

CETACEAN HUNTING AT THE PAR-TEE SITE (35CLT20)?: ETHNOGRAPHIC,  
ARTIFACT AND BLOOD RESIDUE ANALYSIS INVESTIGATION

Senior Honors Thesis

By

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## **Project Summary**

The Confederated Tribes of Grand Ronde Community of Oregon (CTGR), Land and Culture Department, Tribal Historic Preservation Office is creating an ethnographic and ethno-historical database to quantify ethnographic data related to the Northern Oregon Coast. Specifically, the area of interest was the historic land and sea base of two distinct yet, intimate communities, the Salish speaking Tillamook and the Chinookan speaking Clatsop, who lived near the mouth of the Columbia River. As an intern in the Tribal Historic Preservation Office of the CTGR I helped complete these tasks of analyzing and organizing the previously created ethnographic database. The purpose of the database is to provide statistical figures in the interpretation of oral histories and pursue the validation or negation of the ethnographic data using archaeological investigations. This ethnographic data was recorded in Geographic Information Systems (GIS) software to provide a geographic representation of the material.

Due to the high prevalence of ethnographic information related to whales and porpoises (cetaceans), and a need for CTGR to verify this ethnographic information, I focused on an archaeological site situated within present day Seaside, Oregon. The Par-Tee site (35CLT20), a complex archaeological site contains evidence of whale hunting. I investigated whether active or opportunistic cetacean hunting occurred at the site location by Tillamook and/or Clatsop peoples during prehistoric times. In addition, I sought to identify the harpoon technology which may have been used to hunt large sea mammals via blood residue analysis. Future, radiocarbon dating is also planned on the material remains of the whale hunting event, specifically a humpback whale phalange with an embedded elk bone harpoon point, to determine the antiquity of whale hunting within the region. All material remains examined in this report originated from within

the Par-Tee site, collections which are now housed at the Smithsonian Institution's National Museum of Natural History.

## **Introduction**

In this project I explore the importance of whales and other cetaceans to prehistoric peoples who inhabited the Northern Oregon Coast, from the mouth of the Salmon River northward to the mouth of the Columbia River. This area is thought to be associated with both the Tillamook and Clatsop tribes. Site 35CLT20, also known as the Par-Tee site, is located near the territorial interface of the tribes at the southern extent of Seaside, Oregon. The site is culturally associated with the Tillamook, as determined by the National Museum of Natural History (NMNH), Smithsonian Institution. The cultural connection was established during a repatriation claim by the CTGR (Arbolino et al. 2005). The site was originally excavated by amateur archaeologists George Phebus and Robert Drucker during the late 1960's and 1970's. Phebus and Drucker (1979) attributed the site to a prehistoric maritime culture. Maritime cultures are considered to have acquired a large portion of their caloric or protein intake from marine resources. Historically in the Pacific Northwest only communities located further north than Oregon in Washington (Makah, Quinault, and Chehalis) and Vancouver Island, British Columbia (Nuu-chah-nulth and Ditidaht) have been recognized by anthropologists as whaling cultures (Losey and Yang 2007; Underhill 1978). However, ethnographic and ethno-historical data document the practice of whale hunting and scavenging occurring along the Oregon Coast. For example, a historical reference of whale hunting by the Siuslaw (located south of the project area) states,

*“It took about a year to make one of those graceful, powerful war canoes, a craft in which they journeyed 75 to 100 miles into the ocean on whaling expeditions, catching whales weighing 60 to 80 tons. In towing these heavy loads they formed the canoes into a long chain for added power” (Knowles 1965:9).*

Such historical accounts provide anthropologists the opportunity to speculate that whaling could have occurred along the Oregon Coast during prehistoric times.

Recently, Robert Losey and Dongya Yang (2007) demonstrated that opportunistic whale hunting was conducted by the inhabitants of the Par-Tee site. Losey and Yang found evidence of a broken elk bone harpoon point imbedded within a humpback whale (*Megaptera novaeangliae*) phalange. DNA analysis conducted on the bone harpoon point demonstrated that the elk DNA matched the unmodified elk bone within the collection, suggesting that the tool was made and used locally (Losey and Yang 2007:669). However, Losey and Yang did not address ethnographic and ethno-historical data relevant to whale hunting among the Tillamook and Clatsop tribes, data which suggest whaling may have occurred historically in the region. In addition, no supportive evidence was provided for the hunting technology that would have been used to take these large sea mammals.

I expand upon the research initiated by Losey and Yang (2007) by analyzing ethnographic and ethno-historical data pertaining to whales, whale hunting, and whale scavenging among the Tillamook and Clatsop Tribes. In addition, I explored the potential for whale hunting technology among the prehistoric peoples of the region via comparative artifact analysis and blood residue analysis. Comparative analysis of harpoons from the Par-Tee site was conducted at the Smithsonian Institution’s National Museum of Natural History during June 2013. Using computed tomography (CT) scans of the humpback whale phalange (NMNH

Number: A556355-0), I determined the dimensions of the imbedded point. After arranging for a loan of a sample of the Par-Tee harpoon points to the University of Oregon Museum of Natural and Cultural History (MNCH), I worked with Dr. John Fagan at Archaeological Investigations Northwest Inc. (AINW) to conduct blood residue analysis on twelve harpoon points in an attempt to determine the species hunted with them.

### **Maritime Adaptions on the Northwest Coast**

The Oregon Coast comprises a portion of the kelp forests which run from Japan to South America. Research has demonstrated that the peopling of the Americas likely occurred along this rich resource belt often termed the kelp highway (Erlandson et al. 2007). This suggests that maritime cultures within Oregon may have significant time depth. However, current understanding of ancient coastal sites beyond 4000 years is limited in Oregon, due to sea level rise, tectonic forces, tsunamis, and erosion (Erlandson et al. 1998).

The Oregon Coast is part of the Pacific Northwest Coast Culture Area which encompasses the area from Cape Mendocino in Northern California to Yakutat Bay in Alaska (Aikens, Connolly, and Jenkins 2011:211; Lightfoot 1993:167). Differences exist between the Northern and Southern Northwest Coastal regions. In Alaska and segments of British Columbia the bordering mountains are steep and high generally lacking coastal plains but containing, numerous offshore islands and protected marine waters. This results in coastal areas much more easily accessible than terrestrial areas to coastal peoples. In contrast, California, Oregon, and Washington contain much larger areas of unprotected high energy coastlines with less imposing coastal mountains and coastal plains, making terrestrial species more available (Aikens,

Connolly, and Jenkins 2011:212–213; Drucker 1955:5; Moss and Erlandson 1995:6–8). Thus, in studying subsistence practices within different coastal areas, anthropologists expect to find a higher emphasis on marine species where terrestrial species are more limited.

Anthropologists differ in their interpretations of maritime culture or maritime adaptations and the prerequisites in defining these cultural patterns. It is implied that maritime groups lived near and attained a significant portion of their subsistence from the sea, possessed seaworthy watercraft, potentially hunted large sea mammals, and obtained some foods from resources beyond the littoral zone (Workman and McCartney 1998:361–362). Often, extensive sea mammal hunting, deep sea fishing, semi-sedentary villages (containing semi-subterranean houses), and the accumulation of large shell middens have been considered hallmarks of maritime cultures (Lightfoot 1993:175; Workman and McCartney 1998:364). These cultures often termed “complex hunters gatherers” live relatively sedentary lives, based on large-scale food processing and storage, the presence of large houses, complex technologies, higher populations, the ability to affect their surrounding environment, the accumulation of large shell middens, and developed social complexity (occupation specialization and social stratification) (Ames 1999:25–28; Aikens, Connolly, and Jenkins 2011:212–217; Butler and Campbell 2004:328; Lightfoot 1993:178; Erlandson et al. 1998:9). The features outlined above are witnessed within the Northwest Coast and the project area.

Shellfish use in the form of well-developed middens becomes apparent in the Northwest Coast around 5000 B.P. (Lightfoot 1993:173; Workman and McCartney 1998:364). The oldest known fish trap, associated with mass storage of fish, on the Southern Northwest Coast is dated to ca. 2400 B.P. (Erlandson et al. 1998:15; Tveskov and Erlandson 2003). The specialized sea mammal hunting technology (i.e. the composite “toggle” harpoon) is present on the Northern

Northwest Coast by 3000 B.P., with barbed bone dart points present between 6000 B.P. and 5000 B.P.(Workman and McCartney 1998:365). The oldest large rectangular structure on the Northern Oregon Coast (Palmrose site 35CLT47) has been dated to 2600 B.P. and 1700 B.P. (Phebus and Drucker 1979:9; Connolly 1992; Aikens, Connolly, and Jenkins 2011:247). It is not until the Late Holocene (~3500 years ago) that a vast majority of archaeological sites (94%) along the Southern Northwest Coast exhibit the prerequisites for complex hunters, gatherers, and fishers with maritime adaptations (Erlandson et al. 1998:9–10; Moss and Erlandson 1995:14). The dearth of old sites along the Oregon Coast makes it difficult to understand the deeper history of the evolution of maritime cultures in the area.

### **Geomorphology of the Oregon Coast and of the Seaside Area**

Early sites (Before 4000 B.P.) are rare along the Oregon Coast. This is due to geologic factors such as erosion, landslides, tsunamis, and tectonics forces of the Cascadia Subduction Zone (Erlandson et al. 1998). Together the natural phenomenon have affected site preservation and visibility (Minor and Grant 1996; Lightfoot 1993:174). Changes in sea level and coastal geomorphology are believed to have affected prehistoric settlement within the last 3000-4000 years B.P. (Connolly 1992:47; Butler and Campbell 2004:335). Due to the rarity of ancient sites, understanding prehistoric resources, and their use, within coastal regions is often limited to later sites (Erlandson et al. 1998; Moss and Losey 2003).

The city of Seaside, Oregon is located at the southern extent of the Clatsop Plains. The plains are comprised of sand dunes, beach ridges, and other sediment accumulations from the Columbia River and Tillamook Head. The coastal plains represent the sedimentation of an

ancient estuary once present within the Seaside region (Connolly 1995). The sedimentation reportedly began 3,500 years ago, with 400 year old dunes making up the primary dunes in Seaside, west of the Necanium River (Connolly 1992; 1995). (Figure 1).

Shellfish remains from the Par-Tee, Palmrose, and Avenue Q sites in Seaside provide evidence that a quiet-water estuary once existed within the area (Phebus and Drucker 1979; Connolly 1992; 1995). In addition, evidence of tectonic subsidence events have been documented within the project area based upon abruptly buried peat deposits dated between 2000 and 450 B.P. (Connolly 1992; 1995). The last large earthquake and tsunami event along the Oregon Coast is believed to have occurred in AD 1700.



