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Other Fish in the Sea: Black Sea Bass (Centropristis striata) and Evidence for Past Environmental Change in the Archaeological Record

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OTHER FISH IN THE SEA: BLACK SEA BASS (*CENTROPRISTIS STRIATA)* AND EVIDENCE FOR PAST ENVIRONMENTAL CHANGE IN THE ARCHAEOLOGICAL RECORD

by

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ABSTRACT

This research examines archaeological fish remains from the Gulf of Maine as indicators of past climate change. Archaeological research has shown that between ca. 5,000 and 3,800 years ago, swordfish were present in coastal Maine waters indicating warmer ocean temperatures. To date, little research has explored the presence of other warm water fish species in the Gulf of Maine at that time. In this study, I examine archaeological samples from the Waterside Shell Midden (44-7) in Sorrento, Maine to identify Black Sea Bass (*Centropristis striata*) within the site's faunal collection. My work complements Sky Heller's doctoral research on the relationship between the presence of fish species in archaeological sites and past climate change in the Gulf of Maine. Heller's research tests the hypothesis that the Gulf was a warm water ecosystem that cooled at approximately 3800 radiocarbon years B.P. Identification of Black Sea Bass in archaeological contexts in the Gulf of Maine provides additional evidence to support Heller's hypothesis.

The research includes four stages: 1) Acquire a sample of Black Sea Bass, deflesh it, and prepare it for inclusion into the comparative collection of the Zooarchaeology Laboratory at the University of Maine; 2) compare the new specimen to samples from the Waterside site to determine if any of the remains match the defleshed fish; 3) draw conclusions based on the data and; 4) and report my findings. This study contributes to the paleoclimatic research at the University of Maine, and also expands knowledge of Maine's zooarchaeological record.

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INTRODUCTION

Archaeological research in Maine has shown that between ca. 5,000 and 3,800 years ago, Native peoples harvested swordfish in the region, indicating that ocean temperatures were warmer than at present. To date, little research has explored the presence of other warm water fish species in the Gulf of Maine at that time. The research presented here attempts to fill this gap in knowledge by identifying the presence of warm water fish species in archaeological samples from the Waterside Site in Sorrento, Maine. Specifically, I attempt to document the presence of Black Sea Bass at this site as an indicator of warmer temperatures in the Gulf of Maine during the Late Archaic Period (ca. 5000-3,800 B.P. uncalibrated radiocarbon dates). This thesis contributes to a growing body of data that points to a shift in climate in the Maine/Maritime region roughly 3800 years ago.

In order to address this research question, I defleshed a sample of Black Sea Bass, made note of identifiable elements, analyzed the remains from Column 2 of the Waterside Shell Heap in Sorrento, and compiled my findings into a research paper. Unfortunately, because of the novel coronavirus pandemic. I was unable to fully complete my analysis. Lack of access to my research materials prevented me from looking at all available samples, reexamining samples I was able to complete, or have Heller review my results. However, while I could not complete the project to my level of satisfaction, I was able to complete a great deal, and expand on my knowledge on several different aspects of my project.

LITERATURE REVIEW

Background: Swordfish and Warm Water Temperatures in Maine

Evidence of swordfish in archaeological contexts exists at several sites in Maine and the Maritimes. The following is a review of the available evidence.

The Stanley Site is a Late Archaic shell midden on Monhegan Island, Maine. It is interpreted as a swordfish processing site because of the large volume of swordfish remains recovered and the identification of various processing areas at the site (Eldridge 2007). Eldridge (2007) reports on excavations at the site. He details the early history of the site, describes the faunal and material culture analyses, and provides general conclusions about site use. The report is significant to the understanding of the specific site, and Late Archaic middens as a whole, but the faunal analysis and Eldridge's (2007) conclusions are most relevant to this thesis. Swordfish constituted over 98% of the entire faunal assemblage (Eldridge 2007:14). That alone is worth noting, but this site is one of the main reasons we associate swordfish remains with the Late Archaic, and this particular midden is a swordfish processing site which highlights a more complex subsistence strategy. This site reflects a maritime adaptation among Late Archaic period peoples, and highlights a broad settlement pattern involving base camps and capture stations. It adds more information to the culture system of a group of people whose faunal remains have greatly deteriorated.

Sanger's coastal research also focuses heavily on Maritime adaptation. His article from 1975 explores two hypotheses to explain the events of the prehistoric Maritime region. The first hypothesis is a continuity population model, which states that today's

Wabanaki peoples are direct descendants of the people who came to this region 5000 years ago after the ice receded. The second hypothesis is a replacement model, where the Susquehanna culture tradition intruded in the area which was not densely occupied at the time. This paper favored the second hypothesis, but Sanger considered both models by looking at them through positive evidence, since there are not enough professionally excavated sites in the region to completely discount hypotheses through a lack of evidence.

In particular, Sanger's (1975) early research helped shape my research question regarding the presence of Black Sea Bass in archaeological contexts. Sanger established what the physical environment looked like during the time of the Late Archaic period peoples by using pollen analysis, faunal remains, and lithics. According to pollen analysis, during the Late Archaic period the area had a higher proportion of deciduous trees which created a better environment for white tailed deer over an environment for caribou and moose, which were present by the early historic period (Sanger 1975:67). There is also evidence that people took advantage of several different sources of food and resources through hunting, fishing, and gathering subsistence practices. In order to do so, they were highly mobile and had a form of water craft. These are all general assumptions, and Sanger mentioned that additional research was needed in order to understand the ecosystems that supported humans 5000 years ago, and that it is incorrect to assume that environmental conditions in the region have stayed the same the entire time. This knowledge about the environment helped shape my understanding of the time period that I was analyzing.

