

Article

Indigenous Fire Data Sovereignty: Applying Indigenous Data Sovereignty Principles to Fire Research

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Abstract: Indigenous Peoples have been stewarding lands with fire for ecosystem improvement since time immemorial. These stewardship practices are part and parcel of the ways in which Indigenous Peoples have long recorded and protected knowledge through our cultural transmission practices, such as oral histories. In short, our Peoples have always been data gatherers, and as this article presents, we are also fire data gatherers and stewards. Given the growing interest in fire research with Indigenous communities, there is an opportunity for guidance on data collection conducted equitably and responsibly with Indigenous Peoples. This Special Issue of Fire presents fire research approaches and data harvesting practices with Indigenous communities as we “Reimagine the Future of Living and Working with Fire”. Specifically, the article provides future-thinking practices that can achieve equitable, sustainable, and just outcomes with and for stakeholders and rightholders (the preferred term Indigenous Peoples use in partnerships with academics, agencies, and NGOs). This research takes from the following key documents to propose an “Indigenous fire data sovereignty” (IFDS) framework: (1) Articles declared in the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP) as identified by the author and specified in Indigenous-led and allied Indigenous fire research in Australia, Canada, and the U.S.; (2) recommendations specific to cultural fire policy and calls for research in the 2023 Wildland Fire Mitigation and Management Commission report; (3) research and data barriers and opportunities produced in the 2024 Good Fire II report; and threads from (4) the Indigenous Fire Management conceptual model. This paper brings together recommendations on Indigenous data sovereignty, which are principles developed by Indigenous researchers for the protection, dissemination, and stewardship of data collected from Tribal/Nation/Aboriginal/First Nations Indigenous communities. The proposed IFDS framework also identifies potential challenges to Indigenous fire data sovereignty. By doing so, the framework serves as an apparatus to deploy fire research and data harvesting practices that are culturally informed, responsible, and ethically demonstrated. The article concludes with specific calls to action for academics and researchers, allies, fire managers, policymakers, and Indigenous Peoples to consider in exercising Indigenous fire data sovereignty and applying Indigenous data sovereignty principles to fire research.

Keywords: Indigenous Peoples; fire; fire management; climate; sovereignty; collaborative research; Indigenous data sovereignty; California; research methods; Indigenous; cultural fire



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1. Cultural Fire Key Words

First and foremost, Indigenous Peoples are distinct by our cultures, worldviews, practices, and ways of being, across the globe. In fire-specific research, there are myriad terminologies rooted in place-centered and Tribal/Nation/Aboriginal/First Nations Indigenous Peoples-specific protocols. The following cultural fire keywords are offered as a start to decolonial word choice when working with and writing about Indigenous Peoples and our fire stewardship practices. As an equitable and just approach, the article encourages deploying these terminologies and the scholarship they are taken from with

Tribal/Nation/Aboriginal/First Nations Indigenous Peoples that researchers, academics, and agency representatives are working with in fire management and/or research.

1.1. Cultural Fire, Cultural Burning

Cultural burning enhances resources and rejuvenates medicinal plants for humans, animals, and insects; it is a restoration of resources for Traditional Indigenous practices and for generational Traditional Ecological Knowledge (TEK) that has been passed down from Ancestral times, allowing for the continuation of a sustainable culture for future generations [1].

Cultural fires go by many names, have many objectives, and provide many sources of healing [2]. Cultural fire can be interpreted as Indigenous-led prescribed fire conducted with the goal of ecological, cultural, and social restoration [3]. Cultural fire/burning is Indigenous-led burning that promotes intergenerational teaching and responsibility to the land and enhances diversity and productivity of species, food, medicine, and ceremony [4–6]; it actively involves communities and families to support overall community health [7].

1.2. Indigenous Fire Stewardship, Traditional Fire Knowledge

Indigenous Fire Stewardship (IFS), synonymous with Indigenous fire management [8] is the intergenerational teaching of fire-related knowledge, beliefs, and practices among fire-dependent cultures regarding fire regimes, fire effects, and the role of cultural burning in fire-prone ecosystems and habitats [9]. Traditional Fire Knowledge (TFK), offered by Huffman (2013), is fire-related knowledge, beliefs, and practices that have been developed and applied to specific landscapes for specific purposes by long-time inhabitants [10].

1.3. Good Fire

The term “Good fire” describes purposefully placed fire for the removal of dead and decaying vegetation; it can also be used to infer Indigenous use of intentional fire. The term has origins to Aboriginal Indigenous Peoples in what is now known as Australia, as Traditional ecological and cultural knowledge in “taking care of Country” [11] and bringing back good fire [12].

1.4. Prescribed and Controlled Fire

Prescribed and controlled fires are planned burns conducted by trained fire professionals to manage and restore lands and waters. Unlike wildfires, prescribed burns take place under specific weather conditions, require significant preparation, and follow explicit incident command safety protocols for both the public and fire professionals [13].

* Note: important differences between cultural fire and prescribed fire are further elaborated in the “challenges” section of this paper.

1.5. Indigenous Fire Data Sovereignty (IFDS, This Paper)

Indigenous fire data sovereignty is presented here as the right of a Tribe/Nation/Aboriginal/First Nations Indigenous Peoples community to govern and steward the collection, ownership, and application of its own fire data, deploying the FAIR (findable, accessible, interoperable, and reusable) and CARE (collective benefit, authority to control, responsibility, ethics) principles toward the betterment of our communities (see [14–17]).

