

Appendix B: Zooarchaeological Analysis of the Indigenous Fishery at the Huu7ii Big House and Back Terrace, Huu-ay-aht Territory, Southwestern Vancouver Island

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Abstract

This paper describes how fish overwhelmingly dominates the animal bone assemblage from the examined column sample deposits at the Huu7ii village site, the named ancestral village of the Huu-ay-aht First Nation. Fish represent 99.9% of all identified bone specimens and are present in every examined litre of sediment indicating the importance of fish in the everyday life of site occupants. The bone assemblage is numerically dominated by Pacific herring, which vastly outnumbers the next most abundant fish: anchovy, salmon, hake, greenling, dogfish, and rockfish as well as two-dozen other fish taxa. I conduct a series of descriptive, quantitative, and graphical analyses that seek to interpret resource harvesting practices at the two examined portions of the site: a very large house (17x35 m) dating to the late-Holocene (ca. 1500–400 yr BP) and mid-Holocene midden deposits recovered on a raised beach terrace (ca. 5000–3000 yr BP).

Introduction

This paper describes the archaeology of the indigenous fishery at the Huu7ii Big House (House 1) and back terrace from the perspective of fine-screen analysis of 12 column samples. During 2004 and 2006, the author participated in the excavation and helped coordinate the recovery and analysis of column samples (small ‘columns’ of precisely excavated archaeological sediment, Figure 1). The goal of this research was to use this detailed recovery strategy to investigate how residents utilized fish over the past 5,000 years of human history represented at this large village site. Column sample excavation and analysis aimed to complement the analysis of larger vertebrate fauna recovered from excavation units that used larger ¼" mesh sizes (Frederick, this vol.). The principal advantage of column sampling is that it provides a much more

accurate assessment of the relative proportion and actual number of fish, mammal, and bird bones present in the site deposits (e.g., Casteel 1976; McKechnie 2005; Nagaoka 1994; Stewart and Wigen 2003).

Methods

Column samples were recovered as contiguous bulk samples from the sidewalls of excavation units (Figure 1). Column sample level dimensions were 20x10x5 cm (1 litre of excavated matrix per individual level), with the exception of a column sample from the back terrace, which measured 20x20x5 cm (2 litres per level, see Table 1). Column samples were excavated in 5 cm arbitrary levels within which stratigraphically distinct layers were separated. Vertical elevations were referenced to an arbitrary datum elevation as well as recorded in depth increments below ground surface.

Due to the considerable effort required to process each recovered column sample level, not all excavated columns or column sample levels could be subject to comprehensive faunal identification. Twelve column samples, six from the 2004 excavations and six from the 2006 excavations were selected for zooarchaeological identification and analysis (Figures 2 and 3). These samples represent the greatest horizontal and vertical extent of the excavated deposits from House 1, which date to between approximately 1,500 and 400 years ago, and two areas of the older back terrace deposits, which date to between approximately 5,000 and 3,000 years ago (Figures 4 and 5).

Eight column samples were examined from separate areas of House 1; four span the length of occupation and known depth-range while the remaining four were collected from the upper ‘house floor’ portions of the deposits exposed during block excavations in 2006 (Figure 3). Two column samples were examined from two separate areas of the back terrace deposits (Figure 2). An additional



Figure 1. Excavating column samples from the sidewall of excavation units (left). Bulk sediment samples were removed in 5 cm levels, wet-screened through 1 mm mesh, and material larger than 1 mm saved. Vertebrate fauna larger than 2 mm was picked from the samples in the laboratory by supervised volunteers (centre and right).

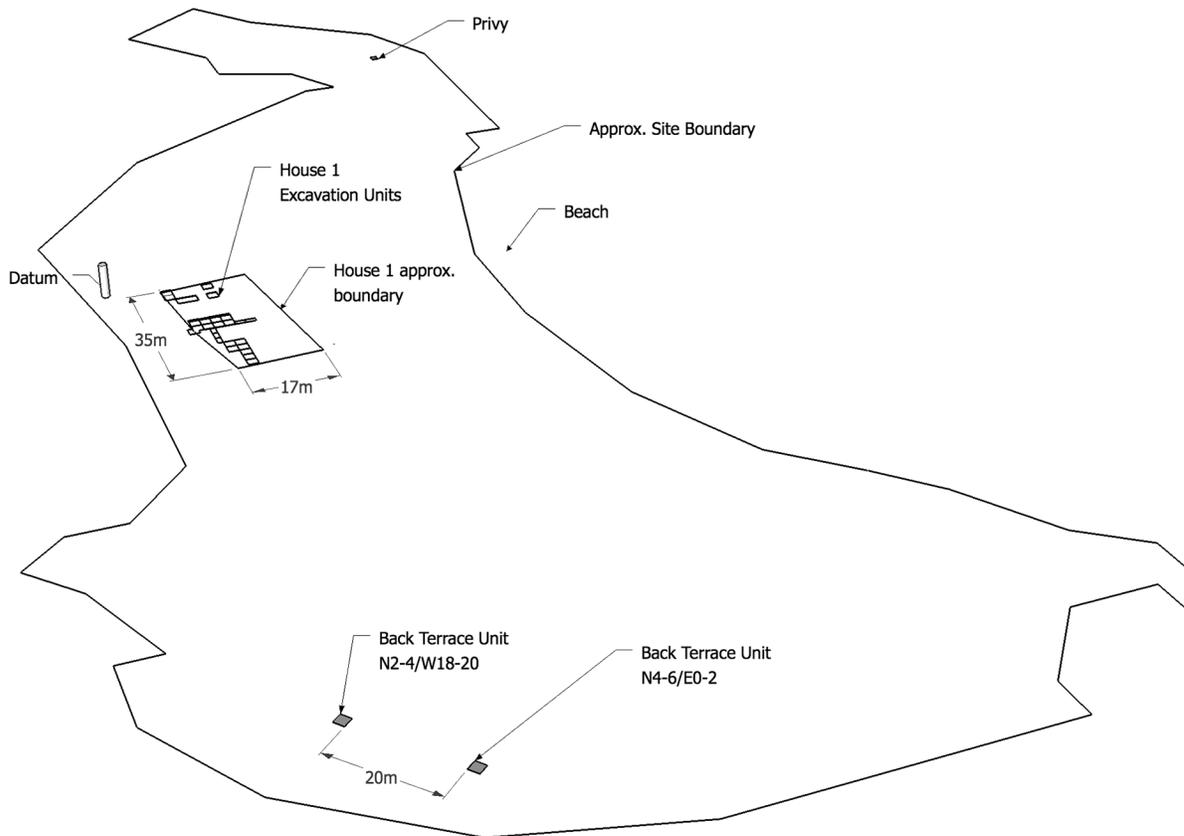


Figure 2. Perspective view of the Huu7ii village looking west showing the location and layout of the House 1 excavation units and the location of the back terrace units.

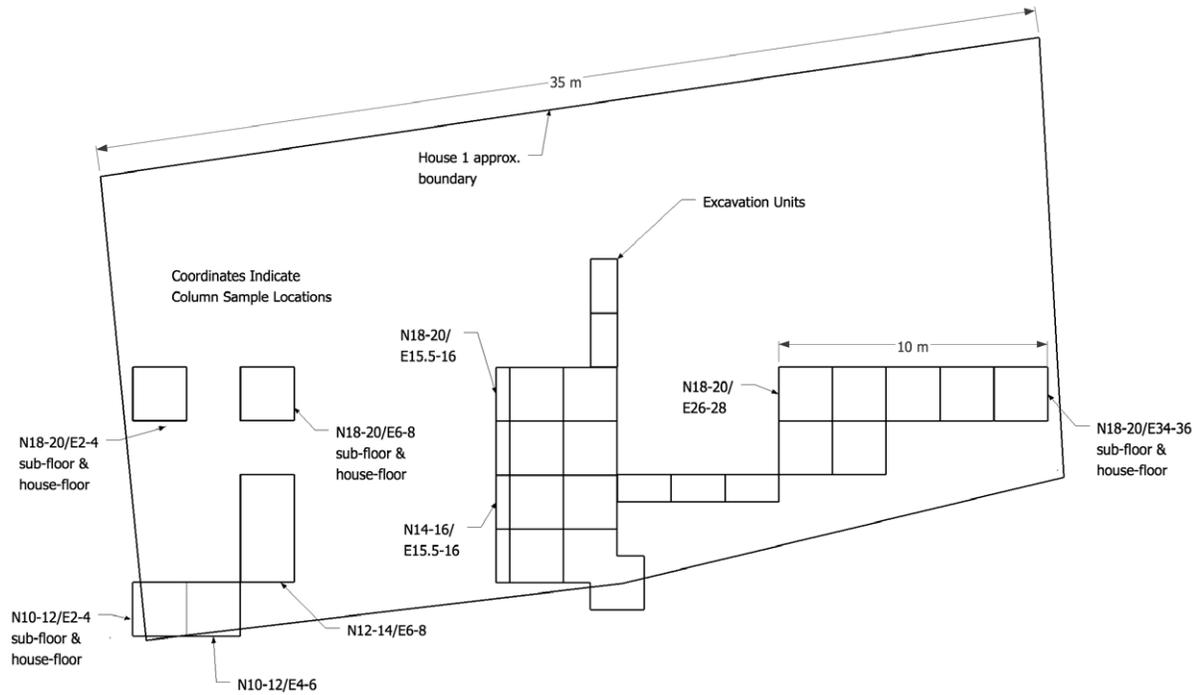


Figure 3. Plan view showing column samples locations recovered from the House 1 excavations. Large squares are 2x2 m excavation units and coordinates with arrows indicate the location of individual column samples.

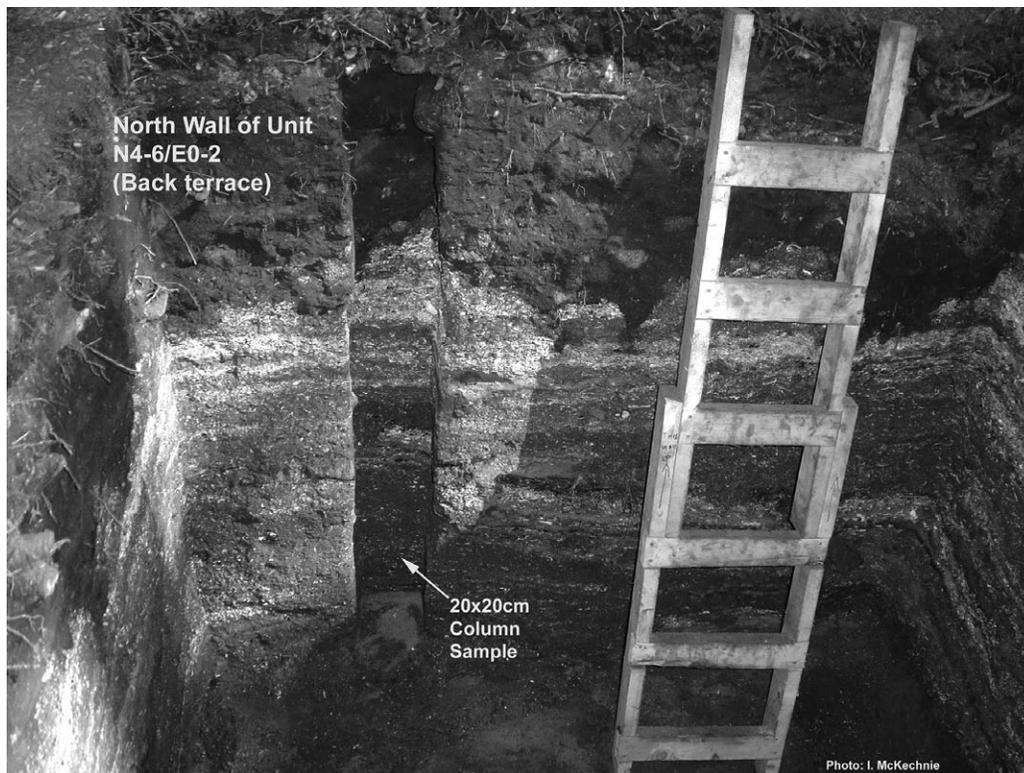


Figure 4. Photo of column sample taken from the north wall of the back terrace unit (N4-6/E0-2) which has initial and terminal dates that span between 5,000 and 3,000 years ago.



Figure 5. Photo of column sample taken from the South wall of unit N18-20/E2-4. This excavation unit reached a depth of 230 cm below surface and has an initial date of approximately 1500 years BP.

column sample was obtained near the mouth of the creek on the northern and western portion of the site in 2004. This small assemblage was obtained from shell midden deposits encountered during the construction of the field camp privy.

Processing

Column samples were removed in 5-cm levels and wet-screened through 1-mm mesh. After each matrix sample had been wet-screened and had sufficient time to dry, sediments were passed through 2-mm mesh using nested geological brass sieves. Vertebrate fauna was systematically collected from 2-mm mesh in well-lit laboratory conditions by volunteer 'rockwashers' at the University of Victoria who graciously donated many evenings picking through these numerous samples (see Figure 1). Through their collective efforts, a large number of samples were processed, a task that would have taken an inordinate amount of time for a single person.

After processing was completed, shell, bone, rock, and charcoal constituents from individual samples were weighed and these data were entered

into an *Excel* spreadsheet. Vertebrate fauna from each individual column sample was retained while the remaining sample constituents were placed back in the original sample bag. Processed non-vertebrate faunal samples were then delivered to the repository at the Royal BC Museum.

Identification

Vertebrate fauna was morphologically identified with the aid of a binocular dissecting microscope (6.3–40x) and the use of the comparative skeletal collection at the University of Victoria Zooarchaeology Laboratory. Identification data were recorded by skeletal element in a row and column database, noting relevant osteological, taphonomic, and provenience information. This database was then converted to a working spreadsheet and finally imported into a stable relational database (*File-Maker Pro*). With the exception of fish spines, ribs, branchials, scales, and gill-rakers, identification was attempted for all skeletal elements recognizable to species, genus or family level. Confidence codes were assigned to each examined specimen to indicate the certainty of identification (for criteria, see

Frederick and Crockford 2005). Briefly, specimens were considered 'identified' (NISP) if they could be confidently assigned to a taxonomic level of family, genus, or species. The remaining specimens were classified as unidentified fish, bird, mammal, or unidentifiable bone (NSP).

