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Indigenous eco-archaeology: past, present, and future of environmental stewardship in central coastal California

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The Amah Mutsun Tribal Band (AMTB) has stewarded terrestrial and aquatic resources in central California since time immemorial. Successive waves of European and Euro-American colonization have sought to suppress and erode AMTB's relationship with land, stewardship, and natural resources. The Tribe has mobilized anthropological and historical ecological data that demonstrate the effect of long-term Indigenous stewardship through cultural burning and other resource stewardship strategies. These Indigenous landscape legacies have influenced ecosystem structure and the sustainability of culturally important species. This paper focuses on the process of bridging archaeological research with contemporary stewardship efforts related to protecting, preserving, and caring for Tribal cultural heritage that exists from a landscape perspective. The collaborative research has helped clarify the record of Tribal relationships with the environment and how those relationships have changed due to colonial land use regimes. In doing so, we highlight how an archaeological research program can be a building point of access to ancestral places, which is a critical step in Tribal-led initiatives of restoring traditional resource management and ecological resilience of plant and animal life on public lands. In addition, we discuss the benefits and limitations of applying eco-archaeological research toward Tribal environmental stewardship.

KEYWORDS

Amah Mutsun Tribal Band, California archaeology, collaborative archaeology, heritage management, Tribal archaeology

1 Introduction

Indigenous and collaborative archaeologies have developed as a direct response to critiques expressed by Indigenous peoples. They seek to make the practice of archaeology more equitable, inclusive, and transparent by recognizing the problematic histories that have made the relationships between archaeologists and Indigenous peoples antagonistic and contentious (Lightfoot, 2008; Colwell-Chanthaphonh et al., 2010; Atalay, 2016; Gonzalez, 2016; Bruchac, 2020; Steeves, 2021). By incorporating community-based participatory research protocols, Indigenous archaeology has aligned itself with other social sciences that have reconsidered how research is conducted and the impacts of extractive research practices that offer little to no apparent benefits to affected communities

(Watkins, 2001; Smith and Jackson, 2006; Atalay, 2007; Colwell-Chanthaphonh et al., 2010; Croes, 2010; Silliman, 2010; Ngandali and Craig, 2023). The legacy of these practices in California has often reinforced injustices resulting from settler colonialism, including the commodification of Indigenous cultural heritage, the erasure of Indigenous peoples, stolen lands, the plundering of sacred sites, and the amassing of vast collections of material culture from archaeological and ethnographic contexts (Lightfoot, 2005a). Lightfoot (2005a) noted that these strained relationships in California archaeology often result from the lack of collaboration, desecration of sacred sites, and tensions between who are the stewards of the past; archaeologists and/or Indigenous people (Weiss and Springer, 2020).

In California, these often-strained relationships between Native American tribes and archaeologists have resulted in a spectrum of collaboration in the practice of California archaeology (Colwell-Chanthaphonh and Ferguson, 2008; Silliman, 2008; Silliman and Ferguson, 2010; Atalay, 2012). In California archaeology, models exist that include fully participatory research between Tribal and non-Tribal archaeologists and Indigenous peoples. In other instances, archaeologists reflect on the complexities of conducting fully collaborative research and how the legacy of anthropology complicates these goals. Critiques of Indigenous roles in archaeology and cultural heritage management are still visible in the present, highlighting issues related to the disposition of ancestral remains, items of cultural patrimony, and the protection of sacred sites and landscapes, among other issues.

In the context of cultural resource management, significant strides have been made through the California legislature to protect Indigenous cultural heritage, especially in the last two decades with the passage of CalNAGPRA and other assembly bills, such as Assembly Bill 52 and 389. These initiatives are often driven by activism from Native Californians to protect cultural resources and remedy perceived injustices. However, we recognize that significant issues still exist in the engagement of the field of archaeology with Native Californians (Martinez and Teeter, 2008; Martinez, 2016; Laluk et al., 2022). Nonetheless, collaborative archaeology has demonstrated the mutual benefits of co-created research for Tribes, agency partners, and academic researchers.

This paper highlights the complex history between archaeology, anthropology, and the Amah Mutsun Tribal Band. We outline how initial collaborative archaeology research between the Tribe and academic and agency archaeologists has led to the development of a robust cultural heritage program within the community despite lacking federal recognition. For nearly two decades, the tribe has engaged in collaborative research, moving the practice of California archaeology forward. We document the development of Amah Mutsun Tribal Band field methodologies that seek to fully capture all cultural resources through a tribal landscape lens, including "low-impact" and integrative data collection methods. In addition, we document the long-term use of collaborative field schools to train the next generation of Tribal and non-Tribal archaeologists in archaeological field methods and collaborative research practices with, for, and by Indigenous communities. We further stress the importance of undertaking collaborative Tribal archaeology considering the rapid pace of climate change, sea level rise, storm surges, and coastal erosion that are significantly impacting ancestral places in central coastal California and beyond.

2 Background

The Amah Mutsun Tribal Band are the descendants of the Indigenous peoples forcefully removed from their traditional territories spanning portions of present-day San Mateo, Santa Cruz, San Benito, San Jose, and Monterey Counties and taken to Mission San Juan Bautista and Mission Santa Cruz (Figure 1). Since time immemorial, the Amah Mutsun Tribal Band's ancestors have accumulated knowledge of human-environmental relationships in central California (Lopez, 2013). However, because of Spanish missionization (1769–1821), which forcibly suppressed Indigenous cultural practices and eroded tribal culture, tribal knowledge was altered, and many traditions were lost. Furthering these changes were the seven missions established within the Central California Coast between 1770 and 1797 and Spanish laws prohibiting Indigenous burning practices (Levy, 1978; Lopez, 2013). Underpinning the motivations for colonizing coastal California were the foundations of the 1493 Papal Bull, the Doctrine of Discovery, which provided Spanish agents with the moral and legal ability to dehumanize Native Americans and take possession of their lands. In the eyes of the Catholic church, non-Christians were perceived to possess no inherent human rights (Brew, 2014; Greenberg, 2016).

