Chapter 6 “When the Tide Goes Out, the Table is Set”: [31] Exploring Diet Composition at Nukaunlth through Faunal and Macrobotanical Analyses

Introduction

Archaeological research at Nukaunlth village was carried out to provide data and insights into ancestral Lower Chehalis and Chinookan foodways for the Shoalwater and the Chinook Nation. The communities believe that these data and insights can be directly applied to their efforts to create healthier communities by reviving culturally appropriate food practices, establishing food sovereignty, and regaining legal rights to traditional food resources. An archaeological perspective on southern Northwest Coast diet provides new, tangible evidence that complements what is already known from oral histories and ethnohistorical records. This tangible evidence proves particularly useful when developing community-enriching initiatives and in legal cases affirming Indigenous rights (discussed in detail in Chapter 8).

It is important here to clearly state what an archaeological investigation of the Nukaunlth village site can and cannot do for the Shoalwater and Chinook Nation and their fight to improve the health of their peoples. This investigation does not attempt to delineate the health or nutrition of those living at Nukaunlth in the past. As such, I do not make any claims that those living at Nukaunlth in the past were necessarily healthier than the modern community, as I cannot speak to the life spans or the quality of life of past populations. Diet likely varied among

---

[31] Traditional saying (Earl Davis, personal communication)

those living at Nukaunlth according to gender, age, and status, as it did elsewhere in the greater Northwest Coast region (Moss 1993; Prentiss et al. 2014, 2012; Wessen 1982). Exactly how diet varied according to these attributes at Nukaunlth is beyond the scope of this dissertation and will require further archaeological data.

Current archaeological data from Nukaunlth can, however, lend insight into and physical evidence of the types of foods consumed and the nutrient content of those foods at a macrolevel. The Shoalwater and Chinook Nation can then incorporate these data into their efforts to create healthier, culturally appropriate food practices. The Shoalwater and Chinook Nation do not wish to recreate the diet of their Lower Chehalis and Chinooksn ancestors in totality. This would be an unrealistic choice for these communities. Instead, the goal is to revive aspects of their traditional foodways that are culturally relevant, identity-generating, healthy practices to supplement aspects of the modern diet that are known to be unhealthy. In this respect, the past is adaptable to the present and a potent tool for crafting healthier communities in the future.

To meet these ends, this chapter explores the probable diet composition of Willapa Bay Lower Chehalis and Chinookan peoples through analyses of the faunal and macrobotanical assemblages from Nukaunlth. I begin with the faunal analysis, describing the methods of obtaining, sampling, quantifying, and statistically analyzing the faunal assemblage. I then divide the faunal assemblage into broad classes—fish, terrestrial and marine mammals, avian, and shellfish—and provide a descriptive summary of each identified taxon followed by the results of descriptive and inferential statistical analyses of the faunal class as a whole. Descriptive summaries of taxa describe the criteria used in assigning the specimens to taxonomic category as well as information on ecology, habits, and traditional and ethnographic use when available. The results of the descriptive and inferential statistical analyses compare the relative frequency of taxa and investigate changes in the assemblages between occupation periods. The analysis of the macrobotanical materials from Nukaunlth follows the same structure as the faunal analyses. However, given the small sample size, interpretations are limited to presence/absence information. I then integrate the data to provide information on probable diet composition, focusing on the relative abundance of broad faunal classes and the rank order of resources. Lastly, I briefly explore the potential nutritional contribution of the most commonly recovered animals from Nukaunlth and suggest that the marine resources found at the village may have been good sources of essential caloric and noncaloric nutrients[32] such as fat, protein, iron, zinc, manganese, vitamin B-12, folate, and omega-3 fatty acids.

Analysis of Nukaunlth Faunal Assemblages

Excavations of Nukaunlth produced a large number of faunal remains that represent an important record of Lower Chehalis and Chinookan subsistence practices and animal distributions in southwestern Washington during the Late Pacific, protocontact, and postcontact periods. The goal of the faunal analysis is to identify specimens to the finest taxonomic level and to relate, when possible, analytic results to past human activities and the animal resources used by Willapa Bay Indigenous peoples.

---

[32] I define essential nutrients as those required for normal body function that cannot be synthesized by the body and must be obtained from food.

Methods

Field Recovery

Faunal remains were recovered from excavations in three primary ways:

1. Most faunal remains were recovered from dry screening of matrix in the field through graduated ¼” and 1/8” mesh sieves. Faunal remains (excluding shellfish specimens) were handpicked from sieves, bagged, and recorded separately.
2. Larger faunal specimens uncovered during excavation and those associated with a known subsistence-feature were mapped *in situ* and bagged separately.
3. As screen residue (i.e., all materials left in the screen once sediment passed through) was primarily shellfish remains, screen residue was saved, sampled, and sorted in the lab to provide a representative sample of the shellfish assemblage.

Sampling Strategy

Laboratory-based screen residue sorting was beneficial to this study in two ways. First, sorting all shells in the field would have slowed the fieldwork down considerably. Retaining screen residues allowed me to move forward with excavations at a reasonable pace. Second, it also allowed me to sample, sort, and identify shell and other material culture retained in the screen in a controlled environment (i.e., with proper lighting, equipment, and trained volunteers) once fieldwork had concluded. A previous study from Anthony Graesch (2009) suggests that single-episode, field-only sorting can result in the recovery of less than 25% of combined lithic and faunal artifacts. In contrast, laboratory sorting of screen residue can account for the recovery of nearly 90% of archaeofaunal remains (Graesch 2009). As such, lab-based screen residue sorting also ensured the effective recovery and identification of material culture that was missed in the field.

Excavations produced samples from 36 proveniences. After faunal remains (excluding shell), lithics, and trade objects were handpicked from the screens, the remaining screen residues were retained for sorting and identification at the Santa Barbara Museum of Natural History. For

19 samples, all materials retained in the ¼” screen were sorted into material class, shell specimens were identified to taxon, and bone missed when handpicking materials from the screen in the field was sorted out for later identification. A single sample could contain up to 5,000 shell specimens. As such, a full sort, count, weight, and identification of screen residues proved immensely time-consuming. To increase the efficiency of sorting and identification and given the volume of shellfish remains in fragmentary condition, a sampling strategy of screen residue was developed to obtain a representative sample of the remaining proveniences.

Madonna Moss has shown that a 10% sample is sufficient to predict the major constituents within 5% for 1/8” screen residues containing predominately shell midden (1989:135–138). As such, 10% samples of the 1/8” screen residues from all proveniences were sorted. As ¼” screen samples were slightly easier to sort, I sorted a 25% sample of the ¼” screen residue from the remaining 17 proveniences. In both cases, samples were taken using a mix-and-grab method to ensure natural size-sorting did not affect sample collection. Quarter-inch screen residue from one provenience was used to verify that this sampling strategy would result in a representative sample. This screen residue had been separated into multiple bags in the field because they produced such a high volume of ¼” screen residue. To test whether a 25% subsample would sufficiently predict the constituents of the entire sample, I sorted one bag fully and sampled the remaining bag. I then compared the weight and Number of Identified Specimens (NISP) of major taxa with those predicted from the subsamples. Table 6.1 & Table 6.2 present the results of the experiment. When comparing predicted and actual NISP, the sample estimated all species within approximately 1%. When comparing weight, estimates had greater deviation. The 25% sample overestimated the weight of *O. lurida* by approximately 5% and underestimated the weight of *C. nuttallii* by approximately 4%. Still, this experiment suggests that a 25% sample is sufficient to predict the major constituents within approximately 5% for the ¼” size class.

Table 6.1 Sampling experiment for Unit 423N400N, layer 3, level 1, 1/4" size class

	Bag 2 - 25% Sample		***Bag 1 - Fully Sorted***	
Taxon	**NISP**	**Weight (g)**	**NISP**	**Weight (g)**
Mytilus sp. – mussel	18	2.3	131	17.3
C. nuttallii – cockle	414	247.8	3723	1824.1
S. gigantea, M. nasuta, Tresus sp. – clam	105	83.4	938	484.2
P. staminea – Pacific littleneck clam	0	0	13	9.2
O. lurida – native/Olympia oyster	9	25.3	32	17.4
N. lamellosa – frilled dogwinkle	12	8.5	107	107.4
Balanomorpha – barnacle	0	0	4	0.4
Unidentified Shell	0	0	17	2.6
Land Snail	1	0.1	0	0
Charcoal*	-	1.5	-	10.2
Fire-Modified Rock	16	74.5	157	558
Fish	0	0	13	1.3
Bird	0	0	1	0.2
Terrestrial Mammal	1	0.1	7	1.5
Marine Mammal	1	0.1	24	5.8
Total	577	443.7	5167	3039.5

* Given the fragility of charcoal samples, NISP was not recorded.

Table 6.2 Percent difference between predicted and actual relative proportions of taxa

Taxon	***NISP***	***Weight***
Mytilus sp. – mussel	+0.58	-0.05
C. nuttallii – cockle	-0.03	-4.15
S. gigantea, M. nasuta, Tresus sp. – clam	+0.04	+2.87
P. staminea – Pacific littleneck clam	-0.25	-0.30
O. lurida – native/Olympia oyster	+0.94	+5.13
N. lamellosa – frilled dogwinkle	+0.01	-1.61
Balanomorpha – barnacle	-0.08	-0.01
Unidentified Shell	-0.33	-0.08
Land Snail	+0.17	+0.02
Charcoal*	-	0.00
Fire-Modified Rock	-0.27	-1.57
Fish	-0.25	-0.04
Bird	-0.02	-0.01
Terrestrial Mammal	+0.04	-0.02
Marine Mammal	-0.29	+0.02

* Given the fragility of charcoal samples, NISP was not recorded.

Quantification: NISP, Weight, MNI, & Meat Yields

Faunal specimens were identified to the finest taxon possible with known reference specimens from the University of California, Santa Barbara, the Santa Barbara Museum of Natural History, The California Academy of Sciences, and Dr. Ken Gobalet's (California State University, Bakersfield) comparative osteological collections. The primary counting unit used was Number of Identified Specimens (NISP) and weight. Minimum Number of Individuals (MNI, Grayson 1984) was also calculated when appropriate. NISP and MNI provide a similar measure of taxonomic frequency, and either can be used (Grayson 1984). As such, given the difficulty of assigning skeletal element data to the mammal assemblage due to poor preservation, NISP is favored over MNI. Weight is also used as it is the most common quantification method when investigating shellfish remains. Burning, cutmarks, or other modifications related to human behavior were recorded. I provide NISP, MNI, and weight (in grams) in the descriptive summaries of taxa below. I then tabulate and discuss this information in the results sections for each faunal class.

To understand the food value of the faunal remains and lend insight into dietary and subsistence patterns, scholars have attempted to translate taxonomic abundance into nutritional "currencies" (i.e., meat yields, protein, carbohydrates, etc.) (Moss 1989:151). Put simply, a single elk specimen in the archaeological record likely represents considerably more "food" than a single rabbit specimen, and to treat their contributions to subsistence as equal may be misleading. To circumvent this problem, one of three methods are typically used to determine the amount of meat represented (i.e., estimated meat yields) within the faunal assemblage: MNI, weight, or allometric conversion. Each method has its flaws.

When using MNI conversion, the MNI of a taxon is multiplied by the edible weight of an average individual of the represented taxon (White 1953). This method has drawn criticism, as it relies on MNIs that vary depending on methods of aggregation (Grayson 1984). Similarly, in assemblages with poor preservation, MNIs may be difficult to determine and severely underestimate the actual number of individuals represented in the assemblage. Likewise, the MNI method assumes that a few identifiable osteological elements in the faunal record represent the presence of an entire carcass at the site (Gifford-Gonzales and Hildebrandt 2012:98).

In the weight conversion method, weights of bone or shell are multiplied by conversion factors derived from modern specimens of a particular species or faunal class. This method is commonly used by archaeologists working on Californian (e.g., Ainis et al. 2011; Arnold et al. 2004; Braje et al. 2007; Erlandson 1994; Erlandson et al. 1999; Glassow and Wilcoxon 1988) and Northwest Coast shell midden sites (e.g., Clarke and Clarke 1980; Moss 1989) and is thought to more accurately represent the contribution of shellfish in dietary practices. Some issues arise when using this method, especially when it is applied to vertebrates. In most cases, the conversion factor used does not account for the loss of weight through natural transformation processes like leeching in archaeological deposits (Waselkov 1987). Like the MNI method, using the weight method assumes that the weight of the bones has a predictable relationship to the meat yield and does not take into account transport trade-offs and off-site butchering practices. That is, it assumes that each taxon, on average, was subject to the same butchering and transport decisions between the procurement site and consumption site (Gifford-Gonzales and Hildebrandt 2012:98). Perhaps a bigger issue is the assumption that bone and shell weights are related to meat weights in a simple linear fashion. Casteel (1978) demonstrated that this is not the case for the domestic pig and suggests that a weight method that relies on a linear function is invalid. In using both MNI and weight methods, the conversion factor must account for the seasonal, sexual, and size-related variation on the fauna and archaeological assemblages.

The last method typically used, the allometric conversion method, employs equations that relate the measure of bone size to meat weight for each taxon involved to predict the weights of individuals represented by the archaeological specimens. While this is potentially the most accurate technique, it cannot be used to determine the meat weights for all individuals in a faunal assemblage. More broadly, all methods are flawed in that what parts of an animal are considered "edible" is culturally specific.

Given the issues with the methods described above, all attempts at dietary reconstructions are difficult. Grayson has gone so far as to suggest that "faunal analysts have no valid means of measuring taxonomic abundances in faunal assemblages in terms of meat weight or biomass above an ordinal scale" (1984:174), However, ordinal scale data can provide insights into relative differences and allow for comparative analysis. Ultimately each quantification method—NISP, weight, MNI, and meat yields—has its own set of drawbacks and can misrepresent the contribution of broad faunal classes to the subsistence practices of the past. However, using these methods in tandem can help to mitigate these drawbacks and lend insight into general trends in subsistence practices. In all cases and taken together, these measures provide general approximations of the nutritional yield of the major classes of faunal remains recovered.

In this study, I determine the edible meat yields of broad faunal classes using the weight method. This method is most commonly used on the Northwest Coast and allows for more accurate regional comparison. Given the poor preservation of the mammalian assemblage and the fragmentation of the shellfish assemblage, MNIs would have excluded most of the assemblage from the analysis and unacceptably reduced the sample size. Likewise, the MNI method to estimate meat yields assumes that the whole individual was utilized. Most certainly, that was not the case for some taxa present at Nukaunlth, most notably whale, where people likely selected specific cuts for transport and consumption (Erlandson 1994:58). The conversion factors used to estimate meat yields are presented below in Table 6.3. Several sources were consulted for the average meat weights. In cases where sources differed in their conversion factor, I favored the source that derived their data from samples closest to Willapa Bay. I provide estimated meat yields in the results section corresponding to each faunal class and discuss them more thoroughly in *Reconstructing Diet*.

Table 6.3 Conversion factors used to estimate meat yields (weight method)

Taxon	***Meat Weight conversion*** [a]	***Source*** [b]
Shellfish		
Mytilus sp. – mussel	0.438 [c]	Erlandson 1994
C. nuttallii – cockle	0.72	Crapo et al. 1993 [d]
P. staminea – Pacific littleneck clam	0.610	Serena 1982
S. gigantea – Washington/butter clam	0.768	Moss 1989
M. nasuta – bent nose clam	1.12	Crapo et al. 1993
Tresus sp. – fat or Pacific gaper	1.70	Dietz et al. 1988
O. lurida – native/Olympia oyster	0.292	Erlandson 1994
N. lamellosa – frilled dogwinkle	0.12	Clarke and Clarke 1980
C. productus or *M. magister* – crab	1.5	Crapo et al. 1993
Vertebrates		
Fish	40.0	Moss 1989
Marine Mammal	24.2	Glassow and Wilcoxon 1988
Terrestrial Mammal	10	Tartaglia 1976
Avian	15	Ziegler 1975

a: Gross shell or bone weights are multiplied by these factors to determine edible meat weights.

b: In cases where multiple meat weight conversions for the same taxa were available, the source based on experimental data taken from nearest to Willapa Bay, WA was chosen.

c: The meat weight conversion measure for *M. trossulus* is used for the entire *Mytilus* sp. assemblage, as evidence suggests that this species was most common in Willapa Bay and likely makes up the bulk of the *Mytilus* fragments recovered.

d: Data in Crapo et al. 1993 is presented as % meat out of total living weight. This was converted into a meat weight conversion factor by the author.

Descriptive and Inferential Statistical Analyses

For as long as archaeologists have been interested in employing inferential statistical methods in their analyses of the archaeological record, they have had difficulties applying these methods to zooarchaeological assemblages. This is because archaeological data stemming from faunal assemblages are often ordinal at best (Grayson 1979, 1984; Lyman 2008). Therefore, one cannot assume randomly generated sampling error as is necessary for parametric techniques to test hypotheses (Wolverton et al. 2016). Instead, non-parametric approaches that avoid the use of p-values and confidence intervals derived from probability distributions should be used. When applied to data stemming from faunal assemblages, non-parametric tests are often more robust because they require relatively few assumptions. They also tend to be more resistant because they are less influenced by outliers. As such and although they have their difficulties, the use of non-parametric tests is the more conservative approach to statistical analyses.

In analyzing the faunal assemblage at Nukaunlth I use non-parametric descriptive and inferential statistics. The majority of the analyses are focused on descriptive statistics presented as relative abundance ratios. Understanding that this data is often 'ordinal at best', I often distill this information into rank order of abundance. When comparing changes in the faunal assemblage through time, I have chosen to group proveniences based on their assigned occupation (first occupation: pre-1700 tsunami, and second occupation: post-1700 tsunami). I have chosen to do so for two main reasons. First, while the stratigraphy of the site does appear intact, I assume that a major landscape shift associated with the AD 1700 Cascadia tsunami altered the stratigraphy of the first occupation in some way. Therefore, I cannot assume that the individual strata within the first occupation follows chronological order and must proceed with caution. Second, aggregating the assemblages in this way provides larger sample sizes, which in turn makes the statistical tests more robust. I believe this allows me to investigate the relative abundance of specific taxa and broad faunal classes between the two occupations using conservative inferential statistical techniques that supplement the information provided by the descriptive statistics.

When looking at the changes in relative taxonomic abundance and broad faunal classes (i.e., relating one categorical variable to another), I follow Grayson's (1984:158) suggestion to use two inferential statistical techniques in tandem: (1) chi-square test of independence (χ^2) along with its associated adjusted residuals and effect size measurement, phi, and (2) two-sided Smirnov tests (*T'*). A χ^2 test measures the difference in proportions of specific taxa within the two chronological assemblages. I have set the parameters of the χ^2 test such that no expected value is less than one and no more than 20% of the expected values are less than five (Drennan 1996). This is to ensure that the sample is large enough for a reliable χ^2. To meet these parameters, I combine rare species into a single category when necessary. The benefit of χ^2 tests is that it allows me to investigate species-specific changes in relative abundance between occupations. The difficulty is that it is very powerful when combined tallies in categories are large (Wolverton et. al 2016) and often results in high significance.

To not overinflate the importance of a highly significant χ^2, I discuss two associated measures: effect size (phi/φ) and adjusted residuals. Measuring effect size allows one to judge the relative importance of the differences detected by a significant χ^2 and speaks to the practical significance of such a result (Cronk 2018:121). In essence, a statistically significant result is "one that is unlikely to be the result of chance…[and] it is quite possible, and unfortunately quite common, for a result to be statically significant and trivial" (Ellis 2010:3-4). The inverse is also often the case. That is, the result of statistical hypothesis testing can be non-significant, but still practically important. Phi (the square root of the χ^2 statistic divided by the sample size) is calculated to measure effect size. The result of this test is a number from 0 to 1. Here, I follow Wolverton et al.'s (2016) criteria that a $\varphi = 0.1$ denotes a weak effect, $\varphi = 0.3$ is a moderate effect, and $\varphi = 0.5$ is a strong effect. I also include adjusted residuals (Everitt 1977:47–48) in my discussion of χ^2. Adjusted residuals provide an indication of which taxa or broad faunal class are driving the significant χ^2 result. That is, larger adjusted residuals indicate which taxa changed in terms of relative abundance between occupations.

Alongside χ^2 tests, I provide a two-sided Smirnov test. This test compares the "cumulative distribution function of two samples and provides a test of the null hypothesis that those functions do not differ significantly" (Grayson 1984:155). This test measures whether the underlying distribution between the two occupations has changed but does not take into account the actual species involved in those distributions. Therefore, a non-significant result suggests there is an underlying similarity in the structure of the species-abundance distributions of the two faunal assemblages, one that is independent of the species involved. This method assumed variables to be continuous and can be used with NISP, MNI, weight, and meat yields. When applied to discrete data, however, it is very conservative and increases the chances of concluding that two cumulative distribution functions are statistically identical when they are not. While each method has its interpretative difficulties and notable caveats, I believe using such methods in tandem will provide additional information about differences in faunal assemblages between the two periods that extend beyond the mere significance/non-significance dichotomy and add depth to my interpretations of the faunal assemblage.

The following sections summarize the specific methods, faunal records, and results for each broad faunal class, including MNI, NISP, weight (grams), and estimated meat yields.

Fish Remains

Specimens were identified to the finest taxon possible using comparative skeletons from the Santa Barbara Museum of Natural History and the University of California, Santa Barbara. When some specimens could not be identified using these collections, skeletal specimens from the California Academy of Sciences were used, as were specimens from Ken Gobalet's (California State University, Bakersfield) comparative collection. The taxonomic names used here follow the seventh edition of the American Fisheries Society *Common and Scientific Names of Fishes from the United States, Canada, and Mexico* (Page 2013). NISP was the primary method of quantification; however, weight was also recorded. I report results using NISP unless otherwise noted. The vast majority of identified specimens were vertebrae for all species except sturgeon (*Acipenser* sp.), from which centrum do not preserve and external plates are both distinctive and robust. However, given time constraints and the decision to use NISP and weight for quantification, I did not record skeletal element for all species.

Descriptive Summary

Order Acipenseriformes

Family Acipenseridae – sturgeon

Acipenser sp. – sturgeon

Materials: *Field Recovery:* 2 cranial fragments, 5 postorbital fragments, 1 ceratohyal, 21 scutes, 1 pectoral fin ray, 7 unidentified elements; *Screen Residue Sorting:* 9 unidentified elements; Total 46 NISP

Remarks: Two species of sturgeon are known in the region: white (*A. transmontanus*) and green (*A. medirostris)*. It is not possible to differentiate between the two from skeletal elements. However, white sturgeon is more common, and the specimens recovered are likely from this species. White sturgeon is the largest anadromous fish found in North America, reaching a maximum length of over six meters (Wydoski and Whitney 2003).

Fishing for sturgeon in Willapa Bay and the mouth of the Columbia River among Chinookan and Lower Chehalis peoples is well-documented in ethnographic accounts. Swan describes fishing for sturgeon using a hook and line method. Fishing was generally done when the tide began to rise, and the sturgeon travel up shallow water to feed. Two or three sturgeons could be caught per person in a single tide (Swan 1857:245–246). Swan notes the sturgeon in Willapa Bay and near the mouth of the Columbia was "more delicate flavored and tender, finer grained than any sturgeon I have ever seen in any part of the world" (1857:246) and that Indigenous communities in the area preferred sturgeon over salmon, even though it was more difficult to obtain. Ray corroborates the use of hook and line but adds that sturgeon was also taken with a conical bag net or straight web carried between two canoes (1938:108–109). Sturgeon was often captured for trade as well, particularly with Fort Astoria personnel in the 1810s. Late winter-early spring and late summer were key periods of sturgeon trade with Euro-Americans. This seasonal trade likely corresponds to the peak periods of capture that took advantage of seasonal migrations and aggregation of sturgeon (Martin 2006).

Order Clupeiformes

Family Clupeidae – Herrings

Clupea pallasi – Pacific Herring

Materials: *Field Recovery:* 2 vertebrae; Total 2 NISP

Remarks: Pacific Herring is a small-bodied schooling fish considered a keystone species on the Northwest Coast (Moss 2016). Herring migrate upriver and into intertidal and sub-tidal environments to spawn in winter and early spring. They are known to spawn along the Columbia River shoreline and in Willapa Bay (Monaco et al. 1990:75). Herring was "readily caught by Indians" with a rake made of bone teeth, nets, weirs, or traps (Swan 1857:27).

Order Pleuronectiformes

Family Pleuronectidae – righteye flounders

Materials: *Field Recovery*: 217 specimens; *Screen Residue Sorting*: 54 specimens; Total 271 NISP

Platichthys stellatus – starry flounder

Materials: *Field Recovery:* 1 scale; *Screen Residue Sorting:* 1 scale; Total 2 NISP

Remarks: There are 20 species of flatfish in the northeast Pacific (Wilson et al. 2008:241). Of righteye flounders, two are most common in Willapa Bay: starry flounder and English sole. The 217 specimens of righteye flounders are likely from these two species. Distinguishing between the two is not possible by skeletal element alone. However, starry flounder have small, robust spinous plates as scales that allow for species identification. Starry flounder can be found in Willapa Bay all year round, but are particularly abundant in May through October (Monaco et al. 1990:141).

James Swan describes the flounder fishery in Willapa Bay during the early postcontact period:

> "The turbot and flounders are caught while wading in the water by means of the feet. The Indian wades along slowly, and, as soon as he feels a fish with his feet, he steps quickly on it and holds it firmly till he can reach hold of it with his hand, when he gives it a jerk and away it flies far into the flats. This process is repeated till enough fish are

> caught, when they are picked up, put in a basket, and carried to the canoe…They are easily taken by this method of the Indians, as their rough backs prevent them slipping from under the feet. The catching affords a deal of fun, as usually quite a number are engaged in the sport, and their splashing, slipping, screaming, and laughing make a lively time" (1857:83).

Order Salmoniformes

Family Salmonidae – trouts and salmons

Oncorhynchus sp. – salmon and trout

Materials: *Field Recovery*: 740 specimens; *Screen Residue Sorting*: 109 specimens; Total 849 NISP

Remarks: The importance of salmon is well-known for Indigenous peoples of the Northwest Coast. The first salmon ceremony, a 10 day-event that celebrated the arrival of the Chinook salmon, exemplified the importance of this resource among the Chinook and Lower Chehalis. Among the Chinook, salmon was taken using sieve net, bag net, dip net, weirs, spears, and hook-and-line (Ray 1938:107–109; Swan 1857:137).

Five species of salmon and trout occur in Willapa Bay: cutthroat trout (*O. clarkii*), chum salmon (*O. keta*), coho salmon (*O. kisutch*), steelhead (*O. mykiss*), and chinook salmon (*O. tshawytscha*). Two additional species are commonly found in the Columbia river: pink salmon (*O. gorbuscha*) and sockeye (*O. nerka*). Willapa Bay Chinook and Lower Chehalis often traveled to the mouth of the Columbia River for fishing. Salmonid vertebrae have a distinctive appearance and can easily be identified; however, determining between species is not possible based on appearance alone. Therefore, specimens recovered from Nukaunlth are likely from these seven species. Each species has various spawning seasons, but fall runs of chum are most productive in Willapa Bay and the Columbia River (Monaco et al. 1990; Swan 1857). So abundant are chum salmon at this time that Swan remarks, "every river, brook, creek, or little stream is completely crammed with them, and late in the fall the banks of the rivers are literally piled up in rows with the dead fish killed in attempting to go over the falls" (Swan 1857:140).

Order Scorpaeniformes

Family Cottidae – Sculpins

Leptocottus armatus – Pacific staghorn sculpin

Materials: *Field Recovery*: 9 specimens; *Screen Residue Sorting*: 4 specimens; Total 15 NISP

Remarks: Pacific staghorn sculpin are most commonly found in nearshore waters on the sandy bottoms of lower estuaries. Pacific staghorn sculpins are available year-round in Willapa Bay and are particularly abundant in February through October and in the seawater and mixing salinity zones of the bay (Monaco et al. 1990:46, 141).

Order Squaliformes

Family Squalidae – dogfish sharks

Squalus suckleyi – Pacific spiny dogfish

Materials: *Field Recovery*: 12 centrums; *Screen Residue Sorting*: 1 centrum; Total 13 NISP

Remarks: The Pacific spiny dogfish is an elasmobranch fish, a family that includes sharks, skates, and rays. They are commonly found in Willapa Bay, in both inshore and offshore waters.

Order Perciformes

Family Embiotocidae – surfperches

Amphistichus sp. - surfperch

Materials: *Field Recovery*: 2 specimens; Total 2 NISP

Remarks: *Amphistichus* is a genus native to the eastern Pacific Ocean. Three species are in the genus: barred surfperch, calico surfperch, and redtail surfperch. Of the three, calico and redtail are both known for the Washington coast. However, redtail is far more common. It was not possible to determine the species of these specimens, but redtail is most likely. This species of surfperch is common along sandy ocean beaches and is often found up-bay in estuaries during spring.

Order Rajiformes

Family Rajidae – skates

Materials: *Field Recovery*: 9 centrums*; Screen Residue Sorting*: 1 centrum; Total 9 NISP

Remarks: Skates are cartilaginous bottom-dwelling fish that are generally more common in marine environments than brackish or estuarine environments. Five species of skate are found in Washington: sandpiper skate, big skate, California skate, longnose skate, and starry skate. The specimens found at Nukaunlth could not be identified to species, as appropriate reference specimens were not available.

Results

A total of 2,142 fish specimens were recovered from the field samples; 1,211 specimens (56.5% of the total fish assemblage) could be assigned to at least family (Table 6.4 & Table 6.5). Many specimens that could not be assigned were rays and spines that could not reliably be speciated. Roughly 15% of the assemblage was recovered from screen residue sorting. This percentage holds when accounting for both the entire assemblage and when discussing only identifiable taxa. The majority of fish specimens (72%) were recovered in the 1/8" screen (Table 6.6).

Salmon dominates the assemblage, representing over 70% of identified specimens. The ease in identification of salmon vertebrae is often thought to artificially inflate the abundance of this taxon. However, this is likely not the case here. Almost all "nonsalmonidae" vertebrae were successfully identified to taxon. Likewise, sturgeon specimens are perhaps even more diagnostic and easily identifiable than salmon. Therefore, the abundance of salmon in the assemblage likely reflects the importance of the species to those living at Nukaunlth. Pleuronectiformes (most likely starry flounder) is the second most abundant taxon, representing 23% of the assemblage. Sturgeon is the third most abundant taxon recovered, representing 4% of the assemblage, followed by Pacific staghorn sculpin (1%) and spiny dogfish (1%). All other species represent very small fractions of the total assemblage. A total of 5,131.6 grams of edible meat is represented by the fish assemblage when using the meat weight conversion factor (see Table 6.3) to estimate meat yields by total weight of fish faunal specimens.

Table 6.4 Frequency of fish taxa

Taxon	***NISP***	***% NISP***	***Weight (g)***	***% Weight***
*Acipense*r sp. – sturgeon	46	2.1	21.53	16.8
C. pallasi – herring	2	0.1	< 0.01	<0.01
Pleuronectidae – flounder	273	12.8	17.84	13.9
Oncorhynchus sp. – salmonids	849	39.6	58.73	45.8
L. armatus – Pacific staghorn sculpin	15	0.7	0.43	0.3
S. suckleyi – Pacific spiny dogfish	13	0.6	1.54	1.2
Amphistichus sp. – surfperch	2	0.1	0.29	0.2
Rajidae – skate	9	0.4	1.33	1.0
Unidentified fish	932	43.5	26.6	20.7
Total	2143	100.0	128.29	100.0

Table 6.5 Frequency of fish specimens identified to taxon

Taxon	***NISP***	***% NISP***	***Weight (g)***	***% Weight***
Acipenser sp. – sturgeon	46	3.8	21.53	21.2
C. pallasi – herring	2	0.2	< 0.01	<0.01
Pleuronectidae – flounder	273	22.7	17.84	17.5
Oncorhynchus sp. – salmonids	849	70.1	58.73	57.8
L. armatus – Pacific staghorn sculpin	15	1.2	0.43	0.4
S. suckleyi – Pacific spiny dogfish	13	1.1	1.54	1.5
Amphistichus sp. – surfperch	2	0.2	0.29	0.3
Rajidae – skate	9	0.7	1.33	1.3
Total	1211	100.0	101.69	100.0

Table 6.6 Frequency (NISP) of fish taxa by sieve size, and recovery method

	¼” sieve			***1/8” sieve***		
Taxon	*Field Recovery*	*Screen Residue Sorting*	*Total*	*Field Recovery*	*Screen Residue Sorting*	*Total*
Acipenser sp. – sturgeon	32	5	37	5	4	9
C. pallasi – herring	2		2			
Pleuronectidae – flounder	92	18	110	124	41	165
Oncorhynchus sp. – salmonids	274	14	288	466	95	561
L. armatus – Pacific staghorn sculpin		1	1	11	3	14
S. suckleyi – Pacific spiny dogfish	11		11	1	1	2
Amphistichus sp. – surfperch	2		2			
Rajidae – skate	8	1	9			
Unidentified fish	131	9	140	643	149	792
Total	550	48	598	1252	293	1545

While salmon dominates the assemblages in both occupations, salmon capture appears to increase relative to other fisheries in the second occupation (Table 6.7). Salmon makes up 49% of the earlier occupation assemblage, and 75% in the later occupation. Notably, flounder and sturgeon make up a larger portion of the fish assemblage of the first occupation; 40% and 9% respectively; use of these species diminishes over time, making up 19% and 2% respectively, of the later occupation assemblage. While additional fish taxa are incorporated in the second occupation, namely skate, spiny dogfish, and surfperch, these are present in low quantities and are only a small fraction of the later assemblage.

The difference between the fish assemblage from the first occupation and the second occupation concerning relative abundance (NISP) of taxa is very highly significant (χ^2 = 84.838,

$p < 0.001$, $\varphi = 0.26$).[33] Despite the highly significant result, the effect size is moderate. Therefore, while I can safely conclude there is a non-random change in the relative abundance in fish taxa between occupations, this is likely a moderate change. The adjusted residuals reflect what can be seen in the descriptive statistics: that the increase in salmon in the second occupation and the corresponding decrease in flounder and sturgeon are driving the significant χ^2 result (Table 6.8). The cumulative distribution functions of the first occupation and second occupation, as measured by a two-sided Smirnov test, however, is not significant ($T' = 0.250$, $p > 0.20$). Thus, there is an underlying similarity in the structure of the distributions of these two faunal assemblages independent of the species involved.

Table 6.7 Relative abundance of fish taxa in first and second occupation assemblages

	First Occupation		***Second Occupation***	
Taxon	*NISP*	*% NISP*	*NISP*	*% NISP*
Acipenser sp. – sturgeon	22	9.5	24	2.5
C. pallasi – herring	1	0.4	1	0.1
Pleuronectidae – flounder	93	40	182	18.6
Oncorhynchus sp. – salmonids	114	49.1	735	75.1
L. armatus – Pacific staghorn sculpin	2	0.9	13	1.3
S. suckleyi – Pacific spiny dogfish	-	-	13	1.3
Amphistichus sp. – surfperch	-	-	2	0.2
Rajidae – skate	-	-	9	0.9
Total	232	100.0	979	100.0

---

[33] I adopt the χ^2 test requirement that no expected value be less than one and that no more than 20% of the expected values be less than five. To meet this requirement, all identified taxa with <15 total NISP were binned into a single category, "other". I also ran a χ^2 test in which all taxa with <10 total NISP were omitted with a very highly significant outcome ($\chi^2 = 83.558$, $p < 0.001$).

Table 6.8 Adjusted residuals for fish taxa in the first and second occupation

Taxon	***First Occupation***	***Second Occupation***
Acipenser sp. – sturgeon	5.03732	-5.0373
Pleuronectidae – flounder	7.02679	-7.0268
Oncorhynchus sp. – salmonids	-7.7597	7.75974
L. armatus – Pacific staghorn sculpin	-0.57678	0.5768
“other”	-2.0055	2.00552

Mammals

I identified specimens to the finest taxon possible using comparative skeletons from the Santa Barbara Museum of Natural History with the help of Paul Collins, Curator of Vertebrate Zoology. Standard mammalian taxonomic nomenclature is used. Remains identified to at least taxonomic family are described. NISP was the primary method of quantification; however, weight was also recorded. Minimum number of individuals (MNI) is also reported when possible; however, due to poor preservation, MNI offers little relevant information. Because a limited number of remains could be identified to taxonomic family or genus, interpretations of specific mammalian resources utilized are limited.

Descriptive Summary – Marine Mammals

Most specimens lacked the diagnostic elements needed to permit species-level identification. Whale bone, however, had a distinctive surface texture that allowed for easy identification even when a particular element could not be identified.

Order Cetacea – whales and porpoises

Suborder Mysticeti – baleen whales

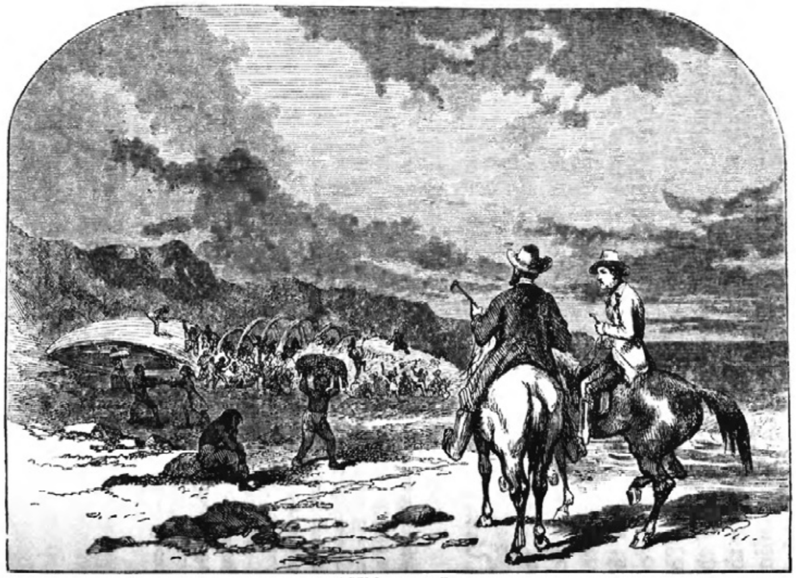
Materials: *Field Recovery*: 1 maxillary fragment; 153 unidentified fragments; *Screen Residue Sorting*: 95 unidentified fragments; Total 249 NISP

Remarks: There are seven baleen whales common to the Pacific Ocean adjacent to Washington state. Of the seven, two are most commonly found at archaeological sites: gray (*Eschrichtius robustus*) and humpback (*Megaptera novaeangliae*). Gray is more commonly found near the coast where they feed in shallow water with muddy or sandy bottoms. While the specimens recovered at Nukaunlth cannot be identified to species, humpback, and even more so, gray, are the most likely species. Only one specimen could be identified to skeletal element. However, the distinctive texture of Cetacea bone allowed for the identification of small bone fragments. Evidence of butchering was present on three specimens in the form of cutmarks. The majority of the large specimens recovered came from a concentration of whale bones near a hearth feature within the house, suggesting the possible use of whales for food. I found no evidence of toolmaking using the whale bone recovered, although I cannot discount the possibility entirely.

The use of whale is well-documented in both oral histories and ethnographic records of Lower Chehalis and Chinookan peoples along the Washington and Oregon coasts (see Chapter 2); "whale meat, blubber, oil, and bones formed a significant part of the Shoalwater economy" (Heritage Committee 1984a:5). Willapa Bay oral histories say that people did not hunt whales, but that people could sing a whale to shore, causing the whale to beach and allowing them to gather meat and blubber (Heritage Committee 1984; Earl Davis, personal communication).

James Swan describes in detail one such meat-gathering event that occurred not far from Nukaunlth in the spring of 1855 (Figure 6.1):

> "…a whale was washed ashore on the beach between Toke's Point and Gray's Harbor, and all the Indians about the Bay went to get their share. The whale was a small one, of the humpback species…The Indians were camped near by[sic], out of the reach of the tide, and were all very busy on my arrival, securing the blubber, either to carry home to their lodges, or boiling it out on the spot, provided they happened to have bladders or barrels to put the oil in. Those who were intending to transport the blubber were hiding it by burying it in the sand till they were ready to go to their homes" (Swan 1857:360).



BLUBBER FEAST.

Figure 6.1 James Swan's sketch of "Blubber Feast" (1857:361)

The whale bone concentration recovered near the hearth of the house at Nukaunlth dates to a similar period as the above description. While I cannot decidedly link the feature to this specific gathering event, the chronological similarity makes Swan's description particularly relevant.

While the ethnographic and oral histories of Willapa Bay provide great insight, there is a noteworthy discrepancy between the faunal remains found at Nukaunlth and this documentation. Ethnographic records and oral histories say that whale was obtained through scavenging carcasses that washed ashore, and that only blubber and meat were brought back to the village.

The presence of abundant whale bone in the assemblage at Nukaunlth suggests something slightly different. It is possible that opportunistic whale hunting occurred at Nukaunlth, as small whales are known to enter the bay and are often spotted not far from Kindred Island (Earl Davis, personal communication). Certainly, whale hunting was central to the subsistence practice of other nearby Northwest Coast Indigenous groups, most notably the Makah of northwest Washington and Nuu-chah-nulth of western Vancouver Island (Coté 2010; Huelsbeck 1988; Kirk 2015). Unfortunately, the current assemblage provides no clear evidence of how those living in this village obtained whale.

Order Carnivora - carnivores

Family Mustelidae – badgers, otters, weasels, and relatives

Enhydra lutris – sea otter

Materials: *Field Recovery*: 1 proximal unfused femur epiphysis, 1 distal left unfused femur epiphysis, 1 proximal left femur fragment, 1 proximal right unfused tibia epiphysis, 1 distal unfused tibia epiphysis, 1 proximal left tibia fragment, 2 ribs, 1 first sternebra; Total 9 NISP; MIN 1

Remarks: Sea otters are found in marine and rocky coastal environments of Washington state (Estes 1980). They are highly social creatures, were at one time very abundant off the coast of Washington, and were considered easy to catch because of their timidity towards humans (Ray 1938:114). As many specimens from this species were unfused epiphyses, the targeted animal(s) was sub-adult. Sea otters breed year-round (Riedman and Estes 1990); therefore, animal age provides little information as to the season of capture.

Oral histories and ethnographic records indicate that the Chinook and Willapa Bay Lower Chehalis prized sea otter skins for clothing and blankets (Heritage Committee 1984:5; Ray 1938:114). Sea otter skins were also a highly important item of trade during the proto- and postcontact periods, as is evident in John Meares' description of sea otter as the first trade item exchanged between Euro-Americans and Willapa Bay peoples (see Chapter 2). James Swan's description of the sea otter trade also highlights the importance of this trade: "the sea-otter is the most valuable of the fur animals taken on the Pacific coast, those to the north of the Columbia being considered of more value than those taken south and along the coast of California" (1857:91). Neither oral histories nor ethnographic records make mention of sea otter meat as food. Of the nine specimens found at Nukaunlth, one specimen shows evidence of butchering, and none show evidence of burning. While sea otter meat is a possible food source, the evidence at Nukaunlth is inconclusive.

Family Otariidae – fur seals and sea lions

Eumetopias jubatus – Steller sea lion

Materials: *Field Recovery*: 1 proximal unfused ulna epiphysis; Total 1 NISP; MNI 1

Remarks: The Steller sea lion is the largest of the eared seals, weighing 1,000 to 2,500 lbs. (Loughlin et al. 1987). They are found in coastal waters, on the rocky shores of Washington, and in the Columbia River for the entire length of Lower Chinook territory (Ray 1938:113). They are often in shallow waters as they forage close to shore at night. Ethnographic records give little information as to how these animals were hunted.

Results

A total of 385 marine mammal specimens were recovered from field samples; 259 specimens (67.3% of the total marine mammal assemblage) were identified to at least suborder (Table 6.9 & Table 6.10). Because whale bone had a distinctive and easily identifiable texture, many of the small, highly fragmented specimens could be assigned to this suborder. Approximately 37% of identified specimens were recovered from screen residue sorting. This ratio increases to 46% when including specimens that could not be identified to at least suborder. The majority of marine mammal bones (63%) were recovered in the ¼” screen (Table 6.11).

Whale dominates the assemblage, representing over 96% of the identified specimens. The ease of identification of whale bone may inflate the abundance of this taxon. However, looking at larger specimens, those large enough to be recorded *in situ*, whale bone still dominates, in part because of the large concentration of whale bone recovered near a hearth feature within the house. So, while 96% might be an overestimation, it is likely that whales still made up a significant portion of the marine mammal assemblage. Sea otter comprises 3.5% of the marine mammal assemblage, and Steller sea lion comprises a very small fraction. The marine mammal assemblage represents an estimated 14,047.4 grams of edible meat.

Table 6.9 Frequency of marine mammal remains

Taxon	***NISP***	***% NISP***	***Weight (g)***	***% Weight***
Mysticeti (suborder)	249	64.7	516.7	89.0
E. lutris – sea otter	9	2.3	33.2	5.7
E. jubatus – Steller sea lion	1	0.3	2.3	0.4
Unidentified Marine Mammal	126	32.7	28.3	4.9
Total	385	100.0	128.29	100.0

Table 6.10 Frequency of marine mammal specimens identified to taxon

Taxon	***NISP***	***% NISP***	***Weight (g)***	***% Weight***
Mysticeti (suborder)	249	96.1	516.7	93.6
E. lutris – sea otter	9	3.5	33.2	6.0
E. jubatus – Steller sea lion	1	0.4	2.3	0.4
Total	385	100.0	128.29	100.0

Table 6.11 Frequency (NISP) of marine mammal taxa by sieve size and recovery method

		¼" sieve			***1/8" sieve***	
Taxon	*Field Recovery*	*Screen Residue Sorting*	*Total*	*Field Recovery*	*Screen Residue Sorting*	*Total*
Mysticeti (suborder)	106	74	180	48	21	69
E. lutris – sea otter	9		9			
E. jubatus – Steller sea lion	1		1			
Unidentified Marine Mammal	36	18	54	8	64	72
Total	152	92	244	56	85	141

Whale dominates the marine mammal faunal assemblage in both occupation periods of Nukaunlth (Table 6.12). Whale is the only identified marine mammal species present in the earlier occupation of the village. Sea otter and Steller sea lion are found only in the second occupation of Nukaunlth. However, these make up a small portion of the assemblage, 6% and 0.7% respectively, and therefore do not suggest a major shift in marine mammal exploitation.

Table 6.12 Frequency of identified marine mammal taxa by occupation

	First Occupation		***Second Occupation***	
Taxon	*NISP*	*% NISP*	*NISP*	*% NISP*
Mysticeti (suborder)	110	100.0	139	93.3
E. lutris – sea otter			9	6.0
E. jubatus – Steller sea lion			1	0.7
Total	110	100.0	149	100.0

Descriptive Summary – Terrestrial Mammals

I identified terrestrial mammal specimens to the finest taxon using standard paleozoology procedures. Most specimens lacked the diagnostic elements needed to conduct species-level identification. Numerous specimens of very small rodents (shrews, moles, etc.) were recovered. Rodents of this size were not typically part of the diet (Heritage Committee 1984). As discussions here are intended to provide an understanding of food resources, I limit discussion to those terrestrial mammal resources that likely contributed to the diets of those living at Nukaunlth.

Order Rodentia – rodents

Family Aplodontidae – mountain beaver

Aplofontia rufa – mountain beaver

Materials: *Field Recovery*: 2 left mandibles; Total 2 NISP; MNI 2

Remarks: Mountain beavers are the only living member of its genus and family. Today, they are restricted to primarily moist forests and thickets, including the Cascades and the coastal ranges of Washington and Oregon (Carraway and Verts 1993). However, their precontact distribution may have been different from their current range (Wake 2006). This small, burrowing rodent is not related to the beaver family but gets its name from its habitual gnawing of small branches off young trees. As it is a burrowing rodent, it is sometimes thought that mountain beaver may enter archaeological deposits naturally and do not represent human use or capture. However, there is ethnographic evidence that mountain beavers were highly prized both for their meat and fur; mountain beaver blankets were considered a very high-status object among Chinookan peoples (Tony Johnson, personal communication, Ray 1938:118). Likewise, an archaeological study of the up-river Chinookan village site, Cathlapotle, uncovered use-wear on mountain beaver mandibles that suggest they were used as chisels and/or engravers (Lyman and Zehr 2003).

The two left mandibles found at Nukaunlth were found together within the house, suggesting that these specimens were not due to natural accumulation, but were deposited by those living at Nukaunlth. One specimen exhibits cutmarks on the coronoid process, suggesting butchering. Furthermore, both show use-wear similar to that found on the mandibles recovered at Cathlapotle. One mandible recovered at Nukaunlth has had the incisor broken out of the alveolus by a fracturing of the lingual side of the alveolus. This use-wear was found in 19 of the 34 mountain beaver mandibles recovered from Cathlapotle (Lyman and Zehr 2003:94). The other mandible recovered at Nukaunlth has had the incisor crushed within the alveolus. Both use-wear types may be the result of side-to-side and downward pressure exerted through the incisor while still set in the mandible and used as a graver or chisel (see Chapter 5).

Family Castoridae – beavers

Castor canadensis – beaver

Materials: *Field Recovery*: 1 scapula; Total 1 NISP; MNI 1

Remarks: Beavers were commonly exploited for food, fur, hides, and tool material in the area during the proto- and postcontact periods. Beavers were hunted at night using barbed harpoons (Ray 1938; Swan 1857). Beaver skins, like sea otter skins, were a common item traded with both Euro-Americans and other Northwest Coast Indigenous groups (Swan 1857:96, 349). The scapula recovered exhibits cutmarks suggestive of butchering.

Order Artiodactyla – artiodactyls

Family Cervidae – cervids

Cervus elaphus – wapiti/elk

Materials: *Field Recovery*: 1 femur fragment, 1 metatarsal; Total 2 NISP; MNI 1

Remarks: Elk is found throughout most of the Pacific Northwest in forests and meadows, and were commonly hunted in Willapa Bay. Verne Ray describes the typical bow and arrow hunting method for deer and elk among Chinookan groups:

> "The object was to surround the game and drive it toward a favorable spot for the bowmen. Each man was assigned to his position; the most expert with the bow and arrow were stationed at the point of concentration. This was always on land; game was never driven into the water" (1938:116).

Decoys made from the elk head were used for elk hunting. Elderberry whistles were used to call deer and elk. Pitfalls were also used for capturing elk, described by Lewis and Clark:

> "Their pits are employed in taking the elk, and of course are large and deep, some of them a cube of 12 or 14 feet. These are usually placed by the side of a large fallen tree which as well as the pit lye across the roads frequented by the Elk. These [pits] are disguised with the slender boughs of trees and moss; the unwary Elk in passing the tree precipitates himself into the [pit] which is sufficiently deep to prevent his escape and is thus taken" (2002:356).

The partial femur recovered from Nukaunlth exhibits evidence of butchering. It has been both ringed (radially grooved to aid in breakage) and chopped to extract the marrow within.

Odocoileus sp. – deer (mule/black-tailed or white-tailed)

Materials: *Field Recovery*: 1 cannon bone; Total 1 NISP; MNI 1

Remarks: Deer, like elk, are common in the Pacific Northwest and were commonly hunted using bow and arrow. Two species of deer are common for the area, mule/black-tailed (*O. heminous*, two subspecies) and white-tailed (*O. virginianus*). From the specimen recovered, it is not possible to distinguish between the two. Deer was obtained for food. Verne states that buckskins were not commonly used, but skins were sometimes smoked (Ray 1938:118).

Order Carnivora – carnivores

Family Felidae – cats

Puma concolor – cougar

Materials: *Field Recovery*: 1 metacarpal; Total 1 NISP; MIN 1

Remarks: Cougars are found throughout the state of Washington except for the Columbia Basin. They are typically found in forested and mountainous areas. Oral histories note that cougars were commonly hunted, not only for their fur but for any part that was usable for food, utensils, tools, or decorative purposes (Heritage Committee 1984a:5).

Results

A total of 442 terrestrial mammal specimens were recovered from excavations at Nukaunlth village. However, only seven of these specimens could be identified to taxonomic family or genus, and therefore interpretations regarding the relative abundance of species within this broad class are limited. This limited number of identified species is due to two factors. First, the preservation of specimens overall was poor; all specimens that were recovered from the house floor were soft and friable because there were not significant amounts of shell in these deposits to create a basic PH environment. Second, many intact specimens appeared to belong to a very small size class, likely belonging to the numerous vole and shrew species common in Washington. Comparative collections for these smaller species were not available. Furthermore, oral histories suggest these were not eaten, and as the focus of this research is to provide insight into the foodways of those living at Nukaunlth, the identification of these small burrowing rodents would prove time-consuming and irrelevant to the focus on this research (Heritage Committee 1984). Weasels, martens, rabbits, and larger rodents, such as squirrels, were common food items for Chinookan peoples in the past, and therefore careful consideration of these species was taken (Heritage Committee 1984; Ray 1938). The assemblage was investigated for the presence of these species, but none could be identified with certainty. The fact that the majority of terrestrial mammal specimens were recovered in the 1/8" sieve (54% of the total terrestrial mammal assemblage) speaks both the friable nature of the specimens and the prevalence of small mammalian species (Table 6.13). Approximately 26% of the mammalian assemblage was recovered from screen residue sorting. The terrestrial mammalian remains described here, however limited, are not taxonomically unexpected given oral histories, ethnographic records, and previous archaeofaunal work in the area (e.g., Wilson et al. 2008; Roll 1974; Shaw 1977). As noted in the descriptive summary, the use of each species is well-documented in either oral histories or ethnographic documents for Willapa Bay and the surrounding region. The terrestrial mammal assemblage represents an estimated 2,192.7 grams of edible meat.

Table 6.13 Frequency (NISP) of terrestrial mammal taxa by sieve size and recovery method

	¼" sieve			***1/8" sieve***		
Taxon	*Field Recovery*	*Screen Residue Sorting*	*Total*	*Field Recovery*	*Screen Residue Sorting*	*Total*
A. rufa – mountain beaver	2		2			
C. canadensis – beaver	1		1			
C. elapahus – elk/wapiti	2		2			
Odocoileus sp. – deer	1		1			
P. concolor – cougar	1		1			
Unidentified terrestrial mammal	143	52	195	176	64	240
Total	150	52	202	176	64	240

Avian Remains

Avian specimens were identified to the finest taxon possible using comparative skeletons from the Santa Barbara Museum of Natural History. I used standard avian taxonomic nomenclature, relying on the American Ornithological Society's checklist (Chesser et al. 2019). Like the other faunal classes, NISP was the primary method of quantification, however, weight and MNI are included when possible. Like terrestrial mammals, only a small number of specimens could be identified to species.

Descriptive Summary

Order Anseriformes – waterfowl

Family Anatidae – ducks, geese, swans

Branta canadensis – Canada Goose

Materials: *Field Recovery*: 2 digit 3 – phalanx 4, 1 right digit 2 – phalanx 1, 1 proximal end of right femur, 1 sternum, 1 coracoid, 1 distal end of ulna, 1 thoracic vertebrae middle (axial), 1 ulna, 1 humerus, 1 right radial carpal, 1 right ulna carpal; Total 12 NISP; MNI 1

Remarks: Canada Goose is the most widely distributed goose in North America. It is common throughout most of Washington state in all seasons provided water is nearby. Limited reference to geese is made in ethnographic and oral histories, however, waterfowl is mentioned often. The bird populations of Willapa Bay are well known, even today, and were once so abundant that "their flocks darkened the sky at moments, when they took flight, and catching numbers of them was quite easy, compared to today" (Heritage Committee 1984a:4). Meat, feathers, bones, pelts, and eggs from larger birds were all used. A canoe blind was used to hunt waterfowl; green branches were placed over canoes and the canoes were allowed to drift, giving the appearance of floating driftwood (Ray 1938:117). Bow and arrow was the most common hunting method, but stones were also used. Birds were generally roasted whole by covering them with hot embers.

Order Characdriformes – gulls, terns, plovers, and other shorebirds

Family Alcidae – auks, puffins, and murres

Uria aalge – common murre

Materials: *Field Recovery*: 1 proximal end of ulna; Total 1 NISP

Remarks: Common murres are most often in Willapa Bay during the summer and fall. They forage in open ocean waters and large bays and are found closer to rocky shorelines during the breeding season. They are much more likely to be on the water than on land, feeding off small fish.

Order Procellariiformes – tube-nosed seabirds

Family Procellariidae – shearwaters, petrels, and fulmars

Fulmarus glacialis – northern fulmar

Materials: *Field Recovery*: 1 proximal end of humerus; Total 1 NISP

Remarks: Northern fulmars are most commonly found in the open ocean. They breed at high latitude and are in Willapa Bay only in nonbreeding seasons (October through March). Northern fulmars closely resemble gulls, and while northern fulmars are not mentioned specifically in any oral histories, there is some mention of gulls in the literature. James Swan notes that "innumerable flocks of gulls of various species are constantly to be seen…[these] birds, also, are readily eaten by the Indians, who never are at a loss to find means to appease their appetite" (Swan 1857:29).

Results

A total of 165 avian specimens were recovered from field samples; only 14 of these specimens (8.5% of the total avian assemblage) could be identified to species (Table 6.14 & Table 6.15). All specimens identified to species were ¼" or larger (i.e., mapped *in situ* or recovered from the ¼" screen). The majority of avian specimens (74%) were recovered from the ¼" sieve (Table 6.16). Approximately 9% of the avian assemblage was recovered from screen residue sorting. Because so few specimens could be identified to species, interpretations of relative frequencies of species within this faunal class are limited. However, some insights can still be gleaned from the assemblage. Most notably, the presence of migratory birds in the assemblage gives some indication of seasonal use of the village. Northern fulmars are only present in Willapa Bay in October through March, suggesting a fall and/or winter use of the village. Common murres are more common in Willapa Bay in the fall and summer months, suggesting that Nukaunlth could have been used year-round. Only one avian specimen appears modified, with a burned chalky appearance. The avian assemblage represents an estimated 2,790 grams of edible meat. Oral histories indicate that feathers, bones, and eggs were used as well (Heritage Committee 1984:4).

Table 6.14 Frequency of avian specimens

Taxon	***NISP***	***% NISP***	***Weight (g)***	***% Weight***
B. canadensis – Canada goose	12	7.3	162.8	87.5
U. aalge – common murre	1	0.6	0.54	0.3
F. glacialis – northern fulmar	1	0.6	0.47	0.3
Unidentified Aves	151	91.5	22.2	11.9
Total	165	100.0	186.0	100.0

Table 6.15 Frequency of avian specimens identified to taxon

Taxon	***NISP***	***% NISP***	***Weight (g)***	***% Weight***
B. canadensis – Canada goose	12	85.7	162.8	99.4
U. aalge – common murre	1	7.1	0.54	0.3
F. glacialis – northern fulmar	1	7.1	0.47	0.3
Total	14	100.0	163.8	100.0

Table 6.16 Frequency (NISP) of avian taxa by sieve size and recovery method

		¼" sieve			*1/8" sieve*	
Taxon	*Field Recovery*	*Screen Residue Sorting*	*Total*	*Field Recovery*	*Screen Residue Sorting*	*Total*
B. canadensis – Canada goose	10		10	2		2
U. aalge – common murre	1		1			
F. glacialis – northern fulmar	1		1			
Unidentified Aves	106	4	110	30	11	41
Total	118	4	122	32	11	43

Shellfish

The majority of shellfish specimens were recovered from screen residue sorting done in the lab, as they made up the bulk of items retained in the screen, and given time constraints, sorting them in the field was not feasible. Some shell specimens that could be used for growth-stage analysis and future diatom analysis and AAR dating were mapped *in situ* and bagged separately. Specimens were identified to the finest taxon possible using reference collections at the Santa Barbara Museum of Natural History. Taxonomic nomenclature follows the *Bivalves Shells of Western North America* handbook (Coan et al. 2000). The shell assemblage from Nukaunlth was extremely abundant, and sorting and quantifying all of the screen residue recovered from excavations proved time-consuming and unnecessary. Therefore, a protocol was put into place to establish a representative sample (described above). All sampled shell specimens from the ¼" screens sorting were counted and weighed. The sampled shell specimens from the 1/8" screens were weighed but not counted, as this assemblage was highly fragmented and counting proved too time-consuming. Therefore, frequency is given by both NISP and weight.

Shellfish vary in the robusticity of their shells. Therefore the rates of fragmentation and weight of the shell specimens vary between taxa and bias NISP values and weight measures. For example, cockle (*C. nuttallii*) shells are highly robust. As such, they tend to weigh more and resist breaking. Mussels (*M. trossulus*), however, have thin, fragile shells that break very easily. In aggregate, therefore, quantifying cockles using NISP may underrepresent their presence in the assemblage, whereas quantifying cockles using weight may overinflate their abundance. The inverse holds for mussels. To evaluate these discrepancies, MNIs and meat yields were also calculated. These extra lines of evidence help to establish the relative importance of these shellfish resources.

I calculated MNI following the tMNI protocol put forward by Harris, Weisler, and Faulkner (2015). tMNI protocol treats each taxon separately. In this method, several non-repetitive morphological elements (NREs) are examined. Examples of these elements include umbo, spire, outer lip, posterior or anterior hinge, posterior or anterior muscle scar, etc.[34] Element frequency is logged by taxon, and MNI is recorded using the highest frequency NRE for each taxon. Typical methods of calculating MNI are based on a restricted number of NREs (spire for gastropods, and umbo or hinge for bivalves) and can underestimate the relative abundance of molluscan shell forms. Incorporating a wide range of NREs provides a more accurate taxonomic abundance measure.

To calculate the tMNI of class Bivalvia the following NREs were recorded for each taxon: (1) umbo and beak, (2) posterior portion of the hinge, and (3) anterior portion of the

---

[34] Admittedly, these are not technically elements but features of the shell. However, this is the conventional term used by archaeomalacologists.

hinge. Harris, Weisler, and Faulkner (2015) use two additional NREs to calculate bivalve MNI: anterior adductor muscle scar and posterior adductor muscle scar. However, as the assemblage was fairly fragmented and these elements are considerably larger than the others, I determined that these NREs would surely result in lower counts than the others. Therefore, they were omitted from the tMNI calculations for this assemblage.

Each NRE that was at least 50% complete was recorded. All bivalve NREs were then sided. The most frequently occurring NRE for the valve side with the highest count was then used to calculate tMNI. Only NREs that could be confidently assigned to a valve side were counted towards the tMNI. The gastropod NREs that I used in the quantification of the assemblage were the (1) spire, (2) anterior canal/notch, and (3) outer lip. Like with the Bivalvia specimens, each NRE that was at least 50% complete was recorded. Unlike Bivalvia, gastropods do not have two valves and therefore do not need to be sided. More details on taxa-specific tMNI protocols are outlined in the remarks section of the descriptive summary.

Descriptive Summary

Phylum Mollusca

Class Bivalvia – bivalves and clams

Order Mytiloida

Family Mytilidae – mussels

Mytilus trossulus or *Mytilus californianus* – bay mussel or California mussel

Materials: 8,599 NISP; 3,041.5 grams; 935 MNI

Remarks: Two species of *Mytilus* exist on the Washington coast, *M. trossulus*[35] and *M. californianus*. Both attach themselves to hard substrates using strong byssal threads and are often found in large clusters. *M. californianus* are typically much larger than *M. trossulus* (up to 25 cm in length compared to 9 cm) and are found most often clinging to rocks in wave-exposed open coasts. *M. trossulus* prefer quiet bays (such as Willapa Bay) but are also found on the open coast in mixed populations with *M. californianus* (Coan et al. 2000:159). Both habitats would be easily accessible from Nukaunlth village. Mussel shells are easily distinguishable from other bivalves as they have a purple hue and fibrous texture. Therefore, even very small fragments can be identified to this family. However, distinguishing between *M. trossulus* and *M. californianus* is not possible from fragments, and due to the friable nature of these shells, no whole shell specimens were successfully removed from midden deposits from Nukaunlth. Some whole shells were uncovered and photographed *in situ*, however, and appear to more closely resemble the smaller *M. trossulus*. The posterior portion of the left hinge was the most commonly identified NRE for *Mytilus* and was used to quantify MNI. While some ethnographic accounts mention mussels in passing (e.g., Ray 1938, Swan 1857), few details are given on procurement methods or frequency of use. Ray simply states that mussels were collected, "though not in quantity to compare with the clams" (1938:113).

---

[35] *M. trossulus* is part of the *M. edulis* complex and is often referred to by this name. However, true *M. edulis* have not yet been introduced to the northern Pacific and are found only in the Atlantic (Coan et al. 2000:157).

Order Veneroida

This order includes the largest and most diverse group of living bivalves. From this order, there were at least five species that a layperson would generally refer to as “clams” found at Nukaunlth. As they are more difficult to distinguish from each other than they are from bivalves of other orders (i.e., mussels or oysters), many of the ethnographic accounts offer little species-specific information and instead group them. As such, I offer a general description of gathering and cooking techniques garnered from these records and give species-specific information when it is available.

Ethnographic records indicated that clams were preferred and procured in greater quantities than mussels and oysters. They were dug by hand or with the help of a digging stick with a tapered and cupped end. This implement varied in length from two to four feet depending on the size of the species (Ray 1938:112) (Figure 6.2). Shellfish collection began in March or February and continued into the fall (Swan 1857:87). Swan describes two methods of preparing clams: drying on a skewer and steaming in an earthen oven. Smaller clams were also eaten raw. Dried clams were a particularly important trade item for interior communities, and “quantities are annually carried from Shoal-water [Willapa] Bay up the Columbia” (Swan 1857:86).