Considerable effort was taken to employ identical identification and quantification procedures for both column and unit sample fauna (i.e., Frederick, this vol.) including the use of the same comparative collection. However, some species level designations, such as distinguishing different species of greenling (*Hexagrammos* sp.) was attempted much less frequently in the column sample assemblage due to a lack of equivalent confidence between analysts.

Quantification

NISP – Number of Identified Specimens

The primary means of quantification used in this analysis as well as in the excavation unit assemblage (Frederick, this vol.) is the number of iden-

tified specimens (NISP). This measure represents the number of skeletal specimens that can be confidently identified to family, genus, or species. NISP is an indivisible quantitative measure fundamental to all zooarchaeological assemblages and is readily compared across archaeological contexts. NISP data are typically expressed in terms of the relative abundance (% frequency) of a particular item relative to all other identified specimens from a taxonomic class (e.g., herring is 81.3% of all identified fish remains). NISP does not include specimens that are only recognizable as 'fish,' which were designated as 'NSP' (see Table 1).

Ubiquity – Frequency of Occurrence

Ubiquity is an additional measure of abundance based on the presence or absence of items in a number of archaeological contexts. Ubiquity is calculated as the percentage of discrete contexts in which a certain taxon is found (frequency of occurrence). For example, herring can be considered 'ubiquitous' in the assemblage because this species is present in over 90% of the 168 examined column

Table 1. Column samples containing identified fish remains wet-screened through 2 mm mesh.

Column Sample	Ex. Date	Number of examined levels	Excavated Volume (Litres)*	Recovered Volume (Litres)*	Orig. wt. (kilograms)	Unid. Fish (NSP)	NISP fish	Total Fish	NISP/Litre (ex. Vol.)
N2-4/W18-20 Back terrace	2006	25	25.0	24.75	33.807	2,110	11,439	13,549	457.6
N4-6/E0-2 Back terrace	2004	17	34.0	42.25	51.821	2,061	5,920	7,981	174.1
N10-12/E2-4 W. wall	2004	19	19.0	24.3	25.063	3,855	2,928	6,783	154.1
N12-14/E6-8 S. wall	2004	12	12.0	16.25	16.802	1,320	1,086	2406	90.5
N18-20/E2-4 S. wall	2004	21	21.0	25.5	28.632	2,477	2,033	4,510	96.8
N18-20/E6-8 E. wall	2004	21	21.4	30.95	34.663	4,674	3,834	8,507	179.2
N10-12/E4-6 S. wall	2004	1	1.0	0.75	0.750	96	99	195	99.0
N14-16/ E15.5-16 E. wall	2006	6	6.0	8.65	9.075	875	855	1,730	142.5
N18-20/ E15.5-16 W. wall	2006	8	8.0	8.6	10.103	812	739	1,551	92.4
Privy Pit	2004	4	4	4.4	5.794	210	33	243	8.3
N18-20/E26-28 W. wall	2006	9	9.0	11.75	11.991	1073	717	1,790	79.7
N18-20/E34-36 E. wall	2006	25	25.0	32.5	36.338	4,185	2,795	6,980	111.8
Total		N = 168	185.4	230.65	264.839	23,748	32,492	56,225	175.2

* Excavated volume is based on the dimensions of the excavation whereas 'recovered' volume is based on the volume of uncompacted sediment recovered and measured using water displacement.

samples levels at the site. Ubiquity is used here to supplement the interpretations of abundance as it is not dependant on the proportion of other species.

MNI – Minimum Number of Individuals

MNI is defined as the most commonly occurring, non-repeatable skeletal elements observed in a temporally distinct paleontological or archaeological context (Lyman 2008). There are several well-known methodological problems with MNI calculations (Grayson 1984; Lyman 2008). MNI estimates are ultimately *derived* from NISP data and are therefore cannot be used as an independent measure. The estimates produced by MNI calculations are particularly affected by how archaeological units of analysis (time periods and depositional events) are defined—the smaller the number of categories, the fewer individuals. Conversely, the larger number of analytical categories, the higher the minimum estimates, which also increase the probability that single individuals might be counted more than once.

Such uncertainty makes the use of MNI problematic, particularly for large mammals such as whales and seals whose large skeletal remains may be widely distributed in an archaeological context due to food sharing, differential butchery, transport, and consumption, as well as use of bone to make tools and or extract oil (e.g., Monks 2003). However, such factors are arguably much less likely for smaller-bodied fish that are much more likely to be redistributed and discarded as individual animals than larger-bodied animals would be.

The benefits to employing MNI estimates is the ability to translate numbers of bone elements to an estimate of the total number of animals represented in a given depositional context. Such a conversion allows for a more detailed comparative assessment of the relative contribution of individual animals, and may differ substantially from the %NISP estimate but is in no way a substitute for it. Given that the column sample faunal assemblage is comprised of small discrete volumes of spatially and temporally distinct deposits, I deemed it worthy of considering the use of MNI estimates for the column sample fish assemblage. A particular motivation was to address the notion that Pacific herring, the most abundant fish in the assemblage, might comprise a relatively less important role in the assemblage if faunal counts are converted to MNI.

Thus, I calculated fish MNI by using the most numerous non-repetitive elements present in an individual column sample level (1–2 litres of sedi-

ment). If many more repeatable elements such as vertebrae were present in a particular sample, I divided this count by the number of elements for particular fish taxa (e.g., 55 vertebrae per herring).

NISP and MNI Per Litre and Cubic Meter

In addition to NISP, ubiquity, and MNI, I also calculate the number of identified specimens per litre (NISP per litre) and the minimum number of individuals (MNI) per litre. These latter measures are derived from the combined excavated volume of individual column sample levels (e.g., 1 litre per 5 cm level) and are then scaled up to cubic meters (i.e., 1,000 litres). These measures provide an “absolute” measure of abundance as opposed to relative percentage data (where a change in the abundance of a particular taxon may reflect a change in the abundance of another species).

Importantly, these estimates do not account for variability within individual column level samples but rather are generated by dividing the total number of specimens by the total examined volume. As such, these precise estimates should be considered tentative but nevertheless distinct from relative percentage data. They are used here to supplement and strengthen the overall abundance estimates by providing another level of scrutiny in assessing the taxonomic composition and temporal trends in the assemblage.

Fish Size Estimations

To measure fish size, I used digital calipers (± 0.1 mm) to measure a select number of herring, greenling, rockfish, salmon, and hake skeletal elements. Estimating fish size is possible due to the predictable relationship between the dimension of individual bones and the length of individual fish (Casteel 1974). Here, I utilize published regression formulae for rockfish, greenling, and Irish lord (Orchard 2003) as well as two new formulae I developed for hake and herring (McKechnie 2010; McKechnie and Tollit n.d.). These regressions were based on comparative collections at the Zooarchaeology Lab at the University of Victoria and the National Marine Mammal Laboratory located in the NOAA Sand Point facility in Seattle, Washington.

To estimate fish length for herring, I measured the greatest anterior width of the 1st and 2nd vertebrae of herring (McKechnie and Tollit n.d.). For hake, I measured the width of the articular surface of the quadrate (McKechnie 2010). For salmon, I measured the greatest transverse diameter of whole

Table 2. Taxonomic list of identified fish, mammal, reptile and bird specimens (NISP) recovered in the examined column sample assemblage.

		Back Terrace	House 1	Total
Fish				
Pacific herring	<i>Clupea pallasii</i>	16,470	9,930	26,400
Anchovy	<i>Engraulis mordax</i>	347	1,519	1,866
Salmon	<i>Oncorhynchus</i> sp.	146	1,616	1,762
Greenling sp.	<i>Hexagrammos</i> sp.	184	527	711
Hake	<i>Merluccius productus</i>	3	637	640
Rockfish sp.	<i>Sebastes</i> sp.	61	276	337
Dogfish shark	<i>Squalus acanthias</i>	42	257	299
Perch sp.	Embiotocidae	64	26	90
Sablefish	<i>Anoplopoma fimbria</i>	1	64	65
Petrale sole	<i>Eopsetta jordani</i>		43	43
Flatfish sp.	Pleuronectiformes	2	25	27
Lingcod	<i>Ophiodon elongatus</i>	1	26	27
Ratfish	<i>Hydrolagus colliei</i>	5	18	23
Irish lord sp.	<i>Hemilepidotus</i> sp.	1	18	19
*Prickleback sp.	Stichaeidae	2	13	15
Pile perch	<i>Damalichthys vacca</i>	1	12	13
Sculpin sp.	Cottidae	1	11	12
Plainfin midshipman	<i>Porichthys notatus</i>		12	12
White-spotted greenling	<i>Hexagrammos stelleri</i>	7	2	9
Cabezon	<i>Scorpaenichthys marmoratus</i>		8	8
*Eulachon	<i>Thaleichthys pacificus</i>	6		6
*Clingfish sp.	Gobiesocidae	6		6
Herring/sardine	Clupeidae	3	3	6
Skate sp.	<i>Raja</i> sp. (unident.)		5	5
*Tomcod	<i>Microgadus proximus</i>		4	4
Halibut	<i>Hippoglossus stenolepis</i>	3	1	4
*Smelt sp.	Osmeridae		3	3
Pacific cod	<i>Gadus macrocephalus</i>		2	2
Red Irish lord	<i>Hemilepidotus hemilepidotus</i>	1	1	2
Buffalo sculpin	<i>Enophrys bison</i>		2	2
Gadid (not hake)	Gadidae, not hake		1	1
*Sand lance	<i>Ammodytes hexapterus</i>	1		1
*Capelin	<i>Mallotus villosus</i>		1	1
*Shiner perch	<i>Cymatogaster gracilis</i>	1		1
*Atka mackerel	<i>Pleurogrammus monopterygius</i>		1	1
Dover sole	<i>Microstomus pacificus</i>		1	1
Starry flounder	<i>Platichthys stellatus</i>		1	1
*Gunnel sp.	Pholididae		1	1
Total NISP Fish = 32,459 (Back Terrace=17,359, House 1=15,067, Privy Pit=33)				
Marine Mammals				
Porpoise/Dolphin	Delphinidae/Phocoenidae		3	3
P. white-sided dolphin	<i>Lagenorhynchus obliquidens</i>		3	3
Whale sp.	Cetacea	1	1	2
Harbour porpoise	<i>Phocoena phocoena</i>		1	1
Harbour seal	<i>Phoca vitulina</i>		1	1
Fur seal	<i>Callorhinus ursinus</i>		1	1
Pinnepedia, sm	Pinnepedia		1	1
Dall's porpoise	<i>Phocoena dalli</i>		1	1
Total NISP Marine Mammals = 13				
Terrestrial Mammals				
Canid	Canis sp.		4	4
Rodent (vsm)	Rodentia (vsm)	2		2
*Vole sp.	<i>Microtus</i> sp.	1		1
Mouse/vole sp.	Rodentia (vsm)	1		1
Rodent (sm)	Rodentia (sm)	1		1
Deer sp.	<i>Odocoileus</i> sp.		1	1
*Shrew sp.	Soricidae		1	1
Total NISP Terrestrial Mammals = 11				
Domestic Mammals				
Domestic Dog	<i>Canis familiaris</i>		7	7
Reptiles				
*Unid. frog	Amphibian	1		1
Bird				
Duck (med)	Anatidae (med)		1	1
Grand Total (NISP)		17,366	15,093	32,492**

* Taxa identified in the column sample assemblage but not in the excavation unit assemblage.

** Grand Total NISP includes 33 fish elements from the privy pit.

salmon vertebrae to attempt to distinguish salmon species from their relative size distribution (Cannon and Yang 2006).

Results

The examined assemblage contains a total of 32,492 identified specimens (NISP) and a total of 58,118 skeletal specimens (including unidentified fish, birds, mammals). This examined assemblage comes from 168 discrete column sample levels representing a total excavated volume of 185.4 litres. Vertebrate remains are present in every examined sample context.

Fish are the overwhelmingly dominant taxonomic group in the column assemblage. Fish represent 99.9% of the total identified assemblage (Table 1) and more than 99% of NISP in each of the 12 examined column samples (Figure 15). Mammal and bird specimens are significantly less abundant although they are frequently encountered in the column sample assemblage. The majority of mammal and bird specimens are small, unidentifiable fragments of what were much larger once-complete elements. The extremely low proportion of identifiable mammal and birds in the column sample assemblage stands in contrast to the excavation unit assemblage, which has a much larger assemblage of identified (NISP) mammalian and bird remains (Frederick, this vol.).

Taxonomic Richness

Thirty-two unique fish taxa were recovered from the column sample assemblage (Table 2). Ten of these fish taxa as well as two small mammal taxa are not present in the excavation unit assemblage (Frederick, this vol.). These taxa are small-bodied and represent relatively minor proportions of the overall assemblage (denoted with asterisks in Table 2). It is notable that these 12 taxa were not identified in the excavation unit assemblage, as their small bones are likely to have passed through the larger mesh sizes used during field-based faunal recovery in ¼" mesh screens.

By contrast, the excavation unit assemblage contains the same number of fish taxa (n = 32) but includes 12 species that *were not identified* in the column sample assemblage¹. These species also represent relatively minor components of the as-

¹ Sevengill shark, Bluefin tuna, Great sculpin, Spinyhead sculpin, Striped seaperch, Rock greenling, Kelp greenling, Rock sole, English sole, Sand sole, and Pacific sanddab.

semblage or were only identified to a genus level in the column sample assemblage (i.e., greenlings, perches, sculpins, and flatfish). Two of the largest species (sevengill shark and bluefin tuna) are rare in the site as a whole. Considering that the excavation unit assemblage is numerically larger and represents a dramatically larger examined volume (Frederick, this vol.), the absence of these in the column sample assemblage is relatively unsurprising. However, it is important to consider how such small proportions may indeed represent significant and sizable contribution to the fishery, especially considering the un-sampled portions of the site and the time depth of human occupation. The taxonomic richness of the assemblage are further discussed in the sampling effort section..