In this article, Sanger (1975) presented evidence suggesting that an intrusive population entered the Maine-Maritime region around 3800 BP. He notes an abrupt culture shift around this time with changes in technology, subsistence patterns, and mortuary practices. New stone tools appear, swordfish is no longer a dominant source of food, and red ochre burials are replaced by cremation pits. These new patterns are nearly identical to the Susquehanna tradition from the south. Sanger (1975) suggests that this new cultural pattern is evidence for a new group of people, with their own customs, settling in Maine, rather than original inhabitants adopting new customs as there is no transitional period.

To explain this huge shift, Sanger (1975) looked to maritime and terrestrial evidence. He notes that after 3800 BP, there was a shift in vegetation toward species that are common now. Specifically, there was a decline in deciduous trees that support a large amount of white tailed deer. This would adversely affect a population that relied heavily on deer as a food source. In the marine ecosystem, the sea levels rose, which created a stronger tidal system within the Gulf of Maine. This increased tidal amplitude resulted in greater mixing, which caused an increase in fish species due to higher productivity, as well as a decrease in the average water temperature.

Sanger (1975) points to swordfish as evidence for this change. Swordfish prefer warmer waters, and the large presence of swordfish remains in earlier sites indicates that they were available close to shore, suggesting water temperatures in the Gulf were warmer. There is a notable absence of swordfish bones in later sites, which could be explained by a lack of availability. An explanation for this would be that the northern Labrador current pushed out the warmer gulf stream from the Gulf of Maine. This,

coupled with the mixing caused by the stronger tides, would have lowered the average temperature of the Gulf. This would have also created a new environmental niche for soft shell clam, which is heavily present in the archaeological record after 3500 BC. Overall, there is a substantial amount of evidence to support the theory of a shift in temperatures in the Gulf of Maine.

In a more recent article by Sanger (2009), he again explores the disappearance of swordfish from the archaeological record after 3800 BP. He maintained that lack of swordfish after 3800 BP, may have been connected to changing sea surface temperatures. To support his hypothesis, Sanger (2009) presents data from several sites in Maine that reinforces an end date of swordfish presence in the Gulf of Maine to be around 3800 BP. Sanger (2009) then goes on to describe the habits of swordfish, and the various ways to hunt them, before transitioning into sections that give more information about the Gulf of Maine. This information helped shape my understanding of the pre-Contact ocean conditions of the Gulf of Maine. While his earlier article from 1975 discussed the effects of marine changes, this later article presented a more robust assessment of oceanic changes and their relationship to swordfish and pre-contact peoples. The rest of the article presents information on the practice of swordfish hunting and ethnographic interviews that described traditional methods. This article helped shape my understanding of the behavior of swordfish, and the pre-Contact conditions of the Gulf of Maine. Both of these points helped me understand the background information I need in order to make my project successful.

In order to explore the discontinuity theory proposed by David Sanger, my work in identifying Black Sea Bass, a warm water fish, within the archaeological record

expands the evidence beyond the disappearance of swordfish remains. Black Sea Bass in the Waterside shell heap could provide additional evidence of shifting ocean temperatures, as well as shed more light on the subsistence patterns of the Archaic period peoples of Maine.

Understanding the dynamics of the human/marine species interaction is crucial to interpreting archaeological sites and past peoples. Lucey and Nye (2010) examine how the change in water temperature and overfishing has shifted species assemblages between sub-regions along the east coast. Their research showed that fish stocks are slowly rebounding from historic overfishing, but the study regions are experiencing warming to the extent that the assemblages are starting to appear more like “the historic assemblages found in the adjacent sub region to the south” (Lucey and Nye 2010), with the exception being Georges Bank. What this means is that each region's natural assemblage is starting to move north to stay within their preferred temperature ranges as the waters warm. Lucey and Nye (2010) note that this is most evident in the autumnal data, and in the south, with the Gulf of Maine being the least variable.

Another important fact that the authors noted, was that species assemblages themselves are shifting, with an increase in community preferred temperatures, which means an increase in both warm water fish species and the preferred temperature of cold water fish (Lucey and Nye 2010: 28). The study noted that while the Gulf of Maine was the most stable sub region in the study, helped in part by its deep waters, there was still a significant amount of change. This stability stems from the presence of Cape Cod, which protects the Gulf from more extreme weather systems and temperature changes. The paper concluded that it would be difficult for each region to return to its historic

assemblage from the 1960s and 1970s, because the stressors of overfishing and climate have shifted the assemblages to resemble the historic ones of its southern neighbor.

Lucey and Nye’s research has important implications for understanding Maine's coastal environment before historical contact. By applying the effects of modern climate change to the changing temperatures of the Gulf of Maine that occurred in 3800 BP, this information provides a general model of what happened to the fish assemblages during the Late Archaic. Instead of warm water forcing fish species farther north, water that was becoming colder may have driven the fish to seek warmer temperatures farther south, which would help explain the absence of swordfish after 3800 BP. While it is difficult to use modern data to explain pre-Contact occurrences, the general idea of shifting assemblages has merit when combined with other information from the Archaic shell middens discussed in previous papers.

