ETHNOBIOLOGY LETTERS
Perspectives
Special Issue: Historical Ecology & Cultural Keystone Places

Archaeofaunal Remains, Geography, and the Investigation of Cultural Keystone Places

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Abstract Cultural Keystone Places (CKPs) are areas on the landscape crucial to individual and group identities, especially descendant communities. As such, they are often significant components of Indigenous land claims and cultural continuity. CKPs commonly have deep temporal roots and unclear spatial boundaries, and archaeological investigation is often relied upon to define them. However, relying on archaeological prospection and data to define a CKP can be problematic. The discovery of archaeological material and, by extension, a CKP is a probabilistic endeavor, often constrained by preservation conditions and sampling strategies. While many archaeologists understand that the material record will always be incomplete and that the absence of archaeological materials does not indicate the absence of a CKP, this view is juxtaposed with comparatively simple legal or regulatory understandings of CKPs as areas exclusively defined by either the presence or absence of archaeological materials in places such as British Columbia, Canada, which we discuss in this paper. To frame that discussion, we turn to the archaeological record from a different region; we use a large multisite database from southwestern Colorado—created and curated by the Crow Canyon Archaeological Center—to illustrate the variability in the quality of the archaeological record across the landscape. By modeling the fragmentation and sample size of animal remains, we demonstrate how even systematically collected archaeological data can still lead to knowledge gaps, potentially resulting in a false negative for the presence of a CKP. We therefore urge regulatory agencies to more thoroughly consider the sampling strategies and preservation conditions of remains related to the investigation of CKPs and to highlight the value of using robust archaeological databases to support Indigenous land rights and the identification and protection of CKPs.

Received November 12, 2024
Accepted April 10, 2025
Published December 1, 2025

OPEN ACCESS
DOI 10.14237/ebl.16.2.2025.1913

Keywords Quantitative archaeology, Zooarchaeology, Applied archaeology, Action ethnobiology, Central Mesa Verde region, British Columbia

Introduction

Cultural keystone places (CKPs) are areas situated on the landscape that have deep meaning to one or more group's cultural identities and prosperity (Cuerrier et al. 2015). Much like theories of place established in human geography (Tuan 1977), CKPs are partially defined by how people interact with the natural world. These material interactions are multifaceted, can occur at a multitude of overlapping spatial scales, and often have deep temporal roots. CKPs, though they may hold a physical manifestation, are also represented in intangible ways, such as through oral traditions about places, land use practices, spirituality, and many other cultural practices that may have been lost and/or recorded through a colonial lens (Turner and Berkes 2006; Wyndham 2009). Our focus in this paper is on one aspect of CKPs that can leave a tangible trace (i.e., the archaeological record of material culture). The archaeological record has been one crucial source of information used to identify and establish where CKPs occur on the landscape (Lepofsky et al. 2017; Rick et al. 2022).

Identifying CKPs with archaeological data is not always straightforward for multiple reasons. These

issues are similar for the identification of archaeological sites, but there are some differences, too. In archaeology, sites are conceptual units (rhetorical devices) used to approach places for the purposes of research, tourism, preservation, and other functions (Hayashida 2005; Matero 2006; McCoy 2020). CKPs, on the other hand, may mesh more meaningfully with ideas of place held by local and/or Indigenous peoples (Armstrong et al. 2022; Lepofsky et al. 2017). One of the main issues in the discovery of CKPs (as with archaeological sites) is that human-environment interactions that constitute them can be subtle, leaving only scant material traces (Wyndham 2009). Exacerbating this problem—and the focus here—are challenges of preservation and sampling that routinely obfuscate archaeological interpretation. How can one confidently identify a CKP if archaeological traces have been erased or have simply eluded the detection of archaeologists?

The consequence of not fully understanding issues surrounding sampling and recovery of where CKPs occur on the landscape is critical. The distribution of CKPs might be unknowable, and what is known might change regularly. This reality may cause legal issues regarding land claims, land use planning, and its appropriate management. Those in the legal and regulatory world often see landscapes, CKPs, and/or archaeological sites through a comparatively simple geographic lens of presence or absence, with little understanding that the empirical archaeological record is far more complex (Martindale 2014; Owen 2015). How, then, might those in the legal and regulatory world come to appreciate these complexities and more thoroughly evaluate the presence or absence of CKPs, at least in terms of their discovery probability via the archaeological record?

