, for Indigenous communities that are revitalizing IFS. It started in 2015 and is active in OR, CA, NM, MN, NC, TX, and WA.	Support network

Our search for web-based information on Tribes and First Nations in the PNW region currently involved in IFS revitalization projects resulted in the identification of 17 Tribes or First Nations.

For example, in summer 2022, the Lil'wat Nation, with support from British Columbia Wildfire Service, conducted a cultural burn on Lil'wat Nation traditional territory that aimed to reintroduce fire to the landscape and revitalize berry populations (<https://prescribedfire.ca/cultural-burning>). In spring 2023, the Cow Creek Band of Umpqua Tribe of Indians brought together teams from Cow Creek's Forestry and Emergency Management departments and the Umpqua Indian Utility Co-Operative to complete a prescribed burn on Cow Creek Tribal Forest lands. The Yunesit'in and Xeni Gwet'in First Nations are currently developing a pilot program, with input from the First Nations Emergency Services Society, British Columbia Ministry of Forests, the British Columbia Wildfire Service, and consulting professionals, that aims to develop, implement, and evaluate a traditional fire management program for Tsilhqot'in title lands in British Columbia (<https://www.gatheringvoices.com/tsilhqotin1>). A number of nontribal agencies were also identified as funding or being involved in IFS revitalization projects, often in collaboration with Tribes and First Nations. These agencies included The Nature Conservancy; the Northern Rockies Fire Science Network; British Columbia Wildfire Service; California Wildfire and Forest Resilience Task Force; British Columbia FireSmart; Firefighters United for Safety, Ethics, and Ecology; University of California, Davis; the Southwest Climate Adaptation Science Center; and the Southwest Fire and Climate Adaptation Partnership.

There are additional activities that the authors are aware of that we were unable to capture through systematic internet searches.

For example, the Long Tom Watershed Council in Lane County, Oregon has been involved for several years in coordination with local Tribes to restore cultural

fire traditions. This Indigenous-led project (members of the Confederated Tribes of the Siletz) began some 10 years ago and resulted 3 years ago in a large multimillion dollar federal grant to conduct trainings and create professional and licensed practitioners in the Eugene, Oregon area. The training was successful and an Indigenous crew, who called themselves "The Wagon Burners," as a way to take back the power of this derogatory term,⁴ began operating in the Willamette Valley. This team involved Indigenous people from many Tribes and coordinated with local Tribes to initiate burn projects in Oregon and Washington states with some work and interaction in Northern California. The project has since lost its funding and has had to disband. There is very little published academically about this project, which trained dozens of Native and non-Native people in cultural fire and inspired additional projects with the Grand Ronde, Siletz, and other Tribes. This project has had a large impact in the region, and is inspiring spin-off projects, yet little is publicized about the project to this date.

Another significant program of work that our search did not capture involves ecological restoration efforts coordinated by the Lomakatsi Restoration Project.

This non-profit organization has an Inter-Tribal Ecosystem Restoration Partnership Program, which works with Tribal and agency partners throughout Oregon and Northern California to incorporate Indigenous TEK into ecosystem restoration projects. For example, Lomakatsi is partnering with the Karuk Tribe, the USDA Forest Service, and the Mid-Klamath Watershed Council on a Tribal-led restoration project that aims to "thin focal areas for the reintroduction of cultural burning to improve conditions of certain sites, objects, features, or properties [and] demonstrate the reintroduction of fire as a cultural environmental management practice project" across 10,000 acres in Siskiyou County, California (<https://lomakatsi.org/what-we-do/tribal-partnerships/>). In spring 2023, Lomakatsi partnered with Latgawa

⁴ A play on the act of cultural burning and throwing off colonialism. Many practitioners, specifically Native people, in cultural burning feel like the cultural practice is a form of activism and part of their decolonization efforts. This team was funded by the Ecostudies Institute, <https://ecoinst.org/>

Nation, the City of Central Point, and local non-profit, Direct Involvement Recreation Teaching, to launch an ecocultural stewardship effort that reduced fuel loads and prepared 10 acres of city land in Oregon for the return of cultural fire and planting of culturally important plant species.

Systematic review

Our systematic review retrieved a total of 266 unique papers from five different search engines. The Boolean search terms “(“Pacific Northwest”) AND (“Indian burning”)” resulted in the largest number of papers, at 81. Search terms that included “Indigenous” also yielded a high number of results and multiple papers were retrieved in more than one search. Publication dates ranged from 1971 to 2023 (Figure 3). Out

of the total of 266 unique papers, we ranked 133 papers as “somewhat relevant” and 67 received a rank of “least relevant”. Only 66 met our criteria for annotation and were assigned a rank of “1”.

These 66 search articles selected for annotation. Our search resulted in 41 articles within the annotation sample that presented empirical research on IFS. The remaining 25 articles consisted of reviews or commentary on IFS. Of the 41 empirical articles, 14 were primarily concerned with social aspects of IFS, 22 were primarily concerned with ecological aspects, and 5 were primarily concerned with policy (Figure 4). However, since many articles contained discussions and recommendations for policy, we coded 44 articles for policy themes.

Figure 3. Publication years for all search result articles and annotation sample articles.

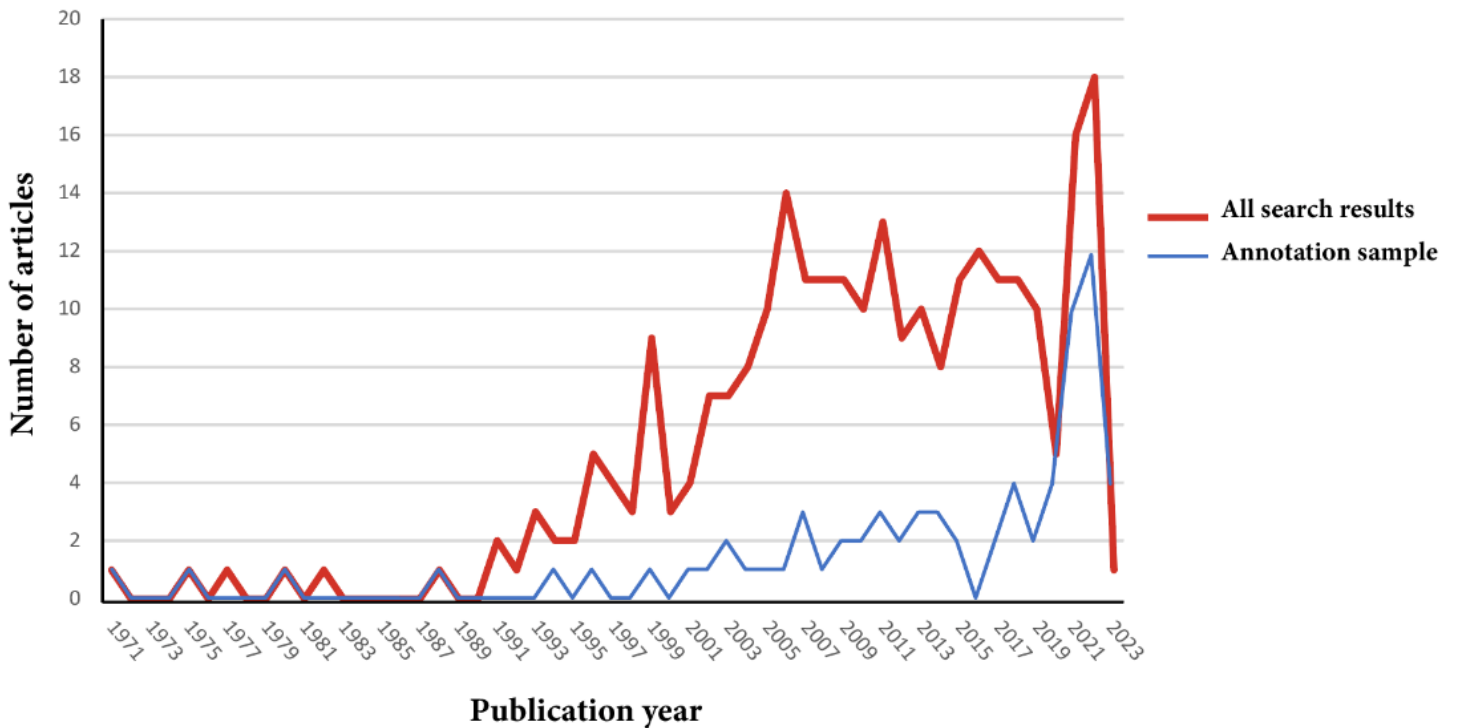
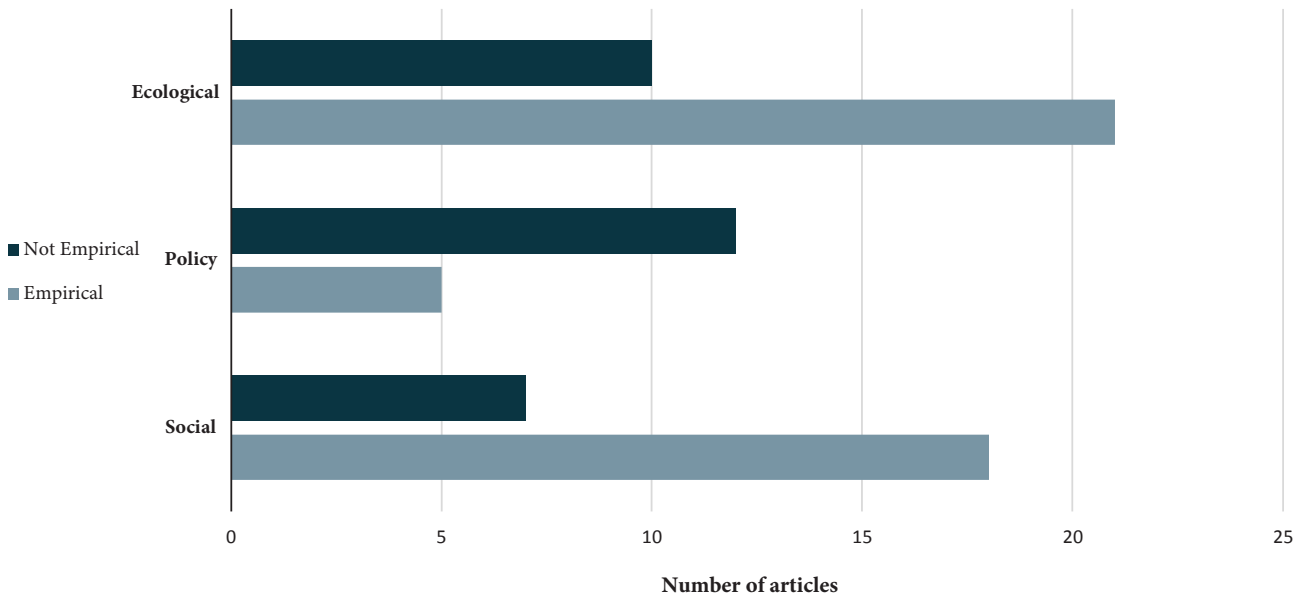


Figure 4. Number of empirical and non-empirical articles by primary topic area.



Additionally, we found that out of the total of 66 articles in the annotation sample, scholars of Indigenous backgrounds were only represented in 24 (e.g., approximately one third of the articles). Furthermore, of these 24 articles with Indigenous authorship, a single scholar was a co-author on ten of them, another author was lead or co-author on three of them, and two other authors were listed on at least two other articles each. Thus, four authors account for over three quarters (n=17 articles) of the diversity of Indigenous input found within this literature search. Although this relatively low representation by Indigenous scholars may not be surprising given that Indigenous peoples are a historically under-represented group in academia, it does suggest that the available information on IFS could be significantly improved by increasing representation of Indigenous voices, perspectives, and knowledge on this subject.

What is Indigenous fire stewardship?

Terminology and definitions for IFS varied widely across publications and through time, depending partly on article focus and audience.

Given the diverse array of terms and meanings, it was surprising that relatively few (n=20) of the papers we reviewed presented an explicit definition for the terms they used. Some scholars defined IFS in terms of a hypothesis, for example by describing it as “anthropogenic alteration of the natural fire regime” (McWethy et al. 2013; Whitlock et al. 2015) or by comparing and differentiating it from conventional fire management, including prescribed burning (Carroll et al. 2010; Eriksen and Hankins 2014; Marks-Block, Lake, and Curran 2019; Hoffman et al. 2021; Hoffman

et al. 2022; Dockry et al. 2023; O’Gorman et al. 2022). Others defined it as a specific practice, e.g., “the routine deployment of small situational burns (i.e., patch burns of <10 ha) along with larger broadcast burns (i.e., >10 ha) during the late winter/early spring and late summer/early fall,” (Knight et al. 2022).

We defined IFS based on the constellation of elements used by authors in our annotation sample to either explicitly define or unambiguously refer to IFS: intentional fire use, management practices, traditional knowledge and cultural practices, and stewardship.

Indigenous fire stewardship is a suite of cultural practices informed by traditional knowledge that involves the application of “cultural fire.” We further define cultural fire as the regular, strategic, and intentional use of fire of varying sizes and intensities by Indigenous peoples for a variety of different culturally defined purposes. Rather than simply being a form of fire management, IFS can also involve diverse practices such as harvesting techniques, tending, and coppicing, as well as ritual and spiritual aspects that may be tightly associated with the application of cultural fire by a specific Indigenous community. Each Tribe and First Nation is likely to have a different sensibility of the practice and use of cultural fire.

The intentional use of fire by Indigenous peoples

The terms “Indian burning” and “Native Burning” were the first terms used within this sample of literature (e.g., Johannessen et al. 1971) and were found in papers published through 2018. These terms were generally associated with the concept of intentionality (i.e., denoting the intentional use of fire); however, some articles that referred to IFS simply as an “ignition source”, either avoided characterizing it as the purposeful application of fire, or did not think intentionality was relevant to their

discussion. Nonetheless, terminology and phrasing from most of the articles suggest that a core piece of any definition of IFS is the intentional use of fire by Indigenous peoples.

Routine, regular, strategic management practice

In general, regardless of terms used, most articles discuss IFS as a management practice and many suggested that IFS was a practice involving “routine”, “systematic”, or “strategic” use of fire on the landscape. By the 2000s, the terms “Indigenous fire management” and “Indigenous burning” became prevalent. The notion that IFS is a management practice is important for distinguishing between other human actions that, intentional or not, can influence fire regimes. For example, some Indigenous peoples historically used fire during warfare and sometimes accidentally set fires. Neither of those behaviors should properly be considered part of IFS. Rather, IFS has specific and strategic goals linked to managing landscape conditions. Some articles defined IFS specifically or narrowly as an ignition source with hypothesized effects on fire regimes or landscapes (McWethy et al. 2013; Whitlock et al. 2015; Hoffman, Lertzman, and Starzomski 2017; Brookes et al. 2021; Hoffman et al. 2021; Knight et al. 2022). We did not include this in our definition because we were interested in defining IFS as a cultural practice, rather than by its ecological consequences.

Traditional fire knowledge and cultural burning

Beginning in the 2010s, articles within our sample increasingly associated IFS with “cultural traditions” and “Traditional Ecological Knowledge” (Carroll et al. 2010; Mason et al. 2012; Ray, Kolden, and Chapin III 2012; Lightfoot et al. 2013; Norgaard 2014; Eriksen and Hankins 2014; Anderson and Jeffrey 2015; Long et al. 2017; Marks-Block, Lake, and Curran 2019; Nikolakis and Roberts 2020; Mucio-ki et al. 2021; Prichard et al. 2021; Adlam et al. 2022; Long, Lake, and Goode 2021; Marks-Block et al. 2021; Hoffman et al. 2021; O’Gorman et al. 2022; Connor et

al. 2022; Hoffman et al. 2022; Vinyeta 2022; Dickson-Hoyle et al. 2022; Dockry et al. 2023; Knight et al. 2022; Christianson et al. 2022). This appears to have accompanied a transition in referring to Indigenous fire use specifically as “cultural burning,” which is common to articles beginning in 2017, presumably to highlight the cultural diversity inherent in knowledge, objectives, and techniques surrounding Indigenous fire use. In other words, “cultural burning” provides a term that captures the importance of the specific cultural contexts inherent in IFS practices.

Fire stewardship

The term “fire stewardship” is a relatively recent term within the IFS literature we sampled.

Within this sample, Mason et al. 2012 discuss IFS within the context of “Native American stewardship practices” and Eriksen and Hankins (2013) suggest it is part of Indigenous people’s philosophy of “responsible environmental stewardship.” However, the use of “stewardship” in association with fire used in tandem with, or sometimes instead of, “Indigenous fire management” became common only after 2017 (Jonathan W Long and Lake 2018; Hart-Fredeluces 2019; Nikolakis and Roberts 2020; Copes-Gerbitz, Hagerman, and Daniels 2021; Adlam et al. 2022; Long, Lake, and Goode 2021; Brookes et al. 2021; Hoffman et al. 2021; Prichard et al. 2021; Vinyeta 2022; Dickson-Hoyle et al. 2022; Hoffman et al. 2022; Knight et al. 2022). The use of the term “stewardship” is significant because it importantly places cultural burning within its larger cultural context, moving beyond specific fire use practices to the suite of cultural practices surrounding the material, social, and spiritual dimensions of IFS.

Social Aspects of IFS

Cultural objectives

In the literature reviewed, interviews with Indigenous informants and analysis of historical documents indicate that Indigenous groups in the PNW have practiced IFS for millennia. Indigenous groups used IFS to increase productivity and predictability of habitats that were important for food,

medicine, and technology. Species often targeted in IFS included black huckleberries (*Vaccinium membranaceum*) (Trusler and Johnson 2008), soapberry (*Shepherdia canadensis*) (Copes-Gerbitz, Hagerman, and Daniels 2021), blackberries (*Rubus* spp.) (Deur 2009), lowbush blueberries (*Vaccinium caespitosum*) (Gottesfeld 1994), mushrooms (Anderson 2013), deergrass (*Muhlenbergia rigens*) (Anderson 1996), hazelnut (*Corylus avellana*) (Marks-Block et al. 2021), and beargrass (*Xerophyllum tenax*) (Hart-Fredeluces 2019; Shebitz, Reichard, and Dunwiddie 2009). The first five species listed are culturally important food sources while the latter three species are culturally important plants for basketweaving. IFS also served as a tool to enhance hunting: either directly, through use of fire to encircle animals (Shinn 1980) or herd them towards waiting hunters, or indirectly through improvement of habitat for animals such as deer and elk (*Cervus canadensis*) (Carroll et al. 2010; Turner, Deur, and Mellott 2011; Boyd 1999). Cultural burning prevented conifer encroachment into villages, forest gardens, berry batches, food gathering sites, and other managed lands (Gottesfeld 1994; Turner, Deur, and Mellott 2011; Anderson 1996). It was also used to open up travel corridors (Norgaard 2014; Anderson and Jeffrey 2015; Nikolakis, Welham, and Greene 2022; Shinn 1980), communicate across long distances (Shinn 1980), and reduce plant diseases (Anderson 2013). Notably, reducing the risk of catastrophic fire is one of the most commonly mentioned motivations for IFS in the literature (Anderson and Jeffrey 2015; Nikolakis, Welham, and Greene 2022; Turner, Deur, and Mellott 2011; Anderson 2013; Gottesfeld 1994; Anderson 1996). Many of these motivations align with modern ecosystem management objectives.

Indigenous groups in the Pacific Northwest also practiced IFS for spiritual and cultural purposes. Many Indigenous informants in the literature mentioned the importance of IFS for cultural identity (Adlam et al. 2022; Mucioki et al. 2021; Norgaard 2014; Vinyeta 2022), social connection (Mucioki et al. 2021; Deur 2009), and physical and mental health (Mucioki et al. 2021; Norgaard 2014; Deur 2009; Eriksen and

Hankins 2014). Cultural burning also plays an important role in spiritual and religious practices for many Tribes by, for example, fostering a connection to place (Adlam et al. 2022; Trusler and Johnson 2008), ecosystems (Mucioki et al. 2021), and ancestors (Adlam et al. 2022; Carroll et al. 2010). IFS, and many of the species managed through burning, are integral aspects of Tribal ceremonies (Norgaard 2014; Carroll et al. 2010; Nikolakis, Welham, and Greene 2022; Gottesfeld 1994). Cultural fire is also recorded in oral histories of Tribes. Oral histories appear in many linguistic volumes, or “texts” in Native languages, as a recordation of cultural events in the past (David Lewis, unpublished data).

IFS is not “prescribed fire”

As noted above, several articles discuss how IFS differs conceptually and in practice from conventional prescribed burning conducted by land management agencies. In addition to an obvious cultural connection to fire that conventional Western fire management lacks (Carroll et al. 2010), IFS differs significantly from prescribed fire in its goals and objectives. For example, whereas cultural burning seeks to improve or maintain the health and productivity of culturally valued species, government agencies employing prescribed fire tend to focus more narrowly on fuels reduction and mitigation of wildfire severity (Marks-Block, Lake, and Curran 2019; Long, Lake, and Goode 2021; O’Gorman et al. 2022). Other important differences between IFS and government-led prescribed fire include: differences in strategies and techniques of burning, personnel conducting the burning, social dynamics related to gender and power, and how fire knowledge is transmitted (Eriksen and Hankins 2014; Hoffman et al. 2021; Hoffman et al. 2022). Whereas prescribed fires are implemented with rigid controls by trained and certified professionals, cultural burning is often conducted as a casual family event with participation by elders and children alike, whose relationships with the burned landscape are intended to be enduring.

Fire as a concept

One important factor that differentiates IFS from conventional Western fire management

relates to the concept of fire itself. As Nikolakis et al. (2020), point out, “fire is perceived through the lens of culture, and is rooted in mythology and religion.” They go on to contrast views of fire within Indigenous and Western mythologies where in the former, fire is a gift to humans, and in the latter, fire is destructive and apocalyptic. The variety of concepts we associate with fire are important to the institutional contexts in which fire management operates.

Dominant (settler colonial) views of fire are fundamentally incompatible with the logic and rationale of IFS (Trusler and Johnson 2008; Shinn 1980). It would be difficult to discuss the history and contemporary practice of fire management without a significant portion of the discussion focusing on fire suppression. Fire suppression policies derive from urban and industrial forestry notions of fire as a destructive force that must be controlled (Vinyeta 2022). These views contrast starkly with many Indigenous cultural views on fire. Eriksen and Hankins (2023) suggest that fire is integral to most Indigenous cultures and that fire is part of “responsible environmental stewardship based upon philosophies of reciprocal relationships.”

It has only been in the last few decades that dominant views have begun to shift from the notion that all fire has negative impacts to the idea that fire can be used as a management tool. However, even revised understandings of fire that look favorably upon IFS often fail to comprehend or accommodate the full context of Indigenous fire knowledge, focusing instead on tangible aspects of IFS that translate most easily into Western science frameworks (Copes-Gerbitz, Hagerman, and Daniels 2021).

Indigenous fire knowledge and Western science

Another factor that differentiates IFS from conventional Western fire science and management is that IFS is rooted in Indigenous knowledge traditions. Several of the articles in our sample called for the “integration” of Indigenous knowledge and ways of knowing with Western science and land management

techniques (Ray, Kolden, and Chapin III 2012; Dockry et al. 2023; Dickson-Hoyle et al. 2022; Prichard et al. 2021; Hamman et al. 2011; Carroll et al. 2010). However, Indigenous fire knowledge, sometimes called TEK or other combinations of those words, is different from dominant Western science in several fundamental and instrumental ways. First, Indigenous fire knowledge is place-based (Ray, Kolden, and Chapin III 2012; Vinyeta 2022). In other words, it is based in local contexts and may not always be generalizable to other places. Second, Indigenous knowledge can have spiritual elements, some of which may not be appropriate for contexts where they are accessible to the general public. Third, Indigenous fire knowledge is embedded within specific cultural traditions of intergenerational knowledge transmission and decision making (Copes-Gerbitz, Hagerman, and Daniels 2021). Many of these embedded traditions are recorded in Tribal Nations' oral histories.

These differences can cause difficulties for integrating Indigenous knowledge, and hence IFS, into Western science-organized frameworks. Nonetheless, as Ray et al. (2012) point out, such integration may be important for designing sustainable solutions to complex social ecological problems which require local responses.

Contemporary IFS: cultural revitalization

For nearly three centuries, Indigenous cultures were overtly suppressed by the colonial governments and discouraged and discriminated against by the dominant Euro-American colonial culture. As a result, vast amounts of traditional cultural knowledge have been tragically lost, and many people of Indigenous heritage have only been able to retain some of their traditions. Early Catholic missionization, followed by forced relocation and confinement of Tribal peoples to reservations by the colonial governments of the US and Canada, were later augmented by assimilation tactics within the educational system as well as development programs that encouraged (and, in some cases, forced) Indigenous peoples to adopt Western ways of farming and

ranching. It is within this context that land management agencies introduced forest fire exclusion and suppression policies that included federal agency attempts to stop IFS (Vinyeta 2022). Nonetheless, IFS and its cultural memory survived, and the practices are continued today by many Tribes and First Nations (Gottesfeld 1994; Carroll et al. 2010). In fact, IFS has become an important part of cultural revitalization efforts across the PNW (Marks-Block et al. 2021; Nikolakis, Welham, and Greene 2022; Anderson 1996; Deur 2009; Vinyeta 2022).

IFS revitalization is one component of a broader suite of cultural revitalization effort such as movements to revive traditional basketweaving and other crafts, the “first food” movement to continue and revive traditional food gathering, processing, and eating, and the “land back” movement to reacquire stolen land (Deur 2009; Marks-Block et al. 2021). Revitalization takes many forms, with notable examples including an Indigenous fire workshop that brought together cultural fire practitioners, researchers, agencies, NGOs, and members of the public in Northern California (Adlam et al. 2022), and an Indigenous fire management pilot program in British Columbia (Nikolakis and Roberts 2020). Revitalization of IFS has the potential to enhance food security, nutritional health, cultural identity, sense of place, Indigenous knowledge, and social connections within Indigenous communities (Mucioki et al. 2021; Norgaard 2014; Eriksen and Hankins 2014). It can also provide training and employment for local Indigenous people (Nikolakis, Welham, and Greene 2022) and possibly help revitalize Indigenous languages (Dickson-Hoyle et al. 2022). However, when considering contemporary IFS, it is important to note that the relationships that Tribes across the PNW have with fire are diverse and variable (Ray, Kolden, and Chapin III 2012). For example, interviews indicate that some Indigenous groups are hesitant about modern use of fire as a management tool (Ray, Kolden, and Chapin III 2012) and others have lost the social memory and knowledge of IFS (Copes-Gerbitz, Hagerman, and Daniels 2021; Deur 2009).

Current issues and constraints to revitalization

There are several constraints that Indigenous groups are facing in their efforts to revitalize IFS. For instance, climate change is altering plant production cycles, which makes it harder to time burning, and thereby affects Tribes' abilities to conduct cultural burning in the Klamath River Basin (Mucioki et al. 2021). For the Nez Perce in northern Idaho, a shrinking and fragmented land base is leading to difficulties controlling fire within allotments, which is further hindered by permitting restrictions that limit their ability to burn (Carroll et al. 2010). Fire suppression policies, which often extinguish even low severity, "good" fires, continue to negatively impact Indigenous people's political sovereignty, health, social relations, and subsistence (Norgaard 2014), as well as efforts to revitalize IFS, as excessive fuel buildups make it difficult to conduct controlled, low-intensity burns (Carroll et al. 2010).

Unequal power dynamics between Tribal and federal, state, or provincial collaborators has slowed wildfire policy reform and created a potential for mistrust between agency and local collaborators (Nikolakis, Welham, and Greene 2022; Hoffman et al. 2022; Long et al. 2017). For example, establishing the credibility of Indigenous knowledge within Western science paradigms has been difficult. This problem, in turn, adds to barriers that prevent the integration of Indigenous fire knowledge into land management (Eriksen and Hankins 2014; Nikolakis and Roberts 2020; Jonathan W Long and Lake 2018). These power imbalances, coupled with the legacies of colonization, fire suppression, and industrial modification of the landscape, have resulted in a loss of fire knowledge within Indigenous communities (Nikolakis and Roberts 2020). At the same time, Tribal natural resources managers have unmet research gaps and needs related to IFS (Dockry et al. 2023).

In addition to climate change and fire suppression, revitalization efforts are further impacted

by mining, overgrazing, and urban development, which reduce both the abundance and diversity of cultural resources, as well as Indigenous access to these resources (Turner, Deur, and Mellott 2011; Anderson 1996). Thus far, state and federal fire management agencies' efforts to learn from IFS have not necessarily supported revitalization. For instance, while Indigenous employment within these agencies has played an important role in the retention of Indigenous fire knowledge, it can also "defy cultural laws and practice, which subverts the revival of Indigenous burning practices" (Eriksen and Hankins 2014). Similarly, Western fire managers often attempt to extract the "content" of IFS without considering the context, diminishing its potential (Copes-Gerbitz, Hagerman, and Daniels 2021), and suggesting a lack of understanding and respect for IFS (Adlam et al. 2022; Eriksen and Hankins 2014). Lastly, it is important to note that recent catastrophic wildfires have a disproportionate impact on Indigenous communities (Norgaard 2014), potentially hindering their capacity for revitalization.

Ecological Aspects of IFS

As noted above, Indigenous oral histories and knowledge indicate that IFS has been practiced from time immemorial in a wide variety of landscapes and ecological contexts within the PNW. In this section, we present empirical findings from our systematic review of peer reviewed scholarship whose primary focus was ecological science. We recognize that this small offering of information on the ecological effects of IFS may seem meager in comparison to the wealth of Indigenous knowledge that has persisted among Tribal peoples in the face of colonial oppression. However, given that this synthesis is a review of peer reviewed scientific work in this area, we are limited to scientific studies that have been published on this topic. We report on systematically collected and published ethnographic information on IFS in the previous section, "Social Aspects of IFS."

Forest systems

In historic forest ecosystems, the extent and ecological impacts of IFS have been surveyed using tree rings (Weisberg and Swanson 2003; Hoffman, Lertzman, and Starzomski 2017; Knight et al. 2022; Brookes et al. 2021), charcoal and pollen deposits (Knight et al. 2022; Derr 2014), sediment core modeling (Klimaszewski-Patterson and Mensing 2020), vegetation surveys and lightning strike patterns (Hoffman, Lertzman, and Starzomski 2017), and historical records (Armstrong et al. 2023). Analyses of sedimentary charcoal, tree rings, and fire scar records at two sites in the Klamath region of California found a positive correlation between these fire proxies and the presence and creation of forest openings (Knight et al. 2022). These proxies indicated a median fire return interval of seven and twelve years for the two sites respectively, with the majority of burns that impacted trees occurring in or after the late summer or fall. Models derived from sediment cores found that IFS likely decreased fire intensity (Klimaszewski-Patterson and Mensing 2020). Vegetation surveys and lightning strike patterns indicated that IFS increased the abundance of “traditional plants” (Hoffman, Lertzman, and Starzomski 2017), and historical accounts indicated that IFS prevented conifer encroachment into meadows and encouraged biological and functional diversity (Armstrong et al. 2023).

