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Bird Bone Taphonomy in the Tse-whit-zen Site

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Introduction

Taphonomy is the study of the processes that affect animal remains after their death, including burning, human butchery, animal gnawing, and natural processes. From studies of taphonomy on animal remains it is possible for us to learn how different people at different times worked with and reacted to environmental factors around them in order to survive. For example, at the Ozette site (45-CA-24) in the Pacific Northwest archaeologists believe native people would use bird feathers to make blankets. This was supported by ethnographic data and the taphonomy of the many wing bones of birds found at the site (DePudyt, 1994). The Tse-whit-zen archaeological site (45-CA-523) in Washington State has a multitude of faunal remains, including mammal, bird, fish, and shell, which make it an excellent site for a taphonomic study.

The abundance of faunal remains is due to the fact that Tse-whit-zen is a large and well preserved site spanning about three and a half acres in the Olympic Peninsula of Washington State. It is located in the Strait of Juan de Fuca right across from the Southern Gulf of Georgia Region, where numerous archaeological sites with abundant faunal remains are located. The site was continually occupied from its earliest known date of 2,700 years ago to its most recent date of 100 years ago when it was completely buried by dirt and rubble due to industrial development. Tse-whit-zen was inhabited by the Lower Elwha Klallam tribe, who still have descendants living in the area today, and is now known to be one of the largest Native American villages ever found in the Pacific Northwest.

The site was uncovered in 2003, and actively excavated from 2003 to 2004. By the end of the active work on the site, 335 human burials were discovered along with a large amount of

artifacts and faunal remains. Since 2007, an ongoing collaborative research project involving all the faunal remains from Tse-whit-zen has been occurring with a specialist for each type of remain. At the University of Rhode Island Dr. Kristine Bovy has been working on the analysis of the bird bones found at Tse-whit-zen, in order to see how birds were used by the people at this site and how this changed (if at all) in response to environmental events, such as earthquakes.

My project is a taphonomy study of a portion of the bird bones found at Tse-whit-zen, which will add to the overall research of the faunal analysis project. I looked at the skeletal part distribution of the bird bones to determine if wings were favored over legs at Tse-whit-zen, as they are in many other sites in the Pacific Northwest (Bovy 2002a, 2012). I also looked at the different types of taphonomy found on the bones to try and determine how the people of Tse-whit-zen processed and cooked their birds, and if this processing varied by taxa.

Materials and Methods

For this report I use a sample of bird bones from the pilot study of Tse-whit-zen. These bones had preliminarily been identified to element and taxon by Dr. Bovy and undergraduate students at the University of Rhode Island. I observed and recorded any taphonomy in a database, which also consisted of the bone's bag type, catalog number, provenience, and identification information (element, taxon). There are three separate bag types used to organize the pilot study bones based on how they were screened at the site. The first bag type, E bags, contains the bones that were found *in situ* at the site and thus not screened. The second bag type, C bags, contains the bones that were water screened through 1", 1/2", 1/4", and 1/8" mesh. The last bag type, S bags, contains the bones that were water screened including only those from the 1/4" mesh and larger. The pilot study consists of four 1x1m excavation units from Structure 1, the largest house structure at the site, in area A4 and contains Units 17, 18, 19, and 20. Due to

time constraints my report contains only a sample of these bird bones; material from all bag types (E, C, and S) are analyzed for Units 17 and 18, but only C and E bags (not S) are analyzed for Units 19 and 20.

I recorded all taphonomy on the bones observed. The types of taphonomy include any heat modification (which includes bones that were charred, calcined, and partially burnt on the shaft), cut marks, chop marks, and marks showing disarticulation of the carcass (such as notches, holes, peeling, and broken olecranon of the ulna). The other few modifications observed include bones that appeared to be digested, gnawed, or worked on in some way. These are recorded alongside the element and taxa of the bone.

