

1 Food or fur? Native American use of sea otters (*Enhydra lutris*) on the Oregon coast prior  
2 to European contact and extirpation.

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### 12 13 **Abstract**

14 Indigenous peoples on the Pacific Northwest Coast have shared coastal landscapes with  
15 sea otters since time immemorial. Sea otters were driven to near extinction in the 19<sup>th</sup>  
16 century fur trade, and despite reintroduction attempts, remain locally extirpated in  
17 Oregon. Renewed interest in sea otter reintroductions to Oregon has prompted study into  
18 the precontact sea otter population. Oregon archaeologists agree that tribal ancestors used  
19 sea otters, but detailed studies of use, including whether sea otters were processed for  
20 pelts, dietary consumption, or alternate purposes have not been systematically pursued.  
21 This study presents a zooarchaeological cutmark analysis of sea otter remains (N=2992)  
22 from two Late Holocene archaeological sites in northern Oregon: Palmrose (35CLT47)  
23 and Par-Tee (35CLT20). Analysis of cutmark patterns on sea otter bones (N=899)  
24 indicate that sea otters were primarily skinned for their pelts, and additional processing  
25 activities are proposed and discussed, including meat removal for dietary consumption,  
26 cleaning of bones for tool manufacture/obtaining sinew, and possible feeding of domestic  
27 dogs. These results affirm tribal assertions of deep-time human-sea otter relationships and  
28 use on the Oregon coast prior to extirpation.

### 29 30 **Keywords**

31 Sea otter, cutmark, Oregon, butchery, skinning, pelts, subsistence, human-animal  
32 relationships, coastal archaeology

### 33 34 **Introduction**

#### 35 *Sea Otters on the Northwest Coast*

36 Sea otters were driven to near extinction on the Pacific Northwest Coast in the 19<sup>th</sup>  
37 century due to the maritime fur trade. While sea otters previously ranged along the  
38 Pacific Rim from Japan to northern Mexico, the species is now restricted to parts of  
39 Russia, Alaska, British Columbia, Washington, and California (Bodkin 2015). In the  
40 United States, sea otter populations in Alaska, Washington, and California receive federal  
41 protection under the Endangered Species Act (ESA) and Marine Mammal Protection Act

1 (MMPA). Sea otter reintroductions to Oregon in 1970 and 1971 failed (Bodkin 2015) and  
2 sea otters are considered extirpated and listed as “threatened” under the Oregon  
3 Endangered Species Act. Sea otters are of interest to diverse stakeholders in Oregon  
4 today, and are considered an ecological priority due to their role as a keystone species  
5 within kelp forest ecosystems (Estes and Palmisano 1974) and a provider of ecosystem  
6 services (Foster et al. 2021; Gregr et al. 2020). Restoring sea otters to the Oregon coast is  
7 the goal of the recently reestablished Elakha Alliance, initially founded by Confederated  
8 Tribes of Siletz member Dave Hatch (Hall 2019). Reflecting these conservation  
9 priorities, studies of archaeological Oregon sea otters have sought to provide historical  
10 ecological data to inform future reintroduction efforts (Lyman 1988; Valentine et al.  
11 2008; Wellman 2018; Wellman et al. 2020).

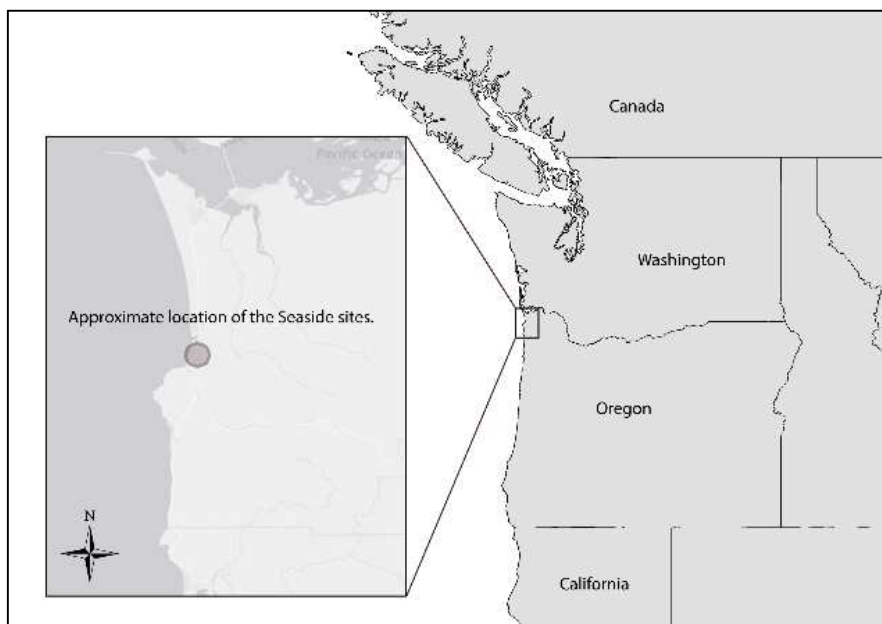
12         Sea otters are culturally significant to Native American, First Nations, and Alaska  
13 Native groups who reside along the Northwest Coast (Burt et al. 2020; Ibarra 2021;  
14 Salomon et al. 2015; 2018). Precontact sea otter hunting and use has been described in  
15 the archaeological and ethnographic record for some regions and communities (e.g., the  
16 Tlingit by Moss [2020]), but detailed zooarchaeological data are lacking for the Oregon  
17 coast (Hall 2019, 117). Oregon archaeologists and historians concur that sea otters were  
18 important based on their predominance in Oregon faunal assemblages (Hall 2019) and  
19 tribal knowledge (Elakha Alliance 2022), but archaeologists have not consistently  
20 reported use patterns. Moss and Losey (2011, 186) recommended detailed  
21 zooarchaeological analyses to gain an understanding of sea otter use, but little progress  
22 has occurred since the time of their writing. The precontact socio-cultural details of sea  
23 otters on the Oregon coast remain unaddressed: how, why, and when were tribal  
24 ancestors using sea otters, and what can the archaeological record tell us about the nature  
25 of the human-sea otter relationship in the coastal Oregon landscape?

26

### 27 *Current Study*

28 I present the analysis of cutmarked sea otter remains from two archaeological sites  
29 located in the town of Seaside on the northern Oregon coast (Figure 1) to determine  
30 whether sea otters were processed for pelt removal, dietary consumption of meat, and/or  
31 additional purposes. A core premise of this study is that sea otters have always been an

1 important resource for Indigenous societies throughout the Pacific Northwest Coast.  
2 Several Oregon tribes (Confederated Tribes of Siletz Indians, Confederated Tribes of  
3 Coos, Lower Umpqua, and Siuslaw Indians, and the Coquille Indian Tribe) are involved  
4 with the Elakha Alliance and reintroduction efforts (Goodell 2020; Elakha Alliance  
5 2022). This research affirms tribal assertions that the reintroduction of sea otters to  
6 Oregon would be a rekindling of a long human-animal relationship disrupted by colonial  
7 incursion and ecological exploitation by Euro-Americans (Elakha Alliance 2021; 2022).  
8 The results of this study indicate that the inhabitants of the Palmrose and Par-Tee sites  
9 were skinning sea otters for their pelts prior to European contact. Sea otter meat may also  
10 have been removed from parts of the skeleton for occasional dietary consumption and  
11 other activities, but the cutmark patterns indicate sea otters were acquired first and  
12 foremost for their pelts. Sea otters were clearly an important animal well before European  
13 contact occurred and the Euro-American fur trade began.  
14



15  
16 Figure 1. Map showing location of the Seaside (Palmrose and Par-Tee) sites on the  
17 Oregon coast. Made in ArcMap 10.0/Adobe Illustrator; data from Natural Earth, U.S.  
18 Census Bureau, Esri, DeLorme, HERE, and MapmyIndia.  
19  
20  
21

1 *Ethnographic Background*

2 At Euro-American contact, the Seaside area was home to the Penutian-speaking Clatsops  
3 (Deur 2016) and likely the Salish-speaking Nehalem Tillamook (Jacobs 2003, 2; Ray  
4 1938). Today, the descendants of these groups are represented by the Confederated  
5 Tribes of the Grande Ronde, Confederated Tribes of Siletz Indians, Confederated Tribes  
6 of Clatsop-Nehalem, and The Chinook Indian Nation (Deur 2016; Johnson 2013, 5).  
7 Lewis and Clark interacted with coastal and lower Columbia tribes and frequently wrote  
8 about sea otters and their pelts (Lewis and Clark 2005; Ray 1938; Sauter and Johnson  
9 1974). The Salmon River Tillamook (located on the north-central coast) reportedly used  
10 both river and sea otter for clothing and bedding, but neither for food (Zobel 2002, 309).  
11 Sea otter skins were highly valuable and coveted (Sauter and Johnson 1974, 53) and  
12 associated with noble status and birth (Lewis and Clark 2005; Ray 1938). Tillamook  
13 shamans reportedly kept their powers in a bag made from sea otter skin (Sauter and  
14 Johnson 1974, 120). Verne Ray (1938, 7:114) noted “early writers speak of sea otter  
15 robes in use by the Chinook but [not] whether they used the flesh for food or not” and  
16 whether “humans ate sea otter meat is ambiguous.” Vernon Bailey (1936, 305) noted that  
17 sea otters can “become very fat and are reported by some to be good eating and by others  
18 as not fit for human food,” similar to contradictory information Moss reported from  
19 Tlingit informants (2020, 213).

20 Clara Pearson, a Nehalem Tillamook informant interviewed in the early 1930s,  
21 did not list sea otter as a food source (Jacobs 2003, 95) but recounted stories and myths  
22 including sea otters (Pearson 1990). For example, the story “The Invisible Husband”  
23 references Seaside as the location where “all those men went sea-otter hunting” (Pearson  
24 1990, 20). “The Round Trip of Ice” describes a sea otter hunt with Ice and his men; they  
25 encounter a “[...] sea otter that was different looking. It was a sea otter all right but it had  
26 a white face” (Pearson 1990, 3). The men, unable to strike the sea otter, follow it back to  
27 the village where they find a young woman who looks just like the sea otter and the  
28 weapons the men had unsuccessfully fired. These stories and others indicate that sea  
29 otters were important symbolically and economically, and were non-human  
30 persons/agents within the lower Columbia River landscape.

31

1 *Previous Archaeological Cutmark Research*

2 To determine if Tlingit ancestors were processing sea otters for dietary consumption,  
3 Madonna Moss (2020) compared cutmarked elements of seals (animals processed for  
4 food) to cutmarked elements of sea otters from archaeological sites near Angoon,  
5 Southeast Alaska. Working with Sealaska Heritage Institute, she received permission to  
6 observe a Tlingit hunter, Kyle Barry, as he skinned a sea otter hunted under the MMPA.  
7 Moss obtained the resulting sea otter carcass and examined the cleaned bones for  
8 cutmarks left by the skinning (Table 1). Moss (2020) reported cutmarks on sternabrae, a  
9 rib, radii, an ulna, a metacarpal, an innominate, a femur, a fibula, a calcaneus, and  
10 metatarsals. Moss (2020, 215) concluded that cutmarks on the archaeological sea otter  
11 mandibles, tarsals, metatarsals, tibiae/fibulae, and ulnae/radii reflected skinning;  
12 cutmarks on the femora/humerii were a result of pulling limbs away from the pelt during  
13 skinning, and cutmarks on scapulae, vertebrae, innominates, and ribs resulted from  
14 obtaining backstrap muscle for dietary consumption by dogs and possibly humans. An  
15 important methodological lesson from Moss's analysis was that "typical" patterns of  
16 cutmarks and their assigned functions, e.g., Binford's (1981) experimental caribou study,  
17 were not necessarily applicable to sea otters, and that skinning resulted in cutmarks in  
18 unexpected areas following zooarchaeological conventions (Moss 2020, 216). For  
19 example, the sea otter skinned by Mr. Barry was cutmarked on metatarsals, consistent  
20 with conventional typologies (Binford 1981), but also on the innominate and femur,  
21 which are not (Moss 2020, 213).

22 Val and Mallye (2011) conducted an experimental skinning study in which  
23 taxidermists skinned small carnivores (Eurasian badgers, stone and pine martens, a  
24 polecat, red foxes, and a weasel). Val and Mallye (2011) reported high numbers of  
25 cutmarks on the cranium, mandible, tarsals, metatarsals, phalanges, ulna/radius,  
26 tibia/fibula, and a few cutmarks on an innominate and ribs (Table 1). Val and Mallye  
27 (2011, 237) noted that forepaws and caudal vertebrae may remain in the fur upon  
28 removal from the skeleton, so archaeological assemblages missing forepaws and caudal  
29 vertebrae may indicate that animals were skinned and the pelts containing the  
30 forepaws/caudal vertebrae were deposited elsewhere. While Val and Mallye's study was  
31 performed by modern taxidermists, it is a useful comparison when considering cutmarks

1 on fur-bearing mammals (e.g., West and Yeshurun’s [2019] archaeological study of  
 2 Alutiiq fox use on Kodiak Island also follows Val and Mallye’s results; Table 1).

3

4 **Table 1.** Cutmarked elements and inferred functions in previous studies.

Study	Skinning/Pelt Removal	Disarticulation	Muscle Removal/Fileting
<b>Moss (2020) Experimental</b>	Ribs, sternabrae, radii/ulnae, metacarpals, innominates, femora, fibulae, tarsals/metatarsals	--	--
<b>Val and Mallye (2011) Experimental</b>	Crania/mandibles, radii/ulnae, metacarpals/carpals, possibly innominates, tibiae/fibulae, tarsals/metatarsals/phalanges	--	--
<b>Moss (2020) Archaeological</b>	Mandibles, humerii, radii/ulnae, femora, tibiae/fibulae, tarsals/metatarsals, innominates/ribs (rare)	Vertebrae, ribs, scapulae, innominates	Vertebrae, ribs, scapulae, innominates, possibly femora
<b>West and Yeshurun (2019)* Archaeological</b>	Crania/mandibles, radii/ulnae, tibiae	Humerii, femora	Humerii, femora
<b>Lyman (1991)</b>	Innominates, tibiae, tarsals/metatarsals	Mandibles, humerii, radii/ulnae, innominates, femora/tibiae, tarsals	Scapulae, humerii, radii/ulnae, innominates, femora/tibiae
*West and Yeshurun analyzed crania, mandibles, humerii, radii/ulnae, femora, and tibiae only.			

5

6 Lyman (1991) recorded cutmarked sea otter remains from three coastal Oregon  
 7 sites, two of which are discussed here: Umpqua-Eden (35DO83) and Seal Rock  
 8 (35LNC14). Lyman sketched and described each cutmark and categorized them by  
 9 function following Binford (1981) and Howard (1973; 1975). Lyman (1991) categorized

1 cutmarks to innominates, tibiae, tarsals, and metatarsals as pelt removal, cutmarks to  
2 joints like mandibles, humerii, radii/ulnae, innominates, femora, tibiae, and tarsals as  
3 disarticulation, and cutmarks to scapulae, innominates, and longbone diaphyses as meat  
4 removal/fileting (Table 1). Cutmarks categorized by Lyman as dismemberment and  
5 filleting may not have been a result of dismemberment/filleting, but from different  
6 aspects of the skinning process, as discussed by Moss (2020) and Val and Mallye (2011).

