MARINE MAMMALS BEFORE EXTIRPATION: USING ARCHAEOLOGY TO UNDERSTAND NATIVE AMERICAN USE OF SEA OTTERS AND WHALES IN OREGON PRIOR TO EUROPEAN CONTACT

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DISSERTATION ABSTRACT

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Doctor of Philosophy

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Title: Marine Mammals before Extirpation: Using Archaeology to Understand Native American Use of Sea Otters and Whales in Oregon prior to European Contact

Tribal ancestors living on the Oregon coast prior to European contact were skilled fisher-hunter-gatherers residing in a rich environment, home to diverse marine mammals. Euro-Americans over-exploited these marine mammals and drove some species to near extinction. Some marine mammal populations rebounded while others, such as the locally extinct Oregon sea otter, never recovered. Threats from hunting are past, but marine mammals on the Northwest Coast today face new challenges, and sea otters and cetaceans are foci of conservation efforts. Despite the interest these taxa enjoy in the present, little systematic study of their use by and relationship with precontact peoples in Oregon has occurred, and this dissertation addresses these gaps in knowledge.

To address ancestral tribal use of sea otters and cetaceans I researched previously excavated faunal assemblages. The Par-Tee (35CLT20) and Palmrose (35CLT47) sites located in Seaside, on the northern Oregon coast, were home to the Clatsop and Tillamook at contact. Par-Tee and Palmrose were occupied at different times in the Late Holocene (~1850-1150 cal BP and ~2750-1500 cal BP, respectively). The two sites were excavated in the 1960s-1970s and contained an enormous quantity of well-preserved faunal remains. The Tahkenitch Landing (35DO130) site is located on the central Oregon coast, north of Reedsport, and was home to the Lower Umpqua Indians at contact. Tahkenitch Landing was occupied from the early to mid-Holocene (approximately 5000-

3000 BP) and contained a large quantity of whale bones which were previously analyzed, but not identified to species level.

I conducted zooarchaeological analysis of the sea otters from Par-Tee and Palmrose (NISP=2992) and cetaceans from Palmrose (N=1174) and Tahkenitch Landing (N=33). With my co-authors, I analyzed ancient DNA from 20 Seaside sea otter specimens and performed Zooarchaeology by Mass Spectrometry (ZooMS) and ancient DNA identifications of 158 cetacean specimens. These analyses provided new insight regarding precontact ancestral tribal use of sea otters and cetaceans and the historical ecologies of the animals. This dissertation provides a socio-ecological dataset with implications for potential reintroductions of sea otters and the conservation of cetaceans in Oregon today.

This dissertation includes previously published and unpublished co-authored material.

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To my friends and family, especially my grandmother,
Alice N. Wellman,
the original family archaeologist,
and in honor of Dave Hatch and the Oregon Elakha.

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CHAPTER I

INTRODUCTION

1.1 Background

Tribal ancestors living on the Oregon coast prior to European contact were skilled fisher-hunter-gatherers and savvy traders residing in a rich environment. The Oregon coast ecotone is home to diverse marine mammals – sea otters, seals, sea lions, porpoises, and whales – as well as other marine and terrestrial resources. Over time, Euro-Americans over-exploited these marine mammals and drove some species close to extinction, while inflicting disease, violence, and displacement upon Indigenous communities. Some marine mammal populations rebounded under state and federal laws, while others, such as the locally extinct Oregon sea otter, never recovered. Threats from Euro-American industrial-scale hunting in the U.S. are now over, but marine mammals living along the Northwest Coast today face new challenges, such as climate change, pollution, resource conflicts, and human-mediated disruptions, such as ship strikes. Sea otters and cetaceans are the foci of conservation efforts and concerns, and are also popular and charismatic fauna. While these taxa enjoy both general and academic interest in the present, little systematic study of these taxa and their use by, and relationship with, precontact peoples in Oregon has occurred. Tribal ancestors living on the Oregon coast prior to contact hunted or otherwise acquired sea otters and cetaceans and deposited the remains of these animals into middens and other archaeological features, but these remains are often overlooked and much remains to be analyzed.

The first two objectives of this dissertation are to fully characterize how Oregon Coast Native Americans used sea otters and cetaceans prior to Euro-American contact, addressing longstanding assumptions regarding use of these species. Addressing ancestral tribal use of these species requires understanding the biological and ecological traits of the animals themselves, which comprises the third objective: to form a historical ecological dataset on the sea otter and cetacean species which can be applied to present-day conservation concerns.

1.2 Dissertation Outline

This dissertation uses faunal remains from archaeological sites in Oregon to address how tribal ancestors used marine mammals (specifically cetaceans and the now-extirpated Oregon sea otter) prior to European contact, and gain insight on species' historical ecologies prior to Euro-American depletion and extirpation.

Chapter II of this dissertation addresses whether tribal ancestors were skinning sea otters to remove their pelts, to remove meat for dietary consumption, or both. Researchers have assumed that tribal ancestors skinned sea otters to obtain pelts based on the importance of the fur trade at contact, but other uses have not been critically evaluated. This chapter explores other purposes for which tribal ancestors might have used sea otters and describes possible dimensions to the human-animal relationship that may have been maintained between tribal ancestors and sea otters in their shared coastal environment. Precontact ancestral tribal use of, and socio-ecological relationships with, sea otters, have implications for potential future sea otter reintroductions which are currently undergoing a feasibility study led by the Elakha Alliance (a group pursuing the reintroduction of sea otters to Oregon).

Chapter III addresses the Oregon sea otter's historical ecology through an ancient DNA analysis of extirpated Oregon sea otters and their relatedness to other groups of extant sea otters elsewhere in the north Pacific. The results of Chapter III have implications for reintroduction efforts, particularly with regards to the source stock for possible relocations of sea otters to Oregon, and these results have already been disseminated to the Elakha Alliance. Chapter III includes previously published co-authored material with Rita M. Austin, Nihan D. Dağtaş, Madonna L. Moss, Torben C. Rick, and Courtney A. Hofman.

Chapter IV shifts from sea otters to a much larger class of marine mammal: cetaceans (dolphins, porpoises, and whales). Indigenous groups south of the Makah tribe (in Washington state) on the Northwest Coast are typically categorized as non-whaling groups by anthropologists and historians, despite the presence of whale remains in archaeological sites in Oregon and California. As a result, ancestral tribal use of cetaceans has generally received more attention north of Oregon at archaeological sites like Ozette (a Makah site) and ancestral Nuu-chah-nulth sites in British Columbia. Researchers have investigated whether tribal ancestors in northern Oregon were hunting or scavenging whales (Losey and Yang 2007; Sanchez 2014; Wellman et al. 2017), but discussion of cetacean use has been limited to mention of oil extraction for trade and consumption (Wellman et al. 2017:272) and other uses have not been systematically evaluated. This chapter moves beyond the focus on how Indigenous peoples living on the Oregon coast acquired whales, and instead seeks to fully characterize how residents of three different archaeological sites used cetaceans, as well as explore possible dimensions to precontact human-whale relationships. Chapter IV also provides a new, expanded dataset on the presence of cetacean species on the central and northern Oregon coasts during the Middle and Late Holocene, which may interest wildlife biologists working on cetacean conservation on the Northwest Coast. Chapter IV includes unpublished material with co-author Camilla Speller.

1.3 Research Programs: Human-Animal Studies and Historical Ecology

In order to address the topics and questions described above, I draw from the research programs of human-animal studies and historical ecology. Human-animal studies seek to understand how humans and animals have interacted and related across temporal, social, cultural, and ecological contexts (Hill 2013; Mullin 2002). Human-animal studies draw from a wide variety of research methods and approaches, and in the case of archaeological applications, often rely heavily upon Traditional Ecological Knowledge or ethnographic analogy.

Historical ecology seeks to describe the relationships between humans and their environments across temporal and spatial contexts (Balée 2006:75). Historical ecology is a descriptive approach that is necessary to create datasets from which to infer the human-animal relationships. In zooarchaeology, historical ecology is also sometimes used to refer to the ecological history of a specific species or family in the past, particularly when the species or community/population of interest is extinct or locally extirpated. Zooarchaeologists have emphasized the relevance of using zooarchaeological analyses to provide baseline biological and ecological data on such species, which can then be applied to modern conservation efforts (Lyman 2006).

Both of these approaches are readily applied in archaeological thought and analyses. Together they form an appropriate research program and framework with which to address: 1) questions of ancestral tribal use of marine mammals prior to Euro-American contact, and 2) the implications the resulting data may have for the animals themselves in terms of conservation and changes in their ecology and/or biology as a result of near-extirpation by Euro-American colonizers.

1.4 Archaeological Sites and Materials

1.4.1. Par-Tee and Palmrose (the "Seaside sites")

The majority of sea otters and cetaceans analyzed in this dissertation come from the "Seaside Collection," comprised of materials from three coastal shell midden sites excavated between 1967 and 1977 at Seaside, Oregon (Phebus and Drucker 1979): Par-Tee (35CLT20), Palmrose (35CLT47), and Avenue Q (35CLT46). Par-Tee and Palmrose are the focus of this dissertation project, and are located in northern Oregon, roughly 15 miles south of the mouth of the Columbia River (Figure 1.1). What is now the town of Seaside formerly contained an ancient bay or estuary, which later filled to form the landscape present today (Connolly 1992, 1995; Phebus and Drucker 1979). Par-Tee is located closest to the shoreline and has undergone additional AMS dating which has refined the site occupation to 1850-1150 cal BP (or cal AD ~100-800; Sanchez et al. 2018). Palmrose is located slightly inland, closer to the proposed ancient quiet-water environment (Connolly 1995) and was occupied primarily 2750-1500 cal BP (Connolly 1992), although an early date of 4000 cal BP associated with whale bone may suggest early "intermittent and opportunistic" use of the Palmrose site (Connolly 1992:39).

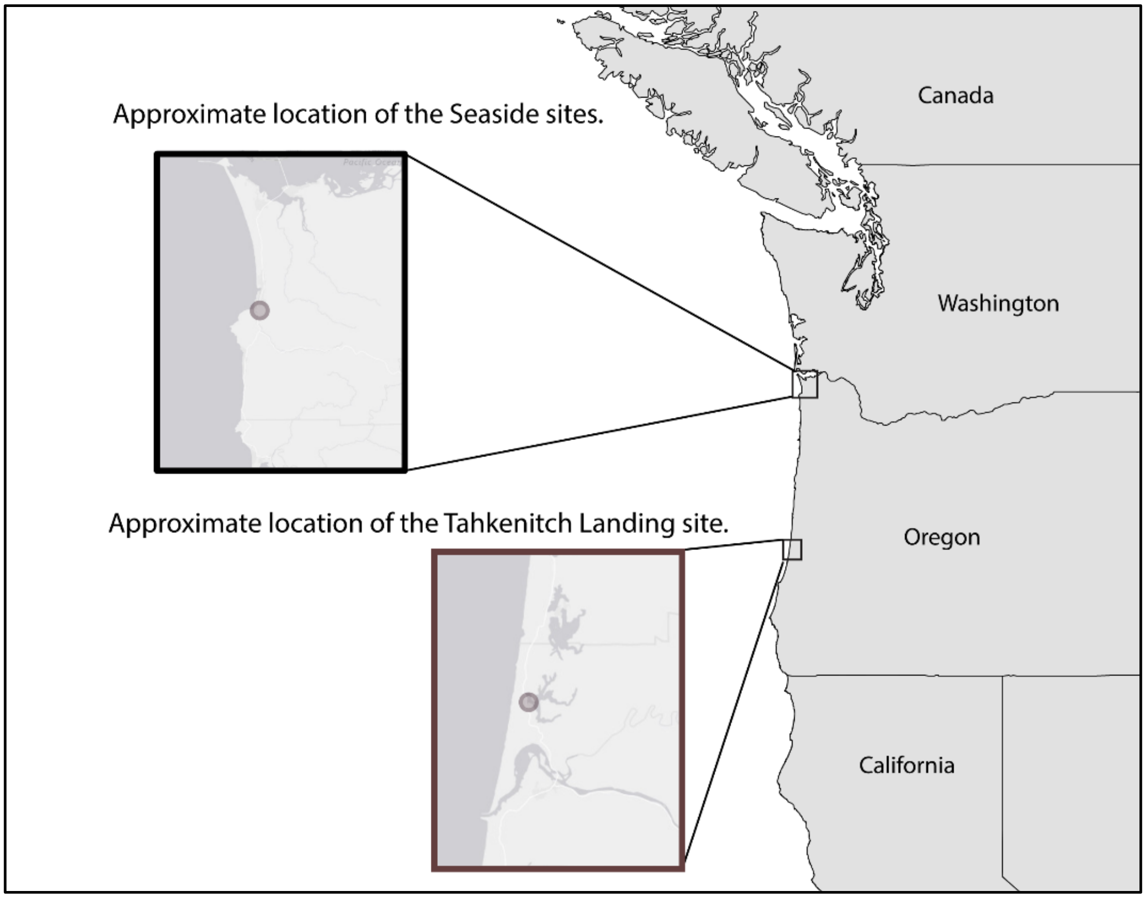


Figure 1.1. Map showing location of the Seaside sites (Palmrose and Par-Tee) on the northern coast (black inset) and the Tahkenitch Landing site on the central coast (red inset). Made in ArcMap 10.0/Adobe Illustrator; data from Natural Earth, U.S. Census Bureau, Esri, DeLorme, HERE, and MapmyIndia.

The sites were excavated by Robert Drucker and George Phebus and their volunteers in 5 × 5 foot (~1.5 × 1.5 m) units in arbitrary one-foot (~30 cm) levels. All sediments were screened over 1/4-inch mesh (Phebus and Drucker 1979). Unit depths varied, reaching up to six feet (1.8 m) in some places. Phebus and Drucker sampled approximately 550 m^2 at Par-Tee, making it one of the largest excavations on the Northwest Coast south of Ozette (Losey and Yang 2007:662), including the extensive excavations at Čḯxwicən (Butler et al. 2019). Faunal and structural remains suggested possible part-time habitation at Par-Tee (Phebus and Drucker 1979), while seasonality of faunal remains and the discovery of the remains of a large, rectangular semi-subterranean plank house suggested possible year-round residence at Palmrose (Aikens et al. 2011:247; Connolly 1992:168; Greenspan and Crockford 1992).

The close relationship between the Tillamook and Clatsop tribes in the area has led to some ambiguity regarding cultural affiliation of the Seaside sites (Aikens et al. 2011; Arbolino et al. 2005; Phebus and Drucker 1979). At Euro-American contact, the Seaside area was home to the Penutian-speaking Clatsops (Chinookan peoples; Deur 2016) and likely the Salish-speaking Nehalem Tillamook (Jacobs 2003:2; Ray 1938). The groups were interconnected through marriage, trade, and language (Deur 2016; Boas 1894; Jacobs 2003). Seaside was also a documented location of Clatsop/Tillamook persistence following contact (Deur 2016). Today, the descendants of these groups are represented by the Confederated Tribes of the Grande Ronde and Confederated Tribes of Siletz Indians, as well as the federally unrecognized Confederated Tribes of Clatsop-Nehalem and Chinook Nation (Deur 2016; Johnson 2013:5). A repatriation report compiled by the Smithsonian Institution National Museum of Natural History (NMNH) determined Par-Tee was culturally affiliated with Tillamook descendants (Arbolino et al. 2005:ii), and Palmrose with Tillamook and Clatsop descendants (Arbolino et al. 2005:iii).

The Par-Tee site assemblage is curated at the NMNH in Washington, D.C. The Palmrose assemblage is split between the NMNH and the Museum of Natural and Cultural History (MNCH) at the University of Oregon (UO) in Eugene. Par-Tee and Palmrose both contain enormous quantities of well-preserved faunal remains, and while research on these assemblages has occurred during the last two decades (Colten 2002, 2015; Loiselle 2020; Losey and Power 2005; Losey and Yang 2007; Sanchez 2014; Sanchez et al. 2016, 2018, 2020; Wellman et al. 2016; Wellman 2018; Wellman et al. 2020) much remains to be analyzed. Publications to date include a brief excavation report (Phebus and Drucker 1979), analysis of a subsample of faunal remains (Colten 2002, 2015), analyses of shellfish and fish remains (Losey and Power 2005; Sanchez et al. 2020), and AMS dating analyses (Sanchez et al. 2016, 2018). Connolly et al. (1992) revisited the Palmrose site in 1988 for limited excavations and reported additional faunal remains, artifacts, and studied the ancient geomorphology. Additional site notes and records are available in the archives at NMNH and MNCH.

1.4.2 The Tahkenitch Landing Site

In addition to cetaceans from the Par-Tee and Palmrose sites, I re-analyzed the cetacean remains from the Tahkenitch Landing (35DO130) site. Tahkenitch Landing is located north of Reedsport on the central Oregon coast, on the shores of modern Tahkenitch Lake (Figure 4.1). At European contact, Lower Umpqua Indians resided in the Tahkenitch Landing area, while the Siuslaw and Coos tribes lived north and south, respectively (Minor and Toepel 1986:4). Today, descendants from these groups are represented by the federally recognized Confederated Tribes of Coos, Lower Umpqua, and Siuslaw Indians. The site was excavated in 1984 and 1985 in 1 m x 1 m units and 10 cm levels. The site is divided into three chronological components (I-III): the beginning of the first component dates to ~8000 BP and the end of the third component dates to post-3000 BP (McDowell and Minor 1986:41). The excavation yielded a significant amount of faunal material, of which a subsample was analyzed (Greenspan 1986:57). Component II contained approximately 31 whale bone specimens, several of which were tentatively identified to Balaenopteridae or Physeteridae (sperm [*Physeter macrocephalus*] whale) families, but further research was recommended (Greenspan 1986:64). Component II at the Tahkenitch Landing site dates to 5200-3000 BP (McDowell and Minor 1986:41), preceding the primary occupation of the Palmrose and Par-Tee sites. Tahkenitch Landing provides a different geographic and chronological context in which cetacean remains were acquired and deposited on the Oregon coast, and serves as a comparison to the northern Oregon sites of Par-Tee and Palmrose. The collection is stored in the Siuslaw National Forest Supervisor's office in Corvallis, Oregon. Prior to the current study, we are unaware of any analysis of the Tahkenitch Landing site assemblage beyond the official excavation report (Minor and Toepel 1986).

CHAPTER II

FOOD OR FUR? ANCESTRAL TRIBAL USE OF SEA OTTERS ON THE OREGON COAST PRIOR TO EUROPEAN CONTACT AND EXTIRPATION

2.1 Introduction

2.1.1 Sea Otters in Oregon

Sea otters were driven to near extinction on the Pacific Northwest Coast in the 19th century due to the maritime fur trade. While sea otters previously ranged along the Pacific Rim from Japan to northern Mexico, the species is now restricted to parts of Russia, Alaska, British Columbia, Washington, and California (Bodkin 2015). Despite successful conservation efforts elsewhere on the Northwest Coast, reintroductions to Oregon in 1970 and 1971 failed (Bodkin 2015). As a result, sea otters are still considered extirpated in Oregon and are listed as “threatened” under the Oregon Endangered Species Act (ORS 496.171-496.192). Sea otters are of interest to diverse stakeholders in Oregon today, and are considered an ecological priority due to their role as a keystone species within kelp forest ecosystems (Estes and Palmisano 1974). Restoring sea otters to the Oregon coast is the explicit goal for the recently reestablished Elakha Alliance, initially founded by Siletz tribal member Dave Hatch (Hall 2019). Reflecting these conservation priorities, several zooarchaeological studies of Oregon sea otters have provided historical ecological data to inform future reintroduction efforts (e.g. Lyman 1988; Valentine et al. 2008; Wellman 2018; Wellman et al. 2020 [Chapter III]).

Sea otters are culturally significant to Native American, First Nations, and Alaska Native groups who reside along the Northwest Coast. Precontact sea otter hunting and use has been described in the archaeological and ethnographic record for some regions and communities, but detailed zooarchaeological data are lacking for the Oregon coast (Hall 2019:117). Hall found that sea otters “frequently rank along with Steller sea lion and harbor seal among the top three” (2019:122) marine mammals in coastal Oregon faunal assemblages. Hall’s findings clearly indicate that sea otters were an important species prior to contact and the historical fur trade. Oregon archaeologists and historians agree with Hall that sea otters were important, but few have reported on use patterns or explored the precontact relationships between humans and sea otters. In a literature review of pinniped and sea otter use in northern Oregon and southern Washington, Moss and Losey (2011:186) recommended more thorough and detailed zooarchaeological analyses to gain an understanding of sea otter use, but little progress has occurred since the time of their writing. The precontact socio-cultural details of sea otters on the Oregon coast remain unaddressed: how, why, and when were tribal ancestors using sea otters, and what was the nature of the human-sea otter relationship in the coastal Oregon landscape?

2.1.2 Current Study

This study characterizes how precontact inhabitants of the Oregon coast used sea otters. I present the analysis of cutmarked sea otter remains from two archaeological sites from the northern Oregon coast to determine whether sea otters were processed for pelt removal, dietary consumption, or both. This study was undertaken with the explicit goal of disseminating results to tribal stakeholders to be used as desired or needed, while also contributing more broadly to understanding relationships between humans and fur-bearing marine mammals in the archaeological record.

A core premise of this study is that sea otters were (and still are) an important coastal resource for tribal groups throughout the Pacific Northwest Coast. The analysis presented here is one of multiple lines of evidence affirming the importance of sea otters. These results are not a new revelation; I build upon current Oregon tribal positions and knowledge to affirm tribal assertions that the reintroduction of sea otters to Oregon would be a rekindling of a long human-animal relationship disrupted by colonial incursion and ecological exploitation by Euro-Americans (Hall 2019). The results of this study indicate that the inhabitants of the Par-Tee and Palmrose sites were skinning sea otters for their pelts prior to European contact. Sea otter muscle also appears to have been removed from parts of the skeleton, but it is not clear if this was for dietary consumption by humans. Sea otters were clearly processed, sometimes intensively, prior to their deposition in the archaeological record, and were an important coastal resource for Oregon tribal groups prior to and at Euro-American contact.

2.2 Background

2.2.1 Archaeological Sites and Materials

The sea otters analyzed in this chapter come from the Par-Tee (35CLT20) and Palmrose (35CLT47) sites, coastal shell mounds excavated between 1967 and 1977 at Seaside, Oregon (Phebus and Drucker 1979). Par-Tee and Palmrose are located south of the Columbia River mouth (Figure 2.1).

Figure 2.1. Map showing location of the Seaside (Palmrose and Par-Tee) sites on the Oregon coast. Made in ArcMap 10.0/Adobe Illustrator; data from Natural Earth, U.S. Census Bureau, Esri, DeLorme, HERE, and MapmyIndia.

The Par-Tee site collection is curated at the NMNH in Washington, D.C. The Palmrose assemblage is split between the NMNH and the Museum of Natural and Cultural History (MNCH) at the University of Oregon (UO) in Eugene. Par-Tee and Palmrose both contain enormous quantities of well-preserved faunal remains, providing an ideal sample size for faunal analyses, and much remains to be analyzed. While full descriptions of the artifact assemblages have not been published, sea otter bacula tools have been identified at Par-Tee (Robert Losey, personal communication, 7/23/2019).

2.2.2 Ethnographic Background

Ethnographic research on the Chinook and Tillamook peoples began with Lewis and Clark's arrival at the mouth of the Columbia, and was followed by that conducted by anthropologists including Franz Boas (1894) and Melville and Elizabeth Jacobs (Jacobs 2003; Pearson 1990). These sources recorded how tribes on the Oregon Coast used sea otters. Lewis and Clark frequently wrote about sea otters and their pelts and are cited in various sources (Lewis and Clark 2005; Sauter and Johnson 1974; Ray 1938). Verne Ray (1938:114) noted "all of the early writers speak of sea otter robes in use by the Chinook but it is not certain whether they used the flesh for food or not." The typical Chinookan method of making sea otter robes required two skins which were sewn together (Ray 1938:137). The Salmon River Tillamook used sea otters for clothing and bedding (Zobel 2002:309), and sea otter skins were highly valuable and coveted (Sauter and Johnson 1974:53). Tillamook shamans reportedly kept their powers in a bag made from sea otter skin (Sauter and Johnson 1974:120). Tillamook hunted "otters" for fur and a "valuable food source" (Sauter and Johnson 1974:5), but further discussion of otters related to subsistence is absent – it is possible Sauter and Johnson are referring to river otter (*Lontra canadensis*), since they do not specify "sea" otter.

Clara Pearson, a Nehalem Tillamook informant interviewed in the early 1930s, did not discuss sea otters with regards to subsistence (Jacobs 2003:95) but recounted stories and myths including sea otters (Pearson 1990). For example, the story "The Invisible Husband" includes a specific reference to Seaside as the location where "all those men went sea-otter hunting" (Pearson 1990:20). "The Round Trip of Ice" describes a sea otter hunt with Ice and his men; they encounter a "[…] sea otter that was different looking. It was a sea otter all right but it had a white face" (Pearson 1990:3). The men cannot strike the sea otter and follow it back to the village where they find a young woman who looks just like the sea otter, along with the weapons they had fired at it (her). In "Moon's Winter Dance," all "types of people" attend, such as Dentalium, Bracelets, and "Those Tanned sea otter hides that only very wealthy people wear"

(Pearson 1990:150). In the “South West Wind Dance,” South Wind wears “quivers made from sea otter skins” while he creates the world (Sauter and Johnson 1974:125). These stories indicate that sea otters were important symbolically and economically, and were non-human persons/agents within the lower Columbia River landscape.

2.2.3 Previous Cutmark Studies

2.2.3.1 Alaska Tlingit Sea Otter/Seal Use and Experimental Skinning Study (Moss 2020). To determine if Tlingit ancestors were processing sea otters for dietary consumption, Madonna Moss (2020) compared cutmarked elements of seals (which were known to be processed for food) to cutmarked elements of sea otters from archaeological sites near Angoon, Southeast Alaska. Working with Sealaska Heritage Institute, she received permission to observe a Tlingit hunter, Kyle Barry, as he skinned a sea otter hunted under the Marine Mammal Protection Act (MMPA). Moss and colleagues obtained the resulting sea otter carcass, prepared the skeleton, and examined the bones to identify cutmarks left by the skinning. Moss concluded that cutmarks on the archaeological mandibles, tarsals, metatarsals, tibiae/fibulae, and ulnae/radii reflected skinning, while cutmarks on the femora/humerii were a result of pulling limbs away from the pelt during skinning. On the archaeological remains that she studied, Moss (2020:215) interpreted cutmarks on scapulae, vertebrae, innominates, and ribs as resulting from obtaining backstrap muscle for dietary consumption by dogs and possibly humans. One major methodological lesson from Moss’ analysis is that the “typical” patterns of cutmarks and their assigned functions (e.g., Binford 1981) were not necessarily applicable to sea otters, and that skinning resulted in cutmarks in unexpected areas following zooarchaeological conventions (Moss 2020:216). For example, the sea otter skinned by Mr. Barry was cutmarked on sternabra, a rib, radius/ulna, metacarpals, calcaneus, and metatarsals, all of which are consistent with skinning, and also on the innominate, femur, and fibula, which are not (Moss 2020:213).

Moss (2020) worked with Tlingit individuals with expertise in sea otter hunting, skinning, and sewing. Today, Tlingit and other Alaska Natives use sea otters primarily as a source of material for sewing regalia, blankets, and handicrafts. To this end, Mr. Barry and others attempt to produce the largest skin possible, removing it from all around the limbs. Mr. Barry produced a fully articulated sea otter carcass, so none of his cutmarks were made for disarticulation. Other people at different times and places could dismember a sea otter for the purpose of sharing small portions that could be used in a variety of ways, even as sources of smaller pieces of fur.

2.2.3.2 Small Carnivore Experimental Skinning Study (Implications for European Upper Palaeolithic) (Val and Mallye 2013). Val and Mallye (2013) conducted an experimental skinning study in which professional taxidermists skinned small carnivores found in Europe (Eurasian badges, stone and pine martens, a polecat) and Europe/North America (red foxes, a weasel). Val and Mallye (2013) recorded the resulting cutmark patterns and reported high frequencies of cutmarks on the cranium, lateral mandible, tarsals, metatarsals, phalanges, ulna/radius, tibia, and fibula (2013). Val and Mallye (2013:237) noted that forepaws and caudal vertebrae may remain in the fur upon removal from the skeleton, so an assemblage missing forepaws and caudal vertebrae may indicate that animals were skinned and the pelts containing the forepaws/caudal vertebrae were deposited elsewhere (2013:237). Conversely, an assemblage consisting solely of forepaws or caudal vertebrae (e.g., the stone marten remains at Çatal Höyük [Pawlowska and Marcizak et al. 2017]) may indicate pelts were deposited in the site. While Val and Mallye's study was performed by modern taxidermists it is a useful comparison when considering cutmarks on fur-bearing mammals.

2.2.3.3 Umpqua-Eden and Seal Rock (Oregon) Archaeological Analysis (Lyman 1991). Lyman (1991) analyzed sea otter bones from two coastal Oregon sites: Umpqua-Eden (35DO83) and Seal Rock (35LNC14). Seal Rock yielded an NISP of 141 sea otter specimens, ~18% of which were cutmarked (Lyman 1991:227), and Umpqua-Eden yielded an NISP of 302, ~19% of which were cutmarked (1991:152). Lyman sketched each cutmark and categorized them by function (following Binford [1981], Howard [1973,1975], and Lyman [1987]). Using Binford's (1981) three categories of cutmarks, Umpqua-Eden sea otter elements exhibited 31 dismemberment, 37 filleting, and 22 skinning marks (Lyman 1991:321-322), and Seal Rock elements exhibited 10 dismemberment, 12 filleting, and one skinning mark(s) (Lyman 1991:333-334).

Cutmarks classified by Lyman as dismemberment and filleting may not have been a result of dismemberment/filleting, but from different aspects of the skinning process, as recorded by Moss (2020) and Val and Mallye (2013). Only three innominates, three distal tibia, four calcaneii, four metatarsals, and five astragali were categorized as exhibiting skinning marks. At Umpqua-Eden, Lyman concluded that complete sea otter hindlimbs had been removed from carcasses because 62% of hip joint elements (% NISP) were cutmarked, followed by the shoulder joint (21%), elbow/ankle (both ~15%), and knee (~13%) (Lyman 1991:156). There were no cutmarks on the wrist joint. Lyman's categorizations of "dismemberment" and "filleting" imply dietary consumption, but he did not explicitly discuss or draw specific conclusions regarding use.

2.3 Cutmark Methods

2.3.1 Cutmark Identification

I examined the Par-Tee and Palmrose sea otter bones for cutmarks under 0.63x to 2x magnification. Cutmarks were described and those that were not too faint were photographed. Most cutmarks on longbones were sketched onto schematic drawings from Post (2006). I studied the muscular anatomy of the sea otter forelimb and hindlimb described by Howard (1973, 1975) as well as a dog anatomy textbook (Budras 2007) to identify possible fascia "targets" of the cutmarks to determine function. The placement of some cutmarks relative to muscle insertions or ligaments was extremely clear, while others were not. While determining cutmark "targets" provided an additional level of detail, it sometimes made function difficult to discern: most cutmark locations could reflect fascia cutmarks even when in locations considered standard for skinning, or vice versa (following Moss 2020). For example, cutmarks on the distal tibia have been cited as consistent with both disarticulation (Binford 1981:118) and skinning (Lyman 1991:322, 334; Val and Mallye 2013:234).

2.3.2 Tallying Cutmarks

I calculated the percentage of each element that exhibited cutmarks (% NISP cutmarked, e.g., 69 of the total 116 femora specimens at Par-Tee are cutmarked, or 59%), as well as a count of cutmarks based on longbone location (e.g., 10 radii cutmarked distally). While % NISP cutmarked does not account for fragmentation (Abe et al. 2002; Lyman 2008), longbone location counts do; it does not matter if the radius is fragmented, as long as it is clear which portion is cutmarked (Lyman 2008:285).

Some authors have suggested that multiple cutmarks in one location on a single specimen reflect the effort of cutting or processing in that area (Milo 1998:106). Val and Mallye (2013:236) found that cutmark location remained consistent and cutmark frequency was a reflection of the processors' skill. Consequently, the number of cutmarks in a given location may be less meaningful than cutmarks in the same location across multiple elements (as found by Val and Mallye 2003:237). In Moss' experimental skinning study, Mr. Barry used a steel knife, but archaeological specimens would have been processed with stone or shell tools. The Par-Tee and Palmrose artifact assemblages contained chert scrapers and knives. Palmrose additionally contained a possible hafted shell blade (Museum of Natural and Cultural History, Eugene, Oregon [MNCH], North Coast Box 11 [NC 11], f. Field Notes [FN]). Sea otter pelts are thick with dense fur, and repeated cutmarks could be also due to the dulling of these blades rather than effort or the skill of the processor.

2.4 Results: Zooarchaeological Analysis

2.4.1 Par-Tee Sea Otter Remains

2.4.1.1 NISP and MNI. I analyzed the sea otter remains from 63 Par-Tee excavation units which yielded a sample size of 2024 NISP and 54 MNI (calculated using right femora: 30 adults and 24 juveniles). In terms of raw NISP, vertebrae, ribs, metatarsals, femora, phalanges, innominates, and humerii are the seven most abundant elements in the sample (Figure 2.2). These elements are representative of the axial skeleton (ribs and vertebrae), the hindlimb (femora, metatarsals, and phalanges), and the proximal forelimb (humerii). The next most abundant elements are innominates, ulnae, radii, and tibiae, which complete the emphasis on the hindlimb and forelimb.

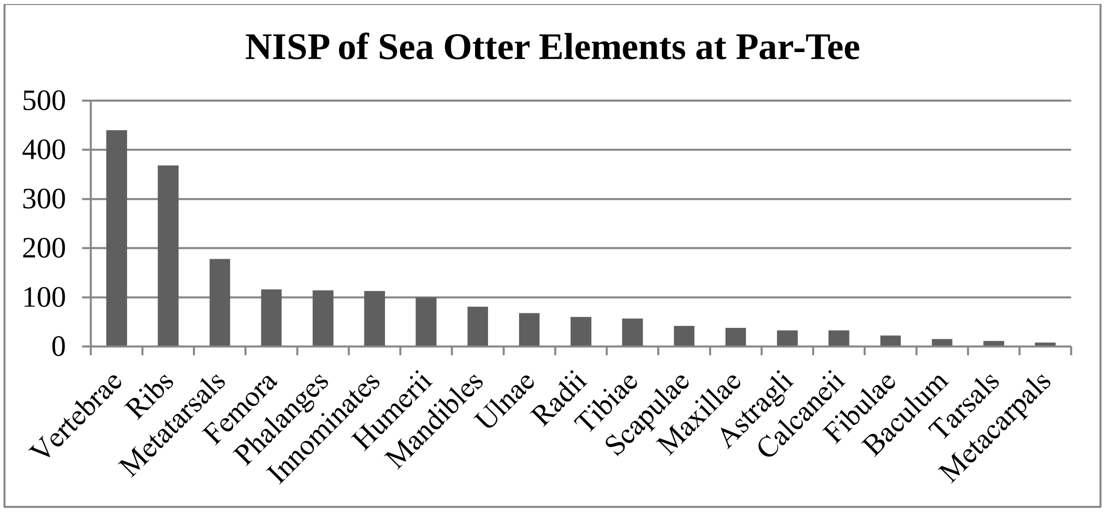


Figure 2.2. NISP of sea otter elements in the Par-Tee sample.

Vertebrae are represented primarily by the robust centra and are easily identified. Only 39 complete ribs were found in this analysis, but the majority of fragments included the diagnostic proximal end. The sample is not dominated by small rib fragments, possibly due to lack of recovery during excavation or difficulty identifying small, undiagnostic fragments. Regardless, fragmentation does not appear to be driving abundance of the vertebrae and ribs in the sample. Approximately 50% of metatarsals are complete, and the remainder are primarily undiagnostic distal ends. Pes phalanges are largely complete. Large proportions (~70%) of femora and humerii are complete, as are roughly 54% of tibiae, 40% of radii, and 20% of ulnae. Innominates are heavily fragmented, and a substantial number of unfused, partial juvenile innominates (NISP=34) are likely driving this abundance. Fibulae (which are long and extremely thin) are represented by the robust medial malleolus and varying intact diaphysis. Similarly, the scapulae are represented by the robust glenoid fossae. Crania fragments other than maxillae are not present. The maxillae are fragmented and underrepresented (N=38) relative to the comparatively robust mandibles (N=81), but 37 left upper P^4s and 38 right lower P_4s were reported in a previous analysis of all sea otter teeth in the assemblage (Wellman 2018:Table S1). The roughly equal representation of maxillary and mandibular teeth suggests that regardless of preservation, the cranium was processed and deposited.

2.4.1.2 Element Representation. While axial and hindfoot elements exhibit high NISP counts, these elements are underrepresented if we consider the remains of 54 complete sea otter carcasses (assuming complete preservation). With 54 MNI, the sample should hypothetically contain 2700 vertebrae, 1512 ribs, 540 metatarsals, and 972 phalanges, but 16% (N=440), 24% (N=368), 33% (N=178), and 12% (N=114) of the expected totals are present, respectively (Figure 2.3). When vertebrae are reported by type, the sample contains 34% of the expected totals of lumbar, 24% of cervical, 14% of thoracic, and 7% of caudal vertebrae.

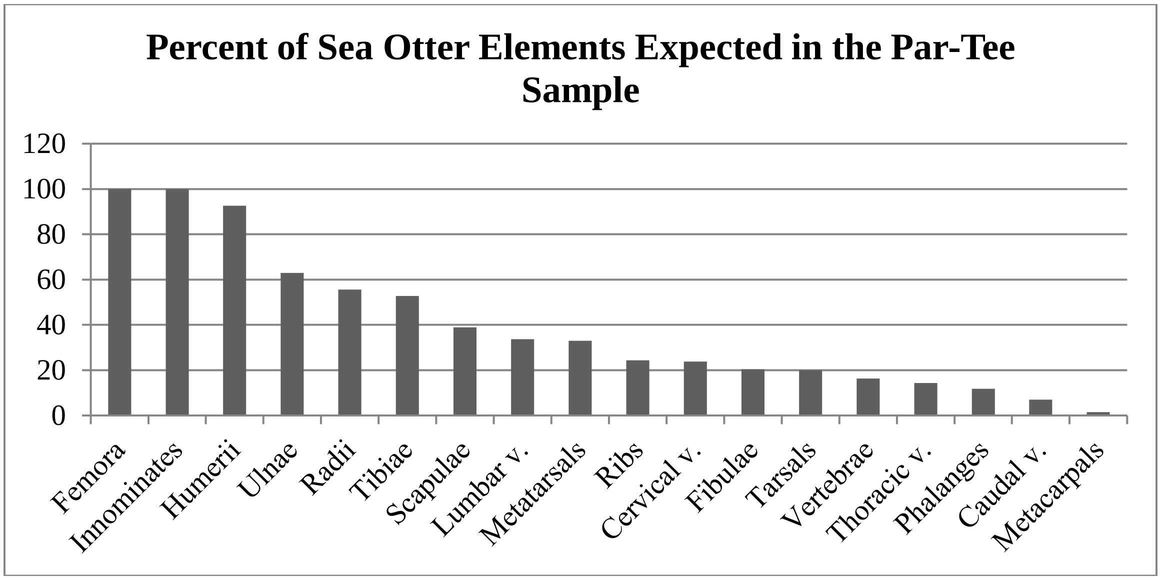


Figure 2.3. Percent of sea otter elements expected in the Par-Tee sample, based on 54 MNI.

Femora, innominates, and humerii are present in quantities over or close to expected totals (although due to fragmentation, especially of innominates, the actual percentage is likely below 100%; Figure 2.3). Ulnae, radii, and tibiae occur at 55%-60% of the expected frequencies; these percentages may also be lower due to fragmentation.

Forefoot elements are extremely underrepresented in the Par-Tee sample: only 1% of expected metacarpal totals are present (Figure 2.3), and carpals/manus phalanges are absent. This may be due to the small size of these elements and archaeological recovery techniques, or the removal of the forepaws along with the pelt (Val and Mallye 2013:237). Alternatively, the lack of forefoot elements, combined with the substantial underrepresentation of caudal vertebrae, may point to pelt removal and deposition outside of the excavated areas of the site.

2.4.1.3 Juveniles at Par-Tee. The Par-Tee sample contains a NISP of 240 juvenile specimens, and an MNI of 24 (calculated using right femora). Juvenile femora, humerii, innominates, ulnae, and mandibles are most abundant (Figure 2.4), likely because these elements have distinctive, diagnostic shapes and tend to be more robust even in a pup or juvenile sea otter. Fragile juvenile elements, such as ribs, are more likely to fragment and be unidentifiable.

