ACORNS AND CAMAS: PLANT UTILIZATION AND SUBSISTENCE
ALONG THE NORTHWEST COAST
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Abstract

The Northwest Coast region of North America has long been reported as relying heavily on a marine subsistence base with little if any exploitation of plant resources. This is one of the few areas of the world where culturally complex tribes and chiefdoms developed without agriculture. Historic records starting in the 16th century, modern ethnographic records, archaeological recovery methods as well as acidic and waterlogged soil conditions may have resulted in an underrepresentation of plant remains and usage. I examined a variety of archaeological and ethnographic records related to plant utilization in prehistoric indigenous groups of the Northwest Coast. For my thesis, I focused on the recovered artifacts from several archaeological sites believed related to the exploitation of plant resources. Additionally, I compared archaeological artifacts with the ethnographic record to determine the usage of the artifacts and see if there are artifacts that may be missing from the archaeological record and which artifacts may have been used to process plant resources. By reexamining the relative importance of plant materials in daily life and the subsistence base of native indigenous groups, I have found a larger reliance and usage of plants than previously reported.
Introduction

The role plant resources have played in the Pacific Northwest Coast cultures has generally been thought to be minor (Ames and Maschner 1999). Instead, a maritime orientation and the exploitation of these resources, specifically salmon, are described in the anthropological literature as providing the main subsistence of the Northwest or North Pacific Coast of North America (Drucker 1965). It is estimated that the modern annual salmon catch is about 123 million pounds or about one pound per person every day (Kirk and Daugherty 1978). These coast cultures developed elaborate fishing technologies like hooks, traps, spears, as well as canoes (Drucker 1965; Stewart 1973). Additionally, cultures of the Northwest Coast were able to reach complex level tribes and chiefdoms without agriculture (Ames and Maschner 1999). However, both the archaeological and ethnographical record show that plant resources are important in most cultures, serving as a form of subsistence, medicine, cordage, clothing and other uses. In Northwest coast sites, basketry is prevalent instead of pottery (Lobb 1978). Ethnographically, we know that recent Northwest Coast cultures manipulated and used 300 different plant resources (Deur and Turner 2005). Although these plant resources are reported ethnographically, there is little information on how they relate to the archaeological record.

Nutrition is an important part of subsistence. Bone analysis studies, specifically the stable carbon isotope test, can determine the relative amount of marine or terrestrial resources an individual ate during the course of their life (Chisholm, Nelson and Schwarcz 1983). The archaeological Namu site burials revealed that children show a lower carbon composition than adult populations indicating that children were consistently consuming a lesser percentage of marine-based food resources (Lazenby and McCormack 1985). Vitamin D is mostly obtained from synthesis from the sun and eating marine resource rich diet. Children are less tolerant of
vitamin D than adults. Thus, a certain level of marine subsistence could prove fatal to children while seemingly unaffected adults. Additionally, excess vitamin D causes bone pathologies that we would be able to see in the archaeological record. Given the ethnographic record, comparisons with other cultures, and bone chemistry results, terrestrial resources must have been used in some form in the subsistence base which may have included plant resources. However, few people have focused on the usage of plants in the prehistoric indigenous populations of the Northwest Coast in the subsistence base.

There is also a notable rarity of flora material recovered as a result of the specific excavation methods employed. Coastal waterlogged sites yield soil conditions that facilitate floral preservation of delicate organic artifacts. However, the method of hydraulic excavation may bias floral material recovery. Certain sites, like the Hoko River site contain both wet and dry site components (Croes 1995). Archaeologists have not focused on the usage of plants within Northwest Coast sites despite the ethnographic record and other evidence of the importance of plants. Additionally, the nature of archaeological excavation and floral recovery in the region complicates the examination of archaeological remains to determine the role of plants in the economy.

My research question is: how important were plant resources in the economy of prehistoric indigenous cultures along the Northwest Coast? What plants were used in the subsistence base, and what other uses did they have? Since macro-floral remains are the only plant remains recovered from waterlogged sites, artifacts and these macro remains will be used and compared to the ethnographic and historic records to clarify plant usage by prehistoric populations. Ethnographic records are also used to detail features we would expect to find in the archaeological record in the event of plant processing technologies.
Northwest Coast Region Environment and Habitat

The Northwest coast region has been defined as extending from southern Alaska to northern California and between the Pacific Coast and the Cascade and Coast Mountain Ranges, see Figure 1 (Adams 1981; Suttles 1990; Deur and Turner 2005). A generally steep and mountainous coastline gradually lowers into more rounded hills south of British Columbia (Drucker 1965). The steep terrain may limit access to the interior where more plant resources may be located.

Figure 1: Geographic map illustrating the region classified as the Northwest Coast: South of Alaska, including the Southwest part of British Columbia south to Upper California, between the Pacific Ocean and the Cascade and Coast Mountain Ranges (Source: Google Maps 2008, geographic labels added by author).
The Northwest Coast has a temperate climate unlike the equivalent latitude of the east coast of North America due to a phenomenon of the Japanese Current which causes heavy precipitation with a generally warm climate and little seasonal variation (Drucker 1965). Heavy precipitation and a steadily warm climate create a unique environment allowing the growth of warm plant species. There are many regions within the Northwest Coast region: low elevation meadows, rainshadow forests, montane forests, freshwater bogs/fens, Tidal wetlands (Turner and Peacock 2005). Low elevation meadows produce edible bulbs called camas that are important to modern Salish peoples. Rainshadow, or Douglas-Fir, forests have fruit bearing shrubs like huckleberry, blackberry, strawberries and hazelnuts. Coast rainforests are associated with berries and cedar and spruce trees. Montane forests differ in that there are yellow cedar trees and berries. Freshwater bogs and fens produces moss, bog blueberries as well as attract ducks and various other aquatic birds which people could hunt. Tidal wetlands offer springbank clover, Pacific silverweed, Nootka lupine, rice-root, wild carrot, wild onion, and berries. Additionally, ethnographic records also tell us that people hunted deer, elk and birds, particularly ducks (Stein 2000). While the environment is rich in plant material, there is a great deal of diversity in a fairly specific, small region.

**Chronology of the Region**

Sites in the Northwest coast region date back to Paleoindian times; see Table 1. As indigenous peoples crossed the Bering Strait to the New World, Clovis sites are found throughout the Americas dating back to around 12,000 years ago. A few Clovis points have been found in the southern Northwest coast region, such as on Whidbey Island and Puget Sound (Stein 2000). No shell was recovered from the deepest layers of Cattle Point site, but terrestrial animal remains, most likely deer and elk based on the size of the bones, were recovered (Stein 2000).
Table 1: Generalized chronology of the Northwest Coast Region
(Source: Ames and Maschner 1999:66).

It appears that people living in the Paleoindian Period (11,500 – 9000 B.P.) occupations of the site did not rely on many if any marine resources. Other sites on the Fraser and Columbia Rivers have yielded salmon vertebrae during the Cascade Phase (9000 – 4500 B.P.). It is quite possible that glacial melt water would have covered up many early shore sites whose inhabitants might have used marine resources, and left us with the “inland” sites whose inhabitants would have exploited more terrestrial based animals. Glacial melt would move the coast line inwards to our current coastlines biasing Paleoindian period archaeology towards more inland sites that remained above water. Locarno Beach, Mayne and St. Mungo Phases (4500 – 2500 B.P.) are associated with the first appearance of shell and shellfish remains, see Table 2. It is during this phase that indigenous peoples are first believed to have developed an extensive marine resource exploitation pattern.
Marine shell was radiocarbon dated to reveal a date for this period that began between 2,500 and 2,300 years ago (Stein 2000). Woodworking tools like stone mauls, adzes and wedges also first appear during this period. Cedar wood also first appeared in the Northwest region, cedar pollen dates to 4,000 years ago. It is during the Marpole Phase (2500 – 1500 B.P.) that cultural complexity and societal organizational structure start to develop. Due to the increased exploitation of cedar wood, plank houses, clothing, carvings, weaving techniques were developed. The last phase, the San Juan Phase (1500 B.P. – Present) takes the prehistoric record up to the first European contact. According to Stein (2000), this period is characterized by an increased use of objects made of wood instead of chipped stone tools.

