The Č́íxʷicən Fishbone Project: Methods, Analytic Protocols, and Descriptive Summary for the 2012-2019 Analysis

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1. Introduction

Číxʷicən[1] (pronounced *ch-WHEET-son*) is a Lower Elwha Klallam Tribe (LEKT) village in Port Angeles, WA at the base of Ediz Hook on the south shore of the Strait of Juan de Fuca (Fig. 1) that was occupied for the past 2,700 years (Butler et al., 2019a; Larson, 2006). The Strait is part of a large inland water system of northwest coastal Washington and southwest British Columbia now called the Salish Sea (Fig. 1). In 2004, Larson Anthropological Archaeological Services (LAAS) and LEKT members excavated Číxʷicən with large open blocks of 1 x 1 m units by finely defined stratigraphic layers (Butler et al., 2019a; Campbell et al., 2019; Reetz et al., 2006). For various reasons none of the excavated materials were analyzed. In 2012, Kristine Bovy (University of Rhode Island), Virginia Butler (Portland State University [PSU]), Sarah Campbell (Western Washington University), Michael Etnier (Western Washington University), and Sarah Sterling (PSU) initiated a large-scale National Science Funded zooarchaeological and geoarchaeological project, targeting excavation Areas/Blocks that were linked to two possible houses, and interior and extramural deposits (Fig. 2).

Fig. 1. Map showing location of Číxʷicən. Dashed line outlines the Salish Sea watershed. (Figure drafted by Kendal McDonald.)

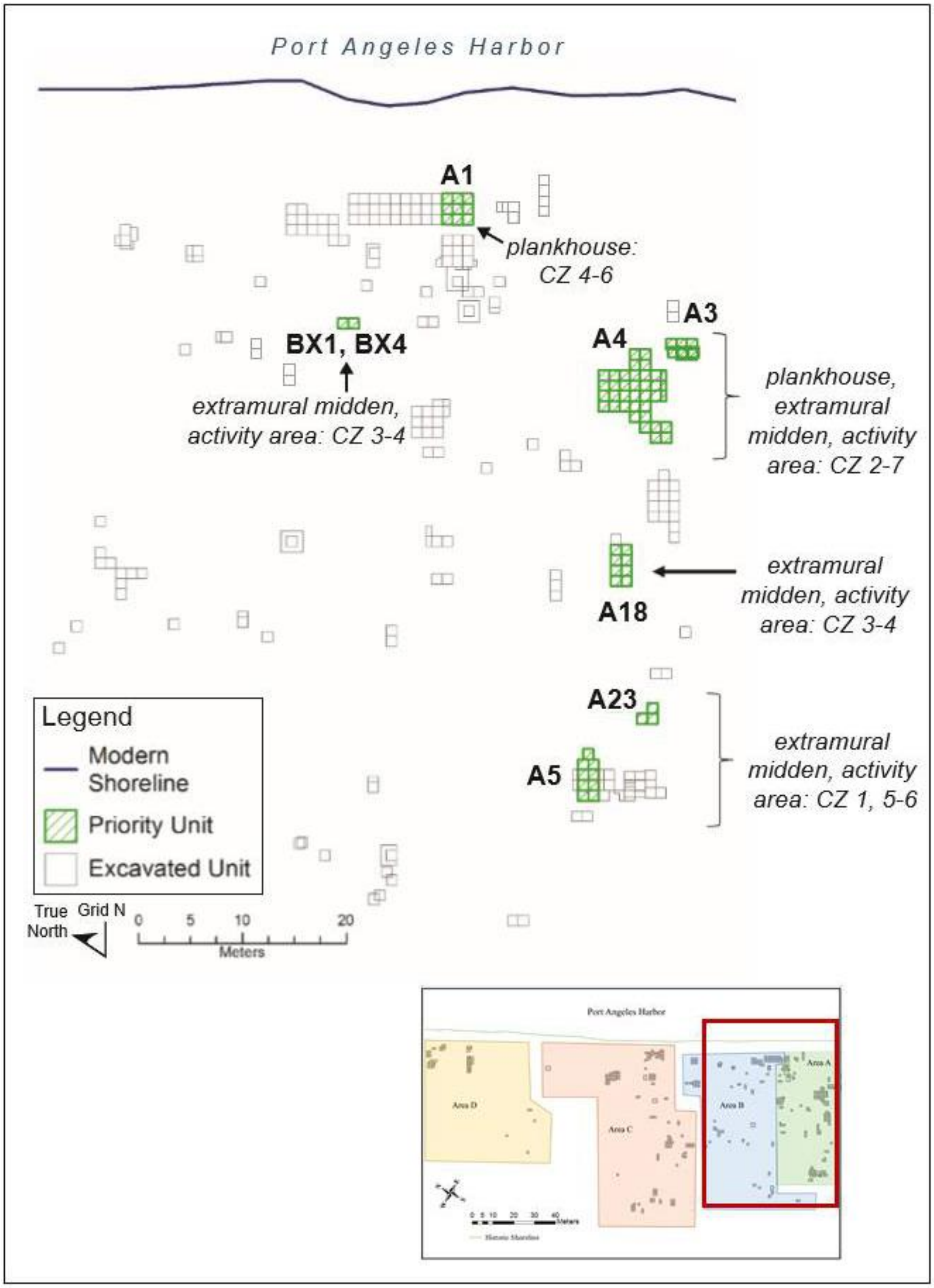

Fig. 2. Map showing areas targeted for geo-zooarchaeological analysis, chronozone (CZ) represented, and cultural activity indicated. (Figure drafted by Kristina Dick.) Inset map shows all areas excavated in 2004 mitigation, with red outlined box indicating focus of the 2012-2019 project. (Figure drafted by Laura Syvertson.)

This report describes the main methods used in fishbone analysis and provides a descriptive summary that reviews conventions and criteria used in assigning specimens to a given taxon and skeletal element. The fishbone analysis focused on seven main Areas/Blocks: A4, A1, A18, BX1, BX4, A5, A23; [Note: Area A3 was part of our NSF-targeted study, but fish remains were not analyzed, given time constraints.] For a general overview of results of Čix̣ʷicən fishbone analysis in the context of project research goals, see Butler et al. (2019b).

2. Sample selection and processing

Field sampling was explicitly designed to allow for integration of all classes of faunal data (Butler et al., 2019b; Reetz et al., 2006), and simple calculation of matrix volume. Matrix was excavated from each uniquely defined deposit into 10 L buckets which was water- screened through graded mesh 1" (25.6 mm), 1/2" (12.8 mm), and 1/4" (6.4 mm) or in some cases to 1/8" mesh (Kaehler and Lewarch, 2006). Most buckets from a given micro-stratum were screened to 1/4" and referred to as *Sample* buckets or 'S' buckets. Shellfish were not retained from S buckets. Every 20th bucket from a micro-stratum was screened to 1/8" and all faunal remains were retained. Such samples were referred to as *Complete* or 'C' buckets. A small number of relatively large remains were not collected in buckets, but recorded *in situ* during excavation and referred to as 'E' samples. [Note: in our overview, the labels "bucket" and "bag" are often used interchangeably. The 10 L bucket was the original collection unit, the bag refers to the constituents from the bucket.]

After excavation, faunal remains were sorted into four main animal groups by LAAS personnel (fish, bird, mammal, shellfish). Remains from each faunal type in a given bucket and screen size were counted and listed in the original catalog. Specimen counting ceased when the tally reached 50 specimens; the catalog entry noted > 50 specimens. Thus, counts listed in the original catalog are underestimates. All materials excavated, processed and cataloged by LAAS were transferred to the Burke Museum in Seattle, Washington for curation.

The first priority for the 2012-2019 project was to study the C buckets from the targeted block excavations. We focused on the C buckets, screened to 1/8" mesh, mainly because remains of small fish and invertebrates are greatly under-represented in large mesh sizes, such as 1/4" (Casteel, 1976, Partlow, 2006)[2]. To assess representation of aquatic fauna – and relate variation in representation to that of birds and mammals – it was essential to focus on samples screened to 1/8" minimally. To increase the sample size of remains from larger animals – mammals, birds, and large-bodied fishes – remains from S buckets were also incorporated into the project. For the fish study, Laura Syvertson (2017) studied 269 S buckets from Area A4.

In sum, all of the fish remains from the C buckets and *in situ* remains, and a subsample of S buckets in the blocks of the site targeted for study were borrowed from the Burke Museum and analyzed at Portland State University, Department of Anthropology (Table 1). Most of the fishbone analysis occurred between July 2012 and December 2015[3].

During early phases of faunal analysis in summer 2012, we realized that the size of many of the fish remains in a given bag did not match the mesh size listed for that bag. For example, fish remains that were supposed to be from 1/4" mesh contained much larger specimens that should have been captured in the 1/2" mesh, as well as much smaller specimens that should have fallen through to 1/8"

Table 1. Summary of field sampling methods and sample types at Čixʷicən, including number of bucket samples included in 2012-2019 fishbone project.

Sample Code	Cu Meters	Description	Analyzed Current Project	
			Num. Buckets	Liters
C	4.57	10 L bucket, to 1/8” mesh	433[1]	4570
CX	3.63	10 L bucket, to 1 /4” mesh	355[1]	3630
S[2]	2.69	10 L bucket, to 1 /4” mesh	269[2]	2690
E		Recorded *in situ*, typically larger specimens	---	---

[1] Buckets from excavation Area/Block A1, A4, A18, A23, A5, BX1/BX4. Note: fishbone analysis *did not include A3*, which was part of the invertebrate, bird, and mammal analyses. A3 provided 24 C buckets and 8 CX buckets.
[2] A sample of fish remains from S buckets in A4 was studied by Syvertson (2017) as part of her thesis project. A total of 269 S buckets was recovered in the 2004 mitigation from the excavation units she focused on. However, after the remains were re-screened (see text for discussion), only 232 buckets retained fish remains in the ¼” mesh. Note this supersedes information noted in Table 6 of Syvertson (2017).

mesh. To mitigate this problem, and ensure comparability with other Northwest Coast faunal assemblages, as well as the other faunal classes within the site (bird, invertebrate, mammal), we rescreened all of the material from the targeted blocks for analysis through nested mesh screens 1/2”, 1/4”, and 1/8” in size. We re-bagged (and weighed) the newly screened material and assigned new catalog numbers to each set of materials.

Importantly, according to LAAS records, 1/8” mesh was the finest screen used for C buckets, but in almost all 10 L bucket sample bags, fish remains, sometimes a substantial number, slipped through the 1/8” mesh during re-screening. We re-bagged and re-cataloged such materials, labelling them <1/8”. Fig. 3 illustrates the quantity of “tiny” fishbone that was recovered, albeit unsystematically, in the <1/8” mesh remains from one C bucket, WS-10704, from graded mesh 2 mm, 1 mm, and <1 mm mesh. We emphasize, LAAS field records do not report use of mesh finer than 1/8” mesh. Because of time constraints and lack of sampling controls (e.g., unknown mesh size used; whether fine-screen fraction was consistently retained), we did not devote much time to this < 1/8” material in the 2012-2019 project. However, we wanted to characterize at least a sample of this fine fraction fishbone for future research. We selected 14 bags from Area/Block A4, from a range of chrono-stratigraphic zones (see Campbell et al., 2019 for methods used in establishing these analytic temporal units). Each bag represents 10 L volume. We analyzed and recorded remains from these bags, using the same protocols of analysis described below (Table 2). These materials were included in the master fishbone database.

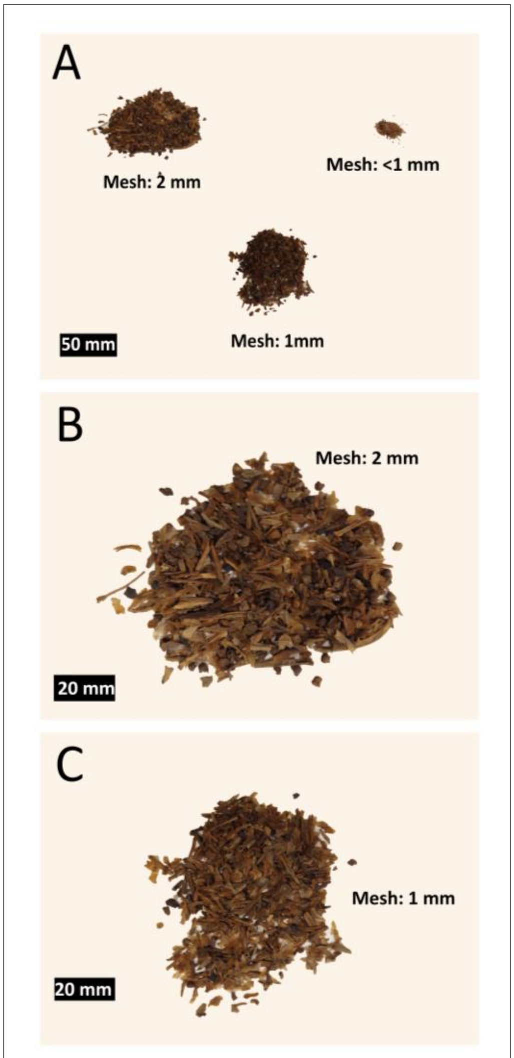

Fig. 3. Example of remains from one C bag/bucket recovered from < 1/8" (3.2 mm) mesh fraction graded by mesh size. **A**, Remains from 2 mm, 1 mm, and < 1 mm mesh. **B**, Close-up of 2 mm mesh. **C**, Close-up of 1 mm mesh. As noted in text, original LAAS field and laboratory records do not mention use of mesh size finer than 1/8" mesh, so the presence of faunal remains from mesh finer than 1/8" is not easily accounted for. Catalog number, WS-10704.99.99.23. Photograph by Virginia L. Butler. Courtesy of the WSDOT, Čƛ́xʷicən Site.

Besides the screen size questions, another issue encountered in summer 2012 was that about half of the bags in our C bag samples did not have any original Burke Catalog records for 1/8" mesh materials. This is contrary to the supposed definition of a C bucket, which should have included remains down to 1/8" mesh. As noted above, because screen size greatly affects faunal recovery –especially for fish and invertebrates-- it was essential that we distinguish buckets that had been screened to 1/4" and those screened to 1/8" mesh. We created a new bag label, "CX" for the buckets/bags that had been originally labelled "C", but which represent matrix screened only to 1/4". [Please see Butler et al., 2018 for background information on how these determinations were made.] For the CX buckets, we focused analysis on fish remains down to 1/4" mesh. Publications on Čƛ́xʷicən fauna (e.g., Butler et al., 2019b, Bovy et al., 2019), include only remains from >1/4" mesh for CX buckets and >1/8" for C buckets.

A final issue our project encountered in 2012 related to multiple catalog numbers being assigned to a single 10 L bucket. Given our interest in calculating density and accumulation rate, having robust estimates of volume was critical to our project. Butler et al. (2018) discuss how our project addressed this issue.

Table 2. List of the 14 C bags/buckets studied as part of fishbone analysis of < 1/8" mesh matrix. Given that the original LAAS excavation report explains that the finest mesh used was 1/8", the high abundance of fish remains *smaller than* 1/8", which the 2012-2019 fishbone project recorded from only 14 buckets, is noteworthy. Of the 4874 specimens counted, 4063 were identified to at least fish family.

Catalog/Bag Number	Number of Specimens
1481	61
4704	80
8232	105
8358	65
8774	195
9144	1872
9471	237
10609	1291
10704	144
13694	10
13972	156
14227	218
15556	57
15624	383
Total	4874

3. Fishbone analysis

Butler directed analysis of the fishbone assemblage at PSU following quality control protocols consistent with Driver's (2011) recommendations (see also Wolverton, 2013): we established the universe of possible fish taxa at the beginning of the project using Strait of Juan de Fuca fisheries survey records (Miller et al., 1980) and north Pacific field guides (Hart, 1973); identification criteria were specified and referred to over the course of the project; difficult to distinguish taxa and elements were specified; and a descriptive summary, which included rules, protocols, and criteria used for assigning skeletal elements was prepared as laid out in this report. A detailed checklist of Salish Sea fishes (Pietsch and Orr, 2015) was available after our project began, so we did not use it originally to delimit the universe of likely fish taxa represented in the site. However, given its comprehensiveness, we heavily relied on it as we made final decisions about taxonomic identifications and nomenclature.

The list of comparative skeletons used in our study is provided in Appendix 1. We had access to 237 skeletons from 29 families and 81 species, which represents all the main families and most commonly found species in the Salish Sea. Most skeletons were from the Portland State University zooarchaeology collections. We also borrowed several skeletons from Robert Kopperl (Willamette Cultural Resources Associates) and Ross Smith (Stantec); and relied on one skeleton from the University of Victoria, Department of Anthropology.

