Winter 12-9-2016

Zooarchaeology of the Native American Sturgeon Fishery in Coastal Oregon, 350 BC to AD 1150

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Fall, 2016

Abstract
Sturgeons are not found often in the archaeological record due to their largely cartilaginous skeleton. What remains are the scutes, bony scale-like plates found on the outside of the body, and some diagnostic cranial features. Perhaps due to this, little is known about sturgeon or their anthropological uses in the past. Due to the size of a site excavated on the Oregon Coast, the collection contains an uncommon amount of archaeological sturgeon bones. The two sturgeon species on the Northwest coast, the green and white, have historically been heavily fished; resulting in a conservation concern for the fishery. As species determination may prove to be difficult, due to the lack of knowledge or fragmentation of the bones, ancient DNA analysis will be preformed at the University of Oklahoma. The project is focused on understanding the prehistoric sturgeon fishery through the analysis of sturgeon osteology, species identification, and sturgeon ecology. This information will hopefully ultimately be used to assist current conservation efforts.

Keywords: Zooarchaeology, human-animal interactions, sturgeon, Northwest Coast

Introduction

Sturgeon remains are rare in the archaeological record due to their largely cartilaginous skeleton. Consequently, little is known about sturgeon ecology and human influence in the past, particularly along the Northwest Coast of North America (Broughton et al. 2015; Gobalet et al 2004; McKechnie and Moss 2016). Two sturgeon species occur in the Pacific Northwest *Acipenser medirostris* (green) and *Acipenser transmontanus* (white), however they have not been differentiated in previous analysis due to their similar bone morphology (Broughton et al 2015; Broughton 1997; Moss 2015; McKechnie and Moss 2016).

Historically heavy fishing of the white and subsequent by-catch of the green has resulted in the listing of the green as near threatened (IUCN 2016). Because of the white's local economic importance and the green's conservation status, knowing about the abundance and uses of sturgeon prior to intensive fishing can provide context for the conservation of pacific sturgeon. Fish remains can tell us about the species exploited, information about the habitat, methods used to capture the fish, and can establish population and body size as well as seasonality of the fishing location (Wheeler and Jones1989). When noting what is present, the settlement patterns and procurement activities of the past can be estimated (Wheeler and Jones 1989). With an understanding of what the requirements and preferred habitats of fishes identified from an archaeological site, it is possible to assume what kind of river was being exploited (Wheeler and Jones 1989). This information is useful for conservation and restoration of both fish species and rivers.

Drawing on ethnohistoric accounts, faunal remains, and ancient DNA (aDNA) analysis from the Par-Tee site (35CLT20) in Seaside, Oregon, we attempt to evaluate the nature of sturgeon utilization based on the large assemblage of archaeological sturgeon bones. We focus on four main questions: 1) What sturgeon bone elements are present in the assemblage? 2) Can we determine the species of sturgeon that are present at the site and estimate their size and age? 3) How are sturgeon remains distributed across space and through time at Par-Tee? 4) What, if anything, can this tell us about the contemporary sturgeon fishery? We examined the identifiable sturgeon remains for any morphological differences and evaluated their spatio-location within the Par-Tee site. We also analyzed aDNA from 30 of these specimens to determine the species of sturgeon that were present in the assemblage.

Background and Context

Biology and Ecology of Sturgeon

Sturgeons are anadromous fish; they hatch in freshwater ecosystems but live and feed in marine and estuarine environments, returning to freshwater habitats to spawn Columbia (The Northwest Power and Conservation Council 2004, Bemis and Kynard 1996, Wheeler and Jones 1989). Because some populations of the white are landlocked in freshwater lakes, reservoirs, and tributaries of the Columbia River due to dams, they may be considered semi-anadromous or facultative potadromous Columbia (The Northwest Power and Conservation Council 2004, Doroshov et al. 1997). Unlike anadromous salmonoid species, white sturgeon do not require physiological changes prior to migration between fresh and salt water and can remain in estuarine habitat for extended periods Columbia (The Northwest Power and Conservation Council 2004, Except for a few outliers, nearly all sturgeon species live in temperate climates of the Northern hemisphere Columbia (The Northwest Power and Conservation Council 2004, Bemis and Kynard 1996, Wheeler and Jones 1989).

Historically, the green sturgeon inhabited the marine and estuarine waters along the eastern North Pacific, from the Gulf of Alaska to Ensenada, Mexico Columbia (The Northwest Power and Conservation Council 2004, Artyukhin et al. 2006, Moyle et al. 1994). Spawning populations occur in the Sacramento, Klamath, and Rogue Rivers and while green sturgeon do not spawn in the Columbia River basin, they do utilize the habitat Columbia (The Northwest Power and Conservation Council 2004, The white sturgeon's distribution overlaps that of the green sturgeon, but is more limited to the western North Pacific and inhabits coastal rivers from California to central British Columbia, the Sacramento-San Joaquin, Columbia, and Fraser Rivers being the only spawning rivers Columbia (The Northwest Power and Conservation Council 2004, Artyukhin et al. 2006, Doroshov et al. 1997).

Food abundance is a major factor in the migration of fish and can have a profound impact on age and size structures Columbia (The Northwest Power and Conservation Council 2004, Wheeler and Jones 1989). The shallow (<100m) interfaces between freshwater and saltwater can be nutrient rich, and sturgeon are known to feed at these productive environments, and are not often found in deep marine environments while at sea nor do they make extensive offshore migrations, staying within 2,500 km of major river systems Columbia (The Northwest Power and Conservation Council 2004, Bemis and Kynard 1996).

White sturgeons are long lived (≤ 82 years of age), slow maturing, and may continue to grow for years after reaching adulthood Columbia (The Northwest Power and Conservation Council 2004, Doroshov et al. 1997; Bemis et al 1997; Birstein et al. 2002; Wheeler and Jones 1989). In the wild, males reach sexual maturity between 10-12 years with a body weight of 12kg and females between 15-32 years with a variable body size and weight Columbia (The Northwest Power and Conservation Council 2004, Doroshov et al. 1997). Acipenseriforms tend to have a flexible pubertal age that may be influenced by environmental factors, as seen here in the white sturgeon (Doroshov et al. 1997).

Whites are communal spawners and spawn repeatedly, males every 2-4 years and females no more frequently than every 5 years, continually over a 30-40 year period Columbia (The Northwest Power and Conservation Council 2004, Bemis and Kynard 1996). The availability of suitable habitat is critical to reproductive success (Bemis and Kynard 1996). Whites spawn in freshwater rivers of low salt content (0-0.1%), even though most adults migrate out to estuarine or seawater to feed (Bemis and Kynard 1996). Both white and green sturgeon generally spawn in high velocity areas associated with hard-bottomed, structured habitats with adequate interstitial space and predation protection Columbia (The Northwest Power and Conservation Council 2004, Bemis and Kynard 1996).

River migrations and spawning follow seasonal patterns, for example, the white sturgeon population in the Sacramento River peak spawn in April, when the water is 14-15° C, whereas in the lower Columbia major spawning occurs in May when the water is between 12 and 14° C, making spawning a function of water temperature Columbia (The Northwest Power and Conservation Council 2004, Doroshov et al. 1997, McCabe and Tracy 1994, Kohlhorst 1976). Green sturgeons migrate into fresh water in the spring beginning in February to spawn from March to July Columbia (The Northwest Power and Conservation Council 2004). Deep (3m), turbulent waters are favored by the green, and individuals will travel hundreds of miles upriver to spawn; the Klamath and Rogue River populations will travel within 100 miles from the ocean, the Sacramento population over 200 miles Columbia (The Northwest Power and Conservation Council 2004). Eggs are broadcast over large rock to settle in the cracks Columbia (The Northwest Power and Conservation Council 2004). Juvenile green sturgeons grow quickly and spend the first 1-4 years in fresh and estuarine environments Columbia (The Northwest Power and Conservation Council 2004).

Information abundance concerning the sturgeon species of the Northwest Coast favor the white over the green. Even though the green sturgeon is the species of conservation concern, this may be due to the white's larger economic impact. Further research is needed.

