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Viking Age Port of Trade in Gotland, Sweden: Understanding Inter and Intra Site Logistics Through Faunal Analysis

By

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Abstract

This dissertation is concerned with the nature of human-animal relations in the context of the Viking Age (9^{th} to 11^{th} century) port of trade and farming settlement known as Ridanäs located in Gotland, Sweden. The overall objective is to gain an understanding of inter and intra site interactions through the faunal data. The primary research questions addressed in this dissertation focus on subsistence strategies, trade connections, socioeconomic conditions, and animal husbandry practices that were occurring on site during the Viking Age. These questions were answered through a zooarchaeological analysis of the faunal remains from two contexts at what is now known as the Fröjel Parish, Gotland.

Chapter 1 will address the environmental, theoretical, and archaeological background of the Viking Age and Viking Age Gotland. Chapter 2 provides a methodological background for the analysis of the material presented in Chapter 3. Chapter 4 will discuss the interpretations of the zooarchaeological data through past ethnographic research and archaeological theories of human-animal relations. Chapter 5 will finish with a summary of the faunal analysis and interpretations made in the previous chapters to identify how these tie into the proposed research question as well as a retrospective section detailing the strengths and weaknesses of the data and the methods that were utilized in this dissertation.

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Chapter 1

Background Information

1.1 Introduction

The Viking age was overall a momentous period in European history, marked by the centralization of authority, Christianization, subsequent advancements in market exchange (as opposed to non-market exchange), the onset of surplus production, and the transition from rural to urban settlements (Barrett et. al., 2000; 1). Knowledge of the Viking Age comes from a number of sources such as written evidence including written runic inscriptions on stones that often date contemporaneously or shortly following a described event, poetry, place and personal names, archaeological evidence from both human activity and faunal and plant remains, as well as climatic and geographical data (Jones, 2001; Roesdahl, 1998; Morris, 1985).

This chapter will attempt to summarize the Viking age by providing a brief historical context as well as a general overview of the Viking homeland and expansion, customs, economy, and trade. This chapter will also provide a more in depth synopsis for the island of Gotland, from which the faunal material analysed in this essay was excavated. The synopsis will include an overview of past archaeological work that has been conducted on the island, as well as specific details about the general area from which the assemblage was excavated. Understanding the context and period of the assemblage is of great importance, as the inhabitants directly influenced the surrounding environment therefore affecting the faunal remains of the assemblage. Building a foundation of general information is crucial to making inferences about the material analysed in this dissertation.

1.2 The Viking Age

1.2.1 Geography, Geology, and Environment of the Viking Homeland

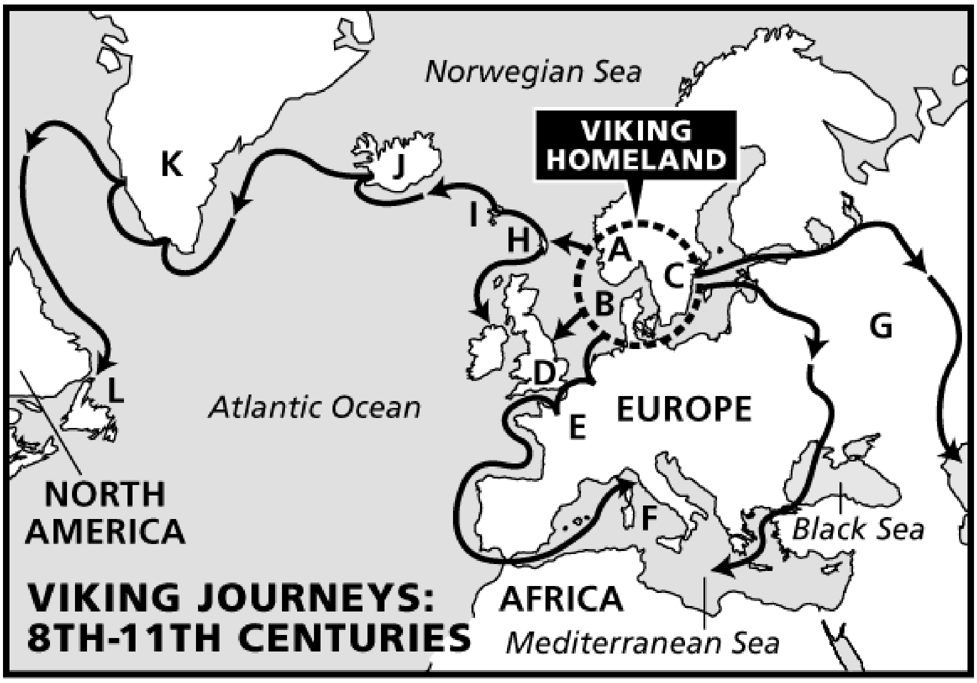


Image 2.1: Map of the Viking homeland and routes of expansion, adapted from: http://1.bp.blogspot.com/_Qw9dB2YZzvY/S83bsW10OBI/AAAAAAAACIw/Bfk4sPRroEM/s1600/eyes_viking_map.gif

The Viking homeland was centred in the Baltic Sea but stretched as far as the Atlantic Ocean to the west and the Black and Caspian Seas to the east, see image 1.1 for a shaded illustration of the Viking homeland and routes of expansion as well as subsequent areas of settlement (Clarke and Ambrosiani, 1991; 46). The Viking homeland therefore covered a vast geographic region composed of varying geology and environmental settings. The Scandinavian Peninsula to which the Vikings called home is the largest peninsula in Europe at 1,150 miles (1,850 kilometres) long and 230 to 500 miles (370 to 805 kilometres) wide. Four seas, the Baltic, North, Norwegian and Barents surround the peninsula. The highest point on the Scandinavian Peninsula is Galdhøpiggen in Norway at 8,100 feet (2,469 meters) above sea level.

The Scandinavian Peninsula is composed of a of Pre-Cambrian granite plateau. On the west facing Atlantic side there is a younger stratified area of folded and tilted rock. In the southern portion of the peninsula the granite layer is covered by limestone and chalk (Clarke and Ambrosiani, 1991; 47). The modern landscape of Scandinavia is the result of glacial forces. The inland glaciers levelled the land and upon melting formed moraines and water-sorted deposits. Additionally, the glaciers caused the land to sink to several hundred meters below the natural sea level due to their weight and downward force. When the glaciers melted isostactic rebound occurred and the earth's crust corrected this weight imbalance by subsequently rising and gaining elevation, this is most evident in the interior from the northern portion of the Scandinavian Peninsula (Clarke and Ambrosiani, 1991; 47). Denmark is located on the line of equilibrium and therefore experienced little to no upward movement. The Eastern portion of Scandinavia is comprised of a brackish water archipelago (Clarke and Ambrosiani, 1991; 47-49).

The climate varies from tundra and subarctic in the North, to a cool marine west coast climate in the northwestern coastal areas, in the centre the climate is humid continental, and the southern and southwestern portions are a marine west coast climate. Around one-quarter of the peninsula is considered to be north of the Arctic Circle.

1.2.2 General Chronology of The Viking Age

The start of the Viking age is thought to have been around A.D. 800 and is marked by an onset of raids by the Vikings on the British Isles. Recent research set on pinpointing the exact starting date of the Viking Age has refined this date to A.D. 793 (Myhre, 1993; Morris, 1985; Barrett et. al., 2000; Ambrosiani, 1998).

The ninth and tenth century mark what is thought to have been the peak of the Viking Age; this is loosely based on the frequency of raids occurring during this time period (Clarke and Ambrosiani, 1991). By the eleventh century there was an overall decline in the number and intensity of Viking raids; this decline is thought to have resulted from Christianization and the formation of nation states in Scandinavia (Graham-Campbell, 2001; Clarke and

Ambrosiani, 1991). The Viking Age is thought to have ended by around A.D. 1100 throughout the whole of the Viking world. The specific date associated with the end of the Viking Age was the death of the last Scandinavian King, Harthacnut, in 1042 (Roesdahl, 1998; 10). The Viking settlements and merchants that remained after the end of the Viking Age were gradually absorbed into the local populations in which they resided (Graham-Campbell, 2001; 10).

1.2.3 The Viking People: Socioeconomics

The Vikings are often viewed as a barbaric people, having unmarked boundaries, and who were often plagued by overpopulation and an insatiable desire for an adventure that led them to an outward warlike migration into the rest of Europe (Clarke and Ambrosiani, 1991; 46). This "romantic" viewpoint of the Viking people tends to gloss over the fact that the Vikings contributed immensely to trade within Europe as well as the discovery and colonization of new lands. The Vikings also had profound effects on the political and social organization of the countries they colonized and ultimately the Vikings can be attributed with laying the foundation of a high medieval social structure in Scandinavia (Jones, 2001; Clark and Ambrosiani, 1991). While it can be argued that piracy contributed a great deal to the livelihood of the Vikings, it was not a constant or reliable source of income. Rather the Vikings relied on their revered skills as tradesmen and leaders. Archaeological and interdisciplinary research has greatly advanced the understanding of the Vikings (Roesdahl, 1998; 19). The Vikings travelled vast expanses, influenced other cultures, and brought home ideals gained from the exploration of the countries they visited which would ultimately lay the foundation for the formation of their own governmental system in the Viking homeland. Thus, close contact with other cultures overtime had profound effects on the internal developments of the Viking homeland (Jones, 2001; Foote and Wilson, 1979).

The Viking homeland stretched across such a vast geographic area that it would be implausible to consider the Vikings in terms of a singular cultural affiliation or settlement pattern (Clarke and Ambrosiani, 1991; 46). However, Andrén (1989) postulates that Scandinavian society as whole, prior to the introduction of the Christianity, can generally be described as feudal. He states that all of the different forms of feudal lordship were existent to one extent or another in the Viking homeland of Scandinavia (Andrén, 1989; 586). Again, there is little doubt that local conditions would have had profound effects on the economy in different geographic regions (Foote and Wilson, 1979; Roesdahl, 1998). That being said agriculture was of primary importance to the Viking economy throughout the whole of the Viking homeland (Roesdahl, 1998; Foote and Wilson, 1979). This livelihood based around agriculture was often supplemented with fishing and the hunting of wild game for the purpose of subsistence or for the pelts and formation of other valuable trade items (Roesdahl, 1998; 96). The experience gained from learning different types of farming in the homeland made colonization of different climatic regions easier (Roesdahl, 1998; 96).

1.2.4 Viking Trade: Major Trading and Market Towns

Trade played a key role in Viking society. The first of the small Viking trading sites in Scandinavia were likely already established by the Ninth century or possibly earlier (Foote and Wilson, 1979; 88). Examples of early trading centres include sites such as Birka in Sweden, Kaupang in Southeast Norway, Hedeby in the Schleswig-Holstein, Grobin in the Eastern part of the Baltic Sea, Wolin in Poland, and Paviken located on the island of Gotland. The growth in trade during the Viking age ultimately spurred the development of larger towns in Scandinavia. The major trading sites and market towns in the Scandinavian homeland were Hedeby, Kaupang, and Birka.

Hedeby is thought to have been built in the tenth century and was abandoned in the mid eleventh century. Hedeby was primarily a market town and manufacturing centre. It was located in a strategic position at the southern end of the Jutland peninsula. This strategic location meant that Hedeby could control the majority of the important trade routes from Western Europe to the Baltic (Graham-Campbell, 2001; 92). Based on the burials at Hedeby its residents were likely influenced early on by Christianity; the burials, with the exception of one, are thought to have been quintessentially Christian (Graham-Campbell, 2001; 94).

Kaupang was situated on the western side of the entrance to the Oslofjord in what is known as the wealthy region of Vestfold, lying in southeast Norway. Kaupang is believed to have been operational from the eighth century and into the later part of the ninth century, during which Kaupang was an important market centre for the surrounding region (Graham-Campbell, 2001; 99). Vikings are thought to have depended on internal trade as much as external trade (Foote and Wilson, 1979; 191). There is thought to have been interregional trade involving low-bulk high-value luxury goods and low-value high-bulk necessary goods (Barrett et al, 2000; 15). The "Black Earth" at Kaupang is similar to that at Birka but is significantly smaller; "Black Earth" is a term used to describe the black hued soil that accumulates from charcoal and organic remains over a prolonged period of occupation at a site. The main crafts at Kaupang were metalworking and carving of soap stone vessels. Kaupang is thought to have been a seasonal market place that never reached the same scale as Hedeby or Birka (Graham-Campbell, 2001; 99).

Birka was located on the Island of Björkö that was part of the Mälar archipelago in the Baltic Sea; it is thought that Birka was established before A.D. 800. In the tenth century it is estimated that Birka had a population of approximately one thousand individuals. It appears that Birka was no longer in operation after 1700. A large rampart encircled the area referred to as the "Black Earth" at Birka. Artefacts recovered have suggested that various manufacturing industries were occurring at the site such as iron working, bronze casting, leather working, and the carving of bones and antlers (Graham-Campbell, 2001; 96).

However, the fur trade was likely the main source of income at Birka. Scale weights that were used to weigh silver have also been uncovered at the site. The market was thought to have been operational in both the winter and summer months. During the winter months trappers and middle-women would bring furs to Birka. The furs were shipped to Hedeby and then on to Western Europe or across the Baltic, and then down Russian rivers to the Arab Empire (Graham-Campbell, 2001; 96-97). The decline of Birka has been linked to a loss of long distance trade connections, also sea level fall made the site less viable as a port. Trade sites on Gotland eventually became the main trading hubs for the Baltic region (Graham-Campbell, 2001; 97).

1.3 The Island of Gotland

1.3.1 Geography, Geology, and Climate

Image 1.3: The island of Gotland located in the Baltic Sea on the coast of Sweden

Adapted from: http://upload.wikimedia.org/wikipedia/commons/6/60/Sweden_Gotland_location_map_modified.svg

Gotland is an island located in the centre of the Baltic Sea (see image 1.2). Gotland was once a Danish province but is now considered to be part of Sweden. Gotland is Sweden's largest island stretching some 109 miles (176 kilometres) in length and with a total area of 1,229.2 square miles (3,183.7 square kilometres). The island is located approximately 56 miles (90 kilometres) from the Swedish coast and roughly 81 miles (130 kilometres) from the Baltic countries of which Latvia is the closest. Gotland is part of an archipelago; other islands that are considered to be part of the Gotland province are Fårö, Gotska Sandön, and Karlsö, while Gotland is considered the main island. The main town on Gotland is Visby, with a current population of about 23,600 residents.

The island of Gotland is comprised of a sequence of sedimentary rocks dating to the Silurian Age that dip to the southeast. This is made up of a succession of limestone and shale. The latitude of the Baltic region lies within the world's northern temperate zone. From north to south there are variations in the local climate. Climates that are farther north are colder than those in the south. The maritime climate of Gotland has temperate summers and winters. There are three climatic zones in the Baltic region, subarctic, humid continental climate, and maritime climate (Westin, 2002; 142). The landscape of Gotland is considered to be more similar to that of Baltic countries such as western Estonia than to those of mainland Sweden (Westin, 2002; 143). The highest elevation in Gotland is 269 feet (82 meters) above sea level and is referred to as Lojsta Hed. The island contains several lakes, the largest being Lake Bästeträsk in the northern reaches of Gotland, the lake can be observed on the Northern portion of Gotland in image 1.2.

1.3.2 Brief Overview of the Viking Age in Gotland

The island of Gotland is a historically, culturally, and linguistically unique location. Gotland has unique artefacts and burial customs that differ from mainland Sweden (Clarke and Ambrosiani, 1991; 82). Archaeological evidence suggests that the island of Gotland was extremely wealthy during the tenth century. This wealth is demonstrated by the large silver hoards that have been uncovered on the island. It is hypothesized that the island of Gotland served as the central trading hub for the Baltic Sea (Foote and Wilson, 1979; 214), due to the strategic location of the island between the Swedish coast and the coast of the Baltic countries.

The only trade site known on Gotland until the mid 1980's was the Viking Age harbour of Paviken. Archaeological investigations conducted by Dan Carlsson between 1987 and 1995 on the island of Gotland have since revealed a number of other trade locations along the Gotlandic coastline (Kosiba et. al., 2006; 395). Archaeological research has revealed some fifty ports along coast (Ferguson, 2009). The capital of Gotland, Visby, was likely founded during the Viking age, and Västergarn, which falls to the south of Visby, served as the main port and market town for the island. The beaches on Gotland provided ideal ports for landing the shallow hulled Viking ships (Foote and Wilson, 1979; 214).