For each specimen included in our study, we documented the finest possible taxon and skeletal element. Table 3 and Table 4 list all the skeletal elements recorded for each taxonomic group; the Descriptive Summary below lists all the elements assigned to each taxon. For most bony fish taxa (in subclass Actinopterygii), 28 elements associated with the head, 10 elements associated with paired fins (Table 3), and 19-67 elements associated with the vertebral column (Table 4) were recorded. Several additional elements distinctive of particular taxa were also recorded to assess their representation in site deposits (Table 3, Table 4). Ratfish (*Hydrolagus colliei*) and spiny dogfish (*Squalus suckleyi*) are cartilaginous fishes and much of their skeleton does not preserve; thus, dorsal spines were included to increase potential for identifying these fish. Additional elements from salmonids were included to increase the taxon's representation since elements associated with the head and fins have low density (Butler and Chatters, 1994) and are rarely recovered. Recording a variable number of elements for a given taxon affects quantification units, such as number of identified specimens (NISP). On the other hand, given that decisions were consistent throughout the analysis project, spatial and temporal trends observed are not affected.

It is important to emphasize that the Čí̓xʷicən fish analysis project selected only a subset of elements for study, albeit a large subset, that are likely diagnostic to species. Over 73,000 fish specimens were estimated for the C buckets in our targeted areas based on the original LAAS laboratory sorting, which we knew was an underestimate. Given this large size and a finite amount of resources to carry out analysis, we focused study on a large suite of elements from throughout the skeleton, but excluded elements that other analysts apparently record. Fish faunal analysts such as McKechnie (2005: 208) notes: "with exception of fish spines, branchials, scale, and gill rakers, *identification was attempted for all skeletal elements* recognizable to species or genus", emphasis added) (see Frederick, 2012 for a similar description). Because most faunal reports in the Pacific Northwest do not list the elements that are used for species, genus, and family level identifications, we are uncertain how element selection affects fish quantification estimates. As noted above, given that we were consistent throughout analysis at Čí̓xʷicən, spatial and temporal patterns are not affected by such decisions. Given the extremely large sample sizes in general, we suggest that our samples provide robust estimates of taxonomic representation appropriate for regional comparisons.

Most element nomenclature conforms to that commonly used in fish skeletal anatomy guides (e.g., Cannon, 1987; Wheeler and Jones, 1989). Nomenclature used for vertebrae varied across taxa. Elasmobranch (dogfish shark and ray) vertebrae are relatively undifferentiated along the column and thus all such vertebrae were assigned to "indeterminate vertebrae". For salmonids, we used Butler (1990, 1993) nomenclature to distinguish vertebrae into vertebra type 1 (1st vertebra), 2, 3, and 4. During initial analysis of other bony fish, vertebrae were separated into abdominal and caudal types, following Wheeler and Jones (1989), where abdominal vertebrae are those where the haemal spine is not fused, and caudal vertebrae are characterized by the fused haemal spine. We realized after a few weeks that distinguishing some abdominal from caudal vertebrae required substantial effort with uncertain information value. Moreover, many eroded or incomplete vertebrae could not be separated and were assigned to "indeterminate vertebrae" even with close scrutiny. Thus, all of the vertebrae would need to be aggregated for analysis for many research questions. In light of these issues, with two exceptions, we changed the protocol and assigned bony fish vertebrae simply to first vertebrae and indeterminate vertebrae. For relatively large-bodied cod (Pacific cod, *Gadus macrocephalus*) and lingcod

(*Ophiodon elongatus*), we reasoned that distinguishing vertebrae to abdominal/caudal types could provide insights on past human butchering/processing behavior and thus devoted additional time to this effort.

The category “non-salmonid” was created to quantify vertebral fragments that are definitively not from salmonids in an effort to counter the potential “over-documentation” of salmon specimens, which can be easily identified to genus from very small vertebra fragments (e.g., Casteel, 1976; Ewonus,

Table 3. List of cranial/paired fin skeletal elements included in fishbone analysis. Elements listed "xx" recorded but not used in most quantitative analyses.

	All Bony Fishes	Salmonid	Surfperch	Herring (order, family, species)	Flatfish	Ratfish	Skate	Dogfish	Buffalo Sculpin/Starry flounder
Elements: Cranial									
angular/articular	2								
basioccipital	1								
ceratohyal	2								
dentary	2								
epihyal	2								
hyomandibula	2								
interhaemal spine					1				
maxilla	2								
opercle	2								
otics: prootic and pterotic				4					
otolith (sagitta only)	2								
palatine	2								
parasphenoid	1								
pharyngeal (lower & upper)			3						
premaxilla	2								
preopercle	2								
quadrate	2								
subopercle				2					
supraoccipital				1					
dental plates/teeth						6	xx	xx	
urohyal	1								
vomer	1								
Total cranial elements	28		3	7	1	6			
Elements: Paired Fin									
cleithrum	2								
coracoid		2							
mesocoracoid		2							
pectoral fin ray		2							
postcleithrum		6							
posttemporal	2								
scapula	2								
supracleithrum	2								
basipterygium	2								
dorsal spine						1		2	
Total fin elements	10	12				1		2	
Elements: Misc.									
dermal denticle/scales							xx		xx
dorsal vertebra spine		xx							
Total cranial/paired fin elements	38	12	3	7	1	7		2	

Table 4. Frequency of vertebrae by taxon and within an individual fish.

Taxon	N Vertebrae Recorded[1]	N Vertebrae "too caudal" to identify[2]	N Total Vertebrae listed by Clothier (1950)[3]
Anoplopomatidae	55.3	5.7	62-65
Clupeidae	48.3	2.5	49-53
Cottidae	24.7		
Enophyrs bison	21	7	
Hemilepidotus sp.	21	5	
Hemilepidotus/Scorpaenicthys	23.5	5	36-37
Leptocottus armatus	28	8	35-36
Myoxocephalus polyacanthocephalus	27	4.5	
Embiotocidae	24.5	7	34-39
Gadus macrocephalus	42	4	
Microgadus proximus	45.5	4.5	
Hexagrammidae	43	10	
Hexagrammos sp.	43	9	
Ophiodon elongatus	43	11	56-58
Oncorhynchus sp.	66.3	1	64-66
Pleuronectiformes	26.6	9.5	36-53
Sebastes sp.	18.7	4.7	26-27
Raja sp.	86	0	
Squalus suckleyi	100	0	

[1] Obtained from averaging multiple skeletons of modern comparative reference skeletons, then subtracting the number of "too caudal" vertebrae, which were not identified to fish taxon. N vertebrae reflect what was recorded for a given taxon, not the total number of vertebrae in an individual fish.

[2] The most posterior vertebrae on most bony fishes which were not identified to taxon, other than "nonsalmonid". Frequency listed is an estimate of the number of vertebrae that fall into this category for each fish taxon.

[3] Frequencies are from Clothier's (1950) report on California fish vertebrae, which provides an independent estimate for total number of vertebrae in an individual fish.

2011, Grier and Lukowski, 2012). [See specific criteria for identifying salmonid vertebra fragments in Descriptive Summary, below.] Besides eroded and fragmented remains, this "non-salmonid" category was specifically applied to relatively complete bony fish vertebrae that are located near the end of the vertebral column, which are difficult to distinguish to family or species. Table 4 lists the number of vertebrae by fish taxon that fall into this category, which ranges between none and 11 (Table 4). As with other analytic decisions, with more focused study, it is likely that morphological differences could be detected for at least some of these most caudal vertebrae, but we decided that focusing on the more anterior vertebrae, which could be more easily distinguished across taxa, would provide adequate samples and distinctions would be more reliably made.

For each specimen, we recorded whether it included a unique morphological landmark as a crude way to examine degree of fragmentation and provide a basis for calculating the minimum number of elements (MNE). If fragmentation varies across a site, an increase in frequency of vertebral specimens (or other skeletal parts) assigned to a given taxon would be telling us more about fragmentation than an increase in representation of a taxon. The landmark is the best represented non-overlapping section of a given element, such that the element can only be counted once. The landmark is typically the most robust and distinctive portion of the element that is most useful for taxonomic separation. For example, for the dentary, it was the rostral portion that includes the symphysis border; for hyomandibula, it was the caudal process that articulates with the opercle; for articular/angular, it was the articular surface for the quadrate. Identifying the landmark is especially useful for vertebrae which can often be identified to element and taxon as fragments. The landmark for vertebrae was the opening for the notochord as seen on both faces of the centrum.

While vertebrate faunal analysts typically assign skeletal elements to side of body, we did not follow this practice with the fish remains study. Siding each paired element was possible in most cases, but as with many other analytic decisions in the project, it was decided that the information gained was not worth the labor required. One common reason for siding specimens is to allow calculation of minimum number of individuals (MNI), which is an estimate of the number of original animals that contributed to an assemblage. However, minimum animal unit (MAU, Binford, 1978) also estimates the number of individuals that contributed to a collection, but does not take side into account. For a given site aggregate (e.g., a unit-level, a chrono-stratigraphic zone, an entire site), one would be able to calculate the MAU for each taxon by summing the MNE, then dividing the total by the number of times the element occurs in the body.

Specimens which could not be identified to a taxon of fish, but which appeared to be from fish based on surface texture, were recorded as unidentified (fish).

All of the fish remains were examined to see if they had been burned. For many specimens, it was difficult to determine whether a dark color reflected exposure to heat, flecks of charcoal that attached to specimen surface, or staining that resulted from absorption of minerals in the surrounding matrix. The decision to call a specimen burned was based on conservative criteria: only those specimens which were uniformly black or calcined (white/blueish cast) were called burned.

All specimens from a given catalog number/provenience and mesh size, which shared the same attributes (e.g., taxon, skeletal element, thermal alteration), were tallied and recorded in aggregate, rather than recorded and bagged as individual specimens, given the large sample size. Thus, all fish remains from a given context with similar attributes were bagged together, with acid-free labels summarizing taxon, element, and burning information.

Specimens identified as mammal, bird, or invertebrate found in the fishbone bags were sent to the appropriate Co-Principle Investigator of the Čǐxʷicən project for analysis and not recorded during fishbone analysis. Artifacts (e.g., bone points, lithic debitage) were bagged separately and returned to the Burke Museum. Specimens that we could not assign to a specific animal group, or that we determined were not animal at all (e.g. wood, rock), were not recorded, but were bagged separately and kept with the fish remains. Appendix 2 summarizes all the protocols related to transferring specimens from laboratory to laboratory.

Analysis and recording were a team effort with protocols set up to promote as few errors as possible. Over the ~3 year period of analysis, one or more PSU Master's students -- Anthony Hofkamp, Kathryn Mohlenhoff, Reno Nims, Shoshana Rosenberg, and Laura Syvertson -- carried out initial sorting of remains. From a given bag/screen size fraction, the student poured the remains onto a tray, then sorted each specimen to a given grouping (e.g., same skeletal element, taxon, landmark, and burn category). The student left labels for assignments with each sorted set of remains. Butler then looked through each sorted group (and individual specimens) and verified, or often adjusted, the assignment. Identifications were typically assisted by magnification (2x – 40x) with a binocular loupe or microscope.

Following Butler's review, a student would then manually record the various analytic assignments, with all the catalog and provenience information, onto a spreadsheet. Records were then digitally recorded in Excel or Statistical Package for the Social Sciences (SPSS). Spreadsheets were printed out and proofed against the hand-written records. Then fish records were transferred to the Access database where they were further queried for coding errors associated with catalog numbers, provenience, and faunal identifications. Our database managers then linked chronozone assignments for each excavation area, unit and stratum to each bucket/catalog number. Excel files with this analytical information were then returned to the Butler lab for further analysis. Appendix 3 summarizes definitions for all the column headings/fields used for the Čí̓xʷicən fish remains database.

As part of insuring data quality and assessing potential for "protocol drift" over the 3-year project, Nims and Butler carried out a blind reanalysis, where they reanalyzed a sample of remains from three discrete stages of the analysis project (Nims and Butler, 2017). They found that results were highly consistent for most comparisons. Slight shifts in rank order representation of sculpin (Cottidae) taxa were found between stages; and frequency of burning varied by 9%. Overall, however, their results indicate high degree of reproducibility in results over the analysis period.

4. Descriptive summary of fish remains

The following section describes the basis for taxonomic identifications for particular skeletal elements assigned to taxonomic level and the criteria used to justify those decisions.

Class Chondrichthys – Cartilaginous fishes

Subclass Elasmobranchii

Material: 317 vertebra fragments, 6 indeterminate vertebrae: 323 specimens

Order Squaliformes – Dogfish sharks
Family Squalidae – Dogfish sharks
Squalus suckleyi – Pacific spiny dogfish

Material: 61 dorsal spines, 1 tooth, 1790 vertebra fragments, 565 indeterminate vertebrae: 2417 specimens.

Order Rajiformes
Family Rajidae – Skates

Material: 105 dermal denticles, 74 teeth, 256 vertebra fragments, 95 indeterminate vertebrae: 530 specimens.

Remarks: Elasmobranchs are represented by seven orders and 12 families in the Salish Sea (Pietsch and Orr, 2015). Most of their skeleton is cartilaginous. Hard parts that are likely to occur in archaeological sites consist of calcified vertebrae, dorsal spines, dermal denticles, and teeth; all were found in Čί̓xʷicən. While the reference collection lacks examples from most of the sharks and rays known for the area, distinctive morphology of the parts identified to *Squalus suckleyi* (Pacific spiny dogfish) and *Rajidae* (skates) suggests the identifications are valid. Spiny dogfish are the only species in the squalid family known for the north Pacific, so archaeological specimens closely resembling spiny dogfish were assigned to this species. Three genera and five species of skates are known for the Salish Sea (Pietsch and Orr, 2015). Two species are known from single modern specimens (*Bathyraja interrupta*; *Raja inornata*) (Pietsch and Orr, 2015), so the archaeological specimens are not likely from one of these. More likely the remains are from *Raja rhina* (longnose skate), *Beringraja binoculata* (big skate), or *Bathyraja kincaldii* (sandpaper skate), known for the Salish Sea (Pietsch and Orr, 2015). The reference collection only has examples of longnose skate. While the archaeological specimens closely match this species, the family level identification is assigned given limits to the reference collection.

Dogfish vertebrae are an elongate spool-shape, with a particularly wide opening for the notochord. A lightly built sheath of calcified cartilage covers the spool in life, but is absent in most archaeological specimens. Skate vertebrae are more compressed rostro-caudally, have a smaller opening for the notochord and have a more heavily built calcified sheath surrounding the centrum than dogfish vertebrae. When skate vertebrae break in half, this sheath can be seen as radiating struts that connect to each margin of the centrum, forming a star shape. Side-by-side photographs comparing dogfish shark vs. skate are shown in Fig. 4.

Spiny dogfish have a pair of distinctive spines located anterior to each dorsal fin. The dorsal spine on *Hydrolagus colliei* (spotted ratfish) is superficially similar, but dogfish spines have a deeper posterior groove and bear a dark, shiny enamel-like coating (see Fig. 5; also see Wheeler and Jones, 1989, Fig. 6.4b). Dogfish spines also lack the serrated border found on spotted ratfish dorsal spines.

Embedded in the skin of most elasmobranchs is a layer of distinctive scales known as dermal denticles, which are similar in structure to teeth, with "dentine internally covered by a layer of hard enamel" (Wheeler and Jones, 1989: 83). On dogfish, dermal denticles are extremely small, forming a sandpaper-like surface. Their small size means they would only tend to be recovered in archaeological sites when very fine mesh screens are used. None were recovered from Čί̓xʷicən. The surface of skates is covered by small dermal denticles along with relatively large dermal denticles located on the dorsal surface along the midline and in other patches as well. These prominent dermal denticles, sometimes called bucklers, typically have a robust base with a projecting hooked spine (Wheeler and Jones, 1989; Gravendeel et al., 2002). Archaeological examples of Rajidae bucklers from Čί̓xʷicən are shown in Fig. 6. The dermal denticles from Čί̓xʷicən closely resemble examples from *Raja rhina*, allowing for the taxonomic assignment to family.

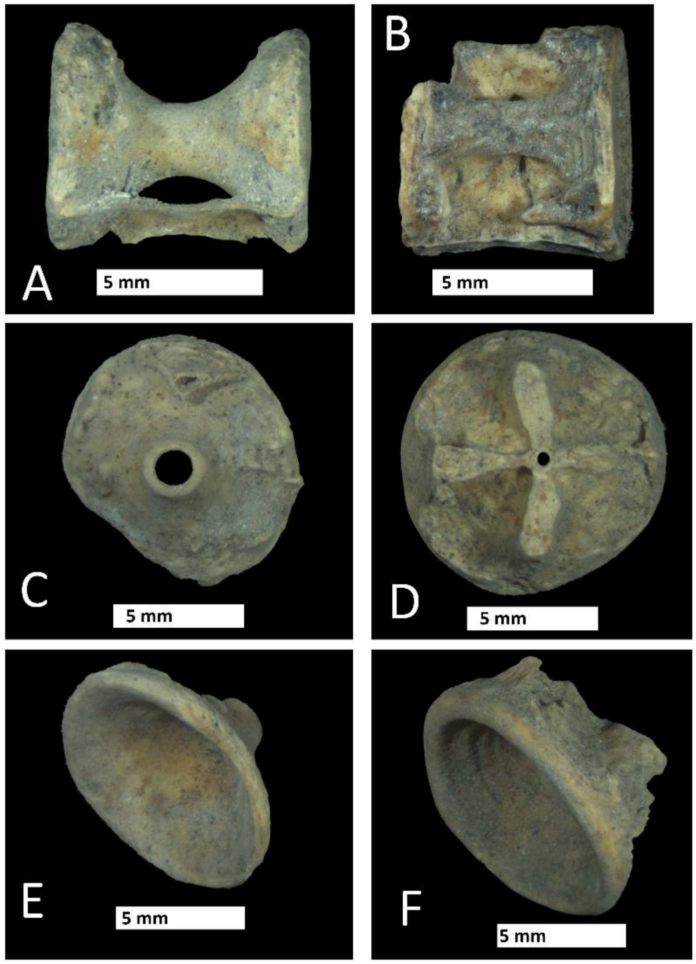

Fig. 4. Side-by-side comparison of archaeological vertebrae. Left- Pacific spiny dogfish (*Squalus suckleyi*), **A, C, E**, vs. Right- skate (Rajidae), **B, D, F**. Catalog numbers: **A**, WS-7045.99.04.23; **B**, WS-9306.99.04.23; **C, D, E, F**: WS-12145.99.04.23. Photographs by Anthony R. Hofkamp. Courtesy of the WSDOT, Čǐxʷicən Site.