2. Indigenous Fire Research Principles

Coupled with a call to employ *Indigenous fire data sovereignty* into fire research with Indigenous Peoples, this Special Issue of *Fire* allows offerings for Indigenous research methods as proposed by an Indigenous fire researcher. Additionally, suggestions on word choice and style serve as a roadmap to decolonize how Indigenous Peoples are written about in wildfire and climate research. The practice and protocol of this writing style come from Opaskwayak Cree Indigenous scholar Gregory Younging and their *Elements of*

Indigenous Style (2018) [18]. This article specifically uses the following principles toward equitable representation and is an invitation for fire researchers, agencies, and fire managers to employ decolonial fire methodology.

- (1) Fire research with Indigenous Peoples draws attention to the practice of acknowledging Tribal/Nation/Aboriginal/First Nations Indigenous Peoples' affiliations directly before or after the first mention of an Indigenous person's name. This form of acknowledgement advances Indigenous presence and visibility within the fire research discourse, a realm in which research about Indigenous Peoples has notably been represented by non-Indigenous persons (see [19]) ([18], principle 2). For example, in McGee and Christianson, 2019, Christianson states she is "a Métis research scientist whose research focuses on wildfire and Indigenous Peoples". Métis, here, is the chosen title and reference, which adds specificity to the First Nations community Christianson belongs to [20]. Tom et al., 2023, forefront the Tribal affiliations of both the Honorable Chairman Ron Goode, leader of the North Fork Mono Tribe, and Adams, of the *N'dee* San Carlos Apache Tribe [2]. Note: This is a practice that is to be determined by the Indigenous researcher/community member/agency representative themselves and should not be a requirement but rather a choice explicitly made by the Indigenous person.
- (2) Words of significance: Terms that hold significant meaning to Indigenous Peoples should be capitalized. Capitalization signals proper noun practices in written documents and garners agency for Indigenous researchers, authors, and community members. Examples include Traditional, Indigenous, Tribe, Land, Relative (as in other than human Relative), etc. ([18], principle 13).
- (3) Possessives that offend: Refer to Tribe/Nation/Aboriginal/First Nations Indigenous Peoples and places in our/the Tribes' own languages as appropriate. Possessives are a refusal [21] or turn away from terms such as "Indigenous Peoples of the United States" or "California's Native People", as this title denotes authority over a group of sovereign Peoples ([18], principle 17).
- (4) Past tense: Avoid the common error of describing Indigenous Peoples in the past tense. The article encourages readers to develop the practice of refraining from using only past tenses when referring to Native Peoples. Speaking of Native Peoples in the present asserts Native identity and existence and emphasizes Native Peoples in the now and always into the future ([18], principle 22).
- (5) Finally, "Indigenous Peoples" is an imperfect legal term that does not necessarily reflect individual Tribe/Nation/Aboriginal/First Nations Indigenous Peoples and our distinct cultures, practices, governance, and worldviews. Here, it is used intermittently throughout the document, mostly to refer to the Indigenous peoples across the world returning good fire to our communities, notably Tribal Peoples (the U.S.), Aboriginal Peoples (Australia), and First Nations Peoples (Canada), but Tribal specifics are referenced as often and as specifically as appropriate.

In offering word choice and etymology, it is best practice to hold conversations about Indigenous-specific terms and definitions with the communities you are working with. Along with conversations before research is written/published/disseminated, permission is also encouraged in word choice so that Indigenous Peoples hold agency in the narrative about how we are written about as a decolonial fire methodology. A step beyond this is for non-Indigenous scholars/allies writing and researching about Tribes/Nations/Aboriginal/First Nations Indigenous Peoples to announce themselves and share their research positionality so that readers understand the perspective and context of the work [22]. This is one way we can begin to build honorable and responsible fire research relationships.

A final note on this proposed *Indigenous fire data sovereignty* framework: similar to other synthesis scholarship presented by colleagues in the fire world, this is considered to be the beginning of a conversation about data sovereignty, which is the right to control and access our own data as Indigenous Peoples reclaiming fire stewardship.

3. Introduction

Indigenous Peoples have been stewarding lands with fire for ecosystem improvement since time immemorial [1,9,23,24]. These stewardship practices are part and parcel of the ways in which Indigenous Peoples have long recorded and protected knowledge through our cultural transmission practices, such as oral histories [16]. In short, our Peoples have always been data gatherers [25] and, as this article presents, we are also fire data gatherers and stewards. Through different iterations of cultural disruption and forced removal, we (Indigenous Peoples) held onto, transmitted, and adapted fire knowledge. This knowledge is fire data, and it is being called on in the face of climactic and environmental change [26]. The current uptick in interest of cultural fire as a wildfire management solution has led to academics and agencies actively seeking to engage with Indigenous partners [3,5,27]. Partnerships are needed since federal, and state suppressive fire policies have altered many ecotones (forests, savannas, and grasslands), which are more susceptible to the current impacts of wildfire [28–31] and are compounded by the effects of climate change [32,33]. The flux of interest suggests a change in attitude towards Indigenous knowledge systems and Traditional Ecological Knowledge but comes with concerns about ethical and equitable data harvesting [17].