Grasslands

Analysis of historical accounts, records, and photographs found IFS played a key role in maintaining historic grassland systems and preventing encroachment of Douglas-fir (*Pseudotsuga menziesii*) and western juniper (*Juniperus occidentalis*) (Keeley 2002; Shinn 1980). In another study, analysis of tree rings suggest that IFS was necessary to maintain open grassland ecosystems and prevented conversion to Douglas-fir forest (Hart-Fredeluces 2019). Roos et al.’s (2018) analysis of sedimentary charcoal found that IFS amplified the climate driven fire regime in this ecosystem (Roos et al. 2018).

Our systematic review did not yield research findings on the impacts of contemporary IFS on grassland ecosystems. Although there is a paucity of empirical research into IFS generally, our lack of findings suggests a clear gap in research on IFS in grasslands.

Oak savanna

IFS maintained Garry oak (*Quercus garryana*) and California hazelnut (*Corylus cornuta*) populations in historic oak savanna systems across the PNW. Reviews of historical records, including land surveys, maps, and aerial photographs, found that IFS was necessary to prevent conversion to Douglas-fir forests (Macdougall, Beckwith, and Maslovat 2004; Johannessen et al. 1971).

Research on the effects of IFS on contemporary oak savanna systems found that forest densification, including Douglas-fir encroachment in the absence of IFS, had a strong negative effect on the resilience of black oaks (*Quercus kelloggii*) and the culturally important resources they provide (O’Gorman et al. 2022).

Individual species

The effects of IFS on culturally important species has been studied in contemporary ecosystems. Using computer simulations and prescribed fire as proxies for IFS, studies revealed that low-intensity fires increased the abundance and productivity of beargrass (*Xerophyllum tenax*) (Hart-Fredeluces 2019; Shebitz, Reichard, and Dunwiddie 2009) and camas (*Camassia quamash*) (Storm and Shebitz 2006) and increased winter habitat suitability for elk (Connor et al. 2022). Prescribed fire and manual proxies, such as stem cutting and blistering, were also found to increase the density and stem production of California hazelnut (*Corylus cornuta*) (Marks-Block, Lake, and Curran 2019; Marks-Block et al. 2021). Analysis of interviews, maps, and historic photographs also suggest that IFS was historically used to maintain productive patches of black huckleberry (*Vaccinium membranaceum*) (Trusler and Johnson 2008).

IFS-related fire treatments

A number of studies administered and evaluated specific IFS-related fire treatments. Hart-Fredeluces et al. (2020) modeled three fire regimes: no fire, “business as usual” (180-year fire return interval with a 58% chance of high-severity fire), and “Indigenous or prescribed fire” (10-year fire return interval with 10% chance of high-severity fire and 90% chance of low-severity fire). Each regime was modeled with and without leaf harvest occurring three years postfire. Shebitz et al. (2009) conducted one experiment with high-severity prescribed fire treatment; one experiment with high-severity fire treatment with combinations of burn/ seed, burn/ no seed, unburned/ seed, unburned/ no seed; one experiment with low-severity prescribed fire and manual clearing using chainsaws, machetes, and string trimmers to remove aboveground vegetation and coarse woody debris; and one experiment using low-severity burning, manual clearing, and no manipulation treatments. Storm and Shebitz (2006) studied three burn treatments conducted by The Nature Conservancy staff at the Glacial Heritage Preserve representing one, two, and three years since fire, plus a control with fire excluded. Connor et al. (2022) studied prescribed burns conducted within Karuk territory between 2013 and 2018. About half of these burns consisted of hand-pile (gathering fuel from the understory by hand, then piling this fuel into small stacks and burning them) or jackpot burns (burning concentrated areas of fuel while leaving other areas unburned) with some manual thinning of live vegetation by hand. The other half were broadcast burns with temporal intervals that varied based on the specific plant species and desired effects. Marks-Block et al. (2019) compared broadcast burning with three proxy fire treatments: manual hazelnut stem cutting to < 5cm, top-killing hazelnut stems via ignition of surface fuels and surface litter, and blistering hazelnut stems via propane torch applied near ground level. Marks-Block et al. (2021) studied prescribed and cultural burns conducted by the Cultural Fire Management Council (CFMC), the Hoopa Valley Fire Department, and the Karuk Tribe working with the USDA Forest Service, the Orleans/Somes

Bar Fire Safe Council, and private landowners. Lastly, Trusler and Johnson (2008) studied periodic burning of berry grounds, but no details on these treatments were provided.

Impacts on fire regime

Some empirical studies identified in this review tended to focus only on whether IFS occurred and whether it impacted historic fire regimes or forest and savanna landscapes (Weisberg and Swanson 2003; Derr 2014; Hoffman, Lertzman, and Starzomski 2017; Christy and Alverson 2011). These studies often broadly concluded that IFS influenced the historic fire regime or that evidence of IFS was found in tree rings (Weisberg and Swanson 2003; Hoffman, Lertzman, and Starzomski 2017), sediment cores (Derr 2014), historic land surveys (Christy and Alverson 2011), and vegetation surveys (Hoffman, Lertzman, and Starzomski 2017). However, these studies provided no further detail on ecological effects of IFS on their respective ecosystems.

Policy Aspects of IFS

Historical policy

Colonialism greatly disrupted and continues to disrupt the practice of cultural burning (Copes-Gerbitz, Hagerman, and Daniels 2021; Vinyeta 2022). Following the rapid colonization of the western United States beginning as early as the eighteenth century, suppression and prohibition of Indigenous fire stewardship, harvesting of old-growth forests, intensive grazing, and fire suppression drastically altered landscapes (Murphy and Bowman 2007). Federal fire management agencies followed a national narrative promoting full fire exclusion starting in the early twentieth century (Ray, Kolden, and Chapin III 2012). Coupled with these policies, federal land management agencies intentionally racialized burning by using rhetoric that associated burning with inferior morality (Vinyeta 2022). These colonial and racist constructs continue to be entangled in federal land management today. For instance, in many cases, Indigenous communities still need to obtain per-

mits from federal agencies for cultural gathering and harvesting on their ancestral lands (Mucioki et al. 2021). Fire suppression policies also contributed to a loss of Indigenous knowledge (Nikolakis and Roberts 2020) and further damaged the relationship between management agencies and Tribes, which was already characterized by distrust due to disregarded treaties, land dispossession, and settler colonialism (Steen-Adams et al. 2023). Fire suppression policies not only disrupted Indigenous ways of life (Norgaard 2014), but also degraded ecosystems across the PNW, resulting in plant invasion by nonnative species, loss of native plant species, and simplification of species composition (Macdougall, Beckwith, and Maslovat 2004; Kimmerer and Lake 2001; Hamman et al. 2011). The excessive fuel buildup and forest densification resulting from fire suppression (O’Gorman et al. 2022; Carroll et al. 2010; Norgaard 2014; Nikolakis, Welham, and Greene 2022) is a major contributing factor in today’s wildfire crisis (Hoffman et al. 2022; Anderson and Keeley 2018; Jonathan W Long and Lake 2018). It is imperative to consider this historical context and agencies’ prior mismanagement when assessing how to incorporate IFS into modern fire management. For example, in seeking help from Tribes and Indigenous groups who work with IFS, managers and practitioners should acknowledge their agencies’ culpability in the cessation of Indigenous stewardship.

Governance issues

Recognition for increased involvement of IFS in wildfire management exists, but barriers to policy reform and IFS revitalization remain, including biophysical and regulatory constraints (Nikolakis, Welham, and Greene 2022). Efforts to revitalize IFS are constrained by climate, fuel, and land ownership conditions, which make it more difficult to conduct controlled, low-intensity burns. Due to climate change, the burning season is limited by increasingly hot and dry conditions, with shorter and less frequent “burn windows” in which cultural burning can be practiced (Marks-Block, Lake,

and Curran 2019; Mucioki et al. 2021). Additionally, a legacy of fire exclusion has led to a buildup of fuels, making it more difficult to control fire severity (Carroll et al. 2010). While fuel buildup and climate change limits the windows of time available for effectively implementing cultural fire, IFS is similarly challenged by changes in land tenure. For example, Tribal land holdings have been greatly reduced and fragmented, leading to difficulties limiting fires to small and isolated allotments (Carroll et al. 2010; Adlam et al. 2022). In instances where these land holdings are near residences within a Wildland-Urban Interface, Tribes face increased concerns associated with public and federal agencies’ fear of fire escape (Marks-Block, Lake, and Curran 2019; Hoffman et al. 2022).

Regulatory frameworks, including burn permitting, air quality regulations, and regulatory fragmentation, also constrain the revitalization of IFS by increasing the barriers to entry. Burn bans are set throughout the year to decrease the risk of wildfire, but when coupled with an already limited “burn window,” these bans further constrain or can even prohibit opportunities to burn (Hamman et al. 2011). Tribal members or land managers are often required to obtain permits in compliance with safety and air quality mandates, but these permitting processes are often challenging, and permitting delays can slow the execution of planned burns or cause them to miss the appropriate timing (Mucioki et al. 2021; Carroll et al. 2010; Adlam et al. 2022). Even though Tribes have emphasized the importance of fire and smoke in supporting the health and habitat of culturally important species, the Federal Air Rules for Reservations require Tribal members or managers to obtain an EPA-approved smoke management permit, which constrains the expansion of IFS (Mucioki et al. 2021; Hamman et al. 2011; Long et al. 2017; O’Gorman et al. 2022). The regulatory environment as a whole has been identified as an ongoing barrier to wildfire governance, leading some scholars to recommend decentralizing wildfire planning and management to allow for more localized solutions.

Tribes' and land managers' capacity to meet the above regulations and execute cultural and prescribed burns is limited by a lack of funding, qualified personnel, and access to land. Investment in wildfire suppression and the underfunding of prescribed and cultural burning results in a lack of resources to plan and implement burns (Marks-Block et al. 2021; Nikolakis and Roberts 2020). As high-intensity wildfires have become increasingly common in the PNW, funding is often diverted from fire prevention (prescribed and cultural burning) to wildfire response (suppression), creating a positive feedback loop of wildfire events and further suppression (Nikolakis, Welham, and Greene 2022). This cycle limits funds available to IFS revitalization efforts and causes a shortage of essential fire personnel for prescribed and cultural burns. Land management agencies typically require federally qualified fire personnel to conduct planned burns, but longer and more intense fire seasons can occupy the current fuels management workforce and make it difficult to acquire enough trained personnel for planned burning (Hoffman et al. 2022; Mucioki et al. 2021; Hamman et al. 2011; Marks-Block et al. 2021). Additionally, Tribes face legal restraints on their access to traditional harvest and fire management sites, which restricts opportunities to collect culturally important resources and practice IFS (Jonathan W Long and Lake 2018; Turner, Deur, and Mellott 2011; Long et al. 2017; Anderson 1996).

Reasons to integrate IFS into current management

As previously noted, differing objectives constitute key distinctions between contemporary prescribed burning and cultural burning. Whereas prescribed burning often prioritizes fuels reduction over other objectives, IFS prioritizes a multitude of objectives, many of which align with current agency, non-profit, and private landowner management goals, such as increased water flow, enhanced wildlife habitat, plant biodiversity, and fire resilience (Anderson and Jeffrey 2015; Anderson and Keeley 2018; Mucioki et al. 2021). IFS has been shown to enhance mammal habitat (Connor et al. 2022; Macdougall, Beckwith, and Maslo-

vat 2004), increase production of ecocultural resources, (Marks-Block, Lake, and Curran 2019; Hart-Fredeluces 2019), and lead to greater biodiversity (Anderson and Jeffrey 2015; Shebitz, Reichard, and Dunwiddie 2009). Furthermore, certain ecosystems, such as Garry oak savanna, are the result of millennia of IFS and depend upon cultural burning to maintain their vegetation structure (Barlow, Pellatt, and Kohfeld 2021). These reasons, coupled with the broader cultural revitalization co-benefits described earlier, are leading many researchers and practitioners to recommend integrating IFS into current ecosystem and fire management (Nikolakis, Welham, and Greene 2022; Brookes et al. 2021).

Despite the overwhelming evidence that integrating aspects of IFS into current fire management would be beneficial, some caution that it should not be thought of as a panacea for the wildfire crisis (Kimmerer and Lake 2001; Nikolakis, Welham, and Greene 2022). For instance, some scholars have suggested that in parts of California, reintroducing cultural burning may produce different ecological effects than it once did, due to climate change, fuel build-up, and invasive species (Anderson 2013; Anderson and Keeley 2018). However, it is important for policymakers to recognize that IFS is not premised on static or intractable practices. It should be understood as adaptive and considerate of ecological change.

Recommendations

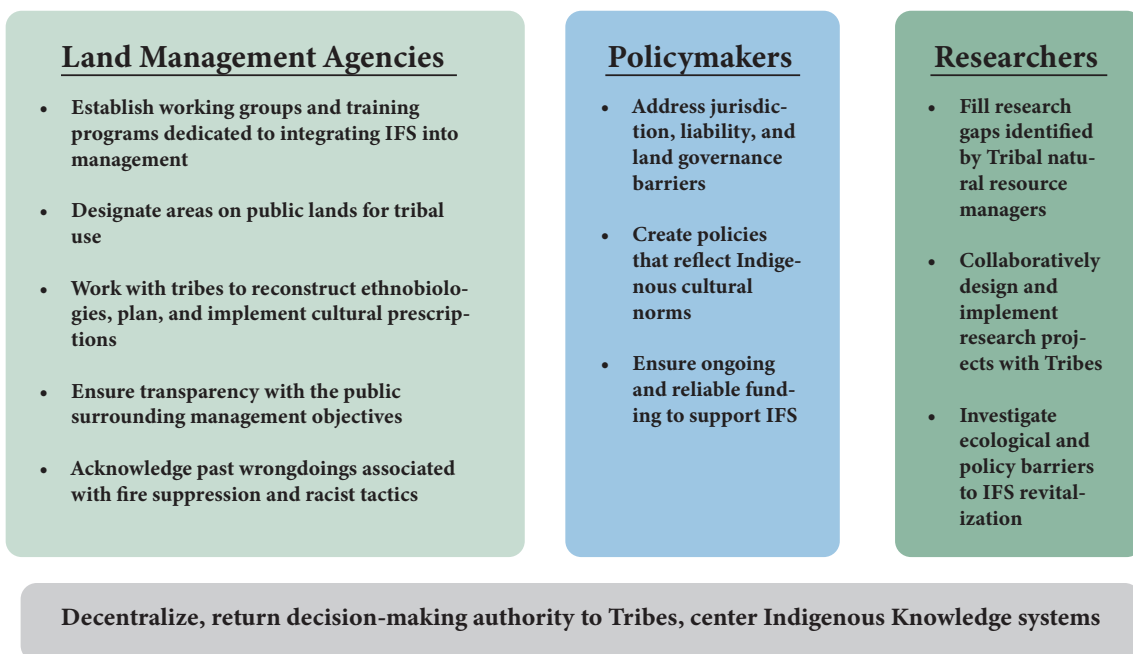
The literature has several recommendations for land management agencies, policymakers, and researchers to support IFS integration and revitalization (Figure 5). The management community can take steps toward integrating IFS into management approaches by establishing dedicated working groups and training programs focused on IFS and the integration of Indigenous knowledge with Western science (Hoffman et al. 2022; Mason et al. 2012). These working groups and programs could facilitate workshops that bring Indigenous knowledge holders together with practitioners (Mason et al. 2012), cross-cultural prescribed fire training and accreditation (Hoffman et al. 2022), and cultural sensitivity training

for fire managers and firefighters (Eriksen and Hankins 2014). Training programs should be followed by professional opportunities for those trained in IFS as well as consistent sources of funding for IFS programs. Public land management agencies could establish designated areas on public land for Tribal use (Long and Lake 2018) and work with Tribes to reconstruct cultural relationships with plants and animals (Anderson and Jeffrey 2015) and plan cultural prescriptions (Connor et al. 2022). These efforts should be “designed by and for Indigenous communities and implemented through Indigenous-led initiatives that affirm Tribal sovereignty” (Mucioki et al. 2021). They should focus on supporting Indigenous-led burning (Hoffman et al. 2022) and returning decision-making authority to Tribes (Vinyeta 2022). Examples of related efforts can be found in Saskatchewan (Hoffman et al. 2022), British Columbia (Nikolakis, Welham, and Greene 2022), and Northern California (Vinyeta 2022).

It is also important that land management agencies be transparent about management objectives (Murphy and Bowman 2007) and explicitly acknowl-

edge past wrongdoing related to fire suppression and racist tactics (Vinyeta 2022; Norgaard 2014). Many researchers and practitioners suggest that fire management should be decentralized and regulated on a local, community-based level (Mucioki et al. 2021; Vinyeta 2022; Hoffman et al. 2022; Marks-Block et al. 2021). These efforts would require ongoing and reliable funding for Indigenous involvement, action, and leadership (O’Gorman et al. 2022; Norgaard 2014; Vinyeta 2022; Adlam et al. 2022; Hoffman et al. 2022). Policymakers can support integration of IFS by addressing identified jurisdiction, liability, and land governance barriers through networks of Indigenous and non-Indigenous fire practitioners and researchers (Hoffman et al. 2022). They should work to create policies that reflect Indigenous cultural norms surrounding fire and respect Indigenous knowledge systems (Eriksen and Hankins 2014). Lastly, researchers can help fill Tribal natural resource managers’ research gaps (Dockry et al. 2023), collaborate with Tribes (Anderson 2013), and investigate ecological and policy barriers to cultural burning (Adlam et al. 2022).

Figure 5. Recommendations for land management agencies, policymakers, and researchers to support IFS integration and revitalization.



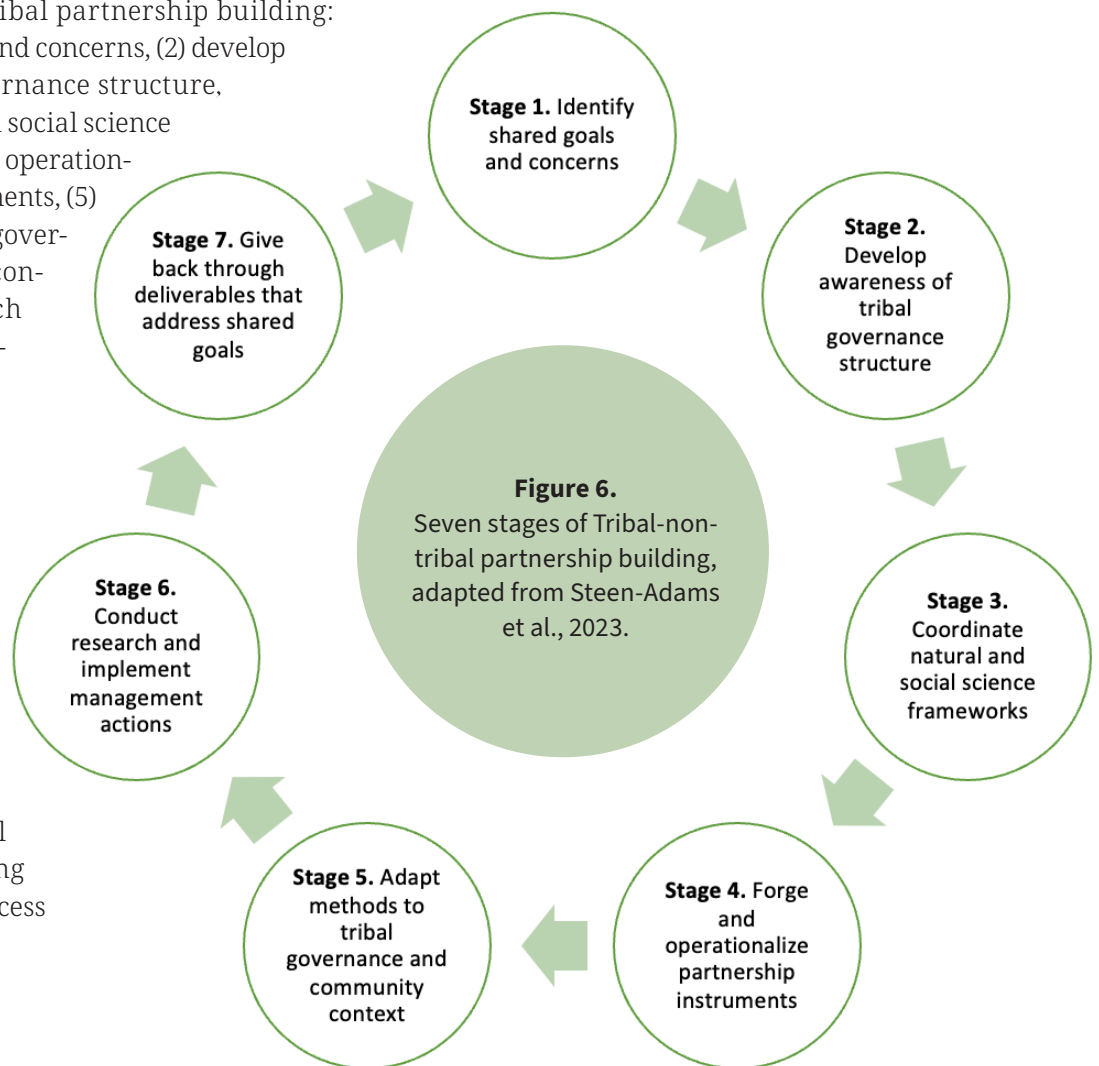
Collaborating with Tribes

When collaborating with Tribes, it may be useful for nontribal agencies and organizations to look to existing frameworks and guidelines.

In 2022, the White House released federal guidance and an implementation memorandum regarding recognizing and including Indigenous knowledge in federal research, policy, and decision making. The guidance and memorandum was informed by extensive engagement with Tribal Nations. It was created with the intent to help researchers, practitioners, and policymakers gain a better understanding of Indigenous knowledge, grow and maintain relationships with Tribal Nations and Indigenous groups, and apply Indigenous knowledge to management approaches. Steen-Adams et al. (2023) identified seven stages of Tribal-nontribal partnership building: (1) identify shared goals and concerns, (2) develop awareness of Tribal governance structure, (3) coordinate natural and social science frameworks, (4) forge and operationalize partnership instruments, (5) adapt methods to Tribal governance and community context, (6) conduct research and implement management actions, and (7) give back through deliverables that address shared goals (Figure 6). Small workshops and roundtable discussions can be helpful for facilitating these processes (Mason et al. 2012). Agencies and other collaborating entities should involve Indigenous individuals in all aspects of decision making and ensure Indigenous access to leadership roles.

Collaborators should take the time to build cultural competency and learn about the role of place in Indigenous worldviews (O’Gorman et al. 2022), as well as the difference between IFS and contemporary prescribed burning (Adlam et al. 2022).

When collaborating with Indigenous communities on research, the research should support Indigenous goals, center Indigenous knowledge systems, and protect Tribal data (Dockry et al. 2023; Dickson-Hoyle et al. 2022). It is important to note that some Indigenous communities may not be comfortable with the validation of Indigenous knowledge through Western science (Nikolakis and Roberts 2020). To aid in the trust-building process, non-Indigenous collaborators should focus not just on the



“content” of Indigenous knowledge, but the context in which it is formed, passed down intergenerationally, and applied through adaptive decision making (Copes-Gerbitz, Hagerman, and Daniels 2021). Above all, Tribal-nontribal collaborations should include oversight protocols that protect culturally sensitive information, preserve Indigenous sovereignty over knowledge, and ensure cultural values are respected (Mucioki et al. 2021; Nikolakis and Roberts 2020). It is also important to assess whether and how these collaborations materially improve the position of Indigenous peoples (Vázquez-Varela, Martínez-Navarro, and Abad-González 2022).

Conclusion

In light of the wildfire crisis, land management agencies and partnerships are increasingly looking to Indigenous Fire Stewardship as a promising tool and practice to learn from to build more resilient ecosystems and communities. While the literature focusing on ecological, social, and political aspects and applications of IFS can provide guidance to the land management community, it is important to note that the literature is significantly behind in demonstrating the work that Tribes, Indigenous-led organizations, and non-Indigenous agencies and entities are leading. Scholars and practitioners interested in IFS could help support the Tribes and other organizations engaged with IFS by co-developing research and monitoring programs that document and disseminate current accomplishments and lessons learned. Such efforts should take care not to perpetuate colonial narratives and modes of interaction.

Within the IFS academic literature, terms and descriptions of the concept of IFS varied broadly and the majority of articles did not explicitly define the terms they used. Since the 1970s, when the IFS literature began to grow, there has been a shift from the terms “Native burning” and “Indian burning” to terms that acknowledge the cultural significance of burning, such as “cultural burning,”



Camas (*Camassia quamash*), an important Indigenous food, is traditionally tended with cultural fire.

Credit: Michael R. Coughlan

or terms that relate IFS to TEK. More recently, the term “Indigenous Fire Stewardship” has become widespread in the literature. These changes in terminology reflect the increasing role that Indigenous scholars and practitioners are playing in moving the scholarly discussion of IFS from one focused on the past to one anchored in contemporary Indigenous cultural revitalization efforts. While researching and emphasizing the importance of IFS in the past is an important part of the story, scholars, managers, and practitioners should recognize IFS as a contemporary management strategy.

IFS is distinct from prescribed fire in its broader and more holistic intentions, as Indigenous groups practice IFS not only to reduce catastrophic wildfire risk, but also to ensure the overall resilience, diversity, and well-being of ecosystems and human communities. Empirical studies confirm that Indigenous groups in the PNW have practiced IFS for millennia for a multitude of cultural, spiritual, and subsistence purposes. Today, IFS is an important component of cultural revitalization efforts across the PNW; however, excessive fuel build-up resulting from fire suppression, climate change, regulatory frameworks, and continuing power inequalities constrain these efforts. Fire managers and practitioners can and should do more to help Tribes and other Indigenous-led IFS initiatives overcome these barriers. More research is needed

to understand which ecological conditions support safe and effective implementation of IFS and which systems require additional interventions before IFS can be practically applied.

Ecological studies and ethnographic interviews suggest that IFS has the potential to decrease risk of catastrophic fire, prevent conifer encroachment, maintain grassland and oak savanna ecosystems, and increase biological function and diversity. However, the practice of IFS differs greatly among different cultures and ecosystems, as do the ecological effects resulting from it. We recommend that policymakers and management agencies partner with researchers and Tribes to co-produce place-based research and to develop locally specific management plans that incorporate Indigenous fire knowledge.

Many researchers and practitioners suggest that fire management should be decentralized and regulated on a local scale and in a manner that gives decision-making power back to Tribes and local organizations. Management agencies and non-profit entities should focus on funding and supporting Indigenous-led efforts by adding capacity and expertise for navigating regulatory environments. When collaborating with Tribes and Indigenous-led organizations, agencies and other non-Indigenous entities should center Indigenous worldviews and knowledge systems and look to existing models of partnership and trust-building. Policymakers, agencies, and other organizations looking to IFS to aid in the wildfire crisis should not view cultural burning as a panacea; rather, they should prioritize Indigenous-led efforts to revitalize the practice and, in some cases, integrate it into broader fire management strategies.



Field trip post-cultural burn at the Andrew Reasoner Wildlife Preserve, Willamette Valley, Oregon. Credit: Michael R. Coughlan

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Appendix A

Indigenous Fire Stewardship Annotated Bibliography

Appendix A: Indigenous Fire Stewardship Annotated Bibliography

Table of Contents

1. Social articles
2. Ecological articles
3. Policy articles

Social articles

Article ID: 1114

Adlam, Christopher, Diana Almendariz, Ron W. Goode, Deniss J. Martinez, and Beth R. Middleton. 2022. "Keepers of the Flame: Supporting the Revitalization of Indigenous Cultural Burning." *Society and Natural Resources* 35 (5): 575-590. <https://doi.org/10.1080/08941920.2021.2006385>

- **Research Questions/ Objectives:** The objective of this article was to summarize the findings from two Indigenous fire workshops. The workshops sought to answer the following questions: What are the uses and benefits (both tangible and intangible) of cultural burning in California? How does it differ from non-Indigenous fire practices? What are its fundamental cultural aspects that might be misunderstood by non-Native people? Lastly, what are the unique needs and challenges faced by practitioners of cultural burning?
- **Terms/ Definitions:** The authors used the term "cultural burning." They defined it as "a dynamic system of land stewardship that is intertwined with values and ethics and nourished by the lifelong experiences of practitioners."
- **Framing and Intended Audience:** The workshops conducted in this article were attended by cultural fire practitioners, researchers, agency and NGO representatives and members of the public. This article was published in *Society and Natural Resources*, an academic journal that publishes social science research on the interaction between society and natural resources. This article is the product of the discussions held during the planning and execution of the two Indigenous fire workshops. Two authors are PhD candidates in the Graduate Group in Ecology at UC Davis. One student has since graduated and is now a regional fire specialist at Oregon State University. One author is a cultural interpreter and demonstration specialist of Maidu/ Wintun/ Hoopa/ Yurok descent and traditions. One author is the Tribal Chairman of the North Fork Mono Tribe. One author is a professor of Native American Studies at UC Davis.
- **Methods:** This article described the findings from two workshops held in Northern California in January and February 2020. The workshops each had 80-100 participants, which included local Native and non-Native community members, wildland fire professionals, and cultural fire practitioners. The first workshop focused on cultural burn preparation and planning, and the second workshop focused on cultural burn execution and postfire resource harvesting. The authors described that an integral component of their methods was centering their Indigenous partners' ecological methods, rather than Western academic methods and priorities, to acknowledge and subvert unequal power dynamics between Western and Indigenous science.
- **Results:** Practitioners at the workshop highlighted that prescribed burning differs from cultural burning. Whereas the former primarily focuses on hazard reduction, the latter primarily focuses on increasing the quantity and quality of ecocultural resources and fulfilling a stewardship obligation to the land. Regarding a stewardship obligation, practitioners emphasized that maintaining the health of the land is at least as important as the material benefits gained by

burning. Participants noted a diversity in age, tribal affiliation, and cultural management methods at the workshops, which should not be viewed as a source of confusion or uncertainty but as valuable to developing diversified fire ecologies.

- **Significance:** Indigenous fire stewardship differs from prescribed fire in that it focuses on generating ecocultural resources and fulfilling an ethical obligation to the land rather than mitigating fuel loads and wildfire risk. An understanding of this difference can more effectively support the work of cultural fire practitioners. By understanding this difference, land managers, researchers, and funding organizations can more effectively support the work of cultural fire practitioners.