7 In conclusion, prior experimental studies (Moss 2020; Val and Mallye 2011)  
8 attributed cutmarks on the ribs, sternabrae, radii/ulnae, carpals, metacarpals, innominates,  
9 femora, tibiae/fibulae, tarsals, metatarsals, and phalanges to skinning/pelt removal (Table  
10 1). Cutmarked elements not attributed to skinning in the experimental studies include the  
11 vertebral column, scapulae, humerii (Moss 2020; Val and Mallye 2011), ribs,  
12 innominates, and femora (Val and Mallye 2011).

13

## 14 **Materials and Methods**

### 15 *Archaeological Materials*

16 The sea otters analyzed in this study come from the Palmrose (35CLT47) and Par-Tee  
17 (35CLT20) sites, coastal shell mounds excavated between 1967 and 1977 at Seaside,  
18 Oregon (Phebus and Drucker 1979). The sites were excavated by Robert Drucker and  
19 George Phebus and their volunteers in  $\sim 1.5 \times 1.5$  m ( $5 \times 5$  foot) units in arbitrary  $\sim 30$  cm  
20 (one-foot) levels. Unit depths varied from 1.4—3m (Sanchez 2021). All sediments were  
21 screened over 1/4-inch mesh (Phebus and Drucker 1979).

22 Today, Palmrose is located approximately one mile inland, but prior to contact  
23 was located on a bay or estuary which has since in-filled (Connolly 1995; Darienzo  
24 1992). This environment is reflected in the terrestrial, marine, and riverine species  
25 present in the Palmrose faunal assemblage (Colten 2015) and likely enabled the transport  
26 of otherwise large species found in the site (e.g., whales, dolphins, sea lions) via boat  
27 (Ames 2002; Loiselle 2020; Wellman 2021). Recent analysis has refined the Palmrose  
28 site occupation to beginning  $\sim 2295$ -2005 cal BP (345-55 cal BC) and terminating  $\sim 1725$ -  
29 1610 cal BP (cal AD 225-340) (see Sanchez [2021] for further discussion). Palmrose  
30 contained evidence for a plank house floor (Phebus and Drucker 1979) and an abundance

1 of salmon (Greenspan and Crockford 1992; Sanchez, Gobalet, and Rick 2020) suggestive  
2 of a year-round occupation (Sanchez 2021).

3 Par-Tee dates to 1850-1150 cal B.P. (Sanchez et al. 2018) and is located close to  
4 the shoreline (~200 m at present, likely closer pre-contact; Losey and Yang 2007). The  
5 Par-Tee faunal assemblage is dominated by marine species (Colten 2015; Sanchez,  
6 Gobalet, and Rick 2020) including small and large cetaceans (Loiselle 2020; Losey and  
7 Yang 2007; Wellman et al. 2017). Unlike the house floor at Palmrose, Phebus and  
8 Drucker (1979) reported temporary structures at Par-Tee. Seasonality has not been  
9 determined.

10 The Palmrose and Par-Tee artifact assemblages have not been fully analyzed but  
11 both contain a variety of lithic and bone tools (Connolly 1992; Losey 2021) including  
12 chert scrapers and knives which would likely have been using for skinning activities. The  
13 artifact and faunal assemblages are curated at the National Museum of Natural History  
14 (NMNH), Washington, D.C., and the University of Oregon Museum of Natural and  
15 Cultural History (MNCH), Eugene.

16

### 17 *Methods*

18 In brief, I identified sea otter bones from a subsample of 34 Palmrose and 63 Par-Tee  
19 excavation units, respectively. This differs from Moss [2020] and Lyman [1991], both of  
20 whom analyzed all sea otter remains from their respective study sites. NMNH and  
21 MNCH collections were analyzed in the summers of 2019 and 2020, respectively. Sea  
22 otter bones were examined under 0.63—2x magnification with a high-intensity oblique  
23 light source (following Moss [2020] and West and Yeshurun [2019]) to identify  
24 cutmarks. Cutmarks were described and/or photographed, and most cutmarks on  
25 longbones were sketched onto schematic drawings from Post (2006). I consulted the  
26 muscular anatomy of the sea otter forelimb and hindlimb described by Howard (1973;  
27 1975) as well as a dog anatomy textbook (Budras et al. 2007) to identify possible fascia  
28 “targets” of the cutmarks to infer function.

29 I calculated the % NISP of total cutmarked skeletal elements (e.g., 739 of 2024  
30 specimens exhibited cutmarks at Par-Tee, or 37%). I also counted cutmarked longbones  
31 based on the locations of the cutmarks (distal, proximal, or on the diaphysis, or some



1 combination thereof, e.g., 5 radii cutmarked distally, or 2 femora cutmarked proximally).  
2 While % NISP cutmarked does not account for fragmentation (Abe et al. 2002; Lyman  
3 2008), longbone location counts do while also assessing the “anatomical distribution of  
4 cutmarks” (Lyman 2008, 285).

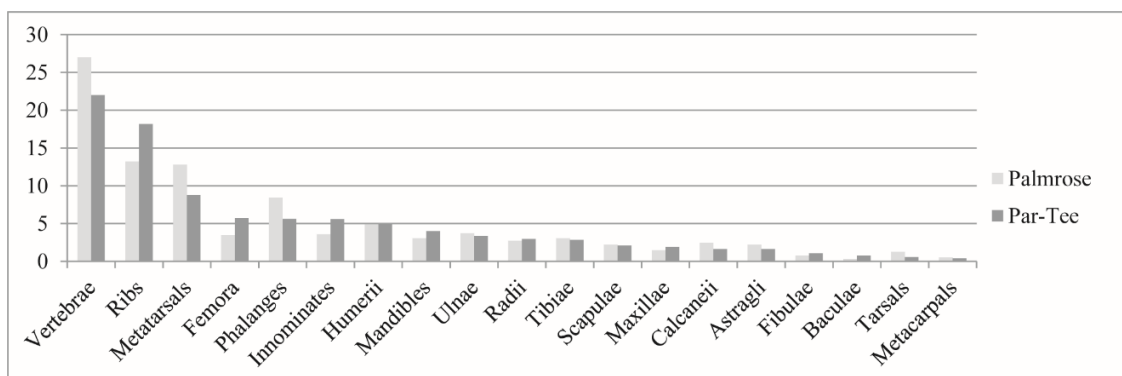
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## 6 **Results**

### 7 *Number of Identified Specimens and Element Representation*

8 I identified 968 sea otter specimens from 34 Palmrose units, for which humerii provided  
9 an MNI of 22 (15 adults and 7 juveniles). I identified 2024 sea otter specimens from 63  
10 Par-Tee units; femora provided an MNI of 54 (30 adults and 24 juveniles). Vertebrae,  
11 ribs, and metatarsals are the three most abundant elements (% NISP) at both sites (Figure  
12 2). At Par-Tee these elements are followed by femora, phalanges, and innominates, and at  
13 Palmrose by phalanges and humerii (Figure 2). Both sexes are represented at both sites:  
14 males by bacula and females indirectly by pups under weaning age. Additional  
15 zooarchaeological results, including juvenile aging criteria, are described in Appendix A;  
16 zooarchaeological data table is Appendix B.

17



18

19 Figure 2. Sea otter element abundance (% NISP) in Palmrose and Par-Tee samples.

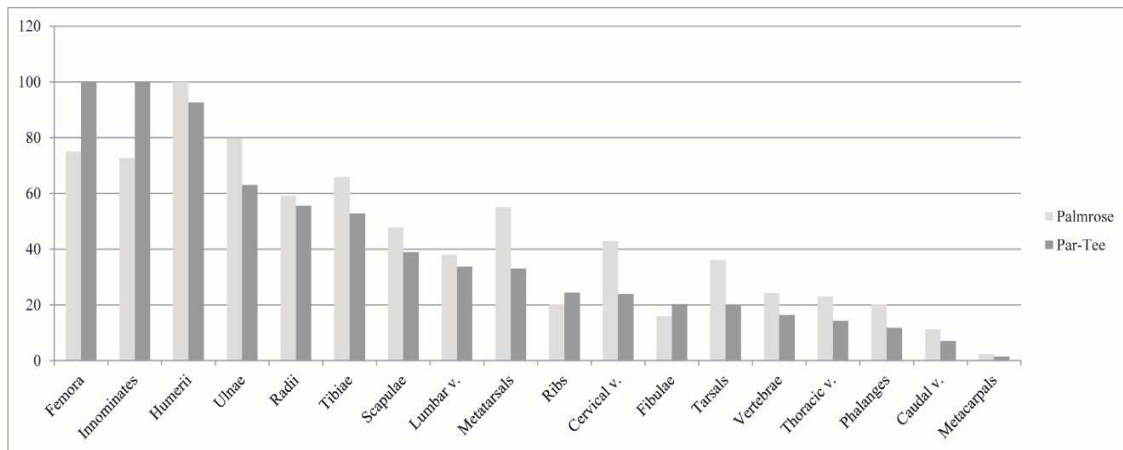
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21 While vertebrae, ribs, and hindfoot elements (metatarsals and phalanges) exhibit a  
22 high abundance these elements are underrepresented if we consider the remains of 22 and  
23 54 MNI sea otter carcasses (assuming complete preservation) in the Palmrose and Par-  
24 Tee samples, respectively (Figure 3). Forefoot elements are extremely underrepresented,

1 likely due to the small size of these elements and poor *in situ* archaeological recovery  
 2 techniques, or the removal of the forepaws along with the pelt (Val and Mallye 2011,  
 3 237). The lack of forefoot elements, combined with the substantial underrepresentation of  
 4 caudal vertebrae at both Palmrose and Par-Tee (Figure 3), may indicate pelts were  
 5 removed and then deposited outside the excavated areas of the site.

6 Conversely, innominates, femora, and humerii do not exhibit a high abundance  
 7 (Figure 2) but are well-represented assuming complete preservation (Figure 3).  
 8 Innominate specimens were highly fragmented which likely accounts for their apparent  
 9 over-representation, while femora, humerii, and other longbone elements were  
 10 fragmented to lesser degrees (see Appendices A and B).

11



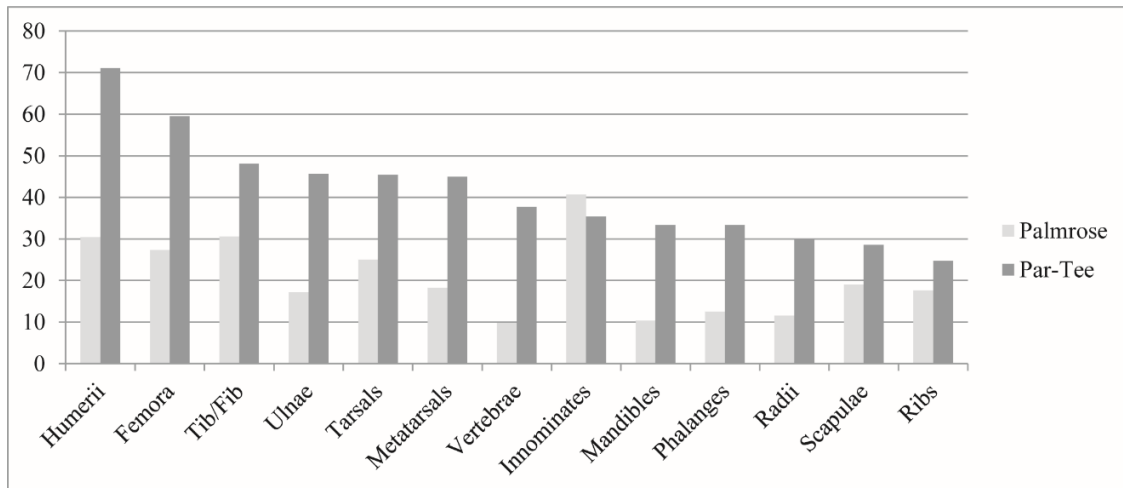
12  
 13 Figure 3. Percent of expected sea otter elements in the Palmrose (22 MNI) and Par-Tee  
 14 (54 MNI) samples, respectively.

15

16 *Palmrose and Par-Tee Cutmarks*

17 The Palmrose sample contained 160 cutmarked specimens, or 17% NISP cutmarked;  
 18 11% of juvenile elements and 18% of adult elements are cutmarked. When calculated by  
 19 element, innominates dominate % NISP cutmarked (Figure 4), followed by tibiae/fibulae  
 20 (driven by tibiae), humerii, femora, and tarsals (driven by calcaneii/astragali). The Par-  
 21 Tee sample contained 739 cutmarked specimens (37% NISP cutmarked): 28% of juvenile  
 22 specimens and 38% of adult specimens are cutmarked. Humerii and femora dominate %  
 23 NISP cutmarked, followed by tibiae/fibulae (driven by tibiae), ulnae, tarsals (driven by

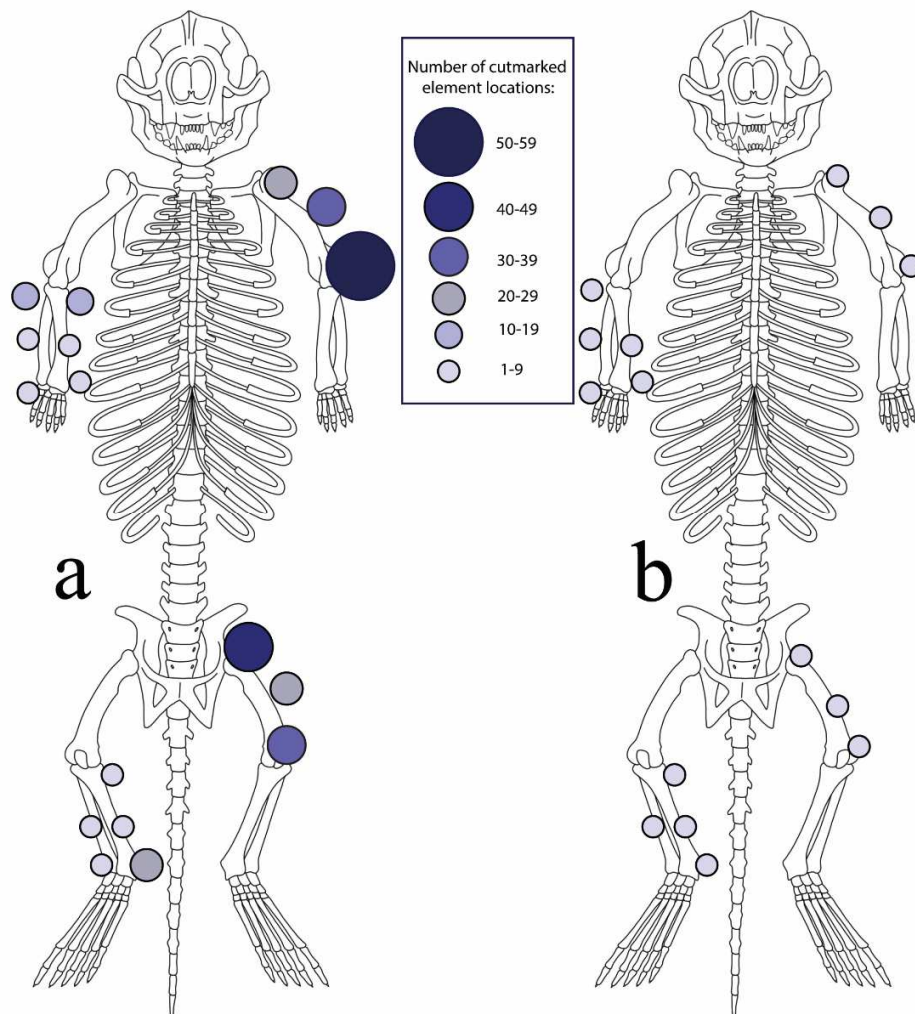
1 calcanei and astragali), and metatarsals (Figure 4). Detailed descriptions of cutmark  
 2 patterns for each element are available in Appendix A; cutmark data table is Appendix C.  
 3



4  
 5 Figure 4. Percent NISP (% NISP) cutmarked of each element in the Palmrose and Par-  
 6 Tee assemblages.  
 7

8 To better understand the distribution of cutmarks across the skeleton, I counted  
 9 the number of longbone locations exhibiting cutmarks (Lyman 2008, 285). The Par-Tee  
 10 longbone sample is depicted in Figure 5a. More femora and humerii are cutmarked on the  
 11 proximal/distal ends and diaphyses relative to other elements. Proximal and distal femora  
 12 are cutmarked in roughly equal numbers, while more distal humerii are cut (N=53)  
 13 relative to proximal humerii (N=22). More distal tibiae are cutmarked (N=25) than  
 14 proximal tibiae (N=7). Conversely, proximal radii and ulnae are both cutmarked in higher  
 15 numbers (N=12 and N=18, respectively) than distally (N=3 and N=8, respectively).