One way in which archaeologists have worked to better understand geographic patterns of archaeological observations is through the construction and analyses of large, multi-site databases. These datasets help answer research questions that focus on multiple geographic scales (Ritchie and Lepofsky 2020). Archaeologists, for instance, can pivot from regional to local to site-level spatial scales to analyze artifact variability. In this paper, we analyze the large, multi-site faunal dataset produced and curated by the Crow Canyon Archaeological Center in southwestern Colorado to demonstrate the usefulness of such datasets to legal and regulatory agents and agencies.

The large database created and curated by Crow Canyon (Crow Canyon Archaeological Center 2025) offers a means to examine the empirical variability of the archaeological record through space and time in the central Mesa Verde region and to draw comparisons to other regions where the presence (and absence) of archaeological data is increasingly implicated in Indigenous land claims and the enforcement of cultural resource management (CRM) regulations. One such area that we focus on in the discussion section is the Northwest Coast, particularly within British Columbia (BC, Canada). Indeed, the Northwest Coast (*sensu* Carlson 1983) comprises collections of sites that represent assemblies of CKPs, and we maintain that the sites in the Crow Canyon database are part of the reason why the central Mesa Verde region is also an accumulation of CKPs (Naranjo 2006; Ortman 2010, 2012; Swentzell 2015).

BC is one of the few regions in Canada where many Indigenous Territories were never ceded (e.g., through treaty or other agreements). This has led, in recent years, to an upswing in legal and regulatory confrontations where archaeological data are squarely positioned to confirm Indigenous use and occupancy—or, more insidiously, to illustrate a presumed lack of use and occupancy (when there is a purported lack of "data"). While in some cases, inference from absence can indeed be justified in some archaeological contexts (Wallach 2019), the logical frameworks within which most "absences" are presented in real-world contexts, such as courtrooms and boardrooms, are anachronistic and untested (Martindale and Armstrong 2019). Moreover, the purported absence of archaeological materials might have no bearing on the cultural relevance, attachment, and inheritances of a given landscape—especially true for CKPs. Although we do not focus on archaeological sites from BC in this paper, our intention is to illustrate variability in the absence and presence of a class of material culture (faunal remains) using a large geospatial dataset. We employ a large dataset from the central Mesa Verde region to this end.

We examine faunal remains because, more than some other types of material culture (e.g., lithic and ceramic artifacts and some forms of architecture), animal remains are perishable. Entire sites can be composed of perishable artifacts (sometimes called ecofacts) and subsequently lost to the vagaries of time. For the central Mesa Verde region, we show that high variability in the preservation conditions of the zooarchaeological record across the landscape is to be

expected. We model this empirical reality through one agent of bone preservation: fragmentation. Here, we use a metric that combines the extent and intensity of bone fragmentation and serves as a proxy for how well archaeological materials might be represented on the landscape. We demonstrate over decades, with ongoing and incremental archaeological field and lab work, that the spatial extent of the archaeological record increases, initiating questions about archaeology as a tool for defining the limits of peoples' presence and/or absence on a landscape (Owen 2015). For example, the absence of artifacts and ecofacts in unsurveyed spaces represents a need for additional attention and information and should not be considered as the absence or presence of archaeological materials. We hold that the exercise we present here has direct relevance to places in the world where the reality of CKPs is legally debated (e.g., BC).

The ability to use archaeological data to influence legal and regulatory bodies regarding CKPs puts the work presented here squarely in the realm of applied archaeology and action ethnobiology (Albuquerque et al. 2024; Armstrong and Brown 2019; Arrivabene et al. 2024; McAlvay et al. 2021; Soldati and Almada 2024). It is this empirical nature of the archaeological record, as conceptualized at the landscape scale, that holds meaning for action ethnobiology, particularly in contrast to binary legal concepts of presence and absence of sites on the landscape. Large, regional multisite databases—though steeped in Western scientific norms—can be used to strengthen Indigenous land claims.