Threats to Sturgeon populations

Sturgeons are increasingly threatened in their native ranges (Bemis et al 1997 Birsten et al 2002). Worldwide, sturgeons have come under conservation efforts in response to increasing numbers of threatened populations; in North America, sturgeons are second only to marine *Sebastes* (Scorpaenidae) in terms of numbers of threatened or endangered species Columbia (The Northwest Power and Conservation Council 2004). Because sturgeons inhabit large river systems, their major threat is large-scale habitat alterations Columbia (The Northwest Power and Conservation Council 2004). Paired with overharvest, habitat loss is the main cause of sturgeon population declines Columbia (The Northwest Power and Conservation Council 2004). The longevity, slow growth, and delayed maturation of sturgeon make them vulnerable to overexploitation Columbia (The Northwest Power and Conservation Council 2004), and make it difficult for the population to bounce back.

Commercial fishing and the construction of dams in the major Pacific rivers at the turn of the century severely depleted and fragmented wild stocks, including the collapse of the Columbia River population Columbia (The Northwest Power and Conservation Council 2004, Doroshov et al 1997, Galbreath 1985, Semakula and Larkin 1968). Intensive fishing of the Columbia began in 1889 and peaked in 1892 with about 2.5 million kg of sturgeon harvested; by 1899 the stock was depleted Columbia (The Northwest Power and Conservation Council 2004). In 1950 a maximum size regulation allowed the population to rebound, as it strove to protect sexually mature adult sturgeons, however, overharvest continued to occur; the harvest rate during the seasons of ’85-’87 took 30% of the 3-6ft population, twice what the population could sustain Columbia (The Northwest Power and Conservation Council 2004).Currently, sport fishing is the major harvester of stocks in the Columbia River and in the San Francisco Bay (Doroshov et al 1997). During times of heavy exploitation, fish sizes decline (Wheeler and Jones 1989), and individuals belonging to depleted populations of sturgeon seldom achieve the sizes of those prior to exploitation (Bemis et all 1997Birstein et al. 2002).

Prior to the damming of major rivers in the NW, white sturgeon historically migrated from the Pacific Ocean to the Columbia’s headwaters in Canada and the upper Snake River in Idaho Columbia (The Northwest Power and Conservation Council 2004). These dams have fragmented this habitat into short sections, isolating landlocked populations which are far less productive than the anadromous population downstream of the Bonneville Dam on the Columbia (The Northwest Power and Conservation Council 2004).

Bone and Individual Variation

Fishbone is less dense than other types of bone as water provides body weight support, making the bones are susceptible to fragmentation and subsequent degradation (Wheeler and Jones 1989). The sturgeon skeleton is mainly composed of cartilage with the exception of the bony scutes and head (Wheeler and Jones 1989). Both white and green sturgeon display a high degree of trunk ossification; the main rows of scutes do not undergo absorption and the body is further covered by smaller scutelets, platelets, and denticles (Artyukhin et al. 2006). In all marine Pacific sturgeons, the patterning (or sculpting) of the scute surface changes during growth from a tubercular–radial pattern to an alveolar pattern (Artyukhin et al. 2006). In North American species, this process occurs later and the alveolar pattern is apparent in adult fish, and in white sturgeon, the pattern becomes quite evident in mature individuals (Artyukhin et al. 2006). In green sturgeon, a row of lateroventral scutelets are often present and these scutelets are adorned with large sharp hooks (Artyukhin et al. 2006).

Acipenseriforms, like the green and the white, often exhibit extreme individual variation, including both external morphology and bone patterning (Bemis et al 1997 Birstein et al. 2002) This variation can also occur across geographic location (Bemis et al 1997 Birstein et al 2002). Natural hybridization and anthropogenic impacts, ranging from selective overfishing of one species to large-scale alterations in river systems, contribute to the difficulties in distinguishing species (Bemis et al 1997 Birstein et al. 2002). Most systematic studies, however, are disproportionately slanted towards juvenile specimens, perhaps distorting the morphological data (Bemis et al 1997, Birstein et al. 2002).

<u>Ethnographic Information</u>

The primary subsistence activities of the Chinookan people involved hunting, gathering, and fishing, and while the Pacific Ocean formed the western boundary of their environment, little to no fishing was done in the ocean (Beierle 2003). They instead preferred fishing out of the more accessible and productive fishing grounds of the Wallapa Bay and Columbia River (Beierle 2003; Ray 1938). They fished for sturgeon from both the bay and the river (Ray 1938). There were a few distinct sturgeon sites favored by the Chinooks on the Columbia (Silverstein 1990). Fishing was the principal economic subsistence endeavor of the Chinook, and while salmon was of primary importance, sturgeon, trout, smelt, herring, and flatfish, as well as sea mammals, also played an important economic role (Ray 1938; Hester 2011). A single sturgeon could provide a huge supply of food (Ray 1938).

Most of the Chinook villages were located along the Pacific seacoast and the banks of the Columbia River (Beierle 2003). Before 1850, the Yurok would live in permanent villages along the Pacific coast and on the lower 45 of the Klamath River because of the wealth of shellfish, salmon, sturgeon, eel, candlefish, surf fish, deer, elk, sea lion, and acorns allowed for sedentary living (Pilling 1978). The seasonal runs of salmon, sturgeon, steelhead trout, eulachon, and herring usually took place in the late spring and early summer (Beierle 2003), but the Chinook would also fish in the lower Columbia in January for smelt and sturgeon (Ruby and Brown 1976).

Fishing techniques included the use of nets, spears, and detachable gaffhooks on lines (Beierle 2003). Commonly, sturgeon was fished using a conical bag net between two canoes, designed to take only one large fish at a time (Ray 1938). The Chinook also used a small straight web for sturgeon (Ray 1938). The Yurok would make a long net that had a six inch mesh with a width of three feet and a length of 85 feet, doubled to double the width and half the length, and set it for sturgeon (Kroeber 1925). A lone fisherman might catch several sturgeon (Ray 1938). Sturgeon might also be obtained by scavenging washed-up individuals from the beach (Ray 1938).

The most common fishing technique to harvest sturgeon was line and hook fishing, next to seining (Ray 1938). Fishers would probe the river bottom with seventy to eighty-foot poles with detachable spears searching for sturgeon, and after spearing a sturgeon, the fisher would wear the fish down before clubbing the fish in the head with a wooden mallet, then haul the fish into their canoe (Figure 10; Ruby and Brown 1976; Silverstein 1990). There are also accounts of Chinooks catching sturgeon using wooden hooks fastened to lines made of twisted tree roots, and bone was also used for harpoon points previous to European contact (Ruby and Brown 1976).

> “The hook was made of hardwood in two pieces bound together with string and pitch so that an acute-angled, V-shaped implement was produced. The line was fastened to one extremity; the opposite one, which was turned slightly inward and sharpened, served both as point and barb. The line permanently fastened to the hook was short; in use it was tied to another line of the required length. This was quite heavy when used for sturgeon and of strong fiber such as spruce root or cedar bark. Hooks, and also nets, were rubbed with wild celery root to attract the fish” (Ray 1938).
>
> “From Swan: As soon as the sturgeon feels the hook, away he starts like an arrow, and the canoe goes whizzing and spinning along at a fearful rate, and requires a good deal of dexterous management to prevent being turned over. As

> the fish slackens speed, the Indian hauls in the line, and by perseverance at last tires the fish so that it is hauled to the surface of the water, and stunned by a blow on the head or nose with a heavy club carried for the purpose. The trouble now is to get he sturgeon into the canoe, for sometimes these fish weigh from three to four hundred pounds, and are from twelve to fifteen feet long. The Indian contrives to get the sturgeon's head over the gunwhale of the canoe, and with a peculiar twist suddenly jerks the fish in without any apparent difficulty…. Sometimes an Indian will catch two or three great sturgeon during one tide, for they generally begin to fish as the tide begins to flood, when the sturgeon follow up in the shoal water to feed…. The Indians prefer them to salmon, but it is much more difficult to take them" (Ray 1938).

Sturgeon carcasses were prepared, as described by Swan,

> "The fish "is opened, care being taken to save all the blood, which is put into a kettle with some choice cuts, and then boiled. The head, like that of the salmon, is esteemed the best part, and is either boiled, or cut in strips and broiled or roasted before the fire. The pith of the back bone is considered a great luxury…. The rest of the fish is then cut in thin strips and dried in the smoke" (Ray 1938).