16 The Palmrose longbone sample is depicted in Figure 5b. Overall, distribution of  
 17 cutmarked Palmrose longbone locations is roughly equal across the skeleton (Figure 5b),  
 18 unlike the Par-Tee sample in which large numbers of proximal femora and distal humerii  
 19 were cutmarked (Figure 5a). Similar to Par-Tee, the Palmrose humerii exhibit the most  
 20 diaphysis cutmarks (N=8) and slightly higher numbers of proximal femora and distal  
 21 tibiae are cutmarked relative to other locations on these elements.



1  
 2 Figure 5. Sea otter skeleton with total cutmarked longbone locations from the Par-Tee (a)  
 3 and Palmrose (b) sample tallied and diagrammed. Circle size and color corresponds to  
 4 number of elements cutmarked at a given location (proximal, distal, diaphysis).  
 5 Illustration by Keeley Davies.

6

7 **Discussion**

8 *Skinning and Pelt Removal*

9 Palmrose and Par-Tee sea otters (both adult and juvenile) were skinned for their pelts.  
 10 Evidence for skinning includes cutmarks at locations recorded in the Moss (2020) and  
 11 Val and Mallye (2011) experimental studies (Table 2; Appendix A). Both the Palmrose  
 12 and Par-Tee samples contain cutmarked mandibles, ribs, sternabrae, radii/ulnae,  
 13 metacarpals, innominates, femora, tibiae/fibulae (especially distal tibiae at Par-Tee),

1 tarsals (especially astragali and calcanei), metatarsals, metacarpals, and phalanges (Moss  
 2 2020; Val and Mallye 2011).

3

4 **Table 2.** Elements cutmarked from skinning in the Moss (2020) and Val and Mallye  
 5 (2011) experimental studies and the Palmrose and Par-Tee samples.

Study	Skinning/Pelt Removal
<b>Palmrose and Par-Tee Samples</b>	Mandibles, ribs, sternabrae, distal humerii, radii/ulnae, metacarpals, innominates, femora, tibiae/fibulae, tarsals/metatarsals/phalanges
<b>Moss (2020) Experimental</b>	Ribs, sternabrae, radii/ulnae, metacarpals, innominates, femora, fibulae, tarsals/metatarsals
<b>Val and Mallye (2011) Experimental</b>	Crania/mandibles, radii/ulnae, metacarpals/carpals, possibly innominates, tibiae/fibulae, tarsals/metatarsals/phalanges

6

7 R radii and ulnae in Val and Mallye's (2011) study were cutmarked in areas where  
 8 fascia are absent on the diaphysis, as well as parts of the olecranon process and radial  
 9 head. Cutmarks are found in some of these locations on the Palmrose and Par-Tee  
 10 radii/ulnae as well as in additional locations lacking musculature (Howard 1973)  
 11 suggesting skinning. In Moss's (2020, 212) observation of the skinning process, the sea  
 12 otter's forelimbs were drawn in towards the body, making them difficult to work around  
 13 as Mr. Barry removed the pelt. Cutmarks to the proximal radius/ulna may reflect the  
 14 difficulty of prying the pelt away from the elbow joint. Although neither Val and Mallye  
 15 (2011) nor Moss (2020) recorded cutmarks to the distal humerus, the frequency of  
 16 cutmarked distal humerii at Par-Tee may be related to the quantity of cutmarked proximal  
 17 ulnae (Figure 5a) and prying the pelt from the elbow.

18 Moss (2020, 211) determined cutmarks to the hip joint (left femoral head and  
 19 right innominate) occurred when Mr. Barry applied leverage to pull the pelt away from  
 20 the skeleton. Val and Mallye (2011, 232) also recorded two cutmarks to an innominate  
 21 although this was rare. Processing of the hip joint is typically associated with butchery  
 22 and meat removal (Binford 1981; Lyman 1991, 199) but following these recent  
 23 experimental studies, skinning may account for some of the cutmarks to innominates and  
 24 proximal femora at Palmrose and Par-Tee.

1 To summarize, cutmarks to the mandibles/maxillae, ribs, sternabrae, radii/ulnae,  
2 metacarpals, innominates, proximal femora, fibulae, distal tibiae (especially at Par-Tee),  
3 tarsals (especially astragali and calcanei), metatarsals, metacarpals, and phalanges in the  
4 Palmrose and Par-Tee samples are likely skinning cutmarks (Table 2).

5  
6 *Non-Skinning Cutmarks*

7 Cutmarked elements not attributed to skinning in the experimental studies include the  
8 vertebral column, scapulae, humerii (Moss 2020; Val and Mallye 2011), ribs,  
9 innominates, and femora (Val and Mallye 2011). Following Moss (2020, 215) cutmarks  
10 to vertebral processes and ribs are from stripping the backstrap muscle for meat or  
11 disarticulating the axial skeleton. Palmrose and Par-Tee scapulae are infrequently  
12 cutmarked, but always on the ventral surface, which may reflect removal of the entire  
13 forelimb from the rib cage as opposed to the shoulder joint. Lyman (1991, 321) and Moss  
14 (2020) attributed scapulae cutmarks to filleting and disarticulation, respectively. The  
15 humerii at Palmrose are cutmarked evenly across element locations (Figure 5b), while  
16 more humerii at Par-Tee are cutmarked on the diaphysis and distally (Figure 5a).  
17 Cutmarks to the elbow joint elements at Par-Tee may indicate disarticulation (Binford  
18 1981; Lyman 1991) or skinning, while proximal and diaphysis humerii cutmarks could  
19 reflect disarticulation or meat removal (Lyman 1991; Val and Mallye 2011; West and  
20 Yeshurun 2019). Moss (2020) attributed archaeological femur cutmarks to skinning and  
21 innominate cutmarks to backstrap removal. However, innominates in the Palmrose/Par-  
22 Tee samples and femora in the Par-Tee sample have a higher % NISP cutmarked than the  
23 archaeological sea otters in Moss's (2020) study. The femora at Palmrose and Par-Tee are  
24 cutmarked on the diaphysis, proximally, and distally (especially at Par-Tee), often on the  
25 femoral neck and at the gastrocnemius origin (Figure 6).

26



1

2 Figure 6. A distal femur cutmarked on and around the medical gastrocnemius insertion  
3 origin (L) and a proximal femur cutmarked on the femoral neck (R). Scale in cm;  
4 Palmrose units NE1J-3 and SE1M-3.

5

6 These cutmarks may reflect processing activity at the hip and knee joints, such as  
7 dismemberment or meat removal.

8 To summarize, cutmarks to the vertebrae, innominates, femora, and humerii at  
9 Palmrose and Par-Tee may infer meat removed, but was this for consumption by  
10 humans?

11

### 12 *Evaluating Dietary Consumption*

13 An unpublished sea otter meat utility model (Lucy Lewis Johnson, personal  
14 communication to Madonna Moss 2016) can help to evaluate the meat yield of elements  
15 given expected abundances (Figure 3) and % NISP of cutmarked elements (Figure 4) at  
16 Palmrose and Par-Tee. According to the model, vertebrae, innominates, femora, and  
17 humerii are ranked 1<sup>st</sup>, 3<sup>rd</sup>, 7<sup>th</sup>, and 12<sup>th</sup>, respectively.

18 Despite being ranked first, vertebrae are underrepresented at both sites and less  
19 frequently cutmarked, particularly at Palmrose (Figures 3 and 4). Innominates are ranked  
20 third, but representation at both sites is driven in part by fragmentation (Appendix A and  
21 B). Innominates are also the most frequently cutmarked element at Palmrose but only at  
22 ~40% NISP cutmarked (and ~35% at Par-Tee; Figure 4). Femora are ranked 7<sup>th</sup> in the  
23 meat utility model, have high representation and % NISP cutmarked at Par-Tee (Figure  
24 4), and seem the most likely of the elements discussed to reflect meat removal for dietary  
25 purposes, yet may still reflect pelt removal following Moss (2020). Humerii are well-  
26 represented at both sites (Figure 3) and frequently cutmarked at Par-Tee (~70%; Figure  
27 4) but have a low ranking (12<sup>th</sup>). The humerii at Par-Tee are also overwhelmingly

1 cutmarked distally as opposed to proximally (Figure 5a), which may correspond with  
2 difficulty removing the pelt from the elbow following Moss (2020).

3 Other elements highly ranked in the meat utility model include tibiae (4<sup>th</sup>) and  
4 metatarsals (5<sup>th</sup>). The tibiae at Par-Tee in particular are cutmarked distally at locations  
5 strongly indicative of skinning (Lyman 1991; Val and Mallye 2011; West and Yeshurun  
6 2019). Metatarsals could have been processed for meat but are either poorly represented  
7 (as at Par-Tee; Figure 3) or infrequently cutmarked (as at Palmrose; Figure 4). A  
8 relatively large percentage of expected ulnae and radii are present in the samples but  
9 these elements have very low meat utility rankings (13<sup>th</sup> and 14<sup>th</sup>).

10 The meat utility model provides an additional framework with which to assess  
11 dietary consumption of sea otter meat, and I suggest best explains the processing of the  
12 sea otter hip joints and axial skeleton for meat removal. However, the elements with  
13 highest meat utility rankings are generally not the most well-represented (vertebrae, ribs,  
14 metatarsals) and/or most frequently cutmarked (innominates, scapulae) elements in the  
15 Palmrose and Par-Tee samples, which might be expected if meat removal for dietary  
16 consumption were a priority and/or being optimized.

17 It is possible that highly ranked and under-represented elements were processed  
18 for meat removal and discarded outside of the excavated site area, and/or that cutmarks  
19 were simply not made during processing. At the Nah-so-Mah (35CS43) site in Bandon,  
20 Oregon, bones of an individual sea otter were found and re-assembled from within a  
21 single excavation unit (Hall 2001). While some units at Palmrose and Par-Tee contain  
22 multiple elements that could be from a single sea otter, the stratigraphic resolution is poor  
23 and it is not currently feasible to determine whether sea otter carcasses were discarded  
24 intact or in discrete portions after skinning or dismemberment (see Appendix A). Neither  
25 the Palmrose nor Par-Tee samples contain zooarchaeological evidence for cooking sea  
26 otter (only four specimens are burned). The Chinook and Tillamook reportedly boiled  
27 meat in containers/trenches using hot rocks and roasted meat in earth ovens (Jacobs 2003,  
28 76; Ames and Sobel 2013, 135). These methods, if used prior to contact, would not leave  
29 evidence of cooking on the bones.

30 Sea otter meat could have been consumed opportunistically to avoid waste or at  
31 times when preferred prey items were unavailable or scarce, although other key resources



1 (cetaceans, elk, pinnipeds) would have been available to the Palmrose and Par-Tee  
2 inhabitants throughout the year (Colten 2015, 273; Greenspan and Crockford 1992, 164;  
3 Wellman 2021). Habitation may also have been adequately supported by salmonid  
4 capture/storage at Palmrose and supplementation by other fishes (Sanchez, Gobalet, and  
5 Rick 2020) and shellfish (Greenspan and Crockford 1992, 164). Sea otter processing  
6 appears to have “intensified” at Par-Tee relative to Palmrose in terms of % NISP  
7 cutmarked (Figure 4). If Par-Tee was indeed a temporary/seasonal encampment, perhaps  
8 this intensification reflects targeted acquisition of the species for their pelts at that  
9 location near the coast, and/or removal of meat for dietary consumption as provisions at a  
10 shorter-term, activity-specific campsite.

11

### 12 *Beyond Pelts and Meat*

13 While cutmark patterns suggest sea otters were hunted primarily for their pelts and  
14 possible dietary consumption, other processing activities may result in similar cutmark  
15 patterns. In Moss’s (2020) experimental study Mr. Barry removed the pelt whole, but we  
16 should not expect all societies to skin sea otters with the same goals or outcomes. A  
17 carcass that is divided prior to skinning, for example, would result in cutmark patterns  
18 that may be confused for disarticulation and meat removal following conventional  
19 typologies. Attempting to skin just a forelimb or hindlimb, for example, would change  
20 points of entry and leverage angles and leave cutmark patterns reflecting multiple stages  
21 of processing. Sea otters are large animals, and pieces of a pelt could yield enough  
22 material to trim items of clothing or accumulate quickly over hunts to sew larger items.  
23 Sea otter robes were often described as two skins sewn together (Drucker 1951; Lewis  
24 and Clark 2005; Ray 1938) but Ray (1938, 7:137) also reported robes made with strips of  
25 sea otter pelt “twisted and woven by twining with thin, strong cords.” The latter method  
26 would not necessarily require an intact pelt.

27 Other activities resulting in cutmarks might include the removal of tendons and  
28 ligaments to dry and make sinew for sewing, or to clean bones to use for tool  
29 manufacture. The removal of fascia would leave cutmarks in locations traditionally  
30 associated with disarticulation or muscle removal on the bones. For example, cutmarks  
31 observed on the ventral surface of ~50% of vertebrae in the Palmrose and Par-Tee

1 samples (Appendix C; Figure 7) cannot be a result of skinning or backstrap removal, but  
2 could result from severing the anterior longitudinal ligament which helps to stabilize the  
3 length of the vertebral column (Budras et al. 2007) to either breakdown the skeleton or  
4 remove sinew.

