Bulbs and Biographies, Pine Nuts and Palimpsests: Exploring Plant Diversity and Earth Oven Reuse at a Late Period Plateau Site

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Abstract

Earth ovens, hearths, and middens are common archaeological features in western North America that contain the residues of everyday activities. Ethnographic and archaeological research indicates these in-ground food preparation features were frequently reused over many months and years. These quotidian features therefore can be productively thought of as having use-lives or biographies. Here we present a framework for interpreting these archaeological food preparation feature biographies and the palimpsest nature of earth oven features. We illustrate the value of this framework through paleoethnobotanical analysis of archived soil samples from a bulk food processing site on the Columbia-Fraser Plateau in northeastern Washington State. While this site and other food preparation sites throughout the Plateau are largely interpreted as remains of intensive geophyte processing, our finds indicate that a wide range of economic plants were processed at this location, indicative of a dynamic and flexible subsistence system. We suggest that residents and visitors to the Pend Oreille Valley from ca. 2700-500 cal BP frequently returned to and reused earth oven features as they processed multiple plant food taxa including nodding onion (*Allium cernuum*), camas (*Camassia quamash*) goosefoot chenopod seeds (*Chenopodium atrovirens*), and pine nuts (*Pinus* spp.). We see a biographical approach as a potential solution to the common “palimpsest problem” and suggest this framework may be a fruitful way of investigating multiple food preparation recipes, methods, and events, as well as adding paleoenvironmental datasets to biographical or life-history archaeological rhetoric.

Keywords: Columbia-Fraser Plateau, bulbs, geophytes, earth oven, pine nuts, dietary diversity, fire-modified rock

Introduction

In-ground earth ovens are perhaps one of the oldest and most efficient food preparation technologies for societies worldwide, with evidence of their use dating to at least 12,000 cal BP in western North America (Kennedy 2018). Earth ovens are specialized cooking features that are excavated into the ground and employ a heating element of wood fuel and heated rocks, which are then layered with matting, vegetable or meat foods, and capped with sediment (Black and Thoms 2014; Thoms 2008). These features are designed to bake or steam foods at high temperatures for long periods of time, often over the course of several days. Earth ovens are common across western North America (Black and Thoms 2014; Thoms 2008, 2009; Yu 2006), and are particularly critical in rendering complex carbohydrates edible, which are found in many ethnographically consumed “root” foods (Wandsnider 1997). A variety of other recipes and food preparation methods also took place in ovens and other pits (Thoms 2008, 2009). In western North America, these features are often used to investigate topics such as hunter-gatherer mobility (Bonzani 1997; Lepofsky and Lyons 2003), plant food intensification (Elliot 2013; Lepofsky and Peacock 2004; Thoms 1989; Yu 2006), labor and gender (Fulkerson and Tushingham 2021; Wollstonecroft 2002), traditional foodways and seasonality (Lyons et al. 2020; Lyons et al. 2018; Wollstonecroft and Baptiste 2016), risk reduction strategies (Peacock 1998), and plant food resource management and production strategies (Carney et al. 2021; Peacock and Turner 2002; Turner and Peacock 2005).

For the past residents of the Columbia-Fraser Plateau, earth ovens were a primary means of mass plant food preparation, with some of the oldest features dating to ca. 6,500-5,500 BP (Andrefsky et al. 2000; Thoms 1989). The Pend Oreille Valley in northeastern Washington State

(Fig. 1) is known as one of the most productive geophyte-harvesting grounds, and mobile, forager groups from all over the Columbia-Fraser Plateau and greater Pacific Northwest traveled to the valley specifically to harvest and process camas for long-term storage and exchange (Anastasio 1972; Andrefsky et al. 2000; Turney-High 1941:32). Camas (*Camassia quamash*) is a bulbous, perennial geophyte food that was and continues to be a staple in many Columbia-Fraser Plateau Indigenous subsistence economies. Within regional archaeological literature, the valley is primarily known for what are interpreted as camas processing features (Andrefsky et al. 2000; Thoms 1989), which are often considered direct material correlates of camas exploitation and intensive processing for central place storage (e.g., Ames 2005:94-96; Lepofsky 2004:428; Roll and Hackenberger 1998:132). Such interpretations, however, rely primarily on radiocarbon dating and do not fully consider the paleoethnobotanical remains or feature morphology, and therefore gloss over the role of human agency in subsistence decision-making.

This interpretive bias is exemplified by research at 45PO422, a site located on the eastern margins of the Pend Oreille Valley (Fig. 1), where excavated earth ovens were assumed to be camas processing features (Gough 1997). The site was excavated in the late 1990s and the unanalyzed and partially sampled bulk soil samples were stored for over 20 years. In 2017, bulk soil samples were returned to the ancestral and contemporary stewards of the Pend Oreille Valley, the Kalispel Tribe of Indians. We undertook the paleoethnobotanical analysis of the legacy 45PO422 collection in collaboration with the Tribe, primarily to further understand their history of food selection and preparation, and secondarily to assess the aforementioned assumptions about precontact earth oven usage.

In the following paper, we look to recent approaches to archaeological palimpsests and object biographies to tease apart cooking events, provisioning decisions, and precontact earth

oven recipes. Biographical approaches are similar to artifact life history reconstructions and are useful in tracing connections between past people and material culture. We argue that these earth ovens, with their aggregate palimpsest paleoethnobotanical, geoarchaeological, and artifactual datasets, can be best understood through tracing their histories or biographies. Through this lens, we argue that these features were reused multiple times as people repeatedly came together to process a diverse suite of plant, animal, and non-food resources, including several geophyte species, pine nuts, and berries. Palimpsests and biographical approaches are thus well-suited for understanding the historical processes and myriad characteristics that comprise complex features, such as earth ovens, wherein multiple economic activities and social gatherings took place in the past.

Fig. 1 Northern locus of the 45PO422 site showing distribution of features. Note that Feature 8 was only identified within the wall of Trench 4. Red marker on inset indicates approximate location of the Pend Oreille Valley in northeastern Washington State.

Palimpsests and Biographies

Palimpsests

The archaeological palimpsest concept is commonly used to conceptualize formation processes and archaeological time within geoarchaeological deposits. Palimpsests are archaeological deposits that defy the law of superposition; they are “problematic” deposits considered by most archaeologists as smeared, blurred, distorted, or overlapping in nature (Henry 2012). The concept is most frequently employed as a methodological approach within geoarchaeology to tease apart complicated stratigraphic sequences (Karkanas and Goldberg 2019), though the metaphor itself comes from European practices of writing, erasing, and rewriting on wax tablets or medieval manuscripts (Lucas 2012:115).

Although the earliest uses of the concept were more generally applied to landscapes, in which archaeologists sought to understand how past landscapes were constructed and then changed (Crawford 1953), the term did not become commonplace in archaeological rhetoric until the 1980s. In a series of papers (Bailey 1981; Binford 1981; Foley 1981; see also Bailey 2008:13-14), the term was re-worked to illustrate the difficulty of separating events in the past. According to Bailey (1981, 2007, 2008) archaeological “...data often represents a palimpsest of activities ranging over a period of at least a hundred years to several thousand or more. It refers not to the activities of individuals, or even individual societies, but to larger aggregates of behavior...” (Bailey 1981:109). Lucas (2012:18) notes that this is in direct opposition to Crawford’s notion that palimpsests contain the possibility of dissection and event reconstruction. In the intervening years, however, the term came to be primarily employed by the time perspectivism schools of thought in which formation processes occurring at differing scales require specific analytic and explanatory lens. In 2007, Bailey revisited the palimpsest concept

and defined five categories ranging from his true palimpsest, in which all traces of earlier activities are removed except for the most recent, to those that involve the accumulation and transformation of successive deposition episodes, but which are re-worked or turbated so that it is impossible to separate the sequence of events (Bailey 2007:203-208). These categories and definitions of palimpsests have since become common in archaeological discourse and are used most frequently in paleolithic microstratigraphic analyses (e.g., Karkanas et al. 2015; Machado et al. 2013).

Lucas's (2012) treatise on the archaeological record combines this concept of the palimpsest and materiality theoryⁱ to argue for a holistic approach to excavation, analysis, and interpretation. Lucas (2012:120), commenting on Bailey's palimpsest types, suggests that researchers should not focus attention solely on the end product that archaeologists are most familiar with (i.e., reworked or ambiguous archaeological deposits). Rather, archaeologists should foreground the processes which create palimpsests. Lucas argues that a focus on deposition, inscription, erasure, and cutting re-orientes the study of palimpsests to understanding how archaeological assemblages fusion and fission. In this perspective, the palimpsest helps us to understand how historic processes blend or blur archaeological deposits (which may include both blended archaeological deposits as well as discrete strata representing past depositional events), but also how to trace those processes when reconstructing past events. They provide a way of understanding how the archaeological assemblages we encounter today may have come together in the past, as well as rematerialize through taphonomy, excavation, and interpretation. Indeed, by tracing how assemblages coalesce and scatter, we can link the processes of field or lab work with both archaeological theories and interpretations. As we discuss below, however, the palimpsest concept alone does not help us to understand the social processes that determine

how or why palimpsests form in the first place. In the next section, we look to object biographies to add dimension to archaeological palimpsests.

Object biographies

Object biographies, life histories, and itineraries are various metaphors used by archaeologists to trace the histories and connections of material culture with past human lives (i.e., Gosden and Marshall 1999; Joy 2009; Joyce and Gillespie 2015; Meskell 2004). Objects, the physical materials we engage with daily, are not just products of culture, but are fundamental to social reproduction. Within archaeology, the biographical approach is generally grounded in recent discussions of materiality (cf. Hicks 2010) and seeks to disentangle and understand the relationships between people and things (Gosden and Marshall 1999:169; Joy 2009).

Methodologically, this requires following an object or set of objects over the course of their “life,” from construction to various uses, to eventual “death” or decommission (Kopytoff 1986).

Tracing the histories of specific pieces of material culture has deep roots within archaeology. Artifacts are not static, but were created, used, deposited, and subjected to taphonomy. Tool use-life studies are useful models that track how raw materials are procured, manufactured, use, maintained, and discarded, as well as stored, transported, recycled, and reused (Schiffer 1972). These studies draw on the notion of an object life cycle in explaining long-term variation and technological change in primarily lithic or ceramic artifacts as well as overall assemblage structure (Shott and Sillitoe 2004). However, tools are never solely functional, and one major critique is that such studies do not often consider the social or cultural connections objects had in the past (e.g., Dobres 1995; Schiffer and Skibo 1997).