Previous Research

Our intent in this paper is not to provide a literature review of work in environmental archaeology that demonstrates the increasing geospatial extent of artifacts and sites. Archaeologists know spatial coverage of the archaeological record increases with fieldwork; that said, there are fewer studies that engage the intersection of the geography of the archaeological record and heritage ethics and environmental management, though such works exist. Lee Lyman (1988, 1994a, b, 1998), for instance, investigated the probability that remains of rare mammals would be recovered from archaeological sites during his assessment of the Olympic National Park mountain goat (*Oreamnos americanus*) eradication plan in the 1990s. Over multiple articles and books, Lyman highlighted how faunal assemblages are narrow subsets of the life and death assemblages of past animal populations. Those species that are rare on the landscape, such as mountain goats, are not likely to show up in the record (Lyman 1995a).

As a result, it is logically flawed that mountain goats should be culled from Olympic National Park because "they were never there" based on a material record of absence (Lyman 1998). When mountain goat remains are recovered, they are found in exceedingly low proportions across many archaeological sites because of low discovery probability caused by rarity on past landscapes and taphonomic variables (Lyman 1995b). Preservation conditions, for instance, relate closely to the degree to which bones are fragmented, which is our focus here. Fracture of bone can happen ante- or post-mortem, but the probability of fragmentation increases once carcasses are butchered by those who hunt prey. As the taphonomic history of a fauna unfolds from death to deposition, and (potential) eventual excavation, recovery, and analysis, the potential for fragmentation and destruction increases. Archaeologists encounter faunal remains late in this taphonomic trajectory; thus, zooarchaeologists study remains subject to diverse preservation conditions both within and across faunal assemblages. As a result, the absence of a species from the faunal record does not mean they were not present on prehistoric landscapes.

Similarly, culturally modified trees in the Pacific Northwest are obscured over time—after a harvest event, the lobes on either side of the tree begin to heal and envelop the harvest scar, masking the harvest event. Assessing post-logged sites (stump cross sections) in a forestry cut block in Nuu-chah-nuulth territory, BC, Earnshaw (2019) found that approximately half of the bark peeling scars on culturally modified trees were embedded inside healing lobes. This meant that the diagnostic features on half of the potential culturally modified trees (especially the older ones) were invisible to archaeologists and were therefore not subject to regulatory protections.

In this paper, we use similar logic—that absence and presence relate to taphonomy and sampling intensity—to counter the legal perspective that the absence of sites in a region or area means that people were not there in the past or that important cultural practices did not occur on the landscape (Owen 2015). Many areas have not been studied, and even then, variability in the preservation and/or visibility of

the archaeological record is to be expected (e.g., see growing knowledge of clam gardens in the Northwest Coast [Lepofsky et al. 2021; Smith et al. 2019]). In this paper, we examine the taphonomic condition of remains from the Crow Canyon faunal database of sites in the central Mesa Verde region of southwestern Colorado to demonstrate variability in preservation as well as a changing record of absence and presence geographically. Although this region is dramatically different from the Northwest Coast, our purpose here is to investigate a well-studied archaeological database geographically, which is relevant to the study of CKPs elsewhere. Our results show that decades of fieldwork have increased the geospatial extent of the archaeological record of faunal remains in the region; what would have been considered areas of geographic absence decades ago show the presence of archaeological materials (i.e., sites and/or CKPs) today.

Understanding Bone Fragmentation in the Central Mesa Verde Region Dataset

One way to examine the variability in the condition of faunal remains between and within archaeological sites is to develop measures of bone fragmentation (Lyman 1994b; Munro and Bar-Oz 2005; Stiner 1994; Wolverton 2002). In this paper, we follow Lyman (1994b) and conceive of fragmentation in two ways: extent and intensity of fragmentation. Extent of fragmentation refers to how many bones are fragmented and how many are complete. We measure this as "%whole bones" in an assemblage, which is a ratio of the number of whole skeletal specimens relative to the total number of specimens (whole and fragmented) in a faunal assemblage. The lower the % whole, the greater the extent of fragmentation. Intensity of fragmentation refers to how often fragments are fractured into smaller pieces. Conceptually, the smaller the fragments, the more intense the fragmentation. At a coarse taxonomic scale, we use the measure of "%unidentifiable" remains from an assemblage as a proxy of intensity with the logic that progressively smaller fragments have a lower probability of maintaining taxonomically diagnostic morphological characteristics (Cannon 2013).