During the Mexican Period (1821–1848), the secularization of the missions in 1834–1836 resulted in Indigenous people leaving the missions to work as manual laborers on the ranchos established in their traditional lands previously held by the Spanish (Levy, 1978; Lightfoot, 2005b; Rizzo-Martinez, 2022). With the onset of the American Period (1850–present), state and federal officials sanctioned and facilitated a coordinated genocide of California's Indigenous peoples between 1848 and 1900 (Cook, 1943; Heizer, 1974; Rawls, 1984; Jacknis, 1993; Lindsay, 2012; Madley, 2016a). Furthermore, as outlined by Madley (2016a), disease, dislocation, and starvation increased the number of deaths. Abduction, bounties, forced labor, high mortality rates, unrelenting murders, battles, and atrocious massacres by state militias and federal troops also took countless lives (Madley, 2016b). Therefore, throughout these three periods of colonialism, the Amah Mutsun and other Indigenous people's main concern was survival (Lopez, 2013). Many California Indian tribes, including the Amah Mutsun, were unable to pass on their knowledge regarding traditional resource and environmental management practices and other cultural traditions (Lopez, 2013), which led to these practices becoming dormant in later historic times. In recent years, the Amah Mutsun have used archaeology as one approach to revitalize dormant Indigenous knowledge and cultural practices, along with the study of ethnographic and ethnohistorical documents, partnerships with other Indigenous Californian tribes, and other organizations.

2.1 History of relationship between AMTB and University of California, Berkeley archaeologists

In 2007, archaeologists and environmental scientists from the University of California, Berkeley (UC-Berkeley) approached the Amah Mutsun Tribal Band to initiate an eco-archaeological study

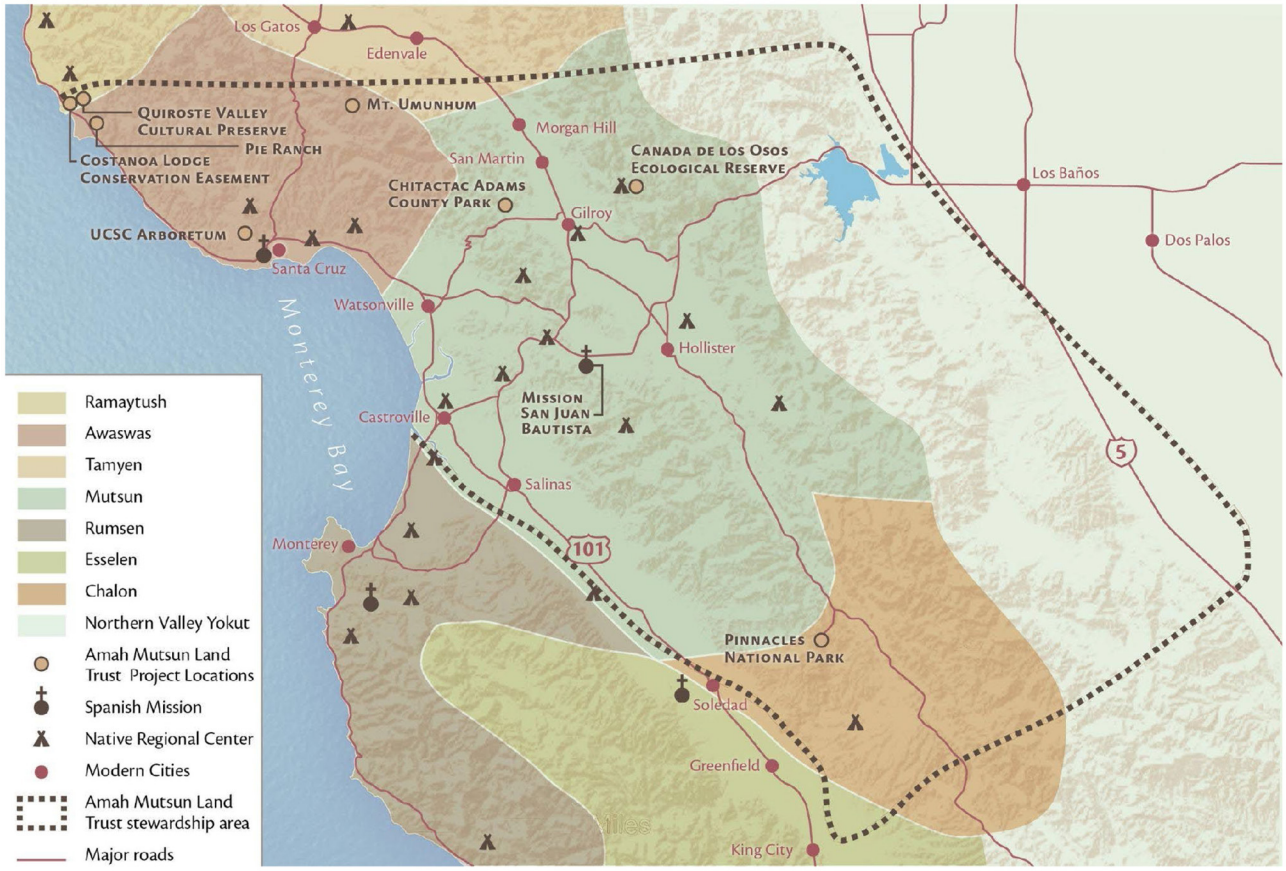

FIGURE 1
Overview of the central California coast with ethnographic boundaries. The map includes the locations of Spanish Missions and Indigenous village sites. The map includes the boundary of the Amah Mutsun Land Trust stewardship area. The image is used with the permission of the Amah Mutsun Land Trust.