In order to determine the different types of taphonomy on the bones I used a variety of sources. The criteria I use for burning followed R. Lee Lyman (Lyman 1994: 384-392). Charring is considered to be any type of blackened color on the bone, and is identified as "partially burnt on the shaft" if the blackened area is located specifically on the broken shaft of the bone. A bone was identified as calcined if it is extremely white or white with a bluish hue to it, which means it was heated to at least 600 degrees Celsius (Lyman, 1994:384-392). To determine marks of human butchery (cut marks and chop marks) I use the criteria of Dale Serjeantson (Serjeantson 2009: 132-144). Cut marks are identified as deep parallel lines in bones, often with at least two marks together. Chop marks are identified as clean breaks in bones that appeared to have happened before they were excavated. To identify these marks I used a microscope and the naked eye and compared them with pictures of cut and chop marks from Serjeantson (2009). To determine marks of disarticulation the criteria I use followed Veronique Laroulandie (Laroulandie, 2002). A "hole" is considered as a rather large jagged circle on either the proximal or distal end of the bone. A bone is identified as "notched" if one of

the condyles on its end was missing. "Peeling" of a bone is identified as a set of parallel lines which are adjacent to the part of the bone that is fragmented.

I then quantify the assemblage using both NISP (Number of Identified Specimens) and MNE (Minimum Number of Elements). Although typically referring to the number of bones identified to a specific taxon, I use NISP here to indicate the number of bone fragments in the assemblage that could be identified to element. The NISP can be used to show the level of fragmentation of the bones at the site. The MNE is used to show the skeletal part distribution of the entire bird body and to show a "wing-to-leg ratio" (Bovy, 2002a). A wing-to-leg ratio is calculated as the proportion of the larger elements of the wing (humerus, radius, ulna, and carpometacarpus) to the leg (femur, tibiotarsus, and tarsometatarsus) (Bovy, 2002a). The MNE shows a conservative estimate of the number of complete bones elements in the assemblage. For example, the proximal and distal ends of a humerus could be identified as two specimens, but since it is possible they could fit together they are considered one element in the MNE. The father apart the NISP and MNE numbers are the more fragmentation occurred at the site.

The percent of all types of burning is calculated for all bones in the assemblage. I compare the amount of burning at Tse-whit-zen to the burning observed at other sites in the Pacific Northwest. I also describe other modifications of the bones (cut marks, marks of disarticulation, digestion, etc.). In total I observed 2,394 bones for this report and of those 1,595 are identified to element. Of those identified to element, 798 of them are also identified to taxa (Table 1). 781 bones are identified as "Aves", which includes those bones not identified beyond class level (Aves) and those that are likely identifiable beyond "Aves", but need further work and analysis.

Table 1- Identified Taxa (NISP)

Taxonomic Name	Common Name	NISP
Alcidae	Murres/Auklets	320
Anatidae	Ducks/Geese	223
Laridae	Gulls	80
Procellariidae	Shearwaters	64
Gaviidae	Loons	54
Podicipedidae	Grebes	36
Diomedeidae	Albatross	10
Phalacrocoracidae	Cormorants	10
Corvidae	Ravens/Crows	1
	Total	798

Results and Discussion

Skeletal Part Analysis

In the Pacific Northwest, and especially in the Southern Gulf of Georgia Region that is across the Strait of Juan de Fuca from Tse-whit-zen, many archaeological assemblages are dominated by wing bones rather than leg bones. Some of the sites where this pattern has been seen include the Whalen Farm Site (DFRs 3), where out of the 296 bird bones that could be identified to element 95.9% of them are wing bones with only 3.4% leg bones (Seymour, 1976). The Yuquot excavation also shows wings being favored much more over legs among the various taxa identified. The biggest discrepancy between wings and legs occurring at this site is among the gulls with 87% wings and 13% legs (McAllister, 1980). Even at the Watmough Bay Site (45-SJ-280), with its impressive assemblage of 7,504 identifiable bird bones, wings out number legs. The duck assemblage (n= 4,195) at Watmough Bay is most prevalent in this pattern with 99% (n=4,151) of its bones from the wing (Bovy, 2012). Due to Tse-whit-zen's proximity to these sites where wing bone abundance is so prevalent, I wanted to do a skeletal part analysis of the bird bones I observed from Tse-whit-zen to see if the pattern continues. Using NISP and MNE numbers I show that at Tse-whit-zen all body parts are present among all the birds, and

that an overabundance of wing bones is not as prevalent here as it is at many other sites in the area.