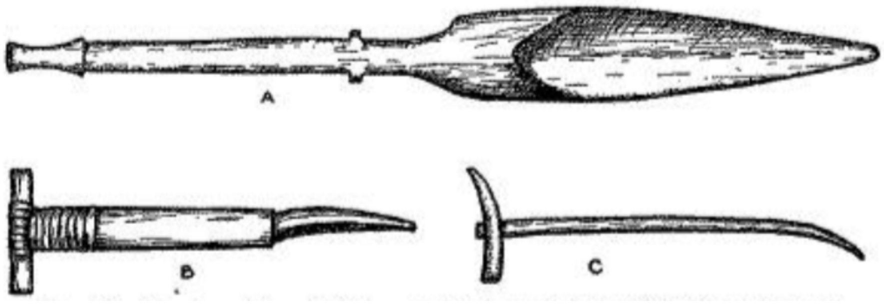


Figure 6.2 Digging sticks from Ray 1938, (A) for large shellfish; (B) for small shellfish; (C) for root digging

Family Cardiidae

Clinocardiumm nuttallii – basket cockle

Materials: 20,767 NISP; 13,809.9 grams; 416 MNI

Remarks: The basket cockle is the only known cockle for the region. The thick shell has a distinct dorsal surface with prominent radial ribs and an undulating ventral margin, making it easy to identify in a fragmentary state. They inhabit the intertidal zone in fine sand and mud sediment. They do not burrow deeply and are found just below the surface, often in eelgrass beds. Individuals in modern populations reach up to 14 cm (~ 5.5 in) in length. The NRE most represented in the *C. nuttallii* assemblage is the anterior portion of the right valve hinge. The large lateral tooth on this species made the anterior portion of the hinge easily identifiable.

Cockles are hardly mentioned by name in ethnographic records. However, Ray states that cockles were likely the single most important shellfish resource in Willapa Bay for the Chinook (Ray 1938:112). In all likelihood, what Swan calls either a large clam or hard-shell clam/quahaug (giving them the names *smetár* and *clolum* respectively to denote the Chinookan term) is *C. nuttallii.* These, he indicates, were far more important than oysters for Indigenous communities (Swan 1857:85).

Family Veneridae

Protothaca staminea – Pacific littleneck clam

Materials: 63 NISP; 49.3 grams; 3 MNI

Remarks: The shell of *P. staminea* is easily identified by its radial and commarginal ribs. It can be distinguished from *C. nuttallii* because it lacks strong radial ribs and an undulating ventral margin. It lives in the lower half of the intertidal zone in stable sand, packed mud, or gravel-clay mixtures. It is a shallow burrower, usually found less than 8 cm below the surface. This is one of the smaller species of shellfish found at Nukaunlth, typically reaching 4 cm (~1.5 in) in length. The left umbo the most common NRE in the assemblage and used to quantify MNI. Overall, however, few specimens of *P. staminea* were recovered.

Pacific littleneck clams are sometimes referred to as hard-shell clams, and so Swan may be referring to these species when he writes of *clolum*. He describes the process of cooking *clolum* as such:

> "The clolum is opened by being heaped on stones previously heated, then covered with sea-weed and mats. The water contained in the clam runs down the hot stones, causing steam, which, being confined by the mats and sea-weed, soon cooks the whole pile, containing usually from ten to twenty bushels…The shells, now being open, are easily separated, and the meat stuck on skewers…and dried in smoke" (Swan 1857:85–86).

Order Veneroida

"Clams" (non-basket cockle or Pacific littleneck clams)

Materials: 6,472 NISP; 3,412.5 grams

Remarks: Besides *C. nuttallii* and *P. staminea,* the remaining specimens attributed to the order Veneroida exhibit concentric striations radiating from the hinge of the dorsal surface. When in fragments without NREs, these specimens cannot be identified to taxa. Instead, they were grouped in a general "clam" class. From the presence of NREs on some specimens and some intact bivalve shells recovered during excavation, we know this general class contains at least three species: *Saxidomus gigantea, Macoma nasuta,* and *Tresus* sp.[36] Using NREs specific to each species, the MNI for each taxon is stated below, while NISP and weight are given for this broader category. The MNI calculations suggest that *M. nasuta* makes up the bulk of this group. These taxa represent all bivalves in the Order Veneroida native to Willapa Bay save one, *Siliqua patula* (razor clam). This species was a known food source for Indigenous communities and was found in nearby archaeological sites (Kidd 1960; Swan 1857). This species may be present in this assemblage. However, there are no specimens with *S. patula*-specific NREs to suggest it was a resource commonly exploited by those living at Nukaunlth.

Saxidomus gigantea – Washington butter clam

Materials: 19 MNI

Remarks: The Washington butter clam is one of the more important harvested clams of the Northwest Coast in modern times (Coan et al. 2000:384). They are found in sheltered sand, sandy mud, and gravel beaches, and burrow between 8 and 14 inches in the lower intertidal zone. Like the basket cockle, this is one of the larger species of clam found at Nukaunlth, reaching 14 cm (~5.5 in) in length. Unlike the basket cockle and Pacific littleneck, it lacks radial ribs. Instead, it has prominent concentric striations radiating away from the hinge on the dorsal surface. It shares this characteristic with some other clams found at Nukaunlth (*M. nasuta, Tresus* sp.), and is therefore difficult to identify *S. gigantea* fragments lacking diagnostic NREs. Fortunately, all three species have distinct umbo and hinge characteristics that allow for a

---

[36] Two species of *Tresus* are found in Willapa Bay, *T. capax* and *T. nuttallii*. It is not possible to distinguish between the two in a fragmentary state, therefore it is not known if one or both species are represented in the assemblages at Nukaunlth.

calculation of MNI. For *S. gigantea* the left umbo is the NRE most commonly identified in the assemblage and was used to calculate the MNI. The distinctive cardinal hinge teeth directly below the umbo and lack of chondrophore make this element distinguishable from *M. nasuta* and the *Tresus* species.

Again, no specific mention of this species is made in the ethnographic records. However, the term *aryuk* is used to denote a clam "resembling the common clam of Massachusetts in shape" (Swan 1857:86). Swan was likely attempting to transcribe the Chinook word for steamers or butter clams (Earl Davis, personal communication). At a cursory level, *S. gigantea* do resemble the quahogs of the east coast (*M. mercenaria*). Swan states that *aryuk* were eaten raw. However, oral histories indicate that they were steamed in the fashion Swan describes from *clolum* (Earl Davis, personal communication).

Family Tellinidae

Macoma nasuta – bent-nosed clam

Materials: 113 MNI

Remarks: The bent-nosed clam can be found in the low intertidal zone at a depth between 10 and 20 cm, preferring mudflats and silt in bays and offshore (Coan et al. 2000:419). They are small compared to other clam species found at Nukaunlth, usually not more than 6 cm in length. Like *S. gigantea* or *Tresus* sp., the bent-nosed clam has concentric striations making it difficult to distinguish from these other species when in small fragments. However, its umbo, hinge plate, and hinge cardinal teeth are distinct and can be used to identify specimens containing these NREs. The left umbo was most commonly represented in the assemblage and used to calculate

MNI. In his description of shellfishing, Ray (1938) mentions this species by name as an important resource but gives no specifics on procurement method or processing practices.

Family Mactridae

Tresus sp.– fat gaper or Pacific gaper

Materials: 50 MNI

Remarks: Two species of *Tresus* are found on the Northwest Coast, *T. capax* and *T. nuttallii*. When fragmented it is not possible to distinguish between the two, however, *T. capax* is more common in Willapa Bay (Monaco et al. 1990:186). Both prefer the middle intertidal zone of quiet bays and burrow to up to a meter in mud and sandy sediment (Coan et al. 2000). These are some of the largest intertidal clams found on the Northwest Coast (the geoduck being larger). They can reach up to 28 cm (~11 in) in length, making them twice as big as any other clam found at Nukaunlth. *Tresus* is distinguishable from other clams lacking radial ribs by its large shelf-like chondrophore directly below the umbo. This portion of the shell is also the most robust and therefore more likely to remain intact in the archaeological record. The NRE most identified in this assemblage was the right umbo.

As this is one of the largest clams found in Willapa Bay, Swan is likely referring to this species when speaking of the “large clams” or *smetár*. In his description, he notes that these clams were buried about a foot deep and were dug by hand. According to Swan, *smetár* were “opened with a knife, and…stuck on skewers holding about two dozen; these are then washed clean, drained, and dried in smoke” (1857:85).

Order Ostreida

Family Ostreidae

Ostrea lurida – Olympia oyster

Materials: 133 NISP; 128.4 grams; 12 MNI

Remarks: The Olympia oyster is the only oyster species native to western North America. It can be found in the lower intertidal and shallow subtidal zones in clumps on rocks, piling, or oyster shells and can form extensive reefs. They are smaller than many other oyster species, usually not growing past 6 cm (~2.4 in) in length. The flaky texture and pearlescent white coloration of this shell make it easy to identify. The NRE most commonly found in this assemblage was the posterior portion of the right valve hinge and this was used to calculate the MNI.

This oyster species is sometimes referred to as *Ostrea conchaphila* when the form is attached to living mollusks or the carapace of large crustaceans and is usually solitary. The form named *O. lurida* is found attached to dead shells or rocks and often forms reefs (Coan et al. 2000:214). Given that ethnographic records indicate that the oysters of Willapa Bay formed extensive beds throughout the bay (Hittell 1882; Swan 1857; Ray 1938), this name is favored for this discussion. Furthermore, recent studies have indicated that *O. conchaphila* is a separate species found off the coast of Mexico (Polson et al. 2009).

When Europeans first arrived in the area, Willapa Bay had large natural beds of this species (Lloyd 1999; Ray 1938; Swan 1857). As much as 27% of the bay bottom was occupied by oyster beds in the late 1800s (Blake and zu Ermgassen 2015). This species was extensively harvested in Willapa Bay by Euro-Americans for commercial use beginning in the 1850s (Blake and zu Ermgassen 2015; Espy 1992; Hittell 1882; Swan 1857). By the 1930s the native populations were decimated by the industry and at near extinction (White et al. 2009). Since then, continuing efforts have been made to help this species recover. However, competition by introduced species, sensitivity to emersion, and the removal of previous oyster beds (thereby removing materials for larval settlement) have slowed the recovery of this species in Willapa Bay (Trimble et al. 2009).

In his description of shellfishing practices among the Chinook, Ray notes the large quantities of oysters present in Willapa Bay but states that Chinookan peoples did not favor oysters and instead preferred clams (Ray 1938:112). Swan notes that in the spring and summer "the weather was now propitious for prosecuting the oyster-fishery and hundreds of Indians came to the Bay from Chenook and the tribes at the north. Some…came as far as the region around Puget Sound" (1857:59). However, he specifies that these communities came to Willapa Bay to procure clams and crabs for themselves and oysters to sell to Euro-Americans.

Class Gastropoda

Order Neogastropoda

Family Nucellidae

Nucella lamellosa – frilled dogwinkle

Materials: 714 NISP; 621.47g; 70 MNI

Remarks: The frilled dogwinkle is one of the most common intertidal whelks in the Pacific Northwest. They are found in the low to mid intertidal zone on rocky substrates, particularly mussel beds. They are carnivorous and often feed on mussels and associated acorn barnacles. This species is unique in that it is highly variable in shape, size, and color. Frilled dogwinkles have a thick shell and well-developed spire. They typically 5 to 8 cm (~2 to 3 in) in height. The most notable variation between individuals is the presence or absence of large, frilly lamellae as axial sculpture depending on the turbidity of the waters in which it inhabits. Shells from quiet bays more often exhibit lamellae than those from open environments with current or wave action. To calculate the MNI, specimens were investigated for the presence of the spire, anterior canal/notch, or outer lip NREs. The most common NRE identified in the assemblage was the anterior canal/notch.

No mention of this species is given in any of the ethnographic records or oral histories reviewed, therefore, we do not know exactly how they were procured or their function for Indigenous communities. However, this species is one of the most commonly recovered taxa from Northwest Coast archaeological sites (Cannon et al. 2008). A cluster of *N. lamellosa* was recovered at Nukaunlth on top of a living surface. The specimens in this cluster exhibit the same modification, in that they appear to be broken at the same angle to expose the inside of the body whorl. I presume that this would enable one to more easily extract the meat from the shell.

Phylum Arthropoda

Suborder Balanomorpha – acorn barnacles

Materials: 60 NISP; 49.6 grams

Remarks: Several species of acorn barnacles exist in the waters of the Northwest Coast: *B. crenatus, B. glandula, B. nubilus, B. rostratus, S. cariosus*. While the specimens identified at Nukaunlth could not be identified to species, they were very small and are therefore most likely *B. crenatus* or *B. glandula*. These are found in the intertidal zone (mostly the upper half) attached to rocks, pilings, and on the mussel shells, competing with mussels for space in this habitat. Barnacles are edible, and archaeological, ethnographic, and historical data all suggest that in some parts of the North Pacific they were exploited and consumed (Moss and Erlandson 2010). However, the barnacles targeted for consumption were most often the larger species, and therefore I surmise that those recovered from Nukaunlth were likely not consumed. Instead, they were most likely attached to the mussels that were harvested.

Order Decapoda

Family Cancridae – cancer crabs

Cancer productus or *Metacarinus magister* – red rock crab or Dungeness crab

Materials: 12 NISP; 3.33 grams

Remarks: Twelve fragments of crab dactylus or pollices were recovered from Nukaunlth. These parts of the propodus (i.e., claw) of the crab are most likely to be preserved in the archaeological record because they are the most robust parts of the exoskeleton. There are two species of large crabs in Willapa Bay that possess a dactyl or pollex of the size found at Nukaunlth: *C. productus* and *M. magister*. *C. productus* are found in the intertidal zone in tidepools, in rocky reefs, or on rocks in the sand. They are one of the largest intertidal crabs on the west coast with a carapace width up to 20 cm (~8 in). *M. magister* is one of the most important commercial crabs of the Pacific coast of North America. They prefer the low intertidal zone of bays, harbors, sandy beaches, eelgrass flats, and sandy areas of the continental shelf (Wicksten 2011). This is the largest cancer crab in North America with a carapace length up to 25 cm (~10 cm).

Crabs were a well-known source of food for Willapa Bay Chinookan and Lower Chehalis peoples in the postcontact period. Swan describes two types of crab that were procured in large quantities: a small crab and a large crab. The small crab was collected, boiled, and eaten whole.

The large crab was commonly found in spring and the early part of the summer and would be "gathered by the bushels" (Swan 1857:82). Swan specifies that when captured, only the claw part would be retained and brought back from processing. This may explain why only portions of the propodus were recovered from Nukaunlth.

Results

A total of 21.17 kilograms of shell recovered from field samples were sorted in the lab. Of this, only 49.4 grams (0.23% of the total sampled shellfish assemblage by weight) could not be assigned to the taxa described above (Table 6.17). These unidentified specimens were highly eroded and fragmentary. They were either very small or did not retain the dorsal surface and thus could not be identified to specific taxa. From the sampled ¼" screen residue and *in situ* samples, a total of 37,043 shellfish specimens (NISP) were identified. Over 99% of the sampled shellfish assemblage by count (36,820 specimens) could be identified to the taxa described above. At least 10 genera are represented in this sample, with a total shellfish MNI of 1,618.

Cockle dominates the assemblage, representing approximately 52% of the assemblage when quantifying by NISP and by weight. By both quantification methods, mussels (*M. californianus* or *M. trossulus*) are the second most abundant identified species of shellfish (23% by NISP, 32% by weight), and various species of clam (*Tresus* sp., *S. gigantea,* & *M. nasuta*) is the third most represented grouping (17% by NISP, 12% by weight). Frilled dogwinkle makes up 2% of the identified assemblage by count and by weight. Oyster, crab, Pacific littleneck, and barnacle each comprise less than 1% of the assemblage when quantifying by weight and count.

Table 6.17 Frequency of shellfish taxa

Taxon	***NISP***	***% NISP****	***Weight(g)***	***% Weight****
Mytilus sp. – mussel	8599	29.09	3041.50	32.49
C. nuttallii – cockle	20767	51.59	13809.89	52.33
S. gigantea, M. nasuta, Tresus sp. – clam	6472	16.63	3412.50	11.77
P. staminea – Pacific littleneck clam	63	0.12	49.33	0.12
O. lurida – native/Olympia oyster	133	0.37	128.36	0.39
N. lamellosa – frilled dogwinkle	714	1.64	621.47	2.07
Balanomorpha – barnacle	60	0.14	49.56	0.65
C. productus or *M. magister* – crab	12	0.08	3.33	0.03
Unidentified shellfish	233	0.34	49.39	0.15
Total	37043	100.0	21165.37	100.0

*Relative frequencies are adjusted to reflect subsampling strategy

Comparing the relative frequencies of shellfish taxa by sieve size, when quantifying by weight, reveals differing rates of fragmentation according to shell species. Across the entire site, mussel fragments make up the bulk of shell specimens from the 1/8” screen residue (69%), whereas they represent only 6% of the specimens larger than ¼” (Table 6.18). This trend holds when investigating specific proveniences—across all units, mussel shell fragments are found at a higher relative frequency in the 1/8” sieve than the ¼” sieve. This suggests that differences in fragmentation are not due to a differential level of trampling across the site, but rather due to varying friability between species. For cockle shells, the inverse appears to be true. Comparing these relative frequencies suggest that cockles possess a robust shell that resists fragmentation—in the assemblage as a whole and when comparing unit-specific assemblages, cockle shell fragments are found at a higher relative frequency in the ¼” sieve than the 1/8” sieve. This indicates that using a 1/8” sieve was necessary to obtain an accurate representation of the shell assemblage at Nukaunlth.

Table 6.18 Relative frequency of shellfish taxa (% weight) by recovery methods

Taxon	***> ¼" Sieve****	***> 1/8" Sieve***
Mytilus sp. – mussel	5.90	68.69
C. nuttallii – cockle	71.78	23.65
S. gigantea, M. nasuta, Tresus sp. – clam	17.93	4.20
P. staminea – Pacific littleneck clam	0.27	0.02
O. lurida – native/Olympia oyster	0.69	0.05
N. lamellosa – frilled dogwinkle	3.15	1.56
Balanomorpha – barnacle	0.03	1.55
C. productus or *M. magister* – crab	0.01	0.07
Unidentified shellfish	0.24	0.22
Total	100%	100%

* Whole valves or shells that were recorded *in situ* are included in the relative frequency of ¼" sieve, as these specimens were larger than ¼ inch in size.

Calculated MNI paints a somewhat different picture of the relative abundance of shellfish species than NISP and weight quantification methods. Using MNI, mussels dominate the assemblage, representing 80% of the total identified shellfish species. Cockle is the second most abundant assemblage (11%), followed by bent-nosed macoma clam (5%), frilled dogwinkle (2%), and Pacific gaper/fat gaper (1%). The Pacific littleneck clam, Washington butter clam, and Olympia oyster each comprise less than 1% of the shellfish assemblage by MNI (Table 6.19). While each method of quantifying shellfish remains—NISP, weight, and MNI—presents a different rank order of abundance within the assemblage, some general trends persist. That is, cockles (*C. nuttallii*), mussels (*Mytilus* sp.), and various species of clams (*M. nasuta*, *S. gigantea*, and *Tresus* sp.)[37] are consistently the most abundant within the shellfish assemblage **(**Table 6.21). In particular, mussels and cockles are ranked first or second by NISP, weight, and MNI.

Table 6.19 Shellfish MNI by taxa

Taxon	***MNI***	***% MNI****
Mytilus sp. – mussel	935	80.08
C. nuttallii – cockle	416	10.91
P. staminea – Pacific littleneck clam	3	0.10
S. gigantea – Washington/butter clam	19	0.28
M. nasuta – bent nose clam	113	5.33
Tresus sp. – fat or Pacific gaper	50	1.13
O. lurida – native/Olympia oyster	12	0.40
N. lamellosa – frilled dogwinkle	70	1.76
Total	1618	100.0

*Relative frequencies are adjusted to reflect subsampling strategy

While MNI calculations suggest that mussels were harvested in greater quantities than any other shellfish species, it does not speak to the volume of edible food obtained. Although quite obvious, it's important to acknowledge that shellfish species vary in size, and therefore in edible mass. The *Mytilus* species most likely recovered from Nukaunlth grow up to 9 cm in length.[38] *C. nuttallii*, on the other hand, grows up to 14 cm in length and has deeper valves that

---

[37] As mentioned in the descriptive summary, these species could not be distinguished without the use of NREs. Therefore, they are grouped as a general class except when discussing MNI. It is plausible that grouping these species together would inflate their importance. However, quantification using MNI shows that even when treated separately, *M. nasuta* still ranks third in the rank order of abundance.

[38] I use the upper reaches of shell size for the smaller mussel, *M. trossulus*, as *in situ* recordings of whole mussel shells at Nukaunlth suggest a species of a smaller size.

hold a larger edible organism. Furthermore, mussels are a highly clustered resource that can be easily stripped from piles, rocks, and driftwood *en masse*. Therefore, a larger MNI may not reflect a greater quantity of edible food or labor invested in the gathering of this resource. An investigation of meat yields, therefore, sheds some light on the proportion of foodstuffs reflected in this assemblage and may work to mitigate some of the biases inherent in MNI, NISP, and % weight calculations.

An estimated 15,664.23 grams of edible meat is represented by the shellfish assemblage (Table 6.20). When comparing relative meat yields of shellfish species, cockles are estimated to contribute the greatest quantity of meat, approximately 56% of the shellfish-derived foodstuff. In this way, meat weight estimates align with NISP and weight quantification methods, all suggesting the cockle was the most abundant shellfish taxon. Meat weight conversions suggest that various species of clams contributed the second largest quantity of edible meat, approximately 22%, followed closely by mussel at 21%. For the various species of clams, this is a higher portion of the shellfish assemblage than is estimated by NISP and weight, owing to the large size of *Tresus* sp. and the large edible organism contained within the relatively thin and light shell of *M. nasuta*. All three species of clam have the highest meat weight conversion factor, meaning they contain, on average, more meat per shell weight than any other shellfish species found at Nukaunlth. In light of this, the effort in harvesting cockle to produce such a high proportion of the overall shellfish meat yields is noteworthy. All other shellfish taxa represented in the assemblage make up less than 1% of the shellfish meat yields, combined. In three out of the four quantification methods used—NISP, weight, and meat yields—cockle are ranked first in abundance within the shellfish assemblage (Table 6.21). *Mytilus* sp. is most often ranked second, and various species of clams (*M. nasuta, S. gigantea*, and *Tresus* sp.) are most often ranked third.

Table 6.20 Estimated meat yields of the shellfish assemblage

Taxon	*Meat weight Conversion*	*Meat weight (g)*	*% Meat Weight*[a]
Mytilus sp. – mussel	0.438	1332.18	21.23
C. nuttallii – cockle	0.72	9943.12	56.21
P. staminea – Pacific littleneck clam	0.610	30.09	0.11
“Clams”	1.243[b]	4241.79	21.83
O. lurida – native/Olympia oyster	0.292	37.48	0.17
N. lamellosa – frilled dogwinkle	0.12	74.58	0.37
C. productus or *M. magister* – crab	1.5	5.00	0.07
Total	-	15,664.23	99.99

[a] Relative frequencies are adjusted to reflect the subsampling strategy.
[b] Weighted average of meat weight conversion factors for *S. gigantea, M. nasuta,* and *Tresus* sp..

Table 6.21 Rank order of abundance of shellfish taxa by quantification method

Taxon	*NISP*	*Weight*	*MNI*	*Meat Yields*
C. nuttallii – cockle	1	1	2	1
Mytilus sp. – mussel	2	2	1	3
“Clams”*	3	3	-	2
S. gigantea – Washington/butter clam	-	-	7	-
M. nasuta – bent nose clam	-	-	3	-
Tresus sp. – fat or Pacific gaper	-	-	5	-
P. staminea – Pacific littleneck clam	7	7	8	6
O. lurida – native/Olympia oyster	5	6	6	5
N. lamellosa – frilled dogwinkle	4	4	4	4
C. productus or *M. magister* – crab	6	5	-	-
O. lurida – native/Olympia oyster	8	8	-	7

* *M. nasuta*, *S. gigantea*, and *Tresus* sp. are grouped in these quantification methods because they could not be distinguished without the presence of NREs.

Investigating the shellfish assemblage for change between occupations of Nukaunlth shows some persistent trends and interesting shifts in shellfish use. The same suite of shellfish taxa is present in assemblages from both occupations, except crab (Table 6.22). However, the lack of crab in the assemblage from the first occupation is possibly due to preservation bias. Crab shells degrade quickly and are unlikely to be preserved in early deposits. Cockle (*C. nuttallii*) is the most abundant shellfish taxa recovered in both occupations when quantifying by weight, NISP, and meat yield, making up 48-65% of the shellfish assemblage. This does not hold, however, when using MNI to determine the relative frequency of shellfish taxa, which suggests that mussels were more commonly exploited in both occupations than cockles. Most notably and by all measures, the relative frequency of mussel shell recovered increases by anywhere from 13% to 45% in the second occupation (Table 6.22, Figure 6.3). By most measures, this increase in mussel use in the second occupation represents a shift in rank order abundance, in which the mussel "moves up" in rank and becomes more prevalent than clam and/or cockle (Table 6.23). This is not the case when quantifying by MNI, which suggests no change in rank order abundance of the most prevalent shellfish species between occupations. Conversely, the relative frequency of cockles, frilled dogwinkle (*N. lamellosa*), and various species of clams, decreases by all methods of quantification. Interestingly, neither the Olympia oyster nor razor clams, two species of shellfish that were known to inhabit Willapa Bay in significant quantities in the postcontact period, were exploited in any great quantity.

Table 6.22 Frequency of shellfish taxa by occupation

	First Occupation								***Second Occupation***							
Taxon	*NISP*	*% NISP*	*Wt (g)*	*% Wt*	*MNI*	*% MNI*	*Meat (g)*	*% Meat*	*NISP*	*% NISP*	*Wt (g)*	*% Wt*	*MNI*	*% MNI*	*Meat (g)*	*% Meat*
Mytilus sp.	929	8.43	285.48	17.51	48	38.74	145.60	10.67	7670	33.76	2756.02	35.37	887	83.92	1204.63	23.39
C. nuttallii	6984	64.97	3652.51	56.91	167	34.65	3104.81	56.99	13783	48.86	10157.38	51.56	249	8.71	7266.61	56.05
"Clams"*	2080	21.16	1087.93	17.62	-	-	1352.09	30.47	4392	15.70	2324.61	10.69	-	-	2889.04	20.07
S. gigantea	-	-	-	-	14	1.84	-	-	-	-	-	-	5	0.13	-	-
M. nasuta	-	-	-	-	25	11.20	-	-	-	-	-	-	88	4.79	-	-
Tresus sp.	-	-	-	-	23	4.22	-	-	-	-	-	-	27	0.84	-	-
P. staminea	36	0.38	25.47	0.40	1	0.53	15.54	0.34	27	0.38	23.86	0.07	2	0.06	14.55	0.06
O. lurida	46	0.52	58.64	1.25	3	1.19	17.41	0.51	87	0.34	69.72	0.23	9	0.33	20.36	0.10
N. lamellosa	461	4.52	372.15	6.11	40	7.64	48.21	1.02	253	1.01	249.32	1.31	30	1.21	29.74	0.24
Balanomorpha	4	0.03	2.51	0.20	-	-	-	-	56	0.17	47.05	0.74	-	-	-	-
C. productus or *M. magister*	0	0.00	0	0.00	-	-	0	0	12	0.10	3.33	0.04	-	-	5.00	0.09
Total	10540	100.0	5484.69	100.0	321	100.0	4683.65	100.0	26280	100.0	15631.29	100.0	1297	100.0	11429.93	100.0

* *M. nasuta*, *S. gigantea*, and *Tresus* sp. are grouped in these quantification methods because they could not be distinguished without the presence of NREs.

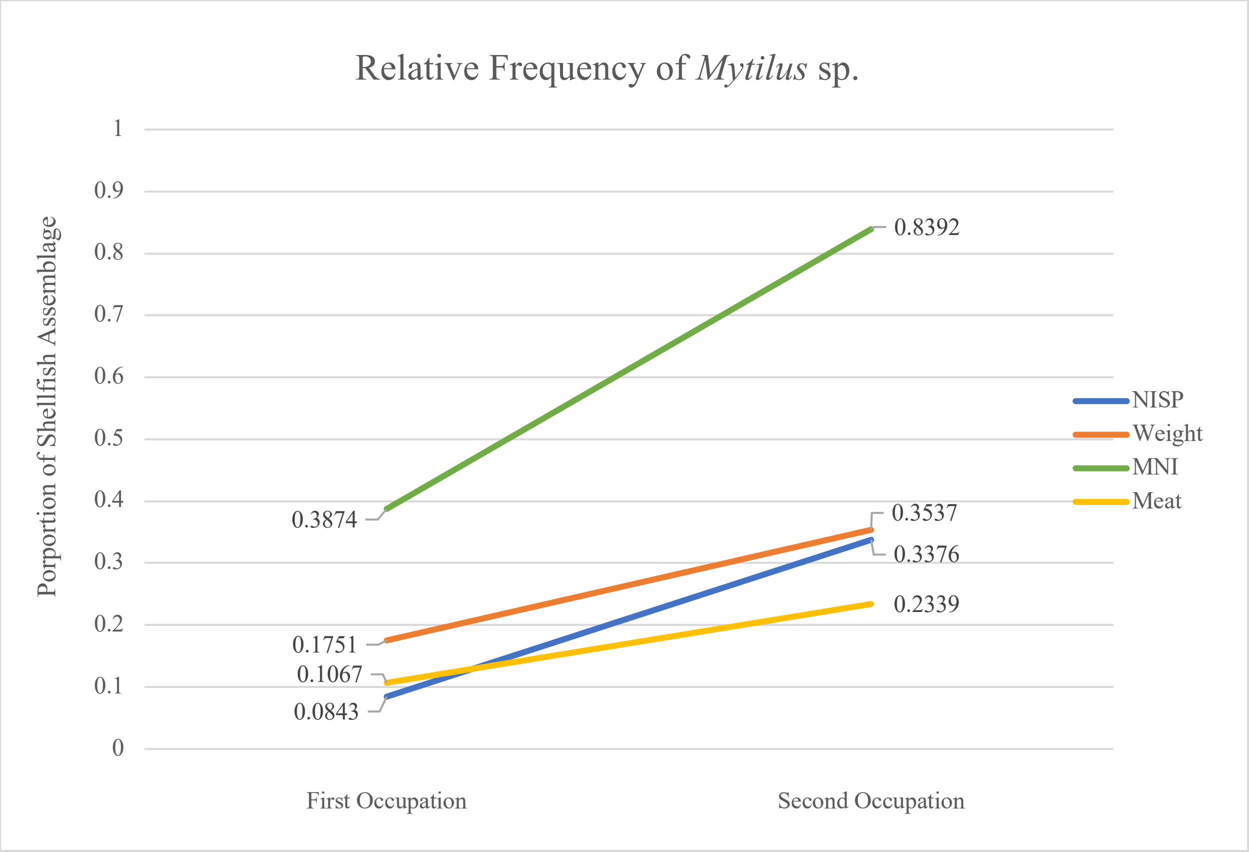


Figure 6.3 Change in relative frequency of *Mytilus* sp. according to varying quantification techniques

Table 6.23 Rank order of abundance of shellfish taxa by occupation

	First Occupation				***Second Occupation***			
Taxon	*NISP*	*Weight*	*MNI*	*Meat*	*NISP*	*Weight*	*MNI*	*Meat*
Mytilus sp.	3	3	1	3	2	2	1	2
C. nuttallii	1	1	2	1	1	1	2	1
“Clams”*	2	2	-	2	3	3	-	3
S. gigantea	-	-	6	-	-	-	7	-
M. nasuta	-	-	3	-	-	-	3	-
Tresus sp.	-	-	5	-	-	-	5	-
P. staminea	6	6	8	6	5	7	8	6
O. lurida	5	5	7	5	6	6	6	5
N. lamellosa	4	4	4	4	4	4	4	4
Balanomorpha	7	7	-	-	7	5	-	-
C. productus or *M. magister*	-	-	-	-	8	8	-	7

* *M. nasuta*, *S. gigantea*, and *Tresus* sp. are grouped in these quantification methods because they could not be distinguished without the presence of NREs.

The difference in the relative abundance of shellfish taxa between the first and second occupation by all quantification methods is very highly significant (Table 6.24). However, the effect size (φ) is moderate to weak. That is, while the χ^2 test suggests there is a non-random change in the relative abundance of shellfish taxa between occupations, it is not likely a very substantial change. The strongest effect size is found when quantifying by MNI (φ = 0.33). Conversely, the weakest effect size is found when quantifying by meat yield (φ = 0.15). The adjusted residuals corroborate the descriptive statistics: that the change in relative abundance is greatest for mussels than for any other shellfish taxa, regardless of the quantification method (Table 6.25). This indicates that the change in the relative abundance of mussel, and to a lesser extent the change in the relative abundance of cockle, clams, or frilled dogwinkle (depending on quantification method) is driving the significant χ^2 result. The cumulative distribution functions of the first and second occupations, as measured by a two-sided Smirnov test, however, is not significant by any quantification method. Thus, there is an underlying similarity in the structure of the distributions of these two faunal assemblages independent of the species involved.

Table 6.24 Inferential statistical analyses of the shell assemblage between occupations

	Chi-square			***Smirnov***	
Quantification Method	χ^2	*p*	φ	*T'*	*p*
NISP	4625.562	<0.0001	0.24	0.375	>0.20
Weight	2758.706	<0.0001	0.20	0.143	>0.20
MNI	992.003	<0.0001	0.33	0.375	>0.20
Meat Yield	1058.700	<0.0001	0.15	0.429	>0.20

Table 6.25 Adjusted Residuals for Shellfish Taxa in the first and second occupation

	First Occupation				***Second Occupation***			
Taxon	*NISP*	*Weight*	*MNI*	*Meat*	*NISP*	*Weight*	*MNI*	*Meat*
Mytilus sp.	-61.89	-36.76	-29.82	-25.27	61.89	36.76	29.82	25.27
C. nuttallii	35.80	10.33	21.93	-1.55	-35.80	-10.33	-21.93	1.55
"Clams"[a]	16.25	20.71	-	20.44	-16.25	-20.71	-	-20.44
S. gigantea	-	-	8.53	-	-	-	-8.53	-
M. nasuta	-	-	7.52	-	-	-	-7.52	-
Tresus sp.	-	-	8.40	-	-	-	-8.40	-
P. staminea	10.25	9.38	3.87	6.91	-10.25	-9.38	-3.87[b]	-6.91
O. lurida	3.46	15.76	3.55	8.01	-3.46	-15.76	-3.55[b]	-8.01
N. lamellosa	30.68	32.53	12.89	10.47	-30.68	-32.53	-12.89	-10.47
Balanomorpha	-4.19	-6.50	-	-	4.19	6.50	-	-
C. productus or *M. magister*	-3.90	-2.08	-	-2.66	3.90	2.08	-	2.66

[a] *M. nasuta*, *S. gigantea*, and *Tresus* sp. are grouped in these quantification methods because they could not be distinguished without the presence of NREs.

Macrobotanicial Analysis

Methods

Nine one-liter bulk samples were removed from cultural layers during targeted excavations at Nukaunlth. These samples were then separated into light and heavy fractions using the bucket flotation technique (Pearsall 2015). Nine light fraction samples were submitted to Archaeological Macrofloral Identification in Olympia, WA for microscopy and macrobotanical identification of seeds within the samples. Charcoal was recovered in these samples but excluded from this analysis.

Each subsample was subjected to microscopy under a Swift M29TZ stereoscopic microscope at 10x-30x magnification. All identified fragments or seeds were counted and separated into glass vials. Botanical identification was achieved by visual means only, using seed or plant attributes; seed attributes were assigned by presence/absence within 25 categories listed within the five groups of size, shape, texture, color, and bract/wing. Comparison and confirmation were made using the digital seed library template in *Pacific Northwest Paleobotany* (Diedrich 2009), the laboratory's comparative seed/plant collection, as well as published and online native plant references (Delorit 1970; Gilkey and Dennis 1967; Pojar et al. 1994; Royer and Dickinson 2004; Young and Young 1992).

Descriptive Summary

Claytonia perfoliata – Miner's lettuce

Materials: 1 charred seed

Remarks: *C. perfoliata*, also known as miner's lettuce, Indian lettuce, spring beauty, or winter purslane, is an annual, herbaceous plant that is native to western North and Central America (USDA and NRCS 2020). It is common in springtime in cool, damp environments. It is an edible plant, and the leaves are similar to spinach in taste. Oral histories for Willapa Bay say that *C. perfoliata* was eaten raw, similar to other leafy salad greens.

Schoenoplectus americanus – Chairmaker's bulrush

Materials: 4 charred seeds

Remarks: *S. americanus,* also known as bulrush, tule, or sweetgrass, is a member of the sedge family. It grows in coastal and wetland habitats and is native to most of North America (USDA and NRCS 2020). This plant is not edible. Its fibrous leaves were used for making baskets, mats, and clothing among many Northwest Coast groups (Turner and Bell 1971, 1973). The leaves were collected in late summer and dried before use. In Willapa Bay, it was often combined with cattail and eelgrass and was primarily used as the inner material of wrapped twine baskets (Kristen Torset, personal communication).

Arctostaphylos uva-ursi – bearberry or kinnikinnick

Materials: 1 charred seed

Remarks: *A. uva-ursi*, also known as bearberry or kinnikinnick, is a dwarf shrub native to most of North America. It grows well on open dunes and in the partial shade of forests (USDA and NRCS 2020). Both its fruit and leaves are known to have uses among Northwest Coast Indigenous peoples. The Lower Chehalis peoples considered the berries to be too seedy and without taste, however, the berries were regularly eaten by Lower Chinookan peoples, either fresh, dried, or with oil (Gunther 1945:44; Swan 1857:88). The leaves were dried and used as smoking material throughout the Northwest (Turner and Bell 1971, 1973). The leaves of the plant act as a slight narcotic when smoked like tobacco (Gunther 1945; Swan 1857).

Urtica dioica – Stinging Nettle

Materials: 1 uncharred seed

Remarks: *U. dioica* is a perennial, herbaceous plant native to almost all of North America. It prefers wet, shady environments and often forms dense colonies (USDA and NRCS 2020). It is known to have numerous uses for the production of technology, medicine, and food among Northwest Coast Indigenous groups. Most Northwest Coast communities use nettle fibers to make twine, fishing nets, and ropes (Gunther 1945:28; Turner and Bell 1971, 1973). Yellow dye was created by a mixture of nettle roots and another shrub obtained from northern groups (Swan 1857:163). *U. dioica* has medicinal properties and was used by Northwest Coast communities in a variety of ways to treat ailments, from rheumatism to childbirth (Gunther 1945:28). Limited ethnographic records exist of specific uses of stinging nettle in Willapa Bay, however, Swan notes that soreness was treated with a compress of pounded or boiled nettle roots (1857:178). Local oral histories state that nettle was rubbed on the skin as a stimulant to keep hunters and travelers awake through the night (Mechele Johnson, personal communication). Young nettle stems and leaves were eaten like spinach or used to make a soup (Earl Davis, personal communication).

Five of the samples contained disarticulated insect remains; four of these also contained uncharred partial and whole seeds. The fifth, subsample number 883 contained one western redcedar (*Thuja plicata*) cone fragment. Some of the seeds found in subsamples 878 and 880 were non-native spear thistle (*Cirsium vulgare*) and black mustard (*Brassica nigra*), weed seeds generally associated with postcontact disturbance. As the uncharred seeds are associated with insect remains in these subsamples, they are probably related to present-day surface seasonal deposits and their vertical provenience is likely due to bioturbation.

Results

Only two subsamples contained charred seeds. These seeds were from the plants *Arctostaphylos uva-ursi* (bearberry)*, Claytonia* sp. (miner's lettuce), and *Schoenoplectus americanus* (American bulrush). Still, only one each of *Claytonia* and *Arctostaphylos,* and four *Scirpus* were located within the subsamples. One intact uncharred *Urtica dioica* (stinging nettle) was also identified. Without a doubt, more plants than those recovered from these samples were used by those living at Nukaunlth. However, despite the limited number of charred samples preserved at Nukaunlth, some insights can be gained from the presence of these four plant species. The two subsamples that contained charred seeds were taken from the house floors (one from the first occupation, and one from the second), indicating the use of these plants in household activities. Ethnographic and oral histories confirm that Chinookan and Lower Chehalis peoples routinely utilized all four species for food, technology, and/or medicine. Furthermore, the presence of these species, all commonly found in the region today, may suggest that the local ecology was generally similar at the time of site use as it is today.

Discussion and Conclusion

Reconstructing Diet

To lend insight into the ancestral foodways at Nukaunlth, the relative abundance of major foods represented in the faunal assemblage was compared according to differing quantification methods: NISP, weight, and estimated meat yields. These methods are used in tandem, as they each have their drawbacks, but taken together illustrate some broad trends. In the first part of this discussion, I examine the overall site assemblage grouped by broad faunal class and by "major food taxa". "Major food" is a categorization method that treats shellfish taxa separately, while grouping other non-shellfish taxa into their respective broad faunal classes. I use this categorization method because shellfish make up such a large portion of the faunal assemblage that it is often useful to investigate shellfish taxa in relation to other broad faunal classes. Table 6.26 presents the abundances in percentages of the major food taxa (those contributing more than 1% of the total faunal assemblage by any of the three quantification methods). Table 6.27 and Table 6.28 simplifies these data into relative rank order of major food and broad faunal classes. In the second part of this discussion, I compare assemblages by occupation, noting shifts in resource use between the first and second occupation. Throughout my textual descriptions of the assemblage, I often start by examining assemblage using the NISP and weight quantification methods. I then proceed to discuss estimated meat yields. In most cases, I understand estimated meat yields to give the most accurate translation from archaeological record to dietary contribution.

Quantifying the faunal assemblage using different methods produces differing results; however, some trends hold. Across all three measures—NISP, weight, and estimated meat yields—shellfish, when aggregated into a broad faunal class, makes up the largest portion of the faunal assemblage and likely represents the most prevalent animal food source (Table 6.28). When quantified using NISP and weight, shellfish comprise 92-98% of the faunal assemblage. Cockles alone make up the bulk of the faunal assemblage by these methods, representing between 47% and 51% of the overall assemblage when quantified using NISP and weight.

Estimates of meat yields suggest that NISP and weight measurements exaggerate the edible foods obtained from shellfish compared to other faunal food sources. Estimating meat yields suggests that shellfish as a broad faunal class contributed approximately 63% of the animal foodstuffs as it is reflected in the archaeological record. Using this quantification method, marine mammal contributed the second most edible food to the diet of those living at Nukaunlth, approximately 20%. Breaking down marine mammals into taxa, whale was the bulk of the marine mammal specimens (96% of specimens identified to taxon). This, in turn, suggests that whale specifically contributed the bulk of edible meat in this broad faunal class. However, cockles still provide the highest meat yields.

Table 6.26 Relative frequency of major foods (> 1%) at Nukaunlth

Taxon	***% NISP***	***% Weight***	***% Meat Yield***
Shellfish			
C. nuttallii – cockle	47.44	51.41	35.31
Mytilus sp. – mussel	26.76	31.92	13.72
S. gigantea, M. nasuta, Tresus sp. – clams	15.29	11.57	13.34
N. lamellosa – frilled dogwinkle	1.50	2.03	<1.00
Total	91.96	98.24	62.93
Vertebrates			
Fish	5.28	<1.00	9.84
Marine Mammal	1.27	<1.00	19.87
Terrestrial Mammal	1.20	<1.00	3.53
Avian	<1.00	<1.00	3.83

Table 6.27 Rank order of abundance of major foods* by quantification method

Taxon	***NISP***	***Weight***	***Meat Yield***
Shellfish			
C. nuttallii – cockle	1	1	1
Mytilus sp. – mussel	2	2	3
S. gigantea, M. nasuta, Tresus sp. – clams	3	3	4
N. lamellosa – frilled dogwinkle	5	4	-
Vertebrates			
Fish	4	-	5
Marine Mammal	6	-	2
Terrestrial Mammal	7	-	7
Avian	-	-	6

* Faunal classes with relative frequency <1% are not included in rank order

Table 6.28 Rank order of abundance of broad faunal classes* by quantification method

Taxon	***NISP***	***Weight***	***Meat Yield***
Shellfish	1	1	1
Fish	2	-	3
Marine Mammal	3	-	2
Terrestrial Mammal	4	-	5
Avian	-	-	4

* Faunal classes with relative frequency <1% are not included in rank order

Comparing the food taxa by occupation using NISP and weight indicates that shellfish overwhelming dominates the assemblage in both occupations and increases slightly in the second occupation (Table 6.29, Figure 6.4). In the second occupation, there is a rise in the use of mussel and a corresponding decrease in clams and cockles. The increase of mussel in the second occupation assemblage produces a jump in rank order for this species from the third most abundant in the first occupation, to second most abundant in the second occupation, and a corresponding rank decrease in clams (Table 6.30). Despite the slight decrease in cockle between occupations, cockles are still the highest in the rank order of abundance in both periods. Treating each shellfish species separately, shellfish taxa are consistently ranked higher than other broad faunal classes (Table 6.29 & Table 6.30). When aggregating shellfish and looking at the rank order of abundance of broad faunal classes, fish is ranked second in both occupations when measuring by NISP (Table 6.31). There is a change in rank order of marine mammal and terrestrial mammal when measuring by NISP, however, it should be noted that these faunal classes represent small portions of the overall faunal assemblage by this measure. When measuring by weight, no faunal class besides shellfish makes up more than 1% of the assemblage.

As both NISP and weight likely overestimate the degree to which shellfish contributed to the foodways of those living at Nukaunlth, meat yield estimates may paint a more accurate picture of diachronic changes to diet. Meat yield estimates still suggest that shellfish, specifically cockle, contributed the most edible meat to the foodways of those at Nukaunlth, albeit a considerably smaller share than NISP and weight suggests (Table 6.29). Meat yield estimates also suggest greater importance of the other broad faunal classes. In the first occupation, cockles, clams, and fish are the three most abundant food taxa, respectively (Table

6.30). In the second occupation, cockles, marine mammals and mussels are the three most abundant food taxa, respectively. While the estimated meat yields of cockles decrease slightly in the second occupation, meat yield estimates show a rise in the use of marine mammals during this occupation, making up 11% of the first occupation assemblage and 22% of second occupation faunal assemblage. Likewise, the same increase in mussel seen in NISP and weight is also seen in meat yield estimates. When aggregating shellfish and looking at the rank order of abundance of broad faunal classes, shellfish is still the top-ranked faunal class in terms of estimated meat yields (Table 6.31). However, the increase in marine mammals in the second occupation results in a shift in rank order, rising from third in the first occupation (following fish) to second in the second occupation.

In either occupation and by all quantification methods, marine resources were more commonly recovered from Nukaunlth than avian or terrestrial mammal specimens. Avian and terrestrial mammal specimens combined comprise at most 9% of the faunal assemblage from the earlier occupation, and at most 7% of the faunal assemblage from the second occupation.

Table 6.29 Relative frequency of major foods (> 1%) at Nukaunlth by occupation

	First Occupation			*Second Occupation*		
Taxon	*% NISP*	*% Weight*	*% Meat Yield*	*% NISP*	*% Weight*	*% Meat Yield*
Shellfish						
C. nuttallii – cockle	57.43	55.68	36.42	45.15	50.60	35.09
Mytilus sp. – mussel	7.45	17.13	6.82	31.19	34.72	14.64
S. gigantea, M. nasuta, *Tresus* sp. – clams	18.70	17.24	19.47	14.51	10.49	12.56
O. lurida – native/Olympia oyster	<1.00	1.22	<1.00	<1.00	<1.00	<1.00
N. lamellosa – frilled dogwinkle	3.99	5.98	<1.00	<1.00	1.29	<1.00
Total	88.97	98.10	64.10	92.65	98.27	62.70
Vertebrates						
Fish	7.08	<1.00	15.99	4.86	<1.00	8.61
Marine Mammal	2.31	<1.00	10.78	1.04	<1.00	21.69
Terrestrial Mammal	1.39	<1.00	8.06	1.15	<1.00	2.62
Avian	<1.00	<1.00	1.07	<1.00	<1.00	4.38

Table 6.30 Rank order of abundance of major foods* by occupation

	First Occupation			*Second Occupation*		
Taxon	*NISP*	*Weight*	*Meat Yield*	*NISP*	*Weight*	*Meat Yield*
Shellfish						
C. nuttallii – cockle	1	1	1	1	1	1
Mytilus sp. – mussel	3	3	6	2	2	3
S. gigantea, M. nasuta, *Tresus* sp. – clams	2	2	2	3	3	4
O. lurida – native/Olympia oyster	-	5	-	-	-	-
N. lamellosa – frilled dogwinkle	5	4	-	-	4	-
Vertebrates						
Fish	4	-	3	4	-	5
Marine Mammal	6	-	4	6	-	2
Terrestrial Mammal	7	-	5	5	-	7
Avian	-	-	7	-	-	6

* Faunal classes and/or taxa with relative frequency <1% are not included in rank order

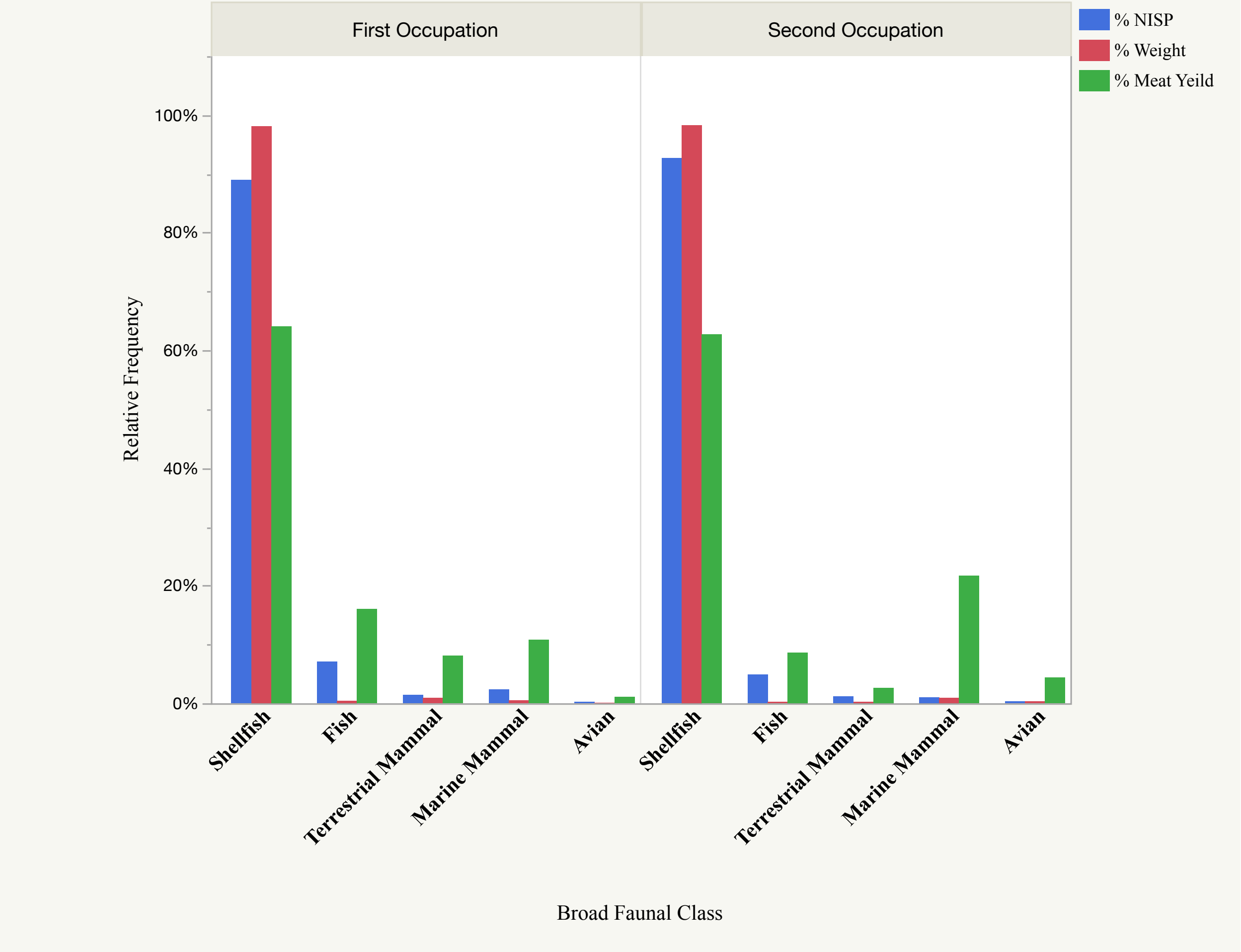


Figure 6.4 Relative frequency of broad faunal classes at Nukaunlth by occupation

Table 6.31 Rank order of abundance of broad faunal classes* by occupation

	First Occupation			***Second Occupation***		
Taxon	*NISP*	*Weight*	*Meat Yield*	*NISP*	*Weight*	*Meat Yield*
Shellfish	1	1	1	1	1	1
Fish	2	-	2	2	-	3
Marine Mammal	3	-	3	4	-	2
Terrestrial Mammal	4	-	4	3	-	5
Avian	-	-	5	-	-	4

* Faunal classes with relative frequency <1% are not included in rank order

Like the descriptive statistics above, inferential statistics were used to investigate changes in the faunal assemblage between occupations by several measures: NISP, weight, and estimated meat yield. Similarly, the faunal assemblages were categorized in two different ways: as major foods and broad faunal classes.

The difference in the relative abundance of major foods between the first and second occupation by all quantification methods is very highly significant (Table 6.32). However, the effect size (φ) is fairly weak. That is, while the χ^2 test suggests there is a non-random change in the relative abundance of major foods between occupations, it is unlikely that this is a substantial practical change. The difference in cumulative distribution functions of major foods in the first occupation and second occupations, as measured by a two-sided Smirnov test, is not significant by any quantification method. Thus, there is an underlying similarity in the structure of the distributions of these two faunal assemblages independent of the species involved.

By and large, the inferential statistics show the same outcome when comparing broad faunal classes between occupations. Like when comparing major foods and by all quantification methods, the χ^2 test comparing broad faunal classes is highly significant and suggests a non-random change between occupations (Table 6.32). The effect size, however, is much weaker than is suggested when comparing major foods. This indicates that what little change is occurring between occupations in the faunal assemblage is likely more related to changes *within* broad faunal classes (most likely changes in the relative abundance of shellfish species) than to changes *between* broad faunal classes. Likewise, the difference in cumulative distribution functions of broad faunal classes in the first occupation and second occupations, as measured by a two-sided Smirnov test, is not significant by any quantification method. Thus, there is an underlying similarity in the structure of the distributions of these two faunal assemblages independent of the species involved when categorized by both major food and broad faunal class.

Table 6.32 Inferential statistical analyses of faunal assemblage between occupations

Major Food					
	Chi-square			***Smirnov***	
Quantification Method	χ^2	p	φ	T'	p
NISP	4878.978	<0.0001	0.231	0.295	>0.20
Weight	2919.451	<0.0001	0.203	0.353	>0.20
Estimated Meat Yield	3441.783	<0.0001	0.215	0.417	0.10 < p < 0.20

Broad Faunal Classes					
	Chi-square			***Smirnov***	
Quantification Method	χ^2	p	φ	T'	p
NISP	335.526	<0.0001	0.061	0.400	>0.20
Weight	153.691	<0.0001	0.047	0.800	= 0.20
Meat Yield	23359.996	<0.0001	0.178	0.600	>0.20

Here I've used multiple quantification methods, categorization techniques, and inferential statistics with the recognition that each has its drawbacks. I use them in tandem in the hope that, despite their drawbacks, cumulatively they may point towards some real insights into the faunal assemblage of Nukaunlth as it relates to Chinookan and Lower Chehalis ancestral foodways. By and large, some trends emerge even when using these various techniques. The archaeological data presented here suggest that shellfish (cockles, mussels, and various species of clam in particular), marine mammals (specifically whale), and fish (salmon, flounder, and sturgeon, most notably) played major roles in Lower Chehalis and Chinookan foodways at Nukaunlth. While there was a non-random change in the makeup of the faunal assemblages between occupations, it was likely a marginal change. That is, the faunal assemblages of both occupations are remarkably similar in the relative abundance of taxa and distribution. Likewise, the suite of taxa present in the faunal assemblage of one occupation is similar to the suite of taxa present in the other occupation and suggests that those living at Nukaunlth during the earlier occupation were likely utilizing the same species as those who lived at Nukaunlth in the later occupation. Changes in the faunal assemblage that did occur between the first and second occupation likely relate to an increase in the relative abundance of mussel (*Mytilus* sp.), salmon (*Oncorhynchus* spp.),[39] and marine mammal, and a corresponding decrease in the relative abundance of cockle, various species of clams, and flounder.

By all quantification methods, shellfish dominate the faunal assemblage. While NISP and weight measures of quantification undoubtedly overestimate the contribution of shellfish to the diets of those living at Nukaunlth, meat yield estimates still suggest that shellfish made up the largest portion of edible food reflected by the archaeological record. Overall, the faunal assemblage obtained from Nukaunlth suggests that between 93% and 99% of the animal food sources for those living at this ancestral village came from the marine/estuarine environment.

It is important to note that my attempts to reconstruct the dietary patterns of those who lived at Nukaunlth are severely limited when addressing the incorporation of plant foods. While the macrobotanical analysis described above provides a small window into plant use at this village, preservation bias limits the number of botanical remains recovered and the small sample size reduces interpretations to presence/absence data. Therefore, I cannot estimate the portion of

---

[39] While the salmon increased in the second occupation relative to other fish species, this does suggest an overall increase in the use of fish more broadly in the second occupation. In fact, the use of fish appears to go down, albeit not significantly.

the diet made up of plant foods, and my dietary reconstruction is limited to animal foodstuffs. We know from ethnographic records, oral histories, and archaeological investigations from elsewhere in the region, however, that Lower Chehalis and Chinookan peoples used a wide variety of plant foods (see Chapter 2) and this is likely the case at Nukaunlth as well. Ethnobotanists and archaeologists have demonstrated that some plant resources, most notably camas and wapato, were cultural keystone resources and were actively managed, cultivated, and intensified elsewhere on the Northwest Coast (Darby 1996, 2005; Lyons and Ritchie 2017). I have found no study that estimates the portion of the diet made up of plant foods for any Northwest Coast group, even at sites where the preservation of botanical remains was extraordinarily good. However, where such active management of plant resources occurred, they could have contributed significantly to the diet. Further excavations at Nukaunlth may provide more evidence of the plants utilized at the village and enrich our understanding of this likely important part of Lower Chehalis and Chinookan diet in Willapa Bay.

A Brief Exploration of Nutritional Contributions

While it is not possible to delineate the specific dietary habits or health of those living at Nukaunlth in the past, it is nonetheless important to briefly discuss the information gleaned from the faunal and macrobotanical analyses through the lens of nutritional ecology. Nutritional ecology seeks to understand the "relationship between essential nutrient intake and its effects on overall human health" (Hockett and Haws 2003:211). Investigating the faunal and botanical assemblages at Nukaunlth through this lens produces a more comprehensive understanding of how local marine resources used by those at Nukaunlth may have contributed to the health of the community. This, in turn, may help the Shoalwater and Chinook Nation in their efforts to improve dietary health through revitalizing traditional foodways.

Investigating the nutrient content of the most commonly represented animal foods in the Nukaunlth assemblages suggests that each major food may have provided essential vitamins, minerals, and calories that contributed to human health, growth, and development (Table 6.33). The nutritional content of animal foods can vary seasonally, by life-stage, and by part. Cooking practices may also alter the vitamin, mineral, and caloric make-up of the food. Therefore, the nutritional contributions discussed here and stated in Table 6.33 are, of course, estimates of what they might have been for those living at Nukaunlth.

While shellfish provide fewer calories and less fat and protein than fish and marine mammals, they likely provided key minerals and vitamins. Mussels and clams contain higher concentrations of manganese, selenium, riboflavin, thiamin, vitamin B-12, folate, and vitamin C than the other commonly found animal foods at Nukaunlth. Information regarding potassium, manganese, selenium, vitamin B-12, folate, and vitamin C content of cockles could not be found. Cockles may also be a good source of these vitamins and minerals, but this could not be confirmed. Cockles contain less iron than whale meat. However, they were likely also a good source of iron when whale was not available, containing well over twenty times the amount of iron than is found in salmon (Health Canada 2015). Likewise, shellfish ranks second in concentration of copper and zinc behind whale and may have been a good source of these minerals when whale was hard to come by. Shellfish also contain more carbohydrates than any other animal food (Hockett and Haws 2003:212). While they contain less than most plant foods, they could have been critical during winter months when fresh plant foods were scarce and stored plant foods such as dried berries were running low.

Whale meat may have provided key protein content, as well as iron and zinc. Whale blubber is rich in calories, fat, and monounsaturated and polyunsaturated fatty acids. In particular, whale blubber contains very high concentrations of omega-3 fatty acids. Some omega-3 fatty acids are important in the treatment and prevention of many diseases, including elevated blood pressure and cholesterol, heart disease, and diabetes (Cordain et al. 2002; Moss 2016; Sidhu 2003), and appropriate omega-3 fatty acid levels are important for healthy pregnancies and proper neonatal development (Reynolds, III et al. 2009). Salmon and sturgeon may have been sufficient sources of protein and omega-3 fatty acids, particularly when marine mammal meat was unavailable. Likewise, salmon is rich in calcium, potassium, niacin, and vitamin B-6 whereas sturgeon would have added magnesium and retinol to the diet.

Undoubtedly, the plant foods consumed at Nukaunlth provided several key nutrients that animal foods either lacked or generally provided less of. Data on the essential nutrients of the few plant foods recovered at Nukaunlth was unavailable in all cases except stinging nettle. Thus, I am limited in what I can say regarding the specific essential nutrients provided by these foods. Likewise, there were likely many other plant foods consumed at Nukaunlth that did not survive in the archaeological record. Stinging nettle, in particular, contains high concentrations of calcium (10 times that of salmon), magnesium, beta carotene, and vitamin K. In general, plant foods provide essential carbohydrates that most animal food lack. Plant foods are also rich in various carotenoids, vitamin E, and vitamin C (Hockett and Haws 2003:212) and would have also provided a critical source of fiber instrumental in metabolism and digestion (Kaczmarczyk et al. 2012).

In sum, marine resources—shellfish, marine mammals, and fish—dominate the faunal assemblage at Nukaunlth and were likely important parts of Lower Chehalis and Chinookan diet at this village. This brief examination of the nutritional contributions of these foods suggests that each of these resources, shellfish included, provided different essential nutrients to their diet, cumulatively affecting human health, growth, and development.

Shellfish is often assumed by archaeologists worldwide to be a marginal, secondary, or starvation resource for human foragers (e.g., Broughton and O'Connell 1999; Fagan 2001; Osborn 1977; Renfrew and Bahn 1996). Shellfish are a poor source of calories when compared to some plant, terrestrial, and/or other marine animal foods (Erlandson 1988), and it has been argued that the investment required to obtain shellfish is not worth the economic return (Osborn 1977). And archaeological studies of Northwest Coast subsistence systems have emphasized salmon as the key resource that dominated the diet. The idea that ownership of salmon fishing localities, storage, and systems of distribution were essential for the development and persistence of durable inequalities has historically dominated the subsistence model (Hayden 1992; Hewes 1938; Maschner 1998; Matson 1985; Schalk 1977), so much so that it inspired the neologism "salmonopia"—an inability to see anything but salmon as relevant to Northwest Coast livelihoods (Monks 1987).

Salmon is often considered "the most important single resource in the culture area as a whole" (Mitchell and Donald 1988:301) because it "can be harvested in great numbers, provision large populations with a substantial supply of protein, and arrive in predictable runs" (Tushingham and Bettinger 2013:528), and assumed to be a staple in the diet of hunter-gatherers to the extent that its numbers would allow. However, the seasonality and duration of salmon migration impose scheduling constraints on harvesting practices (Tushingham and Bettinger

2013). Processing salmon entails further scheduling and preservation constraints—salmon must be processed quickly due to its high fat content and each salmon species must be processed and preserved differently.

In contrast, shellfish were often "a predictable and readily available meat source that could be gathered by virtually all members of society" (Erlandson 2001:294). Despite containing fewer calories per gram than many other food sources, shellfish can be gathered in abundance fairly quickly, provide enough daily protein to sustain an individual, and are easily dried and stored (Erlandson 1988). Furthermore, analyzing the nutritional content of shellfish as I have done here suggests that they are a source of key vitamins and minerals that may have been difficult to obtain from other food sources. It is no wonder then, that for Lower Chehalis and Chinook communities in Willapa Bay "when the tide goes out, the table is set" (Earl Davis, personal communication).

Table 6.33 Nutritional comparison of animal foods found at Nukaunlth per 100g portion
Bolded numbers indicate the highest proportion of this nutrient compared to other animal foods*

	Shellfish			***Fish***			***Whale***	
Essential Nutrient	*Cockle*	*Mussel*	*Clam*[a]	*Salmon*[b]	*Flounder*	*Sturgeon*[c]	*Meat*[d]	*Blubber*[e]
Caloric								
Energy (kcal)	79	86	86	120	70	105	110	**470**
Fat (g)	0.70	2.24	0.96	3.70	1.93	4.04	0.5	**46.1**
Protein (g)	13.5	11.90	14.67	23.10	12.41	16.14	**26.5**	12.6
Carbs (g)	**4.70**	3.69	3.57	0	0	0	0	1.20
Minerals (mg)								
Ca	30	26	39	**44**	21	13	7	1.97
Fe	16.20	3.95	1.62	0.66	0.18	0.70	**25.9**	0.32
Mg	-	34	19	31	18	**35**	22	0.75
K	-	320	46	**378**	160	284	283	14.5
Na	-	286	**601**	94	296	54	78	24.8
Zn	-	1.60	0.51	0.58	0.32	0.42	**2.76**	0.22
Cu	-	0.09	0.05	0.06	0.02	0.04	0.11	**0.99**
Mn	-	**3.40**	0.09	0.015	0.01	0.03	0.05	-
Se (µg)	-	**44.8**	30.6	36.5	26.6	12.6	36.5	-
Vitamins (mg)								
Niacin	3.2	1.60	0.35	**15.40**	1.04	8.30	5.39	-
Riboflavin	0.2	**0.21**	0.04	0.11	0.02	0.07	0.18	-
Thiamin	0.01	**0.16**	0.02	0.08	0.02	0.07	0.01	-
Retinol (µg)	-	48	90	30	10	**210**	102	-
Vitamin B-6	-	0.05	0.01	**0.64**	0.10	0.20	0.05	-
Vitamin B-12 (µg)	-	**12.00**	11.28	3.25	1.13	2.20	2.59	-
Folate (µg)	-	**42**	5	3	5	15	4	-
Vitamin C	-	**8.0**	0	0	0	0	0	0.25
Fatty acids (g)								
saturated, total	-	0.43	0.19	0.94	0.44	0.92	0.09	**14.8**
monounsaturated, total	-	0.51	0.12	1.54	0.54	1.94	0.34	**38.7**
polyunsaturated, total	-	0.61	0.19	1.28	0.37	0.69	0.03	**18.9**
EPA (omega-3)	-	0.19	0.04	0.28	0.14	0.19	0.004	**6.14**
DPA (omega-3)	-	0.02	0.01	0.08	0.03	0.05	0.003	**1.03**
DHA (omega-3)	-	0.25	0.06	0.58	0.11	0.09	0.006	**1.40**

* All data are presented for raw foods
a: Species of clam not specified, labeled as "mixed species".
b: Based on chum, raw.
c: Species of sturgeon not specified, labeled as "mixed species".
d: Species of whale not specified.
e: Data on energy, fat, protein, and carbs based on gray whale. All other data based on Bowhead whale.