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Table 2: Details the chronology of Southern Northwest Coast (Based on: Stein 2000; Carlson 1960).

**Historic and Ethnographic Records**

Early explorers to the Northwest Coast of North America mainly sought the possibility of a Northwest Passage and to exploit the fur trade. Alaska and the northern edge of the Northwest Coast were discovered and explored in 1741 by Captain Bering who had been hired by the Russians (Eberstadt 1941). Captain Cook, a British captain, in 1778 was the first to make a
detailed account of the indigenous populations in the Nootka Sound region where they refitted their expedition and obtained furs for trade before Cook was killed by natives of the Sandwich Hawaiian Islands (Eberstadt 1941). Captain Vancouver’s expedition in 1792 extensively mapped the coastline and concluded that there was no Northwest Passage.

Lewis and Clark’s expedition (1803-1806) included an encounter with the Pacific Coast Indians (Lewis 1966[1814]; Moulton 2001a,b,c). They detail that the coast Indians primarily subsisted on salmon, and when they couldn’t get that they relied on other fish. Often, they hunted elk, but their arrow technology was not adapted to continuously obtain elk. Additionally, they often traded among themselves for wapatos and camas (potato like root plants indigenous to the coast region). Occasionally, the Chinnooks ate wild fowl, elk and deer as luxuries, but mainly subsist on salmon and other fish and some plants, with wild licorice as the most popular, also shanataque and wapato both of which were obtained by trading with tribes up river. Additionally, all groups existing near the mouth of the Columbia River are similar in language, habits and almost all other particulars. In describing the Clatsop, both Lewis and Clark tell of the digging stick used to dig up roots. It is a three and a half foot long strong stick with a sharpened end often curved at the lower end while the upper end is often inserted into a handle made of an elk or deer antler, see Figure 2. Waterproof baskets and hats are made of cedar bark and bear-grass that is interwoven so closely that it does not need resin to make it watertight. Bear-grass is found only in the mountains which makes it a highly prized trade item. Leggings or moccasins were unnecessary for protection against the weather (because it is mild) and the water causes them to decay anyway. Instead, textiles made of mountain sheep wool and plant resources were used as basketry, cloaks and clothing.
On their travels, Lewis and Clark observed the use and processing of tubers including camas (*Camassia quamash*), wapatos (*Sagittaria latifolia*), liquorice root called Culhomo, a black root called the Shannatahque (Moulton 2001b). All of these tubers could have been eaten raw, but cooking processes such as roasting or steaming were preferred because the process would make the roots taste sugary. If the tubers were not eaten within 24 hours of being processing, the tubers would spoil, so they were dried and pounded into cakes ¼ to ¾ inch thick and dried on sticks over an open flame. These tuber cakes were then stored in basketry hung in either the rafters of houses, or under the raised beds. The dried cakes or loaves of tuber bread could then be eaten as bread, or were most often used as an ingredient in almost every food dish. As long as the bread loaves were kept free of moisture, they would keep fresh for a very long time, ideal for winter storage. Additionally, Lewis recounts how “some very good beer “is made of the camas bread (Moulton 2001a:318). Clark wrote on September 20th, 1805, “The natives are extremely fond of this root and present it to their visitors as a great treat. When we first arrived at the Chopunnish last fall at this place our men who were half starved made so free a use of this root that it made them all sick for several days after” (Moulton 2001c:21). The same day, Lewis
wrote this account, “This root is palatable but disagrees with me in every shape I have ever used it” (Moulton 2001c:17). Clearly, tubers were considered important in the subsistence level in making it through the winter season, and as a treat, but took some effort to get used to it.

Early attempts at ethnography include Johan Adrian Jacobsen’s ethnographic study of the entire coast region. The only artifact or mention of plant resources Jacobsen included in his study was an illustration of a mortar and pestle used for grinding food and tobacco used by the Haida of Queen Charlotte Island (Jacobsen 1977:20). One problem with the kind of ethnography written while visiting indigenous populations is that publications tend to include the extraordinary instead of the everyday behavior. Historically, this period in the development of archaeology is primarily based in antiquarianism, or the collection of artifacts as novelties instead of attempting to understand the culture and meaning behind the artifacts. After spending only twenty-one days among them, Jacobsen (1977) spent much of his time discussing cannibalism among the Kwakuitl instead of their methods of subsistence. Additionally, being male, it is possible that his male informants would not have instructed him on the gendered work of which root gathering and berry picking might be a part.

**Ethnobotanical Record**

A distinct field of study is ethnobotany, or looking at the plants that current ethnographic groups use. Modern ethnographical studies show that Northwest Coast cultures gathered roots, fruits, shoots and nuts and also that gathering plants was gendered and considered women’s work (Kirk 1986). Ethnobotany by Nancy Turner and Marcus Bell (1971) has shown that modern Coast Salish tribes of Washington had access to and used of camas bulbs. Ethnographic evidence shows that camas bulbs were not only gathered, steamed and stored, but also traded
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(Kirk 1986). Lewis writes that these bulbs were highly prized and often traded particularly between coastal and inland societies (Moulton 2001b).

Turner and Bell (1971) conducted an ethnobotanical study of the Coast Salish peoples on Vancouver Island. They found that *Nereocystis luetkeana*, a type of seaweed was used to place above and below camas roots, clams, deer, seal and other resources processed in a steaming pit adding moisture and flavor to the food. *Wapatos* (*Sagittaria latifolia*), were abundant in swampy areas on the mainland with a wide distribution limited by excess exploitation. Camas were abundant and easy to gather along the coast and were the only extensive source of starch. They were dug between June and August and the entire family, including men, participated in the harvest. Only large bulbs, two to three inches across, where kept to allow the smaller immature bulbs to continue growing and reproduce. Often the broken stems from the stalk bearing the bulb were placed back into the hole. Additionally, to increase yields, the camas beds were burned over annually. These camas beds were generally divided into family plots and passed down from one generation to the next generation. Devil’s Club (*Oplopanax horridum*) was distributed from Alaska to Oregon and used by almost every tribe as a charm and medicine for rheumatism and general aches and pains. Hazelnuts had a limited distribution on Vancouver Island, but the indigenous people enjoyed them when they were available. Interestingly enough, red elderberry was considered not fit to eat and only used as a children’s play thing.

In total, 122 species of plants were used by the Coast Salish on Vancouver Island (Turner and Bell 1971). Of these, 74 species were used for food, the five most used families are: Liliaceae, Ericaceae, Grossulariaceae, Rosaceae, and Umbelliferae. Plants used in technology, like mats, baskets, plants for houses, canoes, clothing, and fishnets totaled 54 species. Many plants used for medicinal purposes were kept in secret, but 39 species were identified as
medicinal to the Island Salish. Thirty of these plants were also used for other purposes. Red cedar was not only used in technology of plant houses, canoes and masks among other things, but was considered sacred. While there are differences in the use and exploitation of plant resources among different coastal groups, these differences decrease as the amount of contact and trade between groups increases. This difference is mostly due to the ecological distribution of these plant resources.

**Cultural Region, Social Complexity and Development in Northwest Coast Cultures**

The cultural diversity in the Northwest coast is immense, but can be typified as a few main groups: the Tlingit, Haida, Tsimshian, Kwakiutl, Coast Salish, see Figure 3.

![Cultural map of the Northwest Coast](image)

*Figure 3: Cultural map of the Northwest Coast; (Source: Woodcock 1977).*
Even so, there are a few generalized characteristics for all nations. Northwest Coast cultures are known to have developed high social complexity without agriculture unlike the pattern of social evolution worldwide. People lived in villages and towns of up to one thousand people (Ames 1994). Ethnographically, we know that Northwest Coast cultures were ranked including nobles, commoners and slaves; rank was ascribed and inherited (Ames 1994). High status was portrayed through wearing knobbed top hat which is found in the archaeological record dating to 3000 years B.P. (Kirk 1986; Croes 1992). Potlatches were also used to show status and provided a way to pass on ceremonial dances, songs and artifacts also representing high status (Kirk 1986). In addition, most cultures had slaves, who were prisoners of raids of other villages whose families did not pay or could not afford a ransom; the possession of slaves indicated great status, and the sacrifice of a slave at a ceremony was an act in which only the richest could indulge in (Kirk 1986; Drucker 1965).