Site and Sample

The Waterside site in Sorrento, Maine was selected for analysis. This site was first reported on by Rowe in 1940 at a time when excavating practices were not as comprehensive and refined as they are now. Rowe documents the site size, location, and history. He describes the stratigraphy of the site and identifies two distinct occupations. The second occupation, and the most recent, was identified as a pre-Contact component, and only produced pottery and a few lithics, because of its small size. The first occupation covered a much larger area, and contained a variety of animal bones, lithics, crushed shells, and possible fire pits. This section is a bit unclear because he refers to strata by soil types rather than occupation, which makes it more difficult to reconstruct

stratigraphic units and associated material culture when several of them have a similar soil composition.

After describing the stratigraphy of the site, Rowe discusses the assemblage of artifacts that were recovered from the site. Several worked bone artifacts were recovered from the second occupation, such as a beaver tooth chisel; however, Rowe focuses most heavily on the stone tools that were recovered. The first occupation also had bone artifacts such as a bird-bone awl, another beaver tooth chisel, and a worked swordfish sword, which Rowe said was the first tool made from this material in Maine. The sword is very fragile, and this piece was partially restored (Rowe 1940:10).

The most significant portion of the assemblage to my project were the faunal remains, unworked animal and fish bones, found in both occupations. Since this is a shell heap, Rowe mentioned the shells were mostly from soft shell clam, with the rest consisting of mussels, white clam, wrinkles, and small amounts of quahaugs, and sea urchin. The majority of the animal bones were recovered from the first occupation layer, and they were more numerous in the eastern section of the site.

Most of the bones were identified by Dr. Glover M. Allen. They consisted primarily of Northern Virginia Deer (*Odocoileus virginianus*), along with small amounts of Woodland Caribou, and two occurrences of domestic pig. There was a noticeable absence of the extinct sea mink. As for fish bone, Allen identified swordfish, dogfish, and laughing gull, which he said suggests a summer occupation. Rowe also reached out to another colleague to identify more fish bones. Dr. Theodore White identified the fish remains, finding cod, pollock, haddock, swordfish, dogfish, goosefish, sculpin, and

sturgeon. Several of those fish species can tolerate warm water, if not survive as a warm water species, which is relevant to this thesis.

This paper is extremely significant to my research project. It is the first report of any excavation on the Waterside Shell Heap, which is where my samples are from. I was able to gain an understanding of the stratigraphy of the site, as well as the general layout, and I was also exposed to the information about the other cultural remains that were found. I was aware that the collection was quite substantial, but my focus on the fish bones made it difficult for me to place the remains in the context in which they were found. Dr. White's fish bone analysis is important to note because of species that were identified, some of which occupy warm water habitats. Rowe's article provided good background to the archaeology of the Waterside site.

Robinson (2005) provides additional background to the Waterside Site and other Archaic Period coastal sites by reexamining four different Archaic Period shell middens with Moorehead Burial Tradition components. He first described the tradition, saying that it was first identified by its elaborate mortuary practices that sensationalized a "mysterious culture" that disappeared. Robinson (2005) attempts to place the burial tradition into the context of its time, by also focusing on the other aspects of Archaic period culture. To do so, he reexamines the Nevins site, the Tafts Point site, the Waterside Shell Heap, and the Turner Farm site. My study focuses on samples from the Waterside site, and Robinson's (2005) research is useful because it provided more information on the excavation than what was reported on by Rowe in 1940. For example, I was unaware that the site was in Rowe's backyard, which cleared up some questions I had on permissions for excavation. It also emphasized the presence of deer bones and

swordfish, which are two lines of evidence for Sanger's (1975) interpretation discussed above.

Robinson (2005) also mentions two hypotheses for the abundance of shellfish in middens that I had yet to consider. First, shellfish was more likely to be harvested at winter sites, which would lead to better preservation of winter occupations as there is more shell to neutralize the acidity in the soil. Warm water species representing a summer occupation would be less likely to survive over time in acidic soils. Another point that Robinson (2005) makes is that summer sites may have been located on land that has since been covered by rising sea levels or eroded away. These two points also support a two population model proposed by Sanger, as a maritime population that had two different occupations in different locations on the coast, could easily be confused as one population if the summer sites did not survive. This new information helped frame my understanding of the Archaic period, as well as the theories behind settlement patterns of the time period.

Robinson (2005) emphasized the importance of preserving these shell heaps. They all show the importance of deer and swordfish for food, and highlight the broad nature of Archaic subsistence strategies. The middens also help place a sensationalized burial tradition into the context from which they were removed. They provide the only insight into the Archaic period of Maine, a period for which contemporary archaeological techniques can reveal additional information on past lifeways.