Article ID: 1123

Anderson, M. Kat and Frank K. Lake. 2013. "California Indian Ethnomycology and Associate Forest Management." *Journal of Ethnobiology*, 33(1): 33-85. <https://doi.org/10.2993/0278-0771-33.1.33>

- **Research Questions/ Objectives:** The article evaluated how Indigenous groups utilized and managed mushrooms in California, with a particular focus on how Indigenous burning practices affected mushroom biology. They authors presented two case studies to investigate these questions.
- **Terms/ Definitions:** The authors used the term "Indigenous burning practices," but did not define it. They discuss how "tribes set fires in areas to foster the growth of certain types of mushrooms." They also used the terms "cultural", "stewardship", and "management" when discussing "Indigenous burning practices."
- **Framing and Intended Audience:** The article was published in the *Journal of Ethnobiology*, a peer-reviewed journal that publishes research on the study of past and present relationships between humans and their biological worlds. Both authors are research ecologists, one was affiliated with the University of California, Davis, and the other was affiliated with the USDA Forest Service. One author is of Karuk descent.
- **Methods:** First, the authors conducted a review of published literature, university theses, Karuk Tribal reports, Six Rivers National Forest Heritage Program, museum collections, and ethnobotanies related to mushroom use and management by California tribes. Between 1986 and 2012, they conducted qualitative interviews with Native Americans from the Amah Mutsun (Ohlone), Big Pine Paiute, Central Sierra Me-Wuk (Miwok), Chukchansi/Choinumni, Coast Miwok, Hupa, Karuk, Luiseño/Cupeño, Mono, Salinan, Southern Sierra Miwok (Miwok), Tuolumne Band of Me-Wuk (Miwok), Washoe, and Yurok tribes. Lastly, a few native consultants worked with the authors to identify mushrooms in the field and send them to a plant pathology lab at the University of California, Davis for identification.
- **Results:** The review indicated that California Indian tribes utilized at least 26 species of mushrooms for food, medicine, and technology. Today, mushrooms are still collected and used as food in many Indigenous communities. Many mushrooms used by tribes historically are harder to find today, which native consultants attribute to development, fire suppression, climate change, and pollution. Fire impacts the abundance and diversity of mushrooms, as well as their spatial and temporal availability. Certain mushrooms fruit abundantly in burn sites due to several factors, such as the elimination of competition from other plants and the fire stimulation of mycelium underground. Some California tribes used fire to encourage growth of certain mushroom species. Native interviewees from the lower montane mixed conifer case study in the central and southern Sierra Nevada noted burning under black oaks to enhance the size of the mushroom, increase population numbers, and reduce the build-up of duff without harming mycelium. They specifically recalled burning in the fall each year in areas they hunted for acorns. Interviews for the second case study, in the mixed evergreen forests of the Coast Ranges and Klamath Mountains, also indicated that Native Americans burned to manage mushrooms, encourage vegetation growth, and create animal habitat. Lastly, interviewees discussed benefits of burning beyond mushroom enhancement, such as for disease control and catastrophic fire prevention.
- **Significance:** Fires set by Native Americans increased the size, abundance, and diversity of many mushrooms used for food, medicine, and technology. The article emphasized that these results have relevance beyond mushroom management, as many of these mushrooms are used by wildlife and are critical for overall forest health and resilience. They argue that mushrooms

should be considered in forest management and they suggest that new research, in collaboration with tribes, investigating Indigenous fungi harvesting and management practices, would be useful. Outcomes of this research could be used to write management prescriptions for specific areas.

Article ID: 1137

Anderson, M. Kat, and Jeffrey Rosenthal. 2015. "An Ethnobiological Approach to Reconstructing Indigenous Fire Regimes in the Foothill Chaparral of the Western Sierra Nevada." *Journal of Ethnobiology* 35 (1): 4-36.

- **Research Questions/ Objectives:** This article contributes to the debate surrounding the extent to which Indian burning altered chaparral landscapes in California by demonstrating the ways in which Native peoples' material culture depended on chaparral plants and animals. The authors explored how Native people used Indian burning in relation to manage these plants and animals.
- **Terms/ Definitions:** The authors used the term "Indian burning" and "Native American burning" to discuss "deliberate burning of the chaparral to maximize its ability to produce useful products."
- **Framing and Intended Audience:** The article focuses on the nine ethno-linguistic groups that inhabited the western foothills of the Sierra Nevada and is intended for ecologists and natural resource managers. It was published in the *Journal of Ethnobiology*, which is a peer-reviewed journal managed by the Society of Ethnobiology. The first author is an ecologist and was a faculty member at the University of California, Davis.
- **Methods:** The authors performed a literature review of published and unpublished ethnographic descriptions, journal articles, and university theses related to Indian burning in chaparral. In addition, they conducted interviews with knowledgeable direct descendants of the Foothill Yokuts, Mono, and Sierra Miwok cultural groups. These interviews focused on understanding cultural memory associate with practices of foothill chaparral plant and animal management and use. The authors additionally assembled a list of plant and animal species used by Native American groups in foothill chaparral communities of the Sierra Nevada.
- **Results:** The tribes of the study area historically used more than 250 plant and animal species as part of their material culture, and chaparral plants that are fire-adapted played a critical role in tribal economies. The authors found evidence that Indian burning of chaparral altered the natural fire regime of the Sierra Nevada foothills through: (1) lengthening fire season, (2) shortening fire-return intervals, and (3) enhancing the abundance and density of species that suited specific cultural objectives. In addition to managing plant and animal resources, Native consultants explained that fire was also used as a tool to reduce the likelihood of catastrophic fire. One Native consultant from the North Fork Mono tribe described how the tribe would burn every two years, and typically would burn to prevent catastrophic fire if shrubs became more than two to four feet high.
- **Significance:** Indian burning likely impacted the chaparral landscape in ways that align with modern management values. For instance, burning created more heterogenous mosaic landscapes with greater biodiversity and ideal habitat for mammals. The authors assert that "working with tribes to reconstruct ethnobiologies" can help ecologists have a better understanding of fire-adapted species and the role of fire in chaparral communities.

Article ID: 1133

Carroll, Matthew S., Patricia J. Cohn, Travis B. Paveglio, Donna R. Drader, and Pamela J. Jakes. 2010. "Fire Burners to Firefighters: The Nez Perce and Fire." *Journal of Forestry* 108 (2): 71-76. <https://doi.org/10.1093/jof/108.2.71>

- **Research Questions/ Objectives:** This article had three objectives. The first objective was to document current and historical burning practices of the Nez Perce tribe in Northern Idaho. The second objective was to examine the reasons for decline of cultural burning practices over the last several decades. The third objective was to identify potential ways to mitigate some of the practical and policy constraints to cultural burning.
- **Terms/ Definitions:** The authors used the terms "Indigenous burning" and "tribal burning practices." The terms were not explicitly defined, but the authors noted that fire was used by tribes to improve production of food and medicinal plants, clear undergrowth to facilitate travel, improve forage production for wildlife and later livestock, and drive game animals. They also noted that a cultural connection to fire is one of the greatest differences between tribal and nontribal fire use. The authors used the terms "fire use" and "intentional" when discussing "Indigenous burning."
- **Framing and Intended Audience:** This article presents the results from interviews conducted with cultural fire practitioners. It was published in *Journal of Forestry*, a peer-reviewed journal by the Society of American Foresters that aims to inform forest management professionals about new research developments in forest economics, ecology, history, policy, hydrology, and other facets of forestry. At the time of publication, four authors are in the Department of Natural Resource Sciences at Washington State University: one was a professor, two were PhD candidates, and one was a master's student. One author was a research forester for the USDA Forest Service. The study was supported by the National Fire Plan.
- **Methods:** The authors conducted qualitative interviews with a total of 55 people – 45 tribal members and 10 nontribal members – during the summer and early fall of 2006. Interviewees were identified through a chain referral process and selected for their knowledge or experience with cultural fire practices. Interview topics covered personal experiences with fire, knowledge of historical uses of fire, and views on land management. Interview notes and transcriptions were coded to identify emergent patterns in interviewees' responses.
- **Results:** This study found that fire was used as a landscape management tool to prepare or improve food gathering sites and improve deer and elk habitat. Fire also has strong cultural and spiritual significance for the Nez Perce. Many of these uses of fire are not currently conducted to the extent they once were on lands held by the tribe. The article identified three general constraints to contemporary fire use on the Nez Perce Reservation: a shrinking and fragmented land base leading to difficulties controlling the fire within small and fragmented allotments; permitting and management regulations restricting fire use; and a legacy of fire exclusion that has led to a buildup of fuels and increased challenges conducting controlled, low-intensity burns.
- **Significance:** Constraints surrounding land tenure, regulatory frameworks, and the legacy of fire exclusion present some of the biggest challenges to the reintroduction of cultural burning in the inland Northwest. These constraints could be partially mitigated by additional training of tribal employees; negotiations between the tribe and other government authorities or neighbors in the interest of allowing expanded burning when necessary; and examining and documenting knowledge of Indigenous fire stewardship among members of the Nez Perce tribe. The authors identified a cultural and spiritual connection to fire as one of the greatest differences between tribal and nontribal uses of fire. They note that, because of this difference, land managers

working with Indigenous populations would be well advised to account for those cultural connections in their management plans, rather than only the uses of fire a forester might recognize as materially important.

Article ID: 1136

Christianson, Amy C., Colin R. Sutherland, Faisal Moola, Noémie G. Bautista, David Young, and Heather MacDonald. 2022. "Centering Indigenous Voices: The Role of Fire in the Boreal Forest of North America." *Current Forestry Reports* 8(3): 257-276.
<https://doi.org/10.1007/s40725-022-00168-9>

- **Research Questions/ Objectives:** The objective of this article was to provide a review of the existing literature documenting Indigenous perspectives and the historical relationship of Indigenous people to fire on the landscape, with a focus on the boreal region of North America.
- **Terms/ Definitions:** The authors used the terms "cultural burning" and "Indigenous fire practices", but do not explicitly define them. They discussed "the application of fire on the landscape to fulfill numerous objectives" and used the term "intentional" when discussing "cultural burning." They noted that Indigenous peoples in the boreal forest region view fire as a dynamic, destructive, and creative agent, acting on the landscape to create order in a connected environment.
- **Framing and Intended Audience:** This article was published in *Current Forestry Reports*, a journal publishing review articles on developments in the field of forestry. This article is part of the journal's "Topical Collection on Fire Science and Management." Three authors work for the Canadian Forest Service: one identifies as a member of the Métis First Nation and a fire research scientist; one is an Indigenous Engagement and Science advisor; and one is an interdisciplinary social scientist. Two authors work at the University of Guelph: one is a postdoctoral researcher with the Conservation through Reconciliation Partnership and one is a professor of geography with a focus on Indigenous-led forest conservation. One author is a PhD student in anthropology at Université Laval in Québec.
- **Methods:** This article reviewed literature on Indigenous fire knowledge in the boreal forest of North America. Papers selected for review made explicit reference to the boreal forest and Indigenous use of fire and burned sites. To foreground Indigenous perspectives about fire, papers selected for review relied on archival and ethnographic methods, including interviews with tribal Elders. Papers that hypothesized Indigenous fire use practices based on archaeological, dendrochronological, or other methods of documenting fire history that did not directly engage with Indigenous peoples were excluded from review.
- **Results:** For thousands of years, Indigenous people in the boreal forest of North America have applied fire to their landscapes to achieve a variety of objectives. Indigenous people in this region view fire not just as a tool, but as an active and dynamic agent of change. Fire is a cultural keystone practice of Indigenous Nations in this region, used in part to cultivate cultural keystone species, or species that significantly shape the cultural identity of a people. The suppression of fire as a traditional environmental management practice can be thought of as an act that functionally disrupted the relationships between people and land and remains a challenge today.
- **Significance:** Indigenous fire stewardship is part of a diverse and holistic system of environmental stewardship. Indigenous people in the boreal forest of North America have applied fire to their landscape for a variety of reasons, including cultivating keystone species and fulfilling a custodial duty to the land. Foregrounding Indigenous people and their knowledge systems in wildfire and forest management policies and practices can create a more holistic and accurate understanding of fire regimes by shifting the focus from large-scale, stand-replacing fires to subtler, small-scale fires that often escape the detection of large-scale measurements such as dendrochronology.

Article ID: 1150

Copes-Gerbitz, Kelsey, Shannon M. Hagerman, and Lori D. Daniels. 2021. "Situating Indigenous Knowledge for Resilience in Fire-Dependent Social-Ecological Systems." *Ecology and Society* 26 (4): 25. <https://doi.org/10.5751/ES-12757-260425>

- **Research Questions/ Objectives:** This study examined the context of Indigenous knowledge in a fire-dependent social-ecological system by utilizing the concept of "situated resilience," which views knowledge as a process contained within power dynamics. To achieve this aim, the study focused on two questions: (1) What is the context of fire knowledge for the T'exelc (Williams Lake First Nation)? (2) How can understanding this context help guide decision making for future forest management?
- **Terms/ Definitions:** The authors used the term "Indigenous fire stewardship", but did not define it.
- **Framing and Intended Audience:** This article reports the findings from two land-based forest walks between a total of eight T'exelc Elders, two Williams Lake Community Forest managers, four archaeologists, and three researchers. The study was published in *Ecology and Society*, a peer-reviewed journal that publishes research on social-ecological systems and resilience. All authors are affiliated with the University of British Columbia's Department of Forestry.
- **Methods:** The authors conducted two forest walks, each averaging 3 ha, in September 2018 and June 2019. Topics of conversation during the forest walks centered around experiences, perspectives, and knowledge about the history of fire and the land and visions for future forest management. The walks were audio-recorded with consent and transcribed. Transcripts were coded to identify key themes in the participants' discussions. Key themes were triangulated using several other sources including interviews with T'exelc elders, maps of archaeological and cultural heritage sites, and tree ring-based fire histories.
- **Results:** A situated resilience approach holds that knowledge is fundamentally changed if it is extracted from its broader context and solely viewed as content. By using an approach that stresses the context of fire knowledge, rather than its content, the authors found that they were able to make steps toward shifting the colonial contexts in which this knowledge is situated. They presented two key findings about the context of T'exelc fire knowledge: first, the intentional use of fire is now considered a "lost practice" that was disrupted by colonialism. Second, future forest management should focus on restoring the context of T'exelc knowledge, which stresses place-based intergenerational knowledge exchange and respect for the fire, the land, and their ancestors.
- **Significance:** Although the Western science community is starting to acknowledge the knowledge and contributions of Indigenous people to fire-adapted landscapes, these efforts often focus on integrating only the content of Indigenous fire knowledge that is most easily adaptable to Western science frameworks, such as material objectives of fire use. However, from an Indigenous fire stewardship perspective, the context of this knowledge is also important and includes spiritual components, processes of intergenerational knowledge transmission, and adaptive decision making. Forest management practices and collaborations with Indigenous communities can be improved by focusing on not just the content of Indigenous fire knowledge, but the context in which this knowledge is situated.

Article ID: 1151

Dickson-Hoyle, Sarah, Ronald E. Ignace, Marianne B. Ignace, Shannon M. Hagerman, Lori D. Daniels, and Kelsey Copes-Gerbitz. 2021. "Walking on Two Legs: A Pathway of Indigenous Restoration and Reconciliation in Fire-Adapted Landscapes." *Restoration Ecology* 30 (4): e13566. <https://doi.org/10.1111/rec.13566>

- **Research Questions/ Objectives:** This article introduced the concept of "walking on two legs," a collaborative and action-oriented process, led by Indigenous perspectives, that combines Indigenous knowledge with science. The goals of the article are to offer readers a pathway to advance the process of Indigenous-led restoration and reconciliation in Indigenous territories.
- **Terms/ Definitions:** The authors used the term "Indigenous fire stewardship," but did not define it. They noted that burning was a common form of vegetation management by Indigenous peoples across the dry forests and grass-lands of British Columbia. They additionally used the terms "stewardship", "management", "cultural", "ignition source", and "fire use" when discussing "Indigenous fire stewardship."
- **Framing and Intended Audience:** This article was published in *Restoration Ecology*, a journal of the Society for Ecological Restoration. This journal publishes papers from multiple different disciplines concerned with the restoration of terrestrial, marine, and freshwater ecosystems. Four authors are affiliated with the University of British Columbia's Department of Forestry. One author is a Secwépemc historian, storyteller, and anthropologist and retired Chief of the Skeetchestn Band. One author is a professor of Linguistics, with a focus in Indigenous language and oral history, at Simon Fraser University.
- **Methods:** This article discussed the application of "walking on two legs" to two case studies in the fire-adapted ecosystems of western Canada. In the first case study, Skeetchestn community Elders were interviewed and their oral histories regarding their memories of Indigenous fire stewardship were recorded. The second case study analyzed fire scars at 43 sites across 400 ha in the Vaseux-Bighorn National Wildlife Area in southern BC to reconstruct historical fire regimes. These results were compared to Indigenous oral histories to situate pyro dendrochronological data (information about fire activity recorded in the annual growth rings of trees) in the context of Indigenous knowledge and histories.
- **Results:** The authors' reconstruction of fire histories found that the historical fire regime was primarily driven by Indigenous ignitions, characterized by frequent small fires, often in the spring, for various purposes including enhancement of plants for food and medicine. To reconstruct this fire history, the authors noted that it was important to move away from solely analyzing quantitative metrics of fire frequency that filter out signals of localized cultural burns, instead situating these localized burns and Indigenous oral histories in balance with quantitative metrics, a process they refer to as "walking on two legs." This article found that bridging Western science with Indigenous knowledge enhanced the understanding of Indigenous peoples' role in historical fire regimes in British Columbia and aids in conducting meaningful collaboration with Indigenous communities.
- **Significance:** This article's results demonstrate that Indigenous fire stewardship influenced the landscape and historical fire regime patterns in British Columbia prior to European colonization. Methodologically, restoration can be improved, particularly in landscapes shaped by a history of Indigenous fire stewardship, by advancing reconciliation with First Nations and by upholding Indigenous sovereignty. The authors suggest that the restoration of Indigenous fire stewardship can be advanced by rethinking the role of Western science and adopting the framework of "walking on two legs."

Article ID: 1188

Diekmann, Lucy, Lee Panich, and Chuck Striplen. 2007. "Native American Management and the Legacy of Working Landscapes in California." *Rangelands* 29 (3): 46-50.

[https://doi.org/10.2111/1551-501X\(2007\)29\[46:NAMATL\]2.0.CO;2](https://doi.org/10.2111/1551-501X(2007)29[46:NAMATL]2.0.CO;2)

- **Research Questions/ Objectives:** The goal of this paper was to reframe the idea that humanity's relationship to nature is one in which humans should be absent from, and not work in, natural landscapes. By highlighting Native American management practices and their ecological effects, the authors aimed to present an alternative idea called the "working landscape," which is rooted in responsibly working with nature for mutual benefit.
- **Terms/ Definitions:** The authors used the terms "Native management practices" and "Indian burning." They did not define these terms, but they used them to describe how Native Americans manipulated ecosystems through burning to increase the quantity, availability, and predictability of culturally important plant and animal species.
- **Framing and Intended Audience:** This article was published in *Rangelands*, a journal of the Society for Range Management that publishes work on the science, management, and use of rangelands. At the time of publication, all authors were PhD candidates at University of California Berkeley. One author is an urban agriculture/ food systems scientist and one is an anthropologist. Chuck Striplen is a tribal advisor for the California Fish & Game Commission and a member of the Amah Mutsun Tribe.
- **Methods:** No methods are stated.
- **Results:** The "working landscape" idea is a counterpoint to a narrative of inevitable environmental decline wherever humans interact with nature. Native management practices contribute in important ways to the working landscape model by demonstrating a system of management designed to maintain and enhance biodiversity and the abundance of culturally important resources. For example, California Indians used fire to ensure new growth of tule (*Schoenoplectus spp.*) for basketweaving. Research on a case study of Native management practices will occur in Año Nuevo State Park in California, with a focus on determining the role of fire in maintaining specific habitats and the consequences of removing Indian burning.
- **Significance:** This article suggests that realizing that humans have historically shaped their ecosystems – and that their work in nature often maintained and enhanced structural and species diversity – can suggest alternate ways of managing landscapes. By drawing on traditional ecological knowledge and revitalizing Native land management practices, land managers could strengthen cultural practices, build political relationships with Tribes, and benefit both people and ecosystems.

Article ID: 1135

Dockry, Michael J., Serra J. Hoagland, Adrian D. Leighton, James R. Durglo, and Amit Pradhananga. 2022. "An Assessment of American Indian Forestry Research, Information Needs, and Priorities." *Journal of Forestry* 121 (1): 49-63. <https://doi.org/10.1093/jofore/fvac030>

- **Research Questions/ Objectives:** The objective of this study was to expand upon a tribal research needs assessment from 2011 that used a survey to identify tribal professionals' research needs, access to research findings, and interest in participating in research.
- **Terms/ Definitions:** The authors used the term "Indigenous burning" but did not define it. They noted a difference between Indigenous burning and prescribed fire treatments, noting that additional research into the differences between these practices is needed for the reintroduction of "Indigenous fire-use" on the landscape.
- **Framing and Intended Audience:** This article updates and expands upon a similar tribal research needs assessment conducted by the Intertribal Timber Council (ITC) Research Subcommittee in 2011. The article was published in *Journal of Forestry*, a peer-reviewed journal by the Society of American Foresters that aims to inform forest management professionals about new research developments in forest economics, ecology, history, policy, hydrology, and other facets of forestry. One author is a professor in the Department of Forest Resources at the University of Minnesota and a member of the Citizen Potawatomi Nation. One author was a tribal relations specialist for the USDA Forest Service. One author was a Forestry advisor and instructor at Salish Kootenai College and co-chair of the ITC Research Subcommittee. One author was a Fire Technical Specialist with the Intertribal Timber Council. One author was a research associate in the Department of Forest Resources at the University of Minnesota.
- **Methods:** A survey was developed in meetings between the authors and the ITC Research Subcommittee. A pilot survey was initiated over a 2-month period to refine questions, which resulted in 8 respondents. The finalized survey consisted of 46 questions divided into topical categories on information needs, information access, and interest in participating in research. It was disseminated through the Annual ITC Timber Symposium, emails, and a student call center at Northern Arizona University and remained open for 10 weeks. T-tests were conducted to examine response differences between tribal and nontribal respondents, and between respondents who had worked in forestry for 25 years or less and more than 25 years.
- **Results:** This study analyzed 59 survey responses. 92% of respondents valued information needs as either very important or extremely important, and the most important information needs (listed from highest to lowest importance) were identified as forest health, silviculture, water quality, workforce development/training, fish and wildlife responses to treatments, fuels management, planting/reforestation, planning, growth and yield, and invasive species. Postfire response and valuation, Indigenous burning, fire, protecting tribal data, and resilience and long-term forestry were more important research needs for tribal members than for nontribal members. Professionals with fewer years of experience were more interested in Indigenous burning, postfire response, and new and innovative markets than professionals with more years of experience.
- **Significance:** This article identifies and describes research needs for tribal natural resource managers. Enhancing research output, availability, and participation on forest health, silviculture, water quality, and other topics can support tribal natural resource management goals.

Article ID: 1131

Eriksen, Christien and Don L. Hankins. 2014. "The Retention, Revival, and Subjugation of Indigenous Fire Knowledge through Agency Fire Fighting in Eastern Australia and California." *Society and Natural Resources* 27: 1288-1303. <https://doi.org/10.1080/08941920.2014.918226>

- **Research Questions/ Objectives:** The objective of this article was to explore the potential impact of training and employment with wildfire management agencies on the retention of Indigenous fire knowledge. To achieve this, the article asked four questions: (1) How does Indigenous fire knowledge connect with "modern" political constructs of fire? (2) Does the mixing of fire cultures change the outlook and practices of wildfire management agencies or the cultural laws of Indigenous burning? (3) Does the knowledge or ignorance of cultural or gendered landscapes, such as Indigenous sacred and ceremonial sites off-limits to women or men, affect agency policy or the on-the-ground practices of firefighters? and, (4) Which issues impede cross-cultural acceptance?
- **Terms/ Definitions:** The authors used the term "Indigenous burning." It was not explicitly defined but is rooted in a recognition of the interrelated and interdependent aspects of fire that follow the laws of nature and differs from agency fire management in the context of traditional law, objectives, and the right to burn. The authors also used the term "traditional knowledge" when discussing "Indigenous burning."
- **Framing and Intended Audience:** This article is part of a bushfire resilience project funded by the Australian Research Council. Its findings are based on research with Native Americans in California and with Aboriginal Australians in New South Wales and Queensland from 2004-2014. It was published in *Society and Natural Resources*, an academic journal that publishes social science research on the interaction between society and natural resources. One author is a professor of geography and planning at California State University, Chico. One author is a human geographer – formerly at the University of Wollongong and currently at the Swiss Federal Institute of Technology – and was a visiting scholar to California State University, Chico, from March to April 2011.
- **Methods:** From 2004 to 2014, over two dozen Indigenous Elders, cultural fire practitioners, and land stewards shared oral narratives during fire knowledge workshops, prescribed burns, and field trips with students in New South Wales, Queensland, and California. These oral narratives were supplemented with audio-recorded interviews with two Aboriginal employees of the New South Wales National Parks and Wildfire Service and six California Indigenous cultural fire practitioners and/or wildland firefighters. Interviewees were selected purposively for criteria including current engagement with fire practice, cultural storytelling, and Indigenous heritage. Interviews were conducted in 2011, transcribed, and then coded using both a priori themes (e.g., fire knowledge) and emergent themes (e.g., emotional responses).
- **Results:** Employment with state and federal wildfire management agencies has played an important role in the retention of Indigenous eco-cultural fire knowledge and stewardship duties. At the same time, it has engendered the breaking of cultural laws and practices, which can subvert the revival of Indigenous burning practices. There exist several obstacles that impede cross-cultural acceptance between Indigenous and agency fire practitioners, including: lack of co-management agreements; establishing the credibility of Indigenous ways of knowing within Western science paradigms; and cultural sensitivity to the deeper significance of a place regarding the implementation or suppression of fire.
- **Significance:** Aspects of Indigenous fire stewardship are simultaneously revived and subjugated through state and federal management agencies in Australia and California. Employment of Indigenous fire practitioners with state and federal wildfire management agencies can support

the retention of Indigenous fire knowledge. A greater integration of the cultural knowledge and practices of fire into the practices of wildfire management agencies can better support the revitalization of Indigenous fire stewardship and healthy landscapes.

Article ID: 1313

Lewis, John L. 2010. "Interethnic Preferences for Landscape Change: A Comparison of First Nations and Euro-Canadian Residents." *Landscape Journal* 29 (2): 215-231.

<https://doi.org/10.3368/lj.29.2.215>

- **Research Questions/ Objectives:** The author's research question was "In what ways, and why, do landscape preference judgments and perceptions of landscape change vary across and within ethnic groups? More specifically, how and why do preferences for and perceptions of landscape change between and among First Nations and Euro-Canadian residents?" The study region was the upper Skeena valley of northwestern British Columbia, Canada
- **Terms/ Definitions:** The author used multiple terms, including "controlled use of fire," "First Nations fire management," and "traditional use of fire." These terms were not defined, but were used to broadly discuss intentional, large-scale modification practices to enhance the availability of food resources.
- **Framing and Intended Audience:** The author is an urban planner and landscape architect. The study was published in *Landscape Journal*, a peer-reviewed journal by the Council of Educators in Landscape Architecture that publishes research, reviews, editorials, and exhibitions on the theory, practice, and education of landscape architecture and allied disciplines.
- **Methods:** Thirty participants (15 First Nations and 15 Euro-Canadian) were chosen from criteria-based key informant lists and interviewed in semi-structured interviews guided by a list of questions. Computer-generated photo simulations were developed for four landscape-change scenarios – pre-industrial, industrial, multi-use, and natural – across three viewpoints that were accessible and familiar to upper Skeena residents. Participants were presented with the landscape simulations and asked to rate the images from most to least preferred condition. Rankings were supplemented with probing questions for additional detail. Participants' rankings were recorded; interviews were recorded, transcribed, and analyzed for cluster themes.
- **Results:** Preference clusters for the different landscape scenarios largely consisted of participants from both ethnic groups, indicating that ethnicity was a weak determinant of relative preference evaluations. The ways in which an individual uses the landscape and the knowledge resulting from said purposive activity appeared to be a more essential determinant of preference judgements. The principal factor appearing to unite First Nations and Euro-Canadians in their landscape preferences was less "who" they were in terms of ethnicity than "how" they used the forest for various purposes such as employment, subsistence harvesting, hunting, fishing, recreation, or a combination of these and other activities.
- **Significance:** Sociodynamic variables such as ethnicity mattered less in understanding landscape preferences than communities of shared interests, such as hikers, subsistence hunters, trappers, or other groups, who tend to prefer landscape qualities that are most relevant to or capable of providing their preferred activities. These findings highlight that for landscape researchers and land managers, the specification of community is important for understanding the attitudes that underpin landscape preferences.

Article ID: 1235

Lightfoot, Kent G., Rob Q. Cuthrell, Chuck J. Striplen, and Mark G. Hylkema. 2013. "Rethinking the Study of Landscape Management Practices among Hunter-Gatherers in North America." *American Antiquity* 78 (2): 285-301. <https://www.jstor.org/stable/pdf/23486319>

- **Research Questions/ Objectives:** This article had two objectives. The first objective was to address the challenges of studying traditional resource and environmental management in archaeology and why archaeologists have, until recently, been reluctant to engage in the debate about the scale and environmental impact of those practices. The second objective was to explore how archaeologists can contribute to our understanding of past resource management practices through the creation of new collaborative, interdisciplinary, eco-archaeological methods.
- **Terms/ Definitions:** The authors used the term "anthropogenic burning." They did not explicitly define it, but used it to refer to management practices used by hunter-gatherers to enhance the productivity of non-domesticated plants and animals. They also used the term "traditional resource and environmental management," which they defined as the various activities and knowledge employed to enhance the abundance, diversity, and/or availability of local resources.
- **Framing and Intended Audience:** This article was published in *American Antiquity*, an academic journal publishing on the methods and theories of the archaeology of North America. Two authors work at UC Berkeley: one is a professor of historical anthropology and one is a research associate in paleoethnobotany. One author is a tribal liaison and archaeologist for the Santa Cruz district of California State Parks. Chuck Striplen is a tribal advisor for the California Fish & Game Commission and a member of the Amah Mutsun Tribe.
- **Methods:** This article is not a systematic literature review but drew on publications about historic management practices and the authors' own past research experiences at Quiroste Valley in Año Nuevo State Park, California, to consider management practices, particularly anthropogenic burning, used to enhance the productivity of select plants and animals. To suggest interdisciplinary eco-archaeological approaches that could be utilized in future studies, the authors combined a range of methods used in ecological, historical, and ethnographic studies, including mapping, geomorphological surveys, partnerships with tribal groups, sediment coring, and dendrochronology.
- **Results:** This article found that factors contributing to a lack of archaeological scholarship in the debate about the magnitude and impact of traditional resource management in North America included: a long tradition of viewing Indigenous populations as passive foragers who exerted minimal impact on their environment; a tendency to link Indigenous management practices with an evolutionary process culminating in agriculture; a rigid definition of resource management that is too large-scale to account for niche, localized, community-based fire activities; and the difficulty of identifying anthropogenic fires using current archaeological methods. Archaeologists can make significant contributions to this debate through the creation of new interdisciplinary, collaborative, eco-archaeological approaches that combine archaeological research with tribal partnerships and historical ecological approaches.
- **Significance:** Developing new collaborative methods that combine approaches in archaeology, historical ecology, and tribal initiatives can help contribute to our understanding of the scale and impact of traditional resource management practices, particularly anthropogenic burning.