Additionally, it was believed that all people belonged to one of several ancestral families, called minmint, in which certain fishing, hunting and plant collecting grounds were owned. These ancestral families were basically houses of extended clans; each house had its own head chief in charge of economic and ceremonial activities. Within each village, the house head chiefs were ranked to each other. Chiefs more closely related to the original family ancestors obtained higher rank. Several ways a chief may increase his status is through “effective exploitation of resources, clever trading, raids, shrewd marriage alliances and effective potlatch displays” (Kirk 1986:49). Economic trade and kinship may also link different villages together.

Even though these people developed a highly complex culture of ascribed social rank, they did not practice agriculture or complete sedentism. Cultures ranged between partial and full sedentism, relied on winter storage of food resources, and often had complex patterns of
residential mobility to take advantage of seasonal resources (Ames 1994, Kirk 1986:132). Models of social evolution of the Northwest coast involve the intensification of marine resources, specifically exploitation of the annual salmon run. The increase of salmon available or the ability of people to store salmon may have increased population causing an increase in sedentism. It is generally believed that the storage-based economy developed around 3500-3000 years B.P. (Ames 1994). Storage techniques, given the lack of consistency in sun or wind for drying, required smoking and commonly smoke houses. Rectangular plank houses appear in the archaeological record around 3000 years B.P. (Ames 1994). Large shell middens appear around 5000 years B.P.

Methods and Materials

In order to generalize about the Northwest coast, I describe several different sites from different geographical locations and cultural groups along the Northwest Coast. I provide evidence from the Duck Lake, Sunken Village, Conway, Hoko River, Ozette Village, Namu, and Cape Addington sites (Slocum and Matsen 1972; Pringle 2007; Bramlett 2007; Munsell 1976; Croes 1995; Croes 2005; Samuels 1991; Lazenby and McCormack 1985; Curtin 1984; Lepofsky, Moss and Lyons 2001, respectively). While the Northwest coast cultures are often considered one cultural identity, the coast which extends from southern Alaska to northern California is a very large region and there are cultural differences based on location and cultural group. These sites are primarily waterlogged sites which allow for the preservation of macro-artifacts like cordage and basketry with the exception of the Hoko River complex site. These artifacts can then be compared with culturally contiguous ethnographic groups in the region to determine artifact usage. The ethnographic records may give us new insights into the usage of these artifacts in the procurement of natural resources and the local subsistence. From these insights,
we can determine the relative use of marine and plant resources in the Northwest coast subsistence pattern. The investigation into the relative usage of plants in the subsistence base will also give evidence in the question of the evolution of complex cultures and societies in an area that did rely on full-scale agriculture. It is my hypothesis in this study that both the original historic accounts and the archaeological record have for the most part underrepresented the reliance on plant resources by prehistoric peoples. We have records that some groups did grow tobacco, and ethnographic records of using digging sticks for camas roots. I expect to find based on the artifacts that these traditionally “fishing” peoples additionally relied on plant resources to a greater degree than previously recognized.

**Excavation Methods and Floral Recovery**

Waterlogged sites, or wet sites, have been proven to be as effective as very dry sites at preserving material. Preservation has been possible due to the abundance of water and rainfall in the Northwest Coast. Most importantly, the “lack of oxygen in the water-saturated soils, the usual decay organisms, bacteria and more importantly fungi, are unable to operate” (Croes 1976). It is this unique situation that allows for the preservation of flora and fauna remains. As a distinct type of site, it requires specialized excavation technology and methods, see Figure 4. In response, hydraulic technology has been developed. Since all wet sites are located on or near a water source, many techniques involve the pumping of water to expose new surfaces. In one situation, water was pumped using garden hoses and pipes a quarter of a mile to the excavation site (Onat 1976). Another site required archaeologists to place water in oil cans and siphon water using pumps and hoses for a finer spray excavation (Hobler 1976). The Hoko River site was excavated using a pump on a boat with hoses used on the shore (Croes 1976).
Hydraulic technology is composed of both high pressure hoses and low pressure hoses, see Figure 5. The high pressure hoses are used to blast away the overburden to within inches of the cultural deposits. As in the case of the Ozette Village site, the overburden was a thick, six to ten feet deep, mudslide of clay, as determined through explorative coring (Samuels 1991). It was decided the clay was too heavy and too much sediment to move using conventional methods, and so the blasting method of hydraulic excavation was employed. Most sites employ water screening. Based on the presence of shovels and the fact that there are screens, which are appear to be fine sized screens (see Figure 6), I can determine that not all sediment was excavated using hoses. The soils from features were shoveled into fine mesh screens for water screening in situ. Even though water is used as the agent of excavation, units are still set up using a grid system; note, the unit strings seen in Figures 4 and 6. Additionally, waterlogged sites cannot be
excavated the same way as terrestrial sites because that would create a pool of water in the unit. Because of this, excavated units require drainage trenches to allow for water drainage in a prescribed one meter trench length and ten centimeters excavation levels (Croes, Fagan, and Zehendner 2007).

![Figure 5: Picture of using low pressure hoses to unearth delicate organic materials at the Ozette Village site, Washington (Source: Samuels 1991:20).](image)

While many water techniques have been created, refinement of these techniques is needed to ensure the recovery of sensitive material. Given the nature of hydraulic excavation, micro-floral remains are not recovered unless flotation samples and pollen are taken before using water techniques are employed or they are simply washed away. Additionally, many sites
contain dry portions, or are located sufficiently inland or away from aquifers, where terrestrial excavation methods can be employed (dry screening, excavation with trowels and shovels, etc.). However, the method of hydraulic excavation may have a local ecological impact. Since most waterlogged sites are located on or nearby water sources, the blasted overburden and excavated soils are washed into that water source. Future studies should take this possibility into account.

Archaeological Sites and Data

There are a number of sites that have recovered floral materials through water screening or flotation samples that provide information on the use of plants in the Northwest coast region. Presented here is the excavation methods employed and archaeological evidence recovered for each site discussed in this paper.
Scowlitz Site

The Scowlitz site, a wet site in Washington dating to around 3000 years B.P. (Lepofsky et al. 2000), is one case in which careful efforts were taken to recover the microdebitage, faunal and botanical remains. All floor deposit matrix was collected for flotation. Excavation lasted six seasons, and units were excavated in 2x2 meters. From each unit, a 50x50 cm subsquare was designated for flotation. Flotation samples were collected from other surfaces, and features. Initially, all excavated soil was screened. During the second and third seasons, only 25% of the excavated soil was screened due to the redundancy in artifact types. The last season, no soil was screened in order to facilitate a quicker excavation.

Several plant species were recovered at Scowlitz. Salal berries and red elderberries were the most common plant food resource recovered. A total of 144 red elderberry seeds were recovered with an 81% ubiquity. Salal (Gaultheria shallon) was the most abundant plant species recovered with a total of 212 seeds representing a 39% site ubiquity. Other wild berries (Rubus spp.) recovered include salmonberry, currants, hawthorns, and strawberries for a total count of 37 seeds, and a 48% ubiquity among the site (Lyons 1996). Additionally, traces of tuber starch, like the starch of wapatos and camas, were recovered in few numbers. However, as of yet, these starchy signatures cannot be distinguished to the family level (Lyons 1996; Lyons 2000). Thus, we can determine that tubers were used and processed in a site, but not the specific tuber.

Sunken Village Site

Dr. Dale R. Croes of South Puget Sound Community College in Washington led the excavation of the Sunken Village site in Oregon in 2007. The site, located on Sauvie Island, was named “Wappato Island” by Lewis and Clark in 1805 because of the great number of wapato beds (Croes, Fagan, and Zehendner 2007). In total, 60 shallow acorn pits were excavated. It’s
estimated that approximately 2.5 million acorns were processed each winter, if the pits were filled annually (Bramlett 2007). “You just don’t think of acorns as being a way of making a living here; [i]t’s poorly understood that plant foods are a major part of the economies” stated Dr. Croes (Pringle 2007).