## **Ethnographic Background**

The Tillamook and Clatsop peoples inhabited a large geographic area beginning near the mouth of the Columbia River (Clatsop) and continuing south to the Siletz River (Tillamook) (Verne 1975:123; Jacobs and Seaburg 2003:2; Aikens, Connolly, and Jenkins 2011:216). During the historical era the interface of these two tribes was located near the present location of Seaside, Oregon (Lewis et al. 1904:vol. 3; Jacobs and Seaburg 2003:2). It is unknown if this boundary extends back to pre-contact times or if this was a recent phenomenon due to population loss and displacement. However, the Clatsop and Tillamook people shared a close cultural connection and members of both groups often intermarried (Jacobs and Seaburg 2003:4; Arbolino et al. 2005:6). During the historical period Clatsop tribal members also adopted the Tillamook language (Boas 1894; Jacobs and Seaburg 2003:4; Arbolino et al. 2005:6). Today members of the Tillamook and Clatsop are represented at the CTGR, the Confederated Tribes of Siletz Indians of Oregon, within the federally unrecognized Clatsop-Nehalem Confederated Tribes, the federally unrecognized Chinook Nation, and other tribal communities.

Due to evidence that the Tillamook and Clatsop have shared a common territory, a certain amount of cultural overlap occurred. Because ethnographic research suggests that cetacean hunting may have occurred within both groups, I will approach the ethnographic information of these populations together.

### ***Tillamook***

The word Tillamook is a Chinook word for the people meaning “Those of Nehalem” (Boas 1965:3; Crawford 1983:4; Edell 1939:2). The Tillamook represent the most southern group of the coastal Salish (Boas 1898:23) and were divided into two main groups: the Nehalem of the

north and the Siletz in the south (Edel 1939:2). The Tillamook language was spoken along the Northern Oregon Coast and along all coastal rivers south to Siletz (Edel 1939:2; Jacobs and Seaburg 2003:2).

It has been noted that dialect variations existed within the Tillamook language, including Nehalem, Tillamook, Nestucca, Salmon River, and Siletz (Crawford 1983:4). Concerning the Tillamooks, Melville Jacob's stated that, "All one has a right to say is that river villages, speaking a number of Tillamook-Siletz provincialisms, occupied or possessed this territory. They were neither one tribe, nor two tribes, nor many tribes" (Jacobs and Seaburg 2003:2). In AD 1805 Lewis and Clark noted the similarities of the Tillamook (Kil-a-mox) and Clatsop, "The Kil-a-mox in their habits and customs, manner dress and language differ but little from the Clatsops, Chinooks and others in the neighborhood" (Lewis et al. 1904:vol. 3:326).

Linguistic data suggest that the Tillamook migrated southward from the Strait of Georgia or Puget Sound region. Although no dates have been provided for the time of the potential migration, the northern region exhibits Salishan-Marpole phase sites, similar to the Palmrose site in the Seaside area, suggesting a migration 2400 RYBP and 1500-1000 RYBP (Moss 2011:98). Tribes from the northern region (Strait of Georgia and Puget Sound) conducted whale hunting to some extent, perhaps the ancient link to whaling witnessed in Oregon is tied to a migration from the northern region. However, further research is needed to confirm the connection. In addition, linguists have concluded that Tillamook and Chinook languages had converged grammatically demonstrating the close relationship of these two distinct people (Arbolino et al. 2005:8-9).

### *Clatsop*

The Clatsop are Penutian speakers of the Chinookan tribe living from the south bank of the Columbia River, along the Clatsop Plains and inland (Verne 1975). The Chinook and Clatsop were renowned traders and fisherman who demonstrated superb canoe handling and navigation (Lewis et al. 1904:vol. 3 part. 2; Verne 1975). The Chinook facilitated trade north and south along the coast and the interior (Drucker 1955:12; Braun 1999:30). Items traded included whale meat, blubber and oil obtained through trade with the Makah, Nuu-chah-nulth and Quinault (Braun 1999: 32). However, according to ethnographic and ethno-historical sources these resources were also acquired locally (Lewis et al. 1904:vol. 3: 324-325; Ray 1938:114; Duer 2005: 117). During the historical era the Clatsop adopted a variety of languages such as Tillamook and Chehalis (Boas 1894).

The Clatsop have inhabited the Clatsop Plains for many generations. This is supported by tribal oral history including, a creation story related to the formation of the Clatsop Plains which began around 3,500 years ago (Evans and Hatch 1999: 13) . The indigenous knowledge of the geomorphology of the region could provide a time marker for habitation as many native oral histories are based on aboriginal knowledge.

### **Archaeological Investigations Based on Ethnographic Information**

Anthropologists differ on the validity of oral histories and their use within archaeological research. The issue is confounded when ethnographic information is applied to ancient sites. Prior research investigating ethnographic and ethno-historical data have had varied results. For example, intensive salmon fishing is often linked to the growth of social complexity and sedentism within the region (Workman and McCartney 1998:367). It has been noted that estimates of salmon consumption within Northwest sites have been inflated with smaller fish

often underrepresented (Tveskov and Erlandson 2003; Butler and Campbell 2004:330). Tveskov and Erlandson (2003) demonstrated the archaeology of tidal fish weirs supported native oral histories related to the technology, with weirs dating to 2000-3000 years ago. Tidal fish weirs were used during salmon runs but were also part of the day to day life of indigenous peoples catching a variety of fish species.

Other research, based on indigenous knowledge and western science, has shed light on geologic forces and the effects that earthquakes and other natural disasters have had on native populations. The Cascadia Subduction Zone is familiar to geologists and anthropologists within the region. McMillan and Hutchinson (2002) demonstrated that Northwest indigenous knowledge related to earthquakes, landslides, and tsunamis had validity when viewed alongside current geologic data. Indigenous knowledge related to geologic events often involved mythological figures that created earthquakes and tsunamis. Although not all events within oral traditions were datable, recent accounts of a Cascadia subduction earthquake and tsunami in AD 1700 were recounted by many indigenous communities demonstrating the accuracy of traditional oral histories during the last hundred years.

Therefore, research based upon oral traditions, previously conducted within the region has demonstrated that native oral histories can provide valuable insights into geologic and archaeological investigations.

### **Quantifying Ethnographic Data**

An ethnographic and ethno-historical data set was established by the CTGR Tribal Historic Preservation Office, Land and Culture Department. This data set provides the

foundation for the ethnographic section of this project. Sources utilized represent Tillamook and Clatsop ethnographic sources summarized in Appendix 1.

Entries were input according to the reference's description of faunal resources, with data recorded for the variables type, common name, Latin names, date, season, month, use, source and page number (Figure 2).

Figure 2. Example of Ethnographic Database. Courtesy of The Confederated Tribes of Grand Ronde, Land and Culture Department.

Record	Type	Name_Common	Name_Latin	Date	Season	Month	Myth_times	Historic_times	Modern_times	Hunting_Fishing	Gathering
FAU-0996	Mammals	Whale					y			y	
FAU-1104	Mammals	Whale						y		y	
FAU-1085	Mammals	Whale						y		y	
FAU-1114	Mammals	Whale						y		y	
FAU-1275	Mammals	Whale						y		y	
FAU-1282	Mammals	Whale							y	y	
FAU-1081	Mammals	Whale					y			y	
FAU-0951	Mammals	Whale						y		y	
FAU-0956	Mammals	Whale					y			y	
FAU-0876	Mammals	Whale					y			y	
FAU-0878	Mammals	Whale					y			y	
FAU-0880	Mammals	Whale					y			y	
FAU-0881	Mammals	Whale					y			y	
FAU-0883	Mammals	Whale					y			y	
FAU-0894	Mammals	Whale					y			y	
FAU-0981	Mammals	Whale					y			y	
FAU-1040	Mammals	Whale					y			y	
FAU-1021	Mammals	Whale					y			y	
FAU-0310	Mammals	Whale						y		y	
FAU-0346	Mammals	Whale					y			y	
FAU-0440	Mammals	Whale					y			y	
Record	Type	Name_Common	Name_Latin	Date	Season	Month	Myth_times	Historic_times	Modern_times	Hunting_Fishing	Gathering
FAU-0546	Mammals	Whale						y		y	
FAU-0552	Mammals	Whale					y			y	
FAU-0553	Mammals	Whale					y			y	
FAU-0584	Mammals	Whale					y			y	
FAU-0606	Mammals	Whale					y			y	
FAU-0627	Mammals	Whale					y			y	
FAU-0629	Mammals	Whale					y			y	
FAU-0632	Mammals	Whale					y			y	
FAU-0768	Mammals	Whale					y			y	
FAU-0770	Mammals	Whale					y			y	
FAU-0772	Mammals	Whale					y			y	
FAU-0815	Mammals	Whale					y			y	
FAU-0832	Mammals	Whale					y			y	
FAU-0837	Mammals	Whale					y			y	
FAU-0838	Mammals	Whale						y		y	
FAU-0865	Mammals	Whale					y			y	
FAU-0871	Mammals	Whale						y		y	
FAU-0874	Mammals	Whale					y			y	
FAU-0798	Mammals	Whale					y			y	
FAU-0580	Mammals	Whale					y			y	
FAU-0525	Mammals	Whale						y		y	



**Use 1**

South Wind finds a whale on the beach near Bay City, but since he had no knife he didn't know what to do about it.

At Cannon Beach in 1853 Warren Vaughan saw a "captured" whale being cut up, pieces of blubber and meat were cooked in full-sized canoes by adding water and fire-heated rocks---the fat was skimmed off with bones, used for the burial ritual bows, secured in the tops of young trees by the two men in the early 1930s who unearthed then reburied canoe burials at Dicks Point after the Hobsonville Mill incident

Smith claims that earlier generations living north of Grays Harbor used to hunt whale, using it as a "portion of their ordinary subsistence".

bones removed from shell midden during 1953 excavation at Ruble Wilkens' farm at Idaville

eaten by Thunderbird on the summit of Saddle Mountain

As al'Yahai, convinced two men sitting by the fire together in a house, Ne'atE'gyen (flint nose) and TALE'qten (copper for making arrow-points), to fight so that he could have a knife to cut up some of the stranded meat, the present given to the Tillamook by 'Xaxai' after they lost the ball game challenge and their stake of roots and berries

caught by Thunderbird like fish

When Thunderbird brought home his catch, the whale would jump and shake the whole mountain. The man staying with Thunderbird was hurt twice trying to watch.

thought by people to be at sea with birds sitting on it, but it was a whale skin covered canoe with people from across the ocean

The men on the other side of the ocean had gone whaling, including the chief, when the last living brother returned to find his wife and son.

meat, in the house of two blind women living on the other side of the lightning door

meat, given in thanks to the canoe men for giving mouths to the mouthless people

pets of Ocean, as were other "ugly animals"

South Wind cut up a whale on the occasion when the old grunted man visited him, to celebrate and to feed the old man.

The man with the snake belt told a whale that when South Wind packs him, he should pull South Wind out into the ocean. He did, and South Wind was stuck with the whale in the ocean for months, getting cold a fat, for brighter indoor lighting

beached by Thunderbird, property of man with Thunder power, owner cuts off dorsal fin then sells pieces to others

**Use 1**

food, measured by number of joints of the backbone

eaten by Ice and his party, sliced by a character called Sharp Nose

two whales breathed into whalers' sweat for Ice and his party, filling the house with steam

A woman's invisible husband and his people brought a whole whale to her.

