



SOUTHWEST INDIGENOUS STEWARDSHIP

*An annotated bibliography of sources published between
2014-2024*

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Cover photo: The San Carlos/Tonto National Forest Highway Tanks Project. Photo taken by Molly McCormick.

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Kottot wyke? halsaty waali? – In the beginning, fire burned the world. My *Miwko?* (Plains Miwok) ancestors have passed this understanding of fire through generations... Fire is codified in the law of the land, and it has been so since time immemorial; it has always been here and always will be. To live in balance with this land, one must embrace and accept fire's presence.
Don Hankins, *Reading the Landscape for Fire*, Bay Nature Magazine 2021

Overview

Indigenous Peoples have used fire in their stewardship of Southwest landscapes for thousands of years. Understanding how, when, and why Indigenous Peoples have used fire can help keep southwestern ecosystems healthy and resilient. Research on cultural burning and Indigenous Fire Knowledge has often been conducted through extractive ways which have primarily or exclusively benefited Euro-American settlers. To help prevent extractive research methods, studies should be produced collaboratively with Indigenous people, consider cultural priorities, and respect the ways knowledge is produced and guarded by Tribes; information about how research was conducted and informed by Indigenous peoples should be included. The need for a resource that explores fire and forestry publications on Tribal lands with Indigenous support was realized during meetings of the Southwest Fire and Climate Adaptation Partnership's Cultural Burning Roundtable. This annotated bibliography is a purposeful effort to highlight how Indigenous Knowledges can be incorporated with western science research methods in respectful ways, detail information about Indigenous authorship and participation in studies, and elucidate research gaps.

Indigenous burning has been conducted at different scales from small-scale ignitions of individual plants or patches of habitat for cultivation of culturally important food, basketry, and ceremonial plant species to large, landscape-scale fires ignited to maintain grasslands and meadows. Most studies on Indigenous burning in the Southwest involve larger-scale burning practices, highlighting a gap in smaller-scale Indigenous fire stewardship research. However, this lacuna may be intentional as some knowledge of cultural practices is not appropriate to share, the burn may not have been labeled as such or may have taken place in 'working lands' and therefore been overlooked (i.e., use of fire in farm fields), may have been lost or nearly so due to colonization, or may be in the process of cultural recovery. Furthermore, the Southwest contains 45 Indigenous Tribes and Pueblos, each of which has distinct values and practices, heightening the challenge of characterizing cultural uses of fire across this diverse cultural landscape.

This annotated bibliography summarizes fourteen articles published between 2014 and 2024 on historical and modern Indigenous fire practices and cultural burning in the southwestern states of Arizona and New Mexico. This bibliography is intended to be an accessible resource for land managers, wildfire professionals, researchers, cultural burn practitioners, and anyone interested in and affected by fire in the Southwest.

Approach

Literature review

The literature for this synthesis was found primarily through searches of online databases, including Google Scholar and Web of Science. Search terms such as “southwest OR Arizona OR New Mexico OR Colorado Plateau OR Mogollon Rim OR Sonoran Desert,” “Indigenous OR Native American OR Tribal,” and “wildfire OR fire OR forest fire OR cultural burn” were used in combination to find relevant literature. The inclusion criteria for this annotated bibliography were:

- Must be focused on historical or current use of fire by Indigenous People as a land management tool.
- Must be within the Colorado Plateau, Mogollon Rim, Sonoran Desert, and Sky Island bioregions, largely within the US states of Arizona and New Mexico. Because Tribal homelands do not conform to state boundaries, research undertaken outside of Arizona and New Mexico is to be included if current or historical homelands of the Tribes involved overlap with the state boundaries of Arizona or New Mexico.
- Must be a peer or editorially reviewed journal article, book chapter, or Tribal or state or federal agency publication.
- Must have been published between 2014 and July 2024.

Sources cited within the articles that fit our criteria were also reviewed, as well as an overview of articles which included key papers in their citations (via Google Scholar’s “cited by” function), and searches on especially prolific researchers within the field.