Sturgeon could be kept for days by being immersed in water, then were cooked by being cut into pieces, spitting these pieces, and placing them in layers over heated stones that were wetted to produce steam with green boughs between them (Ruby and Brown 1976). Sturgeon were also cooked by steaming them in an earth oven or by smoke-drying (Silverstein, quoting Lewis and Clark 1990). The great seasonal runs of salmon, sturgeon, steelhead trout, eulachon, and herring provided smoke-dried food for the winter (Silverstein 1990).

The Chinook regarded sturgeon as fine a food as salmon, even as a greatly prized delicacy (Ruby and Brown 1976; Silverstein 1990, Ray 1938). First salmon ceremonies were preformed for the first salmon caught of the season, and these rites were likely preformed for the first sturgeon as well (Beierle 2003). A girl going through a period of isolation during a puberty ritual is not allowed to eat anything that is in season, be it salmon, sturgeon, shell-fish, or berries as it was believed that the fish would disappear, the shell-fish would make the people sick, and the berries would not ripen (Ray 1938). Dried sturgeon was a commodity that was traded in all directions from the Columbia, along with dried salmon, dried smelt, dried seal meat, blubber, and canoes (Ray 1938). Lewis and Clark documented many instances of sturgeon being bartered and traded on equal frequency as salmon (Ruby and Brown 1976). A sinew-backed bow was made using sturgeon gelatin glue, made by boiling the head, and was used extensively in hunting and war (Ray 1938, Ruby and Brown 1976; Olsen 1936).

<u>The Par-Tee Site (35CLT20) and Previous Research</u>

The Par-Tee site, a Native American village and shell midden near Seaside, Oregon, contains a large assemblage of archaeological sturgeon. The Par-Tee site is located on the Oregon Coast south of the Columbia River and dates to 350 BC to AD 1150 (Wellman et al. 2016). Sturgeon bones were part of a zooarchaeological assemblage containing mammals, birds, and other fish.

Materials and Methods

We inventoried 1770 sturgeon bones from the Par-Tee assemblage. Bones were identified systematically by provenience and determined to be sturgeon based on their characteristic morphology and in comparison to modern skeletal reference specimens. Bones that were identifiable to element were the focus; fragments were those bones that demonstrated alveolar patterning on the external side of the bone, as is characteristic of sturgeon.. Only external bone displays the alveolar patterning; several sturgeon bones do not exemplify this characteristic and there may be bone that remained unanalyzed due to this. Element identifications were made using the comparative white and green sturgeon specimens provided by the California Academy of Sciences.

After identifying bone to element, we grouped the bone by element and analyzed each bone for signs of cut marks and conducted a morphological comparison between archaeological bone using the comparative specimens. Here is where we noted any differences in bone morphology, size of bone, and number of element present (Findeis 1996; Thieren et al. 2015). Counts of sturgeon bones and all other fish bones were kept by provenience.

<u>Sample Preparation and Ancient DNA</u>

Because the green and white sturgeon species on the Northwest coast have not previously been identified to species ((Broughton et al 2015; Broughton 1997; Moss 2015; McKechnie and Moss 2016), we sampled 30 bones for aDNA analysis in order to determine which species, if both, were present.

Results

Analysis of the Par-Tee sturgeon remains produced 1770 sturgeon bones identified from the assemblage out of a total of 43861 fish bones, making sturgeon represent 4% of the fish bones analyzed in the assemblage. 600 of the bones identifiable to sturgeon were too fragmentary to identify to element. The bones were then grouped by area of the body. Of the 1173 identifiable sturgeon bones, 405 were cranial bones, 140 were pectoral girdle bones, and 628 were scutes. The most numerous were scutes (35%), followed by fragments (34%), cranial bones (23%), and pectoral girdle bones (8%) (Figure 1 and 2).

Further, the preservation of the cranial bones and scutes was enough to further identify the bones to element. Although pectoral girdle bones were identifiable to body group, they were not identifiable to element, outside the first pectoral fin ray. Of the cranial bone group, the most represented bone are neurocranial bones (34%), followed by gill arches (27%), jugal bones (22%), and then Entopterygoid, vomer, dentary, dermopalatine, ectopterygoid, and parasphenoid (under 10%) (Figure 3). Of the scutes, the most represented are both dorsal and ventral scutes (25%), followed by lateral scutes (17%), platelets and fragments (both 14%), and preanal scutes (5%) (Figure 4). The percentage of those scutes that showed a 'clawed' trait is 8% (Figure 5). The most active level overall was level 6 (Figures 6, 7, 8, 9).

Because of the nature of sturgeon skeletal anatomy, an MNI was not preformed. Further, because of the fragmentary nature of the bone, size reconstruction was also not preformed.

Discussion

Our research focused on four main questions: What sturgeon bone elements are present in the assemblage? Can we determine the species of sturgeon that are present at the site and estimate their size and age? How are sturgeon remains distributed across space and through time at Par-Tee? What, if anything, can this tell us about the contemporary sturgeon fishery? Our research was successful at addressing each question, though questions still exist and further research is needed.

<u>What sturgeon bone elements are present in the assemblage?</u>

A small percentage (4%) of all fish bones from Par-Tee are sturgeon. The majority of the bones in the assemblage are fragments, with diagnostic bones consisting largely of scutes and some cranial elements. Because a small percentage of sturgeon skeletal anatomy is ossified, sturgeon abundance is likely underestimated compared to other fish, like salmonoids (Moss 2015). And because the total percentage of ossified bones in an individual sturgeon is not known, this information may or may not be indicative of typical taphonomic patterns, let alone representing butchery. However, based off of the ethnographic accounts of preparation of sturgeon meat and use of sturgeon heads for glue, the higher proportion of cranial bones and scutes in comparison to pectoral girdle bones might be explained. If harvested sturgeon were skinned and beheaded in the midden area, the majority of the bones would remain there, whereas bones connected to flesh, like girdle bones, might have been deposited somewhere else.

Further, if the ethnographic accounts of preparation can be interpreted, a sturgeon carcass was likely split up to the cranial elements, it would fracture the pectoral girdle bones. These bones may account for the bulk of the fragmented bones unidentifiable to body group or element, and may also account for why the pectoral girdle body group is the least represented.

<u>Can we determine the species of sturgeon that are present at the site and estimate their size and age?</u>

Some minor differences were noted in scute morphology. A small number (~8%) of the scutes analyzed were distinctly hooked in comparison to the majority of scutes present, which were labeled “dull.” This may be indicative, morphologically, of two separate species. As Artyukhin et al. described, sharp (or clawed) scutes are a trait of green sturgeon (2006).

Also, the research did find a morphological difference in alveolar patterning in the sturgeon remains from Par-Tee. Some bones displayed a linear pattern, whereas in others the pattern was more organic. Future research could determine if the alveolar patterning discussed in previous research in relation to white sturgeon is markedly different than the alveolar patterning of green sturgeon bones (Artyukhin et al. 2006).

Questions remain about the attribution of these traits to species (see NOAA). As has been previously reported, systematic studies on sturgeon are usually conducted on juvenile specimens, likely skewing the morphological findings as individuals markedly change between juvenile and adult stages (Artyukhin et al. 2006). Further, individual variation is extreme even within a single species (Bemis et al 1997 Birstein et al. 2002).

Following the recorded ecology of both species of sturgeon, and using ethnographic records, we attempted to determine the likelihood of either species to be chosen. The river and estuary habitats were preferentially fished for a variety of reasons, including safety, productivity, and accessibility (Beierle 2003; Ray 1938). As it happens, sturgeons, due to food abundance, remain within and close to estuary and river systems. Both species of sturgeon spawn in river ecosystems, yet green sturgeon does not spawn in the Columbia River while the white does (The Northwest Power and Conservation Council 2004). Further, the green travels great distance to spawn, likely lessening their numbers in the estuary of the Columbia River. The fish prefers to feed at a shallow water depth at the nutrient rich brackish water interface, correlating with the native fisher's use of long poles. Following prey-target thought, fishers would likely target the larger white sturgeon over the smaller green. Further, white have been historically over-fished for their flesh, while green are in decline due to by-catch for the white. It is by no stretch of the imagination that native peoples would also prefer the meat of the white to that of the green. Finally, juvenile fish of both species tend to remain in fresh and brackish environments, perhaps skewing the amount of juvenile fish taken in comparison to adults, as this type of environment was the most heavily fished.

