Fire - Chaos and Control -

How Archeological Case Studies Can Present Solutions for Contemporary Wildfires in the WUI

Katherine Zilligen

Department of Anthropology, University of Colorado Boulder

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Thesis Advisor:

Dr. Douglas Bamforth, Department of Anthropology

Committee Members:

Dr. Steven Leigh, Department of Anthropology

Dr. Kendi Davies, Department of Environmental Studies

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1 INTRODUCTION

Fire is a tool of both destruction and control, chaos and order. Yet, certainly, our Eurocentric Western culture is more familiar with its calamity. Contemporary experience holds fire as an increasing issue with detriment to homes, businesses, health, livelihoods, ecosystems, and much more. Indeed it has received more and more attention as our planet begins to change and preservation of ecology, focusing on fertile land, healthy plant communities, and animal species survival, becomes more essential. However, regarding the majority of long-held practices within fire management, it can be said: “It is the symptoms, not the disease we treat”. With the cyclical impact of wildfire and destruction, it is becoming more pertinent to understand that people, communities, and ecosystems are irrevocably intertwined (an understanding Indigenous groups have advocated for unmistakably). Thus, I look for archeological evidence of fire as an ecological management tool and advocate for the voices long held by Indigenous people regarding their fire knowledge and practices to better the current wildfire crisis.

1.1 Stories of Fire and Destruction

1.1.1 *The Marshall Fire*

On December 30th, 2021, the Marshall fire began in east Boulder late in the morning. It spread rapidly and uncontrollably on strong downslope east winds to the towns of Superior and Louisville. The most costly fire in Colorado history to date, it demolished over 1000 homes and businesses, 1300 vehicles, 6200 acres of land, and ended 2 lives. The fire was extinguished by heavy snowfall on the evening of December 31st (Juliano et al., 2023). Yet the impact of the wildfire hardly stopped with it. Lingering contaminants were found in the air (outside of and within homes) for months after the fire ended (Silberstein et al., 2023). During and because of the fire, power to all water systems was lost, impairing the ability to combat the fire.

Additionally, this led to the presence of water contaminants and sometimes water structure destruction (Whelton et al., 2023). Further, shallow wells had fire debris contamination as well as plumbing and multi-home well damage (Jankowski et al., 2023). There was also a negative effect on air quality in surrounding areas, detriment to agriculture and environmental health, as well as the financial and emotional tax of rebuilding a community (Fovell et al., 2022). Years later, the community is still impacted by this disaster.

1.1.2 *Lahaina*

The fire in Maui Lahaina in 2023 was the nation's deadliest fire in over a hundred years with 100 confirmed deaths. The fire was perpetuated by strong winds and hot dry conditions. The (PDC) and (FEMA) estimate 2,200 buildings were destroyed. The United States Department of Commerce published the total cause of wildfire damage as $5.5 billion (National Interagency Fire Center, 2020). A state of emergency was declared for all of Hawaii along with a major disaster declaration made by the president. It is estimated that it may take residents as long as 5 years to rebuild, needing to wait 2 years to be capable of starting the process, and many residents/affected individuals are still being displaced in hotels (Canady, 2023). Throughout the whole tragedy, many reported a complete failure of coordination, safety procedures, leadership, aid and resources, and more. This has led to an outcry by many, including Indigenous communities, for the governance of habitats centering on Indigenous environmental management and ecotourism (Fox, 2023).

1.1.3 *Canada 2023*

Canada burned extensively (in regions of British Columbia, Alberta, Ontario, Nova Scotia, the northwest territories, and Quebec) beginning in early May with larger fires only becoming under control in July of 2023 Canada burned extensively. These fires generated the

highest carbon emissions on record for the country accounting for 23% of the total global wildfire carbon emissions of 2023 (*Copernicus: Canada produced 23% of the global wildfire carbon emissions for 2023 | Copernicus*, 2023). The intensity, persistence, and impact on local and global communities were immense and powerful in terms of evacuation, sheer destruction of environments and habitats, and air pollution as well as quality, harming even the residents of New York (exemplifying the global impacts of wildfires) (Voiland, 2023).

1.1.4 *Stories Implications*

Each of these stories exemplifies the devastation fire is capable of and is what much of the general public is used to or expects when considering wildfires. More deeply, each of these stories deals with and impacts Indigenous communities in one way or another, whether it be on traditional lands or destroying local communities and ecosystems.

Many aim to understand how these events could be prevented, mitigated, and responded to more effectively and efficiently. While these stories are more infamous examples of the harm wildfires can have, and will cause, in the Wildland Urban Interface (WUI), they are far from isolated in the contemporary struggle of our world regarding the destructive and seemingly uncontrollable power of fire. It will be my argument that turning to archeology, ethnography, and leadership of Indigenous peoples throughout America is what could become most beneficial.

1.2 Wildfires and the Problem Felt

1.2.1 *Wildfire Nationally and Regionally*

Yet beyond these stories, the detrimental impacts of wildfires can be clearly understood on a regional, national, and global level. Wildfires have roughly quadrupled in frequency, intensity, and extent since the mid-1980s (Burke, M., et al., 2021). Wildfire numbers and burned areas are increasing for forest fires and non-forest vegetation types alike. Northern U.S. Rockies

contribute 50% of the increase in large fires. The increase is strongly associated with warming and earlier spring snowmelt (Westerling, A. L., 2016). According to the National Interagency Fire Center (NIFC), 1,174 human-caused wildfires burned 225,324 acres and 734 lightning-caused wildfires burned 24,039 acres in 2023 within the Rocky Mountain region (Colorado). The NIFC also reported that the Rocky Mountain region was among the warmest and driest areas of 2023. As of two months into 2024 (or up until March 1), the NIFC has recorded 33 incidents total Number of Large Fires, 91 total new large fires, 4,604 year-to-date wildfires 1,458,044 acres burned on large fires, and 148,173 acres year-to-date burned (National Interagency Fire Center, 2020). It is evident after encountering the data and literature, and likely obvious to many, that the increase in risk and damage is a consequence of and exacerbated by both global warming and the growth of WUI.

1.2.2 *Global Warming*

The growing contemporary problems of wildfire can not be separated from global warming. The temperature of our planet has increased by 1.8° F from 1901-2016. The rate of this current heating process is the fastest in Earth's history. The Earth is now the warmest it has been in 1,500 years. There is no natural cause or explanation for this unprecedented climate variation other than human activity involving heat-trapping gasses (USGCRP, 2018). Contemporarily there is much discourse on growing concerns of and involving global warming and how it will negatively impact many environmental topics.

Yet, this is of dire pertinence to wildfires. As the Climate Science Special Report or CSSR, puts it. “The frequency of large wildfires is influenced by a complex combination of natural and human factors. Temperature, soil moisture, relative humidity, wind speed, and vegetation (fuel density) are important aspects of the relationship between fire frequency and

ecosystems. Forest management and fire suppression practices can also alter this relationship from what it was in the preindustrial era. Changes in these control parameters can interact with each other in complex ways with the potential for tipping points—in both fire frequency and in ecosystem properties—that may be crossed as the climate warms" (NOAA, 2022). With the dysregulation of climate comes less predictable and more severe weather patterns, fire is more likely to occur, spread, and be harder to relinquish. The increasing frequency and intensity of wildfires mentioned above are a seemingly obvious consequence of the mechanisms of global warming. Due to this, more strategies for managing environments to be fire-resistant are of increasing importance and relevance (USGCRP, 2017).

1.2.3 *The Growing Wildland Urban Interface (WUI)*

The (WUI) or Wildland-Urban Interface refers to a social-environmental context within ecology that concerns the entwinement of human communities (of varying density and organization) and fire-prone wildland spaces. The WUI has been present in America, and numerous other spaces globally, for hundreds if not thousands of years. The papers examined acknowledge that Indigenous communities of the Americas have been living in WUI-like conditions for millenia (Roos, et al. 2021).

The WUI is an important consideration concerning fire management as any time a community of people has existed in wildlands or near them (creating a WUI), farming, semi-permanent or permanent infrastructure, means of travel or transportation, and people's lives can be affected by spillover of fire into residential or inhabited areas and of course, fire is a natural occurrence (Roos, et al. 2021). Thus it is important to learn from communities who have found technologies and practices of using fire as a tool to protect livelihood rather than struggle to separate naturally occurring and ecologically necessary fire from equally important residential

and human-inhabited areas. Indeed, concerning the WUI and fire as a tool for ecological management and wildfire mitigation is something many Indigenous nations and more and more modern science suggest and support. Many Indigenous people around the world have and do live in the WUI managing and participating in such places.