Sources: (Health Canada 2015; Kozlov et al. 2009; O'Hara et al. 2004; Reynolds, III et al. 2009)

Chapter 7 Chinookan & Lower Chehalis Subsistence Practices at Nukaunlth and Beyond

Introduction

With this research, the Shoalwater, Chinook Nation, and I sought to evaluate (1) the importance of marine resources among Chinookan and Lower Chehalis peoples living at Nukaunlth, and (2) the makeup of the larger subsistence system within which marine resource use was situated pre- and post-European contact. Analyses of faunal and botanical materials, as described in Chapter 6, get us partway in that evaluation. These analyses show that those living at this ancestral village utilized at least 29 different species of animals, and at least four species of plants. The data presented in Chapter 6 suggest that the majority of animal food resources, between 93% and 99% of those that remained in the archaeological record, were from the marine/estuarine environment. Given the sheer volume, shellfish (cockles, mussels, and various species of clam, in particular), marine mammals (predominantly whale), and fish (salmon, flounder, and sturgeon, most notably) likely played major roles in Lower Chehalis and Chinookan foodways at Nukaunlth. In analyzing the nutritional contribution of these food sources, I propose that each of these resources, shellfish included, provided different essential nutrients in the Lower Chehalis/Chinookan diet, cumulatively affecting human health, growth, and development.

However, by investigating the archaeofaunal and archaeobotanical remains, more can be gleaned about the subsistence practices of those at Nukaunlth beyond what is presented in Chapter 6. In this chapter, I relate the archaeological data presented in chapters 5 and 6 to the subsistence practices carried out at Nukaunlth and regionally. I do so by exploring three primary dimensions of subsistence: seasonality, procurement locales, and shellfish harvesting strategies. While these are by no means all the dimensions of subsistence for ancestral Lower Chehalis and Chinookan people, they are the dimensions that (1) are most represented by the archaeological data obtained from excavations at Nukaunlth and (2) best address the research questions, alternative explanations of midden composition, and initial expectations.

Seasonality helps archaeologists elucidate the annual rhythm of life for past communities. It lends insights into settlement patterns that may have changed, not just over centuries, but on a patterned yearly basis to make the most of seasonally abundant but spatially dispersed resources. And while seasonality explicates the *when* of everyday food systems, identifying procurement locales helps us grasp the *where*. Considering procurement locales assists in understanding the movements of populations to gather resources from specific environments to sustain communities. In that sense, it is often a necessary component to understanding both subsistence practices and settlement patterns. Furthermore, examining the strategies employed to obtain resources (i.e., the *how*) adds depth to our picture of daily subsistence practices. Most relevant to our work at Nukaunlth are shellfish harvesting methods. Northwest Coast scholars have shown that such strategies were often related to social organization, resource depression, and management practices (e.g., Cannon and Burchell 2009; Coupland et al. 2003; Wessen 1982).

After exploring the seasonality, procurement locales, and harvesting strategies embedded in the subsistence practices at Nukaunlth, I evaluate the alternative explanations of midden composition to inform our understanding of the importance of marine resources, particularly shellfish, among Lower Chehalis and Chinookan peoples in the past. I propose two alternative explanations: (1) that midden composition reflects the natural variability in shellfish species, indicating that shellfish were harvested opportunistically and with low levels of investment, or (2) that midden composition differs significantly from that expected under natural conditions and indicates selective and/or intensive harvesting. My initial expectations were that midden composition would differ significantly from that expected under natural conditions and that the abundant shellfish resources available in Willapa Bay were harvested intensively, incorporated heavily into Chinookan/Lower Chehalis diet, and played a similar role to other gathered foods. More specifically, I expected to see the management of specific shellfish resources and variable intensity of harvest across shellfish species.

As is often the case in research, I find that the results do not fall neatly into either alternative explanation nor do they entirely conform to my initial expectations. On the whole, midden composition faithfully tracks the natural spatial and temporal variability of shellfish (and other marine species) distribution conditioned by environmental characteristics. However, I find no evidence of opportunistic harvesting. Nor do I find evidence that shellfish were harvested intensively to the point of resource depression. Instead, preliminary analysis of growth-stage profiles of *C. nuttallii* suggests that populations of the top exploited shellfish species may have been selectively harvested and/or managed in some way by those living at Nukaunlth. It is reasonable to suggest that shellfish acted as a staple resource as they would have been easily accessible, available year-round, abundant close to the village, and possibly managed to prevent resource depletion.

I then discuss our understanding of the subsistence practices at Nukaunlth from a regional perspective by reviewing archaeological investigations and faunal analyses of three coastal Lower Chehalis and Chinookan sites. I summarize the methods used in these archaeological investigations, as well as site chronology and characteristics. I then provide a more thorough review of what is known of the faunal assemblages and subsistence practices of these sites. This information is then compared with Nukaunlth in terms of species diversity, key resources, and relative abundance of broad faunal classes. Common among all sites is an emphasis on locally available marine resources. I conclude by briefly discussing the cultural influence of shellfish as described by the cultural director of the Shoalwater. Although shellfish do not possess the same grandeur or require the same pageantry as salmon and other marine resources, they are embedded in Chinookan and Lower Chehalis culture as an everyday staple.

Subsistence Practices at Nukaunlth

Seasonality

Identifying seasonal resource use, and by proxy seasonal of site use, can help archaeologists reconstruct numerous aspects of past human behavior and investigate broad anthropological questions. Such inquiries most commonly focus on changing land-use and settlement patterns (e.g., Burchell, Cannon, et al. 2013; Burchell, Hallmann, et al. 2013; Cannon 1991, 1998; Eerkens et al. 2013; Jones et al. 2008), the development of sedentism and winter villages (e.g., Ames 1996; Bar-Yosef et al. 1998; Grier 2003; Grier et al. 2013), seasonal subsistence strategies (e.g., Hallmann et al. 2013; Ham 1983), and the relationship between mobility and complexity (e.g., Arnold 1996; Kelly 2013; Kennett and Kennett 2000). A complete overview of seasonality studies is beyond the scope of this dissertation. However, two commonly addressed and interrelated foci of these studies are relevant and worth summarizing here: settlement patterns, and seasonal subsistence systems.

Seasonality is half of settlement pattern reconstruction. It allows researchers to identify behavior on a landscape at a specific point in space at different times of the year. In aggregate, these data link time to space and smaller temporary camps to larger villages, producing a framework of larger seasonal-settlement systems and/or testing preexisting notions of seasonal rounds. Broadly speaking, the seasonal round thought to be characteristic of the Northwest Coast is one in which people moved around the landscape to various resource procurement locales in times of 'abundance' (i.e., spring and summer), gathering enough storable foods to last them through 'lean' times (i.e., late fall and winter) when they occupied winter villages (Ames 1981; Coupland et al. 2010). This notion of Northwest Coast seasonal rounds is highly generalized for the region and largely based on Euro-Americans' observations from the early contact period. As such, some scholars have questioned the spatial and temporal breadth of this pattern and found increasing evidence of more permanent year-round occupation of large villages throughout the Northwest Coast (e.g., at Namu: Coupland 1991, 1998; at Little Qualicum River West Site: Bernick and Wigen 1990; throughout the central coast of British Columbia: Burchell, Cannon, et al. 2013) as far south as the central coast of California (e.g., Jones et al. 2008). In particular, Jones and colleagues have suggested this was more often the case in coastal settings where shellfish populations were available year-round (2008).

In hunter-gatherer communities, subsistence strategies are often part and parcel of settlement patterns because people move around to obtain resources from local landscapes. To understand *when* they move is to understand an integral part of their subsistence system (Andrus and Crowe 2000; Coutts and Higham 1971; Godfrey 1988; Kennett and Voorhies 1996; Lieberman 1993). Furthermore, foodways are central to daily life. Eating is quite literally essential to human existence, and quotidian food practices, therefore, are "the ultimate habitus…forming the foundation of sociality" (Atalay and Hastorf 2006:283). Grasping how such practices changed with the season is one step closer to comprehending the inner workings of everyday life within a community.

Ethnohistorical records indicate that, at least in the contact era, Chinookan peoples in the Greater Lower Columbia practiced a settlement pattern similar to the generalized Northwest Coast seasonal round; populations remained sedentary in winter but were mobile the rest of the year to exploit the seasonal availability of desired resources (Boyd and Hajda 1987; Lewis and Clark 2002). Similarly, archaeological studies have corroborated this patterned yearly round subsistence activities and settlement patterns in the region (see Chapter 2 and Darby 2005; Butler and Martin 2013). However, both ethnohistorical records and archaeological studies of the region have focused primarily on communities and sites along the Columbia River and less attention has been given to communities in coastal areas where the temporal distribution of key resources may differ.

Archaeologists typically use one of three ways to measure seasonality: the remains of migratory animals and seasonal plants (e.g., Bovy 2005; Broughton 1995; Grier et al. 2013), fish otoliths (e.g., Andrews et al. 2003; Peacock et al. 2016), and sclerochronology and stable isotope analysis of marine shells (e.g., Burchell et al. 2014; Cannon and Burchell 2016; Culleton et al. 2009; Hallmann et al. 2013). Here, given the scope of this project and the assemblage available, I use the temporal distribution of species in Willapa Bay and nearby Grays Harbor and Columbia River in comparison to those found at Nukaunlth to assess seasonal subsistence practices and site use. Do the animal and plant resources found in the archaeological assemblage at Nukaunlth indicate a seasonal use of the village? Is there evidence of species-specific seasonal harvesting, fishing, or hunting practices? Fortunately, in-depth studies of commercially and recreationally valued west coast estuarine species exist (e.g., Lewis et al. 2019; Monaco et al. 1990), and many of the species in the Nukaunlth assemblage fit in this classification. Unfortunately, the majority of these studies pertain to modern populations, and some degree of conjecture about past populations is needed.

Below I describe what we know from modern ecological studies of the seasonal distribution of the marine, avian, and botanical resources found at Nukaunlth (summarized in Figure 7.1, Figure 7.2, & Figure 7.3). I discuss the frequency of these species within the Willapa Bay, Grays Harbor, and Columbia River estuaries using the relative abundance categories put forth by Monaco and colleagues. They are as follows:

- “Rare: species is present but not frequently encountered.
- Common: species is generally encountered but not in large numbers, does not imply an even distribution over a specific salinity zone.
- Abundant: species is often encountered in substantial numbers relative to other species.
- Highly abundant: species is numerically dominant relative to other species” (1990:4).

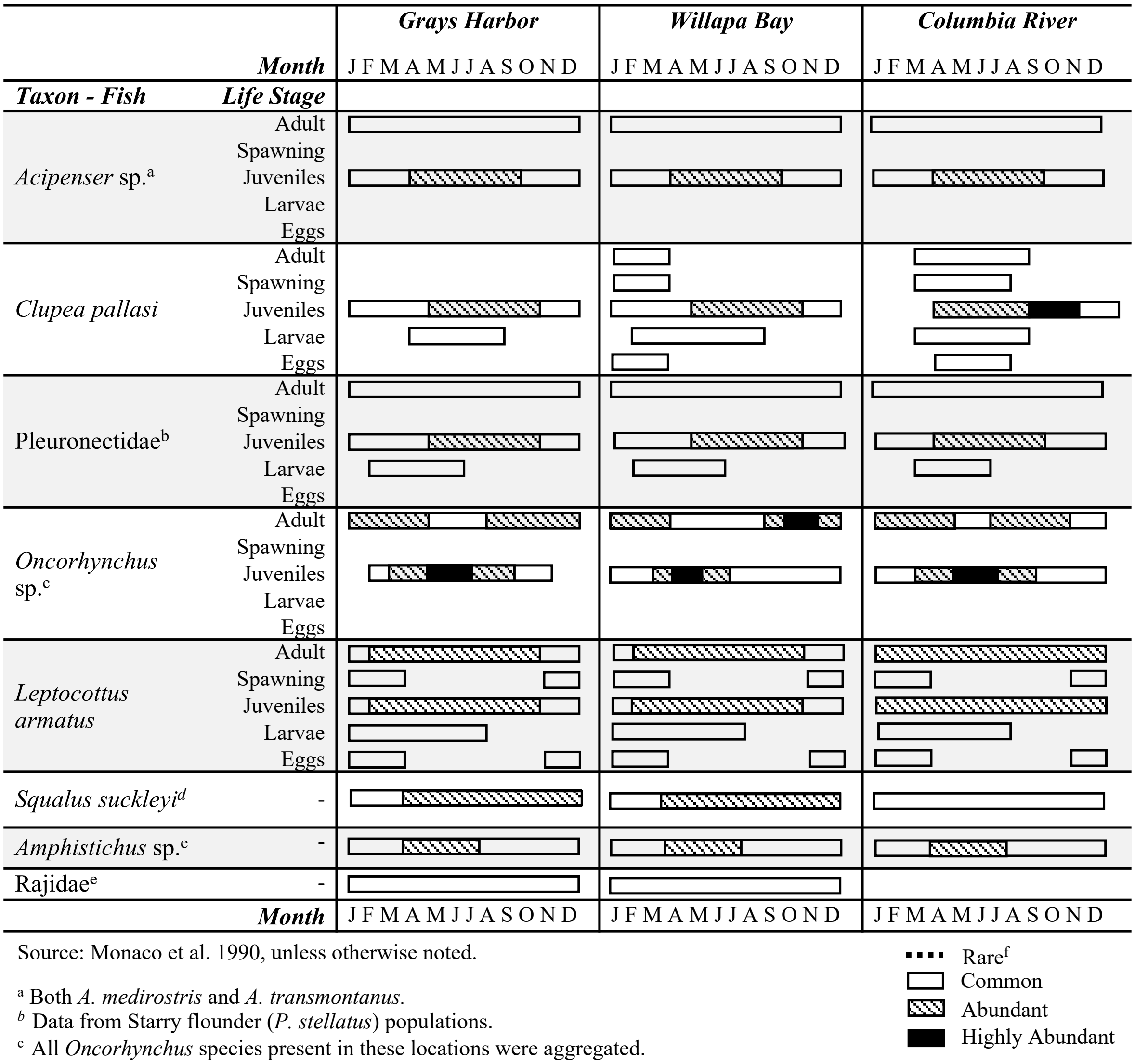
When available, I also present ethnographic and oral historical information on past seasonal use and distributions of these resources. I then combine these data to suggest the time of year that Lower Chehalis/Chinookan peoples most likely used Nukaunlth and any seasonal subsistence patterns.

Fish

Modern studies of temporal distributions of estuarine fish species suggest nearly all fish found at Nukaunlth are common in Willapa Bay, Grays Harbor, and the Columbia River estuary year-round (Figure 7.1). An exception to this is Rajidae (skates), which generally do not enter the Columbia River estuary. Given that most fish were available year-round, there is no definitive evidence from Nukaunlth that fishing activities were restricted to a particular season. However, some species are more prevalent in the area seasonally and those residing at Nukaunlth could have taken advantage of this periodic abundance.

Today in Willapa Bay, adult salmonids (*Oncorhynchus* sp.) are highly abundant during fall runs, and juvenile members of this species are highly abundant during early spring runs. Modern late spring/summer runs of salmon, on the other hand, are most productive on the Columbia River. Ethnographic records indicate the same seasonal pattern of *Oncorhynchus* sp. in Willapa Bay and on the Columbia River during the second half of the 19th century (Swan 1857:103, 135). Therefore, *Oncorhynchus* sp. fisheries likely occurred most prominently in the fall and spring in Willapa Bay and the summer on the Columbia River.

Other species of fish found at Nukaunlth—sturgeon, herring, flounder, sculpin, dogfish, and surfperch—are typically abundant in Willapa Bay and Grays Harbor during the summer months, excepting Rajidae (skates), which do not appear abundantly in the region in any season. Conversely, these species are not abundant but still available during winter. As such, those residing at Nukaunlth could have taken advantage of the increased frequency of these fishes in these estuaries during summer.



Source: Monaco et al. 1990, unless otherwise noted.

[a] Both *A. medirostris* and *A. transmontanus.*

[b] Data from Starry flounder (*P. stellatus*) populations.

[c] All *Oncorhynchus* species present in these locations were aggregated.

[d] Orlov et al. 2012.

[e] Isakson 1977.

[f] Relative abundance categories follow definitions in Monaco et al. 1990: 4

Figure 7.1 Temporal distribution of fish taxa present at Nukaunlth

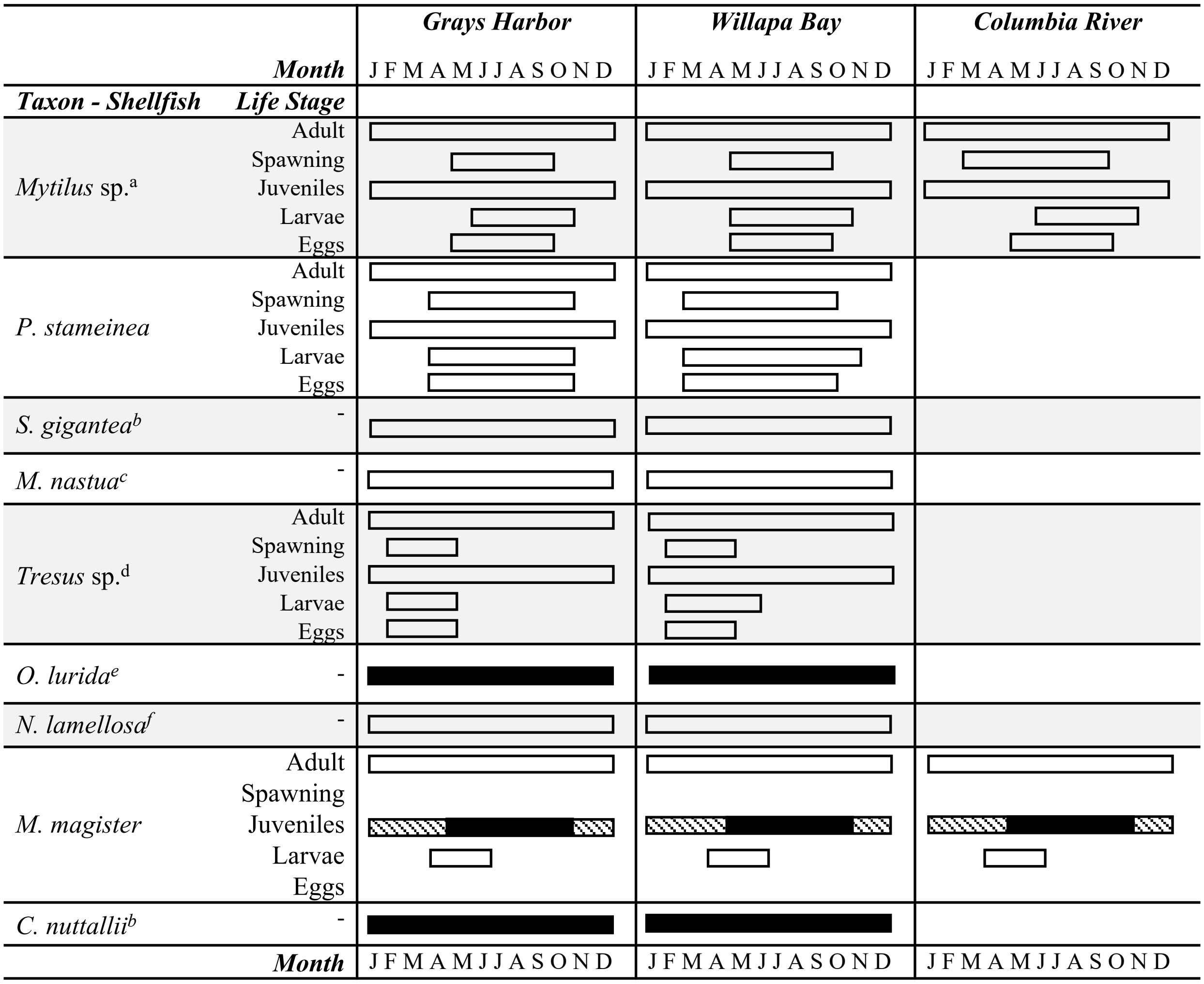
Shellfish

The shellfish species represented in the Nukaunlth faunal assemblage are commonly found year-round in Willapa Bay and Grays Harbor (Figure 7.2). However, two species—cockles and native oysters—are more prevalent in these estuaries than other species. Cockles (*C. nuttallii*) are highly abundant today and were likely highly abundant in the past. Likewise, native oyster (*O. lurida*) populations were pervasive year-round before their near decimation in the late 1800s (Polson and Zacherl 2009). Juvenile crabs (*M. magister* or *C. productus*) are highly abundant in spring and summer and abundant in fall and winter. The Columbia River estuary, however, only sustains populations of mussels and crabs. Given that mussels and crabs were also readily available in Willapa Bay, it's unlikely Nukaunlth residents traveled to the Columbia River for these resources, specifically.

Many Northwest Coast Indigenous communities generally avoided shellfish during specific seasons, probably due to two occurrences: shellfish spawning and toxic phytoplankton blooms (often called red tides) (de Laguna 1972, 1990). Some think spawning negatively affects the taste of shellfish, making them tough and lean, and were thus avoided at this time (Moss 1993; Newton and Moss 1984). In Willapa Bay, most shellfish spawn in the summer months. Shellfish toxicity, caused by red tide seasonal blooms of toxic phytoplankton, may have also caused groups to avoid shellfish harvesting during certain times of the year. When specific species of phytoplankton (typically *Alexandrium catenlla*) contaminate shellfish that are then consumed by humans, it can result in paralytic shellfish poisoning (PSP) and death (Horner et al. 1997). Incidents of PSP on the Northwest Coast are documented in the early postcontact period and likely also occurred before European arrival (Horner et al. 1997; Quayle and Quayle 1969). Although the existence of a seasonal bloom cycle of phytoplankton is well-known, the specifics are poorly understood. Patterns of phytoplankton distributions are closely related to site-specific upwelling and downwelling conditions (Horner et al. 2000), and there is no one season in which PSP occurs across the entire west coast. In general, however, PSP and red tides often occur during warmer months.

This suggests, then, that if Chinookan and Lower Chehalis peoples seasonally avoided shellfish due to spawning and PSP, they did so in the summer. However, ethnographic records and contemporary community knowledge suggest otherwise. Earl Davis, cultural director for the Shoalwater, knows of no seasonal avoidance of shellfish mentioned in oral histories, although precautions are taken today (personal communication). Moreover, Swan (1857:59) indicates that summer was the primary time for shellfish harvesting in Willapa Bay, drawing communities from as far north as Puget Sound. Supplemental shellfish harvesting might have occurred during winter, as well, when other foods were available but less abundant.

As all shellfish species are available year-round, and ethnographic and oral historical accounts do not indicate that Lower Chehalis and Chinookan peoples avoided shellfish in the summer, I have no evidence to suggest that those living at Nukaunlth restricted their harvesting any particular season. Future high-resolution sclerochronological and stable isotope analysis of shells may elucidate seasonal shellfish harvesting practices, as they have done elsewhere in on the Northwest Coast (e.g., Cannon and Burchell 2016; Burchell, Cannon, et al. 2013; Burchell, Hallmann, et al. 2013; Hallmann et al. 2009, 2013). Methods first need to be developed for *C. nuttallii*, as these studies have thus far focused on *S. gigantea* and whole shell samples of this species are very limited at Nukaunlth.



Source: Monaco et al. 1990, unless otherwise noted.

[a] Data from blue mussel (*Mytilus edulis)* populations.
[b] Lewis et al. 2020.
[c] Historic Populations. Ray 1938.
[d] Both *T. capax* and *T. nuttallii*.
[e] Historic Populations. Polson & Zacherl 2009.
[f] Coan et al. 2000.
[g] Relative abundance categories follow definitions in Monaco et al. 1990: 4

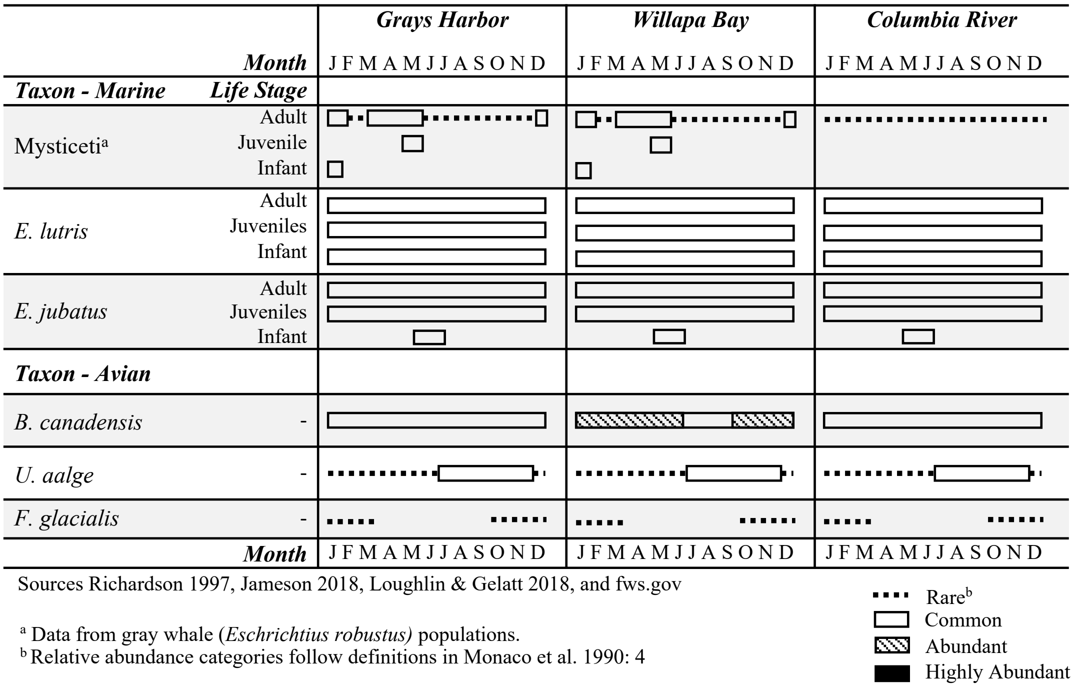
Figure 7.2 Temporal distributions of shellfish taxa found at Nukaunlth

Marine Mammal

The marine mammal assemblage, particularly the presence of whale, may provide more clues as to the seasonal occupation of the village and subsistence practices than the fish or shellfish assemblages. While Steller sea lion and sea otter are common in Grays Harbor, Willapa Bay, and the Columbia River estuary year-round, whales have predictable migratory and breeding patterns that limit their availability (Figure 7.3). Gray whales (the species most likely represented at Nukaunlth) are seen in or near Grays Harbor and Willapa Bay during their spring migration, from the end of March until June (Richardson 1997). They are also common in the area in December and January, during their winter migration. At all other times of the year, they are rarely sited in the region. As such, those residing at Nukaunlth likely procured whales in winter or spring.

Avian

Like the marine mammal assemblage, the avian species present at Nukaunlth provides some evidence of site seasonality (Figure 7.3). Two out of the three species identified have limited seasonal distributions. In particular, northern fulmars are migratory birds that are only rarely present in the area in fall and winter, and not present at other times of the year (Hatch et al. 2010). Likewise, common murres are only commonly seen in fall and spring and rarely sighted otherwise (Phillips et al. 2019). Canada Goose is the most identified bird species in the assemblage and is common year-round in Grays Harbor and the Columbia River estuary and abundant in Willapa Bay in all seasons except summer. Therefore, the presence of Canada Goose at Nukaunlth tells us little about seasonal site use. However, the northern fulmar specimen in the assemblage suggests people were using Nukaunlth in the fall/winter, while the common murre specimen suggests people were using Nukaunlth in the fall and/or spring. I should note, however, that in each case I recovered only one bone per species. Thus, further evidence is needed to conclusively assign a season of occupation to Nukaunlth.



Sources Richardson 1997, Jameson 2018, Loughlin & Gelatt 2018, and fws.gov

[a] Data from gray whale (*Eschrichtius robustus)* populations.
[b] Relative abundance categories follow definitions in Monaco et al. 1990: 4

Figure 7.3 Temporal distributions of marine mammals and avian species found at Nukaunlth

Botanical

While admittedly sparse, the botanical record also gives some indication of seasonal use of the village. Most botanical remains recovered from Nukaunlth are either perennial or were commonly dried and stored for future use. As such, their presence does not reliably indicate their season of harvest. However, there is one exception; a charred seed identified as *Claytonia perfoliata* (miner's lettuce) was recovered from the house floor at Nukaunlth. This is an annual plant that is most common in springtime and into early summer (Rana and Yadav 2018). As miner's lettuce was typically eaten fresh and not dried or preserved, this likely indicates a springtime harvest and use of this plant food.

Seasonal Site Use and Subsistence Practices

Ultimately, the faunal and botanical assemblages do not provide conclusive evidence of seasonal site use or subsistence rounds. Nonetheless, the presence of northern fulmar, whale, and miner's lettuce in the assemblage suggests a fall/winter habitation of the village that likely persisted into spring. No plant or animal specimen recovered at Nukaunlth was available only in summer. While not conclusive, the data here conform to our understanding of seasonal village residency garnered from oral histories, ethnographic records, and other archaeological studies: that large villages with substantial architecture were used most frequently in winter, a time for craft production, maintenance, and storytelling (Boyd and Hajda 1987; Hajda 1984). However, most shellfish and fish found at the site were available year-round in the region, and therefore a summer occupation cannot be ruled out entirely.

Seasonal subsistence practices are far more difficult to pinpoint than the period of village occupation, and the data here provide little information on this dimension of past foodways. This is because those food resources most commonly recovered at Nukaunlth are available year-round. Those that are only seasonally available occur in the assemblage in insufficient numbers to indicate an annual procurement pattern. Further sclerochronological or stable isotope studies of the shellfish assemblage may provide insight into temporal harvesting practices, but such analyses are beyond the scope of this dissertation.

Procurement Locales

While identifying seasonal subsistence practices and site use helps us to understand *when* people moved on the landscape, identifying procurement locales helps us to understand *where* they may have gone to procure resources from specific environments. In that sense, it is often a necessary component to understanding subsistence practices and landscape use. In particular, locating potential procurement environments for the resources found at Nukaunlth can elucidate two things: (1) how far village residents needed to travel and (2) how many different environments residents needed to frequent to obtain these foodstuffs. To identify potential procurement locales for those living at Nukaunlth, I compare the habitat requirements of the identified marine species to each other and to the environment around Kindred Island. The attributes of habitat that I compare are bathymetric depth or zone, sediment type, salinity zone, energy/exposure, and, when relevant, burrowing depth. Such a process does not indicate precisely where Nukaunlth residents went to obtain their food, only potential procurement locales and the degree to which residents could obtain marine resources locally.

Twenty different taxa of marine resources were recovered from Nukaunlth. Like temporal distribution, spatial and habitat-type variation is well-documented for modern populations (e.g., Dethier 1990; Gillespie 2009; Isakson 1977; Lewis et al. 2019; Monaco et al. 1990), but less so for historical populations. The preferences of these species likely have not changed. However, Willapa Bay is a highly dynamic watershed, and some speculation is needed as to the environments that might have existed in Willapa Bay and near Nukaunlth within the last 500 years. Most notably, there has been severe erosion of the north side of the mouth of the bay (described in Chapter 2). It's unclear exactly how this erosion has altered the environment around Kindred Island and elsewhere in the bay. In all likelihood, the salinity, energy, and exposure have shifted in the area around the mouth of the bay. It is reasonable to posit that the salinity has increased in this area, as the mouth of the bay has widened, and more ocean water is allowed to flow into the bay. Likewise, the open estuarine setting on the south side of Tokeland and near the Shoalwater Reservation was once partially enclosed by a landmass that has since been destroyed. This shift in landscape likely altered the fetch and energy of the currents in the area.

Shellfish Procurement Locales

The shellfish species present in the Nukaunlth assemblage represent a wide but overlapping range of habitat preferences (Table 7.1). All species occupy the low-intertidal zone,[40] but most can also be found subtidally. Interestingly, the most abundant shellfish species at Nukaunlth—*C. nuttallii*—occupies the widest range of bathymetric depths: from high intertidal to subtidal. Although *C. nuttallii* accepts this wide range of tidal levels, modern studies have noted that they are most often found in the lower intertidal (Coan et al. 2000). This may be due to predation by gulls, food limitations, more intense environmental fluctuations, and/or a propensity for desiccation at high tidal levels (Dunham et al. 2013; Gallucci and Gallucci 1982). Mussels, also prevalent in the assemblage, often occupy the high and mid-intertidal zones. This suggests that these species were easier to access than others, as they may have been available during neap tides.

In contrast to bathymetric depth, the sediment requirements of the shellfish found in the Nukaunlth assemblage have less overlap. Cockles need sand or mud/sand/gravel. Mussels attach themselves to rocks, pilings, driftwood, or any other hard surface. Most other shellfish species find a range of mud types suitable. There is a general gradient in sediment type throughout the bay, ranging from sandy at the mouth of the bay to muddy in its upper parts

---

[40] Defined as between -0.78 – 0.37 meters from the mean lower low water datum.

(Clifton and Phillips 1980). This gradient probably existed in the past as well. As such, the area around Nukaunlth was likely of a sandy nature. This is corroborated by the sediments of Kindred Island itself, where the sterile subsoil is nearly entirely sand based (see Chapter 5). Therefore, the intertidal and subtidal area around Kindred Island was likely suitable for shellfish species that thrive in sand or sand/mud/gravel sediments: cockles, crabs, and all species of clams found at Nukaunlth (*M. nasuta, Tresus* sp., *S. gigantea,* and *P. staminea*).

As of today, there are no obvious rocky outcroppings near Kindred Island that would provide habitat for mussels. The closest area in Willapa Bay that may have provided the proper habitat for mussels is Stony Point, some 6 km (3.75 miles) from Kindred Island. However, Lower Chehalis and Chinookan people considered this area sacred and avoided it (Swan 1857:68). Thus, it is unlikely that people from Nukaunlth harvested mussels from Stony Point (Tony Johnson, personal communication). Several possibilities may explain where mussels were procured by those living at Nukaunlth. A rocky environment may have existed near Kindred Island that has since been destroyed, possibly near the mouth of the bay where significant topographic changes have occurred in the recent past. Alternatively, mussels attach themselves to driftwood, and those living at Nukaunlth may have gathered mussels from logs that washed up to shore. It seems improbable that this would be an important or reliable way to obtain mussels. Or, perhaps, the presence of large quantities of mussels in the assemblage indicates that residents were traveling some distance to access this food source, either during trips to hunt or gather some other resource, or specifically for mussels.

Interestingly, there is an uptick in mussel-use at Nukaunlth in the second occupation, suggesting that if a change in environment resulted in more mussel availability near the site at this time, that environmental modification has not persisted today. I often wonder if the tsunami caused massive amounts of debris to swirl around the bay, such as large trees and branches, that then became host to mussel colonies. Perhaps these mussel-covered logs washed ashore and provided a new resource for those living at Nukaunlth. Likewise, I wonder about the possibility of mussel gardens, where logs were intentionally left in the intertidal zone for mussels to colonize. Unfortunately, these explanations are pure conjecture and I have no reasonable evidence to assert these claims.

All shellfish species found at the site tolerate lower-estuary/marine salinity, and most can tolerate mid-estuary levels as well. The area around Kindred Island likely falls within these zones today, depending on seasonal freshwater inundation from nearby streams and rivers, and likely so did in the past as well. Similarly, all shellfish, except frilled dogwinkle (*N. lamellosa*), inhabit partially enclosed estuarine environments. Partially enclosed estuarine environments are defined as "bays or river mouths partially enclosed by headlands, bars, spits, or artificial obstructions reducing circulation…[with] minimal wave action or currents" (Dethier 1990:12). Kindred Island is protected from long fetch and wind waves by Tokeland and was much farther from the open ocean in the past (see Chapter 2). Therefore it is considered a partially enclosed estuarine environment. The shellfish species in the assemblage exhibit a range of burrowing depths; while cockles and Pacific littlenecks (*P. staminea*) are shallow burrowers, *Tresus* sp. is found at depths greater than 40 cm (~ 16 in). Cockles may have been relatively easy to access because they can be found high in the intertidal and are shallow burrowers.

By all indications, most of the shellfish species present at Nukaunlth village, with the possible exception of mussels, require habitats found near Kindred Island, at least in modern times. Lewis et al. (2019) combined many of these habitat requirements with ecological data to estimate suitable bivalve habitat in estuaries across the west coast and provide useful data specific to Willapa Bay (Figure 7.4). Examining their habitat suitability index suggests that the intertidal area around Kindred Island is highly suitable for cockles. I cannot say for certain that this environment was the same in the past as it is today. But if it was, then those living at Nukaunlth would not have had to go far to obtain cockles. The same cannot be said for mussels, which require a rocky substrate. Precisely where the residents of Nukaunlth were gathering mussels is unknown, but I have no evidence to suggest that they could have gathered them close to their village. While the Lower Chehalis/Chinookan community at Nukaunlth was likely able to harvest many of the shellfish species in the same area, different species likely required different techniques and tools. Cockles could be raked or gathered from the surface, but *Tresus* sp. requires considerable digging. Likewise, mussels and oysters would require something by which to pry them off hard substrates.

Table 7.1 Habitat requirements of shellfish taxa represented in the Nukaunlth assemblage

			Shellfish								
			Mytilus sp.	*P. stameinea*	*S. gigantea*	*M. nastua*	*Tresus* sp.	*O. lurida*	*N. lamellosa*	*C. nuttallii*	*M. magister* or *C. productus*
Bathymetric depth[a] (m)		*Subtidal (< -0.79)*		X	X	X	X	X		X	X
		Low-Intertidal (-0.78 – 0.37)	X	X	X	X	X	X	X	X	X
		Mid-Intertidal (0.38 – 1.56)	X	X			X		X	X	
		High-intertidal (>1.56)	X							X	
Sediment (% silt-clay)		*Sand (<7.51)*				X	X			X	X
		Mud/Sand/Gravel (7.51-39.00)		X	X	X	X			X	
		Mud/Sand (39.01-60.00)		X	X	X	X				
		Mud (> 60.00)				X	X	X			
		Rocks/Pilings (n/a)	X					X	X		X
Salinity Zone (PSU)[b]		*Upper-estuary (<16.00)*				X					
		Mid-estuary (16-27.00)	X	X	X	X			X	X	X
		Lower-estuary/Marine (>27.00)	X	X	X	X	X	X	X	X	X
Energy/ Exposure[c]	***Estuarine***	*Open*	X	X	X	X	X	X	X	X	X
		Partially Enclosed	X	X	X	X	X	X		X	X
		Lagoon		X		X		X			
		Channel/Slough						X			
	Marine Intertidal	*Exposed*									
		Partially Exposed	X						X		X
		Semi-protected	X	X	X	X	X		X		X
		Protected	X	X	X	X	X	X	X		X
	Marine Subtidal	*High*			X						X
		Moderate		X	X	X					X
		Low		X	X					X	X
Burrowing Depth (cm)		*Shallow (0 – 10)*		X						X	
		Intermediate (11-40)			X	X					
		Deep (>40)					X				

Sources*:* Moss 1989, Dethier 1990, Gillespie 2009, Monaco et al. 1990, Lewis et al. 2019, inverts.wallawalla.edu, and sources therein.

[a] From Mean Lower Low Water datum

[b] Practical Salinity Unit

[c] Energy/Exposure zones as defined by Dethier 1990: 11-12

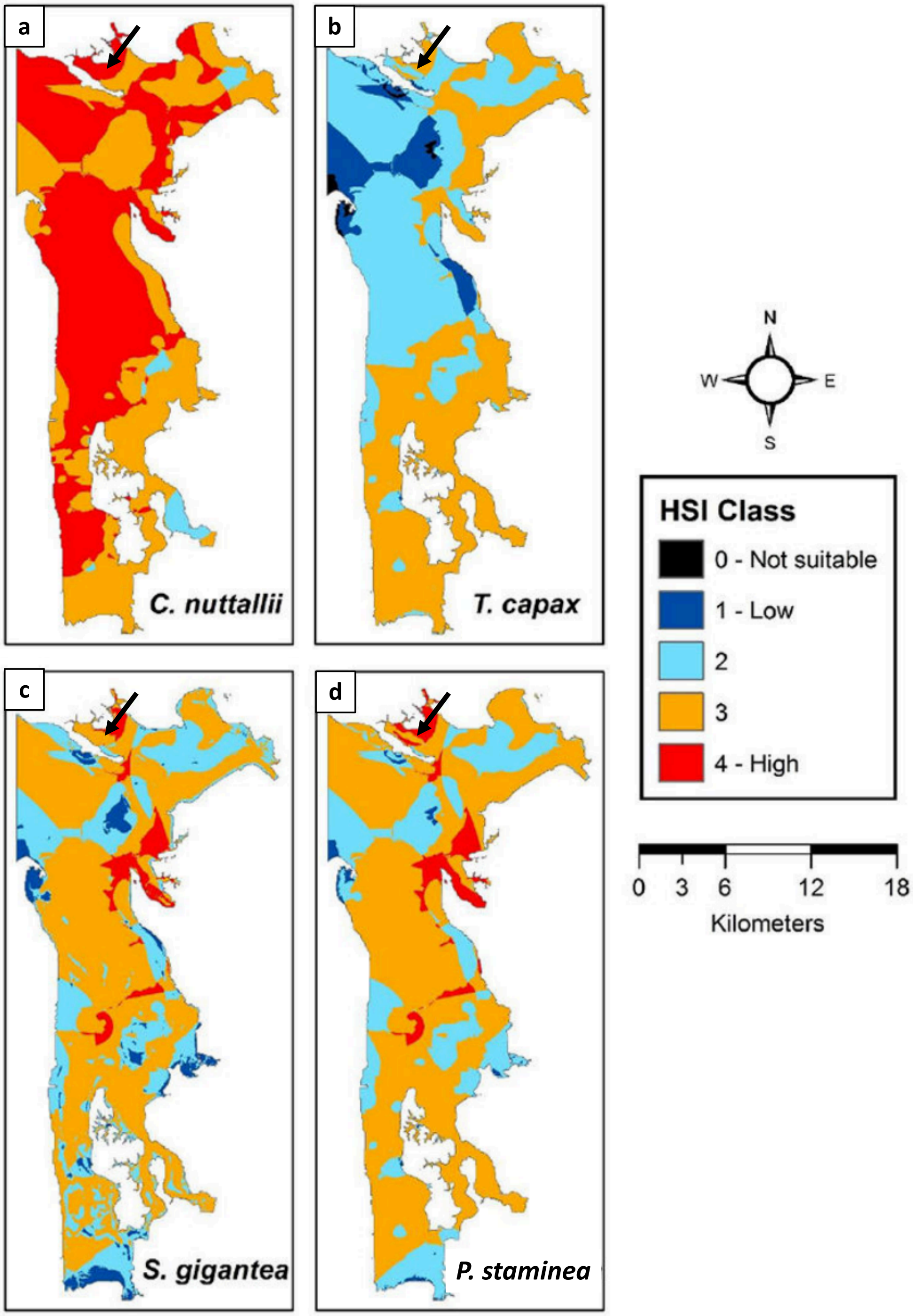


Figure 7.4 Habitat suitability index predictions from Lewis et. al 2019
Reproduced and adapted with permission from Elsevier. Arrow indicates the location of Nukaunlth.

Fish and Marine Mammal Procurement Locales

Like the shellfish species represented in the Nukaunlth assemblage, the fish and marine mammal species also have a wide but often overlapping range of habitat requirements (Table 7.2). All fish and marine mammals from Nukaunlth occupy littoral/intertidal and/or neritic bathymetric zones. In these zones, all species except Steller sea lion are at least partially benthic. Within the benthic zone, all species except Steller sea lion and sea otter tolerate sandy sediment. These species instead prefer mud/sand or rocky areas. All fish and marine mammal species tolerate lower-estuary/marine salinity. As such, the area around Kindred Island likely has the correct sediment, salinity, and bathymetric zones for the majority of the fish and marine mammal species found at Nukaunlth.

The necessary energy/exposure zones for some fish and marine mammals, however, suggest they may not have been readily available around Kindred Island. Seven species tolerate the exposure zone near the site, that of a partially enclosed estuarine environment. However, four species—sturgeon, spiny dogfish, skates, and gray whales—are found only in open estuarine or marine environments. This indicates that residents of Nukaunlth likely traveled westward towards the mouth of the bay or to coastal beaches to obtain these species.

When assessing the habitat requirements of the shellfish, fish, and marine mammal species found at Nukaunlth in comparison to the habitats around or near the village, it seems that most of these resources could have been obtained nearby. Some notable exceptions are mussels, sturgeon, dogfish, skates, and gray whales. Mussels require a rocky substrate that, at least in modern times, is not present near Kindred Island. Sturgeon, dogfish, skates, and gray whales need open estuarine or marine environments. These environments, however, are very close to

Kindred Island today and likely were not far in the past. This suggests that those living at Nukaunlth relied on locally available marine resources.

Table 7.2 Habitat requirements of fish and marine mammal taxa found at Nukaunlth

			Fish								***Marine Mammal***		
			Acipenser sp.	*C. Pallasi*	Pleuronectidae	*Oncorhynchus* sp.	*L. armatus*	*S. Suckleyi*	*Amphistichus* sp.	Rajidae	Mysticeti	*E. Lutris*	*E. jubatus*
Bathymetric zone		*Littoral/Intertidal*	X	X	X	X	X		X	X	X	X	X
		Neritic	X	X	X	X	X	X		X	X	X	X
		Oceanic	X			X		X			X		X
		Benthic	X	X	X	X	X	X	X	X	X	X	
		Pelagic		X		X		X	X		X	X	X
Sediment (% silt-clay)		*Sand (<7.51)*	X	X	X	X	X	X	X	X	X		
		Mud/Sand/Gravel (7.51-39.00)	X	X	X	X	X	X			X		
		Mud/Sand (39.01-60.00)	X	X	X	X	X	X			X	X	X
		Mud (> 60.00)	X	X	X		X	X		X	X		
		Rocks/Pilings (n/a)		X			X	X				X	X
Salinity Zone (PSU)^a		*Upper-estuary (<16.00)*	X		X	X	X						
		Mid-estuary (16-27.00)	X	X	X	X	X	X	X				
		Lower-estuary/Marine (>27.00)	X	X	X	X	X	X	X	X	X	X	X
Energy/ Exposure^b	***Estuarine***	*Open*	X	X	X	X	X	X	X	X	X	X	X
		Partially Enclosed		X	X	X	X		X			X	X
		Lagoon											
		Channel/Slough			X	X	X					X	X
	Marine Intertidal	*Exposed*	X	X	X		X		X		X	X	X
		Partially Exposed	X	X	X		X		X		X	X	
		Semi-protected	X		X	X	X				X	X	
		Protected	X	X	X		X			X	X	X	
	Marine Subtidal	*High*		X	X						X		X
		Moderate		X	X			X			X		X
		Low		X	X		X	X		X	X		

Sources*:* Isakson 1977, Dethier 1990, Monaco et al. 1990, and sources therein.

[a] Practical Salinity Unit

[b] Energy/Exposure zones as defined by Dethier 1990: 11-12

Shellfish Harvesting Strategies

Shell middens are the most numerous site-type on the Northwest Coast and exhibit regional and local variability in shape, size, depth, and species profiles (Burchell, Cannon, et al. 2013; Stein 1992; Wessen 1988). The ubiquity of and variation between shell midden sites suggest that shellfish may have been collected in substantial numbers throughout the region but that the harvesting strategies and the dietary, economic, and social importance of shellfish likely varied dramatically within and between Northwest Coast societies. Many researchers have investigated shellfish harvesting strategies as they relate to social organization (e.g., Daniels 2009; Wessen 1982), resource depression (e.g., Anderson 1981; Coupland et al. 2003; Hockey and Bosman 1986; Hockey et al. 1988; Mannino and Thomas 2001; Mannino et al. 2003; Thomas and Mannino 1999), and management practices (e.g., Cannon and Burchell 2009; Croes 1992; Lepofsky and Caldwell 2013; Pierce 2011). While a complete summary of shellfish-focused research on the Northwest Coast is not feasible here, some review is necessary.

Some archaeologists have posited that the clumped distribution of shellfish led to the control and management of shellfish beds throughout the culture area (e.g., Cannon et al. 2008; Drucker 1983; Wessen 1988), and Wessen's (1982) study at the Ozette site confirms that shellfish harvesting had social dimensions and was regulated through ownership. Wessen's work demonstrated that differences in the relative abundance of shellfish taxa were correlated to household spatial organization and linked high-value clam species with high-ranking families. Since then, several other studies have shown the development and ownership of clam gardens as a marker of wealth (Deur and Turner 2005; Erlandson and Moss 2001; Garza 1999; Moss 1993; Newton and Moss 1984; Richardson 1982; Williams 2006). The collective nature of food gathering maintained the economic security of the household while the ownership of new resource locales may have provided an opportunity to reconfigure social arrangements (Grier 2014; Oberg 1973). Communities may have used the ownership of new resource locales to buffer existing social inequalities that reduced some groups' access to other resources by broadening the suite of resources they harvested (Parkington et al. 2013; Rosendahl et al. 2014; Smith et al. 2014) or intensifying the use of resources previously collected only opportunistically (Whitaker and Byrd 2014).

Other scholars have addressed shellfish resource depression and management. Most agree that declines in the relative abundance of large or choice species and/or reductions in the average size/age of individuals is due to resource depression caused by either a change in the environment or overexploitation. Conversely, stability in relative abundance or targeted age and/or size may indicate resource management. Constancy in the relative abundance of shellfish species is thought to indicate either non-intensive harvesting practices or particularly robust shellfish populations (Daniels 2009; Pierce 2011). Consistent targeting of senile individuals suggests that harvesters were managing shellfish populations by rejecting young individuals or allowing beaches to lay fallow (Cannon and Burchell 2009; Cannon et al. 2008). Either of these strategies would maintain reproductively viable populations. As is often the case, environmental fluctuations can also produce patterns in shellfish populations that appear to be from human agency. Thus, in all cases, careful attention to the characteristics of the local environment is necessary to distinguish between environmental and human-generated changes in the shellfish assemblage.

Croes (1992) used age-at-harvest to argue for the management of mussel populations at the Hoko River Rock shelter in Washington. Croes saw an initial decline and subsequent plateauing of age-at-harvest at this site and suggested that conservation practices prevented further decline. Coupland et al. (2003) used size as a proxy for age and attributed a decline in the size of *P. stamina* specimens found at the McNichol Creek site to overharvesting and resource depression. Cannon and Burchell (2009) investigated age-at-harvest at several sites and saw differing proportions of mature to senile clams based on site-type. They argue that a greater abundance of senile stage shells at village sites indicated conservation strategies, whereas short-term encampments were more likely to have an even ratio of mature to senile-stage individuals. Long-term occupations of villages likely necessitated management practices to prevent subsistence economies from depressing available resources (Whitaker 2008:115). Furthermore, it is unlikely that such deliberate conservation efforts would occur for an unimportant, undesirable, or occasional food source.

Estimating Age-at-Harvest

I investigate shellfish harvesting strategies and resource management at Nukaunlth by examining the age-at-harvest of the most abundant shellfish species, *C. nuttallii*. There are three primary ways to estimate the age-at-harvest of shell species within the assemblage: size as a proxy for age, external annuli (growth rings), and internal annuli (growth lines). While all three methods produce estimates of the growth stage of the species (juvenile, mature, or senile) and are discussed below, internal growth lines are the most reliable.

Size is often correlated to age; younger individuals are typically smaller, whereas older individuals of the same species are typically larger. Therefore, many use the size of the shell as a proxy for age. However, without location-specific environmental data and/or modern ecological studies, size is often an unreliable maturity measure. Growth rates are dependent on a suite of environmental factors such as water temperate, salinity, sediment type, currents, valve opening types, and bathymetric depth (Claassen 1998; Dunham et al. 2013). To correctly correlate size to age in *C. nuttallii,* some malacologists have tracked growth rates in modern populations to produce a Von Bertalanffy (1938) function of somatic growth (e.g, Brooks 2001; Gallucci and Gallucci 1982; Weymouth 1931). However, growth rates and thus the Von Bertalanffy function varied significantly with location: *C. nuttallii* individuals could be anywhere from 2.6 to 50.3 mm in length after one year, depending on location (Gallucci and Gallucci 1982, Weymouth 1931).

Most shellfish species experience fluctuating rates of calcium carbonate deposition, which are influenced by seasonal physical and chemical changes in the environment. During winter months, they typically undergo a growth cessation, producing in some species a deep notch in the outer shell (external annuli or growth rings). In *C. nuttallii,* these often correlate to winter dormancy but can also be caused by spawning or other stressful events (Brooks 2001). The deep notches produced by such events are called ‘false checks’ and their presence can cause an overestimation of age by those relying on external annuli to construct age-at-harvest profiles. True winter annuli, however, create internal growth lines: “distinct discontinuities in the shell’s structure caused by an apparent excursion of the inner lamellar layer through the outer prismatic layer to the shell’s surface” (Brooks 2001:139). These growth lines are visible in the cross-section of the shell (from the umbo to ventral margin) and correspond to valid external annuli (Figure 7.5).

As in most species, growth rates slow as shellfish mature. Most shell growth occurs at juvenile and mature stages, while senile individuals are slow-growing (Claassen 1998). As a result, senile individuals exhibit closer spacing of annuli at the ventral margin (Claassen 1998; Ropes and Jearld 1987). While this makes determining the exact age of senile individuals difficult, it does allow one to distinguish between mature and senile specimens. As described above, such information can be used to construct growth-stage profiles of the assemblage and lend insight into selective harvesting or management practices.

Growth-Stage Profiling at Nukaunlth: A Preliminary Analysis

S. gigantea are most commonly the focus of growth-stage profile studies using internal growth lines (e.g., Cannon et al. 2008; Cannon and Burchell 2009; Daniels 2009; Ham 1983; Pierce 2011) and growth patterns are not the same in all clam species. However, Ham (1983) shows that *C. nuttallii* also exhibits clear internal growth-lines in which spacing differs between mature and senile individuals. Furthermore, studies of growth rates in modern *C. nuttallii* populations suggest that these internal growth lines are reliably deposited annually (Ambrose et al. 2012; Brooks 2001; Carroll et al. 2009; Hiebert 2015; Ratti 1977). I investigate internal growth lines to determine age-at-harvest (mature or senile) following Cannon and Burchell's classification of these growth stages:

> "Mature growth is evident in broadly spaced, regular incremental growth bands up to and including the ventral margin. Shells from the senile stage, when shell growth is much slower, exhibit numerous small incremental growth bands packed in the ventral margin area of the shell" (2009:1051).

I selected only whole cockle shells that were mapped *in situ* for growth-stage profiling. Cannon and Burchell (2009) have demonstrated that shell fragments with intact ventral margins can be used for this process. However, only one previous study investigated internal growth lines of *C. nuttallii* found in archaeological deposits (Ham 1983), and no images were available that demonstrated mature vs. senile growth line patterns in this species specifically. Therefore, I concluded that I needed the entire shell to compare the distribution of growth lines across the length of the shell and reliably assign a growth stage. Because of the high degree of fragmentation of the shell assemblage, typical of a village midden, and these strict sampling requirements, I was only able to investigate 10 *C. nuttallii* individuals.

These 10 samples were submitted to Burnham Petrographics LLC for thin sectioning. Shells were sectioned down the middle, from the edge of the umbo to the ventral margin. The lab was instructed to follow the processing techniques described in Pierce (2011). A shell was cut down the middle to produce a 10mm slice and this slice was embedded in a 1:2-part epoxy-resin solution and glued to the slide. It was then ground down to remove excess shell such that it was thin enough to transmit light through. Although most internal annuli were visible with the naked eye, slides were examined under a dissecting microscope to detect thin, hard to see, growth lines. The length of the thin-sectioned shell was photographed through the eyepieces of the microscope using an iPhone, which proved to be an easy, fast, and inexpensive way to produce accurate images of the specimens (Figure 7.5).

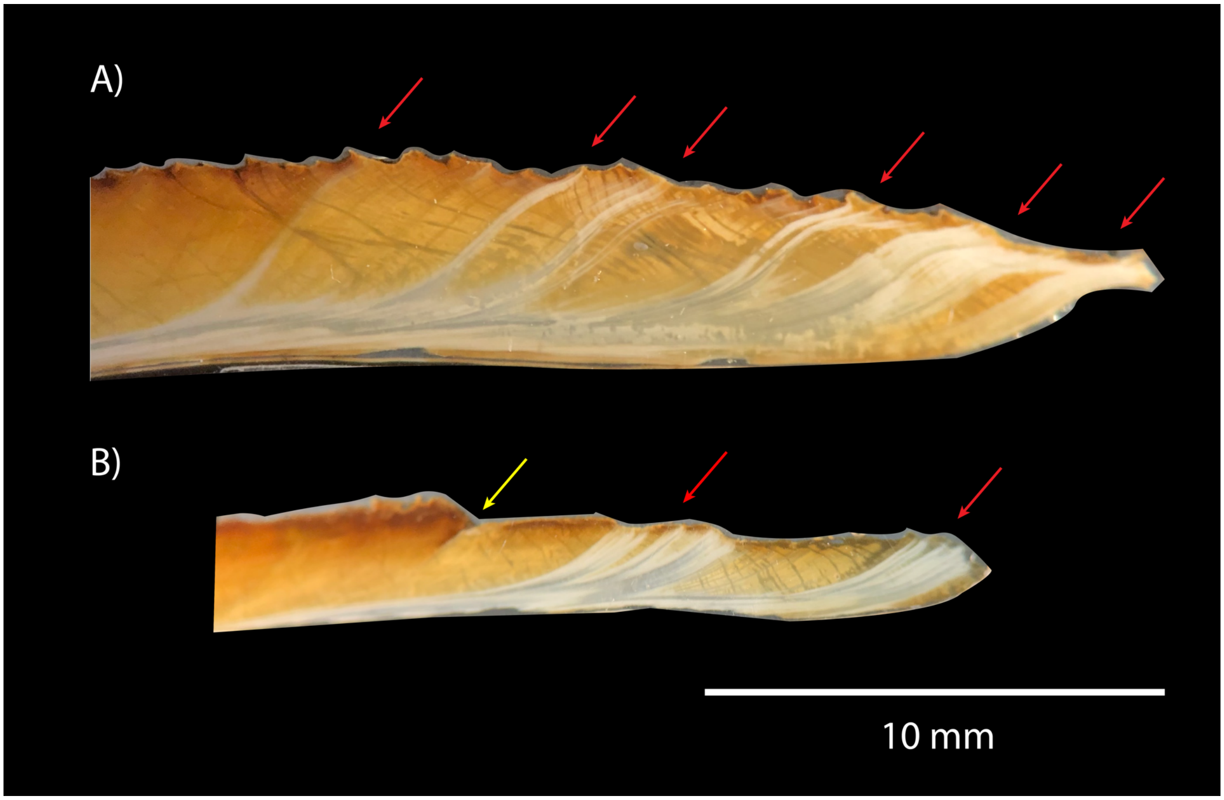


Figure 7.5 Senile growth lines (A) and mature growth lines (B).
Red arrows indicate winter annuli. Yellow line indicates a 'false check'. New growth can be seen on the ventral margin of the mature specimen.

Of the 10 specimens, eight were classified as in the senile growth stage, and two were classified as mature. While this is a small sample and further sampling is needed, it suggests that those living at Nukaunlth may have been practicing some selective harvesting or resource management. Cockles are shallow burrowers and are often found barely buried in the sediment. Therefore, individuals of all growth stages can be raked or handpicked from the surface. As such, it is notable that senile individuals make up the majority of those sampled. If the high proportion of senile individuals in this small sample holds for the rest of the assemblage, it may indicate that harvesters were managing *C. nuttallii* populations by selectively collecting senile individuals or allowing beaches to lay fallow so that *C. nuttallii* populations could continue to reproduce. It is feasible that skilled shellfish gatherers could identify senile cockles with the naked eye because *C. nuttallii* produces external growth lines that are visible and approximate growth-stage. These preliminary data hint that Nukaunlth may adhere to Cannon and Burchell's suggestion that villages exhibit less intensive harvesting, and perhaps active conservation efforts to protect nearby shellfish resources from over-harvesting.

There are a few alternative explanations for this sample containing more senile individuals than mature. Many of these have been raised and addressed by Cannon and Burchell (2009), but it is necessary to address them as they pertain to the Nukaunlth assemblage. The high proportion of senile-age individuals in the sample may be due to post-depositional taphonomic processes and sample selection. If senile individuals possess more robust shells that are less prone to breakage, then my strategy of investigating only whole shells would bias my sample towards senile individuals. I cannot complete out rule this possibility. Further sampling of fragmented shells and/or taphonomic experiments would be needed to do so conclusively. However, Cannon and Burchell tested the fragmentation propensity of mature and senile-stage butter clams and found there was no significant difference between the two growth stages. Similar studies would need to be done on *C. nuttallii* to ensure relative proportions of senile and mature shells were not due to post-depositional influences.

It is also possible that the pattern observed is a result of environmental factors. Cannon and Burchell point out that if the targeted species were "less common and therefore less commonly harvested at particular locations, it is possible that more clams would reach the age of senility before harvest" (2009:1054). However, given what we know of the environment surrounding Nukaunlth and the habitat requirements of *C. nuttallii* (see *Procurement Locales* discussion above), there is no evidence to suggest that this species was uncommon in the area. Modern studies indicate that the area around Kindred Island is highly suitable for this species.

While I cannot say for certain that this was the case in the past, I have no evidence to suggest otherwise.

Cannon and Burchell also point out that, because environmental conditions affect annuli, shellfish harvested from different locations may exhibit senile-stage growth patterns at different ages. However, these specimens are from a single village and one in which suitable habitat for *C. nuttallii* appears to have been nearby. It seems unlikely that the 10 individuals sampled came from such drastically different environments that they resulted in different senile-stage growth patterns.

In sum, while this is study investigates a small sample, too small to conduct rigorous quantitative analyses, some information can still be gleaned. The high proportion of senile individuals suggests that some resource management may be at work. Further studies would be needed to confirm this. Importantly, this investigation provides clear evidence of differences in mature vs. senile growth-line patterning in *C. nuttallii* that can be used in future studies on shell fragments with intact ventral margins. This would allow for more ample sampling and rigorous quantitative analysis in the future.

Evaluating Alternative Explanations of Shellfish Species Composition and Midden Characteristics

To determine the importance of marine resources, particularly shellfish, among the Lower Chehalis and Chinookan peoples living at the ancestral village of Nukaunlth, I offer two alternative explanations of shellfish species composition and midden characteristics seen at this site:

1. Midden composition reflects natural variability in shellfish species distribution and abundance. That is, the midden composition at Nukaunlth faithfully tracks natural spatial and temporal shellfish distributions that are primarily conditioned by water temperature, water chemistry, salinity, and substrate type. Changes in midden characteristics through time owe primarily to macro- and micro-environmental fluctuations. Composition does not, therefore, indicate selective harvesting, management, or control of shellfish resources. This pattern would suggest shellfish did not play a significant role in the economic or social systems of those living at Nukaunlth. Shellfish may have been gathered in substantial quantities, made up a significant portion of the diet, and acted as a staple resource of subsistence but, when collected, were taken opportunistically and at a low level of investment.

2. Midden composition differs significantly from that expected under natural conditions. Characteristics including species richness and evenness and age profiles indicate selective and/or intensive harvesting, which may reflect changes in harvesting technologies, intensities, and/or management strategies. While some temporal changes in shellfish consumption may be partly in response to natural fluctuations in shellfish availability, variability in midden composition is primarily due to the increased (or decreased) importance of shellfish at Nukaunlth. Shellfish was a key resource, either for subsistence or for its role in Chinookan/Lower Chehalis economic systems.

Before the archaeological investigations at Nukaunlth, I expected that midden composition would differ significantly from that expected under natural conditions and that the abundant shellfish resources available in Willapa Bay were harvested intensively, incorporated heavily into Chinookan/Lower Chehalis diet, and played a similar role to other gathered foods. More specifically, I expected to see the management of specific shellfish resources and variable intensity of harvest across shellfish species. Here, I evaluate whether the data obtained from archaeological investigations at Nukaunlth adhere to these explanations and whether my initial expectations were met.

As described in *Procurement Locales* above, the shellfish species most often found in the archaeological deposits prefer habitats that, at least in modern times, are found close to Kindred Island and Nukaunlth. In this way, midden composition seems to track natural distributions of shellfish species, as is suggested in explanation 1. The environment around Nukaunlth was likely different at the time of occupation, and some conjecture is needed as to the nearby marine and estuarine habitats at that time. We know from historical records that there has been severe erosion on the north side of the mouth of the bay (described in Chapter 2) and can thus make some inferences based on this historical documentation. Even when taking into account estimated changes in exposure, salinity, and sediment surrounding Kindred Island, it is still reasonable to suggest that those shellfish species most commonly found in the midden, particularly *C. nuttallii*, could have been found nearby. This distribution trend holds for the fish and marine mammal species found at Nukaunlth as well, although many of these species are more likely found in neighboring marine environments to the west of Kindred Island. The only species that goes against this trend is *Mytilus* sp. (mussels), which need rock, pilings, driftwood, or some other hard surface to adhere to. I have no evidence to suggest that such a habitat existed near Kindred Island in the past and cannot say for sure where residents of Nukaunlth were obtaining this species.