Another significant site involving swordfish from the Late Archaic period in the Maine Maritime region, is the Turner Farm site. It was discovered in 1969 and was first excavated in 1971 by Bruce Bourque. During his excavation, he identified four

occupations, with Occupation 2 being associated with the Moorehead phase, and Occupation 3 being associated with the Susquehanna tradition. The faunal remains from Occupation 2 emphasized the “importance of swordfish to people of the Moorehead phase” (Bourque, 2012:46), which means that, along with the Stanley site, this site helped created the association between the Late Archaic period and swordfish. The book that Bourque wrote on his excavations of the Turner Farm site, included information about the end of the Moorehead phase, and the possible reasons for the abrupt transition into the Susquehanna tradition. One of the possible explanations that Bourque mentions included the stress that overfishing, especially of swordfish, may have had on the population. This book provided more information on a Late Archaic shell midden, helped associate swordfish with the Moorehead phase, and broadened my understanding of the Late Archaic period.

METHODS

The methods applied here consisted of a two-step process. The first step consisted of defleshing a modern Black Sea Bass and identifying each of its faunal elements. I then identified those elements useful for archaeological identifications by comparing them to other species within the existing zooarchaeological comparative collection.

Prior to processing, the fish was confirmed as *C. striata* based on characteristics described by Bigelow and Schroeder (2002). Bigelow and Schroeder wrote a comprehensive guide to the fish of the Gulf of Maine in 1925. It has since been updated; most recently in 2002. The authors classify fish based on order, suborder, and family, before detailing each individual fish. Each entry includes the fishes scientific name, a drawing of a typical specimen, a description, its meristics, color, size, distinctions, habits, and a variety of other characteristics of fish behavior.

Bigelow and Schroeder's (2002) descriptions of the Black Sea Bass enabled me to confirm the species identification of the sample fish before it was defleshed. Black Sea Bass descriptions in Bigelow and Schroeder (2002) also aided my identification of the sample as an adult male based on the large adipose dorsal hump. This informed my analysis of the archaeological samples.

Bigelow and Schroeder (2002) also served as a reference for understanding Black Sea Bass behavior which is significant for my project. The fish's behavior such as "being strictly confined to saltwater" and having an "inshore-offshore range [that] extends from close in to the coastline in depths of only 1 m out to about 165 m" (Bigelow and Schroeder 2002:393), have a significant impact on the methods humans use to catch

them. Migratory pathways of the Black Sea Bass are also significant, since they travel south to spawn in inner shelf waters, which means they are unlikely to spawn in the Gulf of Maine.

In their discussion of fish behavior, Bigelow and Schroeder (2002:394) note that "Black sea bass enter the Gulf only as rare strays from the south", but since research has been published on historically warmer water temperatures in the Gulf of Maine, it would make sense to include a note in certain sections describing their historical presence. Especially since they included Black Sea Bass in a book about the Gulf of Maine, and then said that they only occur in Maine as rare strays. My assumption is that this is updated information about a fish that was more present in the Gulf of Maine during the original publication in 1925.

Step 1: Defleshing

First, I removed the surface ice using warm water. Since the fish was still frozen, its position was bent, but proper measurements were taken. The fish's standard length (from the tip of the snout to just before the beginning of the tail) was 45 cms, while its total length was 58 cms. After taking measurements I removed scale samples from the head and from multiple locations on the body.

Figure 1: Black Sea Bass (*Centropristis striata*) before filleting and defleshing

From there, we proceeded to use a modified version of a defleshing protocol suggested by Dr. Ryan Kennedy from the University of New Orleans in order to prepare the sample. The fish was filleted to remove as much flesh as possible before further processing. Using a sharp knife, I made an angled incision just behind the pectoral fin across the body vertically and cut along the spine of the fish horizontally to slice the flesh from the rib bones by sliding a knife in between. The process was repeated on the other side until much of the flesh was removed from the body. After that, the organs were removed by cutting through their connective tissue. Interestingly, the stomach contents of the fish were able to be saved and identified as a small crab. The head could not be defleshed without damaging the bones, so it was left alone to be boiled away.

Figure 2: Early on in the filleting process

Figure 3: Removing Excess Flesh


Figure 4: Stomach Contents

After as much flesh as possible was removed, the remains were placed in a large pot on an induction burner, set to 110 degrees Celsius, to be lightly simmered. After several hours, we noticed the pot used was not even warm, so the temperature was then raised to 120 degrees, then to 150 degrees, until finally the burner was set to 200 degrees Celsius. However, the burner, which was apparently not working properly, never registered higher than 185 degrees, and the water never reached a simmer. After three hours and fifteen minutes in the water, the flesh of the fish had begun to pull away from the bones. The fish was removed, and the bones were placed in a five-gallon bucket, with a solution of ¾ water to 2 cups Biz detergent. This was then left to sit for a week. At this time, the stomach contents were also placed in a solution of 300mL of water to ¼ tsp of Biz.

After a week, the fish was removed from the solution by draining the liquid through a 1 mm sieve to retain small elements. Many of the bones were separated and cleaned before being placed in a tub of water to soak and remove excess grease and Biz. Most of the bones were not fully clean, and were returned to the bucket for more soaking time in Biz using a similar ratio as before.


Figure 5: Filtering out the Biz solution

On January 27th, the bones were again removed from the Biz solution. The liquid was drained through a 1mm sieve and more of the bones were separated and placed in a tub of clean water to soak. Some bones, such as the vertebrae and fins are connected with cartilage and required significantly more time in the enzyme solution. I placed these back in a solution of water and Biz and removed them from the solution several times over the course of two weeks to examine their progress. Finally, they were placed in a long term soak for three weeks to fully dissolve the cartilage.