5



6

7 Figure 7. A lumbar vertebra cutmarked on ventral aspect. Scale in cm, Palmrose unit  
8 SE3B-4.

9

10 To date, no systematic analysis of the artifact assemblages from the Palmrose or  
11 Par-Tee sites have been undertaken, but sea otter bacula were used for tool manufacture  
12 at Par-Tee (Robert Losey, personal communication, 2019). Other artifacts in the site were  
13 manufactured from whale (Losey and Hull 2019) and elk bone (Losey and Yang 2007).  
14 Some sea otter elements, like the robust and compact radii and ulnae, could have been  
15 useful raw materials for tool manufacture, and future research into the artifacts at  
16 Palmrose and Par-Tee should be pursued to determine if additional sea otter remains were  
17 used.

18

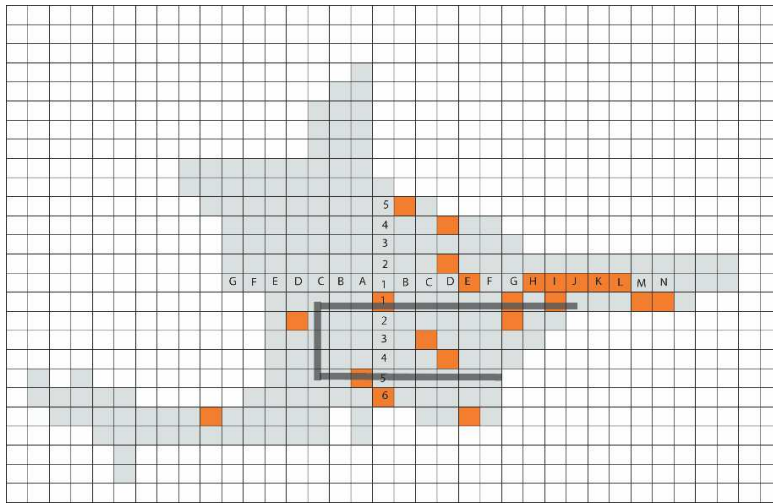
### 19 *Feeding Domestic Dogs?*

20 Moss (2020) reported large amounts of carnivore gnawing on the archaeological sea  
21 otters in her study, and suggested that sea otters may have been fed to Tlingit dogs. The  
22 Palmrose and Par-Tee samples contained small amounts of sea otter exhibiting carnivore  
23 tooth punctures and gnawing, ~1.4% and ~3.7%, respectively (likely an undercount as  
24 other taphonomic signatures made toothmarks or gnawing difficult to identify). It is

1 unknown if domestic dogs were living at these sites, but Colten (2015, 262) reported  
2 “canids” at Par-Tee (NISP=18, MNI=1) and a notable number at Palmrose (NISP=93,  
3 MNI=2). Other carnivores are poorly represented in the Palmrose sample: racoon  
4 (*Procyon lotor*; NISP=1), black bear (*Ursus americanus*; NISP=3), and unidentified  
5 carnivora (NISP=21) (Colten 2015, 262; Greenspan and Crockford 1992, 128). Par-Tee  
6 units containing gnawed elements are dispersed across the site, but at Palmrose,  
7 excavation units containing gnawed elements are primarily located in or adjacent to the  
8 house feature (within ~3m) with a concentration to the east of the north house wall  
9 (Figure 8).

10         According to the ethnographic record, Tillamook dogs were trained to help in  
11 game drives (Sauter and Johnson 1974, 80) and skilled dogs were called “elk charmers,”  
12 capable of charming an elk to stand still (Jacobs 2003, 75). Dogs were also human  
13 companions, and possibly “sanitation workers,” eating trash and refuse (Mack 2015, 65–  
14 66). Chinook dogs were reportedly allowed indoors (Ray 1938, 7:117). Boas (1898, 30)  
15 recorded a Tillamook story in which men shoot a sea otter and arrive at a village where  
16 the chief accuses them of shooting his dog which he had “sent across the sea to hunt elk.”  
17 This story affirms Tillamook dogs as hunting partners and also presents an intriguing  
18 juxtaposition of sea otters and dogs. If dogs were important hunting partners and  
19 companions precontact, perhaps marine mammals (including sea otters) were hunted,  
20 processed for human use and leftover meat and/or bones given to the dogs. If dogs were  
21 indeed living indoors, this may explain the presence of gnawed sea otter specimens  
22 within and adjacent to the Palmrose house feature.

23



1  
 2 Figure 8. Palmrose excavation units (orange) containing gnawed sea otter elements in  
 3 relation to house feature (shaded outline). Map adapted from Connolly (1992).  
 4

5           Archaeological domestic dogs in coastal Oregon have not been extensively  
 6 studied, but dogs are documented at the lower Columbia River site of Cathlapotle  
 7 (45CL1) where they were selectively fed a diet of marine resources, potentially eulachon  
 8 and other fish (Ames et al. 2015). Domestic dogs are also documented further north, such  
 9 as the prized wool dogs of the Salish Sea region (McKechnie, Moss, and Crockford  
 10 2020). At Namu in British Columbia dogs also had a diet dominant in marine resources  
 11 (Cannon, Schwarcz, and Knyf 1999). Further south, dogs in a Chumash site in the  
 12 Channel Islands ate primarily marine food items compared to the generalized diet of the  
 13 endemic carnivore in the area: the island fox (Rick et al. 2011).

14           While speculative, the juxtaposition of sea otters and dogs in the Tillamook tale is  
 15 interesting, and while gnawing percentages are low overall, the proximity of gnawed sea  
 16 otter remains to human living areas suggest studies of coastal Oregon domesticated dogs  
 17 represent a rich avenue for future research. Future ancient DNA and isotopic analyses  
 18 should clarify whether the canids at Palmrose were indeed domesticated, and whether  
 19 their diet reflected the diversity of both marine and terrestrial food items found at the site,  
 20 or if the dogs were intentionally provisioned marine foods like at Cathlapotle and other  
 21 Northwest Coast sites.

22

23 *Human-Sea Otter Relationships*

1 Anthropologists have criticized the tendency to consider animals passive actors, relegated  
2 to fulfilling functional roles as sources of subsistence, prestige, and/or symbolic values  
3 (Noske 1993; Shanklin 1985). In the case of fur-bearing mammals such as sea otters, this  
4 functional value is usually a source of pelts and furs (Overton 2016). While by no means  
5 comprehensive, select Chinook and Tillamook ethnographies and legends referenced  
6 below are indicative of human-sea otter relationships beyond an economic function. Sea  
7 otter pelts were powerful and associated with wealth, but sea otters were also considered  
8 non-human persons, inter-married with humans, and in at least one story transformed into  
9 a human or vice versa. The persistence of these relationships in stories illustrates their  
10 significance from time immemorial through the present, and demonstrates the unique  
11 character of Oregon Coast Native Americans' relationships with sea otters.

12 In the tale "The Round Trip of Ice" a human female takes sea otter form (or vice  
13 versa) and evades hunting (Pearson 1990, 3). Otters (sea, river, or undifferentiated) had  
14 associations with shamans. Bags made of sea otter skin held a shaman's spirit powers  
15 (Sauter and Johnson 1974, 120) which were extremely powerful (Boas 1898, 33). The  
16 Southwest Wind had a quiver made of otter skin (Sauter and Johnson 1974, 120, 125).  
17 George Wasson of the Coquille tribe recounted a story of a woman who married a sea  
18 otter. She and her husband sent a beached whale ashore each year as a gift to her family,  
19 explaining "the special meaning of a beached whale" and accounting "for why the Coos  
20 and Coquille would not hunt sea otters" (Moss and Wasson 1998, 189; Toelken and  
21 Wasson 1998, 189). Sea otter pelts were deeply associated with wealth, and worn by  
22 those of high or noble status (Ray 1938; Lewis and Clark 2005). In the story "Moon's  
23 Winter Dance" told by Clara Pearson, the high status Moon hosts a dance to which  
24 "Every kind of person came by himself" (Pearson 1990, 150). Guests like Bracelets,  
25 Dentalium, and "Those Tanned Sea Otter Hides that only very wealthy people wear  
26 came" (Pearson 1990, 150).

27 Forepaw bones and caudal vertebrae are underrepresented in the Palmrose and  
28 Par-Tee samples, possibly a result of forepaws and tails being removed with pelts (Val  
29 and Mallye 2011). Slade et al. (2021, 2) note that sea otter pelts were "curated,  
30 accumulated, and handed down across generations" following ethnographic descriptions  
31 of First Nations in British Columbia. If forepaws and tails were removed with pelts at

1 Palmrose and Par-Tee, the persistent under-representation of these elements throughout  
2 the midden samples may be an archaeological indication that such pelt curation (and  
3 concern with passing down pelts as status/wealth) was occurring prior to Euro-American  
4 arrival on the Oregon coast, and should be considered in future zooarchaeological  
5 analyses.

6 In terms of ecological relationships, sea otters may have been a competitor for  
7 human resources on the Oregon coast prior to their extirpation. While sea otters were  
8 hunted primarily for their pelts, an additional benefit may have been managing sea otter  
9 populations to prevent over-consumption of invertebrate prey also harvested by humans,  
10 such as clams, mussels, and sea urchins. The question of balance between sea otters,  
11 shellfish, and humans has been evaluated in the archaeological record of other regions of  
12 the Pacific Coast (Erlandson et al. 2008; McKechnie and Wigen 2011; Salomon et al.  
13 2015; Slade, McKechnie, and Salomon 2021; Szpak et al. 2012) and maintaining this  
14 balance remains a concern for Indigenous peoples who share coastal landscapes with sea  
15 otters today (Burt et al. 2020; Ibarra 2021; Moss 2020; Salomon et al. 2018).

16

## 17 **Conclusion**

18 The archaeological remains of sea otters from the Palmrose and Par-Tee sites, coupled  
19 with available ethnographic evidence, demonstrates a human-sea otter relationship on the  
20 Oregon Coast before and after contact with Euro-Americans. The Indigenous inhabitants  
21 of the Palmrose and Par-Tee sites, the ancestors of tribal members living today, hunted  
22 sea otters for their pelts. They may also have processed sea otters to remove meat for  
23 dietary consumption by humans, to obtain raw materials like bone or sinew, and feed  
24 domestic dogs. The ethnographic record is contradictory regarding the dietary role of sea  
25 otters in precontact Oregon. Zooarchaeological evaluation in this study using element  
26 representation, cutmark frequency, and a meat utility model was ambiguous, but the hip  
27 joint and axial skeleton were the most likely to have been processed for meat. Sea otter  
28 meat consumption was probably opportunistic relative to other high value prey found in  
29 the assemblages like whale, salmon, sea lion, and elk (Colten 2015).

30 Future zooarchaeological work should include regular and consistent cutmark  
31 analyses of archaeological fur-bearing mammal remains to facilitate cross-temporal and

1 geographic comparisons. To my knowledge, Lyman's (1991) study is the only prior  
2 Oregon zooarchaeological analysis describing detailed sea otter cutmark patterns.  
3 Precontact sea otter use may differ between societies, and descriptions of cutmark  
4 patterns from different regions of the Oregon coast would greatly improve overall  
5 understanding of sea otter use. It may also be helpful to revisit Lyman's (1991) and  
6 Moss's (2020) studies and evaluate their data with the meat utility model to see if highly  
7 ranked elements are better represented or more frequently cutmarked than in the  
8 Palmrose and Par-Tee samples. An experimental butchery study of a sea otter would also  
9 help to determine patterns resulting from skinning versus meat removal.

10         It is important to remember that sea otters fulfilled roles beyond the economic and  
11 utilitarian provisioning of fur and other resources. Sea otters were sometimes regarded as  
12 non-human persons inhabiting a shared landscape alongside Oregon Coast Native  
13 Americans, and/or as beings whose power was reflected by or embodied in their pelts.  
14 The deep-time data presented here affirm tribal assertions that the reintroduction of sea  
15 otters to Oregon would be a rekindling of a long human-animal relationship disrupted by  
16 colonial incursion and ecological exploitation by Euro-Americans. Future  
17 zooarchaeological work should strive to fully explore human-marine mammal  
18 relationships in the coastal archaeological record with special consideration for socio-  
19 ecological applications regarding ecological sovereignty, navigating conservation  
20 challenges, and understanding human-marine mammal relationships in the present.

21

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## Appendix A: Supplementary Information for

Fur or food? Ancestral tribal use of sea otters (*Enhydra lutris*) on the Oregon coast prior to European contact and extirpation.

Hannah P. Wellman\*

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## Archaeological Materials

The sea otters analyzed in this study 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 study and are located in northern Oregon, roughly 15 miles south of the mouth of the Columbia River (Figure 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).

The sites were excavated by Robert Drucker and George Phebus and their volunteers in 5 × 5 foot units in arbitrary one-foot levels (they did not use the metric system). All sediments were screened over 1/4-inch mesh (Phebus and Drucker 1979). Unit depths varied, reaching up to six feet in some places. Phebus and Drucker sampled approximately 550 m<sup>2</sup> 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 Čixwicən (Butler et al. 2019).

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, Connolly, and Jenkins 2011; Arbolino, Ousley, and Bubniak-Jones 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 (Boas 1894; Deur 2016; 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). A repatriation report compiled by the Smithsonian Institution National Museum of Natural History (NMNH) determined Par-Tee was culturally affiliated with Tillamook descendants, and Palmrose with Tillamook and Clatsop descendants (Arbolino, Ousley, and Bubniak-Jones 2005).

1           The Par-Tee site assemblage is curated at the NMNH in Washington, D.C. The  
2 Palmrose assemblage is split between the NMNH and the Museum of Natural and  
3 Cultural History (MNCH) at the University of Oregon (UO) in Eugene. Par-Tee and  
4 Palmrose both contain enormous quantities of well-preserved faunal remains, and while  
5 research on these assemblages has occurred during the last two decades (Colten 2002;  
6 2015; Loiselle 2020; Losey and Power 2005; Losey and Yang 2007; Sanchez 2014;  
7 Sanchez et al. 2016; 2018; Sanchez, Gobalet, and Rick 2020; Wellman et al. 2017;  
8 Wellman 2018; Wellman et al. 2020) much remains to be analyzed. Publications to date  
9 include a brief excavation report (Phebus and Drucker 1979), analysis of a subsample of  
10 faunal remains (Colten 2002; 2015), analyses of shellfish and fish remains (Losey and  
11 Power 2005; Sanchez, Gobalet, and Rick 2020), and AMS dating analyses summarized in  
12 Table A.1 (Sanchez et al. 2016; 2018; Sanchez 2021). Connolly et al. (1992) revisited the  
13 Palmrose site in 1988 for limited excavations and reported additional faunal remains,  
14 artifacts, and studied the ancient geomorphology. Additional site notes and records are  
15 available in the archives at NMNH and MNCH.