of Indigenous fire use in central California at Quiroste Valley in Año Nuevo State Park (Hylkema and Cuthrell, 2013). Initial archaeological surveys in the Quiroste Valley during the 1980s recorded over a dozen ancient and historic sites. During 2004–2006, Cabrillo Community College led test excavations and obtained radiocarbon dating assays that suggested a contact era site within the valley, potentially Casa Grande or *Metenne*, a Quiroste village documented by the Portola overland expedition in 1769, comprised of multiple house structures and a large ceremonial dance house to hold more than a hundred people (Hylkema and Cuthrell, 2013). A collaborative project involving the Amah Mutsun Tribal Band, California Department of Parks and Recreation, and UC-Berkeley was initially facilitated by Dr. Chuck Striplen, an Amah Mutsun tribal member and Ph.D. student at that time in the Department of Environmental Science and Policy Management, pursuing dissertation research on fire ecology and the historical ecology of California's forests.

A collaborative enterprise was developed to study cultural burning and ancient Indigenous landscape management practices in Quiroste Valley (Cuthrell, 2013a; Lightfoot and Lopez, 2013; Lightfoot et al., 2013a,b; Lopez, 2013). While initially hesitant to collaborate with archaeologists due to a legacy of non-collaboration and disturbance of sacred Indigenous sites, the Amah Mutsun Tribal Council approved the archaeological research (Lopez, 2013). Their decision to jointly engage in archaeological research was based on an agreement with UC-Berkeley archaeologists, which ensured they would: (a) minimize adverse impacts to any sites investigated; (b) avoid all sensitive cultural materials, such as human remains and other sacred objects; and (c) employ low-impact field methodologies guided by geophysics to identify discrete deposits with the potential to contain high-density cultural materials and artifacts related to Indigenous foodways and other activities of particular interest to the tribe. The collaborative program emphasized the inclusion of tribal members in all phases of research and recognized the final decision-making authority of the Amah Mutsun Tribal Band (Lopez, 2013).

By 2009, CDPR and Amah Mutsun Tribal Band co-created a 220-acre (80.9 hectares or 809,371 m^2) Quiroste Valley Cultural Preserve to protect cultural resources, restore native vegetation, and re-implement and experiment with traditional resource stewardship practices, such as cultural burning. In 2012, the Amah Mutsun Land Trust was created—a nonprofit organization directed toward conservation, restoration, stewardship, education, and research on aboriginal lands (Amah Mutsun Land Trust, 2024). The organization partners with other conservancy groups to facilitate the Amah Mutsun Native Stewardship Corps, which

employs young adult tribal members in resource conservation and research opportunities. Therefore, after many years of struggle to regain access to their traditional territories and practices, the Amah Mutsun are now working to restore the Indigenous knowledge suppressed during colonization (Lopez, 2013; Sigona et al., 2021; Apodaca and Sigona, 2023).

Given that they do not currently possess landholdings within their tribal territory, Amah Mutsun have established partnerships with public and private landowners to return their stewardship to their traditional homelands, as well as neighboring lands that are included in their contemporary stewardship area (Sigona et al., 2021). Below we outline the various ways in which the Amah Mutsun Tribal Band is bridging archaeological research with contemporary stewardship efforts related to protecting, preserving, and caring for Tribal cultural heritage. We begin with the steps taken to document and restore "Dormant Knowledge." The collaborative research has helped clarify the record of Tribal relationships with the environment, and documenting ethnographic and ethnohistorical records has been a crucial component of those endeavors.

Over recent years, the Amah Mutsun have reaffirmed their role as stewards of traditional lands through several programs developed by the Amah Mutsun Land Trust, including programs in Native Plant Propagation, Cultural Resource Management, Ocean and Coastal Stewardship, and their premier program, the Native Stewardship Corps. These programs have emphasized increasing access and relationship re-building to land, and collaborating on long-term research projects is one of the ways highlighted in our paper. Collaborative archaeological research can provide content and pathways to cultural education to revitalize traditional ecological knowledge and help guide natural resource management today. The central idea is that Amah Mutsun is part of a broader movement of Tribal Nations that have co-designed and implemented Indigenous and Western methods of scientific inquiry as a means of accomplishing goals that involve historical ecology, anthropology, and environmental justice (Apodaca and Sigona, 2023).

2.2 Documenting "dormant knowledge" through ethnography and ethnohistory

As discussed above and in Rizzo-Martinez (2022), the Amah Mutsun Tribal Band are descendants of survivors of three waves of successive European and Euro-American colonialism. Therefore, throughout these three periods of colonialism, the main concern for the Amah Mutsun and other Indigenous people was survival (Lopez, 2013). Most California tribes, including the Amah Mutsun, were unable to continue the tradition of passing on some of their Indigenous knowledge regarding traditional resource and environmental management (TREM) practices and other cultural traditions (Lopez, 2013). These Indigenous practices had become dormant in later historical times.

Consequently, by the time ethnologists began field research with tribal members in the late 19th and early 20th centuries, significant changes to Indigenous lifeways had already occurred. As a result of the successive waves of colonialism, by the early 1900's fewer than a dozen native elders remembered any of the eight Costanoan languages (Bocek, 1984). Also, the "memory culture" methodology employed by these ethnographers, which involved interviews with a few tribal elders in recounting Indian life in their childhood, underestimated the effects of colonialism on Indigenous lifeways (Lightfoot, 2005b; Lightfoot and Parrish, 2009). Nonetheless, in the 1920s and 1930s, John P. Harrington of the Bureau of American Ethnology studied the Costanoan language and cultural practices, focusing primarily on the Rumsen and Mutsun language groups (Bocek, 1984; Callaghan, 1991). Harrington worked with Isabelle Meadows and Ascensión Solórsano, his primary Rumsen and Mutsun consultants, to re-elicit older word lists and the Mutsun grammar and phrasebook of Franciscan missionary Arroyo de la Cuesta (1861–1862) (Callaghan, 1991). Also, Harrington collected more than 500 plant specimens, which he then highlighted in discussions with tribal members to understand their uses (Bocek, 1984).