1.3.3 Ridanäs Viking Age Port of Trade

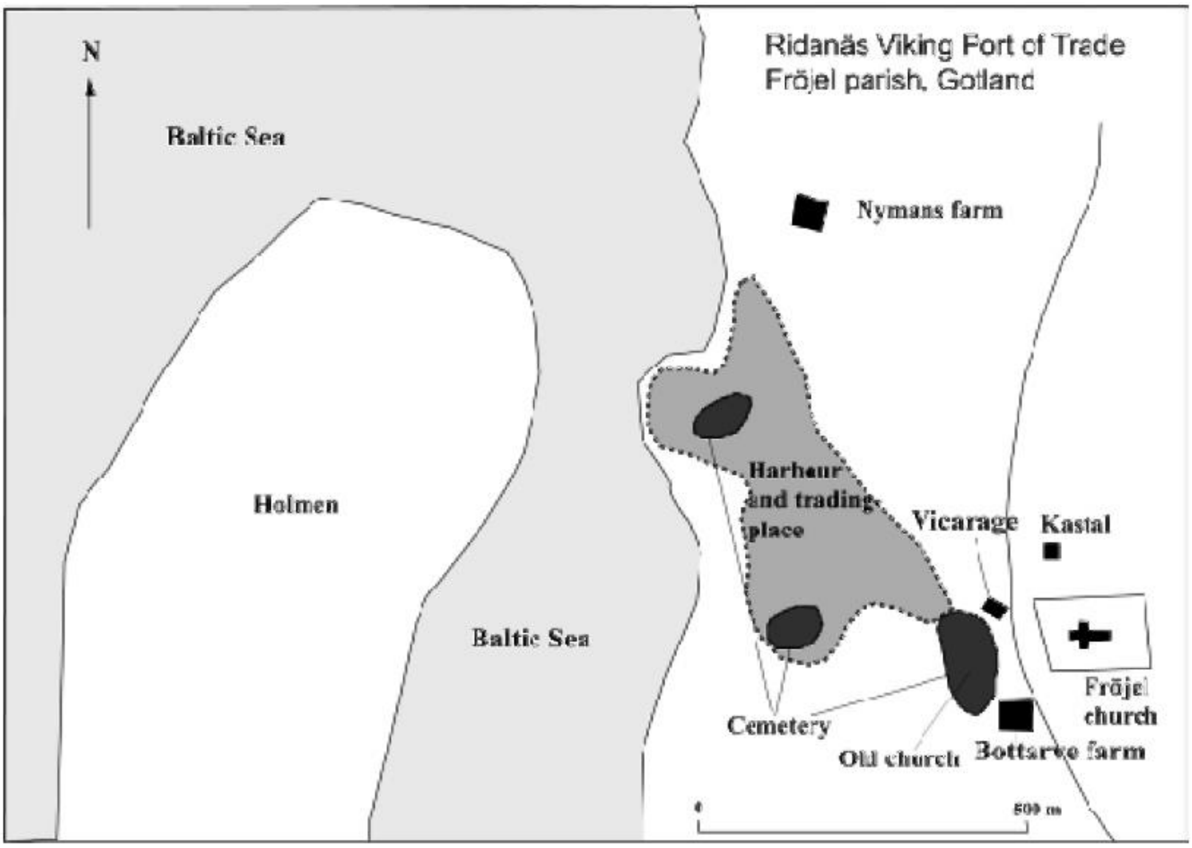


Image 1.3: Ridanäs Viking Age Port of Trade in Gotland, adapted from: (Carlsson, 2008)

Ridanäs located at what is now the modern day Parish of Fröjel was another important Viking Age port of trade in Gotland, and has parallels to the other important trade centres as those afore mentioned, Birka, Hedeby, and Kaupang. Ridanäs located (image 1.3) between the Fröjel church and the coastline (Carlsson, 2008; 131). The port was active from about the late sixth century to around A.D. 1180. The port at Ridanäs was among the largest of Viking

Age Gotland. The height of activity at the port of Ridanäs was during the eleventh century. Towards the end of the twelfth century activity at the port declined and by A.D. 1180 the port was completed abandoned. The primary reason for the abandonment of the port is thought to have resulted from falling sea levels. Falling sea level due to post-glacial isotactic rebound at the port consequently made the strait to the harbour too shallow for ships to traverse (Carlsson, 2008; 134). The settlement at Ridanäs moved further inland to the location of Fröjel when the harbour was no longer in use (Kosiba et. al., 2007, 398). Visby ultimately became the main port of trade on Gotland.

Archaeological excavations at Ridanäs unearthed a settlement and associated cemeteries as well as artefacts that can be tied to trade and manufacturing activities occurring at the site. Around 1,500 square meters have been excavated to date; from these excavations roughly 35,000 artefacts have been removed along with bone, burnt clay, slag, flint, and charcoal. The nature of these artefacts suggests there was intensive trade and industrial activities taking place at Ridanäs (Carlsson, 2008; 132). Some artefacts also suggest that Ridanäs was part of a long distance trade network. The artefacts include items of value from the North Atlantic, Arabian Peninsula, Black sea, the Swedish mainland and even as far away as Kiev in the Ukraine. Artefacts originating from Finland, Germany, England and Denmark have also been uncovered at the site. These items range from iron ore, whetstones, glass cullet and silver (Kosiba et. al., 2007). The area surrounding the settlement contains at least three cemeteries (image 1.3), it is hypothesized that there are more that have yet to be excavated. At this point in time excavations and preliminary research have been conducted at a number of these burials (Carlsson, 2008; 132-133). To the west of the early churchyard the remains of a vicarage were discovered (image 1.3), the building was believed to have been in use from the thirteenth century to the early seventeenth century (Carlsson, 2008; 133).

The Bottarve farm is thought to have been a major contributor in the development of the Viking Age harbour at Ridanäs. The Bottarve farm is located near the present day church above the harbour site where in the assemblage analysed in this dissertation was excavated (image 1.3). The farm owned a majority of the land within and adjacent to the harbour from the medieval period and into the early modern periods. Maps show that prior to the 1700's the Bottarve farm was located farther north than it is currently. It is hypothesized that a strong connection between the farm, harbour, and church existed. The "first" church in Fröjel is thought to have been a mission church (Carlsson, 2008; 134). Christianity first appeared in Norway in the tenth century, but did not play an important role politically until the eleventh century (Barrett et. al., 2000; Sawyer, 1978; Solli, 1996). When the port at Ridanäs was no longer operational and viable for regional trade the community became a more isolated and self-sustaining Christian settlement (Kosiba et. al., 2007).

1.3.4 Research Question Pertaining to Ridanäs

The following dissertation will analyse two faunal assemblages comprised of mammal, bird, and fish remains from two archaeological contexts that were excavated from the Viking Age Baltic trading port and farming settlement of Ridanäs. The ultimate goal of the faunal analysis is to provide insights into the subsistence strategies, trade connections, socioeconomic conditions, and animal husbandry practices that were occurring during the Viking Age at the modern day Fröjel Parish.

Chapter 2

Materials and Methods

2.1 Introduction

This chapter will present the materials and methods that were used in the analysis of the faunal assemblage from Gotland, Sweden. The methodologies presented in the following chapter were selected in regards to the research question proposed in Chapter 1 (see section 1.3.4).

2.2 Background

The faunal assemblage is from Ridanäs a Viking Age port of trade, and is dated to between the ninth to eleventh centuries leading into the Early Christian period in Gotland, Sweden. The material is from two different contexts within the modern day Fröjel Parish. The first context, hereafter referred to as construction 3800, was excavated in 2000 and the second, the culture layer, was excavated in 2005. Dr. Dan Carlsson was the principle investigator for both of the excavations. The faunal material was stored in paper bags with the recorded county, Parish, Year, Property, trench, construction, find ID, layer, square and weight (weight was taking prior to washing and analysis of the material).

The construction 3800 and the culture layer were approximately 164 feet (50 meters) apart. The faunal assemblage from construction 3800 was excavated from trench 2 (see table 4 in appendix). The assemblage from construction 3800 was excavated from a single culture layer. The faunal assemblage from the culture layer context is divided into respective squares and layers. Unfortunately due to sample size the material will be analysed as one culture layer. The culture layer was excavated from two trenches (trenches 1 and 2), see table 4 in appendix. The assemblage is comprised of mammal, avian and fish elements. The assemblages from both contexts include both domestic and wild species as well as marine and terrestrial species.

2.3 Preparation of the Material

The faunal assemblage from construction 3800 and the culture layer were prepped prior to analysis in accordance with the guidelines set forth in White and Folkens (2005) for the cleaning and removal of sediment of well-preserved faunal material. This procedure was conducted in the wet prep laboratory located at the University of Sheffield Archaeology Department in Sheffield, United Kingdom. Each element was washed in lukewarm water with brushes, care was taken not damage the surface of the bone. Fragile elements were not exposed to water but rather were dry brushed to remove adhered sediment. Specimen bags from each context and layer were washed separately to avoid comingling. A screen was used at all times during the procedure to prevent the loss of material. Fragmentary remains were washed in a sieve to remove sediment, but were not cleaned individually. The material was then let to dry for approximately 48 hours or until sufficiently dry.

2.4 General Overview: Recording Protocol

2.4.1 Mammal and Bird

The comparative analysis and recording of the faunal assemblage was carried out at the University of Sheffield Zooarchaeology Laboratory located in the Archaeology Department. The material was recorded in a digital database. The recording protocol utilized is an adapted version of the Davis (1992) system; as stated by Albarella and Davis (1994) the adapted protocol includes a number of substantial changes that make the Davis (1992) protocol compatible with computer databases. The digitally based recording protocol is composed of two datasets, one for bone and the other for teeth. Additionally, the rib and vertebral elements were recorded in a separate dataset; vertebra and ribs were recorded into a three tier size category ranging from small, medium, and large when present. Elements recorded in the "bone" dataset took into account surface preservation, anatomical element, taxon, fusion, butchery, burning, and gnawing, as well as applicable measurements on an element-by-element basis. Elements with a diagnostic zone that was fifty percent or more complete were recorded in the bone dataset. The teeth dataset recorded teeth by side and taxon, as being either maxillary or mandibular (X/N respectively), loose or in jaw (L/J respectively), as well as measurements and tooth wear stages where applicable. Teeth with fifty percent or more of the occlusal surface intact were recorded in the tooth dataset. The mandible, scapula, pelvis, humerus, femur, tibia, astragalus, and calcaneum, as well as teeth, were all sided.

The bone dataset contains elements that are deemed "non-countable," but are otherwise recorded despite lacking a diagnostic zone. A "non-countable" element will not be used for quantitative analysis. Some non-countable elements were recorded including the proximal ends of the four main long bones, horn-cores and antlers, and elements that are otherwise not usually recorded but were because of butchery, unusual species or size, pathologies or other aberrant conditions. For non-countable elements recorded as OTH, anatomical part and identification are recorded in the comments. The proximal ends of long bone shafts are recorded as OTHU, OTHRA, OTHRE, OTHTI and horn-cores and antlers are recorded as HC.

2.4.2 Fish

The recording protocol proposed by Albarella and Davis (1994) is not applicable to fish remains. Therefore slight alterations were made to the Albarella and Davis (1994) recording protocol to allow for the recording of fish remains. The adapted system for recording fish remains from an archaeological context was loosely modelled off of the system set forth by Colley (1990). Colley (1990) states that fish remains, in contrast to other vertebrates from archaeological contexts, are some of the most variable in size, shape, and physical character, thus making the speciation of archaeological fish remains particularly taxing. Elements that are deemed useful when analysing an archaeological fish assemblage are the jawbones, preoperculum, operculum, cleithrum, and certain median cranial bones. The other commonly recorded elements such as otoliths, vertebrae, or scales are considered less useful because they are difficult to assign to species due to the variability in and among fish species (Colley, 1990; Wheeler, 1978). However, speciation of the vertebrae centrum will be attempted due to the abundance and lesser degree of fragmentation of this element in the assemblage. The fish elements were recorded in a separate dataset.

2.5 Condition and Recovery

2.5.1 Surface Preservation

The surface preservation of each recorded element was ranked on a five-tier scale ranging from "awful" to "excellent" (A/awful, B/bad, M/medium, G/good, E/excellent) in accordance with Albarella and Davis (1994). The preservation data was presented in a histogram to assess the overall surface preservation of both contexts.

2.5.2 Recovery Bias

The recovery bias was assessed using the methodology set forth by Maltby (1985). Maltby (1985) states that the common index which utilizes of long bone fragments to compare specimen lengths of different species in size classes with the goal of estimating the fragmentation in the assemblage to address the recovery bias (Lyman, 1994) does not take into account the differential survivorship of skeletal elements and the universality of butchering practices (Allentack, 2013; 89-90). Another proposed methodology for approximating recovery bias and survivorship is to consider the frequencies of the first and second phalanxes of cattle and caprines.

Lyman (1994) states that the first and second phalanx in cattle and caprines have an equivocal survivorship in the archaeological record due to similar bone density values and these two elements also occur at the same frequency within the skeletal system of artiodactyls. Furthermore, the first and second phalanx tend to not fragment, are also easy to identify to element, and are not commonly disarticulated during the butchering process (Allentack, 2013; Russel and Martin, 2005). Thus, Maltby (1985) postulates that the ratio between these two elements can assess the occurrence of a size related recovery bias within an archaeological context. Therefore, the total number of second phalanges was divided by the total number of first phalanges. This was completed for both the cattle and caprine assemblages. The percentage is then used to address the degree to which the smaller faunal remains were affected by a recovery bias, the closer to one the lesser the degree of a size related recovery bias.

2.5.3 Taphonomic Processes

The assemblage was also examined for signs of rodent (R) and carnivore gnawing (C), partially digested bone (D), as well as elements that were gnawed by carnivores and rodents (CR) and for elements that were gnawed by carnivores and then digested (CD). Fire damage was also recorded for the assemblage. Based on colour and texture the fire damaged element was recorded as either singed (S), burnt (B), or calicined (C). These various taphonomic processes can create a skewed survivorship of elements in an archaeological assemblage, which can consequently affect quantitative analysis.

2.6 Identification and Species Found

Elements were recorded to the highest identifiable taxonomic level. The reference collection at the University of Sheffield Archaeology Department was utilized in the comparative analysis of the Gotland assemblage.

2.6.1 Fish

As previously stated vertebra are difficult to assign to species. However, Casteel (1976) states that with an adequate reference collection vertebra can in fact be identified to the species level, although speciation to genus should be attempted for smaller or fragmented vertebral elements. Speciation of fish vertebra can be accomplished through the examination of specific morphological features. These features include the centrum profile, sculpturing on the lateral and ventral aspects, as well as the position, shape and angle of the processes, and lastly, the shape and size of the neural arches (Colley, 1990; 214-215). Fish elements were identified to highest taxonomic level, in some instances species was not readably discernible and the element was identified to genus.

2.6.2 Sheep/Goat Distinction

The majority of caprine (sheep/goat) elements are difficult to accurately assign to species, therefore a large proportion of the elements in the assemblage were recorded as sheep/goat for taxon (See tables 5 and 6 in appendix for a full list of the taxonomic abbreviations that were used in the dataset). The sheep/goat distinction was, however, attempted for the third deciduous premolar and the fourth deciduous premolar, the permanent lower molars (when multiple teeth were present), distal humerus, proximal radius, distal metacarpal, distal tibia, astragalus, calcaneum, and distal metatarsal. The sheep/goat distinction is relatively easy in these elements based on the criterion set forth by Boessneck (1969) and Payne (1985).

2.7 Quantification of Species

The quantification of species in an assemblage can provide insights into the subsistence pattern and socioeconomic status of the residents at the site.

2.7.1 MNI and NISP

The species quantification for the assemblage was attempted using number of identified specimens (NISP) (Grayson, 1984) and minimum number of individuals (MNI). The NISP can overestimate the number of individuals at a well-preserved but highly fragmented site (Crabtree, 1990; 159). Furthermore, the MNI tends to underestimate the actual number of individuals when the material is highly fragmented (Crabtree, 1990; 159-160). The calculation of the MNI in conjunction with the NISP can avoid discrepancies in the data (Klein and Cruz-Uribe, 1984; 37). Therefore, MNI in addition to the NISP was calculated for both contexts and for the cumulative assemblage. Teeth were not considered for the NISP to avoid discrepancies, such as an overrepresentation of otherwise less represented species. Teeth were used to calculate the MNI.

2.8 Butchery/Cut Marks and Body Part Distribution

2.8.1 Butchery/Cut Marks

A wide range of processes can occur between the death of an animal and the subsequent recovery by the archaeologist, these processes are both human and non-human in nature (Meadow, 1980; Crabtree, 1990). To gain an understanding of the taphonomic processes that affected the faunal remains in the Gotland assemblage butchery was recorded. The assemblage was examined for cut (T), chop (P) and saw (S) marks, as well as combinations of butchery including chopped and cut (PT), sawn and chopped (SP), cut and sawn (TS). Butchery occurrence by species was also assessed for the three main domestics, caprine, cattle, and pig. The butchery occurrence based on anatomical element was taken into account for cattle; the results of the analysis were recorded into an anatomical diagram. Butchery based on anatomical element was not analysed for the caprine or pig data due to a small sample size.

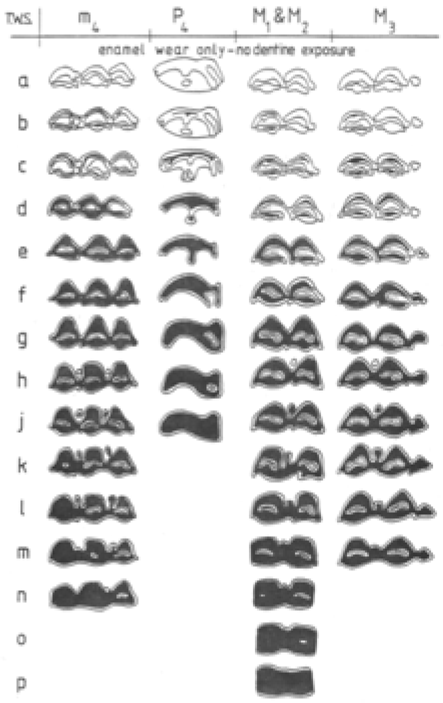
The distribution of anatomical elements was also taken into account for both the mammal and fish components of the assemblage to assess butchery related processing techniques.