Midden characteristics remained remarkably stable across occupations at Nukaunlth, and it is difficult to determine whether what little change did occur was due primarily to macro- and micro-environmental fluctuations, as suggested in explanation 1, or some other cause. The biggest changes in midden characteristics seen at Nukaunlth are an increase in the relative abundance of mussel and a corresponding decrease in clams and cockles, an increase in the relative abundance of marine mammal (most likely whale), and an increase in the use of salmon relative to other fish species. Given the current archaeological data, I have no evidence to suggest these changes are due to anything other than environmental changes, although further research may prove otherwise. Regardless, the relative abundance of shellfish in the faunal assemblage changed little from the first to the second occupation (+3.68% NISP, +0.17% weight, & -1.4% meat yield) and does not suggest a decrease or increase in the importance of shellfish relative to other broad faunal classes at Nukaunlth.

The increase in the relative abundance of mussel at Nukaunlth is the inverse of a well-documented trend seen across the Northwest Coast; more often, the relative abundance of mussel decreases over time, and the relative abundance of clams increase (Cannon et al. 2008:10). Various causes have been suggested for this typical trend including maturing of estuaries and deltas producing silty, clam-friendly environments (Conover 1978; Ham 1976; Sumpter 2017), decreasing predation of sea otters on clam populations (Clarke and Clarke 1980), and changing economic practices (Wessen 1982). Most likely, the causes of such a trend are site or subregion specific. Coupland et al. (2003) noted the inverse of this trend, similar to what I have found at Nukaunlth. However, they also saw a concomitant decrease in clam size over time and suggest this resource shift is due to the depletion of clam beds from overharvesting. I have no evidence for overharvesting at Nukaunlth and cannot attribute this trend to the same cause as Coupland and his colleagues. In fact, there is some evidence to the contrary: preliminary growth-stage analysis suggests most harvested cockles in both occupations were allowed to grow to senile-age before harvest, and the size of these cockles (ranging from 58 mm to 82 mm) represent the upper reaches for the species (Packard and Packard 1918). Other species that increased in relative abundance over time, namely salmon and whale, are species that many in the region consider high-ranked prey (Broughton 1994; Butler 2000; Coupland et al. 2003; Rosenberg 2000). One would assume a decrease in such prey-types if overharvesting were an issue. Still, given current archaeological data, I cannot suggest a reason for the slight increase in the use of these species.

As suggested in explanation 1, it appears that residents of Nukaunlth gathered shellfish in significant quantities, and shellfish likely made up a significant portion of the animal foodstuffs in their diet (see Chapter 6). Similarly, given the sheer abundance of shellfish in the faunal assemblage and its year-round, nearby availability, shellfish could have been a reliable and accessible staple subsistence resource. The shellfish that are most abundant in the faunal assemblage, cockles, are in many ways the most accessible; they occupy a wide range of bathymetric depths including the high intertidal zone and are shallow burrowers that are typically found just beneath the surface. In that sense, it seems a low level of investment would be needed to harvest large quantities of this species. However, I hesitate to suggest that those living at Nukaunlth gathered shellfish opportunistically, as preliminary investigations of growth-stages suggest some selective harvesting practices at work.

As suggested in explanation 2 and described in *Shellfish Harvesting Practices*, preliminary growth-stage analysis of cockle shells indicates that those living at Nukaunlth may have used selective harvesting, management, and/or conservation strategies. Eighty percent of whole cockle shells analyzed were in the senile growth stage at the time of harvest. If residents of Nukaunlth were gathering cockles opportunistically, as is suggested in explanation 1, one would expect a mix of growth-stages, as cockles of all ages could be quickly raked from the surface *en masse*. Alternatively, if cockles were intensively harvested to the point of resource depletion, one might expect mostly mature specimens, as overharvesting would prevent individuals to reach the senile growth stage. I found neither the pattern expected of opportunistic harvesting nor the pattern expected of overharvesting. Admittedly, this analysis was done on a very small sample (N=10), and the results are not unambiguous. There may be other reasons why a large proportion of senile stage individuals were found (see *Shellfish Harvesting Practices* above), and further growth-stage analysis, taphonomic experiments, and/or environmental studies would needed to decidedly rule out these. However, at present, the results of this preliminary analysis are promising.

The data presented here and in chapters 5 and 6 allow me to evaluate these alternative explanations and my initial expectations. From these data, I suggest that the midden composition at Nukaunlth reflects aspects of both explanations. That is, while midden composition seems to track natural spatial shellfish distributions, as is suggested in explanation 1, there is some indication of selective harvesting and conversation strategies by those living at Nukaunlth, as is suggested in explanation 2. Likewise, I find that some of my initial expectations were met and others were not. I found no indication that midden composition differs significantly from that expected under natural conditions, nor is there evidence of resource depression caused by intensive harvesting. Yet, all data suggest that shellfish made up a large part of Chinookan/Lower Chehalis diet and were harvested in great numbers. And although not conclusive, there are preliminary data to suggest the management and/or conservation of *C. nuttallii* populations. The relative abundance of taxa in the shellfish assemblage suggest that some species of shellfish were harvested in greater quantities than others, but this may have been a product of the local habitat and accessibility—the most commonly harvested species, *C.*

nuttallii, was likely in the greatest abundance and the most accessible species around Kindred Island. By and large, it appears that shellfish was an important resource that was harvested in great quantities and with remarkable consistency by those living at Nukaunlth. It's reasonable to suggest that shellfish could have been a staple resource for Nukaunlth residents because shellfish made up the bulk of the faunal assemblage, were available year-round, and likely present in large numbers close to the village.

Regional Subsistence Systems

The following section describes three sites on the southwestern Washington coast that lend insight into coastal Lower Chehalis and Chinookan subsistence practices: the Middle Village/McGowan site (45PC106) on the mouth of the Columbia River, the Minard site (45GH15) in Grays Harbor, and the Martin site (45PC7) on the Long Beach Peninsula (Figure 7.6). These three sites fall within Lower Chehalis and Chinookan territory and are the closest coastal sites to Nukaunlth from which we have information on subsistence practices. They are therefore well-suited for comparison with Nukaunlth and can lend insight into how Nukaunlth conforms and/or defies general subsistence trends in the region.

Figure 7.6 Middle Village/McGowan (45PC106), Martin (45PC7), Nukaunlth (45PC19), and Minard (45GH15).
Map adapted from Google Earth.

Lower Columbia Chinook: The Middle Village Site

The McGowan/Middle Village site (45PC106) lies along the north side of the mouth of the Columbia River, approximately 11 miles (18 km) east of the Pacific Ocean and 32 miles (53 km) south of Nukaunlth (Figure 7.6). The site is located on a small strip of flat land nestled between the Columbia River and the steep Coast Range. The Columbia River estuary, on which Middle Village is located, contains many species found in or near Willapa Bay including fish such as salmonid, sturgeon, and herring, and marine mammals such as cetaceans (usually in offshore waters), sea otter, and three species of pinnipeds. It differs more significantly from Willapa Bay in its molluscan resources. Those present are most prevalent in the coastal areas to the north and south of the river area and are fewer in the estuary itself. These species include mussels, horse clam, butter clam, cockle, razor clams, geoduck, Pacific littleneck clam, mud clam, sand clam, and piddock clam.

The site is composed of two occupations: a fur-trade period occupation associated with Lower Chinookan peoples known as Middle Village (*qiìq'ayaqilxam*) and a late 19th- to early 20th-century cannery and fishing village called McGowan. Of interest here is the Middle Village occupation that lasted roughly 30 years, between AD 1790 and AD 1820. There is limited evidence to suggest that the site was used precontact. Middle Village contained five, possibly more, 8 x 10-meter to 8 x 12-meter plank houses that were likely primarily used in summer. While some domestic and productive activities took place at Middle Village, the focus of the site was predominantly the acquisition and consumption of fur trade goods.

Of the three sites used here as case studies from which to draw comparative insights into the subsistence practices of coastal Lower Chinook and Lower Chehalis groups, Middle Village is the one we know the most about. While the focus of activities there was trade, subsistence refuse tells us about the types of foods consumed during a postcontact era summer village. Archaeological excavations and investigations there were conducted in 2005 in conjunction with a highway realignment project. Approximately 143 m^2 were excavated using hand-trowel methods in the testing and formal excavation phases (Wilson et al. 2008). An additional 486.5 m^2 was mechanically stripped and trenched. These excavations occurred relatively recently, are the most comprehensive, rigorous, and up-to-date archaeological investigations on the southwestern Washington coast, and certainly provide the most in-depth descriptions of the archaeological methods, deposits, and insights of the three sites chosen for comparison here. Most notably, Middle Village is the only site discussed in which excavated deposits were passed through 1/8" mesh. Given the large-scale nature of these excavations and the sheer volume of faunal remains recovered, a subsample was analyzed.

The faunal remains from Middle Village, analyzed by Virginia L. Butler, Kristine M. Bovy, and R. Lee Lyman, show that fish was a true staple for those who resided there. Fish was the most abundant food resource by NISP—17,859 fish specimens were recovered. By comparison, a mere 181 shellfish, 12 bird, and at least 56 mammal[41] specimens were recovered (Table 7.3). Of the 7,162 fish specimens that could be assigned to at least family, the overwhelming majority (88%) were identified to be sturgeon (*Acipenser* sp.). Following sturgeon, salmonids (mainly *Oncorhynchus* sp.) were the second most common, representing 11% of the fish assemblage. Only 6% of identified fish were neither sturgeon nor salmonid. These included rockfish, flatfish, minnow-sucker, shark, eulachon, and herring (Wilson et al.

---

[41] Lyman, when reporting his analyses of mammal faunal remains at Middle Village, does not indicate how many specimens could be positively identified as mammal, but were unidentifiable to Order. Therefore, 56 is the minimum number of mammal specimens recovered and may underrepresent the true nature of the assemblage overall.

2008:241). Given the period at which Middle Village was occupied, its proximity to Fort Astoria and Fort George, and the abundance of sturgeon and salmonid remains at the site, Middle Village was likely a production center for the fish trade. However, a high proportion of fish remains were charred and calcined and found in association with hearths, floor midden, and activity areas (Wilson et al. 2008:406). This suggests that at least some portion of the fish remains recovered represent food that was consumed on-site.

The avian, mammalian, and shellfish assemblages, though meager in comparison to the fish assemblage, nonetheless give us some insights into the areas exploited by those living at Middle Village. The majority of the very small avian assemblage were duck specimens (five of the eight bones identified to element). The mammalian faunal assemblage is composed of species common to the area: mountain beaver, beaver, porpoise/dolphin, black bear, harbor seal, elk, and deer. Most notably, five species of mollusks were identified: *Mytilus* sp. (*M. trossulus* or *M. californicus*), Tellinidae (likely *M. nasuta*), *Tresus* sp. (*T. Capax* or *T. nuttallii*), *C. nuttallii*, and *S. gigantea* (Table 7.5 & Table 7.6). *Tresus* sp. was the most abundant of the species identified. However, its unique chondrophore is both easily distinguishable and particularly robust and is, therefore, more likely to preserve and be identified in the assemblage. It is also important to note that only 5.5% of the assemblage (a mere 18 specimens) could be identified to taxon due to the extreme fragmentation of the assemblage. However, both *Mytilus* sp. (due to the shell's purplish hues) and *C. nuttallii* (due to the shell's distinct radial ridges) are easily identifiable, even when highly fragmented. Therefore, it is safe to assume that the remaining 163 unidentified shellfish fragments are neither Mytilus nor *C. nuttallii* and are most likely one of the identified clam species. Again, the charred and calcined condition of the mammalian, avian, and molluscan remains, as well as the association with hearths and other activity areas suggests that these foods were consumed on-site (Wilson et al. 2008:406).

Table 7.3 Faunal classes at the Middle Village site

	NISP	***% NISP***
Fish	17,859	98.62
Shellfish	181	1.00
Terrestrial Mammal	50	0.28
Avian	12	0.07
Marine Mammal	6	0.03
Total	18108	100.0

Lower Chehalis: The Minard Site

The Minard site is located on the first of two dune ridges immediately west of the western shore of North Bay in Grays Harbor, Washington (Figure 7.6). It lies only 1200m east of the Pacific shore, 6 miles (10 km) north of the entrance to Grays Harbor, and approximately 22 miles (36 km) north of Nukaunlth. It is, as far as we currently understand, a large Lower Chehalis shell midden site that contains evidence of house features including post molds, hearths, and heavy ash concentrations. Lower Chehalis peoples continuously occupied or otherwise utilized this area (likely year-round) from AD 1000 to AD 1600 and again after AD 1680. Artifacts from this shell midden also suggest a protocontact and early postcontact occupation (Bovy 2005).

Richard D. Daugherty first recorded this site in 1947, likely during the same survey in which he recorded Nukaunlth. Archaeological testing and excavations of the site were carried out by Daugherty and Tom Roll in 1969 and 1970. The best record of this fieldwork is Roll's (1974) dissertation. Portions of the site were excavated in 2 x 2-meter squares. Other areas of the site were tested using a 30 cm diameter power auger. Excavations were carried out in 20 cm arbitrary levels, and unearthed materials were passed through a ¼" screen. While all mammalian and avian remains were collected, only "judgmental" samples of fish and shellfish occurring in each level were collected. The part of the site called "Area B" was the deepest portion of the midden, reaching a maximum depth of 1.5 meters, and is from where the richest and largest samples were taken (Roll 1974). The following information on the faunal remains and subsistence practices at the Minard site comes from this area.

In a general overview of subsistence remains found at Minard, Roll indicates that shellfish, fish, and mammal remains were the most common elements in the midden deposits: "whole broken and crushed shellfish remains comprised the bulk of the midden, with fish bone, land mammal, sea mammal, and bird bone as successively less prominent constituents" (1974:203). As such, he suggests that those living in or otherwise utilizing Minard practiced an "estuarine/riverine-coastal lowland procurement system" (Roll 1974:254). Artifacts found at the site reinforced this orientation, with 75% of all procurement tools associated with riverine/estuarine microenvironments. Furthermore, Roll proposes that the midden assemblage contains limited evidence of diachronic change and presents a relatively stable procurement system within the 600+ years of occupation.

Unfortunately, raw numbers were few and far between in Roll's account of the faunal assemblage at Minard. This is likely due to the large volume of excavated materials typical of archaeological investigations at that time. Instead, Roll provides rough estimates and percentages to give us insights into the subsistence system of the Lower Chehalis peoples who occupied Minard. Within the shellfish assemblage, bent nose clam (*M. nasuta*), basket cockle (*C. nuttallii*), bay mussel (*M. trossulus*), and razor clams (*S. patula*) were abundant. Other species present include gaper clam (*Tresus* sp.), butter clam (*S. gigantea*), and Pacific littleneck clam (*P. staminea*). Whelk, barnacles, limpets, and crab were recovered, but Roll classifies them as “rare” or “very rare” (Roll 1974:204). Little attempt to classify fish was made. Salmon vertebras were abundant and appear most prominently in the midden after shellfish. Fish other than salmon were not abundant. Rockfish were rarely noted, and sturgeon was a “rare element in most strata” (Roll 1974:204).

Within the mammal assemblage, Snowshoe hare (*L. americanus*) was the most prominent. The rest of the assemblage was given as a percentage (excluding snowshoe hare). Like the mammal assemblage at the Middle Village site, the Minard assemblage is made up of the sea and land mammals typical of the region. Elk and deer comprise 45% of the non-hare mammal assemblage collectively. Smaller marine mammal species comprise 20%, smaller land mammals comprise an additional 20%, and larger marine mammals comprise the remaining 15%. Roll indicates that avian remains are a minor element of the faunal assemblage. However, he provides no raw numbers, nor does he estimate the percentage of the entire faunal assemblage that avian remains might encompass. In 2005, Kristine Bovy investigated the entire avian assemblage from the Minard site as a part of her dissertation. She analyzed 3,498 avian bones. This gives us some clues as to the prolific faunal assemblage recovered at Minard. Her dissertation goes into more detail about the avian species present at Minard than is needed here. It is sufficient to state that the avian assemblage at Minard is diverse, but Sooty Shearwaters (*P. griseus*) and Cassin’s Auklets (*P. aleuticus*) are the most abundant species recovered (Bovy 2005).

The Willapa Bay Sub-Region: The Martin Site

The Martin site is on the eastern slope of a north-south trending dune on the Long Beach Peninsula of Willapa Bay, 14 miles (23 km) south of Nukaunlth (Figure 7.6). It is difficult to state the distance between the site and the Pacific Ocean at the time of occupation, as the coastline of the Long Beach Peninsula has changed drastically within the last 200 years. However, it is very likely that, at the time of occupation, water probably abutted the site on the southeast via a slough that joined Willapa Bay, and the Pacific shore would not have been far. The Martin site is a precontact shell midden spanning 150 m north-south by 50 m east-west (Kidd 1974:15) with evidence of possible structures. The known maximum depth of the midden is approximately 1 meter. The Martin site lies within the northern portions of what most consider to be Chinookan territory. Like Nukaunlth, it lies in an area that may have been Lower Chehalis at one point in time, or more likely, was used regularly by both communities throughout history. Given its relatively early occupation[42]—as early as 1,860 ± 100 BP—and that archaeological investigations of the Martin site happened at the start of the discipline's interest in the Washington coast, there has been little discussion about the ethnic identity of the occupants of this site. Most archaeologists who have worked here have accepted that they were likely ancestral Chinookan people.

An overview of the archaeology done at the Martin site is given in Chapter 2. Here, it suffices to say that of the four distinct excavations efforts that occurred at the site between 1958 and 1974, only Robert S. Kidd's (1960) report gives anything more than a cursory discussion of the evidence of subsistence practices. In his general overview of the site, Kidd makes several references to a diet that was probably heavily reliant on shellfish, particularly oysters and cockles. In his view, the subsistence refuse at the Martin site indicates that shellfish harvesting

---

[42] It should be made clear that the chronology of the Martin site was determined via limited radiocarbon dating. Only two samples from the Martin site were submitted for radiocarbon dating by Robert Shaw in 1974. Therefore, our understanding of the antiquity and chronology of the Martin site is limited, at best.

was more important than fishing for those who lived there, although he gives little empirical evidence to support this claim. More detailed information, however, is provided in Margaret L. Susia's analysis of faunal remains provided at the end of Kidd's report.

Susia focused her analysis on the faunal assemblage excavated from 5.5 m^2 of the deepest part of the midden. Excavations were carried out following 20 cm arbitrary levels, and materials were passed through a ¼" screen. In her analysis, only land and sea mammals, and a subsample of shellfish, were identified to taxon. Like the Minard site, Snowshoe hare (*L. americanus*) is the most abundant mammal found. Mouse, deer, sea otter, harbor seal, elk, muskrat, bobcat, and beaver were found in lesser quantities, respectively. Remains of cetaceans, large and small, were found, but no species identification was made, nor an MNI estimate. While bird and fish bones were not analyzed in any great detail, weights of mammal, fish, and bird bone were given to indicate relative quantities (Table 7.4).

Susia also conducted a more detailed analysis of selected layers of a 20 cm x 20 cm column that ran the depth of the midden. Because these samples come from a column, they were not screened in the field. Therefore, Susia calculates the total percentage by including all residue, i.e., all materials and soil that passed through a 1/8" screen. Her analysis takes a closer look at the shellfish assemblage and provides relative percentages of shell and bone. Reflected here is a potentially very high percentage of shellfish in the diet of those living at the Martin site. In all samples analyzed, bone frequencies do not surpass 2% of total weight. Shellfish, comparatively, comprise as much as 39%. However, Susia is careful to note that these are small samples (approximately 50 grams each) and that bone found at the site tended to be concentrated in specific areas. Thus, in her opinion, these numbers give us a good idea as to the makeup of the shell assemblage but may not be an accurate description of the relative frequency of bone in the midden deposits. Within the shell assemblage, Susia estimates that 70% of the shell by weight was Olympia oyster (*O. lurida*) (Kidd 1960:136). This preference for native oysters is unusual, given what we know from oral histories and historical records. These sources state that Chinookan people tended to favor clams above oysters, and in postcontact times Native peoples in Willapa Bay harvested oysters purely for trading with Euro-Americans (Swan 1857:59). This suggests that something, whether it be preference, harvesting technology, ecology, or something else entirely, may have shifted between when the Martin site was occupied and the postcontact period. Following oyster, basket cockle was the most consumed, then various species of clams. Only slight quantities of mussels were recovered. All species found at the Middle Village site, the Minard site, and the Martin site are presented in Table 7.5 & Table 7.6.

Table 7.4 Weight of faunal classes at the Minard site, test pit 3 (Kidd 1960)

	Weight (g)	***% Weight***
Mammal	2,332.0	91.45
Fish	142.3	5.58
Avian	75.8	2.97
Total	2,550.1	100.0

Foodways at Nukaunlth in a Regional Perspective

To situate our understanding of the subsistence practices and use of marine resources at Nukaunlth within a regional perspective, I compare species diversity, key resources, and relative abundance of broad faunal classes at the three sites described above and Nukaunlth. These three sites and Nukaunlth have several things in common. All sites are water-oriented, that is, they are all adjacent to and approachable via water, or were at the time in which they were occupied. Although approximately 56 miles (90 km) lie between the southernmost and northernmost sites, most sites are near similar ecological zones, and the wildlife present in the general area around the sites are similar. Not surprisingly then, the three sites share many species in their faunal assemblages (Table 7.5 & Table 7.6). The primary difference geographically and ecologically between the sites is that the Columbia River estuary, where the Middle Village site is located, is a high flow estuary. In contrast, Grays Harbor and Willapa Bay are low flow estuaries. This affects what species will be found in the area, most notably the shellfish in the immediate vicinity of the site.

Species Diversity

The ecological variation between the Columbia River estuary, on the one hand, and Grays Harbor and Willapa Bay on the other, is represented in the subsistence refuse and species diversity found at Middle Village. Here, there is a scant record of shellfish consumption. Middle Village is not near an ecological zone that contains shellfish beds. Despite this, five species of shellfish were identified in the assemblage: *Mytilus* sp. (*M. trossulus* or *M. californicus*), Tellinidae (likely *M. nasuta*), *Tresus* sp. (*T. Capax* or *T. nuttallii*), *C. nuttallii*, and *S. gigantea.* All of these species, besides *Mytilus,* are not found in the Columbia River estuary itself, preferring sheltered low-flow estuaries (Figure 7.2). Interestingly, most of the taxa identified are more commonly present in Willapa Bay and exposed Pacific coastlines. This suggests that Willapa Bay was the main target of the shellfishery occurring at Middle Village (Wilson et al. 2008:236).

In contrast to Middle Village and similar to what was found at Nukaunlth, shellfish appears to be heavily utilized at the Minard and Martin sites. These three sites are adjacent to bays known for shellfish productivity, and nearly identical suites of shellfish taxa were recovered from them (Table 7.5). All shellfish represented in the Martin assemblage was recovered from

Nukaunlth, except razor clam (*S. patula*). The shellfish assemblage from Minard contained limpets, which were not found at Nukaunlth or Martin, but lacked Olympia oyster (*O. lurida*). By and large, all shellfish taxa most commonly found in Grays Harbor, Willapa Bay, and on the adjacent ocean beaches were recovered from the sites located on these estuaries, albeit in different relative frequencies, discussed below.

There is more variation between the fish assemblages of Martin, Minard, Middle Village, and Nukaunlth. This may be due, in part, to differences in sampling and reporting techniques. Unfortunately, the fish assemblage from the Minard site was only minimally described, and no data were given on the fish assemblage at the Martin site. As such, there are some obvious unknowns. That being said, two of the most utilized taxa at Nukaunlth—salmonids, and sturgeon—were found at Middle Village and Minard. In comparing the fish assemblages of Middle Village and Nukaunlth, there is a good amount of overlap in the species represented. Of the seven taxa found at Nukaunlth, five were also found at Middle Village.[43]

Some of the disparities in the fish assemblages are likely due to environmental differences. Rockfish (*Sebastes*) was recovered at both Middle Village and Minard, but absent in the assemblage from Nukaunlth. Rockfish, as their name suggests, often inhabit benthic areas around rock outcrops (Carrasquilla-Henao et al. 2019). Such areas are lacking around Nukaunlth, and I suspect this is the reason for their absence in the assemblage. Likewise, minnow or suckers (Cyprinidae/Castostomidae) were found in the Middle Village assemblage but were absent at Minard and Nukaunlth. Minnows and suckers are freshwater fishes.

---

[43] Analysis of the fish assemblage from Middle Village groups all members of subclass Elasmobranchii (sharks, rays, and skates) together. Thus, I collapsed this group for comparison.

Freshwater streams and rivers are not far from both sites, but Nukaunlth, in particular, shows an emphasis on lower estuary/marine resources and little use of purely riverine species. Surfperch (*Amphistichus* sp.) was recovered from Nukaunlth, but not from Middle Village. Surfperches are commonly found in the Columbia River estuary throughout the year. However, they have a narrower range of suitable habitats than other species, and such habitat requirements may have limited their availability in the area around Middle Village.

Unlike surfperch, there are no environmental differences that I am aware of that can explain why sculpin (*L. armatus*) was found at Nukaunlth and not in the Middle Village assemblage. Sculpins tolerate a wide range of habitat characteristics and are abundant in the Columbia River estuary year-round, at least in modern times (Figure 7.1). Eulachon is present in the Middle Village assemblage but absent at Nukaunlth. Again, I cannot find any environmental differences between the two sites that would account for this absence. Eulachon was an important resource for Chinookan and Lower Chehalis peoples (Boyd et al. 2013) and annually traveled up Willapa Bay during their spawning events (Mallette 2014). Eulachon bones are quite small, and further sampling at Nukaunlth with 1/16" sieves and/or an investigation of the heavy fraction of flotation samples may indicate that my sampling strategy overlooked their presence at the site.

The marine mammal, terrestrial mammal, and avian assemblages from the four sites differ more than the shellfish and fish assemblages. Still, some general trends exist. Whale and sea otter were identified at all sites except Middle Village. Whales rarely enter the Columbia River estuary and are generally not in the region during the summer months, when Middle Village was likely occupied. As such, the absence of whale at Middle Village is not unexpected. All marine mammal species identified at Nukaunlth were also found at Minard. The Minard site has a much more diverse marine mammal assemblage than Nukaunlth, Martin, or Middle Village. Seven species of marine mammals were recovered at Minard. In contrast, only three species at Nukaunlth, three at Martin, and two at Middle Village were identified. This may be because Minard is closer to marine environments than any other site, and those living at Minard were utilizing this environment more frequently.

Of the terrestrial mammal species identified, three were found at all four sites: elk/wapiti (*C. canadensis* or *C. elaphus*), deer (*O. hemionus*), and beaver (*C. canadensis*). Mountain beaver (*A. rufa*) was recovered from all sites except the Martin site. All four species are common throughout the Northwest Coast and are known to be important terrestrial resources for Chinookan and Lower Chehalis peoples (Gahr 2013; Hajda 1990; Harpole 2006). Cougar (*P.* concolor) was the only terrestrial species found exclusively at Nukaunlth. However, oral histories suggest they were commonly hunted in the region (Heritage Committee 1984a). No avian species was ubiquitous at all sites. Avian remains from the Martin site were not identified to species, and therefore the Martin site is excluded from this particular discussion. The Minard site has an extremely diverse avian assemblage, and all avian species in the Middle Village and Nukaunlth assemblages were also found at Minard, although not the same species. Nukaunlth and Middle Village do not share any avian species. Two of the species recovered from Nukaunlth are rarely in the region during summer (Figure 7.3), the season in which Middle Village was occupied.

When comparing these four sites, I find that many species were ubiquitous in the faunal assemblages, including five species of shellfish, three species of terrestrial mammal, and two species of fish (Table 7.5 & Table 7.6). I suspect the sites would share many more fish species in common had the identification of fish specimens been carried out with the same rigor at the

Minard and Martin sites as at Middle Village and Nukaunlth. The variation that does exist in species diversity seems to be related, in some cases, to the season of occupation and local environmental conditions and this is to be expected. Some of the species absent from the Middle Village assemblage—whale (Cetacean), northern fulmar (*F. glacialis*), and common murre (*U. aalge*)—are rare or absent in summer. Likewise, some differences may be due to differences in the local environments around the sites. The presence of minnows and suckers in the assemblage from Middle Village suggests the use of riverine environments, which would have been both nearby and productive. In contrast, the diversity of marine mammals at the Minard site may indicate more use of the adjacent open Pacific coastline and environment.

By and large, this variation indicates that those occupying the sites investigated here were utilizing the resources found locally. However, one notable exception exists. The presence of shellfish at Middle Village, albeit in small quantities, suggests that those occupying this summer village were traveling to Willapa Bay to target this resource. I can only speculate as to why this was the case. Middle Village was a summer village that would have been used by people throughout the Chinookan territory to partake in the trade with Euro-American settlers. Perhaps communities who resided in Willapa Bay at other times of the year brought shellfish with them or periodically returned to gather shellfish, either for personal consumption or trade. Broadly speaking, however, the suite of animal resources used by those living at Nukaunlth are very similar to those indicated by the assemblages at the Minard, Martin, and Middle Village sites. Only three species were unique to Nukaunlth: cougar (*P. concolor*), sculpin (*L. armatus*), and surfperch (*Amphistichus* sp.). I suspect further identification of the fish assemblage at Martin and Minard would indicate the presence of surfperch and sculpin at these sites.

Table 7.5 Faunal taxa identified at Middle Village, Martin, Minard, and Nukaunlth sites

Taxon	***Middle Village 45PC106***	***Martin* 45PC7***	***Minard 45GH15***	***Nukaunlth Village 45PC19***
Shellfish				
Mytilus sp. – edible mussel	X	X	X	X
Tellinidae (likely *M. nasuta*) – bent-nosed clam	X	X	X	X
Tresus sp. (*T. capax or T. nuttallii*) – fat or Pacific gaper	X	X	X	X
C. nuttallii – basket cockle	X	X	X	X
S. giganteus – Washington/butter clam	X	X	X	X
O. lurida – native/Olympia oyster		X		X
P. staminea – Pacific littleneck clam		X	X	X
S. patula – razor clam		X	X	
N. lamellosa – frilled dogwinkle		X	X	X
Land snail	X	X		X
Crab		X	X	X
Barnacle		X	X	X
Limpet			X	
Fish				
Acipenser sp. – sturgeon	X		X	X
Oncorhynchus sp. – salmonids	X		X	X
Sebastes – rockfish	X		X	
Pleuronectiformes – righteye flounders	X			X
Cyprinidae/Castostomidae – minnow or sucker	X			
Elasmobranchii – ray, shark, or skate	X			X
T. pacificus – eulachon	X			
Clupeidae – herring	X			X
L. armatus – sculpin				X
Amphistichus sp. – surfperch				X
Marine Mammal				
E. lutris – sea otter		X	X	X
Cetacean (large) – whale		X	X	X
Cetacean (small) – porpoise or dolphin	X		X	
P. vitulina – harbor seal	X	X	X	
C. ursinus – northern fur seal			X	
E. jubatus or *Z. californianus* – sea lion			X	X
M. angustirostris – northern elephant seal			X	

* Fish was not identified to taxon at this site.

Table 7.6 Faunal taxa identified at Middle Village, Martin, Minard, and Nukaunlth sites, continued

Taxon	***Middle Village 45PC106***	***Martin* 45PC7***	***Minard^ 45GH15***	***Nukaunlth Village 45PC19***
Bird				
Puffinus griseus – Sooty Shearwaters			X	
P. aleuticus – Cassin's Auklets			X	
Phoebastria sp. – Albatross	X		X	
Anatinae, large – duck	X		X	
Anatinae, small – duck	X		X	
B. canadensis – Canada goose			X	X
F. glacialis – northern fulmar			X	X
U. aalge – common murre			X	X
Terrestrial Mammal				
L. americanus – snowshoe hare		X	X	
O. hemionus – mule deer	X	X	X	X
C. canadensis or *C. elaphus* – elk/wapiti	X	X	X	X
A. rufa – mountain beaver	X		X	X
Castor canadensis – beaver	X	X	X	X
C. familiaris – domestic dog			X	
C. latrans – coyote			X	
L. canadensis – river otter			X	
O. zibethicus – muskrat		X	X	
U. americanus – black bear	X		X	
Scapanus sp. – mole	X			X
Sciuridae – squirrels and relatives	X			
B. taurus – domestic cow	X			
Peromyscus sp. – mouse		X		
L. rufus – bobcat		X		
P. concolor – cougar				X

* Bird was not identified to taxon at this site.

^ Many more avian species were identified at the Minard site by Bovy (2005). Listed here are the most abundant.

Key Resources and Relative Abundance of Species

While those who occupied the Middle Village, Minard, and Martin sites utilized a similar suite of faunal resources, the species that were targeted or exploited most frequently varied. Without question, those living at Middle Village focused their efforts on fishing sturgeon. In contrast, the Nukaunlth, Minard, and Martin sites assemblages indicate a strong emphasis on shellfish.

At each site, the most exploited shellfish species varied (Table 7.7).[44] Bent-nose macoma (*M. nasuta*) was the most abundant species found at Minard (Roll 1974:204). At the Martin site, there appears to have been a strong preference for the native Olympia oyster (*O. lurida*). As is described in detail in Chapter 6, cockle is the most frequently recovered shellfish species at Nukaunlth. At Martin and Nukaunlth, the most commonly recovered shellfish species make up the majority of the shellfish assemblage, comprising more than 70% and 52% at each site, respectively. This reflects a broad trend found among Northwest Coast midden sites; there is often a high diversity of species represented, but a proportional dominance of a single species in the assemblage (Cannon et al. 2008). Unfortunately, limited quantitative data were given in Roll's description of the shell assemblage at the Minard site. Therefore, it is impossible to know just how much more abundant bent-nose clam was than other species in the assemblage and if the Minard site also adheres to this trend.

Given the available data, it is unclear whether the focal shellfish species varies between sites due to temporal or spatial microenvironmental differences, dietary preferences, or some other reason. Each focal species has differing yet overlapping habitat requirements (Table 7.1). However, the Minard and Martin sites have occupation dates that begin well before Nukaunlth—somewhere in the range of 1,500 and 500 years earlier—and thus current data on the microenvironments of Willapa Bay and Grays Harbor are less relevant when discussing the possible procurement locales. Future environmental reconstructions of past habitats in and around Willapa Bay and Grays Harbor would go far in elucidating the cause of such variation.

---

[44] As does the quantification method. At the Martin site, weight was used to determine relative frequencies. Roll (1974) does not indicate whether weight, NISP, or some other measure was used to calculate the rank order of abundance.

Table 7.7 Rank order of abundance* of top four shellfish taxa at regional sites with emphasis on shellfish harvesting

	Martin	*Minard*	*Nukaunlth*
C. nuttallii – cockle	2	2	1
Mytilus sp. – mussel		3	2
S. gigantea, M. nasuta, Tresus sp. – clam	3	1[a]	3
N. lamellosa – frilled dogwinkle			4
O. lurida – Olympia oyster	1		
S. patula – razor clams	4	4	

*Rank order of abundance is calculated using the weight of shell for Martin and Nukaunlth. No data were found on the quantification method used to calculate the rank order of abundance by Roll (1974) for the Minard site.

[a] *M. nasuta* is ranked highest in the Minard assemblage. *S. gigantea* and *Tresus* sp. were not present in high enough quantities to rank in the top four shellfish taxa at this site.

Within the fish assemblages, salmon is exploited most frequently at Minard and Nukaunlth. Unfortunately, fish was not identified to species at the Martin site. As noted earlier, Middle Village differs significantly from the other sites investigated in that the vast majority of the fish assemblage (and the faunal assemblage overall) is sturgeon. However, Middle Village diverges from the other sites investigated here, as it had a clear seasonal occupation that was oriented towards participating in trade with Euro-American settlers. In her analysis of fish from the site, Virginia Butler posits that the village was a production center for the fish trade (Wilson et al. 2008:249). Thus, the fish assemblage at Middle Village may not reflect Indigenous foodways in the same way as the other sites in this discussion. That is, the high proportion of sturgeon at Middle Village may reflect an emphasis on sturgeon trade and is not necessarily equivalent to the portion of sturgeon in the diet of the Indigenous community who resided there.

Using meat yield estimates, I posit that marine mammal species, particularly whale, were likely important resources that contributed more edible meat to the diet of those living at Nukaunlth (approximately 20% of the edible meat reflected in the assemblage) than would be expected when quantifying using NISP and bone weight (see Chapter 6). Marine mammal was recovered from all three comparative sites, and whale specifically was recovered at the Martin and Minard sites. However, limited data on the relative abundance of marine mammals were given for these sites. Thus, it is difficult to say with certainty whether whale should be considered an important resource regionally, or if this is unique to Nukaunlth. Further quantitative analysis of the faunal assemblages from the Martin and Minard sites, both housed at the University of Washington Burke Museum, would be hugely beneficial to our understanding of ancestral Indigenous foodways in this part of Chinook and Lower Chehalis territory.

While Minard, Martin, and Nukaunlth differ in the top exploited shellfish species, the rank order of abundance of broad faunal classes is the same at these sites (Table 7.8). That is, shellfish appear to be most used, followed by fish, then mammals. Roll, in his comparison of the Martin and Minard sites, notes that while the tool assemblage overrepresents the use of land mammals at the Martin site, the faunal assemblage shows the same orientation towards an estuarine environment. He interprets this discordance to technological differences, with those occupying the Martin site relying more heavily on nets rather than weirs to capture salmon and other migratory fish (Roll 1974:272). At all four sites, the faunal assemblages indicate an orientation towards the marine/estuarine environment and a reliance on marine resources.

Table 7.8 Ranking of broad faunal classes^ at Middle Village, Martin, Minard, and Nukaunlth

	Middle Village 45PC106	***Martin 45PC7***	***Minard 45GH15***	***Nukaunlth 45PC19***
Shellfish	2	1	1	1
Fish	1	2	2	2
Mammal*	3	3	3	3
Avian	4	4	4	4

^ Middle Village and Nukaunlth ranking are based on NISP quantification methods. Martin rankings are based on weight. The quantification method of ranking at the Minard site is unknown.

*Sea Mammal and Terrestrial Mammal are grouped as they are not differentiated in previous studies.

Conclusion

In this chapter, the archaeological data from Nukaunlth were examined in light of three aspects of subsistence practices: seasonality of site use and subsistence rounds, procurement locales, and shellfish harvesting strategies. This information was then used to evaluate alternative explanations of midden composition to inform our understanding of the importance of marine resources among Lower Chehalis and Chinookan people living at the ancestral village of Nukaunlth. Our understanding of the use of marine resources in the foodways at Nukaunlth was then put into a regional perspective by examining three other coastal Lower Chehalis and Chinookan villages.

Analyzing the seasonal availability of resources identified in the Nukaunlth assemblage suggests a fall/winter occupation of the village that likely persisted into spring. While no resource identified was available exclusively in summer, it is possible that the village was also occupied during this season. Given the year-round availability of shellfish and many fish species, seasonal subsistence rounds were difficult to ascertain. However, future stable isotopic and sclerochronological analyses would go a long way in elucidating this aspect of subsistence practices at Nukaunlth and confirming the season of site use.

Comparing the habitat requirements of the faunal species present in the Nukaunlth assemblage with local environmental data indicates that most animal foodstuffs could have been procured close to the village. The most abundantly used shellfish species, *C. nuttallii*, may also have been the easiest to access as it is a shallow burrower and occupied a wide range of bathymetric depths. However, four species—sturgeon, spiny dogfish, skates, and gray whale—are found only in open estuarine or marine environments, and residents of Nukaunlth likely traveled westward towards the mouth of the bay or coastal beaches to obtain these species.

The growth-stage profiles of 10 samples of *C. nuttallii* shells were investigated to lend insight into shellfish harvesting practices. Although derived from a small sample, 80% of the specimens investigated were at the senile-growth stage. This preliminary analysis suggests that those living at Nukaunlth may have been practicing some selective harvesting or resource management, or at the very least, were not intensively harvesting this species to the point of resource depression. Further sampling is needed, but this small sample is important in that it provides clear evidence of differences in mature vs. senile growth-line patterning in *C. nuttallii* that can be used in further studies on shell fragments with intact ventral margins.

When evaluating alternative explanations for midden composition in light of the data presented here and in Chapter 6, I suggest that the midden composition at Nukaunlth reflects aspects of both explanations. Midden composition faithfully tracks the natural spatial distributions of shellfish, given what we know of past and present Willapa Bay ecology. However, there is some indication that shellfish harvesting did not occur purely opportunistically, as preliminary growth-stage analysis hints at some degree of resource management.

Likewise, I find that some of my initial expectations were met and others were not. Shellfish were likely a large part of Chinookan/Lower Chehalis diet and were without a doubt harvested in great numbers. However, I found no indication that they were harvested intensively to the point of resource depression. Some species of shellfish were most certainly harvested in greater numbers than others, but this may have been a product of the local habitat and accessibility. In particular, cockles (*C. nuttallii*), the most utilized species, was likely the most abundant and the most accessible species around Nukaunlth. By and large, it appears that shellfish was an important resource that was harvested in great quantities and with remarkable consistency by those living at Nukaunlth. It’s reasonable to suggest that shellfish could have been a staple resource for this community because shellfish made up the bulk of the faunal assemblage, were available year-round, and likely present in large numbers close to the village.

In investigating foodways at Nukaunlth from a regional perspective, I found that at this village like at other coastal Lower Chehalis and Chinook villages, subsistence practices centered on locally available marine resources. Many of these resources were ubiquitous in the faunal assemblages investigated, and common throughout Northwest Coast sites. In most cases, the limited variation that exists between sites in the diversity of species can be reasonably attributed to seasonal and microenvironmental differences, further indicating an emphasis on local food sources. This pattern is generally expected when considering the diversity of species between sites (Cannon et al. 2008; McKechnie and Moss 2016).

Those villages on shellfish-rich bays contain assemblages dominated by shellfish, followed by other marine resources. However, the focal shellfish species varied between sites. With the data presently available, I cannot conclusively determine if this variation is due to spatial and/or temporal microenvironmental differences, dietary preferences, or some other cause. However, given that the dominant species at Nukaunlth was likely found in abundance in the adjacent tidal flats, I suspect that those living at Martin and Minard were also utilizing the species most readily available to them, and thus this variation in focal shellfish species is due to microenvironmental differences. Further researcher into the paleoenvironmental characteristics of the tidal flats adjacent to all three sites would help clarify why such variation exists. Despite this difference, common among all sites investigated is an orientation towards the water and an emphasis on the food resources therein.

When discussing the cultural influence of shellfish, the cultural director of the Shoalwater, Earl Davis, described shellfish as important in the sense that they were "just always there" (personal communication). When I pressed him to rank the cultural importance of shellfish compared to salmon and other species known to be culturally relevant to Northwest Coast communities, he stressed that it would be wrong to think of one food source as more important than the other. Instead, they are important for different reasons and in different ways. Shellfish is not associated with the same pageantry as salmon, but shellfish is an everyday food, and "culture is everyday living" (Earl Davis, personal communication).

Cockles are no longer commonly eaten within the community, and many people were surprised to find they were eaten in the past, but other shellfish including butter clams and razor clams are still staples. Shellfish is still served at community events, and in preparing for such events, elders come together to clean shellfish in their traditional way. Davis describes these processing events as an opportunity for cultural learning. As elders teach younger community members how to clean shellfish properly, they share stories and other cultural knowledge. Davis also noted that shellfish were and continue to be an opportunity for trade with other communities. It's well-documented that clams were commonly traded by Willapa Bay Chinook and Lower Chehalis peoples to eastern tribes in the past (Swan 1857). Today, oyster aquaculture is the leading industry in Willapa Bay, and several families of Chinook and Lower Chehalis ancestry are oyster farmers. Recently, the Shoalwater has started to revive their oyster beds for aquaculture production. The research presented in this dissertation may aid in this endeavor, as described in the following chapter.

Chapter 8 From Outcomes to Impact: Supporting Community Well-being and Revitalizing Traditional Foodways using Archaeological Data

The work we have done at Shoalwater may sometimes seem like just a few test excavations, but it is so much more than that to those of us that live here. It is a physical link to our ancestors, it is materials to be used as ambassadors to the outside world, it is evidence of our rights to coexist and possibly most importantly; being able to be a partner in this work rather than a recipient has enabled us as a people to truly believe that for the first time in a very long time we can shape and mold our own destiny. We can develop programs to combat short lifespans, we can turn to the knowledge of our ancestors so that our descendants may have a prosperous tomorrow.

- Earl Davis, Cultural Director of the Shoalwater Bay Indian Tribe

In previous chapters, I described archaeological research and data that contribute to our understanding of the importance of marine resources in the subsistence systems of Chinookan and Lower Chehalis peoples living at the ancestral village of Nukaunlth in the Late Pacific, protocontact, and postcontact periods. Through archaeological investigations of Nukaunlth, I have demonstrated that marine resources—shellfish, marine mammals, and fish—were key resources used by those living at this ancestral village and arguably indispensable to their lifeways. In Chapter 4, I described *why* and *how* representatives of the Shoalwater and Chinook Nation and I developed this research agenda. In this chapter, I detail the resulting *what*. That is, I discuss the programs and public goods stemming from this research that the Shoalwater are using to revitalize traditional foodways, establish food sovereignty, and improve dietary health. In doing so, I present one of many possible answers to the question; how can archaeological research contribute to the well-being of Indigenous communities?

Each community is unique, with distinctive needs, interests, and priorities and therefore warrants their own particularized notion of applied archaeological research. I nonetheless contextualize my discussion of these programs and public goods by describing both the broad issues that they are meant to address and that afflict Indigenous groups globally and the social movements that arose to combat these issues. In doing so, I seek to elucidate how archaeological data are particularly suited to aid in an Indigenous rights-based approach to food sovereignty, community health, and sustainable practices broadly. I then detail how archaeological data from our work are doing so specifically and through four public goods and programs: (1) an exhibit in the Shoalwater Heritage Museum, (2) an accompanying education kit for K-12 classrooms, (3) a module for the Shoalwater Adult Diet and Nutrition course, and (4) evidence for the Shoalwater's upcoming legal case to reclaim access to traditional food resources. Through these initiatives, the Shoalwater are using Western scientific data to corroborate the long-held Indigenous understanding that local natural resources, especially marine, were indispensable to life before European settlement and that the right to access these resources is an inherent right of Indigenous peoples.

I conclude by highlighting some of the creative ways the community is using this research and the data it generates in ways that go beyond the initial scope of the project. Research at Nukaunlth has spurred first food celebrations, tribal-sponsored fishing licenses and equipment, and pilot funds for legal research. I take this as a sign of the success of our collaboration and project. More so, I see it as evidence that archaeology, when done in tandem with descendant communities and driven by their interests and needs, can be more than the data it generates; it can be a creative and speculative process by which Indigenous communities can explore their history on their own terms and craft possible futures that bring culture, health, and wellness to the forefront.

The Health Disparities of Indigenous Communities

Before the arrival of Europeans in the Americas, Indigenous communities were relatively free of lethal infectious diseases (Boyd 1999). With Europeans came numerous epidemics—smallpox, malaria, measles, and influenza, among others—and dramatic population losses. On the Northwest Coast, Indigenous populations declined by 80 percent within 100 years of colonization (Boyd 1999). Those residing on the south coast, Chinookan and Lower Chehalis peoples among them, suffered a near decimation of their communities with an estimated 87% loss in population (Boyd 1990).

Even in the globalized world that we live in today, Indigenous communities are often affected by infectious and non-infectious diseases at greater rates than non-Indigenous groups (Power et al. 2020). And while many of the infectious diseases that decimated populations at the onset of colonization have now subsided, the health impacts of colonization are far from over for Indigenous populations. Indigenous communities around the world are rapidly acquiring non-communicable diseases (NCDs, also known as chronic or lifestyle diseases) such as obesity, cardiovascular disease, and type 2 diabetes. Native Americans and First Nations peoples are particularly prone to these diseases "perhaps because of genetic disposition, changed diet and lifestyle" (Gracey and King 2009:70). A study of type 2 diabetes in Canada's First Nations saw the prevalence of this disease to be 3.6 and 5.3 times higher among First Nations men and women respectively than among Canadian men and women (Young et al. 2000). Indigenous populations in British Columbia specifically are 25% more likely to suffer from heart disease, 40% more likely to suffer from diabetes, and 54% more likely to be overweight or obese (Elliott et al. 2012). While U.S. white populations experienced significant decreases in all-cause mortality from 1990 to 2009, Native Americans did not share this positive trend. Overall, Native Americans had mortality rates that were 46% higher than white populations during this decade. This is strongly influenced by the high incidents of diabetes, smoking prevalence, problem drinking, and social determinants (Espey et al. 2014). Today, as the pandemic of COVID-19 wreaks havoc globally, the health disparities of Indigenous communities are all the more worrisome. Historical data show that Indigenous communities suffer higher infection rates and more severe symptoms and death during pandemics due to poor health, poverty, and lack of political power (Clay et al. 2019; Power et al. 2020). A recent study by the CDC indicates that Native Americans in the U.S. suffer from COVID-19 infection rates that are 3.5 times higher than white populations (Hatcher et al. 2020:1166).

In addition and compounding the issue of NCDs, Native American populations have high rates of food insecurity and consequentially inadequate nutrition (Gundersen 2007). Roughly a quarter of Native American households receive Supplemental Nutrition Assistance Program (SNAP) benefits and 68% of Native American children qualify for free and reduced lunches at school (NCAI 2019:3). A nation-wide study of food insecurity found that Native American households in the U.S. are significantly more food insecure than non-Native American houses, even when compared to households of the same income level and controlling for other factors (Gundersen 2007). Just across the border in British Columbia, 41% of Indigenous households on reservations are food insecure. The disruption of the global food systems and the economic crisis caused by COVID-19 has exacerbated an already dire situation for many Indigenous communities. Since the beginning of the pandemic, there has been an increase in the use of

FDPIR, and the numbers are expected to continue to rise (Hoover 2020). This, in turn, is correlated to higher diet-related health concerns and NCDs. Besides NCDs, food insecurity is related to an onslaught of negative health effects in Indigenous communities globally. These include inadequate dietary energy (calories), and deficiencies of specific nutrients such as iron, iodine, folic acid, zinc, and vitamins A and D (Gracey and King 2009).

NCDs are often called “lifestyle diseases”, implying personal choice. However, the rapid and patterned spread of these diseases is correlated to social inequalities and environmental changes largely imposed upon the communities that they affect. Most scholars studying the health disparities of Indigenous communities attribute these disparities to socioeconomic causes and the devastating and persistent effects of colonization. On a global scale, Indigenous peoples are overrepresented among the poor and disadvantaged and their disease susceptibility is exacerbated by poor living conditions and water supplies, restricted access to fresh and nutritious food, and inadequate health services (Gracey and King 2009). The social inequalities afflicting Indigenous communities “result from a combination of classic socioeconomic and connectivity deficits as well as Indigenous-specific factors related to colonization, globalization, migration, loss of language and culture, and disconnection from the land, lead to the health inequalities of Indigenous peoples” (King et al. 2009:76).

The colonization of Native American territories and the unresolved and often deceitful treaty processes led to a loss of access to traditional territories and relationships supporting the hunting, gathering, fishing, cultivation, and traditions of Indigenous foods. Colonization physically severed the ties of Indigenous peoples to their land, weakening or destroying the cultural practices essential for the health and well-being of these communities (King et al. 2009). This, in turn, necessitated first dependence on government rations and treaty annuities and then on state-funded commodities programs and provisions (Chino et al. 2009; Grey and Patel 2015). This was part of a broader set of assimilation practices that were designed to disavow Indigenous people of their indigeneity through destroying food production, consumption, and identity and replacing them with Western forces of modernity. These assimilation practices started the nutrition transition (described in Chapter 2) and replaced traditional foods with unfamiliar foods of interior nutrient quality, namely the "five white sins: flour, salt, sugar, alcohol and lard" (Elliott et al. 2012:5). Through the forced adoption of a Westernized diet, colonization decultured people "from the inside out" with non-nutrient-dense, industrial food—food that does not promote the health of peoples nor lands and fails to reinforce the relationship between the two (Grey and Patel 2015:438).

This legalized suppression of traditional life is worsened by modern socioeconomic and political marginalization and by racial prejudice that is often entrenched and institutionalized (Robertson 2015; Coates 2011). Subsequent poverty, under education, unemployment, exploitation, and increasing dependence on social welfare plagues the world's Indigenous communities. These oppressive factors culminate in severe inequalities in Indigenous health status and impaired emotional and social well-being (Gracey and King 2009). Compacting these issues is the widespread degradation of the environment—climate change, pollution, and deforestation—that is negatively affecting the health of all peoples.

While Indigenous communities suffer from poor health by any Western definition, they also suffer poor health by Indigenous definitions. Indigenous notions of health include elements of physical, emotional, spiritual, and mental well-being and are affected by a range of cultural factors including racism, loss of autonomy, language, and connection to the land, and environmental deprivation. Being disconnected from major aspects of cultural identity is widely understood to harm Indigenous health (Nettleton et al. 2007). The result is a layering of circumstances that have ultimately produced and sustains the health disparities that plague the world's Indigenous communities (Figure 8.1).

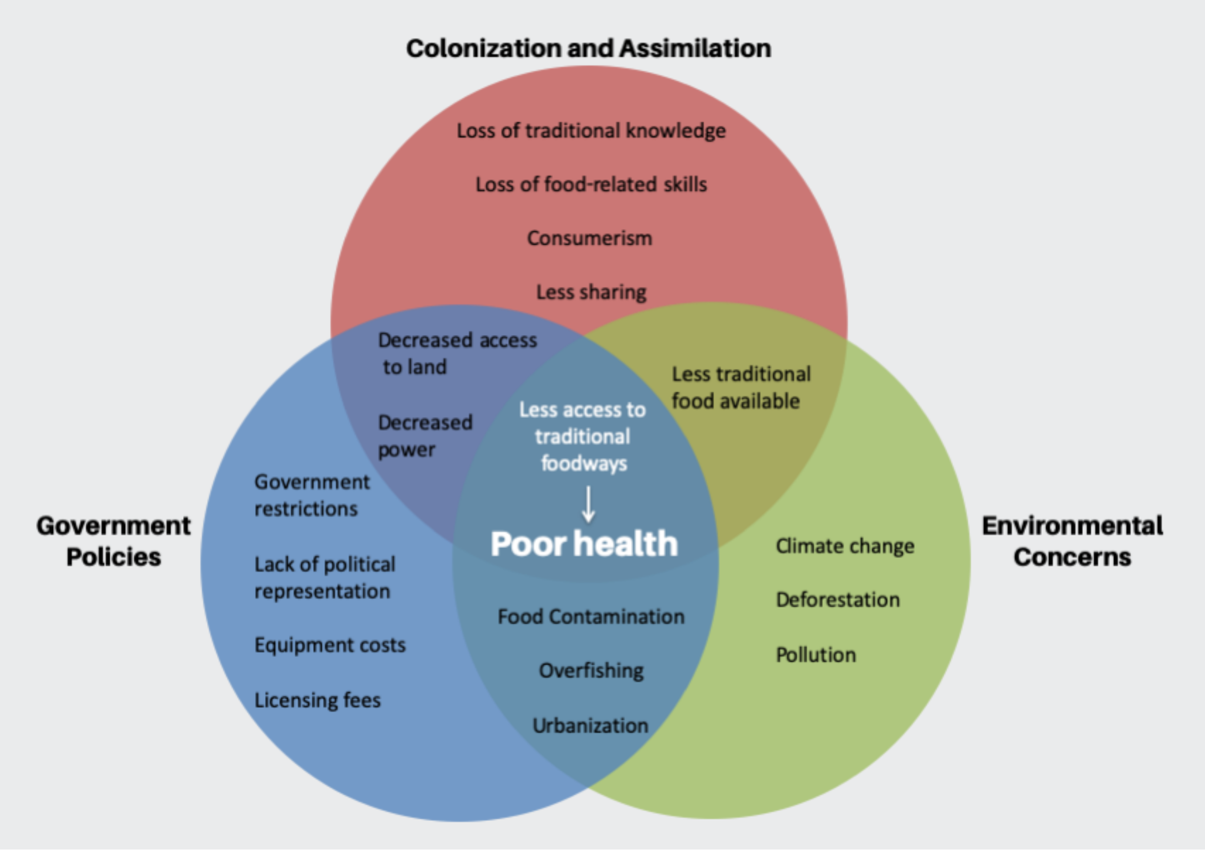


Figure 8.1 Socioeconomic determinants of health disparities in Indigenous communities

Improving Community Health through the Indigenous Rights & Food Sovereignty Movements

To remedy these widespread health disparities, a growing number of Indigenous communities are turning towards the Indigenous rights and food sovereignty movements to help revive traditional foodways and regain their rights to local and sustainable food sources. If government policies that restrict access to traditional lands, degradation of the physical environment, loss of traditional practices, and marginalization is negatively affecting the health of Indigenous peoples, then it stands that increased access to traditional territory, environmental stewardship, revitalization of traditional practices, and empowerment of Indigenous peoples would go a long way towards improving the holistic health of these communities (Elliott et al. 2012). The Indigenous rights and food sovereignty movements work towards these ends.

A major step forward for the global Indigenous rights movement occurred in 2007 when, after 22 years of consultation and development with Indigenous peoples and state governments, the UN General Assembly voted to ratify the Declaration on the Rights of Indigenous Peoples (despite Australia, Canada, New Zealand, and the United States voting against the ratification). Often referred to as UNDRIP, this legally non-binding declaration lays out a commitment to equal rights for Indigenous peoples and their right to self-determination. Among other things, the declaration states:

> "1. Indigenous peoples have the right to maintain and develop their political, economic, and social systems or institutions, to be secure in the enjoyment of their own means of subsistence and development, and to engage freely in all their traditional and other economic activities.
> 2. Indigenous peoples deprived of their means of subsistence and development are entitled to just and fair redress" (United Nations 2007).

The initial framing of the Indigenous rights-based discourse as evident in this declaration frames the goals of this movement in terms of state-derived individual rights and emphasizes political and legal entitlements. Following this declaration, there has been a movement towards reframing the Indigenous rights discourse as sustainable self-determination with the explicit goal of producing economically, environmentally, and culturally viable means of asserting rights that reflect the Indigenous reciprocal relationship to the natural world. While rights-based discourses help promote political maneuverability of Indigenous peoples within a state-centered system, sustainable self-determination puts on equal footing the cultural responsibilities and relationships critical for the well-being of current and future Indigenous communities (Corntassel 2008). These efforts are sustainable in two senses of the word. They seek to establish an autonomy that can persist for future generations while maintaining resources (cultural, political, and environmental) over the long term.

The Indigenous-rights discourse is inextricably linked to food sovereignty, as Article 20 of the UNDRIP illustrates. The food sovereignty movement got its start in 1996 when a transnational organization of peasants representing 69 countries, La Via Campesina, called for the rights of all people to healthy and culturally appropriate food produced through ecologically sound and sustainable methods and the right of peoples to define their own food systems (Patel 2009). Broadly, the food sovereignty movement works towards strengthening community and livelihoods, and environmental and social sustainability in the production, consumption, and distribution of nutritious and culturally appropriate food (Desmarais and Wittman 2014). While initially started by a group of small-scale farmers, the food sovereignty movement is particularly useful in enumerating the goals of historically non-agrarian communities working towards revitalizing traditional foodways. Indigenous food sovereignty explicitly recognizes that the loss of access to traditional territories and the destruction of the relationships supporting the hunting, gathering, and fishing of traditional foods needs to be redressed because Indigenous communities, like all communities, have the right to healthy, culturally appropriate foods (Coté 2016).

Inherent in the Indigenous rights and food sovereignty movements are environmental sustainability efforts. Eighty percent of the world's biodiversity thrives in the 22% of global territories home to Indigenous groups (Corntassel and Bryce 2012:151). The environmental destruction that threatens biodiversity also threatens Indigenous people's livelihoods, health, well-being, relationships with their homelands, and ability to exercise land- and water-based subsistence practices such as gathering, hunting, and fishing. The intersection of the Indigenous rights and food sovereignty movements and the fight for responsible environmental practices is exemplified by the massive anti-DAPL movement begun by the Standing Rock Sioux tribe (Ruelle 2017).

For Indigenous peoples, food-generating practices are accompanied by environmental maintenance activities deeply embedded in a cultural ecology (Grey and Patel 2015). Habitats of local foods and plants were protected to maintain their long-term sustainability (Gracey and King 2009). These practices are entrenched in the Indigenous idea of reciprocal relationships with the natural world and the sacredness ethic which views the taking of resources as an exchange and privilege that comes with stewardship responsibilities and direct consequences (Corntassel and Bryce 2012; Kealiikanakaoleohaililani and Giardina 2016). The sustainability of many Indigenous food practices is well established in traditional knowledge of Indigenous practices and corroborated by archaeological research (Groesbeck et al. 2014; Lambrides and Weisler 2016; McKechnie 2007; Rick 2011; Toniello et al. 2019). If nothing else, a resurgence of Indigenous foodways would prompt a movement towards local food production that is often more sustainable because it omits the need for carbon-producing, long-haul transportation, and can more easily adapt to local environmental fluctuations due to climate change (IPES-Food 2016).

Some communities, particularly on the Northwest Coast, have already made much progress in reducing health disparities and promoting sustainability by revitalizing traditional foodways through the food sovereignty and Indigenous rights movements. The CDC's Native

Diabetes Wellness Program Compendium of Traditional Food Stories (Wesner 2013) highlights 26 different programs in culturally and geographically diverse Native American communities designed to promote sustainability, revive traditional foodways, and improve health. Among them are programs by several Northwest Coasts groups including the Suquamish, Confederated Tribes of Siletz Indians, and the Muckleshoot Indian Tribe. There is also a precedent of successful court cases restoring traditional hunting, fishing, and gathering rights for Native groups. The most relevant of these is the case brought by the Nuu-chah-nulth-aht of Vancouver Island, BC. The Nuu-chah-nulth-aht are actively implementing sustainable self-determination strategies aimed at "the sustainable production and consumption of traditional foods through an ecologically sound food systems that honors [their] sacred relationships to the land, water, plants and all living things" (Coté 2016:11). In November 2009, the Nuu-chah-nulth successfully won a decade-long legal battle and were granted the legal right to control their fisheries. Contrary to the notion that these legal rights promote the reckless depletion of aquatic resources by Native communities, the Nuu-chah-nulth approach their fisheries with the notion of *uu-a-thluk* (taking care of) and have launched a marine resource management organization that promotes practices grounded in the community's respect of and responsibility to the natural world (Coté 2016:11).

COVID-19 related disruptions to agricultural, economic, and governmental systems—the loss of jobs, empty shelves at grocery stores, and insufficient aid from government agencies—make Indigenous food sovereignty projects all the more pressing and has "resulted in a doubling down of efforts on the part of many grassroots programs devoted to traditional foods" (Hoover 2020:569). The slowdown in the food supply chain has caused shortages in the FDPIR program. In response and to increase responsiveness during this crisis, many tribal advocates have urged for greater local control over these programs, including the ability to locally source foods for

FDPIR packages (Duren et al. 2020). Others have focused their efforts on creating resilient, self-determined food systems that cushion the community from the tumult of the global food system. The recent popularity of "resilience gardens", home vegetable gardens fashioned after the victory gardens of the World War II era, has caused a surge in the demand for seeds from the Indigenous Seedkeepers Network and other Indigenous seed repositories (Hoover 2020:570). Both the increased risk of COVID-19 mortality due to the prevalence of health disparities (Power et al. 2020) and the upending of many globalized systems of which Indigenous communities have been forced to rely on places in stark relief the timely importance of food sovereignty projects and the need for locally sourced, healthy, culturally appropriate foods.

Archaeological Data in Action

Archaeological research, when conducted collaboratively and motivated by community interests, values, and needs, is often well-suited to serve in Indigenous rights and food sovereignty efforts. I see three aspects of archaeological research that are particularly helpful in these endeavors. First, the physicality of the archaeological record and its grounding in the physical landscape can provide tangible evidence of past lifeways which can assist Indigenous communities in reclaiming the knowledge and rights that were lost due to colonialism, population decline, and centuries of government assimilation programs. Second, archaeological data have validity in Western judiciary systems and can be put forward when arguing for the legal entitlements rightfully owed to Indigenous communities so that they may restore traditional foodways in a state-centered system. Lastly, archaeology's broad public appeal can help to advance public perceptions of cultural revitalization efforts. In this way, community-driven archaeology can aid on multiple levels by both enriching these efforts within the community and translating these efforts for a broader audience entrenched in a Western value system.

A Physical Narrative

Indigenous grassroots efforts to restore and revitalize traditional foodways are often reliant on place-based knowledge. It is fortuitous then, that inherent within the discipline of archaeology is an approach to history that is grounded in the physical landscape and tangible evidence. After suffering through 200+ years of colonization, forced assimilation, population loss, and marginalization, access to a historical narrative, whether it be through the Western discipline of archaeology or Indigenous traditional knowledge, can be instrumental towards rebuilding a powerful Indigenous identity. Furthermore, a physical connection to that historical narrative through archaeological sites, artifacts, and features can further strengthen this identity. This is due, in part, to the importance of place-based knowledge within Indigenous communities and, in part, to the undeniable appeal of physically seeing and touching history. In essence, archaeology can assist in revitalizing traditional foodways by infusing these efforts with historical, place-based scientific data and tangible evidence that bolster traditional knowledge of past subsistence practices. This is particularly true when working with coastal hunting, gathering, and fishing communities that amassed large shell middens through daily subsistence practices because the archaeological record is composed heavily of evidence of food systems.

Archaeology as Evidence

A recent trend in the Indigenous-rights movement is to envision self-determination as more than a political and legal struggle and move towards a discourse that emphasizes responsibilities over rights. Many Indigenous legal scholars agree that "the environment, community health/well-being, natural resources, sustainability, and the transmission of cultural practices to future generations [are] critical, interlocking features of an Indigenous self-determination process" (Corntassel 2008:116). However, in many cases, reaffirming legal rights to land and/or resources is critical to this process. This is often the case when revitalizing traditional foodways and establishing food sovereignty. Because these foodways are so deeply embedded in the landscape and entrenched in the notion of a reciprocal relationship with the natural world, it is nearly impossible to rebuild these foodways without access to these landscapes and resources. And attempting to access these spaces without legal rights puts communities at the very real risk of prosecution.