Crow was eating pitch from a log on the beach, and calling it whale.

hunted by the men living in Thunderbird's place

Thunderbird loved to eat the tail of a whale

hunted by Crow's niece's nephew, traded for plants

Crawling One wished for a big fresh whale and one appeared. He cut it up into pieces.

meat, that Split-His-Own-Head's sister asked her brother to go buy with dentalia she gave him

Split-His-Own-Head's sister told him to go along on a trip to buy whale meat, and he sat beneath the people paddling

meat, served to the man with a crooked leg by South Wind, from a whale South Wind brought home with him from Bay City, that had meat taken from it but never died

like fish to Thunderbird. He would catch them for food, and cut them up on a big board

back fin is the best part, the big fat part. It was taken home to burn in the fire of the man who owned the whale.

Human flesh (meat from face and body, stomach, liver, kidneys) from captured people was used by Those People as whale bait.

the most precious food to the Tillamook

bought by Split-His-Own-Head

bought by Split-His-Own-Head

The man with the snake belt told a whale that when South Wind packs him, he should pull South Wind out into the ocean. He did, and South Wind was stuck with the whale in the ocean for months, getting cold.

Clem Ester stood on a whale until Ice and the people went home, leaving him standing in the rising tide.

eaten by the Tillamook



Analyzing the quantified ethnographic data for 1,260 entries, I found that 600 entries represented mammals comprising 47.6 percent of all accounts. The two additional fauna with significant percentages were fish (20.6 percent) and shellfish (11.6 percent). Accounts of mammals were dominated by elk (18.5 percent), whale and porpoise (10.3 percent), deer (9.5 percent), beaver (7.5 percent) and bear (6.8 percent). Additional marine resources such as sea otter (2.6 percent), sea lion (3 percent), and seal (4.3 percent) also account for significant percentages of the data. Based upon the high frequency of whale and porpoise, seals, sea lions, and sea otters within the ethnographic data, I focused on marine mammals for my research. I was particularly interested in the gap between the ethno-historic significance of cetaceans and archaeological evidence for the hunting of such animals on the Northern Oregon Coast.

### **Note on Ethnographic Information: Population Loss and Site Antiquity**

Three archaeological sites within the Seaside area are well recognized today. In order of antiquity they include the Palmrose site (35CLT47) (800 B.C. to A.D. 400), the Par-Tee site (35CLT20) (A.D. 300 to 1150), and the Avenue Q site (35CLT13) (A.D. 400 to 1000) (Arbolino et al. 2005:12–16). Because of the antiquity of the Par-Tee site, the application of ethnographic data in interpreting its archaeological materials may be viewed as speculative. However, I seek to demonstrate that the concepts and practices represented within the ethnographic data could provide a lens into prehistoric customs. There are pros and cons related to ethnographic data use in interpreting ancient sites. Researchers have suggested that archaeologists should use archaeological evidence to test whether ethnographic models may be seen in antiquity (Moss and Erlandson 1995:29). However, Moss and Erlandson (1995) also cautioned that the combined effects of disease and land displacement following European contact had major effects on

indigenous communities (Underhill 1978:32–33).

On the Northern Oregon Coast Lewis and Clark noted the effects of European diseases on the Clatsop, “This nation (Clatsop) is the remains of a large nation destroyed by the Small pox or Some other [diseases] which those people were not acquainted with” (Lewis et al. 1904:vol.3: 245). In addition, researchers have noted other illnesses such as sexually transmitted diseases, which were introduced by sailors and traders within the Columbia River region as early as 1780s (Thornton 1987:83). Lewis and Clark also noted the potential that procreation (between natives and Europeans) had occurred, the expedition met a member of the Clatsop of which they stated, “With the party of the Clatsops who visited us last was a man of much lighter Coloured than the natives are generally, he was freckled with long dusky red hair, about 25 years of age, and must certainly be half white at least, this man appeared to understand more of the English language than the others of his party, but did not Speak a word of English, he possessed all the habits of the Indians” (Lewis et al. 1904:vol. 3: 301). For more information of early European contact see *Log of the Columbia 1790-1792* (Society 1920).

Mortality estimates associated with Old World disease epidemics in the Columbia River region vary from 80%-95% population loss dependent upon area and population density (Ramenofsky 1987:7–8; Aikens, Connolly, and Jenkins 2011:411–412). Smallpox outbreaks were noted to have begun as early as AD 1775 and continued into 1853, right before the reservation era.

Campbell (1990) suggested smallpox may have spread from Mesoamerica to the Pacific Northwest during the 1520s. However, Boyd (1999) states that the hypothesis of a smallpox related population decline must be tested in comparable archaeological regions before the hypothesis of a 1500’s smallpox epidemic can be accepted (16). Other diseases affected natives

within the region such as venereal disease, measles, malaria, influenza, and dysentery (Aikens, Connolly, and Jenkins 2011:410–415). The combined effects of disease and removal from aboriginal lands must be understood to make sense of the ethnographic record. Yet, the ethnographic information may be viewed as a means of deeper interpretation of the archaeological record.

Lewis and Clark provide insight into the lifeways of Northwest tribes half a century before the reservation era began in the late 1850's. During the late 1800's when researchers such as Franz Boas were recording oral histories in Oregon, attempts to assimilate native peoples were underway. As many native people became wary of Europeans, researchers were limited to a small number of consultants willing to speak with anthropologists. Often, researchers conducted redundant questioning (confirming the accuracy of previous work) with a limited number of subjects. Beginning with Gatschet in 1877 through Crawford in 1977-78, fourteen anthropologists over a century spent a total of fifteen months with the Tillamook (Jacobs and Seaburg 2003: 9-29).

Edel (1944) has demonstrated that Tillamook oral histories and their narrations exhibit stability throughout time. Edel collected tales from Clara Pearson, many in Tillamook in 1931. Bess Langdon, three years later, collected talks from Clara Pearson in English. Although, the two works were collected under different conditions, with a time span between each recital, the texts are nearly identical. Lewis and Clark also noted that natives demonstrated great memory reciting the names of sailors, months that trade occurred, and items traded within the region.

### **Ethnographic Data: Lewis and Clark and the Ethnographic Era**

Ethnographic data demonstrate that the Tillamook and Clatsop were knowledgeable in whale processing. I seek to clarify whether this arises from active whale hunting, opportunistic whaling, whale scavenging or a combination of the three.

Lewis and Clark provide the insight into the lives of Clatsop and Tillamook people for the purpose of this research, nearly a century before ethnographers began research within Oregon. Beginning in November 1805 and continuing into 1806 Lewis and Clark, had constant contact with the Tillamook and Clatsop in the form of trade, conversations, and observations (Lewis et al. 1904:vol 3 part 2; Verne 1975). During this period the tribes that inhabited the Columbia River were already familiar with Europeans. Lewis and Clark noted that, “The Clatsops, Chinooks, Killamucks (Tillamooks) &c. are very loquacious and inquisitive; they possess good memories and have repeated to us the names capacities of the vessels &c. of many traders and others who have visited the mouth of this river” (Lewis et al. 1904: vol. 3 305-307 ). A list of 13 traders and vessels who visited the natives for the purpose of trade and hunting were furnished to Lewis and Clark by the natives of the area (Lewis et al. 1904:vol. 3: 306).

The contact between the tribes and outsiders was noted by the explorers who during witnessing the natives scavenging sturgeon that was left by the tide recorded an Indian stating in English, “Sturgion was very good” (Lewis et al. 1904:vol. 3: 276). However, what is most relevant to this project is that Lewis and Clark recorded an instance of whale processing.

On Friday December 27<sup>th</sup> 1805 Lewis and Clark sent out two men to make salt. The men camped near Seaside, Oregon (Lewis et al. 1904:vol. 3: 291). On December 29<sup>th</sup> 1805 there was a report from the natives that a “whale has floundered” on the coast. The expedition wanted to acquire some “whale oyle” from the natives but the weather and the parties inability to navigate the waters delayed the expedition from reaching the whale (Lewis et al. 1904:vol. 3: 293-296).

On January 3<sup>rd</sup> 1806 the Clatsops arrived to trade with Lewis and Clark, bringing berries, roots, dogs, and fresh blubber. The blubber had been obtained from the Tillamooks. Lewis and Clark stated that, “this blubber the Indians eat and esteeme it excellent food” (Lewis et al. 1904:vol. 3). Further reports of the whale continue on January 5<sup>th</sup> when two members of the expedition returned from salt making, 15 miles southwest of Fort Clatsop (Seaside) near the houses of certain Clatsop and Tillamook families. The tribes had been very friendly with the explorers and had provided them with whale blubber. After this report Clark became determined to acquire more whale blubber and oil. While heading toward the village Clark viewed a Tillamook canoe burial ground and proceeded to the whale. Clark noted while approaching the whale:

*“[we] crossed a creek 80 yards near 5 cabins, and proceeded to the place the whale had perished, [we] found only the Skelleton of this monster on the sand between (2 of) the villages of the Kilamox nation; the whale was already pillaged of every valuable part by the Kilamox indians...this skeleton measured 105 feet. I returned to the village of 5 cabins on the creek which I shall call E-co-la or Whale creek, [I] found the nativ[e]s busily engaged boiling the blubber, which they performed in a large squar[e] wooden trough [trough] by means of hot stones; the oil when extracted was secured in bladders and the Guts of the whale; the blubber from which the oil was only partially extracted by this process, was laid by in their cabins in large flickes [fliches] for use; those flickes they usually expose to the fire on a wooden Spit until it is prutty wormed through and then eate it either alone or with roots of the rush or Diped in the oil ” (Lewis et al. 1904:vol. 3: 324-325).*

These passages demonstrate the knowledge of whale processing and the value this species represented to the indigenous populations of the Northern Oregon Coast. However, the passage does not provide direct evidence of whaling. Nevertheless, it is known that whale was highly valued and prescribed regulations were observed during the processing of scavenged animals. Oral histories of the Clatsop people recorded by Boas (1894: 263) state that when the Clatsop find a whale (beached) they place holes in the skin and tie straps to it or kelp if straps are

not at hand, for themselves and their relatives (therefore marking their portion of the whale).

When the people arrive to cut the whale they do so in their respective portion. Those who arrive last take the lower portion of the whale. This demonstrates that beached whales were scavenged and utilized. But, it is unknown whether whales were actively hunted. However, Clark noted the potential of whale hunting within the project area:

*“The whale is sometimes pursued, harpooned, and taken by the Indians of this coast; though I believe it is much more frequently killed by running on the rocks of the coast S.S.W. in violent storms, and thrown on different parts of the coast by the winds and the tide. In either case the Indians preserve and eat the blubber and oil” (Ray 1938:114).*

The above passage provides insight into the possibility of whaling occurring within the region. Further ethnographic information also supports the possibility of whale hunting. For example, the hunting of whale by Tillamook and Clatsop people is mentioned by Louis Fuller in a 1940's interview with anthropologist John P. Harrington:

*“when I ask about the California Redwood [kíkəłłəx], says that sometimes the ocean brings floating redwoods way up to the Tillamook coast & such a tree is worth a lot to the indian, that is, if he finds one that is not hollow inside, some of them are hollow...The inds. Make a canoe of it for going out to kill whale & seals” (Deur 2005: 117).*

This supports the possibility that some whale hunting occurred among the Tillamook people and demonstrates that the Tillamook culture was based upon both a maritime and a terrestrial subsistence. Additional evidence of the importance of whale has been found in ethnographic interviews from the Lower Chinook,

*“This fish (salmon) was of primary importance to the natives, but sturgeon, trout, smelt, herring, and flatfish played each an important economic role. In addition,*

*sea mammals including the seal, porpoise, and whale were extensively utilized” (Ray 1938:46).*

Hence, ethnographic data supports whale being an important subsistence resource, but does not clearly clarify the procurement process.