2.9 Age at Slaughter

Age profiles or kill off patterns were estimated for the assemblage. The age profiles were based on two forms of zooarchaeological data; mandibular wear stages calculated from the recorded tooth wear stages and degree of epiphyseal fusion for all recordable elements subject to fusion.

2.9.1 Mandibular Wear Stages

A majority of mammals have two sets of teeth, the deciduous teeth and then the permanent teeth that replace the deciduous teeth. Age at death can be approximated in immature animals based on replacement of the deciduous teeth by permanent teeth. On adult mandibles with a fully erupted dental sequence age estimates can be calculated based on the enamel wear of the permanent teeth by assigning a tooth wear stage and then calculating the mandibular wear stage (Crabtree, 1990; 162). A tooth wear stage was only attempted on teeth that were more than half present. Tooth wear stages were attributed to cattle and pig teeth in accordance with the system for analysing and recording tooth wear set forth by O'Connor (1988), see image 2.1 and 2.2. The tooth wear stages for caprines were recorded using Payne's (1973) system for classifying tooth wear (image 2.3). A tooth is considered to be "in wear" when the dentine has been exposed by wear on the enamel (Payne, 1973; 293). Erupting teeth that are not yet in wear were recorded by stage of eruption based on the anterior pillar of the tooth (Ewbank et. al., 1964). The tooth wear stage following the eruption sequence is recorded as "a" as described by O'Connor (1988). If the degree of wear on the tooth fell between two of the illustrated tooth wear stages the tooth was assigned to the tooth wear stage that most closely resembled the wear stage of the tooth (Grant, 1982; 91). Wear stages "J" and beyond are from Grants (1982) classification system for mandibular wear stages.



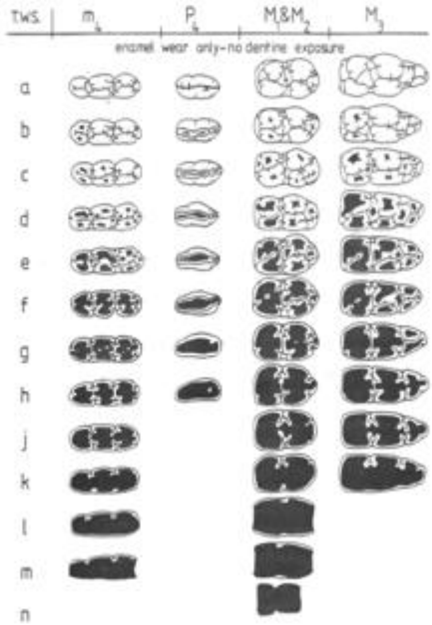


Image 2.1 and 2.2: Tooth wear stages of cattle teeth and tooth wear stages of pig teeth, from O'Connor (1988). For illustration of caprine tooth wear stages see Payne (1973)

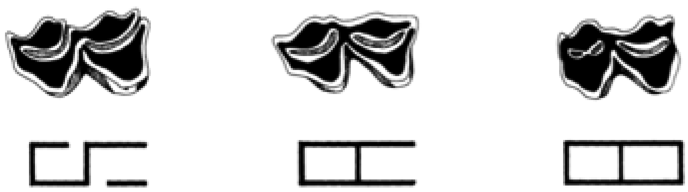


Image 2.3: Example of tooth wear recording system created by Payne (1973)

Mandibular wear stages were calculated from the tooth wear stages using O'Connors (1998) system for cattle and pig to determine approximate age at death of the specimen (table 2.1). Mandibular wear stages are only calculated for mandibles with two or more recordable teeth to avoid discrepancies in the data. Payne's (1973) system for assessing the wear patterns of caprine teeth was used to determine mandibular wear stages for caprines (table 2.2).

Table 2.1: O'Connor's (1988) mandibular wear stages for cattle and pigs. *Not part of the original O'Connor system

Age	MWS
Neonatal	4th deciduous premolar not in wear*
Juvenile	4th deciduous premolar in wear; 1st permanent molar not in wear
Immature	1st permanent molar in wear; 2nd permanent molar not in wear
Sub-adult	2nd permanent molar in wear; 3rd permanent molar not in wear
Adult	3rd permanent molar in wear, but not heavily worn
Elderly	3rd permanent molar heavily worn (wear stage j or beyond from Grant, 1982)

Table 2.2: Payne's (1973 mandibular wear stages for sheep and goat

Age	MWS
A (0-2 m)	4th deciduous premolar not in wear
B (2-6 m)	4th deciduous premolar in wear; 1st permanent molar not in wear
C (6-12 m)	1st permanent molar in wear; 2nd permanent molar not in wear
D (1-2 y)	2nd permanent molar in wear; 3rd permanent molar not in wear
E (2-3 y)	3rd permanent molar in wear; posterior cusp is unworn (wear stages 1-8)
F (3-4 y)	Posterior cusp of M3 in wear but pre-stage 11 (Wear stages 9-10)
G (4-6 y)	M3 stage 11; M2 stage 9
H (6-8 y)	M3 stage 11; M2 stage post-9
I (8-10 y)	M3 post-11

2.9.2 Fusion Data

Epiphyseal fusion in mammals occurs at the ends of long bone shafts, and in a juvenile animal the epiphyses and diaphysis are separated by a cartilaginous layer. When the bone growth is complete the plates ossify and the epiphyses and diaphysis are permanently fused. This sequence of bone growth and fusion occurs in a set pattern for each species, and thus can be used to make inferences regarding kill off patterns (Crabtree, 1990; 162).

Fusion data was calculated in addition to the mandibular wear stages. Fusion data alone is limited for assessing kill off patterns because once bone growth has ceased epiphyseal fusion can no longer be used to assess the age of an individual, MWS's can however be used to distinguish between adult and elderly individuals where fusion data cannot (Crabtree, 1990, 162). Elements that displayed a site of fusion where in the line of fusion was fully closed were classified as 'fused' and as 'fusing' once the spicules of the bone are formed across the epiphyseal plate thus joining the epiphyses to the metaphysis leaving areas that are observably open along the line of fusion (Albarella and Payne, 2005; Albarella and Davis, 1994). Elements were recorded as "fused/fusing" when the line of fusion was still apparent in parts and fully closed at other portion along the line of fusion. Un-fused elements were recorded as either "un-fused diaphysis" if only the diaphysis of the bone was present, "un-fused epiphyses" if the un-fused epiphyses of the bone was present, or un-fused diaphysis and epiphyses if both un-fused portions of the element were present. It should be noted that immature bird elements with 'spongy' bone ends that were not completely ossified or still growing were recorded as Juvenile (J).

The epiphyseal fusion data was used to estimate the age at death for the three main domesticates in the assemblage. The criterion for estimating age based on epiphyseal fusion compiled by Allentuck (2013) was utilized to estimate age at slaughter. Age based on epiphyseal fusion for cattle was gathered from Silver (1969). The age of pig epiphyseal fusion was calculated from Habermehl (1975) and the fusion age groupings were based on Bull and Payne (1982). The epiphyseal fusion groups and the respective ages for the caprine epiphyseal fusion data were based on Zeder (2006), see tables 2.3, 2.4, and 2.5. "P" and "D" in the tables represent the proximal and distal sites of fusion.

Table 2.3: Caprine fusion chart

Group/Age	Epiphyses
A 0-6 m	P Radius
B 6-12 m	D Humerus, Innominate (acetabulum), Scapula (glenoid)
C 12-18 m	P 2nd Phalanx, P 1st Phalanx
D 18-30 m	D Tibia, D Metacarpal, D Metatarsal
E 30-48 m	Calcaneus, P Femur, P Ulna, D Radius, P Tibia
F/G* 48+	P Humerus

Table 2.4: Cattle fusion chart

Fusion Group	Epiphyses	Age (months)
Early Fusing	Scapula (Glenoid)	7-10
	Innominate (acetabulum)	7-10
	P Radius	12-18
	D Humerus	12-18
	P 2nd Phalanx	18
	P 1st Phalanx	18
Middle Fusing	D Metacarpal	24-30
	D Metatarsal	24-30
	D Tibia	24-30
	Calcaneus	36-42
Late Fusing	P Ulna	42-48
	P Femur	42 m
	D Femur	42-48
	D Ulna	42-48
	P Tibia	42-48
	D Radius	42-48
	P Humerus	42-48

Table 2.5: Pig fusion chart

Fusion Group	Epiphyses	Age (months)
Early Fusing	Scapula (Glenoid)	12
	Innominate (acetabulum)	12
	P Radius	12
	D Humerus	12
	P 2nd Phalanx	12
Middle Fusing	P 1st Phalanx	24
	D Metacarpal	24
	D Metatarsal	24
	D Tibia	24
	D Fibula	24-30
	Calcaneus	24-30
Late Fusing	P Ulna	36
	P Femur	42
	P Fibula	42
	D Femur	42
	D Ulna	42
	P Tibia	42
	D Radius	42
	P Humerus	42

2.10 Morphometry

Measurements were taken in regards to the criteria set forth by Albarella and Davis (1994), Albarella and Payne (2005), Davis (1992), Von Den Driesch (1976), and Payne and Bull (1988), primarily focusing on the size and shape indexes created by Von Den Driesch (1976). All measurements were recorded in millimetres and approximated to a tenth of millimetre. Measurements were taken using digital callipers and a measuring box (no decimal points were taken on measurements using the box measuring box, which were rounded to nearest millimetre). Measurements were taken on teeth when the enamel was sufficiently preserved. Fused, fusing as well as un-fused elements were all measured. Elements from fetal or neonatal specimens were measured as greatest length without the epiphyses (GL) and minimum shaft diameter (SD). Measurements were taken for avian elements; the primary reason to measure avian elements is to determine species and to document size and variation. Measurements taken for avian elements followed the guidelines set forth by Von Den Driesch (1976).

Lyman (1987) recommends that at minimum of no less than thirty individuals from a given taxon should be used to construct a mortality profile, therefore based on sample size only the three main domesticates (caprine, cattle, pig) could be considered for morphometric analysis.

2.10.1 Log Scaling Index

The size scaling index technique was used to analyse the morphometric data taken from the Gotland assemblage. The assemblage presented challenges for morphometric analysis because of the small sample size, and also because a large proportion of the assemblage, primarily the three main domesticates that would normally be considered for morphometric analysis (pig, caprine, and cattle), was comprised of immature individuals with un-fused and fusing elements. The un-fused and fusing elements cannot be considered for morphometric analysis therefore the already small sample size was further reduced. The log scaling index (LSI) can be used to assess morphometric data with small sample sizes. Meadow (1999) recommends that the use of the size scaling index alone is not particularly accurate for determining the size characteristics of a given population, therefore the size estimates determined in this essay are best estimates. A larger sample size would be needed to conduct morphometric analysis on an element-by-element basis.

The logarithm size index (LSI) was calculated for the data and then graphed using histograms to determine the relative size of the three main domesticates from the Gotland assemblage (Uerpmann, 1979). The formula is listed below, x is the element measurement and m is the standard measurement.

$$LSI = (\log x - \log m) = \log (x/m)$$

The calculated values for the LSI were plotted in bar charts using the statistical software SPSS. The standards used to calculate the LSI for the caprine data were derived from a single flock of adult female Shetland sheep (Davis, 1996). The measurements are from the limb bones of twenty-six unimproved adult (fully fused) Shetland ewes (Davis, 1996; 593). The cattle data standard was derived from Pleistocene wild aurochs (Albarella et. al., 2008). The cattle morphometric data was a particularly small sample size, and should therefore be viewed as preliminary in regards to size profiles for the cattle of Viking Age Gotland. The pig LSI was calculated from the standard set forth by Albarella and Payne (2005) that took into account measurements from both maxillary and mandibular teeth. The postcranial portions of the pig could not be used due the small sample size resulting from the multitude of immature specimens

Chapter 3

Data and Analysis

3.1 Introduction

In the following chapter the previously described methods from chapter 3 are applied to the faunal assemblage from Gotland, Sweden. The author collected the data that will be presented in this chapter and the subsequent analysis will constitute the quantitative core of the dissertation.

3.2 Condition and Recovery

3.2.1 Surface Preservation

The recorded elements displayed a good surface preservation for both contexts. Figure 3.1 displays the surface preservation for construction 3800 and the culture layer. Roughly 80% of the elements recorded for construction 3800 were considered to have “good” surface preservation. The surface preservation of the elements from the culture layer was slightly less than that of the other context. Roughly 70% of the material from the culture layer was recorded as having “good” surface preservation. The elements from the culture layer that were recorded as having “bad” surface preservation were likely weathered. The surface of these elements displayed a network of fine, parallel surface cracks. This observable texture often occurs as a result of the weathering (White and Folkens, 2005; 52-54).

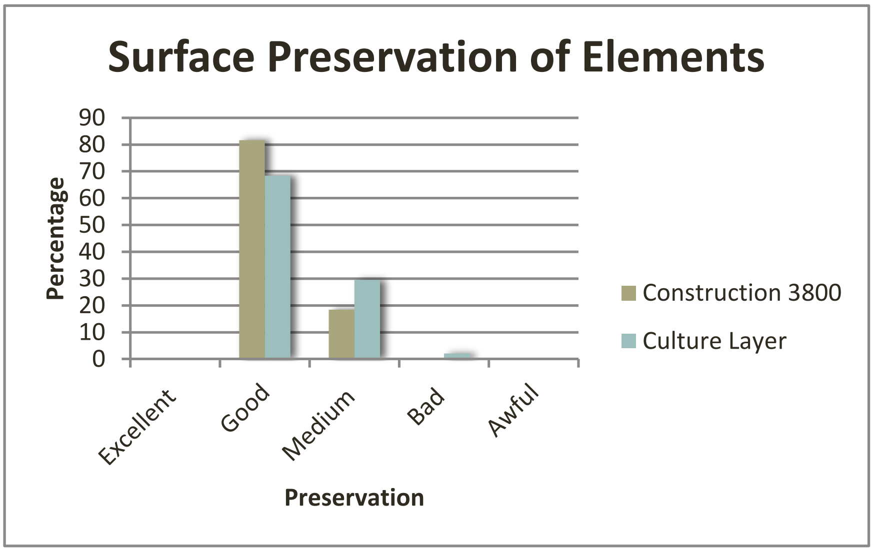


Figure 3.1: Histogram detailing the surface preservation of faunal assemblage for both contexts

The fish assemblage did not have as good of preservation as the mammal and avian assemblage; this was true for both contexts (figure 3.2). This is likely due differential survivorship of fish elements as opposed to mammal and bird elements in archaeological contexts; overall the surface preservation of the fish assemblage was recorded as “good” for construction 3800 and “medium” for the culture layer. The difference in surface preservation of fish elements between the two contexts may be taphonomic in nature.

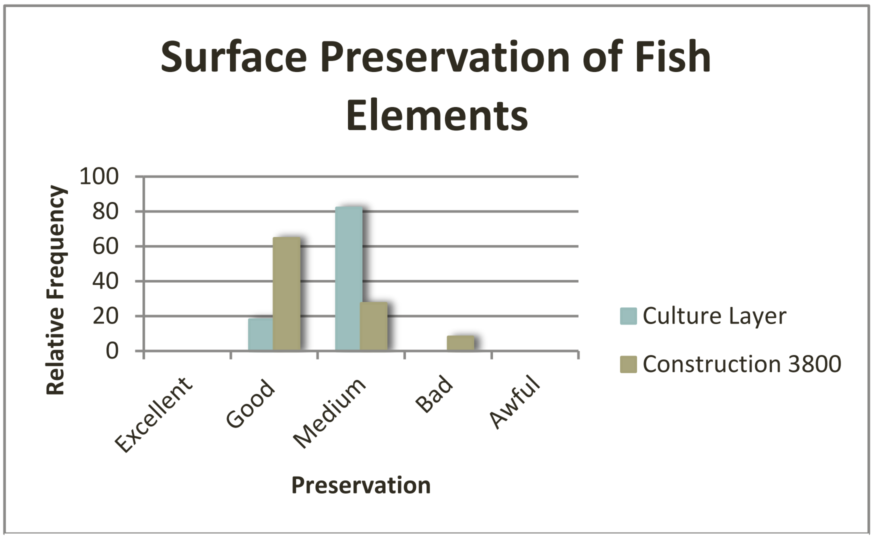


Figure 3.2: Histogram detailing the surface preservation of the fish elements for both contexts

3.2.2 Recovery Bias

The data that calculated the differential survivorship of the first and second phalanx for cattle and caprines would suggest that caprine phalanxes were recovered more frequently than those of cattle for both contexts (table 3.1). In an assemblage with a higher survivorship of cattle to caprine phalanges one could infer that medium animals and smaller would have a relatively high recovery bias. However, this does not appear to be the case for the faunal assemblage from Gotland. Rather this trend is likely not the result of a recovery bias but perhaps is rooted in other on site logistics that will be explored further in the following chapter.