Figure 6: Different stages of soaking

Step 2: Identification of Faunal Elements

The bones that had been soaked in water were removed and dried and I began identifying elements that would be distinguishable in the archaeological record. These elements were then compared to a variety of different fish from the existing zooarchaeological comparative collection to identify their differences before the samples from column two of the Waterside site were examined under a microscope. The elements that were compared to other species were ones that are distinctive and could be recognized when in smaller pieces, such as dentition, otoliths, and the articulating ends of bones such as the quadrate. These bones were then compared to species that have been shown to be present in the area during the time of deposition. Cod, striped bass, flounder,

salmon, and scup, were the main species that the defleshed Black Sea Bass was compared to, and the identity of the Black Sea Bass sample that was already in the collection was confirmed.

For my project, we chose to investigate column two, in which every other level screened was screened for analysis. This made it much more manageable to examine. First, we designed a notecard to record my observations. Then the remains were examined under a microscope. After the first few samples were examined, we realized that the condition of the remains would make exact identification almost impossible. The remains were so small that it was difficult to determine their kingdom, let alone their species. Because of this observation, we decided to create two sections on the notecard where I wrote what species the sample compared to and was distinct from. By creating a list of possible species, we could gain some insight on the general makeup of the faunal remains.

Diagnostic Element Card Site# ____________

Spec# ____________________ Column ____ Level ____ Scrn ________

Element ________________________ Side ___ Cnt _______ Wgt __________g

Compares Favorably	**Distinct From**

Place notes on back

Figure 7: Diagnostic Element Card Example

The first few levels contained a smaller amount of bone than the deeper levels. These samples were also much smaller and more difficult to identify because of their lack of features. As the levels became deeper, there was more bone to be examined, and the bone was more identifiable. Unfortunately, the University of Maine was shut down because of the Covid-19 virus, and the lab was unable to be used because of it. There were two levels left to be examined, with Level 13 being the most promising out of all of them. Those samples have yet to be examined, and will not be before the conclusion of this project. This also means that the samples I have already gone through are unable to be reexamined by myself or my advisor, in order to determine the accuracy of my identifications.

Figure 8: Analyzing the remains

ANALYSIS

The Waterside site is located in Sorrento Maine. The initial excavations for the samples I worked on were completed in July and August of 2013. The original excavation units made by Rowe were reopened and two column samples from each east wall of Rowe's N3/W2 and N2/W1 units. Columns 1 and 2 were from the former unit, while Columns 3 and 4 were from that latter with Columns 1 and 3 located to the north of Columns 2 and 4 within their respective units. Profiles of the units were also created. The unit N3/W2 is located in the northern section of the site towards the top of a slope in the ground.

The time for proper identification of the remains was cut short because of the novel coronavirus pandemic. The following analysis was performed on the incomplete raw data that was collected before the closure of the University of Maine.

Modern Comparative Research

My first step in completing my analysis required me to compare the elements of the Black Sea Bass I defleshed to other fish species within the zooarchaeological collection of the University of Maine. Due to restrictions on lab access, this comparative analysis focused exclusively on American Cod (*Gadus morhua*). I focused on this fish because of how common its presence is archaeologically in the Gulf of Maine, the similarity in size, and the variation observed between the two species elements.

I found multiple distinctions between like elements in my comparison. The tooth patterns in the dentary and premaxillary of Cod are more structured and more widely

spaced towards the front than those of Black Sea Bass. These bones were also much thinner in the Cod than the Black Sea Bass. Further, the dentary is distinguished between the two species due to a differently shaped foramen. Another element with notable difference between the bass and the cod was the pharyngeal. The cod pharyngeals are narrower and have a more regular tooth pattern, as well as being generally shorter than the bass.

The Black Sea Bass had some notable characteristics to several of its elements. For example, it has a distinct pattern in its vertebrae that was not evident in any other species I examined. The pattern appeared quite fibrous and haphazard, which looked like stretched cheese strands in a small hourglass shaped bone. This noticeable pattern was very helpful in my identification of the vertebrae in the column samples. Another important characteristic of the Black Sea Bass is the articulating end of its quadrate. Quadrates from a variety of species appear to have an end that looks like a bow tie. The Black Sea Bass quadrate is distinct in having a different shape which aided in identifying sections of quadrates throughout the analysis. These were some of the defining characteristics of Black Sea Bass identified during analysis. They also served to distinguish this species from American Cod.

Element	Total Examined	Compares Favorably		Distinct From	
		C. striata	G. morhua	C. striata	G. morhua
Otolith	13		12		
Dentition	10	2			2
Quadrate	4			4	
Pharyngeal	3	1		1	
Premaxilary	3			3	
Vomer	2	2			
Vertebrae	2	2			
Dentary	1			1	

Table 1: Comparison of Identified Elements

Identifying Patterns

Multiple patterns were observed in the data, and each of them had a variety of possible explanations for their presence.

The first pattern I found was the higher density and variety of elements in lower levels. The first few levels had smaller amounts of bone than later levels, and they were from more recent dates than later levels. The bones that were the most identifiable were vertebrae, articulating ends, bones with detention, and otoliths. Most of the samples were unidentifiable beyond class, and could only be classified as fish, mammal, or bird bone. However, some were identifiable to the specific element, and then these were compared to the Black Sea Bass, and a variety of different fish species.