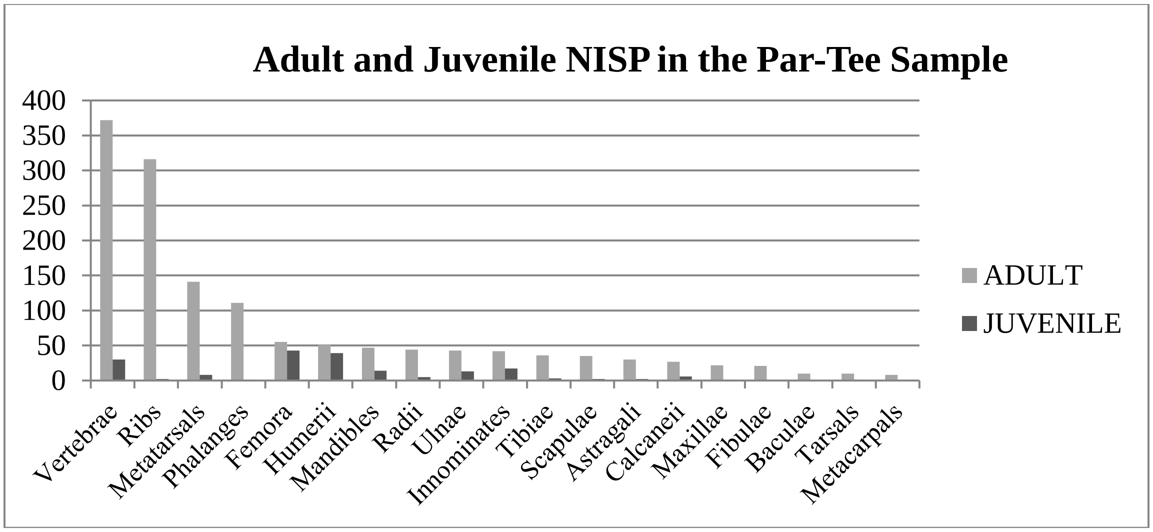


Figure 2.4. Adult and juvenile sea otter element abundance (NISP) in the Par-Tee sample.

Determining ages of partial sea otter remains is difficult. I used the broad term “juvenile” to categorize elements missing one or both epiphyses, or in the case of the innominate, lacking fusion through the acetabulum. Using age criteria described in Nicholson et al. (2014), I determined age ranges for mandibles and maxillae: fourteen sea otters are aged ≤2 months old and eleven sea otters are aged ≤6.5 months old (Nicholson et al. 2014). Because the mandibles/ maxillae are fragmented and teeth are often missing, absolute ages could not be determined. These estimates are primarily limited to those based on the presence/absence of the lower deciduous premolars (pm_3/pm_4)/permanent molars (M_1/M_2) and upper 1st deciduous premolar (pm^4)/permanent molar (M^1). The majority of sea otter elements in the Par-Tee sample are fused or show adult dentition (Nicholson et al. 2014).

Sea otter pups can be born year round and juvenile remains are dispersed throughout levels at the site, making seasonality inferences difficult. It is interesting nonetheless to have so many juveniles in the sample and the age estimates (albeit approximate ranges) are informative. Sea otter pups are weaned on average at 6 months of age (Thometz et al. 2014), so the 2-6.5 month old pups in this sample would have been with or nearby their mothers and possibly hunted in association with the adult females. Distribution throughout the site lends additional evidence for co-capture: adults always co-occur in units containing juveniles and frequently within the same level.

2.4.1.4 Gnawing. The Par-Tee sample contains 28 specimens that exhibit carnivore tooth punctures and gnawing: one femur, two humerii, one innominate, nine metatarsals, one phalanx, one rib, one sternabra, five tibiae, four ulnae, and four vertebrae. This is likely an undercount, as other taphonomic signatures (wear/erosion/breakages) made toothmarks or gnawing difficult to identify. I noted several repeated irregular erosion patterns that, upon reflection, may have been gnawing. For example, I noted “divets” on the palmar and plantar surfaces of some distal metatarsals, as though they were ground between two canine teeth. A total of seven elements are both gnawed and cutmarked. Unfortunately, there is no clear spatial patterning at Par-Tee to differentiate between carnivore scavenging and domesticated dog gnawing, though the proximity of the gnawed elements both in and near the house feature at the Palmrose site may reflect domesticated dog activity. At contact dogs were reportedly human hunting partners, human companions, and possibly “sanitation workers,” eating trash and refuse (Mack 2015:65-66).

2.4.1.5 Pathology. The Par-Tee sample contained 33 specimens exhibiting pathologies: seventeen vertebrae exhibit signs of arthritis on the centrum, and five metatarsals, six phalanges, two sternabrae, four ribs, two tibiae, one radius, and one calcaneus show signs of active or healed infection. One radius is badly misshapen, but the cause is unclear.

2.4.1.6 Element Representation: Spatial Distribution. In order to identify any spatial patterning in skeletal element representation, I re-categorized elements based on their broader anatomical unit: cranium (teeth, mandibles, maxillae), the axial skeleton (vertebrae, sacra, ribs, sterna/sternabrae), hindlimb (innominates, femora, tibiae, fibulae), forelimb (scapulae, humerii, radii, ulnae), hindfoot (tarsals, metatarsals, pes phalanges) or forefoot (carpals, metacarpals, manus phalanges). I tallied the % NISP for each anatomical category within each excavation unit (Figures 2.5-2.8).

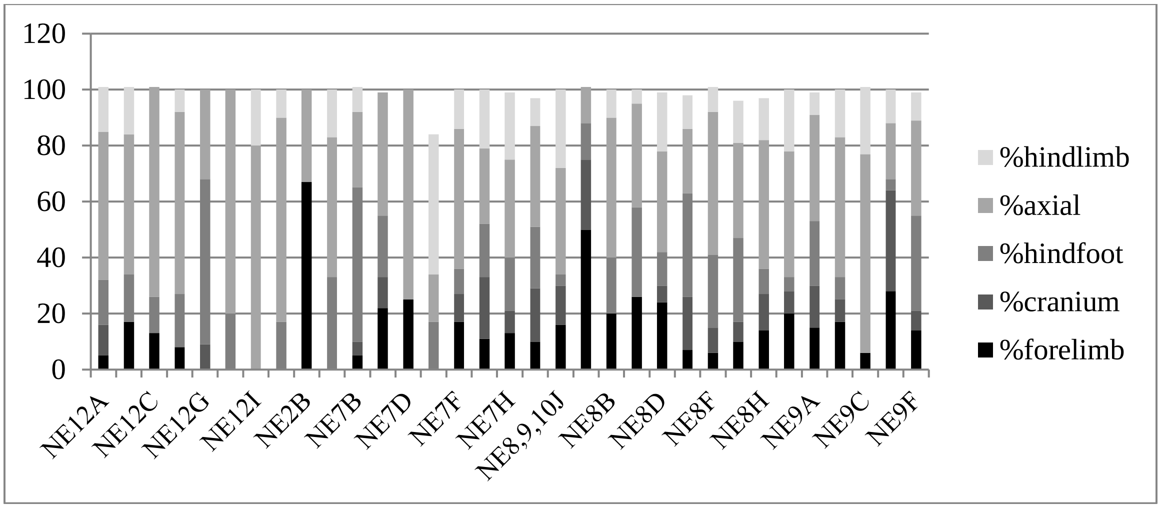


Figure 2.5. Proportions of sea otter anatomical unit in the excavation units of the northeast quadrant of the Par-Tee site.

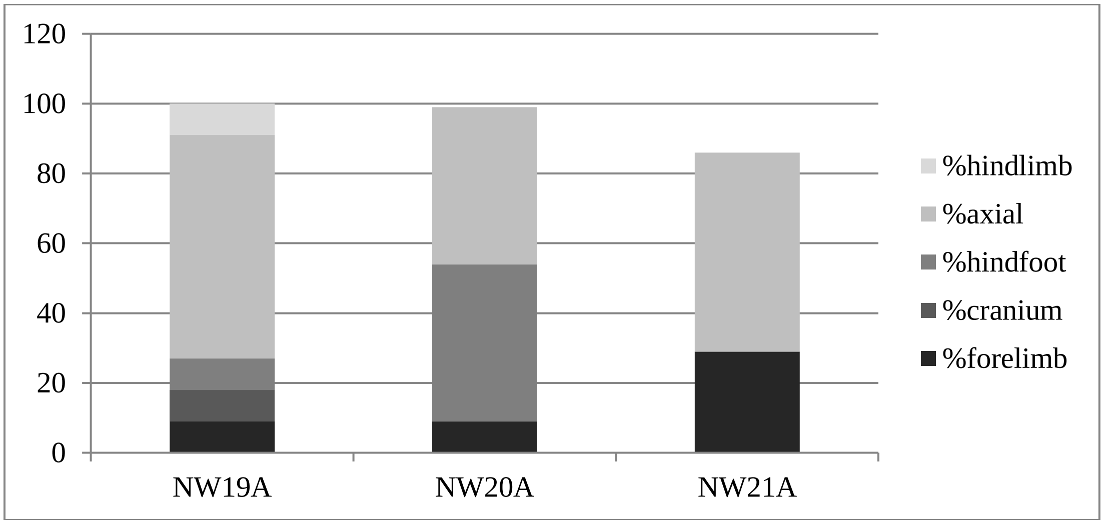


Figure 2.6. Proportions of sea otter anatomical unit in the excavation units of the northwest quadrant of the Par-Tee site.

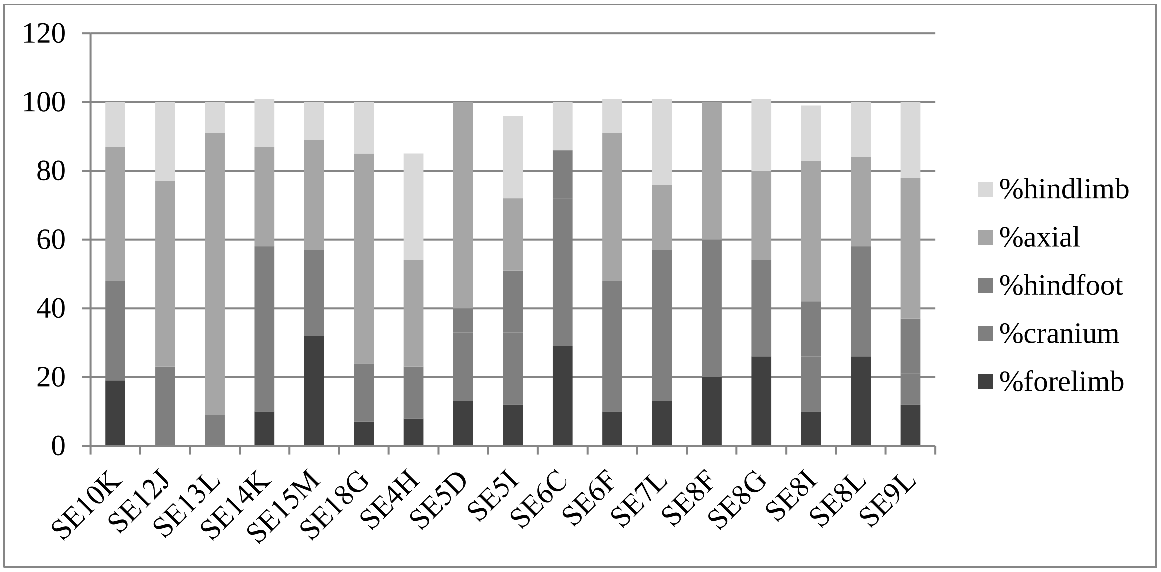


Figure 2.7. Proportions of sea otter anatomical unit in the excavation units of the southeast quadrant of the Par-Tee site.

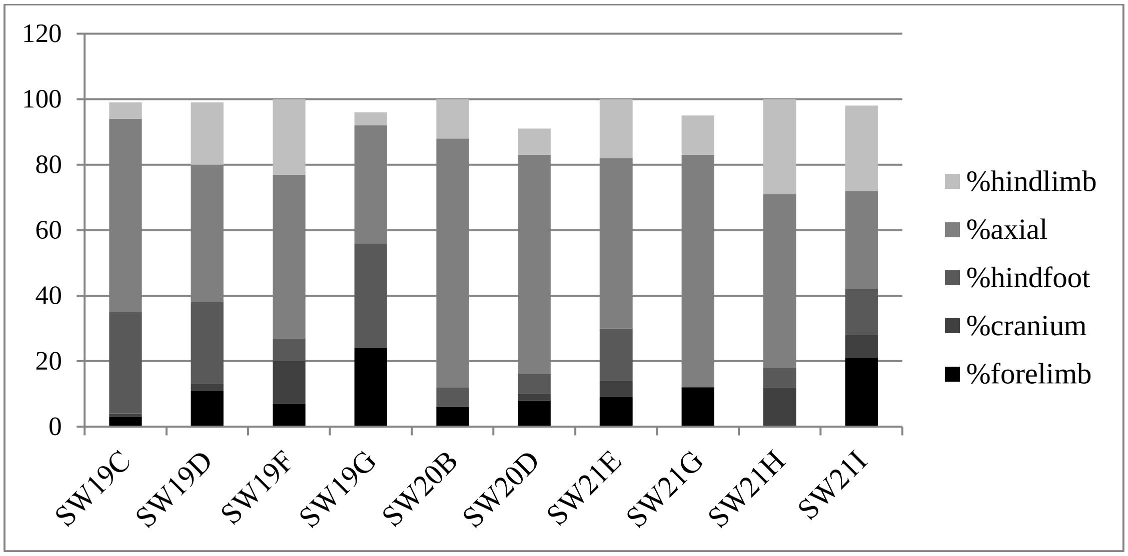


Figure 2.8. Proportions of sea otter anatomical unit in the excavation units of the southwest quadrant of the Par-Tee site.

All units except for five (NE12H, NE12I, NE2B, NE7D, NW21A) contained elements from three or more of the anatomical categories. Yet because these five units produced very small samples (NISP≤10), this likely accounts for the lack of element diversity.

At Par-Tee, vertebrae and ribs are the two most abundant elements by NISP, and all units except one (SE6C, NISP=7) contain axial elements. Axial elements also make up a large portion of the unit NISP (almost half of units contain at least 50% or greater axial elements). Several units deviate from the majority axial component, although this is also attributable to small sample size (e.g., units NW20A, NW21A, NE2B). Unit NE2B (NISP=3), for example, contains two humerii (right and left) and a rib fragment, skewing the forelimb representation for the unit.

Units NE12G and NE7B, however, do not appear to be skewed solely due to sample size. Unit NE12G contains six phalanges as well as left metatarsals I-V, and unit NE7B contains three phalanges and left metatarsals I-III and V. The excavation levels were imprecise (~1 ft), so it is difficult to ascertain whether deposition of groups of matching elements like left metatarsals accurately reflect processing activity/deposition of single sea otters within a specific area of the site, but it is possible. Overall, however, elements from a variety of anatomical units of the sea otter body appear to have been processed and deposited in units across the site without obvious patterning.

2.4.2 Palmrose Sea Otter Remains

2.4.2.1 NISP and MNI. I analyzed the sea otter remains from 34 excavation units from the Palmrose site, which yielded a 968 NISP and 22 MNI (calculated using right humerii [15 adults and 7 juveniles]). In terms of raw NISP, vertebrae, ribs, metatarsals, phalanges, and humerii are the most abundant elements (Figure 2.9). These elements are representative of the axial skeleton (ribs and vertebrae), the hindfoot (metatarsals and phalanges), and the proximal forelimb (humerii). The next most abundant elements are ulnae, femora, and mandibles, which complete the emphasis on the hindlimb and forelimb.

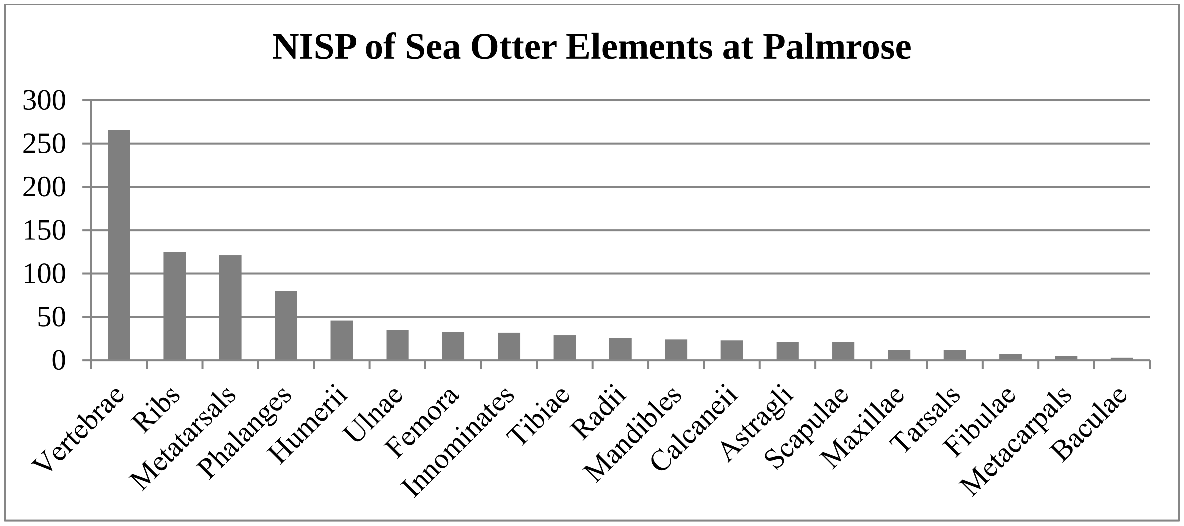


Figure 2.9. NISP of sea otter elements in the Palmrose sample.

Vertebrae are represented primarily by the robust centra and are easily identified. Only nine complete ribs are found in this analysis, but the majority of fragments included the diagnostic proximal end. The sample is not dominated by small rib fragments, possibly due to lack of recovery during excavation or difficulty identifying small, undiagnostic fragments. Regardless, fragmentation does not appear to be driving abundance of the vertebrae and ribs in the sample. Approximately 42% of metatarsals are complete, and the remainder are primarily undiagnostic distal ends. Pes phalanges are largely complete. Large proportions of femora (~74%) and humerii (~65%) are complete, as are roughly ~50% of tibiae, ulnae, and radii. Innominates are heavily fragmented and are likely driving this abundance. Fibulae (which are long and extremely thin) are represented by the robust medial malleolus and varying intact diaphysis. Similarly, the scapulae are represented by the robust proximal articular ends. Crania fragments other than maxillae are not present. The maxillae are fragmented and underrepresented (N=14) compared to mandibles (N=29), but eight left upper M^1s and 13 right lower M^1s were reported in a previous analysis of all sea otter teeth in the assemblage (Wellman 2018: Table S1). The roughly equal representation of maxillary and mandibular teeth suggests that regardless of preservation, the cranium was processed and deposited.

2.4.2.2 Element Representation. While axial and hindfoot elements represent high NISP counts, these elements are underrepresented as at Par-Tee. With 22 MNI, the sample should hypothetically contain 1100 vertebrae, 616 ribs, 220 metatarsals, and 396 phalanges, but 24% (N=266), 20% (N=125), 55% (N=121), and 20% (N=80) of the expected frequencies are present, respectively (and these totals include fragmented/incomplete elements) (Figure 2.10). When vertebrae are reported by type the sample contains 38% of lumbar, 43% of cervical, 23% of thoracic, and 11% of caudal vertebrae expected totals. Humerii and ulnae are present in quantities over or close to expected totals (although due to fragmentation the actual percentages are likely lower; Figure 2.10). Femora, innominates, tibiae, and radii are represented by ~60%-75% of expected totals; these percentages may also be lower due to fragmentation. Forefoot elements are extremely underrepresented in the Palmrose sample as at Par-Tee; only 2% of expected metacarpal totals are present (Figure 2.10), and carpals/manus phalanges are absent. This may be due to the small size of these elements and archaeological recovery techniques, or the removal of the forepaws along with the pelt (Val and Mallye 2013:237). The lack of forefoot elements, combined with the substantial underrepresentation of caudal vertebrae, may point to pelt removal and deposition outside of the excavated areas of the site.

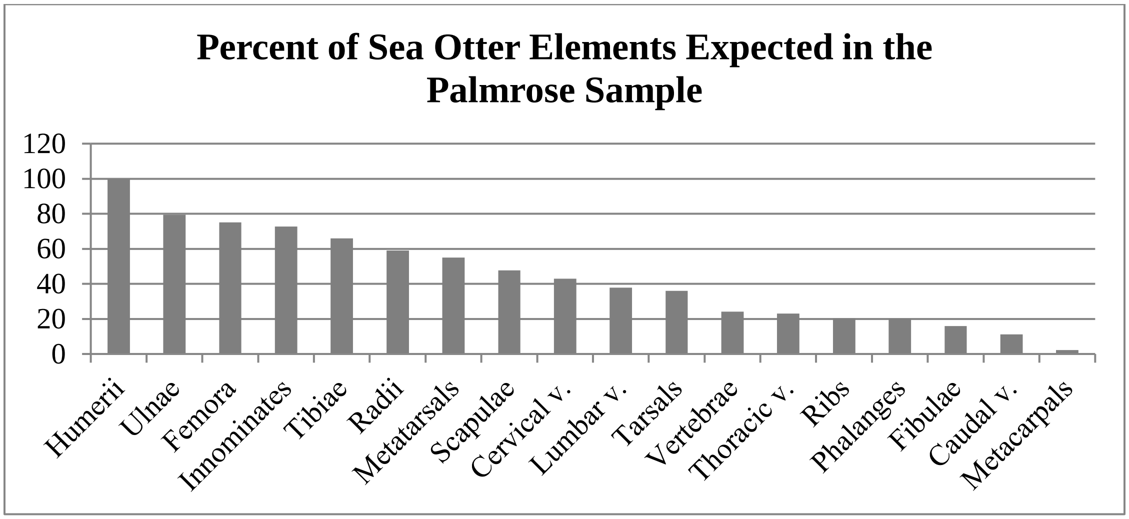


Figure 2.10. Percent of sea otter elements expected in the Palmrose sample, based on 22 MNI.

2.4.2.3 Juveniles at Palmrose. The Palmrose sample contains an NISP of 138 juveniles and an MNI of seven (calculated using right humerii). Vertebrae, humerii, femora, and mandibles are the most abundant juvenile remains (Figure 2.11). There are no juvenile maxillae fragments, but five sea otter mandibles are aged ≤2 months old and seven are aged ≤6.5 months old (Nicholson et al. 2014). As at Par-Tee, juveniles are distributed throughout the site and co-occur with adults, and the pups represented by mandibles are under or at weaning age (Thometz et al. 2014).

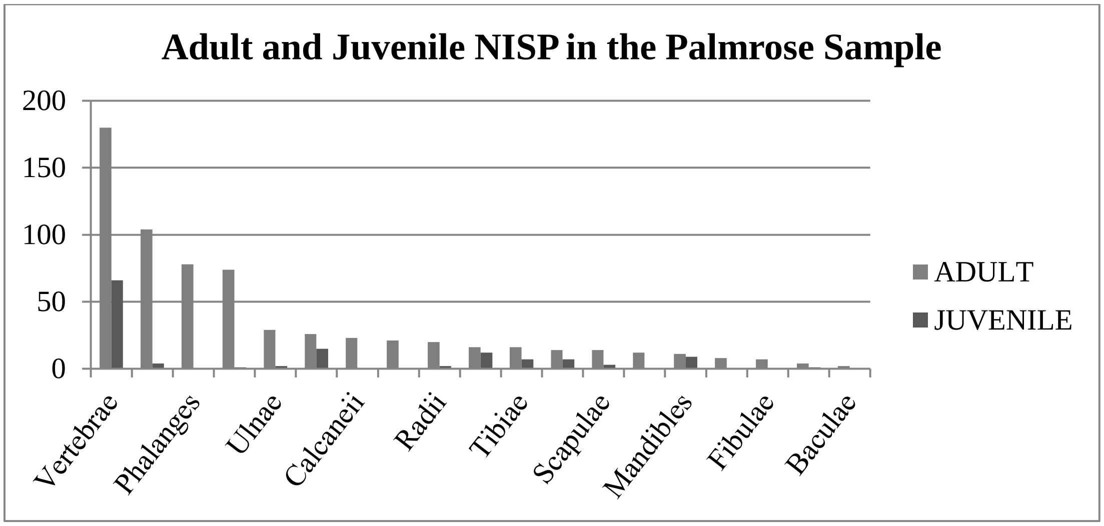


Figure 2.11. Adult and juvenile sea otter element abundance (NISP) in the Palmrose sample.

2.4.2.4 Gnawing. The Palmrose sample contains 36 specimens exhibiting carnivore tooth punctures or gnawing: one astragalus, one baculum, three femora, five metatarsals, one phalanx, two radii, five ribs, one scapula, six tibiae, one ulna, and ten vertebrae. This is likely an undercount for the reasons described with regards to the Par-Tee assemblage. Gnawed elements are distributed throughout the site, including units within or in proximity to the house feature. A total of six elements are gnawed and cutmarked. While I cannot confirm that the gnawing was made by dogs, the proximity of the gnawed elements to and in the house feature may reflect domesticated dog activity. At contact dogs were reportedly human hunting partners (Jacobs 2003; Mack 2015; Ray 1938), human companions, and possibly “sanitation workers,” eating trash and refuse

(Mack 2015:65-66). According to Ray (1938:117), Chinook dogs were allowed indoors, which might explain the presence of gnawed specimens within the house feature.

2.4.2.5 Pathology. The Palmrose sample contains 17 specimens exhibiting pathologies: ten elements exhibit signs of arthritis, while two metatarsals, two phalanges, one metacarpal, one rib, and one fibula appear to show signs of active or healed infection.

2.4.2.6 Element Representation: Spatial Distribution. As at Par-Tee, axial elements are present in the majority of units (except for SW8L and SW6D), and make up large proportions of the unit NISP (Figures 2.12-2.13).

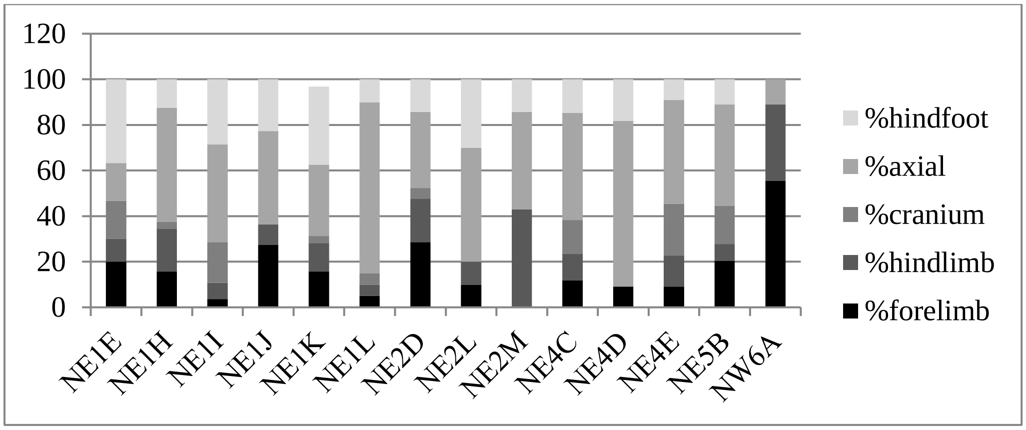


Figure 2.12. Proportions of sea otter anatomical unit in excavation units of the NE and NW quadrants at Palmrose.

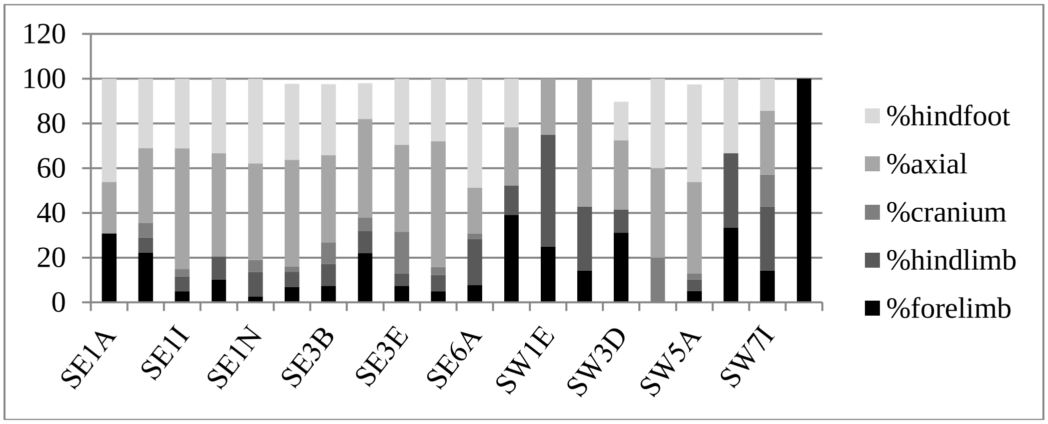


Figure 2.13. Proportions of sea otter anatomical unit in excavation units of the SE and SW quadrants at Palmrose.

SE8L (NISP=1) contains a radius and SW6D (NISP=12) contains forelimb and hindlimb/foot elements. Several units deviate from the majority axial representation, and these discrepancies may be due to small sample size combined with a lack of axial elements (e.g., units NE2M, NW6A, and SW1E, NISP≤9). While these units do sometimes contain interesting combinations of elements, the lack of stratigraphic resolution precludes clear conclusions regarding processing and deposition. For example, unit NE2M (NISP=7) contains two cervical and one thoracic vertebrae, an astragalus, and three right innominate bones across three levels, giving the impression that a large portion of the hindlimb was processed and deposited in this location. Unit NE1E contains teeth, mandibles, and an assortment of forelimb and hindlimb bones, and only two vertebrae and one sternum. Overall, it appears skeletal elements from all portions of the sea otter body were being processed and deposited in units across the site, with occasional exceptions.

2.5 Cutmark Results

2.5.1 Cutmarks at Par-Tee

2.5.1.1 Cutmark Sample. The Par-Tee sample contained 739 cutmarked specimens (37% of the overall NISP); 28% of juvenile specimens and 38% of adult specimens are cutmarked. Humerii and femora dominate % NISP cutmarked, followed by tarsals (driven by calcaneii/astragali), tibiae/fibulae (driven by tibiae), ulnae, and metatarsals (Figure 2.14). The only element that does not exhibit any cut marks is the axis vertebra (C2). Twenty different elements are cutmarked: bacula, maxillae fragments (included in Figure 2.14 as “crania”), patellae, phalanges, sterna/sternabrae, and sacrum fragments. There is an average of five cutmarks per specimen, and the highest average for a specific element is the average eight cutmarks per femur.

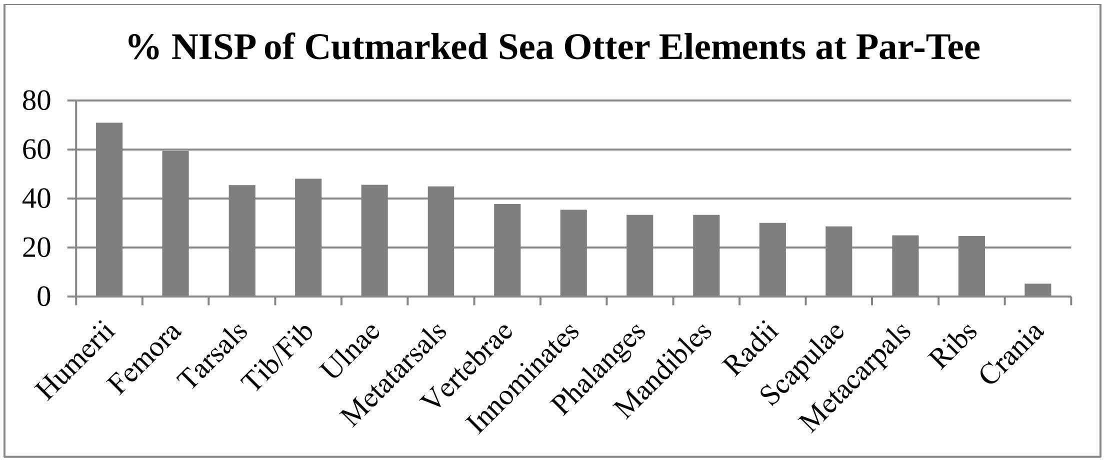


Figure 2.14. Abundance (% NISP) of cutmarked sea otter elements in the Par-Tee sample.

The % NISP of cutmarked elements follows patterns described in Moss' results. Sea otter humerii, ribs, metatarsals, radii/ulnae, and mandibles are cutmarked at both Par-Tee and the Angoon sites, but at higher proportions at Par-Tee (Moss 2020:211). Moss found sea otter femora and humerii (closely followed by vertebrae) had the highest % NISP cutmarked (2020:211). At Par-Tee, humerii and femora also represent the highest % NISP cutmarked, but are followed by tarsals, not vertebrae. At Par-Tee, 70% of humerii are cutmarked (versus Moss' 10% and 20% for seals and sea otters, respectively) and 60% of femora are cutmarked (similar to the proportion of seal femora cutmarked in Moss' analysis [~70%]) (2020:211). Cutmarked innominates at Par-Tee are intermediate (~35%) to the sea otter and seal innominates cutmarked in Moss (roughly 10% and 50%, respectively) (2020:211). At Par-Tee, tarsals, ulnae, radii, scapulae, vertebrae, ribs, and tibiae/fibulae are cutmarked at higher percentages than *both* sea otters and seals in Moss's analysis (2020:211).

Moss noted that eight different seal elements were cutmarked (no cutmarks on ribs, metatarsals, and mandibles) compared to 13 sea otter elements (2020:211). Lyman (1991) reported 12 elements cutmarked at Umpqua-Eden and eight at Seal Rock (1991:154, 228), while 20 different elements are cutmarked at Par-Tee. Moss suggested differences in anatomy affect how animals are processed, and the greater variety of sea otter elements exhibiting cutmarks may indicate a different approach or relative complexity when processing sea otters compared to seals (2020:210).

2.5.1.2 Cutmarks on the Axial Skeleton. Sterna and sternabrae at Par-Tee exhibit small nicks, which may be indicative of skinning and working the pelt away from the ribcage or vertebral column (Moss 2020:212; Val and Mallye 2013). At Par-Tee roughly half of ribs exhibit cutmarks on the shaft; the other half exhibit cutmarks on the head and/or neck. Cutmarks on the rib shaft may result from peeling the pelt away from the rib cage or stripping thoracic muscles. The rib head/neck cutmarks may reflect skinning or removing ribs from vertebrae. Vertebrae are cutmarked on processes or on the ventral centrum. Cutmarks to spinous processes may be the result of backstrap muscle removal (Figure 2.15), while ventral cutmarks may be from rib removal or gutting the animal (Moss 2020:215). The majority of vertebrae cutmarks at Par-Tee are located on the ventral centrum (Figure 2.16). Moss described a similar pattern in her data and suggested vertebrae cutmarks reflected butchering of the axial skeleton to obtain backstrap for either human or dog consumption (Moss 2020:215). Pulling the pelt from the vertebral column would not make cutmarks through the backstrap to the spinous process, nor would skinning explain the ventral vertebral cutmarks (Val and Mallye 2013:236).

Figure 2.15. A thoracic vertebra cutmarked at the base of the spinous process, possibly indicative of backstrap removal (scale in cm; Palmrose unit SE4D-3).

Figure 2.16. A lumbar vertebra cutmarked on the ventral centrum (scale in cm; Palmrose unit SE3B-4).

2.5.1.3 Cutmarks on the Forelimb. Scapulae at Par-Tee are cutmarked on the ventral blade surface at the edges of the subscapular fossa (origin of the subscapularis muscle) (Figure 2.17). The cutmarks may have resulted from working under the scapula to separate it from the rib cage; cutmarks underneath the scapula are unlikely to result from skinning. Several humerii are cutmarked near the lesser tuberosity (insertion of the subscapularis). Taken together, these cutmarks may reflect efforts to sever the subscapularis and separate the humerus from the scapula. Humerii are cutmarked in various locations, particularly on or near the distal epiphyses. Multiple specimens are cutmarked above the anterior trochlea, as well as on/near the medial epicondylar ridge and foramen (Figure 2.18). These cutmarks may reflect disarticulation of, or difficulty skinning around, the elbow joint.

Figure 2.17. A scapula cutmarked ventrally, on the edge of the subscapular fossa (scale in cm; Palmrose unit NE4C-3).

Figure 2.18. A distal humerus cutmarked on the medial epicondylar ridge (scale in cm; Palmrose unit SE3C-5).

Radii and ulnae are also cutmarked in various locations, particularly on the proximal end. Radii are frequently cutmarked under the radial head and along the anterior/posterior diaphysis. Ulnae are frequently cutmarked on/near the olecranon process and on the medial fossa (insertion for multiple brachialis muscles). Some ulnae specimens are cutmarked on the posterior and medial diaphyses where Howard (1973) labeled muscles absent. Both elements exhibit infrequent distal cutmarks. The ulnae/radii cutmarks may reflect skinning, especially in places where fascia are not present (Val and Mallye 2013:236). The cutmark activity on the lower forelimb is surprising given the relatively small size of it's muscles relative to the hindlimb. Perhaps these cutmarks do not reflect muscle removal but the separation of the radii and ulnae: these elements are robust and could be used for specialized tool manufacture (e.g. an ulna awl, bone point). The bones of the forepaws (manus phalanges, metacarpals, and carpals) are underrepresented at Par-Tee, but several metacarpals exhibit cutmarks on the palmar surface and likely reflect skinning.

2.5.1.4 Cutmarks on the Hindlimb. Innominates are cutmarked in various locations. Repeated locations included the iliofemoral ligament attachments and the gluteus medius, obdurator externus, and pectineus muscle origins. These muscles and ligaments insert in the proximal femur. Approximately half of cutmarked innominates exhibit cutmarks on or near the acetabulum and may reflect leverage applied to the joint while skinning as described by Moss (2020:215). Muscle and ligament attachments around the acetabulum anchor the femoral head, so these cutmarks may also reflect disarticulation.

Femora are cutmarked on the diaphyses and epiphyses. Cutmarks on the proximal end are at muscle insertions (e.g., the greater/lesser trochanter). Femoral necks (the location of the iliofemoral ligaments) are frequently cutmarked (Figure 2.19). Distal cutmarks are frequently superior to the lateral and medial condyles (on or near the gastrocnemius origin) (Figure 2.19). Three femora are cutmarked on a distal condyle, which may reflect a knife slip during disarticulation or working the pelt away from the knee joint. Tibiae are cutmarked at various locations, especially distally (Figure 2.20). Approximately half of cutmarked tibiae exhibit cutmarks on or immediately around the medial malleolus. Tendons and ligaments are present on the distal tibia underneath retinacula and may be severed for disarticulation or skinning (Val and Mallye 2013:236). Fibulae are primarily cutmarked on the lateral shaft; two are cutmarked on the lateral malleolus. Cutmarks to the fibulae may be due to skinning (Moss 2020:213; Val and Mallye 2013:236).

Figure 2.19. A distal femur cutmarked on and around the medial gastrocnemius origin (L) and a proximal femur cutmarked on the femoral neck (R) (scales in cm; Palmrose units NE1J-3 and SE1M-3).

Figure 2.20. A tibia cutmarked on the medio-distal aspect (scale in cm; Palmrose unit SE1N-6).

Cutmarks on the astragalus, calcaneus, and other tarsals likely reflect skinning (Val and Mallye 2013:230), but may also be due to disarticulation following Binford (1981). One Par-Tee calcaneus has over 15 cutmarks on the posterior surface (Figure 2.21), possibly reflecting efforts to sever the calcaneal tendon or difficulty working through the pelt at the ankle joint. Cutmarks on the phalanges and metatarsals likely reflect skinning (Val and Mallye 2013).

Figure 2.21. Calcaneus exhibiting cutmarks on the posterior surface (scale in cm; Par-Tee unit NE8F-6).

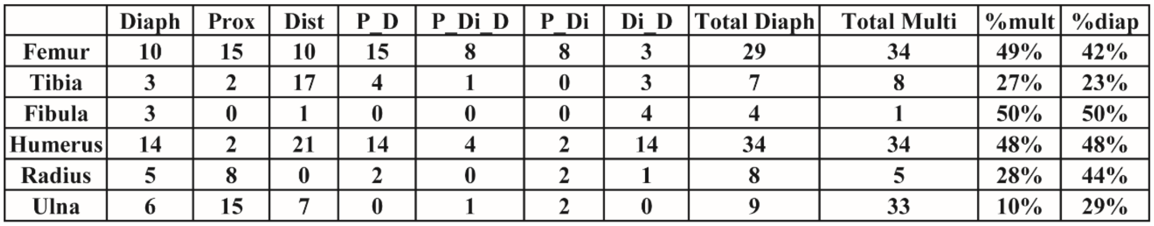
2.5.1.5 Cutmarks on the Cranium. Par-Tee mandibles are frequently cutmarked on the lateral or inferior horizontal ramus which reflects skinning (Val and Mallye 2013). Several are cutmarked on the ascending ramus which may indicate removal of the mandible from the cranium (several muscles originate/insert at that location). Several maxilla fragments are cutmarked which likely reflect skinning.