Contrasting the Column and Excavation Unit Assemblages

The analysis of vertebrate fauna from 2-mm mesh identified a similar suite of fish species as the ¼-inch excavation unit assemblage but resulted in a much greater recovery of small fish bones and thus a much greater number of bones per litre of examined volume. One of the interpretive consequences of such a shift is a dramatic change in the relative abundance of taxa present in the deposits. This shift has been widely observed by researchers working with fish assemblages throughout the Pacific (Casteel 1976; McKechnie 2005b; Nagaoka 1994; Partlow 2006; Stewart and Wigen 2003).

Figure 6 compares the relative percentage of the fine-screen column sample with the excavation unit assemblage, which illustrates the dramatic extent of the contrast. Notably, herring represent less than 4% of the excavation unit assemblage but they vastly outnumber all other fish in the column sample assemblage (81% NISP). This numerical dominance dramatically alters the percentage data for all other species and has vital consequences for interpreting subsistence and resource harvesting practices in the site as a whole.

Within the excavation unit assemblage, hake numerically dominate followed by salmon, rockfish, greenling, and dogfish (Figure 6). However, there was a single deposit containing several thousand hake specimens (a specific unit in the sub-floor deposits of House 1). As this does not adequately represent the overall composition of the unit assemblage (across space and time), fish from this particular deposit were subtracted and the percentage data recalculated (Frederick this vol.). Figure 6 illustrates this 'modified' total, indicat-

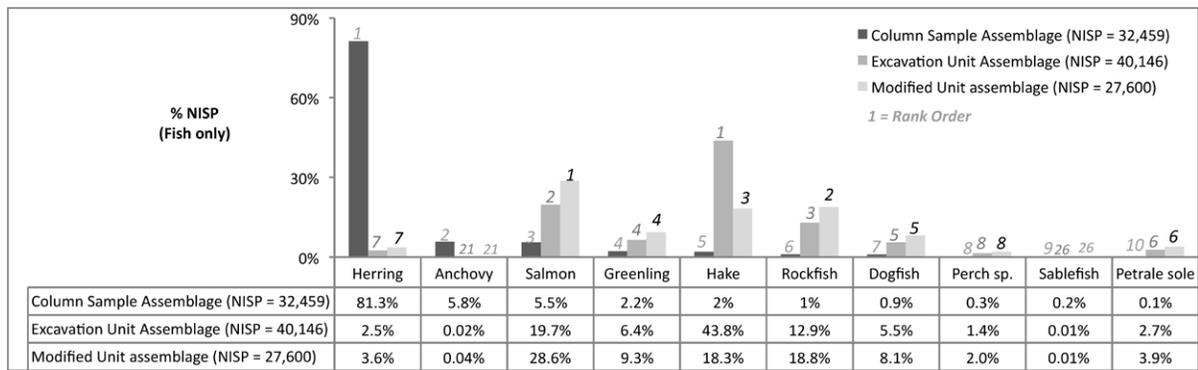


Figure 6. Comparison between the relative abundance of fish remains in the column sample assemblage (2 mm mesh) and the excavation unit assemblage (1/4-inch mesh) for the 10 most numerous taxa in the column assemblage. Numbered bars indicate rank order abundance.

ing that salmon are the most abundant fish taxon, followed by rockfish, hake, greenling and dogfish. Thus, while excavation unit assemblage provides invaluable perspective on the large-volume excavation, the collection strategy dramatically under-represents the taxonomic abundance of small fish and thus fish in the site as a whole.

Abundance and Ubiquity

Figure 7 illustrates the overall composition of the column sample fish assemblage according to two analytically distinct measures of abundance (%NISP and %Ubiquity). It is interpretively significant that the relative abundance of fish specimens so closely corresponds to the rank-order sequence of ubiquity. This demonstrates that the most abundant taxa (%NISP) also occur very regularly in the deposit as a whole. Conversely, less numerous taxa occur very infrequently. There are, however, some notable exceptions, indicating that some taxa are present in high numbers in only a few contexts (e.g., hake) while others are consistently present in low numbers (e.g., rockfish). These similarities and differences provide critical insight into the spatial and temporal variability of these taxa in the examined assemblage and are discussed in more detail below. The overall similarity between these two measures provides a level of confidence that the taxonomic composition of the total assemblage is broadly representative and that the numerically dominant species are also likely to be the most abundant in small portions of the assemblage.

Taxonomic Composition

While a large number of fish taxa are present in the examined deposits (n = 32), the ten most numerous

taxa represent more than 99% of the identified specimens while the remaining 22 taxa represent less than 1% of the combined total. This indicates that the bulk of the fishing activity focused on a limited number of species. In the following section, I discuss the ten most abundant and ubiquitous fish as shown in Figure 7. To more fully document the temporal and spatial changes, I also employ MNI measures as well as density measures (e.g., NISP per m³) to further distinguish the characteristics of relative abundance (Figures 8 and 9).

Herring

The column sample vertebrate faunal assemblage from HuuZii is dominated by herring, which represents 81.3% (NISP) of the total column sample fish assemblage (Figure 7). Similarly, herring is the most ubiquitously occurring species within the 168 column sample levels (90.5%). Herring is also the most numerous taxon as indicated by MNI calculations (Figure 12). The numerical abundance and consistent ubiquity values of herring reveals this species dominates the indigenous fishery at HuuZii throughout the archaeologically examined period of human occupation. Herring is most dominant in the back terrace deposits (ca. 5,000–3,000 years ago), where herring represents 94.9% of NISP and 60% of MNI (Figure 8). Herring is less abundant but still dominates the House 1 assemblage in both the sub-floor and house-floor deposits (65% NISP and 25–28% MNI). Herring from the back terrace also exhibits a much higher NISP and MNI per m³ than in the later House 1 deposits (Figure 9), strongly indicating that herring use and as a consequence, fish utilization was more intense than in the House 1 deposits. Despite these differences, the consistency of herring utilization (as most strongly indicated by ubiquity) indicates continuity

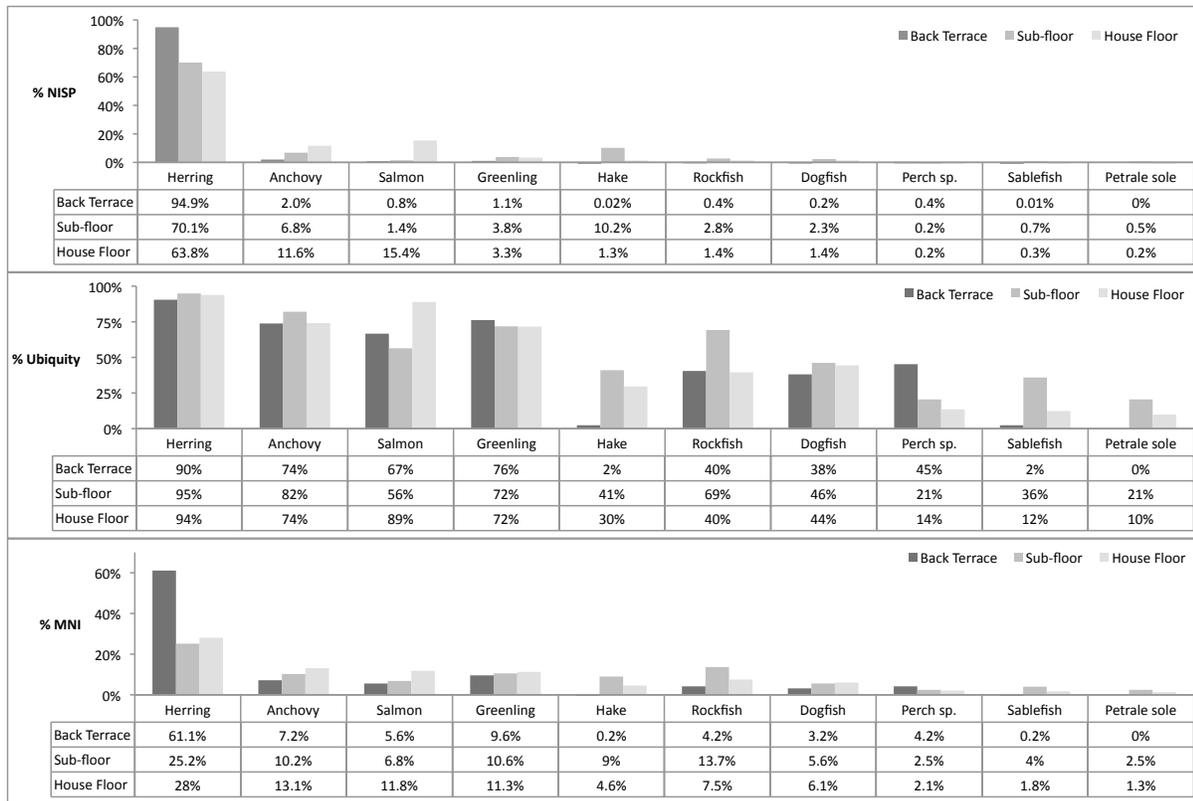


Figure 8. Relative abundance over time for the ten most numerous fish taxa shown as percent of identified specimens (top), ubiquity (middle), and the estimated minimum number of individuals (bottom). Grouped bars represent fauna from the three temporally distinct deposits; the back terrace, sub-floor deposits, and the House 1 floor deposits.

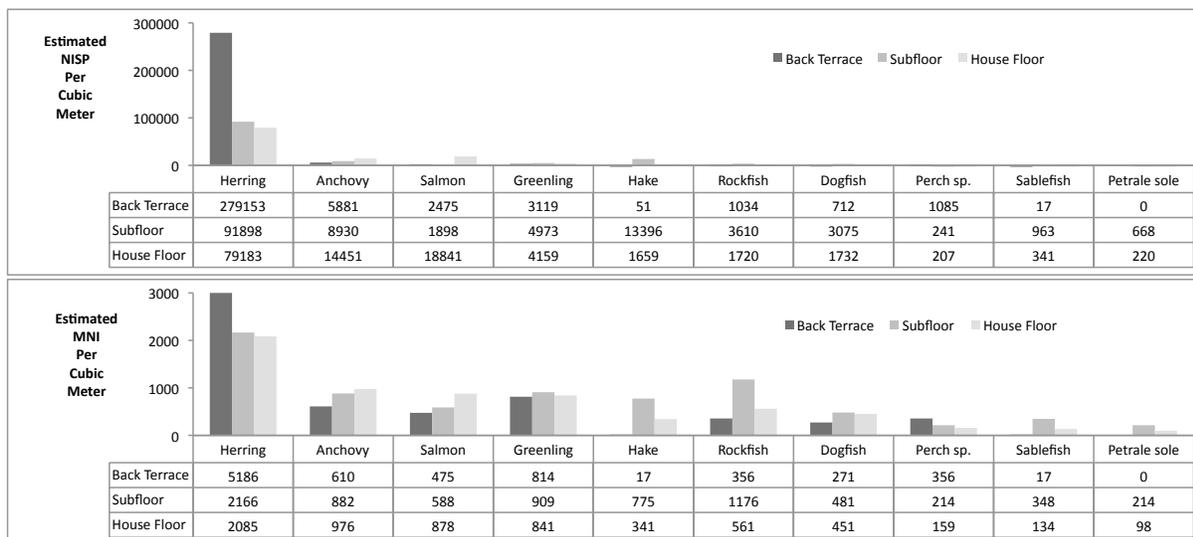


Figure 9. The number of specimens (NISP) and minimum number of individuals (MNI) per cubic meter based on sampled volumes from the back terrace (59 litres), the subfloor (37.4 litres) and house floor assemblages (82 litres). Note: estimates are overly precise (extrapolations) but nevertheless give a n additional comparative basis for assessing change over time and differences between species.

by MNI, anchovy represents over 10% of the assemblage but its rank-order abundance drops from second to third using this measure (Figure 12).

Anchovy are sequentially more abundant over the three temporal periods, rising from a low 2% NISP in the in the back terrace assemblage to 6.8% in the sub-floor assemblage, to a high of 11.6% in house floor assemblage (Figure 8). Comparing the number of anchovy specimens (NISP) per cubic meter and individuals (MNI) per cubic meter indicates there is a similarly progressive increase in anchovy over time (Figure 9). As shown in Figure 8b, the ubiquity value of anchovy remains virtually the same over time, suggesting that this species was harvested consistently but became increasingly important relative to other fish.

Salmon

Salmon are the third-most numerically abundant taxon in the assemblage, representing 5.5% of the total NISP (Figure 7) and 8.8% of the total MNI (Figure 8). Salmon are also relatively ubiquitous in the examined assemblage indicating consistent use throughout the site deposits (70%). However, salmon are considerably more abundant in the House 1 deposits than in the back terrace based on NISP, ubiquity, and MNI, as well as NISP per m³ and MNI per m³. Within the House 1 deposits, salmon increase in abundance between the sub-floor and House floor deposits, reaching their highest abundance in the period just prior to site abandonment (ca. 400 years BP).

Greenling

The next most numerically abundant taxon is greenling, which represents only 2.2% of the total NISP but has a ubiquity value of 70% indicating it is found in low quantities but is regularly utilized (consistently present in most examined contexts). This circumstance appears to impact the MNI estimate for greenling, which shifts it to the second-most abundant fish in the assemblage (Figure 12). There is no discernable difference in the relative abundance and ubiquity of greenling over the three temporal periods represented at the site, suggesting this taxon remained consistently important throughout the occupation of HuuZii.