Object biographies attempt to understand the entire span of an object's "life" by foregrounding the dynamic interplay between people and objects. Most biographical studies of objects focus on single artifacts. For example, Joyce (2015) traces the paths of carved marble vases from quarry to museum, illustrating the significant mobility of static artifacts. Other studies highlight how curated items in museums carry specific narratives and stories, while excluding the voices and interpretations of others (e.g., Pezzarossi 2015). Biographical approaches have also been applied to architectural features such as houses or monuments. These discussions emphasize the capacity for dwellings to shape or structure human action (e.g., Gillings and Pollard 1999; Pauketat and Alt 2005). Others highlight the stages of construction, various uses, and eventual abandonment or closure of spaces, all of which have cultural and social implications on human bodies and lives (e.g., Souvatzi 2012).

Biographical approaches are not simply narratives of artifacts or architecture but are also relational histories which identify the social connections that influenced the materials archaeologists encounter (Joy 2009:544). Joyce (2015:28) describes these relations as entangled; it is almost impossible to define a start and a finish to an object's life, and that would be an arbitrary exercise. Rather, researchers who trace how objects and structures were created, used, and circulated should consider how these objects may have functioned or facilitated action within long-term historical networks.

Many scholars who engage with object biographies warn that the biographical metaphor itself comes with anthropocentric undercurrents (Meskell 2004:58). By suggesting objects even have lives, we are personifying objects; we are taking these things from other cultures and describing and analyzing their histories and relations using our own western categories. Joyce and Gillespie (2015) suggest the term *itinerary* in lieu of *biography*, as itineraries capture how

objects may move through various social contexts and functions. Itineraries are useful heuristics for tracing and recording how objects circulate, move, and come to be found in the archaeological record; however, we find that the concept still denotes a planned journey or route. There is still a unidirectional element in the metaphor with little room for novel paths or spontaneity. The terms biographical approach and object biographies, despite their shortcomings, are still regularly used in archaeological discourse today. As it is familiar and commonplace, we still use the term here, but with the caveat that we are interested in both the narrative capacity as well as the emphasis on tracing relationships and connections which do not have fixed beginnings or ends.

Biographical frameworks for food-preparation palimpsests

How then do we move from palimpsests and object biographies to the study of archaeological earth oven features? We suggest archaeologists consider these features have the potential to be palimpsests with complex biographies. Archaeological food preparation features generally consist of heat-altered soils sediments, fire-modified rocks (FMR), and charred plant and animal remains. Many factors likely influenced these features in the past and their resultant biographies: people may have selected locations for ovens not only due to their physical proximity to food resources, but also considered soil properties, wind direction, distance to village, campsite, or food cache, and availability of preferred wood fuel and cooking stones. Ovens were actively excavated into the ground by people who collected and carried those rocks, fuel, and plant or animal foods to that location. Even the social elements of food preparation have the potential to impact oven biographies; for example, ethnographic sources indicate cultural taboos prevented men from partaking in certain cooking events (Wright 2003), and specific cooking places were

and continue to be crucial within Plateau identities (Ackerman 2005). The interactions between the past people who created, used, and either abandoned or returned to and reused these earth ovens and their material constituents worked in tandem to create the features archaeologists excavate and analyze today. To understand those interactions, we cannot isolate each component of the entire earth oven; they must be analyzed and interpreted as a whole.

The preparation of different foods also required different types of ovens or cooking processes, and these alternate morphologies would leave different archaeological signatures (Thoms 2008). In our review of North American archaeological and food preparation practices we identified eight general types or forms of in-ground, cooking-related features. Table 1 outlines the variation in foods prepared, feature morphology, construction decisions, and archaeological expectations for various feature biographical trajectories. This diversity in feature type and morphology suggests that past peoples had complex technological solutions to bulk food processing as well as everyday cooking needs. We argue that a fine-grained analysis of these features is necessary to explore the breadth of past provisioning decisions, the environmental factors influencing decisions to target and process specific resources, and even the social factors guiding human movement across landscapes. Of course, the feature types and expectations outlined in Table 1 should be thought of as a spectrum with the archaeological expectations as points illustrating the full suite of potential indicators.

Below, we draw on this framework, palimpsests, and object biographies to interpret the complex archaeological earth oven, hearth, and midden assemblages of 45PO422. In the following section, we situate our case study, the Pend Oreille Valley, in its cultural and environmental context. Next, we present the results of the paleoethnobotanical analyses in conjunction with the other datasets generated by the original site excavators before interpreting

these results and western North American archaeological knowledge production through a biographical lens.

Table 1 Ethnographic descriptions of food preparation features and archaeological expectations for their material and paleoethnobotanical contents.

<i>Food-preparation related features</i>	<i>Closed earth oven with rocks heated within</i>	<i>Steaming pit with rocks heated nearby</i>	<i>Shallow, open earth oven or roasting pit</i>	<i>Surface oven or griddle</i>	<i>Stone boiling pit</i>	<i>Pine nut roasting pit</i>	<i>Hearth</i>	<i>Midden</i>
<i>Dimensions</i>	Small: 0.75 m in diameter, large: 2-3+ m in diameter, depth: 0.15-1 m, elliptical to occasionally circular	Small: 0.75 m in diameter, large: 2-3+ m in diameter, depth: 0.15-1 m, elliptical to occasionally circular	Variable, "smaller than camas ovens" (Smith 2000:7.14)	Unknown	Diameter: 0.3-0.75 m, depth: 0.1-0.5 m, scaled for amount of food, alternatively cooked in basket	Diameter: unknown, depth: 1 m	Size varies but typically max diameter of 1.5 m and max depth of 0.5 m, shape varies from circular to elliptical to rectangular	Varies, often irregularly bounded
<i>Construction</i>	1-2 pavement layers of cobble-sized rock and wood fuel, covered with green grasses, boughs, pine needles, or skunk cabbage leaves, geophytes, with additional layer of greenery, then covered with soil. Fire sometimes lit above oven	Cobble-sized rock heated nearby and brought to basin floor, covered with grasses, skunk cabbage leaves, pine needles, or ferns. Stick placed upright in oven and then oven covered in soil. Water added to hole left by stick, then covered. Fire sometimes lit above oven	Rock heated nearby and brought to basin, then covered with fresh conifer boughs. Meat laid on top.	Boulder to cobble sized rocks are heated beneath a fire. Rock(s) may be covered with green branches, then food added.	"Bucket-shaped" pit lined with ponderosa or lodgepole pine bark and/or hide, 3-12 "tennis ball size" stones (6.5-6.9 cm diameter) heated nearby added to water in pit	Hole dug in ground and hot rocks heated nearby added to bottom. Grass or tule added above rocks, followed by pinecones, 20 cm of pine needles, and 1 foot of soil	May be excavated shallowly into paleosurface, may be ringed with rock	Debris and everyday waste accumulate at variable rates, often gradual

<i>Food-preparation related features</i>	Closed earth oven	Steaming pit	Shallow, open oven	Surface oven or griddle	Stone boiling pit	Pine nut roasting pit	Hearth	Midden
<i>Location</i>	Well-drained sediments near geophyte meadows, fuel, and rock sources	Well-drained sediments near geophyte meadows, fuel, and rock sources	Near meat-processing locations	Near other ovens or meat-processing locations	Usually located within 2 m of hearth or other FMR concentration	Unknown	Varies, may be located within structures, adjacent to structures, or constructed as-needed	Often near food preparation sites or residential sites
<i>Foods prepared</i>	Camas, acorn bread, balsamroot, biscuitroot, silverweed, water-parsnip, springbank clover, and lichens or moss	Camas, balsamroot, biscuitroot, onion, glacier lily, tiger lily, wild parsnips, lichen, eggs	Meat or fish, whole berries or berry cakes, dried seaweed	Meat, acorn cakes, some geophytes	Meat, bone rendering, fish, berries, acorns, Brodiaea corms, Mariposa lily bulbs, camas, or bitterroot	Pine nuts	Meat, Brodiaea corms, Mariposa lily bulbs, occasionally biscuitroot, other “root”geophytes, bay nuts	Varies
<i>Cooking time</i>	12-48 hours of continuous heat and steam	12-48 hours of continuous heat and steam	20-30 minutes	1 hour	10-30 minutes	Overnight	Varies	N/A
<i>In-situ Archaeological feature signatures</i>	Flat, convex, or concave breakage faces common in FMR, ash, rubified and/or organic-rich sediments defining feature	Flat, convex, or concave breakage faces common in FMR, ash, rubified and/or organic-rich sediments defining feature	Single layer of FMR, limited rubification, ash, residues on FMR	Boulder to cobble sized FMR, rubified sediments beneath FMR, ash, residues on FMR	Contraction fracturing on igneous and coarse grained FMR, quartzite FMR jagged and/or exhibiting surface crazing, residues	FMR pavement, no ash, organic-rich sediments	Definable feature boundaries, rubified sediments at base of hearth, ash, potential for FMR, FMR may be prismatic shaped, residues on FMR	Stratified, organic-rich and/or mottled soils, faunal remains, debitage, gravel-sized FMR fragments