Table 2 shows the values of the NISP, MNE, and %MNE for each element and the total of each for each area of the body. These calculations include all birds, as well as for ducks (Anatidae) and murres (*Uria sp.)* because they are the two most abundant taxa identified. The %MNE is then compared with the expected percent for each element in a whole bird to determine the skeletal part distribution at Tse-whit-zen. Overall the percents observed for each of the four major body regions are very similar to what would be expected to be found in a whole bird. This could indicate that at Tse-whit-zen people were bringing back and depositing the whole bird at their village and not at the site where the bird was found or killed. As noted by Schalk, at many other sites in the Pacific Northwest, such as the Ozette and Yuquot sites, whole bird carcasses do not appear to be making their way back to the village given the lack of leg bones. He argues birds died at sea and only wings were found on the beaches, where they were scavenged by people, and the legs fell off in the water never making it to the beaches. Native people used bird feathers for blankets, making wings more important to bring back intact as they had more feathers than legs (Schalk, 1993).

There is a slightly higher percent MNE for some elements than expected; the difference could be due to the fact that some bones may be overrepresented because they are denser, and/ or more identifiable, such as the ulna. Certain smaller bones, such as the carpals and parts of the skull, could also not be as present due to the fact that their size would make them more likely to be missed when screening.

Table 2- Body Part Distribution at Tse-whit-zen

	Expected	% Expected	All Birds			Ducks			Murres		
			NISP	MNE	% MNE	NISP	MNE	% MNE	NISP	MNE	% MNE
Axial Skeleton											
skull	1	2.6	86	17	3.1	8	1	0.8	24	8	4.5
mandible	2	5.1	37	17	3.1	7	4	3.0	10	8	4.5
hyoid*	-	-	1	-	-	1	-	-	-	-	-
vertebra*	-	-	270	-	-	-	-	-	-	-	-
pygostle*	-	-	1	-	-	-	-	-	-	-	-
rib*	-	-	67	-	-	-	-	-	-	-	-
pelvis/synsacrum	2	5.1	70	21	3.9	15	4	3.0	10	6	3.4
Total Axial	5	12.8	532	55	10.3	31	9	6.9	44	22	12.4
Pectoral Girdle											
sternum	1	2.6	64	19	3.5	1	1	0.8	12	6	3.4
furcula	1	2.6	36	13	2.4	7	5	3.8	12	6	3.4
coracoid	2	5.1	68	46	8.5	16	15	11.5	19	12	6.7
scapula	2	5.1	37	29	5.3	7	6	4.6	10	9	5.1
Total Pectoral	6	15.4	205	107	20.1	31	27	20.6	53	33	18.5
Wing											
humerus	2	5.1	127	53	9.7	32	12	9.2	45	19	10.7
radius	2	5.1	114	44	8.1	13	7	5.3	26	19	10.7
ulna	2	5.1	148	38	7.0	28	6	4.6	39	18	10.1
cuneiform	2	5.1	9	9	1.7	2	2	1.5	2	2	1.1
scapholunar	2	5.1	14	14	2.6	7	7	5.3	4	4	2.2
carpometacarpus	2	5.1	89	62	11.4	21	14	10.7	23	20	11.2
pollex	2	5.1	10	10	1.8	2	2	1.5	2	2	1.1
digit 3	2	5.1	1	1	0.2	0	0	0	0	0	0
digit 2 phalanx 1	2	5.1	35	32	5.9	9	9	6.9	10	10	5.6
digit 2 phalanx 2	2	5.1	13	13	2.4	5	5	3.8	4	4	2.2
Total Wing	20	51.3	560	276	51.8	119	64	48.9	155	98	55.1
Leg											
femur	2	5.1	58	19	3.5	8	6	4.6	10	5	2.8
tibiotarsus	2	5.1	106	37	6.8	23	13	9.9	14	8	4.5
fibula	2	5.1	10	10	1.8	1	1	0.8	2	2	1.1
tarsometatarsus	2	5.1	63	29	5.3	10	6	4.6	10	8	4.5
phalanx*	-	-	61	-	-	-	-	-	-	-	-
Total Leg	8	20.5	298	95	17.8	42	26	19.8	36	23	12.9
Grand Total	39		1,595	533		223	131		288	178	

** Hyoid, vertebra, pygostyle, rib and phalanx not included in MNE because not identified beyond Aves*

There is quite a bit of fragmentation occurring among the long bones, the bones of the axial skeleton, and pectoral girdle. Though the whole body is represented, this fragmentation could be the cause of the processing being done in order to eat these birds by the people who lived at Tse-whit-zen. This fragmentation due to processing has also been proposed by Wigen and Stucki at the Hoko River Rockshelter site (45-CA-21) (Wigen and Stucki, 1988). They also attributed these varying types of processing patterns to the differences in distribution of elements among species at the site, such as murres and ducks having the highest percentage of body elements found and loons having the most legs found. They postulated that the highly fragmented wings were cut off from the carcass and discarded separately while the legs remained attached to the whole carcass while it cooked. Wigen and Stucki also suggested that the difference in the way the legs were cooked could have caused them to be carried off by dogs, which lead to there being few leg bones at the site (Wigen and Stucki, 1988).