Many elasmobranchs have distinctive teeth, which allows for taxonomic assignment to at least family (e.g., Naylor and Marcus, 1994). Dogfish teeth are quite small, however, and only a single archaeological specimen was recovered, likely because the finest mesh size used was mainly 1/8" mesh. Skate teeth can be larger and thus more likely to be recovered at the site: these are characterized by a flattened pavement-like surface with blunt crowns useful for crushing invertebrates. At the base of each tooth are two pedestals that affix the tooth to the jaw. Archaeological and modern examples of shark and skate teeth are provided in Fig. 7.

Extremely eroded complete vertebrae or vertebra fragments that were clearly from calcified centra but which could not be assigned to dogfish or skate were assigned to the subclass elasmobranch.

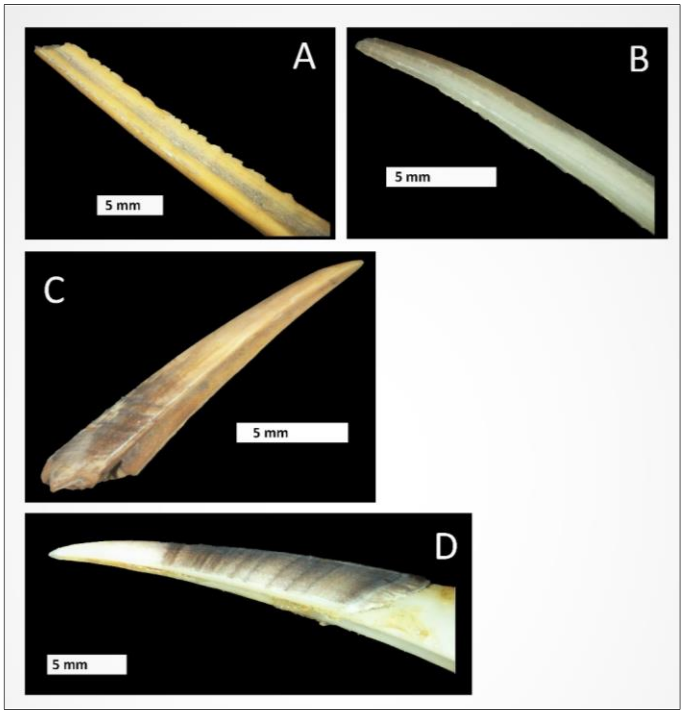

Fig. 5. Comparison of dorsal spines from spotted ratfish (*Hydrolagus colliei*), **A** (archaeological), **B** (modern); and Pacific spiny dogfish (*Squalus suckleyi*), **C** (archaeological), **D** (modern). Catalog numbers: **A**, WS-15993.99.04.23; **B**, VLB85-10-1; **C**, WS-9139.99.08.23; **D**, Kopperl Skeleton, no catalog number. Photographs by Anthony R. Hofkamp. Courtesy of the WSDOT, Čícxʷicən Site.

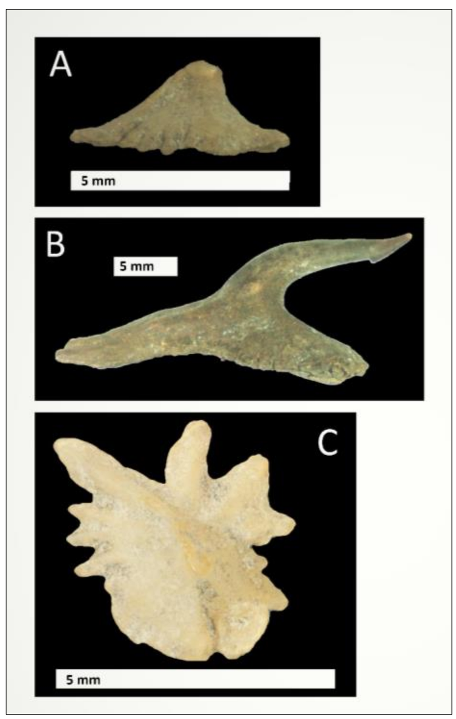

Fig. 6. Archaeological examples of skate (Rajidae) dermal denticles. **A** and **B** - side views, **C** - plan view. Catalog numbers: **A,** WS-13495.99.08.23; **B**, WS-8358.99.04.23; **C**, WS-13495.99.08.23. Photographs by Anthony R. Hofkamp. Courtesy of the WSDOT, Čícxʷicən Site.

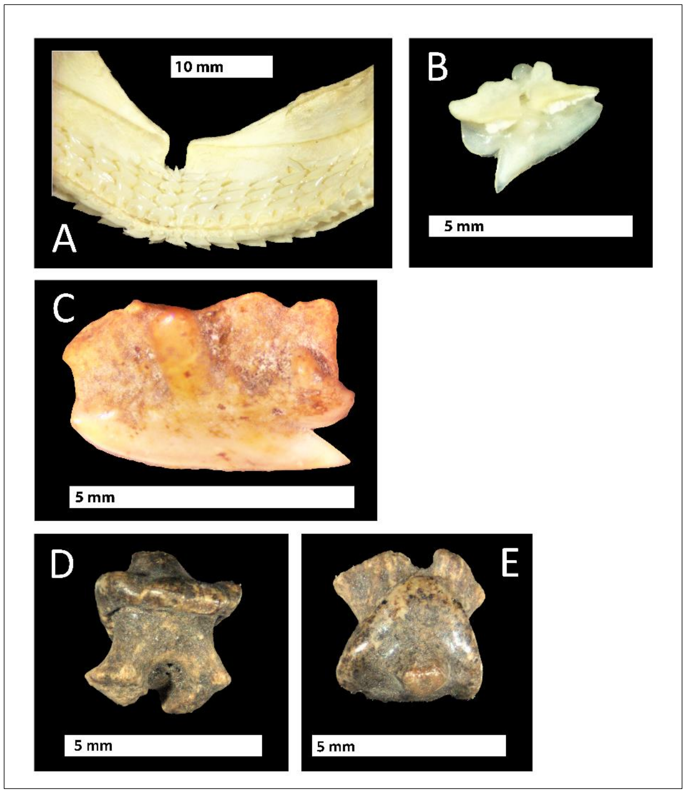

Fig. 7. Comparison of teeth. **A, B, C** from Pacific spiny dogfish (*Squalus suckleyi*): vs. **D, E**. skate (Rajidae). **A**, dogfish mandible, showing teeth *in situ*; **B**, single tooth extracted from mandible. Both from modern Kopperl skeleton, no catalog number; **C** (archaeological) dogfish tooth, WS-4807.99.08.23; **D, E** (archaeological), WS-4807.99.08.23, same specimen, different angles shown. Photographs by Anthony R. Hofkamp. Courtesy of the WSDOT, Čížʷicən Site.

Subclass Holocephali
Order Chimaeriformes – Chimaeras or ratfishes
Family Chimaeridae – Chimaeras or ratfishes
Hydrolagus colliei – Spotted ratfish

Material: 102 palatine tooth plates, 119 vomerine tooth plates, 114 mandibular tooth plates, 35 misc. tooth plates, 6 dorsal spines: 376 specimens.

Remarks: *Hydrolagus colliei* is the only member of this family of cartilaginous fishes found in the north Pacific. The distinctive morphology of the hard parts found on an individual fish – six tooth plates occurring in three pairs and a single dorsal spine – allowed for species identification (Fig. 5, Fig. 8). The tooth plates are relatively thick and have sharp anterior edges that form nipping blades (Didier, 1995, see Fig. 33 for nomenclature). One pair of plates is in the lower jaw (mandibular tooth plates); these meet at the mid-line and occlude with the vomerine tooth plates, roughly rectangular incisor-like structures located at the anterior edge of the upper jaw (Didier et al., 2012). Together the vomerine and mandibular tooth plates form a beak-like bite. The roughly triangular palatine tooth plates are posterior to the vomerine plates; they lie flat on the roof of the mouth and occlude with the tongue and posterior edges of the mandibular plate (Didier, 1995). The tooth plates of all chimaerids are comprised of "trabecular dentine," a mineralized network of tissue through which blood vessels pass (Didier, 1995). Two forms of hypermineralized tissue comprise a tooth plate: rods –that appear as beads or pearls on a string and pads located at the center of the tooth plate (Didier, 1995). This unique construction and form allow ratfish tooth plates to be identified even when heavily eroded (Fig. 8E).

A single dorsal spine, triangular in cross-section, is located on the anterior margin of the first and most prominent dorsal fin. The spine is less robust than that of dogfish; it has two rows of serrations along the posterior border (Didier et al., 2012); and lacks the dark, glossy, enamel-like surface on the anterior side of dogfish spines (Fig. 5).

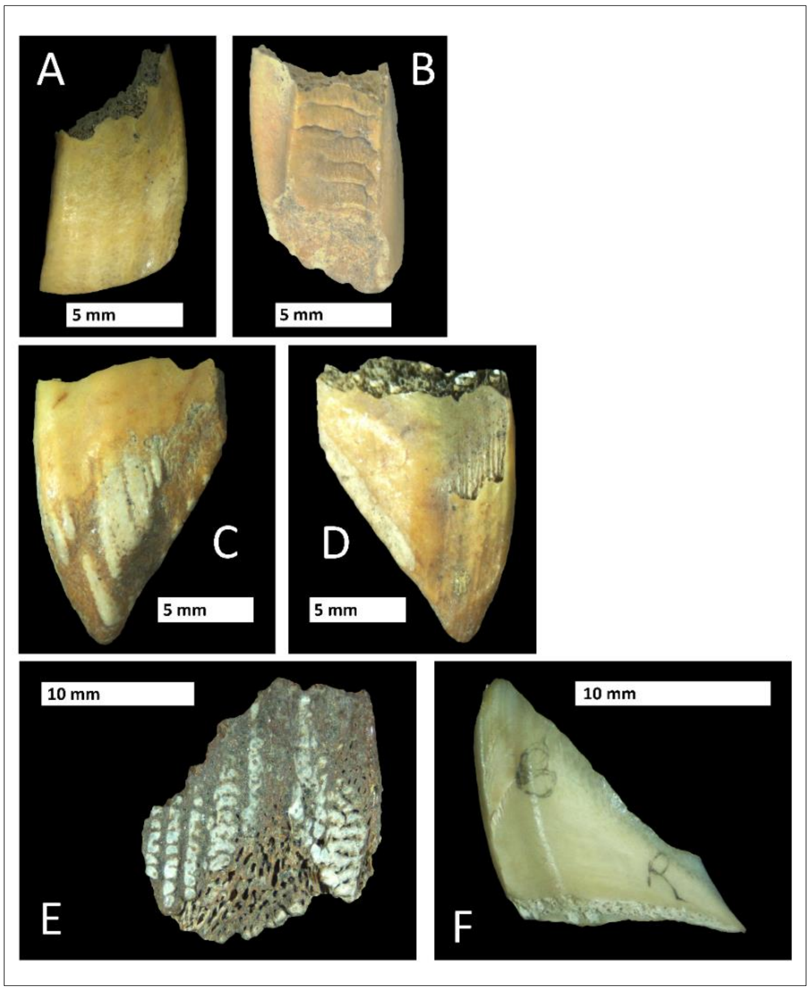

Fig. 8. Spotted ratfish (*Hydrolagus colliei*) tooth plates. **A, B**- vomerine; **C, D**, palatine; **E, F** mandibular. **A-D** (archaeological), Catalog number, WS-9306.99.04.23; **E** (archaeological), Catalog number, WS-8205.99.08.23. **F** (modern), VLB85-10-1. Photographs by Anthony R. Hofkamp. Courtesy of the WSDOT, Čix̌ʷicən Site.

Class Actinopterygii – Ray-finned fishes
Subclass Neopterygii
Order Clupeiformes -- Herrings

Material: 4473 prootic/pterotics, 3 quadrates, 1 urohyal: 4477 specimens.

Family Clupeidae – Herrings and sardines
Clupea pallasii – Pacific herring

Material: 208 angular/articulars, 83 basioccipitals, 370 ceratohyals, 434 dentaries, 143 epihyals, 115 hyomandibulae, 93 maxillae, 313 opercles, 13 premaxillae, 27 preopercles, 122 quadrates, 117 subopercles, 50 supraoccipitals, 12 urohyals, 23 basipterygia, 162 cleithra, 15 posttemporals, 48 supracleithra, 369 1st/2nd vertebrae, 22,710 indeterminate vertebrae, 257 vertebra fragments: 25,684 specimens.

Engraulidae – Anchovies
Engraulis mordax – Northern anchovy

Material: 1 dentary, 8 1st vertebrae, 26 indeterminate vertebrae: 35 specimens.

Remarks: Clupeiformes is represented by two families in the north Pacific: Clupeidae (herrings) and Engraulidae (anchovies). Two species in the herring family, *Clupea pallasii* (Pacific herring) and *Sardinops sagax* (Pacific sardine) and a single species of anchovy, *Engraulis mordax*, are noted for the Salish Sea (Pietsch and Orr, 2015). Pacific sardine, however, is extremely uncommon historically in the Salish Sea and there is some question about whether the fish even spawns there (Pietsch and Orr, 2015). The Clupeiformes order is notable for having a highly modified apparatus at the rear of the neurocranium that is functionally linked to the swim-bladder and lateral line system, serving as an acoustic sensory organ and perhaps regulating buoyancy (Allen et al., 1976). This distinct anatomy is revealed in two pairs of neurocranial elements, the prootic and the pterotic, which are characterized by a hollow bulla surrounded by a small border of spongy bone (Fig. 9). When the elements are complete and well-preserved, the prootic and pterotic can be distinguished, but the differences are subtle on eroded specimens. Given the huge number of fish remains from the site overall and the need to maximize information gained for effort, the prootic and pterotic were recorded together as "otics". In addition, the otics from herring, sardines, and anchovy are difficult to distinguish, and thus all the otics were assigned to the Clupeiformes order.

While several quadrates and a single urohyal were assigned to Clupeiformes given their eroded condition, most vertebrae and other skeletal elements are distinct across species in the order and could be assigned to species. The 1st and 2nd vertebrae of *Clupea pallasii* are similar in being compressed rostro-caudally and having a distinct notch on their dorsal border; and thus, these first two vertebrae were recorded together as 1st-2nd vertebrae (Fig. 10). Gobalet et al. (2004) highlight differences between the first three vertebrae of Pacific herring and sardines. The 1st vertebra of anchovy is clearly distinct from other species in the order, with the rostral end having a rounded projection with a central small opening (Fig. 11). Given the overwhelming dominance of *Clupea pallasii* relative to anchovy, most of the remains identified to the Clupeiformes order are probably this species as well.

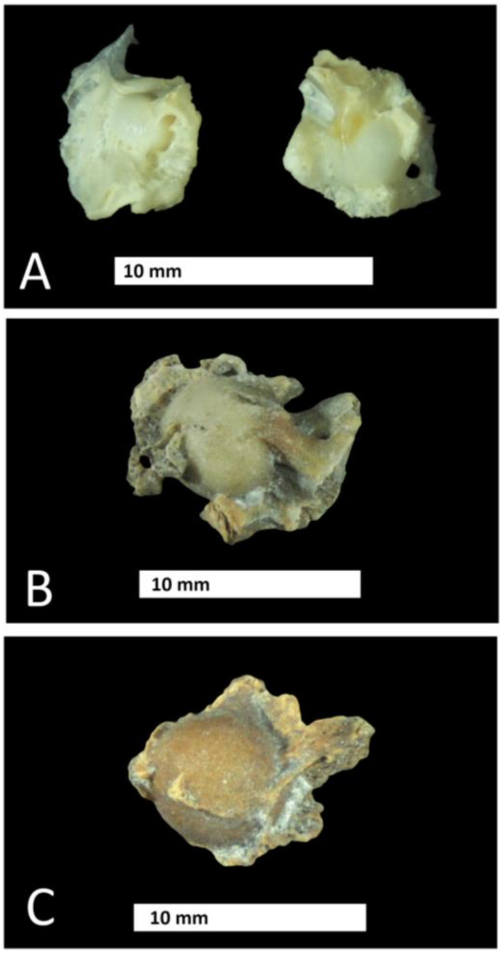

Fig. 9. Prootic and pterotic (= otics) from Pacific herring (*Clupea pallasii*). **A** (modern), Catalog number PSU 07-1-17; **B, C** (archaeological), Catalog number, WS-9139.99.08.23. Photographs by Anthony R. Hofkamp. Courtesy of the WSDOT, Číxʷicən Site.