Contemporarily, the WUI is of increasing interest and concern, taking on a more complex meaning and role within society. For starters, it has grown and continues to grow, exponentially (more than 30% since 1970 (Theobald et al., 2007). Further, the modern WUI complicates fire management immensely in routinely experiencing large fires spreading from remote wildlands into more heavily developed areas (Boulder being an acute example) (Chas-Amil et al., 2013). Further, fire management must be approached differently in both wildlands and urban areas due to the nature of structures and resources, making the WUI an even trickier place to address fire threats. Lastly, in our current culture populated areas are often densely complicated and extremely sedentary, which adds another layer to the complexity of the WUI. (Ager et al., 2019).

Each of the fire stories discussed above are located at the WUI and such locations contributed to the problems and degree of circumstances they faced. The archeological case studies reviewed within this paper are also belonging to the WUI. This was done to hopefully compare, and find parallels, focusing on solutions for fire management within the complexity of the modern-day WUI.

1.2.3 *Harm to Biodiversity and Way of Life*

In terms of biodiversity and ecological health, there are undeniable benefits to fire. It can trigger germination, reduce competition for seedlings, release seed pods from the canopy onto fertile ashy grounds, encourage new growth, create hollows in logs to be used by animals as shelter, and more. Undoubtedly, this is part of the reason my paper promotes fire as an ecological

tool and resource of management. Yet the intensity, frequency, and extent of wildfires can cause unprecedented harm.

To put it bluntly, fire kills. It can kill individual animals and plants as well as entire ecological communities. They cause erosion and sedimentation of creeks and wetlands. They can change a land's ability to retain water. Habitats, shelter, and food sources of animals can be obliterated. Smoke and other pollutants can detrimentally impact the environment on a larger scale as well. All of these detrimental impacts of major wildfires can take hundreds of years to heal and regrow, establishing a new healthy system (*How Fire Affects Plants and Animals*, 2023). Further, particularly intense or hot fires can cause more irrevocable damage to soil and plant species. Organic material within the soil helps protect against erosion, but this can be damaged and consequently become less effective. Additionally, solid particles can become more hydrophobic as a consequence of these particularly bad fires, causing a loss in water retention and an additional contribution to increased erosion. Plant species and other vegetation can also become completely killed off in these fires and new plants become the new standard (*Fire Ecology*, 2009).

Harming ecology harms people's means to and ways of life. All over the world communities and cultures rely on (to extensively varying degrees) the environment for survival. From the use of land for farming or pastoralism to tools and resources such as products for shelter, food, medicines, and more. Further, habitats and ways of life are already under threat from unsustainable practices, overdevelopment, global warming crisis, and more. Wildfires are yet another cyclically impactful issue threatening the health of environments and the well-being of communities (Altman, 2023).

1.2.4 *Indigenous Voices and Disproportionate Impacts*

Ecosystems and animals are often in conversation with wildfires. Their preservation as well as protection are considered when thinking about the damage sustained from wildfires. Indeed I have addressed this as important and pertinent to the discussion within this paper. Additionally people, as a whole, have been given concern and thought of in regard to maintaining safety, health, and happiness in the retelling of wildfire stories. Yet, I think it important, as well as undervalued, to discuss the impact of wildfire on marginalized communities due to disproportionate determinants that risk traditional ways of life and cultural survival.

Often marginalized communities are disproportionately harmed in the wake of fires. Due to affluence, neighborhoods of lower socioeconomic status are often less protected, lack proper infrastructure or safety measures, are located in more at-risk areas, or possess fewer resources to evacuate safely (*Wildfires Impact Minorites*, 2024). Further than this, the ability to rebuild or sustain an adequate quality of life while displaced and waiting to rebuild can be disproportionate as well (*The unequal impacts of wildfire,* 2021). This was a problem seen with Lahaina as highlighted above. Sadly, many are still displaced in hotels and unable to rebuild or find better solutions. Further, communities can be more vulnerable to the consequence of fire in pollutants to air and water after a fire for affordability and health reasons (Baker, 2024).

Further than this, I think it is worthwhile to focus on the marginalized community of Indigenous peoples in America. Not only is there a greater risk for the potential for the harm mentioned above but a risk to a way of life. What I mean by this and what I want to draw attention to is the risks to hunting, risks to traditionally farmed or foraged foods, risks to sacred lands, and much more. Yet overall this means the risk of tradition and heritage that has already been historically threatened and denied. It is ironic and tragic that current fire mitigation now

knows and accepts the validity of traditional solutions to a wildfire, practices that Indigenous communities have been kept from practicing for centuries (Hoffman, 2022).

What is even more significant and confounds the points mentioned above is the correlation between locations of Native Reservations and areas of higher wildfire risk (Davies, 2018). Although the overlap is not perfect it is significant enough to be given note. With the territories outlined in blue depicting Federal Indian Reservations and the colored sections of the mad illustrating the scale of potential wildfire hazard, there are more reservations at risk than not. Thus a deeper layer of complication can be found when considering the experience of many Indigenous Americans regarding fire and retention of cultural practices and agency. Addressing the fact that fire stewardship is a cultural practice that has been denied and the inability to participate in this tradition has allowed further and disproportionate harm to Indigenous communities is a central aim of this paper (Davies, 2018).

1.3 Fire Suppression and Suppression of Tradition

Fire as an ecological management tool has only recently come back into common practice with the acceptance of widely known benefits. Even with this, however, there is still much research and discovery to be done. Yet, prior to contemporary movements, many Indigenous people have practiced land management with fire and have ethnographically as well as culturally called for their right to maintain and return these practices. Consequently, fire suppression has not only led to the long-term detriment of ecosystems but also cultural repression and community detriment (Kerlin 2020).

In the past and present extensive fire suppression has impeded not only the practice of cultural burning but has suppressed a surprising amount of other significant traditional participation as well. This is due to the fact that such stewardship helped shape the land to what

was needed and wanted culturally. For example, fire was used as drive lines while hunting bison, there was burning in order to increase the fertility of agriculture sites, it could promote greater growth of culturally significant foods or even reduce the growth of undesirable plants and invasive species, and more. Yet who has initiated and provoked fire as a sole force of demolition and not a cultural mechanism is a pertinent question to be asked when considering fire suppression and cultural prohibition (Roos, et al., 2021) and (Copes-Gerbitz, et al., 2023).

1.3.1 *Colonialism: Separation of People and Nature*

Moving forward in the paper it will become apparent that a key issue historically has been the separation of people and nature in mentality. This has allowed for fire suppression and disengagement or disallowance of cultural fire-burning practices among Indigenous groups. Yet, it is important to introduce to the discussion, the difference between what is thought of as wild and civilized is wrapped up in colonization and note that fire suppression is inevitably tied to (colonialism in this way) cultural suppression not only in the significance of cultural burning or fire stewardship but also in the origins of fire suppression being colonial. This history will be further and more deeply pondered in the background section (Loreau, 2023).

1.3.2 *The Legacies of Fire Suppression and its Persistence Today*

Although the dichotomy of fire as both chaos and a more positive tool of wildfire control is becoming more widespread, there is still the pervasive feeling that it is purely destructive as explained above and demonstrated through the relevant stories regarding fire. Because of the legacy of fire suppression, we societally instruct and learn how to avoid fire and are minimally taught how to safely interact with it. To learn about its potential positive impacts is a very niche topic and rare unless for example reading this paper and ones in conversation with it. Consequently, we fail to understand the ecological benefits of fire, and how to reap them, on a

communal and systematic level. This is not the case when regarding traditional ecological knowledge (Steel, 2015).

Additionally, there are physical remnants of fire suppression. To take a naturally occurring and ecologically healthy happening out of a system, change it, and particularly for the better. Burning, at lower intensities regularly, helps foster new growth and fertility, clears debris and underbrush, prompts seed fall, and germination, and changes soil compositions and capacities for water retention in positive ways (*Fire Ecology*, 2009). To repress all fire not only hampers such things but can conflate the issues. Contemporarily, as a consequence of the long-lasting effects of fire suppression, there is often greater kindling for wildfires found in the underbrush and deceased or dry plants allowed to persist relatively unchecked. There are more stagnant soil conditions and less new growth generated at a time or cyclically. When concerning the legacy of fire suppression there is more harm to wildfire mitigation than benefit (*Fire Suppression: Threats to Wilderness From The Removal of A Profound Natural Disturbance*, n.d.).