2.5.1.6 Cutmark Patterns on Longbones. I categorized longbone cutmark locations for each specimen as follows:

1) on the diaphysis proper ("Diaph")
2) on/near either the proximal or distal epiphysis ("Prox"/"Dist")
3) on/near both the proximal and distal epiphyses ("P_D")
4) on either the proximal or distal end and diaphysis ("P_Di"/"Di_D")
5) on both the proximal and distal ends and diaphysis ("P_Di_D")

I tallied the number of cutmarked locations described above, the total diaphysis cutmarks (Total Diaph), and the total of specimens that were cutmarked in multiple locations ("Total Multi") (Table 2.1). Because the specimens analyzed were not always complete, tallying the locations of cutmarks helps account for fragmentation by providing an overall characterization of longbone locations that exhibit cutmarks (Lyman 2008:285).

Table 2.1. Cutmarks on Par-Tee forelimb and hindlimb longbones based on location.



	Diaph	Prox	Dist	P_D	P_Di_D	P_Di	Di_D	Total Diaph	Total Multi	%mult	%diap
Femur	10	15	10	15	8	8	3	29	34	49%	42%
Tibia	3	2	17	4	1	0	3	7	8	27%	23%
Fibula	3	0	1	0	0	0	4	4	1	50%	50%
Humerus	14	2	21	14	4	2	14	34	34	48%	48%
Radius	5	8	0	2	0	2	1	8	5	28%	44%
Ulna	6	15	7	0	1	2	0	9	33	10%	29%

In the Par-Tee sample 29 femora, seven tibiae, four fibulae, 34 humerii, eight radii, and nine ulnae are cutmarked on the diaphysis. Following standard conventions (Binford 1981; Lyman 1991) these diaphysis cutmarks may reflect muscle removal from the element.

Femora and humerii are most frequently cutmarked at the proximal and distal ends (or both). A combined 46 femora are cutmarked at the proximal end and 36 are cutmarked distally. A total of 22 humerii are cutmarked at the proximal end and 53 are cutmarked distally. Tibiae are cutmarked proximally (N=7) and distally (N=25). Conversely, 12 radii are cutmarked proximally and three distally; 18 ulnae are cutmarked proximally and eight distally. I totaled these cutmark locations and labeled a template of sea otter skeleton with these frequencies (Figure 2.22). These groupings suggest that the hip, knee, elbow, and ankle joints were intensively processed relative to other joints. When the % NISP cutmarked is calculated by major joint, the hip (38%) and elbow (36%) joints actually rank below the ankle joint (42%) in overall processing (Figure 2.23).

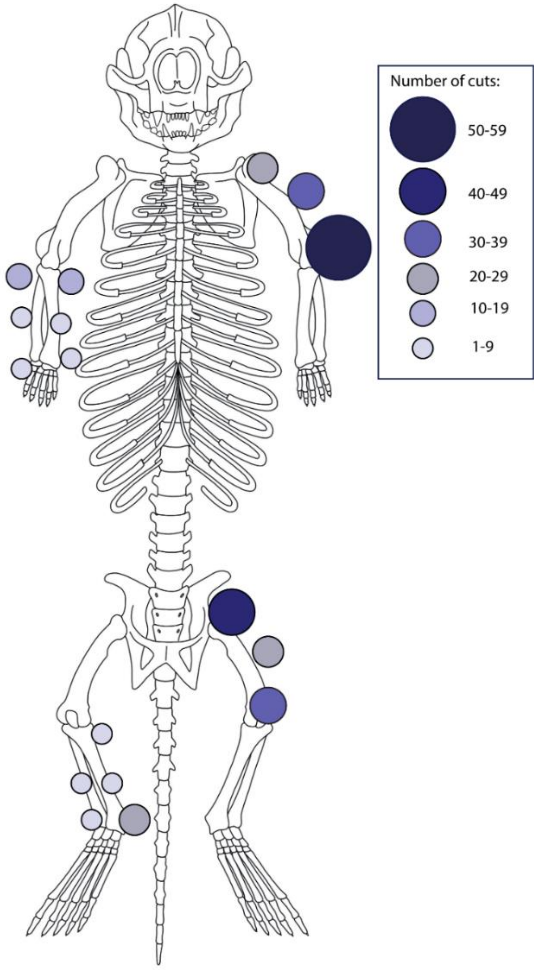


Figure 2.22. Sea otter skeleton with total longbone cutmarks from the Par-Tee sample tallied by location (Table 2.1). Circle size and color corresponds to number of cuts at location (proximal, distal, diaphysis). Illustration by Keeley Davies.

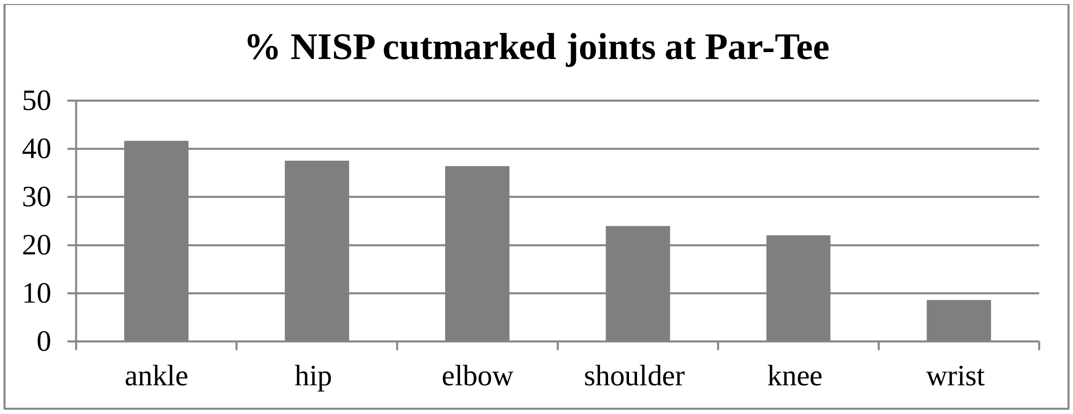


Figure 2.23. Percent NISP of sea otter elements cutmarked in the Par-Tee sample (calculated by joint).

Some complete individual elements provide an additional impression of cutmark intensity. For example, 15 complete femora are cutmarked at both ends and eight are cutmarked at both ends and the diaphysis; 14 complete humerii are cutmarked at both ends and 4 are cutmarked at both ends and diaphysis. Tibiae, radii, and ulnae do not follow these patterns, instead exhibiting more cutmarks at the articular ends (either distal/proximal or both).

2.5.1.7 Par-Tee Cutmark Patterns. The Par-Tee sample yielded a notably high overall proportion of cutmarked specimens (37%), especially compared to the proportions found by Moss (13%; 2020:210) and Lyman (18% and 19%; 1991:151, 227). The humerii and femora are cutmarked in multiple regions and are overall more intensively cutmarked than the tibiae, ulnae, and radii (including when calculated by percentage [% multi, Table 2.1] to account for the higher NISP of femora and humerii). Femora and humerii specimens show relatively large numbers of cuts to the diaphysis (which may indicate muscle removal, interpreted as "filleting" by Lyman [1991]) but there are more cutmarks to the distal and/or proximal epiphyses at the hip, elbow, and ankle joints (Figure 2.22). The hip joint was also intensively processed at the Umpqua-Eden site (Lyman 1991:156) and in Moss's analysis (2020:211). The processing on the hip and elbow joints could indicate dismemberment (Lyman 1991; Binford 1981) or skinning (Moss 2020; Val and Mallye 2013). The processing at the ankle joint could also reflect both, but the distal tibiae cutmarks correspond to the cutmark activity recorded in that location by

Val and Mallye (2013). A large proportion of tarsals at Par-Tee are cutmarked, corresponding with the distal tibiae cutmarks. The distal humerii and proximal radii/ulnae exhibit more cutmarks which could reflect dismemberment or skinning; Moss (2020:212) reported the forelimbs were pulled tightly into the body requiring extra leverage at the elbow joint during skinning. These cutmarks could also reflect efforts to remove the lower forelimb from the humerus. The axial skeleton is cutmarked, possibly indicating backstrap/thoracic muscle removal, and the mandibles are cutmarked primarily in locations associated with skinning.

2.5.2 Cutmarks at Palmrose

2.5.2.1 Cutmark Sample. The Palmrose sample contained 160 cutmarked specimens, or 17% of the overall NISP: 11% of juvenile elements and 18% of adult elements are cutmarked. Innominates dominate % NISP cutmarked (Figure 2.24), followed by tibiae/fibulae (driven by tibiae), humerii, femora, and tarsals (driven by calcaneii/astragali). There is an average of three cutmarks per specimen in the assemblage, (lower than at Par-Tee), and the highest average for a specific element is the average of five cutmarks per humerus, tibia, and ulna.

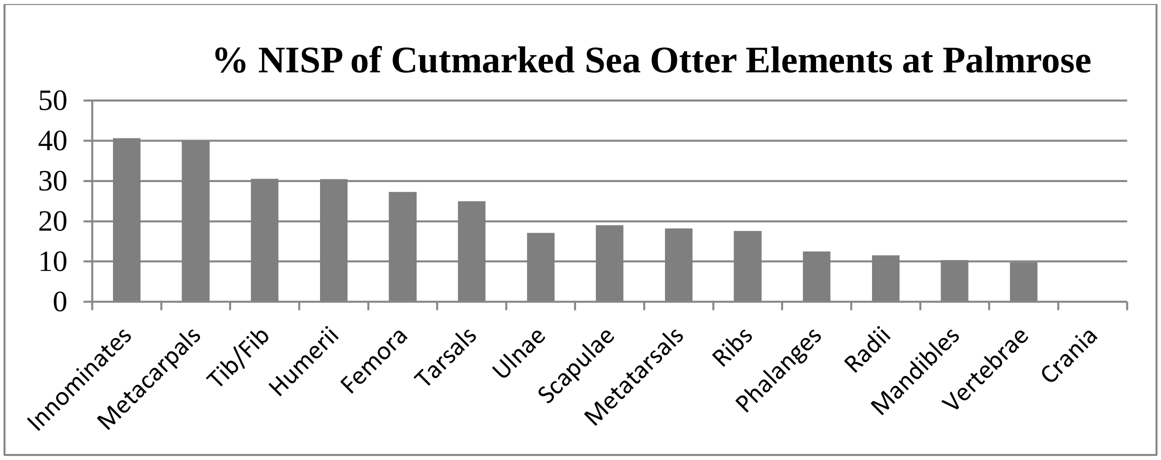


Figure 2.24. Abundance (% NISP) of cutmarked sea otter elements in the Palmrose sample.

The % NISP of cutmarked elements follows patterns described in Moss' results. Sea otter innominates, tibiae, humerii, ulnae/radii, and mandibles are cutmarked at both Palmrose and the Angoon sites, but at higher proportions at Palmrose (Moss 2020:211).

Moss found sea otter femora and humerii (closely followed by vertebrae) had the highest % NISP cutmarked (2020:211). At Palmrose, innominates and tibiae/fibulae represent the highest % NISP cutmarked, followed by humerii and femora. Moss recorded ~20% of vertebrae cutmarked, while at Palmrose only ~10% are cutmarked. At Palmrose ~27% of femora are cutmarked, as opposed to ~38% of sea otter and 70% of seal specimens from the Angoon sites. Cutmarked innominates at Palmrose are intermediate (~41%) to the cutmarked sea otter and seal innominates reported in Moss (roughly 10% and 50%, respectively).

Fewer elements (N=14) are cutmarked at Palmrose (compared to 20 at Par-Tee) but this still represents a greater diversity of elements cutmarked compared to the 8 seal elements reported by Moss (2020) and is comparable to the 12 elements cutmarked at Seal Rock/Umpqua Eden (Lyman 1991;154, 228). It may indicate that sea otters were more intensively processed at Par-Tee than Palmrose, but the smaller sample size from Palmrose may also be driving this pattern (fewer bones identified means fewer opportunities to identify cutmarks).

2.5.2.2 Cutmarks on the Axial Skeleton. Sterna and sternabrae at Palmrose are not cutmarked. Roughly ~70% of ribs exhibit cutmarks on the shaft and ~30% exhibit cutmarks on the head and/or neck. Cutmarks on the rib shaft may result from peeling the pelt away from the rib cage or stripping thoracic muscles. The rib head/neck cutmarks may reflect skinning or removing ribs from vertebrae. Vertebrae are cutmarked on processes or on the ventral centrum. Cutmarks to spinous processes may be the result of backstrap muscle removal, while ventral cutmarks may be from rib removal or gutting the animal (Moss 2020:215). At Palmrose, processes and vertebral centra are cutmarked roughly equally. Following Moss, these cutmarks may indicate backstrap removal for either human or dog consumption (2020).

2.5.2.3 Cutmarks on the Forelimb. Scapulae at Palmrose (like Par-Tee) are cutmarked on the ventral blade surface, often on the edges of the subscapular fossa. The cutmarks may have resulted from separating the scapula from the rib cage. Humerii are cutmarked at various locations including inferior to the caput, on the lateral diaphysis, anterior trochlea, and on/near the medial epicondylar ridge and foramen. Radii are cutmarked on the diaphyses but not on epiphyses. Ulnae are cutmarked proximally, distally, and on the diaphysis in roughly equal numbers. The ulnae/radii cutmarks at Palmrose do not exhibit clear patterning like at Par-Tee. Cutmarks to the radii may reflect skinning (following Val and Mallye 2013:236), while the ulnae cutmarks may reflect skinning, filleting, or disarticulation. The bones of the forepaws (manus phalanges, metacarpals, and carpals) are underrepresented at Palmrose, but several metacarpals exhibit cutmarks on the palmar surface and likely reflect skinning.

2.5.2.4 Cutmarks on the Hindlimb. Innominates are cutmarked in various locations. Repeated locations include those described at Par-Tee, such as the iliofemoral ligament attachments and the gluteus medius. These cutmarks could reflect leverage applied to the joint while skinning following Moss (2020), or disarticulation of the hindlimb at the hip joint. Femora are cutmarked on the diaphyses and epiphyses in roughly equal numbers. Cutmarks on the proximal end are at muscle insertions (e.g. the greater/lesser trochanter). Femoral necks (the location of the iliofemoral ligaments) are frequently cutmarked. Distal cutmarks are frequently superior to the lateral and medial condyles (on or near the gastrocnemius origin). Tibiae are cutmarked equally across diaphyses and epiphyses. One tibia is cutmarked repeatedly along the anterior crest which may reflect disarticulation or skinning following Val and Mallye (2013:234). Distal tibiae cutmarks are on/near the medial malleolus. One fibula is cutmarked proximally with small nicks, similar to Moss' experimentally skinned sea otter (2020). Cutmarks on the astragalus, calcaneus, and other tarsals likely reflect skinning (Val and Mallye 2013), but may also be due to disarticulation (following Binford 1981).

2.5.2.5 Cutmarks on the Cranium. The cutmarked Palmrose mandibles exhibit cutmarks on the lateral horizontal ramus, reflecting skinning. Maxillae fragments at Palmrose are not cutmarked.

2.5.2.6 Cutmark Patterns on Longbones. I categorized longbone cutmark locations for each Palmrose specimen (Table 2.2). Unfortunately, the sample size of cutmarked elements at Palmrose is smaller than at Par-Tee, so patterns evident in the Par-Tee sample are not as clear in the Palmrose sample.

Table 2.2. Cutmarks on Palmrose forelimb and hindlimb longbones based on location.

	Diaph	Prox	Dist	P_D	P_Di_D	P_Di	Di_D	Total Diaph	Total Multi	%mult	%diap
Femur	3	2	2	1	0	1	0	4	2	22%	44%
Tibia	3	1	4	1	0	1	0	4	2	20%	40%
Fibula	1	0	0	0	0	0	0	1	0	0%	100%
Humerus	6	4	2	0	0	0	2	8	2	14%	57%
Radius	3	0	0	0	0	0	1	4	1	33%	100%
Ulna	0	2	2	1	0	1	0	1	2	29%	14%

From Palmrose, four femora, eight humerii, four tibiae, one fibulae, four radii, and one ulnae are cutmarked on the diaphysis. Following standard conventions (Binford 1981; Lyman 1991) these diaphysis cutmarks may reflect muscle removal from the element.

Distribution of cutmarks across Palmrose longbone locations is roughly equal when visualized across the skeleton (Figure 2.25), unlike the Par-Tee sample in which proximal femora and distal humerii were clearly intensively processed (Figure 2.22).

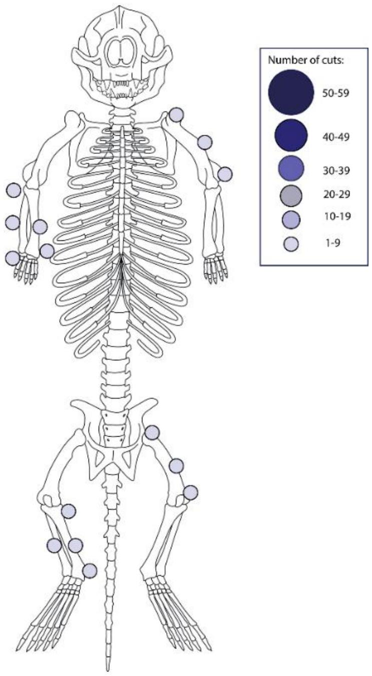


Figure 2.25. Sea otter skeleton with total longbone cutmarks from the Palmrose sample tallied by location (Table 2.2). Circle size and color corresponds to number of cuts at location (proximal, distal, diaphysis). Illustration by Keeley Davies.

The humerii at Palmrose do exhibit slightly more diaphysis cutmarks, and tibiae exhibit slightly more distal cutmarks; both of these patterns are also present at Par-Tee. When the % NISP cutmarked is calculated by major joint, the hip (26%) and ankle (21%) appear to be slightly more intensively processed compared to the shoulder (12%), knee (9%), and elbow/wrist (7%) (Figure 2.26).

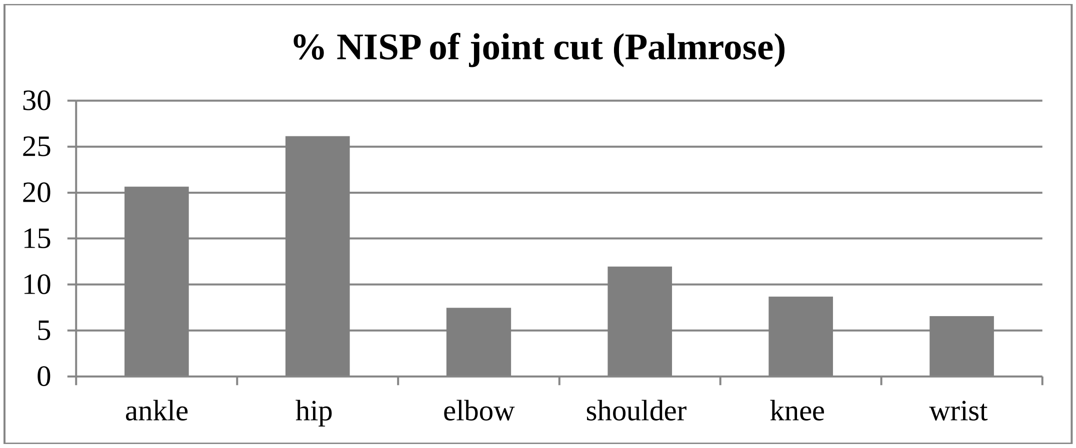


Figure 2.26. Percent NISP of sea otter elements cutmarked in the Par-Tee sample (calculated by joint).

2.5.2.7 Palmrose Cutmark Patterns. The proportion of specimens exhibiting cutmarks at Palmrose (17%) is smaller than that at Par-Tee (37%), but similar to those reported by Moss (13%; 2020:210) and Lyman (18% and 19%; 1991:151, 227). Fewer specimens exhibit cutmarks on the diaphysis, although humerii and radii do exhibit slightly more on the diaphysis compared to the proximal/distal ends. Unlike at Par-Tee, femora, humerii, tibiae, radii, and ulnae do not exhibit high concentrations of cutmarks on the distal and proximal ends, and no single joint is intensively processed when visualized across the skeleton (Figure 2.25). When calculated as % NISP cutmarked by joint, however, the hip and ankle do appear to exhibit relatively more processing (as at Par-Tee), which could indicate dismemberment (Lyman 1991; Binford 1981) or skinning (Moss 2020; Val and Mallye 2013). Mandibles at Palmrose are also cutmarked in locations consistent with skinning, and cutmarks on the axial skeleton may indicate backstrap/thoracic muscle removal.

2.6 Sea Otter Use at Par-Tee and Palmrose

2.6.1 Skinning and Pelt Removal

Par-Tee and Palmrose sea otters (both adult and juvenile) were skinned for their pelts. Evidence for skinning includes cutmarks at expected locations on the skeleton, as well as at locations not conventionally considered associated with skinning but identified by Moss (2020) and Val and Mallye (2013). Both sites contain cutmarked mandibles (adult and juvenile), tarsals (especially astragali and calcaneii), distal medial tibiae (especially at Par-Tee), metatarsals, metacarpals, and phalanges. Both sites also contain elements that were cutmarked at locations found on Moss' experimentally skinned sea otter: ribs, radii, ulnae, metacarpals, innominates, proximal femora, fibulae, and sternabrae. Val and Mallye (2013) also recorded skinning cutmarks on radii/ulnae and tibiae/fibulae.

Radii and ulnae in Val and Mallye's study were cutmarked in areas where fascia were absent on the diaphysis, as well as parts of the olecranon process and proximal radius (2013). Cutmarks are found in some of these locations on the Par-Tee/Palmrose radii/ulnae and Umpqua-Eden/Seal Rock ulnae (Lyman 1991:154, 228), as well as in additional locations lacking musculature (following Howard's [1973] sea otter forelimb anatomy) suggesting skinning. In Moss' observation of the skinning process, the sea otter's forelimbs were drawn in towards the body, making them difficult to work around as Mr. Barry removed the pelt (Moss 2020:212). Cutmarks to the radius and ulna may reflect the difficulty of prying the pelt away from the elbow joint.

Val and Mallye also recorded cutmarks on the proximal and distal parts of the fibula diaphysis (a pattern found in Moss [2020] and on the Par-Tee/Palmrose fibulae), as well as along the medial tibial shaft, medial malleolus, and anterior crest/shaft (also present on the Par-Tee/Palmrose and Umpqua-Eden/Seal Rock sea otters [Lyman 1991:156, 228]).

Contrary to Val and Mallye (2013) and Moss (2020), Lyman categorized cutmarks on the fibular lateral malleolus as dismemberment, tibiae cutmarks (except those on the medial malleolus) as filleting or dismemberment, and all radii/ulnae cutmarks as filleting or dismemberment (Lyman 1991:154, 156, 228). Lyman attributed cutmarks on most Umpqua-Eden/Seal Rock calcaneii and all astragali, metatarsals, and innominate pubises to skinning (1991:155-156, 228). The mandibles from Umpqua-Eden/Seal Rock did not exhibit cutmarks on the horizontal ramus, but did on the ascending ramus (which Lyman [1991:154, 228] categorized as dismemberment).

To summarize, cutmarks to the mandibles, maxillae, tibiae/fibulae, tarsals, metatarsals, phalanges, radii, ulnae, and metacarpals in the Par-Tee and Palmrose assemblages are likely skinning cutmarks. Cutmarks to the ribs, innominate, and femora may reflect skinning, but may also indicate disarticulation or muscle removal.

2.6.2 Additional Processing

Some cutmark locations cannot be explained by skinning and likely reflect disarticulation or muscle removal. Cutmarks on vertebral processes and ventral centra are unlikely to result from skinning. Val and Mallye did not record cutmarks associated with skinning activity on cervical, thoracic, or lumbar vertebrae, and only found several cutmarks on ribs (2013). Ribs are cutmarked at similar frequencies at both Par-Tee and Palmrose, but fewer vertebrae are cutmarked at Palmrose (Figure 2.27). Moss (2020:215) suggested cutmarks to the vertebral processes and ribs are from partitioning the axial skeleton and stripping the backstrap for muscle. Cutmarks to the ventral vertebral centra may reflect rib disarticulation, gutting, or other processing in the abdominal cavity. Axial elements were not consistently reported in the Umpqua-Eden/Seal Rock assemblages, and none were cutmarked (Lyman 1991).

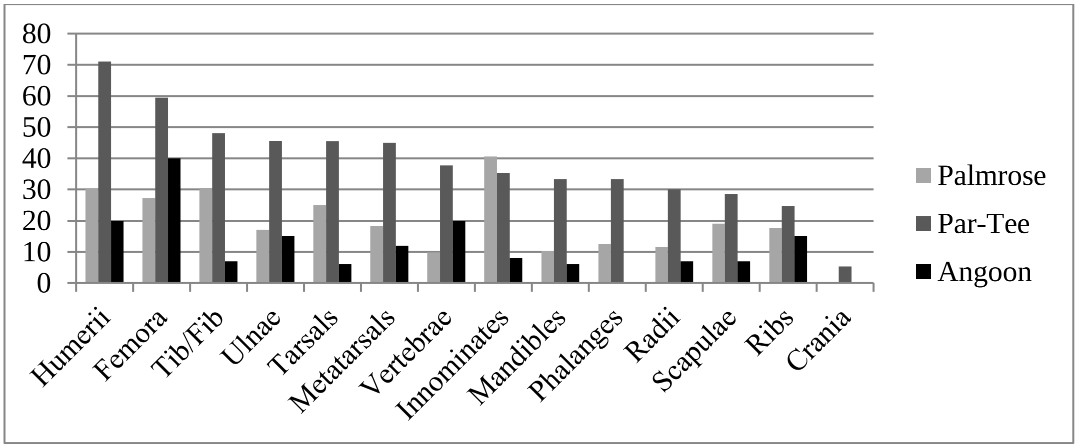


Figure 2.27. Percent of cutmarked sea otter elements comparing Palmrose and Par-Tee assemblages (this study) and Tlingit assemblages near Angoon (Moss 2020).

Par-Tee and Palmrose scapulae are cutmarked on the ventral surface, which may reflect efforts to remove the entire forelimb by working under the scapula and pulling it away from the ribcage. Binford (1981) categorized dorsal cutmarks to the scapula as filleting, but did not discuss ventral cutmarks. Lyman (1991:321) categorized all scapulae cutmarks as filleting. At Par-Tee, relatively few humerii are cutmarked proximally, suggesting that forelimb disarticulation was not occurring at the shoulder joint, but at the scapula and rib cage.

The humerii at Palmrose are cutmarked relatively evenly across locations, while humerii at Par-Tee are frequently cutmarked on the diaphysis and distally (the latter corresponding with an abundance of proximal radii/ulnae cutmarks). The distal humerii and proximal radii/ulnae cutmarks may indicate disarticulation at the elbow joint following Binford (1981) and Lyman (1991), but may also reflect skinning following Val and Mallye (2013) and Moss (2020). The humerii at both Par-Tee and Palmrose exhibit large numbers of diaphysis cutmarks. Based on the high frequency of cutmarked humerii at both sites, cutmarks to the humerii cannot be explained by skinning alone, and it appears that the upper forelimb underwent multiple stages of processing and possible muscle removal.

Some cutmarks on the radii/ulnae may indicate efforts to separate the two elements, especially cutmarks on or near the pronator teres muscles and interosseous membrane. The lower forelimb has less muscle mass than the humerus and hindlimb, so the intensive processing on the lower forelimb may have been directed at obtaining raw materials for tool manufacture. Sea otter bacula were used for tool manufacture at Par-Tee (Robert Losey, personal communication, 7/23/2019), and both sites contain small artifacts that could have been manufactured from any of the sea otter forelimb bones.

Hindlimb removal at the hip appears likely based on the high frequencies of cutmarked femora and innominates (especially compared to Moss [2020:211], Figure 2.27). Moss determined hip cutmarks could result from leverage while pulling the pelt away (2020:211) but the innominates at Par-Tee and Palmrose are cutmarked at frequencies too high to be accounted for by skinning alone. The femora at both sites are also cutmarked distally, frequently at the gastrocnemius origins. These cutmarks may reflect processing activity at the knee joint such as dismemberment. The femora at Par-

Tee and Palmrose (like humerii) exhibit high frequencies of diaphysis cutmarks. It is likely the femora were being disarticulated and processed further, possibly including muscle removal.

To summarize, cutmarks to the vertebrae, ribs, and humerii may reflect disarticulation and muscle removal. Cutmarks to the innominates, femora, radii, and ulnae may reflect skinning, as well as disarticulation or dismemberment and possible muscle removal.

2.6.3 Skinning Strategies

When Moss conducted her experimental sea otter skinning study, Mr. Barry removed the pelt whole. Moss (personal communication, 12/11/20) noted this is culturally-specific and we should not expect all societies to skin sea otters with the same goals or outcomes. Perhaps the tribal ancestors at Par-Tee and Palmrose did not remove the pelt whole, but instead divided carcasses prior to skinning. Such a system would result in dismemberment cutmarks as well as different skinning patterns (attempting to skin just a forelimb or hindlimb, for example, would change points of entry and leverage angles). Sea otters are large animals; pieces of a pelt could yield enough material to trim items of clothing or accumulate quickly over hunts to sew larger items. Ray noted sea otter robes were made by two skins sewn together or with strips of sea otter pelt “twisted and woven by twining with thin, strong cords” (1938:137). The latter method would not necessarily require an intact pelt.

2.6.4 Sea Otter for Supper?

Vertebrae, innominates, femora, and humerii at Par-Tee and Palmrose may have had muscle stripped from diaphyses, but what was the exact purpose of these cutmarks? Was muscle removed for consumption by humans, to feed to dogs, or to clean the bone as a source of raw material? An unpublished sea otter meat utility model (Lucy Lewis Johnson, personal communication to Moss 2016) ranked elements in the following order: vertebrae, ribs, pelvis, tibia/fibula, metatarsals, tarsals, femur, scapula, cranium, bulla, mandible, humerus, radius, ulna, metacarpals, carpals, and phalanges. The meat utility ranking may explain the high percentage of expected abundances of innominates, tibiae, and femora at both Par-Tee and to a lesser degree at Palmrose (Figure 2.3 & Figure 2.10). A relatively high percentage of expected humerii, ulnae, and radii are also present at both sites (especially humerii at Palmrose) (Figure 2.3 & Figure 2.10) but these elements are ranked at the bottom of the meat utility index. Despite their high ranking in the meat utility index, vertebrae/ribs are underrepresented at both sites and less frequently cutmarked, particularly at Palmrose (Figure 2.27). Metatarsals are somewhat well-represented, highly ranked in the meat utility index, and also frequently cutmarked. Metatarsals may have been processed for muscle removal, but cutmarks to metatarsals are also consistent with skinning (Lyman 1991; Moss 2020; Val and Mallye 2013). Other relatively highly ranked elements are cutmarked in higher proportions, such as femora and tibiae at Par-Tee, and innominates and tibiae at Palmrose (Figure 2.27). The cutmarks on tibiae at both sites strongly indicate skinning following Val and Mallye (2013), but perhaps cutmarks to the femora and innominates indicate occasional muscle removal for dietary purposes.

Neither the Par-Tee nor Palmrose samples contain zooarchaeological evidence for cooking sea otter. Only four specimens are burned: an innominate fragment and olecranon process fragment are charred at Par-Tee, and a rib shaft and baculum fragment at Palmrose exhibit burning and early stages of calcination. The Chinook and Tillamook reportedly boiled fish and meat in containers and trenches using hot rocks and roasted meat in earth ovens along with other food items such as camas (Jacobs 2003:76; Ames and Sobel 2013:135). These methods, if used precontact, would not leave evidence of cooking on the bones.

Both Palmrose and Par-Tee sea otter remains exhibit carnivore gnawing, although it is unknown if domestic dogs were at the sites. Colten (2015:262) reported “canids” at both Par-Tee (NISP=18, MNI=1) and Palmrose (NISP=93, MNI=2). The gnawed elements often co-occur in units with cutmarked elements, although only a few elements are both gnawed and cutmarked (seven at Par-Tee, and six at Palmrose). Excavation units containing gnawed elements at Palmrose are primarily located in or adjacent to the house feature (within ~10 feet/3 m) with a concentration to the east of the north house wall (Figure 2.28). Par-Tee units containing gnawed elements are concentrated in the northeast and southwest corners of the excavated areas, but are present in several other units dispersed across the site. Ethnographic records recorded that Tillamook dogs were trained to help in game drives (Sauter and Johnson 1974:80). Skilled hunting dogs were called “elk charmers” and were said to be able to charm an elk to stand still (Jacobs 2003:75). If dogs were also important hunting partners precontact, perhaps sea otters were hunted for their pelts and then butchered or otherwise processed for feeding dogs (especially given the proximity of gnawed sea otter remains to the house at Palmrose). Moss (2020:213) also suggested that the Tlingit processed sea otters to feed their dogs. Boas (1898:30) recorded a Tillamook story in which men shoot a sea otter and arrive at a village where the chief accuses them of shooting his dog which he had “sent across the sea to hunt elk.” This story affirms Tillamook dogs as hunting partners, and also presents an intriguing juxtaposition of sea otters and dogs.

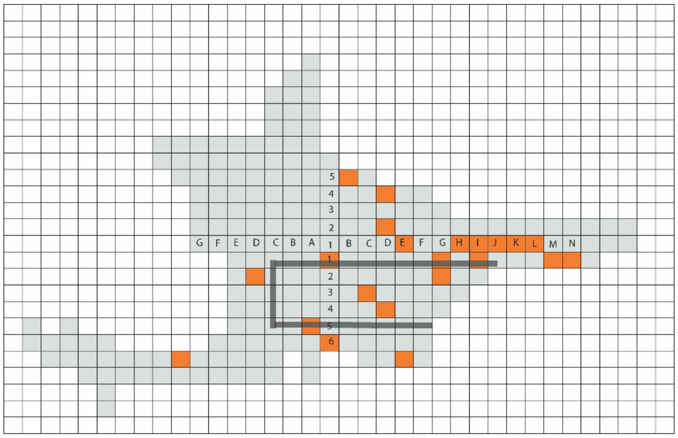


Figure 2.28. Palmrose excavation units (orange) containing gnawed sea otter elements in relation to the house feature (shaded outline). Map adapted from Connolly (1992).

2.6.5 Alternative Food Items at Seaside

Archaeologists frequently seek to explain human behavior related to subsistence. Explanations of why and how precontact hunter-gatherer-fishers on the Northwest Coast selected resources has been studied under different frameworks such as Traditional Ecological Knowledge, historical ecology, and optimal foraging models (Campbell and Butler 2010; Cannon 2002; Lepofsky and Caldwell 2013; Moss 1993). Optimal foraging models presume humans will behave in ways that maximize fitness (Broughton et al. 2010) and therefore target prey that yields the greatest energetic tradeoff (Bird and O’Connell 2006). These models will not be formally tested in this study, but it is important to consider how sea otters may have ranked relative to other potential food species available to the inhabitants of Par-Tee and Palmrose.

Sea otter use by the Salmon River Tillamook was reportedly limited to clothing and bedding, while California and Steller sea lions, harbor seals, porpoises, and gray whales were considered food sources (Zobel 2002:309). Clara Pearson listed deer, elk, seal, sea lion, beaver, fowl, and whale grease as important food items (Jacobs 2003:75, 81). Whale meat and blubber were highly prized food items amongst the Tillamook (Sauter and Johnson 1974:99). Ray (1938:114) noted the importance of whales and porpoises to the Chinook, and noted that whether "humans ate sea otter meat is ambiguous." Vernon Bailey (1936:349) described harbor porpoises as important prey species; "the Indians [specific group unclear] frequently shoot or capture them in the sheltered coastal waters and regard their flesh as a great delicacy." Sauter and Johnson (1974:5) stated that "otters" were eaten, but it is unclear if they are referring to river or sea otter. Bailey (1936: 305) noted that sea otters can "become very fat and are reported by some to be good eating and by others as not fit for human food," similar to contradictory information Moss reported from Tlingit informants (Moss 2020:213). Hall (2019) reports that sea otters are frequently the most abundant marine mammal in coastal Oregon assemblages, but that may be due to pelt acquisition and incidental/occasional meat consumption.

In the Umpqua-Eden and Seal Rock assemblages, Lyman (1991) categorized cutmarks on sea otter remains as "filleting," but did not explicitly state that this was indicative of muscle removal for meat consumption. Lyman reported comparatively intense cutmarking on sea lion remains from Seal Rock (984 NISP, with ~50% cutmarked [1991:229]) compared to sea otters (141 NISP, ~18% cutmarked). At Umpqua-Eden, seal remains (1303 NISP, with ~11% cutmarked [1991:157]) also greatly outnumbered sea otter (302 NISP, ~19% of which were cutmarked). The seals at Umpqua-Eden underwent "extensive and regular disarticulation" at the hip joint (Lyman 1991:162), similar to the seals consumed by the Tlingit in Moss' study (2020:215). Sea otters were also frequently processed at the hip joint at Umpqua-Eden (Lyman 1991:156) and apparently at Par-Tee and Palmrose (Figure 2.27). Following Moss's findings, the hip joint processing may indicate both seals and sea otters were a dietary focus at

Umpqua-Eden. Seals at Umpqua-Eden, however, were four times as abundant as sea otters (Lyman 1991:157) (and sea lions similarly outnumber sea otters at Seal Rock [Lyman 1991:229]). Lyman's cutmark drawings of seal/sea lion elements suggest these species were cutmarked intensively and consistently on the anterior and posterior diaphyses of longbones, although there are some shared cutmark locations on the sea otters (Lyman 1991:162, 232).

Sea otter meat could have been consumed at certain times of the year when preferred prey items were unavailable or scarce, although other maritime resources would have been available to the Palmrose and Par-Tee inhabitants year round (Colten 2015:273; Greenspan and Crockford 1992:164). Resident gray whales are found off the Oregon coast all year; migratory individuals head south in December/January and north in the spring (Oregon Department of Fish and Wildlife [ODFW] 2021a). Returning north, gray whale females and their calves swim close to shore (ODFW 2021a) making them vulnerable to stranding (Geraci and Lounsbury 1993; Norman et al. 2004) or hunting (Loiselle 2020; Losey and Yang 2007; Ray 1938; Wellman et al. 2017). Humpback whales are found off the Pacific Coast through the fall, and Pacific white-sided and bottlenose dolphins are present in the summer (ODFW 2021a). Seals, sea lions, and Harbor/Dall's porpoises are available year round (ODFW 2021a). All of these species have been identified at the Par-Tee and Palmrose assemblages (Colten 2015; Greenspan and Crockford 1992; Loiselle 2020). Palmrose contained especially large numbers of Steller sea lion (NISP = 179) and fur seal (NISP = 105) (Colten 2015:261) and porpoises and large whale are abundant at Par-Tee (Colten 2015; Loiselle 2020).

Greenspan and Crockford (1992:164) concluded that Palmrose may have been inhabited year round and/or intensively in the late summer/early fall, following the Clatsop seasonal round and salmon season. Partial or full sedentism seems likely given the evidence for the frequently rebuilt plank house at Palmrose (Aikens et al. 2011; Connolly 1992). Habitation may have been adequately supported by salmonid capture/storage and supplementation by other fishes (Sanchez et al. 2020), shellfish (especially late winter-early spring when vertebrate fauna were more "weakly represented" [Greenspan and Crockford 1992:164]) and marine and terrestrial mammals (Colten 2015). Habitation patterns at Par-Tee may reflect seasonal encampment, although

Phebus and Drucker do not explain their logic in detail (Phebus and Drucker 1979), nor have subsequent analyses confirmed seasonality (Colten 2015). The Par-Tee assemblage lacks salmonids but contains rockfish/lingcod and possible evidence for mass-capture of other diverse fish species (Sanchez et al. 2020). Colten (2015:273) noted an abundance of pelagic birds and resident marine mammals which could support seasonal visits/habitation in the area as needed.

Modern sea otters give birth year round (Monson and DeGange 1995:1165; Riedman et al. 1994:393), although regional variables (e.g. food availability, weather conditions) may contribute to seasonal pupping tendencies in the late winter and early spring (Jameson and Johnson 1993:164). The Par-Tee/Palmrose sea otters who are lacking permanent M_1s but have fully-erupted pm$_4$s (between approximately one and five months of age [Nicholson et al. 2014]) could therefore have been hunted year round, or following modern seasonality, anytime in late winter through the fall. If sea otter pups reflect spring through fall hunting activity, they partially overlap with elk (Jacobs 2003:75) and salmon seasons (Greenspan and Crockford 1992:161). Sea otters almost always co-occur in units/levels with cetaceans at both sites, indicating that sea otters and cetaceans were at least deposited at similar times. If porpoises and dolphins were considered valuable food resources, sea otters were probably not replacing them as a dietary resource.