### **Franz Boas Whale Tales and other Ethnographic Whale Taboos**

Franz Boas collected the following Tillamook materials during a field season in 1890 at the Siletz Indian Reservation. The texts are oral histories which demonstrate the extent of whaling and whale scavenging by Tillamook and Clatsop peoples.

I have summarized the oral histories discussed below.

*In one oral history a man goes to the sea and finds a beached whale. The people of the village came together to butcher the whale. The man who had found the whale cut open the whale stomach and went inside. However, the people who were butchering the whale became angry because the man had cut right into the body of the whale. Someone then wished that the whale would go back out to sea, which it did. After a year at sea the man was finally returned to his people when encountering a canoe (Boas 1965:12–13).*

The oral history demonstrates that whales were to be respected by the people and that particular taboos were followed when processing whale demonstrating that the Tillamook were familiar with whale processing.

Another oral history collected by Boas and later Elizabeth Jacobs (1959) demonstrates the cultural and mythological importance of whale and Thunderbird, a prominent figure in Tillamook and Clatsop mythology. The oral history links whales to Thunderbird, believed to be

the creator of the Clatsop and Tillamook people, and mentions whaling, the beaching of whales and the economic importance of whales to the people.

*In the narrative a man went out to catch salmon. On his journey he encountered Thunderbird who carried the man to his country (on the other side of the ocean). They entered Thunderbirds home, which was made of whale skin and whose entrance was the mouth of a whale. One evening the man went out and saw people fishing with “torches”. Thunderbird advised the man that the people were catching salmon meaning however, that they were catching whales. In the morning the man seen that the canoes had many caught whales. After a year Thunderbird returned the man to his people at Nestucka and carried with him two large whales. The people found the man and he sang. The next day he instructed the people to go to the location where they had found him. The people found that two whales had beached at that location. The man instructed them to not carve the whales and instead he went and carved the whales. People from all around came to buy whale oil from the Nestucka people and brought dentalia and other valuable shells (Boas 1965:14–15).*

In another version dictated to (Boas 1898:23–27) similar events took place at Slab creek.

Although there is some variation in that text and the one above they contain the same basic framework and therefore will not be reviewed further. Various oral histories describe a whale hunter who has the power to sing thereby bringing whales to the people.

*In a further account a man goes into the wilderness to attain “power”. He was gone for a year and when he returned he climbed a rock on the Nestucka River. Later he was found singing with his face painted and with his head covered in feathers. He was brought back to his people and dances were held. One morning he instructed three boys to go to the mountains and to take only their knives and butcher the elk the man had previously killed. The boys did as instructed and found four elks in the mountains slaughtered. Afterwards the man instructed the boys to go the sea and bring back whale meat. In the same manner the boys brought back whale meat. Therefore, whenever the people needed meat the man would sing and he would get elk and whales for the people, and he was paid (Boas 1965:15–16).*

The ability to bring whales to the people has also been noted to have existed within the Chinookan worldview.

*A Chinook with the proper spirit power would set up a pole on the beach and in that location a whale would drift ashore. Then the man would sing for five days. On the sixth day a whale would be within that location (Underhill 1978:32–33).*

The oral history related to the creation of the Tillamook and Clatsop people also has the potential to demonstrate the importance of Thunderbird and whale to the people of the region.

The cultural significance of whale to the Clatsop and Tillamook can also be understood by an oral history tying a sacred site, the location of a creation myth, related to whale consumption.

*Harrington's consultants recalled stories of Thunderbird dwelling atop Saddle Mountain and eating whales there. The importance of Saddle Mountain to the indigenous peoples of the area can be understood as oral tradition states, "Clatsop oral tradition, and probably those of other area tribes, indicate that the first Clatsops, Chinooks, Nehalems, Tillamooks, and others were created at the top of Saddle Mountain (Deur 2005: 85).*

I believe the oral histories and ethno-historical data above demonstrate the potential that Tillamook and Clatsop populations may have hunted and utilized whales as long as they have lived along the Oregon Coast.

### **Harpoon Technologies: Pacific Northwest Coast**

Ethno-historical data related to harpoon typologies and their uses reveal that composite toggling harpoons of various sizes (Figure 3) were most commonly used for fish and sea mammal hunting (Drucker 1955:25–33; Sauter and Johnson 1974:55). The second harpoon type used was formed from a solid piece of bone either of the unilateral or bilateral barbed form associated with fishing and sea mammal hunting (Drucker 1955:25–26; Sauter and Johnson

1974:57). Lastly, the leister type harpoon (double pronged and often with compound heads) were often fitted with sharp points projecting inward or backward (Figure 4) and are associated with salmon fishing (Drucker 1955:26).

Sauter and Johnson (1974: 57) noted that although whale hunting was closely associated with harpoons, “the Tillamook seldom hunted whales. They seemed interested in whales only if the huge creatures wandered into bays at high tide and were stranded when the tide went out-or if they died and washed ashore”. As I have shown, however, ethnographic evidence from within the region suggests otherwise. The claim by Sauter and Johnson make fits the traditional view within anthropology associating whale procurement (specialized or unspecialized) to northern coastal tribes.

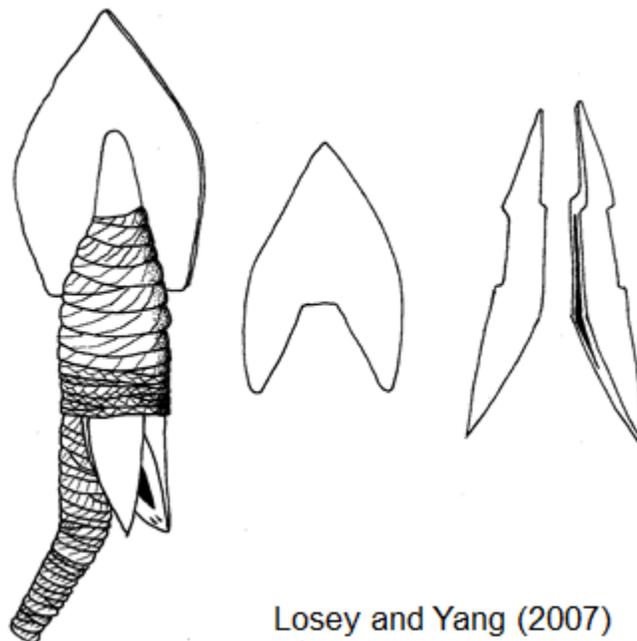


Figure 3. Composite “Toggle” Harpoon Point technology



Figure 4. Bone Harpoon Points from the NMNH Par-Tee Site Collections, showing a Bi-Laterally Barbed Harpoon (bottom), Unilaterally Barbed Harpoon (middle), and Leister Harpoon Point (top). Photo by the author.

### The Par-Tee Site

Excavation of the Par-Tee site was conducted by amateur archaeologists Phebus and Drucker (1979) from 1967 to 1977. The Par-Tee site is a shell midden deposit, heavily disturbed by relic collectors and by the removal of shell for road fill prior to controlled excavation. However, a substantial portion of the site remained intact (Phebus and Drucker 1979:21). Excavation occurred in five foot excavation squares dug in one foot arbitrary stratigraphic levels,

with sediments screened over  $\frac{1}{4}$  in mesh sieves (Colten 2002:17; Losey 2005:4; Phebus and Drucker 1979). A total of 220 units were excavated. The site has been noted to contain half of all artifacts collected during controlled excavation on the Oregon Coast (Losey 2005:7). Carbon-14 dating of the Par-Tee site demonstrates that primary habitation occurred from 2,300 cal B.P. to 800 cal B.P. (Colten 2002:17; Arbolino et al. 2005:13; Losey and Yang 2007:663).

In their report of the Par-Tee site Phebus and Drucker (1979) noted numerous whale bone atlatls (common among the Eskimo) which they related to an extensive involvement in sea mammal hunting. The emphasis of marine resources has been corroborated by Colten's (2002) quantitative analysis of faunal remains from the Par-Tee site. The research suggests that vertebrae remains were predominantly comprised of sea mammals with pinnipeds, sea otters, and cetaceans representing 65% of the faunal assemblage by meat weight contribution. Of 945 sea mammal bones identified to family level, 154 (16.3%) are cetacean. These include minke whale (Number of Identified Specimens (NISP)=4), harbor porpoise (NISP=25), pantropical spotted dolphin (NISP=1), and bottlenose dolphin (NISP=4) (Colten 2002; Losey and Yang 2007:663). Analyzing all vertebrae species by habitat suggests that 62% of species found within the Par-Tee collection were taken from marine ecosystems (Colten 2002:17-18). Colten (2002) also analyzed a sample from the Palmrose site. Colten found that the Par-Tee site contained a higher quantity of marine species (62%) than Palmrose (58%). Harbour porpoises are represented at both sites while, the Palmrose site contained many bottlenose dolphin remains (NISP=50). The Par-Tee site had a significantly higher rate of cetacean bones such as minke whale and other large cetaceans. However, minke whale was the only identified large cetacean in the sample (by Colten); other large cetaceans were identified to order and not to species. Terrestrial species at both sites are dominated by elk and deer. The Palmrose site contained a higher occurrence of salmon bone by

weight while the Par-tee site fish assemblage contained virtually no salmon bones (Colten 2002:18; Arbolino et al. 2005:15).

Later, Dr. Losey (2007) identified within the Par-Tee fauna collection a humpback whale (*Megaptera novaengliae*) phalange with an embedded bone harpoon point. DNA testing was conducted on the imbedded bone harpoon indicating it was made of Elk (*Cervus elaphus*) bone. In addition, the DNA sequence matched the unmodified elk bone from within the collection. The DNA evidence suggests that the whale was harpooned locally (Losey and Yang 2007:657). The humpback whale phalange was excavated from level 4 of unit 21F in the southwest portion of the Par-Tee site. Charcoal samples from the same level of two adjacent units produced C14 dates of 1195±80 (SI-4967) and 1295±70 (SI-4966) (Losey and Yang 2007; Moss 2011:115). I proposed to radiocarbon date the humpback whale phalange and the elk harpoon point to establish a secure date for the harpooning event. Currently, I am pursuing the C14 dating of the artifact and the dates are not available at this time.