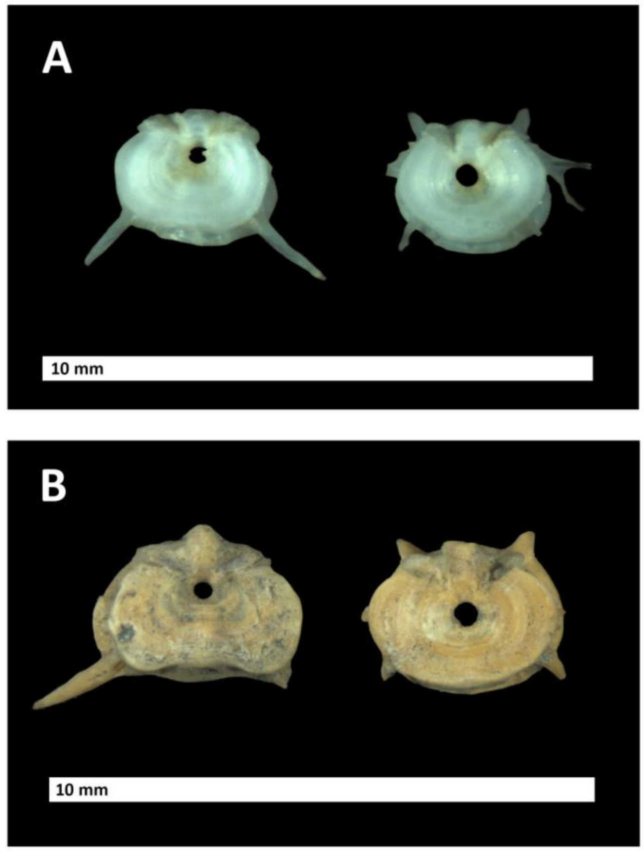

Fig. 10. Contrasting first (left) and second (right) vertebrae from Pacific herring (*Clupea pallasii*). **A** (modern), PSU 07-1-17; **B** (archaeological), Catalog number, WS-9144.99.99.23. Photographs by Anthony R. Hofkamp. Courtesy of the WSDOT, Číxʷicən Site.

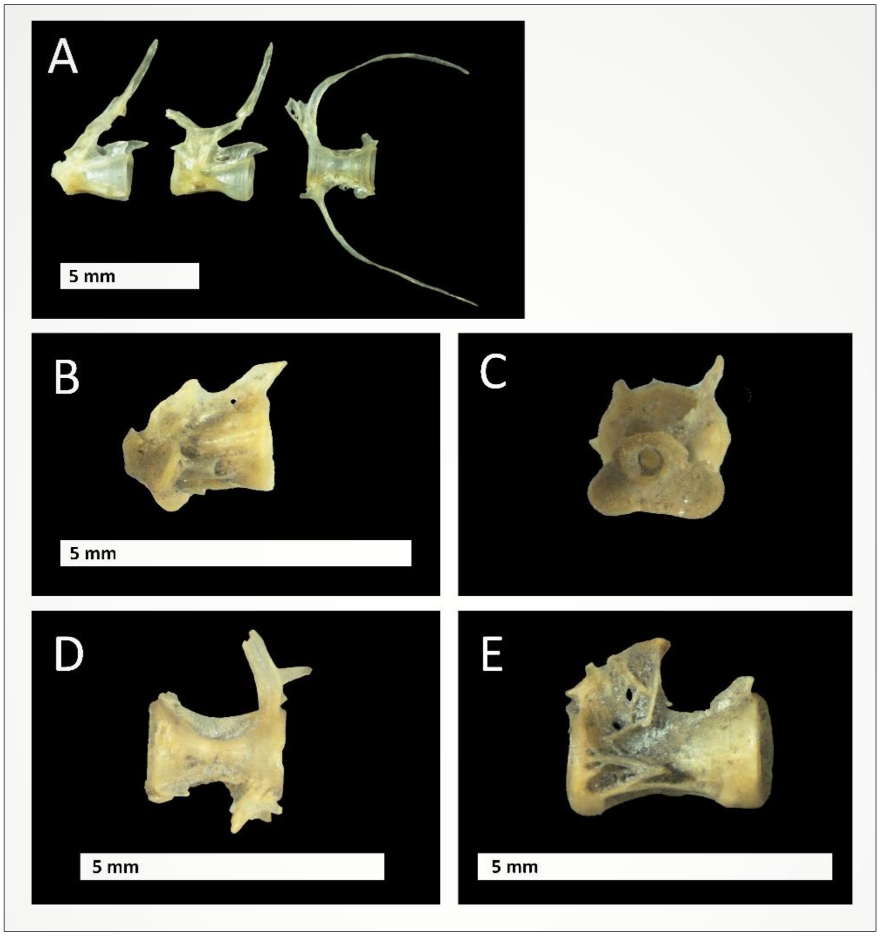

Fig. 11. Northern anchovy (*Engraulis mordax*) vertebrae. **A** (modern), left – first vertebrae; middle - abdominal; right – caudal vertebra. Kopperl Skeleton F97. **B, C** (archaeological), first vertebra. **B** is lateral view; **C** is view of rostral end looking caudally. Note in **C**, the distinctive opening on the rostral face. **D** and **E** are two examples of abdominal vertebrae (not differentiated in our records). Archaeological- Catalog number, WS-10609.99.99.23. Photographs by Anthony R. Hofkamp. Courtesy of the WSDOT, Čǐxʷicən Site.

Order Osmeriformes – Freshwater smelts
Family Osmeridae – Smelts

Material: 1 indeterminate vertebra.
Remarks: Six species in the smelt family are known for the Salish Sea (Pietsch and Orr, 2015). Smelt vertebrae are small and lightly built like Clupeiformes, but quite distinct in having a very large canal through the centrum, the passage for the notochord (Gobalet et al., 2004).

Order Salmoniformes -- Trouts
Family Salmonidae – Trout and salmons (includes chars/whitefishes)

Material: 1 vertebra type 1, 3 vertebra type 2: 4 specimens.

Oncorhynchus sp.

Material: 2 angular/articular, 4 basioccipitals, 1 ceratoyhyal, 2 dentaries, 1 maxilla, 1 palatine, 1 parasphenoid, 1 quadrate, 1 vomer, 53 basipterygia, 2 coracoids, 3 mesocoracoid, 17 pectoral fin rays, 7 postcleithra, 2 posttemporals, 14 scapulae, 18 type 1 vertebra, 614 type 2 vertebrae, 738 type 3 vertebrae, 66 type 4 vertebra, 34 vertebra type indeterminate, 1769 vertebra fragments, 3 caudal bony plates, 8 ultimate vertebrae/hypurals, 84 dorsal vertebral spines: 3446 specimens.

cf. *Salvelinus malma* – Dolly Varden

Material: 1 vertebra type 1.

Remarks: Seven species of salmon and trout (genus *Oncorhynchus*) that include anadromous and resident freshwater forms and two species of trout that strictly occupy freshwater streams (*Salvelinus confluentus* – bull trout; *S. malma* – Dolly Varden) are native to the Salish Sea (Pietsch and Orr, 2015). Two species of whitefishes in the salmonid family (*Prosopium williamsoni* and *P. coulteri*) are known for streams and rivers of western Washington State (Wydoski and Whitney, 2003). In general, *Salvelinus* and *Prosopium* tend to be much smaller than the anadromous forms of *Oncorhynchus*. Moreover, *Oncorhynchus* vertebrae have a fenestration pattern that tends to uniformly surround the centrum, which distinguishes their vertebrae from other salmonids and other fish orders entirely, even as small fragments. However, because vertebrae from other species (e.g., *Anoplopoma fimbria*, *Lepotocottus armatus*) also show fenestration patterns (Nims, 2016), the presence of fenestrated centrum fragment alone was insufficient for identifying *Oncorhynchus* vertebra fragments. Specimens needed to have a remnant of the lip that rings the rostral and caudal borders, or neural or haemal spine, or the orifice for the neural/haemal spine for vertebra type 2 (Nims, 2016) (Fig. 12). Specimens were assigned to Salmonidae, when size and fenestration criteria were ambiguous. The single vertebra assigned to cf. *Salvelinus malma* closely matches a Dolly Varden comparative specimen (Fig. 13).

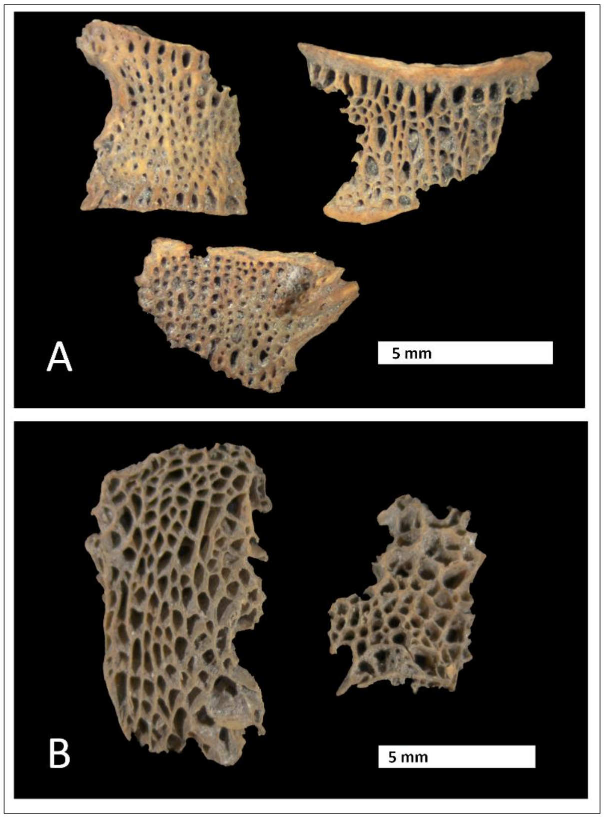

Fig. 12. Comparison of fenestrated fishbone fragments, all archaeological. **A**, identified as *Oncorhynchus*, with the remnant of the lip that rings the rostral and caudal borders, or the orifice for the neural/haemal spine for vertebra type 2; **B**, recorded as unidentified fish. Catalog number, WS-14677.99.08.23. Photographs by Anthony R. Hofkamp. Courtesy of the WSDOT, Čǐxʷicən Site.

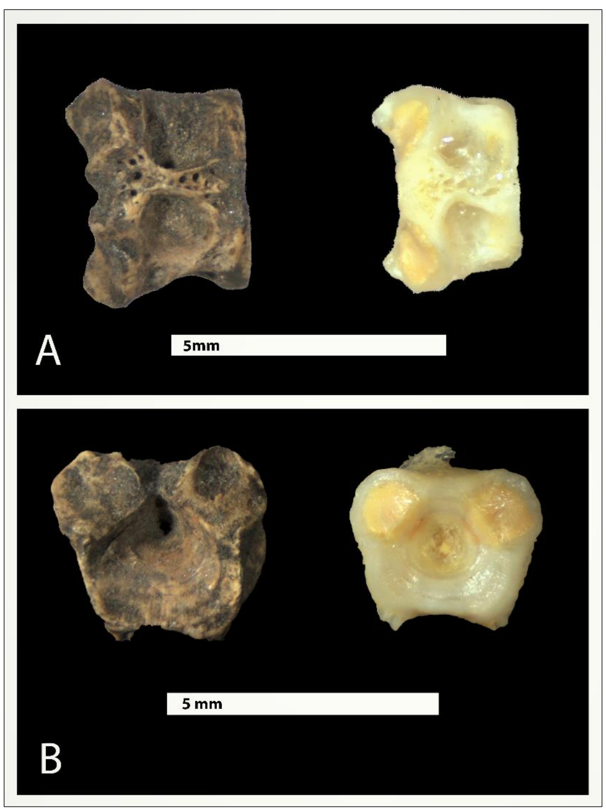

Fig. 13. Comparison of archaeological (left) vs. modern Dolly varden (*Salvelinus malma*) (right), first vertebra (vertebra type 1). **A** is view of dorsal margin looking ventrally. **B** is view of rostral face looking caudally. Archaeological - Catalog number, WS-112.99.08.23. Modern- Catalog number, VLB85-7-2. Photographs by Anthony R. Hofkamp. Courtesy of the WSDOT, Čǐxʷicən Site.

Order Gadiformes – Cods
Family Gadidae – Cods

Material: 11 articulars/angulars, 11 basioccipitals, 7 dentaries, 3 epihyals, 2 hyomandibulae, 13 maxillae, 2 opercles, 2 palatines, 5 parasphenoids, 19 premaxillae, 11 quadrates, 15 vomer, 8 posttemporals, 15 supracleithra, 38 indeterminate vertebrae, 285 vertebra fragments, 39 1st vertebrae, 1115 abdominal vertebrae, 1298 caudal vertebrae: 2899 specimens.

Microgadus proximus – Pacific tomcod

Material: 9 articulars/angulars, 13 basioccipitals, 3 ceratohyals, 1 dentary, 9 maxillae, 19 premaxilla, 1 opercle, 1 otolith, 4 palatines, 9 parasphenoids, 1 quadrate, 9 vomers, 3 posttemporal, 26 1st vertebrae, 652 abdominal vertebrae, 226 caudal vertebrae, 38 indeterminate vertebrae, 3 vertebra fragments: 1027 specimens.

Gadus macrocephalus – Pacific cod

Material: 48 angulars/articulars, 15 basioccipitals, 2 ceratohyals, 67 dentaries, 15 epihyals, 7 hyomandibulae, 107 maxillae, 10 opercles, 67 otoliths, 46 palatines, 6 parasphenoids, 6 preopercles, 195 premaxillae, 97 quadrates, 76 vomers, 1 basipterygium, 5 cleithra, 115 posttemporals, 2 scapulae, 43 supracleithra: 930 specimens.

Family Merlucciidae – Merluccid hakes
Merluccius productus – Pacific hake

Material: 5 indeterminate vertebrae: 5 specimens.

Remarks: Four species found in two families of the Gadiformes order are known and common in the Northeast Pacific and the Salish Sea in particular. The Gadidae family is represented by Pacific cod (*Gadus macrocephalus*), walleye pollock (*Gadus chalcogrammus*) and Pacific tomcod (*Microgradus proximus*); while Merlucciidae is represented by a single species, *Merluccius productus* (Pietsch and Orr, 2015; Hart, 1973). Hake remains are clearly distinct from skeletal parts of other members of the order, and allowed confident assignment of vertebrae to this species. As well, the skeletal anatomy (from the head, fins, and vertebrae) of relatively small-bodied Pacific tomcod is distinct from Pacific cod and walleye pollock, allowing remains from tomcod to be isolated from the rest of the family. Close comparison of walleye pollock and Pacific cod skeletal elements associated with the head and paired fins showed clear differences as well, for example, in the dentary, premaxilla, and vomer, the arrangement of teeth and overall shape of the element. Vertebrae from walleye pollock and Pacific cod could not be easily distinguished, however, and thus archaeological examples were assigned to the gadid family. As well, fragmentary and eroded elements from the cranium and paired fins that could not be assigned to Pacific cod or walleye pollock were assigned to gadid. Given that walleye pollock was not identified in the assemblage, and tomcod remains were distinguished from other gadid remains, all the materials assigned to gadid are likely from Pacific cod, given its prominence in site deposits. Pacific cod premaxilla and maxilla were especially abundant; archaeological examples are shown in Fig. 14.

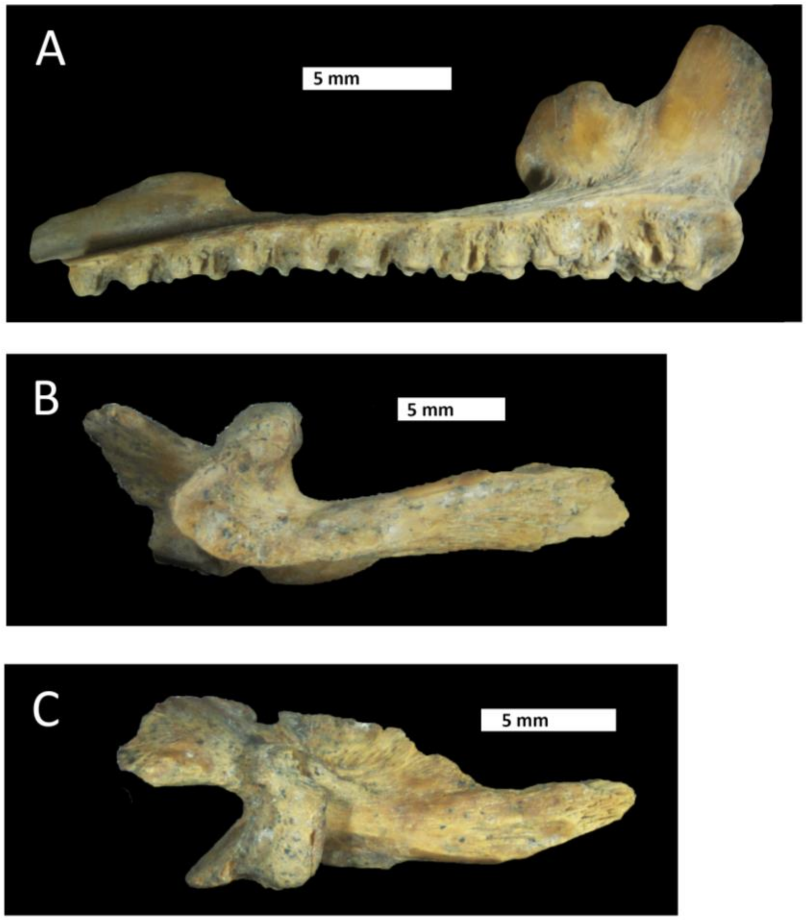

Fig. 14. Archaeological examples of Pacific cod (*Gadus macrocephalus*). **A**, right premaxilla, lateral view. **B** and **C**, left maxilla, same specimen two views. Catalog number, WS-9306.99.04.23. Photographs by Anthony R. Hofkamp. Courtesy of the WSDOT, Čı́xʷicən Site.