1.4 People, Fire, and Ecological Interaction

When considering the implications of fire stewardship and fire suppression - and realizing the difference of impacts between the two - the relationship between people, fire, and ecology is apparent as well as central to this paper. As seen through the history briefly highlighted above, there is a pervasive idea that fire is solely destructive and must be separated and suppressed from what is considered natural resources (seen in the creation of national forests). Through this narrative, fire is presented as less natural, less a part of forests and more a risk to them (McLauhlan, et al., 2020). Yet today - and throughout many Indigenous communities understanding - it is known that fire and forests are intertwined. Put simply, fire is a

part of a healthy forest. Additionally, fire can be utilized by people to promote healthy environments that are simultaneously optimized to human lifestyles. Yet again, as highlighted above colonial and anglo-western influence prompted a view that wildlands were uninhabited and uninfluenced by Indigoness activity. This is also seen by the removal of people from national forests (Dalrymple, 2022). Consequently, by colonial influence, people, fire, and ecology, became individualized and separate entities. However, in the theory of this paper and many other anthropological studies, culture, people, and environments are intertwined and not entirely cleaved. In other words, people shape the environment and the environment shapes people. This is seen throughout the paper in people, fire, and ecological interactions highlighted and evaluated (McLauhlan, et al., 2020).

1.5 A Source for Solutions: Archeology

Archeology can benefit this conversation. Works like *Bigger than History: Why Archaeology Matters, Climate Chaos: Lessons on Survival from Our Ancestors,* and *Archaeology Matters: Action Archaeology in the Modern World.* by Brian Fagan, Nadia Durrani, and Jeremy Sabloff, respectively, have very fascinatingly demonstrated the modern lesions that can be gleaned from ancient archeology. Whether learning from past mistakes or taking note of successes, archeology is a source of different practices, methods, and strategies that span histories. Making it truly an untapped resource for problem shooting and experimentation outside of the cost and plausible failure of initiating new studies but still in conversation with and adding to them. There is more and more emerging knowledge of how beneficial fire can be. The knowledge of traditional practices, and their archeological context, can greatly aid this growing understanding.

1.6 Hypothesis

It is the aim of this paper to contribute to contemporary wildfire management through the application of archeology. Not only this but to find specific and useful consequences of cultural burning that can be used and help solve more contemporary concerns like growing WUI, global warming, or species survival. What's more, is that acknowledging and encouraging a more positive attitude toward fire can lend additional help through the increased acceptance and education of cyclical burning rather than a preference for total fire suppression. Further, fire should be given recognition for its cultural and historical function, and the narrative of nature and people as separate entities must dissipate. Then Indigenous groups can be more widely heeded and given the needed acknowledgement for expertise specifically in consideration of cultural burning. I hypothesize that looking at and examining the archeological use and effect of fire - realizing the inseparability of interactions between humans, fire, and ecology - could help contemporary understanding and management of it. Further, with this in mind, it is paramount that Indigenous communities be involved, and allowed to be leaders of cultural burning and fire stewardship - which has been long suppressed.

2 BACKGROUND

2.1 Current Wildfire Management Practice

Contemporary wildfire mitigation practices understand the need to burn landscapes widely at low intensity more frequently. This is known to reduce the risk of wildfires and improve ecological health. However, there are obstacles to the wide use of this practice, and a large amount of current studies are dedicated to this area. It is the goal of this paper to aid such dialog through the examination of pre-existing practices encountered through archeological sites

and contemporary Indigenous knowledge as well as advocates for more recognition of Indigenous voices.

A big part of fire mitigation is fuel mitigation. This can be pertinent for many ecosystems but woodlands are prominently considered in this paper. Fuel can thus be underbrush, dry grasses, dead branches and trees, and more. This means a reduction in flammable materials. Underbrush, dead vegetation, dry grasses, flammable trees, barks, and more. This can be reduced by human foraging or natural occurrences like fire *Communicator's Guide for Wildland Fire Management: Fire Education, Prevention, and Mitigation Practices - 9. Fire Mitigation,* (n.d.). Yet it is hard to mainly address possible kindling when most of the population thinks of nature as void of human influence. Many farmers, rural communities, or Indigenous communities will independently collect and burn off excess vegetation and other foliage (Long, 2021). Although this is independent of systematic fire mitigation it is often regulated. Currently, there is far more to be found, in extent and breath, on wildfire control over mitigation outside of suppression. Other information on wildfire practices includes the fact that there are currently 254 individuals assigned to fight fires within wildlands nationwide (*Statistics | National Interagency Fire Center*, 2019).

2.2 Fire Suppression

Fire is and has been a naturally occurring phenomenon within ecosystems and one with which humans have had a relationship. Yet, upon the arrival of Europeans in the Americas, there was a shift in attitudes toward this. Rather than being seen as a natural occurrence that could be culturally utilized, and beneficial to the ecology of the area it was viewed as a risk to the forest and land resources they wished to use. An unfortunate but widely pervasive sentiment held as a stereotype even today is that the Americas were widely uninhabited and "wild" before colonial

contact. Of course, this is due to cultural distinctions and prejudice surrounding ideologies on land management. Even though Indigenous people had and have been undeniably influencing the lands in which they live for thousands of years, one way being with fire as focused on in this paper, this was not acknowledged and in part is still misunderstood. Thus sparking the aim to eradicate fire from said spaces. (*The History of Wildland Firefighting*, n.d.).

Total fire suppression, with more resources and manpower dedicated to the cause, came about in the early 19th century. In the late 18 hundreds the devastating impacts of the Peshtigo Fire of 1871 convinced conservationists that wildfires threatened future commercial timber supplies. In response, the National Forest Reservations began, - later remanded National Forests. The U.S. Forest Service was established in 1905 and was given managerial control of these lands. Yet in what was known as the "Big Blowup" in 1910 (burning 3 million acres in two days), National Forest Service administrators convinced Congress and the public that only extreme and complete fire suppression could prevent such events from continuing to occur. Total fire suppression aims to prevent any fires from starting and end any that have started as quickly as possible. (more modern fire suppression tactics involve controlling fire to certain areas rather than exterminating any and all that start). (*U.S. Forest Service Fire Suppression*, n.d.).

Disrupting naturally occurring and cyclical fire patterns within ecological contexts disrupts the functioning of said environment. As a consequence of the past century of intense fire suppression, vegetation, and other flammable forest debris has accumulated to a vast degree. This is largely why the legacy of fire suppression has been so harmful to wildfire efforts (U.S. Department of the Interior, 2015). Something of additional note regarding fire suppression is the history of its cost. Contemporarily, fire suppression as a fire mitigation strategy is extraordinarily

expensive. Reports from NIFC document the spending of hundreds of millions of dollars in recent decades (National Interagency Fire Center, 2020).

2.3 Ethnographic Data and Indigenous Practice

Contemporary Indigenous communities have been increasingly vocal about fire stewardship. There is a significant extent of injustice derived from the operation at the hands of Western values that confounds obstructing both access to tradition and healthy land that infringes on the future. This is an especially potent sentiment after understanding what has been outlined above regarding the ideologies between land and people, suppression of fire and harm to the environment, as well as the correlation between reservations and areas at higher risk of wildfire coupled with disproportionate determinants to marginalized communities. What's more, is the contemporary realization that the traditional practices of many Indigenous groups around the globe have been and are more advantageous towards the environment and fire mitigation. (Avitt, 2021).

2.3.1 Fire Stewardship

Indigenous Fire stewardship otherwise known as IFS has been practiced for thousands of years - and persists today - by various Indigenous, tribal, and Aboriginal peoples consisting of intergenerational teachings of fire-related knowledge, beliefs, and practices. It aims to modify fire regimes (which are the patterns of naturally occurring fire within ecosystems over extended periods). IFS adapts and responds to climate and environmental conditions in order to promote desirable habitats, species, and landscapes as well as increase the overall abundance of preferred resources. IFS can occur for reasons related to ceremonies, agriculture, hunting practices, or more (Lake and Christianson, 2019). Of the extensive and many specific applications of IFS traditional fire knowledge encompasses over 69 distinct elements that pertain to geology,

topography, solid, vegetation, fuels, weather, fire behavior, fire effects, and more. This was documented in a global synthesis of Indigenous peoples' relationship with fire, showcasing the substantial database of knowledge that would potently add to current wildfire efforts (Lake, 2021).