Hake

While hake is the fifth-most numerically abundant fish in the column sample assemblage, it is significantly less ubiquitous than other abundant taxa. This indicates hake was not as consistently harvested over the 5,000-year period of occupation,

but rather occurs much more frequently within a particular context or time frame (i.e., a portion of the House 1 deposits). This inference is strongly supported by the temporal trends in abundance where hake very rarely occur in the back terrace deposits but spike in abundance and ubiquity in the sub-floor deposits, only to drop in abundance within the house floor deposits (Figures 8 and 10).

As discussed for the excavation unit assemblage (Frederick, this vol.), there is an extremely high density of hake remains present in the lower portion of column N18-20/E6-8 from House 1 that disproportionately increases the calculated abundance for the total unit assemblage. In contrast to the very high abundance estimates for hake in the excavation unit assemblage, the column sample data indicate that this species represents not much more than 10% of the assemblage in the sub-floor deposits. Hake MNI estimates range from a low of 0.2% to a high of 9% in the sub-floor deposits (Figure 8).

Rockfish

Rockfish represent only slightly more than 1% of the total assemblage but are found in 45% of the examined column level samples (Figure 7) and comprise nearly 8% of the estimated MNI (Figure 12). Rockfish are considerably more abundant and ubiquitous in the sub-floor deposits than in either the back terrace or house-floor deposits indicating this taxon was utilized most intensively during this period (Figure 8).

It is noteworthy that rockfish are slightly less abundant than greenling in the column assemblage (Figure 6) but strongly outnumber greenling in the excavation unit assemblage (Fredrick, this vol.) This likely reflects a screen size bias favoring recovery of larger fish, whereas greenlings have a smaller size-range than rockfish at the Ts'ishaa village in the Broken Group (McKechnie 2005b:217). Similarly, greenling has a slightly smaller size range than rockfish in this assemblage (Figure 13).

Dogfish

Dogfish are the seventh-most abundant fish but are not particularly abundant in the column assemblage, representing less than 1% of total NISP (Figure 7). However, they do occur regularly throughout the examined occupational history as indicated by their consistent ubiquity (Figure 8). Dogfish abundance does not appear to change significantly over time but House 1 deposits have slightly higher frequencies relative to the back terrace (Figure 9).

Despite a low relative abundance, it is notable

that dogfish cartilaginous sharks that have significantly fewer skeletal structures than bony fish, which would further diminish the potential importance of this taxon relative to others (Rick et al. 2002). However, dogfish do have highly distinctive and numerous vertebrae (ca. 100–110, Last et al. 2007), which in comparison with many other fish may help offset an otherwise sparse skeletal anatomy.

Perch

Perch is a taxonomic family level designation (Embiotocidae) referring to several species (e.g., pile perch, surf perch, shiner perch) that occur moderately frequently in the overall assemblage but represent small abundance values (Figures 7 and 12). Interestingly, perch progressively decrease in abundance over the three time periods among all relative abundance measures (%NISP, Ubiquity, %MNI) as well as absolute abundances as estimated by NISP and MNI per cubic meter (Figure 9). Thus, perch appear to be most regularly utilized in the back terrace deposits and progressively decrease over time.

Sablefish

Sablefish are long-lived fish that inhabit deep pelagic waters along the continental shelf edge (King et al. 2000). Sablefish occur moderately regularly in the column sample assemblage (14% ubiquity) but represent only 0.2% of the total assemblage (NISP). Sablefish is nearly absent in the back terrace but increases in the later sub-floor and house-floor deposits (Figure 8).

Based on visual comparison to mature fish in the UVic comparative collection, it appears the majority of the archaeological specimens are from small, juvenile-sized fish (King et al. 2000), which inhabit shallow inshore waters before maturation. The moderately frequent occurrence of juvenile-sized sablefish in the House 1 assemblage is consistent with the use of the nearshore water in the vicinity of site. However, additional measurements and metric comparison to known age specimens might improve understanding of where in the environment these fish were harvested.

Petrale Sole

In contrast to the noted ethnographic importance of halibut (e.g., Arima 1983), the most numerous 'flatfish' in the column assemblage is Petrale sole, a plate-sized flatfish that inhabits relatively deep-waters between 80 and 500 meters (DFO 1999). Petrale sole represent a small portion of the overall

assemblage and exhibit a moderate ubiquity in the House 1 deposits but are absent from the back terrace column deposits (Figure 8). Petrale sole are also the most numerous flatfish identified in the excavation unit assemblage (Frederick, this vol.), considerably out-numbering all other flatfish including halibut.

Other Fish

As shown in Table 2 and Figure 7, a host of other fish taxa are present in the assemblage but occur in very low quantities relative to the ten most numerous taxa. However, although numerous identified fish taxa may appear 'unimportant' in this assemblage, this assumption is not warranted given the fact that this assemblage 1) comes from a very small portion of what is a much larger site, 2) may occur in greater frequency in these un-sampled areas, 3) derive from deposits representing several thousand years of human occupation, and 4) is only one of numerous large shell midden sites in Huu-ay-aht territory. Nevertheless, these small numbers of comparatively 'rare' taxa preclude a justifiable assessment of their abundance and history of use within this particular assemblage.

Notably, there is a relative paucity of halibut in the column and unit assemblages (Frederick, this vol.), a circumstance that is not uncommon in archaeological contexts on the Northwest Coast (Orchard and Wigen 2008). The relative lack of halibut appears to reflect differential processing of halibut (butchery on the beach and public distribution of meat) as well as the taphonomic effects of a lower bone density value for halibut relative to other fish (Smith et al. 2008). Culinary processing such as the use of halibut for soup is a common practice that likely contributes further to the relative paucity of halibut in the assemblage (Blackman 1990; de Laguna 1972:392–400).

There are some unique and relatively unexpected occurrences of taxa such as eulachon, a small oily smelt known to spawn in large rivers, as well as possible sardine in the back terrace and the House 1 deposits, indicating the potential presence of this southerly species that rarely occurs at this latitude (see Wright et al. 2005). However, it is notable that that some of these 'rare' taxa occur much more frequently in the excavation assemblage than would be expected based on screen size alone. For example, the number of rockfish, lingcod, cabezon, and Irish lords specimens are recovered in considerably larger numbers in the unit assemblage (Frederick, this vol.). While this is likely due in part to a strategy

that preferentially recovers large visually distinctive bones, it also potentially reflects the spatially restricted sample of fish remains in the column sample assemblage relative to the spatially and volumetrically larger sample from the excavation units. For instance, at the completely sampled house floors at the Ozette village site, there are horizontally patterned concentrations of fish species in certain parts of the house floor (Huelsbeck 1981) that might be less likely to be captured in vertically oriented column sample deposits (see discussion in Gray 2008). Thus, it remains possible that those taxa that are rare in the column assemblage might appear comparatively more abundant if a larger spatial area was sampled.

Temporal Trends in the House 1 and Back Terrace Assemblages

House 1 (ca. 1500–400 yr BP)

To assess the temporal trends in fish use within the House 1 deposits, I plotted the relative abundance of three important fish taxa by individual column sample level (Figure 10). This analysis compares trends across the four column samples spanning the full depositional sequence of House 1 and utilizes both %NISP and NISP per litre values in order to evaluate if an increase in relative abundance is a simple consequence of an increase in another taxa.

Overall, there is strong similarity between %NISP and NISP per litre for the House 1 column samples, providing greater confidence that the observed trends are not spuriously caused by fluctuations in other taxa, but reflect actual changes in abundance. In some cases, however, the two sets of data (%NISP and NISP per litre) diverge, which allows further clarification for specific temporal periods. For example, the increasing NISP per litre for salmon in column sample N10-12/W2-4 does not match the decrease in salmon %NISP due to a particularly large increase in herring per litre (left column of Figure 10).

Secondly, there are distinct similarities in the temporal trends for specific taxa throughout the depositional sequence, suggesting that coherent change occurred in resource harvesting practices, with the most striking trends noted for hake and salmon. In particular, hake do not occur in either the lowest or in the highest column sample levels from House 1 but exhibit a dramatic spike in abundance in the middle portion of each of the examined column samples (both %NISP and NISP per litre, Figure 10). In the upper layers of the house floor deposit (later in time), there are dramatic in-

creases in salmon abundance (relative percent and bones per litre), in contrast to the consistently low abundance values for salmon in the lower, earlier levels. The increase in salmon also occurs in the upper levels of the four column samples that span only the house floor portions of House 1 deposits.

The sudden and progressive increase in the relative abundance of salmon appears just after the period of intense use of hake (Figure 10), suggesting a long-term and spatially coherent shift in the focus of resource harvesting practice at a household level. Thus, despite the potential for spatial variability in a house deposit, this aspect of resource use appears to have shifted throughout the house deposit sometime after approximately 800 years ago.

In contrast to the dramatic shifts in the abundance of hake and salmon, the most numerous taxon in the assemblage, herring, shows progressive long-term fluctuations in abundance that range widely but relatively consistently over time. For instance, there are broad similarities in the trends in abundance between the four columns, with high abundances in both the lower levels and the upper levels. In contrast, there is a period of comparatively low herring abundance in the middle portion of the depositional sequence from House 1. Interestingly, this corresponds to the peak in hake abundance, suggesting that the number of herring per litre drops when hake reach their highest frequencies (Figure 10). Similar to herring, anchovy appear to exhibit broad temporal trends in the House 1 deposits with somewhat consistent increases in abundance when herring decrease in abundance.

Back Terrace (ca. 5000–3000 yr BP)

Herring consistently dominates the fish assemblage in both of the back terrace column samples, representing more than 94% of total NISP and more than 70% of NISP in individual levels in all but three of the 38 examined levels from the two columns (Figure 11). This consistently high percentage is similarly reflected in the number of herring per litre, which vastly outnumbers all other taxa throughout the depositional sequence. These consistent trends occur in physically separate deposits (20+ metres apart) that have overlapping age ranges, and therefore likely represent a deposit-wide pattern over a broad 2,000-year period, between 5,000 and 3,000 years ago.

Notably, the highest herring frequencies occur in the upper half of the deposits between 125 and 90 cm below the surface in both column samples (both %NISP and NISP per litre). This spike

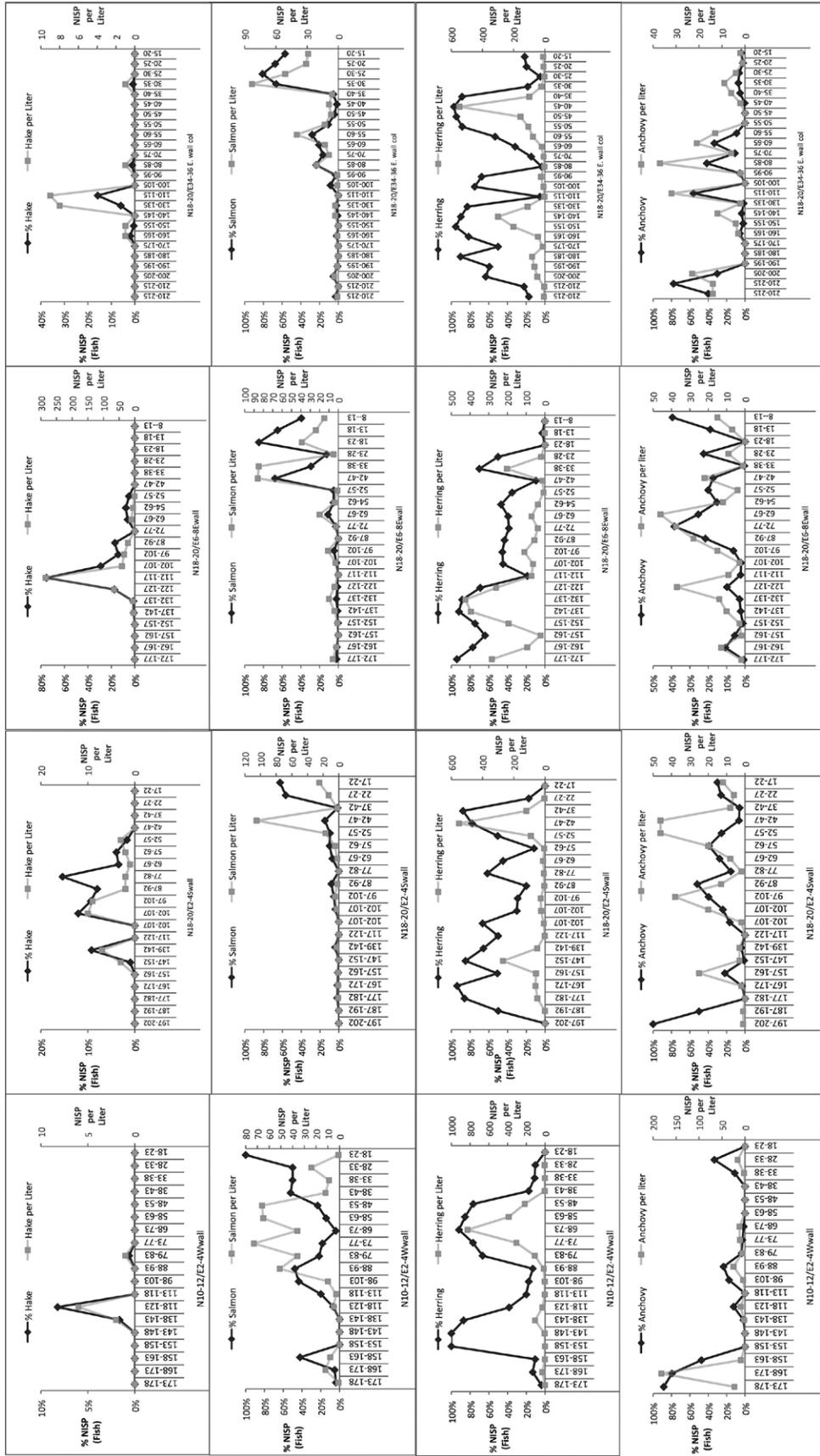


Figure 10. Temporal trends (left to right) in the abundance of four important fish taxa in four different areas of the House 1 deposits (top row–hake, upper middle–salmon, lower middle–herring, bottom–anchovy). Dark lines indicate the relative percent (%NISP) while the grey lines indicate absolute abundance (NISP/litre) and are plotted on a secondary vertical axis. The individual data points on the horizontal axis are 5-cm column sample levels shown in depths below ground surface. Note the different scales. Interpretations of patterning: Hake suddenly occur in the middle portion of House 1 deposit but are then consistently absent. Salmon exhibit dramatic increases in abundance in the upper levels of all column samples after Hake spike in abundance. Herring exhibits broad fluctuations in abundance but is generally less abundant when hake is present. Anchovy abundance broadly fluctuates but exhibits its highest abundances when hake spikes in abundance.