Faunal assemblages that are poorly preserved and considered highly fragmented will be extensively and intensely fragmented with low %whole and high % unidentifiable remains. We combine the two variables mathematically through dividing measures of intensity of fragmentation by extent of fragmentation to create a Fragmentation Agency Index (FAI). The FAI is calculated by dividing %unidentifiable by %whole. This calculation can be simplified to the number of unidentifiable specimens divided by the number of whole specimens. The higher the value, the more fragmented a faunal assemblage is.

With the use of the FAI, variability in fragmentation can be studied as one important measure of preservation across the sites represented in the database. Correspondingly, we can illustrate the continuum of preservation conditions within and between sites in the region. We calculate FAI per study unit in the Crow Canyon database; a study unit is defined as a specific area of similar deposition or cultural use in time and space. Different structures or middens are common types of study units, which are then explored further using provenience designations that specify exact vertical and horizontal locations within a study unit (Crow Canyon Archaeological Center 2001).

To be clear, what we see is variability in the preservation of faunal remains across the 890 study units from 48 sites represented in the Crow Canyon database (Figure 1; Supplementary File 1)[1]. Our point related to CKPs is that even perishable cultural materials, such as zooarchaeological remains, are expected to vary considerably in their condition and presence across sites. How does this play out geographically in the region?

The Geography of the Central Mesa Verde Region Faunal Record

Crow Canyon's database contains detailed information for 48 archaeological sites, however, there are over 30,000 recorded sites in the county where the center resides (additional sites exist on non-surveyed lands). If we think in terms of FAI and the presence of faunal remains, data from the 48 sites can be visualized in terms of the taphonomic importance of fragmentation.

The maps in Figure 2A show the median FAI per site; larger, lighter circles reflect sites with higher FAI remains (meaning less well preserved, more fragmented). There is spatial variability in the magnitude of the importance of fragmentation and associated preservation condition of remains. The geographic implication of the map visualization is that