Ray notes that sea otters were “previously easily caught” (although it is unclear what era “previously” is referencing [1938:114]). Mortality in modern female sea otters increases at the end of lactation due to the energetic demands of reproduction (Thometz et al. 2016), and females “are often emaciated during late pup dependency” (Chinn et al. 2016). Perhaps females and weaning/newly weaned pups were especially vulnerable and easily captured, and taken out of convenience. According to Meriwether Lewis (2005, journal entry February 23rd, 1806) “the fur of the infant [sea] Otter is much inferior in point of colour and texture to that of the full grown otter, or even after it has been weaned,” so it is unclear if pups would have been targeted for their fur.

An additional possibility is that sea otters were hunted close to shore or in proximity to villages to keep them from eating invertebrate prey harvested by humans, such as clams and mussels. This strategy has been documented in the archaeological record of other regions along the Pacific Coast (Erlandson et al. 2008; McKechnie and Wigen 2011; Salomon et al. 2015; Szpak et al. 2012) and maintaining this balance remains a concern for Indigenous peoples who share coastal landscapes with sea otters today (Burt et al. 2020; Ibarra 2021; Salomon et al. 2018).

2.7 Comparing Par-Tee and Palmrose Assemblages

The Par-Tee sea otter assemblage (2024 NISP) is more than twice as large as that from Palmrose (968 NISP). At Par-Tee, 54 MNI are represented, with 24 of these as juveniles, whereas at Palmrose, 22 MNI are represented, with 7 juveniles. Juveniles are present at both sites (44% of MNI at Par-Tee, and 32% of MNI at Palmrose), usually in association with adults, and sea otter pups are at or under weaning age. Both sexes are represented at both sites (directly by bacula and indirectly by pups under weaning age). Palmrose contains more gnawed elements despite its smaller sample size (N=38, 3.9% NISP) than Par-Tee (N=28, 1.3% NISP), possibly indicating more provisioning of dogs earlier in the occupation of the Seaside area. The most substantial differences between sites are in % NISP cutmarked (37% at Par-Tee and 17% at Palmrose), which could indicate intensified processing of sea otters for pelts and/or dietary consumption later in time in the Seaside area.

At both Par-Tee and Palmrose the most abundant elements are vertebrae, ribs, and metatarsals (Figure 2.29). Despite their raw abundance, these elements are underrepresented at both sites, (based on MNI, see Figure 2.3 & Figure 2.10) because an individual carcass contains so many. In terms of expected abundances based on MNI, femora, innominates, humerii, and ulnae at both sites (plus tibiae at Palmrose) are the most well-represented (>60%), although specific rank order differed (Par-Tee: femora, innominates, humerii, ulnae; Palmrose: humerii, ulnae, femora, innominates, tibiae). As discussed above, the meat utility ranking may explain the expected abundances of innominates, tibiae, and to a lesser degree, femora (Figure 2.3 & Figure 2.10), but not the expected abundances of humerii and ulnae (Figure 2.3 & Figure 2.10). Despite their high ranking in the meat utility index, vertebrae/ribs are underrepresented at both sites and less frequently cutmarked, particularly at Palmrose (Figure 2.27).

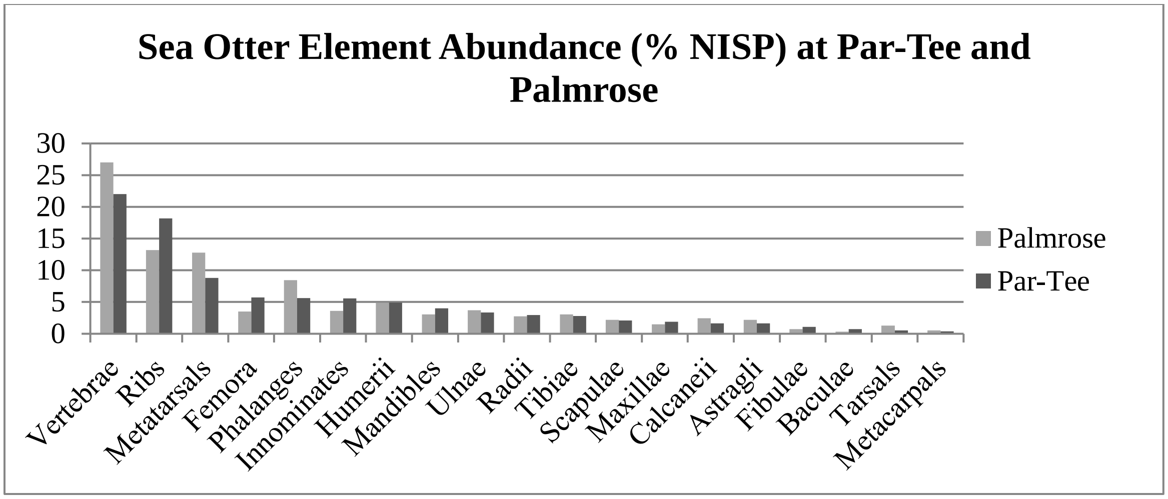


Figure 2.29. Sea otter element abundance (% NISP) at the Par-Tee and Palmrose sites.

At Par-Tee the most frequently cutmarked elements are humerii, femora, and tibiae/fibulae, closely followed by tarsals/metatarsals (Figure 2.14 & Figure 2.27). At Palmrose, innominates, tibiae/fibulae, and humerii are the most frequently cutmarked, followed by femora and tarsals (Figure 2.24 & Figure 2.27). Elements at Par-Tee are cutmarked at higher proportions than Palmrose, except for innominates which are cutmarked ~40% at both sites (Figure 2.27). Following the sea otter meat utility index, the most frequently cutmarked element at Palmrose (innominates) is ranked 3rd, and the most frequently cutmarked element at Par-Tee (humerii) is ranked 11th. Tibiae/fibula, tarsals/metatarsals, and femora are ranked 4th, 5th, and 7th, respectively, in the meat utility index. These results may suggest that these elements were not cutmarked as a result of meat removal, or that the meat utility index is flawed and does not account for factors like culturally specific food preferences/processing strategies. Another possibility is that these elements did have meat removed for dietary consumption, but that sea otter meat did not constitute a dietary staple compared to animals which would yield overall higher meat quantities (such as elk, cetaceans, seals, etc.).

The cutmarks on tibiae at both sites strongly indicate skinning following Val and Mallye (2013). The ankle joints are relatively intensely processed and distal tibiae are more frequently cutmarked than diaphyses (Figure 2.22 & Figure 2.25). This pattern suggests skinning (or even disarticulation of the hindfoot) rather than muscle removal from the diaphysis, especially when considering the high proportion of tarsals and metatarsals that also exhibit cutmarks (Figure 2.27). All combined, however, the tibiae, metatarsals, and tarsals could potentially indicate meat removal as they are ranked 4th, 5th, and 6th in the meat utility index.

Humerii are frequently cutmarked and well-represented at both sites, but rank 11th in the meat utility index, suggesting muscle removal for dietary consumption was unlikely. Humerii at Par-Tee exhibit cutmarks on the diaphyses, but the distal ends exhibit relatively intense processing (corresponding with cutmarks on the proximal radii/ulnae which are also ranked low for meat utility) (Figure 2.22). Palmrose humerii are well-represented and frequently cutmarked, but not at the scale of Par-Tee (Figure 2.27). Perhaps elbow joints at Par-Tee were disarticulated to procure the bones as raw materials, or skinning strategies changed over time.

Femora and innominate cutmarks at both Par-Tee and Palmrose probably reflect a combination of pelt removal and dismemberment, although the high % NISP at Par-Tee may suggest intensive dismemberment and processing on the femora in particular, since innominates are cutmarked at a lower proportion (Figure 2.27). Perhaps innominate cutmarks reflect skinning as proposed by Moss (2020) at both sites, hence similar % NISP cutmarked, but the higher proportion of Par-Tee femora cutmarks reflect stripping of muscle, dismemberment, or processing for other purposes not occurring at Palmrose.

Elements were overall cutmarked at higher proportions at Par-Tee (Figure 2.27), with cuts at joints and on the diaphysis (Figure 2.22), while cutmarks at Palmrose are evenly distributed across the skeleton (Figure 2.25). It is possible that the smaller sample size of units analyzed at Palmrose influenced these results; fewer specimens analyzed overall means fewer opportunities to identify cutmarks. It may also reflect an increase in cutmark activity later in the occupation of the Seaside area, potentially due to changing skinning strategies, dietary preferences, or increased use of sea otters for raw materials (sinew, bone). It is possible the high % NISP cutmarked at Par-Tee reflects increased muscle removal for dietary consumption by humans, considering the lower frequency of carnivore gnawing compared to Palmrose. Following the meat utility index rankings, element representation, and cutmark frequencies, innominates would be likely targets for muscle removal for dietary consumption, although the overall intensive processing might suggest muscle removal from other elements. While other resources would support year-round habitation of and/or visits to the Seaside area (Colten 2015; Greenspan and Crockford 1992), perhaps the seasonal camp occupation pattern suggested for Par-Tee (Phebus and Drucker 1979) resulted in temporary, yet intensive, overall use of sea otters. It is important to note that if this pattern does reflect a more intensive harvest and/or use of sea otters, there is no evidence to suggest that sea otters were taken above sustainable levels prior to their industrial extraction by Euro-American fur traders/companies (Hall 2019).

2.8 Human-Sea Otter Relationships

Anthropologists have criticized the tendency to evaluate archaeological animal remains in terms of functional-ecological or symbolic value (Noske 1993; Shanklin 1985). In the case of fur-bearing mammals such as sea otters, this functional value is usually a source of pelts and furs (Overton 2016). Nick Overton, writing about fur-bearing mammals in the British Mesolithic, argued:

> Accounts of contemporary hunter-gatherers demonstrate a complex relationship between clothes and wearer, in which fur from different species, and particular parts of species, are used for specific pieces of clothing, referencing significant human–non-human relationships and allowing humans to harness certain non-human abilities through wearing [them] (e.g. Issenman 1997). The experiences and relationships between humans and smaller mammal species […] are equally relevant to discussing the potential significance of the furs humans wore, as well as the skinned bodies they deposited. (Overton 2016:575)

Overton suggested that wearing fur from carnivores "may have allowed humans to harness the stealthy, silent moving affects of wildcat, marten, fox or badger […]. The otter […] may have been used to harness their abilities to swim and negotiate watery contexts such as rivers and marshes" (Overton 2016:575).

Forepaw bones are underrepresented at the Par-Tee and Palmrose sites, and while this may be a result of archaeological recovery techniques or forepaws being removed with pelts, perhaps paws were removed for use as amulets or other animism-related reasons (Overton 2016:574). I make this suggestion with caution – I am a Euro-American writing about a community I am not a part of, and Indigenous ontologies regarding human-animal relationships are often incorrectly considered symbolic or as metaphor, when they are in fact inherently empirical (Nadasdy 2007:25). A possible example of animistic/totemic use of sea otter elsewhere on the Northwest Coast is the famous Makah "whale saddle" effigy from the Ozette site. The wood carving is studded with more than 700 sea otter teeth (Kirk and Daugherty 1974:102) which form an outline in the shape of a thunderbird: the supernatural, non-human whaler and "source of hereditary prerogatives for chiefs" (McMillan 2019:309). The whale saddle effigy is assumed to have ritual associations with whaling, "perhaps in the context of a whaling chief's residence" (McMillan 2019:317). By extension, the inclusion of so many sea otter teeth is likely important, as an indicator of wealth and/or status, and may represent an ontological orientation or species-specific significance.

While the Chinook and Tillamook ethnographies and myths do not explicitly support the animism/totemism interpretation as proposed by Overton (2016) for the British Mesolithic, they do demonstrate the unique character of Oregon Coast Native Americans' relationships with sea otters. A human female takes sea otter form (or vice versa) in the tale "The Round Trip of Ice" and is able to evade hunting (Pearson 1990:3). Otters (sea, river, or undifferentiated) had associations with shamans. Bags made of sea otter skin held a shaman's spirit powers (Sauter and Johnson 1974:120) which were extremely powerful (causing death in a story recorded by Boas [1898:33]). The Southwest Wind (a Trickster and Transformer [Duer and Thompson 2008]) had a quiver made of otter skin (Sauter and Johnson 1974:120, 125). "Sea Otter Pelts" are titled characters who attend the "Moon's Winter Dance," along with other guests like Dentalium (Pearson 1990:150). George Wasson of the Coquille tribe recounted a story of a woman who married a sea otter. She and her husband sent a beached whale ashore each year as a gift to her family, explaining "the special meaning of a beached whale" and accounting "for why the Coos and Coquille would not hunt sea otters" (Wasson and Toelken 1998:189). These accounts are by no means comprehensive, but are indicative nonetheless of human-sea otter relationships beyond an economic function. Sea otter pelts were powerful enough to hold a shaman's powers, and associated with human wealth, Tricksters, and Transformers. Sea otters were considered non-human persons, inter-married with humans, and in at least one story transformed into a human or vice versa. The persistence of these relationships in stories illustrates their significance from the myth/Transformer times through the present, and suggests that the species represented more than a source of pelts.

2.9 Conclusion

The archaeological remains of sea otters from the Par-Tee and Palmrose sites, coupled with available ethnographic evidence, unequivocally demonstrate a human-sea otter relationship on the Oregon Coast since time immemorial, before and after contact with Euro-American colonial powers. The Indigenous inhabitants of the Seaside sites, the ancestors of tribal members living today, hunted sea otters for their pelts. They may also have intensively processed sea otters to obtain bone or sinew and occasionally removed muscle for dietary consumption by humans or dogs. Although dietary consumption may have occurred prior to Euro-American contact, the ethnographic record is ambiguous regarding the dietary role of sea otter, and the lack of mention in oral histories/traditional narratives suggests they were not a critical source of food relative to other animals (e.g., whales, porpoises, seals). Sea otters likely fulfilled roles beyond the economic and utilitarian provisioning of pelts. Sea otters may have been regarded as non-human persons inhabiting a shared landscape alongside Oregon Coast Native Americans, and/or as beings whose power was reflected or embodied in their fur and skin. The deep-time data presented here affirm tribal assertions that the reintroduction of sea otters to Oregon would be a rekindling of a long human-animal relationship disrupted by colonial incursion and ecological exploitation by Euro-Americans. Future zooarchaeological work should strive to fully explore human-marine mammal relationships in the coastal archaeological record, with special consideration for socio-ecological applications with regards to ecological sovereignty and navigating conservation challenges and human-marine mammal relationships in the present.

The next chapter (Chapter III) shifts from ancestral tribal use of sea otters and the human-animal and socio-ecological relationship to focus on the animals as the subject of historical ecological research. Chapter III is an analysis of ancient Oregon sea otter DNA and explores how the extirpated subpopulation compares to other extant Northwest Coast sea otters and has implications for future reintroduction efforts. While the next chapter focuses on the sea otter, it is important to remember the lessons from this chapter: the sea otters analyzed for ancient DNA are inseparable from the tribal ancestors who hunted and processed them and deposited their bones in archaeological sites.

CHAPTER III

ARCHAEOLOGICAL MITOGENOMES ILLUMINATE THE HISTORICAL ECOLOGY OF SEA OTTERS (*ENHYDRA LUTRIS*) AND THE VIABILITY OF REINTRODUCTION

From H.P. Wellman, R.M. Austin, N.D. Dağtaş, M.L. Moss, T.C. Rick, and C.A. Hofman. 2020. Archaeological mitogenomes illuminate the historical ecology of sea otters (*Enhydra lutris*) and the viability of reintroduction. *Proc. R. Soc. B.* 287: 20202343. http://doi.org/10.1098/rspb.2020.2343

3.1 Introduction

3.1.1 Reintroductions and Applied Archaeology

The extinction and extirpation of animals and plants, and associated ecological degradation are increasing at a rapid rate (Ceballos et al. 2015). Responses to these challenges include reintroductions, translocations, and other strategies used to bolster or re-establish populations of threatened or endangered species (Armstrong and Seddon 2008). Significant challenges exist related to animal homing instincts, source population choice, predation, and reproductive failures (Hardman et al. 2016; Houde et al. 2015; Mulder et al. 2017; Rathbun et al. 2000).

Genetic analyses are valuable for assessing reintroduction and translocation viability, and for documenting the impact of genetic rescue (Flanagan et al. 2018; He et al. 2016; Rathbun et al. 2000). For example, microsatellites in desert tortoises have been used to show poor reproductive success in translocated males (Mulder et al. 2017), while genomic approaches, including RADSeq and transcriptomics, highlight the importance of local adaptation in other organisms (He et al. 2016). To avoid outbreeding depression and translocation failure and to account for potential local adaptation, genetic studies suggest that reintroduction efforts should maximize ecological similarity and minimize population divergence times between source and sink populations (Bell et al. 2019; Flanagan et al. 2018; Frankham et al. 2017). Past extirpation events may present particular challenges due to the lack of recent genetic data on the extirpated population. Ancient DNA approaches provide a powerful method to bridge temporal gaps and provide relevant data, such as identifying appropriate source populations (Marr et al. 2018) and documenting genetic diversity before extirpation (Larson et al. 2002a).

We present a novel approach integrating new methods and sources of ancient DNA to inform reintroductions of the sea otter (*Enhydra lutris*). The sea otter, a keystone species in kelp forest ecosystems, was hunted to the verge of extinction around the Pacific Coast during the maritime fur trade, but has yet to re-occupy a large portion of its former range (Larson and Bodkin 2015). Our study demonstrates the importance of an applied analytical toolkit for investigating 21st century global extirpations and efforts to repair ecological degradation and disruption.

3.1.2 The Sea Otter on the Pacific Coast

Prior to the 19th century, the sea otter occurred along the coast from Japan to northern Mexico (Kenyon 1969). Intensive hunting by Russian and Euro-American companies during the maritime fur trade (1741-1911) severely depleted sea otter populations, resulting in genetic bottlenecks (Beichman et al. 2019; Larson et al. 2002a; Larson et al. 2012, 2015; Ralls et al. 2017), and triggering profound ecological and socio-cultural changes. Sea otters are an ecological priority due to their role as a keystone species in the kelp forest ecosystem: sea otters eat urchins (benthic echinoderms) which graze on kelps, thus filling an important role in nearshore community structuring (Estes and Palmisano 1974; Kenyon 1969). Kelp forests protect coastlines from erosion (Estes and Palmisano 1974), support biodiversity, and provide carbon fixation (Gregr et al. 2020). Disruptions to kelp forest ecosystems, whether through the loss of sea otters or other factors (e.g. climate change), are cause for great concern. Socio-cultural consequences of the fur trade included disruption and dismantling of Indigenous social-ecological and economic systems at the hands of colonial powers (Salomon et al. 2015), and in some contexts, Indigenous peoples were coerced into hunting on behalf of fur companies (Igler 2013; Jones 2014). Reviving sea otter populations to revitalize coastal ecosystems remains a conservation priority in the present, and a recent study suggests that reintroducing sea otters yields a net ecological/economic gain (Gregr et al. 2020).

By the mid-20th century sea otters were patchily distributed throughout their original range due to rebound and conservation measures. Northern sea otter sub-populations (*E. l. kenyoni*) in the Aleutian Islands and southern sub-populations (*E. l. nereis*) in parts of California survived peak hunting in the late 19th century due to their geographic isolation (Bodkin 2015). In the 1960s-70s biologists reintroduced sea otters from Southcentral and Southwest Alaska to Southeast Alaska, British Columbia (B.C.), and Washington, and successfully re-established populations in parts of their former range. However, two 1970s reintroduction attempts at Port Orford and Cape Arago in southern Oregon failed (Bodkin 2015; Jameson et al. 1982). The "most plausible explanation" for the Oregon failure was emigration (the sea otters' attempt to return to their original range/habitat [Rathbun et al. 2000]) and small post-release populations that subsequently collapsed (Jameson et al. 1982). The translocated northern sea otters may also have lacked adaptations suitable for their new Oregon coast habitat (Jameson et al. 1982). Today, sea otters remain extirpated in Oregon. The species is listed as endangered on the International Union for Conservation of Nature's (IUCN) Red List (Doroff and Burdin 2015), and the Oregon Endangered Species Act (ORS 496.171-496.192) lists the Oregon sea otter as "threatened." There is growing interest in assessing whether reintroducing sea otters to Oregon is desirable and/or feasible. The Elakha Alliance non-profit is conducting a feasibility study as a step towards reintroduction, coastal ecological restoration, and cultural revitalization with the partnership and support of the Confederated Tribes of Siletz and Coquille Indian Tribe (Hall 2019; Kone 2020).

Sea otter use and significance to tribal groups in Oregon is documented in archaeological and historical records, and tribal stories and oral histories (Bailey 1936; Hall 2019; Lyman 1991; Ray 1938; Sauter and Johnson 1974). Alaska Native and First Nations groups also have vested interests in sea otter conservation, use, and management (Burt et al. 2020; Moss 2020; Salomon et al. 2015, 2018). However, both Native and non-Native stakeholders are concerned about sea otter predation on commercially-fished invertebrates (Carswell et al. 2015; Gregr et al. 2020; Larson et al. 2013), such as Dungeness crab in Alaska (Moss 2020). Because sea otters in Oregon were extirpated by the end of the fur trade (circa 1876, but possibly as late as 1906 [Kenyon 1969]) there are some gaps in cultural and ecological knowledge pertaining to the species; evidence is limited and few fur-trade era specimens or records are available for study. As a result, available historical and archaeological Oregon sea otters represent a valuable, but often overlooked, source of data (Hall 2019).

Reintroductions and subsequent management are complicated efforts involving many factors and stakeholders. Our study seeks to address a key aspect of Oregon reintroduction discussions: which post-fur trade sea otter populations are most closely related to the original (pre-fur trade) Oregon sea otter population, and should serve as a source for reintroductions? We present a long temporal perspective and dataset by recovering complete mitogenomes from archaeological (Late Holocene) and 19th century fur trade Oregon sea otters and compare them to post-fur trade (20th century and modern) sea otters to determine the relationships between populations.

3.1.3 Previous Studies

Mitochondrial DNA (mtDNA) and microsatellite analyses demonstrate that sea otter populations vary genetically along the Northwest Coast (Cronin et al. 1996; Larson et al. 2012; Larson et al. 2002a, Larson et al. 2002b; Ralls et al. 2017; Valentine et al. 2008). Larson et al. (2002b) identified four modern sea otter mtDNA haplotypes on the Northwest Coast. Valentine et al. (2008) analyzed a 222 base pair (bp) region of mtDNA from 16 archaeological Oregon sea otters and found four haplotypes: a California genotype represented by 11 Oregon individuals, an Alaska genotype represented by 2 Oregon individuals, and two new genotypes represented by 2 and 1 Oregon individuals, respectively. Valentine et al. (2008) concluded the archaeological Oregon sea otters were therefore more closely related to the California sea otters, and future reintroductions using California sea otters might be more successful. Larson et al. (2012) performed microsatellite analyses on pre-fur trade and modern sea otters, and found that gene flow occurred between Oregon, California, and Alaska sea otters, including between Oregon and northern populations. Beichman et al. (2019) identified specific aquatic adaptations and low genomic diversity in modern populations. Morphometric studies of sea otters have demonstrated some phenotypic traits vary along a latitudinal cline on the Pacific Coast, with Oregon sea otters intermediate by varying degrees (Lyman 1988; Wellman 2018; Wilson et al. 1991). We build on this research, presenting the first complete ancient mitogenomes for Oregon sea otters and demonstrate a new minimally destructive sampling technique using dental calculus.

3.1.4 Current Study

To expand upon and contribute to the current understanding of pre-fur trade Oregon sea otters, we sequenced complete mitogenomes from 20 archaeological sea otter teeth (tooth dentine). We sampled 10 right lower first molars (M_1s) from the Par-Tee site (35CLT20) and 10 right M_1s from the Palmrose site (35CLT47). Palmrose and Par-Tee are located adjacent to each other in northern Oregon (Figure 3.1). These sites were excavated in the 1960s through 1970s (Phebus and Drucker 1979) and the faunal remains are abundant and well-preserved (Losey and Yang 2007; Sanchez et al. 2016; Wellman 2018; Wellman et al. 2017). We compared the archaeological Oregon mitogenomes to 21 historical Pacific Coast mitogenomes captured and sequenced from dental calculus for this study (Table 3.1; Figure 3.1) and previously published modern California mitogenomes (Ralls et al. 2017). These historical mitogenomes include sea otters from the end of the fur trade (just prior to extirpation) and the post-fur trade era, including several 1960s Amchitka Island sea otters (Kenyon 1969; Scheffer 1940). Amchitka sea otters were reintroduced to Southeast Alaska, B.C., and Washington, and therefore likely reflect present genetic diversity in those areas (Larson et al. 2012). Historical pre-extirpation Oregon sea otter specimens are a rare and unique data source, and dental calculus was used to minimize destructive sampling to these museum specimens. Sea otter mitogenomes are assumed to accurately reflect geographic origin as they are maternally inherited, and while male sea otters may travel upwards of 100 km (Garshelis and Garshelis 1984; Ralls et al. 1996), females tend to maintain small home ranges and geographic fidelity (extending ~20km along the coast and ~0.3 km offshore) (Elliott Smith et al. 2015; Loughlin 1980; Tarjan and Tinker 2016). Based on previous findings (Larson et al. 2012; Lyman 1988; Valentine et al. 2008; Wellman 2018; Wilson et al. 1991), we hypothesized that the archaeological Oregon sea otters would share mitochondrial lineages with both California and northern Pacific Coast populations, but more with the latter. We also anticipated that the archaeological specimens would exhibit greater genetic diversity compared to the available modern California specimens

(Ralls et al. 2017) due to past bottlenecks (Beichman et al. 2019; Gagne et al. 2018; Larson et al. 2012).

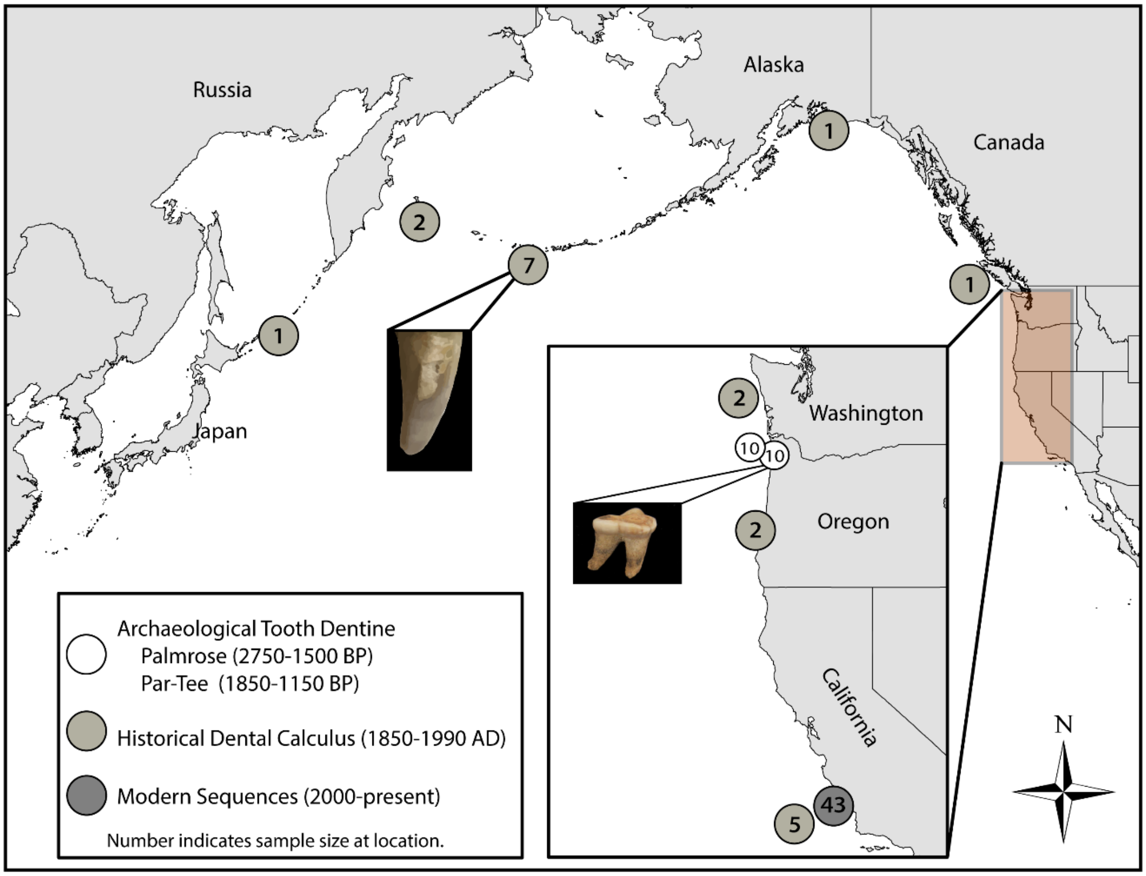
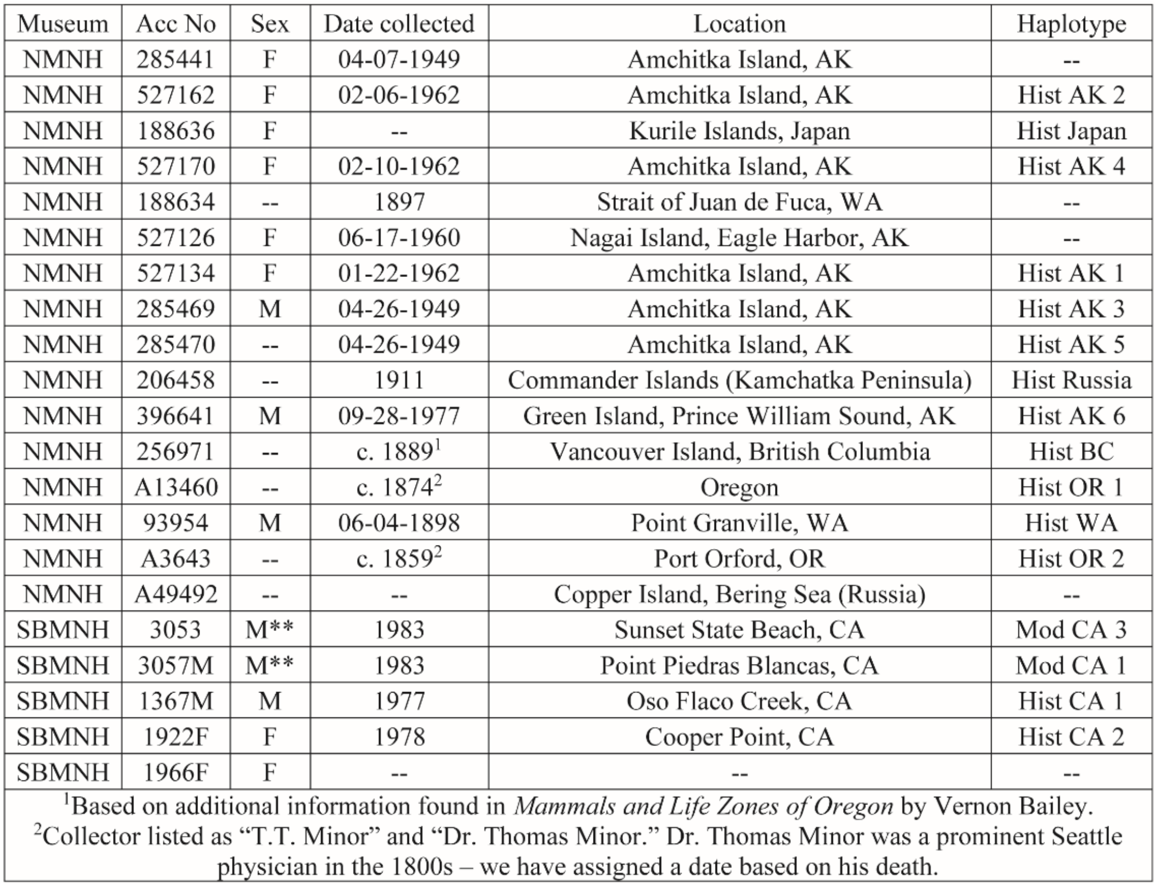


Figure 3.1. Map showing geographical origins of archaeological sea otter tooth dentine (white circles) and historical and published modern sea otter dental calculus (colored circles) analyzed in this study. Number in circle indicates sample size at location. Made in ArcMap 10.0/Adobe Illustrator; data from Natural Earth, U.S. Census Bureau, Esri, DeLorme, HERE, and MapmyIndia.

Table 3.1. Historical museum specimens analyzed in this study (from the National Museum of Natural History [NMNH] and the Santa Barbara Museum of Natural History [SBMNH].



Museum	Acc No	Sex	Date collected	Location	Haplotype
NMNH	285441	F	04-07-1949	Amchitka Island, AK	--
NMNH	527162	F	02-06-1962	Amchitka Island, AK	Hist AK 2
NMNH	188636	F	--	Kurile Islands, Japan	Hist Japan
NMNH	527170	F	02-10-1962	Amchitka Island, AK	Hist AK 4
NMNH	188634	--	1897	Strait of Juan de Fuca, WA	--
NMNH	527126	F	06-17-1960	Nagai Island, Eagle Harbor, AK	--
NMNH	527134	F	01-22-1962	Amchitka Island, AK	Hist AK 1
NMNH	285469	M	04-26-1949	Amchitka Island, AK	Hist AK 3
NMNH	285470	--	04-26-1949	Amchitka Island, AK	Hist AK 5
NMNH	206458	--	1911	Commander Islands (Kamchatka Peninsula)	Hist Russia
NMNH	396641	M	09-28-1977	Green Island, Prince William Sound, AK	Hist AK 6
NMNH	256971	--	c. 1889[1]	Vancouver Island, British Columbia	Hist BC
NMNH	A13460	--	c. 1874[2]	Oregon	Hist OR 1
NMNH	93954	M	06-04-1898	Point Granville, WA	Hist WA
NMNH	A3643	--	c. 1859[2]	Port Orford, OR	Hist OR 2
NMNH	A49492	--	--	Copper Island, Bering Sea (Russia)	--
SBMNH	3053	M**	1983	Sunset State Beach, CA	Mod CA 3
SBMNH	3057M	M**	1983	Point Piedras Blancas, CA	Mod CA 1
SBMNH	1367M	M	1977	Oso Flaco Creek, CA	Hist CA 1
SBMNH	1922F	F	1978	Cooper Point, CA	Hist CA 2
SBMNH	1966F	F	--	--	--

[1] Based on additional information found in *Mammals and Life Zones of Oregon* by Vernon Bailey.
[2] Collector listed as "T.T. Minor" and "Dr. Thomas Minor." Dr. Thomas Minor was a prominent Seattle physician in the 1800s – we have assigned a date based on his death.

3.2 Methods

3.2.1 Sampling

Archaeological tooth dentine was sampled at the Laboratories of Molecular Anthropology and Microbiome Research (LMAMR) at the University of Oklahoma, Norman, in the dedicated sample preparation area following standard ancient DNA contamination protocols (Shapiro and Hofreiter 2012; Yang and Watt 2005). The archaeological sea otter teeth were cleaned with a dilute bleach solution to remove surface contamination. A Dremel was used to abrade/remove remaining debris and the outermost layer of cementum from the tooth root being sampled. The root was then removed from the crown and ground into a powder and ~100 mg was used for DNA extraction.

Dental calculus was sampled on location in museum research collections following a calculus-specific sampling protocol designed to reduce contamination. Dental calculus was carefully removed from the tooth using a dental scaler directly into a sterile Eppendorf tube. Each tube is placed in a “bowl” shaped from tin foil, ensuring the dental calculus is contained and will not contaminate other tubes or the work surface. Gloves were changed between taking samples, cleaning, or handling specimens. Dental calculus contains both host and microbial DNA (Mann et al. 2018; Ozga et al. 2016; Ziesemer et al. 2019) and can be removed without destruction to the specimen, preserving the integrity of rare museum collections while also addressing research questions regarding biodiversity/conservation biology. Due to differential preservation of endogenous DNA in dental calculus (Mann et al. 2018) and documented degradation of DNA in calculus museum specimens (Austin et al. 2019) the historical DNA was extracted and sequenced following ancient DNA protocols and workflows.

3.2.2 Ancient DNA Analysis

Ancient and historical DNA extraction and library construction was performed in the LMAMR Ancient DNA Laboratory, a dedicated, six-room ISO-6 class clean room custom-built for ancient DNA and microbiome research. Detailed procedures are provided in Wellman et al. (2020:Supplementary Material). In brief, DNA was extracted from dental calculus and dentine using a protocol described in Morales-Arce et al. (2017). DNA extracts were converted into dual indexed Illumina sequencing libraries and captured using a custom in-solution biotinylated RNA bait set (Arbor Biosciences). Captured libraries were sequenced on an Illumina MiSeq with 2 x 150 bp chemistry.

The raw fastq files were quality filtered using the program Adapter Removal2 (v. 2.1.7) (Schubert et al. 2016) and mapped using bwa (v. 0.7.17) (Li and Durbin 2010) with ancient DNA parameters to the published modern sea otter mitogenome (Yonezawa et al. 2007). DNA authenticity was assessed using the program MapDamage2 (Ginolhac et al. 2011) and fragment length plots. Consensus sequences were called from rescaled bam files in Geneious (v. 11.1.4) and aligned with MAFFT (v. 7.308) (Katoh et al. 2002; Katoh and Standley 2013). This alignment was stripped for identical sites and ambiguities and rendered into a network (Figure 3.2) using the median-joining network in

PopArt (Bandelt et al. 1999; Leigh and Bryant 2015). Haplotype diversity was calculated in DnaSP (v. 6) (Rozas et al. 2017). In order to explore and visualize the temporal signal associated with haplotype diversity, we used TempNet in R (v. 3.6.3) (Figure 3.3). We attempted estimating divergence times with BEAST (v. 1.10) but this dataset violated clocklike assumptions as tested with TempEst (v. 1.5.3). Raw sequence data are available through the NCBI Short Read Archive (SRA) under BioProject accession PRJNA550086. Consensus sequences and the alignment used for analysis (ModAlign.fa) are available from the Dryad Digital Repository (https://doi.org/10.5061/dryad.djh9w0vxz).

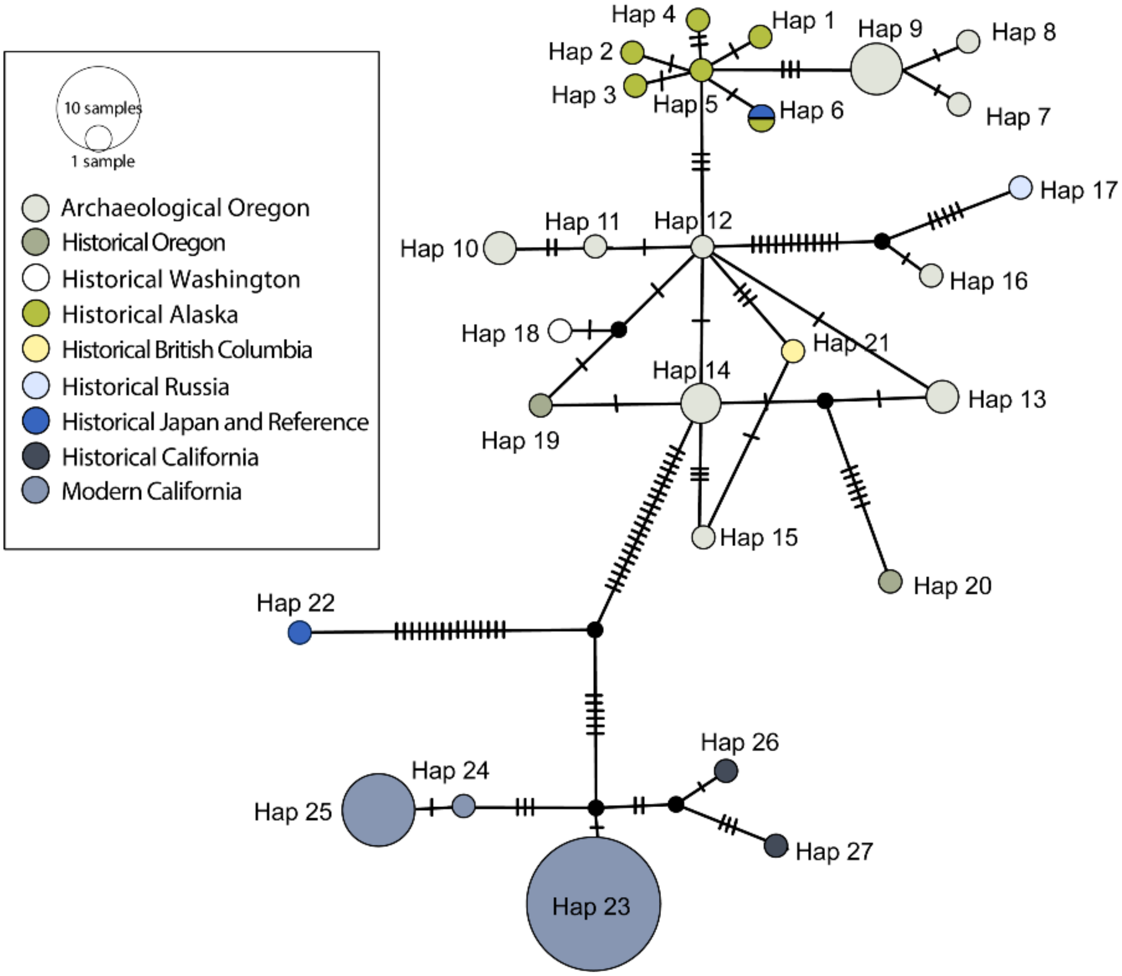


Figure 3.2. Median-joining network of archaeological Oregon, historical, and modern haplotypes. Node size represents hapolotype frequency and hash marks represent nucleotide changes between haplotypes. The reference mitogenome (Yonezawa et al. 2007) came from a sea otter in the Toba Aquarium, Mie, Japan, but shares haplotype 6 with an Alaskan sea otter.