16

17 **Table A.1.** Published AMS dates referenced in this paper.

<b>Publication</b>	<b>Sample Type</b>	<b>Calibrated Date (cal BC/AD)</b>	<b>cal BP</b>
Sanchez et al. 2016	Bone	cal AD 430-550	1520-1400 cal BP
Sanchez et al. 2018	Bone	cal AD 100-800	1850 BP-1150 BP
Sanchez 2021	Bone	Initial Occupation: 345-55 cal BC Terminal Occupation: cal AD 225-340	Initial: 2295-2005 cal BP Terminal: 1725-1610 cal BP

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## **Zooarchaeological Analysis Results**

21

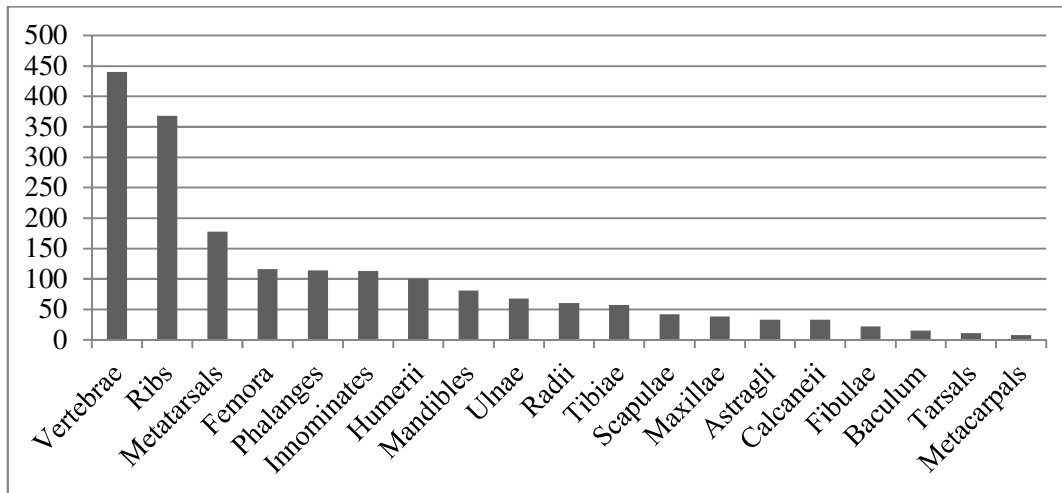
### **Par-Tee Sea Otter Remains**

#### NISP and MNI

24 Sixty three Par-Tee excavation units yielded a sample size of 2024 NISP and 54 MNI  
25 (calculated using right femora: 30 adults and 24 juveniles). Vertebrae, ribs, metatarsals,

1 femora, phalanges, innominates, and humerii are the seven most abundant elements in the  
2 sample (Figure A.1).

3



4

5

**Figure A.1.** NISP of sea otter elements in the Par-Tee sample.

6

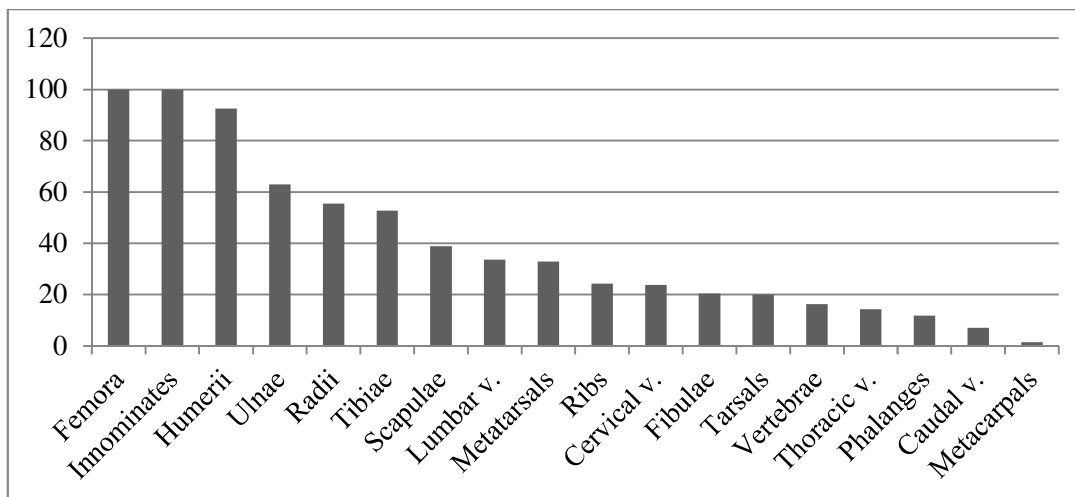
7 Vertebrae are represented primarily by the robust centra and are easily identified. Only 39  
8 complete ribs were found in this analysis, but the majority of fragments included the  
9 diagnostic proximal end. The sample is not dominated by small rib fragments, possibly  
10 due to lack of recovery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

1 roughly equal representation of maxillary and mandibular teeth suggests that regardless  
2 of preservation, the cranium was processed and deposited.

3

#### 4 Element Representation

5 While axial and hindfoot elements exhibit high NISP counts, these elements are  
6 underrepresented if we consider the remains of 54 complete sea otter carcasses (assuming  
7 complete preservation). With 54 MNI, the sample should hypothetically contain 2700  
8 vertebrae, 1512 ribs, 540 metatarsals, and 972 phalanges, but 16% (N=440), 24%  
9 (N=368), 33% (N=178), and 12% (N=114) of the expected totals are present, respectively  
10 (Figure A.2). When vertebrae are reported by type, the sample contains 34% of the  
11 expected totals of lumbar, 24% of cervical, 14% of thoracic, and 7% of caudal vertebrae.  
12



13

14 **Figure A.2.** Percent of sea otter elements expected in the Par-Tee sample, based on 54  
15 MNI.

16

17 Femora, innominates, and humerii are present in quantities over or close to expected  
18 totals (although due to fragmentation, especially of innominates, the actual percentage is  
19 likely below 100%; Figure A.2). Ulnae, radii, and tibiae occur at 55%-60% of the  
20 expected frequencies; these percentages may also be lower due to fragmentation.

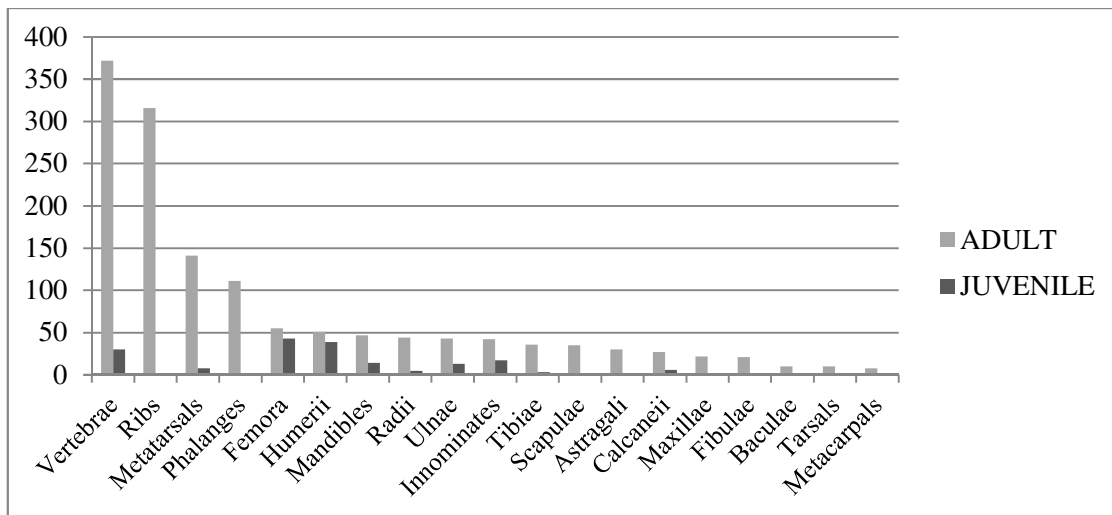
21 Forefoot elements are extremely underrepresented in the Par-Tee sample: only 1% of  
22 expected metacarpal totals are present (Figure A.2), and carpals/manus phalanges are  
23 absent.

24

1 Juveniles at Par-Tee

2 The Par-Tee sample contains a NISP of 240 juvenile specimens, and an MNI of 24  
3 (calculated using right femora). Juvenile femora, humerii, innominates, ulnae, and  
4 mandibles are most abundant (Figure A.3).

5



6

7 **Figure A.3.** Adult and juvenile sea otter element abundance (NISP) in the Par-Tee  
8 sample.

9

10 Determining ages of partial sea otter remains is difficult. I used the broad term “juvenile”  
11 to categorize elements missing one or both epiphyses, or in the case of the innominate,  
12 lacking fusion through the acetabulum. Using age criteria described in Nicholson et al.  
13 (2020), I determined age ranges for mandibles and maxillae: fourteen sea otters are aged  
14  $\leq 2$  months old and eleven sea otters are aged  $\leq 6.5$  months old (Nicholson et al. 2020).  
15 Because the mandibles/ maxillae are fragmented and teeth are often missing, absolute  
16 ages could not be determined. These estimates are primarily limited to those based on the  
17 presence/absence of the lower deciduous premolars ( $pm_3/pm_4$ )/permanent molars  
18 ( $M_1/M_2$ ) and upper 1<sup>st</sup> deciduous premolar ( $pm^4$ )/permanent molar ( $M^1$ ). The majority of  
19 sea otter elements in the Par-Tee sample are fused or show adult dentition (Nicholson et  
20 al. 2020).

21 It is interesting to have so many juveniles in the sample and the age estimates  
22 (albeit approximate ranges) are informative. Sea otter pups are weaned on average at 6  
23 months of age (Thometz et al. 2016), so the 2-6.5 month old pups in this sample would

1 have been with or nearby their mothers and possibly hunted in association with the adult  
2 females.

3

#### 4 Gnawing

5 The Par-Tee sample contains 27 specimens that exhibit carnivore tooth punctures and  
6 gnawing: one femur, one innominate, one humerus, five metatarsals, two phalanges, one  
7 rib, one sternabra, four tibiae, three ulnae, and seven vertebrae. This is likely an  
8 undercount, as other taphonomic signatures (wear/erosion/breakages) made toothmarks  
9 or gnawing difficult to identify. I noted several repeated irregular erosion patterns that,  
10 upon reflection, may have been gnawing. For example, I noted “divets” on the palmar  
11 and plantar surfaces of some distal metatarsals, as though they were ground between two  
12 canine teeth.

13

#### 14 Pathology

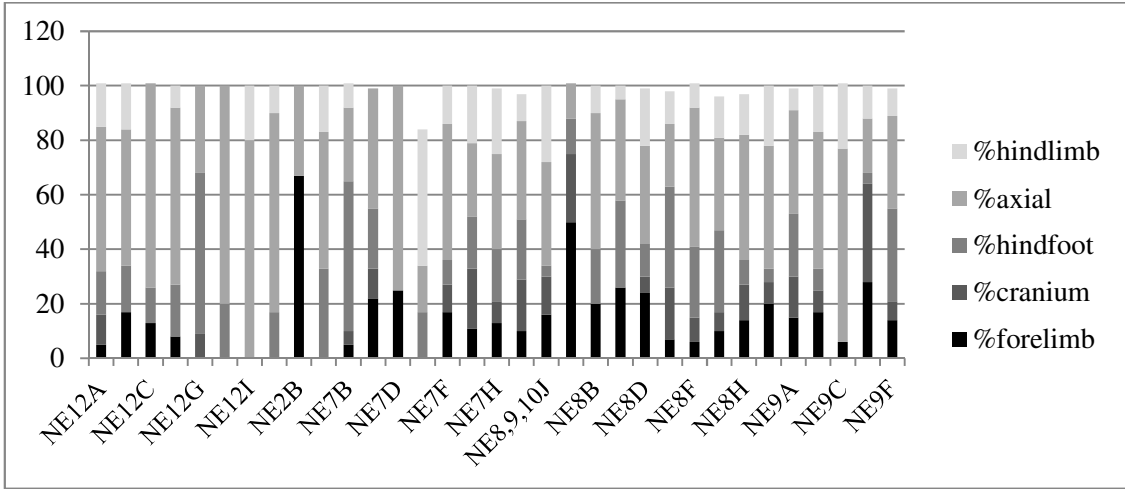
15 The Par-Tee sample contained 34 specimens exhibiting pathologies: 11 vertebrae, a tibia,  
16 and a femur exhibit signs of arthritis. Five metatarsals, six phalanges, one sternabrae,  
17 three ribs, two tibiae, one radius, and one calcaneus show signs of active or healed  
18 infection. An additional radius is badly misshapen, but the cause is unclear.

19

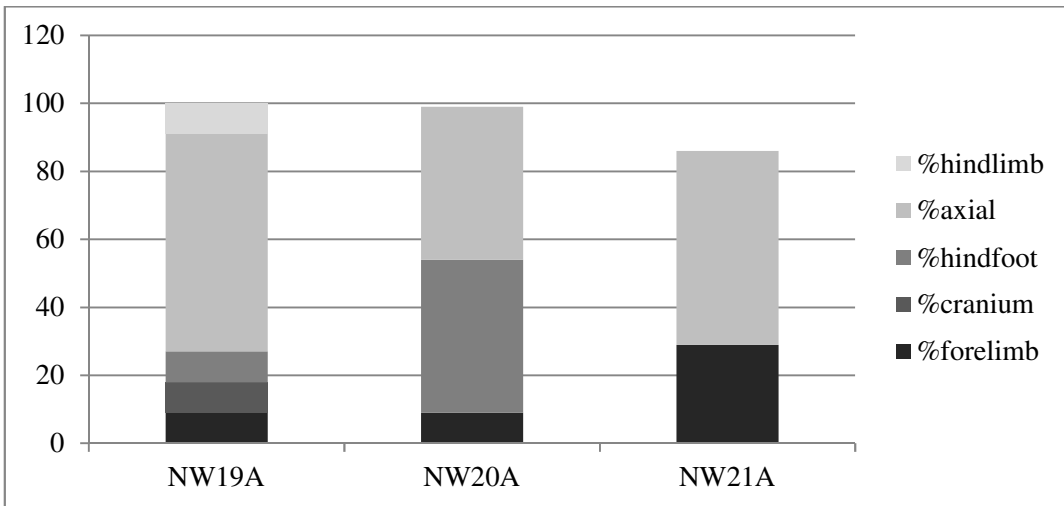
#### 20 Element Representation: Spatial Distribution

21 In order to identify any spatial patterning in skeletal element representation, I re-  
22 categorized elements based on their broader anatomical unit: cranium (teeth, mandibles,  
23 maxillae), the axial skeleton (vertebrae, sacra, ribs, sterna/sternabrae), hindlimb  
24 (innominates, femora, tibiae, fibulae), forelimb (scapulae, humerii, radii, ulnae), hindfoot  
25 (tarsals, metatarsals, pes phalanges) or forefoot (carpals, metacarpals, manus phalanges).  
26 I tallied the % NISP for each anatomical category within each excavation unit (Figures  
27 S4-7).