Resulting from the work of Harrington are ~80,000 pages of field notes that are held within the Costanoan collection currently curated by the National Anthropological Archives, Smithsonian Institution. In 2015, under the direction of the Amah Mutsun Tribal Band and Dr. Rob Cuthrell, students at the University of California, Berkeley, began translating the Harrington notes. Since 2017, these data have facilitated the publication of Mutsun Ways, a newsletter sharing information from the Harrington notes with Amah Mutsun tribal members. The information includes the Mutsun language, ethnobiology, and tribal histories. The wealth of information contained within the Harrington notes is aiding in the revitalization of Amah Mustun's traditional knowledge. Below, we outline how archaeological studies of ancient and historical era sites are being used to complement Native oral traditions and the information contained within the Harrington notes and other historical sources to investigate human-environmental interactions in coastal central California.

2.3 Quiroste Valley and the Quiroste Valley cultural preserve

In 2007, a team from the University of California (Berkeley and Santa Cruz campuses), the California Department of Parks and Recreation, and the AMTB engaged in collaborative research on stewardship practices of natural resources and foodways at *Metenne*, otherwise known as CA-SMA-113, a keystone cultural place in the Quiroste Valley along the central coast of California (Hylkema and Cuthrell, 2013). The collaborative approach emphasized low-impact and fine-grained archaeological techniques, as well as integrating anthropological, paleoecological, and historical evidence. This location is now the Quiroste Valley Cultural Preserve (Figure 1), where the Amah Mutsun have been regularly implementing Indigenous stewardship to revitalize the cultural landscape to ecological conditions evident from available eco-archaeological data. This integrative and collaborative research on Indigenous stewardship also expanded to other coastal sites in the region, which indicated that the burning of targeted habitats was not an isolated practice, but a vital component of coastal ecosystems (Cowart and Byrne, 2013; Cuthrell, 2013a,b; Evett and Cuthrell, 2013; Fine et al., 2013; Gifford-Gonzalez et al., 2013; Lightfoot and Lopez, 2013; Lightfoot et al., 2013a,b, 2021; Cowart,

2014; Striplen, 2014). This research also highlighted evidence of stewardship of marine biological resources, such as shellfish, forage fishes, and kelp (Sanchez, 2019; Grone, 2020).

Documenting Indigenous landscape stewardship practices in the archaeological and historical ecological records develops guideposts for revitalization efforts for the Tribe and agency partners. For archaeologists, these cultural perspectives and insights related to Indigenous stewardship rather than Indigenous "management" have also contributed to a reorientation in practice highlighting long-term relationships between people and the environment rather than engagement and extraction of "resources." Collectively, the research has provided a vision for the conditions of coastal grassland prairies that may have been under Indigenous regimes of land stewardship. These ecosystems once flourished along the Pacific coast of North America for many centuries or longer. Furthermore, Lightfoot et al. (2021) and others argue that Indigenous prescribed burning played an essential role in the long-term sustainability of these biological communities connected to the subsistence and economy of Native people in the region.

This collaborative eco-archaeological research program that involved Amah Mutsun's leadership in the design, fieldwork, and laboratory work has created pathways for Native people to be in decision-making roles in the research and stewardship of their cultural heritage. This experience has provided a body of re-learned knowledge regarding ancestral foodways, land use, and the relationship with the environment used in educational and revitalization programs. These collaborative efforts have also bolstered the Tribe's approach to surveying sensitive cultural areas using Indigenous perspectives integrated with cutting-edge archaeological techniques (Sigona et al., 2021, P, 214).

2.4 Evidence of indigenous burning at Quiroste

In a special issue of *California Archaeology*, Lightfoot and Lopez (2013) summarize a series of empirical investigations designed to evaluate the possibility that anthropogenic fires modified the vegetation history in and around the Quiroste Valley Cultural Preserve at the archaeological site CA-SMA-113. The interdisciplinary research team evaluated multiple independent lines of evidence (i.e., historical records, landscape geomorphology, paleoethnobotany, palynology, plant population genetics, faunal analysis, and dendroecology) to reconstruct past fire histories, faunal and floral resources, vegetation conversions, and Indigenous cultural practices. The findings of these investigations involving Tribal scholars, California State Park researchers, and academics from UC-Berkeley and UC-Santa Cruz indicate that Indigenous people implemented sustained landscape burning practices that created and maintained productive coastal prairie habitats from ~cal AD 1000 to the time of Spanish colonization (Cowart and Byrne, 2013; Cuthrell, 2013a,b; Cuthrell et al., 2013; Evett and Cuthrell, 2013; Fine et al., 2013; Gifford-Gonzalez et al., 2013; Lightfoot and Lopez, 2013; Lightfoot et al., 2013a,b; Cowart, 2014; Striplen, 2014).

In summarizing the research program in the Quiroste Valley and CA-SMA-113, Lightfoot et al. (2013a,b) highlight what each diverse dataset has allowed the eco-archaeological project to elucidate regarding the five primary research questions. First, is there empirical evidence for anthropogenic burning in diverse regions of the state? Second, when did people first initiate sustained anthropogenic burning? Third, what were the characteristics of the anthropogenic fire regimes and what potential impacts did they have on local ecosystems (e.g., what is the evidence for transformation in the structure of local habitats and enhanced biodiversity?). Fourth, how extensive were the areas burned by Native Californians? Fifth, whether anthropogenic burning activities were incidental to other subsistence practices, such as game hunting, or more systematically managed by individuals, family groups, or broader communities to produce intended landscape-scale outcomes.