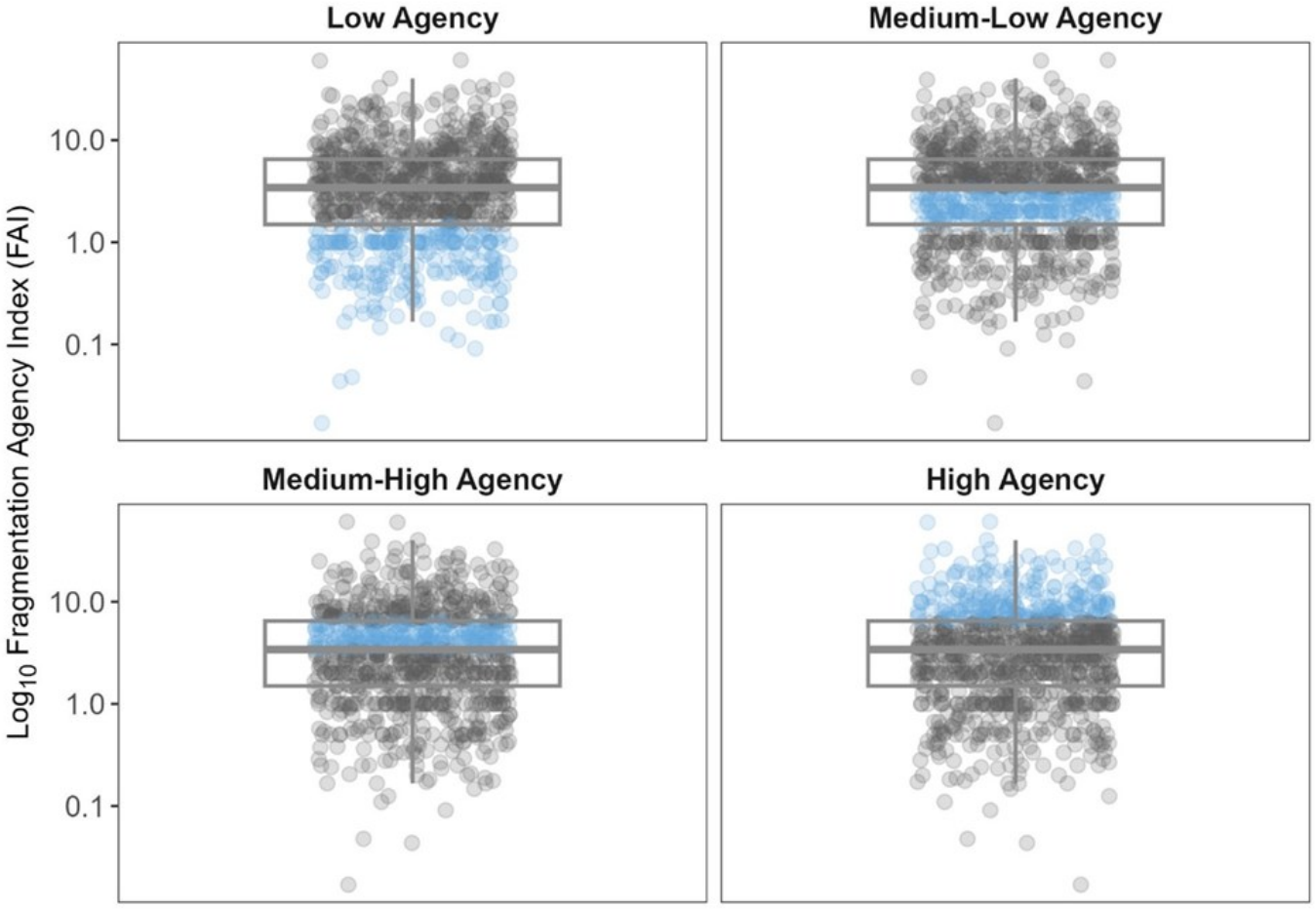

Figure 1 The variability in the Fragmentation Agency Index (FAI) from 890 study units across 48 archaeological sites in Crow Canyon databases. FAI values are divided into four categories for visual purposes (demarcated visually in blue, sequentially): low (below the first quartile), medium-low (between the first and second quartile), medium-high (between the second and third quartiles), and high agency (above the third quartile).

variable differential preservation of faunal remains is to be expected across space. Importantly, then, the absence of zooarchaeological bone in one or another location is hypothetical until it has been determined through fieldwork. Extending this logic to regulatory reviews for environmental or other impact assessments, reliance on existing databases to determine the archaeological or CKP potential of a landscape is hypothetical without field and laboratory work.

Differential preservation of bone is but one factor that influences the probability of encountering faunal remains; another variable is the extent and intensity of fieldwork over time. Preservation combined with recovery efforts leads to zooarchaeological samples that vary in size (conceivably from n = 0 to very large faunas, such as > n = 30,000 remains). Here we map the distribution of faunal sample size from sites in the dataset (Figure 2B). Larger, lighter circles represent larger faunas. Recall the geographic distribution portrayed in the map is not for all sites in the region, nor is it for all remains at the sites; it's a distribution of what has been reported by Crow Canyon as a result of their archaeological sampling of sites.