While a more even distribution of body parts occurs at Tse-whit-zen, as can be more easily seen in Figure 1, the amount of fragmentation is very high (Table 2). For example, there are a total of 148 bones that could be identified as ulna, and of those only 15 are whole ulnae with the rest being fragmented portions. The high level of fragmentation at Tse-whit-zen could be the result of intense processing of some species or due to post-depositional processes.

While all body parts of the birds are present at Tse-whit-zen and more or less in keeping with what would be expected in a whole bird unlike other sites in the Southern Northwest Coast, there is a slight bias towards wings compared to legs at this site. Table 3 shows the distribution of the long bones in both wings and legs observed at Tse-whit-zen for all birds and the most represented taxa, and then compares their wing-to-leg ratios to that of what is expected in a whole bird. As can be seen in the table, there is a slight pattern toward having more wing bones

than leg bones. The expected wing-to-leg ratio of a bird is 8:6= 1.33. In all birds the wing-to-leg ratio is 197:85= 2.31, making the total of all birds' wings recovered slightly higher than would be expected. Murres, however, have a much larger difference of their wing-to-leg ratio of 76:21=3.62 compared to what is expected. In fact when compared with the other less represented taxa, the murre wing-to-leg ratio is only lower than the gulls, which have a wing-to-leg ratio of 32:8= 4.00.

Figure 1- Skeletal Part Distribution at Tse-whit-zen for all birds and Expected Distribution in a Complete Bird (% MNE)

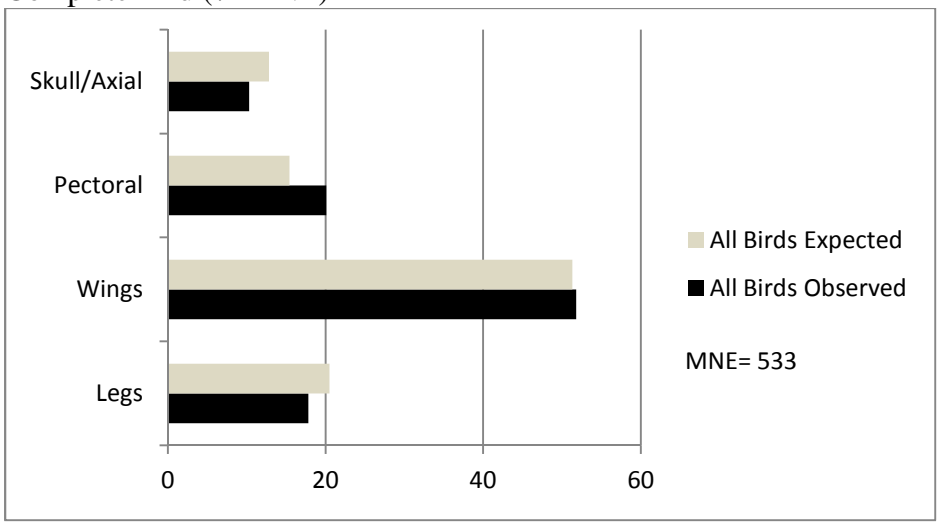

Table 3- Wing-to-Leg Ratio for all major taxa (%MNE)

Element	Expected	All Birds	Ducks	Murres	Loons	Shearwaters	Grebes	Gulls
Humerus	14.3%	18.8%	18.8%	19.6%	25.0%	19.2%	14.3%	5.3%
Radius	14.3	15.6	10.9	19.6	12.5	19.2	7.1	26.3
Ulna	14.3	13.5	9.4	18.6	6.3	11.5	14.3	5.3
Carpometacarpus	14.3	22.0	21.9	20.6	18.8	11.5	14.3	26.3
Femur	14.3	6.7	9.4	5.2	6.3	3.8	28.6	10.5
Tibotarsus	14.3	13.1	20.3	8.2	18.8	11.5	7.1	15.8
Tarsometatarsus	14.3	10.2	9.4	8.2	12.5	23.1	14.3	10.5
MNE Number	14	282	64	97	32	35	24	40
Wing-to-Leg Ratio	1.33	2.31	1.56	3.62	1.67	1.69	1.18	4.00