3800	First phalanx	Second Phalanx	Second/First Phalanx
Cattle	4	2	.5
Caprine	2	2	1

CL	First phalanx	Second Phalanx	Second/First Phalanx
Cattle	4	1	.25
Caprine	3	2	.67

3800/CL	First phalanx	Second Phalanx	Second/First Phalanx
Cattle	8	3	.37
Caprine	5	4	.8

Table 3.1: Tables showing the frequency of first and second phalanges for both cattle and caprines for construction 3800 and the culture layer (CL) and the combined assemblage (3800/CL). The difference is calculated in the third column, the closer the number is to one the less recovery bias was present.

3.2.3 Taphonomic Processes

A large proportion of the assemblage was deemed highly fragmented. It should be noted that a substantial component of the fragmentary assemblage was comprised of fire-damaged elements, primarily in the form of small unidentifiable fragments. Prolonged heat exposure as well as various cooking methods can effect on the survival of bone material in the archaeological record; therefore differential cooking and butchery techniques for different species may ultimately lead to a recovery bias at the site.

Elements were also recorded as being gnawed by both rodents and carnivores, see image 3.1 and 3.2. Carnivore gnawing can differentially destroy the un-fused epiphyses of immature animals as well as the less dense portions of both adult and immature skeletons (Crabtree, 1990; Brain, 1967; Binford and Bertram, 1977). The destruction of the bones in this manner can contribute to a recovery bias and consequently the outcome of quantitative methods such as the NISP and MNI (Crabtree, 1990; Payne and Munson, 1985).

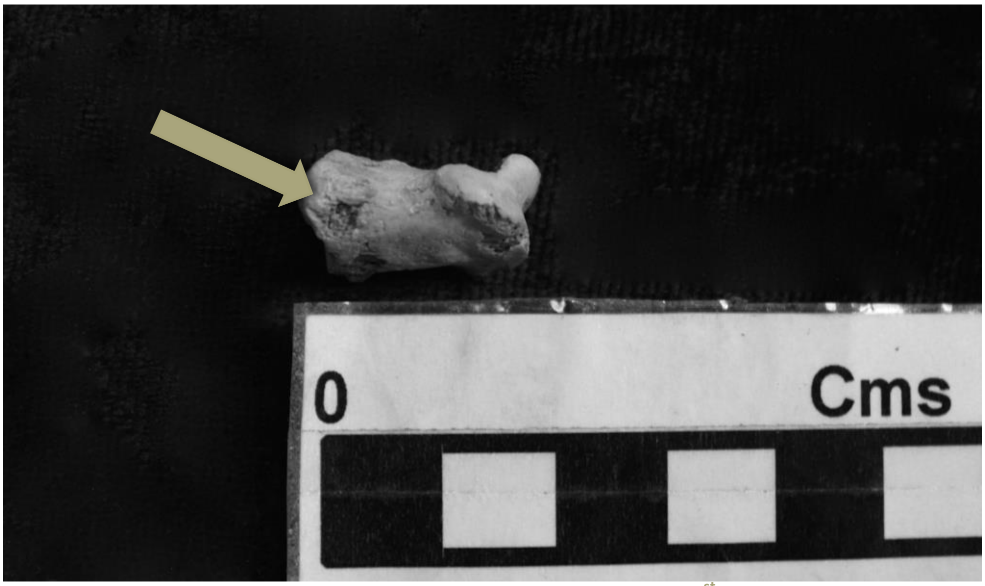


Image 3.1: Carnivore gnawing present on a possibly digested caprine 1st phalanx; note the puncture mark on the proximal aspect resulting from the canine tooth (from construction 3800)

Image 3.2: Rodent gnawing and potential carnivore gnawing on the distal portion of a pig right tibia shaft (from construction 3800)

3.3 Identification and Species Found

3.3.1 Construction 3800

The four most predominant species are, in order of occurrence, cattle, caprine, duck and cattle in the construction 3800 faunal assemblage, this is calculated using the NISP (figure 3.3). Based on the NISP the assemblage was comprised of 56% domestic species and 44% wild species, see figure 3.6; fish were not included in this data. The domestic species in the assemblage are primarily the three main domestics, (cattle, pig and caprine) and to a lesser degree the domestic cat and chicken. The most commonly occurring wild species in the assemblage was the duck. All other species deemed wild comprise 10% or less of the total assemblage. The assemblage was an even proportion of marine and wild species, see figure 3.5. The data from the MNI (figure 3.4) reveals the same trend as the NISP, however seal was more abundant than in the NISP. There is no doubt an over representation of the otherwise rare species in the assemblage is occurring in the MNI data.

The construction 3800 is comprised of a wide variety of avian species, the most predominant being duck, common eider, murres, and razorbills. Additionally, avian elements were identified as being from the typical merganser, common herring gull, and tern. A single element from a chicken was identified in the assemblage, and is assumed to be domestic. Approximately, 5% of the assemblage is comprised of hare and seal elements. Lastly, a single element belonging to a rat was identified and an ulna from a small rodent (tentatively identified as a vole) was also identified in the assemblage.

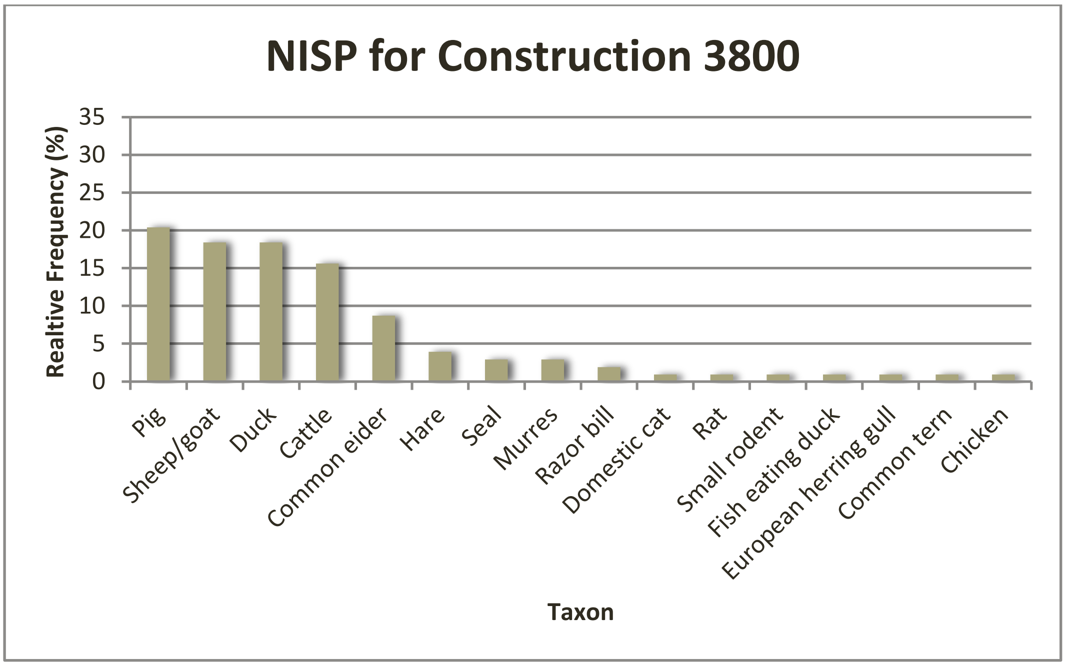


Figure 3.3: NISP for the construction 3800 faunal assemblage

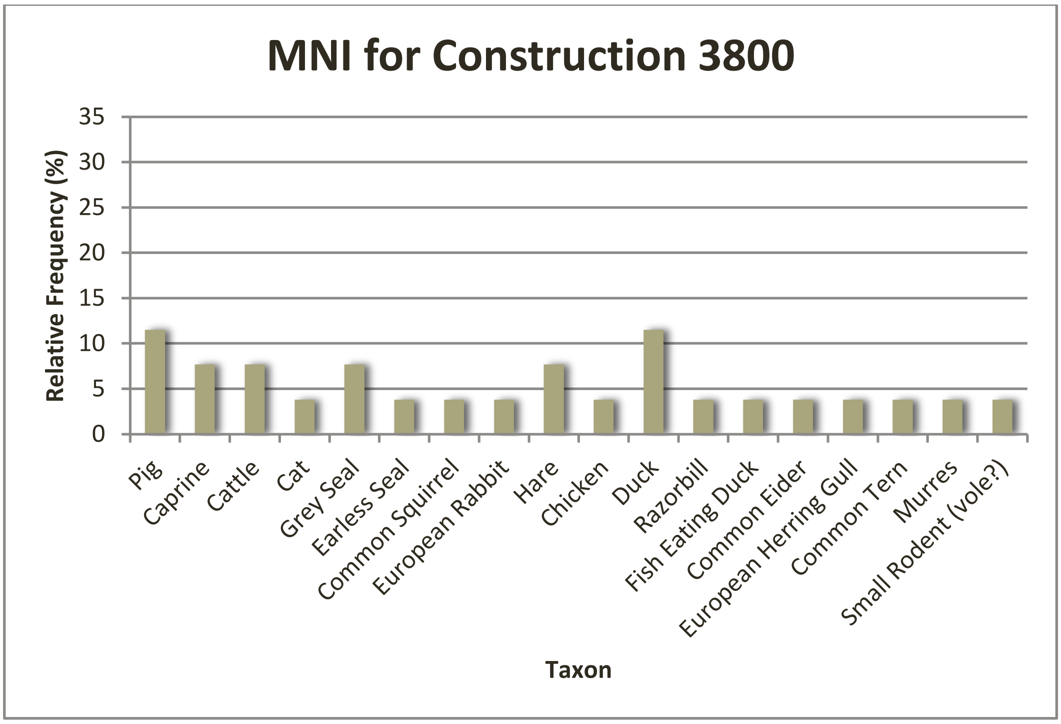


Figure 3.4: MNI for construction 3800 assemblage

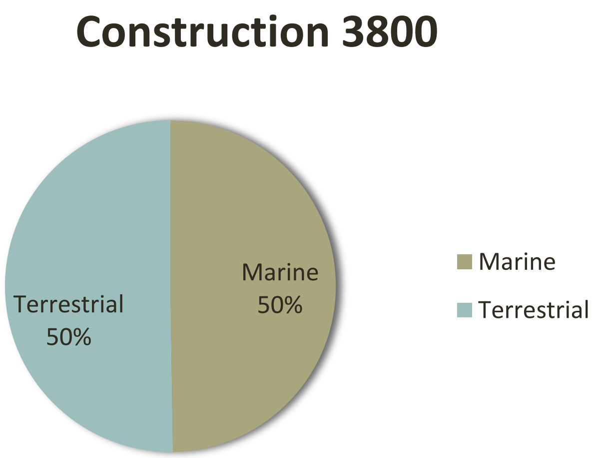


Figure 3.5: Percentage of marine versus terrestrial species present in the construction 3800 assemblage calculated from the NISP data

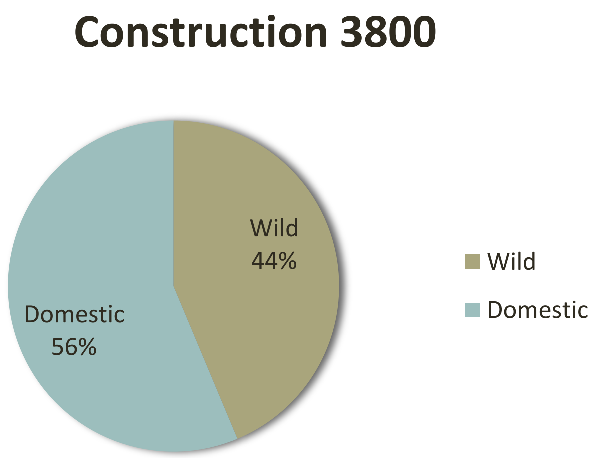


Figure 3.6: Percentage of domestic versus wild species present in the construction 3800 assemblage calculated from the NISP data

The most abundant species of fish in the construction 3800 contexts were cod, herring and pike, with cod being the most abundant; this is based on the NISP (figure 3.7). There is a trace element of perch, salmon, river herring, and flounder in the assemblage

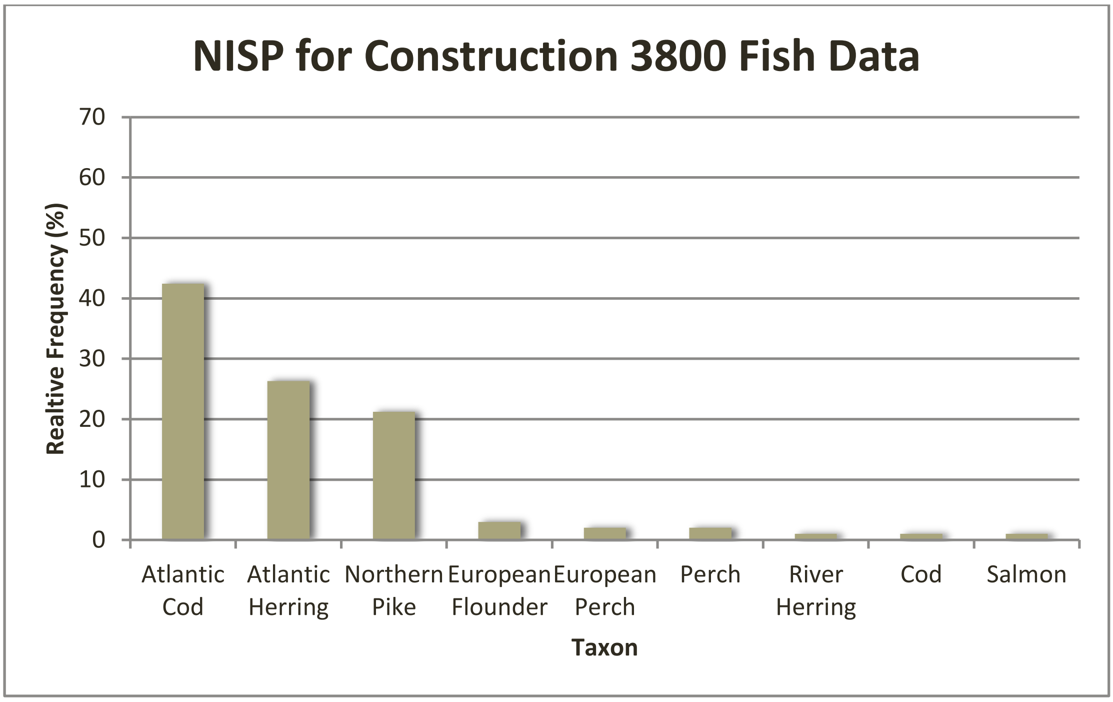


Figure 3.7: NISP for the construction 3800 fish assemblage

<u>*3.3.2 The Culture Layer*</u>

The most predominant species in the culture layer assemblage is pig, roughly 33% of the total assemblage is comprised of pig elements based on values calculated using the NISP, see figure 3.8. After pig the most abundant species in the assemblage are cattle and caprines, in that order. All other species represent 10% or less of the culture layer assemblage. The most abundant avian species is duck; duck comprises roughly 7% of the total assemblage from the culture layer. Roughly 3% of the assemblage is chicken, which is likely domestic. The genus referred to as the earless seals and hares comprise 2% of the total assemblage. A single rat femur and a single domestic cat femur were identified in the assemblage. Additionally, a red fox third phalanx was identified. Lastly, a distal humerus was identified as being from a European hedgehog. Based on values calculated from the NISP the culture layer assemblage was comprised of 82% domestic species and only 18% wild species (figure 3.11). Elements from terrestrial species were more common (65%) than those from marine species (35%), see figure 3.12. The data from the MNI (figure 3.9) produces somewhat the same trends as the NISP, however duck are more predominant and caprines are underrepresented in the data. Again, rare species are overrepresented with the MNI.