The potential that whales and other cetaceans were hunted and struck further north and “drifted” to the Par-Tee site was examined by Losey and Yang (2007). Considering whale swimming speed, distance from closest known whaling community, and that the point embedded in the whale phalange does not match the ethnographic whaling technology of the north Losey and Yang did not believe the whale represented a drift whale. In addition, researchers have noted that humpback whales sink quickly upon death (Monks, McMillan, and Claire 2001:65). Although the gases of decomposition may have brought some carcasses back to the surface (Monks, McMillan, and Claire 2001:65). Given these results, it seems unlikely that the humpback whale at the Par-Tee site is that of a whale struck elsewhere or the beached carcass of a whale that died naturally.

As noted below, there was variation in the harpoon technologies used by Pacific Northwest Coast tribes. Toggling harpoons are closely associated with whaling to the north, but large toggling harpoons are not present in the Par-Tee collection. Instead, the composite points found are too small to have been utilized for sea mammal hunting. However, the Palmrose and Avenue Q sites both contain toggling harpoons. But, the points from those collections were not examined for this current study.

### **Whaling Culture: Washington and British Columbia**

The Nuu-chah-nulth inhabited a large portion of western Vancouver Island, and the Makah inhabited the Olympic Peninsula of Washington State. Wakashan speakers such as the Nootka and the Makah possessed a specialized whale hunting culture in the Pacific Northwest Coast. It is said that only these tribes (and some of their Salish neighbors, who according to anthropologists learned the tradition from the Makah) participated in whale hunting, although this claim is not supported by further evidence (Drucker 1955:11; Underhill 1978:32). The Coastal Salish of Washington inhabited the coast region from the Gulf of Georgia, Puget Sound, Straits of Juan de Fuca, Olympic Peninsula and most of Washington to the Chinook territory on the Columbia River (within Washington and Oregon).

The traditional technology associated with whale hunting is the composite harpoon (with a sharp mussel or slate cutting blade cemented with spruce gum between two elk horns barbs) attached to long lines, sea-worthy canoe, and seal skin buoys (to create drag that tired the whale) (Drucker 1955:35; Underhill 1978:32). The whale hunt was conducted by a crew of eight men (Underhill 1978:32). During the hunt the crew approached the whale from the rear and always on the left side. The harpooner would then strike the whale just behind the left flipper or near the

shoulder. Often, a second whaling canoe accompanied the chief whaling canoe. This second crew would often strike the whale with harpoons and were used as a precaution in case the whale flipped or broke the main boat (Drucker 1955:35; Underhill 1978:37–39). The primary and secondary canoes would continue to strike the whale with harpoons attached to short lines and floats until the whale was weakened from loss of blood and the resistance of the floats. Next, a lance was used to sever the tendons controlling the flukes (tail). Afterwards a long sharp bone point (lance) was driven behind the flipper and into the heart of the whale, killing the animal (Drucker 1955:36; Underhill 1978:39). Once the whale was dead, holes were cut on the upper and lower jaws, and the mouth was tied shut to prevent water from entering the body cavity and sinking the whale. Next the whale was hauled to shore, a very difficult task (Drucker 1955:35–36; Underhill 1978:39–40). On shore the whale was butchered and the blubber divided by set precedents (Underhill 1978:40–41).

Another form of whaler existed amongst the Northern communities. This whaler or whale-ritualist had the ability to cause whales that died naturally drift ashore (Drucker 1955: 36–37). As noted earlier this ability was also recognized to have existed within the worldview of the Tillamook and Chinook Indians.

### **Whaling Technology and Culture: Makah and Nuu-Chah-Nulth**

The Makah (Olympic Peninsula) and Nuu-chah-nulth (Vancouver Island) have been closely associated with whaling culture along the Central Northwest Coast (Huelsbeck 1988:1; Monks, McMillan, and Claire 2001:60; Erikson 1999:556; Monks 2011:188). Archaeological evidence from the Ozette, T’ukw’aa and Ch’uumat’a sites within the region may be representative of other whaling cultures within the area.

The Ozette site, located on Cape Alava on the Pacific Coast of Washington, was occupied for 800 to 1,500 years on a year round basis, until the early 1900's (Huelsbeck 1988:1). A prehistoric layer within the site known as area B70 is capped by thick layers of landslide debris (Huelsbeck 1988:4; Erikson 1999:570). Radiocarbon dates from this layer fall between ~250 and 450 B.P. (Huelsbeck 1988:4). From the identifiable whale bones (70% of the assemblage was not identifiable to the species level) in the collection slightly over 50% of large cetaceans are gray whale (*Eschrichtius gibbosus*), 46% humpback whale (*Megaptera novaeangliae*), 2% right whale (*Eubalaena sieboldii*), and 1% finback whale (*Balaenoptera physalus*) (Huelsbeck 1988:4; Monks, McMillan, and Claire 2001:65–66; Monks 2011:195). The Ozette site contained a large amount of mammal remains, but due to screening methods (¼" mesh, the same as Par-Tee) fish species may be underrepresented (Butler and Campbell 2004:360).

The primary tools associated with whaling include the canoe, harpoon (often toggling), line, and buoys or floats (Huelsbeck 1988:6; Waterman 1920). Many of these technologies were recovered from the Ozette site. In addition, several vertebrae, scapulae, a maxilla, and an intermaxillary with fragments of mussel shell harpoon blades imbedded within have been recovered from the site (Huelsbeck 1988:6; Monks, McMillan, and Claire 2001:66). Along the Central Northwest Coast it has been noted that whale hunting harpoon technology did not develop until after ~1200 B.P., when large bone valves from composite harpoon heads first appear in the deposit. Often these points are not seen in large numbers within cultural areas linked to whaling practices. It has been suggested that these points were carefully treated and stored and therefore would not become primary refuse in the archaeological record. Often these points were incised to increase their effectiveness ritually (Monks, McMillan, and Claire 2001:66) a pattern that is seen at the Par-Tee site. It may also be possible that other harpoon

technologies were used in earlier times to take whales, seals, and sea mammals including unilateral and bilateral points (Monks, McMillan, and Claire 2001:66; Sauter and Johnson 1974:55–74). Although the points would be less effective (than toggling harpoons) such technologies may have evolved over time (Monks, McMillan, and Claire 2001:66).

The T'ukw'aa site, located on Western Vancouver Island, British Columbia, is a former village that contains extensive archaeological deposits dating to at least 1200 B.P (Monks 2011:189). The site is located in a defensive position with 20m drop offs over steep cliffs. Such defensive positions are typical of many Nuu-Chah-Nulth village locations. The Ch'uumat'a site is another village near the western edge of Barkley Sound with deeper archaeological deposits than T'ukw'aa with some excavated deposits slightly over 4 m in depth, with radiocarbon dating placing initial occupation around 4000 B.P. (Monks, McMillan, and Claire 2001:62). Whale bones were common throughout the deposits at both sites with the earliest identifiable element (a vertebra) from a stratum dated to 3500 B.P. (Monks, McMillan, and Claire 2001:62; Monks 2011:189).

Research concerning the taphonomy of whale bones brought to village locations, their distribution, and purpose has been conducted on sites within the Central Northwest Coast (Monks 2011). Such research has not been conducted for the Par-Tee fauna assemblage (Colten 2002). Phebus and Drucker (1979:22) noted work areas, fire hearths, and concentrated dietary accumulations within the site but no further data has been provided.

The Cattle Point site is located on San Juan Island in Washington's Puget Sound. This shell midden was excavated in 5 foot squares and in 6 inch arbitrary levels. No radiocarbon dates were available for the site due to the fact that it was excavated in the 1940s before the technology

had been invented. However, later work by Stein (2000) placed the Cattle Point site within recognized phases. The site contains three periods of occupation identified by the excavators, based on the stratigraphy of the site. The first phase termed the Island Phase (Cascade Phase) is determined as a period when the occupants were better adapted to life on land than the sea (however, the site is located on an island). The Developmental Phase (St. Mungo, Mayne and Locarno Beach Phases) is seen as a period where shellfish use is first recognized and an increase in bone and antler artifacts is related to exploitation of sea resources. The Maritime Phase (Marpole Phase) artifacts demonstrate a full adaptation to the exploitation of the sea. Lastly, the Late Phase (San Juan) demonstrates a recent cultural development, lacking many of the Maritime Phase artifacts (King 1950:3–12; Stein 2000).

Harpoon points from the Cattle Point site include unilateral, bilateral, leister, open socket, and composite harpoon types. Leister points are confined to the Maritime and Late Phases. Composite harpoons are found in the Developmental and Maritime Phases. Unilateral and Bilateral Points are found throughout the Maritime Phase. Open socket harpoon heads (similar to Eskimo style toggling points which have been viewed as a precursor to composite toggling harpoons) was found during the Developmental Phase. The composite harpoon heads and the open socket style both contain slots for large stone or shell blades (King 1950:43–46). Seals and whale represented the most common marine mammals within the collection.

The Coastal Salish comprise the southernmost recognized whaling culture relative to the Seaside area, the closest culture includes the Quinault with their non-Salish neighbors the Quileute and Hoh (Erlandson et al. 1998:12). Anthropologists suggest that the practice of whaling amongst the Salish was learned from the Makah (Drucker 1955). Archaeological

evidence from various Coastal Salish sites provides evidence of maritime adaptations in the form of sea mammal hunting technologies.

### **Comparative Analysis: Embedded Harpoon Point and the Par-Tee Collection**

I visited the Anthropology Collections at the Smithsonian Institution's National Museum of Natural History in June 2013. The goal of the visit was to examine the Par-Tee harpoon points and attempt to find a match of the embedded harpoon point within the humpback whale phalange. The harpoon technology represented within the Par-Tee site does not match the toggling harpoons from archaeological sites to the north or those described in accounts of hunting large sea mammals. The harpoon points described ethnographically contained a shell or slate blade tip. All measurements were taken using a digital caliper to reduce the possibility of error on the part of the researcher.

Computed tomography scanning was conducted by Dr. Mathew Tocheri, a paleoanthropologist with the Smithsonian Institution's Human Origins Program. Due to the variation in bone density between the whale bone and the embedded elk bone harpoon the dimensions of the point could be determined (Tocheri, Personal Communication, 2013). Unfortunately, the harpoon point tip was too small to be diagnostic of one particular technology or to match the style within any of the other bone harpoons in the Par-Tee collection. The point tip was 38 mm long, 16.43 mm wide and 9.6 mm thick (See Figure 5). Therefore, I selected three harpoon types the leister harpoon, unilateral harpoon, and bilateral harpoon. The three harpoon point types were of substantial size and may have been used to hunt sea mammals.

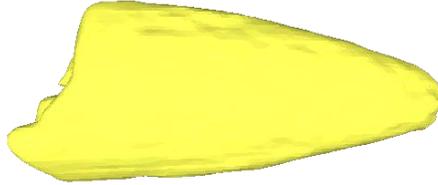


Figure 5. Computed tomography scan, of the embedded harpoon point in the humpback whale phalange.