Because of sturgeon skeletal anatomy, they are likely underrepresented in the archaeological record. Ethnographic records also emphasize the economic and sacred importance of sturgeon. As some ethnographic accounts recall, sturgeon meat was considered on par with salmon meat and in some cases it was preferred (Ruby and Brown 1976; Silverstein 1990, Ray 1938). Sturgeon was also an important trade item, again equal to salmon (Ray 1938, Ruby and Brown 1976). Sturgeon was important for valuable items, such as weapons used for hunting and war (Ray 1938, Ruby and Brown 1976, Olsen 1936). Rituals were preformed for the first sturgeon caught and to sustain sturgeon abundance and harvest, similarly to salmon (Beierle 2003, Ray 1938). Importance of sturgeon to the Native American communities was apparently high, perhaps equal to that of salmon.

Finally, we did not estimate size, and therefore age, as we had a low proportion of complete cranial bones to use previously reported regression formulae (Broughton et al. 2015, Thieren and Van Neer 2014). Due to this, we cannot comment on the sturgeon population dynamics of the prehistoric fishery. This is an area for potential further research using the Par-Tee assemblage.

<u>How are sturgeon remains distributed across space and through time at Par-Tee?</u>

Distribution of the sturgeon bone suggests that most elements are found in levels 5-7, which are the densest levels of faunal material at the site. This suggests that the most active levels for sturgeon resource exploitation occurred during that time. The most common bones to occur at the peak included the ventral scutes, the pectoral girdle bones, and fragments, which supports the method of butchering illustrated by the ethnographic accounts if the sturgeon were processed at the midden site. Further analysis that will describe the distribution across space is planned.

<u>What, if anything, can this tell us about the contemporary sturgeon fishery?</u>

Archaeological analysis of sturgeon bone can contribute to the understanding of the modern fishery, but preservation and identification issues need to be worked out before we can accurately evaluate this question. Further, population dynamics of the prehistoric fishery would likely be the most beneficial information for current management decisions, and, because we did not conduct an MNI nor a size estimation, we cannot contribute in this way. However, because the high presence of sturgeon bone supports the ethnographic accounts of resource targeting for sturgeon, this may comment on the historic over-exploitation of sturgeon and could possibly be used in a critique of the dams on the river systems in the Northwest, as loss of habitat is likely the main cause of population decline.

Conclusion

Because of the sturgeon's mostly cartilaginous skeletal anatomy, they are a species that does not preserve well in the archaeological record and, because of this, may be underrepresented and possibly overlooked in the discourse concerning the prehistory of the Northwest coast. Because Par-Tee has a high occurrence of sturgeon bones, due to the site's size, we conducted an analysis of the sturgeon bone present. We were unable to preform basic quantitative zooarchaeological analysis due to the fragmentary condition of the bone preservation, and because the skeletal anatomy of the preserved bones of a sturgeon does not lend itself well to basic minimum number of individual counts or others like it. We also did not conduct size estimates because the bones used in previous regression formulae were fragmentary or present in low numbers. However, these types of analyses may be conducted for future research questions.

We did, however, conduct a morphological comparative analysis of the bones present and found a minor morphological difference in the scutes (~8%), which could be indicative of the two species found in the Northeastern Pacific. The collection was also concentrated at levels 5-7, with the most common bones reported possibly supporting the ethnographic accounts for butchering methods. Given the limited understanding around sturgeon, ethnographic accounts were used in order to better understand the process of sturgeon exploitation. This line of evidence concluded that sturgeon was an important resource for the prehistoric peoples utilizing the Columbia River and Wallapa Bay not only for immediate food use, but also for trade with inland peoples and as food storage for the winter months. It was also recorded to have been a highly prized and frequently fished resource, perhaps suggesting that sturgeon as a resource have been overlooked by previous research due to their poor preservation in the archaeological record. Because of this potential, further research on sturgeon resource exploitation on the Pacific Coast is needed. Not only would this be beneficial to understanding the prehistory of the region, it has the potential to inform current ecology and resource management questions, especially given the white and green sturgeon's history of overexploitation and conservation threats.