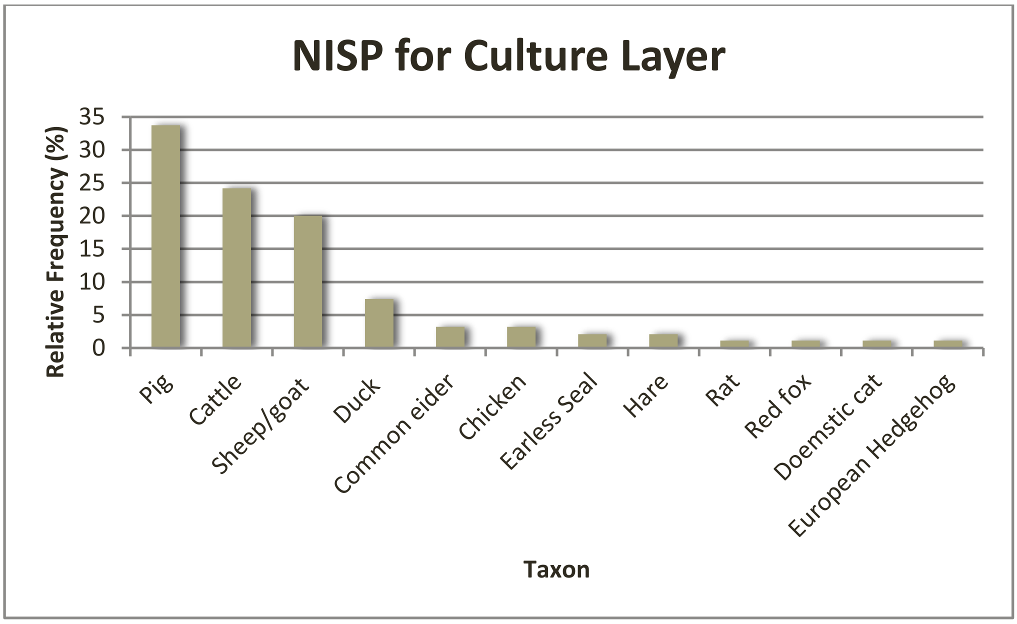


Figure 3.8: NISP for culture layer faunal assemblage

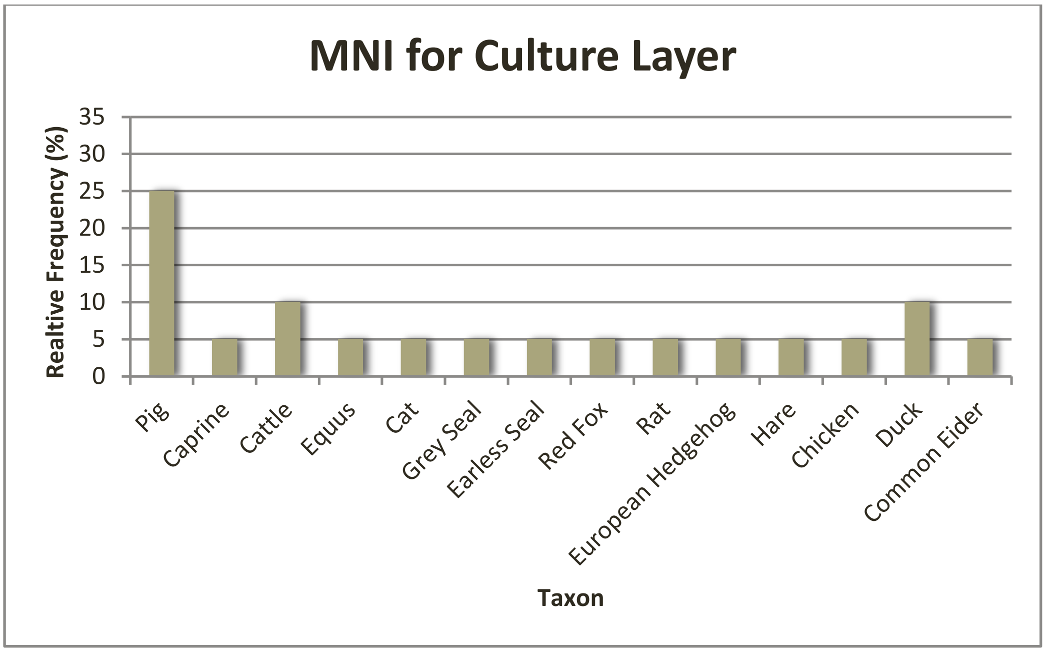


Figure 3.9: MNI for the culture layer

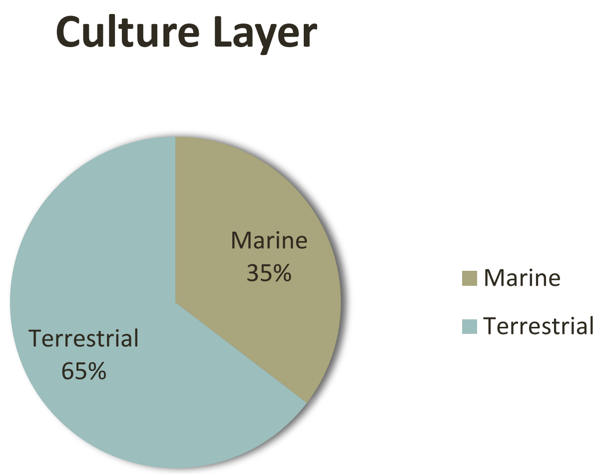


Figure 3.10: Percentage of marine versus terrestrial species present in the culture layer assemblage calculated from the NISP data

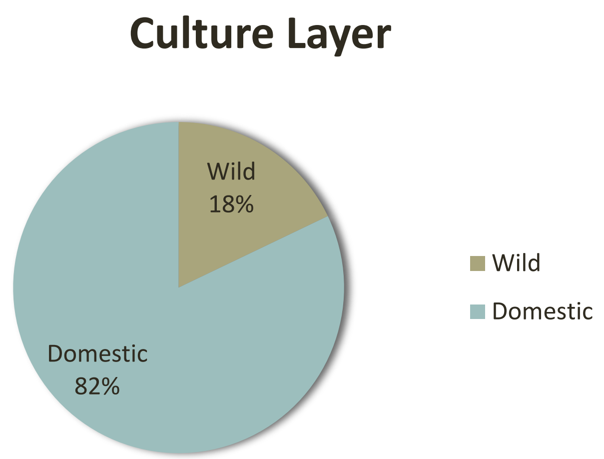


Figure 3.11: Percentage of wild versus domestic species present in the culture layer assemblage calculated from the NISP data

The values calculated for the NISP revealed an overwhelming predominance of cod in the culture layer fish assemblage (figure 3.12). The other species of fish identified comprised 5% or less of the total fish assemblage, these were identified as pike, perch, salmon, flounder, and eel. It should be noted that identification of the eel vertebra was tenuous due to the fragmented condition of the element.

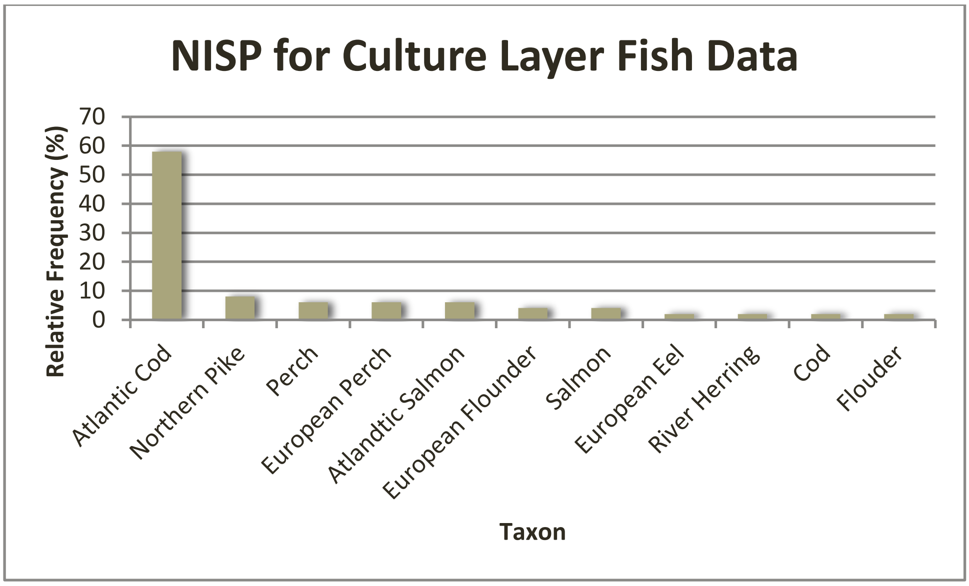


Figure 3.12: NISP for the culture layer fish assemblage

3.3.3 Comparative Frequency of Species Between Contexts

The most commonly occurring species in both contexts based on the NISP is pig. Additionally, both contexts had high occurrence of cattle, caprines, duck, and common eider, see figures 3.3 and 3.8 The percentage of wild versus domestic species varied between the two contexts (figures 3.6 and 3.11). There are notably more wild species in the construction 3800 assemblage than were identified in the culture layer assemblage. Roughly 44% of the faunal remains from the context construction 3800 context were identified as wild species (56% domestic), while only 18% (82% domestic) of the assemblage from the culture layer is comprised of wild species. There are fewer terrestrial species in the construction 3800 assemblage than in the culture layer assemblage (see figures 3.5 and 3.10). Roughly 65% of the culture layer assemblage was identified as terrestrial species (35% marine), while the construction 3800 assemblage was evenly distributed between terrestrial and marine species.

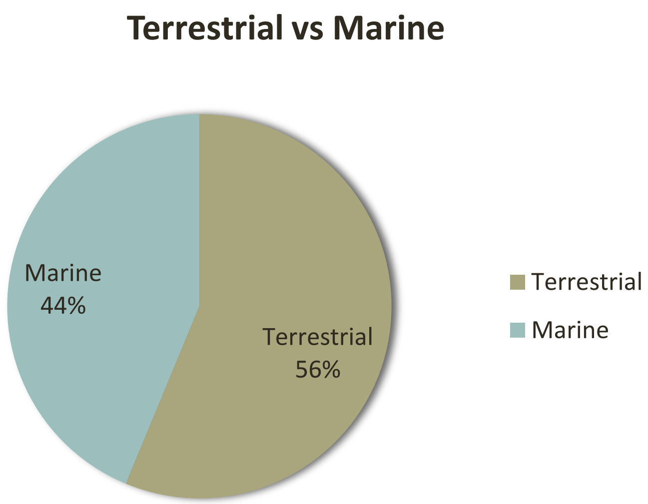


Figure 3.13: Occurrence of terrestrial versus marine species for both contexts

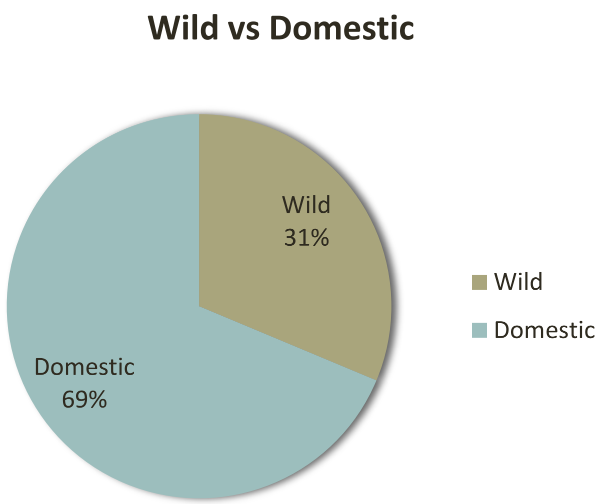


Figure 3.14: Occurrence of domestic versus wild species for both contexts

The species data was analysed by combining the datasets from both contexts with the hopes of gaining insight into the overall continuity of the site. The combined assemblage dataset from Gotland is evenly comprised of both marine and terrestrial species, with a slight preference toward terrestrial species, see figure 3.13. Approximately 56% of the assemblage was identified as terrestrial species and 44% were identified as marine species, this was based on the data from the NISP. Roughly 69% of the combined dataset from Gotland was comprised of domestic species while 31% of the assemblage was identified as wild species (figure 3.14).

3.3.4 Sheep/Goat distinction

Table 3.2: Frequency of sheep and goats in total assemblage calculated from the NISP

Taxon	Frequency
Sheep	6
Goat	0
Sheep/Goat	38
Total	44

The sheep/goat distinction was attempted on certain elements during the recording process. Table 3.2 shows the frequency of sheep/goat, sheep, and goat elements in the assemblage. No elements were identified as goat, however a small percentage of elements were identified as sheep. Ambiguous elements were recorded as sheep/goat. Sheep and sheep/goat data was combined for quantitative analysis because of the small sample size of sheep/goat elements, and are referred to as "caprine" throughout the dissertation.

3.4 Butchery/Cut Marks

Butchery was recorded during the analysis of the assemblage. The butchery is primarily noted on the rib and vertebral elements. Non-recordable elements that were recorded in the database as "OTH" as well as the proximal ends of long bones have been considered in the butchery data to provide a larger sample size. Butchery was noted on mammal, bird, and fish elements. Butchery was present on 44% of the elements from the construction 3800 assemblage (figure 3.15), and was evident on 22% of the elements from the culture layer (figure 3.16).

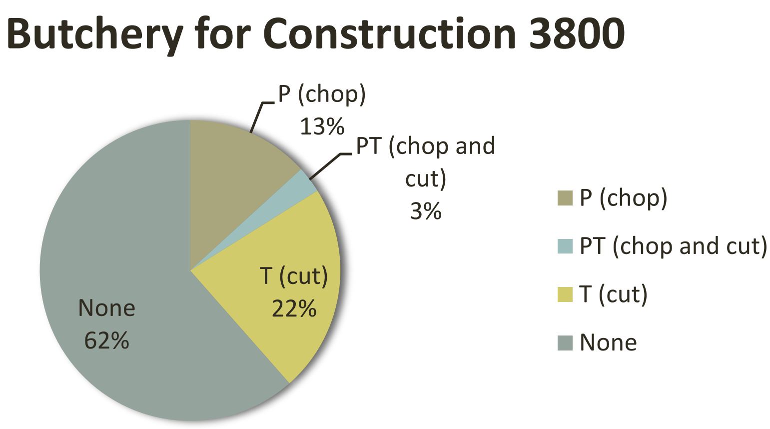


Figure 3.15: Butchery data for construction 3800

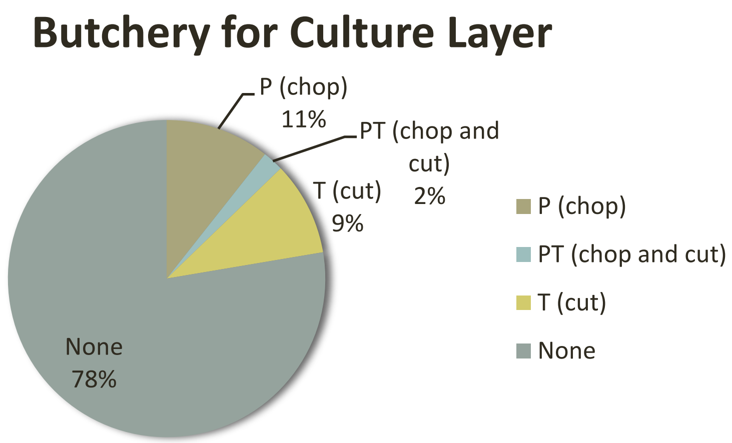


Figure 3.16: Butchery data for the culture layer

The occurrence of butchery by species was also calculated for the three main domesticates. Only elements that could be identified to species were considered for the data. Due to a small sample size data from both contexts was combined during the quantification process. Butchery was far more prevalent in the cattle remains than in the caprine or pig elements, see table 3.3.

Table 3.3: Butchery by species from the construction 3800 and culture layer context

Taxon	Chop	Cut	Chop/Cut	Sawn	Total
Cattle	26	4	2	0	32
Pig	1	5	1	0	7
Caprine	6	1	0	0	7
Total	33	10	3	0	46

Butchery by body part was considered for the cattle data. This was not attempted for the other two main domesticates due to a small sample size. Figure 3.17 illustrates the occurrence of butchery on the cattle skeleton for both contexts. The most heavily butchered (chop and cut marks) elements were the femur and tibia. The axial portions of the skeleton including the vertebra, pelvis, cranium and horn cores also displayed a relatively high degree of butchery, in addition to the humerus. A lesser extent of butchery was also noted on the ribs, scapula, radius, axis, and mandible.

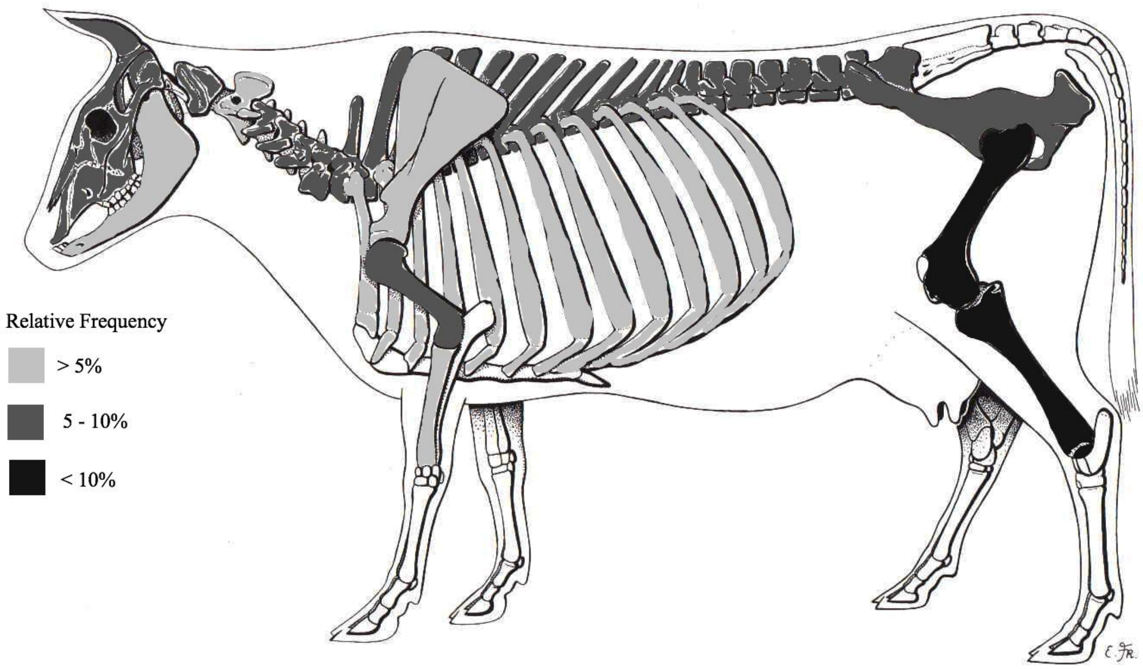


Figure 3.17: Frequency of butchery by skeletal element for cattle from both contexts

A large proportion of the assemblage was burnt, however, the burnt remains were often in the form of unidentifiable fragments, and as previously stated this can be evidence for the cooking and further processing of the butchered remains. The burnt remains were not recorded due to fragmentation. Depicted in image 3.3 is a calcined (converted into calx by heating or burning) left duck femur.