Given the growing interest in fire research with Indigenous communities, there is an opportunity for guidance on data collection conducted equitably and responsibly with Indigenous Peoples, especially as written by Indigenous authors (see [34]). Indigenous Peoples' data include data generated by Indigenous Peoples, as well as by governments and other institutions, on and about Indigenous Peoples [35]. An assertion of governance, Indigenous data sovereignty is the right of a Tribe/Nation/Aboriginal/First Nations Indigenous Peoples community to govern the collection, ownership, and application of its own data [14,16,36]. Conversation and scholarship produced within the realm of data sovereignty have emerged amongst Indigenous Peoples from concerns about data representation and the lack of Indigenous participation in the processes [37]. Notably, advocacy for data ethics emerged from First Nations in Canada through OCAP© principles, which are ownership, control, access, possession of data [38]. Trademarking the acronym to prevent its misuse, these principles provide First Nations with collective and broad-based control of their own data, its collection, and use [39]. Recent scholarship has additionally deployed the FAIR (findable, accessible, interoperable, and reusable) and CARE principles (collective benefit, authority to control, responsibility, ethics) toward the betterment of our communities (see [15–17]). While the principles provide context for working with Indigenous communities, Indigenous scholars implore that Indigenous data sovereignty is underpinned by Indigenous governance, that is, decisions made with, by, and for Indigenous Peoples, and exercised by Indigenous Peoples as rightsholders, particularly through fire research, as offered in this article (see also [17]). The Special Issue of *Fire* presents opportunities to consider fire research approaches and data harvesting practices with Indigenous communities as we *Reimagine the Future of Living and Working with Fire*. Specifically, this article provides future-thinking practices that can achieve equitable, sustainable, and just outcomes with and for fire stakeholders and rightholders (the preferred term Indigenous Peoples use in partnerships with academics, agencies, and NGOs).

4. Methods: Assembling the Framework

The choice of literature search and review intentionally focused on data sovereignty scholarship produced with Indigenous communities in the U.S. [35] and abroad [15]. A primary goal of this targeted literature review is to decentralize wildfire management research methodologies and concentrate on Indigenous-led or cultural-burning-centered research. Here, this research takes from the following key documents to inform an *Indigenous fire data sovereignty* framework (IFDS) (Figure 1): (1) Articles declared in the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP) as identified by the author and specified in Indigenous-led and allied Indigenous fire research in Australia, Canada, and the U.S.; (2) recommendations specific to cultural fire policy and calls for research in the 2023

Wildland Fire Mitigation and Management Commission report [33]; (3) research and data barriers and opportunities produced in the 2024 Good Fire II report [32] and threads from (4) the Indigenous Fire Management conceptual model [19]. This paper also brings together recommendations for Indigenous data sovereignty, an apparatus developed by Indigenous researchers for the protection, dissemination, and stewardship of data collected from Tribal/Nation/Aboriginal/Indigenous communities. Significantly, this paper is informed by the following key data sovereignty research by [14–17]. It is important to note that the proposed conceptual model is the beginning approach to contemplate and integrate into conversations with Indigenous Peoples while engaging in fire research with Indigenous communities. It is a living document that can and should evolve over time, always developed with place-specific Tribal/Nation/Aboriginal/First Nations Indigenous Peoples, and in collaboration with local Indigenous communities. This paper is not intended to represent a complete, all-encompassing framework of our Indigenous communities and our/their goals of fire stewardship. Instead, this paper reflects the author’s positionality as an Indigenous fire scholar working, researching, and performing on-the-ground fire stewardship, governance, and fire science work with, by, and for our Indigenous communities.



Figure 1. *Indigenous fire data sovereignty* framework informed by the scholarship of Indigenous fire scholars and allies working in Indigenous-centered or Indigenous-informed cultural burning research in Australia, Canada, and the U.S.; and Indigenous-identified Indigenous data sovereignty scholars adopting IDS FAIR and CARE principles into research, institutional, and governmental partnerships with Indigenous Peoples. The IFDS framework is informed by the following key documents: (1) Articles of the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP) as identified by the author and specified in Indigenous-led and allied Indigenous fire research in Australia, Canada, and the U.S; (2) recommendations specific to cultural fire policy and calls for research in the 2023 Wildland Fire Mitigation and Management Commission report [33]; (3) research and data barriers and opportunities produced in the 2024 Good fire II report [32]; and threads from (4) the Indigenous Fire Management conceptual model [19].

5. Incorporating the UNDRIP into Indigenous and Allied Fire Research

Following other Indigenous scholars thinking, writing, and integrating Indigenous data sovereignty principles into their respective fields, and to inform the *Indigenous fire data sovereignty* framework, articles of the United Nations Declaration on the Rights of Indigenous Peoples may be threaded into Indigenous fire research. UNDRIP, one of the

policy apparatuses that influences Indigenous data sovereignty principles (which can also be situated within fire research), was adopted by the General Assembly in 2007 [40]. The Declaration offers 46 articles on the guidance and principles for states and Indigenous communities to address historic and ongoing challenges faced by Indigenous Peoples worldwide [41]. The Declaration is the most comprehensive international instrument on the rights of Indigenous Peoples. It establishes a universal framework of minimum standards for the survival, dignity, and well-being of Indigenous Peoples of the world, and elaborates on existing human rights standards and fundamental freedoms as they apply to the specific situation of Indigenous Peoples [42]. Acknowledging and referring to the UNDRIP is helpful for informing fire research with Indigenous Peoples and in understanding the nuances of Indigenous Peoples rights to self-determination as political entities [35]. According to Anishinaabe legal scholar Sheryl Lightfoot, “The United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP) recognizes both Indigenous peoples’ right to self-determination and simultaneously offers protections in regard to states’ right to sovereignty and territorial integrity vis à vis Indigenous peoples’ claims” [43]. UNDRIP is an instrument that should motivate and guide steps toward reconciliation with Tribes/Nations/Aboriginal/First Nations Indigenous Peoples on just terms [42].