For centuries, archaeology has been fundamentally a colonialist endeavor, but it is archaeologists' duty to assist Indigenous communities' in their fight to regain the rightful legal entitlements that settler colonialism stripped away. Whether just or not, the U.S. and Canadian legal systems value archaeological data based in Western science over traditional knowledge of Indigenous oral histories (Charlton 2015:152, Mitchell v. M.N.R 2001). Archaeological evidence can be useful in legal cases that contest treaties signed by Indigenous groups and the U.S., because American law sources hunting, fishing, and gathering rights in the historical tribal use, occupation, and possession of territory by tribal entities (Charlton 2015). This is best summarized by Chief Justice Marshall during Johnson v. M'Intosh (1823) when he noted that the legality of the relationship between the U.S. government and Native Americans is premised on the idea that tribes were "the rightful occupants of the soil, with a legal as well as just claim to retain possession of it, and to use it according to their own discretion" (Johnson v. M'Intosh 1823:574).

Even archaeological evidence lacking long term data (in archaeological terms) can be useful in these cases, as there is no requirement under U.S. law that Indian title predates European "discovery" or assertion of sovereignty, only that it was continuous and exclusive unless forcibly removed (U.S. v. Turtle Mtn. Band of Chippewa Indians 1974). For tribes that signed treaties, using archaeology to help define the content and scope of off-reservation hunting, fishing, and gathering rights can be relatively straightforward. Historical, anthropological, and archaeological evidence can be put forward that indicates that at the time the treaty was signed, the tribes engaged in the claimed activities or engaged in historical activities that are retrospectively related to present-day activities (Charlton 2015:103). In addition to the successful Canadian Nuu-chah-nulth-aht case described above, there have been several U.S. court cases in which archaeological evidence has cemented the rights of Native American tribes. Most notable of these is a series of litigations between 1974-2008 that reaffirmed the fishing rights for tribes surrounding the Upper Great Lakes (see Cleland 2011; Mitchell v. M.N.R 2001).

Appealing to the Public

Archaeologists often bemoan the sensationalizing of the discipline through film, television, and other forms of popular media. But this popular portrayal has sparked an interest in archaeology among the general public. Archaeologists can use this broad public appeal to insist on scientific rigor while promoting the community agendas that they are contributing to.

While misconceptions of the discipline have endowed archaeologists with undeserved popularity, Indigenous communities have suffered the opposite. Misconceptions of Native culture in entertainment, media, and sports teams' mascots have served to reproduce stereotypes and racial bias (Robertson 2015). It is well documented that Indigenous Americans continue to cope daily with overtly racist language, images, and behaviors without social recourse. This is to the detriment of Indigenous efforts to strengthen and enrich their communities. As archaeologists, we often benefit professionally and economically from studying the past of the disenfranchised. We owe it to the communities we work with to use our popularity to bolster public perceptions of their community-enriching efforts. Within the context of traditional foodways revitalization and food sovereignty projects, we can do this by taking the extra step to link archaeology to the projects that it informs, and to make the link straightforward and apparent to the general public.

From Outcomes to Impact

Understanding the utility of archaeological data described above, research at Nukaunlth was carried out to further the Shoalwater's mission to revitalize their traditional foodways, regain rights to local food sources, and improve dietary health. To move from outcomes to impact, I collaborated with members of the Shoalwater and Chinook Nation communities (Earl Davis, Pam Drake, Tony Johnson, and Kristen Torset) to produce four tangible end products. Each end product, described below, is designed to translate and adapt an archaeological understanding of past subsistence practices so that it may best contribute to the well-being of these communities.

Living Off the Bay – Past & Present at the Shoalwater Heritage Museum

In August of 2017, the Shoalwater established their Heritage Museum (Figure 8.2) but had few archaeological materials to exhibit there. Our work at Nukaunlth was the first tribal-initiated archaeological research project. As such, it provided an opportunity to launch an exhibit that displayed archaeological materials related to Lower Chehalis and Chinookan traditional foodways in a manner that reflects the communities' own understanding of their past and present connection to their homelands.

The exhibit stemming from our work, entitled *Living off the Bay – Past & Present*, was designed by Earl Davis, Tony Johnson, Kristen Torset, and myself and completed in 2019 (Figure 8.3). The exhibit is divided into an introductory section, three thematic sections describing the use of resources from the aquatic, terrestrial, and botanical landscapes (Figure 8.5 & Figure 8.4), and three mini-displays highlighting some of the unique materials from Nukaunlth. The primary goal of this exhibit is to show both the community and visitors to the Shoalwater Reservation the cultural significance of the ancestral village of Nukaunlth and the importance of the local environment to the foodways of the past. In this way, we see this exhibit as both helping to pique interest in traditional foodways within the community through tangible evidence of past subsistence and utilizing archaeology's broad public appeal to build support and stewardship among people outside the Indigenous community. Below, I present a summary of each section of the exhibit.

Introduction: Layers of History

Visitors of the museum are introduced to the *Living off the Bay – Past & Present* exhibit and our work at Nukaunlth through an introductory informational board and "layers of history" display (Figure 8.4). This display is a reproduction of a stratigraphic profile from unit 418N385E that illustrates the culturally rich midden from the second occupation of Nukaunlth, tsunami-related deposits, a cultural surface representing the first occupation of the village, and sterile subsoil. The frame for the display was custom built by Earl Davis. I constructed the reproduction of the stratigraphic profile using different colors of sand and bulk unsorted midden samples from the site. The bulk midden samples used were from a single provenience from which a subsample had been analyzed previously. This ensures that, should this bulk sample be needed for further testing, the materials could be extracted from the display, passed through a sieve, and analyzed. The *Layers of History* display gives visitors a glimpse of how archaeological deposits look *in situ* and illustrates the chronology of the village.

Living off the Aquatic, Terrestrial, and Botanical Landscapes

Each aquatic, terrestrial, and botanical landscape section contains a collection display, informational board, original carving, and tool reproductions (Figure 8.5). These sections illustrate the importance of these landscapes to the community, past and present. The collection displays contain examples of each plant and animal species recovered from Nukaunlth. These displays incorporate Lower Chehalis and Chinook words for each of these resources to highlight the importance of the languages within the community. Because botanical remains did not preserve in the assemblage, dried samples gathered by Museum Curator, Kristen Torset, are on display. Information boards introduce the materials presented in the exhibit and engage the audience by asking them to look closely at the artifacts for things like cut marks. Tool reproductions link the botanical samples and faunal remains on display to ancestral hunting, fishing, and gathering techniques. Original carvings by Earl Davis blend traditional motifs and modern techniques to represent the contemporary communities' connection to these landscapes and their heritage.

Mini-Displays: Blubber Feast, Specialized Technologies, and Hints of Wealth & Status

Some information and artifacts garnered from excavations of Nukaunlth did not fit neatly within the above sections but were nonetheless deemed important to display and incorporate into the exhibit. To incorporate these materials, three mini-displays and corresponding informational boards were created.

The *Blubber Feast* display showcases the concentration of whale bone recovered near the hearth of the house. The informational board highlights James Swan's description of whale scavenging and connects the materials recovered from Nukaunlth to this rich ethnographic record. *Specialized Technologies* displays the bone toggles and projectile point recovered. The corresponding informational board describes how Chinookan and Lower peoples often customized hunting and fishing implements for specific prey and presents the displayed artifacts as examples of such customization. *Hints of Wealth and Status* showcases the prestige objects found at Nukaunlth: the copper, glass, and dentalium beads, cooper sheeting, and ceramic fragment. The informational board explains how these artifacts indicate that some people living at Nukaunlth were connected to trade networks and likely high-ranking.

Figure 8.2 Shoalwater Bay Indian Tribe Heritage Museum

Figure 8.3 Living off the Bay - Past & Present exhibit layout

Figure 8.4 Living off the Bay - Past & Present "Layers of History" introductory display

Figure 8.5 Living off the Bay - Past & Present exhibit landscape panels

Living Off the Bay – Past & Present Education Kits

An education kit that follows the same thematic organization as the museum exhibit will bring the Shoalwater's revitalization project into K-12 classrooms throughout the greater Washington Coast region. This kit is designed to (1) promote understanding and appreciation of past and present Native cultures and foodways, (2) foster a sense of stewardship for natural and cultural resources, and (3) provide curriculum-based materials emphasizing critical-thinking skills and hands-on discovery learning in social studies, and STEM.

Like the *Living off the Bay: Past & Present* exhibit, this education kit explores the daily lives of those who lived at Nukaunlth by focusing on the foods they consumed and the resources they utilized. The kit is organized into four sections: *Layers of History*, *Living off the Terrestrial*

Landscape, *Living off the Aquatic Landscape*, and *Living off the Botanical Landscape*. *Layers of History* familiarizes students with the history of the site and provides a brief overview of archaeological excavation methods. The remaining three themes focus on the foods and resources garnered by those living at Nukaunlth from the corresponding landscape. Each section includes an overview, activity lesson plan and materials, laminated photographs, artifact replicas made by Chinookan and Lower Chehalis artists, and samples of natural materials.

In the *Layers of History* activity, students are introduced to the concept of stratigraphy and learn to think like an archaeologist as they build up archaeological deposits in a transparent shoebox to replicate the cultural layers found at Nukaunlth. In the *Living of the Terrestrial Landscape* activity, students explore tool morphology as it relates to function through hands-on experience with different hafting styles. To explore the aquatic landscape, students build a model of a fish weir. This activity asks students to consider how those living at Nukaunlth used engineering practices to adapt fish weirs to various environmental conditions and community-needs over time. When exploring the *Living off the Botanical Landscape*, students discover how past peoples used plant resources by making cordage using traditional Chinookan and Lower Chehalis techniques.

An Educator's Guide (Appendix C) gives educators everything they need to incorporate this curriculum into their teaching. The kit is designed for 6-8th grade classes but can be modified for all age groups. Currently, the Shoalwater Education Department is working with the Ocosta School District to incorporate these kits into their regular curriculum.

Shoalwater Diet & Nutrition Course Curriculum

The Shoalwater Wellness Center offers a weekly public diet and nutrition class taught by a local Nutritional Therapy Practitioner, Pam Drake (Figure 8.6). This course addresses issues of healthy living, specifically the dietary needs of the descendant community. In collaboration with the Shoalwater Education Program and Pam Drake, archaeological data from the Nukaunlth village excavations have been incorporated into a module for this course (Appendix D). This module is composed of six one-hour classes. Like the museum exhibit and education kit, it is organized around the landscapes utilized by Lower Chehalis and Chinookan peoples; two classes focus on aquatic foods, two classes describe terrestrial foods, and two classes center on botanical foods. With this module, Pam Drake teaches the local community about Native foods, ancestral foraging and hunting techniques, cooking practices, natural resource stewardship, and the importance of cultural patrimony in Willapa Bay. In particular, this module aims to disseminate information about culturally important food practices from a time when Western settlers had minimal impact on the lifestyles of the Shoalwater. Each course concludes with a community meal that incorporates Native food and cooking practices. By incorporating archaeological data into this course, the Shoalwater hopes to translate and adapt the subsistence practices of a known, nearby ancestral village into modern healthy food practices.

Figure 8.6 Shoalwater Diet & Nutrition Course taught by Pam Drake

Archaeological Data for Legal Rights

Because the Shoalwater is federally recognized through executive order and lacks a ratified treaty, the State of Washington does not recognize their right to hunt, fish, and/or gather off-reservation and in their traditional territory. This is due, in part, to an oversight in the court case United States v. Washington (1974), commonly known as the Boldt Decision after the trial court judge who wrote the opinion, George Hugo Boldt (Johansen and Pritzker 2008). After more than a century of violent clashes between Indigenous groups and settlers over treaty fishing rights, the Boldt Decision reaffirmed the rights of treaty tribes to off-reservation fishing "at all the usual and accustomed grounds and stations…in common with all citizens of the territory" (U.S. v. Washington 1974:331) and specified that such tribes have rights to 50% share of fisheries (Goodman 2000; Johansen and Pritzker 2008).

As justification for the decision, Boldt cites the precedent of a 1905 Supreme Court case that ruled in favor of the Yakama Nation, a federally recognized tribe with territory in Washington state. In this case, the Court interpreted Indian treaties not as agreements that "grant rights *to* the Indians, but were rather a grant *from* them, and therefore, reserved those rights not granted to the United States by the treaty" (U.S. v. Winans 1905:381). In the surprisingly poetic opinion, the Court further acknowledged that the aboriginal fishing rights of the Yakama were "not much less necessary to the existence of the Indians than the atmosphere they breathed" (U.S. v. Winans 1905:381).

The Boldt Decision has had a profound impact on those tribes whose rights were reaffirmed. Recently, further court cases have acknowledged that the right to take fish, as recognized by treaties and the Boldt decision, is not limited to any particular fish species and that shellfish are "fish" within the meaning of these treaties (Combs 2020; U.S. v. Washington 1994). Exercising such rights, for both commercial and subsistence uses, are critical to many tribal economies. Furthermore, it's widely understood by legal scholars and tribes alike that the exercise of hunting, fishing, and gathering rights is contingent upon the existence and vitality of such resources. As such, tribes have reserved the right to "the maintenance and well-being of those resources, a right which includes protection of the habitat upon which such resource depend" (Goodman 2000:282). With these rights, tribal entities have become comanagers of traditional resources, utilizing traditional ecological knowledge to ensure the survival of these resources so that they may continue to hunt, gather, and fish for generations to come.

The Boldt Decision reaffirmed the off-reservation rights of 24 tribes with treaties in

Washington state.[45] However, it gave no decision regarding the rights of the tribes in Washington State that achieved federal recognition through executive order, congressional act, or other legal mechanisms. The Supreme Court has held that the same principles of construction of treaties apply to other agreements between a tribe and the United States—i.e., that executive orders, congressional acts, etc. should be interpreted as granting rights *from* tribal entities and reserving rights not granted to the United States by such agreements (Antoine v. Washington 1975). This has acknowledged the off-reservation hunting, fishing, and gathering rights of one tribe in Washington without a treaty, the Colville Confederated Tribes. However, the seven other tribes in Washington of which the Boldt Decision did not apply, including the Shoalwater, still do not possess the legal entitlements necessary to hunt, gather, and fish their traditional foods from their traditional territory.

As a result, it's been difficult for the Shoalwater to revitalize traditional foodways. Fishing and shellfishing permits are prohibitively expensive for the community and as of a few years ago, the last professional fisher of the community retired. The community is now completely dependent on foodbanks, the local gas station (stocked mostly with chips, soda, and frozen dinners), grocery stores (the nearest being a 25-minute drive) for food.

In 1996, the Shoalwater joined forces with another tribe, the Confederated Tribes of the Chehalis Indian Reservation, to argue for their legal rights to off-reservation hunting, fishing, and gathering as implied by the executive orders creating their reservations (Confederated Tribes v. Washington 1996). The case went up to the United States Court of Appeals, Ninth Circuit,

---

[45] Two of these tribes, the Confederate Tribes of the Umatilla Indian Reservation and the Nez Perce Tribe, are located outside of the state, but have off-reservation rights within Washington state per their treaties.

where the court upheld the district court's denial of these rights and findings that the Tribes' claims were not well-founded. In the opinion, the appellate court does cite some evidence that suggests the executive order and preceding documents implied off-reservation fishing rights for the Shoalwater. Ultimately, however, they conclude that they are not "left with the definite and firm conviction that the district court made a mistake in its findings" (Confederated Tribes v. Washington 1996:343). The Shoalwater believe that this ruling against them is partly because they lacked the resources to mount an adequate legal battle and provide sufficient evidence in the case (Earl Davis, personal communication). They feel that, with the proper research and preparation, they can appeal this decision and make a convincing argument of implied rights to traditional resources.

As noted above, using archaeological data in court cases that strive to reaffirm treaty rights is relatively straightforward. Admittedly, the Shoalwater's federal recognition without a ratified treaty makes their path a little less direct. As I am not a legal scholar, I do not presume to know precisely the best path for using archaeological data in this manner. The Shoalwater's legal researchers will need to determine this. But whatever that path may look like, archaeological data from Nukaunlth may be particularly useful due to the geographic and temporal location of the village. Nukaunlth is situated geographically very close to the modern Shoalwater Reservation, which makes the cultural connection between those who occupied Nukaunlth pre- and postcontact and the modern Shoalwater community difficult to deny. Furthermore, the major occupation of Nukaunlth occurred relatively late in the precontact period and continued into the postcontact era. The village was likely abandoned around 1858, only eight years before the executive order granting the Shoalwater their reservation. Likewise, Nukaunlth was occupied near the time at which the Superintended Waterman suggests the placement of the reservation because “these Indians…have always lived upon the beach and subsisted upon fish, clams, oysters, and sea animals…[and] are unwilling to abandon their former habits of life and turn their attention to agriculture” (Waterman 1866) (discussed in detail in Chapter 2). Archaeological data from Nukaunlth provide further material evidence to support Waterman’s claim.

Recently, the Shoalwater have begun applying for grants to fund legal research so that they may begin arguing for their entitlement to access off-reservation traditional food sources. For the reasons stated above, they believe the data on the subsistence practices of Lower Chehalis and Chinookan peoples living at Nukaunlth can be easily linked to the contemporary community and the implied off-reservation rights of the executive order. And with cautious optimism, I anticipate that these links will aid in the future court cases that are necessary to revitalize traditional foodways, restore local food sources, and improve dietary health.

Past Foods as Reimagined Futures

One August afternoon during fieldwork at Nukaunlth, Earl Davis and I were standing over the sieve staring down at the heaps of shell fragments we had just unearthed from the exterior midden. Earl turned to me, sighed, and said “damn, I should really eat more shellfish.” This remark may seem insignificant. He said it almost in passing. But it was at that moment that I was truly convinced of the impact of this project; that archaeological research can provide something new to cultural revitalization endeavors, something supplementary to oral histories and traditional knowledge, that can help Indigenous communities look to their past to reimagine their futures.

Since that day in 2017, the Shoalwater community has used our investigations at Nukaunlth and the information gleaned from them to produce impact in their community beyond the planned programs and initiatives described above. In the spring of 2019, they began holding first foods celebrations. Each quarter, the community gets together to share a meal celebrating a key food resource found at Nukaunlth. As the seasons change, so do the featured traditional foods. The first of these celebrations highlighted flounder, a species recovered from Nukaunlth in greater quantities than the community initially expected. So far, these events have been successful in bringing in younger tribal members who normally don't participate in cultural events (Earl Davis, personal communication).

Recognizing a renewed interest in traditional foods and fishing practices within the community and understanding that knowledge of such practices is dwindling within the community, the Shoalwater tribal council has begun to find alternative means to support these practices. They have recently purchased a fishing boat for the Cultural Department so that they can provide access to marine resources to their community. The Shoalwater Natural Resource Department has begun efforts to restore the oyster beds on their tidelands. They hope to begin oyster aquaculture for personal consumption by tribal members and as well as for sale. Tribal council is also sponsoring fishing licenses for interested community members.

By no means are these permanent solutions to the hindrances imposed by settler-colonialism upon their ability to practice their traditional foodways. Instead, they are much-needed, short-term attempts to ensure the survival of traditional knowledge associated with these practices. Should the community stop hunting, fishing, and gathering completely, they run the risk of losing valuable traditional ecological and cultural knowledge. For the time being, these efforts allow the Shoalwater to further their mission of revitalizing traditional foodways while they continue to fight for food sovereignty by other means. The Shoalwater hope that one day they will have so much evidence that the state will not be able to argue against their right to access local foods in a manner that reflects their traditions. Until then, they are taking matters into their own hands, turning to the knowledge of their ancestors, and creating new ways to use past foodways to craft a prosperous and healthy future for their descendants.

I take the fact that our archaeological investigations at Nukaunlth spurred these new community-enriching programs and projects as a sign that we're on the right track; that Earl's reaction to seeing the products of his ancestors was not a one-off or insignificant. And I take it as evidence that archaeology is more than the data that it produces. For communities wounded by colonization, archaeology can be identity-generating, culturally potent, politically uplifting, and a productive translator for a public steeped in a Western value system. I conclude by stressing that to do so, archaeologists must serve as advocates and allies in these projects. To be successful, this help must be situated within a collaborative approach that recognizes the cultural expertise of the community and Indigenous authority to use their ancestral cultures to creatively assert their modern identities.

Appendices

A. Probe Survey Results

Table A.1 Area 1 probe survey results

Probe #	Location (UTM – Zone 10 T)	Designation	Total depth (cm BS)	Depth of Cultural Deposits (cm BS)	Cultural Materials	Stratigraphic Summary
PC19 – P1	425030m E, 5174139m N	Strong Negative	26	N/A	N/A	Two layers that blend together. Layer 1: very dark grayish brown (10YR 3/2) silty sand. Layer 2: dark yellowish brown (10YR 4/4) sand. No cultural materials.
PC19 – P2	425019m E, 5174139m N	Weak Negative	27	19 – 24	Charcoal	Three layers. Layer 1: dark yellowish brown (10YR 4/4) sand. Layer 2: very dark gray (10YR 3/1) silt and sand. Layer 3: grayish brown (10YR 5/2) sand. Charcoal in layer 2, but no other cultural materials.
PC19 – P3	425011m E, 5174139m N	Strong Negative	31	N/A	N/A	Two layers that blend together. Layer 1: very dark grayish brown (10YR 3/2) sand with traces of silt. Layer 2: brown (10YR 5/3) sand. No cultural materials.
PC19 – P4	425000m E, 5174139m N	Strong Positive	15	3 12	Charcoal, Shell	Three layers. Layer 1: very dark grayish brown (10YR 3/2) sand with trace silt. Layer 2: black (10YR 2/1) sandy silt. Layer 3: very dark gray (10YR 3/1) sand. Cultural materials in layers 2 and 3.
PC19 – P5	425000m E, 5174151m N	Weak Negative	32	N/A	N/A	Two layers that blend together. Layer 1: black (7.5YR 2.5/1) silty sand. Layer 2: brown (10YR 5/3) sand. No cultural materials, but tip of the probe contained dark possibly cultural soil.
PC19 – P6	425000m E, 5174161m N	Strong Positive	14	0 – 14	Charcoal, Shell	One layer of very dark gray (10YR 3/1) sandy silt. Probe was obstructed after 14cm BS.

PC19 – P7	425000m E, 5174171m N	Strong Positive	41	0 – 31	Bone, Charcoal, FMR, Shell	Seven stratigraphic layers ranging in color from black (10YR 2/1 and 2.5Y 2.5/1) to yellowish brown (10YR 5/6). Top six layers contain cultural materials. Layer 1 contains ash. Layer 4 is mostly shell.
PC19 – P8	424987m E, 5174137m N	Weak Positive	78	0 – 59	Charcoal, Shell	At least seven stratigraphic layers ranging in color from black (10YR 2/1) to dark yellowish brown (10YR 4/6). Trace flecking of charcoal and shell in top six layers.
PC19 – P9	424978m E, 5174143m N	Weak Positive	26	22 – 26	Charcoal	Three layers. Layer 1: very dark grayish brown (10YR 3/2) sand with trace silt. Layer 2: black (10YR 2/1) sand with trace silt. Layer 3: charcoal/clay. No cultural materials in layers 1 and 2, but the color of layer 2 and charcoal in layer 3 suggest possible cultural deposits.
PC19 – P10	424970m E, 5174147m N	Strong Negative	38	N/A	N/A	Two layers that blend together. Layer 1: very dark gray (10YR 3/1) sand with trace silt. Layer 2: brown (10YR 4/3) sand. No cultural materials, but first attempt to probe was obstructed by a piece of FMR.
PC19 – P11	424962m E, 5174154m N	Strong Positive	38	0 – 13	Charcoal, FMR, Shell	Three layers. Layer 1: black (7.5YR 2.5/1) sand with trace silt. Layer 2: very dark gray (10YR 3/1) sandy silt. Layer 3: grayish brown/brown (10YR 5/2 & 5/3) sand. Cultural materials in layer 2 & 3.
PC19 – P12	424952m E, 5174158m N	Weak Negative	37	0 – 11	Charcoal	Two layers. Layer 1: very dark grayish brown/dark grayish brown (10YR 3/2 & 4/2) sand with trace silt. Layer 2: light yellowish brown (10YR 4/3) sand. Flecking of charcoal in top layer.
PC19 – P13	425943m E, 5174165m N	Strong Negative	30.5	N/A	N/A	Two layers. Layer 1: black (7.5YR 2.5/1) sand with trace silt. Layer 2: pale brown/brown (10YR 6/3 & 5/3) sand. No cultural materials.
PC19 – P14	424936m E, 5174170m N	Strong Negative	28.5	N/A	N/A	Two layers that blend together. Layer 1: black (7.5YR 2.5/1) sand with trace silt. Layer 2: brown (10YR 5/3) sand. No cultural materials.
PC19 – P17	425000m E, 5174181m N	Strong Negative	31	N/A	N/A	Two layers. Layer 1: black (10YR 2.5/1) sand and silt. Layer 2: light olive brown (2.5YR 5/3) sand. No cultural materials.
PC19 – P18	424990m E, 5174141m N	Strong Negative	44	N/A	N/A	Two layers. Layer 1: very dark grayish brown (10YR 3/2) sand with trace silt. Layer 2: pale brown/brown (10YR 6/3 & 5/3) sand. No cultural materials.

PC19 – P19	424990m E, 5174151m N	Strong Positive	33	0 – 14	Bone, Charcoal	Four layers with gradual transitions. Layer 1: very dark gray (10YR 3/1) sand with trace silt and clay. Layer 2: black (10YR 2/1) silty loam with high stain. Layer 3: very dark grayish brown (10YR 3/2) silty sand. Layer 4: light brownish gray (10YR 6/2) sand. Cultural materials in layers 1 and 2.
PC19 – P20	424990m E, 5174161m N	Strong Positive	66.5	0 – 62	Charcoal, Shell	Five layers with gradual transitions. Layer 1: very dark grayish brown (10YR 3/2) silty sand. Layer 2: black (10YR 2/1) silty sand with high stain. Layer 3: light gray (7.5YR 7/1) mostly shell with some silt. Layer 4: gray (10YR 5/1) sandy silt. Layer 5: light yellowish brown (10YR 6/4) sand. Cultural materials in top four layers.
PC19 – P21	424990m E, 5174171m N	Weak Positive	42	0 – 15	Bone, Charcoal	Two layers that blend together. Layer 1: very dark brown (10YR 2/2) silty sand. Layer 2: yellowish brown (10YR 5/4) sand. Cultural materials in top layer.
PC19 – P22	424990m E, 5174181m N	Strong Negative	35	N/A	N/A	Two layers that blend together. Layer 1: very dark grayish brown (10YR 3/2) silt and sand. Layer 2: yellowish brown (10YR 5/4) sand. No cultural materials.
PC19 – P34	425010m E, 5174151m N	Weak Negative	39	0 – 30	Charcoal	Two layers that blend together. Layer 1: very dark brown (10YR 2/2) silt and sand. Layer 2: yellowish brown (10YR 5/4) sand with trace silt. Flecking of charcoal in top layer.
PC19 – P35	425010m E, 5174161m N	Strong Positive	44	0 – 18	Charcoal, Shell	At least four distinct layers. Layer 1: black (10YR 2/1) silty sand. Layer 2: gray (10YR 5/1) silt with pieces of shell. Layer 3: very dark grayish brown (10YR 3/2) sandy silt. Layer 4: pale brown (10YR 6/3) sand. Cultural materials in layers 1 and 2.
PC19 – P36	424980m E, 5174141m N	Weak Negative	28	0 –14	Charcoal	Two layers that blend together. Layer 1: very dark grayish brown (10YR 3/2) silty sand. Layer 2: yellowish brown (10YR 5/4) sand. Flecking of charcoal in top layer.
PC19 – P37	424980m E, 5174151m N	Weak Negative	37.5	0 – 22.5	Charcoal	Five layers with gradual transitions. Layer 1: very dark grayish brown (10YR 3/2) silty sand. Layer 2: black (10YR 2/1) silt and sand with high stain. Layer 3: brown (10YR 5/3) sand. Layer 4: very dark brown (10YR 2/2) sandy silt. Layer 5: pale brown (10YR 6/3) sand. Charcoal in layers 1, 2, and 4 but no other cultural materials.

PC19 – P38	424970m E, 5174141m N	Strong Negative	36	N/A	N/A	Two layers that blend together. Layer 1: dark grayish brown (10YR 4/2) sand with some silt. Layer 2: pale brown (10YR 6/3) sand. No cultural materials.
PC19 – P39	424970m E, 5174151m N	Weak Negative	48	10.5 – 18	Charcoal	Three layers. Layer 1: very dark brown (10YR 2/2) silty sand. Layer 2: black (10YR 2/1) sandy silt. Layer 3: yellowish brown (10YR 5/4) sand. Cultural materials in layer 2 & 3. Charcoal in layers 1 and 2 but no other cultural materials
PC19 – P40	424970m E, 5174161m N	Weak Negative	49	11 –18	Charcoal	Three layers. Layer 1: very dark brown (10YR 2/2) silty sand. Layer 2: black (10YR 2/1) silt with some sand and high stain. Layer 3: yellowish brown (10YR 5/6) sand. Charcoal in layers 1 and 2 but no other cultural materials. Layer 2 feels greasy.
PC19 – P41	424960m E, 5174141m N	Weak Negative	40	0 – 40	Charcoal	Two layers that blend together. Layer 1: dark grayish brown (10YR 4/2) silty sand. Layer 2: pale brown (10YR 6/3) sand. Charcoal in both layers but no cultural materials.
PC19 – P42	424960m E, 5174151m N	Weak Negative	45	0 – 12	Charcoal	Three distinct layers. Layer 1: very dark brown (10YR 2/2) silt and sand. Layer 2: very dark yellowish brown (10YR 3/4) silt with some sand. Layer 3: pale brown (10YR 6/3) sand. Charcoal in top layer. Midden on surface approximately 3m north of the probe.
PC19 – P43	424960m E, 5174161m N	Strong Positive	46	0 – 18	Charcoal, Shell	Two very distinct layers. Layer 1: black (10YR 2/1) silt with some sand and high stain. Layer 2: pale brown (10YR 6/3) sand. Burnt shell in layer 1.
PC19 – P44	424960m E, 5174161m N	Strong Negative	43	N/A	N/A	Four distinct layers. Layer 1: very dark brown (10YR 2/2) silt and sand. Layer 2: brown (10YR 5/3) silty sand. Layer 3: gray (10YR 4/1) sand with trace silt. Layer 4: brown (10YR 4/3) sand with trace silt. Charcoal in layers 1 and 3, but soil does not have cultural characteristics.

Table A.2 Area 2 probe survey results

Probe #	Location (UTM – Zone 10 T)	Designation	Total depth (cm BS)	Depth of Cultural Deposits (cm BS)	Cultural Materials	Stratigraphic Summary
PC19 – P16	424717m E, 5174230m N	Strong Positive	45	22 – 30	Bone, Charcoal, Shell	Three layers. Layer 1: very dark grayish brown (10YR 3/2) sand with trace silt. Layer 2: very dark brown (10YR 2/2) silty sand. Layer 3: grayish brown (10YR 5/2) sand. Cultural materials in layer 1 and layer 2.
PC19 – P23	424719m E, 5174213m N	Strong Negative	33.5	N/A	N/A	Two layers that blend together. Layer 1: very dark grayish brown (10YR 3/2) silty sand. Layer 2: brown (10YR 3/4) sand. No cultural materials.
PC19 – P24	424719m E, 5174223m N	Strong Negative	43	N/A	N/A	Two layers that blend together. Layer 1: grayish brown (10YR 5/2) sand with some silt. Layer 2: pale brown (10YR 6/3) sand. No cultural materials. In the road, and could be disturbed.
PC19 – P25	424719m E, 5174233m N	Strong Positive	59	0 – 10	Charcoal, Shell	Three layers that blend together. Layer 1: very dark grayish brown (10YR 3/2) sand with trace silt. Layer 2: grayish brown (10YR 5/2) sand. Layer 3: dark grayish brown (10YR 4/2) silty sand. Cultural materials in layer 1.
PC19 – P26	424719m E, 5174243m N	Strong Negative	58	N/A	N/A	Four stratigraphic layers ranging in color from black (10/YR 2/1) to brown (10YR 5/3), but no materials to suggest cultural deposits.
PC19 – P27	424709m E, 5174223m N	Weak Negative	95	0 – 69	Charcoal	Five stratigraphic layers ranging in color from black (10YR 2/1) to dark yellowish brown (10YR 4/4). Heavy staining in top layer. Charcoal present in top four levels, but no other cultural materials.
PC19 – P28	424709m E, 5174233m N	Strong Negative	48.5	N/A	N/A	Two stratigraphic layers that blend together, ranging in color from very dark grayish brown (10YR 3/2) to yellowish brown (10YR 5/4). No cultural materials.
PC19 – P29	424709m E, 5174213m N	Strong Negative	44	N/A	N/A	Two layers. Layer 1: black (7.5YR 2.5/1) silty sand. Layer 2: dark yellowish brown (10YR 4/4) sand. No cultural materials.
PC19 – P30	424729m E, 5174223m N	Strong Negative	37	N/A	N/A	Two layers that blend together. Layer 1: brown (10YR 3/3) sand with trace silt. Layer 2: dark yellowish brown (10YR 3/4) sand. No cultural materials.

PC19 – P31	424729m E, 5174213m N	Strong Negative	40.5	N/A	N/A	Four stratigraphic layers ranging in color from very dark gray brown (10YR 3/2) to light yellowish brown (10YR 6/4), but no materials to suggest cultural deposits.
PC19 – P32	424729m E, 5174203m N	Strong Negative	36	N/A	N/A	Four stratigraphic layers ranging in color from very dark brown (10/YR 2/2) to dark yellowish brown (10YR 4/4), but no materials to suggest cultural deposits.
PC19 – P33	424729m E, 5174233m N	Strong Negative	37	N/A	N/A	Two layers that blend together. Layer 1: very dark brown (10YR 2/2) silty sand. Layer 2: yellowish brown (10YR 5/4) sand. No cultural materials.

B. AMS Radiocarbon Sample Descriptions, Uncalibrated Dates, & Calibration Curves

Table B.3 AMS radiocarbon sample descriptions provided by DirectAMS

DAMS Number	Customer Sample ID	Observations	Pre-Action	Weight (mg)
1954-27919	45PC19/2017/51	single wood charcoal fragment, robust, moderate powderization, visible angular cleavage	broke in half, chopped into pieces, washed in water	29.4
1954-27920	45PC19/2017/41	multiple wood charcoal fragments, rootlets on surface	DNP	
1954-27921	45PC19/2017/42	single wood charcoal fragment, friable, moderate powderization, visible angular cleavage, rootlets	DNP	
1954-27922	45PC19/2017/43	multiple wood charcoal fragments, rootlets on surface	DNP	
1954-27923	45PC19/2017/45	single wood charcoal fragment, robust, moderate powderization, visible angular cleavage	chopped in half, chopped into pieces, washed in water	59.6
1954-27924	45PC19/2017/46	multiple wood charcoal fragments, rootlets on surface	DNP	
1954-27925	45PC19/2017/99	single wood charcoal fragment, friable, moderate powderization, visible angular cleavage, rootlets on surface	DNP	
1954-27926	45PC19/2017/101	single wood charcoal fragment, friable, moderate powderization, visible angular, cleavage rootlets on surface	DNP	
1954-27927	45PC19/2017/102	multiple wood charcoal fragments, clean, robust, minimal powderization	chopped single fragment into pieces, washed in water	42.8

1954-27928	45PC19/2017/105	multiple wood charcoal fragments, clean, friable, minimal powderization	DNP	
1954-27929	45PC19/2017/106	single wood charcoal fragment, friable, moderate powderization, visible angular cleavage	DNP	
1954-27930	45PC19/2017/107	multiple wood charcoal fragments, rootlets on surface	DNP	
1954-27931	45PC19/2017/92	multiple wood charcoal fragments, clean, robust, minimal powderization	chopped single fragment into pieces, washed in water	30.9
1954-27932	45PC19/2017/93	multiple wood charcoal fragments, visible angular cleavage with root intrusions throughout	DNP	
1954-27933	45PC19/2017/94	multiple wood charcoal fragments, visible angular cleavage with root intrusions throughout	DNP	
1954-27934	45PC19/2017/78	multiple wood charcoal fragments, clean, robust, minimal powderization	chopped single fragment into pieces, washed in water	35.3
1954-27935	45PC19/2017/80	single wood charcoal fragment, friable, moderate powderization, visible angular cleavage with root intrusions throughout	DNP	
1954-27936	45PC19/2017/82	single wood charcoal fragment, friable, moderate powderization, visible angular cleavage with root intrusions throughout	DNP	
1954-27937	45PC19/2017/83	single wood charcoal fragment, friable, moderate powderization, visible angular cleavage with root intrusions throughout	DNP	
1954-27938	45PC19/2017/84	multiple wood charcoal fragments, visible angular cleavage with root intrusions throughout	DNP	
1954-27939	45PC19/2017/85	single wood charcoal fragment visible angular cleavage with root intrusions throughout	DNP	

1954-27940	45PC19/2017/86	single wood charcoal fragment visible angular cleavage with root intrusions throughout	DNP	
1954-27941	45PC19/2017/72	single wood charcoal fragment visible angular cleavage with root intrusions throughout	DNP	
1954-27942	45PC19/2017/73	single wood charcoal fragment, friable, moderate powderization, visible angular cleavage	chopped in half, chopped into pieces, washed in water	181.4
1954-27943	45PC19/2017/74	single wood charcoal fragment, friable,rootlets on surface, visible angular cleavage	DNP	
1954-27944	45PC19/2017/64	single wood charcoal fragment, friable,rootlets on surface, visible angular cleavage	DNP	
1954-27945	45PC19/2017/65	single wood charcoal fragment, robust, visible angular cleavage	chopped in half, chopped into pieces, washed in water	18.2
1954-27946	45PC19/2017/67	single wood charcoal fragment, friable,rootlets on surface, visible angular cleavage	DNP	
1954-27947	45PC19/2017/56	single wood charcoal fragment, friable,rootlets on surface, visible angular cleavage	DNP	
1954-27948	45PC19/2017/57	single wood charcoal fragment, friable,rootlets on surface, visible angular cleavage	DNP	
1954-27949	45PC19/2017/58	single fragment of incompletely carbonized wood, rootlets on surface, visible angular cleavage	DNP	
1954-27950	45PC19/2017/59	single wood charcoal fragment, robust, moderate powderization, visible angular cleavage	chopped in half, chopped into pieces, washed in water	28.8
1954-27951	45PC19/2017/60	single wood charcoal fragment, friable,rootlets on surface, visible angular cleavage	DNP	

Table B.4 Uncalibrated dates provided by DirectAMS

DirectAMS code	Submitter ID	Sample type	Fraction of Modern		Radiocarbon Age	
			pMC	1σ error	BP	1σ error
D-AMS 027919	45PC19/2017/51	charcoal	97.15	0.28	232	23
D-AMS 027923	45PC19/2017/45	charcoal	98.03	0.31	160	25
D-AMS 027927	45PC19/2017/102	charcoal	97.62	0.25	193	21
D-AMS 027931	45PC19/2017/92	charcoal	96.36	0.35	298	29
D-AMS 027934	45PC19/2017/78	charcoal	98.47	0.26	124	21
D-AMS 027942	45PC19/2017/73	charcoal	95.85	0.26	340	22
D-AMS 027945	45PC19/2017/65	charcoal	98.9	0.29	89	24
D-AMS 027950	45PC19/2017/59	charcoal	98.6	0.29	113	24

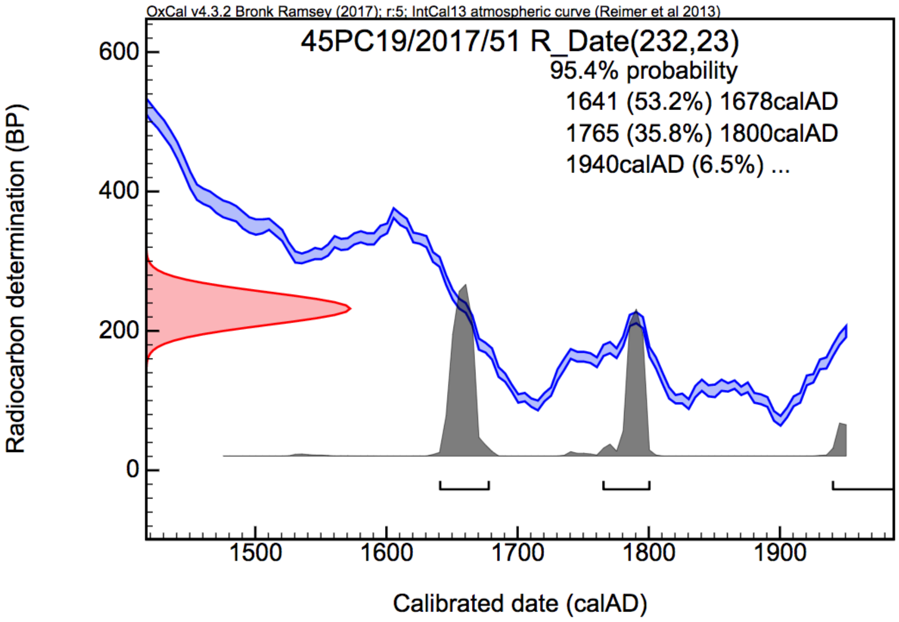


Figure B.1 Radiocarbon calibration curve, sample 45PC19/2017/51

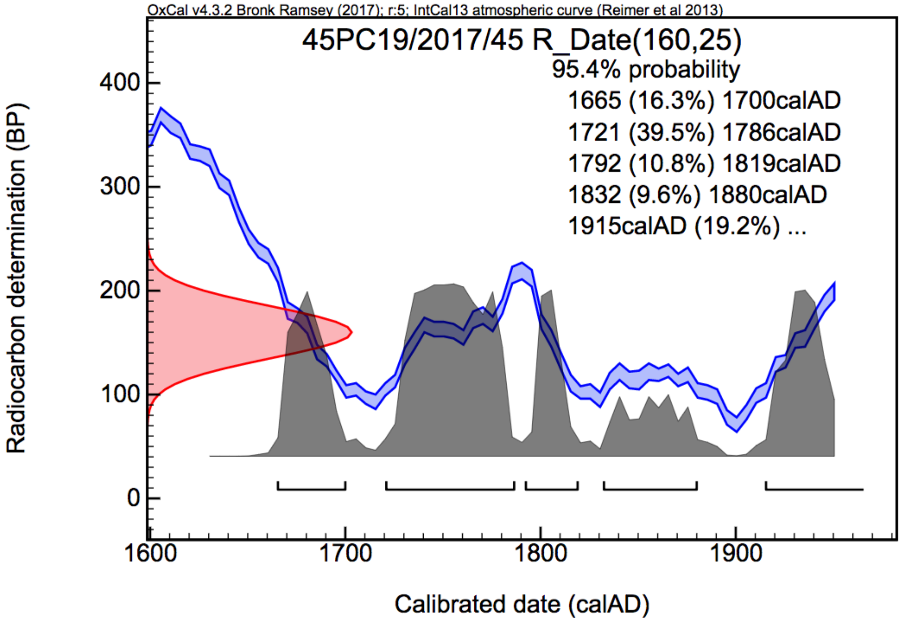


Figure B.2 Radiocarbon calibration curve, sample 45PC19/2017/45

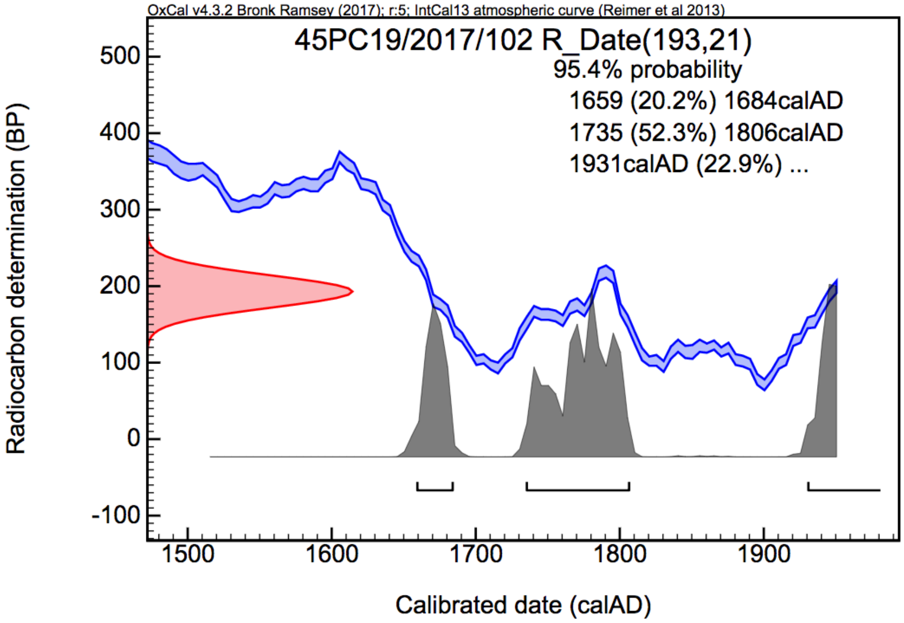


Figure B.3 Radiocarbon calibration curve, sample 45PC19/2017/102

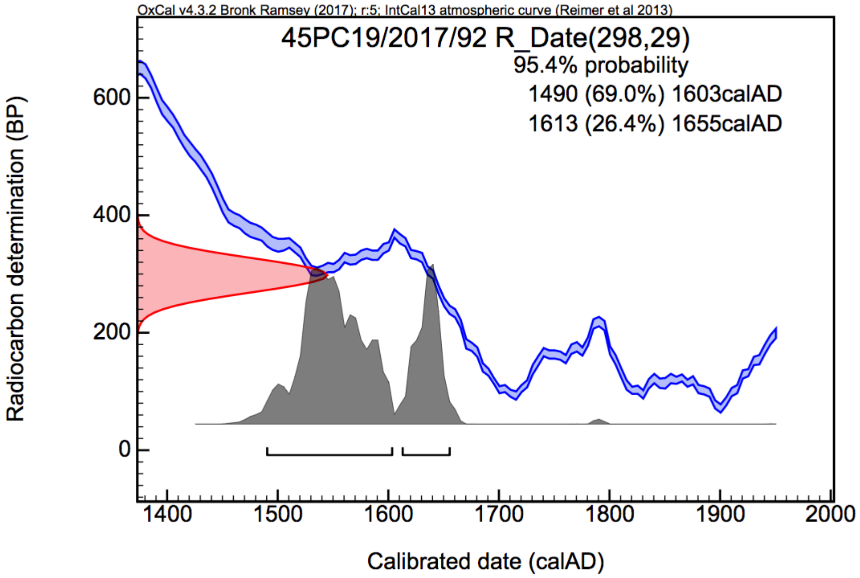


Figure B.4 Radiocarbon calibration curve, sample 45PC19/2017/92

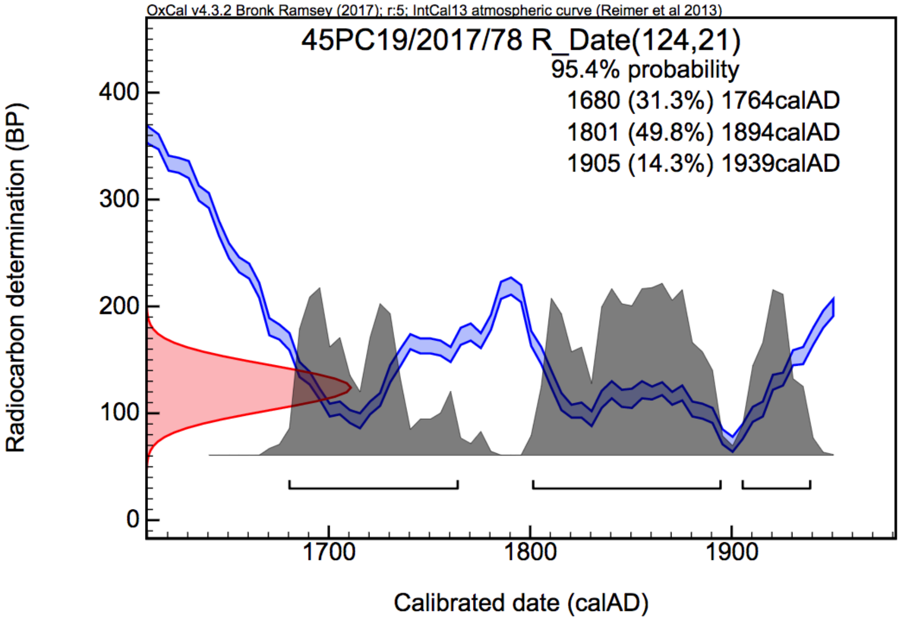


Figure B.5 Radiocarbon calibration curve, sample 45PC19/2017/78

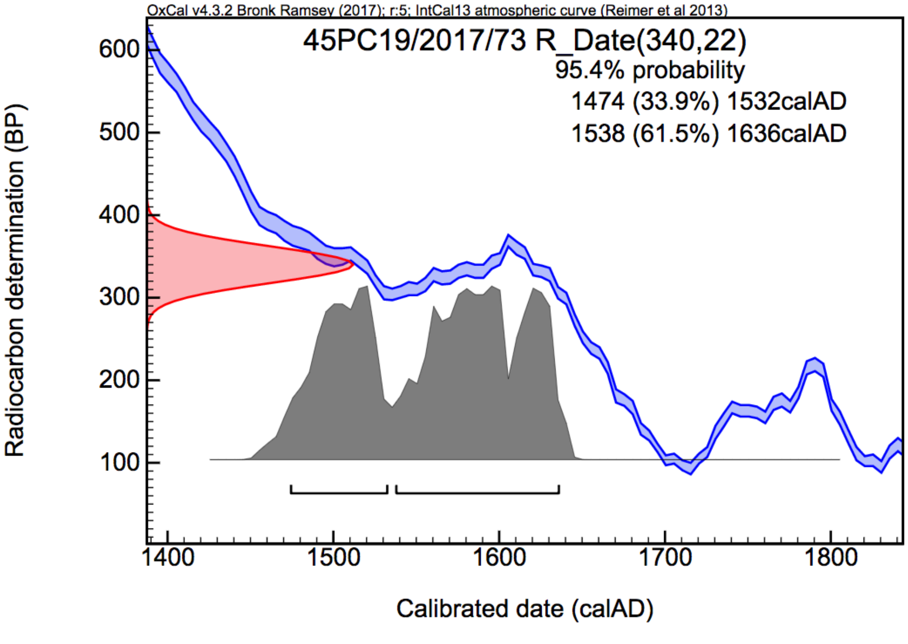


Figure B.6 Radiocarbon calibration curve, sample 45PC19/2017/73

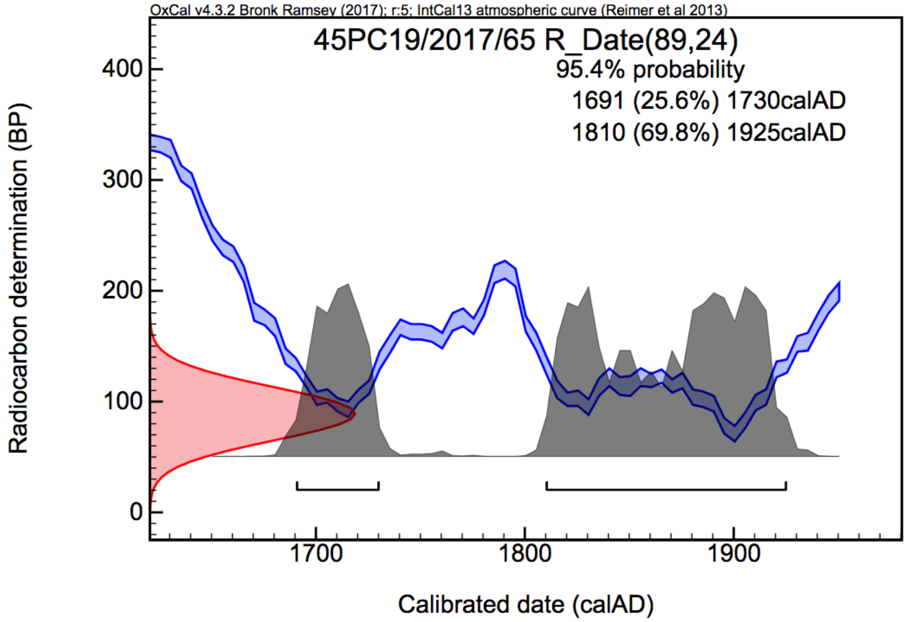


Figure B.7 Radiocarbon calibration curve, sample 45PC19/2017/65

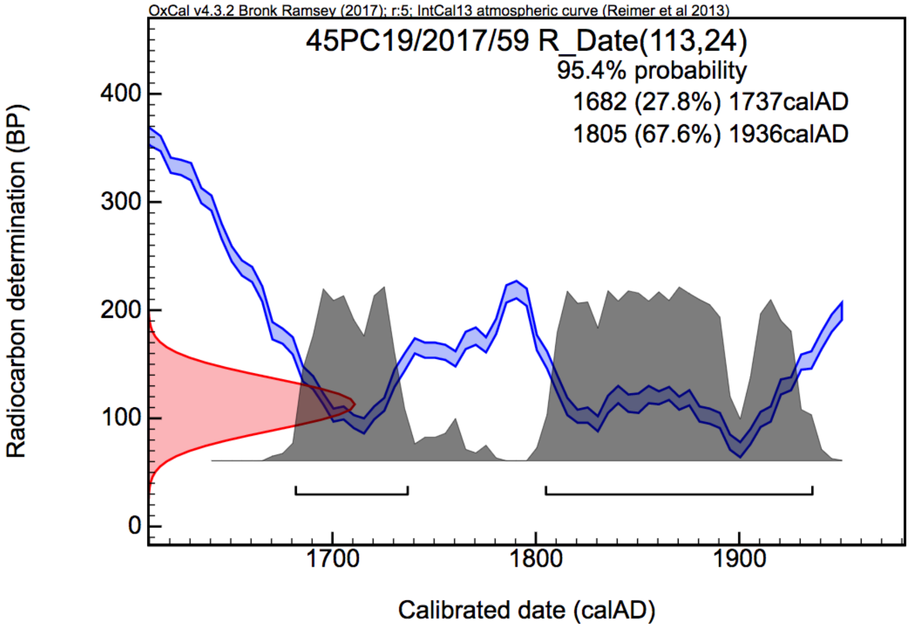


Figure B.8 Radiocarbon calibration curve, sample 45PC19/2017/59

C. Living Off the Bay—Past & Present Educator's Guide

Living off the Bay: Past and Present

An Educator's Guide

Shoalwater Bay Indian Tribe
Education Department
P.O. Box 130, Tokeland, Washington

University of Michigan
Department of Anthropology
Museum of Anthropological Archaeology

To the Educator

Thank you for bringing Living off the Bay: Past & Present into your classroom!

We are delighted you are taking the opportunity to enhance your classroom learning experience through the *Living off the Bay: Past and Present* education kit. Our hope is that this Educator's Guide facilitates the use of this kit and promotes the process of discovery, learning, and enjoyment.

The kit focuses on the archaeological site of Nukaunlth located on Kindred Island near Tokeland, Washington. This Chinookan and Lower Chehalis village was occupied roughly 500 to 175 years ago and shows evidence of the rich daily lives of those living in the area before European settlers.

This guide includes information about the archaeological investigations of Nukaunlth, the evidence garnered from those investigations, and classroom and outdoor activities for grades 4 to 6. The activities focus on four major themes that are paralleled in the *Living off the Bay: Past and Present* exhibit at the Shoalwater Bay Tribal Heritage Museum. These themes are: Layers of History, Living off the Terrestrial Landscape, Living off the Aquatic Landscape, and Living off the Botanical Landscape.

Although this education kit contains everything needed to explore the cultural and natural history of Nukaunlth and its people, we highly encourage a visit to the *Living off the Bay: Past and Present* exhibit at the Shoalwater Bay Tribal Heritage Museum. Please contact Kristine Torset at KTorset@shoalwater-nsv.com, or (360) 267-8138 to schedule a field trip.

We hope this guide and education kit helps you bring history to life in your classroom. Please do not hesitate to call the Shoalwater Bay Tribal Heritage Museum at (360) 267-8138 should you need assistance.

Table of Contents

Living off the Bay: Past and Present

Overview

Goals

The Shoalwater Bay Indian Tribe Education Department in collaboration with the University of Michigan developed this education kit to help classrooms throughout the greater Washington coast region explore the cultural and natural history of Nukaunlth and its people. The project seeks to achieve three goals:

1. To promote understanding and appreciation of past and present native cultures and foodways
2. To foster a sense of stewardship for natural and cultural resources, and
3. To provide curriculum-based materials emphasizing critical-thinking skills and hands-on discovery learning in social studies, and STEM.

Theme

Like the *Living off the Bay: Past & Present* exhibit at the Shoalwater Bay Tribal Heritage Museum, this education kit explores the daily lives of those who lived at Nukaunlth village by focusing on the foods they consumed and resources they utilized.

The kit is organized into four themes: *Layers of History*, *Living off the Terrestrial Landscape*, *Living off the Aquatic Landscape*, and *Living off the Botanical Landscape*. *Layers of History* introduces the history of the site and provides a brief overview of archaeological excavation methods. The remaining three themes focus on the foods and resources garnered by those living at Nukaunlth from the corresponding landscape.

For each theme we've included an overview and a corresponding activity. Associated with some themes are laminated photographs, artifact replicas made by Chinookan and Lower Chehalis artists and samples of natural materials

Background

In summer 2017, the Shoalwater Bay Tribe Education Department collaborated with the University of Michigan to conduct archaeological research at the Nukaunlth village site.

The Nukaunlth village site was a key habitation area for the Lower Chehalis and Chinookan peoples living 500 to 175 years ago. It consists of a large house and associated activity areas. The site preserves the record of a rich cultural life, with evidence of household wealth and intensive cooking and food processing activities. Notably, evidence from this site signifies the importance of the bay in the lives of past Lower Chehalis and Chinookan peoples. The abundance of fish, shellfish, and sea mammal remains at Nukaunlth makes it clear that marine resources from Willapa Bay were essential to the foodways of the past. Making use of these local aquatic resources allowed the people of this region to live a rich and healthy life.

Contents

This kit contains the following:

Layers of History

- Layers of History Overview
- Laminated photograph of an archaeological profile at Nukaunlth
- Transparent Shoebox Dig Lesson Plan
- Transparent Shoebox Dig Activity Materials:
    - One clear plastic shoebox and lid
    - Artifacts: shells, cooking rocks, whalebone, beads, plastic fish (3 of each, for a total of 15 artifacts)
    - Sample record sheets (simple and complex)
    - Copy of an original record sheet from Nukaunlth

Living of the Terrestrial Landscape

- Terrestrial Landscape Overview
- Laminated photographs of bones from Nukaunlth exhibiting cut marks.
- Laminated photograph of bird point from Nukaunlth
- Hafting for Hunting Activity Materials:
    - 1 L-slotted wooden arrow shaft
    - 1 U-slotted wooden arrow shaft
    - 1 Wooden spear shaft
    - 1 Wooden scraper shaft
    - 2 projectile point replicas
    - 1 spear point replica
    - 1 scraper replica

Living of the Aquatic Landscape

- Aquatic Landscape Overview
- Laminated photo of a cockle roasting pit found at Nukaunlth
- Laminated photo of sturgeon scutes exhibiting cutmarks from Nukaunlth
- Laminated photo of whalebone concentration at Nukaunlth
- Building a Fish Weir Activity Materials
    - 5-gal refillable water jug
    - Model stream bin
    - Rubber fishing lures

Living of the Botanical Landscape

- Botanical Landscape Overview
- Dried samples of Bearberry, Miner's lettuce, Stinging Nettle, and Bulrush/Sweetgrass
- Cordage Making Activity Materials
    - Activity Sheet

Layers of History

Overview

The associated laminated photos are of an archaeological profile unearthed at Nukaunlth. These photos show the vertical layers of cultural and organic materials that are uncovered during excavation. Archaeologists refer to these layers as **stratigraphy.**

Stratigraphic layers show the accumulation of materials that happen when people live in one spot for long periods of time. These layers help archaeologists understand the different types of natural and cultural activities that happened at the archaeological site through time.

The top stratigraphic layers of this profile show the dense midden typical of Nukaunlth and other Lower Chehalis and Chinookan village sites. A **midden** is an accumulation of trash, mostly from cooking, that is found outside of houses. Middens are rich with information about foodways, tool production, and household activities. The dense middens at Nukaunlth primarily contain charcoal, bone, cooking rocks, and shells.

This profile shows us two occupation periods at Nukaunlth. The top layers that make up the dense midden are dated between AD 1700 and AD 1858. Underneath the midden is a layer of light yellow sand that was deposited at Nukaunlth during the AD 1700 Cascadia Tsunami. The thin dark-brown cultural layer directly below this sand is rich in charcoal and cooking rocks and represents an earlier, brief occupation of Nukaunlth. This layer is radiocarbon dated to between AD 1493 and the period directly before the tsunami.

Nukaunlth village shows us that Lower Chehalis and Chinookan peoples did not abandon their villages after a tsunami struck but returned to their ancestral land and rebuilt their homes.

Transparent Shoebox Dig

Layers of History Activity

Classroom or Outdoors

Grades 4 to 6

Overview

The shoebox dig is created in a transparent plastic box with a lid. The teacher tells the story of Nukaunlth, and the students help create the layers and deposit the artifacts representing daily life at Nukaunlth. Since the shoebox is transparent, students can see the layers being formed and then observe the resulting stratigraphy through the sides of the box. The class can then either dig the layers or simply discuss the logic behind an archaeologist's careful excavation of one layer at a time.

Objectives

Students will learn basic archaeological terms and concepts and will create a stratified site that archaeologists will (supposedly) later dig. They will see how information is lost if layers are mixed. The dig teaches the logic of horizontal excavation, the nature of stratigraphy, and the importance of recording and preserving the context of finds. The artifact replicas provided for this activity represent the types of materials uncovered during excavations at Nukaunlth and give clues as to the daily tasks (food processing, cooking, tool production, etc.) of those living at Nukaunlth.

Interdisciplinary goals are to

- Help students practice transferable skills of observation, critical thinking, inquiry, and hypothesis-testing applicable to many disciplines, including science, math, social science/history, art, and English.
- Permit teachers to make connections across disciplines and engage in kinesthetic learning, including excavating, presenting orally, writing, listening, and drawing (translating three dimensions into two).
- Illustrate the importance of context to the meaningful interpretation of data.
- Promote teamwork, sharing ideas, academic honesty, and building on the past work of others.

Materials

Provided:

- One clear plastic shoebox and lid
- Artifacts: shells, cooking rocks, whalebone, beads, plastic fish (3 of each, for a total of 15 artifacts)
- Sample record sheets (simple and complex)
- Copy of an original record sheet from Nukaunlth

Needed:

- Light-colored sand (not too fine)
- Dark-colored sand or soil (not too fine)
- A piece of plastic or a plastic tablecloth to work on

Needed if excavating:

- Excavation Tools - plastic spoons and knives, wooden chopsticks, paint brushes
- Containers for excavated dirt
- Small sieves
- Small plastic bags to hold the artifacts from each layer
- Pencils
- Clipboards

- Show the distinction between observations (the discoveries we make) and inferences (the stories we make up).
- Engage students in thinking about multiple interpretations.
- Allow for design flexibility, so that teachers can meet their own classroom's needs.

If students dig the site after creating it, they will experience in a kinesthetic way the fact that excavating an archaeological site destroys it, so that afterward there is no possibility of checking information not recorded.

Although record-keeping needs to be simplified with young children, they should still be asked to do some form of recording if they dig, and the dig should still end with discussion of what the students observed in each layer and why it is important to dig one layer at a time.

Procedures

1. **Divide students into "first occupation" and "second occupation" groups.** The teacher divides students into groups representing the two primary cultural layers of the dig site. Each group represents a different occupation of Nukaunlth village. The teacher shows the students some typical artifacts of each occupation (already pre-determined) and then gives them time to choose, in addition:
    - 4 foods people from their occupation like to eat
    - 3 items of clothing people wear
    - 2 favorite colors
    - 1 favorite animal
2. **Introduce archaeology and the dig.** The class learns basic rules and procedures of archaeology. See *Basics of Archaeology for Simulated Dig Users* in Other Resources.
3. **Tell the story of the site and create the layers**. (Three-layer, simple story)

    The teacher tells the story of the first occupation of Nukaunlth. For example, the first group of people lived at Nukaunlth 500 years ago. They ate fish (represented by the plastic fish), and shellfish,

Other Resources

This activity is adapted from the AIA Education Department. Here are other resources from AIA that may assist with this activity:

- Everything You Need to Know in Brief
- Basics of Archaeology for Simulated Dig Users
- Resources and National Standards for Simulated Digs

used hot rocks to cook, and wore beads…

- Students representing the first occupation take turns putting dark-colored soil/sand and small objects into the shoebox.

Then the teacher explains that a large tsunami struck in A.D. 1700. Large amounts of water cover the village and deposited clean beach sand over the soil and artifacts that the first occupation left.

- The teacher then covers the first occupation layer with a layer of light-colored sand.

After the tsunami, people returned to the village.

- Students representing the second occupation take turns adding soil and new artifacts.

The layers must be thick enough to be easily distinguished in the cross section (and during digging, if the students will excavate; thin layers can easily be mixed together).

4. **Discuss.** Afterwards, students can simply observe and discuss the stratigraphy through the side of the box. At this point, they can compare their archaeological profile with the laminated photograph of the real archaeological profile from Nukaunlth.

Adaptations

After creating the layers, students may carefully excavate the layers. The importance of record keeping during the excavation process should be stressed. Two sample record forms and a scanned copy of an original record sheet from the Nukaunlth excavations can be found in the Appendix of this guide.

Evaluation

The teacher should design a series of questions about the layers (see below) that students answer in teams, so that careful observers and diggers can be rewarded for their understanding of collaborative teamwork, their careful stratigraphic analysis, and their attention to detail.

Students answer and discuss the following questions about the three-layer site described above:

- Which layer is the earlier layer? Which layer is the later layer? (In stratigraphy, each layer builds upon the last, and lower layers are earlier than the ones above.)
- What would happen if an archaeologist dug deeply and excavated dirt and sand together, instead of first removing the dirt separately, and then the sand? (The two occupations would be mixed together!) If the site will not be excavated, the teacher or a student can illustrate by digging with a spoon through both layers and bringing up dirt, sand, and artifacts to show the class.
- Why would it be better to dig each layer carefully and separate the artifacts from each layer? (To preserve the relationships between finds, keep the remains of different occupations separate, and be able to draw meaningful conclusions about them.)
- What would happen to the stratigraphy if there were an earthquake?