The multiple independent lines of evidence provide answers to the research questions outlined above. First, the findings of the first phase of research support anthropogenic burning in the Quiroste Valley circa ~cal AD 1000–1300 to the historic period, which directly structured local flora and fauna. Second, current evidence for the earliest anthropogenic burning in the Quiroste Valley dates to ~cal AD 1000. Third, frequent and low-intensity fire regimes directly shaped the Quiroste Valley's local environment by maintaining coastal prairie habitat and open forests. Fourth, there is limited information about ancient burning practices throughout the state based on archaeological evidence. Fifth, Lightfoot et al. (2013a,b) found that disentangling human agency and intended consequences, whether immediate, long-term, or a combination of factors, is complex. The authors suggest that CA-SMA-113 in the Quiroste Valley may have served as the primary village in the local region and was embedded within a logistically organized settlement.

Cuthrell's (2013b) study found that archaeobotanical frequencies of "fire-adapted" or "fire-following" food and fuel plant resources were found in statistically significant abundances compared to plant resources that are ecologically fire-intolerant. Furthermore, Evett and Cuthrell (2013) correlated the archaeobotanical data with the increased abundance of grassland silica phytoliths collected from on-site and off-site strata. The archaeological and paleoecological evidence has been a vital dataset in visualizing a pathway to understand where and what desired landscape conditions can be implemented. The Quiroste Valley Cultural Preserve remains a living laboratory for applying historical ecological research within the context of Indigenous stewardship research and revitalization.

2.5 Indigenous stewardship outcomes

The status of Quiroste Valley as a Cultural Preserve (QVCP) allows the Amah Mutsun Land Trust to oversee how the QVCP is stewarded. In 2014, the AMLT created the Vegetation Management Plan, demarcating a vision of coastal prairie restoration and the return of low-intensity cultural fire. Since then, much work has been enacted to create conditions suitable for the return of good fire (Lightfoot et al., 2021). Initially, stewardship of QVCP involved the removal of encroaching woody plants and invasive species such as poison hemlock (*Conium maculatum*), milk thistle (*Silybum*

marianum) and bull thistle (*Cirsium vulgare*) to suspend ecological type conversion of coastal prairie and to support the harvesting of traditional foods safely.

Through the efforts of the Native Stewardship Corps program, tree felling of thousands of fast-encroaching juvenile Douglas-fir (*Pseudotsuga menziesii*) has increased sunlight availability on the QVCP floor. In concert with fuel reduction efforts, AMLT initiated a plant propagation program for coastal prairie species, beginning in 2019. The propagation program relied on agricultural lands made available to AMLT through the Cascade Regenerator Program, organized by Pie Ranch, a local social justice oriented educational farm (Cascade Regenerator, 2024). Using several acres of private agricultural land, the AMLT utilized native plant seeds sourced from local open space for the propagation project. The basic premise of the Cascade Regenerator Program is outlined below.

Native seeds are sown into plug trays in a greenhouse before being planted directly into QVCP or in agriculture plant beds at Cascade Ranch. Plants planted at QVCP would support the restoration of native plant species in the preserve. At the same time, plants in the agriculture beds would create seed banks to support further restoration and food sovereignty efforts. Therefore, seeds from the agricultural beds would be harvested and dispersed at QVCP at a later date. Propagation at QVCP entailed clearing small areas with full sun to bare mineral soil, planting plugs or scattering seeds, and maintaining these regularly by removing competing species growing in relative abundance at QVCP.

The species selected for propagation were all appropriate for native coastal prairie and include plants found in the archaeological record, known culturally significant plants, and rare species of unknown cultural significance. Certain species, such as coast tarweed (Madia sativa), were selected based on observations during propagation as being a hearty herb with both a high germination and establishment success rate (Rob Q. Cuthrell, personal conversation with author, April 15, 2024). The majority of the species propagated were known to respond well to propagation and were chosen to ensure AMLT's success in meeting grant deliverables (Rob Cuthrell, pers. comm. 2024).

2.6 Documenting indigenous stewardship outside Quiroste

In the summers of 2015–2017, the second phase of field research was initiated between the Amah Mutsun Tribal Band, California State Parks, and the University of California campuses at Berkeley and Santa Cruz. The project was directed toward investigating the time-depth of anthropogenic fires documented at Quiroste by applying the same field sampling strategies at sites spanning the Middle Holocene, Late Holocene, and Historic era along the central California coast. As part of this research, the collaborative team also sought to investigate the possibility that Indigenous stewardship practices may not have been confined to terrestrial ecosystems but included aquatic environments as well.

A major component of the second phase of field research involved the investigation of additional archaeological sites along the Santa Cruz coast (Figure 2). After consultation with Mark Hylkema and the Amah Mutsun Tribal Band, five archaeological sites (CA-SCR-7, CA-SCR-10, CA-SCR-14, CA-SCR-15, and CA-SCR-123/38) in Santa Cruz County were selected for study. These sites lie south of the Quiroste Valley but were chosen in an attempt to document anthropogenic management practices in the broader central California coast. Previous research suggested these sites spanned from the Middle Holocene to the post-Mission era.

The results of these studies suggest the ancestors of the Amah Mutsun Tribal Band engaged with marine resources in sustainable ways, harvesting marine shellfish such as California mussels (*Mytilus californianus*) for ~7,000 years with evidence of potential stewardship of mussel beds by around cal AD 1300 (Grone, 2020). In addition, Indigenous fisheries targeting marine fishes demonstrated a significant shift in fishing practices during this time. Initially, evidence suggested a broad-based fishery focused primarily on intertidal species during the Middle Holocene. However, by cal AD 1000–1300, the fishery changed, and there was a greater focus on the mass capture of small-schooling fishes such as northern anchovy (*Engraulis mordax*) and Pacific sardine (*Sardinops sagax*) (Sanchez, 2019). This shift in fishing practices coincided with the timing of evidence for cultural burning to enhance the habitat and extent of coastal prairies and the stewardship of California mussels (Lightfoot et al., 2021). Collectively, this data suggests that the ancestors of the Amah Mutsun Tribal Band and their interactions with the environment were diverse during the last 7,000 years. Still, by AD 1000–1300, significant shifts in human–environmental relationships occurred through the stewardship of coastal prairies, intertidal shellfish, and small-schooling marine fishes.