With specific regard to cultural fire research, Indigenous scholars Lake and Christianson, 2020 and their work in the U.S. and Canada, respectively, suggest utilizing UNDRIP to support cultural practices such as burning. Specifically, Article 31(1) of the UNDRIP states that Indigenous Peoples have the “right to maintain, control, protect, and develop their cultural heritage, Traditional knowledge, and Traditional cultural expressions, as well as the manifestations of their sciences, technologies, and cultures”. The article also reaffirms Indigenous people have the right to maintain, control, protect, and develop their intellectual property over their cultural heritage, Traditional Knowledge and for Traditional cultural expressions [9]. Here, “the right to maintain, control protect and develop knowledge” is a vessel of Indigenous fire data sovereignty and implores following the specificities of UNDRIP related to cultural fire practice. The significance of intellectual property further recognizes the need for unique protections of Indigenous fire knowledge while employing an IFDS framework and principles.

Similarly, fire researchers Hoffman et al., 2022 and their work with First Nations Canada Indigenous Peoples note UNDRIP Article 31(1) and suggest cultural burning is a form of cultural expression, and therefore UNDRIP legislation should allow Indigenous Peoples to burn in their territories without oversight. The scholars recognize cultural burning as an enactment of the UNDRIP would avoid all Nations having to develop unique management agreements with provincial and federal governments, allowing Indigenous fire management programs to be implemented across broader territories [7].

Fire researchers Dickson-Hoyle et al., 2022 and their work with First Nations Canada Indigenous Peoples suggest cultural burning expresses the rights of Indigenous Peoples following Article 32 (1): “Indigenous Peoples have the right to determine and develop priorities and strategies for the development or use of their lands or territories and other resources including restoration” [44]. Importantly, Article 32 (2) states “entities shall consult and cooperate in good faith with the Indigenous Peoples concerned through their own representative institutions to obtain their free and informed consent prior to the approval of any project affecting their lands or territories and other resources, particularly in connection with the development, utilization or exploitation of mineral, water or other resources”. Free, prior, and informed consent (FPIC) is a provision of the UNDRIP, enacted to protect and empower Indigenous partnership and aspirations [45]. It is also suggested that FPIC be integrated into fire research with Tribes/Nations/Aboriginal/First Nations Indigenous Peoples through Indigenous fire data sovereignty to protect Indigenous Peoples rights and control of data.

Finally, this article recognizes the return of cultural fire practices, stewardship, and management also fulfills UNDRIP Article 18, “Indigenous peoples have the right to participate in decision-making in matters which would affect their rights, through representatives

chosen by themselves in accordance with their own procedures, as well as to maintain and develop their own Indigenous decision-making institutions". Decision-making can apply first to governance structures, which speak to decisions regarding land access, resources to manage fire, and the planning of fire-related activities—whether the goals are cultural resource improvement, defensible space, wildfire mitigation, or the health and well-being of the land and its peoples. Fire management and fire data gathering decision-making is an exercise of sovereignty, both as a state apparatus as well as communal democracy. Indigenous Peoples participated in democratized decision-making prior to colonization that reflect “seven generations” thinking—the decisions we make now for the betterment of seven generations ahead. Indeed, the right to participate in fire governance and decision-making encompasses both fire management and data gathering principles for the collective benefit of Tribes/Nations/Aboriginal/First Nations Indigenous Peoples, as defined by our communities and for our communities.

In sum, Indigenous and allied fire scholars have identified UNDRIP as an apparatus to recognize Indigenous Peoples right to self-determine and govern through fire stewardship and knowledge as data. Here, UNDRIP principles are folded into Indigenous fire research to inform Indigenous fire data sovereignty approaches.

6. Applying Indigenous Data Sovereignty Principles to Fire Research

This proposed *Indigenous fire data sovereignty framework* offers an opportunity to deploy fire research and data collection principles that are culturally informed, responsible, and ethically demonstrated. Reviews in the literature prioritize scholarship that includes the knowledge and perspectives of Indigenous Peoples stewarding fire toward Indigenous data governance and sovereignty. Governance refers to an exercise in sovereignty, decision-making, and self-determination. As a decolonial method [46] this paper intentionally targeted literature that made explicit reference to Indigenous scholars in both a (1) cultural fire literature review and (2) Indigenous data sovereignty scholarship. Several key documents inform the framework and serve as guidance on ethical and equitable fire research with Indigenous Peoples.

(I) *The Wildland Fire Mitigation and Management Report to Congress*

First, links to Indigenous fire data sovereignty are made by the highly anticipated Wildland Fire Mitigation and Management Commission Report, which provides 148 recommendations to Congress addressing the wildfire crisis. Of the recommendations, 20 provisions specifically address Indigenous fire stewardship and Tribal sovereignty [33]. Related to existing barriers and calls for Indigenous fire research, the following recommendations taken from the report can inform Indigenous fire data sovereignty approaches. Significantly, the document clearly identifies Tribes as the original stewards of the Nation’s landscapes, and regarding data,

“while federal agencies have an important role to play in sharing information with states, Tribes, local governments, and communities, it is important to support these entities in their own efforts to collect, analyze, and apply data for informed local decision-making and risk reduction activities. To be most useful, data needs to be accessible and actionable at a field level and made available at the scales and in formats that align with how it will be used” [33].

Implementation of said data sharing protocols by and for Tribes fosters Indigenous fire data sovereignty, which can fortify Indigenous Peoples’ rights to govern research and its resulting data on Indigenous Peoples’ terms. The commission makes several recommendations to better coordinate, integrate, and strategically align fire-related science, data, and technology, which are folded into this paper’s approach.