<i>Food-preparation related features</i>	Closed earth oven	Steaming pit	Shallow, open oven	Surface oven or griddle	Stone boiling pit	Pine nut roasting pit	Hearth	Midden
<i>In-situ Paleoethnobotanical expectations</i>	Wood charcoal above or interspersed with FMR, geophyte, greenery, or acorn macrobotanicals at margins or base, phytoliths in sediment, starches on FMR	Little to no wood charcoal, wood has pronounced radial cracks (indicative of dried wood), geophyte and greenery macrobotanicals at margins or base, phytoliths in sediment, starches on FMR	~<3 cm estimated diameter in wood charcoal, numerous and small radial cracks on wood (indicative of green wood), greater numbers of incidental seed rain, potential for phytoliths in sediment	~<3 cm estimated diameter in wood charcoal, wood charcoal beneath or interspersed with FMR, geophyte and macrobotanicals, phytoliths in sediment, starches on FMR	Potential for bark and other food-based macrobotanical remains, phytoliths in sediments, potential for starches, manzanita or oak wood used to heat stones in CA	Grass or tule vegetation or seeds, pinecones and/or pine seeds, pine needles, phytoliths	Wood charcoal, potentially with ~> 3 cm diameter, potential for charred macrobotanicals, phytoliths, starches, and/or residues	Wood charcoal in varying sizes, fragmented and whole macrobotanicals, wide variety of incidental seed taxa, potential for phytoliths, starches, and residues, all with some stratigraphic order
<i>Altered or moved feature expectations</i>	Spall to blocky shaped FMR or FMR removed from basin, FMR possibly scattered with wood charcoal and/or rubified sediments on paleosurface	Spall to blocky shaped FMR or FMR removed from basin, FMR possibly scattered with rubified sediments on paleosurface	Spall to blocky shaped FMR or FMR removed from basin, possibly scattered with wood charcoal on paleosurface, protein residues on FMR	spall to blocky shaped FMR or FMR and ash removed from feature, rubified sediment beneath feature	Diagnostic FMR (see above) removed and discarded, potential for feature profile turbation	FMR removed from basin, possibly scattered with organic-rich sediments on paleosurface	FMR may be removed or discarded, gravel-sized FMR fragments, rubified sediments turbated, no ash	Turbated with no clear stratigraphy, organic-rich and/or mottled soils, faunal remains, debitage, gravel-sized FMR fragments

<i>Food-preparation related features</i>	Closed earth oven	Steaming pit	Shallow, open oven	Surface oven or griddle	Stone boiling pit	Pine nut roasting pit	Hearth	Midden
<i>Altered or moved paleoethnobotanical expectations</i>	Low-density wood charcoal and other macrobotanical remains, few geophytes	Low-density macrobotanical remains, few geophytes	Low-density wood charcoal and other macrobotanical remains, ~<3 cm estimated diameter in wood charcoal	Low-density, fragmented wood charcoal and other macrobotanical remains, few geophytes	Few to none macro or microbotanical remains	Low-density macrobotanical remains, 1-2 "escaped" seeds, phytoliths	Most or all wood charcoal removed, light macrobotanical assemblage	Turbated with no clear stratigraphy, wood charcoal in varying sizes, fragmented and whole macrobotanicals, wide variety of incidental seed taxa, potential for phytoliths, starches, and residues
<i>Single-use expectations</i>	Incidental seed inclusions indicative of 1 season, limited macrobot & wood taxa similar to ethnographic food prep descriptions, boulder to cobble-sized FMR, sharp feature stratigraphy	Incidental seed inclusions indicative of 1 season, limited macrobot taxa similar to ethnographic food prep descriptions, boulder to cobble-sized FMR, sharp feature stratigraphy	Incidental seed inclusions indicative of one season, wood charcoal from 1-2 taxa, boulder to cobble-sized FMR, sharp feature stratigraphy in profile walls	Incidental seed inclusions indicative of one season, limited macrobotanical and wood charcoal taxa possibly similar to ethnographic food preparation descriptions, boulder to cobble-sized FMR above rubified sediments	Clear, sharp, and intact feature stratigraphy	Intact pavement of FMR with minimal cracking, clear, sharp, and intact feature stratigraphy	Incidental seed inclusions indicative of one season, limited macrobotanical taxa, sharp feature stratigraphy in profile walls, soil may not be rubified from repeated heating, ash	Shallow deposits of only a few cm

<i>Food-preparation related features</i>	Closed earth oven	Steaming pit	Shallow, open oven	Surface oven or griddle	Stone boiling pit	Pine nut roasting pit	Hearth	Midden
<i>Reuse expectations</i>	Incidental seed inclusions indicative of multiple seasons, diverse macrobot and wood charcoal taxa, fine cobbles to gravel-sized FMR fragments with various fracturing patterns, larger “crater-like” pits from frequent reuse	Incidental seed inclusions-multiple seasons, diverse macrobot taxa, sediment rubification and increased chroma, fine cobbles to gravel-sized FMR fragments with variety of fracturing patterns, larger, “crater-like” pits from frequent reuse	Incidental seed inclusions indicative of multiple seasons, diverse wood charcoal taxa, fine cobbles to gravel-sized FMR fragments with variety of fracturing patterns	Heavily fractured cobble to gravel-sized FMR fragments, incidental seed inclusions indicative of multiple seasons, diverse macrobot and wood charcoal taxa, pronounced rubification, little to no ash	Diffuse or wavy feature stratigraphy, potential for diagnostic or variously fractured FMR discarded nearby	Diffuse or wavy feature stratigraphy, potential for variously fractured FMR discarded nearby, diverse macrobot taxa	Incidental seed inclusions indicative of multiple seasons, diverse macrobot and wood charcoal taxa, pronounced rubification, little to no ash	Thick deposits to mounded landscape features, wide range of FMR size clasts and fracturing patterns

<i>Food-preparation related features</i>	Closed earth oven	Steaming pit	Shallow, open oven	Surface oven or griddle	Stone boiling pit	Pine nut roasting pit	Hearth	Midden
<i>Additional Notes</i>	Geophyte and acorn bread ovens have similar descriptions. Both closed ovens and steaming pits were used to cook similar foods, and cultural preferences may dictate the exact method of food preparation. Large pits for batch cooking camas in summer while smaller pits used for reconstituting dried geophytes; cottonwood and willow preferred for camas. Some acorn bread may be mixed with red clay.	Both closed ovens and steaming pits were used to cook similar foods, and cultural preferences may dictate the exact method of food preparation; large pits for batch cooking camas in summer while smaller pits used for reconstituting dried geophytes; cottonwood or willow preferred; smaller pits may also be used for steaming glacier lily.	Berries sometimes mixed with meat or animal grease. Berry-specific trenches may not have FMR.	In CA used for acorn biscuits. Also used for drying foods after roasting or steaming in NW.	Pits frequently reused but only in summer, berries sometimes mixed with meat or animal grease; boiling pits also reused for reconstituting dried foods; soapstone or basalt preferred in CA	Pine nuts may also be roasted over an open fire or steamed	Plant foods often roasted directly on coals, <50% of all FMR may be fractured or cracked	

<i>Food-preparation related features</i>	<i>Closed earth oven</i>	<i>Steaming pit</i>	<i>Shallow, open oven</i>	<i>Surface oven or griddle</i>	<i>Stone boiling pit</i>	<i>Pine nut roasting pit</i>	<i>Hearth</i>	<i>Midden</i>
<i>Sources</i>	Barrett and Gifford (1933:200); Duncan 1963:11-12; Lepofsky and Peacock (2009); Jacobs et al. 1945:18-19; Kroeber (1932:276); Mackey 1974:43; Neubauer (2018:683); Peacock (1998); Smith (2000:7.8-7.15); Teit (1900:236); Turney-High (1933)	Lepofsky and Peacock (2009); Neubauer (2018:683); Peacock (1998); Ross (2011:340-341); Schaefer et al. (2010:74); Smith (2000:7.19-7.20); Spinden (1908:201-202); Turner (2014a:290-291); Turney-High (1933)	Compton (1993:190); Dufraisie, et al. (2020); Post (1931:27); Ross (2011); Théry-Parisot and Henry (2012); Turner (2014:296-302); Smith (2000:7.19-7.20)	Barrett and Gifford (1933:148); Gayton (1948:179); Neubauer (2018:682); Smith (2000:7.20)	DuBois (1935:19); Gayton (1948:178); Ortiz and Parker (1991:110); Ross (2011:448); Samuels and Olsen (2000:9.3); Shantry (2020); Smith (2000:7.16-7.19), Wilson (1972)	Anderson (2005:280); Post (1931:28); Turner (2014:275, 307)	Custer et al. (2017:267, 282); Darby (2004:202); Samuels and Olsen (2000:9.3)	Knapp 2015; Samuels and Olsen (2000:9.3)

Study Area, Context, and Methods

Site 45PO422 is located in the floodplain of the Pend Oreille River in northeastern Washington State on the ancestral lands of the Kalispel Tribe of Indians (Fig. 1 inset). The Kalispel people reside in the eastern subsection of the Columbia-Fraser Plateau cultural area and Northern Rockies ecoregion (Kroeber 1947; Roll and Hackenberger 1998). This landscape is marked by north-south trending valleys separated by mountain ranges, resulting in a diverse set of geographically close ecozones (Carrera et al. 1996; Hanson and Clague 2016; Miss 2005). The site itself is situated at the upper margin of the Pend Oreille River flood basin, directly below the foothills of the Selkirk range (Clausnitzer and Zamora 1987; Daubenmire 1968; Laser 1980).

The Pend Oreille River, a tributary of the Columbia River, seasonally floods with the melting of the mountainous snowpack, resulting in a landform of open meadows, bogs, sloughs, and marshes. Contemporary summers are typically dry from high atmospheric pressure, with most precipitation falling during as snow winter. Before to the construction of the Box Canyon and Albeni Falls dams, this freshet often inundated much of the Pend Oreille Valley; indeed, the 100-year flood level can fill the entire valley (Stratling et al. 2000:4.13). This combination of seasonal flooding, xeric seasonal moisture regimes, and poorly drained wet meadows creates an ideal landscape for geophytes (Statham 1975), with camas (*Camassia quamash*) covering much of the valley floor (Franklin and Blinn 1988:171).

The Pend Oreille Valley and the Kalispel people were known for these large camas fields, and groups from all over the Columbia-Fraser Plateau and greater Pacific Northwest traveled to the Pend Oreille Valley specifically to harvest and process this nutrient and calorie-dense food source (Anastasio 1972). The archaeological record of the valley reflects these lifeways, as most sites consist of earth oven or other fire-modified rock (FMR) features

(Andrefsky 2000; Gough 1997; Herbel et al. 2008; Thoms 1989; Walker 2004; Willis 2011). As the region is considered one of the foremost places for harvesting and processing camas, most archaeological earth oven features are considered indirect evidence of camas processing (e.g., Andrefsky 2000; Gough 1997; Sanders 1992).