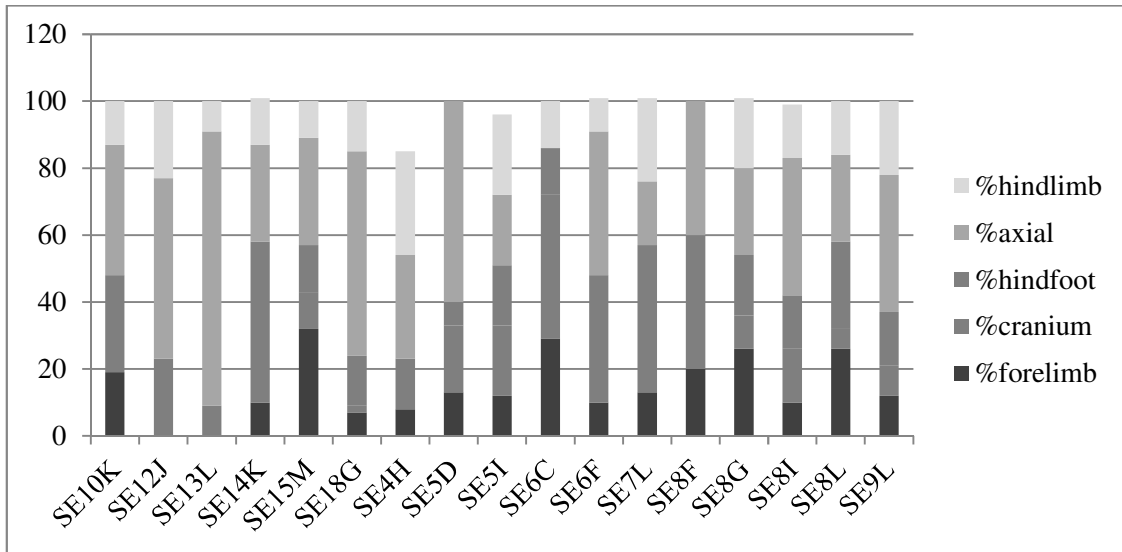
28



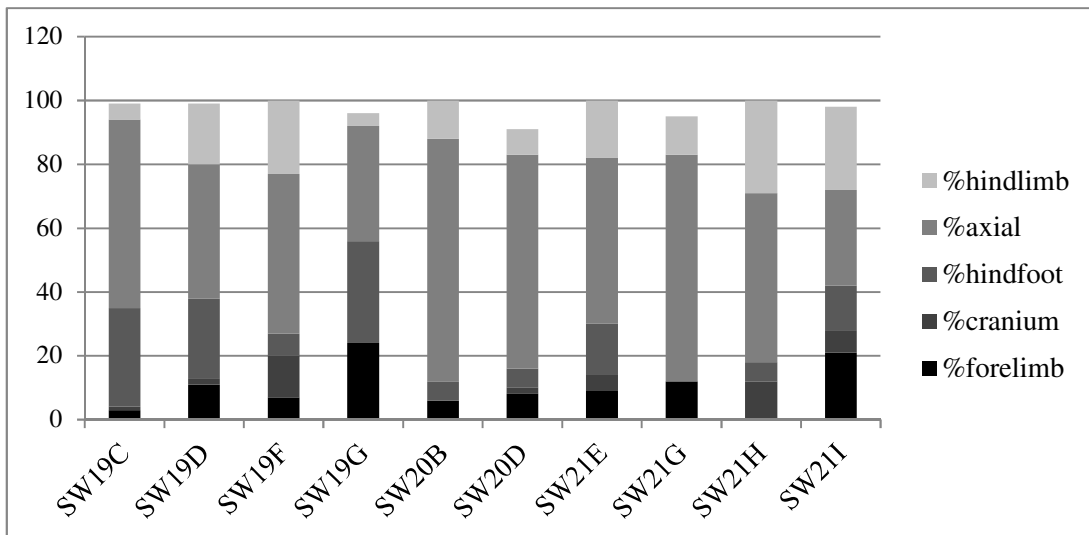
1  
2 **Figure A.4.** Proportions of sea otter anatomical unit in the excavation units of the  
3 northeast quadrant of the Par-Tee site.  
4  
5



6  
7 **Figure A.5.** Proportions of sea otter anatomical unit in the excavation units of the  
8 northwest quadrant of the Par-Tee site.  
9  
10  
11



1  
2 **Figure A.6.** Proportions of sea otter anatomical unit in the excavation units of the  
3 southeast quadrant of the Par-Tee site.  
4



5  
6 **Figure A.7.** Proportions of sea otter anatomical unit in the excavation units of the  
7 southwest quadrant of the Par-Tee site.  
8

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

12 At Par-Tee, vertebrae and ribs are the two most abundant elements by NISP, and  
13 all units except one (SE6C,  $NISP=7$ ) contain axial elements. Axial elements also make up  
14 a large portion of the unit NISP (almost half of units contain at least 50% or greater axial



1 elements). Several units deviate from the majority axial component, although this is also  
2 attributable to small sample size (e.g., units NW20A, NW21A, NE2B). Unit NE2B  
3 (NISP=3), for example, contains two humeri (right and left) and a rib fragment, skewing  
4 the forelimb representation for the unit.

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

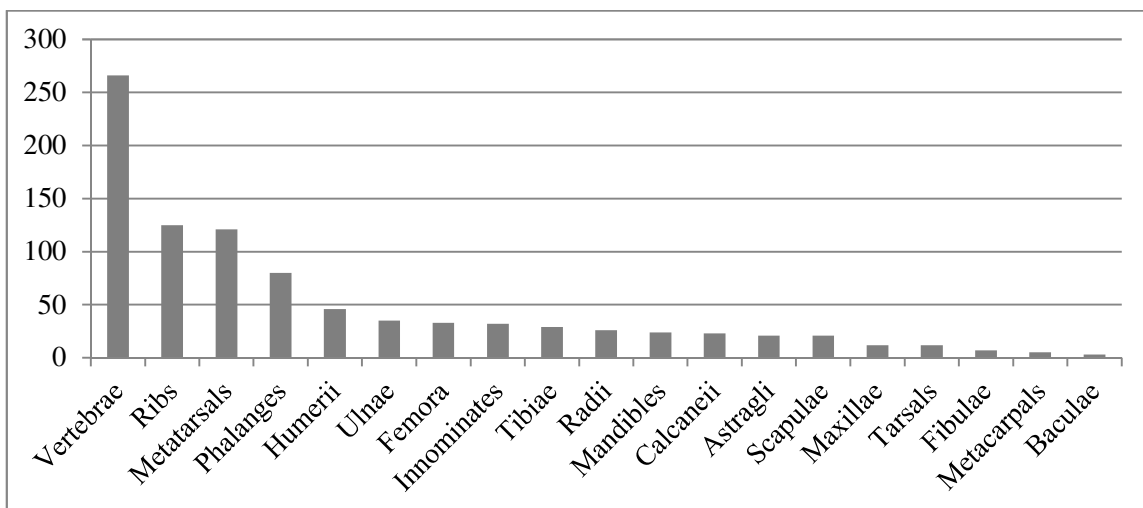
13

#### 14 **Palmrose Sea Otter Remains**

##### 15 NISP and MNI

16 Thirty four excavation units from the Palmrose site yielded a 968 NISP and 22 MNI  
17 (calculated using right humeri [15 adults and 7 juveniles]). Vertebrae, ribs, metatarsals,  
18 phalanges, and humeri are the most abundant elements (Figure A.8).

19



20

21

22

**Figure A.8.** NISP of sea otter elements in the Palmrose sample.

1 Vertebrae are represented primarily by the robust centra and are easily identified. Only  
2 nine complete ribs are found in this analysis, but the majority of fragments included the  
3 diagnostic proximal end. The sample is not dominated by small rib fragments, possibly  
4 due to lack of recovery during excavation or difficulty identifying small, undiagnostic  
5 fragments. Regardless, fragmentation does not appear to be driving abundance of the  
6 vertebrae and ribs in the sample. Approximately 42% of metatarsals are complete, and  
7 the remainder are primarily undiagnostic distal ends. Pes phalanges are largely complete.  
8 Large proportions of femora (~74%) and humerii (~65%) are complete, as are roughly  
9 ~50% of tibiae, ulnae, and radii. Innominates are heavily fragmented and are likely  
10 driving this abundance. Fibulae (which are long and extremely thin) are represented by  
11 the robust medial malleolus and varying intact diaphysis. Similarly, the scapulae are  
12 represented by the robust proximal articular ends. Crania fragments other than maxillae  
13 are not present. The maxillae are fragmented and underrepresented (N=14) compared to  
14 mandibles (N=29), but eight left upper M<sup>1</sup>s and 13 right lower M<sup>1</sup>s were reported in a  
15 previous analysis of all sea otter teeth in the assemblage (Wellman 2018: Table S1). The  
16 roughly equal representation of maxillary and mandibular teeth suggests that regardless  
17 of preservation, the cranium was processed and deposited.

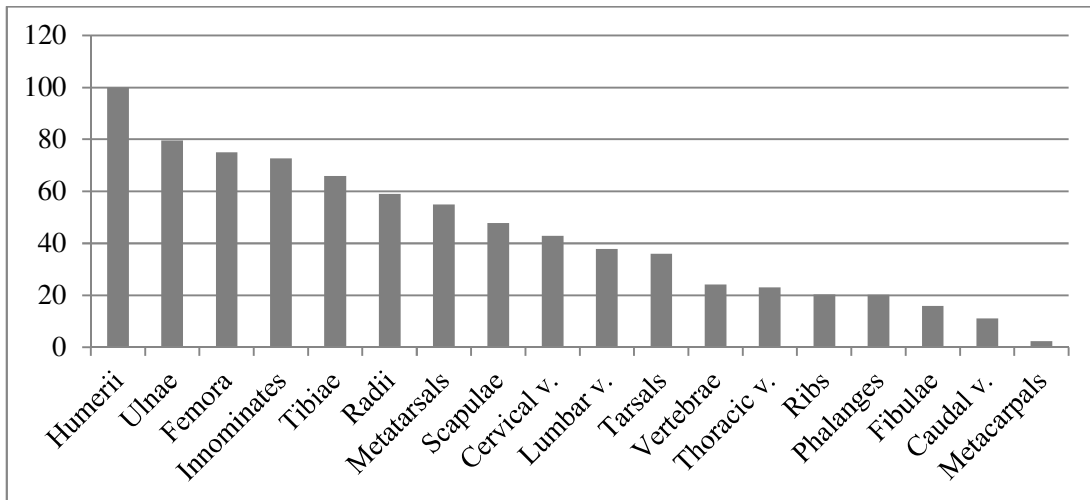
18

### 19 Element Representation

20 While axial and hindfoot elements represent high NISP counts, these elements are  
21 underrepresented as at Par-Tee. With 22 MNI, the sample should hypothetically contain  
22 1100 vertebrae, 616 ribs, 220 metatarsals, and 396 phalanges, but 24% (N=266), 20%  
23 (N=125), 55% (N=121), and 20% (N=80) of the expected frequencies are present,  
24 respectively (and these totals include fragmented/incomplete elements) (Figure A.9).  
25 When vertebrae are reported by type the sample contains 38% of lumbar, 43% of  
26 cervical, 23% of thoracic, and 11% of caudal vertebrae expected totals. Humerii and  
27 ulnae are present in quantities over or close to expected totals (although due to  
28 fragmentation the actual percentages are likely lower; Figure A.9). Femora, innominates,  
29 tibiae, and radii are represented by ~60%-75% of expected totals; these percentages may  
30 also be lower due to fragmentation. Forefoot elements are extremely underrepresented in

1 the Palmrose sample as at Par-Tee; only 2% of expected metacarpal totals are present  
2 (Figure A.9), and carpals/manus phalanges are absent.

3



4

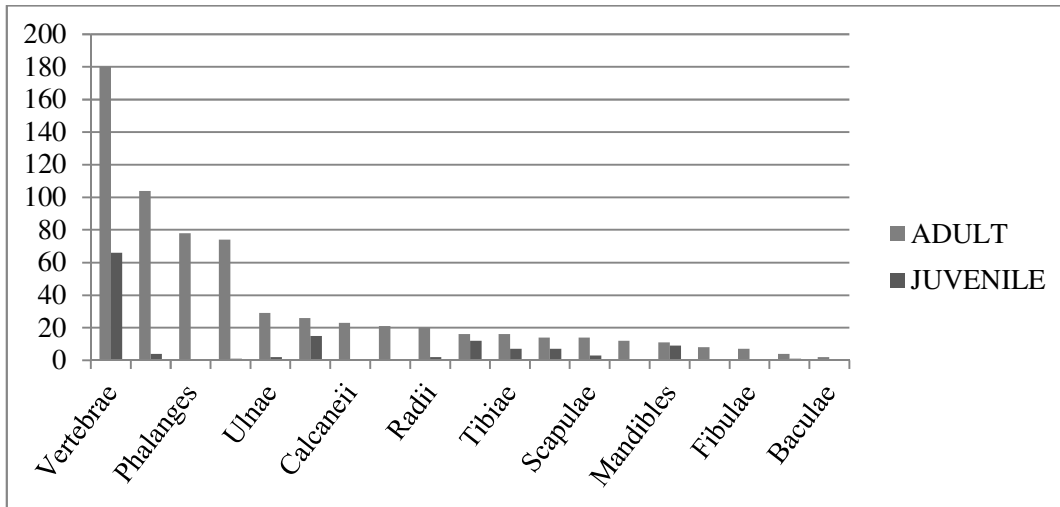
5 **Figure A.9.** Percent of sea otter elements expected in the Palmrose sample, based on 22  
6 MNI.

7

#### 8 Juveniles at Palmrose

9 The Palmrose sample contains an NISP of 138 juveniles and an MNI of seven (calculated  
10 using right humerii). Vertebrae, humerii, femora, and mandibles are the most abundant  
11 juvenile remains (Figure A.10). There are no juvenile maxillae fragments, but five sea  
12 otter mandibles are aged  $\leq 2$  months old and seven are aged  $\leq 6.5$  months old (Nicholson  
13 et al. 2020). As at Par-Tee, juveniles are distributed throughout the site and co-occur with  
14 adults, and the pups represented by mandibles are under or at weaning age (Thometz et  
15 al. 2016).

16



1  
2 **Figure A.10.** Adult and juvenile sea otter element abundance (NISP) in the Palmrose  
3 sample.

4  
5 Gnawing

6 The Palmrose sample contains 35 specimens exhibiting carnivore tooth punctures or  
7 gnawing: one baculum, three femora, seven metatarsals, two phalanges, two radii, four  
8 ribs, one scapula, five tibiae, one ulna, and nine vertebrae. This is likely an undercount  
9 for the reasons described with regards to the Par-Tee assemblage. Gnawed elements are  
10 distributed throughout the site, including units within or in proximity to the house feature.