Article ID: 1182

Mucioki, Megan, Jennifer Sowerwine, Daniel Sarna-Wojcicki, Frank K. Lake, and Shawn Bourque. 2021. "Conceptualizing Indigenous Cultural Ecosystem Services (ICES) and Benefits under Changing Climate Conditions in the Klamath River Basin and Their Implications for Land Management and Governance." *Journal of Ethnobiology* 41 (3): 313-330.

<https://doi.org/10.2993/0278-0771-41.3.313>

- **Research Questions/ Objectives:** This article had two objectives. The first was to examine how climate change is impacting the availability, utilization, and management of culturally significant plants gathered by Indigenous people in the Klamath River Basin. The second was to adapt and expand an ecosystem services framework to conceptualize climate change impacts to Indigenous people and culturally significant plants.
- **Terms/ Definitions:** The authors primarily used the terms "cultural burning" and "cultural fire management." The terms were not defined but referred broadly to the cultural practice of actively and intentionally managing plants with fire.
- **Framing and Intended Audience:** This study was part of a joint Tribal-university-agency research, education, and extension project from 2014-2021 that focused on enhancing Tribal health, food security, and ecosystem resilience in the Klamath River Basin. Research was conducted in collaboration with the Karuk, Yurok, and Klamath Tribes of Northern California and southern Oregon. The article was published in the *Journal of Ethnobiology*, a peer-reviewed journal that publishes research on the study of past and present relationships between humans and the biological world. Two authors are at UK Berkeley: one is an extension specialist and one is a project scientist. One author is a researcher in the Social Science Research Institute at Penn State. One author is a research ecologist with the USDA Forest Service, and one is a research coordinator for the Karuk Department of Natural Resources. The authors worked closely with Tribal collaborators to identify research questions, co-design and implement methods, interpret data, and develop recommendations. All research components and publications were approved by Tribal councils and Tribal-university research ethics boards prior to research or submission for publication. One author is of Karuk descent.
- **Methods:** This study was co-designed in close collaboration with Tribal and agency partners. 21 focus groups, with a total of 128 participants, and 179 key informant interviews were conducted in 2015-16 and 2019-20. Focus groups and interviews were audio recorded and transcribed with consent. Transcriptions were coded and organized along 4 themes: climate change, culturally significant resources, resource benefits, and governance and policy.
- **Results:** This study found that climate change has negatively impacted Indigenous cultural ecosystem services in the Klamath River Basin by altering plant production cycles and making it harder to predict the appropriate timing for harvesting and burning. These changes, in turn, affect Indigenous communities' ability to conduct cultural stewardship practices and the timing, location, availability, and quality of cultural resources. Management decisions in this region have historically privileged Euro-American values, which often emphasize material services, over Indigenous values, which center stewardship, responsibility, and reciprocity. Incorporating Indigenous values and approaches to ecosystem services management could lead to more holistic management decisions and more resilient ecosystems.
- **Significance:** Cultural stewardship practices, including cultural burning, are conducted to increase the availability of culturally important plants. More than just "goods," these plants contribute to enhanced food security, nutritional health, cultural identity, sense of place, and social and familiar connections. Supporting the practice of cultural burning through revised

management policies can enhance the ecosystem services and resilience of the Klamath River Basin. Support for cultural burning can be facilitated through community-based participatory methods and by using an Indigenous cultural ecosystem services framework to incorporate Indigenous ways of thinking into land management.

Article ID: 1287

Norgaard, Kari Marie. 2014. "The Politics of Fire and the Social Impacts of Fire Exclusion on the Klamath." *Humboldt Journal of Social Relations* (36): 77-101.

- **Research Questions/ Objectives:** The article explored how land management techniques that relied on fire suppression and exclusion have impacted Karuk Tribal members in the mid-Klamath River region of Northern California. The author investigated the interwoven nature of social, cultural, and political impacts on Karuk communities resulting from fire suppression.
- **Terms/definitions:** The authors used the term "traditional burning practices" but did not define it. The article described how the practice of burning was, and still is, central to cultural, social, and spiritual practices.
- **Framing and Intended Audience:** The article focused on Karuk members in the mid-Klamath River region of Northern California; however, the implications of the article are relevant for ecosystem and fire management across North America. The article was published in the *Humboldt Journal of Social Relations*, a peer-reviewed journal associated with the Department of Sociology at Cal Poly Humboldt. The author is a sociologist and a professor of sociology at the University of Oregon.
- **Methods:** The author used interviews, surveys, and other documentation from two phases of research to describe the social impact of fire suppression and exclusion on Karuk members. In the first research phase, the author conducted eighteen in-depth interviews with Karuk Tribal members between 2004 and 2006 for a study focusing on the impacts of dams and declining salmon populations. During this time, the 2005 Karuk Health and Fish Consumption Survey was distributed to adult Tribal members living in their Aboriginal Territory, and 90 individuals completed the survey. The second phase of research was specific to the research questions explored in this article and involved the authors conducting 20 additional interviews between 2008 and 2013. For both interview phases, the researchers selected interviewees by determining key informants in the Karuk community.
- **Results:** Fire exclusion and suppression management approaches resulted in several detrimental ecological and social impacts to the Karuk community, including impacts on cultural practice, political sovereignty, social relations, subsistence activities, and mental and physical health. In addition, Karuk members continue to be detrimentally impacted by catastrophic fires resulting from fire exclusion.
- **Significance:** The findings of this article highlight the importance of involving Indigenous expertise and leadership in forest management, not only for the well-being of Indigenous communities, but for ecosystem health and the prevention of catastrophic fires.

Article ID: 1158

Ray, Lily A., Crystal A. Kolden, and F. Stuart Chapin III. 2012. "A Case for Developing Place-Based Fire Management Strategies from Traditional Ecological Knowledge." *Ecology and Society* 17 (3): 37. <http://dx.doi.org/10.5751/ES-05070-170337>

- **Research Questions/ Objectives:** The objective of this article was to evaluate federal wildfire management policies and the Traditional Ecological Knowledge of Indigenous Alaskan resource users for areas of agreement and conflict. This article evaluates the fire management plan and perspectives of Indigenous resource users living in or near the Koyukuk and Innoko National Wildlife Refuges in Alaska. This study compares these perspectives with national and regional fire research and policy to determine whether regional understandings and policies correspond more closely with national narratives or to local Traditional Ecological Knowledge.
- **Terms/ Definitions:** The authors defined Traditional Ecological Knowledge (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." They considered the use of fire as a management tool to be a component of TEK.
- **Framing and Intended Audience:** This article was published in *Ecology and Society*, a peer-reviewed journal that publishes research on social-ecological systems and resilience. At the time of publication, one author was affiliated with the Department of Geography at Clark University. One author is a professor of Forest, Rangeland, and Fire Sciences at the University of Idaho. One author is a professor of ecology at the University of Alaska.
- **Methods:** This study conducted semi-structured interviews with 43 Indigenous residents of Galena and Huslia, Alaska. The authors used a purposive sampling technique to select 24 male and 19 female residents ages 45 and older with extensive forest knowledge. The interviews were recorded, transcribed, and coded for both a priori and emergent themes. Local resource users' responses were compared to the Koyukuk and Northern Unit Innoko National Wildlife Refuge Fire Management Plan. Interview questions were open-ended and focused on gathering perspectives on wildfire and place change.
- **Results:** Both sources of information – Traditional Ecological Knowledge (TEK) and the fire management plan – identified the same general drivers of flammability. Community and agency perspectives on the relationship between flammability and fire return intervals were neither in conflict nor agreement. Most notably, there was substantial disagreement over the idea of fire as a management tool, wherein community respondents generally perceived wildfire effects as more negative while agency supported the use of prescribed fire. This disagreement had two main origins: different objectives between the two groups and conflicting agency approaches driven by national narratives at the expense of regional science. These results indicated that some disagreements between TEK and management agencies stemmed from federal management's reliance on a generalized national fire narrative despite contrary evidence from place-based science and localized traditional knowledge.
- **Significance:** Although support for the use of fire in forest management has surged over recent decades, evidence shows that many ecosystems are not adapted to fire nor burn in low-intensity fire mosaics. This article demonstrates that universal support of a national fire narrative can displace regional science and TEK and adversely affect some social-ecological ecosystems. The authors suggest that policymakers in Alaska and elsewhere recognize the spatial variability of fire and incorporate both TEK and the best available regional science to coproduce improved fire management strategies.

Article ID: 1333

Trusler, Scott and Leslie M. Johnson. 2008. "Berry Patch' As a Kind of Place—the Ethnoecology of Black Huckleberry in Northwestern Canada." *Human Ecology* 36: 553-568.

<https://doi.org/10.1007/s10745-008-9176-3>

- **Research Questions/ Objectives:** The authors' goals were to examine how berry patch sites are chosen for enhancement or management and to examine the "berry patch" as a kind of place for the Gitksan and Wet'suwet'en tribes.
- **Terms/ Definitions:** The authors used the terms "landscape burning" and "aboriginal burning." They did not define these terms, but they used them to refer to an intentional management strategy used to manage patches of black huckleberry.
- **Framing and Intended Audience:** The authors studied black huckleberry (*Vaccinium membranaceum*) patches on the Gitksan and Wet'suwet'en territories in northwest British Columbia, Canada. The article was published in *Human Ecology*, a journal that publishes papers on the social, cultural, and psychological factors impacting the maintenance or disruption of ecosystems, human health, and social organization. One author is an environmental consultant and one author is an anthropologist with research interests in Traditional Ecological Knowledge (TEK) and ethnoecology.
- **Methods:** The data presented in this paper were gathered through a variety of methods, including interviews and field trips with elders and local experts; mapping berry patch locations; examining mapping done for the Gitksan-Wet'suwet'en Tribal Council, the Gitksan Treaty office, and the Office of the Wet'suwet'en; aerial photography; and ecological field research. Six primary study sites were selected through visiting known, formerly managed berry patches and ecological, historical, and cultural heritage features were recorded for each site and compared. The authors did not describe their methods in greater detail.
- **Results:** Ecological conditions (elevation, aspect, setting, successional growth) of the berry patch sites were highly variable. Biophysical characteristics alone could not explain the patterns of black huckleberry patches on the landscape. A key characteristic of the berry patch sites was their proximity to village sites, fishing sites, and access trails. Further, the ecological range of black huckleberry in the study region was not found to be persistent as a productive vegetation type in the absence of a fire regime with a relatively short return interval, which the authors state could only be produced by human management in this region.
- **Significance:** This study found that patterns of black huckleberry patch sites could not be explained by biophysical characteristics alone, and that human geography, resource management strategies, human movement, and social structures must also be considered to characterize black huckleberry patches in northwest British Columbia. This paper highlights the importance of human social systems in the selection, creation, and maintenance of berry patches in the study region.

Article ID: 1172

Turner, Nancy J., Douglas Deur, and Carla Rae Mellott. 2011. "Up On the Mountain: Ethnobotanical Importance of Montane Sites in Pacific Coastal North America." *Journal of Ethnobiology* 31 (1): 4-43. <https://doi.org/10.2993/0278-0771-31.1.4>

- **Research Questions/ Objectives:** This article highlights the ethnobotanical importance of montane regions such as Pacific Coast Mountains, which include ranges spanning from northern Mexico to Alaska. The study additionally examined the role Indigenous Peoples have historically played in managing these environments through, for example, traditional burning practices.
- **Terms/definitions:** The authors used the term "traditional burning practices," but did not explicitly define it. They discussed it as "the intentional burning of meadows and mountainsides to clear away brush and promote the growth and productivity of food plants."
- **Framing and Intended Audience:** This article described two case studies in which montane areas are culturally significant, one in British Columbia and the other in southern Oregon. The article was published in the *Journal of Ethnobiology*, a peer-reviewed journal managed by the Society of Ethnobiology. All three authors were affiliated with the University of Victoria's School of Environmental Studies. The first author is an ethnobotanist. Another author is an anthropologist at Portland State University and was an adjunct professor of environmental studies at the University of Victoria.
- **Methods:** The authors reviewed historical records, as well as archaeobotanical, ethnobotanical, and ethnographic literature to gain a deeper understanding of the importance of montane areas to Indigenous Peoples in western North America. In addition, the authors examined existing data from their previous studies, which included interviews with Indigenous Elders and other Indigenous knowledge holders, as well as participatory observations.
- **Results:** Although Indigenous Peoples throughout the Pacific Coastal Mountains have diverse relationships with the montane areas they inhabit (e.g., manage different species, etc.), the authors found broad and consistent patterns of traditional aboriginal use, management, and occupation throughout the region. The authors identified five themes to describe Indigenous Peoples' use of the Pacific Coast Mountains: (1) Indigenous societies have relied on montane sites for subsistence and cultural practice for millennia, (2) Indigenous societies have actively managed montane landscapes through burning and other management practices, (3) Colonization of North America by Europeans led to restriction and generally suppression of longstanding patterns of Indigenous resource use and management, (4) use and occupancy of montane areas by Indigenous societies has declined in recent decades, and (5) the cultural significance of these montane sites remains strong today.
- **Significance:** Montane areas in the Pacific Northwest are critical biocultural heritage regions and should be protected with management approaches that emphasize the well-being of Indigenous Peoples. These areas have been actively managed by Indigenous societies for millennia through activities such as traditional burning practices. Currently, mismanagement of these ecosystems, as well as climate change, is threatening many culturally important plants in montane areas. The authors suggest that renewal of traditional practices, such as burning, is critical for the preservation of culturally valuable plants, as well as the well-being of Indigenous Peoples.

Article 1360

Tveskov, Mark A. 2007. "Social Identity and Culture Change on the Southern Northwest Coast." *American Anthropologist* 109 (3): 431-441. <https://www.jstor.org/stable/4496717>.

- **Research Questions/ Objectives:** The article employed a case study of Native Americans of the Oregon coast to explore the persistence and revitalization of cultural practices through the lens of social relations.
- **Terms/ Definitions:** The author used the term "anthropogenic fire." While he does not define the term, he describes that it "served to reduce woody debris on the forest or savannah floor, thereby decreasing the threat of catastrophic conflagrations and reducing pests detrimental to the productivity of acorns and other resources."
- **Framing and Intended Audience:** The article was published in *American Anthropologist*, a journal focused broadly on anthropology and managed by the American Anthropological Association. The author is a sociologist and anthropologist.
- **Methods:** There is no formal methods section, but the author drew on archaeological data, ethnohistorical accounts, and oral traditions.
- **Results:** Women were largely responsible for keeping and passing down traditional fire knowledge, which was useful for managing plants important for subsistence. Anthropogenic fire was the primary method of landscape management and was used for enhancing plants, promoting elk and deer browsing, and reducing catastrophic fire risk. The configuration and extent of southwest Oregon's oak prairies are largely the result of human modification through fire—primarily accomplished by women. In just a handful of years following the discovery of gold in the West, colonizers massacred and displaced Native Americans of the Oregon coast. Despite these violent attempts to erase American Indian culture, traditional cultural practices persisted, particularly due to the efforts of American Indian women in retaining traditional knowledge.
- **Significance:** Despite extreme pressures against American Indian societies of southwest Oregon, they maintained their identity and culture through the colonial period. Many of the cultural threads that led to modern cultural revitalization for southwest Oregon American Indians can be traced to precolonial social relations; in particular, Native American women retained and passed down traditional knowledge that makes revitalization efforts possible.

Article ID: 1138

Vinyeta, Kirsten. 2021. "Under the Guise of Science: How the US Forest Service Deployed Settler Colonial and Racist Logics to Advance an Unsubstantiated Fire Suppression Agenda." *Environmental Sociology* 8 (2): 134-148. <https://doi.org/10.1080/23251042.2021.1987608>

- **Research Questions/ Objectives:** This article assessed how settler colonial and racist logics shaped the USDA Forest Service's agency discourse (hereafter, referred to as USFS), specifically as it relates to fire suppression. The research objective was to understand the tactics and narratives the USFS utilized historically to justify fire suppression and delegitimize Indigenous fire practices. It also sought to understand how the social justice movements of the 1960's influenced the gradual shift in USFS rhetoric around prescribed fire, and how colonial settler frameworks continue to influence the agency's fire policy. The article explored these concepts at a regional scale, examining the Karuk Tribe and the Klamath and Six River National Forests.
- **Terms/ Definitions:** The article used the term "cultural burning," which they defined as "strategically burning landscapes for various spiritual and ecological reasons."
- **Framing and Intended Audience:** This article was published in *Environmental Society*, an international, peer-reviewed journal that aims to highlight the relevance of sociological research for environmental policy and management. The author was a doctoral candidate in the Environmental Sciences, Studies, and Policy program at the University of Oregon.
- **Methods:** The author conducted a content analysis of USFS documents over the past century at the national and regional level, which included materials and webpages produced by the agency related to fire policy. At the federal level, the author utilized sources such as the National Archives and the USFS website, while the Six Rivers Heritage Resource Library was the main source for regional resources. The author additionally included secondary data from researchers investigating USFS and Karuk fire management history. The author analyzed and coded these resources, with special attention paid to how the USFS has justified fire suppression policy and discussed or discredited Indigenous burning practices.
- **Results:** The content analysis results found that the USFS historically discredited Indigenous burning practices by racializing "light burning" and employing a narrative that associated fire suppression with superior morality. The USFS utilized discrediting, downplaying, and erasure tactics to justify the banning of Indigenous burning and a fire suppression- only agenda. The study also found that USFS scientists concealed research results that demonstrated the important role of prescribed fire in promoting ecosystem health and preventing catastrophic wildfires. While the content analysis found an agency shift towards recognition of the importance of prescribed fire for ecosystem management, beginning in the 1960's, it revealed that the USFS diffused blame for a century of mismanagement and continues to erase Indigenous peoples from discourse surrounding shifting fire management practices.
- **Significance:** This article highlights how federal agencies are historically and currently entangled with colonial and racial constructs. It reveals the intentionally deceptive rhetoric that the USFS used to discredit cultural burning practices and prescribed fires in general. These findings are significant because they demonstrate the biases inherent in agency actions and scientific publications, both historically and currently. The article provides critical historical context for the evolving discussions around the importance of prescribed fire.

Article ID: 1356

White, Richard. 1975. "Indian Land Use and Environmental Change." *Journal of the Southwest* 17 (4): 327-338. <https://www.jstor.org/stable/40168413>.

- **Research Questions/ Objectives:** The article described how the Salish peoples utilized the prairies and forests of the Puget Sound for subsistence. It focuses on detailing the Salish Tribes' conscious and purposeful ecosystem management approaches, including through burning.
- **Terms/ Definitions:** The author used the term "Indian burning." Though he did not explicitly define it, he explains that burning was intentional and used as a management tool.
- **Framing and Intended Audience:** The article was published in the *Journal of the Southwest* (formerly *Arizona and the West*), a peer-reviewed academic journal which—at the time of publishing—focused on Western American history. The author is a historian with a research focus on the American West, environmental history, and Native American history.
- **Methods:** No methods stated.
- **Results:** The Salish tribes of the Puget Sound consciously and purposefully altered their environment through the use of fire and simple technology. Through burning, they managed for growth of bracken, camas, and nettles-- which were importance subsistence resources. When Europeans settled the area, their intolerance of burning led to its cessation. Indian burning had many impacts on the landscape, such as reducing forest susceptibility to insects and disease, increasing deer and elk habitat, and fertilizing the soil.
- **Significance:** The Salish Tribes of the Puget Sound islands used intentional ecosystem management techniques, such as burning, to increase the abundance of plant foods and to sustain their culture. These practices were interrupted when white settlers colonized the area and begin prohibiting burning and introducing agriculture—these changes led to a dramatic decline in camas, nettle, and bracken populations.

Ecological articles

Article ID: 1122

Anderson, M. Kat, John E. Keeley. 2018. "Native Peoples' Relationship to the California Chaparral." *Valuing Chaparral. Springer Series on Environmental Management*. pp. 79-121.

https://doi.org/10.1007/978-3-319-68303-4_4

- **Research Questions/ Objectives:** This book chapter describes the ways in which Indigenous groups living in California's chaparral ecosystems managed the landscape and altered its vegetative composition. Additionally, the chapter discusses how Indigenous management and use of chaparral can inform current management of chaparral ecosystems.
- **Terms/ Definitions:** The authors used the terms "Indian burning" and "Indigenous burning," but they did not explicitly define the terms. They explained that Native Americans used fire for several purposes, including to enhance the production of plants used for food or basket-weaving, maintain habitat for game birds and mammals, control pathogens, increase water resources, and decrease the chance of catastrophic fire.
- **Framing and Intended Audience:** The chapter focused on California chaparral, but its implications are useful to consider for ecosystem management in other geographies and ecosystems. It is part of the book, *Valuing Chaparral*, which is part of the book series, *Spring Series on Environmental Management*. The goal of the book is to explore chaparral's ecosystem services and discuss management concerns and considerations related to fire, climate change, and land conservation. The first author is a plant ecologist and was faculty member at the University of California, Davis. The other author is a fire ecologist and was an adjunct professor at the University of California, Los Angeles.
- **Methods:** No methods were formally stated. The authors used ethnographic accounts, historical documents from previous research, and biological evidence, such as growth rings, pollen deposits, soil, and charcoal deposits to understand how Indigenous groups managed chaparral ecosystems.
- **Results:** Multiple lines of evidence suggest that Indigenous groups living in California chaparral used intentional burning and other management techniques to sustain and enhance plants that served as food, medicine, and other resources. Prior to European contact, California's chaparral was much more heterogenous and species rich than it is today. Over 400 plant species, and many animal species, in the chaparral were used by at least one tribe for food, medicine, dyes, weaving, or other purposes. The abundance and biodiversity of species that were useful for humans was deliberately managed, mainly through intentional fire. This led to more spatial, structural, successional, and biotic diversity than there likely would have been without human intervention. Fire scar studies are one line of evidence that indicate late Holocene fire regimes with fire-return intervals more frequent than would have been possible from lightning-ignited fires alone. Accounts by early European explorers, anthropologists at the turn of the century, and a second wave of anthropologists in the 1970's also provide evidence for the critical role intentional burning played in Indigenous management of chaparral.
- **Significance:** There is increasing recognition in the scientific and resource management community that restoring Indigenous burning practices to forests, savannas, and other landscapes throughout the world would likely support many values that public land agencies, non-profits, and private landowners aim to manage for. These values are similar to those that Indigenous groups managed for, such as increased water flow, enhanced wildlife habitat, plant biodiversity maintenance, and prevention of catastrophic fire. However, the authors claim that Southern California chaparral is a case in which restoring traditional fire practices would not

improve fire hazards or ecosystem health, primarily because “Indigenous burning in the region has been replaced by even more anthropogenic burning.” They argue that the recent large hazardous fires in Southern California are the result of drought, high temperature, and high winds, rather than fire suppression.

Article ID: 1244

Anderson, M. Kat. 1996. "The Ethnobotany of Deergrass, *Muhlenberg rigens* (Poaceae): Its Uses and Fire Management by California Indian Tribes." *Economic Botany* 50 (4): 409-422.

<https://doi.org/10.1007/BF02866523>

- **Research Questions/ Objectives:** The author's goal was to describe the past and present uses and fire management of deergrass by California Indian tribes.
- **Terms/ Definitions:** The primary terms the author used were "Indian burning" and "Indigenous fire management/ practices." The terms were not defined, but the author used them to describe how tribes enhanced and maintained deergrass populations through the intentional use of fire. The article also referred to "Indian burning" as an "ignition source."
- **Framing and Intended Audience:** This study examined the management and use of deergrass for basketry among tribes in California. The author is an ethnoecologist who was affiliated with the USDA Natural Resources Conservation Service and the American Indian Studies Center, UCLA, at the time of publication. The article was published in *Economic Botany*, a peer-reviewed journal of the Society for Economic Botany that publishes articles, reviews, and notes on the utilization of plants by people around the world.
- **Methods:** The findings presented in this paper were gathered through 24 months of field work among the Sierra Miwok, Western Mono, and Foothill Yokuts tribes, reviews of the ethnographic and ethnohistoric written record, and ecological field studies. No further methods were described.
- **Results:** Interviews with tribal members, field studies, and reviews of records revealed that deergrass was and remains an important cultural resource among Indians due to its incorporation into many basket types, coupled with the large number of culms needed to complete each basket type. Historically, Indigenous people in the Sierra Nevada and Southern California burned deergrass stands to increase production, reduce fuel buildup, and prevent encroachment by surrounding vegetation. Many of these grasslands are thus not natural, but anthropogenic habitat areas created and/or maintained through Indian management. Today, deergrass populations on public and private lands are dwindling, largely due to overgrazing as well as drought, urban development, and lack of access by California tribes to their former territorial lands.
- **Significance:** This study examines the cultural importance of deergrass to California Indian tribes and the use of fire to enhance deergrass production. While deergrass populations were historically maintained through Indian management, the absence of burning has caused a decline in deergrass populations, which affects the continuance of the cultural tradition of coiled basketry in the study region. The author suggests that to preserve deergrass populations and cultural basketry traditions, policies need to grant California tribes' access to public and private harvesting lands, assure the availability and preservation of cultural resources, and blend Indigenous knowledge with Western science in applied resource management. The article also advocates for "the blending of Indigenous folk science with Western science," and granting California Indigenous peoples access to public and private harvesting lands.

Article ID: 1119

Anderson, M. Kat. 1999. "The Fire, Pruning, and Coppice Management of Temperate Ecosystems for Basketry Material by California Indian Tribes." *Human Ecology* 27 (1): 79-113.

<https://link.springer.com/article/10.1023/A:1018757317568>

- **Research Questions/ Objectives:** The author's goals were to describe the reasons why resource management systems were overlooked or ignored by early anthropologists; examine the specific shrub or tree qualities that Indigenous weavers managed for in the wildland environment to ensure large quantities of suitable basketry material; identify approaches scholars have taken to re-discover resource management systems; and present working hypotheses to explain the ecological rationale for Indigenous management at the organismic and ecosystemic scales.
- **Terms/ Definitions:** The author uses multiple terms, including "burning," "fire management" and "fire as a management tool." The author does not define these terms, but she uses them to describe how Indigenous communities used fire to selectively manage vegetation.
- **Framing and Intended Audience:** This article was published in *Human Ecology*, a journal that publishes papers on the social, cultural, and psychological factors impacting the maintenance or disruption of ecosystems, human health, and social organization. The author is a plant scientist.
- **Methods:** No methods are stated. The author uses a combination of methods to achieve different parts of her research goals, including: examining the basketry collection in the Phoebe Hearst Museum at the University of California, Berkeley; adapting data from one of the author's previous studies on shoot production in managed versus unmanaged shrublands; and holding discussions with elders and non-Indian craftsmen.
- **Results:** The author found that Native Americans set fires for the production of young, straight shoots – the desirable qualities for basketweaving – in patches of buck brush (*Ceanothus cuneatus*), deer brush (*Ceanothus integerrimus*), sourberry (*Rhus trilobata*), hazelnut (*Corylus cornuta var. californica*), redbud (*Cercis occidentalis*), black oak (*Quercus kelloggii*), blue oak (*Quercus douglasii*), interior live oak (*Quercus wislizenii*), and willow (*Salix spp.*). Management needed to be frequent enough to promote young growth for basketry material, and landscape patches that had not recently been burned or pruned yielded few "usable" shoots for basketry. The author identified four methods scholars have used to study Indigenous plant management techniques: early photographic and ethnographic literature reviews, analysis of museum artifacts, oral interviews with contemporary California Indian weavers, and field observations of plants growing in a wild versus managed state. Based on this evidence, the author's working hypothesis is that Indigenous fire management was of a scale, type, and frequency that maintained and enhanced the productivity of the plant over long periods of time, enabling a sustained yield of basketry material. In the absence of disturbance, the plant becomes less productive and usable over time.
- **Significance:** The author's findings support the claim that Indigenous people used fire to enhance the production of young, straight shoots of desirable quality for basket weaving. In the absence of fire, the shoots were not of the quality nor quantity needed to support the practice. The author notes that, given these plant management strategies, the term "hunter-gatherer" is overly simplistic. Furthermore, the landscapes managed with fire are not a pristine, virtually unmodified wilderness, but rather were partially engendered by centuries or millennia of indigenous fire management.

Article ID: 1147

Barlow, Celeste M., Marlow G. Pellatt, and Karen E. Kohfeld. 2021. "Garry Oak Ecosystem Stand History in Southwest British Columbia, Canada: Implications of Environmental Change and Indigenous Land Use for Ecological Restoration and Population Recovery." *Biodiversity and Conservation* 30 (6): 1655-1672. <https://doi.org/10.1007/s10531-021-02162-2>

- **Research Questions/ Objectives:** This study examined the development of Garry oak stands at three structurally different sites in southwest British Columbia by analyzing the establishment patterns of dominant tree species using tree-ring analysis, site classification, and site history.
- **Terms/ Definitions:** The authors most often used the term "Indigenous land management," and sometimes more specifically referred to "Indigenous burning practices." They did not define either term, but they noted that Indigenous land management was important for the development of Garry oak ecosystems.
- **Framing and Intended Audience:** This article was published in *Biodiversity and Conservation*, a scientific journal that publishes articles on all aspects of biological diversity, its conservation, and sustainable use. At the time of publication, one author was affiliated with the School of Resource and Environmental Management at Simon Fraser University. One author was an ecosystem scientist working with Parks Canada. One author was a professor of Resource and Environmental Management at Simon Fraser University.
- **Methods:** Three study sites were located on Tumbo and Vancouver Islands in southwest British Columbia, Canada. Representative plots were defined at each of the three study sites and sampled for structural characteristics. Increment cores were collected at each tree in each plot, and tree rings were analyzed to reconstruct the establishment dates of three stands. At two sites, two increment cores were collected from each tree. Due to conservation restrictions at the third site, only half the trees had two cores taken. Tree ages were categorized into 10-year age groups to account for uncertainties in age estimations. The establishment patterns of Garry oak at all three study sites were compared to published data on the broader regional context of Garry oak establishment.
- **Results:** The chronology of oak establishment at one site indicated a clear relationship between Indigenous occupation, oak woodland development, European settlement, and subsequent Douglas-fir encroachment. At the second site, establishment patterns and site history indicated that frequent fire was not necessary to maintain the Garry oak ecosystem; fire disturbance was likely due to sporadic natural rather than repeated anthropogenic ignition; and that Douglas-fir likely established at the same time as the Garry oak. At the third site, Garry oak established relatively later (ca. 1910-1950) and grew quickly.
- **Significance:** Results suggest that Garry oak ecosystems in the study region are likely the product of both site-specific and anthropogenic conditions. Early succession patterns may have been affected by Indigenous burning practices and favorable soil and climate conditions. The study suggests that active management which mirrors past anthropogenic management, combined with the context of site-specific characteristics, will likely be needed to maintain Garry oak ecosystems.