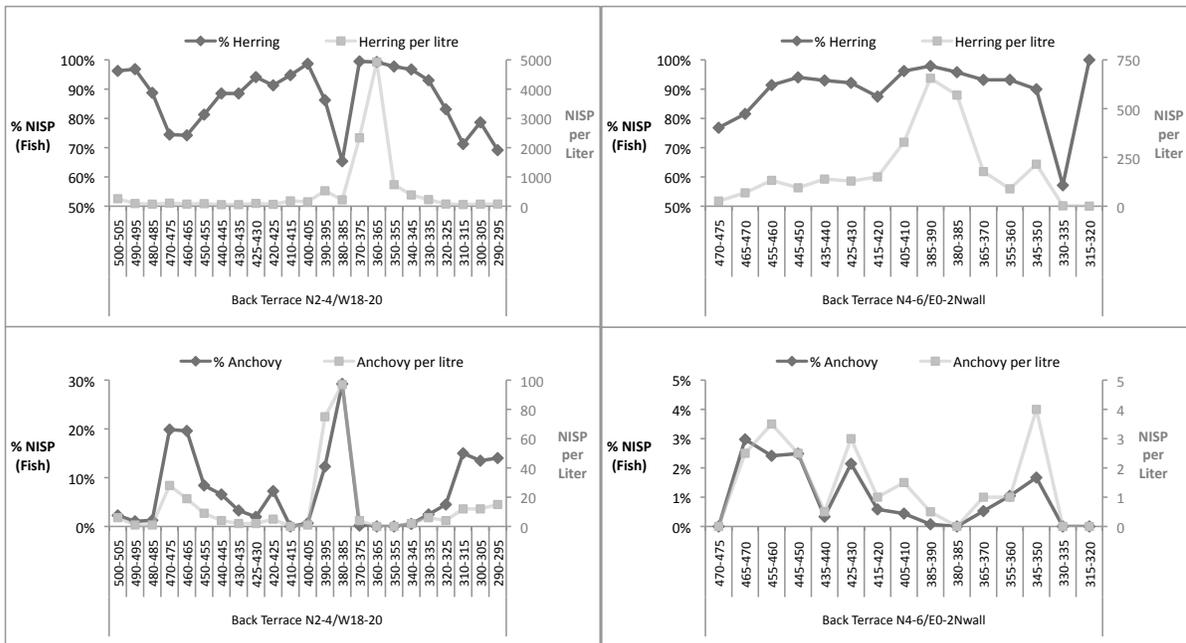


Figure 11. Herring and anchovy abundance in individual column sample levels from the two back terrace column samples. Dark lines indicate the relative percent (%NISP) while the grey lines indicate absolute abundance (NISP per litre) and are plotted on a secondary vertical axis. The individual data points on horizontal axis are 5-cm increments in depths below ground surface.

in abundance therefore appears to represent a deposit-wide period of particularly intense herring use. The most extreme case is a series of contiguous levels in column N2-4/W18-20, which culminates in a single 1-litre level containing nearly 5,000 individual herring bones, representing a minimum of 98 individual herring (approximately 15% of the entire fish assemblage). Observations by excavators recount a “crazy herring” layer in both excavation units where dense concentrations of herring were present across horizontal levels. Such high fish numbers suggests an intense collective effort focused on herring harvesting and processing, presumably over a number of seasons or over the course of a few human generations based on the presence of multiple 5 cm levels containing particularly high numbers of herring.

Both preceding and following this period of particularly intense herring use, herring progressively rises and drops in abundance over successive levels (among both %NISP and NISP per litre). This indicates progressive fluctuations in fishing effort that likely relates to a combination of 1) the abundance of herring in the environment, 2) local conditions conducive to herring spawning habitat, and most vitally 3) the collective social capacity and incentive to collect and process *that* many fish.

Anchovy are the second-most abundant fish

species in the two back terrace column samples but are considerably less abundant than herring in all levels. Similar to herring, the back terrace column sample N2-4/W18-20 contains many times more anchovy remains than in column N4-6/W0-2, reflecting the comparatively greater number of fish in this deposit as well as a comparatively greater percentage of anchovy. Both columns contain higher frequencies of anchovy in the levels preceding the dramatic spike in herring, suggesting that inhabitants may have increased their use of anchovy when herring harvests were lower. Similar patterning was observed in the House 1 deposits. Both fish are high in oil content and were likely caught using similar methods (e.g., rakes, nets).

Collectively, the temporal trends in the abundance of the most numerous and ubiquitous taxa reflect active shifts in fishing practices between the deposition in the back terrace deposits and the creators of the House 1 deposits. The cultural and paleoenvironmental significance of these changes are discussed further in the discussion section.

NISP and MNI

Figure 12 contrasts the NISP and MNI values for the ten most abundant taxa in the entire column assemblage. As previously discussed, MNI is a

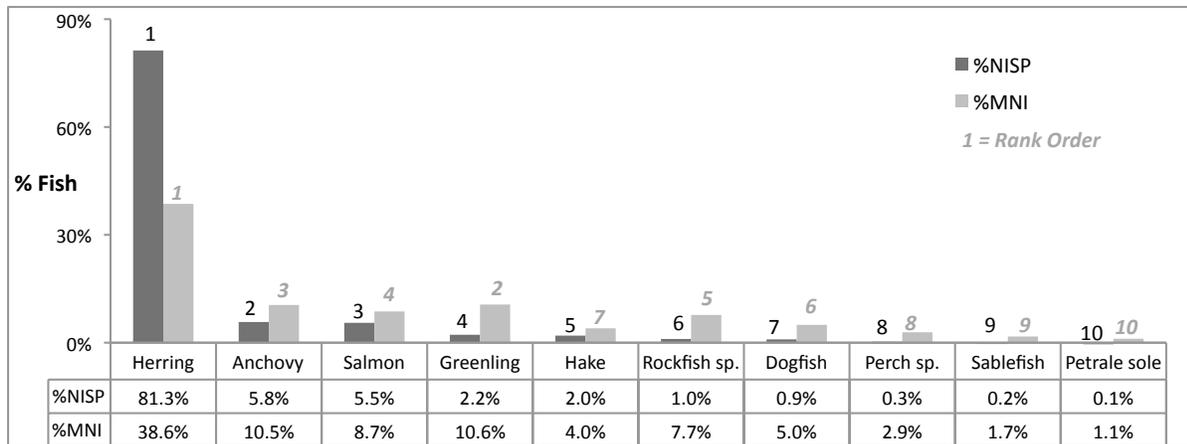


Figure 12. NISP and MNI data for the entire column sample assemblage. MNI represents the minimum number of individuals (%MNI) and is derived from NISP data. Rank orders for NISP and MNI listed as numbers above bars.

minimum estimate derived from the most numerous non-repetitive element in the individual column sample levels and is subject to numerous quantitative and thus interpretive uncertainties (Lyman 2008). Nevertheless, this derived measure of abundance further details the relative and rank order abundance of the top ten fish taxa.

Interestingly, conversion to MNI for the entire assemblage roughly halves the relative abundance of herring (dropping from 81% to 39%). As a result, the percentages of all other taxa increase accordingly (Figure 12). This implies that these other fish have a consistently greater contribution relative to herring than indicated by the NISP data alone. Conversion to MNI also shifts the rank order abundance for several of the 10 most abundant taxa. For example, greenling shifts from the fourth to the second most numerous fish (Figure 12). Conversely, the contribution of hake drops from the fifth to seventh rank despite an increase in %NISP. Overall, rank order abundance generally corresponds with the NISP data and no other taxa occur in the top ten, confirming the numerical importance of these ten taxa.

Fish Length Estimates

Fish length estimations were conducted on hake, herring, rockfish, and greenling using linear regression introduced previously. I also measured the greatest transverse width of salmon vertebrae to estimate the range of salmon species present in the deposits following Cannon and Yang (2006). Fish length data are shown in Figure 13 and salmon vertebrae measurements in Figure 14. The

sample was limited by the presence of measurable elements and therefore represents only a small percentage of all identified specimens. These data are combined from all time periods as small sample sizes preclude temporal comparisons.

The majority of herring are estimated to be between 20 and 27 cm in length, indicating adult-sized (spawning-age) fish were the focus of harvesting based on comparison with studies conducted during the late 20th century (e.g., Hourston 1958; Tanasichuk 1997:2784). Visual inspection of the histogram for herring length (indicates a normal distribution with a central tendency between 22.5–25.0 cm in length. This suggests that aboriginal harvesters targeted herring when they aggregated in large schools of mature adults. The absence of herring smaller than 18 cm (approximately 2+ year old fish) suggests that juvenile schools were not targeted even though they are known to congregate in separate, smaller, more diffuse schools in bays and inlets (Hourston 1958).

As shown in Figure 13, the estimated size-range for hake is between 30 and 55 cm, indicating the exclusive presence of adult-sized fish that are well past spawning size (Benson et al. 2002). This suggests that the hake targeted by site occupants were not part of a year-round resident population that inhabit parts of southern BC (Benson et al. 2002) but are likely part of the California/Oregon migratory population whereby the largest individuals seasonally migrate north into southern British Columbia during the height of summer. As noted by several fishery researchers (Agostini et al. 2006; Benson et al. 2002; McFarlane et al. 2000), hake migration is strongly related to oceanographic

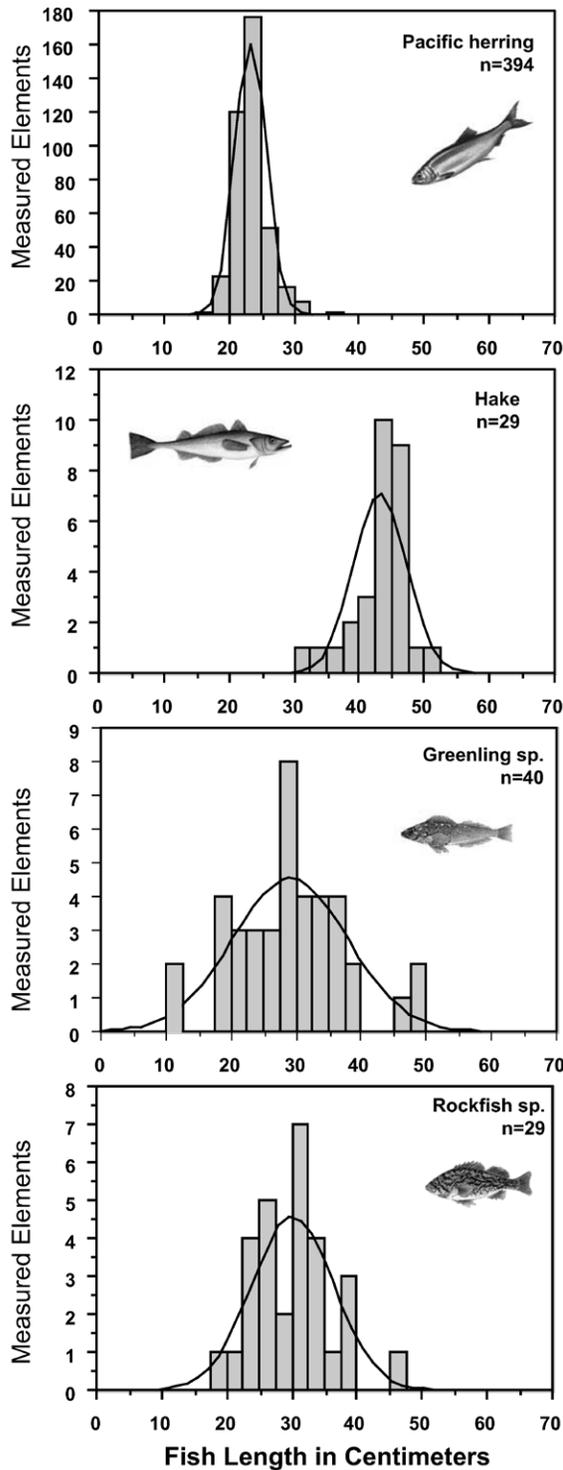


Figure 13. Histograms showing fish lengths measured elements of herring, hake, rockfish, and greenling. Herring is a fork length while the remaining are total lengths. Normal distribution curves shown over histograms. Note the large size of hake relative to other fish.

shifts in climate whereby larger hake migrate further north during years with warm ocean temperatures. Thus the abundant presence of hake in the sub-floor deposits may indicate warmer ocean conditions when they occur in abundance (ca. 1500–800 years BP).

Rockfish and greenling length estimates suggest the majority of these two taxa are between 20 and 40 cm in length (Figure 13). The similar size distributions for both greenling and rockfish and the fact that they share rocky bottom kelp-bed associated habitats indicate they were harvested at the same time and likely using similar technologies. These size ranges are much smaller than fish caught in the modern sport fishery but are identical to the lengths reported for the late-Holocene deposits at the village of Ts'ishaa in the Broken Group Islands (McKechnie 2007c:218). This small size is conducive to a sustainable harvest strategy, which targets young smaller animals that have less reproductive capacity than older, larger fish that exert a disproportionate effect on the survivorship of larval offspring (Berkeley et al. 2004).