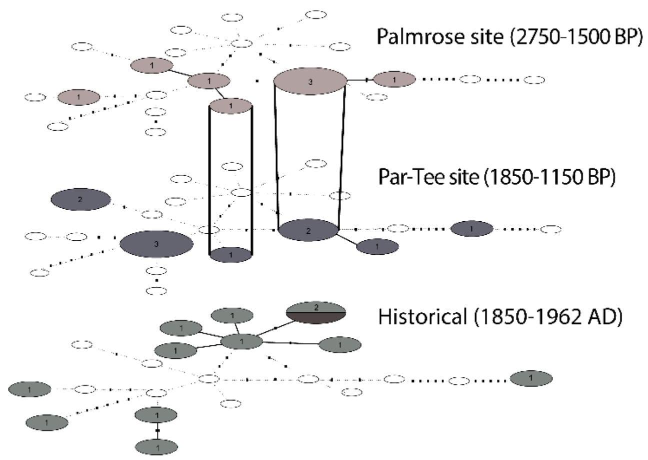


Figure 3.3. TempNet Analysis showing shared haplotypes between archaeological and historical sea otters. Circles represent the haplotypes in the median-joining network; haplotype overlap (bold lines) occurs between two Palmrose and Par-Tee haplotypes (haplotypes 9 and 13 in Figure 3.2). California samples were omitted due to divergence from archaeological and historical northwest coast haplotypes.

3.3 Results

Eighteen of the 20 archaeological specimens and 16 of the 21 historical specimens yielded complete mitogenomes suitable for analysis. The median joining network analysis (Figure 3.2) illustrates the relationships between the sea otter mitogenomes generated for this study, previously published California mitogenomes (Ralls et al. 2017), and the reference mitogenome (Yonezawa et al. 2007). The network analysis yielded 27 haplotypes (Table 3.2): ten (haplotypes 7-16) represent archaeological Oregon individuals, five (haplotypes 23-27) represent historical/modern California, six (haplotypes 1-6) represent historical Alaska, two (haplotypes 19 and 20) represent historical Oregon, and haplotypes 18, 17, 21, and 22 each represent historical Washington, Russia, B.C., and Japan, respectively. Of the ten archaeological Oregon haplotypes, six are unique to single individuals (7, 8, 11, 12, 15, 16), two represent five and three individuals, respectively (9 and 14), and the final two haplotypes (10 and 13) include two individuals each.

Table 3.2. Haplotype assignments of specimens (Individuals) analyzed in this study (Figure 3.2).

Haplotype Number	Geographic Region	Individuals
1	Alaska	527134
2	Alaska	527162
3	Alaska	285469
4	Alaska	527170
5	Alaska	285470
6	Alaska	396641, Reference
7	Oregon	PTSE5G7
8	Oregon	PRSW5D4
9	Oregon	PTSW19H8, PRSE3E6, PRNE1E5, PTSE7F6, PRNE4E4
10	Oregon	PTSE14J7, PTNE12G9
11	Oregon	PRNE2Q6
12	Oregon	PRNE1G3
13	Oregon	PRNE1I5, PTSE11J8
14	Oregon	PTSE5J8, PTSE13K4, PTSALV
15	Oregon	PRSW6N3
16	Oregon	PTSE8J8
17	Russia	206458
18	Washington	93954
19	historical Oregon	A13460
20	historical Oregon	A3643
21	British Columbia	256971
22	Japan	188636
23	California	B6-578, SON-1101-01-S_S18, SO1122_S22, SON-1164-02-S_S13, SO805_S35, SO1144-02_S25, SO1126_S24 , SO1067_S33, SO1157-02_S28, SON-1103-01-S_S19, SO1123_S23, SO1070_S4, SO1069_S3, SO780_S14, SO1077-01_S17, SON-1161-02-S_S12, SO779_S2, SON-1105-01-S_S20, SO1071-01_S5, SO1068_S16, SON-1143-02_S10, SON-1162-02-S_S30, SON-1173-02_S32, SO1116_S8, SO1074_S34, B7-649, B6-665, B7-613, SON-1106-01-S_S36, SBMNH3057M
24	California	SO1130_S9
25	California	B6-243, SON-1163-02-S_S31, SBMNH3053, B6-602, SO1076-01_S6, SO1114_S21, SON-1112-01 -S_S37, SO1156-02_S27, SON-1066-01-S_S15, SON-1100-01-S_S7
26	California	SBMNH1367M
27	California	SBMNH1922F

The mitogenomes of the historical samples occur as expected in the network given their geographic origins, except for the historical individuals from Russia and Japan. The archaeological Oregon/northern haplotypes show substantial separation from California haplotypes. The network also demonstrates high genetic diversity in the archaeological Oregon samples.

The TempNet analysis (Figure 3.3) shows two shared haplotypes through time. The first (haplotype 9) includes three sea otters from Palmrose and two from Par-Tee, and the second (haplotype 13) includes one individual from each site. There are no shared haplotypes between historical and archaeological individuals, despite the proximity of Oregon and northern haplotypes in the network (Figure 3.2). The archaeological Oregon sea otters contain more overall haplotype diversity (Hd = .91) compared to the modern California samples (Hd = .44).

3.4 Discussion

3.4.1 Mitogenome Haplotype Distributions

The mitogenome results provide new insights into archaeological/pre-extirpation Oregon sea otters. As hypothesized, the Oregon sea otter haplotypes are distinct from California haplotypes, and form several clusters with northern haplotypes in the network analysis.

Archaeological Oregon haplotypes 7, 8, and 9 (representing a total of seven individuals from both sites) are more closely related to the Alaska haplotypes (specifically haplotype 5, a 1949 Amchitka Island sea otter). Archaeological haplotypes 10-15 cluster with the historical Washington and B.C. haplotypes (18 and 21) and historical Oregon haplotype 19, all of which date close to extirpation (c. 1874-1898); this clustering is unsurprising given documented gene flow between northern populations prior to fur trade bottlenecks (Larson et al. 2012). Historical Oregon haplotype 20 (c. 1859) is comparatively distant from this historical/archaeological cluster, but was collected from Port Orford in southern Oregon, possibly reflecting variation on a latitudinal cline. Archaeological Oregon haplotype 16 is also distinct: it is closely associated with Russia haplotype 17 (collected 1911), and prior studies have indicated gene flow between archaeological Oregon and Russia populations (Larson et al. 2012). Interestingly, Japan (haplotype 22, no date) is separated from all other haplotypes including Russia, while the reference genome from a sea otter from the Toba Aquarium in Japan shares haplotype 6 with a 1977 historical Alaska sea otter. Overall, the distribution of haplotypes within the network analysis indicate close associations between the archaeological Oregon sea otters and pre-extirpation sea otters from northern populations, especially those immediately north of Oregon (Washington and B.C.), as well as the post-fur trade historical Alaska sea otters used for reintroductions.

3.4.2 Precontact Sea Otter Acquisition

Previous studies have documented Oregon sea otters sharing traits and experiencing gene flow with northern populations (Larson et al. 2012; Wilson et al. 1991). This gene flow along the coast may be responsible for the similar genetic signatures between groups, but animal and/or human behavior may also be a factor. It is feasible sea otters traveled from Southeast Alaska and were hunted in Oregon (Ralls et al. 1996) (yielding the Alaska/Oregon cluster) but it seems unlikely a sea otter from populations further northwest would do so, especially in large numbers. Ethnographic data suggest that Oregon tribes (especially those in the Columbia River trading area) were the source, rather than recipients, of traded pelts (Ray 1938; Zobel 2002), but it is possible precontact groups on the Pacific Rim/Northwest Coast may have moved animals (or in this case, their teeth or other parts) across long distances through trade networks. For example, the famous whale saddle wood carving from Ozette, WA, is inlaid with more than 700 sea otter teeth, mostly molars (Kirk and Daugherty 1974). Such teeth could have been traded widely, perhaps as a symbol of the wealth/status associated with sea otter pelts (Bailey 1936; Ray 1938; Sauter and Johnson 1974). In terms of local context, the overlap in haplotypes 9 and 13 between the two archaeological sites (Figure 3.3) suggests the persistence of some mitochondrial lineages through time in the Seaside, OR area. Palmrose and Par-Tee are close geographically and in age so these overlaps are consistent with local sea otter hunting.

Further investigation is required to increase the archaeological, historical, and modern mitogenome sample size from locations throughout their former range (especially from B.C. and Washington). Overall, the genomic results support our hypothesis of greater haplotype diversity in the archaeological populations.

3.4.3 Implications for Reintroduction

Prior to sea otter extirpation, the Oregon coast apparently served as a transitional zone between southern and northern phenotypes (Lyman 1988; Wellman 2018; Wilson et al. 1991) and possibly haplotypes (Larson et al. 2012; Valentine et al. 2008), and could serve a similar function in the present. The historical samples from Oregon, Washington, and B.C. represent the end of the fur trade (~1850-1900), just prior to extirpation (Kenyon 1969; Scheffer 1940). The historical Amchitka Island sea otters (1949-1962 A.D.) were used for reintroductions to Southeast Alaska, B.C., and Washington in the 1960s-on (Jameson et al. 1982); our results therefore likely reflect current populations in the northern regions. We are therefore able to examine the genetic landscape both before and after reintroduction, and contextualize the Oregon sea otters therein.

A variety of factors may have contributed to the failed Oregon sea otter reintroductions in the 1970s (Jameson et al. 1982), including the possibility that California (rather than Alaska) sea otters would have been a better stock source (Valentine et al. 2008). Our results indicate that the picture is more complicated: northern sea otters are closer to the archaeological and historical Oregon sea otters analyzed in this study, likely reflecting the northern location of Palmrose and Par-Tee in Oregon. In comparison, the Oregon sea otters used by Valentine et al. (2008) came from archaeological sites along the central and southern Oregon coast. Valentine et al. (2008) did find two northern haplotypes in their archaeological Oregon sea otters, while the Oregon sea otters analyzed in this study did not match California haplotypes. Larson et al. (2012) analyzed archaeological Oregon sea otters from throughout the Oregon coast, and found gene flow occurred both to the south and the north. Taken together, these results strongly point to genetic variation along a latitudinal cline.

In addition to geographic variability, there is a methodological explanation for the difference in results: Valentine et al. (2008) used short D-loop sequences following standard protocols at the time, while the analysis presented here utilized the complete mitogenome. We trimmed the mitogenomes to the 222 bp used by Valentine et al. (2008) and performed a new network analysis (Figure 3.4): half the Oregon sea otters grouped with northern haplotypes, but the other half shifted to group with the modern California haplotypes.

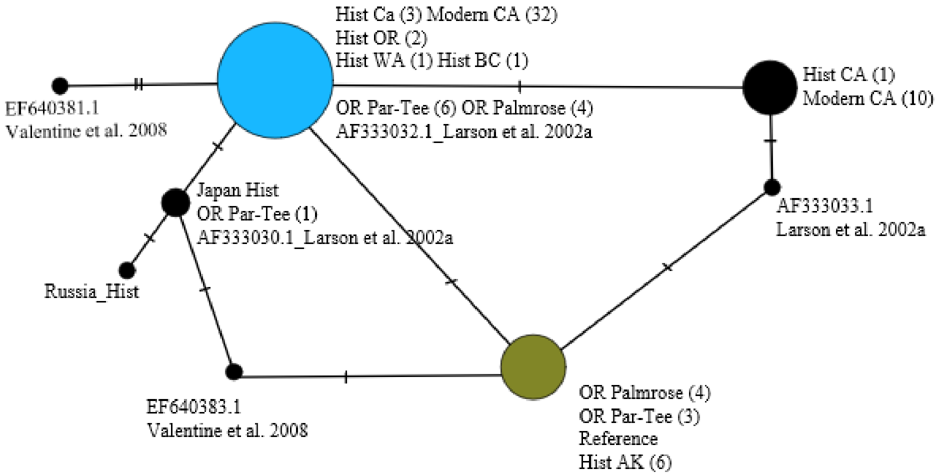


Figure 3.4. Median-joining network of trimmed alignment including Larson et al. 2002b and Valentine et al. 2008 data. Nodes represent unique haplotypes; node size represents haplotype frequency. Hash marks represent nucleotide changes between haplotypes.

Trimming the alignment excluded base changes present in the complete mitogenome outside of the 222 bp D-loop section. The difference in interpretation suggests that complete mitogenome analyses, now enabled by reduced costs and advances in Next Generation Sequencing (NGS), may better capture overall diversity in haplotypes than smaller sequences.

We conclude that while reintroducing primarily California sea otters to the regions analyzed by Valentine et al. (2008) in southern Oregon may yield better results, we contend that future Oregon reintroduction efforts should include sea otters from Washington, British Columbia, and Alaska populations, especially reintroductions occurring on the northern half of the Oregon coast. Including both northern and southern sea otter populations will reflect the hypothesized pre-fur trade hybridization zone between groups (Larson et al. 2012; Lyman 1988; Wellman 2018; Wilson et al. 1991), and reintroducing sea otters from multiple source populations may also promote increased genetic diversity (Larson et al. 2012).

3.4.4 Novel Methodological Approach

Dental calculus from historical museum specimens, in combination with archaeological dentine/bone analysis, can provide a window into past genetic diversity of extirpated populations. This study is a novel demonstration of the feasibility of successfully extracting and amplifying complete mitogenomes using dental calculus from non-human mammals. Previous analysis has been limited by the number of specimens available for sampling, and future analyses can include archaeological, historical, and modern sea otters from additional locations and in larger numbers by using dental calculus to increase resolution of genetic patterns. Nuclear genome data (including from dental calculus) may be used to identify specific adaptations (Beichman et al. 2019; Davis et al. 2019), and other applied methods such as isotopic analyses should be performed to establish past ecological contexts (Elliott Smith et al. 2020; Szpak et al. 2012). While human dental calculus has been used in genomic analyses as a source of endogenous (host) DNA (Ozga et al. 2016; Ziesemer et al. 2019), non-human dental calculus has not been used for this purpose and our study is unique in employing this method. Given the degraded nature of sea otter DNA recovered from dental calculus from recent specimens (c. 1983) in this study and others (Austin et al. 2019), we recommend using protocols designed specifically for ancient DNA when collecting calculus from skeletonized museum specimens. This approach has great potential to provide genetic data from rare museum specimens without destroying the host tissue in service of an integrated approach to conservation challenges in the present.

3.5 Conclusion

Genetic analyses are an important contribution to wildlife reintroductions, particularly in the modern context of extirpations and ecological destruction. Our complete ancient mitogenomes analysis indicates that the extirpated Oregon sea otters are more closely related to extant northern populations relative to extant southern populations, and that northern sea otter populations may be appropriate for future reintroduction efforts. This chapter is a compelling example of applied zooarchaeology using biomolecular methods, and is a contribution towards building a complete historical ecology of the extirpated Oregon sea otter. The data from the preceding chapter (Chapter

II), when combined with these sea otter-specific results, forms a coupled dataset which demonstrates the biological and cultural value of zooarchaeological remains in terms of developing deep-time understandings of both the socio-ecological dimensions of animals and humans in a given environmental context.

The following chapter (Chapter IV) moves on to the research and discussion of another class of marine mammal found on the Oregon coast: cetaceans (including whales, dolphins, and porpoises). Tribal ancestors maintained important human-animal relationships with these marine mammals prior to Euro-American contact, and while cetaceans on the Oregon coast have not been extirpated, many face natural and human-mediated threats in the present. Ancestral tribal use of whales and small cetaceans is poorly understood and often overlooked in the archaeological record on the Oregon coast, but understanding this deep-time relationship is important in the context of growing knowledge and concern with cetacean conservation in the modern day.

CHAPTER IV

ANCESTRAL TRIBAL USE OF ANCIENT OREGON CETACEANS: BIOMOLECULAR ANALYSES REVEAL HUMAN-CETACEAN RELATIONSHIPS

4.1 Introduction

4.1.1 Current Study

This study characterizes how Native Americans living on the Oregon coast used whales and small cetaceans prior to European contact. I present an original zooarchaeological analysis of a large subsample (NISP=1174) of cetacean remains from the Palmrose site and new interpretations of the previously analyzed cetacean remains from the Par-Tee and Tahkenitch Landing sites. I use zooarchaeological analysis and biomolecular identifications to describe element representation, species richness, and modification patterns in order to compare how tribal ancestors used cetaceans on the Oregon coast across different geographic and chronological contexts. This investigation yields new perspectives on Indigenous use of cetaceans prior to European contact on the Oregon coast, and also contributes to understanding cetacean use and presence on the Northwest Coast more broadly by providing a comparison to use patterns in the Ozette and Nuu-chah-nulth site assemblages (Huelsbeck 1994; Monks 2001, 2003) and modern stranding records. Characterizing the cetacean remains from Oregon sites has important implications for understanding human-cetacean relationships on the Oregon coast and the Northwest Coast as a whole, and documenting species presence provides data that can contribute to building cetacean historical ecologies.

This study also has methodological significance: use of biomolecular methods (e.g., ancient DNA and Zooarchaeology by Mass Spectrometry [ZooMS]) to identify cetacean remains is increasing, and ZooMS is particularly popular due to its lower cost and fewer concerns regarding contamination compared to aDNA analyses (Speller et al. 2016). My collaborators and I use ZooMS analyses to identify a large subsample of the cetacean remains from Palmrose (N=116) and Par-Tee (N=31), demonstrating that ZooMS can successfully capture species richness in assemblages containing unidentifiable bone fragments which might otherwise be unreported or unanalyzed.

For the purposes of this analysis, the term "whale" refers to large whale species, particularly those from the Balaenopteridae (blue, humpback, fin, and minke whales), Eschrichtiidae (gray whale), Balaenidae (right or bowhead whales), and Physeterdiae (sperm whale) families. The term small cetacean refers to the Delphinidae (dolphins, including orcas), Phocoenidae (porpoises), and Ziiphidae (beaked whale) families.

4.1.2 Archaeological Cetaceans on the Northwest Coast

Indigenous use of cetaceans and their associated economic and socio-cultural significance to peoples of the Northwest Coast is well-documented at archaeological sites such as the Makah Ozette site in Washington state and ancestral Nuu-chah-nulth sites in British Columbia (Drucker 1951; Kool et al. 1982; Kroeber 1939; McMillan 2015; Monks et al. 2001; Sapir et al. 2004; Waterman 1920). The Ozette site contained a full suite of whaling technology, including toggling harpoons and lines, a whaler's basket, as well as the famous "whale saddle" effigy, which represents the ceremonial and symbolic powers related to whaling (McMillan 2019). Ozette contained a staggering estimate of, at minimum, 67 individual whales (Huelsbeck 1994:293), as well as evidence for extensive and diverse uses of their bones. Tool "blanks" were removed from whale ribs and mandibles and then shaped into tools (Huelsbeck 1994:284). Whale bone was used to manufacture "spindle whorls, bark shredders, and beaters, cutting boards, clubs, wedges, tool handles, and a number of artifacts [which could not] be identified" (Huelsbeck 1994:284). Some of these uses, such as tool blanks and bark shredders, are not necessarily clearly identifiable as an artifact (e.g., photographs of bark shredders from Ozette sometimes appear as worn squares of whale bone; Huelsbeck 1994:284). One of the most impressive uses of whale bone at Ozette was for construction, particularly of retaining walls and drainage features (Huelsbeck 1994:284). The retaining walls were built to protect houses from clay slides (Huelsbeck 1994:288) and the drainage features diverted rainwater runoff from house roofs and away from residences into trenches (Huelsbeck 1994:288). These construction features indicate complex infrastructure within the village, and whale bones were the chosen building material.

Nuu-chah-nulth sites excavated as part of the Toquaht Archaeological Project yielded clear evidence for whaling including whale bones with still-embedded mussel shell blades and harpoons (McMillan 1999, 2015; Monks et al. 2001). Two of the Toquaht site assemblages contained primarily gray (*Eschrichtius robustus*) and humpback (*Megaptera novaeangliae*) whales, suggesting Indigenous peoples targeted “preferred” species in their hunts (Arndt 2011). Maxillary bones were used for features at the Toquaht sites, although the specific details are not described (Monks 2003:202). Scapulae at the Toquaht sites were used as cutting boards, and one was found in situ as a post support (Monks 2003:199). Unlike at Ozette, whale ribs in the Toquaht sites do not appear to have been modified or used for tool manufacture (Monks 2003:199). Modifications to whale remains from both the Nuu-chah-nulth sites and Ozette indicated that coastal inhabitants were removing oil from the bones (Monks 2001). No complete whale skulls were recovered from the Toquaht sites, but Monks (2003:202) points out that this may be due to differences in excavation strategy: Ozette was a remarkably well-preserved wet site excavated using an areal excavation strategy, while the Toquaht sites were excavated using test pits.

Studies of cetacean use have centered on these archaeological sites because they are considered representative of cultures with full, systematic whaling capabilities. Archaeological sites containing more ambiguous evidence for whale use, such as those on the Oregon coast, have yet to undergo a comprehensive characterization of how tribal ancestors used cetaceans, and/or the nature of precontact human-cetacean relationships.

The lack of archaeological cetacean studies in general is partly attributable to the challenges of identifying cetacean remains (Losey and Yang 2007; McMillan 1999, 2015; Monks et al. 2001; Monks 2003; Prentiss 2018; Rodrigues et al. 2016; Smith and Kinahan 1984; Wellman et al. 2017). Due to their size, whales are not usually transported whole to a site and are instead butchered on or near the beach (McMillan 2015). Consequently, few or partial portions of a whale may be transported to a site resulting in whale use that is undetected or underrepresented in the archaeological record (McMillan 2015; Rodrigues et al. 2016; Smith and Kinahan 1984). Fragmented, friable cetacean bone fragments preserve poorly, making remains difficult to identify to species using traditional zooarchaeological analyses (Buckley 2014; Erlandson et al. 2020; McMillan 2015; Rodrigues et al. 2016; Speller et al. 2016). Relatively recent advances in ancient DNA and proteomics identifications have been applied to archaeological samples yielding species identifications (Arndt 2011; Buckley et al. 2014; Erlandson et al. 2020; McMillan 2015; Speller et al. 2016; van den Hurk et al. 2020; Wellman et al. 2017).

4.2 Background

4.2.1 Archaeological Sites and Materials

4.2.1.1. *The Seaside Sites.* The majority of cetaceans analyzed and discussed in this study come from the Palmrose (35CLT47) and Par-Tee (35CLT20) sites. Par-Tee and Palmrose are located in northern Oregon, south of the mouth of the Columbia River (Figure 4.1). Par-Tee cetaceans have previously been analyzed (e.g., Loiselle 2020; Losey and Yang 2007; Wellman et al. 2017) but are re-evaluated as part of this study. Full descriptions of the Par-Tee and Palmrose artifact assemblages have not been published, but whale bone artifacts have been identified at Par-Tee (Losey and Hull 2019) and Palmrose (MNCH, NC 11, f. FN).

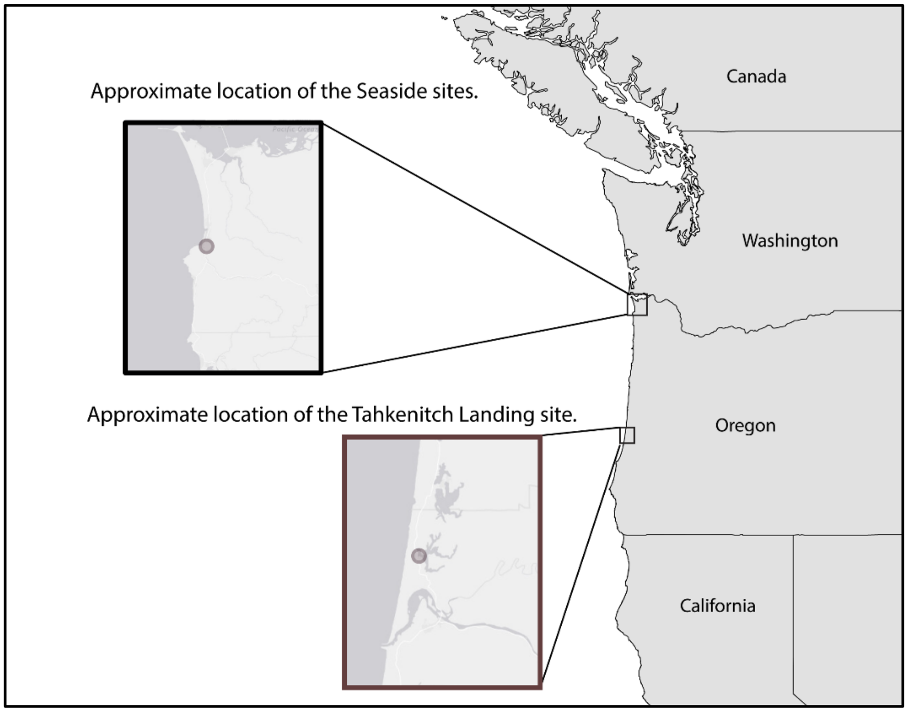


Figure 4.1. Map showing location of the Seaside sites (Palmrose and Par-Tee) on the northern coast (black inset) and the Tahkenitch Landing site on the central coast (red inset). Made in ArcMap 10.0/Adobe Illustrator; data from Natural Earth, U.S. Census Bureau, Esri, DeLorme, HERE, and MapmyIndia.

4.2.1.2 *The Tahkenitch Landing Site.* I also re-analyzed the cetacean remains from the Tahkenitch Landing (35DO130) site which is located north of Reedsport on the central Oregon coast (Figure 4.1). Tahkenitch Landing contained approximately 31 whale bone specimens, several of which were tentatively identified to baleen or sperm (*Physeter macrocephalus*) whale families (Greenspan 1986:64). The whale bone features are estimated to date to 5200-3000 BP (McDowell and Minor 1986:41), preceding the primary occupation of the Palmrose and Par-Tee sites. Tahkenitch Landing provides a different geographic and chronological context in which cetacean remains were acquired and deposited on the Oregon coast, and serves as a comparison to Par-Tee and Palmrose.

4.2.2 Ethnographic Background

Descriptions of cetaceans in the historical and ethnographic record clearly illustrate their importance to Oregon tribes at Euro-American contact. Lewis and Clark (2005) reported seeking out a stranded whale in the hopes of retrieving oil, only to find that it had already "been reduced to a skeleton" (Sauter and Johnson 1974:19), illustrating the multiple resources (e.g., meat, blubber) provided by the animal. The Chinook "extensively utilized" whales (Ray 1938:46) as well as porpoises (Ray 1938:115). The Chinook reportedly obtained whale meat, blubber, and oil via trade (Lewis and Clark: journal entry January 3rd 1806) but these materials were also acquired locally (Ray 1938:114). Oil was removed by boiling blubber in a wooden trough with hot stones (Lewis and Clark: January 10th 1806). Whale meat, blubber, and oil were highly prized among the Tillamook and Clatsop (Sauter and Johnson 1974:99). Clark (January 10th 1806) noted that the tribes "disposed of [blubber/oil] with great reluctance and in small quantities only." Clara Pearson, a Tillamook informant interviewed in the 1930s, reported that whale grease was "drunk in hot soups" (Jacobs 2003:82). Lewis (March 12th 1806) wrote that the whale bone was "also carefully preserve[d] for sale." Joseph Whitehouse (Lewis and Clark: January 10th 1806) was told that "bones of whales lay along the shore in great abundance."

Gray and humpback whales are mentioned as the most frequently targeted species in Oregon (Bailey 1936; Ray 1938), although this may be an assumption based on documented preferences of whaling groups further north (see Kool 1982 for an overview;

also Arndt 2011; Drucker 1951; McMillan 2015; Sapir et al. 2004; Waterman 1920). The Tillamook reportedly used gray whale as a dietary resource, their organs/skin for storage bags, and bones for tool manufacture (Zobel 2002:309). Ray (1938:115) listed the "striped porpoise" (Pacific white-sided dolphin [*Lagenorhynchus obliquidens*]) and "Pacific killer" ("*Orcinus rectipinna,"* now *Orcinus orca*) as important to the Chinook. Bailey (1936:347-349) listed the harbor porpoise (*Phocoena phocoena*) and Pacific white-sided dolphin as prey with reportedly good-tasting flesh, but stated that orcas were rarely taken, although they were sometimes pursued by the Makah further north (see McMillan 2019). The Tillamook reportedly used harbor porpoise specifically for food (Zobel 2002:309).

The Chinook and other tribal groups reportedly shot and captured porpoises and dolphins "in the sheltered coastal waters" (Bailey 1936:349) or speared them up rivers (Ray 1938:115). Coastal inhabitants could also have collected stranded small cetaceans, although that is not mentioned in the ethnographic literature. Several sources reported that the Chinook and Tillamook sometimes hunted (pursued and harpooned) whales but primarily collected stranded animals (Lewis and Clark, March 12th 1806; Ray 1938:114; Sauter and Johnson 1974:57). In the story "Ice Takes a War Party to Nehalem," the Nehalem Tillamook are called "whalers" (Pearson 1990:9). In another story, men go out "in big canoes to spear whales, far out in the ocean" (Pearson 1990:57), implying active hunting of offshore species as opposed to collecting stranded animals. The acquisition and use of stranded whales is well-documented in the ethnographic literature and traditional narratives. When the Chinook were starving, individuals who had supernatural helpers could sing to bring a whale ashore and strand so they could help feed their people, illustrating the importance of stranded whales as a coastal resource (Boas 1894:262; 1923:14-15). George Wasson of the Coquille tribe recounted a story of a woman who married a sea otter. She and her husband sent a whale ashore to strand each year as a gift to her family, explaining "the special meaning of a beached whale" and accounting "for why the Coos and Coquille would not hunt sea otters" (Wasson and Toelken 1998:189).

Cetaceans were an important resource and processing of whales was regulated by culturally-specific protocols, often related to chiefly prerogative (Ray 1938:50).

Boas (1894:263) described the process of butchering and allocating stranded whale portions by the Clatsop: individuals would go to the whale and puncture holes in the skin for them or their relatives. People would then arrive and cut at their marked portion (see also Ray 1938:115). Boas (1894:262) also reported that the chief would measure the whale and assign portions, with the "common people" receiving the tail end. Traditional narratives affirmed the dangers of not following appropriate behaviors surrounding whaling and processing. In one Tillamook story, a man cut into the whale's stomach and disrespectfully walked inside. Onlookers were shocked by his actions, and encouraged the whale to go back out to sea with the man inside as punishment (Boas 1923:12-13).

Whaling on the Northwest Coast was associated with great supernatural beings and powers, particularly the Transformer/Creator Thunderbird, who often played a role in whale hunting or conferred whale (McMillan 2015, 2019) or Thunder (Jacobs 2003) powers onto humans. According to Pearson, Thunderbird might kill a whale and send it to a person "who knows him," and "a whale will come ashore on the sand, drawn there by the man with Thunder power" (Jacobs 2003:182). In a story told by Pearson (1990:168), "Every day Thunderbird would say, 'I am going out fishing.' When he returned home he brought a whale. That was his fish." Thunder/Thunderbird powers were reportedly rare and the few men who had powers would be paid for whale portions because it was their "property" (Jacobs 2003:182). When it thundered a man with Thunder power knew he was being promised a whale and would post people to watch for the whale during the storm (Jacobs 2003:183). Because of the power associated with the Thunder man, it was reportedly dangerous for ordinary people to process the whale before the man with Thunder powers arrived to cut off the fin and offer it to Thunder in his fire at home (Jacobs 2003:183). In the Tillamook tale "Thunderbird," a man with Thunder powers sings to make a whale wash ashore in the summer (when whales had previously only washed ashore in the winter; Pearson 1990:171). The man tells the people to cut off the fin and burn it, presumably in deference to Thunderbird (Pearson 1990:171). The Makah "whale saddle" effigy wood carving is studded with more than 700 sea otter teeth (Kirk and Daugherty 1974:102) which form an outline in the shape of a thunderbird (McMillan 2019:309). McMillan (2019:137) argued the effigy and inclusion of Thunderbird imagery represented the "source of hereditary prerogatives for

[Makah] chiefs" and likely held ritual associations with whaling, "perhaps in the context of a whaling chief's residence."

4.2.3 Oregon Archaeological Cetacean Studies

The archaeological evidence for ancestral tribal whaling in Oregon is relatively ambiguous compared to that available from sites such as Ozette (Huelsbeck 1994). Cetacean remains are listed in faunal reports from Oregon archaeological excavations, but identifications are not often made beyond "cetacean" or family level. Colten (2015) analyzed a subsample of faunal remains from Palmrose and Par-Tee and reported ~21% of the total NISP at both sites was represented by marine mammals, confirming the importance of maritime resources to the site inhabitants. Colten (2015:261) reported roughly equal numbers of harbor porpoise and undifferentiated dolphins at both sites. Palmrose contained more bottlenose dolphins, while Par-Tee contained more undifferentiated large cetacea (Colten 2015:216).

In recent years, several studies have sought to address whether Oregon tribal ancestors were actively hunting whales or collecting stranded animals. The discovery of an elk bone harpoon point embedded in a humpback whale phalanx from Par-Tee (Losey and Yang 2007; Figure 4.2) prompted further investigation of the archaeological cetacean remains (Loiselle 2020; Sanchez 2014; Sanchez et al. 2016; Wellman et al. 2017).

Figure 4.2. Humpback whale phalanx with embedded elk bone point (red arrow) from the Par-Tee site.

Sanchez (2014) searched the artifact assemblage for possible whaling technology and performed blood residue analysis which yielded inconclusive results. Wellman et al. (2017) searched the Par-Tee assemblage for whales, recorded identifiable elements (N=187), and obtained aDNA species identifications for 30 specimens. The majority were identified as gray (N=17) and humpback whale (N=9; Wellman et al. 2017:255). Wellman et al. (2017) found that the majority of elements were phalanges (frequently cutmarked), followed by vertebrae and ribs. Wellman et al. (2017) noted gouging and adzing modifications on several bones (Figure 4.3) which indicated possible oil removal (following Monks 2001). The species represented at Par-Tee were consistent with historic stranding records (Norman et al. 2004). The modified bones in the Par-Tee assemblage did not suggest "intensive" whale use like that at Nuu-chah-nulth and Makah sites. Noticeably lacking were whale bones used for architectural purposes or intensive artifact manufacture, nor were strike marks or embedded points found among the Par-Tee whale remains. Wellman et al. (2017) concluded that whales at Par-Tee were utilized differently and acquired by collecting stranded whales, with occasional opportunistic hunting (similar logic is used in a coastal Mediterranean case study; Rodrigues et al. 2016).

Figure 4.3. Gouging and adzing on a gray whale mandible from the Par-Tee site (scale in cm). Note gouging on the mandibular condyle (black arrow) and adzing on the ramus (gray arrow). Analyzed by Wellman et al. (2017).

Loiselle (2020:60) analyzed small cetaceans from the Par-Tee assemblage (N=1340) and found primarily harbor porpoise and undifferentiated porpoise/dolphin. Species present in lower abundance included Dall's porpoise (*Phocoena dalli*) and Pacific white-sided and bottlenose (*Tursiops truncatus*) dolphins. Vertebrae were the most abundant element, followed by cranial fragments and periotic bones/tympanic bullae (Loiselle 2020:61). Loiselle (personal communication 7/13/2020) did not use magnification when examining the remains, so cutmarks or gnawing may be present but unreported. While the modern stranding record was also dominated by harbor porpoise (Norman et al. 2004), Loiselle (2020:62) concluded that strandings did not account for the abundances and even distribution of small cetaceans throughout the site.

Initial assessment of the Tahkenitch Landing cetaceans suggested more than one species/two families were represented, and two specimens were identified as either baleen or sperm whales; Greenspan 1986:64). All whale remains were associated with Stratum 2B (Greenspan 1986:64) which yielded radiocarbon dates ranging from 3160 to 3120 cal BP (or 1210-1170 cal BC) (Minor and Toepel 1986:40). Other cetacean specimens included one dolphin specimen (also in stratum 2B) and two Pacific white-sided dolphins in a unit not included in the analysis subsample (Greenspan 1986:67). Several specimens were identifiable to element (phalanges, a carpal, and rib/skull fragments). Minor and Toepel (1986:21) also reported cutmarks on some of the whale specimens.

4.2.4 Cetaceans on the Present-day Oregon Coast

The present-day Oregon coast is home to diverse cetacean species, the most well-known of which is the gray whale. The Pacific Coast Feeding Group (PCFG) of gray whales ranges from northern California to southeast Alaska and forms a roughly year-round "resident" population on the Pacific Northwest including the central Oregon coast (Lagerquist et al. 2019; Scordino et al. 2017). Non-resident gray whales pass through Oregon in their long migrations between winter breeding grounds off Baja California, Mexico, and summer feeding grounds in the Bering and Chukchi Seas (Scordino et al. 2017:57). The Oregon coast is a popular destination for watching gray whales during the winter and spring migrations; the whales pass close to shore and are visible from viewpoints along the coast (Green et al. 1990:223). The PCFG feeds close to shore, making areas like Depoe Bay and other known whale feeding grounds popular with whale watchers, as whales may remain in areas with abundant prey for days at a time (Newell and Cowles 2006:2).

Other whales in Oregon waters include additional baleen species, such as the humpback, blue (*Balaenoptera musculus*), minke (*Balaenoptera acutorostrata*), and fin (*Balaenoptera physalus*) whales (ODFW 2021a). These whales are generally present off the Pacific Coast in summer through fall, and migrate to warmer waters in the winter, although exact migration patterns are not well-described for fin and blue whales (National Oceanic and Atmospheric Administration, Fisheries [NOAA Fisheries] 2021a, b). Toothed cetaceans including sperm whales, orcas, beaked whales, Pacific white-sided dolphins, bottlenose dolphins, and harbor and Dall's porpoises (ODFW 2021a) also frequent Oregon waters. Pacific white-sided and bottlenose dolphins prefer warmer waters (Oregon is at the northern end of the latter's range) and are generally present in Oregon's offshore waters in summer (Norman et al. 2004:90; ODFW 2021a). Resident and transient orcas are usually present in Oregon in the spring, while Dall's and harbor porpoises are present in Oregon year-round (ODFW 2021a). Multiple cetacean species that live or feed in Oregon waters are designated as endangered at federal (orca) and state (gray whale) levels, or both (blue, fin, humpback, and sperm whales; ODFW 2021b).

Most baleen whale species typically feed in open, offshore waters on plankton, krill, and small schooling fish, although researchers have documented shifts in feeding habits based on ocean conditions and food availability. For example, during the 2015 El Niño cycle humpback whales were spotted in the Columbia River, presumably chasing food resources in the area (Patton 2015). Gray whales are unique among baleen whales in feeding primarily nearshore; they use benthic suction to siphon mysid shrimp, crab larvae, and other prey from the sea bottom and/or edges of kelp beds (Calambokidis et al. 2002:267; Iddings 2017:3), although they may also adjust feeding strategies based on resource availability and can feed on a variety of other invertebrates and bony fishes (Pyenson and Lindberg 2011). Sperm and beaked whales hunt in deep pelagic waters for squid and fish (NOAA Fisheries 2021c,d). Orcas may come close to shore to prey on sea lions and seals (ODFW 2021a). Dall's porpoises are fast and sleek, feed on schooling and pelagic fish and squid, and tend to stay in deeper waters, while harbor porpoises come close to shore and enter shallow bays and estuaries in search of prey (ODFW 2021a).

Whales, dolphins, and porpoises are considered charismatic fauna and are popular with the general public, but many species face challenges involving ecosystem degradation and human-mediated disturbances, and are subject to stranding and mortality events. Whale strandings can be related to any number of factors, such as migration patterns and climatic events like El Niño oscillations (Norman et al. 2004:89, 92) or even geomorphological features on the coast that entrap a confused or fatigued animal (Brabyn and McLean 1992; Geraci and Lounsbury 1993:135). Human use of sonar technology has been linked to mass strandings in various locations around the globe (Parsons 2017). While stranding data are not a perfect reflection of extant cetacean communities, Pyenson (2011:1) demonstrated that stranding records do "reflect patterns of richness and relative abundance in living communities." Comparisons of stranding data and archaeological assemblages are, therefore, a useful heuristic exercise when considering cetacean presence and acquisition in archaeological assemblages. I consulted two stranding summaries and one raw dataset for this study: Norman et al. (2004) summarized strandings in Oregon and Washington between 1930 and 2002, the West Coast Marine Mammal Stranding Network (NOAA Fisheries 2020) summarized strandings in Washington, Oregon, and California between 2006 and 2017, and the Oregon Marine Mammal Stranding Network (Jim Rice, personal communication 4/7/2021) maintains a database of Oregon strandings beginning in 1989.