Recommendation 12: Federal agencies should work with Tribes, states, and local partners to develop a strategic plan for the implementation of prescribed fire at a national scale. Such a plan should: (1) be developed by a panel of agency and non-agency scientists, managers, and other experts; (2) identify ecologically appropriate targets for prescribed fire use at a regional scale;

(3) assess current scope and scale of prescribed fire use; (4) include a plan for annual monitoring and report on use of prescribed fire relative to targets and to assess its impacts and effectiveness [33]. Recommendation 12 can tie into Indigenous fire research and data sovereignty by including Indigenous knowledge (data) and place-specific Tribal perspectives in the ecological goals for prescribed burning. This will provide community members with roles in annual monitoring and reporting for prescribed fires as well as the impacts and effectiveness. Such tasks would fulfill collective benefits and authority to control of the CARE principles toward Indigenous data sovereignty.

Recommendation 114: Expand support for the development and application of scientific research into, and monitoring of, post-fire ecological recovery and compounding disturbances, especially for wildfires featuring large high-severity patches where ecosystem type conversion is likely in absence of management interventions [33]. Recommendation 114 can be codified while adhering to Indigenous data sovereignty principles through the collective benefit, responsibility, and ethics of the CARE principles. Collective benefit can be reached by informing community members of what post-fire ecological recovery data is in place-specific areas and by making the data accessible and findable. Data management protocols can be contemplated and addressed with Indigenous community members, resulting in fire data governance. In addition to recommendation 114, the commission explicitly states “any new or existing efforts should ensure that research and monitoring strategies consider Indigenous Knowledge and local knowledge” [33], thus incorporating Indigenous perspectives into the process, an exercise in autonomy.

Recommendation 115: Congress should consider the Forest Service Culture and Heritage Cooperation Authority as a baseline for expanded Tribal data sovereignty and Freedom of Information Act exemptions for Indigenous Knowledge. Recommendation 115 unequivocally calls for the implementation of Indigenous data sovereignty through the prohibition on the disclosure of sensitive information important to Tribes (i.e., locations of cultural and Traditional significance). Recommendation 115 enables authority to control, collective benefit, and ethics of the CARE principles. Invoking the recommendation can benefit communities; develop and enact Indigenous data governance protocols; align with ethical frameworks; and minimize harm to Indigenous Peoples. Such protections can help support greater cooperation between Tribes and entities by allowing information to be shared and kept confidential among partners. The Commission’s report further endorses by signaling that such an expansion would provide Department of Interior (DOI) agencies, such as the US Forest Service (USFS), with increased co-management strategies, including wildfire risk reduction and additional fire stewardship projects [33].

Recommendation 119: Upon the request of Tribes, entities gathering data and providing dispatch information regarding fire ignitions should have the authority to enter into agreements with such Tribes to protect the privacy and confidentiality of ceremonial and other fire use. Recommendation 119 identifies Indigenous sovereignty and offers a mechanism to protect culturally sensitive data that can and should be owned (stewarded) solely by Tribes. Enacting recommendation 119 can address ethical frameworks, minimize harm, invoke data governance, and address privacy issues for community and collective benefit.

Recommendation 141: Congress should identify an appropriate venue for continued work towards Tribal self-governance, self-determination and federal co-stewardship and co-management with Tribes. Recommendation 141 presents an opportunity to include data generated by Indigenous communities toward governance. Through co-stewardship and co-management agreements, Tribes can have autonomy over data collection, and analytical tools to address key issues, as formulated by Indigenous perspectives. Research can range from wildfire risk reduction, post-fire recovery, human health, ecological enhancement, and so forth. Moreover, co-stewardship and co-management can empower Indigenous communities to set research agendas, gather data grounded in community values, generate data in our languages and worldviews, maximize research benefits, and minimize harm to our Peoples.

Next to be included in the proposed *Indigenous fire data sovereignty* framework are recommendations taken from the culturally-informed Good Fire II report [32]. Recommen-

dations from the Good Fire II report were conceptualized notably by Indigenous leaders such as Director of Natural Resources and Environmental Policy for the Karuk Tribe Department of Natural Resources, Bill Tripp; California Wildfire and Forest Resilience Task Force Indigenous Stewardship Network co-lead Don Hankins, Ph.D., allied scholars such as legal expert Sara Clark, senior research and policy advisor at the Karuk Tribe Department of Natural Resources, Coleen Rossier, and dozens of others. Gratitude and reverence are given to this group for the articulation and potential codification of their conceived cultural fire recommendations.

(II) *The Good Fire I and II Reports: Current Barriers to the Expansion of Cultural Burning and Prescribed Fire Use in the United States and Recommended Solutions*

A follow up to the first Good Fire report [47], the second iteration moves from addressing California-specific barriers to the expansion of Indigenous cultural burning and prescribed fire recommendations to areas across the United States more broadly (Good Fire II report) [32]. The following recommendations relate specifically to and inform Indigenous data sovereignty approaches.

Recommendation 25: Congress and the California Legislature should ensure that agencies pay cultural fire practitioners and other Indigenous Knowledge, practice, and belief systems (IKPBS) keepers when they assist with agency planning and implementation and ensure that this information is not co-opted or used to preclude the revitalization of Indigenous stewardship to the maximum extent possible. This may involve complying with the Tribal Indigenous Knowledge and data sovereignty protection processes, policies, and protocols and/or agreements of individual Tribes [32]. Here, the authors explicitly recommend agencies comply with Indigenous fire data sovereignty processes as determined by the Indigenous community. Subject to the CARE principles, adhering to these data processes encompasses all CARE principles: collective benefit, authority to control, responsibility, and ethics. Moreover, codification of the recommendation can set precedent in Indigenous fire data developed with, by, and for Indigenous Peoples. The Good Fire II report provides additional directives that if Tribes have established data protocols, agencies should be required to modify or amend their own such policies and procedures. Further, the recommenders are cognizant that since cultural disruptions occurred through colonization, many Tribes may not yet have Indigenous Knowledge and data sovereignty protection processes, policies, protocols, and/or agreements developed, and therefore care must be taken to avoid knowledge (data) appropriation and/or infringement on cultural intellectual sovereignty. An IFDS framework and principles can provide beginning steps for agencies in approaching fire partnerships with Tribes/Nations/Aboriginal/First Nations Indigenous Peoples and have the potential to support Indigenous Peoples in (re)learning and creating Ancestral fire knowledge and data gathering protocols.