Clean Up

When returning this portion of the education kit, please make sure to thoroughly clean the shoebox of any sand/dirt and dry it completely. The artifacts included in the kit should be returned as well.

**This activity is adapted from the AIA Education Department. For original lesson plan visit https://www.archaeological.org/education/lessonplans*

Living off the Terrestrial Landscape

Overview

> *"Land animals included river otters, cougars, wolves, and marten, all of which were hunted not only for their fur, but for any part that was usable for food, utensils, tools or decorative purposes."*
>
> *- Old Shoalwater World, the Ancestral Environment. Heritage Committee, Shoalwater Bay Indian Tribe. 1984*

Provisions from Land and Sky

The Lower Chehalis and Chinookan peoples living at Nukaunlth exploited a wide range of land mammals and birds. Animals of all shapes and sizes were hunted, from big game like elk, to small birds such as the common murre. Over 350 terrestrial mammal bones and over 150 bird bones were recovered during excavations. The following species were recovered at Nukaunlth:

- Land Mammals:
  - Elk (*C. elaphus*)
  - Mule Deer (*O. hemionus*)
  - Mountain beaver (*A. rufa*)
  - Beaver (*C. Canadensis)*
  - Cougar (*P. concolor*)
  - Various Small Rodents, Shrews, and Moles (Order Rodentia & Soricomorpha)
- Birds:
  - Canada Goose (*B. Canadensis*)
  - Northern Fulmar (*F. glacialis*)
  - Common Murre (*U. aalge*)

Many of these specimens exhibit cut marks and evidence of butchering and processing. Laminated photographs included in this kit show the cut marks on a number of these bones.

These animals were used for more than just food. Many species had multiple uses. Mountain beaver were considered very delicious, but their fur was also the most prized for blankets. Deer and elk bone was used to make toggles for fishing or needles for sewing.

The remains of many small rodents were recovered at Nukaunlth. However, most of these were not likely used as food. Instead, these small critters made their home in the trash heaps outside of the house, scavenging for seeds, insects, and other food.

Specialized Technologies

The Lower Chehalis and Chinookan peoples had elaborate technology for hunting that was often customized for a specific prey. The small size of a projectile point found at Nukaunlth indicates it was crafted by a highly skilled individual and intended for hunting small birds. A laminated photograph of this projectile point is included in this kit.

The activity "Hafting for Hunting" allows students to gain hands-on experience crafting the specialized tools used by northwest coast people to hunt a variety of prey.

Hafting for Hunting

Living off the Terrestrial Landscape Activity

Classroom or Outdoors

Grades 4 to 6

Overview & Objective

Students will explore tool morphology and use through different hafting styles.

This exercise is designed to allow the students hands on experience with the stone tool replicas and the different hafts to help them understand concepts of tool use and morphology as it relates to function. It is broken up into two section based on tool technologies (section 1: projectile points; section 2: spear; section 3: scraper). Students can work in groups or on their own.

Background

Many of the stone tools found within the archaeological record would have been hafted. Organic materials including wood, bone, and antler was often used to hold the stone tool heads creating an extended handle that is called a shaft. Hafting a tool within a shaft can provide better handling and leverage when using a tool. In lithic studies, hafted tools are part of what is called a composite toolkit and is an important aspect of stone technology. A composite tool is a tool that is made out of more than one part and can help in identifying and understanding cultural groups, time periods, tool use, and tool morphology.

In many modern societies who have continued using stone technologies, the shaft is the most valued part of the tool and is often passed down through generations. The stone head is often viewed as the more expendable part and is constantly being replaced when broken.

There are many different ways to attach a stone tool to a shaft, binding it in place so that it does not move when in use. Often times in the archaeological record we do not find the shaft with the stone tool. Because of this, we cannot directly observe the techniques used to bind the stone to the shaft. To overcome this we

Materials

Provided:

- 1 L-slotted wooden arrow shaft (#1)
- 1 U-slotted wooden arrow shaft (#2)
- 1 Wooden spear shaft (#3)
- 1 Wooden scraper shaft (#4)
- 2 projectile point replicas
- 1 spear point replica
- 1 scraper replica
- Laminated photo of a projectile point found at Nukaunlth

Needed:

- Role of twine
- Scissors for cutting twine

conduct experiments on replica tools or look to living societies using stone technologies to help us understand different types of binding agents and techniques used in the hafting process. Such binding agents include using gum or sap from trees as well as animal sinew to create glues that act as an adhesive to create a strong hold. Twine is also used, wrapping the tool and the shaft together.

Procedures

1. **Before conducting the hafting activity, discuss with the students the following aspects of hafting in lithic technology.**

   Think about the tools you use today.

   - Are there any tools that are hafted?
   - What types of materials are used to make the hafts?
   - How does hafting help you use the tools?

   Think about different types of hafted tools.

   - How many hafted tool types can you name?
   - Why do you think the shaft is more valuable than the stone tool?
   - How would the difference in value placed upon the shaft and the stone head be reflected within the archaeological record?

   Think about the importance of binding agents and the properties needed for them to work.

   - Can you think of any other types of binding agents that may have been used by past peoples?
   - What type of binding agents do we have now that could work?
   - Why do you think the shaft and binding agents are not found within the archaeological record?

2. **Students try hafting.** Have the students explore the different hafting types provided within the teaching kit. Provided in the kit are 5 different shafts for three different tool types (projectile point; spear; scraper). Have the students try attaching the different stone tool heads to their corresponding shafts using twine as the binding element. Tell the students to observe the different aspects of each technology and then, using those observations and their experience in hafting the stone tools, ask them to answer the following questions in each section.

   Projectile Points: Presented are two different types of shafts (#1 and #2) (Figure 1 and 2) and several projectile points (replicas) (Figure 3). Have the students try and haft the points within the different shafts using the twine to attach projectile points to the shafts.

Figure 1. L shaped shaft for arrow.

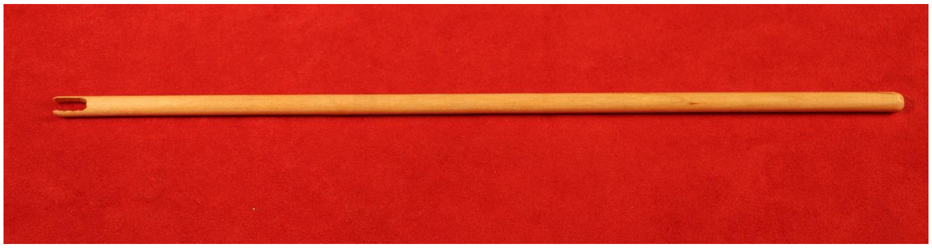


Figure 2. U shaped shaft for arrow.

Figure 3. Projectile point.

Then have the students think about/answer the following questions:

- What are the benefits/strengths of each hafting style and why?
- Where are the weaknesses and why?
- Are there other types of binding agents you could use that would make the hafting stronger?
- Can you think/design other ways of hafting these arrows?

Spear: Presented are one stone tool head (spear point) (figure 4) and one possible shaft (#3) (figure 5). Have the students evaluate the size of both components (spear head and shaft) of this tool and how this reflects its use.

Figure 4. Spear shaft.

Figure 5. Spear projectile point.

- What is the weakest part of the tool and why?
- How would this tool be launched? Can you think of more than one way?
- What type of animals would be hunted using this tool?
- Could the stone tool head be hafted differently? How would this change its use?

Scraper: Presented are one stone tool head (scraper)(figure 6) and one possible shaft (#4)(figure 7). Have the students look at the position of the tool in the shaft and the steepness of the stone tool head's used edge (around 90*) and think about how this reflects the tool's use.

Figure 9. Scraper shaft.

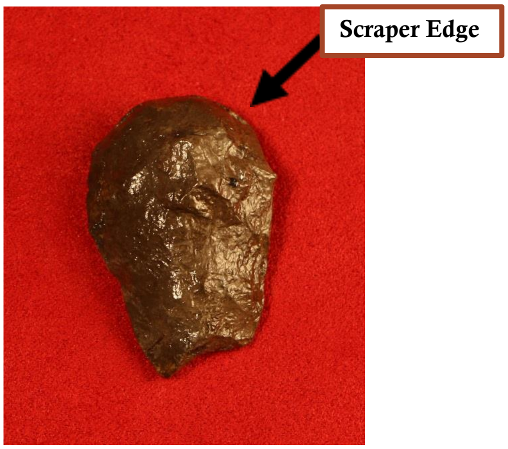


Figure 10. Scraper lithic head.

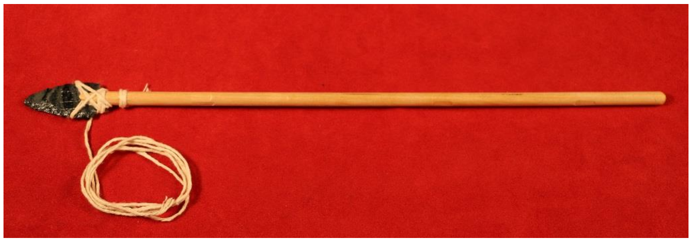
- What motion is this tool being used in?
- How would the steepness of the used edge effect the tool's use?
- What type of material would this tool be used to process?

3. **Hafting Step-by-Step.** After trying to haft the tools on their own, the class will learn the proper way of hafting each tool.

L-Shaped Arrow Shaft:

Step 1: Place end of the projectile lithic into the L part of the shaft (#1). Take the twine and begin wrapping the lithic onto the shaft.

Step 2: To make the projectile point more secure in the shaft, wrap the twine in a crisscross pattern along the body of the lithic.



Step 3: Keep wrapping the tool into the shaft until it is tight and secured.

Step 4: Once the lithic is tight, tie off the end of the twine and you are done!

Scraper Shaft:

Step 1: Obtain lithic scraper, scraper shaft (#4) and twine.

Step 2: Before putting scraper in haft, wrap twine around end following indentations.

Step 3: Place scraper head against the L-slot at the end of the shaft.

Step 4: Holding the scraper in place, wrap the twine around the head in a crisscross pattern.

Step 5: Once the scraper head is firmly in place, tie up the twine ends and that is it!

4. **Discuss.** Students can now compare the way they hafted the tools to the proper method of hafting. At this point, students can compare their hafted arrows to the laminated photo of the projectile point found at Nukaunlth and discuss how this projectile point may have been hafted in the past.

Adaptations

After students try hafting on their own, you may choose to have the students try to "use" these composite tools outside. In a safe setting, students may attempt throwing the spear at a target or using the scraper to see if they've done a good job securing the lithic to the shaft.

Please use caution! Although these are replicas, they can still injure a person. Ensure students throwing the spear are a safe distance and are throwing AWAY from others.

Clean Up

When returning this portion of the education kit, please make sure all provided materials are accounted for and the tools are disassembled.

**This activity is adapted from the Simon Fraser University Museum of Archaeology and Ethnology. For original lesson plan visit http://www.sfu.ca/archaeology/museum/resources.html*

Living off the Aquatic Landscape

Overview

The Bounty of the Bay

> *"But the Shoalwater environment was mainly water – the sea, the tidal waters, the rivers, the wetlands, & the rain! If the Shoalwaters weren't in the water, or being rained on, the chances were good that they were on the water."*
>
> *– Old Shoalwater World, the Ancestral Environment. Heritage Committee, Shoalwater Bay Indian Tribe. 1984*

Most of the food eaten by the people living at Nukaunlth came from the bay. In fact, shell, fish bones, & sea mammal bones comprise nearly 99% of the food waste recovered from the Nukaunlth Village site. Evidence from Nukaunlth shows that Lower Chehalis and Chinookan peoples utilized a wide range of marine resources from large whales to small sea snails. Shellfish, salmon, sturgeon, and whale were their primary food sources.

The following species were recovered from excavations at Nukaunlth:

- Sea Mammals:
  - Whale (*M. novaengliae* or *E. robustus*)
  - Steller Sea Lion (*E. jubatus*)
  - Sea Otter (*E. lutris*)
- Fish:
  - Sturgeon (*A. transmontanus* or *A. medirostris*)
  - Pacific Salmon (*Oncorhynchus*)
  - Pacific Herring (*C. pallasii*)
  - Starry Flounder (*P. stellatus*)
  - Pacific Staghorn Sculpin (*L. armatus*)
  - Surfperch (family Embiotocidae)
  - Skate (family Rajidae)
- Shellfish:
  - Basket Cockle (*C. nuttallii*)
  - Washington Clam (*S. gigantea*)
  - Pacific Littleneck Clam (*L. staminea*)
  - Gaper (*T. capax* or *T. nuttallii*)
  - Bent Nose Macoma (*M. nasuta*)
  - Bay Mussel (*M. trossulus*)
  - Frilled Dogwinkle Sea Snail (*N. lamellose*)
  - Native Olympia Oyster (*O. lurida*)
  - Dungeness Crab (*C. magister* or *M. magister*)

Shellfish was the most abundant food source recovered at Nukaunlth. Over 37,000 pieces of shell have been recorded. Unlike today, where oysters are the most commonly shellfish eaten across Willapa Bay, cockles were the most frequently consumed shellfish at Nukaunlth in the late prehistoric period. Cockles represent nearly 70% of the shells recovered and excavations revealed a roasting pit filled with cockleshells directly outside of the house structure (see associated laminated photo).

Fish also played a crucial role in the foodways of those living at Nukaunlth. Salmon and sturgeon appear to have been the most commonly consumed fish species. However, other species such as herring, flounder, surfperch, and sculpin were caught as well. Some fish bones on display show evidence of butchering. A laminated photograph of sturgeon scutes exhibiting cut marks is included in this kit.

The largest animals utilized by those living at Nukaunlth were marine mammals. Sea otter, sea lion, and whalebones were recovered during excavations. These mammals, like terrestrial mammals, were likely used for more than just food. Sea otter pelts were traded for exotic or difficult to procure items. The blood, blubber, meat, and oil from marine mammals were processed and preserved for later use.

Blubber Feast

> *"About a month after my return from the treaty, a whale was washed ashore on the beach between Toke's Point and Gray's Harbor, and all the Indians about the Bay went to get their share…The Indians were camped near by, out of the reach of the tide, and were all very busy on my arrival, securing the blubber, either to carry home to their lodges, or boiling it out on the spot, provided they happened to have bladders or barrels to put the oil in. Those who were intending to transport the blubber were hiding it by burying it in the sand till they were ready to go to their homes."*
>
> - *James Swan, 1857*

Excavations at Nukaunlth revealed a concentration of whalebones near the central hearth feature of the house (see associated laminated photo). This archaeological feature shows that whale was exploited and processed on-site by those living at this village. Radiocarbon samples date this concentration to approximately 175 years ago, around the same time as the "blubber feast" that James Swan describes in the quotation above.

Oral histories and ethnographic materials point towards a rich history of beached whale scavenging by past native communities. However, oral histories suggest that for ease of transport and convenience only blubber and meat were harvested and brought back to villages for processing. The significant quantity of whalebones present at Nukaunlth is distinct from the smaller numbers of bones typically produced by scavenging beached whale, and may instead suggest opportunistic whale hunting.

Building a Fish Weir

Living off the Aquatic Landscape

Classroom or Outdoors

Grades 4 to 6

Overview

This activity allows students to explore how those living at Nukaunlth (as well as other communities) have used engineering practices to adapt fish weirs to various environmental conditions and community needs over time.

In this lesson, students will gain hands-on experience with engineering by designing, building, and testing a model fish weir. They will also explore the rich historical and cultural traditions of this ancient method of gathering an important food source.

Objectives

This activity is designed to engage students in the skills and practices aligned with the science and engineering practices (SEPs) of the Next Generation Science Standards (NGSS). An NGSS crosscutting concept (CC) associated with this lesson is the Influence of Science, Engineering, and Technology on Society and the Natural World.

Background

A **fish weir** is a human-made structure built of stone, reeds, or wooden posts placed within the channel of a stream or at the edge of a tidal lagoon intended to capture fish as they swim along with the current. Fish weirs were engineered to effectively capture migratory fish during their seasonal spawning periods.

Fish weirs on rivers often consisted of wooden posts connect by basketry netting or wattle fences: the fish swim in and are trapped upstream of the current. Tidal fish weirs are built across gullies. At high tide the fish can swim across the top of the weir, but as the tide recedes, fish become trapped behind the weir. Fish weirs were used throughout Willapa Bay to catch large quantities of migratory fish such as salmon.

Materials

Provided:

- 5-gal refillable water jug to act as a water source
- Model stream bin
- Rubber fishing lures

Needed:

- Graph paper
- Craft sticks - various shapes and sizes
- Pipe cleaners, string, or twine
- Books, wooden block, or otherwise to raise the "water source" and one end of the stream table
- Large bucket for runoff to drain into
- Sand to act as "riverbed"

Other Resources

- Should you wish to create your own stream table: DIY Stream Kit
- A great article about fish weirs in DIG, the archaeology magazine for kids: Sticks In
- A fish weir project based in Boston, Ma: www.fishweir.org
- Historic photos of a fish weir built on the Puyallup River ca. 1885: Yelm Jim's Fish Weir

Activities

1. **Set the Stage.** *Imagine a stream so crowded with fish that you could use their backs as stepping-stones to cross! Imagine it being like this only a few weeks out of the year when the fish return from their ocean habitat to lay their eggs in the stream and die? What if you and your community ate so much fish that it made up a very large part of your diet throughout the year? Imagine having no grocery stores, only the land around you to provide you food. How could you gather enough fish during this short window of time to feed everyone in the community, young and old?*

   The scenario presented above introduces students to the Building a Fish Weir Activity. Students are fish asked to think of the kinds of food their ancestors may have eaten. They should note that in the "old times"; there were no grocery stores or restaurants where they could grab a quick meal. They are then asked to consider the ways they could gather enough food to not just their family, but also their entire community.

   Students should brainstorm answers to the question: How could you capture the most fish in a limited timeframe? Students will likely propose a "hook-n'-reel" method, however they will quickly determine that this is not a very efficient method. This conclusion provides an opportunity to introduce students to the technology their ancestors used: fish weirs.

   Then, define the activity. The students will be designing, building, and testing a model fish weir that will span a model stream and capture model fish.

2. **Plan.** Students are directed to work in groups to draw a diagram of the fish weir they intend to build and eventually test in the model stream. Students are made aware of the materials and supplies they will be able to use. Students collaborate to draw one diagram of their conceptual design on plain graph paper. They should be asked to consider various constraints to their design including the depth and width of the model stream and the size of the model fish they aim to capture. Water should be able to flow through the weir, but not allow all fish to pass. Student's plans should include a list of materials they intend to use.

3. **Review.** Before proceeding to the "building" phase, students should be allowed to discuss their plan with the teacher or review group for completeness. This mimics the process of "peer review" common in engineering practices.

4. **Build.** Student groups use their plan as a guide to build a model fish weir. Teachers should help students brainstorm ways of overcoming the challenges faced during this step and encourage teamwork.

5. **Test and Evaluate.** Next, students test how well their models work and consider if modifications might improve it.

   Before testing can begin, follow these steps to set up the model stream, water source, and runoff collection:

   - To set up the model stream, place the stream bin on the edge of a table so the "downstream" runoff drain is hanging off the side of the table and will not drain onto the table. Place a large bucket on the floor below the drain for runoff collection. If the stream bin is on a high table, you may want to place the runoff bin on a chair to minimize splashing.
   - Then place a large book or a wooden block underneath the "upstream" side of the model stream bin. This will allow gravity to direct the flow of water. Add an even layer of clean sand to the entire base of the stream bin. You may wish to predetermine the route of the stream by creating a path in the sand for which the water can easily flow. The sand should provide enough stability for the fish weirs to stand upright even when the water is flowing.
   - Next, fill the 5-gal refillable jug with water and place it on series of books or a small stool next to the "upstream" section. This will be the water source for the stream. Make sure the spigot will empty into the model stream.
   - Your model stream is ready to go!

   Students can take turns controlling the flow of water and adding fish to the stream. The output of water flow should be adjusted so that there is a steady but light flow of water in the stream to allow the model fish to "swim".

   Students place their models in the stream and first analyze the overall fit, stability, and durability of their weir and then determine how effective their weir is at capturing model fish. Students are provided opportunities to assess needed improvements and redesign their models for further testing.

6. **Discuss.** In a whole-class discussion, teachers ask students to discuss why and how their models work and how they might improve their design to accommodate a changing environment or situation (for example, different fish species they might wish to capture, faster stream, etc.).

Adaptations

Tidal Fish Weir: Those living at Nukaunlth were likely utilizing both river and tidal fish weirs. The original activity design models a river fish weir, but this lesson can be adapted to model a tidal fish weir. Simply remove the block underneath the "upstream" portion of the stream bin and have one student block the runoff drain. Turn on the water source, allow water the fill the bin, and add in the model fish. This process mimics high tide. Then have the student release the runoff drain, and allow the water to drain. This mimics low tide. Analyze the number of fish caught on the other side of the weir. This can prompt a discussion of the different styles of fish weirs needed to catch fish in different environments.

Incorporating Sustainability: Many fish weirs often allowed *some* fish to travel freely past the weir. This was to ensure that plenty of fish could spawn and there would be a sufficient fish population the following year. To add a little more complexity to the activity, tell the students that they must design a fish weir that catches some fish, but not all! This can then prompt a discussion of sustainable fishing practices and highlight the value placed on the sustainability of resources by Native American communities.

Clean Up

When returning this portion of the education kit, please make sure to thoroughly clean and dry the model stream bin and refillable water jug. Please return the rubber fishing lures as well.

This activity was adapted from The Fish Weir: A Culturally Relevant STEM Activity. For a description of the original lesson plan, please visit http://digital.nsta.org/publication/?i=260740&ver=html5&p=47

Living off the Botanical Landscape

Overview

> *"All kinds of roots, stems, flowers, seeds, leaves, vines, bark, sap and wood were used, each species being selected at the right time of year for using the particular part, whether for food or for some other purpose."*
>
> *- Old Shoalwater world, the ancestral environment. Heritage Committee, Shoalwater Bay Indian Tribe. 1984*

Wild plants were crucial to the foodways of native peoples living in prehistoric Willapa Bay. Unfortunately, organic materials like plants, seeds, and nuts decompose quickly and rarely stand the test of time. Charred seeds found near cooking hearths in archaeological deposits can give us small glimpses into the types of plants used by those living at Nukaunlth. The small sample of botanical remains found during excavations shows us that plants had a wide range of uses. The following species were found at Nukaunlth. Dried samples of each of these species are included in this kit.

Bearberry (*Arctostaphylos uva-ursi*)

The use of Bearberry by Chinook and Lower Chehalis people is well documented by the Euro-Americans coming to the region in the 1800s. On January 29th 1806, Meriwether Lewis described the use of Bearberry while at Fort Clatsop, just south of Willapa Bay, saying

> *"the colour of this fruit is a fine scarlet. the natives usually eat them without any preperation. the fruit ripens in september and remains on the bushes all winter. the frost appears to take no effect on it. These berries are sometimes geathered and hung in their lodges in bags where they dry without further trouble, for in their most succulent state they appear to be almost as dry as flour."*

Similarly, James Swan, a Euro-American settler who lived in Willapa Bay from 1852 to 1855 describes bearberry:

> *"The dry, mealy berries of the Arbutus uva ursi, or bear-berry, are bruised and eaten with oil, and the dried leaves, called quer-lo-e-chintl, are smoked like tobacco."*

These accounts are particularly relevant because they are corroborated by oral histories from the Shoalwater Bay tribe and were written when people were still residing at Nukaunlth.

Stinging Nettle (*Urtica dioica*)

Stinging nettle had a myriad of uses for Chinookan and Lower Chehalis peoples. It was a food, a medicine, and even a form of caffeine.

Stinging nettle has a taste that is similar to spinach. Young plants can be soaked to remove the stinging chemical so that it can be handled and eaten without harm. After the stinging chemical is removed, the plan can then be boiled to make a soup, or steeped to make a tea.

Stinging Nettle was also used as a medicine. James Swan described its use among Chinookan and Lower Chehalis peoples during his stay in Willapa Bay:

> *"Soreness of the joints or ankles from cold is alleviated by nettles pounded up with grease, or nettle-roots boiled, and tied on the afflicted part."*

Most remarkably, Stinging Nettle was also used as a form of caffeine. Paddlers would use the stinging properties of nettle as a stimulant to keep them awake and energized during long canoe journeys.

Miner's Lettuce (*Clatonia perfoliata*)

There is no ethnographic description of the use of Miner's Lettuce by Chinookan and Lower Chehalis peoples. However, oral histories tell us that Miner's Lettuce was eaten similar to other leafy salad greens.

Bulrush/Sweetgrass (*Scirpus Americanus*)

Bulrush was not consumed like the other plants found at Nukaunlth. It, instead, was used as a basketry material. Baskets were made with particular purposes in mind, and the materials used to create the baskets were chosen specifically to best fit that purpose. Bulrush was often combined with cattail and eelgrass for basketry and was primarily used as the inner material of wrapped twine baskets.

Cordage Making

Living off the Botanical Landscape Activity

Classroom or Outdoors

Grades 4 to 6

Overview

This activity gives students an opportunity to make cordage using the same process the Chinookans and Lower Chehalis people used. As an extension, students can use the cordage to make necklaces or bracelets that incorporate traditional dentalia shell beads or trade beads they make themselves.

Cordage of all types — rope, string, and fine twine —played an important role in almost every aspect of life in Willapa Bay. Cedar was a favorite material but nettle, rushes, willow bark, and other fibers were also used. Almost any activity you can think of utilized some sort of cordage.

Objectives

Students will be able to identify ways in which those living at Nukaunlth used cordage and recreate the process of making cordage.

Activities

1. **Set the Stage.** Ask the students how they think cordage might have been used. Students should brainstorm activities that require cordage and should touch on the following:

    - Fishing: Twine for nets, rope for fishing lines, anchor lines
    - House Construction: Raising a house beam, rope ruler for measuring lengths
    - Clothing: rope for protective armor, cord or string for blankets

    Have the students consider the fact that one simple blanket would require 300 feet or more of fine twine. Then ask them to imagine having to make all that twin themselves!

Materials

Provided:

- Activity sheet

Needed:

- Natural raffia or hemp – two pieces per student
- dentalia or glass beads (optional)

2. **Make Cordage.** Distribute the activity sheet (see appendix) and two pieces raffia or hemp to eat student, and let them try their hand at cordage making by following the directions on the activity sheet. You may want to practice making cordage yourself so that you can help students who get stuck.
3. **Discuss.** Have the students brainstorm the ways they use cordage today. Do they think those living at Nukaunlth would have used it that way? Ask them to think of additional ways the Chinookan and Lower Chehalis people living at Nukaunlth might have used it.

Adaptations

After cordage making, students can do one or more of the following extension activities:

Incorporate beads: Three bead-types were found at Nukaunlth; dentalia shell, European glass, and copper. Beads were important emblems of status for Chinook and Lower Chehalis peoples. Students can make their own beads out of clay, rolled paper, etc. They can then use their twine to string beads for bracelets, necklaces, etc.

STEM: In corporate aspects of STEM into this activity, have students keep logs of how long it takes to make a specific length of cordage (for example, 10 minutes for 3 inches of twine). Ask them to complete problems such as:

If it takes you ___ minutes to make ____ inches of twin, how long would it take you to make 150" of twine? How many inches of twine could you make in an hour and a half.

Experiment with scientific principles of tensile strength before and after making cordage. Use various fibrous materials to create cordage and compare tensile strength of these materials.

Harvest nettle: If you are ambitious, plan ahead, and have access to a patch of stinging nettle, you can harvest a supply in the late summer/early fall when it is turning brown. Wear gloves! Let it dry. At that stage it will no longer sting. Afterwards, pound the nettle gently with a flat stone along the length of the stem to loosen up the fibers. Gently pull away the bark, leaving the fibers as long as possible. This is another activity students can experience to get a sense of how much work went into the process of cordage making!

This activity was adapted from Ridgefield National Wildlife Refuge Educator's Guide. For the original lesson plan, please visit https://www.fws.gov/refuge/Ridgefield/visit/educator_resources.html

Appendix

Sample Transparent Shoebox Dig Record Sheet (Simple)

Box #_______ Team #________

Recorders' Names:

____

____

____

____

List of Artifacts in LAYER _____________

List of Artifacts in LAYER _____________

List of Artifacts in LAYER _____________

Sample Transparent Shoebox Dig Record Sheet (Complex)

Box #_______ Team #________

Recorders' Names:

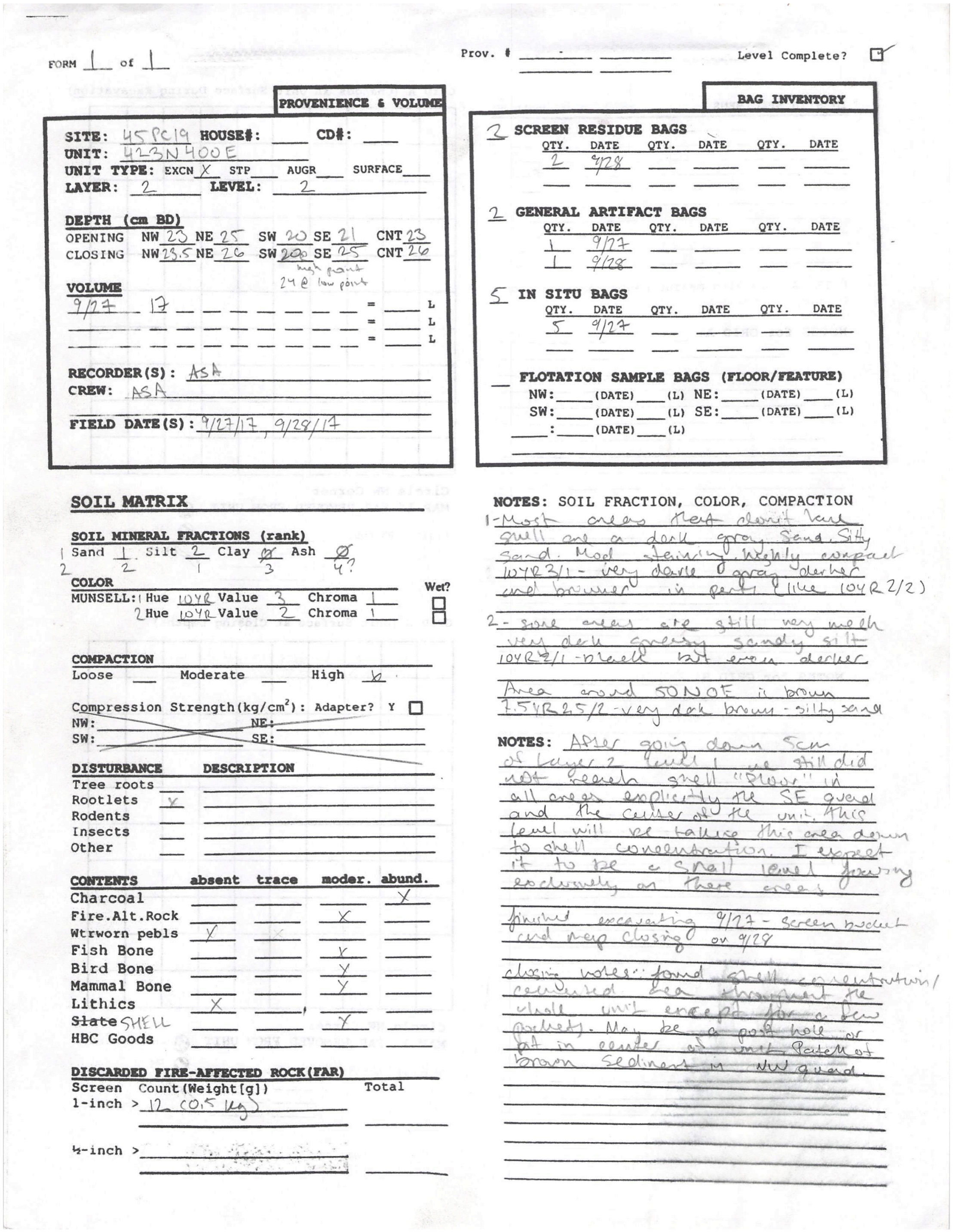
____

____

____

Layer:		**Type of Soil:**	
Artifact	Type/Number	Observation	Sketch
Artifact	Type/Number	Observation	Sketch
Artifact	Type/Number	Observation	Sketch
Comments:			

Layer:		**Type of Soil:**	
Artifact	Type/Number	Observation	Sketch
Artifact	Type/Number	Observation	Sketch
Artifact	Type/Number	Observation	Sketch
Comments:			
Layer:		**Type of Soil:**	
Artifact	Type/Number	Observation	Sketch
Artifact	Type/Number	Observation	Sketch
Artifact	Type/Number	Observation	Sketch
Comments:			



FORM 1 of 1

Prov. # ____ ____

Level Complete? ☐

PROVENIENCE & VOLUME

SITE: 45PC19 **HOUSE#:** ____ **CD#:** ____

UNIT: 423N400E

UNIT TYPE: EXCN X STP ___ AUGR ___ SURFACE ___

LAYER: 2 **LEVEL:** 2

DEPTH (cm BD)

OPENING	NW 23	NE 25	SW 20	SE 21	CNT 23
CLOSING	NW 23.5	NE 26	SW 20 high point 24 @ low point	SE 25	CNT 26

VOLUME

9/27 17 __ __ __ __ __ __ __ = ____ L

__ __ __ __ __ __ __ __ __ = ____ L

__ __ __ __ __ __ __ __ __ = ____ L

RECORDER(S): ASA

CREW: ASA

FIELD DATE(S): 9/27/17, 9/28/17

BAG INVENTORY

2 **SCREEN RESIDUE BAGS**

QTY.	DATE	QTY.	DATE	QTY.	DATE
2	9/28				

2 **GENERAL ARTIFACT BAGS**

QTY.	DATE	QTY.	DATE	QTY.	DATE
1	9/27				
1	9/28				

5 **IN SITU BAGS**

QTY.	DATE	QTY.	DATE	QTY.	DATE
5	9/27				

__ **FLOTATION SAMPLE BAGS (FLOOR/FEATURE)**

NW: ____ (DATE) ____ (L) NE: ____ (DATE) ____ (L)

SW: ____ (DATE) ____ (L) SE: ____ (DATE) ____ (L)

____ : ____ (DATE) ____ (L)

SOIL MATRIX

SOIL MINERAL FRACTIONS (rank)

	Sand	Silt	Clay	Ash
1	1	2	~~0~~	0
2	2	1	3	4?

COLOR

MUNSELL:	Hue	Value	Chroma	Wet?
1	10YR	3	1	☐
2	10YR	2	1	☐

COMPACTION

Loose ___ Moderate ___ High X

Compression Strength(kg/cm²): Adapter? Y ☐

NW: ____ NE: ____

SW: ____ SE: ____

DISTURBANCE		**DESCRIPTION**
Tree roots		
Rootlets	X	
Rodents		
Insects		
Other		

CONTENTS	**absent**	**trace**	**moder.**	**abund.**
Charcoal				X
Fire.Alt.Rock			X	
Wtrworn pebls	X			
Fish Bone			X	
Bird Bone			X	
Mammal Bone			X	
Lithics	X			
~~Slate~~ SHELL			X	
HBC Goods				

DISCARDED FIRE-AFFECTED ROCK(FAR)

Screen	Count(Weight[g])	Total
1-inch >	12 (0.5 kg)	
½-inch >		

NOTES: SOIL FRACTION, COLOR, COMPACTION

1-Most areas that don't have shell are a dark gray sand, Silty sand. Mod staining, highly compact 10YR3/1 - very dark gray. darker and browner in parts (like 10YR 2/2)

2- some areas are still very much very dark greasy sandy silt 10YR2/1 - black but even darker

Area around 50N0E is brown 7.5YR2.5/2 - very dark brown - silty sand

NOTES: After going down 5cm of Layer 2 level 1 we still did not reach shell "floor" in all areas explicitly the SE quad and the center of the unit. This level will be taking this area down to shell concentration. I expect it to be a small level focusing exclusively on these areas

finished excavating 9/27 - screen bucket and map closing on 9/28

closing notes: found shell concentration/ cemented area throughout the whole unit except for a few pockets. May be a post hole or pit in center of unit. Patch of brown sediment in NW quad.

IN SITU SPECIMENS	North ~~south~~	east	depth BD
#1 C14 Sample	29	80	22
#2 Bone	87	36	22
#3 Bone	94	15	23
#4 Bone	55	26	22
#5 ocher	48	38	24

NOTE: All In Situ measurements recorded from NW unit corner.

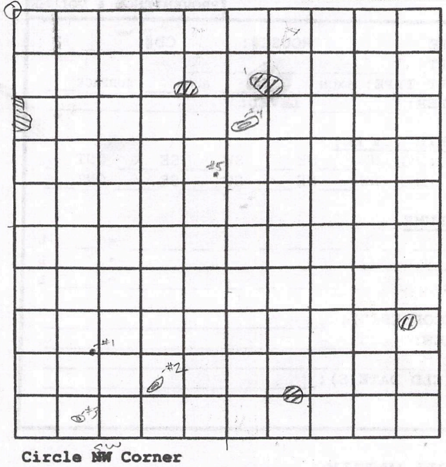
NOTES for GRID A:

NOTES for GRID B: A - concentration of fish bones
B - flakey bone, maybe wood?

1 - possible post hole or pit see Layer 3 level 1 notes for soil and munsell description
2 - areas w/out shell concentration. Possible post holes but less convincing
3 - area where shell concentration is more fragmented and heavily burned
4 - patch of browner soil, see Layer 3 level 1 notes for munsell + soil description

Only whole shell were mapped, shell throughout whole unit other than in area "2"

GRID A (Changes in Unit Surface During Excavation)

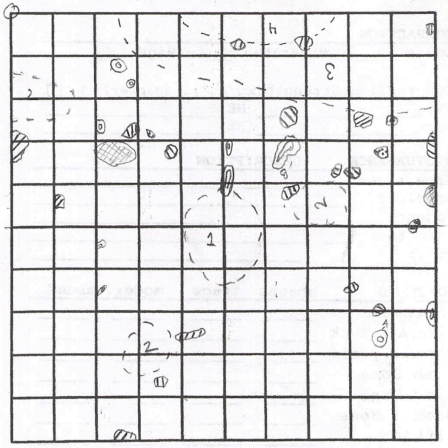


Circle ~~NW~~ SW Corner
MAP 1" FAR REMOVED FROM UNIT

Digital Photos: ___ ; ___

waterworn cobble
FAR
root
⓪-Bone

GRID B (Unit Surface at Closing Depths)



Circle NW Corner
MAP 1" FAR REMOVED FROM UNIT

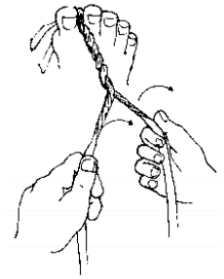
Digital Photos: 101-0028 - 0041

waterworn cobble
FAR
root
⓪-Bone

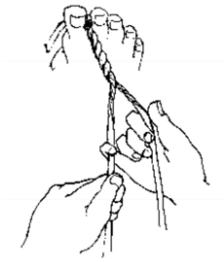
Cordage Making Activity Sheet

Discover what making cordage is all about!

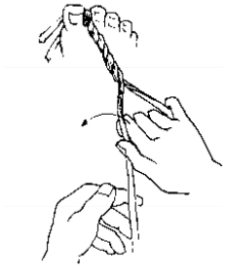
1. Select two strands of raffia, knot them together at the end, and tape to a table. Alternatively, go barefoot as in the diagram below!



2. Holding one strand in either hand, begin to twist each one clockwise.



3. With the little finger of your right had, pick up the left strand

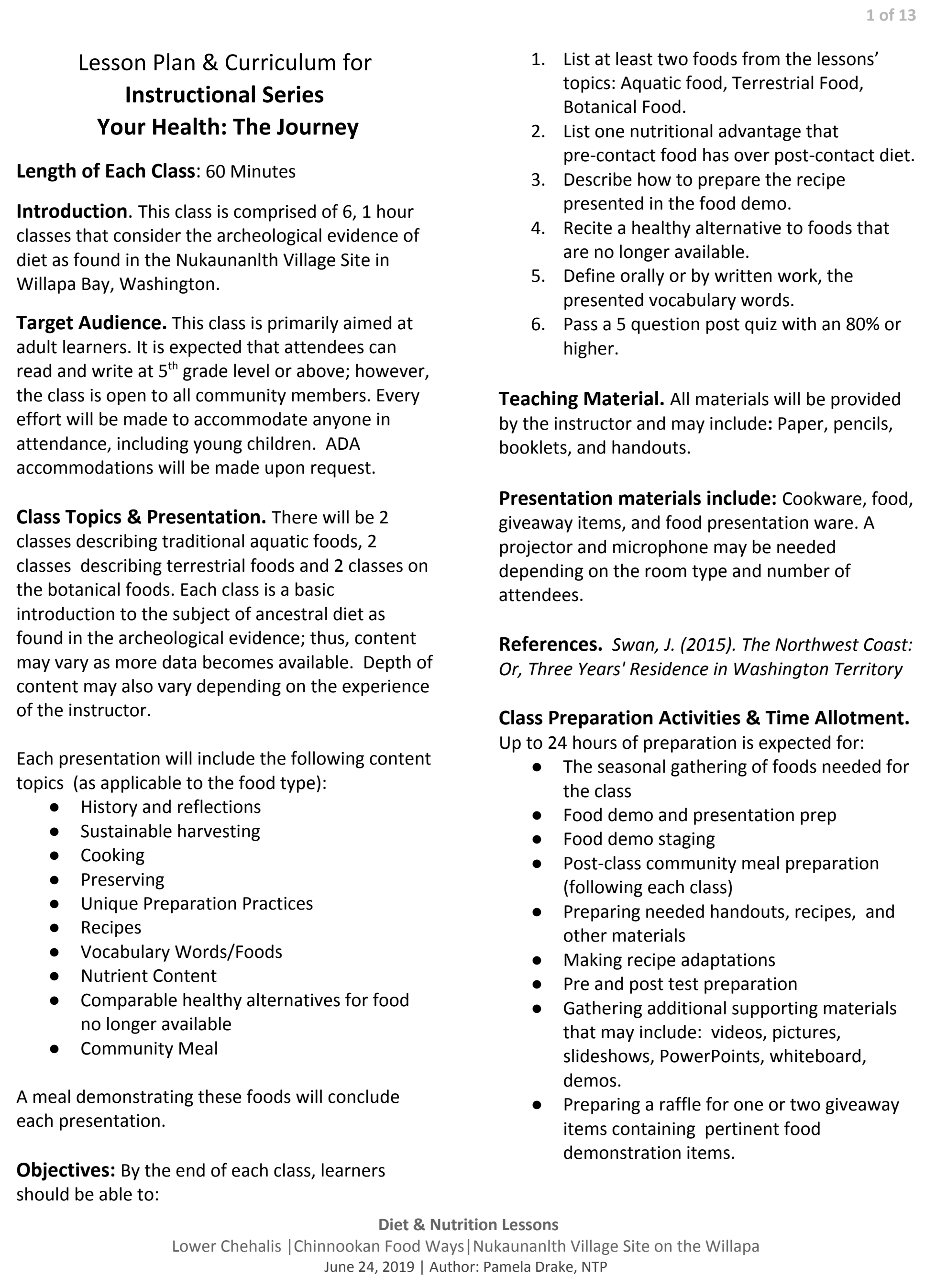


4. Cross your right hand over the left, turning both strands in a counterclockwise direction

Drawings by H. Steward, Cedar, 1984

This activity sheet was adapted from Ridgefield National Wildlife Refuge Educator's Guide. For the original, please visit https://www.fws.gov/refuge/Ridgefield/visit/educator_resources.html

D. Adult Diet & Nutrition Course Lesson Plans



Lesson Plan & Curriculum for
Instructional Series
Your Health: The Journey

Length of Each Class: 60 Minutes

Introduction. This class is comprised of 6, 1 hour classes that consider the archeological evidence of diet as found in the Nukaunanlth Village Site in Willapa Bay, Washington.

Target Audience. This class is primarily aimed at adult learners. It is expected that attendees can read and write at 5th grade level or above; however, the class is open to all community members. Every effort will be made to accommodate anyone in attendance, including young children. ADA accommodations will be made upon request.

Class Topics & Presentation. There will be 2 classes describing traditional aquatic foods, 2 classes describing terrestrial foods and 2 classes on the botanical foods. Each class is a basic introduction to the subject of ancestral diet as found in the archeological evidence; thus, content may vary as more data becomes available. Depth of content may also vary depending on the experience of the instructor.

Each presentation will include the following content topics (as applicable to the food type):

- History and reflections
- Sustainable harvesting
- Cooking
- Preserving
- Unique Preparation Practices
- Recipes
- Vocabulary Words/Foods
- Nutrient Content
- Comparable healthy alternatives for food no longer available
- Community Meal

A meal demonstrating these foods will conclude each presentation.

Objectives: By the end of each class, learners should be able to:

1. List at least two foods from the lessons' topics: Aquatic food, Terrestrial Food, Botanical Food.
2. List one nutritional advantage that pre-contact food has over post-contact diet.
3. Describe how to prepare the recipe presented in the food demo.
4. Recite a healthy alternative to foods that are no longer available.
5. Define orally or by written work, the presented vocabulary words.
6. Pass a 5 question post quiz with an 80% or higher.

Teaching Material. All materials will be provided by the instructor and may include**:** Paper, pencils, booklets, and handouts.

Presentation materials include: Cookware, food, giveaway items, and food presentation ware. A projector and microphone may be needed depending on the room type and number of attendees.

References. *Swan, J. (2015). The Northwest Coast: Or, Three Years' Residence in Washington Territory*

Class Preparation Activities & Time Allotment.
Up to 24 hours of preparation is expected for:

- The seasonal gathering of foods needed for the class
- Food demo and presentation prep
- Food demo staging
- Post-class community meal preparation (following each class)
- Preparing needed handouts, recipes, and other materials
- Making recipe adaptations
- Pre and post test preparation
- Gathering additional supporting materials that may include: videos, pictures, slideshows, PowerPoints, whiteboard, demos.
- Preparing a raffle for one or two giveaway items containing pertinent food demonstration items.

Curriculum for Instructional Series
Your Health: The Journey | Class 1
Aquatic Foods

Pre-Test. A pretest is to be administered before instruction begins.

Aquatic Foods: The aquatic foods of the pre-contact Nukaunanlth Village appears to be comprised 70 % shellfish as well as the following evidence based aquatic foods. Some aquatic foods and botanical foods may have broken down and not evidenced in the data excavated at the site. This consideration will be given in the class. Example: Seaweeds, Smelt.

Some of the food is still harvested and is available. Some must have a license for gathering, some are endangered or extinct. Please note the key below.

KEY
NA= No longer available in the location
LM=Limits Monitored through regulation
E = Endangered
EX= Extinct

Vocabulary Words/Foods
*Basket Cockles (NA)
*Bay Mussels
*Fat Gaper Clams
*Bent Nosed Clams
*Pacific Littleneck Clams (LM)
*Olympic Oysters (native species NA)
*Frilled Dogwinkle /Sea Snails
*Dungeness Crab (LM)
*Salmon, Trout (LM)
*Sturgeon (E)
*Surf Perch (LM)
*Flatfish / Flounder (LM)
*Bull Heads like the Pacific Sculpin
*Skate
*Spiny Dogfish (E)

Preparation Practices. The gathering of shellfish was typically done by hand and placed in handwoven baskets. Fish was speared, or hooked using primitive handmade tools from stone, wood, bone and botanical threads. Primitive style nets and traps were also used to gather in fish. Many parts of shellfish or fish were used but the heads, egg sacks, shells etc. were a valuable source of nutrient, tool and decorative clothing or jewelry.

Cooking. The aquatic foods were eaten raw, boiled, steam baked, smoked on racks or in smoke houses and cooked around fires. Today we have pots and pans to clean and buy but then, pots or pans were not available so food was prepared simply by digging pits and lining them in skunk cabbage leaves, seaweed or other foliage.

Preserving. The preservation was typically through boiling, steaming or smoking.

Building racks of tree limbs for drying, fashioning rope from cedar trees to hang foods around fire for smoking and drying for the winter months were typical methods of preserving foods. Boiled foods were eaten as gathered. The weaves of the baskets could be so tight as to hold water and yet some were loosely woven for steaming or storage. Cedar blocks were dug out to create boxes where water was placed and brought to a low simmer using hot rocks. The extra hot rocks were placed in the water with the food and covered. The food was rarely spiced except for some botanicals like wild onions, cow parsnips, wild carrots and roots, wild garlic, or juniper berries and aromatic leaves or foliage. Not a lot is available for information on actual food prep techniques prior to contact. In the book **The Northwest Coast, or Three Years' Residence in Washington Territory** by James G. Swan, he mentions many of the foods the village ate and even how they were procured and prepared. Unfortunately, this was after contact and by then things had changed.

Nutrient Content. Nutrients found in primitive foods were not challenged by industrial pollution we see today. DDT. PCB's, mercury, oil spills and other contaminants were not rampant in the food chain as we see today. Today where we source our foods is important. Farmed fish and shellfish are not an acceptable substitute for native, sustainable foods. In some cases eating fish and shellfish with possible levels of industrial contaminants may need to be limited- especially for children, pregnant and nursing mothers.

If the shellfish and fish are taken from non-polluted sources or are known to have low levels then eating them freely provides us with amazing, life-giving, healing nutrient properties The aquatic foods alone were adequate to provide all the iron, zinc, copper, B12, healthy sterols including all Omega 3 fatty acids, EPA and DHA needed to be well. They are low in fat, and great sources of protein. The methods of cooking the aquatic foods on low temperatures preserved the sterols in the fish making them even better for brain and nerve development.

Application. *Recipes | Comparable Healthy Alternatives | Community Meal Raffle | Post-Test*

Instructor note: *The food demo is purposely kept simple to appreciate the flavors of seafood. A food preparation demonstration will need to consider the season in which the lesson is being prepared- unless the teacher was able to freeze salmon or shellfish at an earlier time.*

Comparable Healthy Alternatives. Flounder is readily available through local venues in the frozen section. Clams are available through other tribes, and local fishmongers in Westport, WA.

Oysters may not be the native oysters as found in the digs. The local farmed oysters may have high levels of contaminants, fungicides, and other chemical pest controlling medications as used in commercial farming practices.

Recipes/demo. ½ inch of water can be placed in a stainless fry pan with a lid. The water brought to a simmer and fish laid in the water, brought back to a simmer / covered, kept on very low until done.

The class would be told they can add any number of spices, herbs or vegetables including; garlic, onion, lemon even butter, dill, parsley or fennel leaves and still maintain the simplicity.

Community Meal. A simple lightly steamed fish, flounder or salmon, or dairy free chowder along with a green salad with some dried berries, toasted hazelnuts or filberts and a light lemon berry vinaigrette would serve as a community meal.

Giveaway/Raffle. 1 pound of flounder or salmon or the ingredients for the dressing would serve as give away for this class.

Post-Test. Posttest to be administered as a final activity.

Curriculum for Instructional Series
Your Health: The Journey | Class 2
Aquatic Foods

Pre-Test. A pretest is to be administered before instruction begins.

Aquatic Foods 2.

History and Reflections. Aquatic foods as found in the Nukaunanlth Village site teach us a great deal about the diet and lifestyle of this village. All of the harvesting of foods had to have required great skill and physical prowess to procure. The maritime weather with rain and winds, the making of tools, canoes, traps and preservation systems to keep food safe from elements and scavengers. The energy required to acquire this sustenance and shelter reflects the level of health and stamina of these tribes.

Food Preparation. ***The Northwest Coast or Three Years Residence in Washington Territory*** by James G. Swan, Chapter VI goes into great detail concerning the diet he observed of the Nukaunanlth Villagers. He describes the hunting, killing and preparation of sea otters and sea lions, the fat gathering and preserving of the fat from these sea mammals for mixing with dried berries and making cakes for the winter. He describes the fat running off the cooking fat salmon in streams and being caught in big shells and kept for dipping food into. Fish oils were priced for softening skins, dipping food into and oiling wood. Fish oils were a vital part of the community's resources.

Nutrient Content. We know that these oils are rich in DHA and EPA the very fats that create sound brains, nervous systems and healthy babies. Women and children possessed traits of strength and wellness to survive and thrive under daily conditions of life telling us that the Nukaunanlth Villagers were Olympic quality individuals.

Tradition Diets Examined. Most recently a program referred to as the "Blue Zone Project" highlights people groups that have high percentages of centurions with exceptionally good health and no signs of degenerative disease that seems to beset most of the industrialized world. The project is really about communities that come together to make it easier to live healthy lives. In the interviews with these people of over 100 years old, all boast of working very hard in gardens, vineyards, animal husbandry and the outdoors. They walk a lot, they report they gather food together, make meals together, and enjoy their neighbors and friends in a spiritual connectedness around meals. They eat, real, whole foods, fresh from gardens. These centurions, typically are happier, enjoying the arts and creativity, they sing, have good strength and clear minds.

The Nukaunanlth Villagers along with other pre-contacts groups have many similarities in diet and lifestyle to those interviewed in the Blue Zone Project that might inspire us to choose foods from our personal traditional diets or from their diet. *[Emphasize] Ancestral Food preparation methods are honored and respected within the Shoalwater Bay Tribe today.*

Application. *Activities | Recipes- Ingredients| Comparable Healthy Alternatives | Community Meal Raffle | Post-Test*

Activity. *Learners internally process activities of historical practices.* Instructor states: " I want you to imagine your daily life in a village like this if you can. No cell phone, running water, horses, or vehicles except canoes that you make from the ground up, literally". I have been envisioning myself and I fall so short of the ability to simply gather.

[Instructor can add a personal or current day example here]. Recently I was gathering shells and some botanicals and by the time I got home I was stiff and a bit sore from the bending and sorting. If I had a child on my back or was pregnant this could have been even more challenging. Life clearly was not easy yet I believe the ultra- nutrient dense foods that they ate and the daily movement

it took to gather the foods were keys that we might learn how to be healthier in this day and age.

Comparable Healthy Alternatives. Trying to perfectly emulate preparation processes would take away from instructional highlights of the community meal time activity; therefore, food preparation for the classes in these modules are done using more modern cooking methods. Ovens, stoves, grills steaming, boiling and baking the food for classes. If a member of the Tribe chooses to share a traditional cooking method for any of the modules we are grateful.

For this class we will demonstrate how to make 2 different fish stocks. One from an oily fish, Salmon Fish Head Soup and a white fish stock from fresh fish carcasses. We will use some basic herbs and vegetables.

Community Meal and Ingredients. The meal for this class will be a fish stock bar with various flavors to add as desired including, garlic, ginger, lemon, lime, bean thread noodles, fish sauce, carrots, green onions and pieces of cod, flounder or salmon.

The meal will also have a smoked dairy free salmon chowder, stir fried vegetables and jelled berries. Recipes will be available as well to all class members.

Giveaway/Raffle. *Instructor Directions: The ingredients for stock will be given by raffle ticket (no fee) to two class attendee*

Post-Test. Posttest to be administered as a final activity.

Curriculum for Instructional Series

Your Health: The Journey | Class 3
Terrestrial Foods Part I

Pre-Test. A pretest is to be administered before instruction begins.

Terrestrial Foods 1
These next two classes will focus on land mammals and birds that made up the terrestrial foods on the Nukaunanlth Village record. Examples of terrestrial foods are: Elk, mule deer, small rodents. Using <u>all</u> parts of the animal was common and served as a necessary part of the survival and well-being of the tribe. The purpose of this class is not necessarily to encourage participants to hunt beaver, elk and deer and fix it in a traditional fashion, but to

1. Enable each participant to make wise use of organically raised animals that they purchase or hunt, by finding ways to use all the animal.
2. Discover the nutrients in these foods, for the purpose of regaining health and protecting the generations to come. Consuming food and understanding principles of traditional food preparation are essential components contributing to sustained population health.

Vocabulary Words/Traditional Terrestrial
*Indian Middens
*Elk
* Mule deer
*Mountain Beaver
* Cougar
* Small rodents
*Canadian geese
* Northern Fulmar
*Common Murre.
* Bear (<u>though bear bones were not found at this site,</u> it was another mammal used by the village. It is also possible other sites that may contain other types of animals and birds)

<u>KEY</u>
E = Eaten-E
PE = Parts Eaten
PU= Parts Used but not Eaten
NE = Not Eaten
NE-NU = Not Eaten-Not Used

Today's uses for these land mammals
Elk: PE, PU
Deer: PE, PU
Mountain Beaver: NE
Cougar: NE, PU
Small Rodents: NE-NU

History and Comparisons- Past and Present. The most profound food-truth found throughout native people groups around the world is that all parts of the animals killed had a purpose, and none was wasted. In today's world of hunters no such intentional plan exists to use all of the parts of the animal. While some parts are used in select items, such as bone meal, gelatins, sausage components, animal food, and cosmetics, the vast majority of industrialized, modern hunters of today often use just the muscle meat, some organ meat , make select sausage or jerky from muscle meat scraps, then mount a hide or head on the wall. The remaining parts of the animal are most often wasted. Industrialized confinement animals in feedlots are monopolized for all their parts and pieces, but many local hunters still do not use all parts.

Preparation and modern comparisons. It would be of special note to say that no sprays or manmade chemicals were used back then; a majority of meat was free of common contaminants used today. *They were organic in the true sense of the word.* Today, studies in the world of academia are showing our food chain in wild habitations have been contaminated. Animals hunted have chemical contaminants in them. The meat has been tainted at least to a small degree, as forests and fields are sprayed with exfoliates and other poisons.

Reflections. <u>How can hunters be more mindful of the game they kill for food and sport?</u>

<u>How can we be better stewards of the wild and domestic mammals we eat?</u> We might start by looking at what was done in the villages like this.

Traditional Preparation. The use of all of the animal was common and served as a necessary part of the survival and well-being of the tribe. On the Nukaunanlth site were found over 350 land mammal bones and 150 bird bones, showing us a variety of animals were often utilized as a source of sustenance. The people were very resourceful with the products available for survival. Here are a few examples of some well known uses of animal parts.

The first time I saw a tribal member **tanning a deer hide** I learned that the <u>brain matter</u> was used in this process. **Buttons, tribal dress, regalia, knives, and weapons** were made from <u>bones, sinew, hides and fur.</u> **Musical instruments** such drums used <u>hides and organs</u> for stitching. **Medicines** were made of some parts such as the <u>liver, blood, adrenals, and lungs.</u> **Pots and water gathering vessels** from <u>bladders, stomach, and other body parts.</u> **Bedding** from hides and <u>feathers.</u> The <u>oils</u> for **skin,** and **dipping foods.** The meat was boiled, smoked dried, steamed and baked. It was added to berries with the fat to make **pemmican style food** cakes rich in calories for winter months and long traveling.

Modern foods. Hamburger, though popular now, would be difficult to make back then. No grinders or processors were available.

Application. *Activities |Comparable Healthy Alternatives | Community Meal Raffle | Post-Test*

Activity. Vary your animal proteins as was done in traditional diets. Instructions: Consider the uses of proteins and other animal parts. Choose at least 2 options you can <u>newly</u> integrate into your diet or food practices (see options below).

Comparable Healthy Alternatives.

<u>*Main Proteins.*</u> Lamb, beef, pork, bison, elk, deer, chicken, duck, turkey, eggs. If you hunt or have access to them, you can also use: Grouse, peasant, ostrich, or other fowl. Consider rodent meat. In many parts of the world rodents are a part of the diet including: Rabbits, opossum, squirrels, beavers, mice, rats, and guinea pigs.

<u>*Bone Broths*</u>: Learn to make soups, stews and casseroles from broths and lend nutrient denseness to every meal. Cook all the bones and joints, feet, and heads in your broth preparation, releasing minerals, collagen, gelatins and vital proteins into the broth.

Nutrient Content. The collagen, hyaluronic acid, and chondroitin's help keep joints, hair, skin, and teeth and bones healthy. They are known to have anti-aging effects in the joints and skin Minerals are easily absorbed from a well done broth. Osteoporosis, knee and hip replacements, dental caries abound in our society today. People are buying jars of antiaging, wrinkle cream and collagen. Why not learn to simmer bones?

<u>*Use liver and heart at least weekly.*</u> These are inexpensive cuts of meat that can mimic early utilization of animal organs. If you purchase a grass fed animal, ask the butcher grind the heart into the burger. You can also cut the heart into stew meat and place in small packages in the freezer. Then, you can cook it in with your batches of stew as desired. Online, there are resources for organic meat. Lamb liver can be used. Pork livers are good sources of the nutrients listed as well.

Nutrient Content. Liver and heart are rich in CoQ enzyme , B Vitamins, iron, copper, zinc, protein, They are low in fat, rich in trace minerals and folic acid. They strengthen the nervous system, the heart and blood.

Community Meal. The meal for this class will be a beef stew and a green salad. I will encourage the idea that we can use nutrient dense beef broth and a slow cooking process, such as the crockpot, to emulate the pit the villagers used to slow cook foods The recipes will be available.

Giveaway/Raffle. Includes ingredients for a 2 batches of bone stock, as well as frozen chicken feet for a unique addition. Chicken feet can be found in Hispanic frozen food sections of many local stores. These ingredients will be given to two participants using a raffle ticket number they are given when they signed into class. No fee.

Post-Test. Posttest to be administered as a final activity.

Curriculum for Instructional Series

Your Health: The Journey | Class 4 Terrestrial Foods Part II

Pre-Test. A pretest is to be administered before instruction begins.

Terrestrial Foods II.
This class is a continuation of Terrestrial Foods I, in Class 3. It describes the use of birds that made up the terrestrial foods on the Nukaunanlth Village record. Examples of terrestrial fowl are: ducks, Canadian goose, Northern Fulmar. Using all parts of the animal was common and served as a necessary part of the survival and well-being of the tribe. The purpose of this class is not necessarily to encourage participants to hunt fowl and fix it in a traditional fashion, but to

3. Enable each participant to make wise use of organically raised animals that they purchase or hunt, by finding ways to use all the animal.
4. Discover the nutrients in these foods, for the purpose of regaining health and protecting the generations to come. Consuming food and understanding principles of traditional food preparation are essential components contributing to sustained population health.

History and Reflections. In class 3 we discussed some land animals whose bones were found at the Nukaunanlth dig site: Elk, deer, beaver, cougars etc. Bird bird bones were also found on this site. There were 150 bird bones. We note that birds made up a large percentage of the diet of the villagers.

When we think of eating birds the picture of domesticated or commercially raised chickens, turkeys, ducks come to mind; however, in this case, ducks, Canadian geese, Northern Fulmar, and Common Murre were among the bones found.

Instead of domesticated fowl think… seagull type birds, geese, and ducks that live on seacoast diets. Their meat tastes gamey and fishy taste. In the ***The Northwest Coast Book*** by James G. Swan, he acknowledged a butter duck or a black surf- duck (Fuligula perspicillata, p. 357). He chased it as he was very hungry, but the expert diving skills of this duck made it hard for him to catch it. He states that in the fall these ducks are so fat they sometimes can't even fly. He commented also that the flesh was "*coarse and fishy* ". The Northern Fulmar eat lots of fish and refuse and looks like a gull, but with tube-like beaks.

The Common Murre is said to have dark oily meat that tastes like…you guessed it fish! So it is safe to say that the villagers subsisted on many fishy- tasting foods. Prior to contact, when sugars and flours became a traded goods, these flavors were most common and well received by the village palate. Birds like these with darker, oily meat provided the much needed protein and fat needed for energy.

Nutrient Content. *Wild vs. domesticated foods.* The USDA Nutrient chart of American Wild Game Nutrient Content vs. domesticated meat, shows the benefits of a traditional village diet. Though the birds in the chart are limited to wild turkeys verses domesticated turkeys, (not ducks and pheasants), there seems to be a pattern. Dove, partridge, grouse, and crane are listed as well:

> For the most part the wild birds appear to be slightly higher in protein, lower in fat percentages, cholesterol and calories. The iron, selenium, zinc and b vitamin profile of the wild vs. domesticated in typically slightly higher in the wild. Since we do not have data on the Common Murre and Northern Furman as a food product, we might assume they also fall into a nutrient dense profile. In general, dark meat tends to be higher in minerals and fats. Fat is important, as it is vital to the absorption of minerals. Fat carries the minerals into a cell.

Ducks and geese are high in fat. The fat actually preserves the meat for long periods of time. Cooked meat is preserved when submerged or coated in its fat, then stored.

Community Meal Preparation and Rationale. Duck or goose confit (con-fee) is served with cranberries, roasted vegetables wild greens (if these are not available, use arugula salad) with hazelnuts, dried berries, and chanterelles. Seared and sliced breast can be offered alongside or even atop the salad. Nettle Tea or Indian Tea is also served.

Rationale: Learning how to roast a duck or goose for class provides a taste experience for participants.

A duck or goose confit is a simple meal, but requires prep and pre-cook time by the instructor. The demonstration consists of showing what a thawed duck or goose looks like, then removing the thighs, legs and wings to confit. Breast is prepared differently. The duck breast would be prepared by scoring the skin and searing it during class. The meat can be salting and herbed the thighs , wings and legs of the meat for setting in refrigerator overnight or a couple of days, then put in the crock pot for roasting. (An alternative meal is duck stew, served with Hazelnut gluten free biscuits and a no sugar added berry jam.) The class eats the finished product in the community meal.

Acquire domesticated birds as available for the demonstration meal. Inquire to see if anyone in the class knows of someone in the tribe who still hunts ducks or other fowl, and see if they would be willing to supply the fowl for the demonstration meal. Duck and goose are also found in the frozen section of the meat market, or possibly from local farmers.

Giveaway/Raffle. A frozen duck or goose, the salt and herbs used in the community meal.This is a no-cost drawing for two class members. The recipes for today’s meal is provided with the ingredients, and available to other class members as well.

Post-Test. Posttest to be administered as a final activity.

Curriculum for Instructional Series
Your Health: The Journey | Class 5
Botanical Foods Part I

Pre-Test. A pretest is to be administered before instruction begins.

Botanical Foods I

These next two classes will focus on plants making up the botanical foods on the Nukaunanlth Village record. Examples of botanical foods are: Nettles, blackberries, and sweetgrass. Botanicals were used for food, and also utilized for medicine and spiritual practice.