Image 3.3: Calcined left duck femur; cut marks were identied along the anterior meidal aspect of the shaft as indicated by the arrow

3.5 Body Part Distribution

3.5.1 Fish

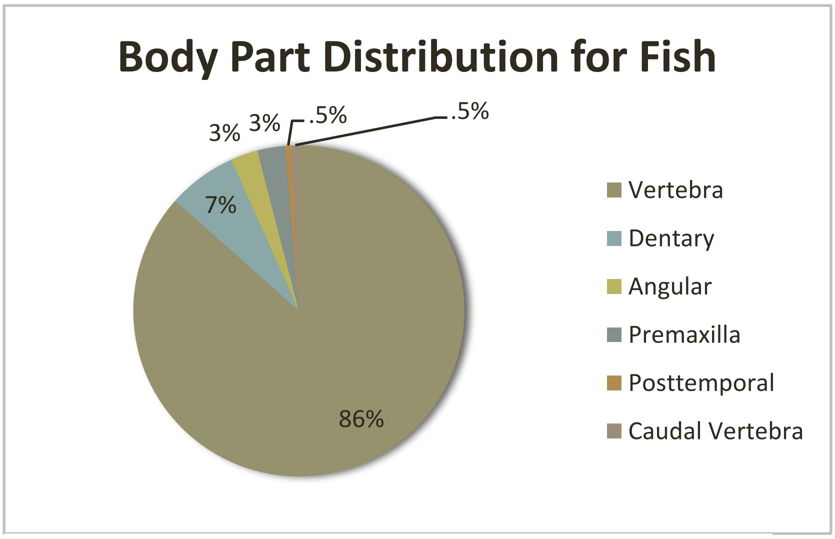


Figure 3.18: Body part distribution for fish component of the assemblage

The body part distribution was calculated for the fish assemblage from the construction 3800 and the culture layer (Figure 3.18). The most abundant element found for fish were vertebra, nearly 86% of the fish assemblage was comprised of vertebra. Roughly, 14% of the assemblage was comprised of cranial elements.

3.5.2 Main Domesticates

The body part distribution was calculated for the three main domesticates, see table 3.4. The most commonly occurring body parts in both contexts are elements from the appendicular portion of the skeleton. The axial skeleton is underrepresented in both contexts, but is generally more prominent in the cattle data. The first and second phalanxes are the most common elements for all three species in both contexts.

Table 3.4: Body part distribution for the three main domesticates for both construction 3800 and the culture layer (CL)

3800				CL			
Element	Pig	Cattle	Caprine	Element	Pig	Cattle	Caprine
HC				HC			
CR				CR			
X				X			
N				N			
AT		2		AT	2	2	1
AX				AX		1	1
SC	1	1	1	SC	1		
HU		2		HU	2	1	1
RA	1	1		RA	3		2
UL	1	1	2	UL	1		
C2/3			1	C2/3		1	
MC		1		MC		1	
PE	2			PE	2		1
FE	3		2	FE	2	3	
TI	3	1	4	TI	4	2	1
AS	1	1	3	AS		2	2
CA	2			CA	3		
SCU				SCU		1	2
MT			1	MT	2	2	
MP	1		1	MP	1	1	
P1	4	4	2	P1	5	4	3
P2	2	2	2	P2	2	1	2
P3				P3	2	1	3

3.6 Age at Slaughter

The age at slaughter estimates were attempted for the three main domesticate species, pig, caprine, and cattle. Age estimation was attempted using mandibular wear stages and sequences of epiphyseal fusion.

3.6.1 Mandibular Wear stages

Mandibular wear stages could not be estimated for the caprine and cattle data due to a lack of mandibles possessing two or more teeth with recordable wear stages. However, mandibular wear stages were calculated for the pig tooth wear data from both contexts. That being said the small sample size does not allow for any conclusive evidence to be drawn regarding an age profile for pigs from this site on Viking Age Gotland. The mandibular wear stages calculated from the recorded pig tooth wear stages are nonetheless presented in table 3.5, a mandibular wear stage was calculated for a total of nine mandibles. Based on the mandibular wear stages there were an equal number of juvenile, sub-adult, and adult pig mandibles in the assemblage.

Table 3.5: MWS calculated from recorded tooth wear stages; data from both contexts is recorded in the following table

	Neonatal	Juvenile	Immature	Sub-adult	Adult	Elderly	Total
Sus	-	3	-	3	3	-	9

A number of teeth from both contexts were recorded as wear stage "J" or beyond (Grant, 1982), these are likely from elderly individuals, however, a larger sample size would be needed to confirm the presence of elderly individuals at the site. Additionally, a cattle deciduous molar was identified at the site; the root of the tooth was reabsorbed meaning it was likely shed ante mortem, the presence of this tooth would insinuate that animals were being raised at or near the site where the assemblage was excavated.

3.6.2 Fusion Data

The fusion data was analysed for the three main domesticates, pig, caprine and cattle (for charts detailing epiphyseal fusion see tables 1-3 in appendix). The fusion data for both contexts was combined to provide a larger sample size. Age based on epiphyseal fusion alone cannot distinguish between adult and elderly animals. It should be noted that a large proportion of pig elements were recorded as “neonatal” and a single juvenile bird element was identified in the assemblage, the left coracoid of a chicken. Additionally, a number of immature seal remains were identified in the assemblage. A single immature cat element was also identified.

The plotted fusion data for cattle forms a bimodal distribution (figure 3.19). The cattle assemblage was comprised of primarily early fusing (between 7-18 months) and late fusing elements (between 42-48). Roughly 50% of the assemblage is early fusing elements and 30% late fusing elements. Thus, the most of the cattle were aged between 7-18 and 42-48 months.

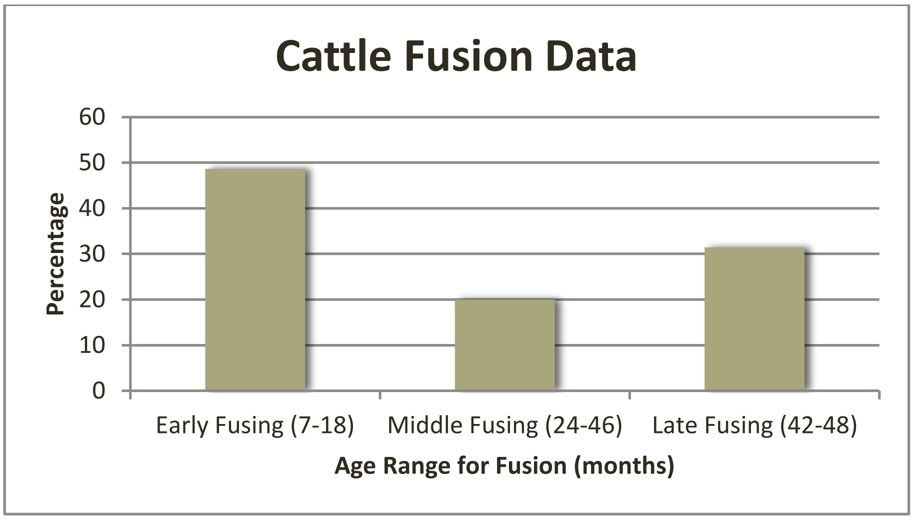


Figure 3.19: Age at death for cattle based on epiphyseal fusion

The pigs from the Gotland assemblage were primarily 36-42 and 24-30 months based on the data from epiphyseal fusion (figure 3.20). Roughly 20% of the elements were assessed as being early fusing and about 12 months of age at time of death.

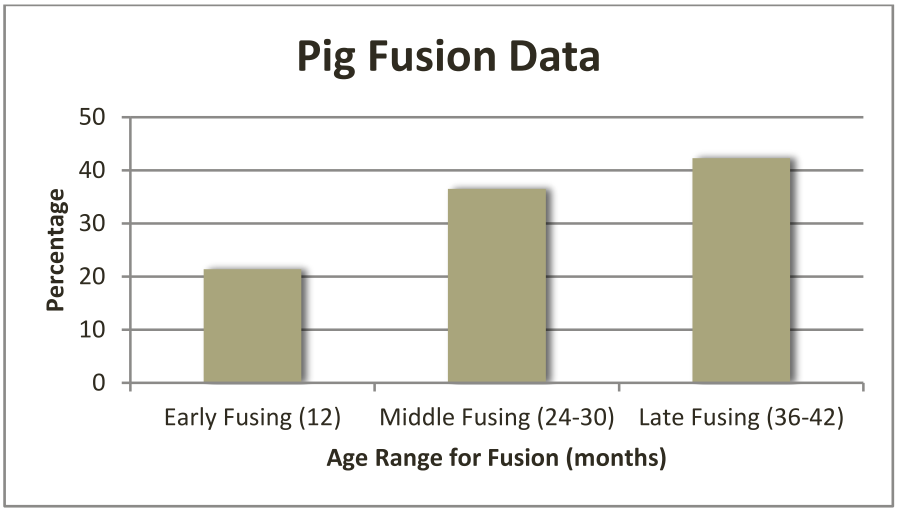


Figure 3.20: Age at death for pigs based on epiphyseal fusion

The most commonly occurring age at death for the caprines in the Gotland assemblage was 12-48 months (figure 3.21). Approximately, 29% of the caprines were aged at 6-12 months and another 29% were aged to 30-48 months based on epiphyseal fusion. About 19% were aged to 18-30 months.

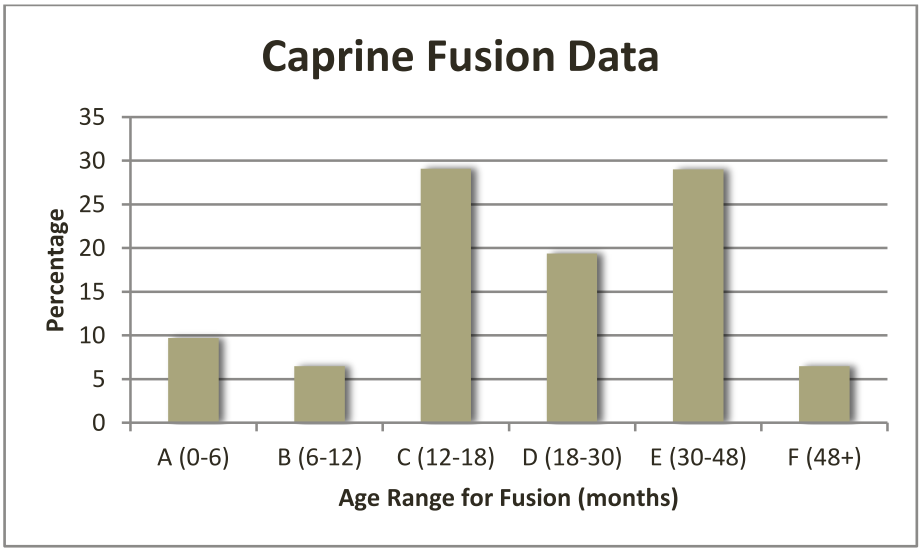


Figure 3.21: Age at death for caprines based on epiphyseal fusion data

3.7 Aberrant and Pathological Conditions

A reduced hypoconulid was observed in a pig maxillary third molar, see image 3.4. In artiodactyls the lower and upper third molar has three pillars. The third pillar, which is referred to as the hypoconulid, is smaller than the other two pillars of the third molar and on occasion will not develop at all (Albarella and Davis, 1996; 15). This anomaly was only observed in a single element within the assemblage.

Image 3.4: Reduced hypoconulid on a pig maxillary third molar as indicated by the arrow; possible reabsorption of the first molar tooth socket indicating ante mortem tooth loss

Pathologies were recorded for a small number of elements, primarily those belonging to caprines and pigs. Osteophytes were primarily observed on the first and second phalanxes (image 3.5). Furthermore, osteophyte formation due to a possible breakage was diagnosed on a fragment of medium sized cartilaginous rib fragment (image 3.6), based on size and species frequency the rib fragment was likely pig or caprine. Overall, a relatively small proportion of pathologies were recorded for the assemblage.

Image 3.5: Osteophyte formation circumnavigating the shaft of the rib fragment and an additional possible fracture resulting from trauma along shaft. Cartilaginous rib fragment from medium size ungulate

Image 3.6: Osteophyte formation along the distal aspect of a pig first phalanx

A small bone fragment in the shape of a triangular wedge and measuring approximately one and a half centimetres in length with a width of a quarter centimetre was identified in the assemblage. This element is of interest because it appears to have been worked; this is the only element of the sort that was identified in the assemblage. The worked element was from the construction 3800 assemblage. It is hypothesized that this worked bone fragment was originally part of a larger object. It may have potentially been a tong on a comb.

Additionally, two small ceramic potshards, a single botanical element, and two iron nail fragments were identified among the faunal material.

3.8 Morphometry

The log scaling index (LSI) was calculated for the three main domesticates from the Gotland assemblage (cattle, caprine, and pig). The red vertical line in the bar charts represents the standard set of measurements that was used to calculate the LSI for the Gotland assemblage and the dotted black vertical is the calculated average size. No un-fused or fusing elements were used in the calculation of the LSI. Maxillary and mandibular teeth measurements were used to calculate the pig LSI due to a lack of recordable and fully fused post cranial elements.

3.8.1 Cattle LSI

The cattle present on Gotland during the Viking Age were smaller than those from Pleistocene Britain (figure 3.22). This is not surprising given that the standard is from a population of wild aurochs. It can therefore be determined that the cattle present on Gotland were domestic as would be expected. The cattle from Viking age Gotland plot closer to the Pleistocene standard, which would suggest that cattle were somewhat large. The smaller outlier in the data could be the result of naturally occurring sexual dimorphism. However, if sexual dimorphism was a factor in the data it would have formed a bimodal distribution.

3.8.2 Caprine LSI

The caprine data plotted near to the chosen standard (figure 3.23). The average size of the caprines present in Gotland was slightly larger than that of the standard. However, it can be inferred from the data that the Caprine population on the island of the Gotland was domestic and similar in size to the caprine population that was used for the standard. Again, the outlier could be the result of sexual dimorphism.

3.8.3 Pig LSI

The pig data plotted to the left of the standard and plotted forming a unimodal distribution (figure 3.24). The pigs present in Viking Age Gotland were therefore slightly smaller than the standard, based on this information it can be inferred that the pigs in the assemblage were domestic. The larger outlier present in the data could be the result of sexual dimorphism; however, it is also possible that the outlying data could be wild boar (Sus scrofa).

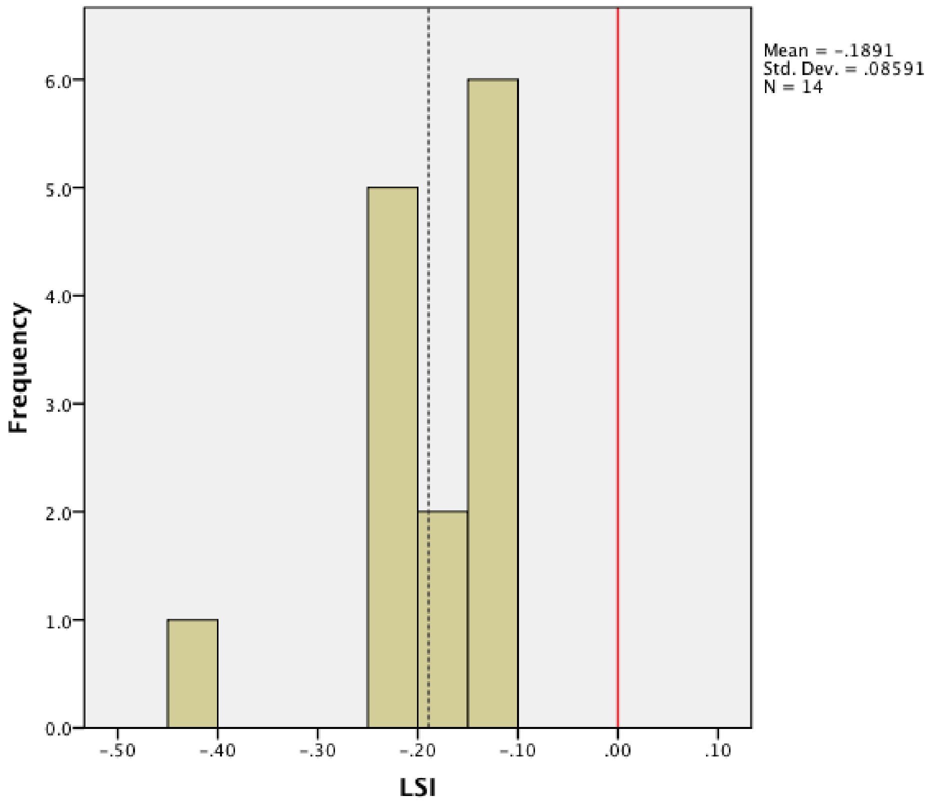


Figure 3.22: LSI for cattle metric data. The red line is the standard and the black dotted line is the average for the data