2.3.2 Traditional Ecological Knowledge (TEK)

Traditional Ecological Knowledge, otherwise known as TEK, is the information understood and possessed uniquely by Indigenous communities regarding the ecology and landscape of a particular place in which they reside. It includes observed abundance and behaviors of varying species of animals and plants as well as their community construction and interactions. This extended to other environmental factors and is both historical and current. Such information is intergenerational - passed down through storytelling - as well as incorporative of personal lived experience. This knowledge is robust as many communities culturally and routinely interact intimately with landscapes and ecology of their locals. TEK is thus impactful and important in any ecological management setting (Devereux, 2021). Fire stewardship is a form of TEK. It requires not only a comprehension of fire regimes but also how such regimes occur and influence the ecologies of an area - the landscape and array of animals and plants species. Further fire stewardship and cultural burning are frequently used to impact landscapes to become more favorable toward cultural and lifestyle preferences. They yield areas more conducive to food production, pastoral environments, or hunting, as well as just the reduction of detrimental and vastly destructive fire.

2.4 Featured Cultures, Time, Societies, and Ecosystems

It is significant to address the featured cultures, times, societies, and ecosystems considered within this paper. In understanding how each of these mentioned factors impacts and

limits fire, the response to and mitigation of wildfire, and attitudes toward fire practices and tool use, I can better address how the featured archeological cases can contribute to the current discussion surrounding fire.

2.4.1 Contemporary

In the modern Western world, there is certainly a history of fire separation and a legacy of ideological separation between what is largely considered the "natural world" or wildlands and that of human society. Yet, as established above, both are very much intertwined. Still, the runoff of this mentality can be seen in ideologies and practices that pertain to cultural, temporal, and societal structures.

The attitude around fire for the wider modern public is generally negative. There is education around fire safety regarding practices when in the "outdoors" and a teaching of fire avoidance in more populated areas. People's relationship with fire today is further complicated by the more sedentary and often highly compact organization of homes, residences, or any other structures within a community. The layout of such communities as well as the materials of which they are made can contribute to how a fire may catch and spread. This structural consideration must also be applied to transportation, non-wiland rural areas such as pastoral or agricultural land, and more. As discussed above, the contemporary environmental factors are most notably impacted by the growing WUI as well as global warming. The development of wildlands is often credited for failing to consider important environmental functions like water retention, wind flow, and human-animal habitation. These factors also contribute to concerns when considering the spread of fire. It is mixed-severity fire regimes (MSFRs) that contain some proportion of low to high severity fires that are recognized as a primary fire regime in the Western North Americas (Copes-Gerbitz, et al., 2023).

2.4.2 Roos Paper

The first paper addressed within this text - Native American fire management at an ancient wildland-urban interface in the Southwest United States - discusses lands in the Jemez Mountains. Here, there is an ecological background of volcanic origin, with varying elevations, and mountainous woodlands. Depending on elevation (lowest to highest), there is a mixed array of tree species including: Juniper savannas, ponderosa pine, mixed conifer forests, Douglas firs, and quaking aspen, white fir, white pine, and alpine spruce-fir forests (Roos, et al. 2021). Prior to fire suppression - fire regimes followed a pattern of frequent surface fires (a fire that spreads at the ground level) occurring in dry mixed conifer forests and small patches of crown fires (a fire that spreads tree top to tree top) within these forests as well. Climate influenced a top-down role in regulating “free-range” fire regimes in governing the production of flammable fuels. Fire occurred during dry years following 1 to 3 wet years that produced abundant and continuous fuels. Fires were less frequent at higher elevations but more likely to burn at higher severity (Fire Effects Information System Glossary).

This paper primarily concerns the traditions and practices of the Hemish people, yet also consults and considers the Hopi, White Mountain Apache, and Zuni tribes. In terms of cultural attitudes and practices around fire, and particularly fire mitigation, the Hemish people have maintained oral traditions. Disposition to fire of many forms would have been less adverse then widespread modern perspective. Original population of Hemish people in this region would have started low but grew to thousands by the final outmigration. Further, populations crashed by about 87% as a consequence of diseases introduced by Spanish colonialism in the 17th century. Cultural landscapes would have been composed of thousands of small “field houses" (Roos, et al. 2021).

2.4.3 Copes-Gerbitz Paper

This paper - The contribution of Indigenous stewardship to an historical mixed-severity fire regime in British Columbia, Canada - although in a vastly different area of North America, (British Columbia, Canada) more specifically Ne Sextsine, there are ecological similarities. The paper includes a study of dryer woodlands mostly dominated by Douglas firs (a species also mentioned in the first paper). Additionally, due to plateaus there is an array of elevations that contribute to microclimates as seen in the prior study as well. However, in more divergent conditions the area studied notes more rivers and is nearer an ocean. Additionally there is a transition of ecology into grasslands incorporated and considered (Copes-Gerbitz, et al., 2023).

Further, there are cultural similarities in dispositions towards fires and fire regimes as opposed to contemporary considerations. The T'exelc people, also known as Williams Lake First Nations, are the primary source for traditions and practices concerning fire within this paper. Like in the paper discussed above there is the preservation of fire regimes and stewardship through oral histories perceived by "fire keepers". There was fire use as a tool, including documentations of fire intentional ignitions, to construct preferred environments. Additionally, and perhaps obviously, there is less aversion or demonization of fire and fire practices within this Indigoness culture than seen within the Anglo-West of today (Copes-Gerbitz, et al., 2023).

2.4.4 Discussion and Justification of Differences

Although it is inarguable that the areas concerned within this paper are different in terms of temporality, ecology, and cultural necessity or practicalities, this by no means takes away from the potential lesions each study offers to present-day efforts. Although the ecology is different, the benefits demonstrated by the case studies, and contemporary literature of low-intensity burning for longer, more cyclical periods of time, has been shown to be beneficial in both fire

mitigation and ecological health. The bigger concern for many modern situations is how to do this, within WUI, effectively and efficiently. Thus, archeology - as well as ethnographic and collaborative efforts - can help to demonstrate, model, and inform, how this has been and could be achieved.

3 LITERATURE REVIEW

The following papers were carefully selected for their very specific yet applicable characteristics. For one, they show fire use as an ecological management tool in the archeological record. In addition to this, they serve as examples of positive and successful stewardship. Each paper examines a specific area and culture (focusing on fire use as a tool) for a wide time range that incorporates both pre and post-colonial impacts. This impact of colonial influence is of particular interest as it demonstrates the origin of fire suppression but more pointedly the lack of fire use as a tool for fire mitigation and ecological improvement and then detriment that follows this absence. Additionally, both papers are found within the WUI or WUI-like conditions.

3.1 Roos Paper

3.1.1 *Overview*

By examining this paper I hope to highlight the ways in which archeology and archeological findings can yield positive applications to contemporary wildlife management efforts. I think that it will be revealed or obvious that the ideological separation of wildlands and human-populated areas has sparked fire suppression, hampered stewardship traditions, and hindered environmental management overall specifically concerning wildfires. Thus, I argue that fire as a tool for ecological management demonstrated in the examined paper should show the

specific benefit of reduction of flammable substances or kindling at a WUI. This result or finding can be and has been used positively today in fire management and suggests a greater need for TEK or fire stewardship to be implemented in current wildfire management practices. I think it is paramount to note the voices of Indigenous communities who have advocated for fire stewardship and been subject to the history of fire suppression within our county. Thus, this should result in or be paired with current ethnographic voices/data of indigenous people for social justice due to disproportionate impacts and long-held advocacy of TEK use that went unheeded.

3.1.2 *Where, Why, and How*

The paper's area of focus is the Jemez Plateau with the temporal archeological scope of initial settlement after colonization by Spaniards (1100 - 1650 CE). Yet it incorporates more modern ethnographic data through a course of interviews with elders from the Hemish Tribe overviewing traditions and internal historical knowledge. However the authors also worked with the Hopi, White Mountain Apache, and Zuni tribes. The ecological context and application of this paper concerns WUI in ponderosa pine forests of the southwestern Jemez Mountains in northern New Mexico. There was frequent focus and mention of Hemish agricultural footprint and the ecological tendency for surface fire as well as the eventual period of “free-range” fire. Many interdisciplinary practices were utilized in this paper including: archaeology, ethnography, dendrochronology, geoarchaeology (charcoal and pollen samples as well as herbivore proxies), and modeling of ancient populations.

Archaeologically, light detection and ranging (LiDAR) were used to estimate populations at approximately 1500 CE via calculation of rubble volumes. Before 1500 CE, room count

estimates to scale population estimates based on LiDAR calculations were used. Population calculations were used to proportionalize the modeling of land use scenarios.