***Vocabulary Words:**

***Diuretic**: Causes increase of passing of urine.

***Oxalates**: A salt or oxalic acid that occurs in plants like spinach, rhubarb, mustard greens, beet greens and nuts that forms an insoluble salt with calcium and interferes with calcium absorption. Should be avoided by kidney stone formers.

***Smudge**: To use smoke from sacred herbs to cleanse or purify a person or space.

HIstory and Reflections. *Botanical Food.* The Nukaunanlth Village site had evidence of 4 botanicals: Bearberry, Stinging Nettle, Miners Lettuce and Bulrush or sweet grass. This is not to say that others were not used but the evidence in this site is what comprises the majority of class instruction.. Wild berries including blackberries, elderberries, strawberries, salal and cranberries were most commonly gathered and readily available in season. Cattail, violet, hazelnuts, dandelion, chickweed, wild leeks, wild celery, juniper, sage, lambs quarters, walnut, and camas are often listed in many books and referenced as commonly-eaten foods of the Lower Chehalis tribes.

Nutrient Content. The raw nutrient found within the botanical realm, by modern explanation, is over-the-top nutrient dense. Vitamins and minerals abound. When eaten and gathered within the seasons, there is a variety available, supporting optimum health and vitality.

Historical Uses. We naturally want to quantify by laboratory standards, the nutrients in each plant, but there is an esoteric edge in tribal culture. These items take on some medicinal /spiritual tones that are known and practiced by the tribal keepers of this information- whether elder, shaman, or medicine men of the tribe. This knowledge is sacred and not readily shared with outsiders. Try not to assume that the following information ascribed to the listed plants is exhaustive in tribal terms, but simply basic nutrition information.

Uses and Preparation. Care should always be taken when gathering wild plants that you are sure of their identity, and that you gather in areas that you know are not sprayed. Avoid sides of the road where other pollutants can affect the value of the nutrients. It is important to vary one's diet using local and regional foods, such as local berries and greens. Local and regionally-grown foods provide nutrients often not present in commercially produced botanicals. Pesticides, poor soil conditions, commercial harvesting conditions, travel time and storage time, may compromise grocery store produce- even when they are marketed as "fresh".

Personal, local harvesting, ensures the nutrients are not as compromised. Gathering these foods locally have other benefits besides high nutrient content. While gathering the plants locally, you are also participating in outdoor exercise, and enrich family and social interactions. Kids can have a fun time outdoors, while learning incidentally about the outdoors and family.

Botanical Foods: Nutrition, Uses, & Harvesting

Bearberry. Arctostaphylos, grape berry, or Common Bearberry. Also called 'uva-ursi' or when combined with other herbs and smoked, it is referred to as 'Kinnikinnick'. This plant has small red berries that bears love. The berries are known for their diuretic* effect and for cleansing the kidneys. The leaves were used for ceremony mixed with other plants and smoked or smudged.*

***Stinging Nettles**.* 'Urtica dioica'. This plant has been used by many cultures for ages. It makes amazing soup and tastes a little like cooked spinach and cucumber when cooked. The raw leaves when touched will make your skin react with itching welts that raise up. Care to wear gloves when gathering is important. Dock leaves typically found near the nettle plant is a remedy that can be rubbed on the welting area to stop the sting effect.

Nettles lose their sting when steamed or cooked and are a delicious addition to a spring meal. They are rich in Vitamin A, C, iron, potassium, manganese, calcium and magnesium. They have oxalates like found in spinach and are best when picked a young age and steamed. The older the plant, the higher levels of oxalates*.

Application. *Community Meal Preparation and Rationale.* The meal for this class will be nettle soup, with a salad with pesto dressing, nettle tea and low sugar berry crisp. Any berries frozen or fresh can be used in place of bearberries since they are not readily available for the most part. Encourage the use of honey or/and stevia for sweeteners. Other options for main dishes are sides would be: A nettle crustless quiche, nettle omelet, stir-fry, nettle pesto, and steamed nettles.

Nettles in recipes. *Nettle Soup is a popular soup made wherever nettles are harvested worldwide.* It is a potato style soup made with either chicken stock or vegetable stock.

Traditional Nettles. Traditionally were used in soups and steamed in meats; also dried and drank as a tea.

Spinach replacement. Fresh steamed nettles can be used like spinach in any application spinach would be found. Examples: Lasagna, stir-fried into vegetables, mixed with cheese and stuffed into mushrooms or pasta shells, or in spanakopita, or in tortillas.

Nettle tea: Dried leaves can easily be purchased in tea bag form or bulk leaf. It is rich in minerals and can be used as a beverage in the class (sweetened or unsweetened).

Locating Nettles. Frozen nettles are often available through some tribal members. The instructor may also gather some, if the class in the spring of the year. Oregon Mushroom LLC or Whole Earth Harvest in Yamhill, Oregon, are a good source to buy frozen fresh nettles. Be aware they do sell out early in the season. Check online for these companies. They are also a good source for berries, leeks and wild mushrooms, as are local farmers markets who buy from local foragers.

Activity/Food Demonstration. A picture of the plant would be valuable to show to the class for identification. If fresh nettle can be procured, show the class what nettle looks like before steaming or cooking it. Wear gloves for this part for safety. Then using a portable burner and pot with water and steamer basket. Do a demo of how to steam them. Or, make a stir fry,by adding fresh nettles when the stir fry is almost done cooking. The soup, quiche, omelet, tea or cobbler, can all be used at the discretion of the instructor for demonstration purposes.

***Giveaways and Raffles*:** Give each participant a raffle ticket when they arrive to the class. There is no charge. Two bags of the ingredients and the demonstrated recipes should be the raffle items. A steamer basket, nettle tea, honey or stevia would also be good giveaways.

Post-Test. Posttest to be administered as a final activity.

Curriculum for Instructional Series
Your Health: The Journey | Class 6
Botanical Foods Part II

Pre-test. A pretest is to be administered before instruction begins.

Botanical Foods II
In this class, we will continue to focus on the botanicals found in the middens of the Nukaunanlth Village Site on the Willapa. We discussed the first two, bearberry and nettles. The other two for this lesson are **miner's lettuce and sweet grass.** The latter of which was not a food but in fact one of the more valuable botanicals used by the pre-contact people of this village.

Emphasis in this class is placed on the idea that traditional diet was able to maintain generations of families long before contact. According to Lewis and Clark, the tribal population was as many as 5000 people. After contact, their numbers were barely 100 (Swan). New germs and foods radically changed the health of this once thriving people.

Vocabulary and Nutrient Content

Miner's lettuce, Claytonia perfoliata, Indian lettuce: is so rich in vitamin C that it can cure scurvy* and was in fact used by the California miners to prevent scurvy hence the name miner's lettuce.

The Journal of American Dietetics says that 100 grams of this vegetable (which is about the size of a small salad) contains 33% of the daily required Vitamin C, 22% of Vitamin A and 10 % of iron. When eaten with foods like nettles and berries, one can see how only a small amount of food was nutrient-dense and capable of providing a healthy life for the villagers.

Sweet grass: A native, perennial, warm season grass found growing in coastal dunes. The urbanization of the habitat has made it more difficult to acquire in some coastal regions.

It is gathered, dried, and then soaked in water again before weaving into baskets, mats, hats, clothing, blankets, jewelry and coverings. Other grasses, pine needles, vines and tree barks are woven in with the grass to give strength and design to each item as determined by the weaver.

Baskets served a big need for vessels to put gathered foods, to store food, to cook food in to rinse foods. Each weave had different uses and each weaver their own special way of weaving. Some of the weavers were well known in their tribe for the unique characteristics of their weave. Baskets were traded and sold. They took considerable artistic ability and time. It is truly an art and filled a big part of native life.

Application. ***Activity /Food Demonstrations:*** The instructor may want to make a point of putting at least part of the meal in baskets. Demonstrate the care of miner's lettuce by washing gently.

Sweet grass baskets are difficult to find and for the sake of the class any basket will serve to show that they are handy. Putting vegetables in them, fruits, rolls or breads, stacking sandwiches are visual reminders that simple is good and baskets play a part. It is also a picture of natural ways to serve food to groups.

Demonstrate to the class the use of baskets in this manner. Dried salmon, jerky, pemmican can be served from the baskets.

Community Meal Options.

1. A simple organic green salad with miner's lettuce, fresh seasonal berries, and hazelnuts and a lemon Vinaigrette, stacked in a basket. Miner's lettuce is seasonal and can be gathered by the instructor for adding to a standard salad. Gathering enough for a full class is not time effective but this plant can be tossed into a salad.
2. Grilled salmon, or chicken and gluten free rolls can be the meal, all served in baskets.
3. Other vegetables and smoked salmon dip can be served in baskets, or even simple gluten free salmon salad sandwiches, tuna sandwiches, or tuna salad in celery- topped with dried fruit juice sweetened cranberries.
4. Dried blueberries, mulberries, or cranberries, can be made into some

shortbread cookies that are placed into baskets.

Instructor should make enough of the recipe for all students to have at least one serving.

Giveaways and Raffles. Tickets to each participant can be given at the beginning of the class, free of charge. Prizes might include a basket with salad fixings, tongs, dressing ingredients, and/or a piece of salmon or chicken. The Book by James Swan ***The Northwest Coast or Three Years Residence in Washington Territory*** would make a good giveaway as well. Books on plant identification are also options.

Post-Test. Posttest to be administered as a final activity.

Bibliography

Acheson, Steven, and James Delgado
2004 Ships for the Taking: Culture Contact and the Maritime Fur Trade on the Northwest Coast of North America. In *The Archaeology of Contact in Settler Societies*, edited by Tim Murray, pp. 48–77. Cambridge University Press, Cambridge.

Adamson, Thelma
1926 Unarranged Sources of Chehalis Ethnology. University of Washington, Special Collections Archives.

Ainis, Amira F., Troy W. Davis, Jon M. Erlandson, and Torben C. Rick
2011 Changes in Marine Subsistence on San Miguel Island from 8,500 to 2,400 Years Ago: Analysis of Bulk Samples from Cave of the Chimneys (CA-SMI-603). *Journal of California and Great Basin Anthropology* 31(1):59–79.

Allen, Douglas
2004 *Shoalwater Willapa*. Snoose Peak Publishing, South Bend, Washington.

Ambrose, William G., Paul E. Renaud, William L. Locke, Finlo R. Cottier, Jørgen Berge, Michael L. Carroll, Benjamin Levin, and Stuart Ryan
2012 Growth Line Deposition and Variability in Growth of Two Circumpolar Bivalves (*Serripes groenlandicus*, and *Clinocardium ciliatum*). *Polar Biology* 35(3):345–354. DOI:10.1007/s00300-011-1080-4.

Ames, Kenneth M.
1981 The Evolution of Social Ranking on the Northwest Coast of North America. *American Antiquity* 46(4):789–805.
1994 The Northwest Coast: Complex Hunter-Gatherers, Ecology, and Social Evolution. *Annual Review of Anthropology*:209–229.
1995 Chiefly Power and Household Production on the Northwest Coast. In *Foundations of Social Inequality*, edited by T. Douglas Price and Gary M. Feinman, pp. 155–187. Fundamental issues in archaeology. Plenum Press, New York.
1996 Life in the Big House: Household Labor and Dwelling Size on the Northwest Coast. In *People Who Lived in Big Houses: Archaeological Perspectives on Large Domestic Structures*, edited by Gary G. Coupland and Edward B. Banning, pp. 131–150. Monographs in World Archaeology no. 27. Prehistory Press, Madison, Wisconsin.
2003 The Northwest Coast. Evolutionary Anthropology: Issues, News, and Reviews 12(1):19–33.

2005 Intensification of Food Production on the Northwest Coast. In *Keeping It Living: Traditions of Plant Use and Cultivation on the Northwest Coast of North America*, edited by Douglas Deur and Nancy J. Turner. UBC Press, Vancouver.

2008a Slavery, Household Production, and Demography on the Southern Northwest Coast. In *Invisible Citizens: Captives and Their Consequences*, pp. 138–158. University of Utah Press, Salt Lake City.

2008b The Archaeology of Rank. In *Handbook of Archaeological Theories*, edited by R. Alexander Bentley, Herbert D. G. Maschner, and Christopher Chippendale, pp. 487–513. Alta Mira Press, Landham, Maryland.

Ames, Kenneth M., and Herbert D. G. Maschner

1999 Peoples of the Northwest Coast: Their Archaeology and Prehistory. Thames & Hundson, London.

Ames, Kenneth M., Doria F. Raetz, Stephen Hamilton, and Christine McAfee

1992 Household Archaeology of a Southern Northwest Coast Plank House. *Journal of Field Archaeology* 19(3):275–290. DOI:10.1179/009346992791548851.

Ames, Kenneth M., and Elizabeth A. Sobel

2013 Houses and Households. In *Chinookan Peoples of the Lower Columbia*, edited by Robert T. Boyd, Kenneth M. Ames, and Tony A. Johnson, pp. 125–145. University of Washington Press, Seattle.

Anderson, A.J.

1981 A Model of Prehistoric Collecting on the Rocky Shore. *Journal of Archaeological Science* 8(2):109–120. DOI:10.1016/0305-4403(81)90020-0.

Anderson, Duane

1985 Reburial: Is It Reasonable? *Archaeology* 38(5):48–51.

Anderson, Ian, Bridget Robson, Michele Connolly, Fadwa Al-Yaman, Espen Bjertness, Alexandra King, Michael Tynan, Richard Madden, Abhay Bang, Carlos E A Coimbra, Maria Amalia Pesantes, Hugo Amigo, Sergei Andronov, Blas Armien, Daniel Ayala Obando, Per Axelsson, Zaid Shakoor Bhatti, Zulfiqar Ahmed Bhutta, Peter Bjerregaard, Marius B Bjertness, Roberto Briceno-Leon, Ann Ragnhild Broderstad, Patricia Bustos, Virasakdi Chongsuvivatwong, Jiayou Chu, Deji, Jitendra Gouda, Rachakulla Harikumar, Thein Thein Htay, Aung Soe Htet, Chimaraoke Izugbara, Martina Kamaka, Malcolm King, Mallikharjuna Rao Kodavanti, Macarena Lara, Avula Laxmaiah, Claudia Lema, Ana María León Taborda, Tippawan Liabsuetrakul, Andrey Lobanov, Marita Melhus, Indrapal Meshram, J Jaime Miranda, Thet Thet Mu, Balkrishna Nagalla, Arlappa Nimmathota, Andrey Ivanovich Popov, Ana María Peñuela Poveda, Faujdar Ram, Hannah Reich, Ricardo V Santos, Aye Aye Sein, Chander Shekhar, Lhamo Y Sherpa, Peter Skold, Sofia Tano, Asahngwa Tanywe, Chidi Ugwu, Fabian Ugwu, Patama Vapattanawong, Xia Wan, James R Welch, Gonghuan Yang, Zhaoqing Yang, and Leslie Yap
2016 Indigenous and Tribal Peoples' Health (The Lancet–Lowitja Institute Global Collaboration): A Population Study. *The Lancet* 388(10040):131–157. DOI:10.1016/S0140-6736(16)00345-7.

Andrews, Elizabeth F.
1994 Territoriality and Land Use Among the Akulmiut of Western Alaska. In *Key Issues in Hunter-Gatherer Research*, edited by Ernest S. Burch, Jr. and Linda J. Ellanna, pp. 65–93. Berg, Oxford.

Andrews, Allen H., Kenneth W. Gobalet, and Terry L. Jones
2003 Reliability Assessment of Season-of-Capture Determination from Archaeological Otoliths. *Bulletin - Southern California Academy of Sciences* 102(2):66.

Andrus, C. Fred T., and Douglas E. Crowe
2000 Geochemical Analysis of Crassostrea virginica as a Method to Determine Season of Capture. *Journal of Archaeological Science* 27(1):33–42. DOI:10.1006/jasc.1999.0417.

Angelbeck, Bill, and Colin Grier
2014 From Paradigms to Practices: Pursuing Horizontal and Long-Term Relationships with Indigenous Peoples for Archaeological Heritage Management. *Canadian Journal of Archaeology* 38(2):519–540.

Anonymous
1861 Memorial of Citizens of Oregon and Washington Asking for Relief for Sundry Indian Tribes to the Commissioner of Indian Affairs. Washington State Library in Olympia. Oregon Territorial Papers of the United States, 1821-1868.

Anonymous
1903 Portrait and Biographical Record of Portland and Vicinity, Oregon: Containing Original Sketches of Many Well-Known Citizens of the Past and Present. Chapman Publishing Company, Chicago.

Antoine v. Washington
1975 Antoine v. Washington. U.S. Vol. 420.

Antoniou, Anna S.
2014 A Pilot Study of Chinookan Cultural Continuity and Change: Evidence from the Diamond Point and Paradise Point Sites, Washington. Submitted to U.S. Fish & Wildlife Service, Willapa Bay, Washington.

Antoniou, Anna S., and Earl Davis
2018 Collaborative Archaeology in Willapa Bay, Washington: Supporting Communities Through Scientific Research. Paper presented at the 83rd Annual Meeting of the Society for American Archaeology, April 2018, Washington, DC.

Arnold, Jeanne E.
1993 Labor and the Rise of Complex Hunter-Gatherers. *Journal of Anthropological Archaeology* 12:75–119.
1996 The Archaeology of Complex Hunter-Gatherers. *Journal of Archaeological Method and Theory* 3(1):77–126.
2004 *Foundations of Chumash Complexity*. Perspectives in California Archaeology v. 7. Cotsen Institute of Archaeology, University of California, Los Angeles.

Atalay, Sonya
2006 Indigenous Archaeology as Decolonizing Practice. *The American Indian Quarterly* 30(3):280–310. DOI:10.1353/aiq.2006.0015.
2008 Multivocality and Indigenous Archaeologies. In *Evaluating Multiple Narratives: Beyond Nationalist, Colonialist, Imperialist Archaeologies*, edited by Junko Habu, Clare P. Fawcett, and John M. Matsunaga, pp. 29–44. Springer, New York.
2012 Community-Based Archaeology: Research with, by, and for Indigenous and Local Communities. University of California Press, Berkeley.
2018 Repatriation and Bearing Witness: Repatriation and Bearing Witness Vital Topics Forum. *American Anthropologist* 120(3):544–545. DOI:10.1111/aman.13079.

Atalay, Sonya, Lee Rains Clauss, Randall H. McGuire, and John R. Welch (editors)
2014 Transforming Archaeology: Activist Practices and Prospects. Left Coast Press, Inc, Walnut Creek, California.

Atalay, Sonya, and Christine Hastorf
2006 Food, Meals, and Daily Activities: Food Habitus at Neolithic Çatalhöyük. *American Antiquity* 71:283. DOI:10.2307/40035906.

Atwater, Brian F.
1987 Evidence for Great Holocene Earthquakes along the Outer Coast of Washington State. *Science* 236:942–944.

Atwater, Brian F., and Eileen Hemphill-Haley
1997 Recurrence Intervals for Great Earthquakes of the Past 3,500 Years at Northeastern Willapa Bay, Washington. U.S. Geological Survey Professional Paper.

Atwater, Brian F., Satoko Musumi-Rokkaku, Kenji Satake, Yoshinobu Tsuji, Kazue Ueda, and David K. Yamaguchi
2016 The Orphan Tsunami of 1700: Japanese Clues to a Parent Earthquake in North America. University of Washington Press, Seattle.

Atwater, Brian F., Minze Stuiver, and David K. Yamaguchi
1991 Radiocarbon Test of Earthquake Magnitude at the Cascadia Subduction Zone. *Nature* 353(6340):156–158. DOI:10.1038/353156a0.

Ballard, Richard L.
1964 Distribution of Beach Sediments Near the Columbia River. Unpublished Masters, School of Oceanography, University of Washington, Seattle.

Banach, Patricia K.
2002 Copper on the Pacific Northwest Coast. Unpublished Master's thesis, Department of Anthropology, Portland State University, Portland, Oregon.

Banas, Neil Solon, Barbara M. Hickey, Parker MacCready, and Jan A. Newton
2004 Dynamics of Willapa Bay, Washington: A Highly Unsteady, Partially Mixed Estuary. *Journal of Physical Oceanography* 34(11):2413–2427.

Banas, Neil Solon
2005 Dynamics of Willapa Bay, Washington Links to the Coastal Ocean, Tidal Dispersion, and Oyster Carrying Capacity. Unpublished PhD dissertation, School of Oceanography, University of Washington, Seattle.

Barsh, Russel Lawrence
1999 Chronic Health Effects of Dispossession and Dietary Change: Lessons from North American Hunter-Gatherers. *Medical Anthropology* 18(2):135–161. DOI:10.1080/01459740.1999.9966153.

Bar-Yosef, Ofer., and Thomas R. Rocek
1998 *Seasonality and Sedentism: Archaeological Perspectives from Old and New World Sites*. Peabody Museum bulletin;6. Peabody Museum of Archaeology and Ethnology, Harvard University, Cambridge, Massachusetts.

Battarbee, Richard W.
1988 The Use of Diatom Analysis in Archaeology: A Review. *Journal of Archaeological Science* 15:621–644.

Beckham, Stephen Dow

1984 This Place is Romantic and Wild: An Historical Overview of the Cascades Area, Fort Cascades, and the Cascades Townsite, Washington Territory. Heritage Research Associates. Eugene, Oregon.

1987 Chinook Indian Tribe: Petition for Federal Acknowledgment. USA Research, Lake Oswego, OR.

Benson, Boyd E., Brian F. Atwater, David K. Yamaguchi, Lorin J. Amidon, Sarah L. Brown, and Roger C. Lewis

2001 Renewal of Tidal Forests in Washington State after a Subduction Earthquake in A.D. 1700. *Quaternary Research* 56(2):139–147. DOI:10.1006/qres.2001.2251.

Bernick, Kathryn, and Rebecca J. Wigen

1990 Seasonality of the Little Qualicum River Wet Site. *Journal of Northwest Anthropology* 24(2):153–159.

Bertalanffy, Ludwig Von

1938 A Quantitative Theory of Organic Growth (Inquiries on Growth Law. II). *Human Biology* 10(2):181–213.

Bishop, Charles, Michael Roe, and Hakluyt Society

2010 The Journal and Letters of Captain Charles Bishop on the North-West Coast of America, in the Pacific, and in New South Wales, 1794-1799. Hakluyt Society, Second Series. Hakluyt Society, Farnham, Surrey.

Blake, Brady, and Philine S.E. Zu Ermgassen

2015 The History and Decline of *Ostrea Lurida* in Willapa Bay, Washington. *Journal of Shellfish Research* 34:273–280.

Blakey, Michael L.

2008 An Ethical Epistemology of Publicly Engaged Biocultural Research. In *Evaluating Multiple Narratives: Beyond Nationalist, Colonialist, Imperialist Archaeologies*, edited by Junko Habu, Clare P. Fawcett, and John M. Matsunaga, pp. 17–29. Springer, New York.

Boas, Franz

1894 *Chinook Texts*. Bulletin of the Bureau of American Ethnology 20. Government Printing Office, Washington, DC.

Bollwerk, Elizabeth, Robert Connolly, and Carol McDavid

2015 Co-Creation and Public Archaeology. *Advances in Archaeological Practice* 3(3):178–187. DOI:10.7183/2326-3768.3.3.178.

Bovy, Kristine M.
2005 Effects of Human Hunting, Climate Change and Tectonic Events on Waterbirds along the Pacific Northwest Coast during the Late Holocene. Unpublished PhD dissertation, University of Washington, Seattle.

Boyd, Robert T.
1985 The Introduction of Infectious Disease Among the Indians of the Pacific Northwest, 1774-1874. Unpublished PhD dissertation. University of Washington, Seattle.
1990 Demographic History, 1774-1874. In *Handbook of North American Indians*, edited by Wayne Suttles, 7: Northwest Coast:pp. 135-148 Smithsonian Institution Press, Washington, DC.
1996 People of the Dalles: the Indians of Wascopam Mission: a Historical Ethnography Based on the Papers of the Methodist Missionaries. Studies in the Anthropology of North American Indians. University of Nebraska Press in cooperation with the American Indian Studies Research Institute, Indiana University, Bloomington, Lincoln.
1999 The Coming of the Spirit Pestilence. UBC Press, Vancouver.
2013 Lower Chinookan Disease and Demography. In *Chinookan Peoples of the Lower Columbia*, edited by Robert T. Boyd, Kenneth M. Ames, and Tony A. Johnson, pp. 229–249.University of Washington Press, Seattle.

Boyd, Robert T., Kenneth M. Ames, and Tony A. Johnson
2013 *Chinookan Peoples of the Lower Columbia*. University of Washington Press, Seattle.

Boyd, Robert T., and Yvonne P. Hajda
1987 Seasonal Population Movement Along the Lower Columbia River: the Social and Ecological Context. *American Ethnologist* 14(2):309–326.

Brady, Liam M.
2009 (Re)Engaging with the (Un)Known: Collaboration, Indigenous Knowledge, and Reaffirming Aboriginal Identity in the Torres Strait Islands, Northeastern Australia. *Collaborative Anthropologies* 2(1):33–64. DOI:10.1353/cla.0.0023.

Braje, Todd J., Tom D. Dillehay, Jon M. Erlandson, Richard G. Klein, and Torben C. Rick
2017 Finding the First Americans. *Science* 358(6363):592–594. DOI:10.1126/science.aao5473.

Braje, Todd J., Douglas J. Kennett, Jon M. Erlandson, and Brendan J. Culleton
2007 Human Impacts on Nearshore Shellfish Taxa: a 7,000 Year Record from Santa Rosa Island, California. *American Antiquity* 72:735–756.

Brighton, Stephen
2011 Applied Archaeology and Community Collaboration: Uncovering the Past and Empowering the Present. *Human Organization* 70(4):344–354. DOI:10.17730/humo.70.4.w0373w8655574266.

Bronk Ramsey, C.
2017 Methods for Summarizing Radiocarbon Datasets. *Radiocarbon* 59(2):1809–1833.

Brooks, Charles

1876 Report of Japanese Vessels Wrecked in the North Pacific Ocean, From the Earliest Records to the Present Time. *Proceedings of the California Academy of Sciences* 6:55–66.

Brooks, Kenneth M.

2001 Final Report Chugach Regional Resources Commission Bivalve Enhancement Program Bivalve inventories and native littleneck clam (*Protothaca staminea*) culture studies. Port Townsend, Washington.

Broughton, Jack M.

1994 Declines in Mammalian Foraging Efficiency during the Late Holocene, San Francisco Bay, California. *Journal of Anthropological Archaeology* 13(4):371–401. DOI:10.1006/jaar.1994.1019.

Broughton, Jack M., and James F. O'Connell

1999 On Evolutionary Ecology, Selectionist Archaeology, and Behavioral Archaeology. *American Antiquity* 64:153–165.

Broughton, John Michael

1995 Resource Depression and Intensification During the Late Holocene, San Francisco Bay: Evidence from the Emeryville Shellmound Vertebrate Fauna. University of Washington, Seattle.

Buikstra, Jane E.

1983 Reburial: How We All Lose-An Archaeologist's Opinion. *Council for Museum Anthropology Newsletter* 7(2):2–5. DOI:10.1525/mua.1983.7.2.2.

Burchell, Meghan, Aubrey Cannon, Nadine Hallmann, Henry P. Schwarcz, and Bernd R. Schone

2013 Inter-site Variability in the Season of Shellfish Collection on the Central Coast of British Columbia. *Journal of Archaeological Science* 40:626–636.

Burchell, Meghan, Nadine Hallmann, Andrew Martindale, Aubrey Cannon, and Bernd R. Schöne

2013 Seasonality and Intensity of Shellfish Harvesting on the North Coast of British Columbia. *The Journal of Island and Coastal Archaeology* 8(2):152–169. DOI:10.1080/15564894.2013.787566.

Burchell, Meghan, Nadine Hallmann, Bernd R. Schone, Aubrey Cannon, and Henry P. Schwarcz

2014 Biogeochemical Signatures of Marine and Estuarine Bivalaves: Implications for Interpreting Seasonality at Shell Midden Sites Using High-Resolution Stable Isotope Sclerochronology. In *The Cultural Dynamics of Shell-Matrix Sites*, edited by Mirjana Roksandic, Sheila Mendonça de Souza, Sabine Eggers, and Meghan Burchell, pp. 241–249. University of New Mexico Press, Albuquerque.

Butler, Virginia L.
2000 Resource Depression on the Northwest Coast of North America. *Antiquity* 74(285):649–661. DOI:10.1017/S0003598X00060014.

Butler, Virginia L., and Jim E. O'Connor
2004 9000 Years of Salmon Fishing on the Columbia River, North America. *Quaternary Research* 62(1):1–8. DOI:10.1016/j.yqres.2004.03.002.

Butler, Virginia L., and Michael A. Martin
2013 Aboriginal Fisheries of the Lower Columbia River. In *Chinookan Peoples of the Lower Columbia*, edited by Robert T. Boyd, Kenneth M. Ames, and Tony A. Johnson, pp. 80–105. University of Washington Press, Seattle.

Campbell, Sarah
1989 Post-Columbia Culture History in the Northern Plateau, A.D. 1500-1900. Unpublished PhD dissertation, Department of Anthropology, University of Washington, Seattle.

Campbell, Sarah, and Virginia Butler
2010 Archaeological Evidence for Resilience of Pacific Northwest Salmon Populations and the Socioecological System over the Last 7500 years. *Ecology and Society* 15(7):1–34.

Canby, William C.
1998 *American Indian Law in a Nutshell*. West nutshell series liii, 463 p. West Group, St. Paul, Minnesota.

Cannon, Aubrey
1991 *The Economic Prehistory of Namu: Patterns in Vertebrate Fauna*. Publication No. 19, Department of Archaeology. Archaeology Press, Simon Fraser University, Burnaby, B.C.
1998 Contingency and Agency in the Growth of Northwest Coast Maritime Economies. *Arctic Anthropology* 35(1):57–67.

Cannon, Aubrey, and Meghan Burchell
2009 Clam Growth-Stage Profiles as a Measure of Harvest Intensity and Resource Management on the Central Coast of British Columbia. *Journal of Archaeological Science* 36:1050–1060.
2016 Reconciling Oxygen Isotope Sclerochronology with Interpretations of Millennia of Seasonal Shellfish Collection on the Pacific Northwest Coast. *Quaternary International* 427: 84-191. DOI:10.1016/j.quaint.2016.02.037.

Cannon, Aubrey, Meghan Burchell, and Rhonda Bathurst
2008 Trends and strategies in shellfish gathering on the Pacific Northwest Coast of North America. In *Early Human Impact on Megamolluscs*, edited by Andrzej Antcsak and Roberto Cipriani, pp. 7–22. BAR International Series. Archeopress, Oxford.

Carrasquilla-Henao, Mauricio, Dana Haggarty, K. Lynne Yamanaka, and Francis Juanes
2019 Predicting Important Rockfish (Sebastes spp.) Habitat from Large-Scale Longline Surveys for southern British Columbia, Canada. *Canadian Journal of Fisheries and Aquatic Sciences* 76(5):682–694. DOI:10.1139/cjfas-2017-0458.

Carraway, Leslie N., and B.J. Verts
1993 *Aplodontia rufa*. *Mammalian Species*(431):1–10. DOI:10.2307/3504188.

Carroll, Michael L., Beverly J. Johnson, Gregory A. Henkes, Kelton W. McMahon, Andrey Voronkov, William G. Ambrose, and Stanislav G. Denisenko
2009 Bivalves as Indicators of Environmental Variation and Potential Anthropogenic Impacts in the Southern Barents Sea. *Marine Pollution Bulletin* 59(4). Environmental Records of Anthropogenic Impacts on Coastal Ecosystems:193–206. DOI:10.1016/j.marpolbul.2009.02.022.

Casselberry, Samuel E.
1974 Further Refinement of Formulae for Determining Population from Floor Area. *World Archaeology* 6(1):117–122. DOI:10.1080/00438243.1974.9979593.

Casteel, Richard W.
1978 Faunal Assemblages and the "Wiegemethode" or Weight Method. *Journal of Field Archaeology* 5(1):71–77. DOI:10.1179/009346978791489970.

Chance, David H.
1972 Fort Colville: The Structure of a Hudson's Bay Company Post, 1825 to 1871. University of Idaho, Department of Anthropology, Moscow, Idaho.

Charlton, Guy
2015 The Law of Native American Hunting, Fishing and Gathering Outside of Reservation Boundaries in the United States and Canada. *Canada-United States Law Journal* 39:69-169.

Chesser, R. Terry, Kevin J. Burns, Carla Cicero, Jon L. Dunn, Andrew W. Kratter, Irby J. Lovette, Pamela C. Rasmussen, J. V. Remsen, Douglas F. Stotz, and Kevin Winker
2019 Check-List of North American Birds (online). *American Ornithological Society*. http://checklist.aou.org/taxa.

Chilton, Elizabeth S., and Siobhan M. Hart
2009 Crafting Collaborative Archaeologies: Two Case Studies from New England. *Collaborative Anthropologies* 2(1):87–108. DOI:10.1353/cla.0.0016.

Chino, Michelle, Darlene Haff, and Carolee Dodge-Francis
2009 Patterns of Commodity Food Use among American Indians. *Pimatisiwin: A Journal of Aboriginal and Indigenous Community Health* 7(2):279-289.

Claassen, Cheryl

1998 *Shells*. Cambridge Manuals in Archaeology. Cambridge University Press, Cambridge; New York.

Clarke, Louise R., and Arthur H. Clarke

1980 Zooarchaeological Analysis of Mollusc Remains from Yuquot, British Columbia. In *The Yuquot Project Volume 2*, edited by William J. Folan, John Dewhirst, and J.E. Muller, pp. 37–57. Parks Canada, Ottawa.

Clay, Karen, Joshua Lewis, and Edson Severnini

2019 What Explains Cross-City Variation in Mortality During the 1918 Influenza Pandemic? Evidence from 438 U.S. Cities. *Economics & Human Biology* 35:42–50. DOI:10.1016/j.ehb.2019.03.010.

Cleland, Charles E.

2011 Faith in Paper: The Ethnohistory and Litigation of Upper Great Lakes Indian Treaties. University of Michigan Press, Ann Arbor.

Clifton, H. Edward, and L. Phillips

1980 Lateral Trends and Vertical Sequences in Estuarine Sediments, Willapa Bay, Washington. In *Pacific Coast Paleogreography Symposium 4: Quarternary Depositional Environments of the Pacific Coas*t, pp. 55–71. SEPM Society for Sedimentary Geology

Coan, Charles Florus

1921 The Federal Indian Policy in the Pacific Northwest: 1849-1870. Unpublished Ph.D. dissertation, University of California, Berkeley.

Coan, Eugene V., Paul Valentich Scott, and Frank R. Bernard

2000 *Bivalve Shells of Western North America: Marine Bivalve Mollusks from Arctic Alaska to Baja California*. Studies in Biodiversity. 2 vols. Santa Barbara Museum of Natural History Monographs 2. Santa Barbara Museum of Natural History.

Coates, Rodney D. (editor)

2011 *Covert Racism: Theories, Institutions, and Experiences*. Studies in Critical Social Sciences V. 32. Brill, Leiden; Boston.

Cole, Douglas, and David Darling

1990 History of the Early Period. In *Handbook of North American Indians*, edited by Wayne Suttles, 7: Northwest Coast: pp.119–134. Smithsonian Institution Press, Washington, DC.

Cole, Steve C., Brian F. Atwater, Patrick T. McCutcheon, Julie K. Stein, and Eileen Hemphill Haley

1996 Earthquake-induced burial of archaeological sites along the southern Washington coast about A.D. 1700. Geoarchaeology: An International Journal 11(2):165–177.

Coleman, Kenneth R.
2019 "We'll All Start Even": White Egalitarianism and the Oregon Donation Land Claim Act. *Oregon Historical Quarterly* 120(4):414.-437 DOI:10.5403/oregonhistq.120.4.0414.

Colwell, Chip
2016 Collaborative Archaeologies and Descendant Communities. *Annual Review of Anthropology* 45(1):113–127. DOI:10.1146/annurev-anthro-102215-095937.

Colwell, Chip, and T. J. Ferguson (editors)
2008 Collaboration in Archaeological Practice: Engaging Descendant Communities. Archaeology in Society Series. AltaMira Press, Lanham, Maryland.

Colwell-Chanthaphonh, Chip
2010 The Problem of Collaboration? Reflections on Engagements of Inclusivity, Reciprocity, and Democracy in Museum Anthropology. *Western Humanities Review* 64(3):49–63.

Colwell-Chanthaphonh, Chip, T. J. Ferguson, Dorothy Lippert, Randall H. McGuire, George P. Nicholas, Joe E. Watkins, and Larry J. Zimmerman
2010 The Premise and Promise of Indigenous Archaeology. *American Antiquity* 75(2):228–238. DOI:10.7183/0002-7316.75.2.228.

Combs, Mariel J.
1999 United States v. Washington: The Boldt Decision Reincarnated. *Environmental Law* 29(3):683–720.

Compher, Charlene
2006 The Nutrition Transition in American Indians. *Journal of Transcultural Nursing* 17(3):217–223. DOI:10.1177/1043659606288376.

Confederated Tribes v. Washington
1996 Shoalwater Bay Indian Tribe, Plaintiff-Appellant, v. State of Washington. F.3d. Vol. 96.

Conover, Kathryn
1978 Matrix Analyses. In *Studies in Bella Bella Prehistory*, edited by James J. Hester and Sarah M. Nelson, pp. 67–99. Publication No. 5. Department of Archaeology, Simon Fraser University, Burnaby.

Cook, Sherburne F., and Robert F. Heizer
1968 Relationships Among Houses, Settlement Areas and Population in Aboriginal California. In *Settlement Archaeology*, edited by Kwang-chih Chang, pp. 79–116. National Press Books, Palo Alto, California

Cook, Warren L.
1973 *Flood Tide of Empire: Spain and the Pacific Northwest, 1543-1819*. Yale Western Americana series 24. Yale University Press, New Haven, Connecticut.

Cooley, D.M.
1866 Commissioner of Indian Affairs D.M. Cooley to James Harlan, Secretary of the Interior. Microfilm M-348, roll 15. National Archives, Washington, DC.

Cooper, H. Kory, Kenneth Ames, and Loren G. Davis
2015 Metal and Prestige in the Greater Lower Columbia River Region, Northwestern North America. *Journal of Northwest Anthropology* 49(2):143–166.

Cordain, Loren
1999 Cereal Grains: Humanity's Double-Edged Sword. In *World Review of Nutrition and Dietetics*, edited by Artemis P. Simopoulos, 84:pp. 19–73. Karger, Basel.

Cordain, Loren, S. Boyd Eaton, Janette Brand-Miller, Neil Mann, and Kim Hill
2002 The Paradoxical Nature of Hunter-Gatherer Diets: Meat-Based, yet Non-Atherogenic. *European Journal of Clinical Nutrition* 56(S1):S42–S52. DOI:10.1038/sj.ejcn.1601353.

Cordain, Loren, S. Boyd Eaton, Anthony Sebastian, Neil Mann, Staffan Lindeberg, Bruce A. Watkins, James H. O'Keefe, and Janette Brand-Miller
2005 Origins and Evolution of the Western Diet: Health Implications for the 21st Century. *The American Journal of Clinical Nutrition* 81(2):341–354. DOI:10.1093/ajcn.81.2.341.

Corntassel, Jeff
2008 Toward Sustainable Self-Determination: Rethinking the Contemporary Indigenous-Rights Discourse. *Alternatives: Global, Local, Political* 33(1):105–132. DOI:10.1177/030437540803300106.

Corntassel, Jeff, and Cheryl Bryce
2012 Practicing Sustainable Self-Determination: Indigenous Approaches to Cultural Restoration and Revitalization. *The Brown Journal of World Affairs* 18(11):151-162.

Coté, Charlotte
2010 *Spirits of Our Whaling Ancestors: Revitalizing Makah and Nuu-chah-nulth Traditions*. A Capell family book. University of Washington Press; UBC Press, Seattle: Vancouver.
2016 "Indigenizing" Food Sovereignty. Revitalizing Indigenous Food Practices and Ecological Knowledges in Canada and the United States. *Humanities* 5(3):57. DOI:10.3390/h5030057.

Coupland, Gary G.
1985 Restricted Access, Resource Control and the Evolution of Status Inequality among Hunter-Gatherers. In *Status, Structure, and Stratification: Current Archaeological Reconstructions*, edited by Marc Thompson, Maria Teresa Garcia, and Francoise Kense, pp. 217–226. The University of Calgary Archaeological Association, Alberta.
1996a The Evolution of Multi-Family Households on the Northwest Coast of North America. In *People Who Lived in Big Houses: Archaeological Perspectives on Large Domestic Structures*, edited by Gary G. Coupland and E.B. Banning, pp. 121–130. Monographs in World Archaeology no. 27. Prehistory Press, Madison, Wisconsin.

1996b This Old House: Cultural Complexity and Household Stability on the Northern Northwest Coast of North America. In *Emergent Complexity: The Evolution of Intermediate Societies*, edited by Jeanne E. Arnold, pp. 74–90. Archaeological series 9. International Monographs in Prehistory, Ann Arbor, Michigan.

Coupland, Gary G., Roger H. Colten, and Rebecca Case
2003 Preliminary Analysis of Socioeconomic Organization at the McNichol Creek site, British Columbia. In *Emerging from the Mist: Studies in Northwest Coast Culture History*, edited by R.G. Matson, Gary Coupland, and Quentin Mackie, pp. 152–169. UBC Press, Vancouver.

Coupland, Gary, Kathlyn Stewart, and Katherine Patton
2010 Do You Ever Get Tired of Salmon? Evidence for Extreme Salmon Specialization at Prince Rupert Harbour, British Columbia. *Journal of Anthropological Archaeology* 29:189–207.

Coutts, Peter, and Charles Higham
1971 The Seasonal Factor in Prehistoric New Zealand. *World Archaeology* 2(3):266–277. DOI:10.1080/00438243.1971.9979480.

Cox, Ross
1957 The Columbia River; or, Scenes and Adventures During a Residence of Six Years on the Western Side of the Rocky Mountains among Various Tribes of Indians Hitherto Unknown; Together with a Journey Across the American Continent. The American Exploration and Travel Series, 24. University of Oklahoma Press, Norman.

Crapo, Chuck, Brian C. Paust, and Jerry Keith Babbitt
2004 *Recoveries & Yields from Pacific Fish and Shellfish*. Marine Advisory Bulletin 37.

Croes, Dale R.
1992 Exploring Prehistoric Subsistence. In *Long-Term Subsistence Change in Prehistoric North America*, edited by Dale R. Croes, Rebecca A. Hawkins, and Barry L. Isaac, pp. 337–363. Research in Economic Anthropology Supplement 6. Jai Press, Greenwich, Connecticut.
2010 Courage and Thoughtful Scholarship = Indigenous Archaeology Partnerships. *American Antiquity* 75(2):211–216.

Cromwell, Robert J.
2006 Where Form and Function are so Agreeably Combined: Consumer Choice Studies of English Ceramic Wares at Hudson's Bay Company Fort Vancouver. Unpublished PhD Dissertation, Syracuse University, New York.

Cronk, Brian C.
2018 How to Use SPSS: a Step-by-Step Guide to Analysis and Interpretation. Tenth ed. Routledge, Taylor & Francis Group, New York.

Culleton, Brendan J., Douglas J. Kennett, and Terry L. Jones
2009 Oxygen Isotope Seasonality in a Temperate Estuarine Shell Midden: A Case Study from CA-ALA-17 on the San Francisco Bay, California. *Journal of Archaeological Science* 36(1354–1363):1354–1363.

Curtis, Edward
1913a The Salishan Tribes of the Coast. In *The North American Indian*, 9:pp. 3–134. Plimpton, Norwood, Massachusetts.
1913b *The North American Indian*. Vol. IX. The University Press, Cambridge.

Daehnke, Jon Darin
2017 Chinook Resilience: Heritage and Cultural Revitalization on the Lower Columbia River. Indigenous Confluences. University of Washington Press, Seattle.

Damman, Siri, Wenche Barth Eide, and Harriet V. Kuhnlein
2008 Indigenous Peoples' Nutrition Transition in a Right to Food Perspective. *Food Policy* 33(2):135–155. DOI:10.1016/j.foodpol.2007.08.002.

Dampc, Anna, and Maria Luczkiewicz
2015 Labrador Tea - the Aromatic Beverage and Spice: A Review of Origin, Processing and Safety. *Journal of the Science of Food and Agriculture* 95(8):1577–1583. DOI:10.1002/jsfa.6889.

Daniels, Phoebe S.
2009 A Gendered Model of Prehistoric Resource Depression: A Case Study on the Northwest Coast of North America. Unpublished Ph.D., Department of Anthropology, University of Washington, Seattle.

Darby, Melissa
1996 Wapato for the People: An Ecological Approach to Understanding the Native American use of *Sagittaria latifolia* on the Lower Columbia River. Unpublished MA, Portland State University, Oregon.
2005 The Intensification of Wapato (*Sagittaria latifolia*) by the Chinookan People of the Lower Columbia River. In *Keeping it Living: Traditions of Plant Use and Cultivation on the Northwest Coast of North America*, edited by Douglas Deur and Nancy Turner, pp. 194–217. University of Washington Press, Seattle.

Daugherty, Richard D.
1984 Survey of the Washington Coast from Cape Flattery to Cape Disappointment. Department of Anthropology, University of Washington. Seattle.

Davis, Loren G., and David B. Madsen
2020 The coastal migration theory: Formulation and testable hypotheses. *Quaternary Science Reviews* 249:106605. DOI:10.1016/j.quascirev.2020.106605.

Deloria, Vine Jr., and Raymond J. DeMallie
1999 Documents of American Indian Diplomacy: Treaties, Agreements, and Conventions, 1775-1979. Vol. 4. Legal History of North America. University of Oklahoma Press, Norman.

Deloria, Vine, and Clifford M. Lytle
1984 The Nations Within: The Past and Future of American Indian Sovereignty. 1st ed. Pantheon Books, New York.

Delorit, Richard J.
1970 *An Illustrated Taxonomy Manual of Weed Seeds*. Taxonomy Manual of Weed Seeds. Distributed by Agronomy Publications, River Falls, Wisconsin.

DePuydt, Raymond (editor)
1994 *Data Recovery Excavations from Site 45PC101, Pacific County, Washington*. Eastern Washington University Reports in Archaeology and History 100–79.

Desmarais, Annette Aurélie, and Hannah Wittman
2014 Farmers, Foodies and First Nations: Getting to Food Sovereignty in Canada. *The Journal of Peasant Studies* 41(6):1153–1173. DOI:10.1080/03066150.2013.876623.

Dethier, Megan N.
1990 *A Marine and Estuarine Habitat Classification System for Washington State*. Washington Natural heritage Program, Department of Natural Resources, Olympia.

Deur, Douglas, and Nancy Turner
2005 Keeping it Living: Traditions of Plant Use and Cultivation on the Northwest Coast of North America. University of Washington Press, Seattle.

Diedrich, Melanie
2009 Pacific Northwest Paleobotany: Native Seeds and the Creation of a Comparative Library. Unpublished, Union Institute & University, Cleveland, Ohio.

Dietz, Stephen A., William Hildebrandt, James Bennyhoff, Terry Jones, Bert A. Gerow, Kenneth Gobalet, Jeff Hall, and Liz Honeysett
1988 *Archaeological Investigations at Elkhorn Slough: CA-MNT-229, a Middle Period Site on the Central California Coast.* Papers in Northern California Anthropology. Northern California Anthropology Group, Berkeley.

Dillehay, Tom D., Duccio Bonavia, Steve L. Goodbred, Mario Pino, Victor Vásquez, and Teresa Rosales Tham
2012 A Late Pleistocene Human Presence at Huaca Prieta, Peru, and Early Pacific Coastal Adaptations. *Quaternary Research* 77(3):418–423. DOI:10.1016/j.yqres.2012.02.003.

Dillehay, Tom D., Steve Goodbred, Mario Pino, Víctor F. Vásquez Sánchez, Teresa Rosales Tham, James Adovasio, Michael B. Collins, Patricia J. Netherly, Christine A. Hastorf, Katherine L. Chiou, Dolores Piperno, Isabel Rey, and Nancy Velchoff
2017 Simple Technologies and Diverse Food Strategies of the Late Pleistocene and Early Holocene at Huaca Prieta, Coastal Peru. *Science Advances* 3(5):e1602778. DOI:10.1126/sciadv.1602778.

Dillehay, Tom D., Carlos Ocampo, José Saavedra, Andre Oliveira Sawakuchi, Rodrigo M. Vega, Mario Pino, Michael B. Collins, Linda Scott Cummings, Iván Arregui, Ximena S. Villagran, Gelvam A. Hartmann, Mauricio Mella, Andrea González, and George Dix
2015 New Archaeological Evidence for an Early Human Presence at Monte Verde, Chile. Edited by John P. Hart. *PLOS ONE* 10(11):e0141923. DOI:10.1371/journal.pone.0141923.

Dillinger, Teresa L., Stephen C. Jett, Martha J. Macri, and Louis E. Grivetti
1999 Feast or famine? Supplemental Food Programs and their Impacts on two American Indian Communities in California. *International Journal of Food Sciences and Nutrition* 50(3):173–187. DOI:10.1080/096374899101210.

Dixon, E. James
1999 *Bones, Boats & Bison: Archeology and the First Colonization of Western North America*. 1st ed. University of New Mexico Press, Albuquerque.

Dobyns, Henry F.
1966 An Appraisal of Techniques with a New Hemispheric Estimate. *Current Anthropology* 7(4):395–416. DOI:10.1086/200749.

Donald, Leland
2003 The Northwest Coast as a Study Area: Natural, Prehistoric, and Ethnographic Issues. In *Emerging from the Mist: Studies in Northwest Coast Culture History*, edited by R.G. Matson, Gary Coupland, and Quentin Mackie, pp. 289–327. UBC Press, Vancouver.

Drucker, Philip
1955 *Indians of the Northwest Coast*. The Natural History Press, Garden City, New York.
1983 Ecology and Political Organization on the Northwest Coast of North America. In *The Development of Political Organization in Native North America*, edited by Elisabeth Tooker, pp. 71–85. American Ethnological Society, Washington, DC.

Duff, Wilson
1997 The Indian History of British Columbia: The Impact of the White Man. Royal British Columbia Museum, Victoria.

Dufour, Dominic, André Pichette, Vakhtang Mshvildadze, Marie-Eve Bradette-Hébert, Serge Lavoie, Angélique Longtin, Catherine Laprise, and Jean Legault

2007 Antioxidant, Anti-Inflammatory and Anticancer Activities of Methanolic Extracts from Ledum groenlandicum Retzius. *Journal of Ethnopharmacology* 111(1):22–28. DOI:10.1016/j.jep.2006.10.021.

Dunham, Anya, Helen Gurney-Smith, Nadia Plamondon, Simon Yuan, and Christopher M. Pearce

2013 Aquaculture Potential of the Basket Cockle (*Clinocardium nuttallii*). Part 1: Effects of Stocking Density on First Year Grow-Out Performance in Intertidal and Off-Bottom Suspended Culture. *Aquaculture Research* 44(8):1236–1253. DOI:10.1111/j.1365-2109.2012.03125.x.

Duren, Colby D., Erin Parker, Carly Friffith Hotvedt, G. Blake Jackson, Whitney Sawney, Josiah Griffin, Nikki Young, and Brenton Jones

2020 COVID-19 Update and Impacts: Administrative and Legislative Actions. Presented at the Native Farm Bill Coalition (NFBC) and Indigenous Food and Agriculture Initiative (IFAI) Webinar and Listening Session, April 1, 2020, University of Arkansas.

Earle, Timothy K., and Robert W. Preucel

1987 Processual Archaeology and the Radical Critique. *Current Anthropology* 28(4):501–538. DOI:10.1086/203551.

Echo-Hawk, Walter R.

1986 Museum Right vs. Indian Rights: Guidelines for Assessing Competing Legal Interests in Native Cultural Resources. *New York University Review of Law & Social Change* 14(2):437.

Eerkens, Jelmer W., Brian F. Byrd, Howard J. Spero, and AnnMarie K. Fritschi

2013 Stable Isotope Reconstructions of Shellfish Harvesting Seasonality in an Estuarine Environment: Implications for Late Holocene San Francisco Bay Settlement Patterns. *Journal of Archaeological Science* 40:2014–2024.

Elliott, Bethany, Deepthi Jayatilaka, Contessa Brown, Leslie Varley, and Kitty K. Corbett

2012 "We Are Not Being Heard": Aboriginal Perspectives on Traditional Foods Access and Food Security. *Journal of Environmental and Public Health* 2012:1–9. DOI:10.1155/2012/130945.

Elliott, T.C.

1912 Journal of John Work, November and December, 1824. *The Washington Historical Quarterly* 3(3):198–228.

Elmendorf, William W.

1960 *The Structure of Twana Culture.* Monographic supplement 2. Washington State University Research Studies, Pullman.

Erlandson, Jon M.
1994 Early Hunter-Gatherers of the California Coast. Plenum Press, New York.
2001 The Archaeology of Aquatic Adaptations: Paradigms for a New Millennium. *Journal of Archaeological Research* 9(4):287–350.

Erlandson, Jon M., Todd J. Braje, Kristina M. Gill, and Michael H. Graham
2015 Ecology of the Kelp Highway: Did Marine Resources Facilitate Human Dispersal From Northeast Asia to the Americas? *The Journal of Island and Coastal Archaeology* 10(3):392–411. DOI:10.1080/15564894.2014.1001923.

Erlandson, Jon M., and Madonna L. Moss
2001 Shellfish Feeders, Carrion Eaters, and the Archaeology of Aquatic Adaptations. *American Antiquity* 66(3):413–432.

Erlandson, Jon M., Torben C. Rick, René L. Vellanoweth, and Douglas J. Kennett
1999 Maritime Subsistence at a 9300 Year Old Shell Midden on Santa Rosa Island, California. *Journal of Field Archaeology* 26(3):255–265. DOI:10.1179/jfa.1999.26.3.255.

Erlandson, Jon M., Mark A. Tveskov, and R. Scott Byram
1998 The Development of Maritime Adaptations on the Southern Northwest Coast of North America. *Arctic Anthropology* 35(1):6–22.

Espey, David K., Melissa A. Jim, Nathaniel Cobb, Michael Bartholomew, Tom Becker, Don Haverkamp, and Marcus Plescia
2014 Leading Causes of Death and All-Cause Mortality in American Indians and Alaska Natives. *American Journal of Public Health* 104(S3):S303–S311. DOI:10.2105/AJPH.2013.301798.

Espey, Huston, and Associates
1990 *California, Oregon, and Washington Archaeological Resource Study*. U.S. Department of Interior, Minerals Management Service, Pacific OCS Region, Austin, Texas.

Espy, Willard R.
1992 *Oysterville: Roads to Grandpa's Village*. University of Washington Press, Seattle.

Estes, James A.
1980 *Enhydra lutris*. *Mammalian Species*(133):1. DOI:10.2307/3503844.

Everitt, Brian
1977 *The Analysis of Contingency Tables*. Monographs on Applied Probability and Statistics. Chapman and Hall; Wiley: distributed in the U.S.A. by Halsted Press, London: New York.

Fagan, Brian M.
2001 *In the Beginning: An Introduction to Archaeology*. Prentice Hall, Upper Saddle River, New Jersey.

Fenn, Elizabeth A.
2001 Pox Americana: The Great Smallpox Epidemic of 1775-82. 1st ed. Hill and Wang, New York.

Ferguson, T.J., Stewart B. Koyiyumptewa, and Maren P. Hopkins
2015 Co-Creation of Knowledge by the Hopi Tribe and Archaeologists. *Advances in Archaeological Practice* 3(3):249–262. DOI:10.7183/2326-3768.3.3.249.

Fine-Dare, Kathleen S.
2002 *Grave Injustice: the American Indian Repatriation Movement and NAGPRA*. Fourth World Rising Series. University of Nebraska Press, Lincoln.

Fisher, Andrew, and Melinda Marie Jetté
2013 "Now You See Them, Now You Don't": Chinook Tribal Affairs and the Struggle for Federal Recognition. In *Chinookan Peoples of the Lower Columbia*, edited by Robert T. Boyd, Kenneth M. Ames, and Tony A. Johnson, pp. 288–306. University of Washington Press, Seattle.

Ford, Giles
1866 Letter from Giles Ford to Superintendent H.W. Waterman. RG 75; Executive Order Files, 1850-1892. National Archives.

Fortuine, Robert
1989 Chills and Fever: Health and Disease in the Early History of Alaska. University of Alaska Press, Fairbanks.

Franchère, Gabriel
1854 Narrative of a Voyage to the Northwest Coast of America in the Years 1811, 1812, 1813, and 1814; or, The First American Settlement of the Pacific. Edited by J.V. Huntington. Redfield, New York.

Franklin, Jerry, and Charles Dryness
1972 *Natural Vegetation of Oregon and Washington.* General Technical Report PNW. USDA Forest Service.

Freeman, Marie, Darlene Hamilton, Charis Szikszoy, and Helen Waterman
1980 *Washington Territory Donation Land Claims*. Seattle Genealogical Society, Seattle.

Frost, John H.
1934 Journal of John Frost, 1840-43. Edited by Nellie B. Pipes. *Oregon Historical Quarterly* 35(1):50–73.

Gahr, D. Ann Trieu
2013 Ethnobiology: Nonfishing Subsistence and Production. In *Chinookan Peoples of the Lower Columbia*, edited by Robert T. Boyd, Kenneth M. Ames, and Tony A. Johnson, pp. 63–79. University of Washington Press, Seattle.

Gallucci, Vincent F., and Betty B. Gallucci

1982 Reproduction and Ecology of the Hermaphroditic Cockle *Clinocardium nuttallii* (Bivalvia: Cardiidae) in Garrison Bay. *Marine Ecology Progress Series* 7:137–145. DOI:10.3354/meps007137.

Garza, Dolores A.

1999 *Tlingit Moon & Tide Teaching Resource: Elementary Level*. University of Alaska Sea Grant, Fairbanks, Alaska.

Gaventa, John

1988 Participatory Research in North America. *Convergence: An International Journal of Adult Education* 21(2–3):19–27.

Gero, Joan, and Dolores Root

1990 Public Presentations and Private Concerns: Archaeology in the Pages of National Geographic. In *The Politics of the Past*, edited by Peter W. Gathercole and David Lowenthal, pp. 19–37. One World Archaeology 12. Unwin Hyman, London; Boston.

Geurds, Alexander

2008 Grounding the Past: the Praxis of Participatory Archaeology in the Mixteca Alta, Oaxaca, Mexico. *Public Archaeology* 7(1):53–55. DOI:10.1179/175355308X306013.

Gibbs, George

1877 Tribes of Western Washington and Northwestern Oregon, with map. In *Contributions to North American Ethnology*. U.S. Government Printing Office, Washington, DC.

Gibson, James R.

1992 Otter Skins, Boston Ships, and China Goods: The Maritime Fur Trade in the Northwest Coast. University of Washington Press, Seattle.

Gifford-Gonzales, Diane, and William Hildebrandt

2012 If Mussels Weighted a Ton: Problems with Quantifying Santa Barbara Channel Archaeofaunas. In *Exploring Methods of Faunal Analysis: Insights from California Archaeology*, edited by Michael A. Glassow and Terry L. Joslin. Cotsen Institute of Archaeology Press, Los Angeles.

Gilbert, M. Thomas P., Dennis L. Jenkins, Anders Gotherstrom, Nuria Naveran, Juan J. Sanchez, Michael Hofreiter, Philip Fracis Thomsen, Jonas Binladen, Thomas F. G. Higham, Robert M. Yohe, R. Parr, Linda Scott Cummings, and Eske Willerslev

2008 DNA from Pre-Clovis Human Coprolites in Oregon, North America. *Science* 320(5877):786–789. DOI:10.1126/science.1154116.

Gilkey, Helen Margaret, and La Rea J. Dennis

1967 *Handbook of Northwestern Plants*. Handbook of Northwest Flowering Plants. Oregon State University Bookstores, Corvallis.

Gillespie, Graham E.
2009 Status of the Olympia Oyster, *Ostrea lurida* Carpenter 1864, in British Columbia, Canada. *Journal of Shellfish Research* 28(1):59–68. DOI:10.2983/035.028.0112.

Glassow, Michael A., and Larry R. Wilcoxon
1988 Coastal Adaptations near Point Conception, California, with Particular Regard to Shellfish Exploitation. *American Antiquity* 53(1):36–51. DOI:10.2307/281153.

Glover, Sheldon L.
1949 *Origin and Occurrence of Gem Stones in Washington*. Division of Mines and Geology, Department of Conservation and Development, Olympia, Washington.

Godfrey, Michael C. S.
1988 Oxygen Isotope Analysis: A Means for Determining the Seasonal Gathering of the Pipi (Donax deltoides) by Aborigines in Prehistoric Australia. *Archaeology in Oceania* 23(1):17–21.

Gonor, Jefferson J.
1989 Willapa Bay Subtidal and Tideland Resources Used by Indians Prior to 1866. Evergreen Legal Services Native American Project, Seattle.

Goodman, Ed
2000 Protecting Habitat for Off-Reservation Tribal Hunting and Fishing Rights: Tribal Comanagement as a Reserved Right. *Environmental Law* 30(2):279–361.

Gosden, Chris
1989 Prehistoric social landscapes of the Arawe Islands, West New Britain Province, Papua New Guinea. *Archaeology in Oceania* 24(2):45–58. DOI:10.1002/j.1834-4453.1989.tb00211.x.

Gracey, Michael, and Malcolm King
2009 Indigenous Health Part 1: Determinants and Disease Patterns. *The Lancet* 374(9683):65–75. DOI:10.1016/S0140-6736(09)60914-4.

Graesch, Anthony P.
2006 Archaeological and Ethnoarchaeological Investigations of Households and Perspectives on a Coast Salish Historical Village in British Columbia. University of California, Los Angeles.
2009 Fieldworker Experience and Single-Episode Screening as Sources of Data Recovery Bias in Archaeology: A Case Study from the Central Pacific Northwest Coast. *American Antiquity* 74(4):759–779. DOI:10.1017/S0002731600049040.

Graesch, Anthony P., Tianna DiMare, Gregson Schachner, David M. Schaepe, and John J. Dallen
2014 Thermally Modified Rock: The Experimental Study of “Fire-Cracked” Byproducts of Hot Rock Cooking. *North American Archaeologist* 35(2):167-200 DOI:10.2190/NA.35.2.c.

Grayson, Donald K.

1979 On the Quantification of Vertebrate Archaeofaunas. *Advances in Archaeological Method and Theory* 2:199–237.

1984 *Quantitative Zooarchaeology: Topics in the Analysis of Archaeological Faunas*. Studies in Archaeological Science. Academic Press, Orlando, Florida.

Greenwood, Margo, Sarah de Leeuw, and Nicole Lindsay

2018 Challenges in Health Equity for Indigenous Peoples in Canada. *The Lancet* 391(10131):1645–1648. DOI:10.1016/S0140-6736(18)30177-6.

Greer, Shelley, Rodney Harrison, and Susan McIntyre-Tamwoy

2002 Community-Based Archaeology in Australia. *World Archaeology* 34(2):265–287.

Grey, Sam, and Raj Patel

2015 Food Sovereignty as Decolonization: Some Contributions from Indigenous Movements to Food System and Development Politics. *Agriculture and Human Values* 32(3):431–444. DOI:10.1007/s10460-014-9548-9.

Grier, Colin

2003 Dimensions of Regional Interaction in the Prehistoric Gulf of Georgia. In *Emerging from the Mist: Studies in Northwest Coast Culture History*, edited by R.G. Matson, Gary Coupland, and Quentin Mackie, pp. 170–187. UBC Press, Vancouver.

2006 Affluence on the Prehistoric Northwest Coast of North America. In *Beyond Affluent Foragers: Rethinking Hunter-Gatherer Complexity*, edited by Junzo Uchiyama, Jangsuk Kim, and Colin Grier, pp. 126–35. viii, 200 p. Oxbow Books, Oxford.

2014 Landscape Construction, Ownership and Social Change in the Southern Gulf Islands of British Columbia. *Canadian Journal of Archaeology* 38:211–249.

Grier, Colin, Kelli Flanigan, Misa Winters, Leah G. Jordan, Susan Lukowski, and Brian M. Kemp

2013 Using Ancient DNA Identification and Osteometric Measures of Archaeological Pacific Salmon Vertebrae for Reconstructing Salmon Fisheries and Site Seasonality at Dionisio Point, British Columbia. *Journal of Archaeological Science* 40(1):544–555.

Groesbeck, Amy S., Kirsten Rowell, Dana Lepofsky, and Anne K. Salomon

2014 Ancient Clam Gardens Increased Shellfish Production: Adaptive Strategies from the Past can Inform Food Security Today. *PLoS ONE* 9(3):e91235.

Guilfoyle, David R., and Erin A. Hogg

2015 Towards an Evaluation-Based Framework of Collaborative Archaeology. *Advances in Archaeological Practice* 3(2):107–123. DOI:10.7183/2326-3768.3.2.107.

Gundersen, Craig

2007 Measuring the Extent, Depth, and Severity of Food Insecurity: An Application to American Indians in the USA. *Journal of Population Economics* 21(1):191–215. DOI:10.1007/s00148-007-0152-9.

Gunther, Erna
1945 *Ethnobotany of Western Washington*. University of Washington Press, Seattle.

Gwynne, Gretchen
1982 The Late Archaic Archaeology of Mount Sinai Harbor, New York: Human Ecology, Economy, and Residence Patterns on the Southern New England Coast. Unpublished PhD Dissertation, Department of Anthropology, State University of New York, Stony Brook.

Habu, Junko
2004 *Ancient Jomon of Japan*. Case Studies in Early Societies. Cambridge University Press, Cambridge; New York.

Hajda, Yvonne P.
1984 Regional Social Organization in the Greater Lower Columbia, 1792-1830. Unpublished PhD Dissertation, Department of Anthropology, University of Washington, Seattle.
1990 Southwestern Coast Salish. In *Handbook of North American Indians*, edited by Wayne Suttles, 7: Northwest Coast:pp. 503–517. Smithsonian Institution Press, Washington, DC.
2013 Social and Political Organization. In *Chinookan Peoples of the Lower Columbia*, edited by Robert T. Boyd, Kenneth M. Ames, and Tony A. Johnson, pp. 146–162. University of Washington Press, Seattle.