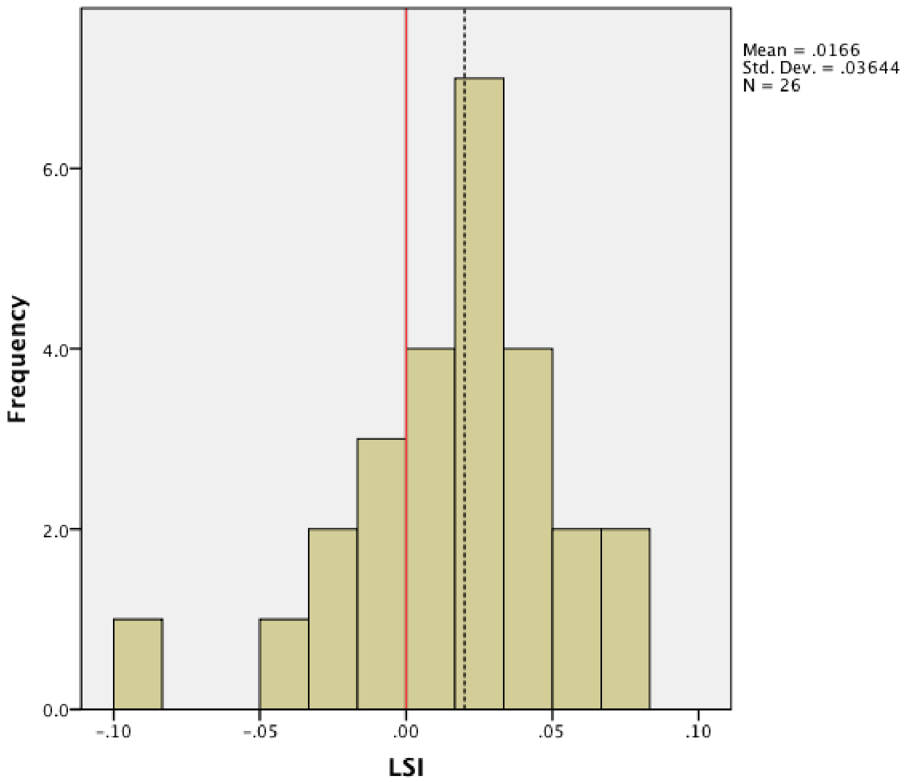


Figure 3.23: LSI for caprine metric data. The red line is the standard and the black dotted line is the average for the data

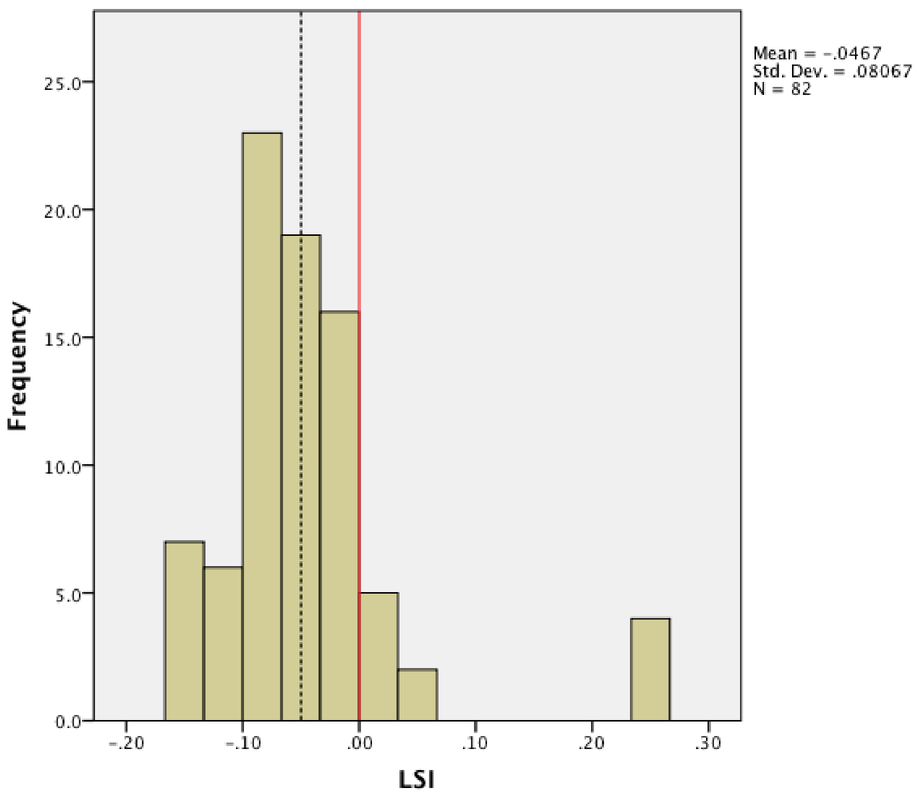


Figure 3.24: LSI for pig metric data. The red line is the standard and the black dotted line is the average for the data

Chapter 4

Interpretation and Synthesis

4.1 Introduction

Based on the data analysis from chapter 3, the following chapter will attempt answer the research question regarding human animal relationships presented in chapter 1, see section 1.3.4. Complex societies tend to develop elaborate food systems with culturally unique patterns dictating how food is produced and distributed, prepared and eventually consumed and discarded (Goody, 1982). This chapter will discuss the faunal assemblage from Gotland to infer what type of meat was being consumed (what species of animals, age and what products were being derived from the animals), how the meat was being produced distributed and consumed, and how this can provide insight into the overall socioeconomic status of the site and the inter and intra site logistics.

4.2 Species Range and Ratios

4.2.1 Overall Trends

The cumulative assemblage for both contexts was primarily domesticates with an inclusion of wild species and the almost equal occurrence of both marine and terrestrial species. There appears to have been a dual or mixed economy at Gotland between animal husbandry, the sourcing of wild animals, and fishing. The dual economy was more prevalent in the assemblage from construction 3800, based on the abundance of domestic and wild species as well as those of marine and terrestrial. There were fewer wild and marine species identified in the culture layer assemblage, which could suggest a more specialized subsistence economy. Based on the occurrence of wild and domestic species it seems plausible to assume that some form of small-scale farming was occurring at this Viking Age port of trade site.

There was a clear bias in the species representation of wild bird over domesticated varieties such as the chicken. This is a common pattern in Viking age assemblages. Geese are typically the most common avian species recovered in archaeological assemblages. Chickens are mentioned in the Old Norse poems and in other textual sources (Foote and Wilson, 1979; 147). However, the high occurrence of the common eider and duck in the assemblage may be due to migration patterns and seasonal availability of the Goose. It has been shown that island sea birds and their eggs provided an essential nutritional addition to the Viking diet (Graham-Campbell, 2001; 123).

The occurrence of wild species in the assemblages could be indicative of a number of different socioeconomic factors at the site, for example the abundance wild species could be related to the socioeconomic status of the inhabitants of the site. In a stratified society access to certain meat or species of animal may only be granted to the upper class (Crabtree, 1990; 171). At other archaeological sites the hunting of wild species of animal has been linked to being an elite activity.

4.2.2 Mammal Species Representation

The most common occurring species in the assemblage was pig; this is a typical feature of Viking Age faunal assemblages in Scandinavia. Caprines are hardier and better suited to survive the harsh winters typical of the Viking homeland of Scandinavia (Foote and Wilson, 1979); therefore Caprines tend to be more abundant than cattle or even pigs in higher latitude climates. The abundance of pig in the Gotland assemblage is likely a result of the warmer climate in the south as opposed to the northern reaches of Viking homeland. A study by McGovern (1984) on Viking farmsteads in Greenland found that high status farmsteads included a higher proportion of cattle bones, whereas low status farmsteads typically had a higher percentage of caprine and seal elements. Additionally, cattle are associated with higher status in Scandinavian Viking Age sites. Overall, the owning of pigs and caprines supplemented with the hunting of seals has been associated with a lower economic status in Viking Age towns. A small number of seal elements were identified in the Gotland assemblage and as previously mentioned pig and caprine were the most abundant domestic species, therefore this trend could indicate a lower socioeconomic status of the site. However, other archaeological evidence from the site contradicts this and suggests it was a wealthy site.

4.2.3 Fish Species Representation

The most commonly targeted species of fish in the Baltic were cod, herring, and sprat (Sparholt, 1994). The most common species of fish from the Gotland assemblage was the cod; true for both contexts. The next most abundant species of fish were herring and pike, in that order. The abundance of cod in both contexts would suggest a specialized fishing economy. The noted size differences in the cod could be the result of different fishing techniques. Hook dimensions will directly affect the size of the fish that is caught (Barrett et. al., 1999; Owen, 1994). Smaller fish are typically caught closer to shore while larger fish are found in deeper waters. Cod can be caught near to shore, or in depths up to about 600 meters, where larger individuals reside (Muus and Dhalstrøm, 1974; Wheeler, 1978). It is worth noting that some of the oceanic species of cod are highly migratory (Garrod, 1977), which could have implications on assemblage composition. The large cod in the assemblage were likely caught by trawl or long line, in which a line is affixed with multiple hooks which are then anchored along the ocean floor (Goodland, 1971). Long lines were commonly used during the Viking Age. The smaller cod in the assemblage were probably caught from shore or near to shore using a line or net cast from boats; small cod could also be caught via coastal weirs or traps (Baldwin, 1982; Fentan, 1978).

The presence of cod, salmon, and eels has been associated with a high socioeconomic status at other Viking Age sites (Colley, 1983); these species were also present in the Ridanäs assemblage. There was a small inclusion of salmon in the Gotland assemblage, and a single tentatively identified eel vertebra. The presence of other smaller species of fish has been interpreted as being accidental catches or as from the stomach contents of the intentionally caught larger fish (Barrett et. al., 1999; 365). Eels and salmon tend to occur in assemblages from consumption sites (Barrett et. al., 1999), a larger sample size would be needed to verify if this site was a consumer or producer site.

4.2.4 Non-Native Species

The wild species of mammals, birds, and fish represented in the assemblage are indigenous to the area. There is no clear evidence to suggest that non-native species were a trade good imported into the site. Evidence of trade goods on the island would be the presence of non-native species. The absence of this data here is not to say this did not occur, however, based on the small sample analysed for this essay there is no constructive evidence to suggest anything else. As stated by Hamblin (1984) species outside of their normal geographic local is an obvious sign of trade.

4.2.5 Other

The presence of cat elements in the assemblage suggests that domestic cats were living at the site. Cats, in addition to dogs, were typically kept at Viking Age farmsteads (Graham-Campbell, 2001). This could explain the occurrence of micro fauna in both contexts as well as the smaller avian species such as the potential Sterna sp. element. If the cat were living with the human population at the site then the cats likely hunted and deposited refuse in the same area, where in the human occupants would dispose of cat killings in the refuse pile. In support of this theory Kosiba et. al. (2007) conducted isotopic analysis from the domestic cats at Ridanäs and found that household domesticates at the site such as cats and dogs had access to household scraps in addition to wild micro fauna and plant materials.

4.3 Specialized Butchery and Element Distribution

4.3.2 Mammal and Avian

Butchery on the cervical vertebra (image 4.2), predominantly on the atlas and axis, as well as along the occipital condyles of the cranium is associated with the removal of the head. The butchery marks observed on the distal lingual portion of the mandible likely resulted from the removal of the tongue (image 4.3). Additionally, the butchery observed on the appendicular elements is likely from dismemberment of the animal during processing (image 4.1). Slaughtered animals were typically dismembered and then smoked, pickled or dried for trade or to fill the larder for the winter months to ensure survival in case of hardship (Foote and Wilson, 1979; 148).

Image 4.1: Cattle distal humerus; Chop mark bisecting distal portion of humerus. Associated with dismemberment

Image 4.2: Cattle cervical vertebra; Chop mark through vertebral body and left superior articular facet as well as a potential chop mark through the spinous process. Associated with the removal of the head

Image 4.3: Cut mark on distal lingual portion of cattle mandible below the second molar. Associated with the removal of the tongue

Body part representation of species can provide insight into the function of the site. If animals were being raised, slaughtered and consumed at a site then the expectation is that all elements would likely be represented at the same frequency in the assemblage. On the other hand at consumer sites the expectation is that body parts are being selected resulting in a high proportion of “meat bearing” elements. At processing sites it would be expected that the assemblage would be primarily composed of butchery waste (Crabtree, 1990; 166). Butchery waste typically includes cranial and foot elements. It has been documented that prior to being salted and dried the cranium, mandible, metapodials, and phalanges would be removed; additionally the carcass would be dissected into 25 centimetre portions, a standard documented procedure (Wijngaarden-Bakker, 1984). Based on the body part distribution data for the assemblage this was likely a producer and consumer site because all elements were represented at the same frequency in the assemblage. The fresh meat would typically be boiled or roasted on spits. The meat that was preserved was done so through salting, smoking, drying, and pickling (Roesdahl, 1998).

4.3.3 Fish

Data pertaining to body part distribution for fish suggests a pattern related to a particular method of fish processing, which is the drying of fish. Dried fish was a staple trade product in the North Atlantic, and likely in the Baltic as well. Dried fish is thought to have been a trade item as early as the ninth century (Hagen, 1995); based upon on an anecdote in Egils Saga that was written in the thirteenth century (Barrett et. al., 2000). Fish were also dried for the purpose of long-term storage. Fish preservation led to the possibility of long-term storage and also long range trade. Fish oil was also traded over long distances and exploited for wealth (Barrett et. al., 1999; Perdikaris, 1999). Dried cod was traded over along range stretching from Arctic Norway to Hedeby in the Baltic (Barrett et. al., 2007).

Additionally, preserved fish was promoted by the church as “white food” or Lenten (Perdikaris, 1999).

There is historical, pictorial and zooarchaeological evidence that details the butchery procedures of fish for drying. Fish from the cod family were primarily butchered and later dried or salted in Scandinavia (Barrett, 1995; Barrett, 1997). The cranial aspect and the anterior segment of the vertebral column would be disarticulated from the body and discarded or used in the process of making stock for soups. The remaining portion of the vertebra and caudal vertebra would therefore remain in the dried fish (Barrett, 1995; Barrett, 1997).

The drying process itself was gradual and is reliant on slight temperature fluctuations between day and night (Perdikaris, 1999). The flesh would freeze during the night and then slightly thaw during the day, over a period of time the flesh would dry and not spoil. The minimum size of a fish that would be considered for drying was roughly 60 centimetres in length and weighed about three to four kilograms, and would likely be used as fodder for humans and animals (Peridkaris, 1999). Fish larger than 110 centimetres in length would likely rot during the drying process. Successfully dried fish could be stored for up to two years (Perkdikaris, 1999).

The fish from the assemblage from Ridanäs would suggest that this was a consumer site, due to the abundance of appendicular elements (the meat bearing portion of the fish). However, there may have been another midden on the site where the fish were being processed. The fish could have been processed at the harbour rather than further inland. Additionally, the high abundance of cod species suggest that fish present at this site were either being processed for drying or were consuming the dried fish. Furthermore, the absence of caudal and pre-caudal elements in the assemblage in addition to the abundance of thoracic vertebra is consistent with the expectation that this is a consumer site.

4.4 Kill off Patterns

The age of slaughter for animals depends on a multitude of different variables including the value of different products, the characteristics of the species, and environmental factors (Payne, 1968). Animals at Viking Age sites were kept for a wide range of purposes. Vikings consumed mutton and lamb, beef and veal. The Vikings also kept animals for other purposes such as wool and hides, dairy, riding, and traction (Graham-Campbell, 2001). The purpose of animals in the archaeological record is typically addressed via age estimates; however this is a bit challenging with a lack of MWS ageing data. Inferences from the data will be attempted from the epiphyseal fusion ageing data.

4.4.1 Caprine: Primary and Secondary Products

According to Payne's (1973) mortality model for optimized milk production in caprines, the young are culled as to not interfere with the milk consumption of the herders. Therefore an archaeological assemblage that is composed of primarily younger caprines can be assumed to be one that kept caprines for milk production. If wool is the primary purpose of the animal then they were likely kept into adult years until the production of wool was no longer viable, while the lamb production was limited to the needs of the flock replacement. The male sheep in this instance are generally castrated (Payne, 1968). A demographic of young and old sheep would suggest the sheep were being kept for milk or meat. Caprine were eaten as lamb or mutton. This was common in the rest of Scandinavia at the time and was likely also occurring at Gotland. There is not a surplus of young sheep as seen in the cattle data; therefore the sheep were likely not kept only for milk. The primary purpose of sheep on Gotland was wool, and a secondary use was either milk or meat (in the form of lamb and mutton). Generally, in the archaeological assemblage if the caprines are ages to 6-9 months they were likely kept for milk and if the age is 2-3 years then they were likely meat animals. In subsistence economies flocks are rarely kept for a singular purpose (Payne, 1968).

4.4.2 Cattle: Primary and Secondary Products

Payne's (1973) model for the production of milk in caprines is often applied to cattle as well, however, Ballasse (2003) cautions against this. Ballasse (2003) argues that the culling of young cattle may have had unwanted effects on the milk production due an inhibition of milk let down, some cultures will keep the young cattle around to stimulate the mothers milk let down (McCormick, 1992; Peske 1994). For the purpose of this essay the presence of immature cattle will be analysed as being indicative of the milking of cattle occurring at the site. The same pattern is true of cattle, in an assemblage where the population distribution is both young and adult it can be surmised that the cattle were kept for milk and meat.