The murres and the gulls show a greater abundance of wings, which could be due to how people had of processed these particular birds, or the legs may not have been returned to the village site once killed. This tendency in murres and gulls was also noted at the Yuquot site by McAllister (1980) who stated that it was very likely that some of the murre legs were discarded before they actually reached the site, and almost all the gull legs were discarded. She hypothesized that the gulls, and at least some of the murres, were being cleaned on the beach where they were found and the legs were being discarded at the beach (McAllister, 1980). The hypothesis of wing bones being more prevalent in bird bone assemblages because birds were found or cleaned on beaches along the Northwest Coast has also been noted at the Tsawwassen site (DgRs 2) (Kusmer, 1994), the Beach Grove site (DgRs 1) (Matson, Ludowicz, and Boyd, 1980), and the Shoemaker Bay site (DhSe 2) (Calvert and Crockford, 1982) in British Columbia. The same thing could very likely have happened at Tse-whit-zen, especially among the murres and gulls.

Another possible reason for this slight prevalence for more wing than leg bones is that wing bones were used for making tools among the people who lived here. Also feathers of birds were often used for making blankets or weaving, it is very likely that larger wing bones were kept more at the village site than leg bones, due to the fact that wings had more feathers than legs (DePudyt, 1994). Ethnographic research showed that the Klallam tribe (the people who lived at Tse-whit-zen) were known to use bird feathers and bones (specifically ducks) for weaving, blankets, and awls (Gunther, 1927). All of these explanations could be part of the cause for the abundance of wings over legs. However, overall the bones at Tse-whit-zen are almost evenly distributed throughout all the elements, which reinforces the idea that whatever is causing the abundance of wings in bird bone assemblages is limited geographically to the Gulf of Georgia

region (Bovy, 2012), and perhaps leads to a different reason for why certain elements are slightly underrepresented at Tse-whit-zen.

Burning

The number of heat modified bones is much higher at Tse-whit-zen than at most other sites in the area. Out of the 1,595 bones identifiable to element, 515 are burnt (charred, calcined, or partially burnt on the shaft) with a total of 32.3% of burnt identifiable specimens at Tse-whit-zen. Table 4 shows the percentage and number of bones burnt in varying degrees among all the specimens I observed at Tse-whit-zen. When the unidentifiable material is included in the burning calculations the large amount of burning at Tse-whit-zen is even more apparent as the percent of total burnt bones rises to 38.8%, with 928 of the 2,394 observed bones being burnt.

Table 4- Types of Burning at Tse-whit-zen

	Unburnt	Charred	Calcined	Partially Burnt on Shaft	Number
All Specimens Included	61.2%	28.8%	8.0%	2.0%	2,394
Specimens Identified to Element	67.7%	21.4%	7.9%	2.9%	1,595
Heat Modified Specimens Identified to Element	-	66.4%	24.5%	9.1%	515

I compare the burning at Tse-whit-zen to other sites in the region where burning is recorded, which can be seen in Table 5. The other sites ranged from 1.4% to 8% burning. The high percentage of burning among the bird bones at Tse-whit-zen is noteworthy, as it may be related to the fact that the bones come from house structures instead of shell middens (garbage dumps) like the bones at the comparative sites. There are, however, currently very few sites where the burning of bird bones has been recorded making definite answers difficult.

Table 5- Comparison of bird bone taphonomy at Tse-whit-zen with other sites

Site Name	Site Number	Location	Total #[1]	# Heat Modified (%)	# Partially Burnt on Shaft (%)[3]	# of Cut Marks (%)	Citation
Tse-whit-zen	45-CA-523	Olympic Peninsula, WA	1,595[2]	515 (32.3%)	47 (9.1%)	12 (0.8%)	Orff, 2013
Watmough Bay	45-SJ-280	Lopez Island, WA	7,712	111 (1.4%)	41 (36.9%)	26 (0.3%)	Bovy, 2005
British Camp (Op-D)	45-SJ-24	San Juan Island, WA	309	24 (8%)	not reported	4 (1.3%)	Bovy, 2011
Minard	45-GH-15	Outer Washington Coast	3,498	250 (7.1%)	113 (45.2%)	60 (1.7%)	Bovy, 2005
Burton Acres	45-KI-437	Vashon Island, WA	322	20 (6.2%)	not reported	0 (0%)	Bovy, 2002b
Umpqua/Eden	35-DO-83	South Central Oregon Coast	1,611	41 (2.5%)	11 (26.8%)	58 (3.6%)	Bovy, 2005

[1]Total number reported includes all specimens identified as bird including some not identified to taxa.
[2]Preliminary sample of pilot study data, includes all specimens identified to element but necessarily to taxon.
[3]Percent of heat modified bones from site that were partially burnt on shaft.