Tables and Figures

Figure 1

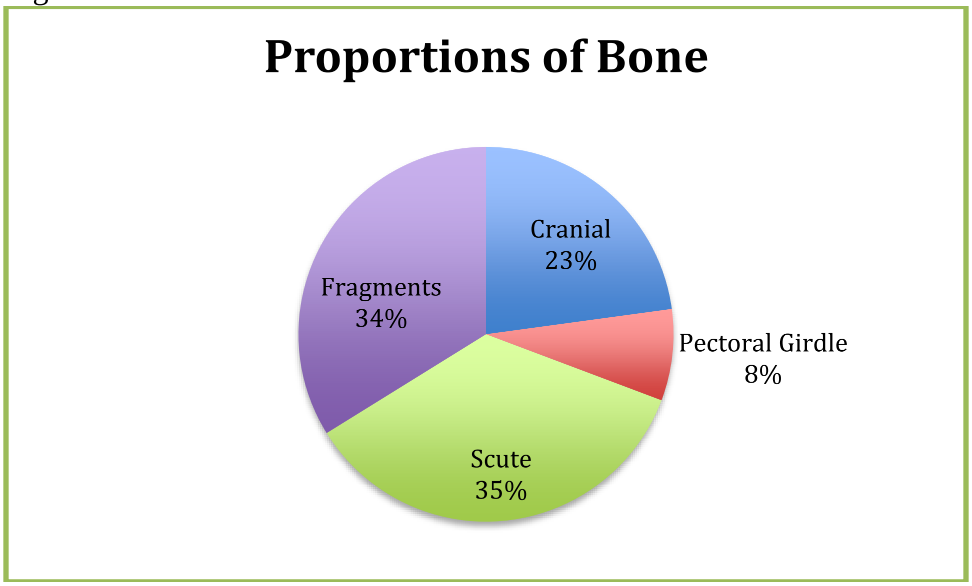


Figure 2

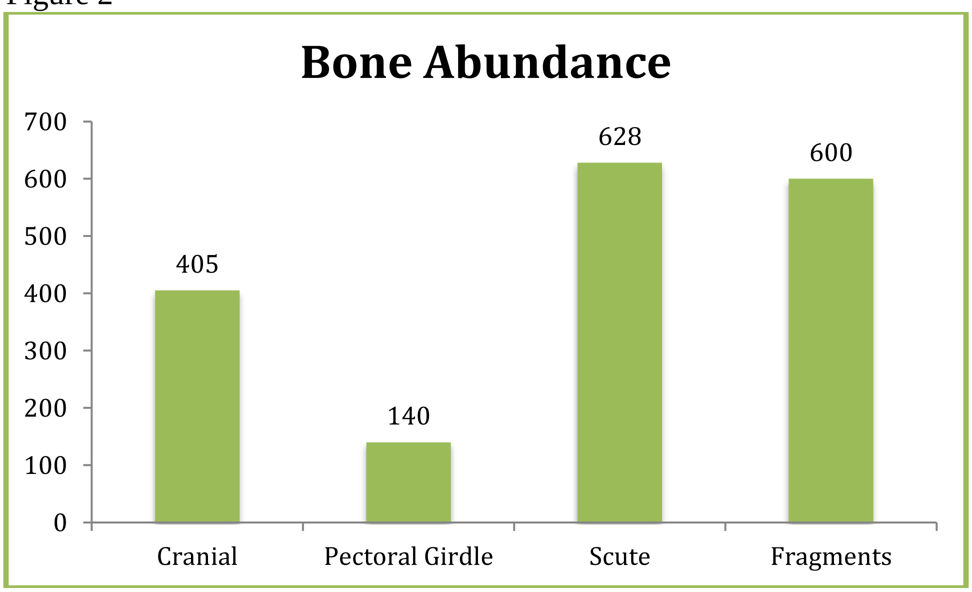


Figure 3

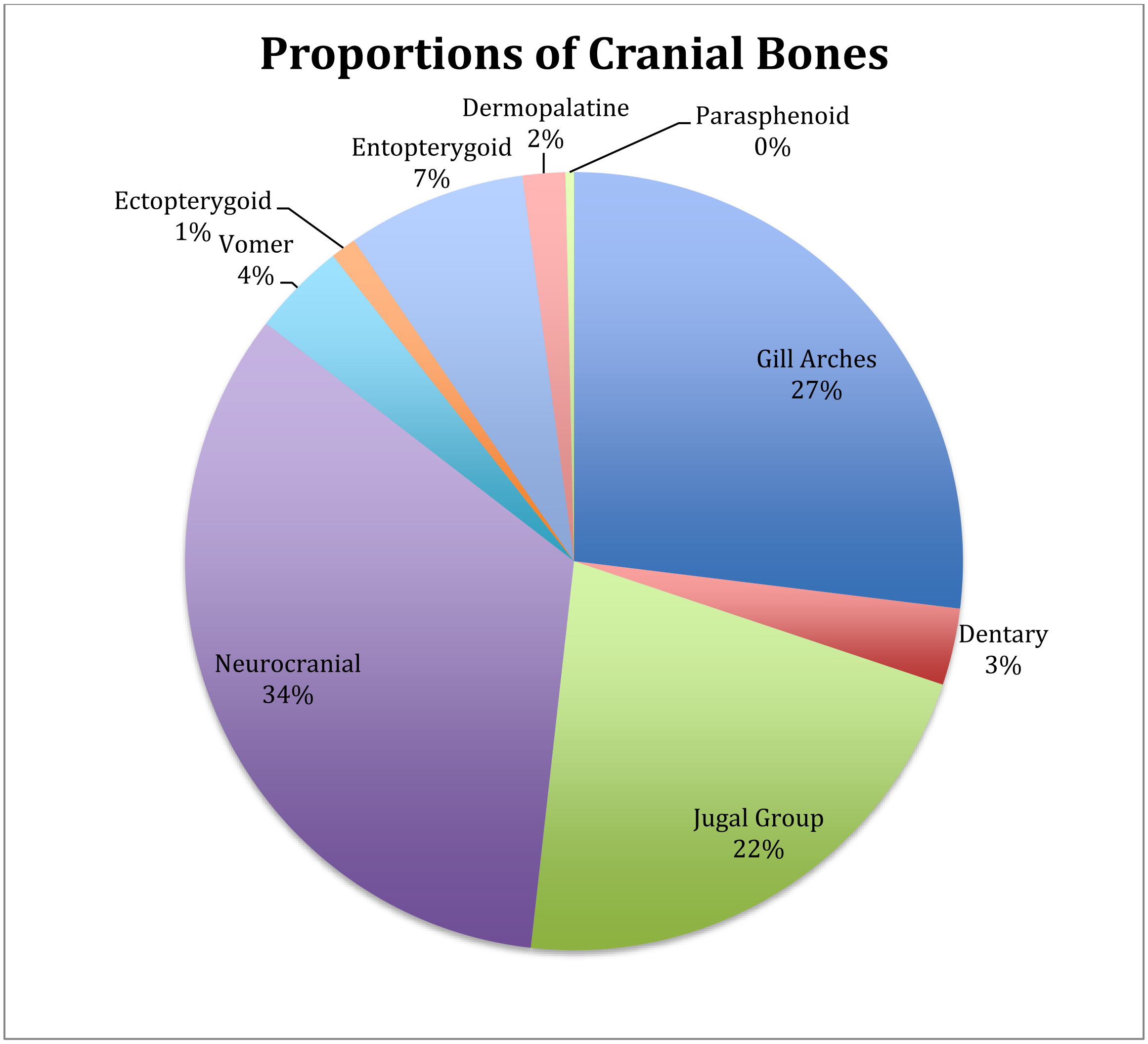

Proportions of Cranial Bones
Dermopalatine
2%
Parasphenoid
0%
Entopterygoid
7%
Ectopterygoid
1%
Vomer
4%
Gill Arches
27%
Dentary
3%
Neurocranial
34%
Jugal Group
22%

Figure 4

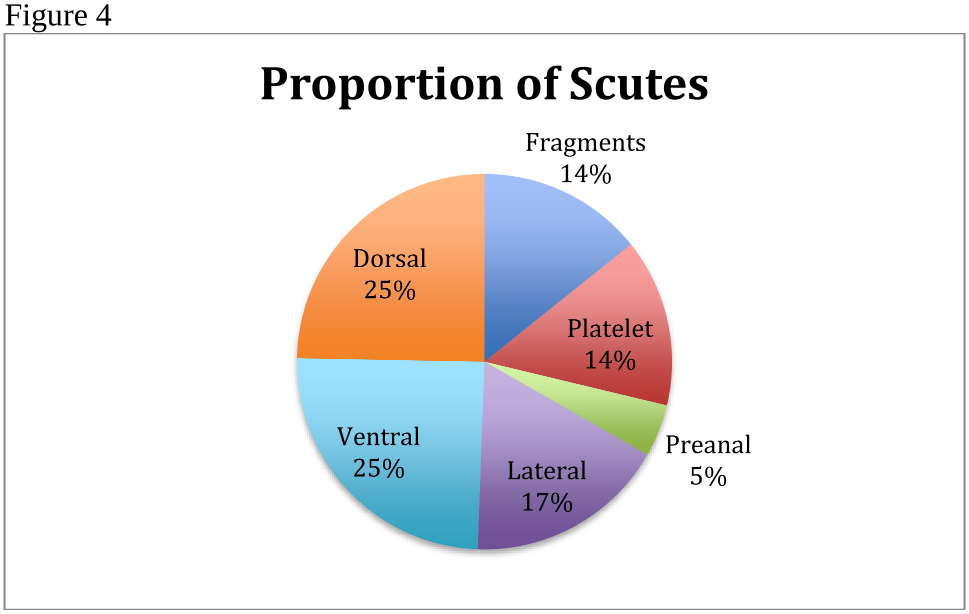

Proportion of Scutes
Fragments
14%
Dorsal
25%
Platelet
14%
Preanal
5%
Ventral
25%
Lateral
17%