Recommendation 31: Congress and the California Legislature should ensure that Indigenous Knowledge shared with agencies is adequately protected from disclosure, including the creation of exceptions from the federal Freedom of Information Act and the California Public Records Act. Likewise, agencies should seek to implement co-stewardship and co-management agreements in ways that protect Tribal data sovereignty [32]. Recommendation 31 identifies protecting Indigenous data sovereignty and offers policy mechanisms to protect cultural data-data that can and should be stewarded and repositied solely by Tribes. Enacting recommendation 31 in *Indigenous fire data sovereignty* can minimize harm, invoke data governance, and address privacy issues for community and collective benefit.

Recommendation 32: Congress and the California Legislature should require agencies and entities gathering ignition data, receiving fire occurrence reports, and providing dispatch information to enter into agreements with Tribes to protect the privacy and confidentiality of ceremonial and other fire use, and prevent unnecessary deployment of suppression resources. Likewise, the federal government should also explore options to ensure that state, local, and private remote detection systems do not infringe on the religious, ceremonial, programmatic, and cultural practices of Tribes [32]. Recommendation 32 of the Good Fire II report is cross-referenced with recommendation 119 of the Wildland Fire Mitigation and Management Commission report. Importantly,

the authors expand to include provisions to protect the privacy of ceremonial fire use. Enacting recommendation 32 addresses ethical frameworks, minimizes harm, invokes data governance, and mitigates potential privacy issues for community and collective benefit, all principles informed by Indigenous data sovereignty and the IFDS approach.

Referencing the Wildland Fire Mitigation and Management Commission report [32], and the Good Fire II report [32] informs the proposed *Indigenous fire data sovereignty* framework by streamlining policy recommendations identified by colleagues working with Tribes, which can provide equitable and just data collection in fire research with Tribes. Targeted selection of these policy reports forefronts scholarship that includes the knowledge and perspectives of Indigenous Peoples stewarding fire toward Indigenous fire data governance and sovereignty. Finally, this paper's framework is informed by three additional pieces of scholarship: concepts recommended from the Indigenous Fire Management model [19], which is threaded with suggestions of incorporating Indigenous fire data sovereignty and data governance by Indigenous researchers Walter and Suina, 2019 [15] and Williamson et al., 2023 [48].

(III) *The Indigenous Fire Management Model*

In response to recent record-breaking fires, calls for decentralized management beyond fire suppression and better fire management with Indigenous Peoples have been made around the world. To synthesize fire management models with Tribes/Nations/Aboriginal/First Nations Indigenous Peoples, researchers Nikolakis and Roberts, 2020, examined scholarly literature on Indigenous Fire Management (IFM) and its accompanying ontological (the nature of reality), epistemological (understanding reality), and methodological (ways for gaining knowledge about reality) complexities [19]. The researchers selected 72 thematic research papers, representing a global perspective, for deeper review, where they developed the following five IFM concepts: (1) Distinct ontologies: the ontology of fire is socially constructed and perceived differently by Western and Indigenous worldviews; (2) Governance: IFM often involves collaboration between Indigenous and Western knowledge systems and occurs within a contested institutional context; (3) Revitalizing Indigenous knowledge: Indigenous knowledge and practices are rooted in an experiential epistemology where the landscape drives decision-making; (4) Co-benefits: IFM can generate a range of ecological, social, economic, and cultural benefits; (5) Desired state: IFM can achieve a desired ecosystem state of resilience. The IFM framework has potential to be incorporated into Indigenous fire data sovereignty toward integration of IFDS into fire research with Indigenous communities. Concentrating on concepts (2) and (3), there are opportunities toward data for governance to inform decision-making, where Indigenous Peoples retain their rights to self-determine their forms of collective governance. CARE principles [35] can be applied here specifically through collective benefit (C2) for improved governance and citizen engagement; authority to control (A2) data for governance and (A3) governance of data; responsibility (R3) for Indigenous languages and worldviews; and ethics (E2) for justice and (E3) future use. Nikolakis and Roberts note that IFM is a practice and tool that has the potential to expand and accelerate fire solutions. By incorporating governance mechanisms, Tribes/Nations/Aboriginal/First Nations Indigenous Peoples can be empowered to engage in fire research and data governance, on their terms, toward improved fire management for all.

(IV) *Indigenous Data, Indigenous Methodologies, and Indigenous Data Sovereignty*

Recognizing a broad agreement on the need for data that meets Indigenous needs and aspirations, Walter and Suina, 2019 convened a "Native think tank" to promote the use of Indigenous methodologies as well as inform efforts to advance the Indigenous data sovereignty movement [15]. According to the authors, Indigenous data sovereignty centers on "Indigenous collective rights to data about our Peoples, territories, lifeways, and natural resources and is supported by Indigenous Peoples' inherent rights of self-determination and governance over their Peoples, country, and resources as described in UNDRIP" [15,45]. Underscoring the relevance of Indigenous data, Indigenous methodologies, and data

sovereignty, the process led to three recommendations that could immediately be acted upon by fire researchers and managers [15]: (1) cultivate technical skills among community members related to the development of data, data collection, analysis, and reporting; (2) build comfort and understanding regarding research methodologies and methods among Tribal/Nation/Aboriginal/First Nations partners; and (3) advocate for Indigenous research methodologies and Indigenous data sovereignty.