If the cattle remains are primarily from older individuals then they were likely used as traction animals, where in it would have been of benefit to keep the animal into adulthood and until traction was no longer viable. This is true of horses as well. However, because of the presence of only a single horse tooth in the assemblage this subject will not be touched on in great detail. It is possible that if horses were present in Ridanäs that they were being used as traction animals rather than cattle or for riding (Graham-Campbell, 2001). Cattle at Ridanäs based on the age profiles revealed the presence of very young cattle were likely kept for milk, there were also older cattle as evidence by lose worn molars (wear stage "J" or beyond), thus a secondary purpose of cattle at the site was for use as traction animals.

4.4.3 Pig: Primary and Secondary Products

Pigs are primarily kept as meat animals. This appears to hold true for the pigs in the Ridanäs assemblage. Pigs are generally slaughtered when they reach full weight or when they are young, which is commonly referred to as the delicacy of "suckling pig." Young or neonatal animals such as "suckling" pig are believed to have been a high status food item. In the Gotland assemblage there were a number of immature pigs; this kill off pattern suggests that they were killing young pigs for the quality of the meat rather than the quantity. If meat quantity were the primary objective than older more robust pigs would likely have been slaughtered. Young male pigs are typically killed when they reach the optimum weight, while a few are kept as stud males for reproduction (Payne, 1968). Based on the age data from the assemblage pigs at Ridanäs were kept for meat and were slaughtered primarily once the pig had reached full weight and also when the pig was young as a form of prestige item.

4.4.4 Old versus Young Animals

At a producer site one would expect to see young and very old animals. At a consumer site there are typically market age animals (1.5 to 2.5 years of age at slaughter) and few animals that are of a reproductive age (Crabtree, 1990; 162). Although the lack of data from the mandibular wear stages was not useful for constructing age profiles for the site, it was still observed that many of the teeth from the main domesticate species showed a large degree of wear suggesting the presence of elderly animals at the site. The presence of young animals at the site was confirmed with the assessment of the epiphyseal fusion data. A site that is self-contained is both a consumer and producer site. The age profiles in a self contained site according to Wapnish and Hesse (1988) will contain all age classes, or all of the mortality profiles that would be experienced from a kept domestic herd, this pattern is apparent in the Ridanäs assemblage.

4.4.5 Castration and Meat Quality

The Vikings were aware of the effects that castration can have the quality of the meat and therefore they exploited this technique (Roesdahl, 1998). When males are left un-castrated it is likely that boar taint will develop in the fatty tissue of the animal, this is not desirable and therefore male pigs that were intended for meat production were castrated at a young age to avoid the occurrence of boar taint (Babol and Squires, 1995; Field, 1971). However, castration delays epiphyseal fusion (Davis and Beckett, 1999; 13) allowing the long bones to continue to grow for a longer duration, but of more importance for the assemblage from Ridanäs is that castration could have been contributing factor towards the high occurrence of un-fused elements.

4.4.6 Seasonal Killing of Seal Pups

The identification of immature seals in the assemblage could indicate the seasonal targeting of seal pups (Hodgetts, 1999, 2000). Seals were commonly hunted via clubbing or netting during the Viking Age. Although there were only a small number of seal elements identified in the Ridanäs assemblage the majority were recorded as being immature due to the un-fused state of the diaphysis or epiphyses. This could be indicative of a systematic predation of "pupping" grounds occurring during the spring months (Krivogorskaya et. al., 2005). The adult seals identified in the assemblage could have resulted from opportunistic kills that occurred during other seasons. A larger sample size would be needed to confirm the seasonal targeting of seal pups on Gotland during the late Viking Age.

4.5 Morphometry

The most confounding evidence that can be derived from the LSI data is that the cattle, caprine, and pigs present in Viking Age Ridanäs were domesticates, aside from perhaps the one outlier in the pig metric data that may tentatively be wild boar. The site was not divided into layers therefore a progression in size through time related to advancements in animal husbandry cannot be drawn at this date and time. Although it has been noted that cattle during the Viking Age in Scandinavia were smaller than the typical cattle of today, animal husbandry was nonetheless advanced in the Viking homeland (Foote and Wilson, 1979; 147). Ideally, morphometric data should be analysed on an element-by-element basis in addition to the LSI to determine size and shape of the animals present at a site, this could not be completed because of the small sample size. Future research should focus on answering these questions; furthermore a larger sample with more complete elements than was present in the current assemblage would be needed to draw inferences regarding this.

4.6 Aberrant and Pathological Conditions

The small bone wedge that was identified in the construction 3800 assemblage is speculated to have been a fragmented piece from a comb. While antler is the most typically utilized material for combs, it is however not uncommon for bone to be used, especially for the connecting plates in the comb. Horse or cattle ribs would often be chosen for the connecting plates. In archaeological assemblage evidence for this is the presence of split and sawn ribs (Ambrosiani, 1981). There has been other evidence from the site to suggest that the production of combs, beads, and jewellery occurred at Ridanäs (Carlsson, 2008; 132). The small number of pathologies observed in the faunal assemblage does not allow for any conclusions to be drawn on the health of the animals present on Viking Age Gotland.

Chapter 5

Concluding Statements

5.1 Summary of Site

This dissertation analysed a faunal assemblage from the Viking Age Baltic trading port and farmstead of Ridanäs located on the island of Gotland, Sweden. The faunal material was excavated from two different contexts during 2000 and 2005 with Dr. Dan Carlsson overseeing the project. The goal of this analysis was to answer questions regarding animal-human relations at the site. More specifically, the analysis aimed to provide insights into the subsistence strategies, trade connections, socioeconomic conditions, and animal husbandry practices that were occurring during the Viking Age at what is now the Fröjel Parish.

The range of species identified in the assemblage would suggest a dual or mixed economy at Viking Age Ridanäs. The economy was likely centred on animal husbandry (likely small-scale farming) and supplemented with the sourcing of wild animals (primarily coastal birds and seals), and fishing. The assemblage from the culture layer appears to be a more specialized subsistence economy, focusing more on animal husbandry rather than fishing or hunting. The assemblage was typical of Viking Age assemblages in almost all aspects. Previous isotopic analysis from the site to determine the diet of Viking inhabitants also confirmed a diet consistent with other Viking age sites. Kosiba et. al. (2006) determined that despite the changing socioeconomic status and cultural identity occurring in Scandinavia at the end of the Viking Age the food preferences and food procurement strategies were maintained on Gotland (Kosiba et. al., 2006; 409). Based on the body part distribution data from the assemblage one can assume that they were consuming dried fish on site, the fish was likely butchered and prepared elsewhere. The body part distribution data and the aging data for the three main domesticates suggests that they were being raised, slaughtered, and consumed on site. Burnt elements further suggest the consumption of the animals on site. In addition to meat, sheep and cattle were kept for wool, dairy, and used as traction animals.

The species identified were all native to the island; therefore there is no clear faunal evidence to suggest the long-range trade of animal products to Gotland. However, the products derived from the animals on site could have been used as trade items. Products such as butter, wool, dried meats, and hides could be traded over long distances. Other archaeological evidence for long distance trade at Ridanäs is the presence includes a resurrection egg from Kiev, Ukraine, a brooch from the Swedish mainland and another from Finland, and about one hundred and fifty coins from various locations including England, Germany, the Caliphate, and Denmark (Carlsson, 2008; 132).

The ageing data pointed to both a wealthy and poor socioeconomic status of the site, however, other archaeological evidence from the site has suggested that this was in fact a wealthy site. Based on species abundance the site seemed to have lower socioeconomic status, however the consumption of young animals loosely suggests a higher socioeconomic status. Additionally, the fish species present at the site, such as cod and salmon, have been linked to a higher socioeconomic status at other Viking Age sites in Scandinavia.

5.2 Future Work

Due to the small sample size of the assemblage the basis of the work completed in this dissertation is preliminary in nature and cannot substantiated without the analysis of a larger assemblage from Ridanäs. With a larger sample size more substantiated inferences could have been made. An increased sample size of faunal data from multiple layers would be useful in exploring changes through time. Additionally, a larger sample size would have increased the potential for more thorough morphometric analysis, allowing the metric data to have been analysed on an element-by-element basis, which in turn would have made inter site comparisons more plausible. An increased sample size would expanded the amount ageing data based on mandibular wear stages would have helped to better understand the kill off patterns for the site. This was a preliminary study, future work exploring the animal human relationships at the site should utilize a larger faunal sample as well as faunal material that can be analysed in regards to change through and intra site variability, this will no doubt build upon the analysis that was presented in this dissertation.

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Appendix

Table 1: Pig fusion data for construction 3800 and the culture layer

Fusion Group	Element	Age (mo.)	Un-fused	Fusing	Fused	Pig Total
Early	Scapula	12			1	1
Early	Pelvis	12	1			1
Early	P Rad	12	2		1	3
Early	D Hum	12	1		1	2
Early	Phal 2	12	3		1	4
Early Total			*7*		*4*	*11*
Middle	Phal 1	24	7		2	9
Middle	D MetaC	24				
Middle	D MetaT	24				
Middle	D Tibia	24	6			6
Middle	D Fibula	24-30				
Middle	Calcaneus	24-30	4			4
Middle Total			*17*		*2*	*19*
Late	P Ulna	36	2			2
Late	P Fem	42	4			4
Late	P Fibula	42				
Late	D Fem	42	5			5
Late	D Ulna	42	1			1
Late	P Tibia	42	5			5
Late	D Rad	42	4			4
Late	P Hum	42	1			1
Late Total			*22*			*22*
TOTAL			46		6	52

Table 2: Cattle fusion data for construction 3800 and the culture layer

Fusion Group	Element	Age (mo.)	Un-fused	Fusing	Fused	Cattle Total
Early	Scapula	7-10			1	1
Early	Pelvis	7-10				
Early	P Rad	12-18	1		1	2
Early	D Hum	12-18			3	3
Early	Phal 2	18	1		2	3
Early	Phal 1	18	4		4	8
Early Total			*6*		*11*	*17*
Middle	D MetaC	24-30			2	2
Middle	D MetaT	24-30	1		1	2
Middle	D Tibia	24-30	2		1	3
Middle	Calcaneus	36-42				
Middle Total			*3*		*4*	*7*
Late	P Ulna	42-48			1	1
Late	P Fem	42				
Late	D Fem	42-48	1		2	3
Late	D Ulna	42-48				
Late	P Tibia	42-48	2		3	5
Late	D Rad	42-48			1	1
Late	P Hum	42-48	1			1
Late Total			*4*		*7*	*11*
TOTAL			13		22	35

Table 3: Caprine fusion data for construction 3800 and the culture layer

Fusion Group	Element	Approximate Age (mo.)	Un-fused	Fusing	Fused	Sheep/Goat Total
A	P Rad	0-6			3	3
A Total					*3*	*3*
B	D Hum	6-12			1	1
B	Pelvis	6-12			1	1
B	Scapula	6-12				
B Total					*2*	*2*
C	Phal 2	12-18			4	4
C	Phal 1	12-18			5	5
C Total					*9*	*9*
D	D Tibia	18-30			5	5
D	D MetaC	18-30				
D	D MetaT	18-30			1	1
D Total					*6*	*6*
E	Calcaneus	30-48				
E	P Ulna	30-48			1	1
E	P Fem	30-48	2			2
E	D Fem	30-48	1	1		2
E	D Rad	30-48	1		1	2
E	P Tib	30-48	1	1		2
E Total			*5*	*2*	*2*	*9*
F	P Hum	48+	1		1	2
F Total			*1*		*1*	*2*
Total			6	4	23	31

Table 4: The Gotland, Fröjel parish, Bottarve 1:17. Construction 003800. Animal Bones. Find number 72; original recording form and Gotland Fröjel Parish, Bottarve 1:17. Animal bones from culture layer, excavation of Viking Age harbor site; original recording form

County	Parish	Year	Property	Trench	Construction	Material	Find ID	Weight (grams)	Layer	Square
GO	Fröjel	2000	Bottarve 1:17	2	3800	Animal bone	72	1617		
GO	Fröjel	2000	Bottarve 1:17	2	3800	Animal bone	72	412		
GO	Fröjel	2000	Bottarve 1:17	2	3800	Animal bone	72	1011		
GO	Fröjel	2000	Bottarve 1:17	2	3800	Animal bone	72	1370		
GO	Fröjel	2000	Bottarve 1:17	2	3800	Animal bone	72	1544	L1	
GO	Fröjel	2000	Bottarve 1:17	2	3800	Animal bone	72	954		
County	Parish	Year	Property	Trench	Construction	Material	Find ID	Weight (grams)	Layer	Square
GO	Fröjel	2005	Bottarve 1:17	1		Animal bone	37424		L4	69/149
GO	Fröjel	2005	Bottarve 1:17	1		Animal bone	37430		L4	69/150
GO	Fröjel	2005	Bottarve 1:17	1		Animal bone	37462		L4	71/153
GO	Fröjel	2005	Bottarve 1:17	2		Animal bone	37465		L5	68/156
GO	Fröjel	2005	Bottarve 1:17	1		Animal bone	37460		L4	70/153
GO	Fröjel	2005	Bottarve 1:17	1		Animal bone	37458		L4	69/152
GO	Fröjel	2005	Bottarve 1:17	1		Animal bone	37429		L4	68/152
GO	Fröjel	2005	Bottarve 1:17	2		Animal bone	37469		L4	68/158
GO	Fröjel	2005	Bottarve 1:17	1		Animal bone	33687	394	L3	70/150
GO	Fröjel	2005	Bottarve 1:17	1		Animal bone			L4	70/150
GO	Fröjel	2005	Bottarve 1:17	1		Animal bone	33574	90	L2	70/150
GO	Fröjel	2005	Bottarve 1:17	1		Animal bone	33578	3	L1	70/150
GO	Fröjel	2005	Bottarve 1:17	1		Animal bone	37459		L4	70/151
GO	Fröjel	2005	Bottarve 1:17	2		Animal bone	37463		L5	68/157
GO	Fröjel	2005	Bottarve 1:17	1		Animal bone	37427		L4	68/149
GO	Fröjel	2005	Bottarve 1:17	1		Animal bone	37431		L4	69/150
GO	Fröjel	2005	Bottarve 1:17	1		Animal bone	37428		L4	69/153
GO	Fröjel	2005	Bottarve 1:17	2		Animal bone	37461		L4	68/159
GO	Fröjel	2005	Bottarve 1:17	2		Animal bone	33519	168	L3	70/157
GO	Fröjel	2005	Bottarve 1:17	2		Animal bone	33502	18	L2	70/157
GO	Fröjel	2005	Bottarve 1:17	2		Animal bone	33692	215	L4	70/157
GO	Fröjel	2005	Bottarve 1:17	2		Animal bone	33587	13	L1	70/157
GO	Fröjel	2005	Bottarve 1:17	2		Animal bone	33592	40	L2	70/155
GO	Fröjel	2005	Bottarve 1:17	2		Animal bone	33591	14	L1	70/155
GO	Fröjel	2005	Bottarve 1:17	2		Animal bone	33691	223	L4	70/155
GO	Fröjel	2005	Bottarve 1:17	2		Animal bone	33517	212	L3	70/155

Table 5: List of mammal and avian species identified in the assemblage and associated recording code used in dataset

Identified	Class	Order	Taxon (lowest)	Common Name	Code in Database
	Mammalia	Artiodactyla	Bos Taurus	Cattle	B
			Ovis Aries	Sheep	OVA
			Ovis/Capra	Sheep/Goat	O
			Sus scrofa	Pig	S
		Perissodactyla	Equus sp.	Horse	E
		Canivora	Felis sp.	Cat	FEC
			Halicoerus grypus	Grey Seal	HG
			Phoca Vitulina	Harbor Seal	PV
			Phocidae	Earless Seal	PHO
			Vulpes vulpes	Red Fox	VV
		Rodentia	Rattus sp.	Rat	RA
			Sciurus sp.	Common Squirrel	SCR
			Oryctolagus cuniculus	European Rabbit	ORC
		Erinaceomorpha	Erinaceus europaeus	European Hedgehog	EE
		Lagomorpha	Lepus sp.	Hare	LE
	Aves	Galliformes	Gallus gallus d.	Domestic chicken	
		Anseriformes	Anas sp.	Duck	ANA
			Alca torda	Razor Bill	AT
			Mergus sp.	Fish Eating Duck	M
			Somateria mollissima	Common Eider	SM
		Charadriiformes	Larus argentatus	European Herring Gull	LR
			Sterna hirundo	Commmon Tern	ST
			Uria sp.	Murres	U
Unidentified	Small rodent				SRO

Table 6: List of fish species identified in the assemblage and associated recording code used in dataset

Identified	Class	Order	Taxon (lowest)	Common Name	Code in Database
	Actinopterygii	Gadiformes	Gadus morhua	Atlantic Cod	GM
			Gadus sp.	Cod	G
		Anguilliformes	Anguilla anguilla	European Eel	AA
		Clupeiformes	Alosa sp.	Shad	AL
			Clupea harengus	Atlantic Herring	CH
			Sprattus sprattus	European Sprat	SR
		Esociformes	Esox lucius	Northern Pike	EL
		Perciformes	Perca sp.	Perch	P
			Perca fluviatilis	European Perch	PFL
		Pleuronectiformes	Platichthys flesus	European Flounder	PF
		Salmoniformes	Salmo salar	Atlantic Salmon	SS