3 AMLT programs

This section describes programs by the Amah Mutsun Tribal Band that are designed to protect, steward, and study ancestral lands. As a reminder, the point of our paper is to celebrate how the Amah Mutsun Tribal Band and interdisciplinary academic archaeologists can craft long-term research projects that maximize support for broader cultural revitalization and stewardship goals of those whose cultural patrimony is the subject of study. As Sigona et al. (2021) highlight, this approach directly supports cultural obligations to steward and protect the earth and non-human relatives (Lopez, 2013). Returning stewardship to land in a manner consistent with place-based Indigenous practices is how the Amah Mutsun Tribal Band honors their ancestors. While Amah Mutsun Land Trust is involved in several programs, such as the Ocean and Coastal Stewardship and Native Plant Propagation, the focus here will be on the Cultural Resources Program.

3.1 Amah Mutsun's cultural resource program

The emergent experience from the collaborative eco-archaeology reified a need for Indigenous perspectives and methods to study cultural landscapes and natural resources on a place-by-place basis. For the AMTB and many other Native American Tribes, biological and abiotic natural resources used

FIGURE 2
Amah Mutsun Tribal Band and UC Berkeley archaeologists conducting fieldwork on the Santa Cruz coast 2015-2016. **(A)** Surface surveying at upland site. **(B)** Example of coastal bluff archaeological site on State Parks property. **(C)** Example of light fraction sorting from soil sample. **(D)** Excavations at coastal terrace site within an active agricultural zone.

traditionally for foods, medicines, and crafting materials are essential for contemporary cultural practitioners and efforts in cultural revitalization. Documenting and stewarding such resources are integral to AMLT's mission to protect, document, and take care of our ancestral places for future generations. From this perspective, natural resources are cultural resources. Therefore, all cultural resources must be studied comprehensively at the landscape scale. To address this obligation, the Tribe engages in integrative cultural resource surveys of the diverse landscapes in their stewardship area (Sigona et al., 2021; Apodaca and Sigona, 2023).

For example, in 2019, AMLT partnered with the US Bureau of Land Management (BLM) to proactively survey Cotoni-Coast Dairies (CCD), a 5,800-acre area of the California Coastal National Monument (Figure 3). This approach to surveying CCD for Indigenous cultural resources was built upon the experience AMTB has gained with eco-archaeological methods that proved useful for evaluating the condition of known archaeological sites and detecting unrecorded sites and other undocumented cultural resources. Limited areas of CCD had been surveyed for archaeological sites with Indigenous participation in the past. Therefore, this presented an opportunity to test AMLT's proactive and integrative approach to cultural landscape assessment. By 2020, AMLT had systematically surveyed more than seven hundred acres of grassland, riparian forests, and woodlands, recording 14 previously unidentified Indigenous archaeological sites (Sigona et al., 2021). Furthermore, hundreds of acres of culturally significant vegetation types were mapped by the Tribe, and the location of over a hundred ethnobotanical plants and other natural resources was recorded over four seasons by AMLT Native Stewards and archaeologists.

Altogether, this integrative survey has demonstrated that two extensive areas within the CCD property contain associations of sensitive Indigenous cultural resources and culturally significant natural resources located in proximity to one another. AMLT considers such areas to be culturally significant landscapes, a type of traditional cultural property meriting special management considerations designed to preserve and revitalize the sensitive resources, rare qualities, and/or associations between landscape attributes that contribute to the significance of the resource. AMLT documents culturally significant landscapes when several cultural and natural resource components occur in a defined area. Through this project, the Amah Mutsun Tribal Band has been actively contributing to research on Indigenous settlement patterns, the locations of non-archaeological cultural resources, and the particular history of Indigenous habitation in the Cotoni-Coast Dairies area.

The methods for this integrative cultural resource survey are outlined in detail in Sigona et al. (2021). The main idea is that survey teams composed of Amah Mutsun Tribe members systematically sample surface soil for Indigenous archaeological resources across broad landscape areas. All materials that are encountered are identified, quantified, photographed, and weighed before being returned to the sample location (see Lightfoot, 2008; Gonzalez, 2016; Sanchez et al., 2021). At the same time, cultural biological resources, such as ethnobotanical plants are documented and recorded when encountered. The scale of ethnobotanical resources can vary from an entire grassland, to a small patch of hazelnut shrubs, or even a single and sometimes rare plant.

FIGURE 3
Amah Mutsun Land Trust conducting Integrative Cultural Resource Survey of Cotoni-Coast Dairies National Coastal Monument in 2019-2020. **(A)** "Catch-and-release" surface survey of grassland valley site. **(B)** Using San Vicente Creek to wet screen surface soils. **(C)** Surface surveying of coastal terrace area. **(D)** Recording location of surface survey unit at interior montane site.

The recording of ethnobotanical plants is important in that it interdigitates with the AMLT's plant propagation program, which uses seeds from sources that are encountered during the integrative survey. In this way, the integrative cultural resource survey directly supports other aspects of the stewardship program for the Tribe. Lastly, other abiotic resources are also recorded such as freshwater springs, viewsheds, and asphaltum seeps, which are important cultural features that provide a comprehensive understand of the landscape.