Article ID: 1152

Brookes, Wesley, Lori D. Daniels, Kelsey Copes-Gerbitz, Jennifer N. Baron, and Allan L. Carroll. 2021. "A Disrupted Historical Fire Regime in Central British Columbia." *Frontiers in Ecology and Evolution* 9 (676961). <https://doi.org/10.3389/fevo.2021.676961>

- **Research Questions/Objectives:** There is debate about whether recent high-severity fires are out of the historical range or inherently a part of the mixed-severity fire regime in mixed-conifer forests. This study investigated the characteristics of historical fires and asked (1) if the fire regime has changed, and if so, (2) how forest structure is impacted.
- **Terms/ Definitions:** This article used the term "Indigenous fire stewardship" (IFS). They defined IFS as the practice of "intentionally setting fire to modify fire regimes and increase resource availability."
- **Framing and Intended Audience:** This article includes excerpts from the master's thesis of Wesley Brookes and all authors were researchers in the Department of Forest and Conservation Sciences at the University of British Columbia. *Frontiers in Ecology and Evolution* is a multidisciplinary open-access journal publishing ecological and evolutionary insights and management implications for researchers, academics, and the public.
- **Methods:** The study area was in the Alex Fraser Research Forest near Knife Creek in BC, Canada, which is the traditional territory of the T'xelcenc. The study analyzed fire scars and increment cores in 35 plots in a Douglas-fir forest to make dendroecological reconstructions of historical fire regimes.
- **Results:** At the scale of this study, fire histories over time and severity of the most recent fire indicate a mixed-severity fire regime, but found little evidence to support that periodic, high-severity fires were a component of the mixed-severity fire regime in this forest type. A lack of fire scars since 1943 or the establishment of new post-fire cohorts in the twentieth century provide strong evidence that fire regimes were disrupted in the study area which is consistent with climatic variations and land-use changes at the time. The tree-ring evidence indicates changes in land-use along with fire suppression of Indigenous fire stewardship disrupted fire regime at Knife Creek.
- **Significance:** Understanding the historical fire regime of an area is important for guiding the characteristics of treatments to avoid oversimplifying restoration treatments. For the Knife Creek forest area, historical ignitions were by lightning and Indigenous fire stewardship, which guides the framework developed for future management in the area. This framework includes the need for long-term management that emulates frequent surface fires historically present that maintain forest structure. The priority actions recommended in this study can be achieved by prescribed burning, which includes the reintroduction of Indigenous fire stewardship, along with other methods.

Article ID: 1179

Christy, John A. and Edward R. Alverson. 2011. "Historical Vegetation of the Willamette Valley, Oregon, circa 1850." *Northwest Science* 85 (2): 93-107. <https://doi.org/10.3955/046.085.0202>

- **Research Questions/ Objectives:** This paper presents a comprehensive summary of the historical vegetation of the Willamette Valley, Oregon, based on land survey data recorded by the General Land Office (GLO) between 1851 and 1910.
- **Terms/ Definitions:** The authors used the terms "Native American burning" and "aboriginal burning" but did not define them. They noted that prior to European colonization, Native Americans managed habitats with fire to enhance the production of plant species.
- **Framing and Intended Audience:** The study area was the Willamette Valley ecoregion in Oregon, excluding a portion that occurs in the Umpqua River basin because it is not part of the Willamette Valley. This study was published in *Northwest Science*, a journal of the Northwest Scientific Association that publishes research on natural history and general science topics in the Pacific Northwest. At the time of publication, one author was an ecologist for the Institute for Natural Resources at Portland State University and one author was an ecologist for The Nature Conservancy in Eugene, Oregon.
- **Methods:** GLO survey notes were transcribed for 202 townships in the study area, including portions of townships extending into the adjacent Coast Range, Western Cascades, and Klamath Mountain ecoregions. Vegetation types were classified based on the surveyors' descriptions of vegetation, species composition, and the distances recorded between survey sections and "witness" trees. Survey notes were supplemented with GLO township plat maps, U.S. Coast Survey maps, modern soils data, and some 1930s aerial photographs.
- **Results:** 10 vegetation classes were mapped. Prairie covered the largest area, followed in decreasing order by upland forest, savanna, woodland, riparian and wetland forest, water, shrubland, emergent wetlands, unvegetated, and herbaceous upland. In general, prairie dominated the central and southern valley, and was surrounded by roughly concentric bands of savanna, woodland, and closed forest, while woodland and forest were more abundant in the northern portion of the valley. Surveyors did not record signs of fire in these ecosystems, which the authors attribute to such evidence being short-lived and routine burning by Indigenous groups having been extirpated in the decade prior.
- **Significance:** An understanding of a landscape's historical composition can promote improved restoration and management decisions for that landscape. Results from this study suggest that historic vegetation patterns in the Willamette Valley reflect the combined influences of topography, geomorphology, climate, and Indigenous land management practices. Although GLO notes from the Willamette Valley contained almost no references to Indigenous inhabitation and fire use, physical legacies of fire-influenced vegetation types remained.

Article ID: 1160

Connor, Thomas, Emilio Tripp, Bill Tripp, B, B.J. Saxon, Jessica Camarena, Asa Donahue, Daniel Sarna-Wojcicki, Luke Macaulay, Tim Bean, Adam Hanbury-Brown, and Justin Brashares. 2022. "Karuk ecological fire management practices promote elk habitat in Northern California." *Journal of Applied Ecology* 59 (7): 1874-1883. <https://doi.org/10.1111/1365-2664.14194>

- **Research Questions/ Objectives:** The purpose of this article was to analyze how modern prescribed burning, informed by Traditional Ecological Knowledge (TEK), effects elk winter habitat in Karuk territory in Northern California. The authors aimed to compare how prescribed burning that focuses solely on fuels reduction and broadcast burning that resemble traditional Karuk practices differentially impacted suitability for elk winter habitat.
- **Terms/definitions:** The authors used phrases such as "prescribed fire used by Indigenous communities." They did not explicitly define this term, but they described it as "intentional burns to manage multiple ecosystem services and conditions for specific food, fiber, medicinal and cultural resources for thousands of years... typically characterized by increased fire frequency and lower severity." They also used the term "Karuk fire management practices," as their study focused on the Karuk region. The article also mentioned the term "Traditional Ecological Knowledge", which the authors described as knowledge developed over hundreds or thousands of years in relation to specific landscapes to achieve desired socio-ecological outcomes.
- **Framing and Intended Audience:** This article focuses on Karuk territory in North America, but its implications are relevant for the ecosystem management community around the globe. It was published in the *Journal of Applied Ecology*, a peer-reviewed journal publishing papers that combine ecological science with applied management of natural resources. Several of the authors are affiliated with the Wildlife Division of the Karuk Department of Natural Resources. The other authors are researchers from the University of California Berkeley's Department of Environmental Science, Policy, and Management and the Department of Biological Sciences at Cal Poly San Luis Obispo.
- **Methods:** The authors analyzed prescribed burns conducted within Karuk territory between 2013 and 2018, most of which involved consultation with Karuk cultural practitioners. About half of these burns consisted of hand-pile or jackpot burns, which focused on fuels reduction alone, and the other half were broadcast burns that more closely resembled Karuk traditional burning practices. They measured elk presence using non-invasive scat DNA surveys and game cameras during winter 2018-2019. To estimate habitat suitability, the authors related elk presence to various vegetation variables, such as percent coverage of shrubs, annual forbs, and perennial forbs and grasses. These data were used together to develop habitat suitability models for 2013 and 2018, which were then compared to determine the change in habitat suitable associated with the prescribed burns between 2013 and 2018. The authors compared habitat suitability change between the two burn types, but did not mention including a treatment with no burning.
- **Results:** Burning methods that most closely resemble Karuk traditional burning practices, especially methods utilizing multi-year broadcast burning, were associated with positive impacts on elk winter habitat suitability. Burns focusing only on reducing fuel loads had negative impacts on elk winter habitat suitability; however, when fuel-reduction burns were coupled with multi-year broadcast burns, there was an increase in suitable habitat.
- **Significance:** The article suggests that prescribed burning that closely follows traditional Karuk burning practices leads to more suitable elk winter habitat, compared to burning that focuses solely on fuels reduction. The authors conclude that the implications are relevant beyond the study area and that ecosystem managers should work closely with Indigenous representatives to

plan and implement cultural fire prescriptions to manage for elk habitat suitability and minimize risk of catastrophic fire.

Article ID: 1283

Derr, Kelly M. 2014. "Anthropogenic Fire and Landscape Management on Valdes Island, Southwestern BC." *Canadian Journal of Archaeology* 38 (1): 250-279.
<http://www.jstor.org/stable/43967084>.

- **Research Questions/ Objectives:** The author's goal was to understand how the historical processes of human landscape alteration and economic plant resource manipulation have shaped and created what has been referred to as "domesticated landscapes" (Deur 2000) in coastal southwestern British Columbia. Specifically, the author aimed to identify anthropogenic fire employed by the precontact Coast Salish during the last 5,000 years to manage terrestrial landscapes.
- **Terms/ Definitions:** The author used the term "anthropogenic fire," which she defined as "fires set intentionally through human activity." She also used the term "ignition source" in relation to "anthropogenic fire."
- **Framing and Intended Audience:** The study was conducted on interior island and upland bog sites on Valdes Island, located in the southern gulf Islands of coastal British Columbia, Canada. The author is an archaeologist who specializes in paleoecology using pollen analysis, fire history, dendrochronology, and faunal analysis. The article was published in the *Canadian Journal of Archaeology*, a peer-reviewed journal by the Canadian Archaeological Association that publishes articles, reports, reviews, and editorials on Canada's archaeological heritage.
- **Methods:** The author collected sediment cores from two bog sites in the study area, then processed the cores to isolate macroscopic charcoal. The number of charcoal fragments in each 1cc sample was calculated and divided by the inferred years represented in the sample. This value was used as a proxy for fire occurrence. Each piece of macroscopic charcoal was characterized by its morphology and assigned to 1 of 7 charcoal morphotypes. Morphotype categories were used to infer fuel type and characterize the nature of fires (anthropogenic or natural).
- **Results:** Analyses of the sediment cores revealed a clear difference in fire frequency, morphology, and amount of charcoal produced between the interior island and upland bog sites. These differences indicate that charcoal production was much more substantial and occurred at regular intervals at the upland bog ("on-site," or primarily anthropogenic) site. Charcoal frequency demonstrated repeated, regular burning at the "on-site" location and variable frequency at the interior island ("off-site," or primarily natural) location. Charcoal morphotypes identified at the "on-site" location pointed to a human-controlled fire regime, in that after an initial period of large, wood/brush consuming fires, anthropogenic burning targeted frequent understory "maintenance" fires.
- **Significance:** These results support the interpretation that the charcoal record observed at the upland bog, "on-site" location was derived primarily from anthropogenic fire. This contrasted with the inland, "off-site" location in fire morphology and frequency. At the on-site location, fire occurrence was consistent with human set rather than lightning ignited fires.

Article ID: 1205

Deur, Douglas. 2009. "A Caretaker Responsibility': Revisiting Klamath and Modoc Traditions of Plant Community Management." *Journal of Ethnobiology* 29 (2): 296-322.

<https://doi.org/10.2993/0278-0771-29.2.296>

- **Research Questions/ Objectives:** The goals of this article were to remedy past misrepresentations of Klamath and Modoc plant management strategies and to expand upon the current literature on the ethnobotanical practices of these two tribes. Further, it aimed to present ethnographic data to support the notion that the Klamath and Modoc tribes actively managed plants in a manner that enhanced the localized output of culturally preferred species.
- **Terms/ Definitions:** The author used the term "plant management," which encompasses a range of practices but includes "burning" and "weeding" of competing vegetation, seed gathering, and selective harvesting. They did not explicitly define the term. The author noted that the range of practices discussed in this paper was not exhaustive of all the plant management practices employed by the Klamath and Modoc Tribes.
- **Framing and Intended Audience:** This is an ethnobotanical study of the plant management strategies conducted by the Klamath and Modoc peoples of Oregon and California along the eastern side of the Cascade Range. The article was published in *Journal of Ethnobiology*, a peer-reviewed journal that publishes research on the study of past and present relationships between humans and their biological worlds. The author is an anthropologist.
- **Methods:** The author conducted approximately 250 ethnographic interviews on the topic of traditional land and resource management with members of the Klamath Tribes between 1999 and 2008. Interview responses were grouped into four primary examples: the management of black huckleberry in subalpine environments, the management of marsh-edge environments for yellow pond lily, the tending of epos or yampah digging sites, and the selective harvest of tree cambium, sap, and wood, particularly from pines and junipers.
- **Results:** Interviews with contemporary tribal members suggested that the Klamath and Modoc Tribes actively managed plant communities at multiple scales to enhance the availability of culturally preferred plant species and to enhance social and spiritual wellbeing. The Klamath and Modoc Tribes enhanced blackberry yields in subalpine environments by burning competing vegetation, maintaining usufruct gathering rights, and reseeding the ground in huckleberry ceremonies. The Tribes used multiple techniques to enhance the production of yellow pond lily seeds, including burning and weeding of competing vegetation, reseeding the ground in wokus ceremonies, and randomizing seed harvests. They enhanced the availability of epos or yampah by selectively harvesting roots and replanting rootlets or scattering seeds in situ. The author suggests that these examples of plant management all rely on similar methods, objectives, or technologies, suggesting that they were part of a larger plant cultivation "complex" practiced by the Klamath and Modoc Tribes.
- **Significance:** Plant cultivation was practiced by the pre-contact Klamath and Modoc peoples to enhance the output of culturally preferred plant species. Plant management often served to geographically concentrate preferred species, and it was motivated by dietary, social, and spiritual motivations.

Article ID: 1203

Hamman, Sarah T., Peter W. Dunwiddie, Jason L. Nuckols, and Mason McKinley. 2011. "Fire as a Restoration Tool in Pacific Northwest Prairies and Oak Woodlands: Challenges, Successes, and Future Directions." *Northwest Science* 85 (2): 317-328.
<https://doi.org/10.3955/046.085.0218>

- **Research Questions/ Objectives:** The authors aim for their article to enhance the effectiveness of prescribed fire as a restoration tool in Pacific Northwest prairies and oak woodlands by reviewing the current literature on successes and limitations of applying fire to those areas. The article sought to answer three research questions: (1) What are ways to tailor prescribed fire to meet ecological objectives? (2) What are the socio-political and programmatic challenges that land managers in the ecoregion have faced with prescribed fire implementation? (3) What are future areas of research that could enhance the effectiveness of prescribed fire for preserving/restoring rare species habitat?
- **Terms/ Definitions:** The authors used the terms "anthropogenic burning", "anthropogenic maintenance", and "Native American burning", but did not explicitly define them. They stated that prairies and oak woodlands were anthropogenically maintained for food and material resources with frequent, low severity fires and used the term "intentional" when discussing "anthropogenic burning."
- **Framing and Intended Audience:** This article was published in *Northwest Science*, a journal of the Northwest Scientific Association that publishes research on natural history and general science topics in the Pacific Northwest. Two authors are scientists for the Nature Conservancy of Washington. One author is a professor of conservation biology at the University of Washington. One author is a scientist for the Nature Conservancy of Oregon.
- **Methods:** This study reviewed scientific literature on prescribed fire, largely focusing on reports from past restoration efforts that utilized prescribed burns. There was no detailed methods section for this review describing how articles were selected nor how the review questions were determined.
- **Results:** From the literature and reports of prescribed fire treatments reviewed, this study found that challenges to the use of prescribed fire included fulfilling local air quality regulations, fire hazard ratings, and burn bans and retaining an appropriate fuel management workforce. Successes included an increase in the number and extent of burns in the ecoregion over the past five years. Future directions included investigating the effects of fire surrogates (weeding and mowing) to mimic fire effects. The authors note that applying practices historically used by Indigenous cultures may not restore ecosystems to an earlier state due to modern fuel loads, invasive species, and risks associated with burning at the wildland-urban interface.
- **Significance:** Restoring fire to prairies and oak woodlands is a complex practice that should consider past knowledge, current challenges, and changing future directions. Knowing about the current strengths and challenges of prescribed fire can help improve its capacity to meet ecological objectives in the future. This report highlights the efficacy of prescribed fire as a tool to achieve goals relating to substrate, vegetation, and community structure in prairie and oak woodland ecosystems. However, modern site conditions can limit the effectiveness of Indigenous burning practices to return sites to an earlier condition. These challenges require a collaborative and adaptive management approach that works across political and agency boundaries.

Article ID: 1153

Hart-Fredeluces, Georgia, Tamara Ticktin, and Frank K. Lake. 2020. "Simulated Indigenous fire stewardship increases the population growth rate of an understory herb." *Journal of Ecology* 109 (3): 1133-1147. <https://doi.org/10.1111/1365-2745.13542>

- **Research Questions/ Objectives:** This study investigated the impact of simulated Indigenous fire stewardship on Beargrass population outcomes in the Pacific Northwest using population models. The purpose of the study was to compare Beargrass population growth rates under different management scenarios and understand various mechanisms driving Beargrass population outcomes. The study focused on Beargrass because it is a culturally important plant for many Native American groups in the Pacific Northwest
- **Terms/ Definitions:** The authors used the term "Indigenous fire stewardship," but did not define it explicitly. They based the parameters of the Indigenous fire simulation on previous literature suggesting that Indigenous fire was primarily low-severity and the frequency ranged from 2 to 20-year intervals. They also used the term "alternative fire management approaches," as a broader term that includes incorporation of Indigenous fire stewardship into contemporary management.
- **Framing and Intended Audience:** The intended audience for this article includes ecosystem and fire management professionals, as well as the broader scientific community. The methods and results section are quite technical, and are most applicable for those in the sciences, particularly plant and fire ecologists. The first author is an ethnobotanist and was in the Department of Sociology at Idaho State University and another author is a conservation biologist and was in the Department of Botany at the University of Hawai'i. Another author is of Karuk descent and was a research ecologist as with the USDA Forest Service's Pacific Southwest Research Station.
- **Methods:** Researchers collected demographic and abiotic data on Beargrass in nine populations at three wildfire sites over the course of two years, from 2015 to 2017. At each site, they measured Beargrass populations, along with soil moisture and canopy openness in high-severity, low-severity, and unburned areas. They additionally utilized data from a leaf harvest experiment detailed in a previous publication (Hart-Fredeluces & Ticktin, 2019). They used these data to build integral projection models, which they tested under six simulations—three fire regimes (no fire, "business as usual", and Indigenous fire stewardship) each with and without leaf harvest. The "business as usual" fire regime was based on recent management history in the study area and reflected a 180-year fire return interval with a 58% chance of high-severity fire. The Indigenous fire stewardship regime was based on a 10-year fire return interval, in which the change of high severity fire was 10%. Beargrass population growth rates were approximated through adult survival rates and vegetative reproduction. The authors compared growth rates among the various simulations.
- **Results:** The "business as usual" and no fire conditions led to a decrease in Beargrass population growth rates, while the Indigenous fire conditions led to an increase in growth rates in the simulation. Population growth rates were higher in low-severity fire models (compared to high-severity or no fire). Leaf harvest for cultural purposes had no significant impact on Beargrass population growth rates in the no fire or "business as usual," but increased population growth rates in the Indigenous fire simulation.
- **Significance:** This study concludes that under current "business as usual" fire management policy, which includes a lack of low-severity fire, Beargrass populations may be threatened. This is significant because Beargrass plays both an ecologically and culturally significant role in the Pacific Northwest. Indigenous fire management, in combination with leaf harvest, led to the

highest Beargrass growth rate, and is likely the best management approach for ensuring Beargrass population vitality in the future.

Article ID: 1145

Hoffman, Kira M., Emma L. Davis, Sara B. Wickham, Kyle Schang, Alexandra Johnson, Taylor Larking, Patrick N. Lauriault, Nhu Q. Le, Emily Swerdfager, and Andrew J. Trant. 2021. "Conservation of Earth's Biodiversity Is Embedded in Indigenous Fire Stewardship." *Proceedings of the National Academy of Sciences of the United States of America* 118 (32).

<https://doi.org/10.1073/pnas.2105073118>

- **Research Questions/Objectives:** This study evaluated the impact of Indigenous fire stewardship on global biodiversity by reviewing relevant literature. The review focused on the characteristics of human-ignited fires and how this informs biodiversity measurements.
- **Terms/ Definitions:** This article used the term "Indigenous fire stewardship" (also used "cultural burning") and defined it as "routinely applying controlled fire to adapt to changing environments while promoting desired landscapes, habitats, and species and supporting subsistence practices and livelihoods." The authors used the terms "management", "intentional", "traditional knowledge", "practices", "ignition source", and "routine" when discussing "Indigenous fire stewardship."
- **Framing and Intended Audience:** The authors were members of the Ecological Legacies Lab in the School of Environment, Resources and Sustainability at the University of Waterloo. This article was published in the *Proceedings of the National Academy of Sciences*, a highly cited interdisciplinary journal. This is the official journal of the National Academy of Sciences and content is open access for the first six months of publication. This study had a global scale across multiple terrestrial biomes, and multiple study locations included the Pacific Northwest.
- **Methods:** This study reviewed relevant primary data papers from 1900-present that examined connections between "Indigenous peoples' use of fire and biodiversity, species composition, and/or habitat heterogeneity." To be included in the review, articles had to compare the impacts of Indigenous fire stewardship (IFS) to areas without evidence of IFS (e.g., unburned areas, lightning fires, etc.). Included articles were then examined to evaluate characteristics of Indigenous fire stewardship on various biodiversity measures.
- **Results:** The study found that of the studies included in the search, 79% saw increases in biodiversity associated with IFS and 63% saw increased habitat heterogeneity. Trends noted throughout included studies was a focus on the savanna/tropical grassland biome, short or historic timescales, regional spatial scales, and impacts on vegetation as opposed to other organisms. In all included studies fire stewardship occurred outside of the normal fire season.
- **Significance:** This study found that of the articles reviewed, 79% demonstrated an increase in biodiversity associated with IFS and asserts that to conserve Earth's biodiversity Indigenous fire stewardship and other Indigenous management approaches are necessary. Organisms across the globe have adapted to local fire regimes, positing Indigenous fire stewardship as a "strong evolutionary force" that influences biodiversity. Additionally, while an increase in biodiversity or landscape heterogeneity is a result of Indigenous fire stewardship, this is not the intention of IFS.

Article ID: 1257

Hoffman, Kira M., Ken P. Lertzman, and Brian M. Starzomski. 2017. "Ecological Legacies of Anthropogenic Burning in a British Columbia Coastal Temperate Rain Forest." *Journal of Biogeography* 44 (12): 2903-2915. <https://doi.org/10.1111/jbi.13096>

- **Research Questions/ Objectives:** The objective of this study was to improve our understanding of the temporal and spatial attributes of historic fire activity, the probability of lightning versus human ignitions, and how fire impacted landscape patterns and processes. The study used a weights-of-evidence approach combining qualitative and quantitative data to test three hypotheses: fires were natural (lightning-caused), fires were human (accidental ignitions), and fires were human (intentional ignitions).
- **Terms/ Definitions:** The authors used the terms "anthropogenic burning" and "intentional burning." They defined anthropogenic burning as "both intentional and accidental ignitions by people." They defined intentional burning as "the practice of periodic burning of landscapes or particular sites by Indigenous peoples over time to achieve specific management goals."
- **Framing and Intended Audience:** The study area is a 2,000 island group of rainforests located on the central coast of British Columbia, Canada. The article was published in the *Journal of Biogeography*, a peer-reviewed scientific journal that publishes research, editorials, synthesis reports, and other papers at the intersection of biology and geography. At the time of publication, one author was a PhD student in ecology at the University of Victoria. One author was a professor of forest ecology at Simon Fraser University, and one author was a professor of environmental studies at the University of Victoria.
- **Methods:** The authors analyzed almost 700 years (1376-1893) of temporal and spatial aspects of fire activity on 30 plots on Hecate Island using fire scars and stand establishment patterns. Partial wedge sections of fire scars were removed in a 1-ha area surrounding every plot, and 2 cores were removed from every living tree > 7.5 cm DBH to identify fire events, determine the year of establishment, and develop a composite fire history chronology. Vegetation surveys were completed to assess the potential effects of fire on plant communities. A paired study was then conducted of 20 former Indigenous habitation and control sites across 15 islands throughout the study area to relate historic fire activity to patterns of human settlement. Lastly, 15 years of lightning strikes were mapped to assess the frequency and association of lightning with prolonged dry periods.
- **Results:** Lines of evidence from fire scars, stand ages, plant community characteristics, and lightning strike densities supports the hypothesis that historic fire regimes in this region are largely consistent with human fire ignitions and opposes the hypothesis that historic fires resulted from natural lightning strikes. Fire activity likely represented a mix of intentional and unintentional ignitions. Fires of human origin occurred regularly in the fire-history data, and a cessation of anthropogenic burning can explain why fire occurrence decreased from the study area at the end of the 19th century.
- **Significance:** This study suggests that fire was strongly associated with Indigenous fire stewardship in coastal British Columbia during the period of Indigenous habitation. Lightning was too rare to explain the fire return activity observed in the study area between the fourteenth and late nineteenth centuries. The authors assert that our ability to understand current forest conditions in this region might be limited if we underestimate the role of humans in shaping historic fire regimes.

Article ID: 1379

Johannessen, Carl L., William A. Davenport, Artimus Millet, and Steven McWilliams. 1971. "The Vegetation of the Willamette Valley." *Annals of the Association of American Geographers* 61 (2): 286-302. <https://www.jstor.org/stable/2562446>

- **Research Questions/ Objectives:** This article provides an overview of the literature on the vegetation of the Willamette Valley between 1853 and 1969.
- **Terms/ Definitions:** The authors used the term "Indian burning," but did not explicitly define it. Later in the article, they referred to the practice as "the conscious setting of fires by Indians."
- **Framing and Intended Audience:** This paper is published in *Annals of the Association of American Geographers*, a journal of the American Association of Geographers that publishes papers on any of the broad facets of geography. At the time of publication, three authors were professors of geography at the University of Oregon, Wisconsin State University, and Mankato State College. One author was a former graduate student in Geography at the University of Oregon.
- **Methods:** Documentation of historic vegetation patterns was assembled from early written accounts, exploration logs, land surveys, maps, and aerial photographs. Maps were compiled from USGS topographic maps, aerial photographs taken in 1960 and 1968, and field observation.
- **Results:** Early written accounts by Euro-American explorers in the Willamette Valley indicate that fires in this region were common before Euro-American colonization. The broad and flat regions of the valley and the adjacent woodlands were maintained by regular anthropogenic fire in the late summer and early fall, possibly as frequently as once a year, to maintain prairie and open woodland-type vegetation. Cessation of Indigenous fire practices by settler agricultural, urban, and industrial activities has replaced former oak prairies with Douglas-fir woodlands. By 1969, the vegetation was similar to what existed at the time of early land surveys, but composition and abundance of respective species was highly different. These vegetation changes suggest that the soils of the Willamette Valley can support dense tree growth, and that pre-settlement open oak prairies were anthropogenically augmented and maintained by fire.
- **Significance:** This article provides a historical account of vegetation patterns in the Willamette Valley during the nineteenth and twentieth centuries. Findings from this article support the influence of Indigenous fire stewardship on augmenting and maintaining open oak prairies in the valley, which were largely replaced by Douglas-fir woodlands following Euro-American settlement in the region.

Article ID: 1112

Johnson-Gottesfeld, Leslie M. 1994. "Aboriginal Burning for Vegetation Management in Northwest British Columbia. *Human Ecology* 22: 171-178.

<https://link.springer.com/article/10.1007/BF02169038>

- **Research Questions/ Objectives:** The author aimed to gain a deeper understanding of the role of burning for vegetation management among the Gitksan and Wet'suwet'en peoples of British Columbia.
- **Terms/ Definitions:** The author used a variety of terms, including "traditional burning practices", "aboriginal landscape burning", "traditional vegetation manipulation", "pre-European burn practices", and "prescribed burning for vegetation management." She did not explicitly define these terms, but referred to burning practices as widespread, regular, and deliberate.
- **Framing and Intended Audience:** The article was published in *Human Ecology*, a peer-reviewed journal focusing on the complex interactions of people and their environment. The author is an anthropologist, with a research focus on ethnobotany and traditional knowledge.
- **Methods:** The author interviewed 14 Gitksan elders and four Wet'suwet'en elders about burning practices, with a focus on berry patch burning. In 1991, she also monitored and mapped spring burning in the two tribes' villages.
- **Results:** Berry patch burning was one of the most significant forms of traditional vegetation manipulation by Gitksan and Wet'suwet'en people. They burned berry patches mainly in late August and September because "nights are cool and fall frontal storm systems are likely to bring precipitation." Informants recalled burning to avoid extensive wildfire and hot burns, which would be counterproductive to berry production. They noted that huckleberry patches are currently less productive than they once were and lowbush blueberry are now rare, both of which are due to fire suppression and forest succession. While berry patch burning ended in the 30's and 40's due to fire suppression, grass and brush burning on reserve lands continues today (at time of writing, 1994).
- **Significance:** Landscape burning was widespread among the two tribes in the study and also more broadly among northwestern tribes. The primary reasons for burning were to maintain berry patches and to prevent brush build up around villages. With the start of fire suppression in the 1930's and 40's, berry patch burning came to an end, and berry patches in the area are now smaller and less productive. The author does not discuss current day management implications.

Article ID: 1129

Keeley, Jon E. 2002. "Native American impacts on fire regimes of the California coastal ranges."