The articles reviewed in this bibliography include research undertaken on the current and traditional territories of the Navajo (Diné), Western Apache (Ndée), Chiricahua Apache (Tsokanende), Jicarilla Apache (Haisndayin), Mescalero Apache (Sehende), Hopi, Ute (Núuchi-u), Havasupai (Havsuw' Baaja), Hualapai, Pueblo, Piro, Comanche (Nɛmɛnɛɛ), Zuni, Yavapai, and Paiute Tribes and Peoples. While the publications herein include research done by, with, and on the lands of these Peoples, we acknowledge that there are many more Indigenous Tribes and Pueblos in the Southwest, most of whom have also practiced land stewardship through cultural burning.

Indigenous participation

Indigenous authorship was determined by author self-identification, either in the article itself, or by a Google search of the author’s full name. *Tribal collaboration* was defined as either: (a) one or more of the authors stating Tribal affiliation (i.e., working for a Tribal natural resource department) and/or

enrollment or (b) a statement on Tribal initiation of the research and/or collaboration in the acknowledgement section of or elsewhere within the article. The absence of explicit self-identification from the authors or a note of Tribal collaboration has been marked as “Unknown.” Corrections to these determinations are welcome and will be included in future iterations of this document.

Key trends across publications

This bibliography focuses on papers published since 2014 as publications from the last decade are more likely to recognize and discuss the effects of changing climate patterns; display a shift in attitudes and practices regarding wildfire management; acknowledge the ongoing and historical impacts of Indigenous land stewardship including cultural burning, fuels management, and directed wildfire; and appreciate and state the importance of Indigenous Knowledge in guiding land management. Articles on historical fire regimes in the Southwest published prior to 2014 were less likely to have Tribal collaboration or Indigenous authorship and often lacked acknowledgement of Indigenous presence and influence on fire regimes. While there are benefits to looking at recent publications, this narrow time frame may unintentionally exclude topics and methods that are not as standard in natural science publications, such as ethnographic reports on smaller-scale Indigenous burning practices. Of the 14 papers examined here, half have Indigenous authorship and all but two have explicit Tribal collaboration.

The research contained in this bibliography investigates 2,000 years of Indigenous cultural burning in the Southwest, with some papers covering a wide range of years (i.e. Roos et al. 2021), while others focus on a single fire season (Victor Jr et al. 2014, Spoon et al. 2015, Pyne 2016). Most historical research used methods such as dendrochronology, archeology, and palynology; fewer studies used social science methods such as interviews, oral histories, and ethnology. All the publications in this bibliography found that Indigenous fire management positively impacted forest resilience and heterogeneity at varying scales.

The historical and current practices of Indigenous fire stewardship by Indigenous Peoples in the Southwest form a rich and complex socio-ecological tapestry, much of which has been decimated by colonization. As wildfire science continues to increasingly look towards Tribal priorities and methodologies, many gaps remain, and more collaborative research is needed.

<i>Title</i>	<i>Authors</i>	<i>Year</i>	<i>Ecoregion</i>	<i>States</i>	<i>Time period</i>	<i>Vegetation type</i>	<i>Jurisdiction</i>	<i>Methodologies</i>	<i>Indigenous authorship</i>	<i>Tribal collaboration</i>
Squaring the triangle: Fire at San Carlos	Pyne	2014	Mogollon rim	Arizona	2014	Ponderosa, Pinyon-Juniper	San Carlos Apache	Interviews, literature	Unknown	San Carlos Apache
Modern fire regime resembles historical fire regime in a ponderosa pine forest on Native American lands	Stan et al.	2014	Colorado Plateau	Arizona	1702-2007	Ponderosa	Hualapai Reservation	Dendrochronology,	Unknown	Hualapai Tribe
Fire management of the San Carlos Apache Tribe: A case study in southeastern Arizona	Victor Jr et al.	2014	Mogollon Rim	Arizona	2013	Ponderosa	San Carlos Apache	Oral history, literature review	Yes	San Carlos Apache Tribe
Nuwuvi (Southern Paiute), shifting fire regimes, and the carpenter one fire in the Spring Mountains National Recreation Area, Nevada	Spoon et al.	2015	Great Basin	Nevada	2013	Mixed Conifer	Nuwuvi Nation, Forest Service	Ethnography, interviews, historical literature	Yes	Nuwuvi Nation (Southern Paiute)
Native American depopulation, reforestation, and fire regimes in the Southwest United States, 1492–1900 CE	Liebmann et al.	2016	Southern Rocky Mountains	New Mexico	1492 - 1900 CE	Mixed Conifer	Jemez Pueblo	Archaeology, dendrochronology, LiDAR,	Unknown	Pueblo of Jemez
Fire regime on a cultural landscape: Navajo Nation	Whitehair et al.	2018	Colorado Plateau	Arizona, New Mexico	1644-1920	Ponderosa	Navajo Nation	Dendrochronology	Yes	Navajo Nation
Spatiotemporal variability of human–fire interactions on the Navajo Nation.	Guiterman et al.	2019	Colorado Plateau	Arizona, New Mexico	1700-2017	Ponderosa	Navajo Nation	Dendrochronology, land-use data	Unknown	Navajo Nation
Legacies of Indigenous land use shaped past wildfire regimes in the Basin-Plateau Region, USA	Carter et al.	2021	Colorado Plateau, Great Basin	Utah	~800 CE - Present	Mixed-conifer	Paiute	Paleoecology, paleoethnobotany, dendrochronology, archeology	Unknown	Unknown
Fire ecology and management of southwestern forests	Fulé et al.	2021	Southwest forests	Arizona, New Mexico	Mostly 20th century	Ponderosa, Mixed Conifer, Pinyon-Juniper, Aspen	Mescalero and Jicarilla Apache; Navajo; Pueblos of Acoma, Cochiti, Hopi, Jemez, Santo Domingo, San Juan, Taos, Zuni, and Zia; Hualapi	Literature review	Yes	Unknown