Recommendation 1 fulfills actions for institutions to adhere to data sovereignty principles through responsibility (R1), expanding capability and capacity through participatory methodologies and initiatives to design, collect, manage, and apply data [17]. Recommendation 2 fulfills collective benefit for inclusive development and innovation (C1) by explaining and demonstrating how research and results are relevant and can be of value to the community and individual community members. Recommendation 3 fulfills all CARE principles in the methodological approach, data capture, dissemination, and ownership actions for institutions and researchers, but most importantly for Indigenous Peoples. Similar to Nikolias and Roberts, 2020 [19], Walter and Suina, 2019 [15] conclude that “Indigenous methodologies provide an alternative epistemological, ontological and axiological approach to the creation and analysis/interpretation of Indigenous data” and therefore can demonstrate how concepts adapted into research areas can increase Indigenous participation in fire data governance and collection processes.

To further support these recommendations, Williamson et al., 2023, offer Indigenous data governance as both guiding principles and a “practical blueprint” that can mitigate against the unintended consequences of Indigenous knowledge theft, as well as providing opportunities to foster self-determination and governance [48]. Williamson et al., 2023 [48] propose: (1) educational opportunities are offered to Indigenous groups so as to be aware of their inherent data rights and mechanisms to protect their environmental data; (2) all universities, scientific, environmental, and research institutions, settler governments, and government agencies formally endorse the CARE principles for Indigenous data governance; and (3) all partnerships between Indigenous groups and settler organizations and institutions in the myriad fields of environmental research develop clear data agreements. Inspired and informed by the portfolio of Indigenous data sovereignty research and Indigenous fire research, mostly led by Indigenous researcher voices, the following serves as recommendations this article proposes to incorporate IDS principles into fire research (Table 1). Integration of the two fields, Indigenous fire stewardship and Indigenous data sovereignty, will not be met without its challenges. Therefore, it is encouraged that researchers engage with Indigenous communities before fire research deployment to obtain consent, collaborate toward the IDS protocol, and mitigate unforeseen challenges.

Table 1. Actions that researchers and fire managers can take to incorporate the CARE principles (collective benefit, authority to control, responsibility, and ethics) into fire research with Indigenous Peoples toward Indigenous fire data sovereignty. The IFDS framework is informed by the scholarship of (1) Indigenous fire scholars and allies working in Indigenous-centered or Indigenous-informed cultural burning research in Australia, Canada, and the U.S.; and (2) Indigenous identified Indigenous data sovereignty scholars adopting IDS principles into research, institutional, and governmental partnerships with Tribes/Nations/Aboriginal/First Nations Indigenous Peoples across the world (see [14–17,36]).

CARE Principle	Ways to Engage in Indigenous Fire Data Sovereignty
Collective benefit	Fire research questions are shaped and informed by Indigenous community members. Make space for Indigenous worldviews, science, and knowledge transmission in fire research agenda. Findings are accessible and findable by community members at any time. Compensate Indigenous community members throughout the research timeline.
Authority to control	Co-develop fire data management with the Indigenous community. Ensure consent is understood and given through each stage of the research process. Honor that community has the right to refuse and withdraw consent. Discuss Indigenous frameworks in the collection and interpretation of fire data.

Table 1. Cont.

CARE Principle	Ways to Engage in Indigenous Fire Data Sovereignty
Responsibility	Co-develop fire research design including data management and storage with the Indigenous community. Identify privacy issues and concerns of fire data with individuals and Indigenous community members. Use the language and word choice of Indigenous peoples in culturally accessible formats. Discuss collective benefits and strive to meet the needs of the community.
Ethics	Prior to the research, identify specific data ethics and data management goals from Tribe. Identify maximum benefits that the fire research presents, as determined by the community. Identify possible harms and concerns of shared data. Minimize harm through ethical engagements. Use community guidelines for use and reuse of data including approval and disposal requests.

Note: The terms Indigenous Peoples and Tribe are placeholders for the specific Tribe/ Nation/Aboriginal/ First Nations Indigenous Peoples that you aim to partner with. It is encouraged that you learn and refer to the Indigenous community by their preferred title.

7. Challenges

Given the rise of data concerns in a technology-intensive reality, Indigenous Peoples recognize the risk of data mining, artificial intelligence, and the threats these modalities pose to Indigenous sovereignty. Threats can include data infrastructure that neither recognizes place-specific Indigenous worldviews, nor consideration for Indigenous-specific data sovereignty [16]. A unique challenge to fire stewardship is the often-conflated grouping of Indigenous cultural burning (and the data generated from such practices) with prescribed burning dynamics and goals [32]. For clarity, both practices improve our surrounding ecosystems, and each aids in the mitigation of catastrophic wildfires through the removal of fuel buildup in fire-prone and fire-deficit areas. But oftentimes, when grouped into prescribed burning, the cultural centering of Indigenous fire practices—and the importance of sovereignty—is lost through interpretation. This is a form of knowledge and data erasure. Fortunately, these concerns are increasingly recognized and articulated in cultural fire practitioners' push for agencies and academics to understand that cultural burning differs from prescribed burns [1–3,33,49–51]. Without consultation and consent from Indigenous practitioners, cultural burn practices risk losing place-based specifics and individual Tribal/Nation/Aboriginal/First Nations Indigenous Peoples burning techniques. For example, McKemey et al., 2022, acknowledge the challenges that can arise in co-developing Indigenous cultural fire management research with Aboriginal Indigenous Peoples [52].