There were 264 heat modified specimens identified to taxon, of which murres were the most frequently burnt (n=123; 46.6%), which makes sense given the abundance of murres at the site. Murres are also one of the most frequently burnt taxa when you take sample size into account. Of 288 bones identified as murre, 42.7% were burnt. Both grebes (n=17; 47.2%) and cormorants (n=5; 50%) had slightly higher percentages of burning than murres, but both have very small sample sizes. All the other taxa had a lower percent of burnt bones than murres. Table 6 shows the burning by element. The most frequently burnt element is the humerus with a percentage of 57.5% (n=73) bones burnt out of the total number of bones identified as humeri (n=127).

Another interesting thing about the burning at Tse-whit-zen is that there are quite a number of bones that are partially burnt on the shaft. Bones that are partially burnt on the shaft are discolored, a brown or black color, around the part of the shaft that is broken off, which usually shows a jagged break about mid-shaft; the majority of these bones are long bones from the wing and leg, although there is one coracoid and one digit 2 phalanx 1 (wing digit). Table 6 also shows the percent of elements partially burnt on the shaft. The humerus is the most frequent element burnt in this way with a percentage of 51.1% (n=24). Table 7 shows the percent of

bones partially burnt on the shaft among the taxa. Of those specimens identified to taxon the murre bones were most frequently partially burnt on the shaft (n=18; 47.4%).

Table 6- Percent burning of each identifiable element

	Calcined		Charred		Partially Burnt on Shaft		Unburnt	
	All Birds	%	All Birds	%	All Birds	%	All Birds	%
Element								
skull	5	4.0	13	3.8	0	0.0	68	6.3
mandible	2	1.6	5	1.5	0	0.0	30	2.8
hyoid	0	0.0	0	0.0	0	0.0	1	0.1
vertebra	17	13.5	57	16.7	0	0.0	196	18.1
pygostle	0	0.0	0	0.0	0	0.0	1	0.1
rib	0	0.0	1	0.3	0	0.0	66	6.1
pelvis	0	0.0	3	0.9	0	0.0	38	3.5
synsacrum	2	1.6	6	1.8	0	0.0	21	1.9
sternum	4	3.2	13	3.8	0	0.0	47	4.4
furcula	2	1.6	8	2.3	0	0.0	26	2.4
coracoid	11	8.7	20	5.8	0	0.0	36	3.3
scapula	1	0.8	5	1.5	0	0.0	31	2.9
humerus	11	8.7	38	11.1	24	51.1	54	5.0
radius	5	4.0	35	10.2	4	8.5	70	6.5
ulna	8	6.3	37	10.8	2	4.3	101	9.4
cuneiform	1	0.8	2	0.6	0	0.0	6	0.6
scapholunar	1	0.8	0	0.0	0	0.0	13	1.2
carpometacarpus	7	5.6	27	7.9	3	6.4	52	4.8
pollex	1	0.8	1	0.3	0	0.0	8	0.7
digit 3	0	0.0	1	0.3	0	0.0	0	0.0
digit 2 phalanx 1	1	0.8	6	1.8	1	2.1	27	2.5
digit 2 phalanx 2	1	0.8	2	0.6	0	0.0	10	0.9
femur	3	2.4	15	4.4	3	6.4	37	3.4
tibiotarsus	18	14.3	22	6.4	8	17.0	58	5.4
fibula	1	0.8	1	0.3	0	0.0	8	0.7
tarsometatarsus	12	9.5	15	4.4	1	2.1	35	3.2
phalanx	12	9.5	9	2.6	0	0.0	40	3.7
Total	126		342		47		1080	

Table 7- Percent of partial burning on shaft of identifiable taxa

	NISP	%PBS
Taxa		
Alcidae (Murres)	18	47.4
Anseriformes (Ducks)	12	31.6
Procellariiformes (Shearwaters)	4	10.5
Laridae (Gulls)	2	5.3
Podicipediformes (Grebes)	1	2.6
Suliformes (Cormorants)	1	2.6
Total	38	100.0