Ethnographic data was collected collaboratively with the Pueblo of Jemez, there was also participation from Hopi, White Mountain Apache, and Zuni tribes, and the involvement of more than 20 tribal research participants. The principle goal of said research was to document the cultural behavioral factors involved with the ignition and suppression of forest fires. This was done through semi-structured interviews primarily conducted in Towa language. Subjects of conversation included the use of fire in agricultural, grazing, and cultural practices, and how the use of trails and the harvesting of wood for fuel and construction would affect fire behavior. Tribal members were also asked to identify healthy forest structure, and comment on personal experience with forest fires.

Dendrochronology was used to reconstruct historical fire frequency. Tree ring scars were taken from 42 sites and an additional 126 individual trees within and in 10 km adjacent to the Hemish agricultural footprint. Sites consisted of 8 - 20 fire-scarred trees. Fire-scar sites were selected to be either adjacent to Hemish archeological sites or were part of the Jemez fire-scar network. Tree rings were cross-dated and fire scar years were determined by standard methods. Fire frequency every half century was calculated via all fires recorded by any tree and widespread fires scared >25% of recorded trees.

Geoarchaeology was heavily involved in the paper. Patterns of fire activity, vegetation change, and herbivore abundance were inferred for the last 2,000 years, through the analysis of six stratigraphic locations within and adjacent to the Hemish agricultural footprint. Proxies, including charcoal and bulk sediment accumulation, soil formation and stability, and pollen, were compared to archeological population estimates, tree-ring climate reconstructions, and

other paleofire studies in half-centy intervals for the past two millennia. Samples were collected at 2, 5, or 10 cm continuously. Concerning the charcoal, variability was assessed in textural characteristics of gravel, sand, silt, and clay percentages and the charcoal concentration was estimated by chemical digestion and loss on ignition and radiocarbon dates provided age control as well as age depth relationships. Concerning pollen, bulk samples were processed and compared to regional databases and lipid biomarkers were extracted and measured (via GC-MS) identifying and quantifying stanols. Charcoal, pollen, and herbivore proxies were averaged to 50 year bins and converted to z-scores.

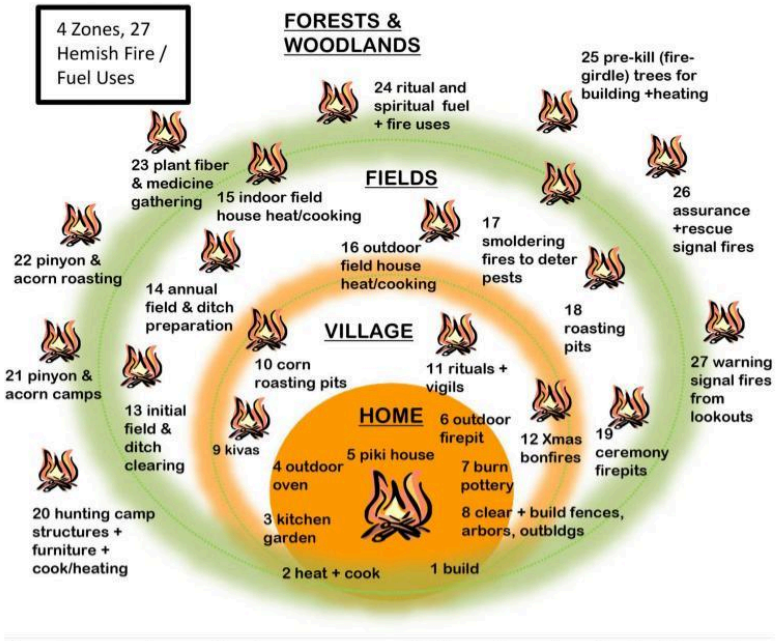
The paper modeled both ancient human and natural fire regime dynamics together through a mechanistic ecosystem process model known as fire BioGeoChemical model v2 or (FireBGCv2). The model constructed scenarios that portrayed modifications to fuel structure, fire ignitions, and forest structure resulting from fuelwood collection by ancient people, human caused fire ignitions, agriculture, and timber harvest. Additionally, there was a null model that depicted scenarios excluding human-landscape interactions meaning vegetation growth and structure and disturbance dynamics were driven solely by climate. Modeling of fire and forest dynamics represented a 900 year time period that included a 200 year period in which no human activities were simulated. There was a subsequent 500 year period of modeled human land fire use, and a final 200 year "free range" fire period. Population size, fuelwood harvest levels, supplemental human ignitions, and agriculture use were all included factors.

3.1.3 *What Was Found*

Through the ethnographic interviews 27 fire and fuelwood uses were identified differentiating and relating to domestic, village, agricultural, and larger forest landscape spaces. Such practices can include making pottery, preparation of food, productivity of wild plant

harvesting, ritual uses, hunting, agriculture, preparation of trees for architectural uses, and more. The variation and differentiation of fire use was demonstrated in the Roos paper as seen in figure 1. This fire and fuel use bridges aspects of cultural and economic systems to ecological ones. To further explain this, open landscape burning is not a feature of domestic scopes. However, human impacts on the geographic plane are driven by fuelwood collection to support controlled fire uses such as heating or cooking in a more domestic location. Thus, although fire is occurrent for many differing reasons and means, it is impactful beyond and in tandem with purposefully ignited fires for intentional ecological management, which is also present. Further, fire was established to be viewed with great respect and caution through the ethnographic interviews by tribal research participants. While indiscriminate fire use would be and is more socially taboo, the ecological benefits of cultural burning are recognised. Geoarchaeology demonstrates most localities of charcoal sedimentation are at their highest rate during Hemish occupation. Localities not matching this peak at an overlap or immediately after Hemish population collapse (when agricultural work is no longer maintained). Twenty-one of twenty-four charcoal dates in the last 2,000 years also date to the period of Hemish agricultural use. When coupling this data the paper finds the period of Hemish

Figure 1
Image of figure 2 from Roos paper (Roos, et al., 2021)



Note. Conceptual map of landscape zones and 27 fire and wood use for Hemish people.

occupation of uplands corresponds to peaks in upland erosion and sediment supply. This is likely related to agricultural clearing and use.

Increased erosion was accompanied by increased fire activity as indicated by charcoal records. There was an average pattern of charcoal presence observed in all localities. However this value was increased initially before slightly declining to average values thereafter. This charcoal peak during initial settlement 1100 CE (despite low populations) indicates increased fire use due to the clearing and establishment of agricultural landscape. Charcoal production then declines as fire use shifted to agricultural maintenance (using finer fuels rather than minimize area burned). Another increase in charcoal presence occurred after 1450 CE, potentially indicating increased population, and then increased again in 1650 CE, overlapping with collapse and subsequent accumulation of fuel with decreased Hemish wood harvesting and fire management.

These findings were corroborated by dendrochronology or tree-ring records. Before 1650 CE fire was common but midimal in scale. After 1650 CE widespread fires became more regular which indicates the “free-range” burning regime wherein fire spreads wildly as conditioned by weather and fuel contexts. The enhanced fire activity is driven by Hemish land use. There is no evidence of any increase in fire severity prior to the late 20th century (which is prompted and changed by fire suppression and repression of cultural burning).

Concerning pollen taxa records, grass pollen peaked in abundance during initial settlement of the Jemez Plateau. Arboreal taxa from mixed conifer forests were highest prior to settlement, dropped to low levels during occupation from 1100 - 1350 CE, but returned to higher levels post Hemish depopulation. Juniper, oak, and forbs increased in abundance during occupation - forbs suggests increase in abundance of disturbance-adapted taxa while juniper and

oak reflect greater patch heterogeneity created by anthropogenic burning of many small patches, thereby protecting more fire-sensitive woody taxa. A rise in juniper and oak in the 20th century reflects woody encroachment and infilling due to fire suppression and/or a rebound from lack of harvesting.

Herbivore proxies also increase with charcoal and grass pollen or initial settlements around 1100 CE. These proxies are dung fungus and fecal stanols. This increase in herbivore proxies diminished by the time Hemish population numbered in the thousands around 1300 CE. Herbivore proxies were not abundant again until the presence of domesticated cattle and sheep. The correlation between grass, charcoal, and herbivore proxies indicate large herbivores benefited from ecological changes regarding anthropogenic burning (although much of this during initial settlement was to establish agricultural landscape). Yet, some of these burnings may have been purposefully to improve habitat for large game.