Journal of Biogeography 29 (3): 303-320. <https://doi.org/10.1046/j.1365-2699.2002.00676.x>

- **Research Questions/Objectives:** The objective of the article was to evaluate the extent to which Indian burning, relative to lightning- ignited fires, impacted vegetation composition in California shrubland landscapes. The author specifically focuses on the conversion from shrubland-dominated to grassland-dominated landscapes.
- **Terms/definitions:** The author used the terms "Indian burning" and "Native American burning." While the author did not explicitly define them, he explained that Native Americans used fire as a land management tool to: (1) increase seed, bulb, and fruit production, (2) increase habitat for mammal resources, (3) increase water resources, (4) reduce hazardous conditions, and (5) facilitate travel.
- **Framing and Intended Audience:** This article focuses on the coastal ranges of southern and central California. It was published in the *Journal of Biogeography*, a peer-reviewed journal that covers spatial, ecological, and historical biogeography. The author is a fire ecologist.
- **Methods:** The article did not contain a methods section and it appeared the author primarily pieced together existing literature to make a case. However, the abstract stated that the author utilized historical documents, ethnographic accounts, and archaeological records to evaluate potential historical patterns of Indigenous burning. No primary data was collected.
- **Results:** Native American burning greatly accelerated the natural fire frequency in California shrubland ecosystems and played a major role in shifting vegetation composition from shrubland to grassland. The author bases this conclusion on the following concepts: (1) lightning-ignited fires in the area were infrequent relative to the rest of the western US, (2) Indigenous populations were large relative to the rest of the US, (3) shrubland have weak resistance to high fire frequency and are easily displaced by grassland, (4) grasslands provide more resources than shrublands for Indigenous communities, (5) fire was the primary land management tool historically used by Indigenous populations in the region, and (6) other ecological studies have found evidence that anthropogenic alterations have shifted landscapes from shrubland to grassland.
- **Significance:** Use of fire by Native Americans to manage landscapes was common in coastal central and Southern California and significantly altered the landscape by converting shrublands to grasslands. The author concludes this was likely also the case in the Pacific Northwest, but doesn't state any implications for future management.

Article ID: 1124

Klimaszewski-Patterson, Anna, and Scott Mensing. 2020. "Paleoecological and paleolandscape modeling support for pre-Columbian burning by Native Americans in the Golden Trout Wilderness Area, California, USA." *Landscape Ecology* (35): 2659-2678.
<https://doi.org/10.1007/s10980-020-01081-x>

- **Research Questions/ Objectives:** The objective of the article was to determine whether the driving force of pre-historic forest composition change in Trout Meadow, California was climate-driven or related to Native American practice of fire management. The researchers used paleoecological reconstructions of the past 1200 years and paleolandscape modeling to evaluate their hypothesis.
- **Terms/ Definitions:** The authors used the term "traditional resource and environmental management (TREM) burning," which they did not explicitly define. They discussed how intentional use of fire to "improve productivity, increase natural yields, facilitate hunting, and clear travel corridors" was a key aspect of TREM. They additionally used the term "active management" in the discussion.
- **Framing and Intended Audience:** The article focused on the Golden Trout Wilderness Area in central California, but its implications are significant more broadly. It was published in *Landscape Ecology*, a peer-reviewed journal at the interface of biophysical and socioeconomic sciences related to ecology, conservation, management, landscape design, and sustainability. The first author is a geospatial scientist and paleoecologist and was an associate professor at Sacramento State. The other author is a biogeographer and paleoecologist and was at the University of Nevada, Reno.
- **Methods:** The authors created a landscape reconstruction of the past 1200 years using a sub-centennial pollen and charcoal reconstruction. To test the two hypothesized drivers of change (climate or TREM burning), they used a forest succession model with scenarios modeled after the two drivers. The authors used the pollen record to hypothesize periods of TREM burning. They compared these models with the paleorecord to evaluate which driver played a larger role in forest change.
- **Results:** The paleoecological reconstructions showed periods in which anthropogenic burning was likely occurring and greatly altering forest structure near Trout Meadow, California. Pollen analysis showed periods in which both vegetation and fire reconstructions were different than what would be expected with climatically-driven disturbances alone, particularly during cooler, wetter periods. The paleolandscape models that included Indigenous burning were most closely correlated to the paleoecological record.
- **Significance:** TREM burning in the Sierra Nevada was a driving force of pre-historic forest changes. The authors suggest that modern land management policy could be more comprehensive by actively engaging tribal communities and recognizing land-use legacies in California's forests. These shifts in modern management approaches may benefit forest health, increase resource yields, and help prevent catastrophic wildfire.

Article ID: 1121

Knight, Clarke A., Lysanna Anderson, M. Jane Bunting, Marie Champagne, Rosie M. Clayburn, Jeffrey N. Crawford, Anna Klimaszewski-Patterson, Eric E. Knapp, Frank K. Lake, Scott A. Mensing, David Wahl, James Wanket, Alex Watts-Tobin, Matthew D. Potts, and John J. Battles. 2022. "Land Management Explains Major Trends in Forest Structure and Composition over the Last Millennium in California's Klamath Mountains." *Proceedings of the National Academy of Sciences of the United States of America* 119 (12). <https://doi.org/10.1073/pnas.2116264119>

- **Research Questions/Objectives:** This study examined multiple records of historical forest conditions in the Klamath region of California to assess the effect that Indigenous fire stewardship had on forest structure and composition. The study used these records of forest conditions to document an "Indigenous baseline" (how Indigenous fire stewardship impacted forests) for the region to understand how human activities and climate interacted to influence forest conditions. Understanding the Indigenous baseline for the Klamath region can inform forest management moving forward.
- **Terms/ Definitions:** The authors used the term "Indigenous burning practices" (also referred to as "cultural burning", "Indigenous fire stewardship practices", and "Indigenous fire use"). The term was defined as the routine and targeted deployment of situational burns and larger broadcast burns during specific seasons to alter the landscape. The authors used the terms "stewardship", "management", "intentional", "traditional knowledge", "ignition source", "fire use", and "routine" when discussing "Indigenous burning practices."
- **Framing and Intended Audience:** The authors are a mix of geographers and forest ecologists, some worked for the U.S. Geological Survey and USDA Forest Service. This article was published in the *Proceedings of the National Academy of Sciences*, a highly cited interdisciplinary journal. This is the official journal of the National Academy of Sciences and content is open access for the first six months of publication. One author is of Karuk descent.
- **Methods:** This study examined multiple records of past forest structure and composition surrounding two lakes in the Klamath region of California to analyze the impacts of Indigenous fire stewardship versus climate in the region. These records of forest conditions included pollen accumulation rates to predict above-ground tree biomass, lacustrine charcoal, tree rings, fire scar records, and local Native oral history, and were compared to analysis of climate, vegetation response, and charcoal influx data as proxies for climate, vegetation, and fire presence. These records were used in various ways to support the research question. For example, local oral histories documenting Indigenous burning practices were paired with fire scar records to infer that some fires were ignited by people.
- **Results:** The biomass record shows climate was not the only factor influencing forest structure and composition, but Native burning practices were responsible for shaping forests in the Klamath Mountains. Both lakes currently have higher levels of biomass than was observed prior to Euro-American contact. Biomass and forest opening data track along fire occurrence proxies and oral histories. The fire regime in the Western Klamath Mountains was influenced by Indigenous fire stewardship and to restore historical conditions, large-scale intervention could be required. These results are applicable in other areas within the region because of similar characteristics in low-elevation areas in the Klamath Mountains.

- **Significance:** There is still some debate about the extent to which Indigenous fire stewardship impacted forest conditions compared to climate, and the concept that climate is the only influence on forest composition and structure still prevails. This study asserts that by discounting the role of Indigenous people in historical forest conditions, the scale of intervention needed in forests is unrealistically minimized. This study emphasizes the importance of integrating multidisciplinary approaches when studying historical forest conditions that more accurately account for the impact of Indigenous fire stewardship on forest composition and structure.

Article ID: 1299.

Lewis, Henry T. and Theresa A. Ferguson. 1988. "Yards, Corridors, and Mosaics: How to Burn a Boreal Forest." *Human Ecology* 16 (57-77). <https://doi.org/10.1007/BF01262026>

- **Research Questions/ Objectives:** This paper interprets the effects of Indigenous burning practices on boreal forests and other similar regions with relatively limited natural resources. The authors developed a model for illustrating anthropogenic fire patterns in the boreal forests of Alberta, Canada by using examples of how anthropogenic "fire yards" and "fire corridors" have been used in other parts of the world, particularly in marginal ecosystems with relatively low primary productivity.
- **Terms/ Definitions:** The authors primarily used the terms "Indian burning" and "habitat fires" but did not explicitly define either. They used the terms "intentional" and "systematic" to describe "Indians firing habitat to influence the local distribution and relative abundance of plant and animal resources." They also used the terms "traditional burning practices" and "pyrotechnology."
- **Framing and Intended Audience:** This article focuses on the boreal forests of northwestern Alberta, Canada, but draws on examples of Indigenous burning practices in northwestern California, western Washington, and four regions of Australia (three states: Tasmania, New South Wales, Western Australia and one territory: the Northern Territory). The article was published in *Human Ecology*, a journal that publishes papers on the social, cultural, and psychological factors impacting the maintenance or disruption of ecosystems, human health, and social organization. At the time of publication, both authors were professors of Anthropology at the University of Alberta.
- **Methods:** No methods were described.
- **Results:** Analysis of historic Indigenous fire practices in relatively resource-scarce ecosystems in the U.S., Australia, and Canada revealed that Indigenous communities used fire to create and sustain "fire yards," or forest clearings maintained by burning and "fire corridors," or similarly maintained grass fringes along streams, swamps, ridges, and trails. Both landscape features can provide a greater abundance of ecocultural resources and prevent forest encroachment. Although the pattern and maintenance of fire yards and corridors can vary greatly due to factors such as climate and vegetation characteristics, the use of fire to maintain openings in regions of low primary production is a tactic shared by Indigenous communities in different regions of the world. Specific to Alberta, at the time of colonial settlement, the general fire mosaic likely consisted of natural (characterized by large patches of variable forest maturity) and anthropogenic patterns (characterized by small forest openings). The creation and maintenance of fire yards and corridors was likely a significant strategy for managing open areas that could be burned (meadows, swamps, ridges, etc.) within an overall boreal forest region in which understory burning was likely precluded.
- **Significance:** Across different Indigenous communities in different parts of the U.S., Canada, and Australia, functionally similar strategies were found in the ways that fire was used to generate ecocultural resources in ecosystems of relatively limited primary productivity. In particular, "fire yards" and "fire corridors" were identified as distinct features represented in the fire mosaics of the study sites.

Article ID: 1117

Long, Jonathan W., Frank K. Lake, and Ron W. Goode. 2021. "The Importance of Indigenous Cultural Burning in Forested Regions of the Pacific West, USA." *Forest Ecology and Management* 500: 119517. <https://doi.org/10.1016/j.foreco.2021.119597>

- **Research Questions/ Objectives:** The objective of this article was to review and synthesize publications about Indigenous fire stewardship in the Pacific West of the U.S. to better understand its cultural importance to Indigenous peoples, its utility in promoting social-ecological wellbeing, and future directions for research and management.
- **Terms/ Definitions:** The article used the terms "cultural burning" and "traditional fire stewardship." They used a definition of cultural burning from Clark et al. (2021) – "purposeful use of fire by a cultural group (e.g., family unit, Tribe, clan/moiety, society) for a variety of purposes and outcomes." The authors noted that "other terms such as Indigenous fire management (Nikolakis and Roberts, 2020), Indigenous burning, and Indigenous stewardship encompass cultural burning." They additionally used the terms "practices" and "fire use" when discussing "cultural burning."
- **Framing and Intended Audience:** This article was published in *Forest Ecology and Management*, a journal that publishes scientific articles linking biological and ecological science with forest management and conservation. One author is a research ecologist for the Conservation of Biodiversity Program, another is a research ecologist at the Fire and Fuels Program with the USDA Forest Service and is of Karuk descent. One author was the Tribal Chairman of the North Fork Mono Tribe.
- **Methods:** The authors conducted a literature review of publications about Indigenous fire stewardship focused on the forested regions of Northern California and southern Oregon, although some studies concentrated on the broader region of Western North America. Publications consulted in this review included review articles and synthesis reports, empirical social science research, observational/ monitoring studies, and policy-oriented reports produced by and for tribal entities. The authors did not describe how the literature was selected for review. Objectives and effects of cultural burning identified in the literature were then organized and described within an ecosystem services framework as outlined in the Millennium Ecosystem Assessment.
- **Results:** From the publications consulted in this review, the authors found that there were several provisioning, regulating, supporting, and non-material cultural services associated with cultural burning, including: provision of ecocultural resources, augmented ecosystem biodiversity, regulation of pests, pathogens, and wildfire, and transmission of Indigenous knowledge, among several others. While this article suggests that an ecosystem services framework can help highlight many of the positive aspects of cultural burning among both Indigenous fire stewards and government management agencies, the authors note that multiple services do not fit solely into one category. It can therefore be challenging to evaluate the closely integrated nature of services across socio-cultural concerns and different knowledge systems. Reviewing studies on the historic influence of cultural burning, this article found that adapting palaeoecological methods to be sensitive to finer-scale, more subtle signatures of cultural burning can improve our understanding of the influence of past fire stewardship.

- **Significance:** Cultural burning can produce several provisioning, regulating, and cultural outcomes that improve social-ecological wellbeing in fire-adapted landscapes of the western United States. Practitioners of Indigenous fire stewardship have identified a duty to steward the land and the production of social-ecological benefits as motivations for cultural burning. This article suggests that there are overlaps between cultural burning and contemporary agency forest management. Leveraging these overlaps through an ecosystem services framework, while expanding long-term tribal collaboratives, can advance our current understanding and restoration of fire-adapted forested landscapes.

Article ID: 1118

Long, Jonathan W., Ron W. Goode, Raymond J. Gutierrez, Jessica J. Lackey, and M. Kat Anderson.

2017. "Managing California Black Oak for Tribal Ecocultural Restoration." *Journal of Forestry*. 115 (5): 426–34. <https://doi.org/10.5849/jof.16-033>

- **Research Questions/Objectives:** The California black oak is a "cultural keystone" species, providing both food and shaping cultural identity for some tribes in California and Oregon. This study examined how different kinds of burns affect black oaks. The objective was to understand how differing treatments provide desired conditions of the black oak for tribal members. The goal to help evaluate the need and opportunities for restoring black oak.
- **Terms/ Definitions:** The authors used the term "cultural burning" and suggested that it is defined by the ignition of low intensity fires within Black Oak groves.
- **Framing and Intended Audience:** This study is a USDA Forest Service initiated project including tribal members and experts in the field. This article was published in the *Journal of Forestry*, a peer-reviewed journal that aims to inform forest managers about developments in forestry.
- **Methods:** This study synthesized findings from scientific studies on black oak and Traditional Ecological Knowledge (TEK) of tribal members with an interest in gathering acorns in the North Fork area. Research was mainly centered in Western Mono ancestral territory in the central Sierra Nevada but included other areas around Oregon and California. The study also generated a map of potentially desired areas for the gathering of acorns on National Forest land using GIS software.
- **Results:** The study identified conditions that contributed to desirability of specific acorn gathering areas and interpreted trends in black oaks that can inform restoration strategies. Many of the desired conditions by Indigenous gatherers were associated with the use of low-intensity fire. The study found that a decrease in frequent fires has lessened conditions for mature black oaks and the gathering of acorns. The study identified 946 areas that could be suitable for acorn gathering using the GIS analysis to inform land management.
- **Significance:** Black oak stands were managed by Native Americans for millennia by using low-intensity fires regularly to promote culturally valuable qualities in trees and acorns. Tribal gatherers of acorns maintain that a lack of fire on the landscape and forest densification have decreased the opportunities for gathering high-quality black oak acorns. To support high-quality black oak acorns, treatments include reintroducing low-intensity fire. Forest management plans can work with tribes to develop fire management activities that help in the restoration of black oaks. This collaboration to enhance acorn production can be a way to promote important socioecological values for tribes in California and Oregon.

Article ID: 1298

MacDougall, Andrew S., Brenda R. Beckwith, and Carrina Y. Maslovat. 2004. "Defining Conservation Strategies with Historical Perspectives: A Case Study from a Degraded Oak Grassland System." *Conservation Biology* 18 (2): 455-465. <https://doi.org/10.1111/j.1523-1739.2004.00483.x>

- **Research Questions/ Objectives:** This article analyzed historical descriptions of an endangered oak grassland ecosystem in southwestern British Columbia (BC), Canada, to achieve three objectives: (1) contrast former ecosystem appearance with present conditions (2) assess current assumptions about past ecosystem functioning, and (3) examine the implications of these findings for restoration in the context of current problems such as fragmentation and species decline.
- **Terms/ Definitions:** The authors used phrases such as "Indigenous burning," "fires set by indigenous people," and "Indigenous land management" but did not explicitly define them. They additionally used the terms "intentional" and "fire use" when discussing "Indigenous burning."
- **Framing and Intended Audience:** This is a case study on the use of historical data for defining restoration targets in a degraded oak grassland ecosystem in southwestern BC. It was published in *Conservation Biology*, a journal of the Society for Conservation Biology that publishes research, literature reviews, essays, reports, and book reviews that address the science and practice of conserving biological diversity. At the time of publication, one author was affiliated with the Department of Botany at the University of British Columbia and one author was an instructor of Biology and Environmental Studies at the University of Victoria. One author was affiliated with the Department of Biology at the University of Victoria.
- **Methods:** The authors examined 23 historical accounts, written between 1790 and 1951, that referenced the *Quercus garryana* grassland ecosystem of southwestern BC. Documents were identified from library and archive searches and from anthropological, ethnobotanical, and historical archives on the region. Documents were qualitatively assessed for three types of information: description of vascular plants and the general ecosystem; evidence of fire; and the timing and method of European settlement. Documents were also assessed for the author's purpose, historical context, and degree of concordance with other passages to detect potential biases.
- **Results:** Historical accounts revealed that former landscape conditions consisted of naturally patchy Garry oak ecosystems characterized by cultural modification by low-intensity fires that maintained structural diversity and prevented conversion to Douglas-fir forest. Landscape change brought about by European settlers was rapid and consisted of three primary changes: fire suppression, habitat loss, and plant invasion by mostly exotic flora. Because this ecosystem has been simplified by habitat loss and fire suppression, results suggest that conservation efforts should focus on expanding the regional distribution of native species and reintroducing fire. The Garry oak ecosystem was dynamic and spatially heterogeneous rather than stable and pristine, and restoration approaches should aim to recreate this heterogeneity.
- **Significance:** This paper looks to historical documents to better understand the previous conditions of oak grassland ecosystems in BC and to help set improved targets for the restoration of these ecosystems. In particular, it analyzes the historic impact of fire on ecosystem structure and function, finding that fires were commonly observed before 1865 and were usually started by Indigenous people. These anthropogenic fires maintained higher degrees of structural and species heterogeneity than current conditions.

Article ID: 1156

Marks-Block, Tony, Frank K. Lake, and Lisa M. Curran. 2019. "Effects of Understory Fire Management Treatments on California Hazelnut, an Ecocultural Resource of the Karuk and Yurok Indians in the Pacific Northwest." *Forest Ecology and Management* 450: 117517.
<https://doi.org/10.1016/j.foreco.2019.117517>

- **Research Questions/ Objectives:** The objective of this study was to evaluate the effects of broadcast fires and three proxy fire treatments on California hazelnut shrubs, a plant that produces valuable ecocultural resources for basketry materials, through collaboration with Indigenous tribal members and basketweavers.
- **Terms/ Definitions:** The authors used the term "cultural burning", which they defined as the term used by "American Indians" for their prescribed fires, because the burns aimed to improve the quantities and densities of ecocultural resources central to subsistence and ceremonial practices. They differentiated cultural burning from the fuel reduction-focused prescribed burns of public land agencies whose primary objective has been to reduce fuel loads, and thus, moderate wildfire intensity. They used the term "intentional" when discussing "cultural burning."
- **Framing and Intended Audience:** This article was published in *Forest Ecology and Management*, a journal that focuses on scientific articles linking biological and ecological science with forest management and conservation. Two authors are ecological anthropologists at Stanford University. One author is a research ecologist with the USDA Forest Service and is of Karuk descent. The study was conducted in collaboration with members of the Karuk and Yurok Tribal councils.
- **Methods:** Three proxy fire treatments and an untreated control were applied to 27 stratified blocks (16) across a 10 ha Douglas-fir and mixed hardwood forest in the Klamath Mountains of Northern California. These treatments included manual hazelnut stem cutting, blistering hazelnut stems via propane torch, and top-killing stems via surface fuels ignition. Broadcast fire was applied to 12 separate blocks. After a full growing season, hazelnut shrub stems were harvested and stem quantity, diameter, and length were compared among treatments and with stems gathered by two Indigenous basketweavers from an adjacent broadcast burned site.
- **Results:** This study found that both broadcast fire and all three proxy treatments increased production of basketry stems compared to the untreated control. Propane torching increased stem production the most, with a 10-fold increase compared to the control. Cutting treatment increased production the least, with a 4-fold increase compared to the control. Broadcast fires or substitute treatments were founded to effectively generate basketry quality hazelnut stems.
- **Significance:** This article suggests that cultural burns or similar proxy fire treatments are an effective way to increase the production of ecocultural resources (defined as biota that are culturally and economically important to Indigenous tribes). Expanding the area and frequency of burns or proxy treatments can increase the availability of basketry stems that are currently in high demand but limited supply. The study acknowledges current constraints of burning, such as a limited burning season and liability concerns in the WUI, and suggests that proxy treatments may not have the same constraints. Further, this article underscores a distinction between cultural burning, which aims to enhance ecocultural resource production, and the fuel reduction-focused prescribed burning of public land agencies, which often aims to mitigate wildfire risk.

Article ID: 1115

Marks-Block, Tony, Frank K. Lake, Rebecca B. Bird, and Lisa M. Curran. 2021. "Revitalized Karuk and Yurok Cultural Burning to Enhance California Hazelnut for Basketweaving in Northwestern California, USA." *Fire Ecology* 17 (6). <https://doi.org/10.1186/s42408-021-00092-6>

- **Research Questions/Objectives:** This study examined the impact of cultural burn characteristics on ecocultural resources, specifically the California hazelnut, in northwestern California. Three main questions of the study include: (1) Is cultural burning by Indigenous people beneficial to ecological and cultural processes? (2) Does it alter species assemblages? (3) How does fire governance affect basketry stem availability and gathering practices?
- **Terms/ Definitions:** The article used the term "cultural burning," which the authors defined as, "the use of prescribed burns to enhance culturally important species." It also used the terms: "intentional", "cultural", and "practices" in relation to "cultural burning."
- **Framing and Intended Audience:** Three authors are ecological anthropologists, and one is a research ecologist with the USDA Forest Service and is of Karuk descent. The article was published in *Fire Ecology*, an international scientific journal that publishes peer-reviewed articles on ecological and management aspects of wildland fire. The article uses cultural burning for California hazelnut basketweaving by Karuk and Yurok cultures as an example that increasing Indigenous fire management supports positive ecosystem outcomes.
- **Methods:** The study area was in the ancestral territory of the Yurok and Karuk tribes, in the mid-Klamath watershed of California. This study monitored hazelnut basketry stems in prescribed and cultural burn sites and analyzed socio-ecological variables. The study included ecological surveys of hazelnut basketry stems and observations of hazelnut stem gathering through interviews and collaborative relationships with basket weavers.
- **Results:** This study found that fire increased basketry stem productivity, but the effect decreased over time with each growing season. Basketry stem length and diameter was affected by burn season and had a negative relationship to overstory tree basal area and ungulate browsing. Hazelnut basketry stems were gathered within a few weeks of bud break in the spring. Most sites where hazelnut basketry stems were gathered were at culturally burned locations.
- **Significance:** In northwestern California, the California hazelnut is a highly valued species of the Karuk and Yurok tribes' for basketweaving, and a major objective of cultural burning is to enhance these stems for basketweaving. This study provides evidence that cultural burning enhances stems of California hazelnut for basketweaving and therefore evidence of positive human ecosystem engineering. The study offers cultural burning as an alternative model for restoring fire to the landscape. This is because Karuk and Yurok practices are partially responsible for the historical fire regime and there are significant contributions to socio-economic wellbeing. For this reason, tribes and local entities are in an easier position to maintain long-term burning in an area as opposed to broader land management agencies working within political and budgetary constraints.

Article ID: 1301

McWethy, D.B., P.E. Higuera, C. Whitlock, T.T. Veblen, D.M.J.S. Bowman, G.J. Cary, S.G. Haberle, R.E. Keane, B.D. Maxwell, M.S. McGlone, G.L.W. Perry, J.M. Wilmshurst, A. Holz, and A.J. Tepley. 2013. "A Conceptual Framework for Predicting Temperate Ecosystem Sensitivity to Human Impacts on Fire Regimes." *Global Ecology and Biogeography* 22 (8): 900-912.

<https://doi.org/10.1111/geb.12038>

- **Research Questions/ Objectives:** The objective of this study was to outline a conceptual framework for examining ecosystem sensitivity to human-set fires, with particular attention to feedbacks driving forest state transitions. The authors tested a methodology using palaeoecological records to evaluate this conceptual framework and answer: (1) Which settings are most vulnerable to shifts in fire regimes resulting from human activity? (2) Where have humans promoted fire in areas where it would not otherwise occur? (3) At what scales are human influences most relevant?
- **Terms/ Definitions:** The article used the term "Aboriginal burning" to refer to "deliberate fire use" by Australian Aboriginals, but used the term "pre-European anthropogenic fire" and "deliberate burning" when discussing fire use by Indigenous people in the Americas.
- **Framing and Intended Audience:** This study focuses on example fire regimes in four temperate forest regions in the northwestern U.S., southern South America, New Zealand, and Tasmania. This article was published in *Global Ecology and Biogeography*, a peer-reviewed scientific journal that publishes studies on broad-scale, general patterns in the organization of ecological systems and processes. The authors are ecologists and biogeographers working in three of the four regions represented in this study: the northwestern U.S. (Montana and Colorado), Tasmania, and New Zealand.
- **Methods:** The authors described a conceptual framework for predicting ecosystem sensitivity to anthropogenic burning based on ecosystem productivity, fuels, and level of human activity. They then compare this conceptual framework against existing historical reconstructions of fire, vegetation, climate, and human settlement in four global regions (Northwestern U.S., southern South America, New Zealand, and Tasmania) to evaluate the effectiveness of this framework. Paleofire records primarily consisted of sediment and charcoal deposits from the Global Charcoal Database.
- **Results:** Previous research on historic fire regimes shows that a temperate ecosystem's sensitivity to human-ignited fires is modulated by the frequency of natural fires and fuel moisture, type, and availability. Palaeoecological data from the four study regions showed that the effects of anthropogenic burning were greatest where fire was naturally rare, fuel availability was high, and vegetation was poorly adapted to fire. The effects of anthropogenic burning were less perceptible in areas where fire was naturally frequent, and vegetation was fire-adapted.
- **Significance:** This article investigates ecosystem sensitivity to anthropogenic burning at a global scale, particularly when and where ecosystem state transitions are most likely to occur due to anthropogenic-fire-vegetation feedbacks. Palaeoecological data from this study suggests that the largest ecosystem state transitions driven by anthropogenic burning have historically occurred in areas experiencing few natural fires. Further, in fire-frequent ecosystems, the effects of anthropogenic burning are less perceptible in paleofire records.

Article ID: 1128

O’Gorman, Cory J., Lisa P. Bentley, Clint McKay, Margaret Purser, and Kylie M. Everly. 2022. “Examining Abiotic and Biotic Factors Influencing Specimen Black Oaks in Northern California to Reimplement Traditional Ecological Knowledge and Promote Ecosystem Resilience Post Wildfire. *Ecology and Society* 27 (2): 19. <https://doi.org/10.5751/ES-13187-270219>

- **Research Questions/ Objectives:** The authors identified and mapped black oak trees at the Pepperwood Preserve in Santa Rosa, California and to identify abiotic and biotic factors affecting the species’ growth and habitat post-wildfire. Three objectives included: (1) measure the effects of forest densification on specimen oak crown shape, (2) measure the accumulation of fire fuels since the Tubbs Fire in 2017, and (3) measure scorch height on the specimen trees to determine the impact of fire severity.
- **Terms/ Definitions:** The authors defined “Traditional Ecological Knowledge” (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.” They considered cultural burning to be a practice within a larger system of TEK, and defined it in relation to prescribed burning, stating that “prescribed burns primarily focus on creating fire breaks and reducing fuels, whereas a cultural burn takes an ecosystem level approach to promote the health of the natural environment as a whole, including plant, animal, and human life.” The authors additionally used the term “intentional” when discussing “cultural burning.”
- **Framing and Intended Audience:** This study was a collaboration between academic researchers at Sonoma State University and the Native Advisory Council of Pepperwood. It was published in *Ecology and Society*, a peer-reviewed journal that publishes research on social-ecological systems and resilience. At the time of publication, one author was a graduate student and one was an undergraduate research assistant, both in biology at Sonoma State University. One author was a professor of biology and one is an emeritus professor of anthropology, both at Sonoma State University. One author was the chair of the Pepperwood Native Advisory Council.
- **Methods:** By performing cruising surveys, 55 specimen black oaks were identified by vehicle and by foot along main roads at the Pepperwood Preserve in northeast Sonoma County, California. Each specimen was measured for tree height, crown area, live crown ratio, the number and size of surrounding trees, and amount of surface and ladder fuels. Within two weeks following the Kincade Fire of 2019, scorch height was measured on all specimen oaks using an inclinometer or meter tape.
- **Results:** Forest densification was found to have a strong negative effect on canopy area and live crown ratio of specimen oaks, but did not affect surface and ladder fuel accumulation. Neither fuel loads nor densification significantly affected scorch height on specimen oaks after the Kincade Fire. Fuel loads were relatively low and homogeneous at all 55 specimen oaks, which the authors attributed to the Tubbs Fire of 2017.
- **Significance:** In black oak woodlands ranging from southern Oregon to Baja California, Indigenous groups have historically used low-intensity anthropogenic fires to support the proliferation of black oaks and the ecocultural resources they provide. More recently, fire suppression has engendered densification by Douglas-fir and hardwood species. Competition by neighboring trees increases oak drought sensitivity, mortality, and decreased acorn production. This study investigated the effects of densification on other biotic and abiotic factors of black oak trees, including crown area, live crown ratio, and post-fire resilience, to support the resilience and regeneration of legacy trees and their ecocultural resources. The authors also stress the

importance of including Indigenous communities in decision making and funding Indigenous involvement and leadership in management.