There are slight differences for bones partially burnt on the shaft between Tse-whit-zen and the comparison sites. Table 5 also shows the percent of bones partially burnt on the shaft at Tse-whit-zen and the comparative sites. At all the sites the humerus is the most frequent element to be partially burnt on the shaft. The comparative sites overall, however, have a greater percent of bones that are partially burnt on the shaft than does the assemblage at Tse-whit-zen with only 9.1% (n=47) of the total burnt bones. Though to a lesser extent at Tse-whit-zen, many bird bones are partially burnt on the shaft in this region.

Given that murres are one of the most frequently burnt taxa (and the most frequently identified taxa), they might have been processed and cooked differently than other taxa. The murres could have been either cooked closer to the fire or in the fire for longer periods of time. Also perhaps more murre bones were discarded in the fire once the rest of the bird had been used. It is also possible, as the majority of the bones burnt were humeri, that if wing bones were being used for other purposes besides obtaining food, that during the collection of feathers from the wing or the making of tools the bones were thrown into the fire as a way to clean up.

It has been suggested by Howard (1929:379) at her study at the Emeryville Shellmound Site in San Francisco Bay, California, that the reason some bones are partially burnt on the shaft is that the bones were broken over the fire. Perhaps at Tse-whit-zen it was easier to get meat

from the murres by breaking their biggest wing bone (the humerus) over the fire. However, without more evidence from other sites it is hard to say the exact reason for why certain bones are partially burnt on the shaft.

Other Taphonomy

While burning is the most common type of taphonomy in the overall study at Tse-whit-zen, other types of modifications are found on the bones as well. One of these types of modifications was butchery (cut marks and chop marks). All of the butchery markings at Tse-whit-zen can be found in Table 8, and Table 5 compares the percent of cut marks with other sites in the area. Murres have the majority for any type of butchery among the different taxa with six elements with cut marks, and two elements with possible cut marks. Only 0.8% (n=12) of the identifiable bones at Tse-whit-zen show definite marks of butchery, but the fact that half of those bones belong to murres is significant because again it shows a preference for murres at Tse-whit-zen in the way they were prepared or used.

Table 8- Description of butchery marks on bird bones at Tse-whit-zen

Taxon	Element/Description	Catalog Number
Alcidae- large (Murres)	proximal humerus, 1 cut mark on shaft	A4-469.01.02
	whole humerus, 1 cut mark on shaft	WS-11591.99.01.22
	carpometacarpus shaft, 1 cut mark on mid-shaft	A4-468.01.03
	coracoid, 1 cut mark on distal end	WS-11548.99.04.22
	distal synsacrum, 2 deep cut marks	WS-6528.99.04.22
	ulna shaft, 1 cut mark on mid-shaft	A4-468.01.03
	whole coracoid, 1 possible cut mark on proximal end	A4-511.01.05
	whole carpometacarpus, 1 possible cut mark on shaft (wide)	WS-10806.99.04.22
Anatidae (Ducks)	distal radius, 2 cut marks perpendicular to shaft on anterior side	WS-11694.99.08.22
	whole scapula, 3 cut marks on mid-shaft	WS-7395.99.04.22
	titbiotarsus shaft, 1 cut mark perpendicular to broken shaft	WS-8258.99.04.22
Gaviidae (Loons)	proximal tarsometatarsus, 1 chop mark on end of proximal side	WS-8996.99.04.22
Aves (Birds)	whole, scapula, 4 cut marks on shaft	WS-6885.99.04.22
	distal tibiotarsus, 4 cut marks perpendicular to shaft on anterior side	WS-9498.99.04.22
	shaft radius, 1 possible cut mark on shaft	WS-6528.99.04.22

There does seem to be a lesser amount of butchery being done at Tse-whit-zen when compared with other sites that have recorded human butchery. Of all the comparison sites, Umpqua/Eden (35-DO-83) has the highest percent of cut marks with 3.6% (n=58). Fewer birds may have cut marks at Tse-whit-zen than some other sites because there is so much burning at this site. The excessive heat used to cook the birds may have made them easier to pull apart without needing to use any kind of cutting implement.