The preservation condition maps also display projects conducted by Crow Canyon over several decades. If the geographic distribution is visualized in a manner that conveys the geographic record of faunal sampling over time (Figure 2), it is clear that what is known about the distribution of faunal remains (and by association other cultural materials) has changed over the last 40 years. Of key concern

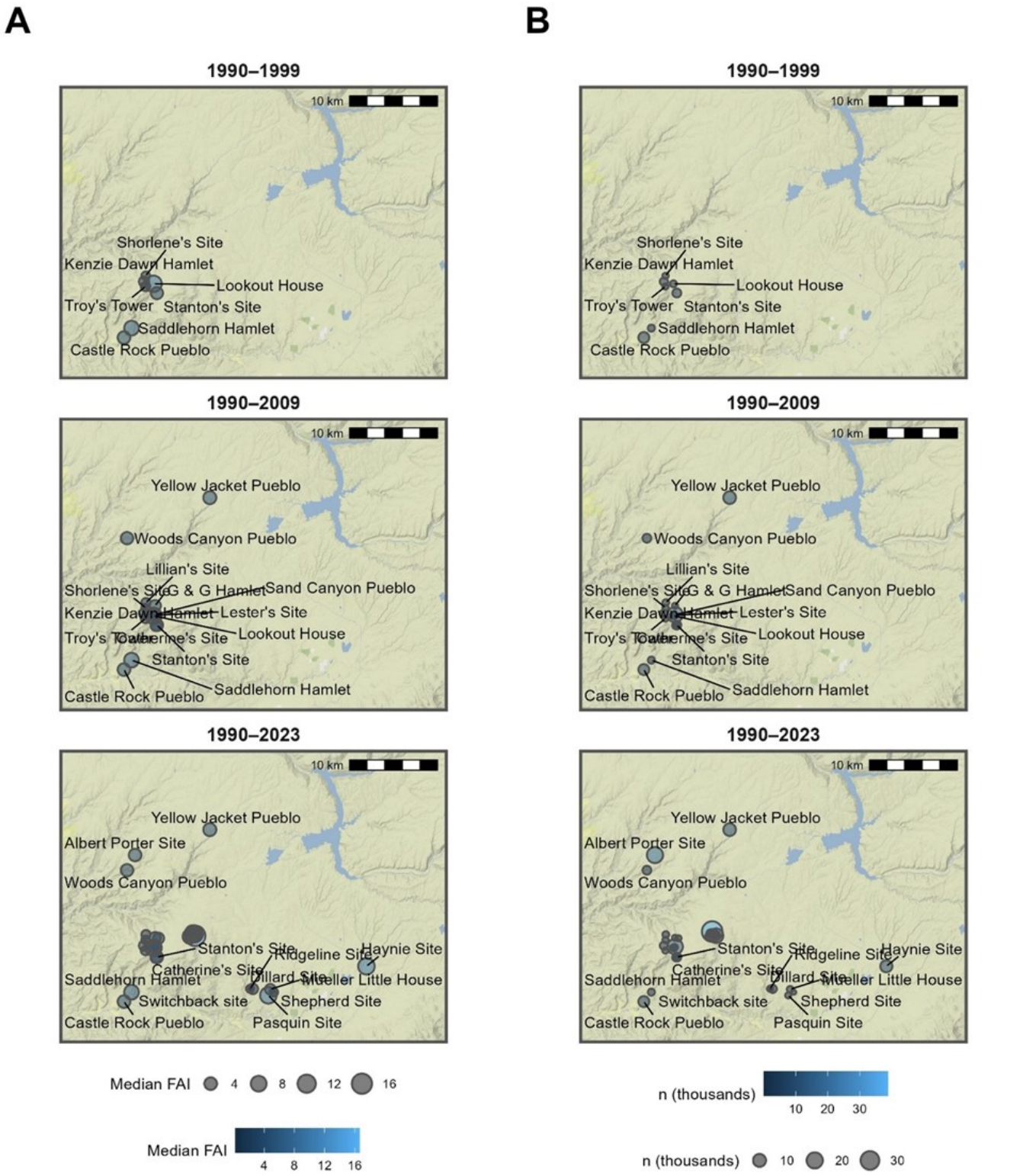

Figure 2 Changes in **A** median Fragmentation Agency Index (FAI) and **B** faunal assemblage sample size (n) through time. Time is measured as the year the last faunal data was added to the database (note that projects were often started years before). This figure illustrates how much information is added across the landscape as time progresses and the variation in its quality.

when thinking in terms of regulatory geography is that what appears to be a record of geographic absence on the cultural landscape has decreased over time. The logic is simple, the more we look, the more we find. Discovery probability of sites, faunal remains, and other cultural materials increases over time because sampling has extended to new areas and sampling technologies have improved over time. Our simple—yet essential—point is that a contemporary map of a landscape reflects the current state of knowledge, not absence. If the importance of a portion of a landscape is to be known, especially in terms of CKPs, absence is not the null hypothesis, rather presence of cultural materials is.