<i>Title</i>	<i>Authors</i>	<i>Year</i>	<i>Ecoregion</i>	<i>States</i>	<i>Time period</i>	<i>Vegetation type</i>	<i>Jurisdiction</i>	<i>Methodologies</i>	<i>Indigenous authorship</i>	<i>Tribal collaboration</i>
Native American fire management at an ancient wildland–urban interface in the Southwest United States	Roos et al.	2021	Southern Rocky Mountains	New Mexico	0 CE - Current	Ponderosa	Jemez Pueblo	Interviews, ethnology, geoarchaeology, dendrochronology, archaeology, LiDAR, paleoecology	Unknown	Pueblo of Jemez, White Mountain Apache, Hopi, Zuni Tribes
Indigenous fire management and cross-scale fire-climate relationships in the Southwest United States from 1500 to 1900 CE	Roos et al.	2022	Sky Islands, Mogollon Rim	Arizona, New Mexico	1500-1900	Ponderosa	Navajo, Jemez, Apacheria	Fire-scar, dendrochronology,	Yes	Jemez Pueblo
Reduced forest vulnerability due to management on the Hualapai Nation	Stan et al.	2022	Colorado Plateau	Arizona	2020	Ponderosa, Pinyon-Oak	Hualapai Reservation	Dendrochronology	Yes	Hualapai Tribe
Stratigraphic evidence for culturally variable Indigenous fire regimes in ponderosa pine forests of the Mogollon Rim Area, East-Central Arizona.	Roos et al.	2023	Mogollon Rim	Arizona, New Mexico	1000 CE-Present	Ponderosa	Fort Apache	Stratigraphic charcoal, pollen, extractable phosphorus, sedimentology, oral history	Yes	White Mountain Apache Tribal Council
Indigenous land use and fire resilience of Southwest USA ponderosa pine forests	Roos et al.	2023	Colorado Plateau, Mogollon Rim	Arizona, New Mexico	1100 CE-Present	Ponderosa, Mixed Conifer	White Mountain Apache, Jemez	Historical ecology, palynology, charcoal stratigraphy, dendrochronology, archaeology	Unknown	White Mountain Apache Tribe, Pueblo of Jemez

Annotated bibliography

Squaring the Triangle: Fire at San Carlos. 2014

This essay uses the 2014 Skunk and Basin fires that occurred on San Carlos Apache Reservation to illustrate the San Carlos Tribe's modern fire management. Pyne reviews literature and conducts interviews with San Carlos tribal members and fire managers to weave a narrative essay on the historic and current state of fire management in the pinyon-juniper woodlands and ponderosa pine forests of the San Carlos Apache Reservation. The Anasazi and Mogollon People, early inhabitants of this land, were densely settled agriculturalists who ignited and used fire extensively. However, by 1500 they had been supplanted by the Western Apache, whose fire practices included management of lightning-ignited wildfires. With the creation of the San Carlos Reservation in 1872 and the amalgamation of the disparate Western Apache groups that were forced off of their lands and onto the Reservation, cultural traditions of fire were also disjointed and divorced from their relevant ecologies. After a century of fire exclusion, both by design and by abusive grazing practices, San Carlos tapped into cultural priorities and decision-making methods to steward natural ignitions towards a fire resilient landscape. Pyne concludes that while such culturally specific practices cannot be copied, they should be learned from and built upon by other southwestern forest and fire managers.