Article ID: 1132

Prichard, Susan. J., Paul F. Hessburg, R. Keala Hagmann, Nicholas A. Povak, Solomon Z. Dobrowski, Matthew D. Hurteau, Van R. Kane, Robert E. Keane, Leda N. Kobziar, Crystal A. Kolden, Malcolm North, Sean A. Parks, Hugh D. Safford, Jens T. Stevens, Larissa L. Yocom, Derek J. Churchill, Robert W. Gray, David W. Huffman, Frank K. Lake, and Pratima Khatri-Chhetri. 2021. "Adapting Western North American Forests to Climate Change and Wildfires: 10 Common Questions." *Ecological Applications* 31(8): e02433. <https://doi.org/10.1002/eap.2433>

- **Research Questions/Objectives:** This study reviewed the scientific basis for adaptation- and restoration-oriented management strategies for western North American forests within the contexts of management history, climate change and shifting wildfires regimes. The paper addressed ten common questions surrounding forest adaptation to climate change and the efficacy of forest management strategies that promote forest resilience. Although not explicitly included within this question list, Indigenous knowledge and fire stewardship were invoked as necessary components for the answers they provide.
- **Terms/ Definitions:** The authors used the term "Indigenous burning practices" (also referred to as "Indigenous fire use", "Indigenous cultural burning", "Indigenous fire stewardship", and "Indigenous ignitions"). The term was not explicitly defined, but referred to the intentional use of fire to create and maintain specific vegetation patterns. The authors used the terms "stewardship", "management", "intentional", "traditional knowledge", and "fire use" when discussing "Indigenous burning practices."
- **Framing and Intended Audience:** Some authors were U.S. government employees and forest ecologists who were invited by *Ecological Applications* to be featured in a "Climate Change and Western Wildfires" special issue. *Ecological Applications* is a journal interested in addressing environmental problems with ecological science and is intended for use in academia and management. One author is of Karuk descent.
- **Methods:** This study reviewed scientific literature on forest adaptation strategies in western North America to evaluate effectiveness of different management strategies. The synthesis provided explanations for adaptive strategies with a structure provided by ten questions they identified as "common" within the subject area of adaptive forest management. There was no detailed methods section for this review describing how articles were selected nor how the review questions were determined.
- **Results:** The article found that while forest management most often cannot return forests to historical fire regimes, adaptive fire management strategies that restore active fire regimes are necessary for forest resilience. The authors consider that the literature reviewed sufficiently establishes that, among other factors, Indigenous fire stewardship has shaped forest composition and fire regimes in western North America for millennia. The literature supported managed wildfire, prescribed burning, cultural burning, and mechanical thinning with prescribed burning as adaptation options that can mitigate the effects of severe wildfires and promote forest resilience if applied over large areas. The article called for the need to merge Indigenous and Western knowledge to restore active fire regimes, but did not describe how this could be done.
- **Significance:** The article states that understanding of cultural burning practices along with other factors affecting wildfire severity is necessary for determining where to prioritize management strategies. The authors also state that the scientific consensus surrounding the management needs for western North American forests are in close alignment with those prescribed by Indigenous knowledge and values and that a successful strategy must merge Indigenous

knowledge with Western knowledge. This article contributes to the literature on Indigenous fire stewardship because, as a broad-scaled, multi-authored review of a high-profile topic (management strategies for western North American forests), it acknowledges and highlights the importance of cultural burning and Indigenous knowledge for informing the restoration of active fire regimes and fostering overall forest resilience.

Article ID: 1243

Roos, Christopher I., María N. Zedeño, Kacy L. Hollenback, and Mary M. H. Erlick. 2018. "Indigenous Impacts on North American Great Plains Fire Regimes of the Past Millennium." *Proceedings of the National Academy of Sciences* 115 (32): 8143-8148.
<https://doi.org/10.1073/pnas.1805259115>

- **Research Questions/ Objectives:** There is debate about the relative importance of human activity and climate in shaping fire regimes. This study explored historic human and climate impacts on fire regimes in the Great Plains region to better understand how human populations can impact fire regimes, even in areas where climate strongly impacts fuel loads.
- **Terms/ Definitions:** The authors used the terms "hunter-gatherer burning", "anthropogenic burning", and "fire use", but did not explicitly define the practices.
- **Framing and Intended Audience:** Two authors were professors of anthropology at Southern Methodist University. One author is a research anthropologist at Arizona State, and one was a graduate student in Sociology and Anthropology at Utah State. This article was published in *PNAS*, a multidisciplinary scientific journal of the National Academy of Sciences.
- **Methods:** This study conducted archaeological surveys and excavations along the Two Medicine River Valley in Montana. Charcoal and animal bone material was collected at excavation sites and radiocarbon-dated to understand historical land use in the Two Medicine Valley. Erosion profiles were manually cleared at two sites to further develop fire chronologies. These deposits were then compared to variability in drought conditions, used as a proxy for fuel production, to compare human and climate impacts on fire regimes.
- **Results:** Unusually high prairie fire activity was found to occur between 1100 and 1650 CE, which aligns with the duration of a phase of Indigenous bison hunting characterized by the use of fire. While fires persisted both before and after this phase, the absence of similar charcoal deposits in strata predating and postdating this phase suggests that the fire regime was quantitatively different during this phase. This pattern suggests that hunter-gatherers can have a significant impact on fire regimes.
- **Significance:** Although there is debate about the mutually exclusive nature of climate and human impacts on fire regimes, this article states that the two are more closely related because climate variability can influence human decisions to burn. Further, the authors state that human activity can significantly impact fire regimes, even at low population densities and variable climate conditions. Through this, the authors support the suggestion that paired human-climate fire regimes are important parts of fire regimes.

Article ID: 1312

Shebitz, Daniela Joy, Sarah Hayden Reichard, and Peter W. Dunwiddie. 2009. "Ecological and Cultural Significance of Burning Beargrass Habitat on the Olympic Peninsula, Washington." *Ecological Restoration* 27 (3): 306-319. <https://doi.org/10.3368/er.27.3.306>

- **Research Questions/Objectives:** The goal of the study was to determine the short-term effect of low- and high-severity reintroduced prescribed fire, along with manual clearing of woody vegetation, on Beargrass populations. The study specifically evaluated Beargrass flowering, vegetative reproduction, and seedling establishment rates in response to the three treatments.
- **Terms/definitions:** The authors used the terms "Indigenous land management techniques," "traditional burning," and "anthropogenic fire," however, they did not explicitly define these terms.
- **Framing and Intended Audience:** The study focused on low-elevation Beargrass sites on the Olympic Peninsula in Washington. It was published in *Ecological Restoration*, a journal intended for restoration ecology scientists and practitioners. The first author was the Executive Director of the School of Environmental and Sustainability Sciences at Kean University. Another author was a botanist and professor at University of Washington's School of Environmental and Forest Sciences. The third author was an ecological consultant and affiliate professor in the Biology Department at the University of Washington.
- **Methods:** The study evaluated two sites—one in the eastern foothills of the Olympic Peninsula on Skokomish territory, and the other in the Quinault lowlands of the western Peninsula. In 2003, the USDA Forest Service burned a high-severity prescribed fire on the Skokomish site, and in 2004 the Olympic National Forest Fire Crew conducted low-severity burns on the Quinault site. These prescribed fires served as the low- and high-severity fire treatments. The researchers measured vegetative reproduction as the number of new shoots formed by each Beargrass individual in the study plot. They also measured percent cover, crown area, height, and leaf length within Beargrass plots. To investigate the effects of high-severity fire, 22 plots in the Skokomish site were established prior to the 2003 burn (10 plots focused on vegetative reproduction, 12 on seedling establishment); half of the plots were in areas that would be included in the burn. Beargrass population measurements were taken before burning and multiple times for two years after burning. To assess the impacts of low-severity prescribed fire and manual clearing of vegetation, six replicates of control, manual clearing, and low-severity plots were established. Researchers took Beargrass measurements before treatment and one year after treatment.
- **Results:** Over the course of two years, high-severity prescribed fire led to a significant increase in Beargrass seedling establishment and vegetative reproduction; however, it also led to a decrease in Beargrass cover. Low-severity fire did not significantly affect seedling establishment and shoot production, but it also decreased Beargrass cover. Woody vegetation clearing decreased Beargrass cover, and increased shoot production and flowering. These results did not align with the author's predictions, and they explained the lack of significance in the low-severity fire treatment may be due to the low number of sample plots.
- **Significance:** The results signify that fire may be a useful tool for enhancing Beargrass populations in low-elevation regions in the Pacific Northwest. However, the results indicating benefits to seedling establishment were only significant for high-severity fire, and much of the

literature suggests that traditional burning was mainly low-severity. Nonetheless, the authors conclude that “incorporating Native American land management into conservation and restoration efforts has great potential to provide an understanding of the past structure of an area, to restore the native biodiversity, and to strengthen cultural traditions.” This article’s focus on Beargrass is relevant for current and future management considerations because Beargrass populations in low-elevation regions have been declining in recent decades and are threatened by mismanagement and climate change.

Article ID: 1303

Shinn, Dean A. 1980. "Historical Perspectives on Range Burning in the Inland Pacific Northwest." *Journal of Range Management* 33(6): 415-423. <https://www.jstor.org/stable/3898574>

- **Research Questions/ Objectives:** The article described the history of cultural broadcast burning in the inland Pacific Northwest and its impact on vegetation ecology and native grazing animals.
- **Terms/ Definitions:** The author primarily used the term "cultural broadcast burning", but did not explicitly define it. They also occasionally used the terms "traditional broadcast burning" and "burning practices."
- **Framing and Intended Audience:** The article was published in the *Journal of Range Management*, a journal focused on the ecology and management that now is titled *Rangeland Ecology and Management*. The author holds a master's degree in botany, anthropology, and forest management.
- **Methods:** The author combined ecological and historical data, such as journals from early explorers and settlers, to assess the influence of cultural broadcast burning on the landscape. The author also analyzed photos of rangelands in east-central Oregon from 1880 to the early 1930's and re-photographed the same sites in 1976 for comparison.
- **Results:** The authors found 24 references to cultural broadcast burning in the journals of early explorers and settlers. Cultural broadcast burning in the Pacific Northwest has a long history, beginning as part of the economies of Pleistocene hunters and evolving to meet objectives such as enhancement of plant foods, opening travel and hunting corridors, and encircling game. European colonization and the eventual policies of fire suppression greatly reduced cultural broadcast burning. This change, along with intensified grazing by European livestock, altered the plant communities of the region. Some white settlers adopted the use of fire from Native groups, but often did so in ways "non consistent with long-standing native cultural standards," that ended up "abusive to native ecosystems." The comparison of site photographs showed that western juniper expanded over time into rangeland ecosystems.
- **Significance:** Cultural broadcast burning in the inland Pacific Northwest has a long and complex history. The author emphasizes that ecologically sound fire management must consider the role of human culture in shaping the "natural fire patterns" of the inland Pacific Northwest.

Article ID: 1282

Storm, Linda and Daniela Shebitz. 2006. "Evaluating the Purpose, Extent, and Ecological Restoration Applications of Indigenous Burning Practices in Southwestern Washington." *Ecological Restoration* 24(4): 256-268.

<https://cascadiaprairieoak.org/documents/Indigenousburning.pdf>

- **Research Questions/ Objectives:** The article evaluated historical data and conducted surveying on the Upper Chehalis River basin prairies in southwestern Washington to determine the extent to which traditional ecological management influenced prairie distribution and composition. They additionally explore how different burning frequencies influence camas productivity.
- **Terms/ Definitions:** The authors primarily used the term "Indigenous burning practices", but used the terms "traditional ecological management practices", "Native American burning", and "prescribed burning" interchangeably. They did not explicitly define any of these terms, but described burning on a regular basis to manage the land.
- **Framing and Intended Audience:** The article was published in *Ecological Restoration*, a peer-reviewed journal focused on the science and practice of restoration ecology. The authors are ethnobotanists.
- **Methods:** The authors evaluated paleoecological, archaeological, ethnographic, ethnohistoric, ethnobotanic, and ecological data to reconstruct the historic patterns and purposes of Indigenous burning in the Upper Chehalis River basin prairies of Washington. To determine the effect of fire on camas productivity, the authors used prescribed burns by The Nature Conservancy staff at the Glacial Heritage Preserve as a proxy for Indigenous fire. They compared camas productivity and abundance prior to burning and 1, 2, and 3 years after burning.
- **Results:** Multiple lines of evidence show that Indigenous people in the Upper Chehalis burned prairies in the fall for a variety of reasons, such as root, berry, and nut production at return intervals of one to two years. Results of the camas experiment indicate that burning had a significant effect on camas abundance, with areas burned annually having more abundance than areas burned every three years or not at all.
- **Significance:** The authors suggest that current land managers should incorporate Indigenous burning practices into current land management through an interdisciplinary and integrative approach. They recommend that restoration ecologists address cultural objectives and simulate or incorporate Indigenous management practices into restoration planning. The article suggests a framework for managing lands that were formerly managed by Indigenous burning, which includes reconstructing historic fire regimes that reflect Indigenous burning, conducting exploratory experiments.

Article ID: 1113

Weisberg, Peter J. and Frederick J. Swanson. 2003. "Regional Synchronicity in Fire Regimes of Western Oregon and Washington, USA." *Forest Ecology and Management* 172 (1): 17-28.

[https://doi.org/10.1016/S0378-1127\(01\)00805-2](https://doi.org/10.1016/S0378-1127(01)00805-2)

- **Research Questions/ Objectives:** The objective of this study was to describe temporal changes in area burned over a 600-year period using ten tree-ring-based fire history studies located west of the crest of the Cascade Range in the Pacific Northwest, and to evaluate the relative importance of human and climate factors for influencing the temporal patterns of area burned.
- **Terms/ Definitions:** The authors used the terms "burning by native people" and "native burning" but did not define them. They noted that native burning may have been an important ignition source for fires in the region prior to the late 1700s.
- **Framing and Intended Audience:** This study analyzes ten landscape-scale fire history studies in the Douglas-fir/ western hemlock forests west of the crest of the Cascade Range in Oregon and Washington. This article was published in *Forest Ecology and Management*, a journal that publishes scientific articles linking biological and ecological science with forest management and conservation. At the time of publication, one author was a forest ecologist at Oregon State University and one was a research scientist with the USDA Forest Service.
- **Methods:** To collect the ten fire history studies for analysis, the authors conducted a review of literature and databases concerning tree-ring-based, fire history studies for the study area then selected for analysis those that reported sizes of historical fires or provided information from which fire size estimates could be derived. A return interval of 25 years was selected to allow for potential dating errors arising from field counting of tree rings, rather than precise dendrochronological cross-dating. The area burned in each 25-year interval was calculated for each study then compared against time periods representing climate effects, anthropogenic activity, and coupled "climate x human" effects. Five time periods representing climate effects were delineated based on published tree-ring chronologies from the Washington Cascades. Four time periods representing human effects included: Indigenous influences (1551-1775), low human population (1776-1850), Euro-American settlement (1851-1925), and fire suppression (1926-1996).
- **Results:** Anthropogenic activity, climate, and fuel loads appeared to have interacted in their influence on temporal patterns of area burned. There was no association found between the frequency of widespread fire and climate effects alone, but the strongest association with widespread fire occurred between periods of combined human and climate effects. Temporal changes in area burned can roughly be characterized as: a period of widespread fire from ca. 1400 to 1650; a period of reduced area burned from ca. 1650 to 1800; widespread fire associated with European exploration and warm conditions from ca. 1801 to 1925; and reductions in burned area resulting from fire suppression beginning in ca. 1911.
- **Significance:** Results from this study suggest that combined changes in climate, anthropogenic activity, and fuel loads likely influenced fire patterns in the study region during the time period considered. While climatic, anthropogenic, and stand development influences have varied at similar times, humans have greatly limited wildfire occurrence between ca. 1911 and 1996 due to fire suppression, despite generally warm temperatures.

Article ID: 1284

Whitlock, Cathy, David B. McWethy, Alan J. Tepley, Thomas T. Veblen, Andrés Holz, Matt S. McGlone, George L. W. Perry, Janet M. Wilmhurst, and Samuel W. Wood. 2015. "Past and Present Vulnerability of Closed-Canopy Temperate Forests to Altered Fire Regimes: A Comparison of the Pacific Northwest, New Zealand, and Patagonia." *Bioscience* 65 (2): 151-163.

<https://doi.org/10.1093/biosci/biu194>

- **Research Questions/ Objectives:** The goal of this paper is to explain the differences in the influence of pre-European human-set fires in the seasonally dry forest types of the Pacific Northwest, New Zealand, and northern Patagonia. To do so, this paper examines the degree to which fire-driven changes in prehistoric vegetation can be explained by: regional differences in the life histories and fire adaptations of the dominant tree species; the strength of positive feedbacks driven by postfire vegetation flammability; late-Holocene climactic conditions; and anthropogenic ignitions.
- **Terms/ Definitions:** The authors used the terms "anthropogenic burning" and "ignition source." Although they did not explicitly define these, they stated that, "Indigenous people alter natural fire regimes directly, by offering a new ignition source, suppressing fires, and modifying vegetation and corresponding fuel patterns." The authors also suggested that this alteration of fire regimes could include the practice of fire use.
- **Framing and Intended Audience:** This article was published in *BioScience*, a peer-reviewed scientific journal that publishes research, essays, and discussion sections on biology and the education, public policy, and history of the biological sciences. The authors are professors, postdoctoral research associates, and research scientists of ecology and biogeography in the United States, New Zealand, and Tasmania.
- **Methods:** No methods were stated. The authors relied on previously published literature to study differences in the life history strategies of the dominant tree species, postfire vegetation dynamics, late-Holocene climactic controls on fire, and prehistoric anthropogenic burning in mesic-dry forests across the three study regions. No empirical evidence was collected in this study.
- **Results:** This analysis suggests that climate conditions and vegetation characteristics of Douglas-fir (*Pseudotsuga*) were largely responsible for a relatively limited impact of prehistoric anthropogenic burning on mesic-dry forests in the Pacific Northwest, whereas mesic-dry forests dominated by gymnosperms and southern beeches (*Nothofagus spp.*) in New Zealand and Patagonia were more vulnerable to changes associated with anthropogenic burning. These climactic and vegetation characteristics include: a relatively shorter duration of the flammable early-seral vegetation state in the Pacific Northwest; the relatively greater persistence of forest canopy in portions of postfire PNW forests, which enable Douglas-fir to rapidly colonize postfire patches; and the more continental setting of the PNW which supports climactic patterns conducive to fire ignition. This study suggests that while there exists potential for positive fire feedbacks in all three forest regions, the long-term state transition from forest to shrubland was and is less common in the PNW than in New Zealand or Patagonia.
- **Significance:** This article states that human efforts to modify vegetation using fire were neither maximally transformative nor were they completely dependent upon random, natural ignitions. Rather, human efforts and ability to modify vegetation using fire were shaped and constrained

by moisture conditions, vegetation characteristics, natural fire regimes, and available resources, together which define the scale of anthropogenic influence on the landscape. Because these variables collectively shape the efficacy of anthropogenic landscape impacts, pre-European anthropogenic burning had a relatively limited effect on vegetation in the mesic-dry forests of the Pacific Northwest relative to comparable forest types in other regions of the world.

Article ID: 1289

Wray, Jacilee and M. Kat Anderson. 2003. "Restoring Indian-Set Fires to Prairie Ecosystems on the Olympic Peninsula." *Ecological Restoration* 21 (4): 296-301.

<https://www.jstor.org/stable/43442712>

- **Research Questions/ Objectives:** The authors aimed to: explore the importance of Pacific Northwest prairie ecosystems to biocultural diversity conservation; detail the creation and maintenance of these prairie ecosystems through natural and cultural processes; and make a case for their restoration in Olympic National Park and the surrounding region of the Olympic Peninsula using Native American traditional ecological knowledge and practices.
- **Terms/ Definitions:** The authors used the terms "Indigenous burning," "Indian burning," "traditional burning," and "Native American burning." They do not explicitly define any of these terms.
- **Framing and Intended Audience:** This is a "case study" article published in *Ecological Restoration*, a peer-reviewed journal focused on the science and practice of restoration ecology. The authors are anthropologists and ecologists.
- **Methods:** No methods stated; however, the authors briefly discuss preliminary findings from their ethnobiological study of the Ozette prairies, which involved a literature review and ethnographic interviews with Makah elders and non-Indian residents of the Olympic Peninsula.
- **Results:** Humans have inhabited the Olympic Peninsula for at least 10,000 years. Indigenous groups on the Olympic Peninsula actively managed prairie landscapes through burning, pruning, and tillage prior to European colonization- likely beginning around 3,000 to 4,000 years ago when coniferous trees became more established. These culturally managed prairies are biodiversity hotspots that support plant and animal species important for basket weaving, food, clothing, medicines, and other tools. Cranberries, snakeberry, yellow avens, camas, Roosevelt elk, and basket sedge were among the many important species that thrive within prairie ecosystems. Other plants used as food as medicine, such as western crab apples and salal grow better in the ecotone surrounding prairies than in dense conifer forests. Indigenous groups burned in order to 1) increase the abundance and diversity of useful plants, 2) increase plant production (of fruits, etc.), 3) increase forage for animals, 4) prevent conifer encroachment into the prairies. Preliminary findings from ethnographic interviews, in which Makah elders recall the history of traditional burning, confirm that burning was an important part of managing prairies up until the beginning of the 20th century.
- **Significance:** Olympic Peninsula National Park Services managers are beginning to recognize the importance of understanding Indigenous land management techniques for conservation of prairie ecosystems. As interdisciplinary teams of researchers uncover historic fire regimes of the Olympic Peninsula, these findings could be used to write burning and other fire management prescriptions that replicate Indigenous burning.

Article ID: 1217

Yonk, Ryan M., Jeffrey C. Mosley, Peter O. Husby. 2018. "Human Influences on the Northern Yellowstone Range." *Rangelands* 40 (6): 177-188. <https://doi.org/10.1016/j.rala.2018.10.004>

- **Research Questions/ Objectives:** The authors' goal was to explore the prehistoric and historical role of humans in the ecology of the Northern Yellowstone Range (NYR). As part of that goal, the authors aimed to examine historical Native American impacts to better understand how the ecosystem has changed through time and how minimizing the role of burning and hunting by Native Americans has created unintended and undesirable outcomes; explore historical impacts by Euro-American fur trappers, miners, ranchers, and tourists; examine the history of management inside Yellowstone National Park (YNP) and how implementation of modern-day management has had unintended consequences for the people and natural resources of the Northern Range; and provide recommendations for future actions to improve natural resource stewardship of the NYR.
- **Terms/ Definitions:** The authors used the term "Native American hunting and burning." They did not define this phrase, but they used it to refer to a practice that was carried out to sustain native plant and animal abundances and ecological processes.
- **Framing and Intended Audience:** This article was published in *Rangelands*, a journal of the Society for Range Management that publishes work on the science, management, and use of rangelands. It was part of a special issue on the ecology of the NYR. The authors are political scientists, rangeland ecologists, and wildlife biologists.
- **Methods:** No methods are stated. The authors' methods are primarily historical, drawing upon primary historical documents and the work of other environmental historians.
- **Results:** The authors' historical overview of the human influences on the NYR states that hunting, burning, fur trapping, mining, ranching, recreation, and fish and wildlife management have shaped the Northern Range ecosystem. For thousands of years, Native Americans often ignited low-intensity forest and rangeland fires, typically at the end of summer, which suppressed conifer encroachment into grasslands and sagebrush steppe. With the creation of YNP in 1872 and the National Park Service (NPS) in 1916, both wildfire and controlled fire were excluded on the NYR until 1987. Fire exclusion policies have, and continue to have, unintended negative consequences on the NYR ecosystem. The authors recommended that the NPS should ignite more controlled burns on the NYR to purposely mimic the low-intensity fires set by Native Americans and sustain the ecological integrity of the NYR.
- **Significance:** This article provides an overview of the history of human land management in the NYR, with a focus on the management of YNP. The history of human influences on the ecosystem outlined by the authors describes Native American hunting and burning as fundamental components of the natural ecological processes on the NYR. The authors stated that a key flaw of modern land management is a failure to acknowledge the importance of Native American influences on the NYR, and that more controlled burns, paired with greater control of ungulate populations, are needed to support the NYR ecosystem.

Policy articles

Article ID: 1126

Hoffman, Kira M., Amy C. Christianson, Sarah Dickson-Hoyle, Kelsey Copes-Gerbitz, William Nikolakis, David A. Diabo, Robin McLeod, Herman J. Michell, Abdullah Al Mamun, Alex Zahara, Nicholas Mauro, Joe Gilchrist, Russel M. Ross, and Lori D. Daniels. 2022. "The Right to Burn: Barriers and Opportunities for Indigenous-Led Fire Stewardship in Canada." *Facets* 7 (1): 464-481. <https://doi.org/10.1139/facets-2021-0062>

- **Research Questions/ Objectives:** This paper identifies key barriers to re-engaging in cultural burning in Canada and describe calls-to-action to help mitigate each barrier.
- **Terms/ Definitions:** The authors used the terms "Indigenous fire stewardship" and "cultural burning." They did not explicitly define either term, but noted that an aspect of Indigenous fire stewardship is the purposeful application of fire to the landscape as a resource management tool. They also noted that prescribed burning is distinct from cultural burning, primarily in the burn objectives, techniques used to burn, and who conducted the burning. The article also used the terms "traditional knowledge", "practices", and "fire use."
- **Framing and Intended Audience:** This is a perspective article that presents viewpoints from Indigenous and non-Indigenous fire practitioners across government, non-profit, and university institutions. The authors are social and biophysical scientists, land managers, fire practitioners, lawyers, and Indigenous knowledge holders. This article was published in *Facets*, a journal of the Royal Society of Canada's Academy of Science. The journal publishes multidisciplinary science research, reviews, and editorials.
- **Methods:** The authors described their experiences navigating existing biases, governance processes, and capacity issues that hinder Indigenous fire stewardship using a barrier and call-to-action framework. Two case studies, one in Saskatchewan and one in British Columbia, were described to illustrate examples of leading cultural burning initiatives.
- **Results:** Five barriers to engaging in Indigenous fire stewardship were identified: a lack of understanding by management agencies, policymakers, and the general public of the cultural importance of fire; power imbalances between federal/ provincial governance structures and Indigenous community practices; constrained opportunities for cultural burning training and accreditation; financial barriers to fire liability and insurance; and lack of resources (time, person power, tools, money) to re-engage in cultural burning. Calls-to-action to mitigate these barriers include: establishing a National Indigenous Wildfire Stewardship working group; Introducing governance processes that equally prioritize Indigenous knowledge systems; opening up prescribed fire training and accreditation outside of wildfire management agencies; identifying jurisdiction, liability, and land governance barriers through provincial networks of Indigenous and non-Indigenous fire practitioners and researchers; and increasing financial support for cultural burning initiatives, respectively.
- **Significance:** There are many social, cultural, financial, and legislative barriers to reviving Indigenous fire stewardship in Canada. While land management agencies are beginning to show increased interest in Indigenous fire stewardship, Indigenous knowledge is often narrowly appropriated into wildfire management frameworks. Revival of stewardship practices - and desired cultural, spiritual, social, and ecological outcomes - would be more successful if led by

Indigenous people and supported through the formation of new collaborative working groups, equal prioritization of different knowledge systems, and greater funding for cultural burning education, accreditation, and execution.

Article ID: 1134

Hoffman, Kira M., Amy Cardinal Christianson, Robert W. Gray, and Lori Daniels. 2022. "Western Canada's New Wildfire Reality Needs a New Approach to Fire Management." *Environmental Research Letters* 17: 061001. <https://iopscience.iop.org/article/10.1088/1748-9326/ac7345>

- **Research Questions/ Objectives:** This article explored the compounding factors contributing to the wildfire crisis in Canada. The authors and argue that prescribed fire and cultural burning must play a central role in wildfire planning and mitigation.
- **Terms/ Definitions:** The authors defined "prescribed fire" as "the intentional use of controlled burning to manage fuels and landscapes" and "cultural burning" as "the intentional use of fire by Indigenous peoples to achieve cultural objectives."
- **Framing and Intended Audience:** This article is written as a "call to action", intended for those in the ecosystem management and policy field. The primary author is a fire ecologist and was Postdoctoral Fellow at the University of British Columbia (UBC). One author is a member of the Metis First Nation and was a research scientist with the Canadian Forest Service. Another author is a wildland fire ecologist with experience in private consulting with the USDA Forest Service, Parks Canada, The World Bank, and other high-profile agencies and organizations. Another author was a professor in the Department of Forest and Conservation Sciences at UBC.
- **Methods:** No methods were described.
- **Results:** The authors argued that the combination of climate change and a century of fire suppression has led to the unprecedented frequency of large and severe wildfires in western Canada. The article discussed how prescribed fire and cultural burning should play critical roles in future efforts to mitigate catastrophic wildfire and restore ecosystem health. The authors asserted that wildfire planning, mitigation, and prevention should be decentralized, with Indigenous Nations and communities playing a leading role in ensuring wildfire management aligns with both cultural and ecological values.
- **Significance:** This article demonstrates the role that historical mismanagement has played in contributing to Canada's current wildfire crisis. It outlines ways in which the fire management community can overcome existing systemic barriers—such as educating the public on risk reduction techniques, enhancing technical training across cultures and areas of expertise, and collaborating with communities on wildfire mitigation. Overall, the article is a call to action for the wildfire management community in Canada to increase use of prescribed fire and support Indigenous-led cultural burning.

Article ID: 1127

Kimmerer, Robin W. and Frank K Lake. 2001. "Maintaining the Mosaic: The Role of Indigenous Burning in Land Management." *Journal of Forestry* 99 (11): 36- 41.

https://www.researchgate.net/publication/285728799_Maintaining_the_Mosaic_The_role_of_indigenous_burning_in_land_management

- **Research Questions/ Objectives:** This article highlights the findings of the literature on Indigenous fire from human and land-centered disciplines (e.g., anthropology, ecology).
- **Terms/ Definitions:** The authors used the terms "Indigenous burning", "aboriginal fire", anthropogenic fire, Indigenous practices, Indigenous fire management, and Indian fires, presumably these terms variously aligned with the literature they cited. Although they did not define the terms, they used them in specific reference to the intentional "application of fire technology" as a management practice to manipulate fire return intervals on the landscape for a variety of listed reasons.
- **Framing and Intended Audience:** This article is a literature review written by a research ecologist with the USDA Forest Service and a professor of environmental biology at SUNY- ESF. One author is a member of the Citizen Potawatomi Nation, the other is of Karuk descent. The article was published in *Journal of Forestry*, a peer-reviewed journal by the Society of American Foresters that aims to inform forest management professionals about new research developments in forest economics, ecology, history, policy, hydrology, and other facets of forestry.
- **Methods:** The authors did not describe their methods for selecting the literature included in their review.
- **Results:** Fire was intentionally used by Indigenous communities to create a mosaic of habitat patches that promoted food security by ensuring a diverse and productive landscape. It is also viewed by many Indigenous groups as a tool given to people to fulfill a spiritual responsibility to care for the land. Indigenous burning differs from a nonanthropogenic fire regime (wildfire) in five respects: seasonality, frequency, extent, site, and outcome. While not a panacea for problems of fuel buildup, the authors conclude that restoration of Indigenous fire stewardship should be part of management agencies' strategies for the forest restoration. Currently, the main impediment to broader acceptance of Indigenous fire use and impact is a lack of understanding of its cultural context.
- **Significance:** This article helps to define Indigenous fire stewardship, its rationale, and its potential role in forest restoration.

Article ID: 1181

Levy, Sharon. 2005. "Rekindling Native Fires." *BioScience* 55 (4): 303-308.