Archaeological Context

Site 45PO422 was excavated by Archaeological and Historical Services and Eastern Washington University in 1996, before the construction of the Kalispel Tribe's fish hatchery (Gough 1997). The excavators uncovered evidence for eight earth ovens, one fire-modified rock (FMR) cluster, midden sediments, and several "natural" features (Table 2). At the time, the site was interpreted as a camas processing locale based on earth oven morphology, associated organic-rich sediments, FMR quantity, limited paleoethnobotanical analyses, and the low density of lithic artifacts (Gough 1997:46-48). The features were variously interpreted as either *in-situ* (intact) or otherwise described as "cleaned out."

Fifteen radiocarbon dates indicate that the site was used across two temporal periods; an initial period of use between 2753-1875 cal BP followed by an apparent hiatus and later use dating to 1296-526 cal BP. These periods roughly fall at the end of Andrefsky's (2004) Middle Archaic (5,000-2,000 BP) period and into the Late Archaic (2000-250 BP). It is during these

Table 2 Feature summaries, dimensions, radiocarbon dates, and descriptions. FMR pebbles and gravels refer to pebble or gravel-sized FMR fragments.

Feature	F4	F7	F18	F20	F6	F19	F14	F9	F21	F8
Sample Liters	8	10.1	6.1	7.8	8	4	12	1.6	2	2.75
Cal date BP	2742-2313	2720-2152	1518-1301	1296-830	1287-1069	1059-788	908-671	731-554	730-558	656-526
Block/Location	4	7	6	14	6	14	14	9	Shovel Test Line E	Trench 4
Feature Length (m)	2.05	3.4	1.8	.9, 2	1.77	2.5	4.55	1.6	-	2.2
Feature Width (m)	>0.7	2.1	1.4	.8, >1	>1.25	1.5	>2.7	>0.7	-	-
Feature Thickness (m)	0.22	0.19	0.19	.11, .15	0.29	0.23	0.26	0.14	-	0.13
FMR weight (kg)	5.2	44.5	57.9	4.5, 23.5	47.2	38.2	513.3	8.1	-	-
FMR count (n)	94	587	497	84, 582	391	114	6105	63	-	-
FMR gravel (n)	94	573	380	610	235	111	5868	60	-	-
FMR cobbles (n)	0	14	117	2	156	3	237	3	-	-
FMR ratio	N/A	0.02	0.31	<0.01	0.66	0.03	0.04	0.05	N/A	N/A

Feature	F4	F7	F18	F20	F6	F19	F14	F9	F21	F8
Description	Steep walls; minimal FMR within feature and no FMR or charcoal adjacent to oven	Irregular oval basin; sloped feature walls; cleanout with charcoal and FMR to east; small amount of oxidized sediment; bone present; nearby pit potentially associated	Bioturbated oval basin; sloped feature walls; berm on north edge; scattered FMR and charcoal-staining to east of feature	Oval basin with sloped walls; bone present; FMR distributed in large arc to south and west	One steep wall and one sloped wall; FMR scattered within feature; FMR and charcoal to southeast	Steep walls; tightly packed FMR	Oval, steep walls; tightly packed FMR at base of feature; large "limb" charcoal; oxidized sediments	Sloped walls; small amounts of FMR and fragmented charcoal; bone present	Exposed in a shovel test on southern edge of site; FMR and charcoal	Exposed in trench; sampled but not excavated; oxidized sediments

broad time periods, the end of the Middle Archaic into the Late Archaic, that the common Columbia-Fraser Plateau ethnographic patterns of seasonal mobility, delayed return economies, and winter villages become archaeologically visible (Ames 1991, 2012; Browman and Munsell 1969; Chatters and Prentiss 2005; Prentiss et al. 2006). Rock shelters were re-purposed from habitation sites to storage caches (Endacott 1992; Hicks 2004) and trade and human movement increases throughout the region (Galm 1994). Climatically, the northern Columbia-Fraser Plateau shifts from a globally recognized cold and wet period at ca. 2200 cal BP to drier conditions (Nelson et al. 2011; Steinman et al. 2016). From 2000-1000 cal BP precipitation alternates along smaller decadal to centurial oscillations, before becoming more varied during the last millennia.

The 1996 45PO422 excavations collected a total of 34 paleoethnobotanical bulk soil samples (66.35 liters) and six spot samples from 10 precontact earth oven and midden features. Only the spot samples and 10 bulk samples were partially analyzed and included in the final report (Stenholm 1997). In 2017, the remaining 24 soil samples were returned to the Kalispel Tribe. We processed and analyzed the remaining bulk soil samples and finished the analyses for the partially sorted samples. The following study reports the macrobotanical analysis for the remaining 24 sediment samples (47 liters total) as well as the completed analysis for the partially sorted paleoethnobotanical samples.

Paleoethnobotanical Methods

Archived soil samples were floated using the bucket flotation technique (Pearsall 2015:29-33). The charred remains were captured by 0.25 mm cloth and were air dried. Charred remains were identified, counted, weighed, and photographed. All pieces of charcoal larger than 2 mm with at least one complete growth ring visible were examined under lower-powered microscopy using an

Olympus SZX7 light 0.8-5.6x microscope and 10–60x Leica stereomicroscope. Select wood charcoal, seeds, and vegetative tissue samples were gold coated to decrease charging following Carney and d’Alpoim Guedes (2021) and were imaged on the Washington State University Franceschi Microscopy and Imaging Center FEI Quanta scanning electron microscope to further establish identifications.

We report both counts and weights as numeric counts are more meaningful for small seeds, while weights are more representative measures for items likely to fragment, including wood charcoal and geophytes. All results other than site summary statistics are standardized by density (Miller 1988:74; Pearsall 2015:196). We also report richness and ubiquity measures. Richness is a count of the number of different taxa within one archaeological unit divided by the volume sampled and serves as a broad, general measure of abundance (Pearsall 1988). Ubiquity is a calculation of the percentage of samples in which a given taxon appears and standardizes presence or absence across all samples (Pearsall 2015:212-216; Popper 1988:60-64).

We attempted a number of exploratory statistics to identify patterning in the paleoethnobotanical data (Smith 2015), though none produced any significant results. We did, however, have success in using an exploratory k-means cluster analysis to identify outliers among seed, vegetation, and wood charcoal datasets. We scaled the density datasets and used the silhouette method to identify the ideal number of clusters. This analysis was run in R 4.0.3 with the factoextra package (Kassambara and Mundt 2017). All code is available at <http://doi.org/10.5281/zenodo.6416264> (Carney 2022) and detailed results are shared in the Supplemental Text.

Site Reanalysis Methods

We also rely on several other datasets generated by Gough (1997) in our reanalysis of the site including radiocarbon data, fire-modified rock counts sorted into size categories, and feature descriptions (Table 2). We recalibrated all radiocarbon dates using OxCal 4.4.1 with the IntCal 20 curve (Supplemental Fig. 1) (Bronk Ramsey 2009; Reimer et al. 2020). We were also interested in whether the features may have been reused over time. Several researchers have identified an direct relationship between the amount of time rocks are exposed to heat and the number of cracked gravels produced from cobbles (Custer 2017; Graesch et al. 2014; Neubauer 2018). As the number of firing episodes increases and heated rocks become structurally weaker, the quantity of fractured rock increases and becomes smaller. In the Pend Oreille Valley archaeological sites, it is common to employ ratios and simple statistics with fire-modified rock data as a proxy for landform or feature use intensity. To estimate cook stone reuse, we calculated a simple ratio of fire-modified rock (FMR) gravel-sized clasts (2-76 mm diameter) to cobble-sized clasts (76-250 mm diameter) (Table 2) (Schoeneberger et al. 2012).

We were further curious about the amount of time and labor required in the construction of a typical earth oven and calculated the amount of time required to construct these features in hours and person days. We used Abrams (1994) concept of archaeological energetics and estimates for excavating and moving soil and cobbles in our earth oven construction calculations. Abrams (1994:44-47) estimates one person can excavate approximately 0.52 m³ of soil per hour with stone tools, collect roughly 24 kg of cobbles from a river point bar per minute, carry 22 kg of cobbles at a rate of 3 km/hr, and walk unloaded at a velocity of 5 km/hr.

To calculate the effort required to construct an earth oven (Table 3), we used the feature dimensions (length, width, and depth, Table 2) to estimate total soil volume removed for the

construction of the feature. In some cases, the entire feature was not excavated, and readers should note that our calculated times underestimate the total time necessary to build those features. Using the measure tool on ArcMap 10.7.1, we estimate people would have had to travel approximately 2 km due west from the site to collect cobbles from the shoreline of the pre-dam Pend Oreille River, underscoring the importance of oven stones. These numbers were used in our earth oven construction time and labor calculations (Table 3).

Paleoethnobotanical Results

A total of 29 taxa were identified, including 17 seed, 10 wood, and 2 geophyte taxa. Paleoethnobotanical results for each feature, standardized by density, are presented in Tables 3-5 and Fig. 2. A discussion of results by feature and undetermined taxa can be found in the Supplemental Text at the end of the chapter. Sample raw results and density are available in Supplemental Tables 1-3 (<http://doi.org/10.5281/zenodo.5395915>) as well as in the reports on file with the Kalispel Tribe (Carney 2021; Carney 2022).

Across the entire site, bearberry or kinnikinnick (*Arctostaphylos uva-ursi*) seeds and ponderosa pine (*Pinus ponderosa*) wood are the most common species, present in 62% of samples. Of all the seeds recovered, chenopods (cf. *Chenopodium atrovirens*) were the most numerous at a total of 197.5 seeds (Fig. 3c). Identified seeds from edible berries, drupes, and nuts include chokecherry (*Prunus virginiana*), hawthorn (*Crataegus* sp.), huckleberry (*Vaccinium* sp.), vetch (*Vicia americana*), and ponderosa pine (*Pinus ponderosa*) (Fig. 4). Edible vegetative tissue includes common camas (*Camassia quamash*) and nodding onion (*Allium cernuum*); some features included additional unidentifiable fruit and bulb tissue (Fig. 3a, b).

Fig. 2 45PO422 frequency abundance barplots for a) seed, b) vegetative tissue, and c) wood charcoal taxa. Y-axis indicates percentage while x-axis represents features. Features are shown left to right in chronological order. Any taxa that account for <1% of a feature's assemblage are omitted from this figure but are present in an accessible color-palette version in the supplemental materials (Supplemental Fig. 2). See Tables 3-5 for Latin names.