Figure 5

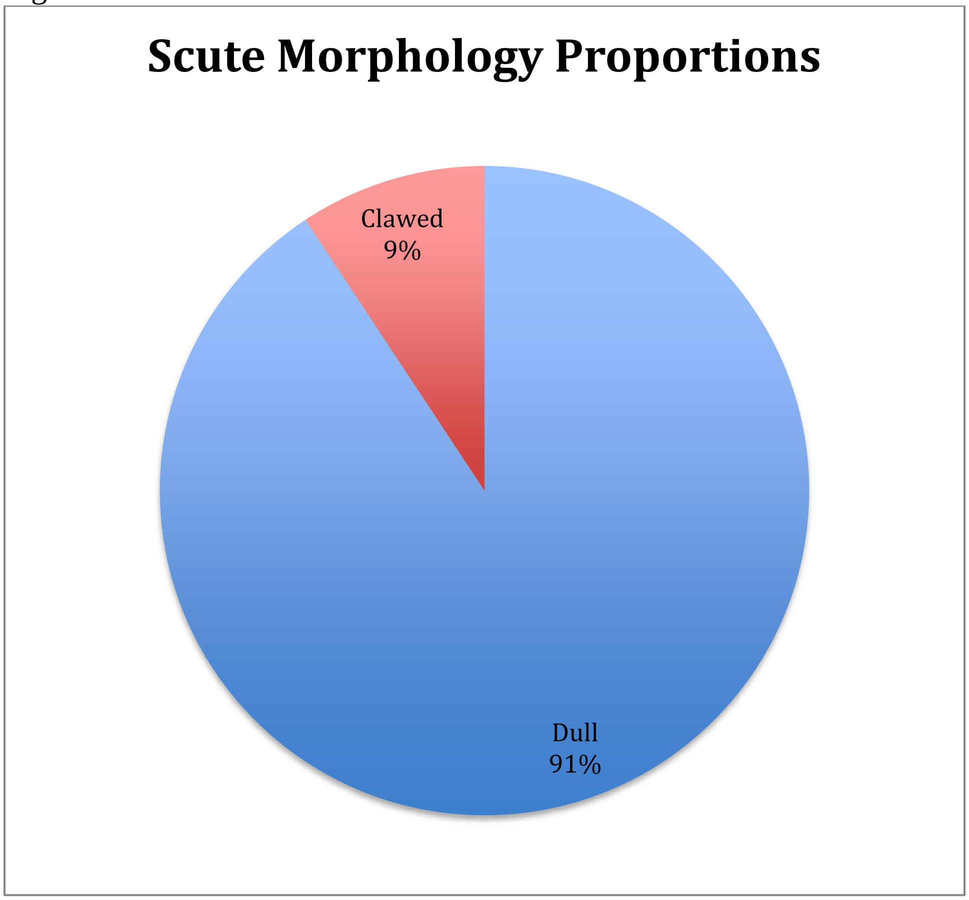


Figure 6

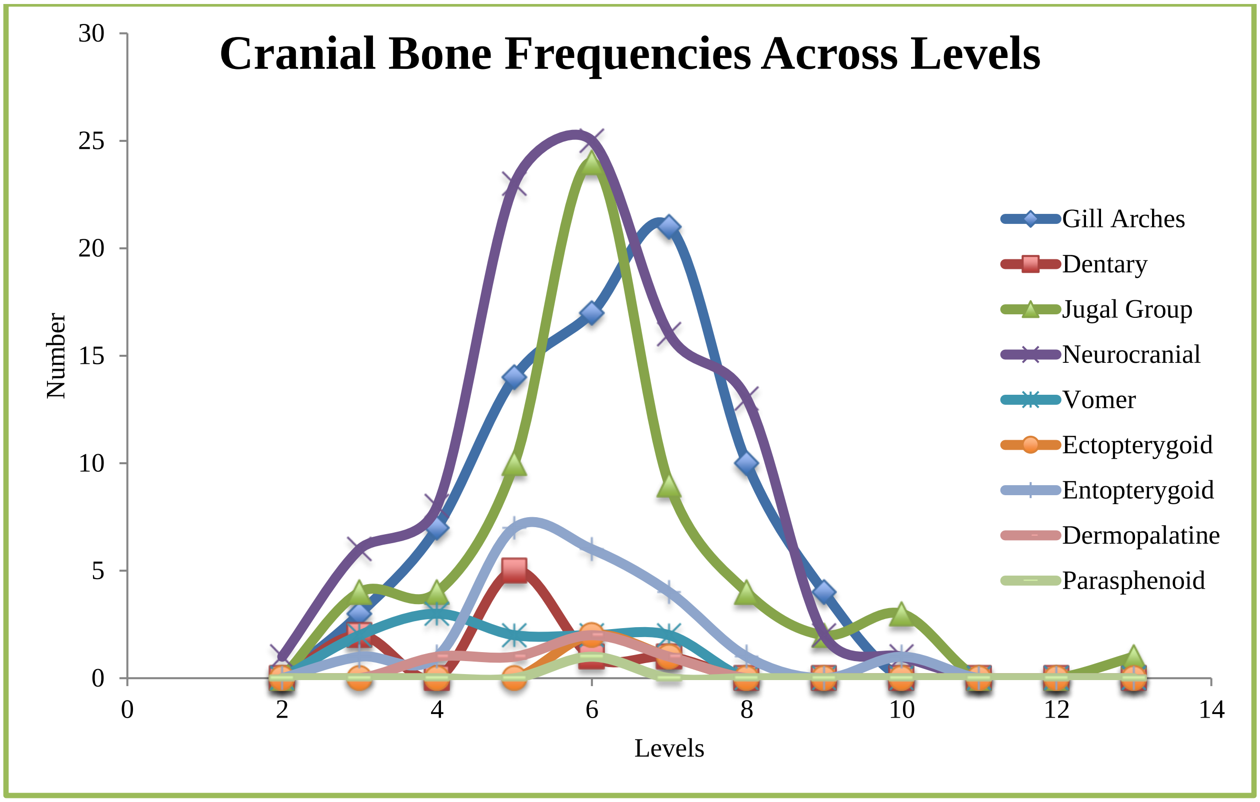


Figure 7

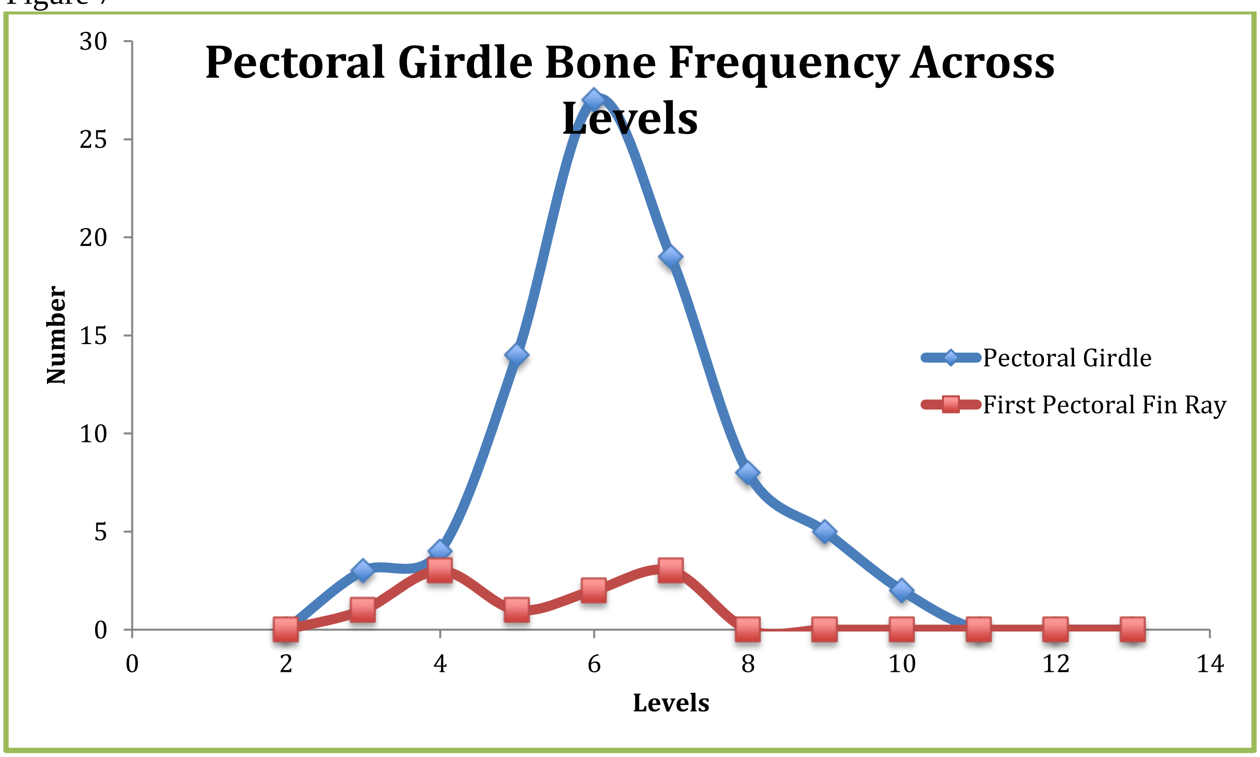


Figure 8

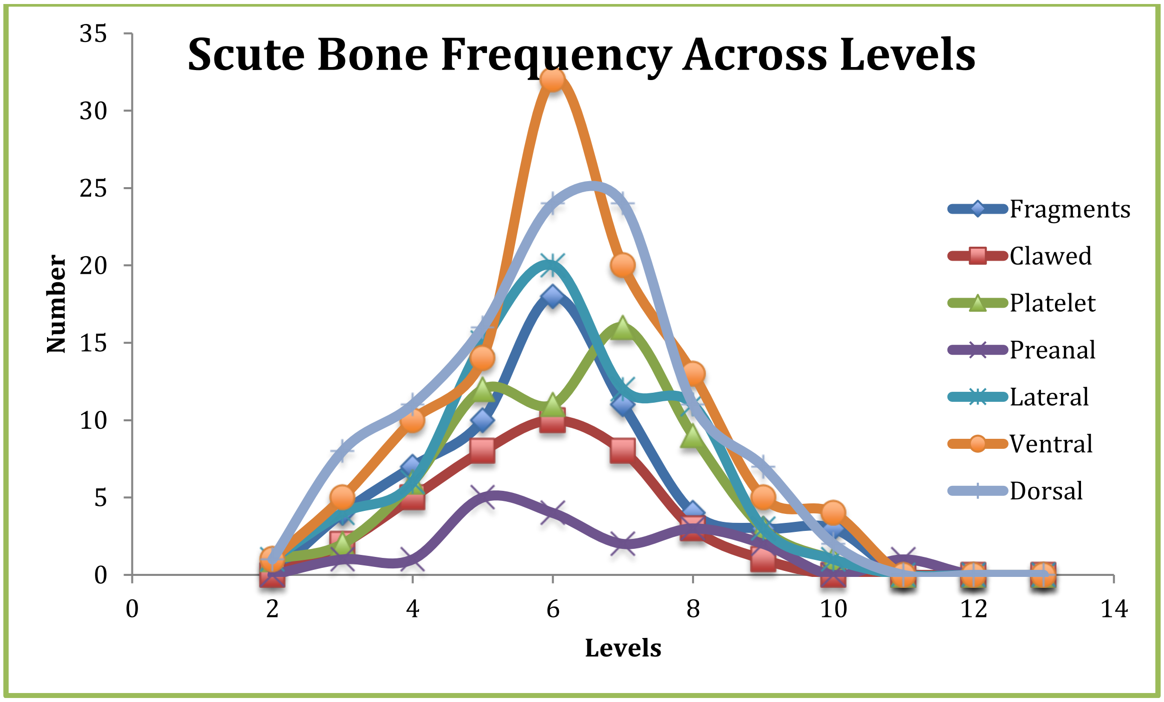


Figure 9

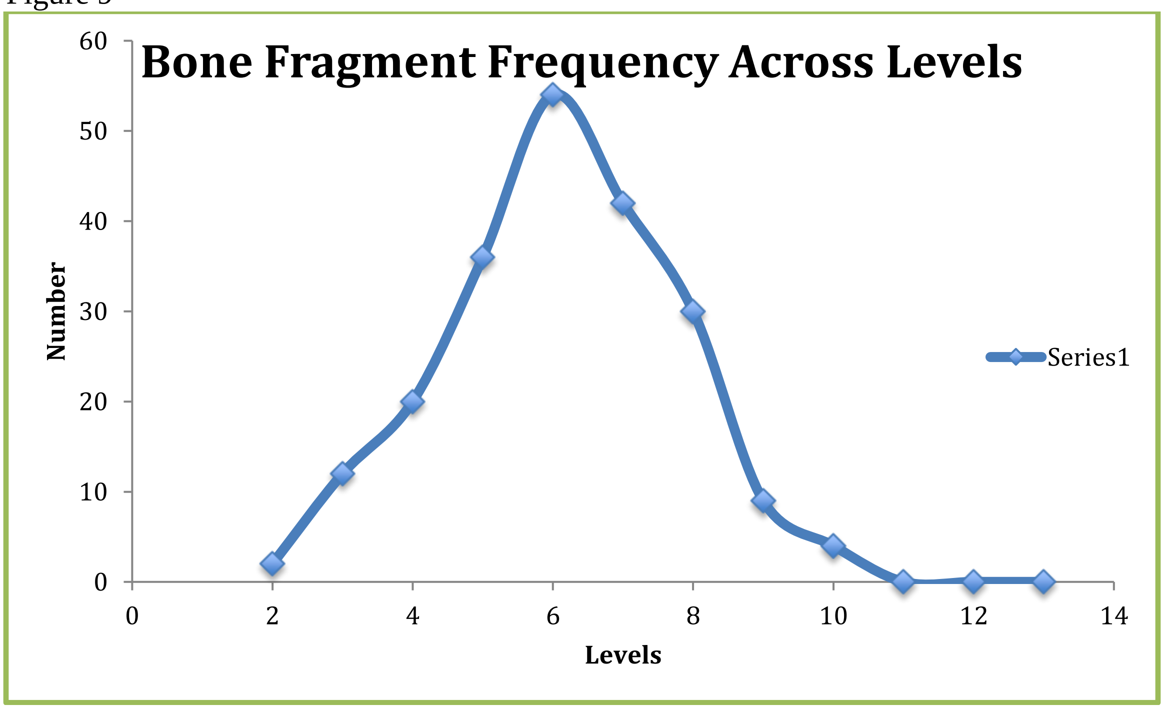
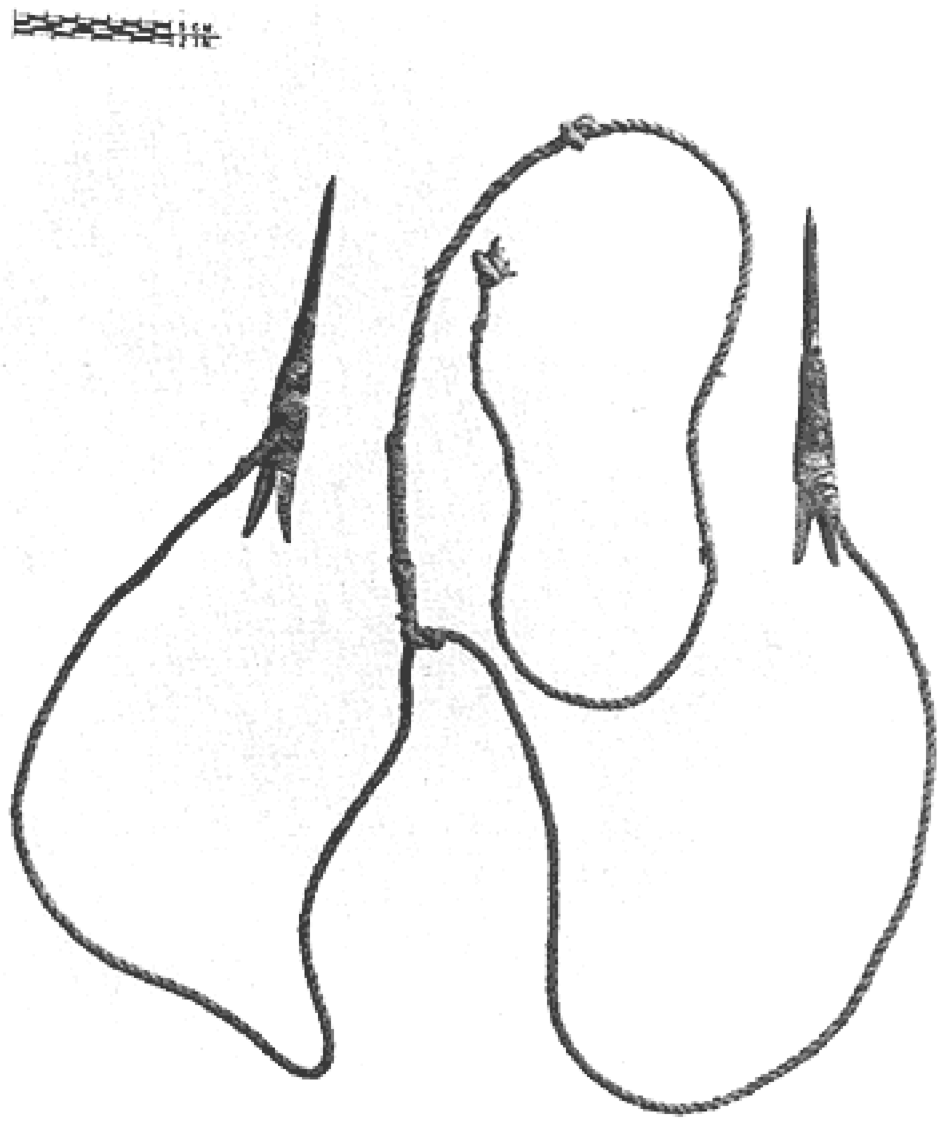


Figure 10



Detachable spear points with line found in Ruby and Brown 1976, courtesy of the Smithsonian Institution (Ruby and Brown 1976).

References

Artyukhin, EN, Vecsei, P, and Peterson, DL. 2006. Morphology and ecology of Pacific sturgeons. Environ. Biol. Fish. 79:369-381

Balazik, MT. 2012. Life history analysis of James River Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) with implications for management and recovery of the species. Dissertation for the degree of Doctor of Philosophy at Virginia Commonwealth Univeristy.