The integrative cultural resource program is a key step for future site stewardship at CCD and other cultural landscapes within the AMTB stewardship areas (Figure 1). It provides geospatial and quantitative information that is particularly useful to ATMB and valuable for land planners engaged in open-space stewardship and development. The ethnobotanical and vegetation geospatial data from the surveys also adds immense value as a cumulative database used by Tribal members when planning plant stewardship, gathering activities, and ceremonies. One example of how the database can be used is willow (*Salix* sp.) stand locations. Using the database, Tribe members can identify the location of willow stands suitable for sweat lodge construction. The database can also guide people interested in visiting locations of red maids (*Calandrinia* sp.) and patches of native grass seeds. Red maids are important because they are becoming increasingly rare in coastal prairies and are currently a species of interest for the Tribes' food and ecosystem revitalization efforts.

The example of red maids brings us back to our main point about how Indigenous prescribed or cultural burning is an intrinsic part of ecosystem health. Our collaborative research indicates that the Amah Mutsun initiated fire regimes over more than a millennium characterized by frequent, relatively small, low-intensity surface burns. The ignition of relatively small patches of land, where fire coverage could be constrained by landscape features, such as streams, ridges, rock outcrops, and past cultural burns, would have created a rich patchwork mosaic that enhanced the productivity and availability of grasslands (including patches of red maids), tubers, berries, nuts, and other important resources, as well as producing excellent forage in successive years that attracted and supported a greater quantity of culturally important game (see Lightfoot et al., In Press). These stewardship practices not only increased the productivity and sustainability of key economic resources used by the Amah Mutsun for foods, medicines, and raw materials (clothing, baskets, houses, dance regalia, etc.), but they diversified the availability of a broad mix of resources across Tribal lands. This practice would have provided flexibility and various choices for the Amah Mutsun, who could harvest alternative crops if one or more other resources failed, such as acorn harvests. In creating a patchwork mosaic via cultural burning, the Amah Mutsun would have contributed to the resilience of their lands by reducing fuel loads and creating fuel breaks that may have served to minimize the size and number of catastrophic firestorms, a point made by other Indigenous scholars (see Lake and Christianson, 2019, p. 2; Long et al., 2021, p. 10; Goode et al., 2022, p. 89).

When Indigenous people and burning practices are excluded from the land, then culturally important plants such as red maids struggle to persist in the absence of burns that are characteristic of frequent, low-intensity fires that are associated with cultural ignition. Red maids exemplify how the Amah Mutsun's cultural resource program is making progress in revitalizing Tribal lands. While our eco-archaeological work recovered considerable evidence for red maids that flourished in the past, recent integrative culture resource surveys have detected few such plants today. Through a concerted effort, a red maid plant was detected by Rob Cuthrell and its seeds carefully collected. These seeds provided the nucleus for raising red maids as part of the AMLT's plant propagation program in both plug trays in the greenhouse and outdoor agricultural beds. Seeds harvested from these carefully nurtured plants have now been employed as part of the reseeding program to regenerate QVCP by the Amah Mutsun and California State Parks. Through these efforts, we are now seeing patches of these culturally important plants return to Tribal lands.

The experiences gained from collaborative eco-archaeology over the years have helped AMLT provide an important and timely service to partner agencies that are committed to more holistic cultural resource management approaches. AMLT's multi-season integrative surveys of Indigenous cultural resources at CCD are

an excellent example of how an initial collaborative archaeological effort can grow substantially over time and emerge as an entity separate from academic and compliance archaeology. For example, AMLT is currently involved in several integrative surveys on the San Vicente Redwoods property in the Santa Cruz Mountains, studying areas damaged by the CZU Lightning Fire complex in 2020.

As Altschul and Klein (2022) recently emphasized, the field of archaeology may face a shortage of CRM labor in the near future. If so, we wonder why archaeology is not doing more to make entry into the field more palatable for Tribes. Based on data from the Society for American Archaeology, Member Needs Assessment (2020), Native Americans represent only 2.2% of society members. These numbers closely resemble those published by VanDerwarker et al. (2018) for the Society for California Archaeology, which the society has directly recognized is an issue, stating, "The Society for California Archaeology acknowledges a lack of diversity in our discipline" (Society for California Archaeology - Diversity, Equity and Inclusion, 2024). To match this need, the Amah Mutsun Tribal Band has developed its own version of a Cultural Resource Management program, whose goals are to protect, study, and steward all cultural resources in their lands. Through this program, the Amah Mutsun Tribal Band is meaningfully engaged in the field of archaeology while providing culturally relevant employment opportunities for its members.

We acknowledge that Indigenous people have played an undersung role in the foundations of archaeology and anthropology. Today, Amah Mutsun Land Trust's Cultural Resource Program leads Native monitoring, integrative cultural resource surveys, archaeological site stewardship, and consulting in the context of the California Environmental Quality Act (CEQA), National Environmental Policy Act (NEPA), Assembly Bill 52, and Native American Graves Protection and Repatriation Act (NAGPRA), and Assembly Bill 389 (California Native American Graves Protection and Repatriation Act). A fundamental component of these efforts is to train and employ the next generation of Indigenous archaeologists in central coastal California. Through these means, the Tribe has leveraged the conventional approaches of archaeology to reformulate ways to study ancestral sites and cultural landscapes. It has also led to an increase in the Tribe's ability to work with other archaeologists and to balance Indigenous and Western ways of studying the past, what scholars have called braiding knowledge (Atalay, 2019, 2020) or bridging traditional knowledge and archaeology (Colwell-Chanthaphonh and Ferguson, 2010).

At the governance level, Tribal-driven studies of cultural landscapes and eco-archaeological research on stewardship practices throughout the Holocene have considerable implications for strategic management plans. Part of the strategy involves formalized agreements [i.e., memorandum of understanding (MOU), cultural easements, and special use permits] between land managers and the AMTB. These agreements usually outline Tribal authority as central to managing cultural resources, stewardship of natural resources, and access to areas for gathering, educational, and ceremonial purposes. For the Amah Mutsun, access is not only related to the physical occupancy of a place, but also recognizes and supports the unique relationship between Indigenous peoples and their land to facilitate stewardship, gathering, and governance. Honoring unique relationships to place and Tribal sovereignty is essential for achieving Indigenous forms of environmental justice (Sigona et al., 2021).