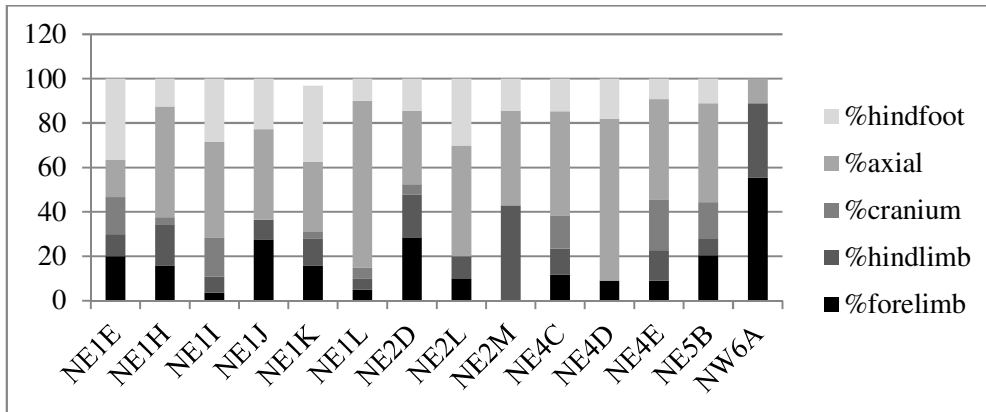
11  
12 Pathology

13 The Palmrose sample contains 19 specimens exhibiting pathologies: 12 elements exhibit  
14 signs of arthritis, while two metatarsals, two phalanges, one metacarpal, one rib, and one  
15 fibula appear to show signs of active or healed infection.

16  
17 Element Representation: Spatial Distribution

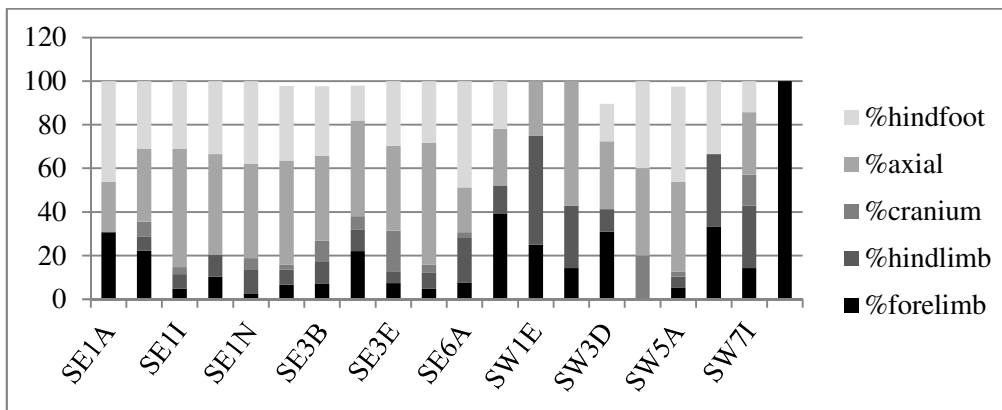
18 As at Par-Tee, axial elements are present in the majority of units (except for SW8L and  
19 SW6D), and make up large proportions of the unit NISP (Figures S11-12).

20



1  
2 **Figure A.11.** Proportions of sea otter anatomical unit in excavation units of the NE and  
3 NW quadrants at Palmrose.

4



5  
6 **Figure A.12.** Proportions of sea otter anatomical unit in excavation units of the SE and  
7 SW quadrants at Palmrose.

8

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

1 sea otter body were being processed and deposited in units across the site, with  
2 occasional exceptions.

3

4

## Cutmark Descriptions

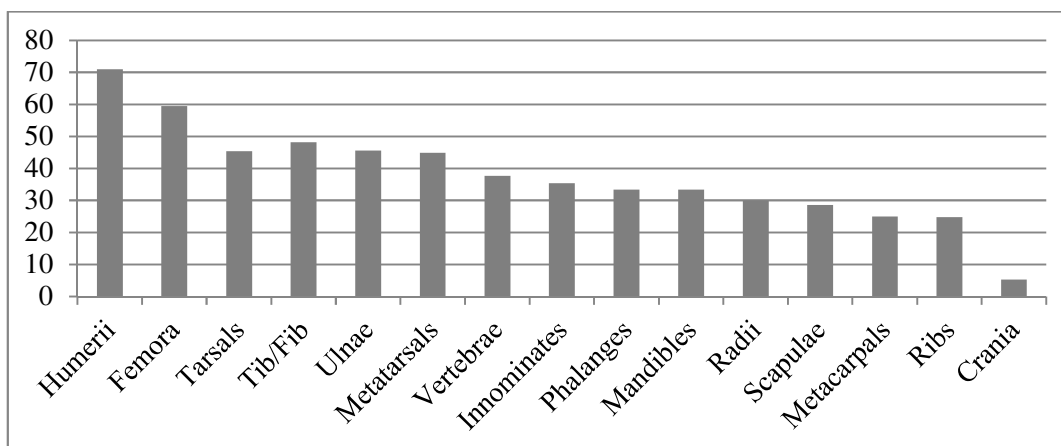
5

### 6 **Cutmarks at Par-Tee**

#### 7 Cutmark Sample

8 The Par-Tee sample contained 739 cutmarked specimens (37% of the overall NISP); 28%  
9 of juvenile specimens and 38% of adult specimens are cutmarked. The only element that  
10 does not exhibit any cut marks is the axis vertebra (C2). Twenty different elements are  
11 cutmarked: bacula, maxillae fragments (included in Figure A.13 as “crania”), patellae,  
12 phalanges, sterna/sternabrae, and sacrum fragments. There is an average of five cutmarks  
13 per specimen, and the highest average for a specific element is the average eight  
14 cutmarks per femur.

15



16

17 **Figure A.13.** Abundance (% NISP) of cutmarked sea otter elements in the Par-Tee  
18 sample.

19

#### 20 Cutmarks on the Axial Skeleton

21 Sterna and sternabrae at Par-Tee exhibit small nicks, which may be indicative of skinning  
22 and working the pelt away from the ribcage or vertebral column (Moss 2020, 212; Val  
23 and Mallye 2011). At Par-Tee roughly half of ribs exhibit cutmarks on the shaft; the other  
24 half exhibit cutmarks on the head and/or neck. Cutmarks on the rib shaft may result from

1 peeling the pelt away from the rib cage or stripping thoracic muscles. The rib head/neck  
2 cutmarks may reflect skinning or removing ribs from vertebrae. Vertebrae are cutmarked  
3 on processes or on the ventral centrum. Cutmarks to spinous processes may be the result  
4 of backstrap muscle removal (Figure A.14), while ventral cutmarks may be from rib  
5 removal or gutting the animal (Moss 2020, 215). The majority of vertebrae cutmarks at  
6 Par-Tee are located on the ventral centrum (Figure A.15). Moss (2020, 215) described a  
7 similar pattern in her data and suggested vertebrae cutmarks reflected butchering of the  
8 axial skeleton to obtain backstrap for either human or dog consumption. Pulling the pelt  
9 from the vertebral column would not make cutmarks through the backstrap to the spinous  
10 process, nor would skinning explain the ventral vertebral cutmarks (Val and Mallye 2011,  
11 236).

12



13  
14 **Figure A.14.** A thoracic vertebra cutmarked at the base of the spinous process, possibly  
15 indicative of backstrap removal (scale in cm; Palmrose unit SE4D-3).

16



17  
18 **Figure A.15.** A lumbar vertebra cutmarked on the ventral centrum (scale in cm; Palmrose  
19 unit SE3B-4).

20

1 Cutmarks on the Forelimb

2 Scapulae at Par-Tee are cutmarked on the ventral blade surface at the edges of the  
3 subscapular fossa (origin of the subscapularis muscle) (Figure A.16). The cutmarks may  
4 have resulted from working under the scapula to separate it from the rib cage; cutmarks  
5 underneath the scapula are unlikely to result from skinning. Several humerii are  
6 cutmarked near the lesser tuberosity (insertion of the subscapularis). Taken together,  
7 these cutmarks may reflect efforts to sever the subscapularis and separate the humerus  
8 from the scapula. Humerii are cutmarked in various locations, particularly on or near the  
9 distal epiphyses. Multiple specimens are cutmarked above the anterior trochlea, as well as  
10 on/near the medial epicondylar ridge and foramen (Figure A.17). These cutmarks may  
11 reflect disarticulation of, or difficulty skinning around, the elbow joint.

12



13

14 **Figure A.16.** A scapula cutmarked ventrally, on the edge of the subscapular fossa (scale  
15 in cm; Palmrose unit NE4C-3).

16





1  
2 **Figure A.17.** A distal humerus cutmarked on the medial epicondylar ridge (scale in cm;  
3 Palmrose unit SE3C-5).

4  
5 Radii and ulnae are also cutmarked in various locations, particularly on the proximal end.  
6 Radii are frequently cutmarked under the radial head and along the anterior/posterior  
7 diaphysis. Ulnae are frequently cutmarked on/near the olecranon process and on the  
8 medial fossa (insertion for multiple brachialis muscles). Some ulnae specimens are  
9 cutmarked on the posterior and medial diaphyses where Howard (1973) labeled muscles  
10 absent. Both elements exhibit infrequent distal cutmarks. The ulnae/radii cutmarks may  
11 reflect skinning, especially in places where fascia are not present (Val and Mallye 2011,  
12 236). The bones of the forepaws (manus phalanges, metacarpals, and carpals) are  
13 underrepresented at Par-Tee, but several metacarpals exhibit cutmarks on the palmar  
14 surface and likely reflect skinning.

#### 15 16 Cutmarks on the Hindlimb

17 Innominates are cutmarked in various locations. Repeated locations included the  
18 iliofemoral ligament attachments and the gluteus medius, obdurator externus, and  
19 pectineus muscle origins. These muscles and ligaments insert in the proximal femur.  
20 Approximately half of cutmarked innominates exhibit cutmarks on or near the  
21 acetabulum and may reflect leverage applied to the joint while skinning as described by

1 Moss (2020, 215). Muscle and ligament attachments around the acetabulum anchor the  
2 femoral head, so these cutmarks may also reflect disarticulation.

3 Femora are cutmarked on the diaphyses and epiphyses. Cutmarks on the proximal  
4 end are at muscle insertions (e.g., the greater/lesser trochanter). Femoral necks (the  
5 location of the iliofemoral ligaments) are frequently cutmarked (Figure A.18). Distal  
6 cutmarks are frequently superior to the lateral and medial condyles (on or near the  
7 gastrocnemius origin) (Figure A.18). Three femora are cutmarked on a distal condyle,  
8 which may reflect a knife slip during disarticulation or working the pelt away from the  
9 knee joint. Tibiae are cutmarked at various locations, especially distally (Figure A.19).  
10 Approximately half of cutmarked tibiae exhibit cutmarks on or immediately around the  
11 medial malleolus. Tendons and ligaments are present on the distal tibia underneath  
12 retacula and may be severed for disarticulation or skinning (Val and Mallye 2011, 236).  
13 Fibulae are primarily cutmarked on the lateral shaft; two are cutmarked on the lateral  
14 malleolus. Cutmarks to the fibulae may be due to skinning (Moss 2020, 213; Val and  
15 Mallye 2011, 236).

16



17  
18 **Figure A.18.** A distal femur cutmarked on and around the medial gastrocnemius origin  
19 (L) and a proximal femur cutmarked on the femoral neck (R) (scales in cm; Palmrose  
20 units NE1J-3 and SE1M-3).  
21



1  
2 **Figure A.19.** A tibia cutmarked on the medio-distal aspect (scale in cm; Palmrose unit  
3 SE1N-6).

4  
5 Cutmarks on the astragalus, calcaneus, and other tarsals likely reflect skinning (Val and  
6 Mallye 2011, 230), but may also be due to disarticulation following Binford (1981). One  
7 Par-Tee calcaneus has over 15 cutmarks on the posterior surface (Figure A.20), possibly  
8 reflecting efforts to sever the calcaneal tendon or difficulty working through the pelt at  
9 the ankle joint. Cutmarks on the phalanges and metatarsals likely reflect skinning (Val  
10 and Mallye 2011).



12  
13 **Figure A.20.** Calcaneus exhibiting cutmarks on the posterior surface (scale in cm; Par-  
14 Tee unit NE8F-6).

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Cutmarks on the Cranium

Par-Tee mandibles are frequently cutmarked on the lateral or inferior horizontal ramus which reflects skinning (Val and Mallye 2011). 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.

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”)

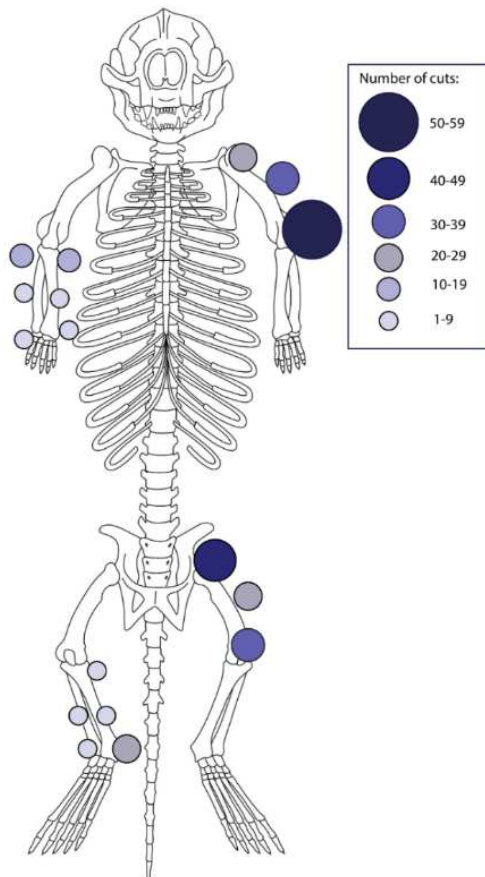
I tallied the number of specimens cutmarked at the locations described above and the total of specimens that were cutmarked in multiple locations (“Total Multi”) (Table A.2). Because the specimens analyzed were not always complete, tallying the locations of cutmarks helps account for fragmentation by providing an overall characterization of longbone locations that exhibit cutmarks (Lyman 2008, 285).