Order Scorpaeniformes – Mail-cheeked fishes
Scorpaenidae – Scorpionfishes
Sebastes sp. – Rockfishes

Material: 4 angular/articulars, 4 basioccipitals, 4 ceratohyals, 3 dentaries, 5 epihyals, 2 hyomandibulae, 2 maxillae, 1 opercle, 2 palatines, 3 parasphenoids, 7 premaxillae, 3 preopercles, 1 urohyal, 5 vomers, 4 basipterygia, 5 posttemporals, 4 supracleithra, 7 1st vertebrae, 70 indeterminate vertebrae, 4 vertebra fragments: 140 specimens.

Remarks: Scorpaenidae is represented by two genera and 28 species in the Salish Sea: S*ebastes* (27 species) and *Sebastolobus* (one species) (Pietsch and Orr, 2015). The skeleton of *Sebastolobus* is much more lightly built than that of *Sebastes*; and the archaeological specimens assigned to *Sebastes* closely resemble the Portland State University comparative skeletons. Species identifications using skeletal morphology are not currently possible given the large number of species; recent aDNA of archaeological rockfish remains from Vancouver Island provided species level identification (Rodrigues et al., 2018).

Family Anoplopomatidae – Sablefishes
Anoplopoma fimbria – Sablefish

Material: 4 angular/articulars, 4 basioccipitals, 1 ceratohyal, 1 dentary, 4 maxillae, 5 premaxillae, 2 quadrates, 91 1st vertebrae, 3078 indeterminate vertebrae, 169 vertebra fragments: 3359 specimens.

Remarks: A single sablefish species in the family is known for the Salish Sea, *Anoplopoma fimbria* (Pietsch and Orr, 2015). The skeleton of sablefish – especially elements from the cranium and paired fins – are lightly built, with a very open structure. Except for the 1st vertebra, centra are round, have a fully fenestrated texture, and are more lightly built than vertebrae from other Scorpaeniformes taxa. Vertebra fragments lacking spurs for neural and haemal spines can be confused with salmonids and cottid vertebrae (Nims, 2016), and were not identified to taxon. Nims (2016) includes photographs of sablefish vertebrae and other taxa that have vertebrae with similar texture and form.

Family Hexagrammidae – Greenlings
Material: 1 premaxilla, 1 1st vertebra, 55 indeterminate vertebrae, 3 vertebra fragments: 60 specimens.

Hexagrammos sp.

Material: 16 angular/articulars, 3 basioccipitals, 8 ceratohyals, 13 dentaries, 2 epihyals, 15 hyomandibulae, 7 maxillae, 1 opercle, 8 palatines, 6 parasphenoids, 2 premaxillae, 3 preopercles, 28 quadrates, 13 vomers, 2 basipterygia, 10 posttemporals, 5 supracleithra, 11 1st vertebrae, 124 indeterminate vertebrae, 2 vertebra fragments: 279 specimens.

Ophiodon elongatus – Lingcod

Material: 2 angular/articulars, 9 basioccipitals, 3 dentaries, 4 hyomandibulae, 2 maxillae, 1 opercle, 1 palatine, 8 quadrates, 7 vomers, 1 urohyal, 2 basipterygia, 3 posttemporals, 6 supracleithra, 6 1st vertebrae, 164 abdominal vertebrae, 107 caudal vertebrae, 37 indeterminate vertebrae, 14 vertebra fragments: 377 specimens.

Remarks: Hexagrammidae is represented by four genera and six species in the Salish Sea (Pietsch and Orr, 2015). Three species are in the genus *Hexagrammos* (*H. decagrammos*, *H. lagocephalus*, *H. stelleri*). Two genera in the Salish Sea are monospecific: *Ophiodon elongatus* (lingcod) and *Oxylebius pictus* (painted greenling), while *Zaniolepis latipinnis* (longspine combfish) is the only species of *Zaniolepis* from the Salish Sea. Comparative specimens from *Oxylebius, Zaniolepis* and *H. stelleri* were not available so identifications are somewhat provisional. Most skeletal elements from *Hexagrammo*s and *Ophiodon* are distinct allowing for separation of the archaeological specimens to these taxa. Also, since lingcod can attain over twice the size of *Hexagrammos* species, extremely large archaeological specimens were assigned to lingcod. Specimens assigned to Hexigrammidae were too fragmentary or eroded to assign to a finer taxon.

Family Cottidae – Sculpins

Material: 11 angular/articulars, 10 basioccipitals, 1 ceratohyal, 19 dentaries, 4 epihyals, 6 hyomandibulae, 4 maxillae, 1 opercle, 3 palatines, 3 parasphenoids, 13 premaxillae, 3 preopercles, 12 quadrates, 7 vomers, 1 basipterygium, 1 posttemporal, 7 1st vertebrae, 309 indeterminate vertebra, 22 vertebra fragments: 437 specimens.

Enophrys bison – Buffalo sculpin

Material: 31 angular/articulars, 24 basioccipitals, 4 ceratohyals, 13 dentaries, 4 epihyals, 33 hyomandibulae, 14 maxillae, 39 opercles, 13 palatines, 6 parasphenoids, 12 premaxillae, 45 preopercles, 23 quadrates, 25 vomers, 1 basipterygium, 5 cleithra, 43 posttemporals, 43 supracleithra, 35 1st vertebrae, 543 indeterminate vertebrae, 10 vertebra fragments, 248 lateral line scales: 1214 specimens.

Hemilepidotus sp. – Irish lord

Material: 24 angular/articulars, 33 basioccipitals, 23 ceratohyals, 49 dentaries, 21 epihyals, 39 hypomandibulae, 40 maxillae, 29 opercles, 27 palatines, 13 parasphenoids, 38 premaxillae, 14 preopercles, 23 quadrates, 43 vomers, 17 basipterygia, 9 cleithra, 18 posttemporals, 29 supracleithra, 6 1st vertebrae: 495 specimens.

Scorpaenichthys marmoratus – Cabezon

Material: 1 basioccipital, 1 hyomandibula, 1 palatine, 1 cleithrum, 1 1st vertebra, 10 indeterminate vertebrae: 15 specimens.

Hemilepidotus sp./*Scorpaenichthys* sp.

Material: 1 dentary, 20 1st vertebrae, 745 indeterminate vertebrae, 5 vertebra fragments: 771 specimens.

Leptocottus armatus – Pacific staghorn sculpin

Material: 87 angular/articulars, 91 basioccipitals, 33 ceratohyals, 38 dentaries, 5 epihyals, 90 hyomandibulae, 20 maxillae, 64 opercles, 28 palatines, 4 parasphenoids, 41 premaxillae, 72 preopercles, 91 quadrates, 39 vomers, 2 basipterygia, 47 posttemporals, 12 supracleithra, 94 1st vertebrae, 1744 indeterminate vertebrae, 9 vertebra fragments: 2611 specimens.

Myoxocephalus polyacanthocephalus – Great sculpin

Material: 15 angular/articulars, 19 basioccipitals, 5 ceratohyals, 19 dentaries, 6 epihyals, 11 hyomandibulae, 21 maxillae, 12 opercles, 3 palatines, 14 paraphenoids, 17 premaxilla, 16 preopercles, 14 quadrates, 17 vomers, 3 basipterygia, 4 cleithra, 13 posttemporal, 13 supracleithra, 42 1st vertebrae, 538 indeterminate vertebrae, 18 vertebra fragments: 820 specimens.

Remarks: Sculpins are a large family of bottom dwelling fish, ranging in length from approximately 5 cm to over 1 m. They are numerous in the northern Pacific, especially in shallow water (Eschmeyer et al., 1983), and on the rocky bottom in kelp forests (Hart, 1973). Of the 34 sculpin species (18 genera) documented for the Salish Sea (Pietsch and Orr, 2015), most are extremely small (less than 10 cm long) (Hart, 1973). Skeletons for the five genera representing the largest sculpins from the Salish Sea were available for comparative analysis: Pacific staghorn sculpin (*Leptocottus armatus*), buffalo sculpin (*Enophrys bison*), red Irish lord (*Hemilepidotus hemilepidotus*), great sculpin (*Myoxocephalus polyacanthocephalus*), and cabezon (*Scorpaenichthys marmoratus*). Reference skeletons also included examples of *Artedius*, *Chitonotus*, and *Cottus*. Most sculpin skeletal elements including vertebrae are quite distinct for the five genera. Four of the genera are represented by a single species in the Salish Sea, and on this basis, archaeological sculpin specimens were assigned to species if they closely conformed to the reference materials. As a reference skeleton for brown Irish lord (*H. spinosus*) was not available for study, all elements except vertebrae matching red Irish lord were identified to the genus *Hemilepidotus.* Vertebrae from *Hemilepidotus* and cabezon are difficult to distinguish, so the joint category, *Hemilepidotus* sp./*Scorpaenichthys* sp., was used for vertebrae from the two genera. Exceptions were made for extremely large vertebrae (>10 mm diameter), which were assigned to cabezon, as this species attains considerably larger size than *Hemilepidotus* (maximum total lengths from Fishbase [Froese and Pauly]): *Scorpaenichthys marmoratus*- 99 cm; *H. hemilepidotus* 51 cm; *H. spinosus* 29 cm). Specimens that did not precisely match any of the reference skeletons or which were fragmentary or eroded were assigned to the cottid family.

Particularly striking distinctions across species include: 1) preopercle spines which vary in number, position and shape; 2) buffalo sculpin has distinctive and very robust lateral line scales; 3) numerous elements of buffalo sculpin possess patches of highly rugose texture (opercle, preopercle, supracleithrum) unique for the species.

Family Agonidae – Poachers

Material: 1 scale

Remarks: The agonids or poachers are small bottom fishes that are represented by 16 species in 10 genera in the Salish Sea (Pietsch and Orr, 2015). The body of the fish is covered with robust bony scales. The single scale noted from Čı́xʷicən is roughly similar to *Xeneretmus triacanthus*, but since this species is the sole representative of the family in the reference collection, the attribution must be to the family level.

Order Perciformes – Perches
Family Embiotocidae – Surfperches

Material: 7 angular/articulars, 6 basioccipitals, 1 ceratohyal, 6 dentaries, 11 hyomandibule, 2 maxillae, 2 otoliths, 1 palatine, 5 parasphenoids, 43 pharyngeals, 3 premaxillae, 7 quadrates, 6 vomers, 3 basipterygia, 1 cleithrum, 5 posttemporals, 4 scapulae, 2 supracleithra, 26 1st vertebrae, 212 indeterminate vertebrae: 353 specimens.

Damalichthys vacca – Pile perch

Material: 15 pharyngeals.

Remarks: The surfperch or embiotocid family is represented by six species in six different genera in the Salish Sea (Pietsch and Orr, 2015); all six are documented for the Strait of Juan de Fuca. While skeletal elements from many of these distinct taxa may be distinguished with close analysis, most remains were assigned to family, because the reference collection was limited to just three taxa: *Damalichthys vacca* (pile perch), *Embiotoca lateralis* (striped sea perch), and *Cymatogaster aggregata* (shiner perch). The only element receiving focused attention was the pharyngeal, which on an individual fish, includes three distinct elements that are derived from modified gill arches: a pair of tooth plates in the roof of the oral cavity, articulating with the parasphenoid that occlude ventrally with one large plate with teeth on the dorsal surface. Pharyngeals of pile perch – both the overall form of the element and molariform teeth – are extremely distinctive even on eroded and fragmentary specimens. All of the pharyngeals were scrutinized closely and those resembling pile perch were recorded. The 43 pharyngeals assigned to the embiotocid family are *not pile perch,* but the species to which they belong is unknown.

Pholidae – Gunnels

Material: 3 indeterminate vertebrae.
Remarks: The gunnels are known from four genera and six species in the Salish Sea (Pietsch and Orr, 2015). Their vertebrae are lightly built and superficially resemble herring, but are distinct in that the horizontal bar on the lateral side of the centrum extends only mid-way from the rostral to the caudal end. The Čʼíxʷicən remains compare favorably with *Pholis ornata* (saddleback gunnel), but as the reference collection lacks two of the species known for the Salish Sea, sub-family identification was not possible.

Gobiesocidae – Clingfishes
Gobiesox maendricus – Northern clingfish

Material: 2 indeterminate vertebrae.
Remarks: The family of clingfishes is represented by a single family and species in the Salish Sea (Pietsch and Orr, 2015). The vertebrae have a unique form and closely match modern reference materials housed at University of Victoria, Department of Anthropology.

Order Pleuronectiformes – Flatfishes

Material: 19 angular/articulars, 58 basioccipitals, 14 ceratohyal, 8 dentaries, 4 epihyals, 62 hyomandibulae, 20 interhaemal spines, 4 maxillae, 2 opercles, 6 palatines, 5 parasphenoids, 11 premaxillae, 3 preopercles, 70 quadrates, 43 urohyals, 16 vomers, 17 cleithra, 30 posttemporals, 1 scapula, 6 supracleithra, 114 1st vertebrae, 3659 indeterminate vertebrae, 38 vertebra fragments: 4210 specimens.

Family Paralichthyidae – Sand flounders

Citharichthys sp. – Sanddab

Material: 5 angular/articulars, 19 basioccipitals, 11 dentaries, 18 hymandibulae, 12 maxillae, 1 palatine, 3 premaxillae, 1 quadrate, 11 vomers, 63 indeterminate vertebrae: 144 specimens.

Family Pleuronectidae – Righteye flounders

Material: 9 angular/articulars, 18 basioccipitals, 3 ceratohyal, 6 dentaries, 4 epihyals, 13 hymandibulae, 8 interhaemal spines, 8 maxillae, 8 palatines, 9 premaxillae, 2 parasphenoids, 14 quadrates, 6 urohyals, 20 vomers, 2 cleithra, 3 posttemporals, 4 supracleithra, 5 1st vertebrae, 22 indeterminate vertebrae: 164 specimens.

Atheresthes stomias – Arrowtooth flounder

Material: 1 articular/angular, 1 dentary, 1 indeterminate vertebra: 3 specimens.

Eopsetta jordani – Petrale sole

Material: 6 articular/angulars, 3 dentaries, 7 maxillae, 11 premaxillae: 27 specimens

Hippoglossus stenolepis – Pacific halibut

Material: 1 articular/angular, 1 hyomandibula, 1 maxilla, 4 indeterminate vertebrae, 1 vertebra fragment: 8 specimens.

Lepidopsetta bilineata – Southern rock sole

Material: 2 dentaries, 3 maxillae: 5 specimens.

Microstomus pacificus – Dover sole

Material: 3 dentaries, 1 maxilla: 4 specimens.

Platichthys stellatus – Starry flounder

Material: 14 articular/angulars, 9 dentaries, 8 maxillae, 5 premaxillae, 3 scales: 39 specimens.

Pleuronichthys coenosus – C-O sole

Material: 1 dentary.

Remarks: The flatfish order is represented by two main families in the Salish Sea: Pleuronectidae (righteye flounders) with 17 species in 16 genera; Paralichthyidae (sand flounders) is known for just two species in one genus, *Citharichthys,* the sanddabs (Pietsch and Orr, 2015) [A single record for a third family of flatfishes, the tonguefishes—Cynoglossidae, is noted for the Salish Sea]. Flatfishes tend to be found on the marine floor and are distinguished from other fish orders by their asymmetry: both eyes are located on one side of the head and in life, fish tend to rest with their "eyed" side up facing the water column and their "blind" side in contact with the bottom. This distinctive characteristic is manifest in the bony anatomy of the cranium and paired fins, such that paired elements from opposing sides of the body are morphologically distinct**.** As well, many unpaired elements of the head are asymmetrical in form, distinguishing them from other fishes.