[https://doi.org/10.1641/0006-3568\(2005\)055\[0303:RNF\]2.0.CO;2](https://doi.org/10.1641/0006-3568(2005)055[0303:RNF]2.0.CO;2)

- **Research Questions/ Objectives:** No research questions, objectives, or goals are stated. The article highlights efforts to revitalize Indian burning practices in California.
- **Terms/ Definitions:** The author primarily used the term "Indian burning," which she does not define but used to describe the use of fire to clear underbrush and induce the growth of culturally important plant species, such as hazelnut and tan oak. The author also used the term "indigenous burning."
- **Framing and Intended Audience:** This article was published in *BioScience*, a peer-reviewed scientific journal that publishes research, essays, and discussion sections on biology and the education, public policy, and history of the biological sciences. The author is a freelance science journalist based in California.
- **Methods:** No methods are stated. The author conducted interviews with key informants and highlighted events and policy developments in the revitalization of indigenous burning.
- **Results:** In the western US, fire suppression has led to the disruption of indigenous burning, dangerous levels of fuel accumulation, and Douglas-fir encroachment in California black oak and ponderosa pine woodlands. A US Forest Service program called Following the Smoke has been developed and pairs volunteers with Karuk weavers to clear excess fuels from areas designated for burns and learn about the basketweaving process. In interior Alaska, the Gwich'in people routinely burned along creeks and wetlands to create fresh forage for moose, muskrats, and waterfowl, but those practices have been disrupted due to fire suppression policies. Few prescribed fires take place in these areas of California and Alaska due to limited burn windows, a lack of qualified fire personnel, and conflicts with air quality regulations, endangered species protections, and liability concerns. Aboriginal burning practices in Australia, which have successfully maintained a patchwork of low-intensity intentional burns, may provide inspiration for land managers dealing with the challenges of today's wildfire.
- **Significance:** This article highlights efforts to revitalize indigenous burning practices in California, Alaska, and Australia, and it describes current challenges to the expansion of prescribed burning. The Karuk and Gwich'in Tribes are actively working to restore Indian burning in the US, but limited burn windows and regulatory constraints present key challenges that need to be overcome.

Article ID: 1304

Long, Jonathan W. and Frank K. Lake. 2018. "Escaping Social-Ecological Traps through Tribal Stewardship on National Forest Lands in the Pacific Northwest, United States of America." *Ecology and Society* 23 (2): 10. <https://doi.org/10.5751/ES-10041-230210>

- **Research Questions/ Objectives:** In this paper, the authors asked: "What strategies for managing national forest lands can promote ecological resources and stewardship opportunities that are important for tribes in the Pacific Northwest region?"
- **Terms/ Definitions:** The authors used the terms "tribal stewardship practices" and "traditional practices." Neither was explicitly defined, but the authors noted that traditional practices are important for sustaining community well-being. They also used the term "intentional burning," which they described as a land-tending practice.
- **Framing and Intended Audience:** This paper is based on a larger synthesis report, commissioned by the USDA Forest Service (hereafter, referred to as USFS) in 2015, to promote sustainability of federal forest lands and tribal community wellbeing through improved forest management. As a report for the USFS, the focus of this article is on ecosystems and management decisions in the Pacific Northwest for which federal public land agencies have primary responsibility. This article was published in *Ecology and Society*, a peer-reviewed journal that publishes research on social-ecological systems and resilience. The authors are research ecologists for the Conservation of Biodiversity Program and the Fire and Fuels Program with the USFS. One author is of Karuk descent.
- **Methods:** The authors conducted a narrative review that began with reference lists used in previous synthesis and monitoring reports published after the Northwest Forest Plan was adopted in 1994. Those lists were then expanded with references submitted by the public through an online portal that was open in the winter of 2015-2016. Sources were limited to peer-reviewed and publicly available publications. Over 300 sources were included in the review, which drew most heavily from articles published in scientific journals but also included agency reports, books, theses, and dissertations.
- **Results:** The authors found that many factors stemming from colonization have generated social-ecological traps (persistent, undesirable states that result from interactions between actors and ecology) that have restricted tribes' ability to continue traditional land stewardship activities that supported their wellbeing and promoted ecological resilience. These factors include: legal and political constraints on tribal access and management; declining quality and abundance of forest resources due to inhibition of both natural disturbance and indigenous tending regimes; competition with nontribal users; species extirpations and introductions of invasive species; and erosion of tribal Traditional Ecological Knowledge (TEK) and relationships that are important for revitalizing resource use. Strategies that could redress those factors include: restoring fire regimes through adaptive management; active management interventions, including understory thinning and use of fire, to promote a diverse and reliable supply of ecocultural resources; establishment of gathering areas on public lands that are reserved for tribal use; reintroduction of cultural keystone species that have been removed, in conjunction with restoring their habitats; dam removal; and tribal and federal co-management of land.
- **Significance:** The prohibition of Indigenous fire stewardship and other traditional land stewardship techniques has reduced ecosystem resilience and diversity, supply of ecocultural

resources, and tribal wellbeing. Forest managers could redress these impacts by engaging in adaptive management of diverse fire regimes, rather than fire suppression. They could also engage in more active management of forests, including the application of fire and fire proxies; and form collaborative management partnerships between tribes and government agencies that consider Indigenous knowledge in the planning, implementation, and monitoring of management techniques.

Article ID: 1167

Mason, Larry, Germaine White, Gary Morishima, Ernesto Alvarado, Louise Andrew, Fred Clark, Mike Durglo, Sr., Jim Durglo, John Eneas, Jim Erickson, Margaret Friedlander, Kathy Hamel, Colin Hardy, Tony Harwood, Faline Haven, Everett Isaac, Laurel James, Robert Kenning, Adrian Leighton, Pat Pierre, Carol Raish, Bodie Shaw, Steven Smallsalmon, Vernon Stearns, Howard Teasley, Matt Weingart, Spus Wilder. 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. <https://doi.org/10.5849/jof.11-006>

- **Research Questions/ Objectives:** This article explores ways to integrate Indigenous traditional knowledge and stewardship practices with Western science to address contemporary forest health and wildfire challenges.
- **Terms/ Definitions:** The authors used the term "Native American ecosystem burning," and occasionally "Indian burning." They did not explicitly define either, but they discussed the use of fire on the landscape motivated by crop management, hunting, growth and yield improvement, fireproofing, insect collection, pest management, warfare, signaling, control of resource access, clearing for travel, felling trees, and riparian habitat management. They also used the terms "stewardship", "traditional knowledge", "practices", and "fire use" in relation to "Indian burning."
- **Framing and Intended Audience:** This article provides a summary of a two-day workshop, held in June 2010 on the Flathead Reservation in western Montana, between 7 tribal Elders and 20 Native and non-Native scientists, resource managers, and academics. The article is coauthored by all 27 participants of the workshop. It was published in *Journal of Forestry*, a peer-reviewed journal by the Society of American Foresters that aims to inform forest management professionals about new research developments in forest economics, ecology, history, policy, hydrology, and other facets of forestry.
- **Methods:** A workshop was held for 2 days in 2010 on the Flathead Reservation of the confederated Salish Kootenai Tribes, located in western Montana. The workshop had 27 participants: 7 tribal Elders and 20 Native and non-Native scientists, resource managers, and academics. During the workshop, members of the Confederated Salish Kootenai Tribes facilitated roundtable discussions. Workshop attendance was limited in number and balanced in Indigenous and non-Indigenous representation.
- **Results:** The authors found that the small workshop format was highly effective in facilitating open dialogue among participants. Participants concluded that bridging traditional knowledge with Western scientific knowledge could produce a resource management approach that is stronger than either knowledge system can provide alone. However, integrating and applying these knowledge systems will require commitments to knowledge sharing that defy the usual boundaries of professional training. The authors recommend that these approaches include the creation of a national program for traditional/ scientific knowledge integration, collaborative development of a set of protocols for future cross-cultural partnerships, and cross-cultural partnerships in higher education and environmental research projects.
- **Significance:** A more holistic approach to wildfire is needed to better address social-ecological challenges such as food sovereignty, wellbeing, and megafire risk mitigation. Integrating traditional knowledge and practices with Western scientific knowledge and management frameworks can help create more holistic management policies. Cross-cultural exchange is

needed to develop improved fire management policies, but it is also important to note that local planning that accounts for regional differences among agencies, communities, and Tribes - rather than a broad and generic solution – will be needed.

Article ID: 1254

Murphy, Alexandra, Jesse Abrams, Terry Daniel, and Victoria Yazzie. 2007. "Living among Frequent-fire Forests: Human History and Cultural Perspectives." *Ecology And Society* 12 (2): 17.

<http://www.ecologyandsociety.org/vol12/iss2/art17>

- **Research Questions/ Objectives:** This article provides an overview of three topics: the social factors that affected the ecological structure and function of forests in the U.S.; the changing laws and policies of public land use and management; and the changing public perceptions of fire.
- **Terms/ Definitions:** The authors used the term "Indigenous fire management." They did not explicitly define it, but they described it as a practice that shaped the structure and composition of frequent-fire forests at the landscape scale, through carefully timed burning at specific locations. They also used the term "Indigenous fire use," which they described as a tool based on a mutually beneficial relationship between landscapes and people that modifies, maintains, and restores the structure and composition of frequent-fire forests to meet cultural needs and subsistence use.
- **Framing and Intended Audience:** This is a synthesis article published in *Ecology and Society*, a peer-reviewed journal that publishes research on social-ecological systems and resilience. It was part of a special feature titled "The Conservation and Restoration of Old Growth in Frequent-fire Forests of the American West." At the time of publication, two authors were affiliated with the Ecological Restoration Institute at Northern Arizona University. One author was an emeritus professor of Psychology and Natural Resources at the University of Arizona. One author was a professor of Natural Resources at the College of Menominee Nation.
- **Methods:** The authors synthesized published literature on the history of forest management and policy in the U.S. They did not describe their methods for conducting the synthesis.
- **Results:** The study found that Euro-American influences have greatly altered the frequent-fire, old-growth forests of the interior West that were previously managed through Indigenous cultural burning. Euro-American-forest interactions have occurred roughly in four periods: a period before the mid-19th century, characterized by Indigenous fire stewardship and a relatively low settler-colonial population; a period of rapid colonization of the western U.S. from 1850-1900, characterized by rapid exploitation of old-growth forests; a period from 1900-1960 characterized by strong governmental control of forests under a use philosophy; and a period from 1960 to the present, characterized by challenges to the use philosophy guided by environmental concerns. Two centuries of forest management, which have included overgrazing, high-grade harvesting, and fire exclusion, have made frequent-fire forests prone to stand-replacing wildfire to which neither extraction, nor preservation approaches, have proven tenable throughout the twentieth century. Future conservation and restoration of frequent-fire forests in the U.S. West will depend on strategies that avoid the pitfalls of utilitarianism and preservationist approaches.
- **Significance:** This article provides a history of forest management and fire policy in the U.S. West from roughly 1800 to the present day. Although Indigenous communities have inhabited and modified frequent-fire forests for millennia, social influences over the last two centuries have disrupted the structure and function of forests that are adapted to low- and moderate-severity, frequent-fire regimes. Current conditions of frequent-fire forests in the western U.S. stem from

social forces that have affected forest structure and function, including fire suppression, overgrazing, and high-grade harvesting.

Article ID: 1146

Nikolakis, William, Clive Welham, and Gregory Greene. 2022. "Diffusion of Indigenous Fire Management and Carbon-Credit Programs: Opportunities and Challenges for "Scaling-up" to Temperate Ecosystems." *Frontiers in Forests and Global Change* 5:967653.

<https://doi.org/10.3389/ffgc.2022.967653>

- **Research Questions/ Objectives:** The authors' goal was to examine the potential, opportunities, and challenges for Indigenous-led fire management programs, potentially supported through carbon markets, to be implemented in central British Columbia, Canada. To do so, the authors drew from eight key enabling factors of the Australian savanna burning model to identify a project area that includes Aboriginal title and reserve lands.
- **Terms/ Definitions:** The authors used the term "Indigenous fire management," which they described as "Indigenous peoples putting fire to the landscape."
- **Framing and Intended Audience:** This article focuses on two member First Nations of the Tsilhqot'in, Yunesit'in and Xenigwet'in, and the feasibility of carbon credit revenues to support the Tribes' efforts to restore their traditional fire practices. The article was published in *Frontiers in Forests and Global Change*, a peer-reviewed journal that publishes articles on forests, forest science, forests and climate change, and forest growth and management. One author is a lawyer and director of Gathering Voices Society, an organization that is supporting a pilot program working with the Tsilhqot'in and Yunesit'in to revitalize both Tribes' fire practices. One author is a forest carbon consultant and another is a fire ecologist.
- **Methods:** No methods are stated. The authors conduct an assessment of policy options and implications, looking to Australia's Indigenous-led savanna burning projects as a case study to identify key enabling factors in their program. The authors then describe applicable methodologies and challenges to implement a similar carbon market support system in British Columbia.
- **Results:** Key enabling factors in the Australian savanna burning program included legislation to support the compliance market for "early drought season" fire management; structural support from companies to broker carbon credits to third parties; simplification of project verification; and strong carbon credit prices. Evidence from these north Australian programs shows reductions in wildfire and greenhouse gas emissions, as well as generating positive social outcomes by drawing on Indigenous knowledge and participation. A carbon offset protocol could be implemented in British Columbia to support the Yunesit'in and Xenigwet'in in a pilot project working to revitalize with fire practices. This protocol offers promise for developing verified carbon credits because it includes three main greenhouse gas emissions and has considerable flexibility in compliance and voluntary markets and permitted activities; however, challenges will include the timing of prescribed burning and the application of the "additionality principle," which holds that emission reductions must exceed a business-as-usual (no project implementation) scenario to be considered "additional."
- **Significance:** This paper identifies key areas of opportunity and anticipated challenges to implementing Indigenous knowledge and fire management practices in the Chilcotin in British Columbia. It examines how a carbon credit offset program could be implemented to support current Indigenous-led efforts to revitalize cultural burning, looking to the north Australian savanna burning model for a successful carbon credit offset project.

Article ID: 1149

Nikolakis, William, Emma Roberts, Ngaio Hotte, and Russell M. Ross. 2020. "Goal Setting and Indigenous Fire Management: A Holistic Perspective." *International Journal of Wildland Fire* 29 (11): 974-982. <https://doi.org/10.1071/WF20007>

- **Research Questions/ Objectives:** The goal of this article was to examine what intrinsically motivates people to engage in fire management within local social contexts, such as belief systems and attitudes, with particular focus on desired outcomes.
- **Terms/ Definitions:** The authors introduced the term "Indigenous Fire Management" (IFM). IFM was not explicitly defined but the authors used it to refer to a dynamic and adaptive process embedded within institutional contexts and situated within multiple knowledges.
- **Framing and Intended Audience:** This study focused on the motivations and goals of the Yunesit'in and Xeni Gwet'in First Nations as they develop a fire management program in the Chilcotin, a fire-prone area of British Columbia, Canada. This article was published in *International Journal of Wildland Fire*, a journal that publishes articles on the basic and applied aspects of wildland fire. Two authors worked for Gathering Voices Society, a foundation focused on supporting environmental stewardship programs for Indigenous Canadians. One author was the executive director and another was a researcher for the foundation. At the time of publication, one author was a PhD candidate in Forestry at the University of British Columbia. One author is an Indigenous fire practitioner and chief of the Yunesit'in First Nation.
- **Methods:** The authors conducted 12 interviews with Yunesit'in and Xeni Gwet'in community members in the pilot fire management program from February to May 2019. Interviewees were purposively selected for their knowledge of cultural burning. The interviews were qualitative and unstructured, but topics centered around the importance of reintroducing cultural burning and the desired outcomes of the pilot program. Interviews were recorded, transcribed, and coded for six initial themes: healthy fire management, fewer wildfires, protection of biodiversity, protection of culturally important sites, knowledge transfer, and livelihoods. These codes were modified during qualitative data analysis.
- **Results:** Qualitative analysis of the 12 interviews revealed three clusters of goals for the Indigenous fire management pilot program. The first goal cluster was to strengthen cultural connection and well-being, which encompassed connecting people to land, improving human health, and maintaining and transferring Indigenous knowledge. The second goal cluster was to restore the health of the land, which included a responsibility to protect culturally important sites, maintain traditional foods and medicines, reduce wildfire, and protect Mother Earth (pyrodiversity and biodiversity). The third cluster, "respect traditional laws," focused on fulfilling stewardship responsibilities to the land and to future generations.
- **Significance:** This study documents the goals of Indigenous fire stewardship for two First Nations in Canada. It provides insight into how Indigenous practitioners perceive fire and the utility of fire to achieve certain goals at both individual and community scales. Results reveal that goals for Indigenous fire management include strengthening cultural wellbeing, ecological wellbeing, and fulfilling a spiritual duty to care for the land, which can be used as benchmarks to guide evaluation of the pilot program's success.

Article ID: 1148

Nikolakis, William D, and Emma Roberts. 2020. "Indigenous Fire Management: A Conceptual Model from Literature." *Ecology and Society* 25 (4): 11. <https://doi.org/10.5751/ES-11945-250411>

- **Research Questions/ Objectives:** The objective of this article was to conduct a conceptual framework analysis of literature on Indigenous fire management to create an illustrative framework that enhances our understanding of Indigenous fire management. In particular, the framework aimed to highlight relationships between five main concepts of Indigenous fire management.
- **Terms/ Definitions:** The authors used the term "Indigenous fire management", which they defined as the proactive use of fire to achieve multiple and complex landscape-level objectives, such as cleaning the landscape, mitigating destructive wildfires, and reducing greenhouse gas emissions; ceremony; promoting biodiversity and food security; and generating sustainable livelihoods.
- **Framing and Intended Audience:** This is a synthesis article that was published in *Ecology and Society*, a peer-reviewed journal that publishes research on social-ecological systems and resilience. Both authors work for Gathering Voices Society, a foundation focused on supporting environmental stewardship programs for Indigenous Canadians. One author is the executive director and another is a researcher for the foundation.
- **Methods:** The authors conducted a systematic literature review of Indigenous fire management. 349 papers were initially identified, and 72 were selected for further review based on the following criteria: they were published after 2000 and published in peer-reviewed journals. Literature was organized by discipline and number of citations, then coded for key concepts. The common concepts identified in the literature were then synthesized into a conceptual model. This model was shared with fifteen academics and fire practitioners for review, and their feedback was incorporated where appropriate into the final model.
- **Results:** The authors identified five key concepts that emerged from their literature review of Indigenous fire management: (1) The ontology of fire is socially constructed and perceived differently by Western and Indigenous worldviews, (2) Indigenous fire management often involves collaboration between Indigenous and Western knowledge systems, which occurs within a contested institutional context, (3) Indigenous knowledge and practices are rooted in experiential learning, whereby the landscape drives decision-making, (4) Indigenous fire management can produce social, ecological, economic, and cultural benefits, and (5) Indigenous fire management can achieve ecosystem resilience.
- **Significance:** This article reviews and synthesizes a large amount of the current literature on Indigenous fire stewardship. It presents a conceptual model that helps answer, "What is Indigenous fire management?" by identifying its key elements and the ways in which the elements are interrelated. Importantly, the authors note that most of the literature consulted was developed by non-Indigenous academics and offer a call to action to include more Indigenous voices in future research and practices of fire management. The authors do not describe ways to do this, but they note that Indigenous fire management also exists on its own terms outside of Western fire management frameworks.

Article ID: 1161

Nikolakis, William D. and Emma Roberts. 2021. "Wildfire Governance in a Changing World: Insights for Policy Learning and Policy Transfer." *Risks, Hazards, and Crisis in Public Policy* 13 (2): 144-164. <https://doi.org/10.1002/rhc3.12235>

- **Research Questions/ Objectives:** The goal of this paper was to reveal why and how policy learning and transfer from Indigenous peoples to the state is occurring in wildfire governance, and what are the current barriers to policy implementation. The article examined wildfire governance and policy in British Columbia over the last two decades, with a focus on independent reviews and their recommendations.
- **Terms/ Definitions:** The authors used the term "Indigenous fire management," which they defined as the proactive use of fire to achieve multiple and complex landscape-level objectives, which can include cleaning the landscape, mitigating wildfire, ceremony, and promoting food security (definition based on previous literature- Nikolakis and Roberts, 2020).
- **Framing and Intended Audience:** The article is published in *Risks, Hazards, and Crisis in Public Policy*, a journal that publishes research and commentary on societies' understanding of and measures taken to address risks, hazards, and crises and how and to what effect public policy should address these concerns. Both authors worked for Gathering Voices Society, a foundation focused on supporting environmental stewardship programs for Indigenous Canadians. One author was the executive director and another was a researcher for the foundation.
- **Methods:** The authors identified and described the acts and regulations, implemented since 2000, that make up the legal framework and jurisdiction for wildfire governance in British Columbia. They then described the Tsilhqot'in Fire Management Pilot Program as a case study to demonstrate how Indigenous fire management is being revitalized. For this case study, the authors conducted in-person, un-structured discussions with program participants in April 2019, November 2020, and April 2021.
- **Results:** This article's results highlighted a trend toward more proactive wildfire management approaches, such as Indigenous fire management and mechanical thinning, that has been driven by policy learning. However, British Columbia continues to prioritize spending on reactive and centralized wildfire response, such as wildfire suppression. There is recognition for increased involvement of Indigenous fire management in wildfire governance, but barriers remain to learning and policy transfer including regulatory fragmentation, fiscal constraints, and established power dynamics between Indigenous fire practitioners and federal or provincial agencies. Evidence suggested that the trend toward Indigenous fire management offers a path to improved and proactive wildfire governance.
- **Significance:** This article highlights Canadian policy trends in wildfire governance since 2000 and suggests that Indigenous fire stewardship is a proactive approach that can help address increasing wildfire threats. While Indigenous fire stewardship is not a panacea for the complex problem of wildfire, this paper demonstrates that Indigenous fire stewardship has delivered holistic ecological, social, cultural, and spiritual outcomes. Current barriers to the transfer of Indigenous fire management in federal policy include financial and regulatory/ permitting constraints and unequal power dynamics. This article suggests that addressing these barriers can support greater implementation of Indigenous-led fire management approaches and improved wildfire governance.

Appendix B

Detailed Explanation of Search Methods

Appendix B. Detailed explanation of search methods

We conducted a preliminary assessment of literature by examining a convenience sample of twelve recent or commonly cited peer reviewed articles on IFS already familiar to some of the authors (Timbrook, Johnson, and Earle 1982; Kimmerer and Lake 2001; Hoffman et al. 2022; Long, Lake, and Goode 2021; Lightfoot et al. 2021; Christianson, 2014; Copes-Gerbitz, Hagerman, and Daniels 2021; Eisenberg et al. 2019; Long et al. 2017; Knight et al. 2022; Shinn 1980; Derr 2014). Using these sources, we identified a list of terms and phrases from the titles, abstracts, key words, and manuscript bodies of these twelve articles that referred to or related to the topic of IFS, many of which we considered synonyms for IFS. We then used this list to create Boolean statements for the systematic literature search. We chose four commonly used academic databases for the search: Web of Science, BioOne, JSTOR, and PAIS Index. We also included the Bibliography of Indigenous Peoples of North America to account for historical or culturally focused articles. In some cases, our Boolean statements were too broad for JSTOR which yielded extensive results unrelated to IFS. Therefore, we modified the search statements for JSTOR iteratively until they yielded mostly relevant results (Table A1).

Table A1. Boolean search statements by academic database.

Search ID	Database Name	Search Phrase
1	Web of Science	("Indigenous burning" OR "traditional burning" OR "Indian burning" OR "cultural burning" OR "Tribal burning" OR "Native burning" OR "Aboriginal burning") AND ("Alaska" OR "Oregon" OR "Pacific Northwest" OR "California" OR "British Columbia" OR "Washington" OR "Idaho" OR "PNW")
2	Web of Science	("Indigenous" OR "Indigenous-led") AND ("fire management" OR "fire stewardship") AND ("Alaska" OR "Oregon" OR "Pacific Northwest" OR "California" OR "British Columbia" OR "Washington" OR "Idaho" OR "PNW")
3	BioOne	("Indigenous burning" OR "traditional burning" OR "Indian burning" OR "cultural burning" OR "Tribal burning" OR "Native burning" OR "Aboriginal burning") AND ("Alaska" OR "Oregon" OR "Pacific Northwest" OR "California" OR "British Columbia" OR "Washington" OR "Idaho" OR "PNW")
4	BioOne	("Indigenous" OR "Indigenous-led") AND ("fire management" OR "fire stewardship") AND ("Alaska" OR "Oregon" OR "Pacific Northwest" OR "California" OR "British Columbia" OR "Washington" OR "Idaho" OR "PNW")
5	Bibliography of Indigenous Peoples in North America	("Indigenous burning" OR "traditional burning" OR "Indian burning" OR "cultural burning" OR "Tribal burning" OR "Native burning" OR "Aboriginal burning") AND ("Alaska" OR "Oregon" OR "Pacific Northwest" OR "California" OR "British Columbia" OR "Washington" OR "Idaho" OR "PNW")
6	Bibliography of Indigenous Peoples in North America	("Indigenous OR "Indigenous-led") AND ("fire management" OR "fire stewardship") AND ("Alaska" OR "Oregon" OR "Pacific Northwest" OR "California" OR "British Columbia" OR "Washington" OR "Idaho" OR "PNW")
7	JSTOR	("Indigenous fire management") AND ("Alaska" OR "Oregon" OR "Pacific Northwest" OR "California" OR "British Columbia" OR "Washington" OR "Idaho" OR "PNW")

8	JSTOR	("Indigenous fire stewardship") AND ("Alaska" OR "Oregon" OR "Pacific Northwest" OR "California" OR "British Columbia" OR "Washington" OR "Idaho" OR "PNW")
9	PAIS Index	("Indigenous fire management") OR ("Indigenous fire stewardship") AND ("Alaska" OR "Oregon" OR "Pacific Northwest" OR "California" OR "British Columbia" OR "Washington" OR "Idaho" OR "PNW")
10	PAIS Index	("Indigenous burning" OR "traditional burning" OR "Indian burning" OR "cultural burning" OR "Tribal burning" OR "Native burning" OR "Aboriginal burning") AND ("Alaska" OR "Oregon" OR "Pacific Northwest" OR "California" OR "British Columbia" OR "Washington" OR "Idaho" OR "PNW")
11	JSTOR	("Pacific Northwest") AND ("Indigenous burning")
12	JSTOR	("Pacific Northwest") AND ("cultural burning")
13	JSTOR	("Pacific Northwest") AND ("traditional burning")
14	JSTOR	("Pacific Northwest") AND ("Native burning")
15	JSTOR	("Pacific Northwest") AND ("Aboriginal burning")
16	JSTOR	("Pacific Northwest") AND ("Indian burning")

Supporting information for this synthesis is on Scholar's Bank and includes:

1. **Search_Citations.CSV.** This is a list of citations identified in the systematic review. It identifies the database and search terms associated with the article, information on citations, authorship, article type, and ranking used for annotation.
2. **ColumnDescriptions.csv.** Defines column headings for the Search_Citations spreadsheet.
3. **SearchLog.CSV.** Provides details for each systematic search.
4. **IFS_Websites.CSV.** List of websites related to Indigenous fire stewardship in the PNW.

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Appendix C

Further Reading

Appendix C: Further Reading

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Appendix D

Codebook

Appendix D: Codebook

Primary	Code	Description
Definitions	Stewardship	article uses the term stewardship to describe IFS
Definitions	Management	article uses the term management to describe IFS
Definitions	Intentional	article asserts intentional use of fire either by using "intentional" or "deliberate" or "use" for a specific reason
Definitions	Cultural	article uses the term "cultural" as in cultural burning or cultural practice
Definitions	Traditional knowledge	article associates IFS with traditional knowledge or Indigenous knowledge or other cognate (e.g., fire knowledge)
Definitions	Systematic/routine	article uses the term systematic, routine, or regular to describe IFS
Definitions	Not Rx Fire	article differentiates their term for IFS from prescribed fire or conventional fire management
Definitions	Active	article uses the term "active" to describe IFS
Definitions	Burn material	article states what is being burned with IFS (burning of landscapes, prairies, meadows, etc.)
Definitions	Ignition source	article refers to humans (within the context of pre-colonial influence on the fire regime) as an "ignition source".
Social	Provides use rationale (1/0)	article presents empirical evidence for IFS rationale- e.g., interview with elder on why fire was used; or archaeological association with game drive structures
Social	Provisioning	child to "Provides use rationale": presents evidence connecting IFS with provisioning (enhancing productivity/tending plant foods, fibers, animal foods)
Social	Transport/travel	child to "Provides use rationale": presents evidence connecting IFS with clearing corridors for travel
Social	Domestic	child to "Provides use rationale": presents evidence connecting IFS with clearing campgrounds/homesites, reducing fuels/wildfire risk
Social	Social function	child to "Provides use rationale": presents evidence connecting IFS with some other social, cultural, or spiritual function (specify in cell)
Social	Current Indigenous management	study investigates present day fire/ecosystem management led by Indigenous groups (e.g., perspectives, needs, approaches)

Social	Fire ontology	article discusses how fire as a concept is different between cultures (i.e., Western-Urban view is that fire is destructive, bad)
Social	IK and Science	article discusses differences or reconciling Indigenous Knowledge with science
Social	Revitalization and co-benefits	article discusses efforts at cultural revitalization and/or co-benefits to Tribal peoples of the reintroduction of cultural burning to traditional landscapes
Social	Current issues	current issues facing Indigenous communities (e.g., fire suppression continues to impact subsistence, etc.)
Ecological	IFS treatment (if present)	if present, how did they create a "treatment" for IFS? For instance, was it a computer simulation, a real prescribed fire with Indigenous consultation, etc.
Ecological	Present	measures the ecological effect under present day ecological conditions, rather than past/historical
Ecological	IFS proxy (if past)	what type of historical proxy/archive was used? (charcoal, tree rings, etc.)
Ecological	Documents ecological effect	study finds a specific ecological outcome associated with IFS
Ecological	Impacted landscape	child to "Documents ecological effect": study attempts to evaluate the extent to which IFS impacted/alterd the landscape (e.g., as compared to lightning fires, usually these studies have a vague outcome like "found evidence of anthropogenic influence on land," but doesn't tell us anything about the specific ecological impact of IFS)
Policy	How to collaborate	describes guidelines for collaborating with Tribes, addresses how, goes beyond just recommending collaboration Tribes
Policy	Integrate management	suggests that fire managers should integrate IFS into their approach, but might not necessarily explain how
Policy	Recommendations	if they say managers should integrate IFS into modern management, what specific recommendations do they have?
Policy	Historical Policy	discusses the history of fire policy (e.g., how fire suppression has impacted our current ecological conditions)
Policy	Indigenous inclusion	child to "Integrate management": article recommends consulting with/collaborating with Indigenous groups
Policy	Indigenous led	child to "Integrate management": article specifically recommends burns/burn planning should be led by Indigenous groups only

Policy	Governance	article discusses governance issues related to revitalization/restoration of cultural burning either on public lands or private
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