### **Blood Residue Analysis: Results, Discussion, and Conclusion**

Twelve harpoons (four of each type) were selected for blood residue analysis, which tests for blood proteins that may have been deposited on artifacts during use. The test seeks to identify preserved immunoglobulin G (IgG), a large Y-shaped protein. The technique has been widely used in forensic laboratories and has also been applied in archaeology to detect protein residues on stone tools (Fagan 2013). To summarize, the cross-over immuno-electrophoresis (CIEP) method, is based on a principle that all animal species produce antibodies that recognize and bind with foreign proteins (antigens). Therefore, the ability of antibodies to precipitate antigens out of solution is the basis of CIEP analysis (Newman and Julig 1989; Yohe, Newman, and Schneider 1991). While most blood residue studies have focused upon stone tools, I proposed to identify residues on bone tools. The raw material of the harpoons in this study likely is cortical bone of elk and deer (Erlandson, Pers. Comm. 2013). It is preferred that soil samples from the matrix

surrounding the artifact are tested as controls during residue analysis (Newman and Julig 1989). However, because the Par-Tee site was excavated during the 1960s and 1970s no control samples could be tested in this analysis. All residue samples for this study were extracted using a five percent ammonia solution, gently agitating the artifact, placed in numbered vials, and refrigerated until testing was completed. The residue analysis was conducted by Dr. Cam Walker and Dr. John Fagan of Archaeological Investigations Northwest Inc. (AINW) in Portland, Oregon. Antiserums used in the study were purchased commercially by AINW. For additional information regarding the blood residue analysis process please refer to appendix 2.

The harpoon points were tested against the antisera of white whale, bottlenose dolphin, trout, bovine (baleen whales) and dog (seals). Dr. Fagan utilized dog antisera as a proxy to test for seals and bovine antisera to test for baleen whales (Fagan, Pers. Comm. 2013). Ethnographic and archaeological data suggest that cetaceans were hunted by prehistoric maritime cultures of the northern Oregon Coast. Of the twelve harpoon points tested, two artifacts tested positive for blood antiserum. Artifact NMNH #536982 a leister harpoon point (Fig. 4) tested positive for trout antibodies, which may indicate use on either salmon, trout species, and char. These suggest that the leister harpoon point was used in the manner described by the ethnographic data. Artifact NMNH #536849 a fragment of a unilaterally barbed harpoon point (Figure 5) tested positive for bovine blood antiserum.

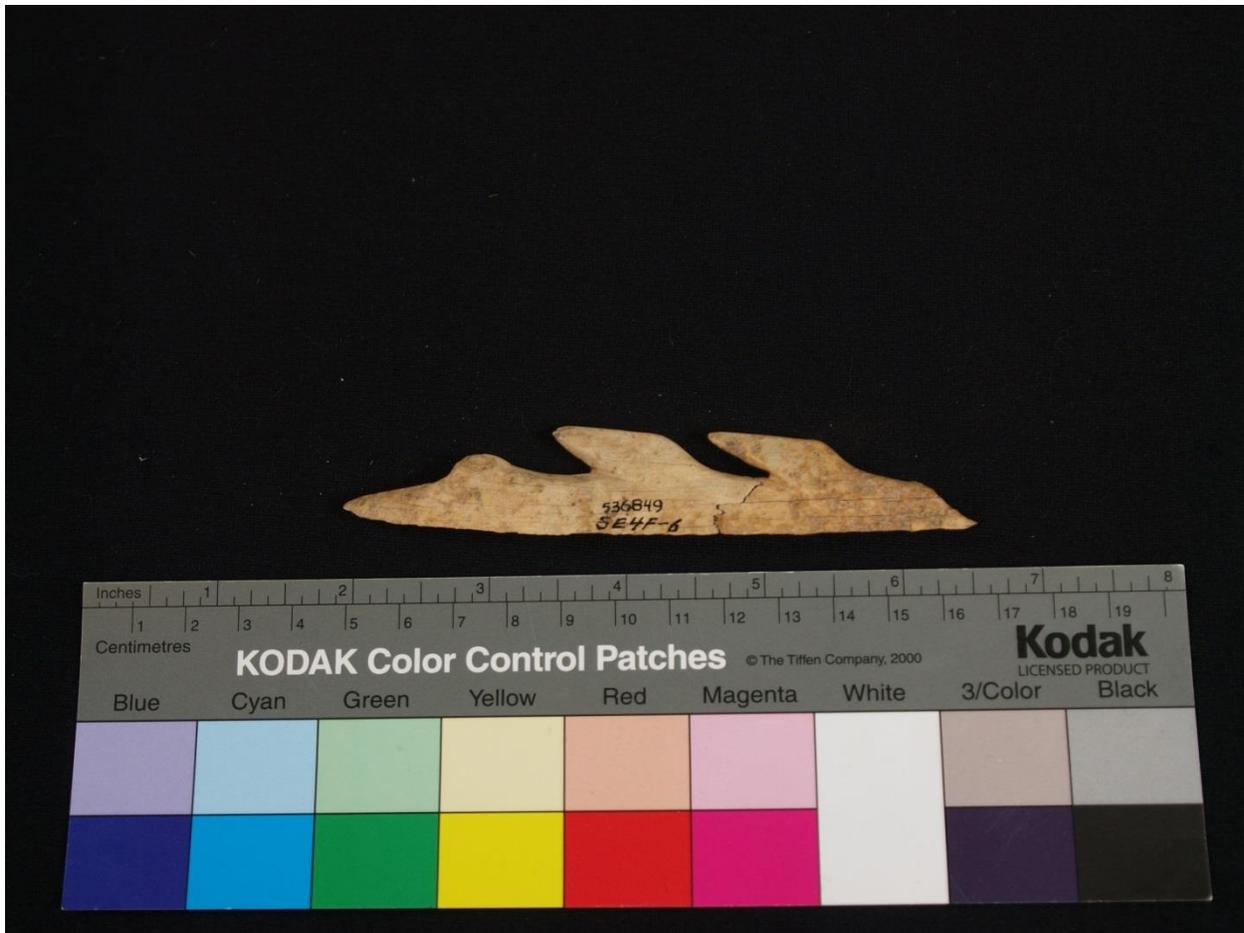


Figure 5. Unilateral Bone Harpoon Point #536849 from the NMNH Par-Tee Site Collections.

Photo by the author.

The bovine antiserum reacts with the family Bovidae (e.g. domestic cattle and bison). There is a possibility that this point (NMNH # 536849) came into contact with bovine blood, although this is unlikely due to the antiquity of the Par-Tee site. Dr. Fagan (2013) suggests that the positive for bovine antiserum may result from cetacean residues. Dr. Fagan states,

There remains a possibility that the positive result for bovine residue could represent another species of cetacean. As with all artifact extractions in this analysis, artifact #11 (NMNH# 536849) was also tested against bottlenose dolphin and white whale antisera, and did not react to either.

We had not previously used the white whale and bottlenose dolphin antisera that were purchased for this analysis. Because of this, we ran ancillary analyses to determine the specificity and reactivity of these antisera, both to each other, and to modern species with which white whales and bottlenose dolphins share (distant)

evolutionary history: namely the bovine lineage. Interestingly, both the white whale and bottlenose dolphin antisera reacted well with bovine serum, with well-defined precipitin lines. Neither antiserum reacted with bear or dog serum, which could have suggested an evolutionary relationship with pinnipeds. As a matter of course, the reaction between bottlenose dolphin antiserum and white whale serum was found to be weak, a reflection of their divergent evolutionary histories.

Family Bovidae is included within the order Artiodactyla (even-toed ungulates). A number of authors have been making an ever-stronger case for the inclusion of all species from the order Cetacea (whales, dolphins, and porpoises) within the order Artiodactyla, or even creating a new Superorder Cetartiodactyla. The last common ancestor between terrestrial Artiodactyls and Cetaceans closely approximated a modern hippopotamus. The evidence for this evolutionary relationship has been put forth by mitochondrial DNA (Graur and Higgins 1994); RNA (Kleineidam et al. 1999); and even with immunoglobulins, by CIEP and Western blot methods (Nollens et al. 2008). In particular, Nollens et al. (2008) found that bovine serum tested positive against baleen whales, beluga (white whale), porpoises, killer whale, and several species of dolphin, including bottlenose. Therefore, if other Cetacean antisera become commercially available in the future, re-testing the extracts from this set of artifacts is likely worthwhile.

Although the blood residue study did not directly corroborate the hunting of cetaceans at the Par-Tee site, the research does demonstrate that the leister harpoon point (Fig. 4) was used as described ethnographically. As stated the purpose of this report was to test the accuracy of ethnographic data of the Tillamook and Clatsop using archaeological investigations while investigating whaling on the Oregon Coast. My research has corroborated the use of the leister harpoon point to hunt a variety of fish species. In addition, the potential exists that cetacean blood residues were found on the unilateral harpoon point tested in this study. However, until further blood antisera become commercially available the current results are not definitive.

The limitation of the present study is the harpoon sample size tested with blood residue analysis. The Par-Tee collection contains hundreds of harpoon points recovered during controlled excavation, but only twelve have been tested. Nonetheless, the study does demonstrate the potential that blood residue analysis may have, despite issues related to availability of antisera and the possibility of contamination.

Further research of the Par-Tee fauna collection will no doubt add to the knowledge of resources utilized by the site inhabitants. The collection is substantial and currently understudied. The site artifacts are held by multiple institutions and in private collections which at times lack provenience information. However, further study of the site collection will provide additional information regarding the prehistoric inhabitant's resource use, technologies, and adaptations. Future research investigating whale hunting in the area should focus on an analysis of the three Seaside sites (Palmrose, Par-Tee, and Avenue Q) analyzing harpoon technologies, faunal remains, and artifacts. As the present study demonstrates the potential exists for future research on these Oregon Coast sites.

## **Conclusion**

In summary, this project investigated the potential that whale hunting, either opportunistic or active, occurred at the Par-Tee site. Losey and Yang (2007) demonstrated via ancient DNA (aDNA) that whaling occurred at the Par-Tee site with locally manufactured harpoon points. My research attempted to identify the hunting technology using CT scans, comparative analysis, and blood residue analysis. Ethnographic research suggested a cultural tradition of whale importance for the Tillamook and Clatsop people. However, the ethnographic data lacked information of the methods utilized in potential whale hunting beyond stating canoes and harpoons were used. Further, ethnographic research of unpublished works (i.e. The Jacobs Collection, University of Washington) could provide further insight of whale use and whaling activities (Deur, Pers. Comm. 2013). However, the size of the collection and the limited time to complete this research project made such ethnographic work unfeasible for the researcher.

As stated earlier, future research examining the three Seaside sites (Palmrose, Par-Tee,

and Avenue Q) for evidence of whale use (i.e. strike marks, evidence of butchering, tool extraction, and an analysis of cetacean bones in the sites) may identify the extent of large sea mammal use in the Seaside region during the Late Holocene.