Several criteria were used to assign flatfish elements to family within the order. Some skeletal elements from the two flatfish families can be distinguished because the asymmetry is different on each family. With righteye flounders, the right side is "eyed"; and for the sand flounders, the left side is "eyed", which as noted above, affects the skeletal morphology for many cranial and paired fin elements. An exception to this rule is the starry flounder (*Platichthys stellatus*), a species of righteye flounder that can grow to be eyed on the left side. Controlling for this condition, well-preserved cranial and paired fin elements from the family could be distinguished using distinctions in orientation/curvature of elements from the right and left side of the body. Apart from the asymmetry, many *Citharichthys* skeletal elements have distinct morphology that distinguishes them from righteye flounder species. Since only a single genus of sanddabs is present in the north Pacific, if a flatfish specimen was clearly not from *Citharichthys*—it was assigned to the righteye fish family. Finally, size was used to assign archaeological specimens to family. The largest of the sanddabs, *C. sordidus*, attain lengths of 40 cm, whereas several righteye flounders routinely reach lengths greater than 50 cm (*Platichthys stellatus*, *Psettichthys melanostictus, Microstomus pacificus*; and especially halibut [*Hippoglossus stenolepis*], which can reach over 200 cm in length). Thus, skeletal remains which were from fish clearly larger than 50 cm (based on comparison with reference skeletons from fish of known length), were placed in the Pleuronectidae family.

Pleuronectiformes vertebrae were distinguished from those of other fish orders based on several criteria. The vertebral centra of many flatfish species have laterally projecting processes emanating from the middle of the centrum border of the rostral/caudal face. When vertebrae are laid flat on either the rostral or caudal face, these processes give the vertebrae a distinctive "star shape." Another distinction especially on abdominal vertebrae is the position of the notochord opening which is slightly dorsal of the centrum center. On most bony fishes, the notochord opening is directly in the center of the centrum face.

Flatfish vertebrae were not assigned to taxa below order, except under the following circumstances. First, as noted above, vertebrae from fish that exceeded 50 cm in length were assigned to Pleuronectidae, given sand flounders do not attain lengths this great. Vertebrae were assigned to halibut if they were extremely large; or were compressed rostral/caudally (for anterior vertebrae); or relatively lightly built; or if they had distinctive, robust zygapophyses. Most vertebrae assigned to C*itharichthys* show a distinctive haemal spine with a bifurcated process, which is characteristic of the first two caudal vertebrae on the column.

Four jaw elements were targeted for study to determine which flatfish species were present: dentary, articular/angular, maxilla, and premaxilla. These were selected because of their relative abundance in the Číxʷicən assemblage and because skeletal elements associated with feeding often show species-specific characters given their link to evolutionary ecology. Time was spent closely comparing modern examples of jaw elements from 12 of the 19 species known for the Salish Sea (missing species include *Citharichthys stigmaeus, Pleuronichthys decurrens, Lepidopsetta polyxystra,* hybrid - *Parophrys vetulus x Platichthys stellaus, Lyopsetta exilis, Isopsetta isolepis, Inopsetta ischyra,* based on Pietsch and Orr, 2015). Many species diagnostic traits were found, including those that relate to the degree of curvature of the dentary and premaxilla, the shape and position of tooth alveoli, and the number and position of foramina on the labial side of the dentary and angular/articular. Given that skeletal materials from seven flatfish species were not included in comparative study, the uniqueness of the characters cannot be known with certainty; criteria applied to archaeological samples are somewhat provisional. Once all the Číxʷicən remains had been identified to at least order or family, these four elements were pulled from the assemblage and studied in one period of time to increase consistency in species assignments. Remains were compared against modern examples, and species were assigned based on distinctive characters.

A final bony structure was used in taxonomic assignments: the bony tubercle or scale that is distinct to starry flounder.

Endnotes

[1] An alternative spelling for the site name, Tse-whit-zen, has been used in some previous reports and publications. The Klallam language spelling, Číxʷicən (Montler, 2012), is preferred by the Lower Elwha Klallam Tribe.

[2] Only a small number of [small volume] bulk samples were collected in the 2004 mitigation, thus limiting our ability to consider the impact of using 1/8" mesh during field recovery. Multiple scholars have noted that remains of very small fish can only be recovered using mesh finer than 1/8 "(e.g., (Butler and Schroeder, 1998; Gobalet, 1989; Moss et al., 2017). As we note in this report, a substantial number of fish remains slipped through the 1/8" mesh during our re-screening process. Future work could study such remains, recognizing the limitations with sample and processing protocols.

[3] Kathryn Mohlenhoff's master's thesis that began before NSF funds were secured in 2012, studied fish remains from four 1x1 m contiguous units in Area A4 (Mohlenhoff, 2013; Mohlenhoff and Butler, 2017). Her project provided an opportunity to develop many of the protocols that were used for the larger project. All of the data from Mohlenhoff's project were folded into the larger database and findings (Butler et al., 2019b).

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Appendix 1. List of comparative fish skeletons used in analysis of Čĭ́xwicən fish remains.

Cat. No.	**Class**	**Order**	**Family**	**Genus**	**Species**	**Common Name**
PSU05-1-3	Actinopterygii	Acipenseriformes	Acipenseridae	Acipenser	transmontanus	White Sturgeon
VLB01-1-27	Actinopterygii	Acipenseriformes	Acipenseridae	Acipenser	transmontanus	White Sturgeon
VLB86-25-1	Actinopterygii	Batrachoidiformes	Batrachoididae	Porichthys	notatus	Plainfin Midshipman
VLB86-25-2	Actinopterygii	Batrachoidiformes	Batrachoididae	Porichthys	notatus	Plainfin Midshipman
VLB86-25-3	Actinopterygii	Batrachoidiformes	Batrachoididae	Porichthys	notatus	Plainfin Midshipman
VLB86-25-4	Actinopterygii	Batrachoidiformes	Batrachoididae	Porichthys	notatus	Plainfin Midshipman
VLB88-2-14	Actinopterygii	Batrachoidiformes	Batrachoididae	Porichthys	notatus	Plainfin Midshipman
VLB85-10-1	Actinopterygii	Chimaeriformes	Chimaeridae	Hydrolagus	colliei	Ratfish
VLB88-2-32	Actinopterygii	Chimaeriformes	Chimaeridae	Hydrolagus	colliei	Ratfish
PSU05-2-1	Actinopterygii	Clupeiformes	Clupeidae	Clupea	pallasii	Pacific Herring
PSU05-2-2	Actinopterygii	Clupeiformes	Clupeidae	Clupea	pallasii	Pacific Herring
VLB01-1-28	Actinopterygii	Clupeiformes	Clupeidae	Clupea	pallasii	Pacific Herring
VLB01-1-29	Actinopterygii	Clupeiformes	Clupeidae	Clupea	pallasii	Pacific Herring
VLB01-1-30	Actinopterygii	Clupeiformes	Clupeidae	Clupea	pallasii	Pacific Herring
PSU 07-1-17	Actinopterygii	Clupeiformes	Clupeidae	*Clupea*	pallasii	Pacific herring
PSU 07-1-16	Actinopterygii	Clupeiformes	Engraulidae	*Engraulis*	*mordax*	Northern anchovy
VLB01-1-33	Actinopterygii	Gadiformes	Gadidae	Gadus	macrocephalus	Pacific Cod
VLB01-1-34	Actinopterygii	Gadiformes	Gadidae	Microgadus	proximus	Pacific Tomcod
VLB85-4-1	Actinopterygii	Gadiformes	Gadidae	Microgadus	proximus	Pacific Tomcod
VLB85-4-14	Actinopterygii	Gadiformes	Gadidae	Gadus	macrocephalus	Pacific Cod
VLB85-4-2	Actinopterygii	Gadiformes	Gadidae	Microgadus	proximus	Pacific Tomcod
VLB86-23-15	Actinopterygii	Gadiformes	Gadidae	Theragra	chalcogramma	Walleye Pollack
VLB86-23-16	Actinopterygii	Gadiformes	Gadidae	Merluccius	productus	Pacific Hake
VLB88-2-6	Actinopterygii	Gadiformes	Gadidae	Theragra	chalcogramma	Walleye Pollack
VLB88-2-7	Actinopterygii	Gadiformes	Gadidae	Merluccius	productus	Pacific Hake
VLB88-2-8	Actinopterygii	Gadiformes	Gadidae	Merluccius	productus	Pacific Hake
VLB88-2-9	Actinopterygii	Gadiformes	Gadidae	Theragra	chalcogramma	Walleye Pollack
VLB93-1-3	Actinopterygii	Gadiformes	Gadidae	Lota	lota	Burbot
VLB88-2-15	Actinopterygii	Gadiformes	Zoarcidae	Lycodopsis	pacifica	Blackbelly Eelpout
VLB95-5-3	Actinopterygii	Gasterosteiformes	Gasterosteidae	Gasterosteus	aculeatus	Threespine Stickleback
VLB95-5-4	Actinopterygii	Gasterosteiformes	Gasterosteidae	Gasterosteus	aculeatus	Threespine Stickleback
VLB95-5-5	Actinopterygii	Gasterosteiformes	Gasterosteidae	Gasterosteus	aculeatus	Threespine Stickleback
VLB95-5-7	Actinopterygii	Gasterosteiformes	Gasterosteidae	Gasterosteus	aculeatus	Threespine Stickleback
VLB95-5-8	Actinopterygii	Gasterosteiformes	Gasterosteidae	Gasterosteus	aculeatus	Threespine Stickleback
VLB88-2-23	Actinopterygii	Perciformes	Bathymasteridae	Ronquilus	jordani	Northern Ronquil
VLB01-1-35	Actinopterygii	Perciformes	Embiotocidae	Damalichthys	vacca	Pile Perch
VLB01-1-36	Actinopterygii	Perciformes	Embiotocidae	Damalichthys	vacca	Pile Perch
VLB85-4-5	Actinopterygii	Perciformes	Embiotocidae	Damalichthys	vacca	Pile Perch

VLB85-4-6	Actinopterygii	Perciformes	Embiotocidae	Damalichthys	vacca	Pile Perch
VLB85-4-7	Actinopterygii	Perciformes	Embiotocidae	Damalichthys	vacca	Pile Perch
VLB85-4-8	Actinopterygii	Perciformes	Embiotocidae	Damalichthys	vacca	Pile Perch
VLB86-23-5	Actinopterygii	Perciformes	Embiotocidae	Cymatogaster	aggregata	Shiner Perch
VLB86-23-6	Actinopterygii	Perciformes	Embiotocidae	Cymatogaster	aggregata	Shiner Perch
VLB86-23-7	Actinopterygii	Perciformes	Embiotocidae	Cymatogaster	aggregata	Shiner Perch
VLB88-2-26	Actinopterygii	Perciformes	Embiotocidae	Cymatogaster	aggregata	Shiner Perch
VLB88-2-4	Actinopterygii	Perciformes	Embiotocidae	Damalichthys	vacca	Pile Perch
VLB88-2-5	Actinopterygii	Perciformes	Embiotocidae	Embiotoca	lateralis	Striped Seaperch
PSU 07-1-1	Actinopterygii	Perciformes	Embiotocidae	*Damalichthys*	*vacca*	Pile Perch
PSU 07-1-2	Actinopterygii	Perciformes	Embiotocidae	*Damalichthys*	*vacca*	Pile Perch
PSU 07-1-3	Actinopterygii	Perciformes	Embiotocidae	*Damalichthys*	*vacca*	Pile Perch
PSU 07-1-4	Actinopterygii	Perciformes	Embiotocidae	*Damalichthys*	*vacca*	Pile Perch
PSU 07-1-5	Actinopterygii	Perciformes	Embiotocidae	*Embiotoca*	*lateralis*	Striped Seaperch
PSU 07-1-6	Actinopterygii	Perciformes	Embiotocidae	*Embiotoca*	*lateralis*	Striped Seaperch
PSU 07-1-7	Actinopterygii	Perciformes	Embiotocidae	*Embiotoca*	*lateralis*	Striped Seaperch
PSU 07-1-8	Actinopterygii	Perciformes	Embiotocidae	*Amphistichus*	*rhodoterus*	redtail surfperch
PSU 07-1-9	Actinopterygii	Perciformes	Embiotocidae	*Amphistichus*	*rhodoterus*	redtail surfperch
PSU 07-1-10	Actinopterygii	Perciformes	Embiotocidae	*Amphistichus*	*rhodoterus*	redtail surfperch
PSU 07-1-11	Actinopterygii	Perciformes	Embiotocidae	*Cymatogaster*	*aggregata*	shiner surfperch
PSU 07-1-12	Actinopterygii	Perciformes	Embiotocidae	*Phanerodon*	*furcatas*	white seaperch
PSU 07-1-13	Actinopterygii	Perciformes	Embiotocidae	*Phanerodon*	*furcatas*	white seaperch
VLB01-1-37	Actinopterygii	Perciformes	Pholidae	Pholis	laeta	Crescent Gunnel
VLB01-1-38	Actinopterygii	Perciformes	Pholidae	Pholis	ornata	Saddleback Gunnel
PSU 07-1-15	Actinopterygii	Perciformes	Scombridae	*Scomber*	*japonicus*	Pacific mackerel
VLB01-1-39	Actinopterygii	Perciformes	Stichaeidae	Lumpenus	sagitta	Snake Prickleback
VLB01-1-40	Actinopterygii	Perciformes	Stichaeidae	Xiphister	atropurpureus	Black Prickleback
VLB86-22-1	Actinopterygii	Perciformes	Stichaeidae	Xiphister	mucosus	Rock Prickleback
VLB86-22-2	Actinopterygii	Perciformes	Stichaeidae	Xiphister	mucosus	Rock Prickleback
VLB95-5-11	Actinopterygii	Percopsiformes	Percopsidae	Percopsis	transmontanus	Sand Roller
VLB95-5-16	Actinopterygii	Percopsiformes	Percopsidae	Percopsis	transmontanus	Sand Roller
VLB95-5-17	Actinopterygii	Percopsiformes	Percopsidae	Percopsis	transmontanus	Sand Roller
VLB95-5-18	Actinopterygii	Percopsiformes	Percopsidae	Percopsis	transmontanus	Sand Roller
VLB95-5-19	Actinopterygii	Percopsiformes	Percopsidae	Percopsis	transmontanus	Sand Roller
PSU 13-1-24	Cephalaspidomorphi	Petromyzontiformes	Petromyzontidae	*Entosphenus*	tridentatus	Pacific lamprey
VLB01-1-41	Actinopterygii	Pleuronectiformes	Paralichthyidae	Citharichthys	sordidus	Pacific Sanddab
VLB86-23-2	Actinopterygii	Pleuronectiformes	Paralichthyidae	Citharichthys	sordidus	Pacific Sanddab
VLB88-2-27	Actinopterygii	Pleuronectiformes	Paralichthyidae	Citharichthys	sordidus	Pacific Sanddab
VLB88-2-28	Actinopterygii	Pleuronectiformes	Paralichthyidae	Citharichthys	sordidus	Pacific Sanddab

VLB01-1-42	Actinopterygii	Pleuronectiformes	Pleuronectidae	Lepidopsetta	bilineata	Rock Sole
VLB01-1-43	Actinopterygii	Pleuronectiformes	Pleuronectidae	Parophrys	vetulus	English Sole
VLB01-1-44	Actinopterygii	Pleuronectiformes	Pleuronectidae	Hippoglossoides	elassodon	Flathead Sole
VLB01-1-45	Actinopterygii	Pleuronectiformes	Pleuronectidae	Parophrys	vetulus	English Sole
VLB01-1-46	Actinopterygii	Pleuronectiformes	Pleuronectidae	Lepidopsetta	bilineata	Rock Sole
VLB01-1-47	Actinopterygii	Pleuronectiformes	Pleuronectidae	Lepidopsetta	bilineata	Rock Sole
VLB01-1-48	Actinopterygii	Pleuronectiformes	Pleuronectidae	Lepidopsetta	bilineata	Rock Sole
VLB01-2-1	Actinopterygii	Pleuronectiformes	Pleuronectidae	Hippoglossus	stenolepis	Pacific Halibut
VLB85-4-10	Actinopterygii	Pleuronectiformes	Pleuronectidae	Lepidopsetta	bilineata	Rock Sole
VLB85-4-11	Actinopterygii	Pleuronectiformes	Pleuronectidae	Lepidopsetta	bilineata	Rock Sole
VLB85-4-12	Actinopterygii	Pleuronectiformes	Pleuronectidae	Parophrys	vetulus	English Sole
VLB85-4-9	Actinopterygii	Pleuronectiformes	Pleuronectidae	Lepidopsetta	bilineata	Rock Sole
VLB86-23-1	Actinopterygii	Pleuronectiformes	Pleuronectidae	Platichthys	stellatus	Starry Flounder
VLB86-23-3	Actinopterygii	Pleuronectiformes	Pleuronectidae	Lepidopsetta	bilineata	Rock Sole
VLB86-23-4	Actinopterygii	Pleuronectiformes	Pleuronectidae	Microstomus	pacificus	Dover Sole
VLB86-6-1	Actinopterygii	Pleuronectiformes	Pleuronectidae	Hippoglossus	stenolepis	Pacific Halibut
VLB86-6-2	Actinopterygii	Pleuronectiformes	Pleuronectidae	Hippoglossus	stenolepis	Pacific Halibut
VLB86-6-3	Actinopterygii	Pleuronectiformes	Pleuronectidae	Hippoglossoides	elassodon	Flathead Sole
VLB86-6-4	Actinopterygii	Pleuronectiformes	Pleuronectidae	Glyptocephalus	zachirus	Rex Sole
VLB86-6-5	Actinopterygii	Pleuronectiformes	Pleuronectidae	Microstomus	pacificus	Dover Sole
VLB88-2-1	Actinopterygii	Pleuronectiformes	Pleuronectidae	Glyptocephalus	zachirus	Rex Sole
VLB88-2-10	Actinopterygii	Pleuronectiformes	Pleuronectidae	Parophrys	vetulus	English Sole
VLB88-2-11	Actinopterygii	Pleuronectiformes	Pleuronectidae	Pleuronichthys	coenosus	C-O Sole
VLB88-2-12	Actinopterygii	Pleuronectiformes	Pleuronectidae	Pleuronichthys	coenosus	C-O Sole
VLB88-2-13	Actinopterygii	Pleuronectiformes	Pleuronectidae	Hippoglossoides	elassodon	Flathead Sole
VLB88-2-16	Actinopterygii	Pleuronectiformes	Pleuronectidae	Glyptocephalus	zachirus	Rex Sole
VLB88-2-20	Actinopterygii	Pleuronectiformes	Pleuronectidae	Lepidopsetta	bilineata	Rock Sole
VLB88-2-21	Actinopterygii	Pleuronectiformes	Pleuronectidae	Microstomus	pacificus	Dover Sole
VLB88-2-22	Actinopterygii	Pleuronectiformes	Pleuronectidae	Microstomus	pacificus	Dover Sole
VLB88-2-29	Actinopterygii	Pleuronectiformes	Pleuronectidae	Parophrys	vetulus	English Sole
VLB88-2-3	Actinopterygii	Pleuronectiformes	Pleuronectidae	Hippoglossoides	elassodon	Flathead Sole
VLB88-2-30	Actinopterygii	Pleuronectiformes	Pleuronectidae	Parophrys	vetulus	English Sole
VLB95-5-10	Actinopterygii	Pleuronectiformes	Pleuronectidae	Platichthys	stellatus	Starry Flounder
PSU 07-1-18	Actinopterygii	Pleuronectiformes	Pleuronectidae	*Parophrys*	*vetulus*	English sole
PSU 07-1-19	Actinopterygii	Pleuronectiformes	Pleuronectidae	*Platichthys*	*stellatus*	starry flounder
PSU 07-1-20	Actinopterygii	Pleuronectiformes	Pleuronectidae	*Platichthys*	*stellatus*	starry flounder
PSU 07-1-21	Actinopterygii	Pleuronectiformes	Pleuronectidae	*Psettichthys*	*melanostictus*	sand sole
PSU 07-1-22	Actinopterygii	Pleuronectiformes	Pleuronectidae	*Eopsetta*	*jordani*	petrale sole
VLB86-26-1	Chondrichthys	Rajiformes	Rajidae	Raja	rhina	Longnose Skate