Citation:

Pyne, S. J. (2014). Squaring the Triangle: Fire at San Carlos (p. 13). Fire Research and Management Exchange System. <https://www.frames.gov/catalog/17764>

Modern fire regime resembles historical fire regime in a ponderosa pine forest on Native American lands. 2014

Prescribed burning was reinstated several decades earlier and has been used more widely and more frequently on Tribal lands than on public lands, exemplified by the ponderosa forests on the Hualapai Reservation in northern Arizona. To continue to refine the effective use of prescribed fire as a management tool, the authors investigate a swathe of factors that have influenced fire regimes on Hualapai lands over three distinct periods: historical (1702-1886), fire exclusion and early Euro-American settlement (1887-1957), and modern (1958-2007). Using line transects at five sites, researchers took cross-sections of all fire-scarred trees and used standard dendrochronological features to identify seasonal timing and both temporal and spatial intervals of fires. Analyses showed that several factors regulated fire regimes, and that the historical period had a higher annual frequency of fire and more fires in the summer than the modern period, with virtually no fires during the exclusion period. The authors recommend that managers vary burning schedules to align more closely with the historical period, and state that continued monitoring and adaptation are crucial in the face of climate change.

Citation:

Stan, A. B., Fulé, P. Z., Ireland, K. B., & Sanderlin, J. S. (2014). Modern fire regime resembles historical fire regime in a ponderosa pine forest on Native American lands. *International Journal of Wildland Fire*, 23(5), 686–697. <https://doi.org/10.1071/WF13089>

Fire management of the San Carlos Apache Tribe: A case study in Southeastern Arizona. 2014

This professional paper looks at the success of a large-scale, resource benefit fire as an example of Tribal management using Traditional Fire Knowledge in combination with western fire science to meet cultural objectives of ponderosa pine forest management. The San Carlos Apache Tribe in southeastern Arizona is an amalgamation of several Tribes who were pushed off their lands and onto the resource-poor area of the Reservation in 1872. Although culturally distinct, each of these Tribes have used fire since time immemorial, both in ceremony and to manage the landscape for various objectives. The authors of this study use modern San Carlos Apache oral history to place the Creek Fire (2013) in the context of the resurgence of Traditional Fire Knowledge as part of culturally relevant current fire management practices. Landscape-scale use of fire was excluded from the creation of the Reservation to the 1940s when some burning was reincorporated, though this fire return interval is still nowhere near historical levels (3-11 years). The lightning-ignited Creek Fire was managed for resource benefit and allowed to burn 18,055 acres, much of which had been previously thinned or had recently experienced small-scale fires. The Creek Fire helped achieve the Tribal objective of creating uneven-aged stands and returning to the pre-Euro-settlement fire regime. The authors lay out some of the importance of, and steps for, engaging with Traditional Fire Knowledge as an area of study within current fire science.

Citation:

Victor Jr, M., Thode, A. E., Fule, P. Z., & Huang, C.-H. (2014). Fire Management of the San Carlos Apache Tribe: A Case Study in Southeastern Arizona. Professional paper, Northern Arizona University, Flagstaff, Arizona. <https://nau.edu/wp-content/uploads/sites/140/2014.MarvinVictor.FireManagementSanCarlosApache.pdf>

Nuwuvi (Southern Paiute), shifting fire regimes, and the Carpenter One Fire in the Spring Mountains National Recreation Area, Nevada. 2015

The authors of this paper use the Carpenter One Fire (2013) in southwestern Nevada as a case study to illuminate how social and ecological factors, specifically the effects of the ongoing suppression of Indigenous relationship to land and practice of fire management methods, affect fire regimes. Ignition events (i.e., lightning strikes, prescribed burns, etc.) are considered separately from the ecological and cultural factors that create the conditions for high-intensity fires. Through interviews with Nuwuvi people and a review of historical literature, the authors find that landscape level fire risk changes were brought about by inappropriate management by settlers and governmental agencies. They construct a

“Nuwuvi Fire Management Model” consisting of three components: “1) fuels reduction; 2) patch burning; and 3) restrictions on old growth and green wood harvest.” They propose moving forward with the Nuwuvi Working Group’s (a Nuwuvi, land manager, and stakeholder collaboration) monitoring of site conditions in areas with long-term cultural value and advising of Forest Service personnel. Under this collaboration, Nuwuvi people would be encouraged and supported in harvesting pine nuts, land stewardship and post-fire replanting, and restoring spiritual and cultural connection to the Land.