Discussion

Scholars of action ethnobiology make a call for researchers to step into the real-world impacts of their work, to literally put themselves on the front lines of activism in social and environmental justice (Armstrong and Brown 2019; Armstrong and McAlvay 2019; references in Turner 2020). Progress is being made in many ways, including but not limited to decolonizing academic programs, courses, and syllabi; direct fieldwork that has important legal implications; and community-engaged research done for community members, not for the primary scholarly benefit of individuals. In these areas, researchers may struggle to integrate into and receive recognition within traditional academic, disciplinary structures. One issue that permeates action scholarship is whether there are frames of understanding that empower academics to recognize the merits of applied and action research, into which examples such as the one we present here—an application of taphonomic and geospatial approaches in archaeology for the benefit of legal actions related to heritage claims—may be meaningfully integrated and recognized. What is legal and ethical to the zooarchaeologist who simply recognizes taphonomy as a theory for understanding the condition of faunal samples?

Without a conceptual superstructure for framing applied and action research, calls for action may not reach full potential. Some ethnobiologists may, for instance, work towards actionable outcomes in their research, but in relative isolation from others in academic communities. Others may make important, periodic attempts to influence key academic and applied conversations outside their disciplines, mainly to fall on deaf ears. In addition, calls for action that are not clearly integrated into the implications of disciplinary frameworks may cause some scholars to retreat deeper into the stability of disciplinary norms and currencies of success, which may lead to further academic gatekeeping against novel forms of scholarship. Beyond codes of ethics for research, we must lay the foundations of why action and applied research make sense within and beyond traditional disciplines.

We have argued elsewhere that historical ecology—a theoretical perspective that portrays the integrated and synergistic complexities of human-environment interactions (Armstrong and Veteto 2015; Balée 2013; Crumley 2021)—provides action-oriented framing for ethnobiology and environmental archaeology (Wolverton et al. 2023), particularly when interwoven with ethical precepts from environmental justice studies. Ethnobiologists, from disciplinary and interdisciplinary perspectives, understand human-environmental interactions are complex, entangled, and widely impactful across many geographic and cultural scales (Ignace and Ignace 2020). Such understanding makes sense to anthropologists, ecologists, geographers, linguists, taxonomists, and others who recognize ethnobiology as an interdisciplinary home (Wolverton et al. 2014; Wyndham et al. 2011). Environmental justice studies provide ethical guideposts that integrate fluidly with foundational precepts of historical ecology (Figueroa and Waitt 2010), such that even a geospatial study of the taphonomic condition of faunal remains in a region (such as this one) can easily be recognized as holding important meaning for action research. For example, in Indigenous land claims cases in BC, Indigenous communities are tasked with providing evidentiary proofs of "land-use" prior to 1846 (i.e., the signing of the Oregon Treaty as declaration of British sovereignty). Archaeological evidence has been particularly important in such cases; however, it is also weaponized against claimants when defendants (the Crown) argue the absence of archaeological data in a given area proves the absence of people—therefore reducing a Nation's strength of claim (see also Martindale and Armstrong 2019). Clearly, the record of archaeological absence in an area might be expected to decrease with increased fieldwork, as is the case for the Mesa Verde region (this study); certainly, absence cannot be assumed for areas not studied.