**Table A.2.** Cutmarks on Par-Tee forelimb and hindlimb longbones based on location.

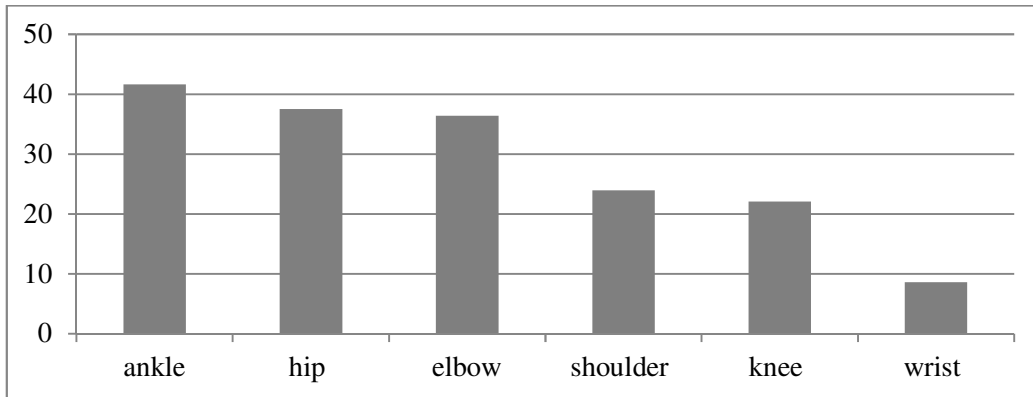
	Diaph	Prox	Dist	P D	P Di D	P Di	Di D	Total Diaph	Total Multi	%mult	%diap
Femur	10	15	10	15	8	8	3	29	34	49%	42%
Tibia	3	2	17	4	1	0	3	7	8	27%	23%
Fibula	3	0	1	0	0	0	4	4	1	50%	50%
Humerus	14	2	21	14	4	2	14	34	34	48%	48%
Radius	5	8	0	2	0	2	1	8	5	28%	44%
Ulna	6	15	7	0	1	2	0	9	33	10%	29%

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.

1 Femora and humeri are most frequently cutmarked at the proximal and distal  
 2 ends (or both). A combined 46 femora are cutmarked at the proximal end and 36 are  
 3 cutmarked distally. A total of 22 humeri are cutmarked at the proximal end and 53 are  
 4 cutmarked distally. Tibiae are cutmarked proximally (N=7) and distally (N=25).  
 5 Conversely, 12 radii are cutmarked proximally and three distally; 18 ulnae are cutmarked  
 6 proximally and eight distally. I totaled these cutmark locations and labeled a template of  
 7 sea otter skeleton with the totals(Figure A.21). These groupings suggest that the hip,  
 8 knee, elbow, and ankle joints were frequently processed relative to other joints. When the  
 9 % NISP cutmarked is calculated by major joint, the hip (38%) and elbow (36%) joints  
 10 actually rank below the ankle joint (42%) in overall processing (Figure A.22).  
 11



12  
 13 **Figure A.21.** Sea otter skeleton with total cutmarked longbone locations from the Par-  
 14 Tee sample (Table A.2). Circle size and color corresponds to number of cuts at location  
 15 (proximal, distal, diaphysis). Illustration by Keeley Davies.  
 16



1  
2 **Figure A.22.** Percent NISP of sea otter elements cutmarked in the Par-Tee sample  
3 (calculated by joint).  
4

5 Some complete individual elements provide an additional impression of cutmark  
6 intensity. For example, 15 complete femora are cutmarked at both ends and eight are  
7 cutmarked at both ends and the diaphysis; 14 complete humerii are cutmarked at both  
8 ends and 4 are cutmarked at both ends and diaphysis. Tibiae, radii, and ulnae do not  
9 follow these patterns, instead exhibiting more cutmarks at the articular ends (either  
10 distal/proximal or both).  
11

#### 12 Par-Tee Cutmark Patterns

13 The Par-Tee sample yielded a notably high overall proportion of cutmarked specimens  
14 (37%). The humerii and femora are cutmarked in multiple regions and are overall more  
15 intensively cutmarked than the tibiae, ulnae, and radii (including when calculated by  
16 percentage [% multi, Table A.2] to account for the higher NISP of femora and humerii).  
17 Femora and humerii specimens are cutmarked on the diaphysis (which may indicate  
18 muscle removal, interpreted as “filleting” by Lyman [1991]) but there are more cutmarks  
19 to the distal and/or proximal epiphyses at the hip, elbow, and ankle joints (Figure A.21).  
20 The processing on the hip and elbow joints could indicate dismemberment (Binford 1981;  
21 Lyman 1991) or skinning (Moss 2020; Val and Mallye 2011). The processing at the ankle  
22 joint could also reflect both, but the distal tibiae cutmarks correspond to the cutmark  
23 activity recorded in that location by Val and Mallye (2011). A large proportion of tarsals  
24 at Par-Tee are cutmarked, corresponding with the distal tibiae cutmarks. The distal  
25 humerii and proximal radii/ulnae exhibit more cutmarks which could reflect

1 dismemberment or skinning; Moss (2020, 212) reported the forelimbs were pulled tightly  
 2 into the body requiring extra leverage at the elbow joint during skinning. These cutmarks  
 3 could also reflect efforts to remove the lower forelimb from the humerus. The axial  
 4 skeleton is cutmarked, possibly indicating backstrap/thoracic muscle removal, and the  
 5 mandibles are cutmarked primarily in locations associated with skinning.

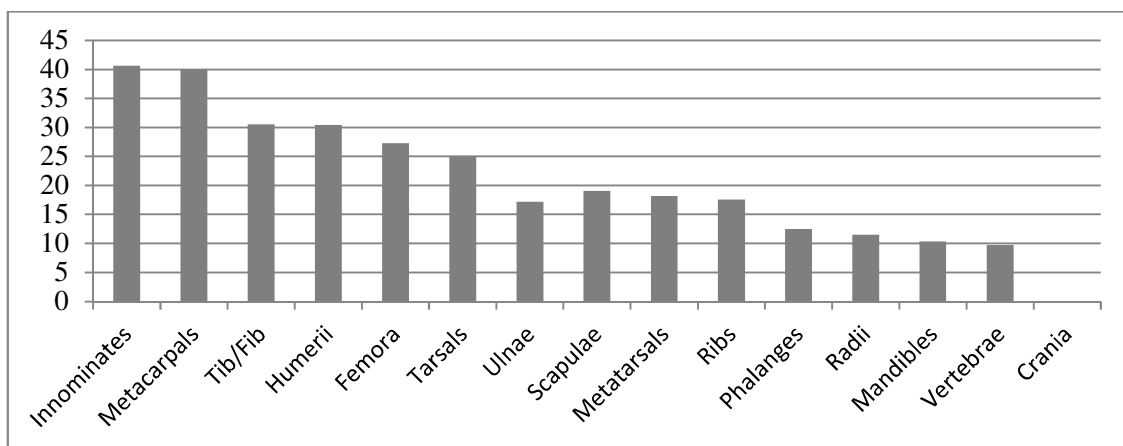
6

7 **Cutmarks at Palmrose**

8 Cutmark Sample

9 The Palmrose sample contained 160 cutmarked specimens, or 17% of the overall NISP:  
 10 11% of juvenile elements and 18% of adult elements are cutmarked. Fewer elements  
 11 (N=14) are cutmarked at Palmrose (compared to 20 at Par-Tee). There is an average of  
 12 three cutmarks per specimen in the assemblage, (lower than at Par-Tee), and the highest  
 13 average for a specific element is the average of five cutmarks per humerus, tibia, and  
 14 ulna.

15



16

17 **Figure A.23.** Abundance (% NISP) of cutmarked sea otter elements in the Palmrose  
 18 sample.

19

20 Cutmarks on the Axial Skeleton

21 Sterna and sternabrae at Palmrose are not cutmarked. Roughly ~70% of ribs exhibit  
 22 cutmarks on the shaft and ~30% exhibit cutmarks on the head and/or neck. Cutmarks on  
 23 the rib shaft may result from peeling the pelt away from the rib cage or stripping thoracic  
 24 muscles. The rib head/neck cutmarks may reflect skinning or removing ribs from

1 vertebrae. Vertebrae are cutmarked on processes or on the ventral centrum. Cutmarks to  
2 spinous processes may be the result of backstrap muscle removal, while ventral cutmarks  
3 may be from rib removal or gutting the animal (Moss 2020, 215). At Palmrose, processes  
4 and vertebral centra are cutmarked roughly equally.

5

#### 6 Cutmarks on the Forelimb

7 Scapulae at Palmrose (like Par-Tee) are cutmarked on the ventral blade surface, often on  
8 the edges of the subscapular fossa. The cutmarks may have resulted from separating the  
9 scapula from the rib cage. Humerii are cutmarked at various locations including inferior  
10 to the caput, on the lateral diaphysis, anterior trochlea, and on/near the medial  
11 epicondylar ridge and foramen. Radii are cutmarked on the diaphyses but not on  
12 epiphyses. Ulnae are cutmarked proximally, distally, and on the diaphysis in roughly  
13 equal numbers. The ulnae/radii cutmarks at Palmrose do not exhibit clear patterning like  
14 at Par-Tee. Cutmarks to the radii may reflect skinning (following Val and Mallye 2011,  
15 236), while the ulnae cutmarks may reflect skinning, filleting, or disarticulation. The  
16 bones of the forepaws (manus phalanges, metacarpals, and carpals) are underrepresented  
17 at Palmrose, but several metacarpals exhibit cutmarks on the palmar surface and likely  
18 reflect skinning.

19

#### 20 Cutmarks on the Hindlimb

21 Innominates are cutmarked in various locations. Repeated locations include those  
22 described at Par-Tee, such as the iliofemoral ligament attachments and the gluteus  
23 medius. These cutmarks could reflect leverage applied to the joint while skinning  
24 following Moss (2020), or disarticulation of the hindlimb at the hip joint. Femora are  
25 cutmarked on the diaphyses and epiphyses in roughly equal numbers. Cutmarks on the  
26 proximal end are at muscle insertions (e.g. the greater/lesser trochanter). Femoral necks  
27 (the location of the iliofemoral ligaments) are frequently cutmarked. Distal cutmarks are  
28 frequently superior to the lateral and medial condyles (on or near the gastrocnemius  
29 origin). Tibiae are cutmarked equally across diaphyses and epiphyses. One tibia is  
30 cutmarked repeatedly along the anterior crest which may reflect disarticulation or  
31 skinning following Val and Mallye (2011, 234). Distal tibiae cutmarks are on/near the



1 medial malleolus. One fibula is cutmarked proximally with small nicks, similar to Moss'  
 2 experimentally skinned sea otter. Cutmarks on the astragalus, calcaneus, and other tarsals  
 3 likely reflect skinning (Val and Mallye 2011), but may also be due to disarticulation  
 4 (Binford 1981).

5

6 Cutmarks on the Cranium

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

9

10 Cutmark Patterns on Longbones

11 I categorized longbone cutmark locations for each Palmrose specimen (Table A.3).  
 12 Unfortunately, the sample size of cutmarked elements at Palmrose is smaller than at Par-  
 13 Tee, so patterns evident in the Par-Tee sample are not as clear in the Palmrose sample.

14

15 **Table A.3.** 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%

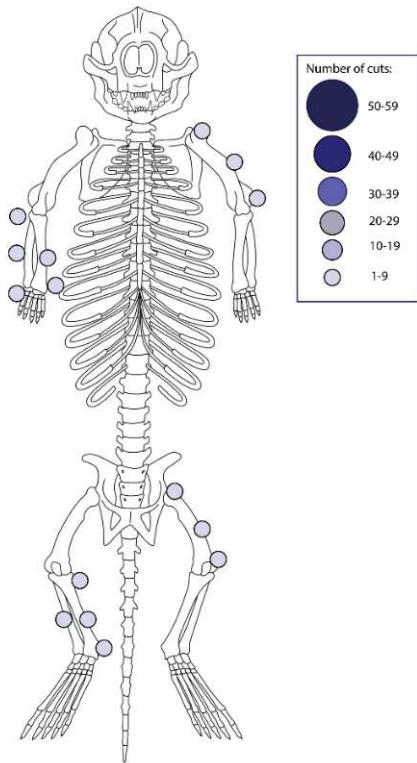
16

17

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

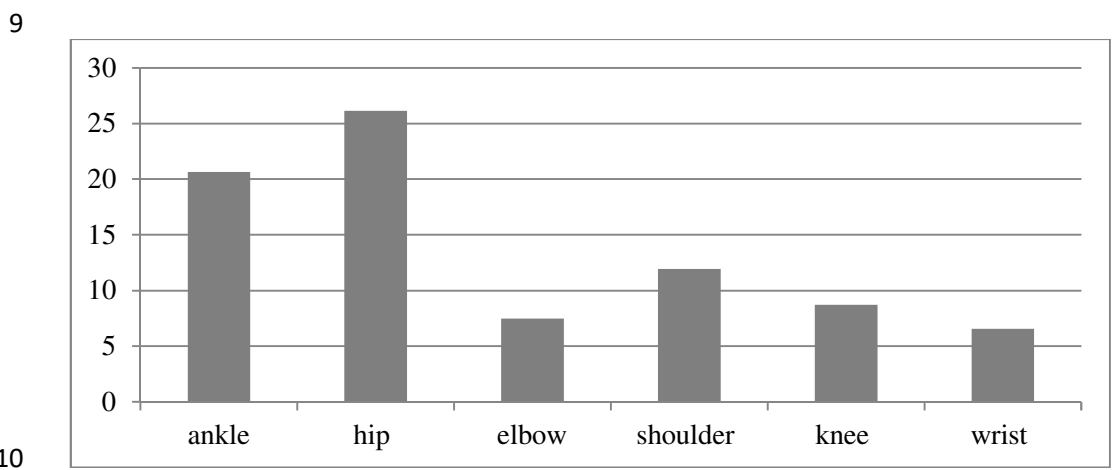
21 Distribution of cutmarked longbone locations at Palmrose is roughly equal when  
 22 visualized across the skeleton (Figure A.24), unlike the Par-Tee sample in which  
 23 proximal femora and distal humerii were more frequently processed (Figure A.21).

24



1  
 2 **Figure A.24.** Sea otter skeleton with total cutmarked longbone locations from the  
 3 Palmrose sample (Table A.3). Circle size and color corresponds to number of cuts at  
 4 location (proximal, distal, diaphysis). Illustration by Keeley Davies.

5  
 6 When the % NISP cutmarked is calculated by major joint, the hip (26%) and ankle (21%)  
 7 appear to be slightly more intensively processed compared to the shoulder (12%), knee  
 8 (9%), and elbow/wrist (7%) (Figure A.25).



10  
 11 **Figure A.25.** Percent NISP of sea otter elements cutmarked in the Par-Tee sample  
 12 (calculated by joint).

13

1 Palmrose Cutmark Patterns

2 The proportion of specimens exhibiting cutmarks at Palmrose (17%) is smaller than that  
3 at Par-Tee (37%). Fewer specimens exhibit cutmarks on the diaphysis, although humerii  
4 and radii do exhibit slightly more on the diaphysis compared to the proximal/distal ends.  
5 Unlike at Par-Tee, femora, humerii, tibiae, radii, and ulnae do not exhibit high  
6 concentrations of cutmarks on the distal and proximal ends, and no single joint is  
7 intensively processed when visualized across the skeleton (Figure A.24). When  
8 calculated as % NISP cutmarked by joint, however, the hip and ankle do appear to exhibit  
9 relatively more processing (as at Par-Tee), which could indicate dismemberment (Binford  
10 1981; Lyman 1991) or skinning (Moss 2020; Val and Mallye 2011). Mandibles at  
11 Palmrose are also cutmarked in locations consistent with skinning, and cutmarks on the  
12 axial skeleton may indicate backstrap/thoracic muscle removal.