Citation:

Spoon, J., Arnold, R., Lefler, B. J., & Milton, C. (2015). Nuwuvi (Southern Paiute), shifting fire regimes, and the carpenter one fire in the Spring Mountains National Recreation Area, Nevada. *Journal of Ethnobiology*, 35(1), 85–110. <https://doi.org/10.2993/0278-0771-35.1.85>

Native American depopulation, reforestation, and fire regimes in the Southwest United States. 2016

There are a variety of estimates of Indigenous population levels in the Jemez Province of northern New Mexico prior to European contact, the timing and magnitude of the subsequent population decline, and how this may have affected local and global environmental conditions. The authors use airborne light detection and ranging (LiDAR) to estimate village sizes and populations, adjacent tree establishment timing and tree-ring dating of wood used in structures to estimate the age of villages, and tree-ring fire scar data to examine fire regimes. They estimate that in the early 1500s, 5,000-8,000 people lived in the 18 Jemez villages studied in this publication and that between 1620-1680 this population decreased by 87% to less than 850 people, supporting the hypothesis that the establishment of Spanish missions and increased interactions were concurrent with a massive loss of life. After the population decrease, the areas around these villages showed an increase both in recruitment of ponderosa pine stands and in extensive surface fires, resulting in a net increase in carbon sequestration, further negating simplistic assumptions about human-fire relationships and showing the need for studies on Early Anthropocene fire-regime changes.

Citation:

Liebmann, M. J., Farella, J., Roos, C. I., Stack, A., Martini, S., & Swetnam, T. W. (2016). Native American depopulation, reforestation, and fire regimes in the Southwest United States, 1492–1900 CE. *Proceedings of the National Academy of Sciences*, 113(6). <https://doi.org/10.1073/pnas.1521744113>

Fire regime on a cultural landscape: Navajo Nation. 2018

Native nations are disproportionately impacted by increasing wildfire frequency and severity, yet the majority of tribal forests and woodlands in Arizona and New Mexico have been excluded from studies using fire-scarred tree chronologies. This study examines the fire history of a ponderosa pine dominated high elevation pass on the Navajo Nation which straddles the border between Arizona and New Mexico.

Researchers searched for fire-scarred trees to cross-section using systematic grid-based sampling across plots at various distances from the pass. Tree-ring chronologies of the cross-sectional samples were evaluated, and samples were categorized by distance from the pass. Area burned was shown to have declined overall in the 1800s. Fires were more frequent and smaller in the interior (higher-use) area of the pass when compared with the outer (lower-use) area. Fire years at this site were shown to be largely synchronous with regional fire years across the Southwest, but were of lower severity and non-stand replacing, likely as a result of cultural landscape use by Navajo people. A century of fire exclusion on this landscape is unprecedented and when combined with climate change creates the conditions for extreme fire events.

Citation:

Whitehair, L., Fulé, P. Z., Meador, A. S., Azpeleta Tarancón, A., & Kim, Y.-S. (2018). Fire regime on a cultural landscape: Navajo Nation. *Ecology and Evolution*, 8(19), 9848–9858.
<https://doi.org/10.1002/ece3.4470>