Three theoretical concepts from environmental justice studies help strengthen the theoretical position

of action research in ethnobiology (Figueroa and Waitt 2010; Wolverton et al. 2023). First, each person holds an environmental identity, comprising their connection to places, their understanding of environments, and even their values related to environmental ethics (which informs their behaviors and choices). Individual environmental identities coalesce in communities to form environmental heritage or held-communal norms that are shared and passed down through time. Second, people encounter places (known and new ones) from the perspective of their environmental heritage, and thus each place is represented to them as a moral terrain because of the identity they bring to it. What a lawyer steeped in legal regulations and currencies brings to a court case about a place represents a different moral terrain than can, and would be, that of someone who belongs to and witnesses the same area as a CKP (Napoleon 2005). Third, and perhaps most important for the action ethnobiologist—who likely walks (or at least may traverse) the halls of academia steeped in Western norms—is that environmental heritage today represents the collective continuance of a given community. Collective continuance holds that heritage is not only about the past but also influences the future well-being of people and their communities (Harjo 2019).

Environmental identity/heritage, moral terrains, and collective continuance offer all ethnobiologists a theoretical framing with which to enter into and better understand the intellectual merits of applied and action research. This is true for practitioners in seemingly disparate cultural and geographic contexts (e.g., Colorado and British Columbia), but where environmental identity/heritage represents nothing other than what anthropologists have recognized as culture, under its many definitions. The concept of moral terrains represents place as known by the geographer, with clear explication that peoples' values connect to places and represent an identity-based lens through which places are understood. And collective continuance represents historical, cultural continuity as experienced in wonder by the archaeologist when encountering material culture from the past. We must look toward the future well-being of communities; to adopt such a framing puts respect before knowledge as scholarship becomes part of the framing of action ethnobiology. A future direction for this research is to work directly with Indigenous community members related to the geographic distribution of the archaeological record and its relation to CKPs.

Conclusion

Our geographic perspective on taphonomy attempts to acknowledge the ethical impacts and relevance of heritage-based data. As co-authors we do not share the same environmental identities and heritage, but our work is informed by the traditions of Western archaeology. Nor do we encounter places through the same lenses as moral terrains, but we are studying places here via the lenses of geospatial data analytics, archaeology, ethnobiology, and historical ecology. Our intention could be to inform the collective continuance of Indigenous cultures in the Mesa Verde region; indeed, we hope this has been achieved. However, we authored this paper because we became aware of simplistic geographic and archaeological data use in court cases and regulatory frameworks in British Columbia and beyond.

The absence of archaeological data is not evidence of human absence or value relative to a particular landscape at a particular point in time. Yet, regulatory compliance regimes often rely on this flawed logic when making land-use decisions. To do so ignores decades of theory and practice in archaeology focusing on site formation processes, taphonomy, and more broadly historical ecology. Have we (archaeologists) grappled enough with these concepts when it comes to Indigenous peoples' presence on the landscape and the legal and political implications of our findings? Is it possible we downplay ancestral presence when we base our conclusions on the established archaeological record without conveying the geographic limitations of our sampling? Evoking the CKP concept may help archaeologists re-frame their approach, from trace-centric (i.e., what has been recovered) to place-centric (i.e., the meaning of a place), reintroducing ourselves with the limitations of archaeological methods and data, while supporting Indigenous land-use cultural legacies and ultimately, sovereignty.

Notes

[1]We have attached raw data needed to replicate the Fragmentation Agency Index across all Crow Canyon study units and sites except for one: the Haynie site (5MT1905). The Haynie site is an ongoing field project. We feel data from Haynie is important to incorporate here to illustrate variability in preservation potential. These data are not completely finalized so we have left them out of Supplementary File 1.

Acknowledgments
We acknowledge the Pueblo, Ute, Paiute, Diné, and Jicarilla Apache peoples on whose traditional homelands sites in the Crow Canyon database rest. We also thank all the researchers, staff, and interns associated with data collection from each of the projects at the Crow Canyon Archaeological Center (and numerous other institutions). The following institutions have helped preserve these sites: The Archaeological Conservancy, National Park Service, the Bureau of Land Management, and Colorado Mountain College. Funding that helped build the Crow Canyon databases was provided by the National Science Foundation, National Endowment for the Humanities, History Colorado State Historical Fund, and the Earthwatch Institute. Three anonymous reviewers greatly improved the content and clarity of the paper. Thank you.

Declarations
Permissions: None declared.
Sources of funding: None declared.
Conflicts of Interest: None declared.

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