There were a total of 735 hazelnut and acorn fragments recovered from the site, approximately 450 hazelnuts and 285 acorn fragments. The majority of acorns were found whole, indicating that they were being stored for later use (Croes, Fagan and Zehendner 2007). The area has several underground springs which pump through the pits removing the toxins in the acorns making them edible. In contrast, of the 450 recovered hazelnut remains only one was found whole while the rest were fragmented indicating that they were consumed once harvested instead of stored. Earlier auguring tests in 1987 recovered tuber remains which have not been identified, but are believed likely to be wapatos (Sagittaria latifolia) given the historical context of the site. Thus, wapatos are believed to be located on the site even though the 2007 excavation did not recover any remains. Flotation and water screening of five different acorn pits yielded a total of 913 NISP of Rubus spp. seeds (berries), 840 Barbarea spp. (garden yellowrocket) seeds (Croes, Fagan, and Zehendner 2007). One pit was radiocarbon dated between 1760 and 1880 A.D. as the last time of use. Therefore, it is likely that due to the natural moving aquifers, that these seeds may be non-cultural and may represent intrusive post-contact seeds. The overall site is suspected to have been occupied in the last 700 years.

Duck Lake Site

In Oregon, the Duck Lake wet site is located just half of a mile south of one of the Chinook Indian villages that Lewis and Clark visited along the coast. The site was excavated in
1967 using water screening but the report does not indicate what screen size was employed. It is believed to be a seasonal habitation site. In total, seven features were found, all identified as hearths, 1 metate (but no mano), 26 fragments of vegetal material consisting of 25 hazelnut shell fragments, and 1 instance of a charred wapato. The site was not radiocarbon dated and based on the Lewis and Clark journals, the site is estimated to have been occupied prior to the 1700’s but deserted by the 1830’s.

**Hoko River Archaeological Site Complex**

The Hoko River Archaeological site complex contained both a wet and a dry site component and was also excavated by Dr. Croes’ team. The wet and dry portion dates between 3000 and 1700 years B.P. (Croes 1995). Hydraulic excavation techniques were used by the waterfront and traditional terrestrial type excavation and coring was able to be done just inland of the wet-site units. Additionally, underwater excavation was performed to test the extent of underwater deposits, efficient strategies for underwater excavation in this locale and future excavations. While several perishable artifacts were recovered, there was no direct association with the artifacts on-shore and the procedure were costly, time consuming and had potential safety risks.

Pollen cores were taken from the wet site portion of the site complex. A total of 3,512 specimens representing five different species of cone trees were discovered: Sitka spruce (61%), western hemlock (32%), Douglas fir (5%), red alder (2%), and western red cedar (.1%). Modern distribution of trees is sitka spruce (81%), western hemlock (19%), indicating that the ecology of the region has not changed significantly in the past 3000 years. Additionally, berry seeds were present, but other floral remains like acorn shells, or tubers were absent from the wet-site
assemblages. The berry seeds recovered were often found in large concentrations, taken to represent coprolites. Of 50 examined seed samples, it was strongly suspected that 75% were coprolites, and only 25% appeared to have been deposited naturally. The coprolites were composed 30% of *Rubus* genus (including salmonberry and thimbleberry), 20% *Vaccinium* genus (huckleberries), and 20% *Prunus* genus (bittercherry). The non-coprolite samples were separated from the coprolites based on the fact that they contained not only different floral materials, but lacked the combination of the *Rubus* and *Vaccinium* genera. These samples contained elderberry in context with either *Rubus* or *Vaccinium*, It is possible that the elderberry was used with other wild berries as flavoring or as a bulk extender (Croes 1995).

The Hoko River site complex also contained a proto-historic and historic component rock shelter dating from 1000 to 100 years B.P. that was excavated following the natural slope, which reflected the stratigraphic layers (Croes 2005). Six pollen samples were tested to see if pollen analysis would be worthwhile, but the samples were too poorly preserved to be of use. Flotation of soil samples from the rock shelter however did yielded analytical floral remains. The dominant seed type recovered was red elderberry (encompassing 64% of the sample size), thimbleberry (20%), salmonberry (4%) and salal-huckleberry seeds (1%). The total number of seeds recovered was not reported, so I am not able to quantify the number of seeds per plant species for this site.

**Ozette Village Site**

The Ozette Village site was extremely well preserved due to a massive mudslide that coated the prehistoric village with 6-10 feet of clay. The site was augered to determine the dept and extent of cultural deposits. As using hydraulic excavation, the clay overburden was blasted
off within inches of the cultural deposits when lower pressure water hoses were then used. While the specifics regarding the method of excavation were not reported, based on the pictures, I was able to determine that they water screened their features *in situ* by shoveling the sediment into the screen and using water to wash the mud and clay through the screen (see Figure 5). Screen size was indeterminate, but only one screen was used, as often water screening employs two sets of screens to capture the larger and smaller artifacts or ecofacts. However, because over 400,000 seeds were recovered, some samples must have been taken from the water-saturated deposits for later flotation. While eight seed taxa were identified, 99.7% of these seeds belonged to only three taxa: salmonberry, red elderberry, and salal-huckleberry (Gill 1983). Roughly 21% of the assemblage are red elderberry (about 84,000 seeds), 24% were salmonberry (about 96,000 seeds), and 55% were Huckleberry (about 220,000 seeds). The site was radiocarbon dated to about 700 years Before Present.

**Namu Site**

The Namu site located in coastal British Columbia and was excavated in 1969/1970 by James Hester of the University of Colorado and again in 1977 by Roy Carlson of the Simon Fraser University. In total, 46 human burials were recovered (29 burials found by Hester, and 17 by Carlson’s team), the majority of which were flexed or semi-flexed and only four were extended burials and lying in a predominantly south-west direction (Curtin 1984; Cybulski et al. 1981; Chisholm and Nelson 1983). The burials date from three different time periods: the Early period (9,720-5,000 BP), the Middle Period (5,000-1,000 BP), and the Late Period (1,000-200 BP). These burials can be used for stable carbon isotope analysis to determine the relative amount of marine and terrestrial resources in the diets of the Namu people. This topic is discussed in-depth later in this paper.
Cape Addington

Cape Addington, a rock shelter in Alaska, is the northern most site report I obtained. It was excavated in 1997 by Madonna Moss and Jon Erlandson of the University of Oregon. Five 1 x 1 meter units were excavated, and all sediment was dry screened using ¼ inch mesh. Radiocarbon dates indicate the site was occupied between A.D. 50 to A.D. 1500, while one unit presented dates ranging from A.D. 600 to A.D. 1050 (Lepofsky, Moss and Lyons 2001). Additionally, five bulk samples were selected for flotation using .425mm screens. Recovered plant remains included kinnikinnick (*Arctostaphylos uva-ursi*) the leaves of which were smoked like tobacco and does contain narcotics, red elderberry (*Sambucus racemosa*), and salmonberry (*Rubus spectabilis*), all of which were used as food according to the ethnographic record. Even so, the authors write that they were not recovered in small quantities (although the actual numbers were not published), indicating that these plant resources were exploited only occasionally.

Other Sites

Other sites excavated are reported here because of the presence of digging sticks. English Camp Site in the San Juan Islands, Washington was occupied during the past 2,000 years and contained digging stick antler handles (Stein 2000). The Conway wet site, located in Washington, was excavated using hydraulic excavation techniques, but in some cases the soil was dry enough for terrestrial excavation methods. Floral materials recovered at the Conway wet site included hazelnuts husks, moss, wild cherry pits, ferns, blackberry seeds and huckleberry leaves, but no formal identifications have been made and therefore no quantitative counts have been published (Munsell 1976). Additionally, a digging stick handle was recovered
in secondary context from a midden. The site is dated between 595 and 745 radiocarbon years B.P., which was obtained from a basket specimen.

**Results and Discussion**

During the course of my research, I drew five general conclusions. Comparing the recovered archaeological remains with the ethnographic uses of the plants revealed the general plant utilization and subsistence pattern. A geographic distribution of ecological resources manifested itself. I was successful in creating a list of artifacts and features we would expect to see in the archaeological record as the result of plant resource utilization. Additionally, there is a chronological exploitation of marine-based resources relative to terrestrial resources. Lastly, nutritional studies of stable carbon isotope analysis showed that vitamin D toxicity may have played a role among marine-based subsistence patterns in influencing the supplemental use of plant resources in their diet.