Spatiotemporal variability of human-fire interactions on the Navajo Nation. 2019

Fire regimes in western US forests are usually proposed as being either entirely climate driven or primarily anthropogenically managed, and this study presents a more nuanced evaluation of these two factors on spatial (location, extent and spatial pattern) and temporal (frequency and seasonality) variability of fire regimes. The Navajo Nation in northern Arizona and New Mexico has had little Euro-American settlement and the high-elevation Chuska Mountains and Defiance Plateau have extensive ponderosa forests which have been continuously used in a variety of ways by the Diné (Navajo) People since the late 1600s. The authors estimate historical human settlement location and density using information from the Navajo Nation Forestry Department on modern homesites and perennial lakes and reconstruct fire history using tree-ring fire history methods (dendrochronology). The fire regime, which was initially defined by frequent, large, low-severity, and largely climate-driven fires, was found to have changed across the study area starting in the 1830s, likely due to increased sheep grazing practices. The Diné were forcibly removed to Bosque Redondo in 1863-64 and were allowed to return to Navajo Nation land in 1868. When they returned, US government incentives to escalate pastoralism led to a rapid expansion of grazing practices and the subsequent collapse of the historic fire regime. The exclusion of fire from Navajo Nation forests over the last 130 years has led to actual and potential risk for extensive high-severity fires, and these findings led the authors support the return of frequent, low-severity surface fires to lessen forest susceptibility to extreme fire events.

Citation:

Guiterman, C. H., Margolis, E. Q., Baisan, C. H., Falk, D. A., Allen, C. D., & Swetnam, T. W. (2019). Spatiotemporal variability of human–fire interactions on the Navajo Nation. *Ecosphere*, 10(11), e02932.
<https://doi.org/10.1002/ecs2.2932>

Legacies of Indigenous land use shaped past wildfire regimes in the Basin-Plateau Region, USA. 2021

Indigenous use of fire in the western United States increasingly informs current land management, and this study uses sedimentary proxies from Fish Lake, Utah to understand human land use in high-elevation forests of the Great Basin and Colorado Plateau from 900 CE to the present. The researchers use sedimentary charcoal to examine past fire activity, sedimentary pollen for indications of vegetation changes, radiocarbon-dated archeological sites as evidence of human presence, and tree-rings to evaluate drought and climate variance as a driver of fire activity. The years 900-1400 CE showed high fire activity, high amounts of pollen associated with ethnobotanically relevant species, and high human activity. All levels decrease after 1400 CE until the beginning of Euro-American settlement in ca 1900 CE. The period of most intensive human impact on the local fire regime was also a period of prolonged extreme drought and climactic variability, and the authors hypothesize that the Indigenous use of fire likely mitigated risk and believe that understanding how fire was used in the past can help current managers minimize catastrophic wildfire impacts today.

Citation:

Carter, V. A., Brunelle, A., Power, M. J., DeRose, R. J., Bekker, M. F., Hart, I., Brewer, S., Spangler, J., Robinson, E., & Abbott, M. (2021). Legacies of Indigenous land use shaped past wildfire regimes in the Basin-Plateau Region, USA. *Communications Earth & Environment*, 2(1), 72. <https://doi.org/10.1038/s43247-021-00137-3>

Fire Ecology and Management of Southwestern Forests. 2021

The chapter from the book, *Fire Ecology and Management: Past, Present, and Future of US Forested Ecosystems*, provides a broad overview of forest ecology and climate, fire exclusion history, ongoing management changes, anthropogenic climate change, the future of possible adaptations under a variety of scenarios, and how these elements currently and will affect wildlife and human communities in Arizona and New Mexico. Cultural burning and fire stewardship practices by Indigenous Peoples are briefly examined, with most of the emphasis on post-colonization livestock grazing and other extractive practices. Indigenous cultural practices are tied to the success of the Red Hats (Native American wildland fire crews, first organized in 1948 as part of the Southwest Forest Firefighters program) as extraordinary firefighters, and Traditional Ecological Knowledge (TEK) is emphasized as a necessary component of ongoing adaptation strategies.

Citation:

Fulé, P. Z., Edgeley, C. M., Chambers, C. L., Hoagland, S., & Céspedes, B. (2021). Fire Ecology and Management of Southwestern Forests. In C. H. Greenberg & B. Collins (Eds.), *Fire Ecology and Management: Past, Present, and Future of US Forested Ecosystems* (Vol. 39, pp. 437–463). Springer International Publishing. https://doi.org/10.1007/978-3-030-73267-7_11

Native American fire management at an ancient wildland-urban interface in the Southwest United States. 2021