The modeling of land-use scenarios (including a control of a “null” of non-human influence) yielded that there was significantly higher overall burned area, a smaller mean and range of fire sizes, lower tree density, and lower tree mortality in peak Hemish occupation than in the null scenario. These included and accounted for fuel and structural wood use, human-augmented ignitions, and clearing and burning agricultural land and scaled for population estimated by archaeology. This accessed what activities and to what magnitude human impact would have been necessary to create fire and vegetation patterns seen through the paleoecology. These models suggest that the anthropogenic fire regime (many, small, low-intensity fires across a landscape) reduced forest vulnerability to fire-caused mortality. Thus, although the overall burned area was greater, there was a maintenance of resilience.

To conclude and reiterate the arguments presented in this paper, wood harvesting (domestic and architectural use) as well as a presence of abundant, small, patchy fires promoted a landscape that burned often but not extensively. Spanish colonial impacts and subsequent depopulation of the studied area contributed to a rebound of fuel accumulation and a return of widely spreading frequent surface fires. However, the stewardship of more than 500 years of perennial small fires and wood collecting followed by frequent "free-range" wildland surface fires made the landscape resistant to extreme fire behavior even when climate prompted more conductive situations.

This community impacted fire regimes to be small but frequent which created a resistance to spreading fires. Further it ultimately decoupled fire activity from climate patterns that promoted and drove fire in dry conifer forests across the western United States. After the population collapsed due to colonial impacts, widespread climate-synchronized surface fires characterized the entire Jemez landscaper just as they did historically for dry forests across the west in a period referred to as "free-range fire period". - Typically, conditions favored surface fires, but during Hemish occupation these fires were of low severity or more frequent.

3.2 Copes-Gerbitz Paper

3.2.1 *Overview*

In examining this paper I hope to further understand the function of fire stewardship in a historical context. This increased comprehension will hopefully highlight the way in which fire as an ecological tool can promote contemporary wildfire mitigation. The specific ecologically significant insight encountered in this paper is contributing further information on ways to instigate frequent cyclical bringing at and with human populations nearby. This aligns with the contribution and arguments of the first paper examined but demonstrates the existence of

purposefully created mixed severity fire regimes promoting heterogeneity. Through examining this paper, and acknowledging these particular benefits, I hope to offer insight to contemporary fire mitigation efforts. I am to highlight archeology and TEK as a resource for beneficial practices. Further I hope to promote and encourage the prioritization of cultural burning as a deeper consideration of Indigenous traditions within the conversation of modern fire efforts.

3.2.2 *Where, Why, and How*

This paper focused on an area within the traditional territory of the T'exelc (Williams Lake First Nation) known as Ne Sextsine in British Columbia, canada. The time span examined stretched from 1550 to 1982 CE. History, as well as oral histories, and archeology mainly concerns and works with the Indigenous community of T'exelc. It is their practices and stewardship traditions that are examined. The paper's aim is to understand these traditions in Ne Sextsine and apply them to modern scenarios through a more nuanced understanding of indigenous contributions to mixed-severity fire regimes. To achieve this, the paper employs dendrochronology, reconstruction of fire frequencies and severities, and oral histories as well as ethnographic records to better understand Indigenous fire expertise on and contributing to fire regimes.

Within the field a stratified-systematic sampling sampling design was used concerning ecology and archeology. This allowed the differentiation of forest benches (referred to as bench throughout the paper) and mesic forest (referred to as plateau). A .5-km grid was placed over the study site, selecting alternate vertices on a bench and every fourth vertex on a plateau. Some locations within this selection were deemed either unsafe to excavate or culturally significant and thus not disturbed and used in the study. An n-tree design was used to sample 20 living trees (samples coming from closest to the trees center) and included 10 canopy and subcanopy each.

Tree species and height were recorded and age samples were taken from both tree roots and tree center.

Dendrochronology analysis tested increment cores and fire-scar samples with a high resolution using CooRecorder. Ring dating was compared visually and statistically against a master chronology for the region. The year and seasonality of fire scars was an important identification in this study as it can help indicate Indigenous fire stewardship. To understand this, tree cores sampled between May and October, were categorized as (earlywood) in late May and (latewood) in early August. Fire scar seasonality was categorized as spring (earlywood), midsummer (latewood) or late summer or autumn (dormant season - in which growth between two rings ended and started the subsequent year). Calender year was assigned to dormant season scars in the following ways: year of ring formation if late wood scars were present in another tree in the same proximal plot - subsequent year if an earlywood scar was present in another tree in the same or proximal plot - the year of ring formation given that the modern peak in fire activity is late summer in this forest type.

Reconstructing fire frequency and severity was done through FHAES software (version 2.0.2). It compiled fire chronologies of individual fire plots located at the bench, plateau, and rest of the studied area in Na Sextsine. To understand severity and duration of a fire the first and last fire-scars as well as the range of scar to scar intervals were compared. Fires that were categorized as widespread affected >30% of the recorded plots. Over time, fire severity was determined at the plot scale based on fire presence in even aged cohorts of 15 year periods (15 years being significant as it was less than the median plot-level fire return interval, which allowed assessment as to whether cohorts were initiated by fire). The start of a cohort was

marked by the oldest pith date in the plot. The first and last pith dates were determined by existing within the first or last 25% of trees created in a 15 year window.

Cohorts were classified as fire-initiated if the start date was within 15 years of or 5 years prior to a fire-scare date (incase of age correction errors). Fire scars were only recorded at 20 fire plots. Fire-initiated and unattributed (growth not attributed to fire) cohorts were also classified based on timing and persistence.

Fire severity over time was considered over event-level severity. Plots were assigned low, mixed, or high severity fire history over time depending on cohort attribution (fire-initiated or unattributed) timing, and persistence. Low severity was determined if all cohorts persisted in absence of subsequent fires (regardless of attribution). Mixed severity was established if more than or equal to 1 cohort established survived subsequent fires (regardless of attribution). Lastly, high severity was assigned if an unattributed cohort had no sample trees alive prior to cohort establishment.

Indigenous contributions to fire regimes were considered and examined through spatial and temporal differences in dendroecological fire regimes in the context of placed-based oral histories and ethnographic records. Spatially, it was considered whether differences in fire regime characteristics were aligned with different stewardship practices and use of Ne Sextsine, in the form of winter village sites, summer fishing camps, travel corridors, and areas of berry picking as well as hunting. Winter village sites and summer fishing camps were more likely to be found along benches (spatial differences in physical plot attributes between bench and plateau used Mann-Whitney U tests). Temporarily changes in cumulative fire frequencies were tested using piecewise linear regression in SigmaPlot (version 13.0) which were compared to key dates of land use change. This data was applied to the following categories (bench, plateau,

low-severity, mixed-severity, and all Ne Sextsine) to identify differences and potential change to fire histories.

3.2.3 *What Was Found*

The ethnographic information regarding historical and modern practices of fire use established multiple objectives or purposes at a variety of scales. This included intentional ignition for the means of promoting abundance of preferred resources and ideal landscapes in addition to fulfilling responsibilities around respect for the land. This intentional fire use often occurs during appropriate seasonalities near communities and along travel corridors. Concerning year round practices, these ignitions occur in what is known as shoulder seasons (spring and fall) when fire risk is low. This use of fire, both as an intentional or unintentional tool for land management reduces potential for future detrimental fires. However, severe limitations on the continuation of this practice occurred due to impacts of colonization. Where the practice was lost and limited, so too was the ability of fire influencing land to support Indigenous livelihoods or maintain the benefit of minimizing the impact of future fires. Despite this, Indigenous fire stewardship continues to adapt.