Levels 1-8 held a variety of different animal bones, with a large part of them being mammal bones. Of the fish bones, five were identifiable to more specific elements, and four of them were tooth bearing bones, with one specifically being a pharyngeal bone. Level 9 held a lot of promise. It was a deeper level with more bone, and three bones were identified in that level. Two of them were otoliths that compared favorably to

cod. In level 11, I was able to identify eight specimens with most of them complete enough to identify a specific element. These elements were a dentary, two pharyngeals, otolith, premaxillary, vertebrae, quadrate, and a vomer. This data shows a higher percentage of identifiable elements in lower levels.

There are several possible explanations for the higher density of identifiable remains in the deeper levels. The first is methodological bias. Another could be because the remains are larger as a result of the screen size used, and larger remains have more identifiable features. There is another, very important reason to recognize, and that is the fact that I became more comfortable with the identifications as I spent more time with the remains and the comparative collection. As I looked through the levels, I was better able to identify different features, when before, I was just getting used to distinguishing between mammal and fish bones. However, it is also possible that this pattern indicates that the deposits have more cultural material the deeper the stratum. To test this, I would need to examine other columns from the Waterside site, and compare the amount of material between stratum. If the pattern was found to be attributable to cultural processes, it could indicate that the site was heavily occupied during the first occupation compared to the second occupation.

Specimen #	Column	Level	Element	Count
150.102.1	2	1	Dentition	2
150.102.2	2	1	Dentition	1
152.104.3	2	3	Pharyngeal	1
154.100.4	2	5	Vertebrae	1
154.102.5	2	5	Dentition	1
156.102.6	2	7	Dentition	5
158A.100.7	2	9	Otolith	1
158A.100.8	2	9	Dentition	1
158A.103.9	2	9	Otolith	1
160.103.10	2	11	Dentary	1
160.103.11	2	11	Pharyngeal	1
160.103.12	2	11	Otolith	11
160.103.13	2	11	Premaxillary	3
160.103.14	2	11	Vertebrae	1
160.103.15	2	11	Quadrate	4
160.103.16	2	11	Vomer	2
160.103.17	2	11	Pharyngeal	1

Table 2: Number of Elements by Level

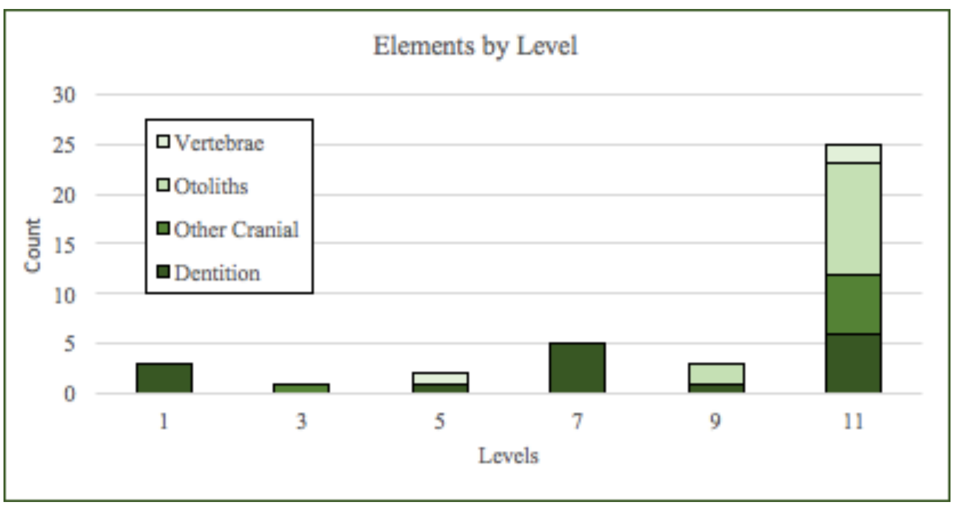

Table 3: Graph of Elements by Their Level

Another reason to explain the higher density of identifiable remains in lower levels would involve the amount of shell deposited in each level. Shells are what provide the calcium carbonate that is needed to neutralize the acidic soil that degraded organic

remains. The more shells in each layer, the more likely that remains would survive. Since these stratigraphic levels are also connected to different time periods, the presence of a large amount of shells would lead to a preservation bias towards certain time periods. In order to determine if a large presence of shells had an impact of the preservation of different levels, I determined the percentage of shell in samples taken from each level. The results actually do not support my hypothesis. There was a much higher percentage of shell in layers that I did not identify many specimens from. Levels 5 and 7 had samples where over 50% of its net weight was from shell, while the level I identified the most elements from had only 1.74% shell compose the sample weight of level 11. This reinforces the idea that the reason for a higher percentage of identifiable elements in the lower levels most likely stems from my lack of experience identifying faunal remains.