Table 3 45PO422 density seed data by feature. Undetermined seeds are shared in the supplemental materials. U stands for ubiquity and is a percentage. P indicates taxa is present but weighs less than 0.01 g.

Feature	F4		F7		F18		F20		F6		F19		F14		F9		F21		F8		U
Seeds	n	g	n	g	n	g	n	g	n	g	n	g	n	g	n	g	n	g	n	g	
<i>Arctostaphylos uva-ursi</i> Bearberry	0.06	P	0.3	P	0.49	>0.01	0.71	P	0.63	0.01	1.75	0.01	2.5	>0.08	7.19	0.02			2.36	P	62
<i>Amaranthus</i> cf. <i>hybridus</i> Amaranth					0.66	P			0.13	P	1.5	P	0.5	P			5.5	P	0.36	P	35
cf. <i>Chenopodium atrovirens</i> Goosefoot	0.13	P	4.6	>.006	1.15	P	0.39	P	2.5	P	5.5	P	1.92	P	0.63	P	20.5	0.01	15.64	P	59
<i>Crataegus</i> sp. Hawthorn									0.13	P											3
Cyperaceae Sedge									0.25	P			0.17	P							6
cf. <i>Eleocharis</i> sp. Spikerush									0.13	P											3
cf. <i>Erigeron</i> sp. Wild Buckwheat													0.08	P							3
Hydrocharitaceae cf. <i>Najas guadalupensis</i> Frogbit	0.13	P																	0.36	P	6
cf. <i>Moehringia</i> sp. Sandwort											0.25	P					0.5	P			6
<i>Pinus ponderosa</i> Ponderosa pine			0.1	P																	3
<i>Polygonum</i> sp. Knotweed									0.13	P											3
<i>Prunus virginiana</i> Chokecherry							0.13	P													3

cf. <i>Ranunculus</i> sp. Buttercup	0.1	P									3
cf. <i>Rumex</i> sp. Dock			0.13	P							3
<i>Vaccinium</i> sp. Huckleberry	0.1	P									3
<i>Vicia americana</i> Vetch									0.36	P	3
Liters	8	10.1	6.1	7.8	8	4	12	1.6	2	2.75	
Cal BP	2742 - 2313	2720-2152	1518-1301	1296-830	1287-1069	1059-788	908-671	731-554	730-558	656-526	
Richness	7	18	10	11	13	12	16	8	5	9	

Table 4 45PO422 density vegetative tissue data by feature. U stands for ubiquity and is a percentage. P indicates taxa is present but weighs less than 0.01 g.

Feature	F4		F7		F18		F20		F6		F19		F14		F9		F21		F8		U
Vegetative Tissue	n	g	n	g	n	g	n	g	n	g	n	g	n	g	n	g	n	g	n	g	
<i>Allium cernuum</i> Nodding onion							0.26	0.01					0.08	P							6
<i>Camassia quamash</i> Common camas															3.13	0.01					3
Pinaceae cone frags Pine			1.88	0.02	0.16	P	0.39	0.01	1.38	0.01	0.75	0.01	2.08	0.01	1.25	P			0.36	P	50
Pinaceae bark Pine					11.4	0.57	58.0	0.25	0.25	P			2.33	0.01	13.1	0.04			1.09	0.01	32
<i>Pinus</i> sp. fascicle Pine needle bundles			5.84	0.01			0.64	P	0.63	P	0.5	P	0.83	P			0.5	P	0.73	P	35
cf. <i>P. albicaulis</i> Whitebark pine			0.59	0.01																	3
<i>P. contorta</i> whole cones Lodgepole pine			0.4	0.09									0.5	0.12							9
cf. <i>P. contorta</i> cone frags Lodgepole pine			13.2	0.1	3.12	0.01	0.64	P	0.38	P			39	2.9			1	0.01			38
<i>P. contorta</i> needles Lodgepole pine			54.5	0.21	0.49	P			0.88	P			0.58	P							24
<i>Pinus ponderosa</i> needles Ponderosa pine			0.2	P	0.33	P	0.64	P	1.5	P	0.5	P	0.08	P					0.73	P	32
Bulb tissue	0.13	P	0.1	P									0.08	P			0.5	P			12
Fruit tissue			0.4	0.01																	3

Table 5 45PO422 wood charcoal density data by feature. U stands for ubiquity and is a percentage. P indicates taxa is present but weighs less than 0.01 g.

Feature	F4		F7		F18		F20		F6		F19		F14		F9		F21		F8		U
Wood	n	g	n	g	n	g	n	g	n	g	n	g	n	g	n	g	n	g	n	g	
Gymnosperm Softwood	43.6 3	1.08	4.95	0.1	6.56	0.10	3.59	0.06	2.75	0.03	3	0.09	6.75	0.23			0.5	0.01	5.09	0.16	100
Pinaceae Pine family	0.13	P	1.78	0.05			0.51	0.01	0.13	P	1.5	0.03	3.58	0.14							29
<i>Pinus</i> sp. <i>Pine</i> genus	5.25	0.75	1.68	0.06	1.64	0.11	2.44	0.05	0.25	0.02	1.75	0.07	5.33	0.36	0.63	0.06			0.36	0.01	65
<i>Pinus contorta</i> Lodgepole pine	2.38	0.22	2.28	0.16	0.82	0.04	0.39	0.02	0.5	0.02	0.25	0.04	7.58	0.96	3.75	0.16			3.27	0.33	50
<i>Pinus ponderosa</i> Ponderosa pine	13.5	1.32	4.46	0.17	0.49	0.01	0.64	0.04	0.5	0.02	0.5	0.02	5.33	0.52	1.25	0.06			1.82	0.16	62
<i>Pseudotsuga</i> <i>menziesii</i> Douglas fir					0.33	P	0.51	0.02			0.5	0.02									12
<i>Tsuga</i> sp. Hemlock															1.88	0.06					3
<i>Abies/Tsuga</i> sp. Hemlock or fir					0.82	P					1	0.03	0.17	0.01					0.36	0.01	15
<i>Picea/Larix</i> sp. Spruce or larch	0.38	0.17	0.89	0.06					0.13	0.02			3.67	0.34					1.46	0.03	21
Angiosperm Hardwood			0.4	0.01																	6
Salicaceae Willow family			0.3	0.01			0.26	0.02					1.58	0.02	0.63	P					12
<i>Salix</i> sp. Willow genus													23.0 8	0.45							9
Undet Angiosperm Hardwood			0.4	0.01	0.33	P					0.75	0.01	0.08	P	0.63	P					12

Unidentifiable wood	94.63	0.99	124.46	0.81	112.46	0.77	94.36	0.53	43	0.29	71.25	0.47	531.08	4.1	125.63	0.85	30.5	0.20	72.36	0.4
Total wood	161.13	4.58	137.03	1.4	123.44	0.76	102.44	0.74	47	0.4	80.5	0.79	575.92	6.65	121.88	1.21	31	0.21	90.56	1.29

The site also yielded a diverse wood charcoal assemblage (Table 5). As in other Pend Oreille Valley sites (Stenholm 2000:14.4) ponderosa pine (*Pinus ponderosa*), ubiquity 62% and 21 g total, and lodgepole pine (*Pinus contorta*), ubiquity 50% and 18.9 g total, wood dominated the paleoethnobotanical assemblage. Other wood taxa are primarily gymnosperm species, including hemlock (*Tsuga* sp.), Douglas fir (*Pseudotsuga menziesii*), and whitebark pine (*Pinus albicaulis*) branches, shoots, and cone scales. Willow (*Salix* sp.) was only identified in feature 14 but comprised the most angiosperm wood identified by weight (5.4 g total). Poplar (*Populus* sp.) was also identified within this feature. Trace amounts of other deciduous hardwoods were also noted at the site, including willow family (willow or poplar) and one unidentified angiosperm (see Supplementary Text). Pine family pinecone and lodgepole pinecone fragments were also common across the site, present in 50% and 38% of all samples, respectively.

Our cluster analyses identified several taxa and feature outliers (Supplemental Text, Supplemental Figs 4-6). In the following section, we present paleoethnobotanical results and other site data thematically to understand those outliers. We first discuss taxonomic-specific results including evidence for geophyte processing, the anomalous ubiquity of chenopods, and the presence of pinecones. We discuss additional k-means clustering patterns while examining evidence for earth oven reuse.

Geophytes

Of all the taxa identified, several findings ran counterintuitive to previous interpretations. The original excavators identified and interpreted the site as a camas processing location, and it was inferred that most features were used to roast and prepare camas for long-term storage. Camas, however, was only identified in two features (features 9 and 20). Nodding onion, another a

bulbous geophyte, was also identified in two features (features 14 and 20) (Fig. 4.3). These features also contained willow and willow/poplar wood, and Fisher's exact test indicates that geophytes and wood identified to the willow family are significantly associated at the 0.05 confidence level ($p=0.03$).

Many features also contained several types of pine needles. These needles are likely the remnants of earth oven matting, as have been found in other regional archaeological earth ovens (Lyons et al. 2018b:8, Table 1). All features yielded evidence for the preparation of other foods (additional unidentifiable vegetative tissues and berry seeds). Features 7, 9, and 14 also contained whole and fragmented pinecones (see below).

cf. *Chenopodium atrovirens*

Across all samples, seeds from cf. *Chenopodium atrovirens* (forest goosefoot or pinyon goosefoot, syn. *Chenopodium fremontii* var. *atrovirens*) are the most ubiquitous (67%) and are only absent from one cultural feature (feature 9). Forest goosefoot is native and widespread across western North America, growing in dry montane zones east of the coastal ranges. In our cluster analyses, goosefoot seeds were consistently outliers, driving much of the variation across taxa and features at the site. In feature 8, identified as a midden, goosefoot seeds are quite common with almost 15 seeds/L. In feature 21, identified as an FMR cluster, there are over 20 seeds/L. Both features are dated to within 700-500 years before present. While edible and consumed across North and South America, few western North American ethnographic sources indicate a memory of chenopod seeds or greens consumption. Only the Nez Perce and the Klamath are reported to have consumed goosefoot seeds (Coville 1904, in Hunn et al. 1998; Spinden 1908:205).