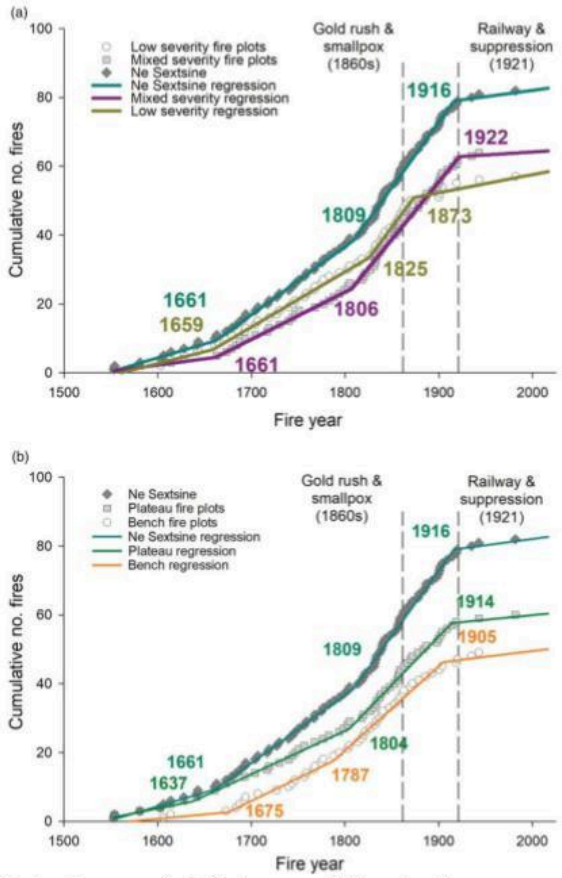
At Ne Sextsine samples from 118 fire scarred trees yielded 189 indicators of fire in fire-scars and scarlets. Between 1553 and 1982 CE 82 fire events were recorded. Most fires (56%) occurred in late summer or autumn. All the 54 plots had cohorts, 10 plots had two distinct cohorts. Of the 62 cohorts identified (throughout the study) 63% established asynchronously 10-50 years following the last widespread fire in 1870. In fire plots 20 cohorts were classified as fire-initiated and three of the five unattributed cohorts established after 1870. In age plots 25 cohorts were fire-initiated, 10 unattributed cohorts established after 1870.

Ten fire plots were classified as low severity and ten others mixed (both including bench and plateau plots). No plots were classified as high-severity due to the presence of fire scars at each. All low-severity plots had veteran trees, or fire-scarred trees, that survived the cohort establishment. Each mixed-severity plot included 2 to 20 fires, plus at least one cohort that survived subsequent fires. Eight of these plots had fire-initiated cohorts.

Regarding age plots, 10 were classified as having a low-severity fire history and 20 were classified as having a mixed-severity history. All low-severity plots were located on the west bench overlooking the Fraser river. Nine mixed-severity plots were on the bench and 11 were on the plateau.

Through piecewise linear regression, four distinct periods of fire frequency were found that were generally consistent across and between plot type (bench vs. plateau) and assigned fire severity over time (low vs. mixed severity). Across the whole of Ne Sexctsine, fires burned more frequently over the second period starting around the turn of the 19th century, indicated by the breakpoints in 1787 (bench plots), 1804 (plateau plots), 1806 (mixed-severity plots) and 1825 (low-severity plots). After this break point, fires become more frequent in the third period. In the fourth period, there is a clear decrease in fire frequency. This break is seen across all records (but has an earlier prevalence in the low-severity plots). All this is visually demonstrated by figure 2. It

Figure 2
Image of figure 5 (Copes-Gerbitz, et al., 2023).



Note. Temporal shifts in cumulative fire frequency.
(a) low-severity, mixed-severity, and all fire plots
(b) bench, plateau, and all fire plots

illustrates how with the decrease of T'excla influence there is an increase in fire frequency. Fire suppression significantly reduces this frequency but is known to hinder long term mitigation efforts and ecological health.

Distribution of fire severity at the plot level is likely tied to fire stewardship across Ne Sextsine in time and space considering what is known through ethnographic comparison to data highlighted above. At and near camps (such as the seasonal summer camps and winter village sites) there were constant campfires functioning for warmth, cooking and drying fish. Barrie picking (of a key medicinal food that can be maintained by frequent low-severity fires) also occurred near the Fraser river. Hunting for mule deer could have had higher prevalence on the plateau as there was more forest cover - managing mule deer continues to be a guiding land-use objective in the communities considered. The complexity of land use is likely to increase the need for localized fires. This is corroborated by data of 35% of fire years recorded at only one plot. Further, fire regimes in the southwestern U.S., a high number of small fires is interpreted as an indication of Indigenous ignitions.

Areas of higher occupation (found on both the benches and the plateau) are coincident with plots classified as low-severity over time. Low-severity plots were also found in locations not previously identified archaeologically or in oral history as areas of high occupation. An explanation for this that supports indigenous stewardship is the possibilities it represents yet to be recorded archeology sites or fire management at travel corridors. Shifting objectives and complexities regarding land interactions also can explain some mixed severity fire occurrence at levels of high occupation. For instance, burning of mixed severity within land that will be intentionally left to recover is beneficial as well as burning of mixed severity at areas more prone to lightning-ignited fires in order to reduce this risk.

Seasonality of fire scars could also indicate shifting objectives and land use over time regarding Indigoness fire stewardship. Spring and fall burned during periods of low risk. Earlywood scars occurred in the areas of highest occupation on the benches in the earlier parts of the fire record in the 1600s. Spring burns could possibly be evidence of cleaning village sites. In the mid-1700s earlywood scars were all situated on the plateau and may be associated with renewing berry patches and foliage - consistent to what is described by T'exelc elders. The specific and shifting functions and objectives regarding Indigoness fire stewardship is seen and supported in these apparent shifts considering fire evidence and seasonality.

Lastly, during early colonization there is the collapse of fire frequency regarding the fire regime. This coincides with a smallpox epidemic killing two thirds of the Secwépemc people. Additionally, land was being sold to settlers (who would mimic Indigenous burning practices to achieve the same conditions maintained by Indigoness stewardship - although for very different reasons), and residential schools forcibly removing Indigenous peoples from their territories. Fire exclusion also started in this period (1874). It is important to note that this history is relatively recent or even ongoing and impacts contemporary communities today outside of, but still pertinent to, fire stewardship. Thus, there are continued tensions in land and fire governance because of these histories.

Regarding culturally and ecologically relevant land management at Ne Sexsine, the paper notes and recognises that Indigenous stewardship contributed to the patch heterogeneity that characterizes MSFRs. With colonization there was a collapse of this fire regime and the landscape transitioned into a dense, homogeneous forest mostly devoid of Indigenous stewardship (with nearly two-thirds of cohorts establishing in the century after 1870). The homogenization of landscapes under altered fire regimes is a common pattern in MSFRs that can

result in increased vulnerability to uncharacteristic, large, high-severity fires. This risk is only elevated with current factors such as increased warming and drying.

4 DISCUSSION

4.1 Roos Paper

4.1.1 *Interpretations*

Native American fire management at an ancient wildland-urban interface in the southwest United States by Christopher I Roos, Thomas W. Swetnam, T.J Ferguson, and Christopher A. Kiahtipes was impactful in the scope of its investigation and execution. It uses a wide range of archaeologically significant explorations pertaining to ethnography, dendrochronology, geoarchaeology, and paleoecology (in proxies to charcoal, pollen, and herbivores), and modeling of ancient human and fire regime dynamics. In this, the paper extensively and effectively demonstrates not only the benefit of indigenous fire stewardship to pertinent land but also its cultural significance and pervasive presence through time.

Through the interviews conducted, the article accumulated important insights and information about attitudes, behaviors, and the managerial significance of Hemish, as well as other involved groups, relationship with fire. It has a variety of uses and applications in both domestic, agricultural, and ritual spaces as well as a foothold in hunting practices and ecological maintenance. Lastly, the paper's ethnographic efforts established an overarching ideology of respect and responsibility regarding fire - making it significant to the involved Indigenous communities in numerous facets from cultural meaning to land optimization and traditional practices. While this information is significant on its own merit, it was utilized in the paper in a significant way. Through application to archeological records, it supplemented and informed

interpretations of historical fire stewardship interactions and impacts on fire regimes that was invaluable and should be more widely practiced.

The use of dendrochronology, geoarchaeology, and paleoarchaeology allowed the paper to demonstrate both the impact Indigenous fire stewardship had on the environment and the benefits they reaped from it. To further elaborate, the paper was able to show how fire was used for many reasons of cultural significance and of pertinence to ways of life through proxies of charcoal, pollen, herbivores, and the analysis of fire scars. This exemplified benefit ecologically to animal and plant species. However it also significantly presented the significance and benefit fire use had in all these areas through promoting agriculture, clearing areas for land use, hunting, foraging, and so on. This is something I think helped argue and exemplify the vast implications and importance of fire use in specifically Hemish livelihoods. It further details ways in which similar fire practices could benefit ecology and livelihoods today.

The inclusion of models demonstrating land-use scenarios (contrasting Hemish practices and non-human influence) significantly contributed to the argument of Hemish Indigenous fire stewardship's contribution to ecological health and optimization. It does so by establishing fire stewardship contributes to ecological health rather than temporality or circumstances. In showing this, it cemented that anthropogenic fire regimes of many, small, low-severity fires, reduced forest vulnerability and increased resilience. Further, it implies that this is a direct consequence of fire stewardship practice.