Column	Level	Sample Weight (g)	Shell Weight (g)	% of Shell
2	1	2191	85.6	3.91%
2	3	2455	797.9	32.50%
2	5	2297	1352.2	58.87%
2	7	2597	1459.9	56.21%
2	9	1680	671.2	39.95%
2	9	970	6.1	0.63%
2	11	2331	40.6	1.74%

Table 4: Shell Weight by Level Sample

A second notable pattern in the data was the variety of elements identified. Thirty-six of 38 elements were from bones located in the skull region of the fish because these have the most identifiable features, such as articulating ends, which is why most of my identifications involved those bones.

Many (17 out of 38) of the identifiable fish bones were one of various elements supporting dentition. There are several explanations for this, but the most likely one is that they are the easiest to spot in a faunal collection. They have distinctive hole patterns, and they are often diagnostic to specific fish species which makes them valuable when making identifications. I knew this information before I started the analysis, which made me more likely to separate them from the collection for later identification. Other reasons that could explain the large amount of dentition, would be that tooth-bearing bones are more likely to survive taphonomic processes; the area that the remains were recovered from was a processing area for fish; or the area was a trash heap for fish remains that were not useful. These explanations would highlight the cultural patterns of the people depositing the remains, and, if confirmed, would provide valuable insight into the thinking of the Late Archaic Period peoples. For example, if an area had a higher density of fish skeletal remains, the area could have been a refuse pile as the head is less useful than the fillets.

After dentition, the next most numerous element was otoliths (13 out of 38). Again, they are extremely recognizable within faunal collections and are extremely diagnostic. Many of the otoliths had already been separated from the samples during initial processing, so they were easy to identify and include in my analysis.

Besides the bones of the head, the other bones in a fish are ribs, spines, fine rays, and vertebrae. These are often indistinguishable between different species. However, as noted above, Black Sea Bass vertebrae were distinctive from both cod and various other species to which I compared them. This is why I separated two specifically in my analysis out of the hundreds that were in the remains. These vertebrae are comparable to

Black Sea Bass in my opinion, although an alternative explanation for their presence could be that the fibrous nature is not exclusive to Black Sea Bass.

I also considered data in the context of the culture period they were assigned to. The original strata described by Rowe were correlated with the strata assigned by Heller during her excavations, and then with their presumed cultural period. The majority of my specimens were from the Late Archaic period, with the rest split between the Woodland period and the uppermost layer which consisted of mixed fill from road construction. The first levels I examined happened to be from the most recent cultural periods. I identified more bones as likely to be Black Sea Bass in these upper layers, which was contrary to what I expected to find. Black Sea Bass is a warm water species, like swordfish, and I hypothesized that the remains would be in the older strata with the swordfish bones. There are several possible explanations for their presence in the more recent component of the site. This could indicate the use of swordfish in earlier occupations, or the remains could have been mixed with the modern fill that contains a mix of differently dated remains. Again, the answer could also lay with my inexperience as a faunal analyst. The first few levels were ones that I was examining when I was learning the process. I became more skilled at examining the remains after I gained more experience using the microscope, and was better acquainted with the nuances of each of the elements. Altogether, comparing the different specimens with the cultural periods that they came from allowed for more patterns to emerge from the data.

Specimen #	Column	Level	Rowe's Strata	Culture Period	Compares Favorabl	Distinct From
150.102.1	2	1	Modern early fill	Modern	C. striata	G. morhua
150.102.2	2	1	Modern early fill	Modern		
152.104.3	2	3	Modern early fill	Modern		
154.100.4	2	5	Disturbed and finely broken shell and humus	Woodland	C. striata	
154.102.5	2	5	Disturbed and finely broken shell and humus	Woodland		
156.102.6	2	7	Large broken shell and humus	Woodland		
158A.100.7	2	9	Brown humus and pebbles	Late Archaic	G. morhua	
158A.100.8	2	9	Brown humus and pebbles	Late Archaic		
158A.103.9	2	9	Brown humus and pebbles	Late Archaic		
160.103.10	2	11	Brown humus and pebbles	Late Archaic		C. striata
160.103.11	2	11	Brown humus and pebbles	Late Archaic	C. striata	
160.103.12	2	11	Brown humus and pebbles	Late Archaic	G. morhua	
160.103.13	2	11	Brown humus and pebbles	Late Archaic		C. striata
160.103.14	2	11	Brown humus and pebbles	Late Archaic	C. striata	
160.103.15	2	11	Brown humus and pebbles	Late Archaic		C. striata
160.103.16	2	11	Brown humus and pebbles	Late Archaic		C. striata
160.103.17	2	11	Brown humus and pebbles	Late Archaic		C. striata

Table 5: The Specimens by their Culture Period

The last notable pattern is the relationship between my identifications and screen size. Every level was screened through a 1/4th inch, 1/8th inch, and 1/16th inch screen. In the upper levels, most faunal material was found within the 1/16th inch fraction. These remains were incredibly small and because of that, they were also very difficult to identify. In the lower levels. more material was found within the larger 1/8th inch fraction of the sample. These larger elements had more attributes that I could compare to the collection specimens. There was also more variety among elements identified from the larger 1/8th inch fraction. This could be because I became better at identifying as I went through the layers, but it could also be the result of taphonomic processes or a preservation bias. The differences in size had an effect on my analysis and on the identifications I made on the remains.