According to the Oregon Marine Mammal Stranding Network, 882 cetaceans have stranded in Oregon since 1989. Approximately 48% of strandings were harbor porpoise, 19% were large baleen or toothed whales, and ~15% were dolphins. In the Seaside area, 41 harbor porpoises, two Dall's porpoises, two dolphins, one beaked whale, three gray whales, one humpback, and one pygmy sperm (*Kogia breviceps*) whale stranded between 1990 and 2019. Strandings at Cannon Beach (located on the southern side of Tillamook Head from Seaside) included multiple harbor porpoises, three sperm whales, a humpback, and several dolphins. Strandings at Gearhart (located north of Seaside) included multiple harbor porpoises, two gray whales, and several smaller cetaceans. While multiple harbor porpoises sometimes stranded in a given year, mass strandings were not reported.

The whale strandings in Oregon were comprised primarily of gray whales, followed by humpback, sperm, minke, fin, and blue (NOAA Fisheries 2020:6). The predominance of gray and humpback whales in the stranding assemblage can be "explained by [the species] coastal presence and increase in population along the West Coast over the past several years" (NOAA Fisheries 2020:6). Small cetacean strandings in Oregon were overwhelmingly harbor and Dall's porpoise (total of 89%) with smaller quantities of dolphins (NOAA Fisheries 2020:6). Small cetacean strandings in Washington were almost completely harbor and Dall's porpoise (total of 96%; NOAA 2020:7). In comparison, common dolphins (*Delphinus delphis*; 45%) made up a larger proportion of stranded small cetaceans on California coastlines (NOAA Fisheries 2020:7), likely because many West Coast dolphin species maintain ranges in temperate waters, and Oregon represents the northern limit of their range (Norman et al. 2004:90).

Some species strand more frequently in certain seasons. For example, gray whale strandings occurred most frequently in spring (April, May, and June) when the gray whales are returning north along, or feeding on, the Oregon coast (NOAA Fisheries 2020:7; Norman et al. 2004:92). Unsurprisingly, the majority of stranded individuals from 2006 to 2017 in April and May were subadults, primarily calves (NOAA Fisheries 2020:8), and a similar pattern was found in stranding data spanning 1930 to 2002 (Norman et al. 2004:92). The majority of harbor porpoise strandings occurred in July and August, during or after calving season (NOAA Fisheries 2020:7) and the majority of stranded individuals were subadults, primarily calves (NOAA Fisheries 2020:7). Mortality rates are high in young cetaceans, especially those with short periods of maternal care like the baleen whales (Geraci and Lounsbury 1993:76).

4.3 Methods and Materials

4.3.1 Zooarchaeological Analysis

I analyzed a subsample of cetacean remains from 90 excavation units from the Palmrose site: material from 22 unsorted units was obtained on loan from MNCH and analyzed in the Northwest Coast Zooarchaeology Lab at UO, and material from 10 units was analyzed at NMNH. I searched an additional 58 units stored at NMNH. The collection is stored on open trays in cabinets, facilitating rapid identifications of cetacean remains. During this search, I generated an inventory of tentative species identifications and took photographs and measurements, greatly increasing the sample size. I did not note taphonomy for this search. I obtained the pre-identified whale remains (Greenspan 1986) from Tahkenitch Landing on loan from the Siuslaw National Forest and re-analyzed them in the Northwest Coast Zooarchaeology Lab. Identifications were made using comparative specimens in the NMNH Division of Mammals and the Northwest Coast Zooarchaeology Lab as well as print references such as Post (2003). Multiple individuals were used when available to account for inter-individual variation, sex, and geographic factors. I measured vertebrae as part of my initial analysis, and considered implementing measurement-based identification systems (Buchholtz and Schur 2004; Evans and Mulville 2018; Thongcharoenchaikit and Eda 2020; Youri van den Hurk, personal communication 7/23/2020), but variation in vertebral size, varied epiphyseal fusion, and inter-species variation combined with taphonomic factors (e.g., erosion, wear, fragmentation, and weathering) rendered morphometric efforts at identifications unreliable. I did not attempt to identify cetacean teeth, but I also did not note any during my analysis. The Palmrose and Tahkenitch Landing assemblages contained numerous non-diagnostic fragments of trabecular bone which may be from whales. I counted 113 unidentifiable pieces of bone at Palmrose that I strongly suspected were cetacean based on the trabecular structure, shape, and/or weight. I sampled 9 of these unidentified specimens for ZooMS identification, and all were, in fact, cetacean. The remaining fragments, however, are excluded to facilitate comparison to the Par-Tee assemblage abundances which also excluded non-diagnostic fragments (Wellman et al. 2017). From Tahkenitch Landing, I counted 16 unidentifiable specimens and sampled one for ZooMS identification, confirming a cetacean identification.

4.3.2 Biomolecular Analysis

4.3.2.1 *Sample.* I sampled 116 specimens from Palmrose and 11 specimens from Tahkenitch Landing to identify using ZooMS analysis. An additional 31 specimens from the Par-Tee assemblage were previously sampled and those results are reported here for the first time. Due to the fragmented nature of cetacean remains, maintaining specimen independence for ZooMS analysis is difficult. Wellman et al. (2017) previously found it impossible to choose a single non-repetitive element to sample across the site. Specimens were chosen as follows: identifiable to genus and/or species using comparative collections (to either confirm or correct the identification), identifiable to element but not beyond genus and/or family, and fragments that were not identifiable to element but strongly suspected to be cetacean. Due to the poor preservation of some Tahkenitch Landing specimens, I also considered the likelihood of successful collagen extraction. ZooMS analysis is unable to differentiate species within the porpoise and dolphin families due to recent evolutionary divergence (Buckley et al. 2014:636; Buckley 2018), and some samples yielded ambiguous peptide spectra. To resolve these ambiguities, 30 samples will undergo further ancient DNA analysis, but these results are delayed due to COVID-19 related-lab closures and are anticipated in early June 2021 (Camilla Speller, personal communication 4/2/2021).

4.3.2.2 *Zooarchaeology by Mass Spectrometry (ZooMS).* Sampling for ZooMS analysis was performed at the Northwest Coast Zooarchaeology lab at UO and laboratory space at the NMNH Museum Support Center. Unlike aDNA analyses, contamination from modern protein sources are less of a concern with ZooMS since there is no amplification step (Speller et al. 2016). To reduce surface contamination I cleaned the area of the specimen to be sampled with a sterile kimwipe dampened with a dilute bleach-H_2O solution (50%). A small sample of bone (approximately 10-30 mg) was cut from the specimen using a bleached utility blade and placed into a sterile Eppendorf tube. Between the sampling and handling of each new specimen I changed gloves, bleached the utility blade (or replaced it as needed), and cleaned the sampling table. This sampling method has been shown to be sufficiently sterile and has yielded accurate species identifications in previous aDNA studies (Wellman et al. 2017; Wellman et al. 2020).

The bone samples were sent to the University of British Columbia where collagen was extracted within the Ancient DNA and Proteins (ADαPT) Laboratories in the Department of Anthropology. The bone sample was demineralized in a weak acid solution (0.6M HCl); the sample was then centrifuged, and the supernatant was discarded. The samples were rinsed with 250 µL of 0.1M NaOH, and then rinsed three times with 200 µl of 50 mMol ammonium bicarbonate, pH 8.0 (AmBic solution), and gelatinized by heating at 65º C in AmBic solution for 1 hour. The collagen was enzymatically cleaved with trypsin at 37˚C, and purified using 100 µl C18 resin ZipTip® pipette tips before being spotted with matrix onto a target plate, with calibration standards. Samples were spotted in triplicate, and the masses of the peptides were measured following desorption/ionization of the sample using laser energy (MALDI) and estimated by time of flight (TOF) (Bruker Ultraflex III MALDI TOF/TOF mass spectrometer with a Nd:YAG smart beam laser). mMass software (Strohalm et al. 2010) was used to visually inspect the spectra and compare them to the list of m/z markers (mass-to-charge ratio) for marine mammals (Buckley et al. 2014; Hufthammer et al. 2018; Kirby et al. 2013). Taxonomic identifications were assigned at the most conservative level of identification (species, genus, or family level) based on the presence of unambiguous m/z markers.

4.3.2.3 *Ancient DNA.* Ancient DNA samples were taken from bone leftover from ZooMS analysis. All samples underwent additional decontamination prior to aDNA analysis. The Par-Tee cetacean aDNA analysis was conducted in the aDNA laboratory in the Department of Archaeology, Simon Fraser University (Burnaby, BC) by Camilla Speller, Dongya Yang and Hua Zhang. The Palmrose and Tahkenitch Landing aDNA analysis will be conducted in the Ancient DNA and Proteins (ADαPT) Laboratories, Department of Anthropology, University of British Columbia (Vancouver, BC) by Camilla Speller, and students Zara Evans and Max Miner.

All ancient DNA extractions and PCR setups were conducted in dedicated ancient DNA laboratories and followed vigorous contamination control protocols (Yang and Watt 2005). Prior to the DNA extraction, the samples were decontaminated using the protocol described by Speller et al. (2012). Briefly, the samples were immersed in a 100% commercial bleach solution (6% sodium hypochlorite) for 5-7 min, rinsed twice in distilled water, and UV irradiated in a crosslinker for 30 min (15 min each side). DNA was extracted from the decontaminated samples using a modified silica-spin column method (Yang et al. 1998; Yang et al. 2008). The decontaminated samples were physically crushed into small bone particles and incubated overnight in 4 mL of lysis buffer (0.5 M EDTA pH 8.0, 0.25-0.5% SDS, and 0.5 mg/mL proteinase K) in a rotating hybridization oven at 48-50˚C. Following incubation, the samples were centrifuged, and 3 mL of the resulting supernatant was concentrated to ≤100 µL using an Amicon Ultra-4 30 KD centrifugal filter (Millipore, Billerica, MA). The concentrated extracts were then purified using a QIAquick PCR Purification Kit (Qiagen, Valencia, California). Blank extracts were processed alongside the ancient samples and subjected to PCR amplification to detect potential contaminations.

Species identification was based on sequence analyses of fragments of the mitochondrial DNA amplified with specific primers (cytochrome *b* gene [Cyt *b*] (Yang and Speller 2006) and cytochrome *c* oxidase subunit I gene [COI] primers). PCR amplifications were performed on Eppendorf™ Mastercycler using a 30 µL reaction volume containing 1.5X Applied Biosystems™ Buffer, 2 mM MgCl2, 0.2 mM dNTP, 1.0 mg/mL BSA, 3.0 µL DNA sample and 1.5 U AmpliTaq Gold (Applied Biosystems). The thermal conditions for the PCRs consisted of an initial denaturation step at 95˚C for 12 min followed by 60 cycles at 95˚C for 30 s (denaturation), 55˚C (for Cyt *b* primer set)/50 ˚C (for COI primer set) for 30 s (annealing), and 72˚C for 40 s (extension), and a final extension step at 72˚C for 7 min. To monitor for contamination, negative PCR controls were included in each PCR setup.

Following amplification, 5 µL of PCR product from each sample was pre-stained with SYBR Green I (Life Technologies, Carlsbad, CA), electrophoresed on a 2% agarose gel, and visualized with a Dark Reader transilluminator (Clare Chemical Research, Dolores, CO). PCR products were directly sequenced with the amplification primers in the forward or reverse direction at Eurofins Genomics (Toronto, ON). The sequences obtained from each sample were visually edited, truncated to remove the primer sequences, and assembled using ChromasPro (http://www.technelysium.com.au).

To determine their closest sequence match and ensure they did not resemble sequences from unexpected taxa or loci, the obtained sequences were compared to reference sequences in GenBank through a BLAST search (Altschul et al. 1990). Multiple alignments of the ancient sequences and published cetacean reference sequences were achieved using ClustalW (Thompson et al. 1994), through BioEdit (Hall 1998), and phylogenetic analysis was conducted using Mega X software (Kumar et al. 2018). Species identity can be assigned to a sample if the obtained DNA sequence matches these reference DNA sequences in GenBank identically or very closely but very different from those of other closely-related species. The latter was examined by phylogenetic analysis of the obtained ancient DNA sequences and those closely-related species.

4.3.2.4 *AMS Dating.* Two Tahkenitch Landing cetacean specimens (K-17-W1 and L-14-W1) were sampled for AMS radiocarbon dating. The samples were sent to DirectAMS (Bothell, WA) and yielded dates of 3647 ± 25 ^{14}C yr BP and 3668 ± 25 ^{14}C yr BP, respectively (Table 4.1). Direct dating of whale remains is difficult because whales feed over a large range depending on their migration patterns (Sanchez et al. 2016:401). Following Sanchez et al. (2016:401-402) we chose a reservoir offset (ΔR) by averaging multiple ΔR values from across the approximate feeding range for humpback, gray, and blue whales on the Pacific Northwest Coast (NOAA Fisheries 2021b,e; Sanchez et al. 2016; Scordino et al. 2017), spanning from northern California (San Francisco Bay) to British Columbia (southern Vancouver Island) in the ^{14}CHRONO Marine Reservoir Database (http://calib.qub.ac.uk/marine/). We used 34 ΔR values from within this geographic range, with a mean ΔR of 228 ± 74. We calibrated the dates using Marine20 (Heaton et al. 2020) in OxCal v. 4.4 (Ramsey 2009) and rounded to report at decadal resolution (following Millard 2014), which yielded dates of 3350-2870 cal BP (1400-920 cal BC) and 3370-2890 cal BP (1420-940 cal BC), respectively. Given the relative imprecision of our ΔR correction, these date ranges are significantly broader than would be expected if direct dating terrestrial mammals or marine species with a limited geographic range.

Table 4.1. New AMS ^{14}C dates from Tahkenitch Landing.

Laboratory Number	Provenience	Material	Conventional ^{14}C age BP	1σ error	cal BP (95.4%)
D-AMS 038850	K-17-W1	bone	3647 ± 25	0.20	3350-2870
D-AMS 038851	L-14-W1	bone	3668 ± 25	0.20	3370-2890

4.4 Zooarchaeology and Biomolecular Results

4.4.1 Tahkenitch Landing

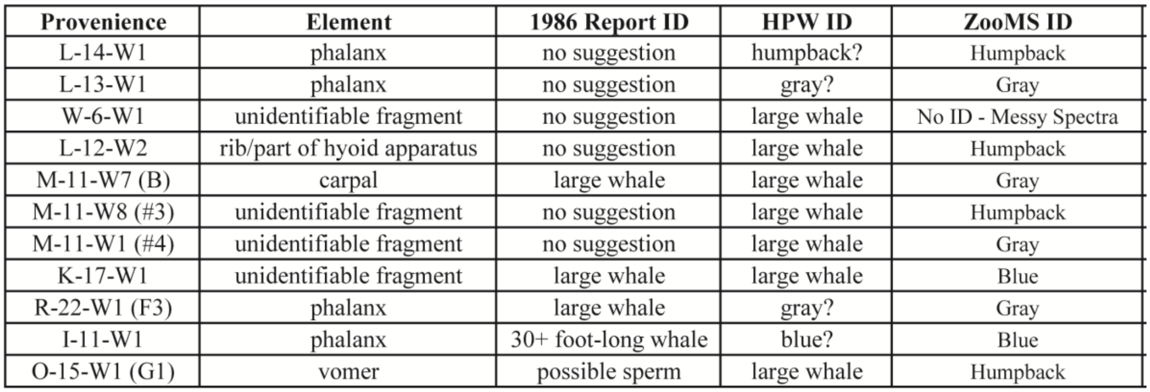
My re-analysis of the Tahkenitch Landing whale remains yielded a small sample size (NISP=33). The majority of specimens were extremely weathered and fragmented. Some specimens represented a single element that degraded and fragmented into too many pieces to reliably quantify (Figure 4.4). Approximately 17 specimens were identifiable to element including large skull fragments, four phalanges, a carpal, and a probable rib (Greenspan 1986:68). I was not able to make element identifications beyond those originally reported (Greenspan 1986:68), nor did I note modifications beyond the apparent processing of the whales into manageable units (resulting in the large cranial fragments) and a cutmark on one gray whale phalanx (L-13-W1. I was able to identify three of the phalanges to species (humpback, gray, and blue whale, respectively).

Figure 4.4. Example of a badly weathered/fragmented element from the Tahkenitch Landing site (scale in cm). The dark-brown coloration is staining and/or attached soil matrix, not burning or other human modification.

ZooMS analysis of the Tahkenitch Landing specimens confirmed the phalanx species identifications (humpback, gray, and blue whale; Table 4.2). The carpal was identified as gray whale, and a vomer and probable rib were identified as humpback. The remaining four specimens were unidentifiable fragments and identified to blue, humpback, and gray whale species, respectively. The fourth specimen yielded a poor spectra sequence (aDNA results forthcoming).

The new AMS dates from the Tahkenitch Landing whales obtained for this study did not change the site's chronology. The original radiocarbon dates reported for stratum 2B (which contained the whale remains) fall within the range of the new AMS dates reported here (McDowell and Minor 1986:40).

Table 4.2. Tahkenitch Landing ZooMS Results



Provenience	Element	1986 Report ID	HPW ID	ZooMS ID
L-14-W1	phalanx	no suggestion	humpback?	Humpback
L-13-W1	phalanx	no suggestion	gray?	Gray
W-6-W1	unidentifiable fragment	no suggestion	large whale	No ID - Messy Spectra
L-12-W2	rib/part of hyoid apparatus	no suggestion	large whale	Humpback
M-11-W7 (B)	carpal	large whale	large whale	Gray
M-11-W8 (#3)	unidentifiable fragment	no suggestion	large whale	Humpback
M-11-W1 (#4)	unidentifiable fragment	no suggestion	large whale	Gray
K-17-W1	unidentifiable fragment	large whale	large whale	Blue
R-22-W1 (F3)	phalanx	large whale	gray?	Gray
I-11-W1	phalanx	30+ foot-long whale	blue?	Blue
O-15-W1 (G1)	vomer	possible sperm	large whale	Humpback

4.4.2 Palmrose

Palmrose yielded a large sample (NISP=1174), the majority of which were small cetaceans (N=900), although whales were present (N=134; Table 4.3). An additional 140 NISP were identifiable to element but not to family/species. A large number of specimens (NISP=522; primarily skull/vertebra fragments) were unidentifiable beyond dolphin/porpoise. Harbor porpoise (NISP=135) and bottlenose dolphin (NISP=136) were the most abundant small cetacean species while Dall's porpoise and Pacific white-sided dolphin were present in significantly smaller quantities (NISP=2 and NISP=9, respectively). Element representation of small cetaceans was dominated by vertebrae (76% of identified elements; Figure 4.5).

The whales were represented primarily by vertebrae (60%) and ribs (22%), but phalanges, a radius, and skull fragments were also present (Figure 4.6). As at Par-Tee, the Palmrose assemblage likely included numerous fragments of cetacean that were unidentifiable due to fragmentation, although several unidentifiable fragments (N=9) suspected to be cetacean were successfully confirmed using ZooMS. Two phalanges were identified as humpback whale using comparative specimens.

Table 4.3. Palmrose Species/Family NISP (Morphological and ZooMS Identifications)

Family/Species	NISP
Cetacean, undifferentiated	140
Dall's porpoise	2
Dolphin, undifferentiated	42
Dolphin/porpoise, undifferentiated	522
Pacific white-sided dolphin	9
Harbor porpoise	135
Porpoise, undifferentiated	50
Bottlenose dolphin	136
Beaked whale	4
Large cetacean, undifferentiated	99
Fin whale	1
Minke whale	1
Humpback whale	26
Gray whale	6
Blue whale	1

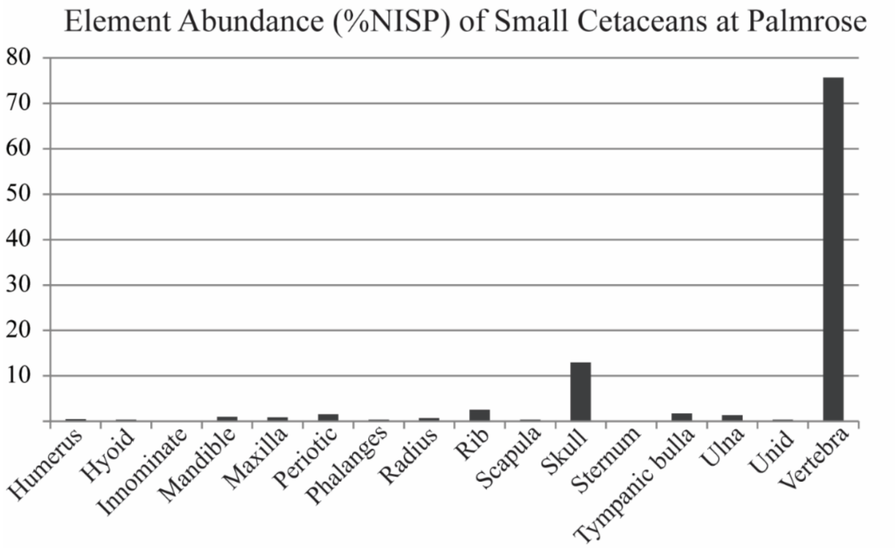


Figure 4.5. Element abundance (% NISP) of small cetaceans (dolphins, porpoises, and beaked whales) at the Palmrose site.

The Palmrose sample contained 42 cutmarked elements: 34 vertebrae, one hyoid or rib, one mandible, two phalanges, two rib fragments, one tympanic bulla, and one ulna. An additional seven elements showed evidence of likely gouging or adzing. Fragmented elements from whales in the sample may be a result of natural taphonomic processes or as a result of human processing. In addition to human modification, 11 cetacean elements exhibited carnivore gnawing. The majority of gnawed elements were harbor porpoise vertebrae, but a dolphin radius and phalanx, and fin whale phalanx were also gnawed. Other specimens may exhibit gnawing but I could not confirm due to weathering, splintering, degradation, exfoliation, and crumbling.

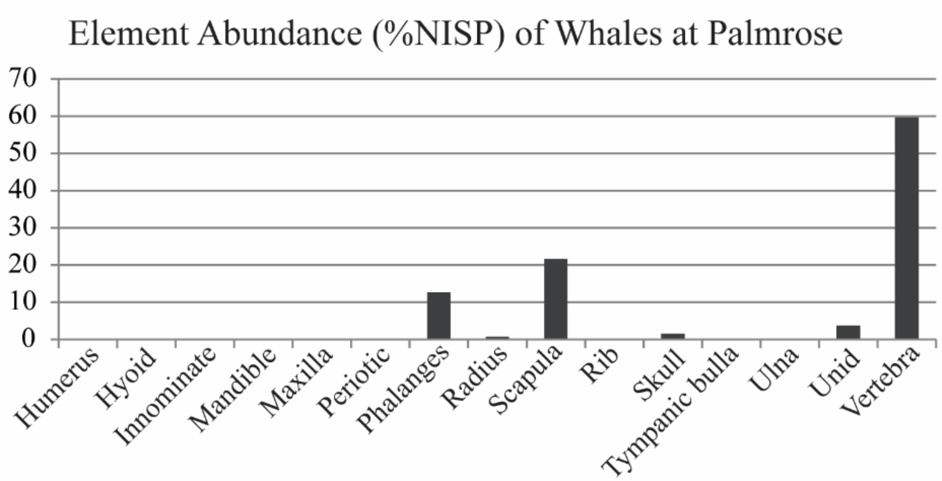


Figure 4.6. Element abundance (% NISP) of whales at the Palmrose site.

ZooMS analysis of the small cetaceans largely confirmed morphological identifications. ZooMS cannot distinguish between porpoise and dolphin species, but all specimens identified morphologically as harbor porpoise and bottlenose dolphin yielded ZooMS identifications of porpoise and dolphin (Table 4.4). Some surprising ZooMS results illustrate the difficulty of cetacean identifications; a vertebra identified as Dall's porpoise based on narrow centrum width and round shape was confirmed by ZooMS to be a dolphin (probably juvenile). Two vertebrae identified as beaked whale based on relatively long centrum length were confirmed by ZooMS to be dolphin and false killer whale (*Pseudorca crassidens*), respectively. The ZooMS results for whale species were gray (N=6), humpback (N=17), minke (N=1), fin (N=1), and blue (N=1). The undiagnostic, but suspected cetacean, specimens were blue, humpback, and beaked whales, respectively. Additional small cetaceans are undergoing aDNA analysis to confirm species identifications. Three whale ZooMS samples yielded undiagnostic peptide spectra which will also be resolved by aDNA analysis.

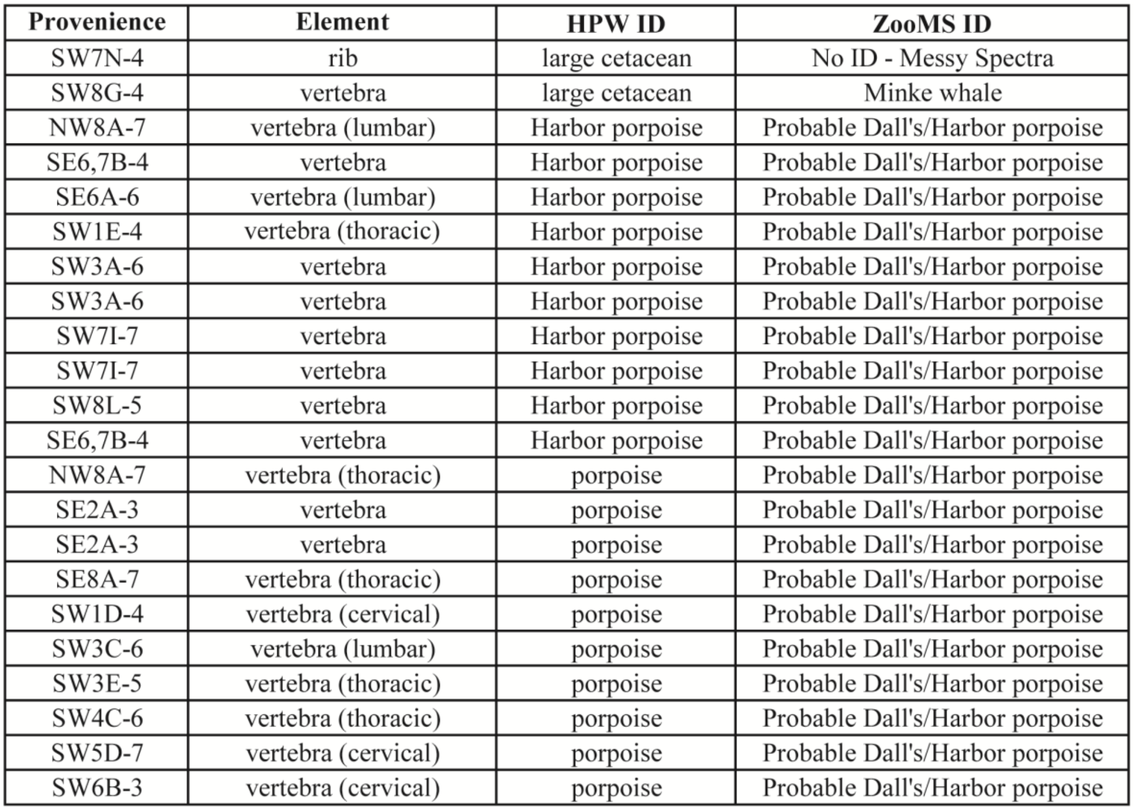
Table 4.4. Palmrose ZooMS Results

Provenience	Element	HPW ID	ZooMS ID
NW10A-10	unidentifiable fragment	large cetacean	Beaked whale
NW10A-9	unidentifiable fragment	large cetacean	Beaked whale
NW10A-9	unidentifiable fragment	large cetacean	Beaked whale
NW10A-9	unidentifiable fragment	large cetacean	Beaked whale
NW10A-10	unidentifiable fragment	large cetacean	Blue whale
SE1A-7	rib fragment	dolphin	Bottlenose/Euphrosyne dolphin
SE1G-4	vertebra (caudal)	dolphin	Bottlenose/Euphrosyne dolphin
NE4C-6	mandible fragment	dolphin	Bottlenose/Euphrosyne dolphin
SE6,7B-4	vertebra	dolphin	Bottlenose/Euphrosyne dolphin
SW2D-3	vertebra	dolphin	Bottlenose/Euphrosyne dolphin
SW3E-7	vertebra (thoracic)	dolphin	Bottlenose/Euphrosyne dolphin
SW4D-6	vertebra	dolphin	Bottlenose/Euphrosyne dolphin
SW4D-6	vertebra (thoracic)	dolphin	Bottlenose/Euphrosyne dolphin
SW5E-6	vertebra (caudal)	dolphin	Bottlenose/Euphrosyne dolphin
SW7M-6	vertebra (caudal)	dolphin	Bottlenose/Euphrosyne dolphin
SW8J-6	rib	dolphin	Bottlenose/Euphrosyne dolphin
NE2C-6	vertebra (lumbar)	Dall's porpoise	Bottlenose/Euphrosyne dolphin
SW5A-42-48	vertebra	Harbor porpoise	Bottlenose/Euphrosyne dolphin
NE1K-4	humerus	Bottlenose dolphin	Bottlenose/Euphrosyne dolphin
NE1K-4	vertebra	Bottlenose dolphin	Bottlenose/Euphrosyne dolphin
NE2L-4	vertebra	Bottlenose dolphin	Bottlenose/Euphrosyne dolphin
NE3A-2	maxilla fragment	Bottlenose dolphin	Bottlenose/Euphrosyne dolphin
NE3A-6	vertebra (thoracic)	Bottlenose dolphin	Bottlenose/Euphrosyne dolphin
NE3B-2	vertebra (lumbar/caudal)	Bottlenose dolphin	Bottlenose/Euphrosyne dolphin
NE3B-2	vertebra (lumbar/caudal)	Bottlenose dolphin	Bottlenose/Euphrosyne dolphin
NW10A-9	vertebra (lumbar)	Bottlenose dolphin	Bottlenose/Euphrosyne dolphin
NW6A-5	vertebra (lumbar)	Bottlenose dolphin	Bottlenose/Euphrosyne dolphin
NW6A-6	radius	Bottlenose dolphin	Bottlenose/Euphrosyne dolphin
NW6A-6	ulna	Bottlenose dolphin	Bottlenose/Euphrosyne dolphin
NW6A-7	vertebra (caudal)	Bottlenose dolphin	Bottlenose/Euphrosyne dolphin
SW4E-7	vertebra (caudal)	Bottlenose dolphin	Bottlenose/Euphrosyne dolphin
SW7H-6	vertebra (thoracic)	Bottlenose dolphin	Bottlenose/Euphrosyne dolphin
NW10A-10	vertebra (cervical)	Bottlenose dolphin	Bottlenose/Euphrosyne dolphin
SW4A-8	vertebra (cervical)	Bottlenose dolphin	Bottlenose/Euphrosyne dolphin
SW6A-84-90	vertebra (cervical)	Bottlenose dolphin	Bottlenose/Euphrosyne dolphin
NE2L-7	vertebra	Beaked whale	Bottlenose/Euphrosyne dolphin
SE6A-3	vertebra	Pacific white-sided dolphin	Bottlenose/Euphrosyne dolphin
NE4C-3	vertebra	Bottlenose dolphin	Bottlenose/Euphrosyne dolphin
SE1A-6	vertebra (thoracic)	dolphin	Bottlenose/Euphrosyne dolphin
SE2G-7	radius	Bottlenose dolphin	Bottlenose/Euphrosyne dolphin
NE2C-5	vertebra (lumbar)	Harbor porpoise	Dall's/Harbor Porpoise
NE3A-2	vertebra (caudal)	Harbor porpoise	Dall's/Harbor Porpoise
SE7A-9	vertebra (caudal)	Harbor porpoise	Dall's/Harbor Porpoise
NE2D-7	humerus	porpoise	Dall's/Harbor Porpoise
SE1G-3	vertebra (thoracic)	porpoise	Dall's/Harbor Porpoise

Table 4.4. continued

Provenience	Element	HPW ID	ZooMS ID
SE3B-7	vertebra (lumbar)	Harbor porpoise	Dall's/Harbor Porpoise
NE2D-7	scapula	dolphin	dolphin
SE1G-6	humerus	dolphin	dolphin
SE1M-5	phalanx	dolphin	dolphin
NE4C-6	vertebra (caudal)	Bottlenose dolphin	dolphin
NE5B-7	vertebra	Bottlenose dolphin	dolphin
SE1A-6	vertebra (caudal)	Bottlenose dolphin	dolphin
NE1E-6	ulna	Bottlenose dolphin	dolphin
NE1I-7	vertebra	Bottlenose dolphin	dolphin
NE1L-4	vertebra (lumbar)	Bottlenose dolphin	dolphin
SW4E-5	vertebra	Beaked Whale	False Killer whale
SE3E-3	phalanx	large cetacean	Fin whale
SE7B-8	phalanx	large cetacean	Fin/Humpback/Grey
SE4D-6	phalanx	large cetacean	Gray whale
SE7A-9	phalanx	large cetacean	Grey whale
SW3E-5	phalanx	large cetacean	Grey whale
SW5B-5	phalanx	large cetacean	Grey whale
SW6P-6	rib fragment	large cetacean	Grey whale
NW10A-10	unidentifiable fragment	large cetacean	Humpback whale
NE1I-4	phalanx	large cetacean	Humpback whale
NE2M-3	unidentifiable fragment	large cetacean	Humpback whale
NW6A-5	unidentifiable fragment	large cetacean	Humpback whale
SE1A-8	phalanx	large cetacean	Humpback whale
SE1G-4	phalanx	large cetacean	Humpback whale
SE1N-4	unidentifiable fragment	large cetacean	Humpback whale
SE2G-6	vertebra	large cetacean	Humpback whale
SE3B-7	vertebra (caudal)	large cetacean	Humpback whale
SE3C-4	vertebra	large cetacean	Humpback whale
SE3E-5	vertebra/rib fragment	large cetacean	Humpback whale
SE3E-9	vertebra	large cetacean	Humpback whale
SE7E-8	rib fragment	large cetacean	Humpback whale
SW4A-4	skull fragment	large cetacean	Humpback whale
SW4C-4	skull fragment	large cetacean	Humpback whale
SW5C-6	phalanx	large cetacean	Humpback whale
SW5D-5	vertebra	large cetacean	Humpback whale
SW5E-6	phalanx	large cetacean	Humpback whale
SW5P-6	rib	large cetacean	Humpback whale
SW5P-6	rib	large cetacean	Humpback whale
SW7A-3	vertebra	large cetacean	Humpback whale
SW7D-5	radius	large cetacean	Humpback whale
SW7I-5	vertebra	large cetacean	Humpback whale
SW8F-6	vertebra (caudal)	large cetacean	Humpback whale
SE3C-5	phalanx	Humpback whale	Humpback whale
SE6A-4	phalanx	Humpback whale	Humpback whale
SW5P-6	rib	large cetacean	No ID - Messy Spectra
SW6P-7	rib	large cetacean	No ID - Messy Spectra

Table 4.4. continued



Provenience	Element	HPW ID	ZooMS ID
SW7N-4	rib	large cetacean	No ID - Messy Spectra
SW8G-4	vertebra	large cetacean	Minke whale
NW8A-7	vertebra (lumbar)	Harbor porpoise	Probable Dall's/Harbor porpoise
SE6,7B-4	vertebra	Harbor porpoise	Probable Dall's/Harbor porpoise
SE6A-6	vertebra (lumbar)	Harbor porpoise	Probable Dall's/Harbor porpoise
SW1E-4	vertebra (thoracic)	Harbor porpoise	Probable Dall's/Harbor porpoise
SW3A-6	vertebra	Harbor porpoise	Probable Dall's/Harbor porpoise
SW3A-6	vertebra	Harbor porpoise	Probable Dall's/Harbor porpoise
SW7I-7	vertebra	Harbor porpoise	Probable Dall's/Harbor porpoise
SW7I-7	vertebra	Harbor porpoise	Probable Dall's/Harbor porpoise
SW8L-5	vertebra	Harbor porpoise	Probable Dall's/Harbor porpoise
SE6,7B-4	vertebra	Harbor porpoise	Probable Dall's/Harbor porpoise
NW8A-7	vertebra (thoracic)	porpoise	Probable Dall's/Harbor porpoise
SE2A-3	vertebra	porpoise	Probable Dall's/Harbor porpoise
SE2A-3	vertebra	porpoise	Probable Dall's/Harbor porpoise
SE8A-7	vertebra (thoracic)	porpoise	Probable Dall's/Harbor porpoise
SW1D-4	vertebra (cervical)	porpoise	Probable Dall's/Harbor porpoise
SW3C-6	vertebra (lumbar)	porpoise	Probable Dall's/Harbor porpoise
SW3E-5	vertebra (thoracic)	porpoise	Probable Dall's/Harbor porpoise
SW4C-6	vertebra (thoracic)	porpoise	Probable Dall's/Harbor porpoise
SW5D-7	vertebra (cervical)	porpoise	Probable Dall's/Harbor porpoise
SW6B-3	vertebra (cervical)	porpoise	Probable Dall's/Harbor porpoise

4.4.3 Par-Tee

The cetaceans at Par-Tee were previously analyzed (Colten 2015; Loiselle 2020; Wellman et al. 2017), but additional ZooMS and aDNA identifications of 31 whale specimens are reported and discussed as part of this project. The new identifications yielded an additional 16 gray and 8 humpback identifications (Table 4.5).

New species identified include one fin, one blue, and three beaked whale specimens. A Steller sea lion vertebra included as a test was identified by ZooMS correctly. A final sample failed (aDNA forthcoming). The beaked whale identifications were confirmed with aDNA analysis and further identified as Cuvier’s beaked whale (*Ziphius cavirostris*).