Salmon vertebrae measurements indicate a range of species present in the modest sample of whole vertebrae (Figure 14). The greatest proportion of vertebrae falls within the size-range of smaller species such as pink, sockeye, and coho, indicating a possible concentration on these taxa. However, this contrasts slightly with measurements taken on a slightly larger sample from the excavation units in 2004 (Frederick et al. 2006). A larger sample is needed to more fully document the salmon species represented and recent papers (i.e., Huber et al. 2011; Orchard and Szpak 2011)

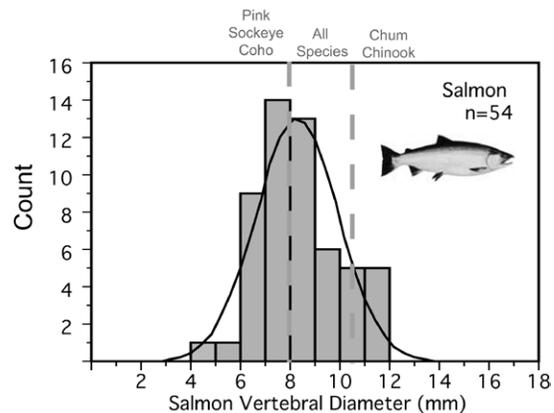


Figure 14. Measured salmon vertebrae from the column sample assemblage showing the size range for individual taxa as determined by Cannon and Yang (2006).

suggest that new metric and imaging approaches will yield useful insights.

Taphonomy, Formation Processes, and Sampling

Taphonomy, “the study of processes of preservation and how they affect information in the fossil record” (Behrensmeier and Kidwell 1985:105), is a fundamental process that underlies the archaeological record (Schiffer 1987) and the archaeology of animal remains in particular (Gifford 1981; Lyman 1994). Researchers have noted that faunal assemblages may be altered, transformed, and/or contributed-to by non-human agents such as burrowing and scavenging animals and microbes (Erlandson and Moss 2001), as well as a host of physical processes such as soil chemistry and sea-level change (e.g., Linse 1992; Moss 1985; Stein 1984). Cultural practices such as butchery, transport, consumption, deposition, and re-deposition can also strongly condition the types and proportions of animal bones recovered in archaeological contexts (e.g., Monks 2003). In addition, it is critical to be aware that the results observed in a zooarchaeological analysis may reflect limitations of the sampling strategy rather than a purported observation of historical significance (Gray 2008; Thomas 1978).

To assess how factors other than past human agency may have conditioned the skeletal assemblage and to consider how this may constrain the interpretive possibilities of the assemblage, this section conducts analyses that explore how taphonomic and sampling factors may affect the assemblage and the strengths of the assemblage.

Identification Rates

The ratio between ‘identified’ (NISP) and ‘unidentified’ (NSP)² specimens in a faunal assemblage reflects variability in the degree of identifiability and fragmentation as well as an analyst’s confidence in identification. To assess the potential relationship between identification and fragmentation, I examined the ratio of unidentifiable to identifiable remains for fish within the 12 column samples (Figure 16).

Each of the nine column samples from the House 1 deposits has a similar rate of fish iden-

² ‘Identified’ refers to specimens that can be assigned to taxonomic family, genus, or species whereas ‘unidentified’ refers to specimens that are only recognizable as fish (i.e., usually ribs, branchials, and/or fragmented bones).

tification (ranging between 40–50% of all fish specimens). This consistency in identification suggests fragmentation is similar within the House 1 deposits despite the potential for variability in a house floor.

In contrast, the two older back terrace column samples have much greater rates of identification (75–85%). This is a counterintuitive result as one might expect a much higher degree of fragmentation and lower identifiability in such an older deposit (ca. 5,000–3,000 yrs ago). However, in this case, the pattern of high identifiability is likely driven by the large numbers of identifiable herring remains in these two deposits (Figures 8 and 11). Regardless, the fact that larger numbers of small herring are abundantly present in these older deposits indicates excellent preservation conditions during that time.

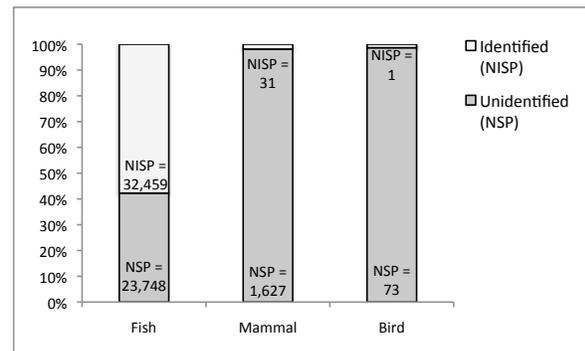


Figure 15. The identification rate for fish, mammals and birds in the column sample assemblage indicating the number of identified and unidentified specimens for each category.

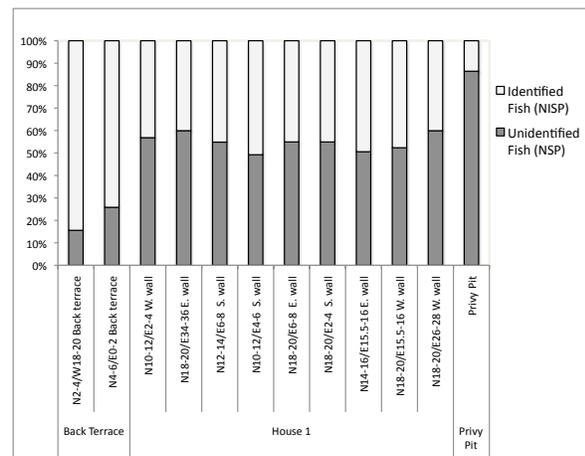


Figure 16. Identification rate for fish remains in the 12 examined column sample assemblages (site area is noted at bottom).

The single column from the privy pit has a notably low rate of identification (15%) but also has the smallest assemblage size and examined volume of the 12 column samples. This undated sample is close to the modern shoreline, and in the context of regional sea level history and site formation processes, it likely dates to within the past 500 years.

Density of Recovered Fish Remains

Based on the total number of fish remains present in the column sample assemblage, there is an estimated density of 175,000 identifiable (NISP) fish bones per cubic meter (from 2 mm mesh). The identified assemblage from the temporally older and spatially distinct back terrace deposits (ca. 5000–3000 yr BP) has the greatest estimated density of 294 identifiable fish remains per litre while the younger House 1 deposits have an estimated 123 bones per litre. While these estimates do not incorporate the considerable variability among individual column sample levels, they nevertheless indicate the considerable scale and intensity of the fishery as archaeologically represented in the examined deposits.

The greater number of bones per cubic meter present in the older deposits demonstrates the excellent preservation conditions and indicates a comparatively more intensive fishery at the site during that time (Figure 17). Conversely, this may also indicate that house-floor and sub-floor deposits are not as conducive to the preservation of bone and/or are subject to differing depositional conditions (e.g., trampling and house cleaning).

To further investigate the absolute abundance of fish remains in the examined assemblage, I developed estimates for the number of individual fish per litre in the three temporally distinct deposits. Figure 17 indicates that the older back terrace deposits have the highest number of fish per litre, which is predominantly due to a greater number of herring overall as there are fewer other fish per litre in this deposit. Conversely, later in time in the sub-floor and house-floor deposits, there is a substantial reduction in the number of herring per litre but an increase in the number of other fish, which appears stable during both periods (Figure 9).

Sampling Effort

To assess the relationship between taxonomic richness and sampling effort within the column sample assemblage (cf. Lepofsky and Lertzman 2005; Lyman and Ames 2004, 2007; Monks 2000), I cre-

ated ‘collectors curves’ depicting the stepwise relationship between taxonomic richness and sampling intensity (Figures 18 and 19). These figures show the ‘rate’ at which new fish taxa are identified as new column levels are cumulatively added together (i.e., new taxa found in individual column levels).

Unsurprisingly, this analysis reveals that the greater number of identified specimens, the more fish taxa were identified. Importantly however, the ‘rate’ of novel identifications slows dramatically as sample size increases. For instance, Figure 18 illustrates that 30 fish species were identified when the sample size reached 15,000 specimens but an additional 15,000 specimens needed to be examined before two additional fish species were identified. Overall, this ‘slowing’ in the rate of identification indicates that the analysis passed a threshold whereby a larger sample size does not dramatically increase the number of new taxa.

Figure 19 compares the collector’s curves for House 1 and the back terrace. This comparison reveals the similar level of sampling intensity in the two temporally distinct deposits. Both assemblages contain similar sample sizes and have reached relatively ‘level’ portions on the ‘curve’. Interestingly, this comparison also indicates that a greater number of fish taxa are present in the House 1 assemblage ($n=29$) than in the back terrace ($n=19$) assemblage, even though the back terrace has a moderately larger sample size. The differences in the shape of these curve is likely due to the higher number of herring present in the back terrace but the overall differences in the number of taxa appears to indicate substantial differences in the use of fish in these different periods in time (an issue discussed elsewhere).

The observation that both assemblages appear to have passed the ‘steepest’ portion of the curve indicates that the level of sampling effort adequately encompasses the taxonomic richness of these deposits. That said, neither collector’s curve appears to ‘level out’ entirely, indicating that new fish species will likely be identified if additional samples are examined. Thus, the assemblage has by no means been sampled to complete “redundancy” (Lyman and Ames 2004) but appears adequate for evaluating compositional differences between them due to both similar sample sizes and similarly shaped collector’s curves.

Shellfish and the Preservation of Bone

There is a widely held observation in shell midden archaeology of an association between the presence of shellfish and the preservation of bones (Erland-

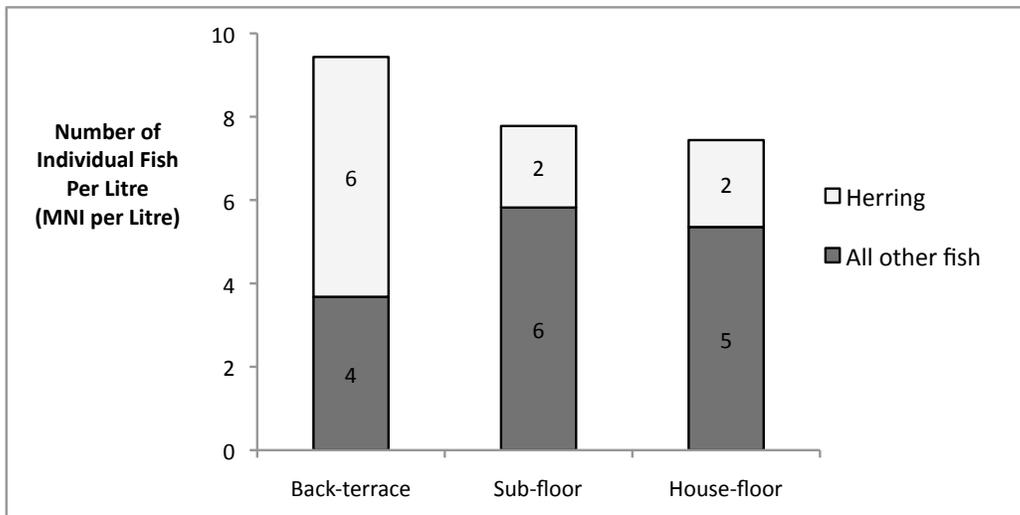


Figure 17. Estimated number of individual fish per litre (numbers have been rounded up) in the three temporally distinct deposits at Huu7ii. Numbers of herring and all other fish are based on the total number of individual fish divided by the total examined volume for each deposit.

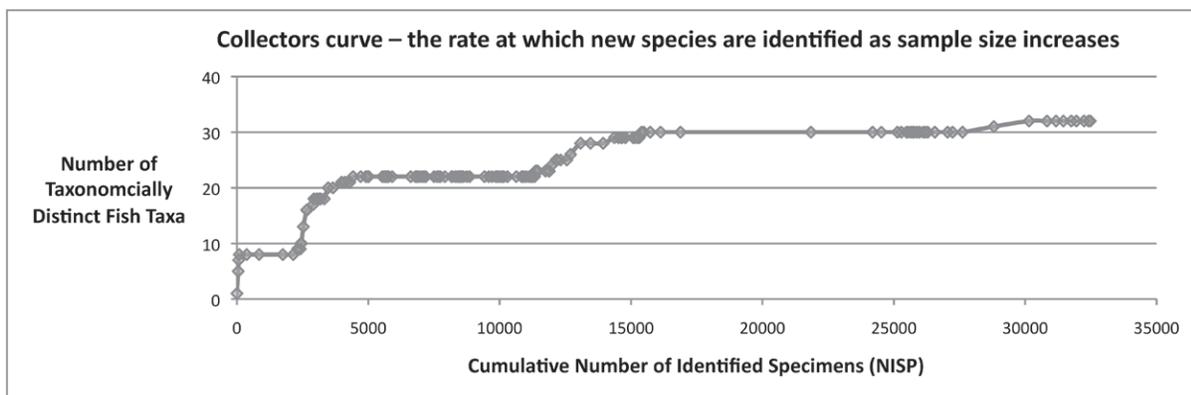


Figure 18. Collectors curve for taxonomic richness in the column sample assemblage depicting the linear relationship between the cumulative number of identified specimens and the number of new taxa present.