Specimen #	Column	Level	Element	Count	Weight	Screen Size
150.102.1	2	1	Dentition	2	n/a	1/16th
150.102.2	2	1	Dentition	1	n/a	1/16th
152.104.3	2	3	Pharyngeal	1	n/a	1/16th
154.100.4	2	5	Vertebrae	1	0.032g	1/16th
154.102.5	2	5	Dentition	1	n/a	1/16th
156.102.6	2	7	Dentition	5	0.02g	1/16th
158A.100.7	2	9	Otolith	1	0.096g	1/8th
158A.100.8	2	9	Dentition	1	n/a	1/8th
158A.103.9	2	9	Otolith	1	n/a	1/16th
160.103.10	2	11	Dentary	1	0.146g	1/8th
160.103.11	2	11	Pharyngeal	1	0.026g	1/8th
160.103.12	2	11	Otolith	11	0.275g	1/8th
160.103.13	2	11	Premaxillary	3	0.07g	1/8th
160.103.14	2	11	Vertebrae	1	0.108g	1/8th
160.103.15	2	11	Quadrate	4	0.042g	1/8th
160.103.16	2	11	Vomer	2	0.44g	1/8th
160.103.17	2	11	Pharyngeal	1	0.007g	1/8th

Table 6: The Specimens by their Screen Sizes

I was unable to complete the full analysis of the remains because of restrictions placed on the University due to the COVID 19 pandemic. The last two levels of Column 2 from the Waterside site remain unanalyzed. This is unfortunate as I anticipated Level 13 to be the most productive in terms of Archaic Period faunal remains.I was also unable to reexamine the samples, which was something I planned to do in order to compare the samples to additional specimens from the zooarchaeological collection. That should explain why the two species I noted each specimen compared to or was distinct from were Black Sea Bass and Cod. Those are the two that I am most familiar with. I was also unable to have Sky Heller review the identifications I made. This would have been very helpful in my analysis because of her experience as a faunal analyst. The COVID 19 interruption to this research limited my ability to draw conclusions about the data set. However, the work I completed holds value and provides some insight into the subsistence strategies of the Late Archaic period peoples of the Maine/ Maritime region.

CONCLUSION

In conclusion, this research focused on the processing of a sample for the Zooarchaeology comparative collection, the identification of notable elements, and the analysis of faunal remains from a Late Archaic shell midden. Throughout these steps, I was able to develop my research and writing skills, organize a committee, deflesh a fish, complete a great deal of my identifications, and report on my results in a comprehensive manor. Defleshing the fish and entering it into the zooarchaeological collection is an important outcome of this research and an important aspect of my professional skill development. I learned a great deal at every step of my project. I identified patterns within my data, made comparisons between American Cod and Black Sea Bass, and developed a replicable methodological approach to faunal comparative studies. I also revealed connections between identifiable faunal elements and their relationship to cultural periods and screen sizes. This research could possibly be used as an analog for the Gulf of Maine in a warmer climate. As sea water temperatures rise, it is important to understand the conditions of the Gulf of Maine during historically warmer periods. I accomplished several academic goals and contributed to the existing data surrounding the questions about the effects of a changing climate on the subsistence patterns of the Late Archaic period peoples of the Maine/Maritime region.

OPPORTUNITIES FOR FURTHER RESEARCH

There are many areas of my project that can be explored further. To start, the original project can be fully completed, with every level examined for identifiable remains. Then the results can be double checked and compared to a more extensive collection of different fish species in order to create a larger base of species each specimen can be identified from. This project could also be repeated with a smaller fish of the same species. We received an adult male Black Sea Bass from our supplier, but we later received smaller (thus younger) samples from a different supplier. I noticed that many of the specimens I found that were comparable to a Black Sea Bass were quite a bit smaller than the bass I defleshed, or the one that was already in the zooarchaeological collection. Having a smaller bass in the collection may make it easier to identify Black Sea Bass in the archaeological record.

Another area of the project that could be expanded on would be to complete identifications on other columns from the Waterside site. The column that I worked on was only a small section from a much larger site. By looking at other areas, there is a greater chance of identifying enough Black Sea Bass to base broader interpretations on. This project could also be conducted on other Late Archaic shell middens, like the Taft's point site at West Gouldsboro or the Stanley site on Monhegan Island. The hypothesis of this project would be made stronger by finding Black Sea Bass at these sites.

The last way that you could expand on this project, would be if the entire thing was to be completed with another warm water fish species. The presence of other warm water fish in the same levels that contain swordfish would help solidify the argument that

there was a change in water temperature between the Late Archaic and Woodland eras. This would help determine if the hypothesis holds true for a variety of warm water species, not just Black Sea Bass. The implications of this are vast, and any amount of evidence that is recovered from archaeological remains can have a huge effect on our understanding of the past.

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Brianna L. E. Ballard was born in Farmington, Maine on January 19^{th}, 1998. She was raised in Detroit, Maine and attended Maine Central Institute before graduating in 2016. She pursued a double degree in History and Anthropology at the University of Maine. While completing her undergraduate degree, she received the Caroline Colvin scholarship, the Comstock-Weston scholarship, the Hildegarde B. Perkins scholarship, and was awarded two CUGR fellowships. She also completed two internships funded by the Putting History to Work grant in the Special Collections department of the Fogler Library, and in the University of Maine Folklife Center.

After graduating, Brianna is going to apply for a program within the Peace Corp. After returning from that, she will go on to get an advanced degree in archaeology.