Table 4.5. Par-Tee ZooMS Results

Provenience	Element	Species	Analyst	ID Method
SW21C-9	phalanx	Gray	Wellman; this study	morphology
SW21C-9	vertebra	Gray	Wellman; this study	ZooMS/aDNA
SW21D-5	ulna	Gray	Wellman et al. 2017	aDNA
SW21H-6	rib fragment	Gray	Wellman et al. 2017	aDNA
SW22D-6	rib fragment	Gray	Wellman et al. 2017	aDNA
SW22D-7	rib fragment	Gray	Wellman; this study	ZooMS
NE10B-7	vertebra	Gray/Humpback	Wellman; this study	ZooMS
NE10B-7	rib fragment	Gray/Humpback	Wellman; this study	ZooMS
SW20D-3	phalanx	Gray/Humpback	Wellman; this study	morphology
NE13C-9	vertebra	Gray	Wellman et al. 2017	aDNA
SE10K-8	phalanx	Gray	Wellman; this study	morphology
SE12L-6	phalanx	Gray	Wellman; this study	morphology
SE17H-5	phalanx	Gray	Wellman; this study	morphology
SW18A	phalanx	Gray	Wellman; this study	morphology
SW19F-5	phalanx	Gray	Wellman; this study	morphology
SW20C-5	phalanx	Gray	Wellman; this study	morphology
SW20C-5	phalanx	Gray	Wellman; this study	morphology
SW22C-8	phalanx	Gray	Wellman; this study	morphology
NE10E-6	phalanx	Humpback	Wellman; this study	ZooMS/aDNA
NE10E-8	phalanx	Humpback	Wellman et al. 2017	aDNA
NE10F-7	phalanx	Humpback	Wellman; this study	ZooMS
NE10H-9	phalanx	Humpback	Wellman; this study	morphology
NE12E-6	innominate	Humpback	Wellman et al. 2017	aDNA
NE12H-7	phalanx	Humpback	Wellman; this study	morphology
NE14E-9	vertebra (caudal)	Humpback	Wellman; this study	ZooMS
NE14H-6	phalanx	Humpback	Wellman; this study	morphology
NE15H-6	phalanx	Humpback	Wellman; this study	ZooMS
NE15H-6	phalanx	Humpback	Wellman; this study	morphology
NE16G-7	phalanx	Humpback	Wellman; this study	morphology
NE7E-6	rib fragment	Humpback	Wellman; this study	ZooMS
NE8F-3	vertebra	Humpback	Wellman et al. 2017	aDNA
NE8I-6	phalanx	Humpback	Wellman; this study	ZooMS/aDNA
NE8I-8	phalanx	Humpback	Wellman; this study	morphology
NW19A	phalanx	Humpback	Wellman; this study	morphology
SE11J-10	phalanx	Humpback	Wellman et al. 2017	aDNA
SE11J-10	phalanx	Humpback	Wellman; this study	morphology
SE11J-10	phalanx	Humpback	Wellman; this study	morphology
SE12K-6	vertebra (caudal)	Humpback	Wellman et al. 2017	aDNA
SE4D-6	radius	Humpback	Wellman et al. 2017	aDNA
SE6D-6	phalanx	Humpback	Wellman et al. 2017	aDNA
SE7J-10	rib fragment	Humpback	Wellman et al. 2021	ZooMS
SW18A	ulna	Humpback	Wellman et al. 2017	aDNA
SW19H-6	phalanx	Humpback	Wellman; this study	morphology
SW20A-9	phalanx	Humpback	Wellman et al. 2017	aDNA
SW21F-3	phalanx	Humpback	Wellman; this study	morphology
SW21F-4	phalanx with bone point	Humpback	Losey and Yang (2007)	aDNA
SE7K-10	phalanx	Humpback	Wellman; this study	morphology
SE10L-8	mandibular condyle	Minke	Wellman et al. 2017	aDNA
NE12H-7	vertebra (caudal)	null	Wellman et al. 2017	aDNA
SE7L-7	vertebra (cervical)	null	Wellman et al. 2017	aDNA
Salvage SE1/4	vertebra (cervical)	Orca	Wellman et al. 2017	aDNA

Table 4.5. continued

Provenience	Element	Species	Analyst	ID Method
SW21G-3	phalanx	Blue	Wellman; this study	ZooMS/aDNA
NE11D-7	vertebra (caudal)	cetacean	Wellman; this study	ZooMS/aDNA
NE11F-5	vertebra	Cuvier's	Wellman; this study	ZooMS/aDNA
NE11F-5	vertebra	Cuvier's	Wellman; this study	ZooMS/aDNA
NE14E-9	vertebra	Cuvier's	Wellman; this study	ZooMS/aDNA
14G 72-84"	phalanx	Fin	Wellman; this study	ZooMS/aDNA
SW20C-5	phalanx	Fin	Wellman; this study	morphology
NE15F-8	phalanx	Fin	Wellman; this study	morphology
NE10D-6	rib fragment	Gray	Wellman; this study	ZooMS
NE10G-8	humerus	Gray	Wellman et al. 2017	aDNA
NE11,12D	phalanx	Gray	Wellman; this study	morphology
NE11D-2	phalanx	Gray	Wellman; this study	morphology
NE11E-8	vertebra	Gray	Wellman; this study	ZooMS
NE12D-7	ulna	Gray	Wellman et al. 2017/this study	aDNA/ZooMS
NE12G-8	phalanx	Gray	Wellman; this study	morphology
NE13A-3	phalanx	Gray	Wellman; this study	ZooMS/aDNA
NE13C-9	phalanx	Gray	Wellman; this study	ZooMS/aDNA
NE13G	scapula	Gray	Wellman et al. 2017	aDNA
NE19F-6	rib fragment	Gray	Wellman; this study	ZooMS
NE7C-6	atlas	Gray	Wellman et al. 2017	aDNA
NE8I-6	vertebra (caudal)	Gray	Wellman; this study	ZooMS
NE9B-7	rib fragment	Gray	Wellman et al. 2017	aDNA
NE9D-6	phalanx fragment	Gray	Wellman; this study	morphology
NE9E-7	vertebra (caudal)	Gray	Wellman; this study	ZooMS/aDNA
NE9I-7	phalanx	Gray	Wellman; this study	ZooMS
NW19A	phalanx	Gray	Wellman; this study	morphology
NW19A	phalanx	Gray	Wellman et al. 2017	aDNA
SE17G-6	phalanx	Gray	Wellman; this study	morphology
SE17H-6	rib fragment	Gray	Wellman et al. 2017	aDNA
SE17H-7	vertebra (cervical)	Gray	Wellman et al. 2017	aDNA
SE18H-6	mandibular condyle	Gray	Wellman et al. 2017	aDNA
SE4E-7	vertebra	Gray	Wellman; this study	ZooMS
SE5D-7	vertebra	Gray	Wellman; this study	ZooMS
SE6E-7	vertebra	Gray	Wellman; this study	ZooMS
SE7L-10	phalanx	Gray	Wellman; this study	ZooMS
SE9D-5	phalanx	Gray	Wellman; this study	morphology
SW19D-4	phalanx	Gray	Wellman et al. 2017	aDNA
SW19H-6	phalanx	Gray	Wellman; this study	morphology
SW19H-6	phalanx	Gray	Wellman et al. 2017	aDNA
SW19H-6	vertebra	Gray	Wellman et al. 2017	aDNA
SW20A-8	phalanx	Gray	Wellman; this study	morphology
SW20H-6	periotic bone	Gray	Wellman et al. 2017	morphology

These new biomolecular identifications facilitated tentative retroactive morphological species identifications of several phalanges previously analyzed by Wellman et al. (2017; Table 4.5). An additional 12 phalanges are humpback, 19 are gray, and two are fin whale. The blue whale phalanx identified by ZooMS is a distal phalanx and therefore smaller than the proximal gray whale phalanges; despite the size difference both exhibit similar shapes and textures (Figure 4.7), illustrating the challenges associated with morphological identifications of cetaceans and inter/intra-species size variation.

Figure 4.7. Blue (L) and gray whale (R) phalanges from the Par-Tee site (scales in cm).

Three additional species (blue, fin, and beaked whales) were identified in the new Par-Tee ZooMS analysis (N=31), nearly doubling the four species previously reported (Wellman et al. 2017; N=30). The number of taxa identified in an assemblage is often a function of sample size (Grayson 1984), and the increase in cetacean species identified here suggests sample size may be an important factor in ensuring accurate assessment of species richness (and derived measures such as diversity) particularly in an assemblage containing unidentifiable cetacean remains.

4.5 Discussion

4.5.1 Oregon Tribal Ancestors' Acquisition of Cetaceans

The species composition at Tahkenitch Landing was similar to that at Par-Tee, and included species considered preferred prey (gray and humpback) as well as species more likely to be acquired from strandings (blue). The whale remains at Tahkenitch

Landing were located entirely within one stratum (Greenspan 1986:64), so it is possible that stranding events served as the source of whales in the assemblage. Minor and Toepel (1986:79) listed stone projectile points and bifaces in the artifact assemblage, but not harpoons or harpoon points. Tahkenitch Landing was located on an ancient estuarine environment, and site inhabitants would have crossed the coastal plain to the west to reach the open coast or canoed through estuaries and creeks (Minor and Toepel 1986:102). Crossing the coastal plain with portions of a blue whale may have been challenging, but the estuaries may have facilitated transport of the whales via boat to the site (Minor and Toepel 1986:101). Additionally, the estuaries and creeks in the proposed ancient environment may have caused whales to strand in the area, as has been suggested for the Seaside sites (Wellman et al. 2017:268), or drawn whales in pursuit of prey close to shore, facilitating opportunistic hunting. The Tahkenitch Landing faunal assemblage contained large amounts of herring (2704 NISP in Stratum 2B alone; Greenspan 1986:59). Greenspan (1986:58) concluded the species was of noticeable significance, and suggested that the quantities probably reflected acquisition during spawning periods when herring come nearshore or into bays and estuaries (Greenspan 1986:60-61). Combined with the presence of estuarine shellfish species in the assemblage (Barner 1986:56), it appears that the inhabitants of Tahkenitch Landing were exploiting a productive estuary ecosystem which may have appealed to whales, particularly grays and humpbacks, as much as it did to the site inhabitants. The lack of small cetaceans suggests that the Tahkenitch Landing inhabitants were not hunting porpoises and dolphins. The lack of small cetaceans and restriction of whale remains to one stratum suggests that site inhabitants likely collected stranded whales as opposed to hunting them. The published faunal analysis reported a subsample of the faunal remains (Greenspan 1986:57), so future study of a larger sample may identify additional small cetaceans.

The Palmrose assemblage also included gray, humpback, and blue whales, as well as fin and minke. None of the cetacean remains exhibited obvious strike marks. Composite toggling harpoons and/or lances armed with blades (made from ground shell or slate) are generally considered the standard tool(s) used by groups engaged in systematic whaling (Losey and Yang 2007:661). The Palmrose artifact assemblage contained pieces of toggling harpoons, but as at Par-Tee, they were not consistent with tools reportedly used by groups who systematically hunted whales (Losey and Yang 2007:664; MNCH, NC 11, f. 2, FN). It is unclear if the toggling harpoons at Palmrose/Par-Tee would have held shell blades or antler/bone points (Losey and Yang 2007:663-664), but pieces of mussel and clam shell blades were listed in site documentation for Palmrose (e.g., “mussel shell blade frags” in unit SE1B [NC 11, f. FN]). Different technology may also have been used for whale hunting in this region and time period. As at Tahkenitch Landing, the Palmrose site was adjacent to a quiet-water feature (bay or estuary) at the time of its occupation (Connolly 1995; Darienzo 1992) which may have caused whales to strand, facilitated opportunistic hunting, and enabled the transport of hunted whales close to or onto the site. The Palmrose faunal assemblage contained invertebrates associated with quiet-water environments and a probable late winter-early spring collection timeframe (Barner 1992:122). Unlike Tahkenitch Landing, the fish remains from Palmrose indicated intensive salmon exploitation, with few forage fish (Sanchez et al. 2020:5). Palmrose was, however, also located near a kelp forest ecosystem (Emma Elliott Smith, personal communication 2020) which would have provided gray whales with aggregations of their preferred prey. The Palmrose site inhabitants likely acquired stranded whales and also hunted them by efficiently exploiting whale feeding habits and behavior. Seasonality is difficult to determine for Palmrose, but the shellfish evidence indicative of an early spring occupation might have coincided with the northwards gray whale migrations and reliable strandings of juveniles. Unfortunately, the whale remains from Palmrose were too fragmented to assess whether individuals were immature.

The Palmrose site inhabitants likely hunted small cetaceans. Following Loiselle (2020), the distribution of remains throughout the site along with modern stranding records suggest mass stranding events are unlikely to account for the small cetacean abundance. Several units did contain relatively high abundances of remains (units NE5B, NE4C, SE2G, SE3C, SW6A; Figure 4.8) but these anomalies are often attributable to fragmentation. Unit SW6A contained 14 vertebral centrum and epiphysis fragments (labeled as a feature on the original excavation tag). Unit SW4C contained five caudal vertebrae that possibly reflect the deposition of a portion of a single individual. These two units are interesting anomalies, but do not form a clear pattern. The proposed quiet-water environment (Connolly 1995; Darienzo 1992) may have facilitated small cetacean capture. Cooke et al. (2016) suggested that dolphins in the Playa Don Bernardo site were driven ashore using noise, while Itoh et al. (2011) hypothesized that dolphins in the Jomon-era Mawaki site were driven ashore in a lagoon/inlet. Perhaps Palmrose site inhabitants drove small cetaceans into the quiet-water environment and then ashore, or netted/speared them (or some combination thereof). Porpoises and dolphins sometimes enter mouths of rivers while feeding or following fish, and harbor porpoises in particular are known to seek out shallow bays and estuaries (ODFW 2021a). Such behaviors could have been efficiently exploited by human hunters (Loiselle 2020; Ray 1938:115). The proximity of Palmrose to the quiet-water feature may have also facilitated transport of cetaceans to the site.

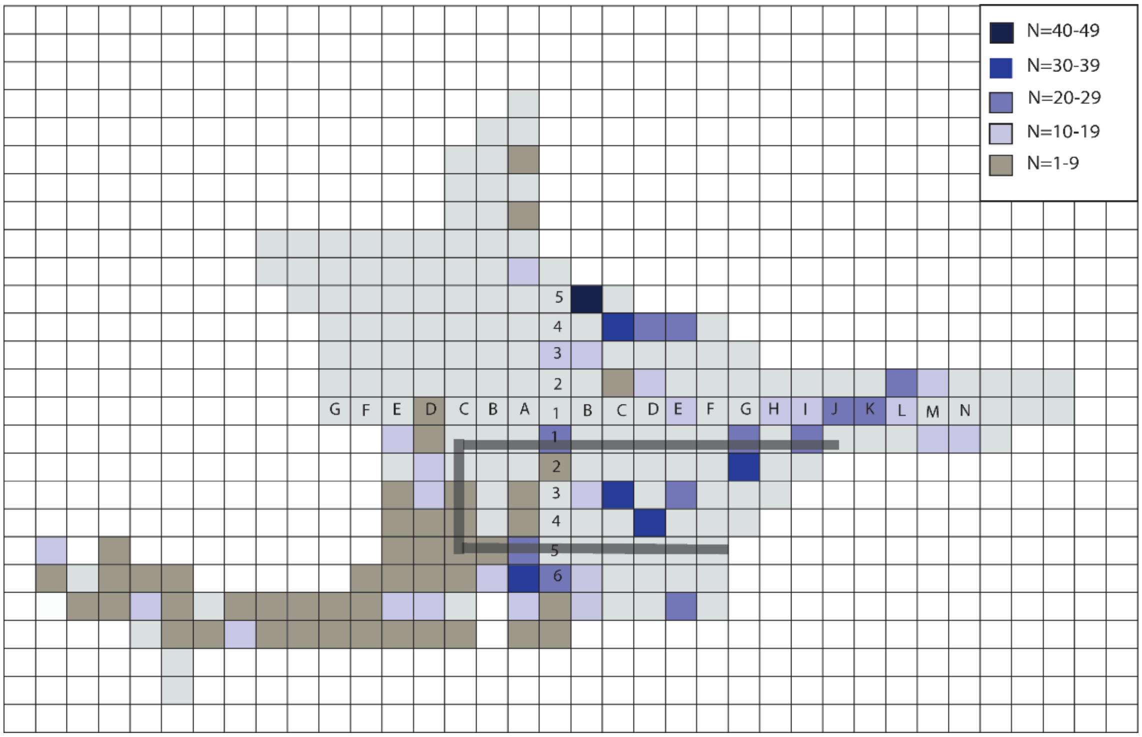


Figure 4.8. Distribution of small cetaceans by total NISP per excavation unit in the Palmrose site. Map adapted from Connolly (1992).

Previous studies of Par-Tee cetaceans focused on whether the site inhabitants were actively hunting whales and small cetaceans in the Seaside area prior to contact. Both Wellman et al. (2017) and Loiselle (2020) found that species composition of the whale and small cetacean assemblages at Par-Tee matched modern stranding records (Norman et al. 2004). In particular, Par-Tee contained substantial quantities of gray whale and harbor porpoise, both of which dominated stranding events from 1930 to 2002 (Norman et al. 2004) and 2006 to 2017 (NOAA Fisheries 2020). Multiple studies (Losey and Yang 2007; Sanchez 2014; Wellman et al. 2017) concluded that while Par-Tee site residents probably relied upon stranded whales as a resource, they also likely hunted whales on an opportunistic basis. The Par-Tee site did not yield whaling technology and other archaeological indications of full-scale whaling found at sites such as Ozette (Huelsbeck 1994; McMillan 2015; Monks et al. 2001). The Par-Tee artifact assemblage contained composite harpoons, as well as barbed and unbarbed harpoons (one of which was slotted, possibly for a blade), but no blades were found (Losey and Yang 2007:664; Sanchez 2014). The additional species identifications from Par-Tee reported in this study affirm that opportunistic hunting of reportedly preferred species like gray whales may have occurred, but that stranded whales were also an important resource. The proposed ancient quiet-water environment around Par-Tee may have caused whales to strand in the area (Wellman et al. 2017:268), and/or resources associated with the quiet-water feature may have drawn whales close to shore in pursuit of prey, facilitating opportunistic hunting and strandings. Baleen whales generally feed on small schooling fish, although gray whales will preferentially feed on amphipods using benthic suction (Newell and Cowles 2006:3). Gray and humpback whales are both known to feed opportunistically on herring and herring eggs in Oregon before or during spawning, which occurs in shallow bays and estuaries on the Oregon Coast (Calambokidis et al. 2002:267; Hughes et al. 2014:121). Sanchez et al. (2020:8) identified some herring and sardine remains in the Par-Tee fish remains, although we cannot know during which season these were obtained. Additionally, the Par-Tee site was located near a kelp forest ecosystem (Emma Elliot Smith, personal communication 2020) which would have supported mysid shrimp, crab larvae, and other gray whale prey. A recent study reported that gray whales “target shallow waters near kelp beds” in order to “locate dense aggregations of prey” (Iddings 2017:3). The inhabitants of the Par-Tee site could have relied upon whale feeding habits and behaviors which made the whales vulnerable to stranding or hunting. Fast moving species like blue, fin, or minke whales are unlikely to have been hunted, but if stranded or washed ashore freshly dead would be a remarkable source of oil, blubber, meat, and other raw materials (e.g., bone). The beaked whales were probably collected after stranding, since these species are also considered offshore, deep-diving species (Schorr et al. 2014). Interestingly, beaked whales (particularly Cuvier's) stranded at high proportions in Oregon compared to Washington between 1930 and 2002 (Norman et al. 2004:95). The continental shelf off Oregon is narrow, deep, and steep, resulting in a pelagic zone relatively close to shore (Byrne 1962) which may have resulted in more frequent strandings (Norman et al. 2004:95). Par-Tee contained pelagic bird species such as albatrosses and shearwaters which may have been collected following beaching (Bovy et al. 2019), but site inhabitants could also have occasionally hunted out in the pelagic zone and acquired birds and beaked whales as an opportunistic, pelagic "by-catch."

Both the Par-Tee assemblage and stranding records were dominated by harbor porpoise, but Loiselle (2020) concluded that the Par-Tee site inhabitants were likely hunting small cetaceans. Loiselle (2020:62) argued that the sheer abundance found at Par-Tee cannot be explained by stranding events alone, and remains were distributed throughout the site and not indicative of a mass stranding event. Some barbed harpoons at Par-Tee were quite long, and could have been used to hunt marine mammals such as seals and sea lions, as well as small cetaceans. Harbor porpoises come close to shore and enter bays or estuaries in pursuit of prey, which may have made them vulnerable to hunting, especially if these shallow, quiet-water environments were adjacent to human habitation areas. The Par-Tee inhabitants would likely make the most of their proximity to such important prey. The stranding data for Oregon affirm Loiselle's interpretation: while harbor porpoises sometimes stranded more than once a year they did not mass strand, and even reliable strandings of multiple individuals a year seems unlikely to account for the totals found at the site.

Whether or not precontact inhabitants of the Oregon coast were actively hunting cetaceans is ultimately not the most important question when considering the human-cetacean relationship in the archaeological record. "Active" or "systematic" whaling implies technological and symbolic complexity (Huelsbeck 1984; McMillan 2019), and consequently groups of precontact fisher-hunter-gatherers who actively hunted cetaceans may be labeled as "complex" or "skilled." Categorizations of complexity based upon subsistence strategies should be resisted. While active whaling may imply certain symbolic and cultural systems, the ethnographic record documents equally complex and important behaviors and powers associated with luring whales to shore to strand, and complicated social taboos and proscriptions regarding the acquisition and processing of such animals.

4.5.2 Oregon Tribal Ancestors' Use of Cetaceans

Tahkenitch Landing cetacean remains were extremely fragmented and fragile, probably due to both human processing and post-depositional desiccation, weathering, and fragmentation during storage. Due to the current condition of the bones, it is difficult to identify human modifications, but the original excavation report noted that several whale bones exhibited cutmarks possibly indicative of butchery (Minor and Toepel 1986:21). Several of the large fragments were from skulls and identified by ZooMS as at least two different species: blue and gray whale. Whales tend to have high concentrations of lipids in their skulls (particularly in the upper jaw), caudal vertebrae, and ribs (Higgs et al. 2011; Monks et al. 2003), all of which were present in the Tahkenitch Landing assemblage in fragmented form. The Tahkenitch Landing whales may therefore represent oil extraction in addition to butchery. The excavation report listed worked bone in the artifact assemblage, but it is unknown if any of the remains were from whale (Minor and Toepel 1986:89). The whale remains were concentrated in Stratum 2B along with over half the artifact assemblage and the majority of invertebrate and vertebrate remains, suggesting "the setting of an aboriginal village" (Minor and Toepel 1986:105). Despite possibly reflecting a village setting, evidence of whales used for architectural purposes is absent (Minor and Toepel 1986:22).

As at Tahkenitch Landing and Par-Tee, the Palmrose site inhabitants did not use whale bone for architectural purposes. The Palmrose artifact assemblage contained worked whale bone and whale bone artifacts, including a beautifully decorated comb from excavation unit SW6P (MNCH, NC 11, f. FN). Whale bone blanks at Ozette were sometimes obtained "from ribs by splitting the bone lengthwise" (Huelsbeck 1994:284), presumably revealing trabecular cortex. Palmrose contained some bones that appeared adzed and worn with straight edges; it is possible that these pieces were bone blanks or bark shredders despite appearing relatively unmodified. The cutmarked phalanges from Palmrose (N=2, likely humpback) were cut along the epiphysis as at Par-Tee (Figure 4.9), possibly reflecting muscle/tendon removal and/or disarticulation.

Figure 4.9. Heavily cutmarked humpback whale phalanx from the Palmrose site (scale in cm/inches). The large gouge on the right of the element is modern (likely excavation damage).

A fragment of a whale vertebra appears to have been gouged, and others appear to have been adzed or worked resulting in smooth surfaces (use as an abrader could also have resulted in these modifications). Other whale remains at Palmrose may have been cutmarked but not identified due to fragmentation and weathering. The fin whale and several gray and humpback specimens were located in or adjacent to the house feature, while the blue, minke, and beaked whales were located at the edges of the excavated area (Figure 4.10).

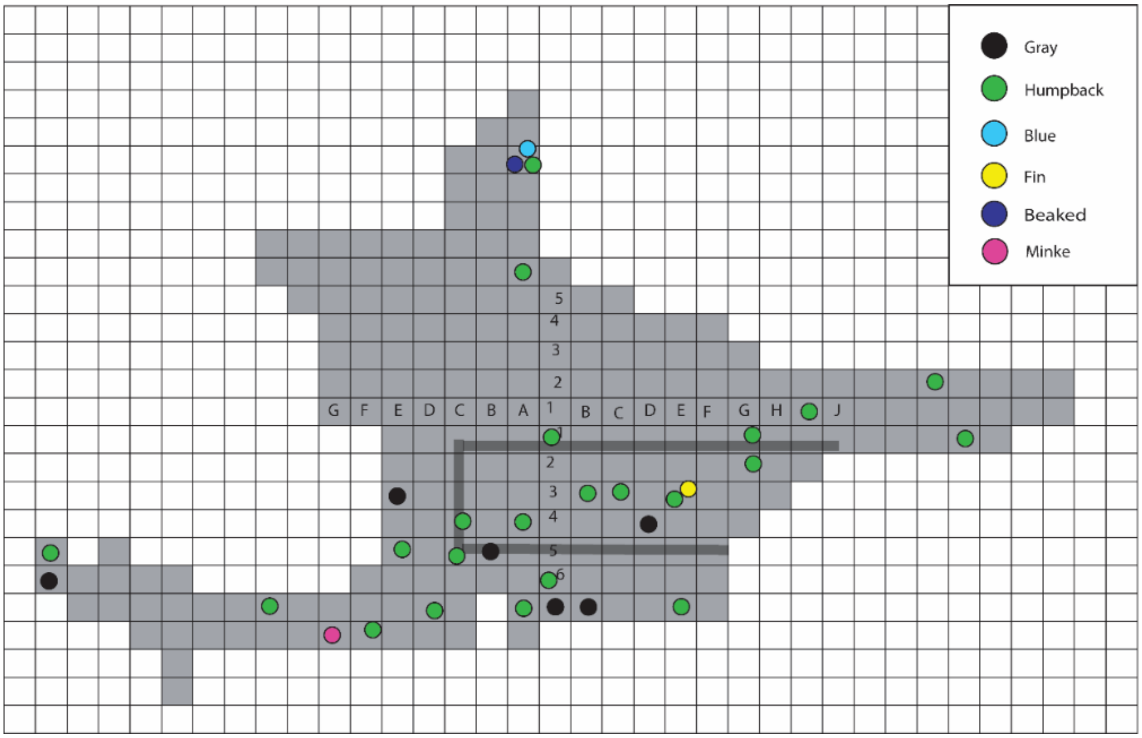


Figure 4.10. Distribution of whale species (biomolecular identifications only) in the Palmrose site. Map adapted from Connolly (1992).

Two large, heavy humpback whale fragments located in Palmrose units SW4A and SW4C were identified as occipital condyles (Figure 4.11). Unit SW4A was located within the house feature and SW4C was located just outside. The presence of such heavy elements in and around the habitation area suggests the processing of skull remains near or directly within the Palmrose site, and the transport of whale portions onto the site. A fin whale phalanx was apparently gnawed by carnivores and deposited within the house feature. According to the ethnographic and archaeological record, Nuu-chah-nulth and Makah whalers may have used whale skulls as trophies or indicators of status both off and on-site (Monks 2003:194). Perhaps the presence of whale remains inside the house at Palmrose was related to display of social prestige or rank.

Figure 4.11. Humpback whale occipital condyles from the Palmrose site (scales in cm).

The element abundance of small cetaceans at Palmrose was similar to that at Par-Tee. Loiselle (2020) did not report cutmarks on small cetaceans at Par-Tee, but at Palmrose vertebrae were frequently cut on the vertebral processes and ventral centrum, which could result from stripping muscle from the vertebral column and gutting the animal. The thoracic, caudal, and lumbar regions are ranked highly in the harbor porpoise meat utility index generated by Savelle and Friesen (1995) and may explain the abundance of vertebrae and the number that exhibit cutmarks. Consumption of small cetaceans would be consistent with the ethnographic record, although 20 of the 34 cutmarked vertebrae were bottlenose dolphin, a species not mentioned. Nonetheless, it appears small cetaceans were hunted and consumed for dietary purposes. Four ribs, an ulna, a hyoid, and a tympanic bulla from small cetaceans were also cutmarked. These may reflect butchery, but the cutmarks on the tympanic bulla are puzzling: porpoise skulls reportedly contain little edible tissue (Savelle and Friesen 1995), so perhaps this suggests targeted butchery of the skull/tympanic complex. Periotic and tympanic bones were present, although they comprised a minor portion of the total assemblage (~2%); perhaps these elements were used for specialized tool manufacture or ornamental or ritual purposes and deposited away from the main midden. Small cetacean vertebrae and dolphin radii/ulnae exhibiting tooth punctures or gnawing were within and near the house feature, although additional elements exhibiting ambiguous gnawing patterns were distributed elsewhere in the site. At contact, Chinook and Tillamook dogs were important hunting partners (Jacobs 2003; Ray 1938), human companions, and possibly “sanitation workers,” eating trash and refuse (Mack 2015:65-66). Dogs were also reportedly allowed indoors (Ray 1938). The presence of gnawed elements within the habitation area suggests that domestic dogs may have been fed leftover cetacean remains.

Wellman et al. (2017) reported cutmarks on Par-Tee phalanges, ribs, ulnae, and scapulae, as well as gouging or adzing on mandibles and vertebrae. Additionally, multiple larger elements such as ribs and vertebrae were broken into small pieces. While fragmentation sometimes appeared to have occurred in situ, some fragmentation likely reflects human processing of elements into manageable units for oil extraction or tool manufacture. Wellman et al. (2017) concluded that gouging reflected oil removal and that cutmarks may have indicated butchering or breaking down the remains for transport. The cutmarks on the phalanges are particularly interesting. Muscles and tendons on whale phalanges run parallel to the mid-line (Cooper et al. 2007), so the perpendicular cutmarks (Figure 4.9) likely reflect disarticulation or stripping of these fasciae, possibly for consumption of flipper meat or use of tendons as a source of sinew. Baleen whales have particularly “thick rounded tendons on both palmar and dorsal flipper surfaces” (Cooper et al. 2007:1128). Processing of flippers to obtain these tendons to make sinew might explain the apparent intensive processing of phalanges at Par-Tee. Although not well-documented in the ethnographic record for Oregon, sinew is an extremely strong, useful material which could be used for sewing, boatmaking, weaving nets, and harpoon lines for whaling (Losey and Yang 2007:661; Robertson and Trites 2018:25). For example, a “scoop net made of whale sinew” used for fishing eulachon from Tongass Island, Alaska, was collected by George Emmons and donated to the American Museum of Natural History (AMNH) in New York (AMNH 2021). Oregon tribal ancestors did not routinely use cetacean bones for architectural purposes, although occasionally complete whale elements were labeled as features in excavation notes (MNCH, NC 11, f. FN; National Anthropological Archives [NAA] MS 97-31/32). Artifacts at Par-Tee were manufactured from whale bone, such as atlatls (Losey 2019) and a possible spindle whorl (Losey 2021).

The minke and blue whale specimens were located at the edge of the excavated area at Par-Tee (Figure 4.12). Humpback and gray whale remains were distributed throughout the site, with humpback primarily in the northeast quadrant (along with the fin and Cuvier's specimens) and gray in the southwest (Figure 4.12).

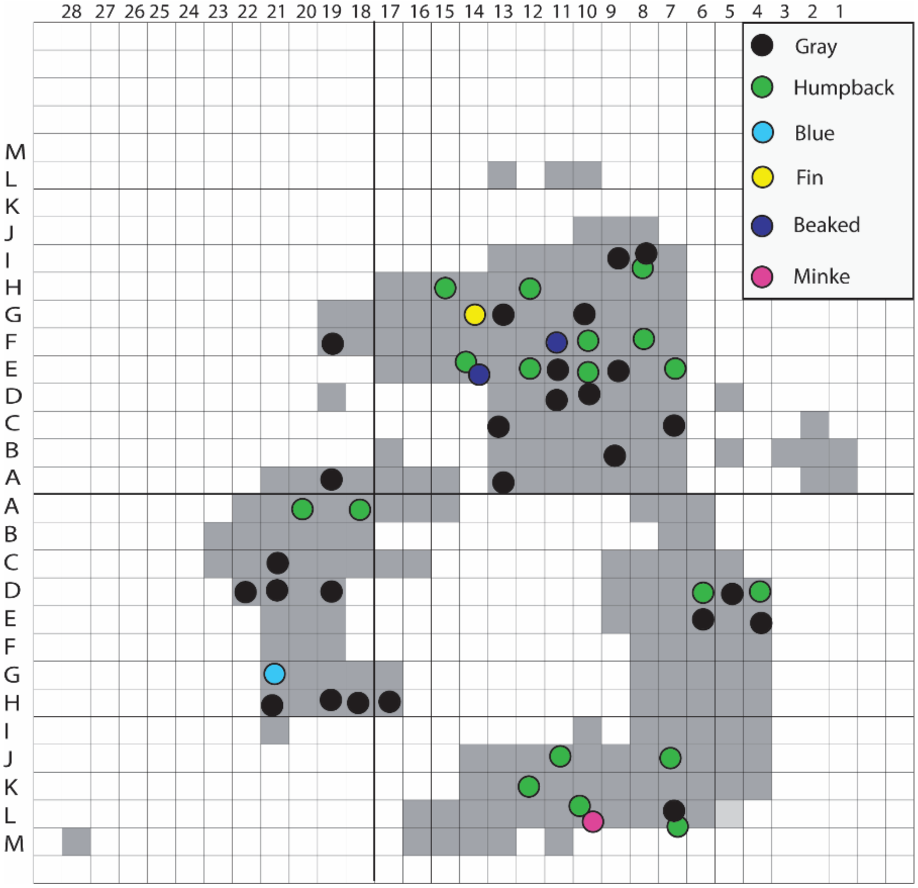


Figure 4.12. Distribution of whale species (biomolecular identifications only) in the Par-Tee site. Map adapted from Sanchez et al. (2018).

4.5.3 Comparisons Across Assemblages

4.5.3.1 Element Representation. In general, the whale vertebral remains at Tahkenitch Landing were more heavily fragmented than those at Palmrose and Par-Tee, and those at Palmrose were more fragmented than at Par-Tee. The Tahkenitch Landing whales were estimated to date before 3000 BP, and were more friable, weathered, and breaking apart either in-situ or post-excavation (despite good storage conditions). Despite several complete elements (phalanges, a rib or hyoid, carpal) the majority of specimens were unidentifiable or fragmented. Large fragments of skulls were also present. The Palmrose assemblage contained more whale vertebrae (N=80) than Par-Tee (N=60) but they were often fragmented, whereas Par-Tee contained multiple complete (albeit often unfused or weathered) vertebral centra. Palmrose yielded substantially fewer phalanges. Small cetacean elements were essentially non-existent in the Tahkenitch Landing assemblage. Small cetacean element representation between the Palmrose and Par-Tee sites was similar (Figure 4.13).

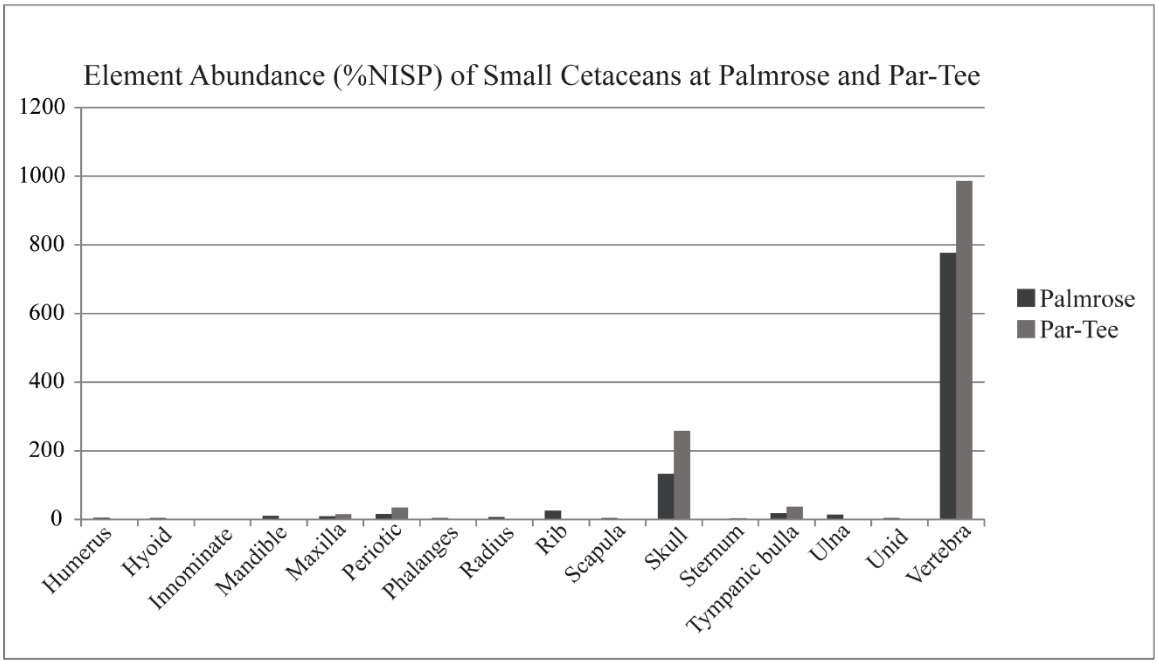


Figure 4.13. Element abundance (% NISP) of small cetaceans at the Palmrose and Par-Tee sites.

4.5.3.2 Small Cetacean Species Representation and Use. Par-Tee and Palmrose exhibited some differences in small cetacean species representation, the most notable of which was that Palmrose contains more bottlenose dolphins and fewer harbor porpoises than Par-Tee (Figure 4.14). Ancient DNA confirmations of harbor porpoise and bottlenose dolphin species identifications are forthcoming. These results may permit retroactive identifications of harbor porpoise, and could potentially reveal incorrect identifications of bottlenose dolphin specimens which might be confused with other dolphin species. Bottlenose dolphin remains are quite distinctive and the abundance found in this analysis follows that reported by Colten (2015), but as discussed earlier, morphological identifications of cetaceans are subject to analyst error.

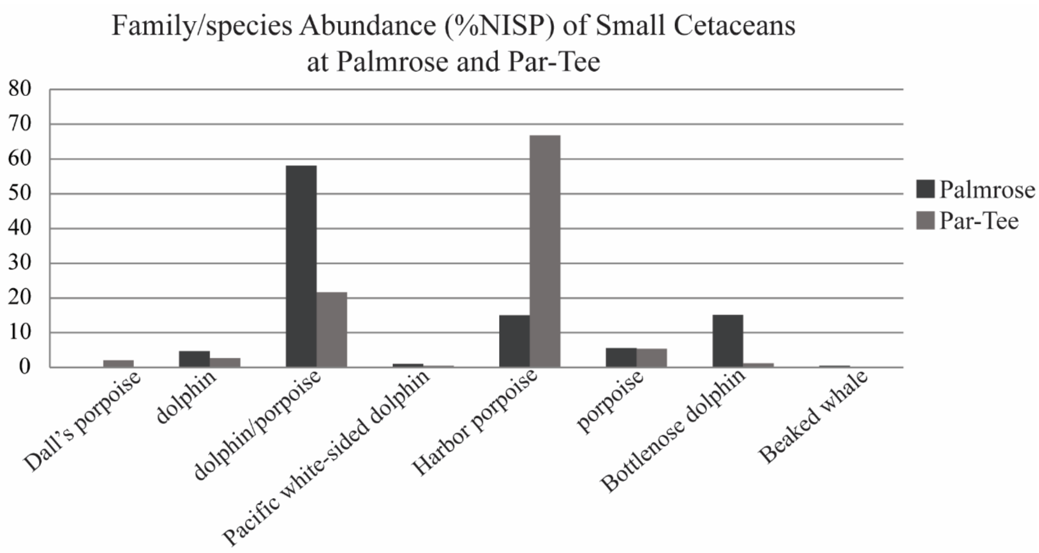


Figure 4.14. Family/species abundance (% NISP) of small cetaceans (dolphins, porpoises, and beaked whales) at the Palmrose and Par-Tee sites.

In their stranding report, Norman et al. (2004:90) noted that bottlenose dolphins, among other small cetacean species, prefer "warm and temperate waters," and that their presence is "rare" as an inhabitant in coastal Oregon waters. The Oregon Marine Mammal Stranding Network reported one bottlenose dolphin stranding since 1989: a July 2012 stranding at Tierra del Mar on the northern coast, although other tropical/temperate water dolphin species stranded in greater numbers. Striped dolphins stranded 59 times between 1989 and present, and Pacific white-sided dolphins stranded 32 times. In general, however, the modern stranding records documented overall fewer dolphin strandings at higher latitudes. Dolphins made up ~57% of small cetacean strandings in California between 2007 and 2016, compared to 11% and 2% in Oregon and Washington, respectively (NOAA Fisheries 2020:7).

The discrepancy between the archaeological bottlenose dolphin remains and modern stranding records could be interpreted several ways. First, if bottlenose dolphins (or dolphin species more generally) do not reliably strand in Oregon in the present day, and the stranding record is a reasonable reflection of an extant community

(Pyenson 2011), perhaps their presence in the Palmrose site indicates that bottlenose dolphins or other dolphin species were present in greater numbers in Oregon waters in the past (due to animal behavior, navigational error, change in local environment, etc.). Alternately, if the bottlenose dolphins or other dolphin species were not stranding (in the present *or* past), perhaps their presence in the site means that the Palmrose site inhabitants conducted targeted hunting of the species.

If Oregon represents the northern limit of modern dolphin species' ranges, perhaps these archaeological individuals were out of range and stranded due to stress or navigational error. In July 2017 approximately 200 bottlenose dolphins were observed off the west coast of northern Vancouver Island, B.C., the northernmost sighting to date and the first sighting of the species in Canadian Pacific waters (Halpin et al. 2017). Researchers concluded that the occurrence "may [have been] associated with a prolonged period of warming in offshore regions of the eastern North Pacific" (Halpin et al. 2017:1). Norman et al. (2004:91) also reported that species with a "normal preference for warm temperate and tropical waters" stranded more frequently "within a year of an El Niño year(s)." Records of ocean or sea-surface temperature (SST) for the Late Holocene Pacific Northwest Coast are not readily available. Some ancient climate meta-analyses address topics like ocean heat content (Rosenthal et al. 2013) or changes in frequencies of the El Niño Southern Oscillation (Wanner et al. 2008) which might have implications for the Northwest Coast, but they do not provide detailed temporal resolution and it is difficult to assess how well these proxy-records might apply to the archaeological record. El Niño events can impact the Pacific Northwest Coast in diverse ways, and the actual impacts vary between events (Lubomudrov 1997:7). Generally, however, El Niño events cause warmer temperatures in Oregon and Washington. For example, the 1982-1983 El Niño resulted in an expansion of range for warm water fish species along the Oregon and Washington coasts (Lubomudrov 1997:8). A reasonable explanation for the predominance of bottlenose or other dolphins at Palmrose may be a temporary range shift in response to coastal conditions during an El Niño or other climatic event. Drawing broader conclusions about the local environment solely based on dolphins as an indicator species is not possible but does present future directions for study. Human behavior, such as a shift in dietary preferences, hunting strategies, or a change in season of site use/occupation, may also explain the abundance of dolphins.