Halligan, Jessi J., Michael R. Waters, Angelina Perrotti, Ivy J. Owens, Joshua M. Feinberg, Mark D. Bourne, Brendan Fenerty, Barbara Winsborough, David Carlson, Daniel C. Fisher, Thomas W. Stafford, and James S. Dunbar
2016 Pre-Clovis Occupation 14,550 Years Ago at the Page-Ladson Site, Florida, and the Peopling of the Americas. *Science Advances* 2(5):e1600375. DOI:10.1126/sciadv.1600375.

Hallmann, Nadine, Meghan Burchell, Natalie Brewster, Andrew Martindale, and Bernd R. Schone
2013 Holocene Climate and Seasonality of Shell Collection at the Dundas Islands Group, Northern British Columbia - a Bivalve Sclerochronological Approach. *Palaeogeography, Palaeoclimatology, Palaeoecology* 373:161–172.

Hallmann, Nadine, Meghan Burchell, Bernd R. Schone, Gail V. Irvine, and David Maxwell
2009 High-Resolution Sclerochronological Analysis of the Bivalve Mollusc *Saxidomus gigantea* from Alaska and British Columbia: Techniques for Revealing Environmental Archives and Archaeological Seasonality. *Journal of Archaeological Science* 36:2353–2364.

Ham, Leonard Charles
1976 Chapter 3: Analysis of Shell Samples. In *Glenrose Cannery Site*, edited by R.G. Matson, pp. 42–78. National Museum of Man Mercury Series Archaeological Survey of Canada Paper No. 52. Canadian Museum of History, Ottawa.

1983 Seasonality, Shell Midden Layers, and Coast Salish Subsistence Activities at the Crescent Beach Site, DgRr. Unpublished PhD Thesis, University of British Columbia, Vancouver.

Harpole, Judith
2006 Dead Deer Do Tell Tales: Mammalian Systematic Paleontology and temporal Variation at Cathlapotle, 45CL1, Southwestern Washington. Unpublished Master's thesis, University of Missouri, Columbia.

Harris, Cole
1994 Voices of Disaster: Smallpox Around the Strait of Georgia in 1782. *Ethnohistory* 41(4):591. DOI:10.2307/482767.

Harris, Matthew, Marshall Weisler, and Patrick Faulkner
2015 A Refined Protocol for Calculating MNI in Archaeological Molluscan Shell Assemblages: a Marshall Islands Case Study. *Journal of Archaeological Science* 57:168–179. DOI:10.1016/j.jas.2015.01.017.

Hatch, Scott A., Verena A. Gill, and Daniel M. Mulcahy
2010 Individual and Colony-Specific Wintering Areas of Pacific Northern Fulmars (*Fulmarus glacialis*). *Canadian Journal of Fisheries and Aquatic Sciences* 67(2):386-400.

Hatcher, Sarah M., Christine Agnew-Brune, Mark Anderson, Laura D. Zambrano, Charles E. Rose, Melissa A. Jim, Amy Baugher, Grace S. Liu, Sadhna V. Patel, Mary E. Evans, Talia Pindyck, Christine L. Dubray, Jeanette J. Rainey, Jessica Chen, Claire Sadowski, Kathryn Winglee, Ana Penman-Aguilar, Amruta Dixit, Jonathan Davis, Victoria Warren-Mears, Sujata Joshi, Thomas Weiser, Abigail Echo-Hawk, Adrian Dominguez, Amy Poel, Christy Duke, Imani Ransby, Andria Apostolou, and Jeffrey McCollum
2020 COVID-19 Among American Indian and Alaska Native Persons — 23 States, January 31–July 3, 2020. *MMWR Morbidity and Mortality Weekly Report* 69(34):1166–1169.

Hauser, Mark W., Whitney Battle-Baptiste, Koji Lau-Ozawa, Barbara L. Voss, Reinhard Bernbeck, Susan Pollock, Randall H. McGuire, Uzma Z. Rizvi, Christopher Hernandez, and Sonya Atalay
2018 Archaeology as Bearing Witness. *American Anthropologist* 120(3):535–536. DOI:10.1111/aman.13071.

Hayden, Brian (editor)
1992 *A Complex Culture of the British Columbia Plateau: Traditional Stl'atl'imx Resource Use*. UBC Press, Vancouver.

Hayden, Brian
1994 Competition, Labor, and Complex Hunter-Gatherers. In *Key Issues in Hunter-Gatherer Research*, edited by Ernest S. Burch, Jr. and Linda J. Ellanna, pp. 223–39. Berg, Oxford.
Hayden, Brian

1995 Pathways to Power: Principles for Creating Socioeconomic Inequalities. In *Foundations of Social Inequality*, edited by T. Douglas Price and Gary M. Feinman, pp. 15–86. Language of science. Plenum Press, New York.
1996 The World's Largest-Lived Corporate Group: Lithic Analysis Reveals Prehistoric Social Organization near Lillooet, British Columbia. *American Antiquity* 61(2):341–356.
2001 Richman, Poorman, Beggarman, Chief: The Dynamics of Social Inequality. In *Archaeology at the Millennium: A Sourcebook*, edited by Gary M. Feinman and T. Douglas Price, pp. 213–268. Kluwer Academic/Plenum Publishers, New York.
2009 Funerals As Feasts: Why Are They So Important? *Cambridge Archaeological Journal* 19(1):29–52. DOI:10.1017/S095977430900002X.

Hayden, Brian, Gregory A. Reinhardt, Dan Homberg, and David Crellin
1996 Space Per Capita and the Optimal Size of Housepits. In *People Who Lived in Big Houses: Archaeological Perspectives on Large Domestic Structures*, edited by Gary Coupland and E.B. Banning, pp. 151–164. Monographs in World Archaeology no. 27. Prehistory Press, Madison, Wisconsin.

Health Canada
2015 Canadian Nutrient File. https://food-nutrition.canada.ca/cnf-fce/index-eng.jsp.

Henry, Alexander, David Thompson, and Elliott Coues
1897 New light on the Early History of the Greater Northwest: the Manuscript Journals of Alexander Henry, Fur Trader of the Northwest Company, and of David Thompson, Official Geographer and Explorer of the Same Company, 1799-1814; Exploration and Adventure among the Indians on the Red, Saskatchewan, Missouri, and Columbia Rivers. Francis P. Harper, New York.

Heritage Committee
1984a Old Shoalwater World. Shoalwater Bay Indian Tribe.
1984b Shoalwater Bay Traveling Exhibit. Shoalwater Bay Indian Tribe.

Hester, Thomas R., Harry J. Shafer, Kenneth L. Feder, Thomas R. Hester, Harry J. Shafer, and Kenneth L. Feder
2009 *Field Methods in Archaeology*. 7th ed. Left Coast Press, Walnut Creek, California

Heusser, Calvin J.
1977 Quaternary Palynology of the Pacific Slope of Washington. *Quaternary Research* 8(3):282–306. DOI:10.1016/0033-5894(77)90073-4.

Hewes, Gordon W.
1938 Aboriginal Use of Fishery Resources in the Northwestern North America. Unpublished PhD Dissertation, University of California, Berkeley.

Hiebert, Terra C.
2015 *Clinocardium nuttalli*. In *Oregon Estuarine Invertebrates: Rudys' Illustrated Guide to Common Species*, edited by Terra C. Hiebert, Barbara A. Butler, and Alan L. Shanks. University of Oregon Libraries and Oregon Institute of Marine Biology, Charleston, Oregon.

Hittell, John S., and A.L. Bancroft & Company
1882 *The Commerce and Industries of the Pacific Coast of North America Comprising the Rise, Progress, Products, Present Condition and Prospects of the Useful Arts on the Western Side of our Continent, and Some Account of its Resources; with Elaborate Treatment of Manufactures; Briefer Consideration of Commerce, Transportation, Agriculture, and Mining; and Mention of Leading Establishments and Prominent Men in Various Departments of Business.* A.L. Bancroft & Co, San Francisco.

Hockett, Bryan, and Dennis Jenkins
2013 Identifying Stone Tool Cut Marks and the Pre-Clovis Occupation of the Paisley Caves. *American Antiquity* 78(4):762–778. DOI:10.7183/0002-7316.78.4.762.

Hockett, Bryan, and Jonathan Haws
2003 Nutritional Ecology and Diachronic Trends in Paleolithic Diet and health. *Evolutionary Anthropology: Issues, News, and Reviews* 12(5):211–216. DOI:10.1002/evan.10116.

Hockey, Philip A. R., Alison L. Bosman, and W. Roy Siegfried
1988 Patterns and Correlates of Shellfish Exploitation by Costal People in Transkei: An Enigma of Protein Production. *The Journal of Applied Ecology* 25(1):353–363. DOI:10.2307/2403631.

Hockey, Philip A. R., and Alison L. Bosman
1986 Man as an Intertidal Predator in Transkei: Disturbance, Community Convergence and Management of a Natural Food Resource. *Oikos* 46(1):3–14. DOI:10.2307/3565373.

Hogg, Erin A., and John R. Welch
2020 Aboriginal Rights and Title for Archaeologists: A History of Archaeological Evidence in Canadian Litigation. *Journal of Social Archaeology* 20(2):214–241. DOI:10.1177/1469605320916099.

Hooshmand, Sahar
2013 Dietary Diversity and Nutritional Status of Urban Primary School Children from Iran and India. *Journal of Nutritional Disorders & Therapy* 03(02). DOI:10.4172/2161-0509.S12-001, accessed October 2, 2020.

Hoover, Elizabeth
2020 Native Food Systems Impacted by COVID. *Agriculture and Human Values* 37(3):569–570. DOI:10.1007/s10460-020-10089-7.

Horner, Rita A., David L. Garrison, and F. Gerald Plumley
1997 Harmful Algal Blooms and Red Tide Problems on the U.S. West Coast. *Limnology and Oceanography* 42(5):1076–1088.

Horner, Rita A., Barbara M. Hickey, and James R. Postel
2000 *Pseudo-nitzschia* Blooms and Physical Oceanography off Washington State, USA. *South African Journal of Marine Science* 22(1):299–308. DOI:10.2989/025776100784125771.

Huelsbeck, David R.
1988 Whaling in the Precontact Economy of the Central Northwest Coast. *Arctic Anthropology* 25(1):1–15.

Hunt, Garett David
2015 Marpole Metal: Contextualizing the Evidence of Pre-contact Copper Technology in the Salish Sea Basin. Unpublished Master's thesis, Purdue University, West Lafayette, Indiana.

Hurt, R. Douglas
1987 *Indian Agriculture in America: Prehistory to the Present*. University Press of Kansas, Lawrence.

Indian Claims Commission
1958 Chinook Tribe v. United States, Opinion and Findings of Fact.

IPES-Food
2016. *From Uniformity to Diversity: A Paradigm Shift from Industrial Agriculture to Diversified Agroecological Systems.* International Panel of Experts on Sustainable Food systems.

Isakson, John
1977 *Critical Area Study, Volume 4: Fish*. Coastal Zone Information Center. U.S. Department of Commerce NOAA, Charleston, South Carolina.

Israel, Barbara A., Amy J. Schulz, Edith A. Parker, and Adam B. Becker
1998 Review of Community-Based Research: Assessing Partnership Approaches to Improve Public Health. *Annual Review of Public Health* 19(1):173–202. DOI:10.1146/annurev.publhealth.19.1.173.

Jacobs, Melville
1934 *Northwest Sahaptin Texts*. Vol. 1. Contributions to Anthropology 19. Columbia University, New York.

Johansen, Bruce E., and Barry M. Pritzker (editors)
2008 Boldt Decision (1974). In *Encyclopedia of American Indian History*, 3:pp. 969–974. ABC-CLIO, Santa Barbara, California.

Johns, Timothy, and Pablo B. Eyzaguirre
2006 Linking Biodiversity, Diet and Health in Policy and Practice. *Proceedings of the Nutrition Society* 65(2):182–189. DOI:10.1079/PNS2006494.

Johnson, Andrew
1866 Executive Order, Unnumbered.

Johnson, Tony A.
2013 The Chinook People Today. In *Chinookan Peoples of the Lower Columbia*, edited by Robert T. Boyd, Kenneth M. Ames, and Tony A. Johnson, pp. 4–20. University of Washington Press, Seattle.

Johnson v. M'Intosh, William
1823 Thomas Johnson and Graham's Lessee v. William M'Intosh. U.S. Vol. 21.

Jones, Terry L., Douglas J. Kennett, and Brian F. Codding
2008 Seasonal Stability in Late Holocene Shellfish Harvesting on the Central California Coast. *Journal of Archaeological Science* 35:2286–2294.

Jorgensen, Joseph G.
1980 *Western Indians: Comparative Environments, Languages, and Cultures of 172 western American Indian Tribes*. W. H. Freeman, San Francisco.

Josephs, Richard L., and E. Arthur Bettis
2003 Short Contribution: A Practical Alternative to Kubiena Boxes for the Collection of Samples for Micromorphological Analysis. *Geoarchaeology* 18(5):567–570. DOI:10.1002/gea.10075.

Juggins, Steven, and Nigel Cameron
1999 Diatoms and Archeology. In *Diatoms: Applications for the Environmental and Earth Sciences*, edited by Eugene F. Stoermer and John P. Smol, pp. 389–401. Cambridge University Press, West Nyack, New York.

Kaczmarczyk, Melissa M., Michael J. Miller, and Gregory G. Freund
2012 The Health Benefits of Dietary Fiber: Beyond the Usual Suspects of Type 2 Diabetes Mellitus, Cardiovascular Disease and Colon Cancer. *Metabolism* 61(8):1058–1066. DOI:10.1016/j.metabol.2012.01.017.

Kealiikanakaoleohaililani, Kekuhi, and Christian P. Giardina
2016 Embracing the Sacred: An Indigenous Framework for tomorrow's Sustainability Science. *Sustainability Science* 11(1):57–67. DOI:10.1007/s11625-015-0343-3.

Keen, Ian
2006 Constraints on the Development of Enduring Inequalities in Late Holocene Australia. *Current Anthropology* 47(1):7–38. DOI:10.1086/497672.

Kelly, Robert L.
2013 *The Lifeways of Hunter-Gatherers : The Foraging Spectrum. Vol. 2nd ed*. Cambridge University Press.

Kennett, Douglas J., and James P. Kennett
2000 Competitive and Cooperative Responses to Climatic Instability in Coastal Southern California. *American Antiquity* 65(2):379–395. DOI:10.2307/2694065.

Kennett, Douglas J., and Barbara Voorhies
1996 Oxygen Isotopic Analysis of Archaeological Shells to Detect Seasonal Use of Wetlands on the Southern Pacific Coast of Mexico. *Journal of Archaeological Science* 23(5):689–704. DOI:10.1006/jasc.1996.0065.

Kidd, Kenneth E, and Martha A. Kidd
1983 A Classification System for Glass Beads for the Use of Field Archaeologists. In *Proceedings of the 1982 Glass Trade Bead Conference*, edited by Charles F. Hayes III, pp. 219–257. Rochester Museum and Science Center, Research Records 16. Rochester, New York.

Kidd, Robert S.
1960 Fort Columbia Archaeology Project - Final Report on Excavation and Survey Conducted in 1959. Department of Anthropology, University of Washington, Seattle.
1974 The Martin Site, Southwestern Washington. *Tebiwa* 10(2):13–38.

King, Malcolm, Alexandra Smith, and Michael Gracey
2009 Indigenous Health Part 2: The Underlying Causes of the Health Gap. *The Lancet* 374(9683):76–85. DOI:10.1016/S0140-6736(09)60827-8.

Kirk, Ruth
2015 *Ozette: Excavating a Makah Whaling Village*. University of Washington Press, Seattle.

Kozlov, Andrew, Vladislav Nuvano, and Galina Vershubsky
2009 Changes in Soviet and Post-Soviet Indigenous diets in Chukotka. *Études/Inuit/Studies* 31(1–2):103–119. DOI:10.7202/019717ar.

Kristensen, Todd J., and Reade Davis
2015 The Legacies of Indigenous History in Archaeological Thought. *Journal of Archaeological Method and Theory* 22(2):512–542. DOI:10.1007/s10816-013-9190-7.

Kroeber, Alfred Louis
1939 *Cultural and Natural Areas of Native North America*. University of California Press, Berkeley.

Kuhnlein, Harriet V., and Olivier Receveur
1996 Dietary Change and Traditional Food Systems of Indigenous Peoples. *Annual Review of Nutrition* 16:417–42.

Kuhnlein, Harriet V., Food and Agriculture Organization of the United Nations, and McGill University (editors)
2013 *Indigenous Peoples' Food Systems & Well-Being: Interventions & Policies for Healthy Communities*. Food and Agriculture Organization of the United Nations; Centre for Indigenous Peoples' Nutrition and Environment, Rome: Ste. Anne de Bellevue, Quebec.

La Salle, Marina J.
2010 Community Collaboration and Other Good Intentions. *Archaeologies* 6(3):401–422. DOI:10.1007/s11759-010-9150-8.

de Laguna, Frederica
1972 Under Mount St. Elias: The History and Culture of the Yakutat Tlingit. Smithsonian Institution Press, Washington, DC.
1990 Tlingit. In *Handbook of North American Indians*, edited by Wayne Suttles, 7: Northwest Coast:pp. 203–228. Smithsonian Institution Press, Washington, DC.

Lambrides, Ariana B. J., and Marshall I. Weisler
2016 Pacific Islands Ichthyoarchaeology: Implications for the Development of Prehistoric Fishing Studies and Global Sustainability. *Journal of Archaeological Research* 24(3):275–324. DOI:10.1007/s10814-016-9090-y.

Lang, William L.
2013 The Chinookan Encounter with Euro-Americans in the Lower Columbia River Valley. In *Chinookan Peoples of the Lower Columbia*, edited by Robert T. Boyd, Kenneth M. Ames, and Tony A. Johnson, pp. 250–271. University of Washington Press, Seattle.

Lee, Daniel, and John H. Frost
1844 *Ten Years in Oregon*. J. Collord, New York.

Lemke, Stefanie, and Treena Delormier
2017 Indigenous Peoples' Food Systems, Nutrition, and Gender: Conceptual and Methodological Considerations. *Maternal & Child Nutrition* 13:e12499. DOI:10.1111/mcn.12499.

Leone, Mark P., Parker B. Potter, and Paul A. Shackel
1987 Toward a Critical Archaeology. *Current Anthropology* 28(3):283–302. DOI:10.1086/203531.

Lepofsky, Dana, and Megan Caldwell
2013 Indigenous Marine Resource Management on the Northwest Coast of North America. *Ecological Processes* 2(1):12. DOI:10.1186/2192-1709-2-12.

Lewis, Meriwether, and William Clark
2002 *The Definitive Journals of Lewis & Clark*. Edited by Gary E. Moulton. Vol. 6. University of Nebraska Press, Lincoln.

Lewis, Nathaniel S., Eric W. Fox, and Theodore H. DeWitt
2019 Estimating the Distribution of Harvested Estuarine Bivalves with Natural-History-Based Habitat Suitability Models. *Estuarine, Coastal and Shelf Science* 219:453–472. DOI:10.1016/j.ecss.2019.02.009.

Lieberman, Daniel E.
1993 The Rise and Fall of Seasonal Mobility among Hunter-Gatherers: The Case of the Southern Levant. *Current Anthropology* 34(5):599.

Little, Barbara J.
2007 *Historical Archaeology: Why the Past Matters*. Left Coast Press, Walnut Creek, Calif.
2009 What Can Archaeology Do for Justice, Peace, Community, and the Earth? *Historical Archaeology* 43(4):115–119. DOI:10.1007/BF03376772.

Little, Barbara J., and Paul A. Shackel (editors)
2007 Archaeology as a Tool of Civic Engagement. AltaMira Press, Lanham, MD.

Lloyd, Nancy
1999 *Willapa Bay & the Oysters.* Oysterville Hand Print, Washington.

Loughlin, Thomas R., Michael A. Perez, and Richard L. Merrick
1987 Eumetopias jubatus. *Mammalian Species* (283):1–7. DOI:10.2307/3503908.

Lyman, R. Lee
2008 *Quantitative Paleozoology*. Cambridge Manuals in Archaeology. Cambridge University Press, Cambridge.

Lyman, R. Lee, and Jamey Zehr
2003 Archaeological Evidence of Mountain Beaver (*Aplodontia rufa*) Mandibles as Chisels and Engravers on the Northwest Coast. *Journal of Northwest Anthropology* 37(1):89–100.

Lyons, Natasha, and Morgan Ritchie
2017 The Archaeology of Camas Production and Exchange on the Northwest Coast: With Evidence from a Sts'ailes (Chehalis) Village on the Harrison River, British Columbia. *Journal of Ethnobiology* 37(2):346–367. DOI:10.2993/0278-0771-37.2.346.

Mackay, Anson W., V.J. Jones, and Richard W. Battarbee
2003 Approaches to Holocene Climate Reconstruction Using Diatoms. In *Global Change in the Holocene*, edited by John Birks, Richard W. Battarbee, Anson W. Mackay, and Frank Oldfield. Routledge.

Madsen, Andrew David
1995 "All Sorts of China Ware...Large, Noble and Rich Chinese Bowls": Eighteenth-Century Chinese Export Porcelain in Virginia. Unpublished Master's thesis, Department of Anthropology, The College of William and Mary, Williamsburg, Virginia.

Mallette, Christine

2014 *Studies of Eulachon Smelt in Oregon and Washington*. Oregon Department of Fish and Wildlife and Washington Department of Fish and Wildlife, NOAA, Washington, DC.

Mannino, Marcello A., and Kenneth D. Thomas

2001 Intensive Mesolithic Exploitation of Coastal Resources? Evidence from a Shell Deposit and on the Isle of Portland (Southern England) for the Impact of Human Foraging on Populations of Intertidal Rocky Shore Molluscs. *Journal of Archaeological Science* 28:1101–1114.

Mannino, Marcello A., Baruch F. Spiro, and Kenneth D. Thomas

2003 Sampling Shells for Seasonality: Oxygen Isotope Analysis on Shell Carbonates of the Inter-Tidal Gastropod *Monodonta lineata* (da Costa) from Populations Across its Modern Range and from a Mesolithic Site in Southern Britain. *Journal of Archaeological Science* 30(6):667–679. DOI:10.1016/S0305-4403(02)00238-8.

Marino, Cesare

1990 History of Western Washington Since 1846. In *Handbook of North American Indians*, edited by Wayne Suttles, 7: Northwest Coast:pp. 169–79. Smithsonian Institution Press, Washington, DC.

Marquardt, William

1986 The Development of Cultural Complexity in Southwest Florida: Elements of a Critique. *Southeastern Archaeology* 5(1):63–70.

Martin, Michael

2006 The Fisheries of the Lower Columbia River, 1792-1850, Based on Euroamerican Explorer and Fur Company Accounts. Unpublished Master’s thesis, Department of Anthropology, Portland State University, Oregon.

Martinez, Desiree Renee

2006 Overcoming Hindrances to Our Enduring Responsibility to the Ancestors: Protecting Traditional Cultural Places. *The American Indian Quarterly* 30(3):486–503. DOI:10.1353/aiq.2006.0030.

Maschner, Herbert D. G.

1998 Salmon Run Volatility, Subsistence, and the Development of North Pacific Societies. In *Proceedings of the 12th International Abashiri Symposium: Salmon Fishery in the North and its Change through Time.*, edited by Hokkaido Museum of Northern Peoples, pp. 11–28. Association for the Promotion of Northern Cultures, Hokkaido.

2012 Archaeology of the Northwest Coast. In *The Oxford Handbook of North American Archaeology*, edited by Timothy R. Pauketat, pp. 161–175. Oxford University Press.

Massong, Tamara M., and David R. Montgomery
2000 Influence of Sediment Supply, Lithology, and Wood Debris on the Distribution of Bedrock and Alluvial Channels. *GSA Bulletin* 112(4):591–599. DOI:10.1130/0016-7606(2000)112<591:IOSSLA>2.0.CO;2.

Matson, R.G.
1985 The Relationship between Sedentism and Status Inequalities among Hunter-Gatherers. In *Status, Structure, and Stratification: Current Archaeological Reconstructions*, edited by Marc Thompson, Maria Teresa Garcia, and Francoise Kense, pp. 245–252. The University of Calgary Archaeological Association, Alberta.

Matson, R.G., and Gary Coupland
1995 The Prehistory of the Northwest Coast. Academic Press, San Diego.

McAnany, Patricia A., and Sarah M. Rowe
2015 Re-Visiting the Field: Collaborative Archaeology as Paradigm Shift. *Journal of Field Archaeology* 40(5):499–507. DOI:10.1179/2042458215Y.0000000007.

McClurken, James M., Charles E. Cleland, Thomas Lund, John D. Nichols, Helen Tanner, and Bruce White
2000 *Fish in the Lakes, Wild Rice, and Game in Abundance: Testimony on Behalf of Mille Lacs Ojibwe Hunting and Fishing Rights*. Michigan State University Press, East Lansing.

McDavid, Carol
2002 Archaeologies that Hurt; Descendants that Matter: A Pragmatic Approach to Collaboration in the Public Interpretation of African-American Archaeology. *World Archaeology* 34(2):303–314. DOI:10.1080/0043824022000007116.

McGimsey, Charles Robert
1972 *Public Archeology*. Studies in Archeology. Seminar Press, New York.

McGuire, Randall H.
1992 Archeology and the First Americans. *American Anthropologist* 94(4):816–836. DOI:10.1525/aa.1992.94.4.02a00030.
2008 *Archaeology as Political Action*. University of California Press, Berkeley.

McKechnie, Iain
2007 Investigating the Complexities of Sustainable Fishing at a Prehistoric Village on Western Vancouver Island, British Columbia, Canada. *Journal for Nature Conservation* 15(3):208–222. DOI:10.1016/j.jnc.2007.05.001.

McKechnie, Iain, and Madonna L. Moss
2016 Meta-Analysis in Zooarchaeology Expands Perspectives on Indigenous Fisheries of the Northwest Coast of North America. *Journal of Archaeological Science: Reports* 8:470–485. DOI:10.1016/j.jasrep.2016.04.006.

McKeown, C. Timothy
2012 In the Smaller Scope of Conscience: The Struggle for National Repatriation Legislation, 1986-1990. University of Arizona Press, Tucson.

McNiven, Ian J., and Lynette Russell
2005 *Appropriated Pasts: Indigenous Peoples and the Colonial Culture of Archaeology*. Archaeology in Society Series. AltaMira Press, Lanham, Maryland.

Meares, John
1790 *Voyages Made in the Years 1788 and 1789 from China to the North West Coast of America*. Logographic Press, Alaska.

Meeker, Cara
2003 Diatoms and Climate Change - the Use of Diatom Analysis in Reconstructing late Holocene Climate for Kigoma Region, Tanzania. Department of Geosciences, University of Arizona, Tucson.

Meskell, Lynn
2002 The Intersections of Identity and Politics in Archaeology. *Annual Review of Anthropology* 31(1):279–301. DOI:10.1146/annurev.anthro.31.040402.085457.

Mihesuah, Devon A.
2000 *Repatriation Reader Who Owns American Indian Remains?* University of Nebraska Press, Lincoln.

Miller, Mark Edwin
2004 *Forgotten Tribes: Unrecognized Indians and the Federal Acknowledgment Process*. University of Nebraska Press, Lincoln.

Minto, John
1915 *Rhymes of Early Life in Oregon and Historical and Biographical Facts*. Statesman Publishing, Salem, Oregon.

Mitchell, Donald H., and Leland Donald
1988 Archaeology and the Study of Northwest Coast Economies. In *Prehistoric Economies of the Northwest Coast*, edited by Barry L. Isaac, pp. 293–351. Research in Economic Anthropology 3. JAI Press, Greenwich, Connecticut.

Mitchell v. M.N.R.
2001 *Mitchell v. M.N.R. Canada*. Vol. SCC 33.

Monaco, Mark E., David M. Nelson, Robert L. Emmett, and Susan A. Hilton
1990 Distribution and Abundance of Fishes and Invertebrates in West Coast Estuaries, Volume 1: Data Summaries. NOAA/NOS Strategic Environmental Assessments Division, Silver Spring, Maryland.

Monks, Gregory G.
1987 Prey as Bait: the Deep Bay Example. *Canadian Journal of Archaeology* 11:119–142.

Morse, Jedediah
1822 *A Report to the Secretary of War of the United States on Indian Affairs*. New Haven.

Moss, Madonna L.
1989 Archaeology and Cultural Ecology of the Prehistoric Angoon Tlingit. Unpublished PhD Dissertation, Department of Anthropology, University of California, Santa Barbara.
1993 Shellfish, Gender, and Status in the Northwest Coast: Reconciling Archaeological, Ethnographic, and Ethnohistorical Records of the Tlingit. *American Anthropologist* 95(3):631–652.
2005 Rifts in the Theoretical Landscape of Archaeology in the United States: A Comment on Hegmon and Watkins. *American Antiquity* 70(03):581–587. DOI:10.2307/40035315.
2016 The Nutritional Value of Pacific Herring: An Ancient Cultural Keystone Species on the Northwest Coast of North America. *Journal of Archaeological Science: Reports* 5:649–655. DOI:10.1016/j.jasrep.2015.08.041.

Moss, Madonna L., and Jon M. Erlandson
2010 Diversity in North Pacific Shellfish Assemblages: The Barnacles of Kit'n'Kaboodle Cave, Alaska. *Journal of Archaeological Science* 37(12):3359–3369. DOI:10.1016/j.jas.2010.08.004.

Moulton, Gary E.
2018 *The Lewis and Clark Expedition Day by Day*. University of Nebraska Press, Lincoln.

Naroll, Raoul
1962 Floor Area and Settlement Population. *American Antiquity* 27(4):587–589. DOI:10.2307/277689.

Nash, Jay Bryan, Will Carson Ryan, and Oliver La Farge
1938 *The New Day for the Indians: A Survey of the Working of the Indian Reorganization Act of 1934*. Academy Press, New York.

Nassaney, Michael Shakir
2012 Enhancing Public Archaeology Through Community Service Learning. In *The Oxford Handbook of Public Archaeology*, edited by Robin Skeates, Carol McDavid, and John Carman. Oxford University Press.

NCAI
2019 National Congress of American Indians Policy Update: "Agriculture and Nutrition." Annual Convention, Albuquerque, New Mexico.

Nettleton, Clive, Dora A. Napolitano, and Carolyn Stephens
2007 An Overview of Current Knowledge of the Social Determinants of Indigenous Health: Working Paper. LSHTM.

Newton, Richard, and Madonna L. Moss
1984 *The Subsistence Lifeway of the Tlingit People: Excerpts of Oral Interviews.* Alaska Region Administrative Document; no. 131. U.S. Dept. of Agriculture, Forest Service, Alaska Region, Juneau.

Nicholas, George P.
2008 Native Peoples and Archaeology. In *Encyclopedia of Archaeology*, edited by Deborah Marie Pearsall, pp. 1660–1669. Academic Press/Elsevier, Oxford.

Nicholas, George P, and Thomas D Andrews
1997 *At a Crossroads: Archaeology and First Peoples in Canada*. Archaeology Press, Burnaby.

Nicholas, George P., Amy Roberts, David M. Schaepe, Joe Watkins, Lyn Leader-Elliot, and Susan Rowley
2011 A Consideration of Theory, Principles, and Practice in Collaborative Archaeology. *Archaeological Review from Cambridge* 26:11–30.

Oberg, Kalervo
1973 *The Social Economy of the Tlingit Indians*. American Ethnological Society Monograph. University of Washington Press, Seattle.

Office of Federal Acknowledgment
1997a *Historical Report*. Proposed Finding Against Federal Acknowledgement of the Chinook Indian Tribe, Inc. Bureau of Indian Affairs.
1997b *Anthropological Report*. Proposed Finding Against Federal Acknowledgement of the Chinook Indian Tribe, Inc. Bureau of Indian Affairs.

Ognjanova-Rumenova, Nadja
2008 Paleoenvironment and Archaeology: the Use of Diatom Analysis in Archaeology. In *Geoarchaeology and Archaeomineralogy*, edited by Ruslan I. Kostov, Bisserka Gaydarska, and Maria Gurova, pp. 291–294. St. Ivan Rilski, Sofia.

O'Hara, Todd M., Paul Hoekstra, Cyd Hanns, Derek Muir, Dana Wetzel, and John Reynolds
2004 A Preliminary Assessment of the Nutritive Value of Select Tissues from the Bowhead Whale Based on Suggested Nutrient Daily Intakes. Presented to the 56th International Whaling Commission. SC/56/E2.

Okamura, Katsuyuki, and Akira Matsuda (editors)
2011 New Perspectives in Global Public Archaeology. Springer, New York.

Olson, Ronald Leroy
1936 The Quinault Indians. University of Washington Publications in anthropology. 6(1).

Orlov, Alexei M., Vadim F. Savinykh, Eugeny F. Kulish, and Dmitry V. Pelenev
2012 New Data on the Distribution and Size Composition of the North Pacific Spiny Dogfish *Squalus suckleyi* (Girard, 1854). *Scientia Marina* 76(1):111–122. DOI:10.3989/scimar.03439.22C.

Osborn, Alan J.
1977 Strandloopers, Mermaids, and Other Fairy Tales: Ecological Determinants of Marine Resource Utilization-The Peruvian Case. In *For Theory Building in Archaeology*, edited by Lewis R. Binford, pp. 157–205. Academic Press, New York.

Packard, Earl L.
1918 *Molluscan Fauna from San Francisco Bay*. University of California Publications in Zoology; v. 14, no. 2. University of California Press, Berkeley.

Page, Lawrence M. (editor)
2013 *Common and Scientific Names of Fishes from the United States, Canada, and Mexico*. Seventh edition. American Fisheries Society special publication 34. American Fisheries Society, Bethesda, Maryland.

Parkington, John J., John W. Fisher, and Katharine Kyriacou
2013 Limpet Gathering Strategies in the Later Stone Age along the Cape West Coast, South Africa. *Journal of Island and Coastal Archaeology* 8(1):91–107.

Patel, Raj
2009 Food Sovereignty. *The Journal of Peasant Studies* 36(3):663–706. DOI:10.1080/03066150903143079.

Patty, Ernest N.
1921 *The Metal Mines of Washington.* Washington State Geological Survey. Olympia.

Peacock, Evan, Rinat Gabitov, Jonathan R. Frisch, Carla S. Hadden, Carlock Bradley, and Kate L. Henderson
2016 LA-ICP-MS Chemical Analysis of Archaeological Otoliths as a Tool for Seasonality and Site Catchment Studies. *Journal of Archaeological Science* 65:11–19.

Pearsall, Deborah M.
2015 *Paleoethnobotany: A Handbook of Procedures*. Third edition. Left Coast Press, Walnut Creek, California.

Phillips, Elizabeth M., John K. Horne, Jeannette E. Zamon, and Jonathan J. Felis
2019 Does Perspective Matter? A case study Comparing Eulerian and Lagrangian Estimates of Common Murre Distributions. *Ecology and Evolution* 9(8):4805–4819. DOI:10.1002/ece3.5083.

Phinney, Lloyd A., and P. Bucknell
1975 *A Catalog of Washington Streams and Salmon Utilization*. Volume 2: Coastal Region. Washington Dept. Fisheries, Olympia.

Pierce, Shona Dejeanne
2011 Bivalve Growth-Stages as a Measure of Harvesting Intensity: Application on the Southern Northwest Coast. Unpublished Master's thesis, Department of Anthropology, Western Washington University, Bellingham.

Pojar, Jim, Andy MacKinnon, and Paul B. Alaback
1994 *Plants of the Pacific Northwest Coast: Washington, Oregon, British Columbia & Alaska*. Lone Pine, Vancouver.

Polson, Maria P., William E. Hewson, Douglas J. Eernisse, Patrick K. Baker, and Danielle C. Zacherl
2009 You Say *Conchaphila* , I Say *Lurida* : Molecular Evidence for Restricting the Olympia Oyster (*Ostrea lurida* Carpenter 1864) to Temperate Western North America. *Journal of Shellfish Research* 28(1):11–21. DOI:10.2983/035.028.0102.

Polson, Maria P., and Danielle C. Zacherl
2009 Geographic Distribution and Intertidal Population Status for the Olympia Oyster, *Ostrea lurida* Carpenter 1864, from Alaska to Baja. *Journal of Shellfish Research* 28(1):69–77. DOI:10.2983/035.028.0113.

Power, Tamara, Denise Wilson, Odette Best, Teresa Brockie, Lisa Bourque Bearskin, Eugenia Millender, and John Lowe
2020 COVID-19 and Indigenous Peoples: An Imperative for Action. *Journal of Clinical Nursing* 29(15–16):2737–2741. DOI:10.1111/jocn.15320.

Prentiss, Anna Marie, Hannah S. Cail, and Lisa M. Smith
2014 At the Malthusian Ceiling: Subsistence and Inequality at Bridge River, British Columbia. *Journal of Anthropological Archaeology* 33:34–48. DOI:10.1016/j.jaa.2013.11.003.

Prentiss, Anna Marie, Thomas A. Foor, Guy Cross, and Lucille E. Harris
2012 The Cultural Evolution of Material Wealth-Based Inequality at Bridge River, British Columbia. *American Antiquity* 77(3):542–564. DOI:10.7183/0002-7316.77.3.542.

Price, T. Douglas, and James A. Brown
1985 Aspects of Hunter-Gatherer Complexity. In *Prehistoric Hunter–Gatherers: The Emergence of Cultural Complexity*, edited by T. Douglas Price and James A. Brown, pp. 3–20. Academic Press, New York.

Pringle, Russell
1986 Soil Survey of Grays Harbor County Area, Pacific County, and Wahkiakum County, Washington. USDA Soil Conservation Service.

Pritchard, Catharine, Alan Shanks, Rose Rimler, Mark Oates, and Steven Rumrill
2015 The Olympia Oyster *Ostrea lurida* : Recent Advances in Natural History, Ecology, and Restoration. *Journal of Shellfish Research* 34(2):259–271. DOI:10.2983/035.034.0207.

Quayle, Daniel B.
1969 *Paralytic Shellfish Poisoning in British Columbia*. Fisheries Research Board of Canada. Bulletin 168. Fisheries Research Board of Canada, Ottawa.

Ratti, Frank Douglas
1977 Reproduction and Growth of the Pacific Basket-Cockle, *Clinocardium nuttallii Conrad*, from Intertidal and Subtidal Environments of Netarts Bay. Unpublished Master's thesis, Department of Oceanography, Oregon State University, Corvallis.

Ray, Verne F.
1938 Lower Chinook Ethnographic Notes. *University of Washington Publications in Anthropology* 7(2):29–165.

Renfrew, Colin and Paul Bahn
1996 *Archaeology: Theories, Methods, and Practice*. Thames & Hudson, London.

Renouf, Miriam A. P.
1989 *Prehistoric Hunter-Fishers of Varangerfjord, Northeastern Norway : Reconstruction of Settlement and Subsistence During the Younger Stone Age*. BAR international series; 487. B.A.R., Oxford, England.

Reynolds, III, John E., Dana L. Wetzel, and Todd M. O'Hara
2009 Human Health Implications of Omega-3 and Omega-6 Fatty Acids in Blubber of the Bowhead Whale (*Balaena mysticetus*). *Arctic* 59(2):155–164. DOI:10.14430/arctic338.

Richardson, Allan
1982 The Control of Productive Resources on the Northwest Coast of North America. In *Resource Managers: North American and Australian Hunter-Gatherers*, edited by Nancy N. Williams and Eugene S. Hunn. Westview Press, Boulder, Colorado.

Richardson, Scott
1997 *Washington State Status Report for the Gray Whale*. Washington Department of Fish and Wildlife, Olympia.

Rick, Torben C.
2011 Weathering the Storm: Coastal Subsistence and Ecological Resilience on Late Holocene Santa Rosa Island, California. *Quaternary International* 239:135–146.

Riedman, Marianne L., and James A. Estes
1990 The Sea Otter (*Enhydra lutris*): Behavior, Ecology, and Natural History. Vol. 90. USGS Publications Warehouse.

Robertson, Dwanna L.
2015 Invisibility in the Color-Blind Era: Examining Legitimized Racism against Indigenous Peoples. *American Indian Quarterly* 39(2):113. DOI:10.5250/amerindiquar.39.2.0113.

Roll, Tom E.
1974 The Archaeology of Minard: A Case Study of a Late Prehistoric Northwest Coast Procurement System. Unpublished PhD Dissertation, Department of Anthropology, Washington State University, Pullman.

Ropes, John W., and Ambrose Jearld
1987 Age Determination of Ocean Bivalves. In *The Age and Growth of Fish*, edited by Robert C. Summerfelt and Gordon E. Hall. 1st ed. International Symposium on Age and Growth of Fish. Iowa State University Press, Des Moines.

Rosenberg, J. Shoshana
2000 Study of Prestige and Resource Control Using Fish Remains from Cathlapotle, a Plankhouse Village on the Lower Columbia River. Unpublished Master's thesis, Department of Anthropology, Portland State University, Oregon.

Rosendahl, Daniel, Sean Ulm, Helene Tomkins, Lynley Wallis, and Paul Memmott
2014 Late Holocene Changes in Shellfishing Behaviors from the Gulf of Carpentaria, Northern Australia. *The Journal of Island and Coastal Archaeology* 9(2):253–267. DOI:10.1080/15564894.2014.880757.

Ross, Lester A.
1976 Fort Vancouver, 1829-1960: A Historical Archaeological Investigation of the Goods Imported and Manufactured by the Hudson's Bay Company. Fort Vancouver National Historic Site, U.S. National Park Service, Vancouver, Washington.
1990 Trade Beads From Hudson's Bay Company Fort Vancouver (1829-1860), Vancouver, Washington. *BEADS: Journal of the Society of Bead Researchers* 2:29–67.

Royer, France, and Richard Dickinson
2004 *Weeds of the Northern U.S. and Canada: A Guide for Identification*. Lone Pine; University of Alberta Press, Renton, Washington; Edmonton.

Ruby, Robert H., and John A. Brown
1976 *The Chinook Indians: Traders of the Lower Columbia River*. The civilization of the American Indian series 138. University of Oklahoma Press, Norman.

Ruelle, Morgan L.
2017 Ecological Relations and Indigenous Food Sovereignty in Standing Rock. *American Indian Culture and Research Journal* 41(3):113–125. DOI:10.17953/aicrj.41.3.ruelle.

Sabloff, Jeremy A.
2008 Archaeology Matters: Action Archaeology in the Modern World. Left Coast Press, Walnut Creek, California.

Sapir, Edward
1921 A Characteristic Penutian Form of Stem. *International Journal of American Linguistics* 2(1/2):58–67.

Satterfield, Dawn, Lemyra DeBruyn, Carolee Francis, and Aiko Allen
2014 A Stream Is Always Giving Life: Communities Reclaim Native Science and Traditional Ways to Prevent Diabetes and Promote Health. Edited by Jennie Joe and Robert Young. *American Indian Culture and Research Journal* 38(1):157–190. DOI:10.17953/aicr.38.1.hp318040258r7272.

Schalk, Randall
1977 The Structure of an Anadromous Fish Resource. In *For Theory Building in Archaeology: Essays on Faunal Remains, Aquatic Resources, Spatial Analysis, and Systemic Modeling*, edited by Lewis N. Binford, pp. 207–249. Academic Press, New York.
1981 Land Use and Organizational Complexity Among Foragers of Northwestern North America. In *Affluent foragers: Pacific Coasts East and West*, edited by Shuzo Koyama and David Thomas, pp. 53–76. National Museum of Ethnology, Oaska, Japan.

Schaepe, David M., Bill Angelbeck, David Snook, and John R. Welch
2017 Archaeology as Therapy: Connecting Belongings, Knowledge, Time, Place, and Well-Being. *Current Anthropology* 58(4):502–533. DOI:10.1086/692985.

Schiffer, Michael B.
1986 Radiocarbon Dates and the "Old Wood" Problem: The Case of the Hohokam Chronology. *Journal of Archaeological Science* 13:13–30.

Serena, Jeffery B.
1982 *Study of Shellfish Remains from Archaeological Sites on the San Antonio Terrace.* University of California, Los Angeles, Office of Public Archaeology, Social Process Research Institute.

Seton, Alfred
1993 *Astorian Adventure: The Journal of Alfred Seton, 1811-1815*. Edited by Robert Francis Jones. Fordham University Press, New York.

Shackel, Paul A., and Erve Chambers (editors)
2004 *Places in Mind: Public Archaeology as Applied Anthropology*. Critical Perspectives in Identity, Memory, and the Built Environment. Routledge, New York.

Shanks, Michael, and Christopher Y. Tilley
1987 *Re-Constructing Archaeology: Theory and Practice*. New studies in archaeology. Cambridge University Press.

Shashikantha, S.K., M.P. Sheethal, and B.K. Vishma
2016 Dietary Diversity Among Women in the Reproductive Age Group in a Rural Field Practice Area of a Medical College in Mandya District, Karnataka, India. *International Journal of Community Medicine and Public Health*:746–749. DOI:10.18203/2394-6040.ijcmph20160644.

Shaw, Robert D.
1977 *Report of Excavations: The Martin Site (45PC7), 1974*. Washington Archaeological Society Occasional Paper No. 5.

Shott, Michael J.
1997 Stones and Shafts Redux: The Metric Discrimination of Chipped-Stone Dart and Arrow Points. *American Antiquity* 62(1):86–101. DOI:10.2307/282380.

Sidhu, Kirpal S.
2003 Health Benefits and Potential Risks Related to Consumption of Fish or Fish Oil. *Regulatory Toxicology and Pharmacology* 38(3):336–344. DOI:10.1016/j.yrtph.2003.07.002.

Silverstein, Michael
1990 Chinookans of the Lower Columbia. In *Handbook of North American Indians*, edited by Wayne Suttles, 7: Northwest Coast:pp. 533–546. Smithsonian Institution Press, Washington, DC.

Simpson, George
1968 *Fur Trade and Empire; George Simpson's Journal,* edited by Frederick Merk. Belknap Press of Harvard University Press, Cambridge, Massachusetts.

Sitrin, Marina (editor)
2006 *Horizontalism: Voices of Popular Power in Argentina*. AK Press, Edinburgh, Scotland; Oakland, California.

Smith, Carley B., Claire E. Ebert, and Douglas J. Kennett
2014 Human Ecology of Shellfish Exploitation at a Prehistoric Fishing-Farming Village on the Pacific Coast of Mexico. *The Journal of Island and Coastal Archaeology* 9(2):183–202. DOI:10.1080/15564894.2014.881935.

Smith, Claire, and Hans Martin Wobst
2005 *Indigenous Archaeologies Decolonizing Theory and Practice*. Routledge, London; New York.

Sobel, Elizabeth A.
2004 Social Complexity and Corporate Households on the Southern Northwest Coast of North America, AD 1450-1855. Unpublished PhD Dissertation, Department of Anthropology, University of Michigan.

Sobel, Elizabeth A., Kenneth M. Ames, and Robert J. Losey
2013 Environment and Archaeology of the Lower Columbia. In *Chinookan Peoples of the Lower Columbia*, edited by Robert T. Boyd, Kenneth M. Ames, and Tony A. Johnson, pp. 23–41. University of Washington Press, Seattle.

Spier, Leslie
1936 *Tribal Distributions in Washington*. General Series in Anthropology 3.

Spier, Leslie, and Edward Sapir
1930 Wishram Ethnography. *University of Washington Publications in Anthropology* 3(3):151–300.

Stapp, Darby C.
1985 Copper Artifacts from the Upper Columbian River Region, Northeastern Washington. In *Kettle Falls: 1978*, edited by David H. Chance and Jennifer V. Chance, pp. 367–387. Anthropological Reports 84. University of Idaho.

Steele, Earl N.
1964 *The Immigrant Oyster (Ostrea Gigas) Now Known as the Pacific Oyster*. Warren's Quick Print, Olympia, Washington.

Stein, Julie K. (editor)
1992 *Deciphering a Shell Midden*. Academic Press, San Diego.

Stern, Theodore
1998 Columbia River Trade Network. In *Handbook of North American Indian*, edited by Deward E. Walker Jr., 12: Plateau:pp. 641–652. Smithsonian Institution Press, Washington, DC.

Strickland, Richard, and Daniel Jack Chasan
1989 *Coastal Washington - A Synthesis of Information*. Washington Sea Grant Program. University of Washington, Seattle.

Stuart, Robert
1935 *The Discovery of the Oregon Trail; Robert Stuart's Narratives of his Overland Trip Eastward from Astoria in 1812-13. Edited by Philip Ashton Rollins*. C. Scribner's Sons, New York, London.

Stump, Daryl
2013 On Applied Archaeology, Indigenous Knowledge, and the Usable Past. *Current Anthropology* 54(3):268–298. DOI:10.1086/670330.

Sumpter, Ian D.
2017 *Appendix C: An Analysis of Three Shellfish Assemblages from Ts'ishaa, Site DfSi-16 (204T), Benson Island, Pacific Rim National Park Reserve of Canada*. SFU Archaeology Press.

Suttles, Wayne

1962 Variation in Habitat and Culture on the Northwest Coast. In *Proceedings of the 34th International Congress of Americanists*, pp. 522–537. Vienna.

1968 Coping with Abundance: Subsistence on the Northwest Coast. In *Man the Hunter,* edited by Richard B. Lee and Irene DeVore, pp. 56–68. Aldine De Gruyter, New York.

1987 Cultural Diversity within the Coast Salish Continuum. In *Ethnicity and Culture Proceedings of the Eighteenth Annual Conference of the Archaeological Association of the University of Calgary*, edited by Réginald Auger, pp. 243–249. University of Calgary, Archaeological Association.

1990 Central Coast Salish. In *Handbook of North American Indians*, edited by Wayne Suttles, 7: Northwest Coast:pp. 453–475. Smithsonian Institution Press, Washington, DC.

Swan, James G.

1857 *The Northwest Coast, or Three Years or Residence in Washington Territory*. University of Washington Press, Seattle.

Swanton, John R.

1952 *The Indian Tribes of North America*. Bureau of American Ethnology Bulletin. Government Printing Office, Washington, DC.

Tartaglia, Louis

1976 Prehistoric Maritime Adaptations in Southern California. Unpublished Ph.D. Dissertation, University of California, Los Angeles.

Taylor, Graham D.

1980 *The New Deal and American Indian Tribalism: The Administration of the Indian Reorganization Act, 1934-45*. University of Nebraska Press, Lincoln.

Thomas, Kenneth, and Marcello A. Mannino

1999 The Bioarchaeology of the Culverwell Shell Midden. In *Culverwell Mesolithic Habitation Site: Isle of Portland, Dorset; Excavation Report and Research Studies*, edited by Susann Palmer, pp. 94–114. BAR British series 287. Archaeopress, Oxford.

Thompson, Laurence C., and M. Dale Kinkade

1990 Languages. In *Handbook of North American Indian,* edited by Wayne Suttles, 7: Northwest Coast:pp. 30–51. Smithsonian Institution Press, Washington, DC.

Titus, James G., and Vijay K. Narayanan

1995 *The Probability of Sea Level Rise*. United States Environmental Protection Agency, Office of Policy, Planning, and Evaluation.

Toniello, Ginevra, Dana Lepofsky, Gavia Lertzman-Lepofsky, Anne K. Salomon, and Kirsten Rowell

2019 11,500 y of Human–Clam Relationships Provide Long-Term Context for Intertidal Management in the Salish Sea, British Columbia. *Proceedings of the National Academy of Sciences* 116(44):22106–22114. DOI:10.1073/pnas.1905921116.

Trigger, Bruce G.
1984 Alternative Archaeologies: Nationalist, Colonialist, Imperialist. *Man* 19(3):355–370. DOI:10.2307/2802176.
2007 *A History of Archaeological Thought*. Second edition, reprinted. Cambridge University Press, Cambridge.
2008 "Alternative Archaeologies" in Historical Perspective. In *Evaluating Multiple Narratives: Beyond Nationalist, Colonialist, Imperialist Archaeologies*, edited by Junko Habu, Clare P. Fawcett, and John M. Matsunaga, pp. 187–195. Springer, New York.

Trimble, Alan C., Jennifer L. Ruesink, and Brett R. Dumbauld
2009 Factors Preventing the Recovery of a Historically Overexploited Shellfish Species, *Ostrea lurida* Carpenter 1864. *Journal of Shellfish Research* 28(1):97–106. DOI:10.2983/035.028.0116.

Turner, Nancy C., and Marcus A. M. Bell
1971 The Ethnobotany of the Coast Salish Indians of Vancouver Island. *Economic Botany* 25(1):63-104.
1973 The Ethnobotany of the Southern Kwakiutl Indians of British Columbia. *Economic Botany* 27(3):257–310. DOI:10.1007/BF02907532.

Turner, Nancy J.
1996 Traditional Ecological Knowledge. In *The Rainforests of Home: Profile of a North American Bioregion*, edited by Peter Schoonmaker, Bettina von Haggen, and Edward Wold, pp. 275–298. Island Press, Washington, DC.
1999 Where has all the Clover Gone? A Tribute to B.C. Botanist T.C. Brayshaw. *Botanical Electronic News*(226).

Turner, Nancy J., and Cecil H. Brown
2004 Grass, Hay, and Weedy Growth: Utility and Semantics of Interior Salish Botanical Terms. In *Studies in Salish Linguistics in Honor of M. Dale Kinkade*, edited by Donna B. Gerdts and Lisa Matthewson, 17:pp. 410–28. Occasional papers in Linguistics. University of Montana, Missoula.

Turner, Nancy J., and Harriet V. Kuhnlein
1982 Two Important "Root" Foods of the Northwest Coast Indians: Springbank Clover (*Trifolium wormskioldii*) and Pacific Silverweed (*Potentilla anserina ssp. pacifica*). *Economic Botany* 36(4):411–432.

Turner, Nancy J., Robin Smith, and James Jones
2005 "A Fine Line Between Two Nations": Ownership Patterns for Plant Resources among Northwest Coast Indigenous Peoples. In *Keeping it living: Traditions of plant use and cultivation on the Northwest Coast of North America*, edited by Douglas Deur and Nancy Turner, pp. 151–178. University of Washington Press, Seattle.

Turner, Nancy J., and Katherine L. Turner

2008 “Where our Women Ssed to Get the Food”: Cumulative Effects and Loss of Ethnobotanical Knowledge and Practice; Case Study from Coastal British Columbia (1). *Botany* 86(2):103+.

Tushingham, Shannon, and Robert L. Bettinger

2013 Why Foragers Choose Acorns Before Salmon: Storage, Mobility, and Risk in Aboriginal California. *Journal of Anthropological Archaeology* 32(4):527–537. DOI:10.1016/j.jaa.2013.09.003.

Tymchuk, Michael

1984 Skeletal Remains - In Defense of Sensitivity and Compromise. *Council for Museum Anthropology Newsletter* 8(3):2–8. DOI:10.1525/mua.1984.8.3.2.

Ucko, Peter

1986 Political Uses of Archaeology. In *Archaeology, Politics, and the Public*, edited by Colin Dobson and Roberta Gilchrist, 5:pp. 45–49. York University Archaeological Publications.

United Nations

2007 United Nations Declaration on the Rights of Indigenous Peoples.

United States

1850 Journal of the House of Representatives of the United States. *House journal<1979>* 31(1).

1979 Opinions of the Solicitor of the Department of the Interior relating to Indian affairs, 1917-1974. 2 v. (v, 2194 p.). U.S. Dept. of the Interior, Washington, DC.

U.S. Bureau of Indian Affairs

1919 Assistant Commissioner of Indian Affairs E. B. Meritt to Otis O. Benson. Superintendent. BIA Agency, Hoquiam, Washington.

U.S. Congress, Senate, Committee on Indian Affairs.

2011 The Indian Reorganization Act - 75 years later: Renewing Our Commitment to Restore Tribal Homelands and Promote Self-Determination. 112th Congress, 1st session, June 23, 2011.

U.S. Congress, Senate, Committee on Indian Affairs and Senate Committee on Nutrition and Forestry

1993 Barriers to Participation in the Food Stamp Program and Other Programs of the Department of Agriculture by People Residing on Indian Lands. 103rd Congress, 1st session.

U.S. Department of State

1832 Treaty with the Sauk and Foxes. In *Indian Affairs: Laws and Treaties*, edited by Charles J. Kappler, 2:pp. 635ff. Government Printing Office, Washington, DC.

U.S. Office of Indian Affairs

1874 Annual Report of the Commissioner of Indian Affairs, for the year 1874. Washington, DC.

1876 Annual Report of the Commissioner of Indian Affairs, for the year 1876. Washington, DC.

1877 Annual Report of the Commissioner of Indian Affairs, for the year 1877. Washington, DC.

1893 Annual Report of the Commissioner of Indian Affairs, for the year 1893. Washington, DC.

U.S. v. Turtle Mtn. Band of Chippewa Indians

1974 U.S. v. Turtle Mtn. Band of Chippewa Indians. F.2d. Vol. 612.

U.S. v. Washington

1974 UNITED STATES of America, Plaintiff, Quinault Tribe of Indians on its own behalf and on behalf of the Queets Band of Indians, et al., Intervenor- Plaintiffs, v. STATE OF WASHINGTON, Defendant, Thor C. Tollefson, Director, Washington State Department of Fisheries, et al., Intervenor- Defendants. F. Supp. Vol. 384.

1994 UNITED STATES of America, et al., Plaintiffs, v. STATE OF WASHINGTON, et al., Defendants. F. Supp. Vol. 873.

U.S. v. Winans

1905 United States v. Winans. U.S. Vol. 198.

USDA, and NRCS

2020 The PLANTS Database. http://plants.usda.gov, accessed May 5, 2020.

USFWS

1991 Wildlife of the Willapa National Wildlife Refuge and the Columbia River estuary, Ilwaco, Washington. U.S. Fish & Wildlife Service.

Van Syckle, Edwin

1982 *The River Pioneers: Early Days on Grays Harbor*. The Friends of the Aberdeen Public Library. Pacific Search Press, Seattle.

Vantrease, Dana

2013 Commod Bods and Frybread Power: Government Food Aid in American Indian Culture. *The Journal of American Folklore* 126(499):55–69. DOI:10.5406/jamerfolk.126.499.0055.

Vernon, Rachel

2015 A Native Perspective: Food is More Than Consumption. *Journal of Agriculture, Food Systems, and Community Development*:1–6. DOI:10.5304/jafscd.2015.054.024.

Vizenor, Gerald
1986 Bone Courts: The Rights and Narrative Representation of Tribal Bones. *American Indian Quarterly* 10(4):319–331. DOI:10.2307/1183840.
2010 *Manifest Manners: Narratives on Postindian Survivance*. 1. Bison Books print. University of Nebraska Press, Lincoln.

Wake, Thomas A.
2006 Archaeological Sewellel *(Aplodontia rufa*) Remains from Duncan's Point Cave, Sonoma County, California. *Journal of Mammalogy* 87(1):139–147.

Waselkov, Gregory A.
1987 Shellfish Gathering and Shell Midden Archaeology. In *Advances in Archaeological Method and Theory*, edited by Michael Schiffer, 10:pp. 93–210. Academic Press, Orlando.

Washington Sea Grant
2015 Shellfish Aquaculture in Washington State. Seattle.

Waterman, H.W.
1866 Letter From H.W. Waterman, Indian Agent, to the Department of the Interior Secretary. Executive Order Files, 1850-1892. National Archives.

Wendler, H.O., and G. Deschamps
1955 Logging Dams on Coastal Washington Streams. *Washington Department of Fisheries, Fisheries Research Papers (1)3*:27–38.

Wesner, Chelsea
2013 Traditional Foods in Native America. Part I: A Compendium of Stories from the Indigenous Food Sovereignty Movement in American Indian and Alaska Native Communities. Edited by Native Diabetes Wellness Program (U.S.), Centers for Disease Control and Prevention (U.S.); National Center for Chronic Disease Prevention and Health Promotion (U.S.). Division of Diabetes Translation., and Native Diabetes Wellness Program (U.S.). Traditional Foods in Native America ; part I.

Wessen, Gary C.
1982 Shell Middens as Cultural Deposits: A Case Study from Ozette. Unpublished PhD Dissertation, Department of Anthropology, Washington State University, Pullman.
1988 The Use of Shellfish Resources on the Northwest Coast: The View from Ozette. In *Prehistoric Economies of the Pacific Northwest Coast*, edited by Barry L. Isaac, pp. 179–207. Research in Economic Anthropology 3. JAI Press, Greenwich, Connecticut.
2008 A Cultural Resources Overview for the Willapa National Wildlife Refuge, Willapa Bay, Washington.

Wesson, Cameron
1999 Chiefly power and food storage in southeastern North America. *World Archaeology* 31(1):145–164. DOI:10.1080/00438243.1999.9980436.

2013 Rumors of Our Demise Have Been Greatly Exaggerated: Archaeological Perspectives on Culture and Sustainability. *Sustainability* 5(1):100–122. DOI:10.3390/su5010100.

Weymouth, Frank Walter
1931 The Age and Growth of the Pacific cockle (*Cardium corbis*, Martyn). U.S. Government Printing Office.

Whitaker, Adrian R.
2008 Incipient Aquaculture in Prehistoric California?: Long-Term Productivity and Sustainability vs. Immediate Returns for the Harvest of Marine Invertebrates. *Journal of Archaeological Science* 35:1114–1123.

Whitaker, Adrian R., and Brian F. Byrd
2014 Social Circumscription, Territoriality, and the Late Holocene Intensification of Small-Bodied Shellfish Along the California Coast. *The Journal of Island and Coastal Archaeology* 9(2):150–168. DOI:10.1080/15564894.2014.881934.

White, Jacqueline, Jennifer L. Ruesink, and Alan C. Trimble
2009 The Nearly Forgotten Oyster: *Ostrea lurida* Carpenter 1864 (Olympia Oyster) History and Management in Washington State. *Journal of Shellfish Research* 28(1):43–49. DOI:10.2983/035.028.0109.

White, Theodore E.
1953 A Method of Calculating the Dietary Percentage of Various Food Animals Utilized by Aboriginal Peoples. *American Antiquity* 18(4):396–398. DOI:10.2307/277116.

Whitlock, Cathy
1992 Vegetational and Climatic History of the Pacific Northwest During the Last 20,000 Years: Implications for Understanding Present Day Biodiversity. *The Northwest Environmental Journal* 8:5–28.

Wicksten, Mary K.
2011 Decapod Crustacea of the Californian and Oregonian Zoogeographic Provinces. UC San Diego: Library - Scripps Digital Collection.

Wilcox, Michael
2010 Saving Indigenous Peoples from Ourselves: Separate but Equal Archaeology is not Scientific Archaeology. *American Antiquity* 75(2):221–227. DOI:10.7183/0002-7316.75.2.221.

Wilkes, Charles
1845 *Narrative of the United States Exploring Expedition during the Years 1838, 1839, 1840, 1841, 1842*. Lea and Blanchard, Philadelphia.

Williams, Judith

2006 *Clam Gardens: Aboriginal Mariculture on Canada's West Coast*. Transmontanus 15. New Star Books, Vancouver ; Point Roberts, Washington.

Williams, Thomas J., and David B. Madsen

2020 The Upper Paleolithic of the Americas. *PaleoAmerica* 6(1):4–22. DOI:10.1080/20555563.2019.1606668.

Wilson, Douglas C., Kenneth M. Ames, Kristine M. Bovy, Virginia Butler, Robert Cromwell, Loren G. Davis, Christopher R. DeCorse, Brian F. Harrison, R. Lee Lyman, Michele L. Punke, Cameron M. Smith, and Nancy A. Stenholm

2008 Historical Archaeology at the Middle Village: Station Camp/McGowan Site (45PC106), Station Camp Unit, Lewis & Clark National Park, Pacific County, Washington.

Winterhalder, Bruce, and Carol Goland

1993 On Population, Foraging Efficiency, and Plant Domestication. *Current Anthropology* 34(5):710–715. DOI:10.1086/204214.

Wissler, F. Clark

1914 Material Cultures of the North American Indians. *American Anthropologist* 16:447–505.

1917 *The Relation of Nature to Man in Aboriginal America*. McMurtrie, New York.

Wolverton, Steve, Jonathan Dombrosky, and R. Lee Lyman

2016 Practical Significance: Ordinal Scale Data and Effect Size in Zooarchaeology: Effect Size and Ordinal Scale Data in Zooarchaeology. *International Journal of Osteoarchaeology* 26(2):255–265. DOI:10.1002/oa.2416.

Woxell, Lorraine Katherine

1998 Prehistoric Beach Accretion Rates and Long-Term Response to Sediment Depletion in the Columbia River Littoral System, USA. Unpublished Masters Thesis in Geology, Portland State University, Oregon.

Wydoski, Richard S., and Richard R. Whitney

2003 *Inland Fishes of Washington*. American Fisheries Society in Association with University of Washington Press, Seattle, Bethesda, Maryland.

Wylie, Alison

2008 The Integrity of Narratives: Deliberative Practice, Pluralism, and Multivocality. In *Evaluating Multiple Narratives: Beyond Nationalist, Colonialist, Imperialist Archaeologies*, edited by Junko Habu, Clare P. Fawcett, and John M. Matsunaga, pp. 201–212. Springer, New York.

Young, James A., and Cheryl G. Young

1992 *Seeds of Woody Plants in North America*. Dioscorides Press, Portland, Oregon.

Young, T. Kue, Jeff Reading, Brenda Elias, and John D. O'Neil
2000 Type 2 Diabetes Mellitus in Canada's First Nations: Status of an Epidemic in Progress. *Canadian Medical Association Journal* 163(5):561-566.

Ziegler, Alan C.
1975 Recovery and Significance of Unmodified Faunal Remains. In *Field Methods in Archaeology*, edited by Thomas R. Hester, John A. Graham, and Robert F. Heizer. Mayfield Publishing Company, Palo Alto, California.

Zimmerman, Larry J.
2004 First, be Humble: Working with Indigenous Peoples and Other Descendant Communities. In *Indigenous Archaeologies*, edited by Claire Smith and H. Martin Wobst, pp. 284–296. Routledge, UK.

Zimmerman, Larry J., Duane C. Anderson, Maria Pearson, Alton Fisher, Debby Zieglowsky, Shirley Schermer, Bruce Baird, Jan Hammil, Larry J. Zimmerman, United States Air Force, and Phillip L. Walker
1986 "Tell Them about the Suicide" A Review of Recent Materials on the Reburial of Prehistoric Native American Skeletons. *American Indian Quarterly* 10(4):333–343. DOI:10.2307/1183841.