**Archaeological Record vs. Ethnographic Record**

Despite the methods of excavating water saturated sites, we do have floral remains recovered from archaeological sites, summarized in Table 3. Table 3 presents the counts discussed earlier in the Archaeological Sites and Data section. Where counts were available, numbers are entered. However, some site reports did not quantify the remains recovered. In these cases, I use general statements of abundance to illustrate the presence of floral materials.
Table 3: Table of Floral Seeds/Remains Present in Sites (Counts of Seeds/fragments)

<table>
<thead>
<tr>
<th>Sites</th>
<th>Red Elderberry</th>
<th>Rubus spp.(berries)</th>
<th>Salal/Huckleberry</th>
<th>Nuts</th>
<th>Tubers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cape Addington*</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scowlitz</td>
<td>144</td>
<td>37</td>
<td>212</td>
<td></td>
<td>X?</td>
</tr>
<tr>
<td>Conway*</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Ozette**</td>
<td>84,000</td>
<td>96,000</td>
<td>220,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hoko River</td>
<td>X+</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sunken Village</td>
<td>913 (cultural?)</td>
<td></td>
<td>735</td>
<td>X?</td>
<td></td>
</tr>
<tr>
<td>Duck Lake</td>
<td></td>
<td></td>
<td></td>
<td>25</td>
<td>1</td>
</tr>
</tbody>
</table>


Note: “X” indicates the presence of remains; “+” indicates that large numbers of remains were recovered. X? indicates that the specimen is suspected present, but not formally identified.

Sites are arranged from north (Cape Addington) to south (Duck Lake). For detailed discussion of counts and recovery methods, see the discussion above on Archaeological Sites and Data.

*Quantitative numbers for seeds were not published in site reports
**Total seeds for these sites are estimates

The presence of red elderberry (*Sambucus racemosa*) in the archaeological record is an interesting find. This wild berry was considered unfit for consumption and the stems of the plant are easy to hollow out, and were used as children’s toys and made into whistles, blow guns and pipe stems (Turner and Bell 1971; Turner 1998). However, it is commonly found in the archaeological record in association with features. Other ethnographic records indicate that red elderberries were cooked to remove the toxins and then the seeds, stems and skins were removed before consumption (Lepofsky, Moss and Lyons 2001). Given that the seeds were removed during the processing of red elderberries, it is also possible these seeds are recovered in larger frequencies, not indicative of the indigenous exploitation pattern, compared to salmonberries or strawberries of which the seeds are ingested along with the fruit. Another complication is the fact that the toxins in the berries allow for uncharred elderberries to be preserved for at least 500 years (Losey et al. 2003).
Other wild berries lumped under the heading “Rubus spp.,” include salmonberries and salal. Many wild berries, like the salmonberries (Rubus spectabilis), were simply eaten fresh. Ethnography of the Vancouver Coast Salish revealed that these wild berries were considered too sweet to preserve well (Turner and Bell 1971). While other wild berries, like the leaves of the salal tree (Gaultheria shallon), were used for additional purposes. The fruit could be eaten fresh or was boiled, pounded into cakes and dried for winter storage and use, but the leaves were often used in drying food and in lining earth ovens discussed later in this paper (Turner and Bell 1971). Thimbleberry berries (Rubus parviflorus) were also eaten fresh, but the leaves of the plant were used to dry berries, wrap cooked elderberries for storage, line elderberry preserving baskets and some indigenous nations folded the leaves to make dishes for serving berries (Turner 1998).

The heading “Tubers” is an all encompassing category including camas (Camassia quamash) and wapatos (Sagittaria latifolia). This was done because charred tubers are often difficult to distinguish due to the destruction of the identifying shape, size and specific features of the root. Namely, camas (Camassia quamash), wapatos (Sagittaria latifolia), Yellow Avalanche Lily (Erythronium grandiflorum), Broad-Leaved Starflower (Trientalis latifolia), Mariposa Lily (Calochortus macrocarpus), and Spring Beauty (Claytonia lanceolata) are tubers that could be confused in the identification of tubers (Spurgeon 1996).

Acorns and hazelnuts were linked into the “Nuts” category because they both were similarly exploited. However, they have different processing techniques. Oregon white oak acorns (Quercus garryana) have tannins or tannic acid that would taste bitter and require processing for consumption. Tannic acid is commonly leached by boiling, steaming or roasting for hours (Turner and Bell 1971). However, other sources indicate that water could be used to slowly remove tannin. The storage pits at the Sunken Village site were used to leach the tannic
acid from the acorns. The pits were lined with wood branches and pine needles lining, see Figure 7. Also, 34 stakes were found located near or within the acorn pit features (Croes, Fagan and Zehendner 2007). It is likely that these stakes were markers for the pits for the return of the indigenous peoples. Slowly, over the course of the winter, the tannic acid would leach out of the acorns, making them less bitter and making them edible in large quantities without making people sick. Hazelnuts, on the other hand, do not have tannic acid, and so they could be eaten raw in massive quantities without the effects that acorns would have.

Figure 7: An acorn pit from the Sunken Village site with wood lining and acorns. The arrow points out the wooden stake and likely identified the pit’s location for the returning inhabitants. (Source: Croes, Fagan and Zehendner 2007:64).
Nuts like the Oregon white oak acorn (*Quercus garryana*) and hazelnuts (*Corylus cornuta*) were commonly exploited for their nutritional values and notably high concentrations of fat. In actuality, hazelnuts have higher contents of calories, protein and total fat than acorns, see Table 4 (USDA 2008a; USDA 2008b). Comparing nutritional values of raw hazelnuts to raw acorns per ounce, hazelnuts have 68 more calories, 2.5 grams more protein, and 10 grams more fat per ounce. The only value of which acorns have a higher content is carbohydrates. However, if we break down the nutritional value of nut per percent edible material, the wide gap between hazelnuts and acorns in nutritional value lessens, see Table 5. Hazelnuts still have greater values of calories, protein and total fat; however, the lessened gap makes the harvesting of acorns more economical.

<table>
<thead>
<tr>
<th>Table 4: Nutritional Values of Raw Hazelnuts and Raw Acorns</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>Calories (kcal)</td>
</tr>
<tr>
<td>Protein (g)</td>
</tr>
<tr>
<td>Total Fat (g)</td>
</tr>
<tr>
<td>Carbohydrate (g)</td>
</tr>
<tr>
<td>Refuse (Shells)</td>
</tr>
</tbody>
</table>

*Measurements are per 100 grams*

Bolded entries indicate greater nutritional value.
(Based on USDA 2008a; USDA 2008b).
Table 5: Nutritional Values by Edible Material

<table>
<thead>
<tr>
<th></th>
<th>Hazelnut Edible Weight</th>
<th>Acorn Edible Weight</th>
<th>Difference of edible material</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calories (kcal)</td>
<td>288.88</td>
<td>239.94</td>
<td>48.94</td>
</tr>
<tr>
<td>Protein (g)</td>
<td>6.877</td>
<td>3.813</td>
<td>3.064</td>
</tr>
<tr>
<td>Total Fat (g)</td>
<td>27.945</td>
<td>14.7932</td>
<td>13.1518</td>
</tr>
<tr>
<td>Carbohydrate (g)</td>
<td>7.682</td>
<td>25.265</td>
<td>17.583</td>
</tr>
</tbody>
</table>

*Measurements are per 100 grams*

Bolded entries indicate greater nutritional value.
(Based on USDA 2008a; USDA 2008b).

This difference in nutritional values may also help explain why the hazelnuts were eaten right away at the Sunken Village site, but the acorns were stored over winter. Hazelnuts had slightly higher values, yet acorns were a close second. The only drawback is that acorns needed to be leached of their tannic acid. Even so, they were cost effective to harvest in case of food scarcity and easy to process since they were stored in pits in which the aquifers removed the tannic acid slowly over the course of the winter.