Modern and ancient DNA studies of bottlenose dolphin populations suggest that substantial genetic structure is present in different communities, and that genetically distinct populations may exist (Gaspari et al. 2013; Nichols et al. 2007; Nykanen et al. 2019), particularly depending on whether the dolphins are an “inshore” or “offshore” ecotype (Richards et al. 2013; Tezanos-Pinto et al. 2009). In European waters, some populations demonstrate (or demonstrated) high site fidelity, “preferential use of some geographical areas” (Nykanen et al. 2019:199), and/or “local habitat dependence” (Nichols et al. 2007:1611). One population from the Humber Estuary in the United Kingdom, identified with ancient DNA, was locally extirpated and their former range was never re-populated (Nichols et al. 2007:1615). Investigating questions of genetic structure, gene flow, and habitat preference could be investigated on the Pacific Coast of North America, especially with the well-preserved remains from the Par-Tee and Palmrose sites. Perhaps the Seaside area was home to a distinct community of “inshore” bottlenose dolphins which were extirpated, and the area was never re-populated by a different community from further south. Studies of past bottlenose dolphins would likely have important conservation applications in the face of ongoing climate change and its effects on oceans and marine wildlife (e.g., Halpin et al. 2017).

Despite differences in species abundance, small cetaceans were likely an important dietary resource at both Par-Tee and Palmrose. The abundance of vertebrae corresponds with the meat weight utility index (Savelle and Friensen 1995) and the large quantity of skull fragments may reflect oil removal. No additional modifications suggest alternate uses for the small cetaceans, although it is possible some elements such as ulnae, radii, and humerii were used for tool manufacture and are unidentifiable as cetacean in their artifact form. Few small cetacean phalanges were recovered. According to anatomical studies, dolphin and porpoise flippers have “reduced” tendons which “cannot be separated from the underlying bone and are firmly attached to all of the phalanges and metacarpals” (Cooper et al. 2007:1129). Perhaps tribal ancestors did not, therefore, try to process dolphin and porpoise distal foreflippers to the degree they did those from whales (particularly at Par-Tee).

4.5.3.3 Whale Species Representation and Preference. In terms of species representation, Tahkenitch Landing, Palmrose, and Par-Tee all contained gray, humpback, and blue whales. Palmrose and Par-Tee additionally contained fin, minke, and beaked whales. Par-Tee contained an orca specimen, and Palmrose contained a false killer whale specimen. The majority of specimens at Palmrose and Par-Tee, however, were gray and humpback. When species representation is calculated by percent NISP (% NISP), the quantities of humpback were higher at Palmrose, and quantities of gray whale were higher at Par-Tee (Figure 4.15). These percentages, however, do not reflect the possibility that the Minimum Number of Individuals (MNI) of each species may be one. Calculating MNI for fragmented whales is extremely difficult and could not be done with confidence for these assemblages.

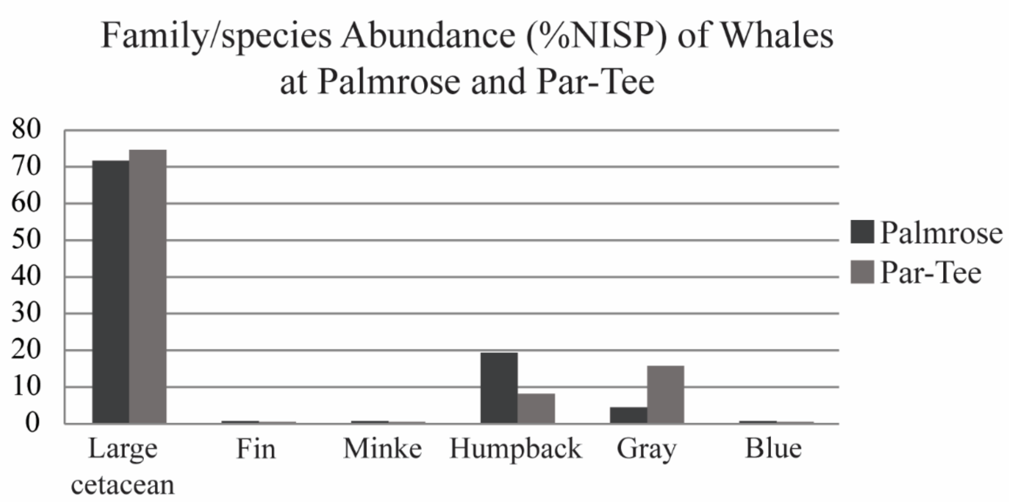


Figure 4.15. Family/species abundance (% NISP) of whales at the Palmrose and Par-Tee sites.

The presence of gray and humpback whale remains at Tahkenitch Landing, Palmrose, and Par-Tee suggests that ethnographic evidence detailing Indigenous prey preference for these species is likely accurate (Kool 1982). Based on the stranding records, gray and humpback whales would have maintained a reliable presence on the Oregon coast prior to contact, and tribal ancestors would have exploited these species as stranded or opportunistically hunted animals (particularly gray whales, whose feeding habits would have brought them close to shore). Other species would have stranded less frequently, but would also have represented priority resources, including fin, minke, and blue whales.

The presence of gray and humpback species at Tahkenitch Landing suggests these preferences and availability have deep chronological precedents. The blue whale finding is also quite exciting; the species was probably collected after stranding rather than hunted, but effort was made to bring portions of this large species back to the sites. In the case of Tahkenitch Landing, a complete phalanx, possibly as part of a complete foreflipper, was transported. A blue whale would have represented a sizeable resource to inhabitants on the Oregon coast. Fin and minke were reportedly too fast to hunt in boats (Kool 1982), so these remains were likely acquired from stranded animals.

The presence of these species in archaeological sites also provide us with additional data on the historical ecology of cetaceans on the Oregon coast prior to European contact and severe depletion due to industrial whaling. The species richness at Par-Tee and Palmrose was close to that documented in modern stranding records for Oregon – the archaeological sites were only missing two whale species also recorded in modern stranding records: sperm and sei (*Balaenoptera borealis*) whales. The large quantity of gray and humpback at the archaeological sites may correspond with the relatively high quantities of these species prior to depletion by Euro-American whalers (Pyenson and Lindberg 2011; NOAA Fisheries 2021e).

4.5.3.4 Oil Extraction from Whale Bones. Despite their size, substantial portions of whales (such as large skull fragments) and (possibly complete) small cetaceans were brought back to habitation areas. The fragmentation of skull elements, ribs, and vertebrae may indicate that oil extraction occurred, as these elements are high in oil (Higgs et al. 2011). Some Ozette whale bones may have been modified to facilitate oil removal, particularly lumbar and caudal vertebrae (Huelsbeck 1994:377). Monks (2002:146) noted that these elements are the heaviest and most difficult parts of the whale to transport, but also highest in terms of oil content; “their presence on the site, and their obvious modification, clearly suggest that oil removal is a likely explanation for their presence and treatment at [Ozette].”

Monks (2002:149) also noted the presence of whale "chips," or bone pieces found in archaeological sites. These chips may simply be a result of processing, but they could have been added to soups or stews to add flavor and calories. Pearson (Jacobs 2003:82) recounted that the Tillamook drank whale grease in hot soups. Tahkenitch Landing, Par-Tee, and Palmrose all contained small pieces of unidentifiable cetacean bone that may be such "whale chips." Palmrose in particular contained a large quantity of skull fragments unidentifiable beyond cetacean – perhaps this abundance reflects extensive oil extraction. Monks (2003:204) suggested that "oil extraction is an intensification strategy," presumably since oil can also (and more easily) be obtained from boiling blubber. Perhaps the Tahkenitch Landing and Palmrose remains were more heavily fragmented as the site inhabitants worked to extract as much oil as possible from fewer stranded or rare hunted whales. Par-Tee contained a substantial number of mostly complete vertebrae. One humpback vertebra exhibited gouging that may reflect oil removal while the others appear unmodified, although apparently unmodified bones could still be "drained" to produce oil (Monks 2003:203).

4.5.3.5 Other Uses for Whale Elements. Monks (2003:201) noted that the foreflipper could be removed as a discrete unit, and this may have occurred at Par-Tee, Palmrose, and Tahkenitch Landing. All three sites contained phalanges, but they dominate the % NISP (83%) at Par-Tee (Wellman et al. 2017). The location of cutmarks on phalanges suggests severing and/or removal of the muscles and tendons (Cooper et al. 2007), possibly for dietary consumption (Monks 2003:201) or sinew production. Other uses for flippers included oil extraction and tool manufacture (Monks 2003:201). Monks et al. (2001:142) suggested scapulae and ulnae served as cutting boards in the Nuu-chah-nulth sites, but a fresh, clean, large vertebra (such as those found at Par-Tee) might also serve as a flat working surface (Figure 4.16). The numerous large, flat cervical vertebrae from humpback and gray whales found at Par-Tee (Figure 4.16) could also presumably serve as a plate or tray (for dietary purposes or otherwise). The third site in the Seaside area, Avenue Q, contained a caudal vertebra that was gouged out to form a bowl or container (Figure 4.17). Baleen is not mentioned in the Northwest Coast ethnographic record (see also Monks 2003), but has been documented as a useful resource in other regions precontact and in the present (Solazzo et al. 2017). Processing of gray, humpback, minke, fin, and blue whale mandibles/skulls could have been targeted towards baleen removal and acquisition.

Figure 4.16. Whale thoracic/lumbar (L) and cervical (R) vertebrae from the Par-Tee site which could have served as work surfaces (scale in inches). Analyzed by Wellman et al. (2017).

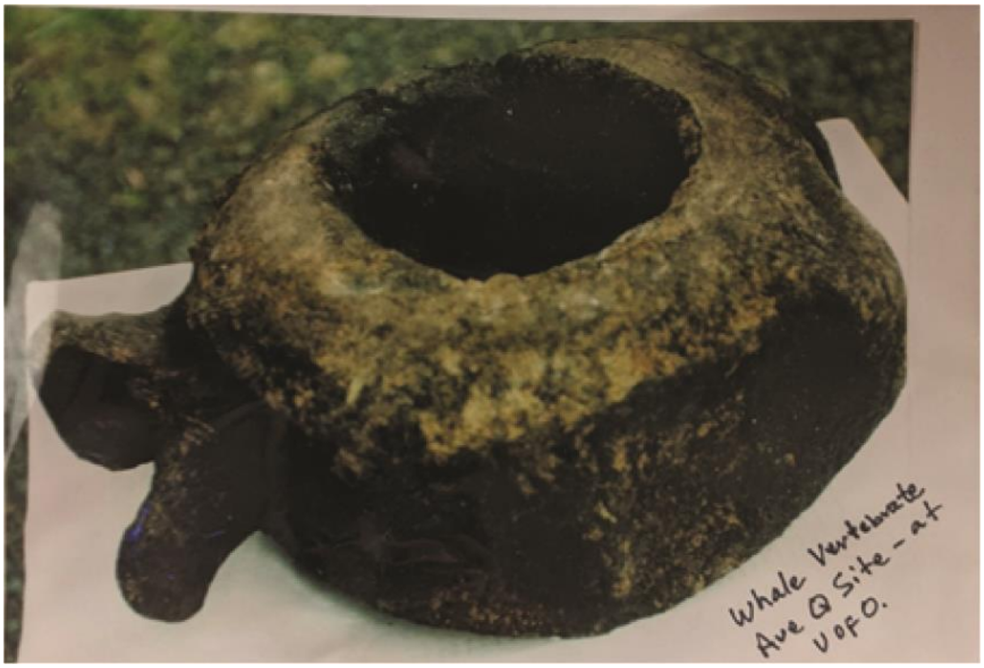


Figure 4.17. Caudal vertebra from a whale gouged out to form a bowl from the Avenue Q site at Seaside. Photo from the MNCH archives (MNCH, NC 11, f. 7).

An additional possibility is that various whale remains were symbolic in nature or linked to the status of the persons acquiring them. Between the blubber, meat, and oil derived from bones, the "amount of prestige resource that is potentially available in a whale skeleton" is high (Monks 2003:204). Monks (2003:204) reported that the successful Nuu-chah-nulth whaler "owned" the whale and could distribute the blubber, and presumably, by extension, the skeleton to those of their choosing. At Ozette, different houses contained different abundances of phalanges, which Huelsbeck (1994:298) interpreted as evidence of different household statuses. Monks (2003:203) suggested that the "differential distribution of these elements suggests that social rules regarding access to specific elements may have existed" for precontact groups, much as they do for some modern subsistence whalers. Perhaps the presence of complete elements at Par-Tee, such as the vertebrae, reflected such social rank differentials, and items remained unmodified as status symbols.

4.6 Tribal Ancestors and Cetaceans on the Oregon Coast

The analysis of the Palmrose cetaceans, in addition to re-evaluations of the Tahkenitch Landing and Par-Tee data, provide new insights and the most complete characterization of precontact whale and small cetacean use on the Oregon coast to date. Tribal ancestors living on the Oregon coast prior to Euro-American contact used species that routinely and reliably inhabited Oregon waters, in particular, gray and humpback whales and harbor porpoises. These species are present in historical and modern stranding records and archaeological assemblages in high abundances. Gray whales pass close to shore when migrating or feeding which may have rendered this species particularly dependable and predictable. Humpbacks generally stay further offshore, but rich ecological niches like bays and estuaries adjacent to human habitation sites, like Tahkenitch Landing, Par-Tee, and Palmrose, may have also drawn this species close to shore in search of prey. Harbor porpoises regularly enter shallow bays and estuaries, and would have been present year-round. Fin, minke, and blue whales, as well as beaked whales, orcas, and Dall's porpoises, are incredibly fast animals that hunt in deeper water. These species also appear in modern stranding records and the archaeological record, although less frequently than the gray or humpback.

Ethnographic data and oral traditions for the Chinook and Tillamook suggest that coastal inhabitants may have hunted whales on the open ocean, despite the tendency of anthropologists and archaeologists to attribute these skills to Indigenous peoples at Ozette and further north. While the inhabitants of Tahkenitch Landing may have opportunistically hunted, the lack of small cetacean remains, whaling technology, and concentration of whale remains within one stratum suggests that whale acquisition may have been limited to use of stranded whales. The use of stranded whales does not imply less advanced hunting capabilities or a lack of cultural advancement. Based on the available ethnographic data, coastal inhabitants likely invested great effort and energy into luring, processing, and distributing stranded whales which would have been equally valuable resources. The acquisition and distribution of stranded whales was likely related to complex social systems, class, power, and other socio-cultural components of a precontact coastal community.

Precontact coastal inhabitants likely used whales and small cetaceans as sources of dietary protein, fat, and oil. Oil appears to have been extracted from whale bone at all sites, although the intensity of extraction may have varied, depending on whale availability and alternate uses for bone. Whale bone at both Palmrose and Par-Tee was used for artifact manufacture, but there was no evidence of whale bone artifacts at Tahkenitch Landing. All sites contained large, heavy portions of whales, demonstrating the precontact Indigenous inhabitants' ability and desire to transport the whales (or portions thereof) away from the ocean or shoreline to activity and/or living areas. Each of these sites had access to the open coast as estuaries and creeks; whales and small cetaceans could have been transported over land or towed by boat via these water routes. Despite the ability to transport large portions of whales, none of the three sites contained evidence of cetacean bone used for architectural purposes, such as the retaining walls and drainage features at Ozette (Huelsbeck 1994:288). Par-Tee contained more complete whale elements (particularly vertebrae and phalanges) compared to Palmrose and Tahkenitch Landing. The presence of complete elements may indicate less intensive oil extraction at the site. The abundance of small cetacean vertebrae and skull fragments suggests that whole or large portions of porpoises and dolphins were also brought to the

Palmrose and Par-Tee sites to be processed near habitation areas. At Palmrose, cetacean bones may have been fed to domesticated dogs.

In summary, the early inhabitants of Tahkenitch Landing likely acquired whales after stranding and then transported large portions of the animals to habitation areas where they extracted oil from the bones. The whale remains at Tahkenitch Landing suggest less intensive cetacean use earlier in the history of coastal habitation and/or on the central coast, in comparison to the northern, more recently occupied, Seaside sites. Whale and small cetacean remains at both Palmrose and Par-Tee are distributed throughout the site, not heavily concentrated in any given unit or stratigraphic level. Whale bone was used for tool manufacture and oil was apparently extracted at both sites. Neither Palmrose nor Par-Tee contained evidence of whale remains used for architectural purposes. Par-Tee contained large numbers of phalanges and overall more complete elements compared to Palmrose, perhaps indicating less intensive oil extraction, use of complete elements for unknown purposes, or perhaps simply a surplus of whale that was not processed further due to lack of need or display of remains associated with status or rank. Par-Tee is the most recent of the three sites analyzed in this study, which may also account for the relative preservation of the cetacean remains. While the inhabitants of both Par-Tee and Palmrose likely exploited stranded whales, they may also have opportunistically hunted whales that came close to shore, particularly gray whales, which may be slightly more abundant at Par-Tee.

4.7 Conclusion

Precontact inhabitants of the Tahkenitch Landing, Palmrose, and Par-Tee sites continuously used cetaceans from at least 3000 BP through contact. Whales and small cetaceans were used for their meat, oil, and bones, although it appears that more intensive use of whale remains occurred later in time at the Seaside sites, and that Tahkenitch Landing inhabitants were likely using stranded whales and not hunting. The Makah used whale bone to construct important infrastructure at Ozette, including drainage channels and retaining walls that would have protected houses, but none of the Oregon sites discussed in this study contained evidence of whale bone used for construction.

Beyond the material remains, the powerful relationships between Thunderbird and humans recorded in oral traditions reflect a long and complex relationship from time immemorial. The value of whales, whether obtained via stranding or hunting, is illustrated in the strict protocols recorded in ethnographic records. Interestingly, small cetaceans receive less consideration and attention in the ethnographic record, and appear to have had fewer social protocols surrounding their acquisition and processing, at least according to post-contact sources. Perhaps small cetaceans were easier to acquire and more reliable or abundant overall, and tribal ancestors did not have to maintain presumably high levels of complex socio-cultural knowledge and/or social rank that was necessary to lure a whale to strand or successfully hunt a gray or humpback.

The characterization of whale use on the Oregon coast will benefit from future study, including the use of ZooMS identifications which will enable future efforts at identifying cetacean remains from both current excavations and legacy collections. Quantifying, describing, and identifying cetacean bone (using biomolecular methods when needed) is necessary to generate data which can be used to more clearly illustrate tribal ancestors' use of whales and small cetaceans prior to Euro-American contact, and contribute to the historical ecology of cetacean species on the Oregon coast.

CHAPTER V

CONCLUSION

5.1 Dissertation Summary

Marine mammal remains are increasingly the subject of archaeological analyses, as zooarchaeologists seek to apply faunal data to answer historical ecological and conservation questions (Lyman 2006; Prentiss 2018). Research as to how, why, and at what scale taxa were used, however, must not be neglected. Both the historical ecological and human-animal relationship components of zooarchaeological analyses have important and complex applications to the present in their respective socio-ecological contexts, and zooarchaeologists are uniquely positioned to provide these deep-time perspectives. Before European contact, tribal ancestors living on the Oregon coast had access to a rich ecological niche with diverse marine and terrestrial resources. These Indigenous coastal residents shared a landscape alongside animal species and negotiated and maintained relationships with different animals. These relationships may have been defined in terms of the resources provided by the animals, but likely also incorporated inter-personal, non-material dimensions, such as understanding and knowing these animals as non-human persons or non-human kin. This dissertation addressed three primary objectives, specifically: 1) understanding how tribal ancestors living on the Oregon coast used sea otters, 2) how tribal ancestors used cetaceans, and 3) what data the faunal remains of sea otters and cetaceans can provide regarding the historical ecology of the species themselves.

Chapter II of this dissertation addressed the first of these objectives by describing tribal ancestor use of sea otters and outlining possible human-animal relationships between the inhabitants of the Seaside sites and sea otters. The people living at the Seaside sites hunted, skinned, and possibly butchered the sea otters for dietary consumption. Tribal ancestors in the Seaside area also appear to have intensified their use of sea otters through time, demonstrated by increased cutmark intensity and sea otter abundance in the Par-Tee faunal assemblage. The presence of juveniles and pups in the assemblage has interesting implications for sea otter acquisition – hunters may have focused on acquiring vulnerable females and their pups. The Seaside sites (and Par-Tee in particular) contain evidence for tool manufacture from sea otter bones and evidence of muscle removal from sea otter bones, suggesting that the site inhabitants ate the meat or fed it to their dogs. Sea otters were probably not a primary prey species for their meat alone, given the availability of other highly ranked prey in the environment, but the use patterns at Par-Tee and Palmrose do suggest that the longstanding assumption that tribal ancestors only hunted sea otters for their pelts is a narrow interpretation. Forefoot bones and caudal vertebrae were underrepresented at both the Par-Tee and Palmrose sites, which can occur when the front paws and tail bones are left in the pelt as it is removed from the rest of the body (Val and Mallye 2013). The lack of forefoot elements may indicate that intensive pelt removal was occurring, and that tribal ancestors were wearing or taking these valuable pelts with them, rather than discarding or depositing them in the main site middens. They could also have removed the forefeet as amulets or for other symbolic purposes. Ethnographic evidence suggests that the sea otter pelts were associated with wealth, rank, and shaman’s powers. For these reasons, sea otters were likely considered valued prey, and possibly as non-human kin. Oregon tribes, particularly the Siletz and Coquille, are interested in, and involved with, potential future sea otter reintroductions to Oregon. The tribes have clearly communicated their cultural and ecological connections with the species and their desire to bring the sea otter home. The results of this study affirm tribal knowledge and serve as an additional source of evidence of the deep-time relationships between sea otters and Indigenous peoples which have been maintained since time immemorial. These data will be shared with the tribes and Elakha Alliance in the hopes that these results can be used to argue for tribal ecological sovereignty and Indigenous priorities as they pertain to potential future reintroductions.

Chapter III was designed and undertaken with the goal of addressing the third objective of this dissertation: informing sea otter reintroduction efforts and contributing to the historical ecology of the extirpated Oregon sea otter. Due to their status as a conservation priority, sea otters on the Northwest Coast have been the subject of relatively frequent genetic studies (Beichman et al. 2018; Larson et al. 2002, 2012, 2015; Ralls et al. 2017; Valentine et al. 2008) which have documented genetic variation in sea otters on a latitudinal cline along the Northwest Coast. Research on central and southern Oregon coast sea otters (Valentine et al. 2008) suggested they were more closely related to modern California populations. Studies of sea otter morphology (Wellman 2018), however, suggested that the Seaside sea otters from northern Oregon were a better phenotypic match for northern populations (such as in British Columbia and Alaska). To further contextualize the extirpated Oregon sea otters relative to extant populations, we extracted mitogenomes from 20 archaeological sea otters (from the Seaside sites) and compared them to previously published California mitogenomes, as well as mitogenomes extracted from historical and modern northern sea otter dental calculus. My co-authors and I found that the Seaside sea otters were more closely related to northern extant populations when comparing complete mitogenomes. Future research, especially that involving nuclear genome analyses, will likely shed more light on the historical ecology of the Oregon sea otter, but our study does have implications for potential future reintroductions: while California sea otters may be appropriate as a source stock for reintroductions into southern Oregon, our study suggests that extant northern populations may be suitable for reintroductions to the northern Oregon coast. Our ancient DNA analysis was conducted using mitogenomes passed from mother to offspring, and female sea otters maintain smaller home ranges than males. The TempNet analysis (Figure 3.3) in our study shows that some archaeological Oregon sea otter mitogenomes persisted through time in the Seaside area. While we do not know exact dates for these sea otters, the presence of identical mitogenome haplotypes in both the Par-Tee and Palmrose sites, combined with the knowledge that female sea otters will not venture far from their home range, suggests that tribal ancestors were hunting sea otters locally during the occupation of both the Par-Tee and Palmrose sites. This insight has socio-ecological implications for affirming Indigenous hunting as well as historical ecological implications of past environments; the Seaside area was probably a productive ecological niche near kelp forest ecosystems, which in turn might have attracted other prey which site inhabitants would have hunted (e.g., gray whales).

Chapter IV explored the second and third objectives of this dissertation by reporting new data on cetacean species presence on the Oregon coast ~3000-1500 years before present, and yielded new insight into Indigenous precontact use of cetaceans. Due to heavy erosion on the Oregon coast, many Early and Middle Holocene sites do not survive – Tahkenitch Landing represents a unique opportunity to examine early ancestral tribal use of whales in the archaeological record. The inhabitants of the Tahkenitch Landing site were acquiring and using large baleen whales (gray, humpback, and blue) around 3000 years BP, and transported large portions of whale skulls, and possibly foreflippers, from the coast to activity and living areas where they likely removed oil, meat, and blubber. Small cetaceans were present in very small numbers in the Tahkenitch Landing faunal assemblage, and the whales were concentrated within a single excavation stratum (Greenspan 1986). These patterns suggest inhabitants of Tahkenitch Landing were likely collecting stranded whales, rather than actively hunting them. Nonetheless, Tahkenitch Landing provides exciting, early evidence of whale use and species presence/prey choice. The inhabitants of the Par-Tee and Palmrose sites used primarily gray and humpback whales, but the use of ZooMS and aDNA analyses enabled additional identifications and a greater understanding of cetacean species richness. Both Par-Tee and Palmrose also contained fin, minke, blue, and Cuvier's beaked whales, as well as small cetaceans (primarily harbor porpoise with smaller quantities of Dall's porpoise and dolphins). Palmrose contained a particularly high abundance of bottlenose dolphins which are not well-represented in the modern Oregon stranding record or at the Par-Tee site, and their abundance is an anomaly which should be investigated in future historical ecology studies. Par-Tee and Palmrose inhabitants also appear to have used cetaceans for dietary consumption of meat and blubber as well as oil extraction. Unlike at Tahkenitch Landing, however, Par-Tee and Palmrose contained worked whale bone and whale bone artifacts, indicating more intensive ancestral tribal use of all parts of the whale as sources of raw material. Phalanges at Par-Tee were frequently cutmarked, which may reflect removal of tendons or ligaments for sinew. Par-Tee contained more unmodified and relatively complete elements (particularly vertebrae and phalanges) which may suggest less intensive oil extraction, or the use of whale remains as trophies/social status indicators. According to the ethnographic record, whales were difficult to hunt, and the acquisition of stranded whales was also a complex process involving tribal ancestors with Thunder powers (or those who knew Thunderbird) expending energy and effort to lure whales ashore to strand. Because whales were difficult to acquire, they represented valuable resources which were treated with respect and proper protocols. Although the human-whale relationship is not known in detail, narratives describe humans communicating with whales or working with Thunderbird as an intermediary. Whales were a resource bound up in complicated ecological and cultural understandings. Chapter IV generated a historical ecological dataset on whale species and presence prior to depletion by Euro-American, industrial-scale whaling. Par-Tee, Palmrose, and Tahkenitch Landing were all located near quiet-water environments (probably estuaries), the productivity of which might have drawn whales (especially humpbacks and grays) to their respective locations, resulting in strandings or facilitating hunting.

5.2 Culture History Implications

5.2.1 Overview

The studies in this dissertation focus on two different classes of marine mammals, but both the sea otter (Chapters II and III) and cetacean (Chapter IV) chapters are unified thematically: both generated new knowledge in the form of anthropological-historical ecological datasets with multiple applications, including critiquing and understanding culture historical patterns previously described for the Oregon Coast (and the Tahkenitch Landing, Palmrose, and Par-Tee sites specifically) prior to contact.

Several models/chronological sequences have been proposed for the precontact Oregon Coast (see Lyman 1991 and Moss and Erlandson 1998 for overviews). Building on earlier models, Lyman (1991) proposed a “Littoral Adaptational Pattern” with three phases: “pre-littoral,” “early littoral,” and “late littoral.” Pre-littoral sites pre-dated 5000 BP, followed by the early (~5000-2000 BP) and late littoral (~2000 BP) phases. Due to poor preservation of Early Holocene sites in coastal Oregon (Moss and Erlandson 1998), Lyman (1991) focused on describing early and late littoral cultures. The former, he hypothesized, should be marked by foraging of coastal, intertidal resources (especially shellfish, marine/anadromous fish, and pinnipeds), a broad range of bone/antler artifacts, less permanent occupation/storage (Lyman 1991:80), and living areas near productive environments like bays or estuaries (Lyman 1991:85). The late littoral phase is “a continuation of the early littoral” with greater evidence of sedentism/storage, accumulated wealth, larger shell middens, and a shift from coastally focused foraging to a “logistical collector strategy,” reflected by “special purpose short term camps” and “long term residential bases" (Lightfoot 1985; Lyman 1991:85). These shifts, Lyman (1991:93, 287) argued, should be reflected by intensified use of specific taxa and an increase in richness and complexity of tool types. Lyman (1991:83-84) also proposed that late littoral winter residences would be further inland on estuaries/rivers, with spring/summer dispersal to the outer coast or upriver. Lyman (1991:315) evaluated this model with the Umpqua-Eden, Seal Rock, and Whale Cove archaeological sites, and while the proposed model did account for some patterns in the data, "many of the archaeological implications" could not be successfully evaluated. Lyman (1991) discussed Tahkenitch Landing, Palmrose, and Par-Tee, but none of the sites perfectly aligned with the proposed phases (Tahkenitch Landing with pre/early littoral, and Palmrose/Par-Tee with early/late littoral).

Aikens et al. (2011:213) noted more generally that coastal Oregon groups shared several key features, including: reliance on coastal resources, extensive woodworking, social stratification, permanent settlements (with associated potential for food storage), and an "intense degree of economic activity in the form of regular trade."

5.2.2 The Seaside Sites

To date no complete monograph or overview synthesizing both the Palmrose and Par-Tee sites has been completed. Instead, subsamples of fauna and artifacts have been excavated and analyzed (Colten 2015; Connolly et al. 1992; Connolly 1995; Loiselle 2020; Losey and Power 2005; Losey and Yang 2007; Losey and Hull 2020; Phebus and Drucker 1979; Sanchez et al. 2016, 2018, 2020; Wellman et al. 2017) which must be taken together to characterize general culture historical patterns and change in the Seaside area. The archaeological evidence from Palmrose and Par-Tee generally match the characteristics summarized by Aikens et al. (2011): both sites contain woodworking implements such as wedges and chisels, as well as enormous quantities of marine mammal, fish, and shellfish remains (although the latter were not systematically sampled during excavation). Palmrose and Par-Tee are both thought to have been located on or adjacent to a quiet-water environment (bay/estuary), although this feature may have gradually in-filled over the course of occupation at Palmrose (Darienzo 1992:60) and Par-Tee was located closer to the open coast. Both Palmrose and Par-Tee are considered Late

Holocene archaeological sites (Aikens et al. 2011), although Palmrose may have been occupied briefly/intermittently at the end of the Middle Holocene (~4000 cal B.P.; Connolly et al. 1992:39). Year-round (and/or intensive fall through winter) occupation has been proposed for Palmrose (Greenspan and Crockford 1992:164) while seasonality has not been determined for the Par-Tee site (Colten 2015; Sanchez et al. 2020).

Palmrose contained the remains of a plank house, while Par-Tee contained evidence for semi-subterranean circular structures (Aikens et al. 2011:250; Phebus and Drucker 1979). Palmrose contained more woodworking implements and zoomorphic motifs on tools (Phebus and Drucker 1979), while Par-Tee contained fewer lithic artifacts (Phebus and Drucker 1979) and yielded relatively more single-piece harpoon points (Moss and Losey 2011:184) and whalebone atlatls (Losey and Hull 2020). Connolly (1992:103) identified similarities between carved bone and antler artifacts from Palmrose and those from Marpole phase sites on the lower Fraser River/Gulf of Georgia area of British Columbia, suggesting possible flow of goods and ideas between Oregon tribal ancestors and Salish-speaking groups further north in the precontact era, as well as the potential for the movement of the Salish language into Oregon. The authors do not, however, explicitly propose migration or population replacement (Aikens et al. 2011; Connolly 1992).

Losey and Power (2005) analyzed the shellfish remains from Par-Tee and compared their results to Palmrose (Greenspan and Crockford 1992). Losey and Power (2005:15) did not find significant differences in species representation, although more invertebrate remains were recovered from Par-Tee by weight (Losey and Power 2005:Table 3). Sanchez et al. (2020) reported that the Palmrose fish assemblage is dominated by salmon, while Par-Tee demonstrates greater species diversity with an emphasis on rockfishes, lingcod, and cabezon, all of which were likely acquired using hook and line fishing (Sanchez et al. 2020:9). Moss and Losey (2011:184) reported that Palmrose contained relatively more Steller sea lions and fur seal compared to Par-Tee, which contained relatively more sea otters and harbor seals. In Chapter IV, I report that Par-Tee also contained more complete whale elements, while Palmrose contained more bottlenose dolphin. In their meta-analysis of Oregon coast bird assemblages, Bovy et al. (2019:23, 25) grouped Palmrose with other site assemblages dominated by ducks (specifically scoters), and Par-Tee with assemblages dominated by murres and shearwaters.

Chapters II and IV of this dissertation outlined two key differences between the Palmrose and Par-Tee sites: 1) sea otter processing appears to have intensified at Par-Tee relative to Palmrose, either in terms of pelt removal and/or removal of muscle for dietary consumption, and 2) Par-Tee contained more complete whale elements, especially phalanges and vertebrae. These differences lend support to Lyman's (1991) suggestion of special purpose short term camp use. The relative increase of sea otter abundance (Moss and Losey 2011:184) in combination with the intensive processing documented in Chapter II may indicate targeted acquisition of the species for their pelts, despite the continued use of other taxa (a pattern which Lyman [1991:293] noted with regards to targeted Steller sea lion hunting at the Seal Rock site). Increased pelt removal would correspond to the hypothesized/expected increase of intensive economic activity and wealth accumulation in the Late Holocene (Aikens et al. 2011:213; Lyman 1991:293). The intensive processing of sea otters could also reflect removal of meat for dietary consumption, but sea otters were probably not a staple food source considering the abundance of whale, elk, and seal in the assemblage, and may have been consumed opportunistically as provisions at a shorter-term campsite.

The whale remains at Par-Tee were processed for food, oil, and artifact manufacture, and although whale remains are difficult to quantify, may have been more abundant at Par-Tee. The Par-Tee whale remains are less fragmented relative to the Palmrose whales, which may indicate less intensive processing for oil extraction. As suggested for the sea otter abundance, Par-Tee may have been a seasonal camp also targeted at acquiring whales to render oil, dry meat, or process sinew. Whales were associated with trade and had high economic value at contact like sea otter pelts. Par-Tee's location on the outer coast may therefore have also been chosen by the site inhabitants to facilitate access to hunted or beached whales, and thereby reduce transport distance and energy expenditure.

Additional evidence suggestive of Par-Tee as a temporary camp site includes the circular, ephemeral architecture, a lack of evidence for storage, fewer salmon in the fish assemblage, and the outer coast location. Following Lyman and Ross (1988), Oregon

Coast residents would disperse in spring to temporary camps on the outer coast or further upriver; Par-Tee may reflect such seasonal movement. Although sea otters can be born year round, they are likely to be born in the late spring/early fall, and Par-Tee contains substantial quantities of juveniles. Although the fish remains do not provide seasonality data for Par-Tee, the species in the assemblage would be obtained with hook and line (Sanchez et al. 2020). The fish species representation, combined with extensive harpoon and atlatl artifacts (Losey and Hull 2020; Moss and Losey 2011), suggestion of opportunistic whale hunting (Losey and Yang 2007), and predominance of murres and shearwaters (Bovy et al. 2019), suggests that the Par-Tee site inhabitants used resources not only from the littoral zone, but also from the offshore pelagic zone which could be more reliably accessed during the spring and summer.

Palmrose contained evidence of a plank house (and implied storage capacity) and large quantities of salmon remains. The proposed year-round and/or intensive fall/winter occupation at Palmrose fits Lyman and Ross's (1988) suggestion of winter residences located further inland on estuarine environments, like the quiet-water environment proposed for Palmrose. In Chapter II, I reported that sea otter elements at Palmrose were more frequently gnawed than at Par-Tee, and that these elements were found in and around the plank house feature. Colten (2015:262) also reported a greater abundance of canid remains at Palmrose relative to Par-Tee. This pattern may reflect the provisioning of hunting dogs during the fall elk season, further emphasizing the potential categorization of Palmrose as a permanent/semi-permanent winter village. I reported fewer sea otter remains at Palmrose, which may be a result of analyzing fewer units compared to Par-Tee. The sea otter remains, however, are clearly less intensively processed than at Par-Tee, which may reflect less intensive harvest, or perhaps solely pelt removal and no opportunistic dietary consumption of the species.

Palmrose contained fewer complete elements of whale remains, which may reflect the distance of Palmrose from the outer coast and difficulties associated with transportation of whales. Alternately, perhaps fewer whales were available or acquired by the Palmrose inhabitants, and the whale bones were more intensively processed to extract as much oil as possible. The small cetacean species representation was similar between Par-Tee and Palmrose (except for the abundance of bottlenose dolphins at the latter) but porpoises and dolphins are likely to come into river mouths and estuaries like the proposed quiet-water environment adjacent to the Palmrose site.

Both Lyman (1991) and Aikens et al. (2011) argued that plank houses should generally appear later in the Late Holocene archaeological record, and reflect increasing population density as well as established social stratification and “corporate structures” (Aikens et al. 2011:257). Par-Tee and Palmrose deviate from this generalization, with the plank house at Palmrose occurring earlier in the chronology of the Seaside area, followed by the circular, ephemeral architecture at Par-Tee. The evidence for Par-Tee as a seasonal camp is compelling, but it is possible that environmental changes in the Seaside area prompted abandonment of Palmrose and shifted occupations to the outer coast. At least one study suggests that a possible subsidence event may have occurred, although the exact chronology cannot be confirmed (Darienzo 1992:60). Such an event could have rendered the quiet-water environment near Palmrose less productive, and perhaps the relative increase in the use of sea otters, seals, whales, and other pelagic species at Par-Tee was necessitated by the reduction of resources further inland.

5.2.3 Tahkenitch Landing

Like Palmrose and Par-Tee, Tahkenitch Landing is also thought to have been located along an estuary prior to contact (Barner 1986:56). The Tahkenitch Landing faunal assemblage contained coastal/littoral species, including fish and shellfish, and relatively few marine mammals (inclusive of the whale remains reported in Chapter IV). The fish assemblage was dominated by sculpin, tomcod, and herring, all of which can be found in estuaries and fished from shore with nets or weirs (Greenspan 1986:58). Based on the faunal remains, Tahkenitch Landing may have been occupied spring through fall, but possibly throughout the year (Greenspan 1986:71). Unlike Palmrose and Par-Tee, Tahkenitch Landing lacks evidence for houses or other structures, and the artifact assemblage is dominated by lithic remains and lacks bone/antler tools and fishing technology (Greenspan 1986:71) like that found in large quantities in the Seaside sites. Minor and Toepel (1986:106) suggested that the site may have been a village, despite the lack of structural remains.

Following Lyman (1991), Tahkenitch Landing contains some features of early littoral sites (primarily fish and shellfish abundance despite a lack of fishing gear), while other characteristics (bone/antler tools), are absent. The inhabitants of Tahkenitch Landing appear to have focused on acquiring fish and shellfish found in estuarine ecosystems (Barner 1986:56; Greenspan 1986:58), following the proposed pattern of a winter village located inland. Since the Tahkenitch Landing site inhabitants were exploiting estuarine resources, the whale remains may also have been obtained from the estuary after stranding or entrapment. Alternately, the whales could indicate at least occasional, opportunistic use of outer coast resources by the Tahkenitch Landing inhabitants. The whale remains formed a large feature in the site dating to around 3000 BP, and their concentrated deposition may reflect a short period of acquisition and indicate a temporary hunting camp in line with Lyman's (1991) late littoral characteristic of targeted resource acquisition. While it is impossible to determine where the whales were acquired prior to deposition in the Tahkenitch Landing site, their presence does warrant consideration of the site as a winter village, and/or the existence of associated temporary hunting camps elsewhere on the outer coast.

5.3 Concluding Thoughts

The biological and ecological aspects of the faunal remains analyzed in this dissertation are inseparably linked with the cultural beliefs and activities that resulted in their deposition by tribal ancestors. In essence, these faunal remains represent both tangible and intangible cultural heritage from the past, as well as deep-time ecological data. These chapters bridge the cultural with the biological and provide insights about the scale and nature of use of sea otters and cetaceans on the Oregon coast using precontact faunal assemblages of unprecedented sample size. This project affirms, and was informed by, current and historical Oregon tribal perspectives and priorities regarding marine mammals (particularly sea otters), contributes new data to the body of work on coastal Oregon archaeology, and demonstrates the importance of multiple applied analytical methods in zooarchaeological research. Finally, this dissertation was based entirely on existing, largely unanalyzed faunal assemblages, demonstrating the research value of legacy collections curated in museums and repositories.

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