Charred *Chenopodium* spp. seeds have been found in domestic, hearth, and earth oven contexts in the Pend Oreille Valley and the greater Plateau (Herbel and Greiser 2008; Herbel et al. 2012; Lepofsky et al. 1996; Lyons et al. 2020; Mossop Cousins 2000; Nicolaides 2010; Stenholm 1985; Wollstonecroft and Baptiste 2016) (Supplemental Table 5). Despite their prevalence, they are generally considered to be incidental environmental inclusions. A review of regional reports, however, indicate that these seeds may have other economic uses. For example,

Fig. 3 SEM composite of geophytes and ubiquitous seeds. A) degraded common camas (*Camassia quamash*) epidermal tissues, B) nodding onion (*Allium cernnum*) epidermal cells, C) goosefoot chenopod (cf. *Chenopodium atrovirens*) seed, D) bearberry seed (*Arctostaphylos uva-ursi*).

at 45OK258 in the nearby Chief Joseph Reservoir a concentration of “popped” *Chenopodium fremontii* seeds was recovered from an archaeological hearth dated to uncalibrated 2763±235 years BP (Stenholm 1985:438). Seed densities between feature 21 and the 45OK258 oven concentration (55 seeds/1.6 L) are comparable. Large quantities of chenopod seeds have also been identified from Late Archaic contexts at numerous Fraser Plateau sites (Lepofsky 2004; Cousins 2000; Wollstonecroft and Baptiste 2016).

Interestingly, *Chenopodium* spp. seeds are also quite common in the Late Holocene Californian paleoethnobotanical record. Although the California archaeological record is known for its focus on acorns (*Quercus* spp.), *Chenopodium* spp. is the second most common taxon (Wohlegmuth and Bruno 2017). It appears that chenopod seed production was intensified over the last 2,000 years within California’s Santa Clara and Sacramento valleys as people harvested seeds in response to a dearth of other nut-crop plant food options (Wohlgemuth and Bruno 2017). Although the data is inconclusive as to whether Californian chenopods were domesticated, current evidence indicates this species played an important role across subsistence economies.

Several chenopod food species were, however, domesticated both in the Andes in South America and eastern North America (Fritz et al. 2017). Chenopod research looks at seed attributes such as testa thickness, seed diameter, and seed coat texture to identify previously undocumented species and varieties with past economic importance (Smith and Funk 1985) and we suggest researchers across western North America further prioritize taxonomic identifications and systematic examination of these morphologic feature

s. Regardless, we argue their presence across the Columbia-Fraser Plateau as well as at 45PO422, with concentrations in features 8 and 21, indicate that the seeds of these *Chenopodium* spp. plants must have had some economic use.

Bearberry

Bearberry or kinnikinnick (*Arctostaphylos uva-ursi*) is the second most common taxa across the site, with a ubiquity value of 62% (Fig. 3d). These berries are quite common in other earth oven assemblages across the valley (Herbel et al. 2012:117; Stenholm 2000). Their presence makes identifying a season of use for most features difficult as the mealy berries ripen late and may stay on branches through winter (Parish et al. 1996:85), though berries were ethnographically collected in fall (Smith 1936-1938). In the ethnographic past, bearberry leaves were commonly used for tobacco (Turner 2007:111) and on the Plains were used in seasoning or flavoring meat (Hellsen and Gadd 1974). Bearberry is also an outlier in our cluster analyses (Supp. Fig. 2).

Fig. 4 Edible seeds. A) ponderosa pine (*Pinus ponderosa*), B) bearberry (*Arctostaphylos uva-ursi*), C) hawthorn (cf. *Crataegus* sp.), D) huckleberry (*Vaccinium* sp.), E) vetch (*Vicia americana*).

Pine seeds

Pinecones and pinecone fragments feature prominently across the site with a ubiquity value of 50%. Features 7 and 14 both contained whole, female lodgepole pinecones, and both features contained quantities of lodgepole pinecone scale fragments. In feature 7, one ponderosa pine seed was recovered as well as several small cf. *Pinus albicaulis* (whitebark pine) cone scales and buds. Almost all the other features at the site also contained Pinaceae cone fragments.

Ethnographic summaries (Hunn et al. 1998; Turner 2014a) indicate the pine seeds of whitebark pine were commonly consumed as a snack, though a closer read of ethnographic works indicate whitebark, ponderosa, and western white pine (*Pinus monticola*) seeds were valued as supplemental foods and collected at the same time as huckleberries (Post 1938:27; Ross 2011:343; Smith 1936-1938; Teit 1900:233, 1928:118).

Lodgepole pinecones and cone scale fragments were the most ubiquitous species identified at the site. The regional variety of lodgepole pines (*Ponderosa contorta* var. *latifolia*), however, produce very small seeds; it would take hundreds of these cones to produce a substantial amount of food. Lodgepole pinecones are serotonous and are glued shut with resin. These resinous bonds begin to break between 45-60 °C but must be heated to 200-250 °C before they fully open and release the seeds (Anderson 2003). Given these fire-related adaptations, we suspect lodgepole pinecones may have survived conflagration and be over-represented in this assemblage. Many other cone fragments that could only be identified to the pine family, and these fragments may belong to other species. Furthermore, while contemporary stands of whitebark pine only grow in infrequent clusters in the nearby Selkirk and Purcell Ranges (Parish et al. 1996:36), it was likely much more common within the region in the past before contemporary deforestation practices and global warming (Wilson et al. 2010).

Pine seeds (nuts) were considered staples across the Great Basin and California cultural and geographic areas (Farris 1982). In upland zones of the Great Basin, green cones were harvested in summer months, cached, and roasted over open fires to melt the resin and force scales of the premature cones to open (Eerkens et al. 2013; Hildebrandt and Ruby 2006). Anderson (2005:280) notes that across parts of California, pine nuts could also be steamed in earth ovens. In these cases, green cone pine seed consumption is a back-loaded provisioning strategy: the seeds are easy to procure and store, and although ultimately take a great deal of time to prepare for consumption, processing can be delayed after storage (Tushingham and Bettinger 2013). To our knowledge, the only ethnographic description of Plateau pine nut roasting indicates cones were collected and immediately processed in a dry-heated earth oven (Post 1938:27). Building on those examples and our findings, we suggest that Plateau people alternated between two strategies: processing pinecones immediately and delayed processing. It is possible to harvest green ponderosa pinecones and the fused cones of lodgepole and whitebark pine and either store those cones for future use or process immediately. Pinecone processing too can happen in several ways; they may have had their own ovens, added to other steaming or baking events, or simply roasted in ovens or features previously used for other food preparation (Table 1). At this time, we do not have the seasonality resolution to determine whether archaeological cones were stored first or processed immediately (Table 6).

Pinecone scales, fragments, and seeds are common components in Pend Oreille Valley earth oven analyses from the last ca. 3,500 years (Herbel et al. 2012:117; Mastrogiuseppe 2008; Miss 2005:H17; Stenholm 2000; Willis 2011:D.11) and in Late Period sites on the Canadian Fraser Plateau (Lepofsky 2004:429; Lyons et al. 2020:189; Stryd 1972:23; Wollstonecroft and Baptiste 2016:145) and sites within the Chief Joseph Reservoir stretch of the Columbia River

(Stenholm 1985). Given their presence in hearths and ovens within the valley and throughout the region, we see the presence of lodgepole pinecones, whitebark pine buds and cone scales, and the ponderosa pine seed as evidence that people were using these features to roast or steam pine nuts in the past.

Evidence for Feature Reuse

Several authors (Black and Thoms 2014:210; Custer 2017; Knapp 2015; Neubauer 2018:697) suggest that people may have reused and returned to ovens over years or decades. The paleoethnobotanical contents of 45PO422 do not conform to ethnographic “recipes” although some features, including features 4, 9, and 21, yielded sparse paleoethnobotanical remains and may accurately reflect the contents of their last use. Other ovens show several signs that these features were frequently reused, including feature descriptions and dimensions, fire-modified rock quantity and size, and species representation (Table 6). To test these observations, we compared the 45PO422 feature data to the archaeological expectations outlined in Table 1.

Putting the mineralogical and chemical properties of available lithologic material aside, many FMR experimental archaeological studies suggest that cooking stones fracture at regular rates and can be used as a proxy for intensity of feature or landform use (Custer 2017; Graesch, et al. 2014; Neubauer 2018). Here we draw on that work and employ a FMR pebble to cobble ratio to estimate cooking stone recycling or reuse (Tables 1 and 2). We assume that cobble-sized stones were preferentially used in food preparation features (Graesch et al. 2014) and that fractured pebble-sized FMR are the result of longer or more intensive cooking stone use (Neubauer 2018:686). Features 4 and 9 contained relatively light FMR distributions (<10 kg) and

had low FMR ratios (<0.1). Features 6, 7, 18, and 20 also yielded FMR and charcoal scattered across the paleosurface adjacent to the features and were likely cleaned out (Fig. 5).

Table 6 Abundant taxa, environmental taxa, and suggested season(s) of use. See Tables 3-5 for taxa Latin names.

Feature	F4	F7	F18	F20	F6	F19	F14	F9	F21	F8
Economic taxa	bulb tissue	chenopods , ponderosa pine nut, lodgepole pinecones, huckleberry, bulb and fruit tissue	lodgepole pinecones	camas, nodding onion, bearberry, chokecherry	hawthorn, bearberry, pinecone fragments	Chenopods , amaranth, bearberry	nodding onion, lodgepole pinecones, bearberry	Camas, bearberry	chenopods , amaranth, vegetative tissue	Chenopods , bearberry, vetch
Abundant wood	ponderosa pine, lodgepole pine	lodgepole and ponderosa pine, willow	lodgepole pine, ponderosa pine	ponderosa & lodgepole pine, douglas fir, willow/poplar	lodgepole pine, ponderosa pine	fir /hemlock, lodgepole pine	lodgepole pine, ponderosa pine, willow, fir/spruce, poplar	lodgepole pine, hemlock, willow/poplar	N/A	lodgepole pine, ponderosa pine, trace amounts of other conifers
Possible environmental inclusions	waterweed / frogbit (aquatic habitats)	buttercup (meadow)	N/A	dock (meadow)	sedge, knotweed (marshes)	sandwort (moist, shady, mountain forests)	sedge, wild buckwheat (meadow)	N/A	sandwort (moist, shady, mountain forests)	waterweed/frogbit (aquatic habitats)
Possible season(s) of use	Mid-summer, year-round	Mid-summer to early fall	late summer to fall	Mid-summer, late summer, year-round	late summer, year-round	summer, year-round	late spring to early summer, late summer, year-round	Mid-summer, year-round	summer	Mid-summer, year-round
Cal date BP	2742-2313	2720-2152	1518-1301	1296-830	1287-1069	1059-788	908-671	731-554	730-558	656-526

We further estimated the amount of time needed to excavate the ovens and source cooking stones and calculated that most ovens at 45PO422 would take only a couple hours at most to construct (Table 7). Feature 14 is the only exception to this pattern, suggesting that the largest oven features (possibly used to process geophytes and other taxa) would have taken several days to construct initially. Carrying stones to the site appears to have been the most time and labor-intensive part of the process and thus explains the high degree of cooking stone reuse at the site. As the site sits at the glacial terrace margin and foothills of the Selkirk range, we assume wood fuel would have been abundantly and locally available.