Ecological Distribution of Plant Resources

Evidence shows that there is likely an ecological distribution of resources along the Northwest Coast. There is a general view that environmental productivity decreases the further north one goes (Croes 1995; Ames and Maschner 1999). Looking at Table 3, there appears a clear pattern between the types of plant material remains between the northern sites and the southern sites. Red elderberry, salmonberry and salal/huckleberry appear more frequently in the archaeological record in the more northern region of Alaska, British Columbia and parts of Washington State. On the other hand, tubers like camas/wapatos and nuts (acorns and hazelnuts) appear associated with the southern coast region including Oregon and the southern part of...
Washington, see Figure 8. The Sunken Village site did recover large quantities of wild berries (*Rubus spp.*), however, it is uncertain if the material was culturally deposited or resulted from the natural water movement in the site. While it is true that ecological distribution of resources clearly change depending on geographic location, the question is whether the differential resource exploitation seen in Table 3 a result of ecological change, cultural utilization, or excavation recovery.

![Figure 8: Map showing the approximate locations of the sites considered in this study. The dotted line reflects the apparent North-South subsistence pattern. (Source: Google Maps 2008, locations and labels added by author).](image)

There are several species of camas roots prevalent along the Northwest coast. Lewis and Clark’s expedition to the coast describe the exploitation of camas (Lewis 1966 [1814]). Their travels took them to the cultural groups ethnographically related to modern peoples located in
modern camas roots distributions along the Columbian River around Oregon and the southern part of Washington. At the Hoko River complex site located at the northwestern tip of the Washington peninsula, Croes (1995) argues that the floral material recovered from the dry components of the site reflect a climate too cold to support a diverse plant community the residents would have exploited. Comparing the Hoko River complex site with the more southerly Sunken Village site reveals wapatos, hazelnuts and acorns as expected of these “southern plant rich areas” (Croes 1992:363).

The current ecological distribution of camas roots in the Northwest Coast region would tend to support this idea as well. Overall, there are individual variations in the pollen record of exactly when each location established its modern vegetation. Some sites have modern plant resources as early as 7000 years ago, while others only as recent as 1,700 years ago (Whitlock 1992). The climate and ecology of the Northwest coast based on pollen analysis recovered from the Hoko River site complex has remained the same for the past 3,000 years (Croes 1995). Therefore, we can compare the modern ecological distribution of camas with the archaeological record seen in Table 3.
Modern large camas (*Camassia leichtlinii*) roots distribution is limited to Oregon State (University of Michigan – Dearborn 2003). However, small camas (*Camassia quamash*) roots are found from Oregon to British Columbia, see Figure 9. However, the blown up maps of Oregon and Washington in Figure 9 show that small camas roots may not be accessible directly along the coast, but are more likely to be found slightly interior but still in the area designated as the Northwest coast region. During his travels, Lewis noted how the camas roots were widely traded for; therefore even if the camas were not directly available, it is likely the cultural groups likely utilized this resource.
Likewise, red elderberry seeds (*Sambucus racemosa*) were only recovered from the Northern sites, from the Olympic peninsula in Washington and further north. However, the modern ecological distribution of red elderberry is nearly across the entire North American continent (see Figure 10), thus making it unlikely that certain culture groups did not have access to this resource. Turner and Bell (1971) wrote that the Coast Salish of Vancouver Island considered the red elderberry unfit to eat. However, the large number of elderberry seeds at sites would seem to indicate their use. Also, if cooked, red elderberries lose their toxicity (Losey et al. 2003). It is possible that the elderberries were intrusive due to natural processes instead of cultural, however the large numbers recovered would suggest otherwise. It is most likely that the differential distribution of elderberry seeds in the archaeological record is due to cultural selection or recovery methods of excavation techniques.
Figure 11: Modern distribution of Oregon white oak (*Quercus garryana*). Green represents the presence of Oregon white oak. (Source: USDA 2009c).

Table 3 also shows the lack of nuts, acorns (*Quercus garryana*) or hazelnuts (*Corylus cornuta*) from northern sites. The distribution of the Oregon white oak would not suggest a northern limitation, see Figure 11. However, ethnographic records state that acorns were a staple among the Oregon and California indigenous nations (Turner and Bell 1971). While the acorns have tannic acid that would need to be removed, nothing in the process of leaching would imply a northern limitation to its exploitation. Interestingly, the distribution of hazelnuts, see Figure 12, is located in several areas that acorns are absent; illustrating that at least one plant resource or the other should be available for exploitation along the Northwest coast. There should be no differential exploitation pattern seen in the recovered floral materials. Hazelnuts do not require processing to remove tannin.
Two sites do not seem to entirely fit this pattern of a north south differential exploitation. The Scowlitz site reported a finding tuber starches, but not an actual tuber remain. The Sunken Village site is the other site, which reported finding large quantities of red elderberry. However, these seeds were found in an acorn storage pit, and it is unclear if the seeds were purposely placed there, or if the flowing water of the aquifers brought the seeds inside the storage pit. If the seeds were in fact cultural, this would contradict the ethnographic evidence regarding the method of processing and storing of red elderberry. While, both of these resources are within their ecological range, both instances do not fit the pattern observed from the other Northwest coast sites.

Overall, there appears to be a north-south difference in the exploitation of plant resources, as seen in Table 3. This appears to be so even though those very resources are...
ecologically present along the zones where the northern sites are present. The one exception to this is the ecological distribution of camas (*Camassia quamash*). While camas are present along the Northwest coast, Figure 9 shows that there is an absence of camas in the Puget Sound/ Gulf of Georgia region where the Ozette Village, Hoko River, and Conway sites are located. However, we would still expect to find red elderberry seeds in the Sunken Village and Duck Lake sites and nuts in all of the northern sites as well.

*Expected Artifacts and Features*

After comparing the archaeological record with the ethnographic and historic records, it became apparent that there was a lack of certain plant materials from different sites. In compiling a list of artifacts and features indicative of plant resource exploitation, I attempted to show plant use in sites where there is a lack of recovered plant material.

The Conway site revealed an elaborately engraved antler; see Figure 13 (Munsell 1976). Antlers like this were used as digging stick handles in the ethnographic record. The antler handle was found in a shell midden, a secondary context so dating of the specimen is not likely. While the wood from the actual digging stick would preserve given the nature of water saturated sites, it is very difficult to distinguish fragments of woods from house stakes, digging sticks and fragments of non-cultural wood. Thus, digging stick handles provide an indication that the inhabitants harvested tubers for part of their subsistence. This find provides evidence for the existence of digging sticks for the exploitation of bulb plant resources along the Northwest Coast. Additionally, historic and ethnographic records, like the Lewis and Clark journals, detail how digging sticks were made and used.
Extensive ethnobotanical, ethnographic and experimental research has revealed the importance of camas roots in Northwest Coast subsistence (Thoms 1989; Peacock 1998). Camas bulbs are composed of complex starches and fructose that require cooking or other chemical alterations to allow for human digestion (Thoms 1989). Current ecological studies and pollen analysis reveals that camas bulbs are and were present in the ecological zones of the Northwest Coast since about 700,000 years ago (University of Michigan – Dearborn 2003; Barnosky 1985). Camas bulbs are more widespread in the Interior Plateau. Interior Salish peoples related to the Coast Salish culture utilized camas bulbs more extensively on the basis of the existence of earth ovens (Peacock 1998).

Interdisciplinary studies have revealed a list of characteristics of earth ovens that we can expect to see in the archaeological record. Earth ovens are typically rock lined pits 2-3 meters in diameter, although they can be smaller in size, are usually half a meter deep with a layer of charcoal from wood fuel and plant lining, and contain fire cracked rock, FCR, see Figure 14.
(Thoms 1989). The stratigraphy of one such pit looks like Figure 15. Generally, these features do not have any associated artifacts. This is probably due to the method of processing tubers which we see in the ethnographic record, see Figure 16. After the pit is excavated, or cleaned out for reuse from a previous earth oven pit, the bottom of the pit is lined with rocks and a fire built on top of this to heat the rocks until they are glowing red. Then a layer of grass lining is laid on top of the rocks and the tubers to be processed are laid on top of the lining. Next, a layer of grass or a mat is placed on top of the tubers which are then covered with dirt. A fire may be lighted on top of the earth oven, and water may also be added to seep down to the rocks to be used as a steaming element for the tubers which are left in the earth oven for 12 to 14 hours before removal (Peacock 1998; Moulton 2001). However, these pits are most likely located close to or at the site of resource collection (Thoms 1989; Peacock 1998).