## **Acknowledgements**

This project would not have been possible without the support and advice of my mentors, Dr. Jon Erlandson and Eirik Thorsgard. Funding and support was also provided by the McNair Scholars Program, University of Oregon, Dr. Kimberly A. Espy, Vice President for Research and Dean of the Graduate School, Dr. Yvette M. Alex-Assensoh, Vice President for Equity and Inclusion, Dr. Karen U. Sprague, (Former) Vice Provost for Undergraduate Studies, and Dr. Ian F. McNeely, Associate Dean for Undergraduate Education. The Confederated Tribes of Grand Ronde, Land and Culture Department, provided assistance and encouragement throughout the project especially Briece Edwards and David Harrelson. Dr. John Fagan and Dr. Cam Walker conducted blood residue analysis, AINW Inc. Also, I would like to thank Dr. Torben Rick, Curator, Smithsonian National Museum of Natural History (NMNH), and Dr. James Krakker, Archaeological Collections Specialist, NMNH for his guidance during my visit of the archives. Special thanks to the Anthropology Department, University of Oregon for providing funding to conduct future C14 dating of Par-Tee archaeological materials and for conference funding. Lastly, thanks to the Oregon State Historic Preservation Office, Oregon Parks and Recreation Department for supporting the project via grant funds.

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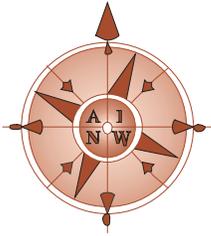
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## Appendix: 1

### Quantified Ethnographic Data: Sources

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# Archaeological Investigations Northwest, Inc.

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October 2, 2013

Mr. Gabriel Sanchez c/o  
Dr. Jon M. Erlandson  
Department of Anthropology  
308 Condon Hall  
1218 University of Oregon  
Eugene, OR 97403

Re: Results of Blood Residue Analysis on 12 Artifacts from  
Site 35CLT20, Clatsop County, Oregon  
AINW Report No. 3163

Dear Mr. Sanchez & Dr. Erlandson:

At your request, Archaeological Investigations Northwest, Inc. (AINW), analyzed 12 artifacts from site 35CLT20 in Clatsop County, Oregon. The analysis was done to identify possible blood residues on the artifacts using cross-over immunoelectrophoresis (CIEP). There were positive reactions on two artifacts.

The CIEP technique has been widely used in forensic laboratories to determine the origin of bloodstains as evidence in criminal investigations, and has fairly recently been adapted for use in archaeology to detect protein residues on prehistoric artifacts. The CIEP technique is based on the immune (antigen-antibody) reaction. Extracts of protein residues from artifacts in an ammonia solution are tested against antisera from known animals. The solutions are placed on a gel substrate and exposed to an electric current which causes the proteins to flow together. An immune reaction between the extract and the antiserum causes a precipitate to form, which is visible after being stained. A brief overview of the CIEP technique and an outline of AINW's laboratory procedures are included with this report.

The CIEP tests were conducted between August 20 and September 26, 2013, by laboratory director Dr. Cameron Walker. The extracts from all artifacts (#1-12) were tested against trout, dog, bovine, white whale, and bottlenose dolphin. The trout antiserum was custom produced for AINW by Cocalico Biomedicals, Inc. The bovine and dog antisera are forensic-grade antisera manufactured by MP Biomedicals, LLC. The white whale and bottlenose dolphin antisera are manufactured by Bethyl Laboratories, Inc. Included with this report is a table that shows the results of the tests for the artifacts and a chart that shows the antisera used in the tests and the species found to react with each antiserum.

Standard analysis procedures begin with extracting residues from the artifacts with a 5% ammonia solution. The artifact extracts are then placed singly into gels, and tested against the antisera selected for these tests with the CIEP technique. In addition to the artifact extracts, positive and negative control sera are run with each gel. This is done to determine if there are any contaminants or extraneous proteins that may give false positive results. If an anomalous result such as an extract reacting with multiple antisera or to a negative control serum is obtained, the extract solution is mixed with an equal volume of a 1% solution of a non-ionic detergent to increase chemical bonding specificity, and is run through the CIEP process again. If a reaction still occurs after the addition of the non-ionic detergent, any reactions of those specimens to the antisera are discounted. None of the extracts analyzed for this project reacted with the negative control or with multiple antisera.

Mr. Gabriel Sanchez & Dr. Jon Erlandson, Department of Anthropology  
University of Oregon  
Results of Blood Residue Analysis on 12 Artifacts from Site 35CLT20  
AINW Report No. 3163

As noted on the attached table, there were positive reactions for two of the artifacts. Artifact #1 tested positive to the trout antiserum and artifact #11 tested positive to the bovine antiserum. The trout antiserum will react to species within the subfamily Salmoninae, which includes Atlantic and Pacific salmon, trout species, and char. The bovine antiserum reacts with species within the family Bovidae, which includes domestic cattle and bison.

For the results of this study, particularly with regard to artifact #11, the positive result for bovine most likely represents the preservation of bovine residue. As with all positive results, it was tested twice against bovine antiserum to confirm the result of a positive test. There remains a possibility that the positive result for bovine residue could represent another species of cetacean. As with all artifact extractions in this analysis, artifact #11 was also tested against bottlenose dolphin and white whale antisera, and did not react to either.

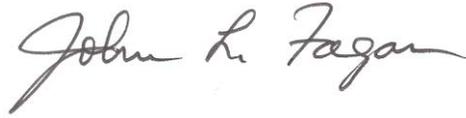
We had not previously used the white whale and bottlenose dolphin antisera that were purchased for this analysis. Because of this, we ran ancillary analyses to determine the specificity and reactivity of these antisera, both to each other, and to modern species with which white whales and bottlenose dolphins share (distant) evolutionary history: namely the bovine lineage. Interestingly, both the white whale and bottlenose dolphin antisera reacted well with bovine serum, with well-defined precipitin lines. Neither antiserum reacted with bear or dog serum, which could have suggested an evolutionary relationship with pinnipeds. As a matter of course, the reaction between bottlenose dolphin antiserum and white whale serum was found to be weak, a reflection of their divergent evolutionary histories.

Family Bovidae is included within the order Artiodactyla (even-toed ungulates). A number of authors have been making an ever-stronger case for the inclusion of all species from the order Cetacea (whales, dolphins, and porpoises) within the order Artiodactyla, or even creating a new Superorder Cetartiodactyla. The last common ancestor between terrestrial Artiodactyls and Cetaceans closely approximated a modern hippopotamus. The evidence for this evolutionary relationship has been put forth by mitochondrial DNA (Graur and Higgins 1994); RNA (Kleineidam et al. 1999); and even with immunoglobulins, by CIEP and Western blot methods (Nollens et al. 2008). In particular, Nollens et al. (2008) found that bovine serum tested positive against baleen whales, beluga (white whale), porpoises, killer whale, and several species of dolphin, including bottlenose. Therefore, if other Cetacean antisera become commercially available in the future, re-testing the extracts from this set of artifacts is likely worthwhile.

It should be noted that the negative results from testing against the selected antisera do not preclude the possibility of a specimen retaining residues from other animals. The liquid extracts obtained from the artifacts have been frozen for storage and will be retained for one year should you wish any additional tests. Please call us if you have any questions about the analysis or this report.

Thank you for providing us the opportunity to run these tests. The results and the process have proven to be of great interest to us.

Sincerely,



John L. Fagan, Ph.D., R.P.A.  
President/Senior Archaeologist



Cam Walker, Ph.D.  
Supervising Archaeologist/  
Laboratory Director

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Attachments

**ARCHAEOLOGICAL INVESTIGATIONS NORTHWEST, INC.**  
**BLOOD RESIDUE ANALYSIS COMPARATIVE RESULTS**

		TYPE OF ANTISERUM				
RAL #	SITE	Bovine	Dog	Trout	White whale	Bottlenose dolphin
1	35CLT20	-	-	+	-	-
2	35CLT20	-	-	-	-	-
3	35CLT20	-	-	-	-	-
4	35CLT20	-	-	-	-	-
5	35CLT20	-	-	-	-	-
6	35CLT20	-	-	-	-	-
7	35CLT20	-	-	-	-	-
8	35CLT20	-	-	-	-	-
9	35CLT20	-	-	-	-	-
10	35CLT20	-	-	-	-	-
11	35CLT20	+	-	-	-	-
12	35CLT20	-	-	-	-	-
GEL #		2131-2		2131-1	2131-1	2131-2
GEL #		2131-4			2131-4	2131-4
REPEAT GEL #						
REPEAT GEL #						

Key: + = Positive; - = Negative

**ARCHAEOLOGICAL INVESTIGATIONS NORTHWEST, INC.  
RESIDUE ANALYSIS LABORATORY  
ANTISERUM CHART**

COMPANY	ANTISERUM	HOST	REACTS WITH
BLI*	BOTTLENOSE DOLPHIN	rabbit	Family Delphinidae: dolphins, less strongly with porpoises and toothed whales
	WHITE WHALE	rabbit	Family Monodontidae: belugas and narwhals, porpoises
	CAMEL	rabbit	Order Artiodactyla: camelids, bovids, cervids
BYT*	PIGEON DUCK	rabbit	Order Columbiformes: pigeons, doves
		rabbit	Family Anatidae: swans, geese and ducks
CBI*	TROUT	rabbit	Subfamily Salmoninae: salmon, steelhead, rainbow trout, char
MP*	BEAR	goat	Family Ursidae: black bear, brown bear, grizzly
	BOVINE	goat	Family Bovidae: domestic cow, bison
	CAT	goat	Family Felidae: cat, mountain lion, lynx, bobcat
	CHICKEN	rabbit	Order Galliformes, Order Anseriformes, Order Columbiformes
	DEER	goat	Family Cervidae: white-tail and mule deer, elk, moose
	DOG	rabbit	Family Canidae: domestic dog, coyote, wolf
	GUINEA PIG	goat	Order Rodentia: guinea pig, porcupine, beaver
	HORSE	goat	Family Equidae: horse, donkey, mule, extinct equids
	MOUSE	goat	Order Rodentia: mice, rats
	RABBIT	goat	Family Leporidae: rabbit, jackrabbit
	RAT	goat	Order Rodentia: rats, mice, squirrels
SHEEP	goat	Genus Ovis: domestic sheep, bighorn sheep	
SIGMA*	HUMAN	goat	Order Primates: humans, apes, monkeys
	SHEEP	rabbit	Sheep and goat, bighorn sheep; less strongly with pronghorn, cervids, and bovids
	GOAT	rabbit	Bovid Subfamilies Bovinae and Caprinae, less strongly with cervids

\*Notes: BLI = Bethyl Laboratories, Inc., BYT = Biorbyt Laboratories, Inc., CBI = Cocalico Biologicals, Inc., MP = MP Biomedicals, LLC, Sigma = Sigma Chemical Laboratories.