Furthermore, several taxa may be overrepresented in the paleoethnobotanical assemblage. Seeds with thicker or harder seed coats and other vegetative plant organs with lignin will be better suited to preserve in the archaeological record. Bearberry seeds are harder than other Northwest native plant seeds and this property may explain their disproportionately high numbers. Similarly, lodgepole pinecones are fire-resistant and may also have preferentially preserved. It is possible that these macrobotanicals fell through and remained part of the total assemblage during periods of reuse.

Even determining the last season of use for the ovens, midden, and FMR cluster proved difficult. Paleoethnobotanical analyses of foraging groups frequently seek to understand seasonality by identifying annual plant remains, yet many of the features at 45PO422 included conflicting seasonal indicators (Table 5). For example, feature 20 contains a whole nodding onion bulb, which was ethnographically processed in the spring (Turner 2007:61), and camas leaflets, which were typically processed in early summer (Turner 2007:67). The onion bulb and camas leaflets appear to have been fresh when they were charred (cf. Carney and d'Alpoim

Fig. 5 Plan and profile views of features 6 and 18, including distribution of “cleanout” charcoal and FMR. Feature 6 was cut into feature 18. Dotted line indicates excavator estimation of indeterminate feature 18 dimensions.

Table 7 Archaeological energetics calculations for each feature. Volume estimated from the dimensions listed by original excavations (Gough 1997) and time calculated using Abrahm's (1994) ethnographic observations for moving earth and stone. Features 8 and 21 are excluded as they were partially excavated and do not have full dimensions available.

	F4	F7	F18	F20 basin	F20 pit	F6	F19	F14	F9
Feature volume (m ³)	0.32	1.36	0.48	0.3	.08	0.64	0.86	3.19	0.16
Excavation time (hrs)	0.61	2.61	0.92	0.58	0.15	1.23	1.66	6.14	0.3
FMR weight (kg)	5.2	44.5	57.9	23.5	4.5	47.2	38.2	513.3	8.1
FMR collection (hrs)	0.01	0.11	0.15	0.06	.01	0.12	0.1	0.34	0.02
Distance to cobbles (km)	2	2	2	2	2	2	2	2	2
Number of trips (n)	1	2	3	2	1	3	2	24	1
Unloaded carrying time (hrs)	0.4	0.8	1.2	0.8	0.4	1.2	0.8	9.6	0.4
Loaded carrying time (hrs)	0.66	1.32	1.98	1.32	0.66	1.98	1.32	15.84	0.66
Total time (hrs)	1.68	4.84	4.25	2.77	1.22	4.53	3.88	31.89	1.38
Total person-days (5 hrs/day)	<1	<1	<1	<1	<1	<1	<1	6.38	<1

Guedes 2021). Both bulbs are usually considered front-loaded resources (cf. Tushingham and Bettinger 2013) in that they must be processed before they are storedⁱⁱⁱ. This oven also contains dock and chokecherry, which are late summer to early fall seasonal indicators (Parish et al. 1996:58). Likewise, features 7 and 14 are the richest features with the highest number of taxa present and were marked as outliers in our cluster analyses (see also Table 1 reuse expectations). Their diverse contents include taxa such as camas and onion bulbs, as well as fruit tissue, a buttercup seed, sedge seeds, and pinecones, all of which ripen at different times of the year. Pinecones could be stored before they are prepared by roasting or steaming (Farris 1982), and the environmental inclusions from seed rain (Minnis 1981) also indicate various seasons of use.

We suggest the evidence for repeated taxa preparation within oven features, evidence for cross-seasonal indicators, evidence features were cleaned, and recycled cooking stones indicate

that many of the 45PO422 features were reused at least once, if not multiple times, over their life histories (Tables 1 and 5). As we were working with a legacy collection and archived soil samples, we were unable to assign an exact food preparation type these oven features; they may be closed ovens, steaming ovens, or may even have been repurposed over their use-lives (Table 1). Four features do not neatly fit this pattern, however; feature 8 appears to be a midden accumulation, earth oven features 4 and 9 appear to have been thoroughly cleaned out, and we suggest feature 21, the FMR concentration, is the only *in-situ* hearth at the site.

Reiterations of Earth Ovens, Midden, and Food Processing

How might the previous results and archaeological palimpsests be interpreted from a biographical approach and palimpsest perspective? In the following section, we reconstruct the feature biographies or life-histories by comparing the 45PO422 data to Thoms' (2008) ethnographic and archaeological expectations for Columbia-Fraser Plateau cooking features. We specifically focus on the relational elements of these features to trace the ways food preparation processes and their constituent parts leads us to new conclusions.

We begin our 45PO422 relational and narrative feature biographies with their initial construction (Figure 6). The 45PO422 earth ovens were first shallowly excavated (10-30 cm) into the earth. People then carried cobblestone the site, a practice which would have taken the most time of the entire process (Table 7). These rocks, most likely gathered from Pend Oreille River fluvial deposits, were variously covered with pine and other coniferous wood species fuel, though in the case of the geophyte-processing ovens, willow and poplar were selected. Rocks were heated and covered with vegetation such as pine needle matting. Plant and animal foods were gathered, harvested, or caught, and were then placed upon the heated rocks,

Fig. 6 An example of the iterative food preparation process, using a closed earth oven as an example. Grey lines indicate potential pathways related to different foods, all of which would have contributed to the complicated feature biographies and archaeological palimpsests. Not all features would have had similar pathways. Figure by Kathryn Killackey.

covered with soil and allowed to cook. The association of food and fuel might be considered a past recipe. Although these recipes were difficult to discern from the paleoethnobotanical assemblage, wood from the willow family is significantly associated with nodding onion remains in features 9, 14, and 20; we can conclude that these associations had relevance in past bulb processing as they continue to do today.

After several hours to days, the ovens were uncovered, and food was removed. Food was either consumed or further prepared and stored for future use and was then moved into new and different associations and places. At some point many ovens were cleaned (most notably features 4 and 9); this included removal of ash, extraneous wood charcoal, and even used cooking stones were pulled from ovens in preparation for future cooking events. Some paleoethnobotanical remains, however, likely escaped these processes, creating the cumulative palimpsests of food processing events that characterize the site. Although we cannot tease apart specific events (Lucas 2008), we can infer most features were likely reused some number of times (features 6 and 7) to intensive repetitive reuse (features 7, 14, and 20), despite a relatively minimal construction effort (Table 7). Thus, the 45PO422 assemblage was iteratively created through repeated cooking feature use and reuse.

The spatial configuration of features across the site also supports interpretations of earth oven reuse. The older (2753-2152 cal BP) features (4, 7, and 18) are located on the eastern and upslope portion of the site, while all but features 6 and 21 of the more recent features (1296-526 cal BP) are downslope and to the west (Gough 1997:47). As people and generations returned to familiar places year after year, they intentionally favored specific cooking basins (cf. Nebaur 2018:697). These reuse episodes reworked and inscribed paleoethnobotanical and FMR remains into the palimpsests encountered in the present. Pend Oreille Valley earth ovens might even be

considered as persistent places, where people and plants came together to create a nexus for food processing activities and community gatherings. Even the communities which used these in-ground food preparation features could be considered part of the overall biography, a medley of people and plants, repeatedly coming together within remembered places to share spaces and food (cf. Jervis 2019:59).

Again, not all of the 45PO422 features can be interpreted as ovens. Two minimally sampled features, feature 8 and 21, were interpreted in 1996 as a midden and FMR cluster, respectively. These two features contained the highest quantities of goosefoot chenopod seeds and appear to have had different histories than the ovens previously discussed. The 13 cm thick organic rich lens of feature 8 contained four coniferous wood species and a hodgepodge of other economic and environmental plant taxa. This feature was not excavated (Gough 1997:33), and little was recorded of the organic-rich stratum. It remains a cumulative palimpsest in our interpretations. Feature 21 was encountered during shovel testing and described as an FMR cluster, though again, few dimensions or other descriptors exist for the feature. While this cluster contained significant quantities of goosefoot chenopod seeds and some bulb tissue, it yielded the lightest wood charcoal assemblage. It was, however, the only feature that contained clear evidence of its season of use (midsummer, Table 5). These two cases demonstrate that it is sometimes impossible to fully trace the relations and histories of legacy collections.

All features were at some point abandoned, creating the archaeological palimpsests the 1996 excavators encountered. The paleoethnobotanical, geoarchaeological, and artifactual data was subject to soil formation processes and turbation. Thus, the material remains of past cooking events became reworked into an archaeological assemblage. In 1996, archaeologists further deconstructed the features through excavation, pulling them apart and recording the deposits as

they encountered them. Soil samples were collected and stored for 20 years where they remained untouched. Finally, the bulk soil samples were returned to the Kalispel Tribe, where we began the process of re-assembling their former relationships and histories.