VLB01-1-49	Actinopterygii	Salmoniformes	Osmeridae	Thaleichthys	pacificus	Eulachon
VLB01-1-50	Actinopterygii	Salmoniformes	Osmeridae	Thaleichthys	pacificus	Eulachon
VLB01-1-51	Actinopterygii	Salmoniformes	Osmeridae	Thaleichthys	pacificus	Eulachon
VLB01-1-52	Actinopterygii	Salmoniformes	Osmeridae	Thaleichthys	pacificus	Eulachon
VLB85-8-2	Actinopterygii	Salmoniformes	Osmeridae	unk.	sp.	
VLB86-24-1	Actinopterygii	Salmoniformes	Osmeridae	Hypomesus	pretiosus	Surf Smelt
VLB86-24-2	Actinopterygii	Salmoniformes	Osmeridae	Hypomesus	pretiosus	Surf Smelt
VLB86-24-3	Actinopterygii	Salmoniformes	Osmeridae	Hypomesus	pretiosus	Surf Smelt
VLB86-24-4	Actinopterygii	Salmoniformes	Osmeridae	Hypomesus	pretiosus	Surf Smelt
VLB86-24-5	Actinopterygii	Salmoniformes	Osmeridae	Hypomesus	pretiosus	Surf Smelt
VLB86-24-6	Actinopterygii	Salmoniformes	Osmeridae	Hypomesus	pretiosus	Surf Smelt
VLB86-5-1	Actinopterygii	Salmoniformes	Osmeridae	Thaleichthys	pacificus	Eulachon
PSU 07-1-51	Actinopterygii	Salmoniformes	Osmeridae	*Thaleichthys*	*pacificus*	eulachon
PSU 07-1-52	Actinopterygii	Salmoniformes	Osmeridae	*Thaleichthys*	*pacificus*	eulachon
PSU 07-1-53	Actinopterygii	Salmoniformes	Osmeridae	*Hypomesus*	*pretiosus*	surf smelt
PSU 07-1-54	Actinopterygii	Salmoniformes	Osmeridae	*Hypomesus*	*pretiosus*	surf smelt
VLB01-1-53	Actinopterygii	Salmoniformes	Salmonidae	Oncorhynchus	mykiss	Rainbow Trout
VLB01-1-54	Actinopterygii	Salmoniformes	Salmonidae	Oncorhynchus	kisutch	Coho Salmon
VLB01-1-55	Actinopterygii	Salmoniformes	Salmonidae	Oncorhynchus	kisutch	Coho Salmon
VLB01-1-56	Actinopterygii	Salmoniformes	Salmonidae	Oncorhynchus	sp.	Perhaps Coho
VLB01-1-57	Actinopterygii	Salmoniformes	Salmonidae	Oncorhynchus	sp.	Perhaps Coho
VLB86-21-1	Actinopterygii	Salmoniformes	Salmonidae	Prosopium	williamsoni	Mountain Whitefish
VLB86-21-2	Actinopterygii	Salmoniformes	Salmonidae	Prosopium	williamsoni	Mountain Whitefish
VLB86-21-3	Actinopterygii	Salmoniformes	Salmonidae	Prosopium	williamsoni	Mountain Whitefish
VLB91-10-1	Actinopterygii	Salmoniformes	Salmonidae	Oncorhynchus	clarki	Cutthroat Trout
VLB92-10-5	Actinopterygii	Salmoniformes	Salmonidae	Prosopium	williamsoni	Mountain Whitefish
VLB92-10-6	Actinopterygii	Salmoniformes	Salmonidae	Prosopium	williamsoni	Mountain Whitefish
VLB95-5-13	Actinopterygii	Salmoniformes	Salmonidae	Prosopium	williamsoni	Mountain Whitefish
VLB96-7-3	Actinopterygii	Salmoniformes	Salmonidae	Oncorhynchus	nerka	sockeye salmon
PSU 07-1-42	Actinopterygii	Salmoniformes	Salmonidae	*Oncorhynchus*	*kisutch*	coho salmon
PSU 07-1-43	Actinopterygii	Salmoniformes	Salmonidae	*Oncorhynchus*	*kisutch*	coho salmon
PSU 07-1-44	Actinopterygii	Salmoniformes	Salmonidae	*Oncorhynchus*	*keta*	chum salmon
PSU 07-1-45	Actinopterygii	Salmoniformes	Salmonidae	*Oncorhynchus*	*keta*	chum salmon
PSU 07-1-46	Actinopterygii	Salmoniformes	Salmonidae	*Oncorhynchus*	*tshawytscha*	chinook salmon
PSU 07-1-47	Actinopterygii	Salmoniformes	Salmonidae	*Oncorhynchus*	*tshawytscha*	chinook salmon
PSU 07-1-48	Actinopterygii	Salmoniformes	Salmonidae	*Oncorhynchus*	*mykiss*	steelhead trout
PSU 07-1-49	Actinopterygii	Salmoniformes	Salmonidae	*Prosopium*	*williamsoni*	mountain whitefish
PSU 07-1-50	Actinopterygii	Salmoniformes	Salmonidae	*Oncorhynchus*	*clarkii*	coastal cut-throat
VLB 92-6-8	Actinopterygii	Salmoniformes	Salmonidae	*Oncorhynchus*	*tshawytscha*	chinook salmon

VLB88-2-24	Actinopterygii	Scorpaeniformes	Agonidae	Xeneretmus	triacanthus	Bluespotted Poacher
VLB88-2-25	Actinopterygii	Scorpaeniformes	Agonidae	Xeneretmus	triacanthus	Bluespotted Poacher
VLB01-1-58	Actinopterygii	Scorpaeniformes	Anoplopomatidae	Anoplopoma	fimbria	Sablefish
PSU 13-2-1	Actinopterygii	Scorpaeniformes	Anoplopomatidae	Anoplopoma	fimbria	Sablefish
PSU 13-2-2	Actinopterygii	Scorpaeniformes	Anoplopomatidae	Anoplopoma	fimbria	Sablefish
VLB01-1-59	Actinopterygii	Scorpaeniformes	Cottidae	Artedius	fenestralis	Padded Sculpin
VLB01-1-60	Actinopterygii	Scorpaeniformes	Cottidae	Leptocottus	armatus	Staghorn Sculpin
VLB01-1-61	Actinopterygii	Scorpaeniformes	Cottidae	Leptocottus	armatus	Staghorn Sculpin
VLB01-1-62	Actinopterygii	Scorpaeniformes	Cottidae	Leptocottus	armatus	Staghorn Sculpin
VLB01-1-63	Actinopterygii	Scorpaeniformes	Cottidae	Leptocottus	armatus	Staghorn Sculpin
VLB01-1-64	Actinopterygii	Scorpaeniformes	Cottidae	Hemilepidotus	hemilepidotus	Red Irish Lord
VLB85-4-3	Actinopterygii	Scorpaeniformes	Cottidae	Leptocottus	armatus	Staghorn Sculpin
VLB85-4-4	Actinopterygii	Scorpaeniformes	Cottidae	Leptocottus	armatus	Staghorn Sculpin
VLB86-25-5	Actinopterygii	Scorpaeniformes	Cottidae	Chitonotus	pugetensis	Roughback Sculpin
VLB86-25-6	Actinopterygii	Scorpaeniformes	Cottidae	Chitonotus	pugetensis	Roughback Sculpin
VLB88-2-2	Actinopterygii	Scorpaeniformes	Cottidae	Myoxocephalus	polyacanthocephal	Great Sculpin
VLB88-2-31	Actinopterygii	Scorpaeniformes	Cottidae	Chitonotus	pugetensis	Roughback Sculpin
VLB92-10-15	Actinopterygii	Scorpaeniformes	Cottidae	Cottus	bairdi	Mottled Sculpin
VLB92-7-9	Actinopterygii	Scorpaeniformes	Cottidae	Cottus	beldingi	Paiute Sculpin
VLB95-5-1	Actinopterygii	Scorpaeniformes	Cottidae	Cottus	asper	Prickly Sculpin
VLB95-5-2	Actinopterygii	Scorpaeniformes	Cottidae	Cottus	asper	Prickly Sculpin
PSU 07-1-23	Actinopterygii	Scorpaeniformes	Cottidae	*Enophrys*	*bison*	buffalo sculpin
PSU 07-1-24	Actinopterygii	Scorpaeniformes	Cottidae	*Enophrys*	*bison*	buffalo sculpin
PSU 07-1-25	Actinopterygii	Scorpaeniformes	Cottidae	*Enophrys*	*bison*	buffalo sculpin
PSU 07-1-26	Actinopterygii	Scorpaeniformes	Cottidae	*Cottus*	*rhotheus*	torrent sculpin
PSU 07-1-27	Actinopterygii	Scorpaeniformes	Cottidae	*Leptocottus*	*armatus*	staghorn sculpin
PSU 07-1-28	Actinopterygii	Scorpaeniformes	Cottidae	*Leptocottus*	*armatus*	staghorn sculpin
PSU 07-1-40	Actinopterygii	Scorpaeniformes	Cottidae	*Scorpaenichthys*	*marmoratus*	cabezon
PSU 07-1-41	Actinopterygii	Scorpaeniformes	Cottidae	*Scorpaenichthys*	*marmoratus*	cabezon
VLB01-1-65	Actinopterygii	Scorpaeniformes	Hexagrammidae	Ophiodon	elongatus	Ling Cod
VLB01-1-66	Actinopterygii	Scorpaeniformes	Hexagrammidae	Ophiodon	elongatus	Ling Cod
VLB01-1-67	Actinopterygii	Scorpaeniformes	Hexagrammidae	Ophiodon	elongatus	Ling Cod
VLB01-1-68	Actinopterygii	Scorpaeniformes	Hexagrammidae	Ophiodon	elongatus	Ling Cod
VLB01-1-69	Actinopterygii	Scorpaeniformes	Hexagrammidae	Ophiodon	elongatus	Ling Cod
VLB01-1-70	Actinopterygii	Scorpaeniformes	Hexagrammidae	Ophiodon	elongatus	Ling Cod
VLB01-1-71	Actinopterygii	Scorpaeniformes	Hexagrammidae	Hexagrammos	decagrammus	Kelp Greenling
VLB01-1-72	Actinopterygii	Scorpaeniformes	Hexagrammidae	Hexagrammos	decagrammus	Kelp Greenling
VLB01-2-2	Actinopterygii	Scorpaeniformes	Hexagrammidae	Ophiodon	elongatus	Ling Cod
VLB86-6-6	Actinopterygii	Scorpaeniformes	Hexagrammidae	Hexagrammos	decagrammus	Kelp Greenling

PSU 07-1-30	Actinopterygii	Scorpaeniformes	Hexagrammidae	Hexagrammos	*decagrammus*	kelp greenling
PSU 07-1-31	Actinopterygii	Scorpaeniformes	Hexagrammidae	Hexagrammos	*decagrammus*	kelp greenling
PSU 07-1-32	Actinopterygii	Scorpaeniformes	Hexagrammidae	Hexagrammos	*decagrammus*	kelp greenling
PSU 07-1-33	Actinopterygii	Scorpaeniformes	Hexagrammidae	*Ophiodon*	*elongatus*	lingcod
PSU 07-1-34	Actinopterygii	Scorpaeniformes	Hexagrammidae	*Ophiodon*	*elongatus*	lingcod
VLB01-1-73	Actinopterygii	Scorpaeniformes	Scorpaenidae	Sebastes	melanops	Black Rock Fish
VLB01-1-74	Actinopterygii	Scorpaeniformes	Scorpaenidae	Sebastes	paucispinis	Bocaccio
VLB01-1-75	Actinopterygii	Scorpaeniformes	Scorpaenidae	Sebastes	caurinus	Copper Rockfish
VLB01-1-76	Actinopterygii	Scorpaeniformes	Scorpaenidae	Sebastes	caurinus	Copper Rockfish
VLB01-1-77	Actinopterygii	Scorpaeniformes	Scorpaenidae	Sebastes	caurinus	Copper Rockfish
VLB01-1-78	Actinopterygii	Scorpaeniformes	Scorpaenidae	Sebastes	caurinus	Copper Rockfish
VLB01-1-79	Actinopterygii	Scorpaeniformes	Scorpaenidae	Sebastes	caurinus	Copper Rockfish
VLB01-1-80	Actinopterygii	Scorpaeniformes	Scorpaenidae	Sebastes	ruberrimus	Yelloweye Rockfish
VLB01-1-81	Actinopterygii	Scorpaeniformes	Scorpaenidae	Sebastes	ruberrimus	Yelloweye Rockfish
VLB01-1-82	Actinopterygii	Scorpaeniformes	Scorpaenidae	Sebastes	ruberrimus	Yelloweye Rockfish
VLB01-1-83	Actinopterygii	Scorpaeniformes	Scorpaenidae	Sebastes	caurinus	Copper Rockfish
VLB01-1-84	Actinopterygii	Scorpaeniformes	Scorpaenidae	Sebastes	caurinus	Copper Rockfish
VLB01-1-85	Actinopterygii	Scorpaeniformes	Scorpaenidae	Sebastes	maliger	Quillback Rockfish
VLB01-1-86	Actinopterygii	Scorpaeniformes	Scorpaenidae	Sebastes	nigrocinctus	Tiger Rockfish
VLB88-2-17	Actinopterygii	Scorpaeniformes	Scorpaenidae	Sebastes	caurinus	Copper Rockfish
VLB88-2-18	Actinopterygii	Scorpaeniformes	Scorpaenidae	Sebastes	caurinus	Copper Rockfish
VLB88-2-19	Actinopterygii	Scorpaeniformes	Scorpaenidae	Sebastes	maliger	Quillback Rockfish
PSU 07-1-35	Actinopterygii	Scorpaeniformes	Scorpaenidae	*Sebastes*	*melanops*	black rockfish
PSU 07-1-36	Actinopterygii	Scorpaeniformes	Scorpaenidae	*Sebastes*	*melanops*	black rockfish
PSU 07-1-37	Actinopterygii	Scorpaeniformes	Scorpaenidae	*Sebastes*	*miniatus*	vermillion rockfish
PSU 07-1-38	Actinopterygii	Scorpaeniformes	Scorpaenidae	*Sebastes*	*mystinus*	blue rockfish
PSU 07-1-39	Actinopterygii	Scorpaeniformes	Scorpaenidae	*Sebastolobus*	*alascanus*	shortspine thornyhead
VLB01-2-3	Chondrichthys	Squaliformes	Squalidae	Squalus	acanthias	Spiny Dogfish
VLB85-4-15	Chondrichthys	Squaliformes	Squalidae	Squalus	acanthias	Spiny Dogfish
Kopperl, F110	Actinopterygii	Perciformes	Anarhichadidae	Anarrhichthys	ocellatus	Wolf eel
Kopperl, F116	Actinopterygii	Pleuronectiformes	Pleuronectidae	Atheresthes	stomias	Arrowtooth flounder
Kopperl, F59	Actinopterygii	Scorpaeniformes	Agonidae	Agonus	acipensirinus	Sturgeon poacher
Kopperl, F52	Actinopterygii	Scorpaeniformes	Scorpaenidae	Sebastolobus	altivelis	Longspine thornyhead
Kopperl, 6019194	Actinopterygii	Rajiformes	Rajidae	Raja	kincaidi	Sandpaper skate
Kopperl, F104	Actinopterygii	Osmeriformes	Osmeridae	Mallotus	villosus	Capelin
Kopperl, no num	Actinopterygii	Osmeriformes	Osmeridae	Hypomesus	pretiosus	Surf smelt
Kopperl, no num	Chondrichthys	Squaliformes	Squalidae	Squalus	acanthias	Spiny Dogfish
Kopperl, No. 8	Actinopterygii	Clupeiformes	Clupeidae	Sardinops	sagax	Pacific sardine
Kopperl, F 102	Actinopterygii	Clupeiformes	Clupeidae	Sardinops	sagax	Pacific sardine

Smith, Ross,, no num	Actinopterygii	Gadiformes	Gadidae	Gadus	macrocephalus	Pacific cod (multiple skels
Smith, Ross,, no num	Actinopterygii	Scorpaeniformes	Cottidae	Myoxocephalus	polyacanthocephal	Great sculpin
Smith, Ross,, no num	Actinopterygii	Pleuronectiformes	Pleuronectidae	Platichthys	stellatus	Starry flounder
Univ.Victoria, Dept. Anthropology	Actinopterygii	Perciformes	Gobiesocidae	*Gobiesox*	maendricus	Northern clingfish

Appendix 2. Č̓íxʷicən Fish Remains, Protocols for Transferring Materials

This section summarizes the main procedures used when transferring remains from laboratory to laboratory, to reach the appropriate analyst.