3.2 Closing remarks

In review, we provide three guideposts for researchers who may want to include a similar collaborative structure with Indigenous partners. First, from our experience collaborating with the AMTB, AMLT, and other Native Californian Tribes, it is critical to formalize research partnerships with Tribes through a memorandum of understanding or agreements. Such agreements should clearly define the protocols of the research partnership, decision-making practices regarding research design, treatment of culturally sensitive materials, pathways for reconciliation, and curation practices, among others. It should be noted that MOU/MOA for research is not a replacement for broader MOU/MOA or cultural easements between Tribes and land managers.

Second, we encourage researchers to prioritize the compensated participation of Tribal members to be involved in all the phases of the research; research design, fieldwork, laboratory work, authoring of manuscripts, and curation. Within this vein, we recognized the importance of creating pathways toward employment and training within the field of cultural heritage management for the Tribe members participating in the project (i.e., capacity building), academic career paths, and cultural education.

Third, borrowing insights from Indigenous colleagues' reciprocity is an important part of one's relationship with the landscape. For example, within the context of environmental archaeology, research questions and outcomes may be pointed toward addressing the ecological and cultural revitalization of landscapes. Deriving insights from ancestral practices regarding the stewardship of plants and animals provides a mutual ground for archaeologists and Tribes to meaningfully collaborate. For some Tribes, reconnecting with "dormant knowledge" is a critical part of revitalization and research on those practices using written records, ethnographies, archaeology, and other available datasets. Understanding cultural fire and food resource harvesting regimes is important for the future management of certain landscapes, such as the QVCP. This goal of understanding historical ecological patterns of how Native people stewarded their cultural resources is critical considering the large-scale changes ushered in during the colonial periods of fire exclusion, fire suppression, and industrial resource extraction. Research findings should aim to be meaningful and have the ability to support Tribal goals years after archaeologists' finalize their studies.

The AMTB continues to incorporate historical ecological data preserved in coastal archaeological sites into its broader cultural, educational, and stewardship initiatives. Ancestral sites contain valuable information regarding past stewardship practices and traditional ecological knowledge of coastal resources. The information contained therein supports many aspects of AMTB's broader goals, especially stewarding lands and restoring dormant knowledge. The archaeological record is a nonrenewable resource with specific windows of opportunity for the Tribe to engage.

FIGURE 4
Overview of previously unrecorded archaeological site near Año Nuevo State Park which was exposed during storm events in the winter of 2024. **(A)** Example of coastal midden with overburden which has protected the site over the past century. **(B)** Profile view of the unrecorded site. **(C)** Example of process for building retaining walls to protect the site from further erosion. **(D)** View of completed retaining wall. **(E)** Overview of creek bisecting site and pedestrian footpath along the site.

Unfortunately, due to climate change-related sea-level rise, these windows are rapidly closing as artifacts are exposed and destroyed, as they are washed out to sea or collected by looters as commodities and curiosities for collection and sale (e.g., Erlandson, 2012; Newland, 2012; Fitzpatrick et al., 2015; Dawson et al., 2017).

Many of the sites in central coastal California are being impacted by rising seas and high-energy storms, both directly linked to climate change (Figure 4). Without adequate monitoring and protection of these sites, this vital historical dataset for the Amah Mutsun Tribal Band could be lost forever. For example, Figure 4 is a previously unrecorded archaeological site that has been capped by overburden for more than a century and was discovered by AMLT staff in 2024 near the QVCP. AMTB led efforts to stabilize the site until research can be conducted at this coastal site. Excavations at the site were completed by AMLT stewards, staff, and summer interns in collaboration with researchers from the University of Oregon in July and August 2024. At the same time, coastal and interior sites across the AMTB stewardship area are constantly threatened or further impacted by development and urban expansion. Indigenous knowledge and evidence from the archaeological record hold information regarding human relationships with ecosystems over thousands of years that deserve to be preserved and protected.

Archaeologists can design research to support and promote the diverse goals of Indigenous partners, as demonstrated through our case study with the AMTB. Centering Indigenous voices and perspectives can be achieved through collaborative research projects with practical outcomes in mind, such as projects that seek to better understand the legacy of stewardship practices and use that evidence to guide contemporary management plans. Historical ecology and eco-archaeology offer the AMTB these opportunities. AMTB continues to successfully apply this approach to ecosystems, using archaeology and modern ecological science to affirm the utility of ancient traditional resource management practices to restore balance and resilience to the diverse ecosystems in AMTB territory. There are now plans to re-introduce cultural and other prescribed burning to several landscapes within the AMLT stewardship area in the coming years. Eco-archaeology has proven relevant for conversations about cultural revitalization, wildfire management, and biodiversity.

Archaeological and historical ecological research can help determine where Indigenous stewardship may be prioritized, and what conditions may be desired. Re-implementing cultural burning under the leadership of Native American tribes to areas where they have been historically excluded and suppressed for more than two centuries under colonialism is a way anthropologists can help demonstrate fires' intrinsic role in the resilience of local ecosystems. While much work is needed to heal from harmful colonial legacies, reconnecting First Peoples to ancestral areas can support healing and a more equitable management system when collaborating with federal, state, and private resource managers receptive to Indigenous knowledge and archaeological research.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Author contributions

AA: Conceptualization, Investigation, Resources, Supervision, Visualization, Writing – original draft, Writing – review & editing.

GS: Conceptualization, Investigation, Resources, Supervision, Visualization, Writing – original draft, Writing – review & editing. AS: Conceptualization, Writing – original draft, Writing – review & editing. MG: Writing – original draft, Writing – review & editing. VL: Writing – original draft, Writing – review & editing. KL: Supervision, Writing – original draft, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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