45PO422 within Late Period Subsistence Choices

While biographies and palimpsests are useful heuristics in working through earth oven minutiae, they can also be used in situating the 45PO422 site within regional contexts. Across the Columbia-Fraser Plateau, it is widely assumed that changes in taxonomic richness are often linked to resource intensification or depression (Butler and Campbell 2004; Solimano and Gilmour 2014). In these diet breadth intensification models, it is assumed that as one resource becomes more important, other resources become relatively less important and may drop out of diets. The Pend Oreille Valley is frequently cited in discussions of Columbia-Fraser Plateau plant food intensification (Ames 2005; Thoms 1989, 2009). Thoms (1989:184) specifically hypothesizes that bulk camas processing, as measured by an increased use of large earth ovens and storage facilities, should be correlated with intensifying plant food production. The 45PO422 features, however, only contain macrobotanical evidence for camas processing within two ovens. Other identified taxa and feature analyses provide strong evidence for a wide range of food taxa preparation. Of course, camas may have been processed in more than just two features and no traces or residues of those activities remain; their components could have been removed or overwritten through human activity and taphonomy. Nevertheless, we see strong evidence for intentional subsistence decisions targeting numerous floral and faunal species and adapting their food preparation processes to accommodate those diverse food choices.

At the nearby Calispell Valley Archaeological Project oven complex (Andrefsky et al. 2000; Stenholm 2000), which did contain substantial macrobotanical evidence of camas preparation, many earth oven features dating to the same time periods *also* contained multiple geophyte taxa (camas, glacier lily, unidentified rhizomes), at least six berry taxa, the ubiquitous bearberry seeds, ponderosa pine seeds, and pinecones. Although most ovens were interpreted as camas ovens, we also see the paleoethnobotanical, geoarchaeological, and artifactual evidence from these cooking features as palimpsests with individual histories. The seed rain further indicates that majority of these features also appear to be reused (Stenholm 2000:14.66). Moreover, while Thoms (1989) sees peaks and nadirs in the number of Pend Oreille Valley earth ovens as evidence for population packing and camas plant food intensification, we urge caution in assigning causality given the diverse range of foods prepared and the sheer challenge of identifying the number of times these features may have been usedⁱⁱⁱ. We agree with Morgan (2015:197) in that intensification is a multidimensional process and that there were likely multiple pathways to increasing economic output for Columbia-Fraser Plateau economies. Perhaps subsistence diversity, flexible scheduling of bulk food processing, and food webs were played with in the past as a means of reducing risk and feeding people. Perhaps, as Lepofsky and Peacock have suggested (in Turner 2014), that larger earth ovens are simply the product of heavy reuse rather than overwintering provisioning or intensification decisions. As Plateau archaeologists and anthropologists continue to generate nutritional data for heat-prepared foods, food processing costs, and storage estimates for the most commonly consumed plant species (cf. Fulkerson and Tushingham 2021), we suggest these hypotheses be re-visited in the future.

Furthermore, throughout the greater Northwest region there is an increasing acknowledgment of food diversity as a risk reduction strategy across mid to late Holocene

subsistence economies. Archaeologists now recognize that a diverse suite of food resources, rather than one or two keystone resources, fueled economic and social practices (Deur and Turner 2005; McKechnie and Moss 2016; Trosper 2003). Other Columbia-Fraser Plateau archaeological studies (which primarily focus on aquatic or faunal food taxa) similarly do not see evidence for a restriction or specialization of diets, but instead report evidence for an increase in taxa diversity during the last 3,500 years (Butler and Campbell 2004; Solimano and Gilmour 2014:138-139). Although the 45PO422 features are limited to the last 2,700 years, the paleoethnobotanical analysis presented here indicates people were processing at least two different geophyte resources, four different types of berries, and two to three pine nut species. Comparisons with 41 other Northern Plateau paleoethnobotanical datasets also indicate consumption of various cultural keystone geophytes including biscuitroot (*Lomatium* spp.), cluster lily (*Brodiaea* spp.), onion (*Allium* spp.), and camas (*Camassia* spp.), nuts such as pine (*Pinus* spp.) and hazelnut (*Corylus cornuta*), as well a minimum of 12 berry taxa (Supplemental Table 5).

Chenopods or goosefoot seeds (*Chenopodium* spp.) are also quite common in Plateau sites. These seeds are present in 15 of the 41 Northern Plateau sites, the majority of which date to the last ca. 1,000 years (Supp. Table 5). We suggest that these plants also played some role in past human lifeways, and like in California, may have been consumed and increasingly targeted during the most recent millennia in drier, inland locations (Wohlgemuth and Bruno 2017). Indeed, the 45PO422 and other Plateau datasets show we should revisit regional biases that prioritize subsistence staples; emphasis on camas in the Plateau or pine nuts in the Great Basin may obscure diversity in past diets. A biographical approach thinking encourages us to consider all these plant taxa as important and trace the relations between people, plants, their

technologies, and their actions. By foregrounding species in the plural, archaeologists are better situated to understand the full breadth of past subsistence practices.

Future Field and Analytical Protocols

Our experience working with legacy collections clarified important limitations and considerations for interpreting food preparation features using palimpsest and biographical approaches. We offer several recommendations that might help guide future fieldwork and research. Excavators should be intimately familiar with their regional ethnographic and archaeological cooking feature correlates, drawing on and expanding Table 1 for their own places and periods prior to implementing their field studies. In this vein, ideally field approaches will allow for adequate excavation of features (i.e., exposures sufficient to determine the nature of earth ovens, field collection of flotation and other critical samples etc.) and prioritize observations by those with expertise in archaeological methods and in traditional gathering, hunting, and cooking. We argue that allowing for adequate time and budget for radiocarbon dating, flotation and specialized analyses of artifact and dietary residue assemblages (archaeobotanical, zooarchaeological, etc.) are necessary to generate a holistic picture of past subsistence decisions. We further suggest that when budgets allow, project investigators pursue techniques such as residue analysis to confirm or expand upon taxa consumed, profile thin sections to determine degree of reuse, and potentially even ZooMS taxa identifications for fragmented faunal material. Even FMR, the most ubiquitous remains in many North American archaeological assemblages, can quickly and easily yield information if archaeologists identify material type, take diameter measurements, and estimate roundness or sphericity as a description

of fragmentation. Without thoughtful consideration of past and existing multidimensional food preparation pathways, archaeological interpretations will remain limited in scope.

Conclusion

Through this analysis, we demonstrate that the earth ovens and cooking features of 45PO422 functioned in several ways to prepare a diverse suite of foods and other economically useful plants. Through our biographical approach to earth ovens as palimpsests, we illustrate the site functioned to process at least two geophyte species and many other berry food products, expanding on the site's original interpretation. We also suggest the earth oven features were used to process pine nuts from at least two and possibly three locally available pine species. Pine nut consumption is occasionally mentioned within original ethnographic texts and within cultural resource management reports, we suggest the evidence at 45PO422 extends this provisioning practice over 2,000 years into the past. We further suggest that the frequent occurrence of goosefoot seeds at 45PO422 and beyond indicate this seed was likely consumed. While we do not see any evidence of plant food intensification at this time, we illustrate that a variety of resources were processed in Pend Oreille Valley food preparation features. These insights provide the Kalispel Tribe with a new understanding of their history of food selection and will be incorporated into future conservation and food security decisions.

As we conclude this study, we see several potential scientific spin-offs from this paper:

1. How many other geophyte or “root” species were consumed in the past, and does the focus on consuming multiple species extend farther back in time beyond ca. 3000 BP?

This question requires that paleoethnobotanists identify the charred vegetative tissues at sites by close comparison with modern bulbs, corms, rhizomes, tubers, and tuberous

roots. Microbotanical analyses, including phytoliths and starches, should also be pursued in fleshing out answers to this question. Once we have a better grasp on what plant foods were consumed in the past, we can begin to investigate changes in diet breadth, plant food production and management, storage, and if these provisioning decisions influenced other economic and social practices.

2. Were goosefoot or chenopod seeds widely consumed in the Plateau past? What specific species used and when? To answer these questions, we suggest paleoethnobotanists revisit archived collections and confirm species identifications of *Chenopodium* spp., compare contextual information, and look to the many decades of chenopod research from Eastern North America, the Andes, and California in elucidating the economic history of goosefoot seeds in the Plateau.
3. Finally, how prominent were pine nuts in precontact diets? Were they just a snack, as ethnographic notes indicate, or were they a more regular part of past menus? If pine nuts did constitute a larger part of past diets, were they immediately processed upon harvest or were they stored before being consumed when needed? How much effort does a pinecone harvest require, what are the seasonal scheduling requirements for green and seritinous cones, and what are the kcal return rates for all Northwest edible pine seed species? Additional experimental work is sorely needed for these pine seeds questions.

Answers to these questions would not only help us better understand the Plateau's history of plant food preparation and consumption but have wider-reaching implications. *Chenopodium* spp. seeds have a long and varied history of consumption and domestication throughout the globe (Fritz 2017; Mueller-Bieniek et al. 2018). Pine nuts and green cone processing are

considered staples of Great Basin diets (Eerkens et al. 2013; Hildebrandt and Ruby 2006). Bulbs and other geophytes are only just regularly entering larger western North American subsistence discussions, as they are challenging to identify in paleoethnobotanical assemblages (Gill 2014). More than half of the 45PO422 features were reused, while food preparation features in other parts of western North America appear to have been single-use events (Black and Thoms 2014:212; Schaefer et al. 2014). In this situation, where we re-analyzed a legacy paleoethnobotanical collection, palimpsests and assemblage thinking were a powerful means of teasing apart the diverse yet difficult-to-quantify datasets. Our fine-grained analysis of cooking features of 45PO422 and food preparation practices of the Plateau thus have relevance not only to descendent communities and regional archaeological discourse but might help global understandings of forager food selection and subsistence flexibility. Feature biographies and palimpsests therefore offer a fresh perspective on mapping the complex processes that result from past human behaviors, the intervening taphonomic processes, and even archaeological excavation and interpretation itself.

Compliance with Ethical Standards

This project was approved by the Kalispel Tribe's research review process. All notes, artifacts, and samples from the project are curated at the Tribe's curational facility in Usk, Washington State, USA. The authors declare no competing interests.

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ⁱ More specifically, assemblage theory.

ⁱⁱ Although Fulkerson and Tushingham (2021) suggest camas may be dried and cached before processing and hydrolyzing the complex carbohydrates, thereby averting some of the initial processing labor.

ⁱⁱⁱ A systemic radiocarbon dating regime paired with soil micromorphology and the above analyses may grant closer spatiotemporal control for these features.