Figure 14: Profile of a typical earth oven: shallow basin depression ranging from 1.5 to 4 meters long, 25 to 80 cm deep, rock layer (heating element), rim deposits consisting of charcoal and FCR. Layer 1 deposits also contain charcoal and FCR. Layer 2 deposits are carbon-stained, containing larger pieces of FCR and charcoal. Layer 3 is sterile (Source: Peacock 1998:198).
It is likely that excavators may not have realized exactly what they were excavating and therefore the true role plant resources play in the local subsistence was underplayed. The Duck Lake site in Oregon yielded a total of six simple hearths and one feature that Slocum and Matsen (1972) call a hearth but appears to be an earth oven for processing tubers. The hearth in square
E-20, level 3 was a pit with a diameter of 24 inches, a depth of 3.5 inches containing charcoal, incompletely burned fragments of brush and small sticks of wood. Surrounding the charcoal area was a grey ash layer which contained fire cracked rocks three to six inches in diameter. Based on the lack of permanent features like housing structures or storage pits, Slocum and Matsen (1972) deemed the Duck Lake site a seasonal habitation site. The one thing we know ethnographically about earth ovens is that they are more likely to appear in the archaeological record near the ecological zone in which the tubers the indigenous peoples are harvesting grow (Thoms 1989). In some cases, they will transport the unprocessed tubers back to camp, but only if the harvest is small or the permanent camp is nearby. These factors combined make an argument that this may be a misidentified earth oven for processing tubers like camas or the wapatos more common in the southern part of the Northwest Coast region. Additionally, earth ovens were used to process not only camas, but to cook the toxins out of red elderberries, and very likely to process other plants as well.

Part of the reason the role plant resources play in the local subsistence may be undervalued is because many of the tools are multi-use tools, or used for the processing of both plant and animal resources. Diet calculations by Suttles (1951) indicated that about ten to twenty percent of the diet of Northwest Coast Indians was based on plant resources. In the case of camas bulbs processing, many of the lithic artifacts may also have been used in faunal processing as well as other uses around camp. Certain artifacts, like abraders and slate knives are multi-use tools that impede the process of investigating the utilization of plant resources. At the Conway wet site in Washington, two bifacially ground stone slate tools were recovered with a worn and highly polished beveled edge (Munsell 1976). This polish may represent the repeated striking of plant materials by these knives to harvest them. Some ground stone tool artifacts recovered from
similar wet sites are shown in Figure 17. Without further chemical and microscopic analysis, the source of the sheen is unknown. At the Scowlitz site, excavators recovered what they termed plant processing tools and “multi-use expedient tools” like bifaces, ground slate knives and abraders (Lepofsky, et al. 2000:409). It is also possible that tools were used for both floral and faunal processing and that no one specific tool type was designated for plant processing. People use tools that get the job done.

![Figure 17: Arrows show ground slate knife fragments recovered from the Little Qualicum River Site. Knifes like these are multi-use tools (Source Simonsen 1976:74).](image)

Additional multiuse artifacts recovered in wet sites are baskets. Ethnographically, we know that baskets are and were used to store all kinds of processed and dried foods including fish, shellfish, berry cakes and camas cakes in sedentary winter villages (Croes 2003; Thoms 1989). Typically, dried tubers were stored in cattail bags (Tuner and Bell 1971). The Sunken Village site revealed an acorn basket, identified as such by Patricia Courtney Gold and Bud Lane, master basket weavers (Croes, Fagan and Zehendner 2007). However unless direct evidence of camas or other plant resources (which do not often preserve) are found in direct association archaeologists have no way of knowing what was stored in each basket. In this same vein, mortars and pestles were used to grind both processed floral and faunal resources to make
flour or cakes for winter storage (Thoms 1989). Even though they were used for the processing of both resources, the role that plants play in the local subsistence are often overshadowed by the importance of salmon and other marine resources in the subsistence base.

Storage of plant resources in cache pits have been used for both floral and faunal resources. Other archaeological sites have revealed that storage pits are often used as garbage pits, or middens, after removal of the stored food products. In agricultural societies, the shapes of pits as well as the remains of corn make the purpose of a pit readily apparent. The Sunken Village site yielded 60 excavated acorn pits and estimated 2.5 million acorns for the purpose of removing the tannic acid and making the acorns palatable (Croes, Fagan and Zehendner 2007). However, if the floral or faunal remains are not recovered, there is no real method to determine the use of a storage pit. For the same reason multi-expedient tool usage is unknown and what kinds of materials were stored in cache pits remains a mystery. It is possible that these pits contained processed and dried camas bulbs, or camas cakes but archaeologists have not yet found the evidence for this (Thoms 1989).

**Temporal Utilization of Plant Resources**

There also appears to be a temporal increase in the use and exploitation of plant resources for subsistence. One method of analyzing human diet is stable carbon-isotope (C13) testing. Over the course of one’s lifetime, bones accumulate carbon from plants either directly eaten or eaten by the animals that humans eat. Therefore, we can compare any skeleton with a baseline of carbon isotope that reflects an entirely marine or terrestrial based diet. Analysis of the carbon-isotope of human burials along coast sites in the British Columbia yielded an estimated 9-18% marine based diet for a human burial dated to 8250 B.P. (Chisholm and Nelson 1983).
contrast, burials dating from 5000 B.P. were found to have up to 90% marine based diet (Cybulski et al. 1981). This may reflect the bias reported earlier in this paper that Paleoindian sites are underwater so that the remaining excavated Paleoindian sites may have exploited more terrestrial resources. So, while groups may be of the same time period, there may be individual variations between these groups depending on the geographic location ultimately they will be comparable. Regardless of this possibility of individual variation, there is a clear increase increased reliance on marine resources around 5000 B.P.

Regarding the Hoko River Complex dry/wet site, Croes (1992) suggests that the lack of floral materials recovered from wet sites accurately reflect the late formative period storage economy of the area. Meaning, the lack of materials is based on the beginnings of storing resources for winter storage to provide protection from famine. As the Northwest coast cultures increased in complexity and became more sedentary starting around 5000 B.P., we see the emergence of storage pits. Peoples were processing plant resources for storage instead of relying on mostly wild berries that could be eaten fresh and immediately.

Nutritional Studies

Vitamin D is an important dietary contribution nutritionally because sufficient intake of vitamin D helps prevent rickets, bone loss, multiple sclerosis, and cancer (Lawn and Harvey 2007; Heaney et al. 2003). On the other hand, vitamin D toxicity causes the buildup of bone or calcium and phosphate in the kidneys and soft tissues of the body, and possibly death (National Institutes of Health 2009). The most common source of vitamin D is in fish like salmon, tuna and mackerel and can also be found in ringed seal flesh, lake trout, caribou kidney and livers, wild duck, oysters, whitefish and burbot all sources common food sources along the Northwest
Coast (National Institutes of Health 2009; Lawn and Harvey 2007). Sunlight is generally considered to supply sufficient vitamin D to prevent disease, but sunlight is limited above 40 degrees latitude for three to four months and nine months for those above the Arctic Circle, see Figure 18 (Lawn and Harvey 2007). Comparing the efficiency of vitamin D synthesis between the elderly (77-82 year olds) and youths aged 8-18 revealed that the elderly are at most half as efficient in synthesizing vitamin D only from sunlight as youths (MacLaughlin and Holick 1985). Additionally, the amount of skin covered with clothing, particularly during the cold season, would decrease the amount of vitamin D synthesis. Hypervitaminosis, or vitamin D toxicity, is common in modern populations usually in the case of the overuse of supplements (National Institutes of Health 2009). Lastly, hypervitaminosis would result from daily over intake of excess vitamin D over the course of a person’s lifetime. Studies of excess vitamin D intake showed that daily excess of vitamin D for twenty weeks yielded no long term adverse effects (Heaney et al. 2003). Instead, excess vitamin D is stored for times of limited intake.