Beierle, J. 2004. Culture summary: Chinookans of the Lower Columbia River. New Haven, Conn.: HRAF. http://ehrafworldcultures.yale.edu/document?id=nr06-000. Accessed October 9. 2016

Bemis, WE, Findeis, EK, and Grande, L. 1997. An overview of Acipenseriforms. Environmental Biology of Fishes 48:25-71

Bemis, WE, and Kynard, B. 1996. Sturgeon rivers: an introduction to acipenseriform biogeography and life history. Environmental Biology of Fishes 48:167-183

Birstein, VJ, Waldman, JR, and Bemis, WE. 2002. Sturgeon biodiversity and conservation. Kluwer Academic Publishers NY. Reprinted from Environmental biology of fishes, 48(1-4) 1997.

Boone, C. 2009. Fish comparative collection photographs: white sturgeon (*Acipenser transmontanus*). University of California, Santa Cruz. http://web.pdx.edu/~virginia/white_sturgeon/white_sturgeon.htm Accessed July 27, 2016

Broughton, JM. 1997. Widening diet breadth, declining foraging efficiency, and prehistoric harvest pressure: ichthyofaunal evidence from the Emeryville Shellmound, California. Antiquity 71:274

Broughton, JM, Martin, EP, McEneaney, B, Wake, T, and Simons, DD. 2015. Late Holocene Anthropogenic Depression of Sturgeon in San Francisco Bay, California. Journal of California and Great Basin Anthropology 35 (1): 3-27

Colten, RH. 2015. Prehistoric coastal adaptations at Seaside, Oregon: Vertebrate fauna from the Palmrose and Par-Tee sites. The Journal of Island and Coastal Archaeology 10:2, 253-276

*Doroshov, SI, Moberg, GP, and Eenennaam, JPV. 1997. Observation on the reproductive cycle of cultured white sturgeon, *Acipenser transmontanus*. Environmental Biology of Fishes 48: 265-278

Findeis, EK. 1996. Osteology and phylogenetic interrelationships of sturgeons (Acipenseridae). Environmental Biology of Fishes 48:73-126

Galbreath, JL. 1985. Satus, life history, and management of Columbia river white sturgeon, *Acipenser transmontanus*. Pp 119-126 in FP Binkowski and SI Doroshov (ed) North American Sturgeons: Biology and Aquaculture Potential, Dr W. Junk Publishers, Dordrecht.

Gobalet, KW, and Fenega, GL. 1993. Terminal Pleistocene-Early Holocene fishes from Tulare Lake, San Joaquin Valley, California with comments on the evolution of Sacramento Squawfish (*Ptychocheilus grandis:* Cyprinidae). Paleobios 15(1):1-8

Gobalet, KW, Schulz, PD, Wake, TA, and Siefkin, N. 2004. Archaeological perspectives on Native American fisheries of California, with emphasis on steelhead and salmon. Transactions of the American Fisheries Society 133:801-833

Government of Canada, Species at Risk Public Registry. Species Profile: White

Sturgeon. http://www.registrelep-sararegistry.gc.ca/species/speciesDetails_e.cfm?sid=123 Accessed June 1 2016

Hester, TR. 2011. Culture summary: Yurok. New Haven, Conn.: Human Relations Area Files. http://ehrafworldcultures.yale.edu/document?id=ns31-000 Accessed October 9, 2016

IUCN. 2016. The IUCN Red List of Threatened Species, *Acipenser medirostris*. http://www.iucnredlist.org/details/233/0 Accessed July 27, 2016.

Kohlhorst, DW. 1976. Sturgeon spawning in the Sacramento River in 1973, as determined by the distribution of larvae. California Fish and Game 62: 32-40

Kroeber, AL. 1925. Handbook of the Indians of California. Bulletin. Washington: Government Printing Office. http://ehrafworldcultures.yale.edu/document?id=ns31-009 Accessed October 9, 2016

Lamb, A, and Edgell, P. 2010. Coastal Fishes of the Pacific Northwest 2nd Edition. Harbour

Losey, RJ, and Power, EA. 2005. Shellfish remains from the Par-Tee Site (35-CLT-20), Seaside, Oregon: Making sense of a biased sample. Journal of Northwest Anthropology 39:1

McCabe, GTJr, and Tracy, CA. 1994. Spawning and early life history of white sturgeon. *Acipenser transmontanus.* Aquaculture 135:27-39

McKechnie, I, and Moss, ML, 2016. Meta-analysis in zooarchaeology expands perspectives on Indigenous fisheries of the Northwest Coast of North America. Journal of Archaeological Science: Reports. In Press.

Moss, ML. 2015. The nutritional value of Pacific herring: an ancient cultural keystone species on the Northwest Coast of North America. Journal of Archaeological Science: Reports 5:649-655

Moyle PB, Foley PJ, Yoshiyama RM. 1994. Status and biology of the green sturgeon, Acipenser medirostris. Sturgeon Q 2(1):7

Nikulina, EA, and Schmölocke, U. 2015. Archaeogenetic evidence for medial occurrence of Atlantic sturgeon Acipenser oxyrinchus in the North Sea. Environmental Archaeology, the Journal of Human Palaeoecology.

NOAA. 2015. NOAA Fisheries: West Coast Region. Green Sturgeon. http://www.westcoast.fisheries.noaa.gov/protected_species/green_sturgeon/green_sturgeon_pg.html Accessed July 27, 2016.

The Northwest Power and Conservation Council. 2004. Chapter 1: White Sturgeon, Chapter 2 Green Sturgeon. Volume 3. https://www.nwcouncil.org Accessed December 10, 2016.

Olson, RL. 1936. "Quinault Indians." *University of Washington Publications in Anthropology.* Seattle, Washington; The University of Washington http://ehrafworldcultures.yale.edu/document?id=nr17-001 Accessed November 26, 2016

Pilling, AR. 1978. Yurok. Handbook of North American Indians. California. Washington D.C.: Smithsonian Institution http://ehrafworldcultures.yale.edu/document?id=ns31-014 Accessed October 9, 2016

Ray, VF. 1938. Lower Chinook ethnographic notes. University of Washington Publications in Anthropology. Seattle: University of Washington. http://ehrafworldcultures.yale.edu/document?id=nr06-001 Accessed October 9, 2016

Ruby, RH, and Brown, JA. 1976. Chinook Indians: Traders of the lower Columbia river. Civilization of the American Indian Series. Norman: University of Oklahoma Press. http://ehrafworldcultures.yale.edu/document?id=nr06-002 Accessed October 9, 2016

Semakula, SN, and Larkin, PA. 1968. Age, growth, food, and yield of the white sturgeon (*Acpenser transmontanus)* of the Fraser River, British Columbia. J. Fish. Res. Board. Can. 25:2589-2602

Silverstein, M. 1990. Chinookans of the Lower Columbia. Handbook of North American Indians. Northeast. Washington, D.C.: Smithsonian Institution. http://ehrafworldcultures.yale.edu/document?id=nr06-009 Accessed October 9, 2016

Thieren, E, Wouters, W, and Van Neer, W. 2015. Guide for the identification of archaeological sea sturgeon (*Acipenser sturio* and *A. oxyrinchus*) remains. Cybium: International Journal of Ichthyology 39(3):175-192

Thieren, E, and Van Neer, W. 2014. New equations for the size reconstruction of sturgeon from isolated cranial and pectoral girdle bones. International Journal of Osteoarchaeology 2014

Vecsei, P. 2000. Sexual Dimorphism of North American Sturgeons (*Acipenser* species). A thesis presented to the Faculty of Graduate Studies of the University of Guelph. Government of Canada.

Virginia Institute of Marine Science College of William and Mary, the. 2005. Essential fish habitat of Atlantic sturgeon *Acipenser oxyrinchus* in the Southern Chesapeake Bay. Final report to NOAA/NMFS for NOAA Award NA03NMF2450200 (AFC) 37

Wellman, HP, Rick, TC, Rodriques, AT, and Yang, DY. 2016. Evaluating Ancient Whale Exploitation on the Northern Oregon Coast through ancient DNA and zooarchaeological analysis. The Journal of Island and Coastal Archaeology 00:1-21

Wheeler, A, and Jones, AKG. 1989. Fishes. Cambridge University Press, NY