This study investigates Hemish (ancestors of Jemez Pueblo in northern New Mexico) fire management practices in predominantly high elevation ponderosa pine forests to assess their intentionality and effectiveness and to learn whether fire regimes surrounding Hemish settlements were primarily influenced by climate patterns or management. The authors worked with Tribal members to ensure that culturally private knowledge was not inappropriately shared or translated from Towa into English, and used a combination of dendrochronology, geoarchaeology, paleoecology, archaeology, and ethnography (a branch of anthropology that studies individual cultures) to compare fire activity during different periods of Hemish occupancy with fire activity after settlement by non-Indigenous people and the resultant Hemish population crash. The Hemish people extensively and intentionally used frequent, low-severity, small (<100 ha) fires to create a resource-rich mosaic landscape with a significantly reduced incidence of high severity or crown fires. The effect of Hemish fire management was found to be strong enough to disassociate fire activity from interannual climate patterns which drove extensive fires during unmanaged fire periods. Looking at these management practices for application in today's increasingly vulnerable wildland urban interface, the authors suggest a similar community-based management involving intensive thinning and collecting for firewood, increased cultural tolerance for smoke from prescribed fires, increased defensible space around homes and towns, and use of many small, discontinuous fires to mitigate the potential for large and intense high-severity fire.

Citation:

Roos, C. I., Swetnam, T. W., Ferguson, T. J., Liebmann, M. J., Loehman, R. A., Welch, J. R., Margolis, E. Q., Guiterman, C. H., Hockaday, W. C., Aiuvalasit, M. J., Battillo, J., Farella, J., & Kiahtipes, C. A. (2021). Native American fire management at an ancient wildland–urban interface in the Southwest United States. *Proceedings of the National Academy of Sciences*, 118(4), e2018733118. <https://doi.org/10.1073/pnas.2018733118>

Indigenous fire management and cross-scale fire-climate relationships in the Southwest United States from 1500 to 1900 CE. 2022

The authors argue that a better understanding of historical Indigenous fire management may help guide current management practices and they seek to clarify whether fire regimes have been largely driven by climate or people in Arizona and New Mexico. They emphasize that collaborative Indigenous-led scientific inquiry needs to be prioritized in this and other disciplines, as much knowledge has been lost due to the historical and ongoing effects of settler colonialism. This study examines fire frequency and intensity at three spatial scales and two usage intensities from 1500-1900 CE using a network of 4,824 fire-scarred trees on Diné (Navajo), Hemish (Jemez), and Ndée (Apache) ponderosa pine forests. These three Peoples have used land in different ways and during different times, and the researchers broadly split each Tribe's management into light-use and intensive-use periods. At the small scale (12-250 acres), they found that fire was related to climactic drivers during times of light-use by each group, but

during intensive-use periods, fire intensity and timing was divorced from climate effects. At the regional scale, encompassing the entire dataset across the high-elevation forests of Arizona and New Mexico, neither light- nor intensive-use periods of any of the cultures showed an effect on wildfire frequency or intensity and the climate-driven pattern was the only detectable factor. This dampening of climate influence on fire at local scales has implications for current fire management. The authors argue that centering and scaling-up strategic Indigenous managed pyro-diversity could lead to benefits for biodiversity, fire-vulnerable communities, global carbon emissions, and Indigenous people.

Citation:

Roos, C. I., Guiterman, C. H., Margolis, E. Q., Swetnam, T. W., Laluk, N. C., Thompson, K. F., Toya, C., Farris, C. A., Fulé, P. Z., Iniguez, J. M., Kaib, J. M., O'Connor, C. D., & Whitehair, L. (2022). Indigenous fire management and cross-scale fire-climate relationships in the Southwest United States from 1500 to 1900 CE. *Science Advances*, 8(49), eabq3221. <https://doi.org/10.1126/sciadv.abq3221>

Reduced forest vulnerability due to management on the Hualapai Nation. 2022

The Hualapai know themselves as the People of the Tall Pines, and the health and continuation of the ponderosa pine forest of the Hualapai Nation on the western end of the Grand Canyon is of extremely high cultural value. The last 60 years of management practices of uneven-aged harvesting, thinning for fuels reduction, and frequent prescribed fire in the Hualapai forest has followed a different management plan than similar forests throughout Arizona, and has thus provided scientists with an opportunity to examine forest metrics related to wildfire risk. These metrics include live tree size and density, cut stump size and density, snag size and density, age distribution, regeneration, forest structure, and surface fuel load using tree coring and standard forestry measurement practices. Researchers found that other Arizona forests had higher densities of small diameter ponderosa pines, more Gambel oak, and more coarse woody debris. The combination of lower density and larger trees, reduced coarse woody debris, and more open forest structure shows that the legacy of management of the Hualapai forest has fostered wildfire resilience and that these forests are less likely to experience high-intensity stand-replacing wildfire. Still, the current mean basal area in the relatively open Hualapai forest is still far above pre-colonization levels. The authors conclude that collaboration of Indigenous knowledge, ecological and climate science, and ongoing forest monitoring has been successful at and is necessary for maintaining this culturally and ecologically vital ponderosa pine forest.