Figure 18: World map showing the 40° latitude of limited vitamin D synthesis due to insufficient sunlight during the winter months of the year (Source: Wikipedia 2009, labels added by author).
Based on current research on levels of vitamin D toxicity, I attempted to calculate the level of daily vitamin D intake to produce toxicity. The current Food and Drug Administration (FDA) tolerable upper intake level (UL) for adults and children over one year old is set at 2,000 International Units, or IU’s, for infants less than one year old at 1,000 IU’s (MayoClinic.com). Heaney et al. (2003) reported that for twenty weeks, healthy men were given daily intakes of 0, 1000, 5000 and 10,000 International Units (IU’s) of vitamin D with no side-effects. Current efforts are attempting to raise the FDA UL for vitamin D from 2,000 to 10,000 for adults (Council for Responsible Nutrition 2007). Nutritional studies measured the amount of vitamin D intake among Inuit women in Ontario, Canada to be 25.4 µg/day or 1016 IU’s per day based on traditional “country” foods like seal flesh and fish that their Northwest Coast counterparts would also have eaten (Lawn and Harvey 2007:8). As one can see, the reported vitamin D intake is far below the current and expected real vitamin D toxicity level. This study also reported that these women had below adequate intake levels (AI’s) of vitamin D.

A study on malnutrition on the Northwest Coast by Lazenby and McCormack (1985) attempted to investigate the role of salmon on the vitamin D toxicity level of the people at Namu, British Columbia. They calculated that the average adult ate 1.5 to 3kg of salmon per day and the average child half of that, so .75 to 1.5kg per day especially during the peak salmon harvesting season. Based on Dam and Sondergaard’s (1964) suggested minimum toxic dose of 45µg per day, or 1800 IU’s per day, for children, the average child was consuming 6600 IU’s of vitamin D from salmon alone. Meaning, children easily could have suffered from vitamin D toxicity based on this model of subsistence. Additionally, salmon exploitation (procuring, processing, and storing) takes place over a few weeks. While it is possible that this intensive exploitation would yield enough salmon for the entire year, indigenous peoples were also eating
other food sources of vitamin D, like seal flesh, and so it is unlikely that this excess of vitamin D would come solely from salmon exploitation. Further factors that influence vitamin D absorption are the amount of skin available to synthesis vitamin D from sunlight, and the amount of calcium also eaten and absorbed. These factors are difficult to quantify and further research needs to be done in order to create a more precise picture of the effects of diet on the level of vitamin D intake. However, it is likely that the subsistence model proposed by Lazenby and McCormack (1985) would yield a toxic level of vitamin D for children and infants.

Carbon stable isotope bone analysis of the coast burials is another method to determine the relative marine or terrestrial diet. Stable carbon isotope tests indicate what percentage of the individual’s diet was based on marine ($\delta^{13}C = -13\%$) or terrestrial ($\delta^{13}C = -20\%$) food resources, although a more strict measure of -12 and -22 for purely marine or terrestrial diets would be better suited (Chisholm, Nelson and Schwarcz 1983). Based on analysis of the carbon stable isotopes in human bones, Richard A. Lazenby and Peter McCormack (1985) calculated that adults consumed more marine resources ($\delta^{13}C = -12.93$, thus $100\% \pm 10\%$) than children did ($\delta^{13}C = -14.46$, thus $79\% \pm 10\%$). This figure for adults is within the range calculated for burials along the coast in British Columbia. A sample of 48 human burials was stable carbon-isotope analyzed for relative marine or terrestrial based subsistence information (Chisholm, Nelson and Schwarcz 1983). The average stable carbon isotope percentage for the sample was $\delta^{13}C = -13.5\pm0.99$ permil. Overall, there appears to be a large reliance on marine resources for their subsistence.

If children consumed the same amount of marine resources, there would be a higher frequency of children’s death due to hypervitaminosis, or the consumption of toxic levels of vitamin D. Such toxic levels would be represented by several pathologies including decreased
bone density and the buildup of calcium deposits in the soft tissue (Riede and Werner 2004). As of yet, the archaeological record has not revealed such a pattern of skeletal pathologies. It is possible that indigenous groups had a greater tolerance for vitamin D toxicity, the diet did not contain toxic levels of vitamin D, or the tribes utilized a greater number of terrestrial resources than previous research has led us to believe. One other theory concerning the lack of toxicity and the discrepancies in child and adult bone carbon-isotope analysis is that gathering plant resources is gendered (female) work and children who would tag along with their mothers, would naturally eat more terrestrial based diet by matter of happenstance. It is also possible that the toxicity of vitamin D is exaggerated, without more precise measurements concerning sunlight synthesis and the effects of calcium, the results are not precisely quantifiable.

Conclusions

Currently, the role plant resources play in indigenous societies’ subsistence is poorly understood. Waterlogged conditions have allowed for the unique preservation of organic material, but hydraulic excavation techniques may have bias the recovery of micro-floral material. Water screening and flotation has recovered seed assemblages we can compare with the ethnographic record for a fuller picture of subsistence along the Northwest coast. Overall, historic and ethnographic records show the importance of plant resources in the proto-historic and likely recent prehistory.

This thesis in part looked at the preserved organic material, artifacts and features to determine the use of plant resources. However, many of the artifacts expected to be used in plant resource processing are multi-use tools, and their appearance in the archaeological record is ambiguous to their use. Likewise, ethnographic, ethnobotanical and experimental research has
revealed characteristics of archaeological features. While these features are prevalent in the coastal interior, they are absent from coastal site reports even though these sites are basically in the same ecological zone. It is possible that earth ovens used to process camas bulbs are being mistaken as possible hearth features. Excavators should keep these earth oven characteristics in mind so that future excavations are more likely to keep the floral subsistence in mind.

Additionally, it appears the archaeological record reveals a geographic limitation of plant resource exploitation, specifically camas bulbs and red elderberry. While the overall diversity of plant species is limited by ecological zones, the spread of both of these plants is widespread along the Northwest coast and therefore the archaeological record should not have such a pattern. Even if the specific resource was not available, historic records reveal that these cultures often traded for camas bulbs. Regardless of if the individual clan was harvesting these resources they were available for consumption through trade. The fact that these species are widespread yet not exploited according to the archaeological record indicates that either the cultural groups were purposefully choosing to not exploit certain resources or there are recovery issues with the excavation recovery methods.

There is also evidence that the predominance of plant utilization is limited by temporal exploitation with the Paleoindian period showing a greater reliance on terrestrial resources including plants and animals and decreasing in importance around 5000 B.P. coinciding with the salmon intensification. This intensification has been thought of as the reason the Northwest Coastal societies developed complex culture and more sedentary villages. In this context, the reliance of plant resources in the subsistence is seen as a protection against years of poor fish harvests. Hundreds of storage pits with millions of acorns shows that plant resources were
utilized. Given all these factors, it is likely that indigenous people relied more on plant resources than original historic and ethnographic records indicate.

Stable carbon analysis of human burials indicates that the diet was primarily marine-based, but there appears to be no evidence that indigenous people suffered from malnutrition of hypervitaminosis. Children are more susceptible to hypervitaminosis or vitamin D toxicity. In the Namu burials, there appears to be an age-specific diet where the cultures may have realized that they were getting sick and adapted their diet to include more terrestrial resources to counteract the vitamin D toxicity from eating a primarily marine-based diet.

To some extent, indigenous populations’ reliance on and processing of local plant resources has been obscured by historic records and an oversight of the importance of plant resources. These have helped create this myth that Pacific Northwest cultures had no need to manipulate their local environment for additional food resources. While archaeological remains are recovered, they are still rare. Combined with the lack of archaeological artifacts and features identified with plant processing, specifically earth ovens, have helped to perpetuate the myth that indigenous peoples did not rely on plant resources. Education in this area as well as additional study of flotation and floral/pollen analysis of sites would be beneficial in completing the picture of subsistence. The technology of excavating waterlogged sites needs to be standardized. The need for water screening and flotation means that floral remains are often rare in archaeological sites, but does not dictate that these remains are not preserved. Continued removal and study of such samples will reveal useful information for future excavations.
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