4.1.2 *Significance*

In thoroughly examining and considering the implications of ethnography, dendrochronology, geoarchaeology, paleoarchaeology, and archeology the paper effectively demonstrated the multifaceted relationship between people, fire, and ecology. It models a

positive example of cultural burning as well as demonstrates how fire use pertains to many significant areas of Indigenous life through a wide and prevailing range of time. Further, it convincingly shows how colonial impacts hindered both cultural practices and ecological health while also contributing to fire risk in a manner that persists today. In understanding this, the paper better informs current efforts on fire mitigation in plausible attitudes and practices. It also gives due recognition to the positive impacts Hemish and other Indigenous cultures had and have ecologically. The article also calls attention to the injustice occurrent in colonial impacts - centralizing on fire suppression and cultural erosion, but pertinent and transgressing into other topics - through expanding upon the understanding of Indigenous impact on fire regimes.

4.2 Copes-Gerbitz Paper

4.2.1 *Interpretations*

The contribution of Indigenous stewardship to a historical mixed-severity fire regime in British Columbia, Canada by Kelsey Copes-Gerbitz, Lori D. Daniels, and Shannon M. Hagerman took a similar approach to the first paper discussed through means of exploring fire regimes and Indigenous fire stewardship with the contemporary collaboration of descendant peoples. However, this paper did not explore as many areas of study but rather focused more heavily on the historical reconstruction of fire regimes through extensive dendrochronological analysis and the application of oral histories to such.

The dendrochronology present in this paper was extensive in its examination of cohorts and plots. As a result, it informed heavily on the historical understanding of fire regimes in dry conifer forests and Indigenous contribution to the maintenance of such. In examining cohorts and cohort age they were able to deduce a pattern of fire severity. Further the examination of fire indications such as fire scars and scarlets added to the detail of understanding fire occurrence and

severity. Information at the plot level allowed for more localized information and patterns to occur. Examining this data at the plateau and bench locations further offered insight into ecological differences and complexities in elevation and habitats. Lastly, considering seasonality helped illuminate the higher occurrence of fires in a patterned time of late summer or fall. All this is valuable and extensive information that yielded a reconstruction of MSFRs in Ne Sextsine.

This knowledge in application with ethnographic insight was impactful in offering an understanding of Indigenous fire use, maintaining and benefiting the pertinent fire regimes for an extensive time period. The use of both oral histories and the history of MSFRs allowed the demonstration of Indigenous impacts on fire behaviors. For example, concerning plots, the paper discussed specific land use showing precise needs and pattern changes. This took the form of low-severity or mixed-severity fire induction that was the potential consequence of fishing camps or barry foraging land optimization, etc. The seasonality of burn indications also offered insight into the diversity of uses and intentions for fire stewardship. The impact of fire stewardship on the history of the fire patterns was also evidently seen with the collapse of fire regime stability when colonial impacts were present.

4.2.2 *Significance*

This paper contributed significantly to the understanding of dry conifer forest histories and their tendency towards mixed-severity fire regimes (MSFRs). Further, it effectively showed Indigenous contribution to the maintenance of this fire regime in understanding fire patterns through ages of tree cohorts and fire indicators such as fire scars and scarlets. Also, in understanding areas through ethnographic applications and seeing occurrences of patterns and maintenance of low severity fire regimes in places of T’exelc occupation the paper supports

Indigenous fire stewardship as a tool of ecological benefit. However with all this said, it focused more heavily on reconstructing fire regime history and could have more extensively examined markers for fire stewardship and its impacts outside of dendrochronology and ethnography. This could have yielded further understanding and implementation of ecologically beneficial stewardship practices to contemporary efforts. Yet, as the paper mentions, there is little literature or investigation into fire regime history specifically concerning indigenous relationships and functions. This is not to say that this paper did not add to such a conversation, and it is significant in the uniqueness regarding fire stewardship implications in historical fire regimes. There was a significant contribution in understanding that Indigenous stewardship helped maintain heterogeneous low-mixed severity fire regimes that were ecologically impactful and that this was disrupted by colonial impact and fire suppression efforts.

5 CONCLUSION

Wildfire, especially within the modern context of the growing WUI and impacts of global warming, is a prevalent contemporary concern. Due to the history of fire suppression, it has been an inflated issue in ecological and mental contexts via the accumulation of fuels and a deep disdain for most wildland fires. Further, although it is destructive and detrimental in any context, it continues to disproportionately harm marginalized communities depending on access to healthcare, affluence, and other inequities. This extends to many Indigenous communities as a result of colonial impacts that confound in fire suppression.

As it becomes more widely known in fire mitigation, low severity frequent burning is an optimal form of fire mitigation practice. Yet, there is still a large degree to which this is unpracticed and uncertain with experimental research dedicated to understanding how to

effectively achieve this. Indigenous communities, as seen in this paper with Hemish and T'execl cultures, have been vocal about fire stewardship and cultural burning as an ecologically beneficial tool of this caliber. There is potential in archaeological records to model successful fire stewardship that archives frequent low-severity burning optimal for contemporary wildfire mitigation efforts.

To examine this, my paper reviewed literature that had a scope of archaeological investigations with modern-day applications in fire management and collaboration with modern Indigenous communities. Although the literature of this caliber is limited, the two very appropriate papers examined, displayed Indigoness fire stewardship (for a variety of purposes and intentions) successfully and positively impacted ecological contexts. Not only did these practices minimize wildfire but optimized land use for an applicable way of life regarding relevant communities. This adds to the conversation of modeling potential current wildfire solutions but also demonstrates the ways in which cultural burning is significant to the Indigenous people represented in the text through the well-being and prevalence of traditions. Yet, the papers also show how this was disrupted by colonial impacts and ideologies.

This should motivate current efforts to incorporate TEK, especially pertaining to fire knowledge in modern mitigation practices. Further, it should motivate a greater body of literature dedicated to the application of archeology in understanding fire regimes and how cultural burning positively impacts them, as informed by current communities. Lastly, conversations and movements around fire in the present day should consult and consider respective Indigenous communities on their perspectives and fire stewardship, especially if this is something advocated for or practiced that has been suppressed.

6 MOVING FORWARD

Further efforts regarding the archaeological application of fire stewardship to contemporary fire mitigation would be most significant in addition to literature within the field. While conducting this thesis a limitation found was the lack of applicable literature exploring the pertinent contexts of contemporary Indigenous collaboration, archeological examination of fire stewardship and its impact on historical fire regimes, and application of this a modern scope. I would like to see an increase in investigations of archaeological facets that specifically ask questions about Indigenous fire stewardship with the inclusion of decedent informants for the purpose of contemplating modern fire mitigation.

With this in mind, I also advocate for an increased consideration in current fire mitigation of contemporary Indigenous communities in which fire stewardship is culturally significant. I think, as demonstrated in this paper and others exploring fire's impact on ecology, that successful cultural burning has optimized land use for time immemorial. The detrimental impacts of fire suppression have thus impacted Indigenous fire stewardship to greater degrees as it disallows traditional land management and culturally significant practices. The best way to correct this moving forward is to incorporate traditional ecological knowledge and the advocating as well as the agency of Indigenous communities in current fire management.

With all this said, it is also important to acknowledge that not every case of fire use in the archaeological record has demonstrated ecological and cultural impact in a positive way. Indeed there are case studies and examples of historical fires that demonstrate unsuccessful fire stewardship, though not included or investigation in the scope of this paper. However I argue that this study and knowledge (in an archaeological demonstration of unsuccessful fire practices) can yield just as much understanding that can be beneficially applied to modern fire efforts as the

papers evaluated in this thesis and their like. As argued above, understanding both a fire regime's history, the ecology of an area, and how people interacted with this in a beneficial way, promotes lessons on how to interact with fire contemporarily. Understanding how histories intersect with fire and people in an unsuccessful context can hold just as many lesions in a cautionary context. This, in conversation with the contents of this paper, is a positive direction in which to move forward or build upon what was argued here.

An additional note concerning this paper and something to keep in mind moving forward is that not all areas where fire mitigation is pertinent have contemporary Indigenous communities practicing or calling for fire stewardship. This complicates the argument presented above as it impacts the ability and available avenues of archaeology and contemporary fire mitigation to collaborate with communities practicing TEK or inform archeological research. In such scenarios I think it is still important and beneficial to consider the archeological and historical context of an area as it can still promote deeper understanding and insight of fire regime behavior and potential solutions for wildfire mitigation in such areas. Through the process of research for this paper I encountered many intriguing and worthwhile studies that exemplified this. I believe that continuing such research is also essential to the further development and efforts of the aim and argument of this paper.

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