Citation:

Stan, A. B., Fulé, P. Z., & Hunter Jr., M. (2022). Reduced forest vulnerability due to management on the Hualapai Nation. *Trees, Forests and People*, 10, 100325. <https://doi.org/10.1016/j.tfp.2022.100325>

Stratigraphic evidence for culturally variable Indigenous fire regimes in ponderosa pine forests of the Mogollon Rim area, east-central Arizona. 2023

This study, part of a larger movement to Indigenize the past by showing a long history of Indigenous land management and fire use, was conducted in east-central Arizona, home to Ancestral Pueblo and Western Apache People since time immemorial. Dividing the last 1,000 years into four periods of varying land use intensity, the authors investigate patterns of anthropogenic fire within the historical fire regime of the ponderosa pine dominant Mogollon Rim in east-central Arizona. Using charcoal and pollen deposits, sedimentology, extractable phosphorus, and Apache oral tradition as equally valuable routes of historical inquiry, the authors of this study surveyed and sampled stratigraphic sequences for fire-related sedimentation and vegetation in two watersheds (Day Wash and Forestdale Valley) with likely Ancestral Pueblo and Apache land-use histories. Fire management was found to have been practiced in areas with intensive cultural use through activities such as firewood harvesting and Indigenous burning, which were indicated by differences in pollen deposits from forest and cultivated plant species, charcoal deposits from different fuel types, and differing levels of livestock- or large game-deposited spores. Periods of intensive land use saw more frequent low-intensity surface fires and fewer high-severity stand-replacing fires, especially when compared to the period of settler colonialism and fire suppression after the 1870s. The authors conclude that the fire regimes in these watersheds were driven by land use practices rather than climate.

Citation:

Roos, C. I., Laluk, N. C., Reitze, W., & Davis, O. K. (2023). Stratigraphic evidence for culturally variable Indigenous fire regimes in ponderosa pine forests of the Mogollon Rim area, east-central Arizona. *Quaternary Research*, 113, 69–86. <https://doi.org/10.1017/qua.2022.61>

Indigenous land use and fire resilience of Southwest USA ponderosa pine forests. 2023

This chapter from *Climatic and Ecological Change in the Americas* examines the relationship in ponderosa pine forests between fire resilience and fire regimes and the occupation and burning practices by the Ancestral Pueblo (Hemish) and Western Apache Peoples over the past 1,000 years. This historical ecology combines a reconstruction of climate-driven fire activity from 1,400-years of tree ring data from across the southern Colorado Plateau; data on localized fire and Western Apache occupation using stratigraphic evidence from the Mogollon Rim in Arizona; and fire, land use, and occupation by Hemish people from charcoal, pollen, and tree ring data from the Jemez Mountains in New Mexico. Together, these data provide robust evidence that Indigenous fire use led to higher forest resilience and resistance to state transitions (i.e., change from mature forest to shrublands), in part due to pyro-diverse small patch burning practices and frequent use of low-severity fires. Continuing the practices of Indigenous fire management can help ensure that ecologically and culturally appropriate fires are kept on the landscape and strengthen forest resilience in the face of increasing climate variability.

Citation:

Roos, C. I., Swetnam, T. W., & Guiterman, C. H. (2023). Indigenous Land Use and Fire Resilience of Southwest USA Ponderosa Pine Forests. In J. A. Whitaker, C. G. Armstrong, & G. Odonne (Eds.), *Climatic and Ecological Change in the Americas* (1st ed., pp. 87–103). Routledge.
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Fire history in riparian canyon pine-oak forests and the intervening desert grasslands of the Southwest Borderlands: A dendroecological, historical, and cultural inquiry. 1998

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Forgotten fires: Native Americans and the transient wilderness. 2002

Stewart, O. (2002). *Forgotten fires: Native Americans and the transient wilderness*. University of Oklahoma Press.

Anthropogenic ecology of the North American Southwest. 2004

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