Further, in a discussion on the challenges of data, Carroll et al., 2020 [35], articulate the rise of government interest in Aboriginal cool burns, as a result of the recent catastrophic bushfires in Australia. The researchers assert that such practices cannot be “picked up as panacea to mitigate the onset of wildfire”; therefore, data needs to be gathered specifically from knowledge holders (if desired and agreed upon) and must be Indigenous-led and Indigenous-controlled to reduce the risk of data exploitation. Finally, data generated without Indigenous interpretation runs the risk of reinforcing, rather than challenging tropes often written *about* Indigenous Peoples, including narratives of disparity, deprivation, disadvantage, dysfunction, and difference (see 5D's by [15]). To mitigate some of these potential data challenges in fire-specific research with Indigenous communities, the following calls to action are presented.

8. Calls to Action

To be clear, the IFDS framework offered in this paper is not intended to encompass a complete answer to all inquiries and challenges in Indigenous fire data sovereignty, fire research with Indigenous Peoples, or research in Indigenous data sovereignty. The conceptual IFDS framework is intended to move forward discussion of data sovereignty and fire research with Tribes/Nations/Aboriginal/First Nations Indigenous Peoples and to empower Indigenous communities as data gatherers, research leaders, and full agents in setting the research agenda [53]. As a takeaway, here are actions that academics, allies, fire managers, policymakers, and Indigenous Peoples can consider.

- (1) A call to academics: to assert Indigenous fire data sovereignty and research for a reimagined future, a call to academics is to educate and exercise IFDS principles into projects and to adopt FPIC and the FAIR and CARE principles into fire research with Indigenous communities. Moreover, academics can engage in consent and consultation through responsibility, reciprocity, relationships, and redistribution of Indigenous methodologies and ethics [54]. This document can provide some beginning steps toward ethical and culturally rooted approaches in fire research and mitigation/management plans with and for Tribes/Nations/Aboriginal/First Nations Indigenous Peoples, but each community must be approached individually. The lessons shared here are adaptable but not transferable. *See table 1 “Actions that researchers and fire managers can take to incorporate the CARE principles into Indigenous fire research toward Indigenous fire data sovereignty”.*
- (2) A call to allies: the history of fire suppression and cultural severance with fire knowledge is increasing in visibility across institutions and levels of government (see [11,23,33,55–57]). While many Indigenous Peoples held on to fire knowledge, many of us are finding our way back to fire stewardship and are in the process of developing tools to protect our knowledge and data transmission. The paper provides some beginning threads on engagement with Tribes/Nations/Aboriginal/First Nations Indigenous Peoples to empower Indigenous Peoples toward governance and autonomy. Allies can allow Indigenous Peoples the time, space, and resources to set the research agenda and develop data harvesting protocols specific to the community for the betterment and protection of our knowledge. You have an important role; step up when you can and step back when it is needed. *See the “Cultural Fire Keywords” and “Indigenous Fire Research Principles” in this paper for guidance on writing with and about Tribes/Nations/Aboriginal/First Nations Indigenous Peoples.*
- (3) A call to fire managers: similar to academics, to assert IFDS, a call is to educate and integrate IDS principles into work with Tribes/Nations/Aboriginal/First Nations Indigenous Peoples. Many Indigenous Peoples and government agencies share in the goals of mitigating wildfires and protecting our communities and economies. Tribes/Nations/Aboriginal/First Nations Indigenous Peoples are unique entities with political status and represent a range of worldviews, values, practices, and lifeways. Many misunderstandings can be eased through efforts to communicate and involve Indigenous Peoples in various stages of planning and mitigation processes. Fire managers can educate and integrate sovereignty, self-determination, and fire governance into collaborations and partnerships with Indigenous communities.
- (4) A call to policymakers: through the hard work and advocacy of on-the-ground Indigenous cultural fire practitioners, community members, and scholars, Indigenous fire policy recommendations are now proposed at the U.S. federal level through the Wildland Fire Commissions Report [33] and the Good Fire II Report, [32] both of which are folded into the proposed IFDS framework. To assert IFDS, a call to policymakers is to (a) review specific calls for legislation on Indigenous fire stewardship, management, governance, and data sovereignty, which are synthesized in this article, and (b) leverage expertise toward potential codification of these recommendations in the return of cultural fire and the fire decision-making process across myriad regions within the U.S. From here, it is encouraged that Indigenous Peoples, fire researchers, fire managers, and policymakers in other countries contemplate similar recommendations adhering to goals set by Tribes/Aboriginal/First Nations Indigenous Peoples home communities. *See suggestions for “Incorporating the UNDRIP into Indigenous and allied fire research” section of this paper.*
- (5) A call to Indigenous communities: first and foremost, the role that removal has had on our Peoples’ ability to retain, create, and transfer fire stewardship knowledge is increasingly recognized by allies and individuals outside of our communities. This document in its entirety is a call for our Indigenous communities to empower ourselves in fire knowledge and fire data revitalization, adaptation, and transmission.

Currently, we are in a cultural fire renaissance in which Indigenous Peoples from all over the world are reclaiming our fire stewardship practices to heal our communities (for example in Australia [12] Canada [24,58] the United States [49] and Latin America [23]. This piece affirms the reawakening of Indigenous fire and data stewardship and serves as a call to assert our own processes and protocols for welcoming fire back to our homelands -on our terms.

Similar to scholars of the Karuk Tribe Climate Vulnerability Assessment [59] may this document assist our Tribes/Nations/Aboriginal/First Nations Indigenous Peoples toward achieving full governance and sovereignty over our Knowledge, Lands, and Spiritual Practices.

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