**ARCHAEOLOGICAL INVESTIGATIONS NORTHWEST, INC.**  
**RESIDUE ANALYSIS LABORATORY**  
**METHODS AND PROCEDURES**

Blood protein residue analysis performed at the Archaeological Investigations Northwest, Inc. (AINW) Residue Analysis Laboratory uses the technique of cross-over immunoelectrophoresis (CIEP) to analyze protein residues extracted from the surface of stone artifacts and other objects. This technique has been widely used in forensic laboratories to determine the origin of bloodstains as evidence in criminal investigations, and has fairly recently been adapted for use in archaeology to detect protein residues on stone tools. The CIEP method used by the AINW Residue Analysis Laboratory is based on techniques developed by the Royal Canadian Mounted Police Serology Laboratory in Toronto, Ontario (Culliford 1971; Newman 1990; Williams 1990). The CIEP technique uses the immune (antibody-antigen) reaction, the principle that all animals produce immunoglobulin proteins (antibodies) that recognize and bind with foreign proteins (antigens) as part of the body's defense system. The ability of antibodies to precipitate antigens out of solution is the basis of CIEP analysis (Newman 1990:56). CIEP indicates the presence or absence of a particular antigen, and is not designed as a quantitative test. While other types of immunoassay have been used effectively to analyze blood protein residues under various conditions, the CIEP test is particularly suitable in that it is sensitive (able to detect protein in concentrations of about two parts per million), does not require expensive or bulky equipment, is relatively fast (about 48 hours per test), and can easily and efficiently accommodate multiple samples (Newman 1990:52).

**BLOOD PROTEIN RESIDUES**

Blood is composed of red and white blood cells and serum, which is composed of about 150 different proteins including albumin, alpha, and beta globulins. Immunoglobulins are large, Y-shaped proteins with antigen binding sites located on the V portion of the Y. There are several immunoglobulin molecules of different weight, size, and function. The most common type (and the most pertinent for CIEP) is immunoglobulin G (IgG). Other less common varieties are immunoglobulin A (IgA), immunoglobulin D (IgD), immunoglobulin E (IgE), and immunoglobulin M (IgM). Some of these proteins can survive in the environment in a nonfunctional but immunologically identifiable form for long periods of time by forming a "covalently cross-linked proteinaceous mass with a high molecular weight" (Marlar et al. 1995:30). This combination of protein, fatty tissues and soil particles is resistant to microbes and is markedly insoluble in water. It seems probable that porosity and surface roughness of the artifact also aids in the preservation of protein residues. Experiments by AINW and others have identified blood residues from mammoth, bison, musk ox, horse, caribou, bear, duck, and trout on Paleoindian artifacts that may be as old as 11,500 years (Forgeng 1998; Loy and Dixon 1998; Williams 1993). Other studies suggest that protein residues can survive in recognizable form for as long as 40,000 years (Prager et al. 1980).

Artifacts can be examined under a binocular microscope (at around 240 x maximum magnification) to identify probable residues, as well as cells, hair and other tissues. Microscopic examination is not always effective as a screening technique as CIEP can still detect otherwise invisible residues. A common medical test for occult blood is sometimes effective when used to screen the extracted residue solution. However, the CIEP technique can detect residues in more dilute concentrations than is possible with the commonly available occult blood test.

## **THE IMMUNE REACTION**

Immunological forensic tests owe their effectiveness to the antigen-antibody reaction, which allows very specific recognition and identification. Essentially, any molecule that can bind to an antibody is an antigen. For archaeological purposes, the antigen is an unknown protein adhering to an artifact after its use. Antigens are foreign proteins that, when introduced into the blood stream of an animal, stimulate the immune system of the animal to produce antibodies (most commonly IgG protein molecules) with specific binding sites that match corresponding sites on the foreign antigen. Polyclonal antibodies, which bind to multiple sites on the antigen and therefore have a high rate of successful matching to unknown proteins, are the most commonly used reactants in CIEP. The meeting of antigen and antibody forms a very strong bond between the two proteins. The visible line formed in a positive CIEP reaction occurs when an antigen with multiple binding sites matches a group of polyclonal antibodies, binds with them, and causes the proteins to precipitate out of solution (Marlar et al. 1995:28).

Antigen-antibody reactions can be highly specific, although proteins from closely related species share enough of the same binding sites on the immunoglobulin molecule to react in similar ways. More distantly related species react less strongly. The purity of the antiserum used in the analysis is thus of primary importance in determining what species of animal is represented. Quantified analyses have been performed using more sophisticated techniques to test the similarity of immune reactions between related animal species, largely to determine relationships between living and extinct species (Lownstein 1980, 1985). These results and CIEP experiments performed by AINW and others indicate that CIEP can generally distinguish between blood proteins at approximately the taxonomic family level.

## **ANTISERA**

The antisera used in AINW's CIEP analysis are obtained from commercial laboratories. A forensic antiserum is made by injecting a host animal, typically a goat or rabbit, with a protein solution obtained from another animal. The immune system of the host animal produces antibodies (mainly IgG) in reaction to the foreign antigen. Blood serum drawn from the host animal is purified and tested to determine the range of reactivity of the antiserum. The purified antiserum is then freeze-dried for storage and shipment. After receipt of a new lot of antiserum, the AINW laboratory routinely tests each antiserum against representative specimens from up to 32 different animal species.

AINW obtains forensic-grade bear, bovine, cat, chicken, deer, dog, guinea pig, horse, mouse, rabbit, rat, and sheep antisera from MP Biomedicals, LLC (MPB). Human and goat, antisera are manufactured by Sigma Chemical Corporation (Sigma). Bethyl Laboratories manufactures Camel antiserum, which will also react with pronghorn antelope residue. Duck and pigeon antiserum is obtained from Biorbyt Laboratories. Trout antiserum is manufactured by Cocalico Biologicals, Inc. (CBI). The bear, bovine, cat, deer, dog, horse, pigeon, and rabbit antisera react well within their own taxonomic family (Ursidae, Felidae, Cervidae, Canidae, Equidae, Columbidae, and Leporidae respectively) but do not react with blood proteins from animals from other taxonomic families. Experiments have shown that the deer antiserum reacts well with other cervids such as white-tail deer, mule deer, elk, and moose, but does not react with other artiodactyls such as domestic cows, bison, antelope, goat, or sheep. The MPB chicken antiserum reacts with members of four families of three orders of Superorder Neognathae. These include Phasianidae (pheasants, partridges and quail) and Tetraonidae (grouse) of Order Galliformes, Columbidae (doves and pigeons) of Order Columbiformes and Anatidae (geese, ducks, and swans) of Order Anseriformes. The MPB rat antiserum also reacts broadly at the level of Order Rodentia with many species of rats, mice, and squirrels. The MPB guinea pig antiserum also reacts with many rodents including beaver and porcupine. The MPB

sheep antiserum reacts with members of the Subfamily Ovidae including domestic sheep and bighorn sheep. Goat antiserum (Sigma) reacts strongest with sub-family Caprinae, which includes goat, sheep, chamois, and muskox. It will react more subtly with other artiodactyls within the Infraorder Pecora, specifically the families of Cervidae (deer) and Bovidae (cattle, goats, sheep, and antelope). The Sigma sheep antiserum reacts with members of Subfamily Ovidae, and less strongly with other bovids, cervids, and antilocaprids. The MPB and CBI trout antiserum reacts with members of the Genus Oncorhynchus: salmon, steelhead, rainbow trout. A chart included with this report shows the species found to interact with each antiserum.

### **THE AINW RESIDUE ANALYSIS LABORATORY**

Ancient protein residues are often difficult to extract from the artifacts that have preserved them. The AINW Residue Analysis Laboratory uses a 5% ammonia solution, which has been used for similar applications in forensic medicine (Dorrill and Whitehead 1979; Kind and Cleevly 1969). Ammonia is generally more effective in lifting old and partially denatured blood proteins than other solvents (Newman 1990). A small amount of the ammonia solution is applied to the artifact in a plastic tray, and the tray and artifact are placed in an ultrasonic bath (Branson 2200) for 30 minutes or longer. The artifact in solution is then placed on a mechanical rotator (Thermolyne Rotomix) for an additional ten minutes. Artifacts too large for the ultrasonic extraction may be placed on the rotator for 30 minutes or longer. Residues from soil samples can also be extracted using variations of these methods. The extraction solution is then drawn off and stored in an airtight microcentrifuge tube. The extracts are centrifuged to clarify the sample, refrigerated, and the CIEP test is run as soon as possible after extraction. The extracts may be frozen immediately if testing is to be delayed for more than one week.

AINW's CIEP method uses an agarose gel as a substrate. Standard analysis procedures begin with extracting residues from the artifacts with a 5% ammonia solution. The artifact extracts are then placed singly into gels, and tested against the antisera selected for these tests with the CIEP technique. In addition to the artifact extracts, positive and negative control sera are run with each gel. This is done to determine if there are any contaminants or extraneous proteins that may give false positive results. If an anomalous result such as an extract reacting with multiple antisera or to a negative control serum is obtained, the extract solution is mixed with an equal volume of a 1% solution of a non-ionic detergent to increase chemical bonding specificity, and is run through the CIEP process again. If a reaction still occurs after the addition of the non-ionic detergent, any reactions of those specimens to the antisera are discounted. Experiments at AINW have implicated plant pitch used in hafting prehistoric stone tools as a possible cause of some cross or non-specific reactions.

Electrophoresis is used to drive the antigens and antibodies together. The gel substrates are placed in acrylic electrophoresis tanks filled with barbital buffer solution, then attached to the regulated H.V. power source. The antibodies move toward the cathode because of the overall negative charge on the molecule, while the antigens move toward the anode. A precipitate is formed where the proteins meet and bond in the area between the wells, visible as a white line or arc (Culliford 1971). The gel is soaked overnight in saline to stabilize the reaction, then dried and stained with a standard protein stain as a permanent record of the CIEP results. The dried and stained gel is then backlit on a light table, and examined under magnification for the presence of precipitate lines, indicating positive reactions.

After testing the extracts are refrozen and stored for one year in case additional testing is requested.

## **HINTS FOR ARTIFACT COLLECTION AND TREATMENT FOR RESIDUE ANALYSIS**

For optimum results, the following suggestions are provided for archeologists considering submitting artifacts for blood residue analysis (see also Marlar et al. 1995:36)

1. Handle artifacts as little as possible in the field. Avoid contamination by using latex gloves, the tip of a clean trowel, or other careful methods similar to the treatment of radiocarbon samples.
2. Do not brush off, spit clean, or wash the artifact. Since proteins are known to bind to soil particles, loss of adhering dirt may result in loss of blood antigen.
3. Place the artifact in a clean ziplock bag with as little loose dirt as possible.
4. Submit a small amount (about one tablespoon) of soil from the area adjacent to the artifact. As bacteria or animal excreta in the soil may cause false positive reactions, soil controls are useful for cross checking results from artifacts.
5. Positive results have been obtained from projectile points, scrapers, flake tools, debitage, bone, burned bone, fire-cracked rock, cobble tools, ground stone tools, and soil samples from features and general site contexts. Surface artifacts are also good candidates for residue preservation. Obsidian, CCS, and basalt artifacts are equally likely to preserve residues, although some more porous materials may contain more proteins.
6. When selecting the type of antisera for analysis, consider allowing for a broad range of testing supplemented by more specific testing of positive results (for example, testing positives for chicken against duck and pigeon to narrow the results). If an artifact tests negative for all of the selected antisera, it may still contain preserved residues from other species.

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