If, during analysis of the remains from fishbone bags, *non-fish* remains were encountered, such materials were bagged and set aside; periodically the bags were shipped to the appropriate analyst with a spreadsheet listing the catalog numbers. In the fishbone bag, we included a small tag indicating the animal type and number of specimens that had been removed and transferred.

When the fishbone lab received transfers from other zooarchaeological specialists, we took those remains through the same analytic protocols used to study the fish remains. The remains were recorded in our analysis forms. The remains were bagged separately with a tag indicating the remains had been transferred.

Mammal and shell specialists studied some Areas/Blocks (e.g., A9, B1, B6), that the fishbone lab did not study. The mammal and shellfish specialists sent the fishbone lab fish remains they found in such areas. In these cases, the fish remains were not studied. They were simply filed for future analysis.

The only exception to this is Area/Block A3. This area had been targeted for fishbone study and the fishbone lab rescreened and recataloged all the fish remains from A3. As noted in the main fishbone report, we did not analyze fish remains from A3 because of time constraints. A3 fishbone transferred to our lab from other specialists, were filed with each new cataloged bag, since we had created a new catalog number linked to the transfer bag number. Thus the A3 fishbone bags include all the fishbone from the Area/Block.

Many remains that were transferred to the fishbone lab were not fish. In fact, it was not clear what faunal type they belonged to at all. We bagged and labelled such items as “indeterminate vertebrate” or sometimes “unknown material” (or rock, plastic, etc. if obvious).

Possible bone tools and lithic debitage were pulled from fishbone bags when encountered; then bagged separately and returned to the Burke Museum.

Appendix 3. Definitions of Column Headings for Fish Faunal Data File

By Virginia L. Butler

Fish_ID

Faunal Identification Number—this is a unique identifier for this specific row/line. Note that each row/line may represent multiple specimens (see “Quant_Fish” below).

The animal categories are marked as follows: invertebrates begin with “S” (shellfish); fish, “F”; birds, “B”; and mammals, “M”.

Catalog Number

Catalog numbers match the artifact and faunal specimen inventory maintained by the Burke Museum. Catalog numbers take one of two basic formats depending on whether they were collected *in situ* during the excavations or if they were collected in the water screens.

Most samples included in our 2012-2019 project were collected from water screens and are designated as “WS” (e.g., “water screen”) catalog numbers. Because of various issues (see Butler et al., 2018a), the project team re-screened all the water-screened samples in our study. This process led us to create a slightly revised catalog system (from the original LAAS/Burke Catalog) with FOUR sub-numbers.

WS-16788.99.04.21

The number after the WS- is the “bag number” (see “Bag Number” below), which is the number assigned by LAAS lab/field personnel (Kaehler and Lewarch, 2006) with numbers assigned in the order in which the Unit/Level bags were added to the Master Catalog. The bag number can range from one to five digits. The “99” after the bag number specifies that this sample was re-screened by the 2012-2019 project.

The “04” in the example above designates the screen size fraction for that particular entry (here, ¼ -inch). Screen size designations are as follows:

01	1-inch
02	½ -inch
04	¼ -inch
08	⅛ -inch
99	<⅛ -inch

The final sub-number (“21” in the example above) specifies the main animal type to which the sample belongs. Those categories are:

10 Invertebrate
20 Unidentified Vertebrate (non-fish)
21 Mammals
22 Birds
23 Fish

Samples collected *in situ,* termed "E" samples (see "Bag Type" and "Analytical Bag Type" below), maintain their original Master Catalog number from the LAAS/Burke Museum. The numbering system begins with the excavation area/block designation (Area A4 in the following example):

A4-197.01.01

The number after the dash (197) refers to the Field Bag number, which can be matched to bag numbers listed in the Unit/Level records (Kaehler and Lewarch, 2006). Explanations for the two sub-numbers after the Bag Number are described in Appendix 5 of the LAAS report (Larson, 2006, Appendix 5: pg 4)

BagNumber
This is the first number of the Catalog Number (see above), which is the number assigned by LAAS lab/field personnel (Kaehler and Lewarch, 2006) with numbers assigned in the order in which the Unit/Level bags were added to the Master Catalog. This is the original bag number as it appears in the LAAS/Burke Museum catalog.

Analytic_BagNum
In most situations, "Analytic_Bag Number" and "BagNumber" are the same. However, as explained by Butler et al. (2018a), we encountered situations where it appeared that constituents from a single original field bag/bucket were split into >1 Bag Numbers during laboratory processing. Butler et al. (2018a) explain how this was deduced. The Analytic Bag number is the team's best identification for the complete, 10 L water-screened bucket that had later been subdivided; and is used when estimating excavation volume for calculations of density/accumulation rate.

Re-screened
This duplicates the sub-number information in the Catalog Number (see above). All of the water-screened samples have the "0.99" code to indicate these were re-screened as part of the 2012-2019 project. The "E" samples—those that were collected *in situ* during excavation, were not re-screened.

ScreenSize
This duplicates the sub-number information in the Catalog Number (see above). This refers to the mesh size from which the constituents were recovered as noted above.

01	1-inch
02	½ -inch
04	¼ -inch
08	⅛ -inch
99	<⅛ -inch

Screen size was not listed for the "E" samples, as they were collected *in situ* without screens.

Material Type
This duplicates the sub-number information in the Catalog Number (see above). This number specifies the main animal type. Those categories are:

10 Invertebrate
20 Unidentified Vertebrate (non-fish)
21 Mammals
22 Birds
23 Fish

Area

The terms "Area" or "Block" are used interchangeably in our reporting. The original site report (Larson, 2006) used the term "Area" to define the four massive project areas that were assigned during 2004 field work (Area A, B, C, D) and the term "Block" for the contiguous excavation units excavated in a particular "Area" (e.g., Block A1, A4, B1, etc., where the alpha code refers to "Area" and the number is the excavation "Block" within the Area). However, the Master Catalog (and faunal bag labels) column heading/field the Burke Museum sent us referred to the set of contiguous units as "Area" *not Block* (e.g., Area A1, A3). For our 2012-2019 project and faunal catalog, we followed the convention used in the Master Catalog. We use Area to refer to the contiguous grouping of excavation units that combines the Area code (A) and the Block number (1, 4, etc.), thus A1, A4. Since most of the NSF project focused on one of the massive Areas (e.g., Area A), the distinction between Area and Block is not critical.

Unit

Unit refers to an excavation unit number (e.g., 1, 2, 3) that was assigned sequentially as an Area/Block was being excavated by LAAS crews (Reetz et al., 2006). The labels listed in "unit" are exactly the code as assigned in the field, in the catalog and on the original faunal bags sent to us. Most units are $1m^2$. Most unit codes are single whole numbers (e.g., 1, 2, 3), but sometimes the label includes an "A" (e.g., 1A, or other alpha), or sometimes units were joined with slashes (e.g., 2/13, 30/32). Reetz et al. (2006) provides detailed maps that show unit numbers in each Area/Block.

Adjusted_Unit

When the Unit code is a simple number (e.g., 1, 2, 3) the Adjusted Unit label is the same as the Unit code. We created the Adjusted Unit field to recode the unit labels that had an "A" or were aggregate units (e.g., 2/13) so that such units could easily be manipulated in the database. LAAS added the "A" codes to excavation unit labels when field crews returned to excavate units that had previously been dug. Thus, in Area/Block A4, field crews returned to the southern part of the block and dug deeper in units 1, 2, 3, 6, 7, 8, 11, 12, 30, 40 that had previously been partly excavated (see Reetz et al., 2006: 40-36). The "A" code was added to these "revisited units" but the excavation units with or without the "A" are the same unit. The Adjusted Unit code that we created simply assigns the units with the "A" to the original Unit number. What was "1A" in the Unit code becomes "1" in the Adjusted Unit code. In a few cases, mostly involving features that overlap two units, provenience was recorded as both units (e.g., 2/13). In these cases, the adjusted unit is the unit in which the strat was most extensive.

Strat

This is the stratigraphic code assigned in the field based on a variety of geoarchaeological criteria, including relative position in the stratigraphic sequence, composition, color, texture, lithology, etc. (Sterling et al., 2006).

Adjusted_Strat

In most cases, the Adjusted_Strat code is the same as the Strat code. In a very small number of cases, the Adjusted Strat was used to correct data entry errors in the Burke Museum catalog. In other cases, matrix with similar characteristics were designated as two or more strata with a slash convention, eg. 5.1.3.2/6.5, because of uncertainty about the best match. Unit level records were consulted to resolve this; generally, there were notes about later determinations of the strat, or continuity with adjacent units was the determinant.

Feature
This code refers to the sequential number unique to each Area (e.g., A, B, C, D) assigned to a cultural feature (e.g., hearths, post molds, etc.,) over the course of fieldwork (Reetz et al., 2006).

Level
Designates an arbitrary level within a natural stratum (Reetz et al., 2006). We retained "OVB" for overburden and "U" designating materials recovered from a collapsed wall as per the Burke Museum catalogue. Our project added the code "NLR" to indicate that no level records existed for the sample.

CZ
CZ refers to chrono-stratigraphic or more simply, "chronozone" (CZ). Campbell et al. (2019) defined seven CZs based on use of 59 radiocarbon ages and analysis of depositional sequences of field-identified strata (see table below). Through this process, all unique field-documented strata and associated samples (C, CX, S buckets and *in situ* E specimens) were assigned to one of the seven CZs, from CZ 1 (2150–1750 cal BP) to CZ 7 (300–150 cal BP). Chronozone 4b (CZ 4b) consisted of material that had been displaced in the past by erosion or house construction; fauna from these samples were not included in the overall analysis.

Chronozone	Age Range (CalBP)	Mid-Point (CalBP)
CZ 7	300–150	225
CZ 6	550–300	425
CZ 5	1000–550	775
CZ 4	1300–1000	1150
CZ 3	1550–1300	1425
CZ 2	1750–1550	1650
CZ 1	2150–1750	1950

In several instances, strata were not assigned to chronozone because of construction disturbance (e.g., Strat 2.0), or because the project team decided to exclude sections of the site from chronostratigraphic study after faunal analysis had already been completed. The CZ code for such samples is "NPA" – "not part of analysis". In some cases, level records did not exist for a given sample, which precluded chronostratigraphic assignment. In these cases, the code "NLR" "no level record" was used.

Depositional Context
Depositional context was determined by Campbell following close analysis of matrix characteristics. Deposits associated with house occupation were designated as floor or fill depending on their characteristics (Floor = spongy, dark, compact, horizontal; Fill = loose, structureless, sloping). Floors were numbered sequentially within a house with 1 designating the initial, or lowest floor. Transition Zone designates the area closest to the wall, inside the house, where the stratified floor sequence cannot be traced due to the different depositional processes in that area. The designations Pre-house and Post-house were used only within the footprint of the house. Extramural deposits lie outside of house footprints.

Extramural
Fill
Floor 1

Floor 2
Floor 3
Floor 4
post-house
pre-house
Transition Zone
NLR
NPA

Bag Type
This code refers to one of three main field sampling methods described by LAAS personnel (Kaehler and Lewarch, 2006) and which appears in the original Master Catalog. Most buckets from a given stratum were screened to 1/4" and called *Sample* or 'S' buckets. Invertebrate shell was not retained from S buckets. A minimum of one bucket was processed from each stratum of each 1 m^2 grid unit and screened to 1/8" mesh. Such buckets were labeled *Complete* or 'C' buckets. Finally, relatively large remains were recorded *in situ* during excavation and referred to as 'E' samples. The codes listed under Bag Type refer to one of these three codes, S, C, or E from the original catalog. The 2012-2019 project team found that about half of the so-called "C" bags were not in fact "complete", but rather were missing 1/8" mesh materials. LAAS protocols changed over the project. Importantly—the Master Catalog did not distinguish such buckets. Both were labelled "C" in the Master Catalog. The project team created a revised coding system to address this issue. See Analytic Bag Type and Butler et al. (2018a).

Analytic_Bag Type
For S and E buckets, the code for Bag Type and Analytic Bag type is the same. We created a new code, "CX" to distinguish true "C" buckets (that included matrix >1/8") from those buckets from which only 1/4" mesh and larger were retained. Thus, for Analytic Bag Type, possible codes include **S, E, C** (which includes all matrix >1/8") and **CX** (which includes only matrix > 1/ 4"). We highlight that our faunal records do in fact include specimens from CX buckets listed from 1/8" matrix because our understanding of the "C" and "CX" distinction occurred after we had already begun our analysis and recorded identifications. The 1/8" samples from CX buckets should not be included in systematic analysis of faunal representation, given lack of control on mesh size.

Quant_Fish
For all bones and shell, the number is either NSP (for specimens identified to class) or NISP (Number of Identified Specimens) for those identified more specifically.

Faunal_Category
This refers to the main animal type--- Aves, Fish, Mammal, Invertebrate and Vertebrate. Note, the Fish data file also includes two reptile specimens (Catalog Numbers: WS-11694.99.08.23 and WS-11992.99.08.23).

A Note on Taxonomic/Linnaean Hierarchy
In general, we attempted to identify bones/bone fragments and shells/shell fragments to the most specific taxon possible. Each specialist has slightly different systems for recording that information, much of which is dictated by the specifics of the taxonomic group they work on.

Identification was recorded according to the Linnaean hierarchy, using the most recent nomenclature available. If a particular level of the hierarchy could not be reached, say a specimen could only be identified to the level of Family, all lower fields (Genus and Species, in this example) are left blank. Note that for species-level IDs, only the species epithet is listed in the "Species" field—both the Genus and the Species fields must be combined to extract the Linnaean species.

Finally, the most specific taxonomic level for each specimen is also listed under "Finest Taxon" (see below).

Class
Subclass
Order
Family
Genus
Species

Finest Taxon
Finest taxon refers to the most specific taxonomic classification (e.g. class, order, family, genus, species) to which a sample can be assigned. This may or may not correspond to a Linnaean taxon. See "A Note on Taxonomic/Linnaean Hierarchy" above. Specimens which could only be assigned to a faunal category are listed here as that category. Thus, specimens which can only be assigned to "Fish" are listed in Finest Taxon as "Fish".

Element
The primary skeletal element represented by the sample.

Landmark
Yes or No. For each specimen, we recorded whether it included a unique morphological landmark. The landmark is the best represented non-overlapping section of a given element, such that the element can only be counted once. The landmark is typically the most robust and distinctive portion of the element that is most useful for taxonomic separation. For example, for the dentary, it was the rostral portion that includes the symphysis border; for hyomandibula, it was the caudal process that articulates with the opercle; for articular/angular, it was the articular surface for the quadrate. The landmark for vertebrae was the opening for the notochord as seen on both faces of the centrum.

Burn
Yes or No. Indicates whether or not the specimen/s showed evidence of burning. Because bone specimens showed a wide range of colors that could be interpreted as staining rather than burning, we took a conservative approach to identifying burning and thermal alteration. The "Burn" category combines all those specimens that were identified as thermally altered, burned, or calcined.

Comments
Additional comments or observations not already captured in another field. These can range from thoughts or impressions on what the likely taxon may be, to specifics about the condition of the bone, notes on the presence of specific elements (such as teeth), or whether the specimen was originally identified as shell, bird, or mammal and transferred to Butler lab for analysis.

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