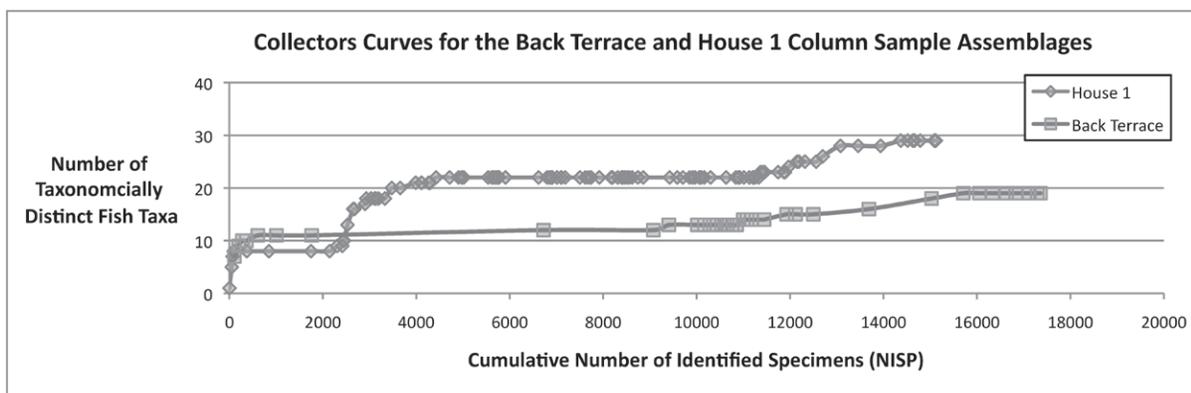


Figure 19. Collector's curve comparing the taxonomic richness of the House 1 and the back terrace assemblages.

son 2001; Linse 1992) whereby the deposition of shell creates alkaline conditions conducive to the preservation of bone. To assess whether this relationship has influenced the amount of bone present in the examined assemblage, I evaluated the strength of this relationship by using correlation between the weight of ¼" shell and the weight of 2 mm bone for 256 samples processed samples. However, I found no correlation between these variables for the assemblage as a whole but rather observed a very insignificant relationship with wildly varying amounts of bone and shell in individual column samples (Figure 20). I further examined this relationship within the back terrace, as these older deposits (ca. 3000–5000 BP) presumably might be more affected by such a relationship but again found no correlation. These results suggest that the presence of shell does not have a direct influence on the amount of bone present in individual levels and provides support for the interpretation that the deposition of bone is a function of cultural practices rather than an artifact of bone diagenesis.

However, this analysis does provide some support for a taphonomic distinction between the main village and the back terrace in that both shell and bone are found in a wider range of quantities per sample in the House 1 deposits relative to the back terrace (Figure 20). In particular, the maximum weight of ¼-inch shell per litre and the bone weight in grams per litre have lower values in the

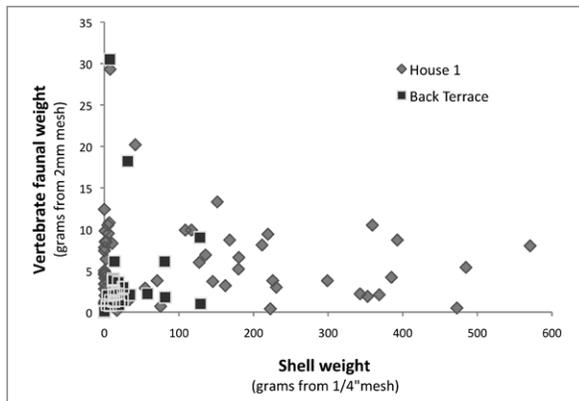


Figure 20. Scatterplot showing the non-linear relationship between the weight of bone per liter and the weight of shell per liter in individual column sample levels within the back terrace and the House 1 deposits (n = 256). Note the lack of a strong correlation overall but the comparatively higher range for shell and bone weight in the House 1 deposits.

back terrace than House 1. This suggests that either the amount of shell and bone is less abundant in these older deposits or is subject to greater rates of fragmentation. However, this does not appear to be positively correlated with the preservation of bone.

Condition of Bone Assemblage

Numerous skeletal specimens from the examined column sample assemblage show evidence of burning, erosion, cutmarks, and/or digestion. The frequencies of these alterations have implications for the preservation of the bone assemblage and for interpreting food preparation and bone disposal practices in the site as a whole.

Mammal bone specimens are the most frequently altered with a total of 45% of bone fragments from House 1 deposits and 8% of back terrace mammals being affected by either burning, erosion, cutmarks, and/or digestion (Figure 21). Bird bones are the second most frequently altered specimens with 8.1% from House 1 being affected while none of the bird from the back terrace appear altered. In contrast, very few fish remains show any evidence for burning or digestion, and no cutmarks were observed on fishbone.

The majority of burned mammal and bird bones consist of unidentifiable fragments of what were much larger skeletal elements and so appear disproportionately frequent relative to the much more numerous fish remains. The low frequency of taphonomic alterations on fish remains may be masked by their vulnerability to burning and digestion, as such bones might be much less likely to survive the digestive process (Jordan 1997). However, the assemblage does not lack fish bones and thus, such processes do not account for the exponentially more abundant fish in the assemblage.

Among the two examined areas of the site, the House 1 deposits contain considerably higher percentages of taphonomically altered bones as might be expected for deposition in a household context (e.g., cooking and consuming food). The large number of digested and eroded mammal bones indicate the influence of carnivore modification, most likely domestic dogs (*Canis familiaris*) that are abundant in the excavation units in both the back terrace and the House 1 assemblages (Frederick, this vol.). Gnawing and consumption of bone fragments (for grease and marrow) is a common canine activity and one that might have been conducive to temporarily removing some mammal bones from a floor surface. Comparatively few fish bones show evidence for digestion with the great-

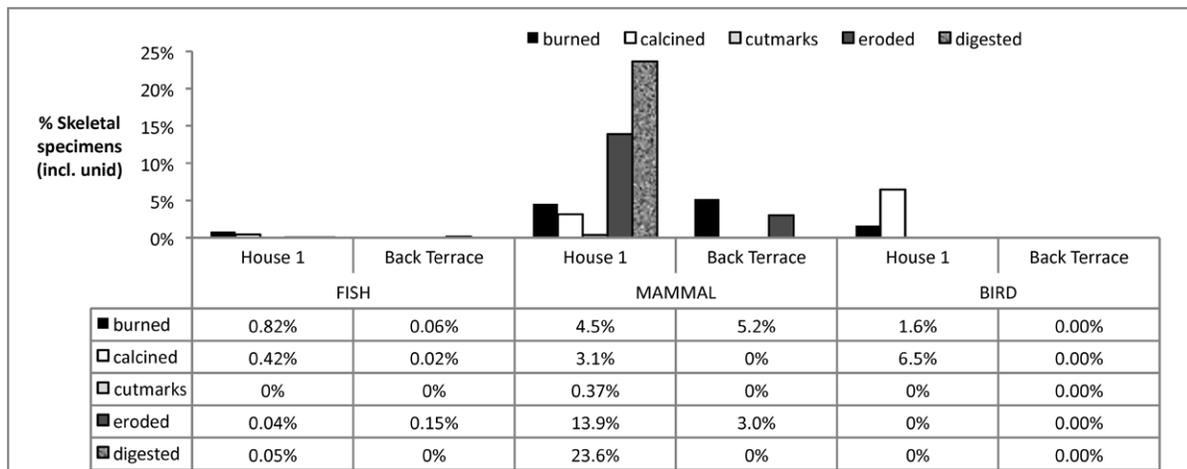


Figure 21. Burning and other modifications to bone specimens in the column sample assemblage by fish, mammal, and bird categories. Calcined refers to highly burnt ‘white’ bones.

est frequencies for digestion occurring on salmon (0.6%) and then greenling (0.1%).

Bird and fish bones also show higher percentages of burning and calcification in the House 1 deposits, which likely reflects culinary processing and/or bone disposal practices. Notably, the highest rate of calcification was observed for birds in the House 1 deposits suggesting high-temperature burning may have been a preferred culinary method or bone disposal method. Among the fish, ratfish had the highest incidence of burning (34%) and this cartilaginous species lacks all skeletal structures except six teeth. Petrale sole was the second most frequently burnt and calcined fish (12%) followed by lingcod (10%), Irish lord (5%), greenling (3.5%), salmon (3.1%), and herring (0.8%). These frequencies suggest that roasting was a more common method of preparation among these taxa.

Cut marks are noted on a few mammal bone shaft fragments, all of which are too fragmentary to identify to a specific skeletal element let alone to species. These nevertheless indicate the use of sharp-edged tools in the butchery process. ‘Chop marks’ are noted on several mammal bones indicating direct percussion by a blunt object. In addition, several thin and warped ‘chips’ of mammal bone may reflect bone artifact production or carving detritus.

Collectively, this patterning suggests that the fish assemblage appears to be the least subject to destructive taphonomic factors and therefore most closely reflective of harvesting practices. In contrast, the highly fragmentary and rarely identifiable mammal remains from the column assemblage provide a much narrower view of the

species utilized, but add considerable detail to the taphonomic dimension of mammal bones present in the fine screen column sample mesh.

Element Representation

The relative proportions of cranial, vertebral, and caudal elements for the ten most numerous fish taxa are depicted in Figure 22. There is broad consistency in that the greatest proportions of identified elements are vertebrae, followed by cranial and then caudal elements. Perch have the largest proportion of cranial elements but this is due in part to their numerous corn-kernel-like teeth that readily separate from the jaw structure, which over-represents the proportion of cranial elements. However, this is not the case for hake, rockfish, and greenling, where over 25% of elements are from crania, which is disproportionate to their skeletal anatomy (see Wigen 2005:90–92). These latter proportions may reflect the robusticity of these species’ cranial elements and/or high discard rate of head bones for these species as opposed to additional culinary processing.

In contrast, salmon have one of the lowest proportions of cranial elements among the ten most numerous fish, as has been observed elsewhere in Barkley Sound (Frederick and Crockford 2005) and on the Northwest Coast (Matson 1992; Orchard 2009; Wigen and Stuki 1988; Wigen 2005:92; Wigen et al. 1990). It remains unclear whether this pattern is due to the differential transport or preservation, the fragility of salmon head bones, or the processing techniques such as boiling, smoking, or some taphonomic combina-

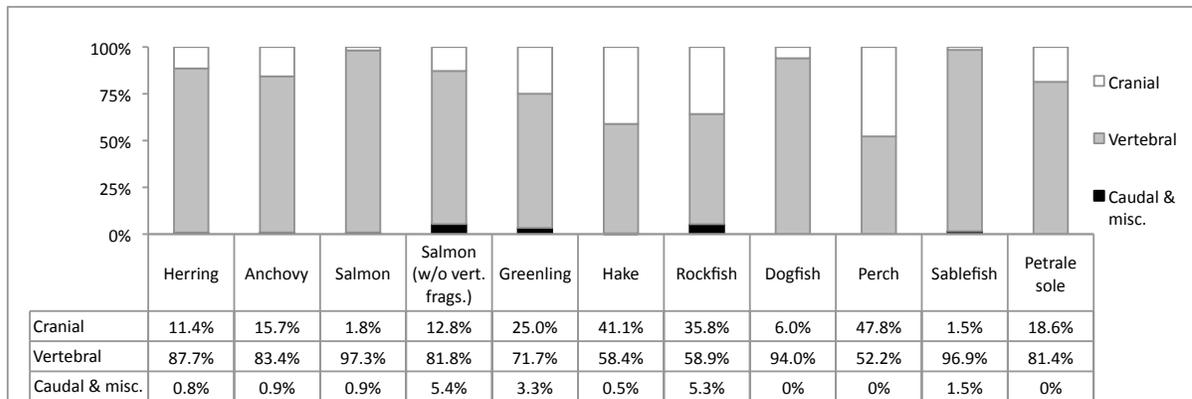


Figure 22. Relative percent of cranial vertebral and caudal elements for the 10-most numerous fish in the column sample assemblage. The cranial category includes the neurocranium, dermocranium, suspensorium, hyoid arch, and branchial arch. Vertebral category also includes the pectoral and pelvic girdle. Caudal includes tail elements and miscellaneous elements.

tion thereof (Butler and Chatters 1994). However, the persistence of this pattern in the HuuZii assemblage reaffirms this is as an intriguing and underexplored research question.

Notably however, fragmentary salmon vertebrae make up over 80% of all identified salmon remains in the assemblage whereas complete vertebrae only represent 5% of identified salmon. Salmon vertebrae are visually distinct from other fish remains due to their unique skeletal shape and texture that produces higher identification rates (Cannon 2000; Orchard 2009; Wigen and Stucki 1988). Thus, while the ubiquity of salmon throughout assemblage demonstrates it was regularly utilized, the high proportion of fragmentary vertebrae disproportionately contributes to an apparent lack of cranial elements. Therefore, Figure 22 also includes a second element ratio for salmon that excludes fragmentary vertebrae and correspondingly increases the proportion of cranial remains to nearly 13%.

Discussion and Interpretation

Sampling Adequacy

The column sample assemblage contains over 32,000 identified fish remains from 32 taxa collected from a number of temporally and spatially distinct contexts in House 1 and the back terrace. The most abundant taxa are also the most commonly occurring, indicating that the most numerous species are also the most widely utilized and thus of particular significance in interpreting the collective social and economic practices of the people who created these deposits.

What is much more challenging to interpret in the column sample assemblage are those ‘rare’ taxa that represent food gathering and consumption activities that may be particularly socially valued but occur comparatively infrequently (e.g., whales and whaling). As noted by Sahlins (2010), the social construction of “value” is often related to culturally defined notions of rarity or “alterity” (i.e., exoticness). He argues, “scarcity is largely a function of exchange-value rather than the other way around” (2010:380). In an archaeological context, this implies that rarely occurring items in an assemblage can have particular cultural significance, but that scarcity will often frustrate attempts to adequately interpret their role in a given archaeological context (Gray 2008). Another interpretive hazard is that such archaeologically rare items may also reflect spontaneously random occurrences which may have less interpretive significance than they sometimes receive, especially in comparison to more common yet perhaps more mundane elements of everyday life that are nonetheless vital to social and economic relations.

Whichever the case, the series of analyses presented in this paper indicate the column sample faunal assemblage is a robust sample, representing common and widespread food harvesting practices present in small volumes of closely examined cultural deposit. I focused on vertical ‘columns’ of sediment from multiple contexts to provide a strong basis for interpreting continuity and change over time, but recognize this approach is less conducive to understanding horizontal spatial patterning within a household context. However, in order to assess the more infrequent dimensions of social and cultural life an even larger sample

size and a larger number of examined contexts is required. Fortunately, this is the case as the excavation unit assemblage (Frederick, this vol.) examined a much larger number of contexts and more rarely occurring taxa, revealing spatial patterning at a household scale discussed at length elsewhere in this volume.