Another type of modification that I recorded are disarticulation marks, such as the breaking of the ulna olecranon, notching of the end of a broken long bone, possible puncture marks, and peeling, which probably occurred when a person removed the skin of the bird (Laroulandie, 2002). The description of different disarticulation marks and what element they were found on is shown in Table 9. Murres have the highest number of modifications. Of all the bones found with definite marks of disarticulation (n=28), 64.3% (n=18) are murres. The highest type of disarticulation mark is the breaking of the ulna olecranon at 71.4% (n=20), and of these the murres hold the majority with 80% (n=16). Of the bones identified as murre proximal or complete ulna 72.7% (n=16) have a broken olecranon. The olecranon likely breaks off due to a person pulling apart the ulna and the humerus, often leaving marks on both. It would seem that the murres were often ripped apart as so many of the murre ulnae have broken olecranons, though more information would need to be collected on the other bones at Tse-whit-zen to see if there are other disarticulation marks that fit this pattern.

The ripping apart of the bird bones also presents another reason for why the bones, especially the wings, are so fragmented. As the majority of disarticulation marks occurred on the ulna, it can be assumed that the wings were the body element getting disarticulated the most. It may also show a certain way of cooking birds, especially murres, as the carcass getting ripped

apart in this way would most likely only be used for food. The large amount of disarticulation marks found on the murres at Tse-whit-zen, combined with the large amount of this taxa having bones partially burnt on the shaft, suggests that the way in which murres were processed was different than the other taxa.

Table 9- Description of disarticulation marks on bird bones at Tse-whit-zen

Disarticulation Description	NISP
proximal ulna, broken olecranon	7
whole ulna, broken olecranon on proximal end	13
notching, femur shaft	1
notching, distal humerus	1
notching, ulna shaft	2
peeling, scapula whole	1
peeling, proximal ulna	2
hole, distal humerus	1
possible notching, femur shaft	1
possible notching, distal humerus	1
possible notching, radius whole	1
possible peeling, scapula whole	1
possible peeling, ulna shaft	1
Total	33

Finally, there are a few bones that showed other types of modifications. A tibiotarsus shaft (possible raven) has definite markings of having been worked by people; it is very highly polished and has several abrasions on one of the ends. There are also two humeri shafts that may have been worked by people as they are very polished, but it could also be due to natural processes. There were also four elements that appear to be digested. Of those elements that were digested, two of them are carpometacarpi (both proximal ends), one scapholunar, and a part of a pelvis. The only bone in this assemblage to show any kind of gnawing was a proximal radius, which appears to have a hole in it big enough to have been made by the beak of a bird. These modifications were noted during data collection, but do not show any type of pattern or preference at this site.

Conclusion

With the enormity of the Tse-whit-zen site, it is no wonder that a large sample of bird bones was found. My report has only covered a little more than half of the pilot study, but even with this small sample, a pattern of how birds were cooked and processed can be seen. The amount of burning at Tse-whit-zen is overall much larger than most other sites in the area, signifying that the bird bones were near the fire more. Possibly this was due to how the birds were cooked, how their bones were discarded after use, of differences in the context of the sites (houses versus garbage middens). Murre bones are abundant in the assemblage and may have been cooked and processed differently than other taxa. This may also be due to murres (and ducks, the next most frequent taxa represented) used for something other than just food. Their wing bones may have been used to make tools, or their feathers used to make blankets. The slight abundance of wings over legs in some taxa at Tse-whit-zen could be explained due to tool and blanket making as well.

The making of tools could also explain the high levels of fragmentation and the larger number of bones burned. When making tools out of the bones it is possible that the parts of the bone that were chipped off to make the tool, or those bones that were mistakes in the manufacturing process, were thrown into the fire in order to clean up the area. A good way to test this hypothesis would be to observe all the bone tools at Tse-whit-zen and see how many are made from bird bones. Also the large amount of burning, butchery marks, and disarticulation marks found on the murre bones could show that the murre was a much more targeted bird than any of the others, and that perhaps they were treated differently than other taxa. The humerus also seems to stand out among the elements for amount of burning and butchery marks, which may be due to the fact that it is the largest wing bone. Also even though the overabundance of

wing bones is not as large at Tse-whit-zen as it is at other sites, there are still more wings than expected at this site for some taxa. At Tse-whit-zen there does seem to be variations in processing and cooking birds based mostly on their taxa, but also somewhat on their element. More research done on the Tse-whit-zen bird bones and their taphonomy will aid in getting more evidence for these cultural processes.

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