Continuity in Resource Use

Although there is considerable dynamism in the composition and proportion of fish in individual column sample levels (Figure 10), there is also broad consistency and continuity across space and over time (Figures 7 and 8). The pervasiveness of fish remains in the site deposits reflects the importance of fish and fishing in the daily lives and social relations of the inhabitants of HuuZii. Fishing targeted a wide range of species but intensively focused on a number of taxa. These are cultural patterns that indicate consistent and enduring connections between the site occupants and particular fish and the places from which they were harvested. Such information represents a vital and important aspect of how people created and sustained a community at this location for over five millennia.

The numerical dominance of herring, as indicated by multiple measures of zooarchaeological abundance over a 5,000-year period, is particularly significant to the interpretation of social and economic practices at HuuZii. Herring represent an excellent winter and spring food, one that is rich in oil and could be mass harvested and stored, then consumed over extended periods (cf. Arima 1983; Hart et al. 1939; Jewitt 1807; McKechnie 2005a; Symlie 2004). Herring and herring roe were a form of wealth that could be traded and distributed widely in a village setting, between households, within families, at feasts, and with other Nations in Barkley Sound and beyond. Herring length estimates (Figure 13) indicate harvests concentrated on adult-sized fish that were likely caught in large schools prior to spawning. In summary, the dominance of herring in the column sample assemblage, both over time and consistently within small volumes of cultural deposit, reflects a particularly concentrated collective investment, focused on processing large numbers of fish for immediate consumption and long-term storage. Community members likely simultaneously harvested the other marine predators (birds and marine mammals) that also consume herring (Monks 1987) and thus the occurrence of herring

likely was a highly anticipated and prepared for time of the year.

Of course, numerous other fish species are also regularly present in the assemblage and these additionally provide a basis for interpreting the persistent and everyday aspects of social, economic, and ecological relations at HuuZii. In particular, anchovy and salmon are two taxa that represent similarly abundant contributions to the overall assemblage and are ubiquitously present, indicating highly regular use. Anchovy, as a small schooling fish, may have served as a supplement the comparatively more intensive harvest of herring. Salmon similarly occur in consistent but relatively low frequencies throughout the 5,000-year record but increase dramatically during the last 500 years of occupation (see discussion below). Greenling and rockfish are two non-migratory taxa that also consistently occur in the assemblage and could be readily obtained within the vicinity of the village at all times of the year. Numerous other fish species additionally played important roles in the daily lives of site inhabitants and further examination of these individual taxa is needed.

From a methodological standpoint, one of the intriguing consequences of calculating the minimum number of individual (MNI) fish in the fine-screened column sample assemblage is the considerable difference between the MNI and NISP values of herring. Herring are the most numerous fish according to both measures, but the NISP value for herring is more than twice as large as its MNI value (Figure 12). This suggests that even though herring represent more than 80% of total NISP, their nutritional contribution (according to MNI) may be equivalent to less numerous but individually larger fish such as salmon. However, this does not account for the uncertainty of MNI calculations (Lyman 2008) and the complexity of estimating 'meat weight', as well as how fish taxa (particularly salmon) change considerably in abundance over time. These estimates will remain under-resolved until additional analyses consider variability over time and space. However, the present analysis represents an important first step towards reconciling the difference between NISP and MNI data for small column sample assemblages.

Change in Resource Use

While there is a strongly expressed continuity in resource use within the HuuZii fish assemblage, there are two particularly robust temporal changes

in the abundance of fish in the House 1 deposits: 1) salmon increase dramatically during the last 500 years of occupation, reflecting a considerable shift from earlier periods and 2) hake occur in large numbers in the middle of the House 1 deposits (prior to ca. 700 BP) but are absent or have low frequencies during all other periods (Figure 10).

The shift towards increasing use of salmon indicates a broad cultural change in the social economy of House 1. This change may reflect an expansion of the political territory of the village, such as securing access to a productive salmon river from, or in cooperation with, another polity. This also may be a product of a more intensive fishery in the immediate vicinity of the village, such as the large troll-based sport fishery for salmon that currently operates off Kirby Point on Diana Island (1 km from the village). Alternatively but not exclusively, the sharp increase in salmon may additionally reflect progressively more favorable oceanographic conditions conducive to the intensification of salmon fishing at a community scale. A similar and contemporaneous trend has been observed at other archaeological sites in Barkley Sound, such as at the Ts'ishaa village in Tseshaht territory (McKechnie 2005a, 2007a; McMillan et al. 2008) and at Ma'acoah in Toquaht territory (Monks 2006), as well as elsewhere on the northern (Orchard and Clark 2005) and southern (Wigen 2005) Northwest Coast. These local and regional patterns may relate to large-scale climatic changes in the North Pacific that occurred after AD 1200 (Anderson et al. 2005; Finney et al. 2002; McKechnie et al. 2008). Future research will help identify the cultural, historical, and climatic circumstance that may be driving these trends. Of particular importance will be identifying the particular salmon species targeted during this period of increased salmon utilization. Further examination of salmon specimens from HuuZii is warranted and new morphometric techniques (Huber et al. 2011; Orchard and Szpak 2011), as well as ancient DNA (Cannon and Yang 2006), have the potential to address this question of a period of dynamic change.

The second particularly notable change in the abundance of fish in the column sample assemblage is the sharp increase in the abundance of hake throughout the House 1 deposits (Figure 10). While this trend is moderately observed at other sites in Barkley Sound (McKechnie 2007a:214), it appears to be much more strongly expressed at HuuZii. This increase may reflect a local specialization, such as community access to particularly productive hake fishing locale. However, since hake

are strongly influenced by marine climate (Agostini et al. 2006; Benson et al. 2002; McFarlane et al. 2000) and the length measurements suggest that primarily large migratory adults were harvested (rather than a local population in which a range of sizes would be expected), the occurrence of hake provides support to the interpretation of a period of warmer ocean conditions prior to AD 1200. It is also significant that the sharp increase in hake occurs prior to the increase in salmon, further suggesting that climatic factors may be influencing this cultural change.

Within the back terrace, the most notable temporal change is the higher abundance and higher numbers of herring per litre relative to the House 1 deposits (Figures 8 and 17), indicating fisheries were comparatively more intensive during this mid-Holocene occupation (ca. 5000–3000 BP). The progressive increase in the middle levels of both deposits suggest a particularly intensive peak in the utilization of herring followed by a progressive decline in the upper levels (Figure 11). A possible factor that might have contributed to the higher abundance of herring in the back terrace is the beach sand present beneath these cultural deposits that represent a former intertidal zone. This may have been an ideal habitat for herring spawning and a reason for intensive human use and settlement. These fine beach sands were likely deposited when sea levels were 3–4 m higher during the mid-Holocene (Friele and Hutchinson 1993) and contrast with the steep rocky intertidal storm beach that dominates the shoreline today. It is therefore possible that during the back terrace occupation, the intertidal zone may have been a herring spawning location and may even have included a fishtrap. Additional paleo-topographic reconstruction of this raised beach landform will help add substance to this interpretation.

Seasonality

The dominance of herring in the back terrace deposits may indicate a comparatively more seasonal use of the site during the period between 5,000 and 3,000 years ago. However, a year-round use of the site is indicated by the continuous deposition of shell midden sediments (Figure 4) and the occurrence of mammalian, bird, and fish species that are summer and fall seasonal indicators abundantly present in the back terrace excavation unit assemblage (Frederick, this vol.). In addition, the back terrace column samples also consistently contain anchovy and salmon that may have been

more readily obtained in summer and fall, as well as herring that may have been used more readily in winter and spring. Later in time, during the House 1 occupation, the column sample assemblage contains a comparatively more 'even' distribution of fish taxa (Figure 8) as well as a greater number of fish taxa (Figure 19), suggesting an even more substantial degree of year-round occupation. This is also supported by the excavation unit assemblage.

An important consideration in determining the seasonality of archaeological faunal assemblages is that the assessment of seasonality is often based on the presence of 'indicator species' in a given depositional context (e.g., Ford 1989). However, a key question is how consistently these species occur: are they ubiquitous and abundant, or are occurrences rare and a thus a reflection of sampling intensity rather than site seasonality? This column sample assemblage provides important insight into this issue, as there are several fish taxa that are both abundant and ubiquitously occurring. Thus, their consistent presence across dozens of depositional contexts (i.e., multiple small temporal snapshots) may represent a more robust indication of seasonality than infrequently occurring but more seasonally diagnostic taxa.

Another key issue in the determination of seasonality is that species may occur over a broader range of seasons than is conventionally understood, especially considering the impact of 20th century industrial commercial exploitation of the marine environment. For instance, the consistent occurrence of adult herring in archaeological deposits on the Northwest Coast is often interpreted to mean that herring were targeted exclusively during the spring spawning season. However, this does not often encompass the range of variability on the coast, particularly relating to the period prior to herring spawning. A series of historic observations suggest that herring were harvested during a much longer period of the year. For instance, John Jewitt's (1807) journal recounting his two and a half years of captivity among the Mowachaht in Friendly Cove (120 km north of Barkley Sound) documents the consumption of herring and herring roe multiple times in all months of the year except July and August (McKechnie 2005a:103). Modern industrial herring fisheries conventionally began fishing for herring in October, well prior to the winter and spring spawning periods (Taylor 1955:111; Tester 1933:287; Mackinson 1999). Department of Fishery and Oceans records going back to the 1940s (DFO 2011) show herring spawn once regularly occurred as early as

late January and early February on western Vancouver Island. These observations indicate that pre-industrial herring populations may be better characterized as a late fall and mid-winter food in addition to the spring spawning period. Moreover, the storability of herring would mean that it could be consumed for months afterwards and thus well into summer.

Similarly, anchovy is a species said to occur more frequently in summer as it is at the northern edge of its latitudinal range (DFO 2002). However, paleoecological analysis of fish scales recovered from a geological sediment core in nearby Effingham Inlet (~15 km north of Huu7ii) indicates that anchovy were the dominant fish in that particular inlet over the past 4,000 years (Wright et al. 2005:376), implying that anchovy are a resident non-migratory population and were likely available throughout much the year. The occurrence of salmon from multiple size ranges and species (Figure 14) suggests that this taxon could also have been harvested at multiple times of the year (spring through fall). Thus, rather than seeking to identify seasonal indicators, it is additionally important to consider the consistent utilization of species that are present during multiple seasons as a proxy for year-round site occupation.

Comparisons to Other Assemblages

The examined column sample assemblage can be compared with available precontact archaeological faunal assemblages in Huu-ay-aht territory and elsewhere in Barkley Sound. However, there are only three other sites within Huu-ay-aht territory where fine-screen fish remains (smaller than ¼-inch mesh) have been used. The nearby Huu-ay-aht village of Kiix7in (DeSh-1) contains a modest vertebrate assemblage (NISP = 700), in which herring are the most abundant fish (48% NISP fish), followed by salmon (22%) and greenling (16%) (Wigen 2003). Herring is considerably less abundant (18% NISP) but still the second most frequent fish in the small assemblage (NISP = 171) from the adjacent defensive site at Kiix7in (DeSh-2), which is dominated by greenling (49%) (Wigen 2003). An additional fine-screen assemblage (NISP = 187) from the Klanawa Rivermouth (DeSf-6), 20 km south of Cape Beale (McKechnie 2007c:9), is dominated by salmon and greenling and only contains a small percentage of herring (6% NISP).

Northwest of Huu7ii in the Broken Group Islands, herring are also dominant among the fish

at the large Tseshah village of Ts'ishaa (DfSi-16&17), followed by anchovy, rockfish, greenling, and salmon (McKechnie 2005a; McMillan et al. 2008). Herring is similarly the most abundant fish (58%) in a small (NISP = 151) column sample assemblage from a defensive site on Clarke Island (DfSi-26) in close proximity to Ts'ishaa (McKechnie 2007b:29) and is overwhelmingly dominant (85%) in an assemblage from Dodd Island in a protected portion of the Broken Group Islands (Wigen 2009).

Two fine-screened assemblages from Ucluelet Harbour in western Barkley Sound, Little Beach (DfSj-100) (Wigen 2008) and Ittatsoo North (Brolly and Pegg 1998:167), have identically high abundance values for herring (79% of NISP). The fish identified from Ma'acoah (Monks 2006) in Toquaht territory and Shoemaker Bay at the head of Alberni Inlet (Calvert and Crockford 1982) are not directly comparable to the HuuZii column assemblage as these excavations did not utilize column sample recovery methods. However, it is notable that these ¼" assemblages contain only a negligible number of hake specimens, which further indicates the uniqueness of the HuuZii assemblage. However, all sites appear to have significant frequencies of rockfish, greenling, and salmon and a host of other taxa that speak to the common utilization of these fish in other archaeological contexts. Grasping the variability will require considerably more analysis to fully synthesize and assess the spatial and temporal variability.

Conclusions

This study has explored the archaeological expression of vertebrate faunal remains, particularly fish, from the ancestral village site of HuuZii. I analyzed over 58,000 vertebrate specimens containing over 32,000 identified remains from 12 column samples representing 168 depositional contexts spanning 5,000 years of human occupation. Fish bones were the most numerous and commonly encountered vertebrate elements, followed distantly by mammals and birds. Herring was the most numerous and consistently present fish species, followed distantly by anchovy, salmon, greenling and a host of other taxa. I analyzed these frequencies using multiple measures of abundance and argue they reflect cultural, social, and economic relations within the village.

Collectively, these site specific and regional patterns indicate the vital importance of herring in indigenous precontact fisheries in Barkley Sound

and have broader significance for interpreting the archaeological history of fishing on the Northwest Coast. The column sample assemblage from HuuZii further confirms that small fish are grossly under-represented using conventional recovery techniques, which contributes to the under-recognized role of herring relative to the more well-known and disproportionately emphasized taxa such as salmon (cf. Coupland et al. 2010; Monks 1987). A long-standing gap in understanding is the lack of column sample analysis, which is widely recognized to offer the most precise determination of the relative abundance of fish. A full-scale comparison of the temporal and spatial variability is ongoing and will yield more detailed insights into the regional character and intensity of ancient Nuu-chah-nulth fishing practices.

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