MARINE RESOURCE SPECIALIZATION IN VIKING AGE ICELAND: EXPLOITATION OF SEABIRDS AND FISH ON HEGRANES IN SKAGAFJÖRÐUR

by

GRACE M. CESARIO

A dissertation submitted to the Graduate Faculty in Anthropology in partial fulfillment of the requirements for the degree of Doctor of Philosophy, The City University of New York

2021

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This manuscript has been read and accepted for the Graduate Faculty in Anthropology in satisfaction of the dissertation requirement for the degree of Doctor of Philosophy.

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ABSTRACT

Marine Resource Specialization in Viking Age Iceland: Exploitation of Seabirds and Fish on Hegranes in Skagafjörður

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Grace M. Cesario

Advisor: Dr. Thomas H. McGovern

This dissertation focuses on the zooarchaeology of four Viking Age sites on Hegranes, located in Skagafjörður, north Iceland, in order to understand the early economy of the region and place it in a broader context with other settlement sites across the island. This research helps to understand the ways the earliest people in Iceland provided for themselves through niche construction activities that included landscape domestication, animal husbandry, bird hunting, and fishing. It also looks at the zooarchaeological indicators of household autonomy to understand the early social and political landscape in Skagafjörður. At these sites, there is evidence for a specialized focus on wild marine resources. In particular, I explore the signatures of pre-commercial artisanal processing of *gadid* fish into a dried product, which show both the producers and consumers within Skagafjörður. The data also show specialized butchery of seabirds in the *Alcidae* family, which suggest cultural continuity of their use across the North Atlantic.

This dissertation project aims to highlight the early animal use strategies in one region of Iceland, while also recognizing that other areas have different signatures. As more and more research is showing, there is no singular model for initial settlement strategies in Iceland, and by examining the first sites, we can understand the different paths peoples engaged in colonization movements took to make a living in their new homes. By studying the earliest sites, we can gain

insight into the social, political, and economic (re)organizations that took place as people set up their new society, focusing in this case on the Skagafjörður region in northern Iceland.

ACKNOWLEDGMENTS

The say no one achieves anything alone, and the completion of this dissertation is a real testament to that. I would have never gotten to this point without the support of more people than I can possibly name here. Apologies to anyone I may have forgotten (and thank you nonetheless!).

First, major thanks go out to my dissertation committee. We pulled this off on a tight timeline, and I am so grateful that they took time during the holidays to read through drafts and answer frantic emails. My committee chair and academic advisor, Tom McGovern, has been a fountain of encouragement, inspiration, and wisdom all of these years. Andy Dugmore and Jim Woollett provided great insight and ideas and helped me situate my work within a broader context. My external reader, Doug Bolender, talked me through theory for hours and convinced me to rewrite an entire chapter which ended up tying the whole work together much better than I could have imagined.

Another big shoutout goes to John Steinberg and Doug Bolender, who took a chance on me and brought me onto the project that ultimately led to this dissertation. Thanks for the years of collaboration, good discussions, debates, and proving each other wrong. I look forward to many more! Special thanks to John Steinberg, who has been there throughout my development as a scholar to offer honest critiques and feedback, and who has finally persuaded me to appreciate statistics (and ran all of the statistics for this project and patiently explained them to me).

The Skagafjörður project could not have happened without the partnership of Byggðasafn Skagafirðinga and all of the staff. I want to especially thank Sirrí Sigurðardóttir, who not only provided a wealth of knowledge and on-the-ground support, but wrote me letters of recommendation that helped secure funding so I could finish this research. Guðný Zoëga was also an integral part of this collaboration, and I am grateful for her encouragement, continued friendship, and bakery dates. Bryndís Zoëga gets my thanks for having a good sense of humor, always being ready for an adventure (and an ice cream), and sharing her knowledge of the landscape.

More thanks go to Kathryn Catlin for partnering with me in fieldwork, conference organization, future plotting, and of course for friendship, knitting, and road trips. All of the SCASS scholars and students from 2015-2018—especially Eric Johnson, Alicia Sawyer, Laura Marqués-Jackson, Rita "Candy Rita" Shepherd, John Schoenfelder, Melissa Ritchey, and Grace Bello—get my thanks for their hard work both in and out of the field.

I am indebted to the farmers and landowners on Hegranes for graciously allowing us to excavate on their land: Jón Gunnar Magnússon, Guðríður Valtýsdóttir, Einar Valur Valgarðsson, Elísa Björk Einarsdóttir, and Bjarney Anna Björnsdóttir (Ás 1 and 2); Margrét Ólafsdóttir, Sigrún Ólafsdóttir, and Sæunn Jónsdóttir (Svanavatn/Vatnskot); Þórey Jónsdóttir and Jóhann Már Jóhannsson (Keflavík); Heiðbjört Pálsdóttir and Mikael Brennan (Utanverðunes); Andrés Magnússon, Ragnar Ólafsson, and Ólafur Jonsson (Helluland); María Eymundsdóttir and Pálmi Jónsson (Hulduland); Þórarinn Leifsson and Guðrún Lárudóttir (Keldudalur); Davíð Jónsson and Embla Björnsdóttir (Egg); Einar Kristinsson, Kristinn Sævarsson, Sævar Einarsson and Unnur Sævarsdóttir (Hamar); Jón Sigurjónsson (Garður), Elvar Birgisson, Sigurður Birgisson and Sigurlína Magnúsdóttir (Ríp); and Símon Traustason, Hrefna Gunnsteinsdóttir, and Ingibjörg Jóhannesdóttir (Keta).

To my fellow CUNY students—Megan Hicks, Frank Feeley, Sant Mukh Khalsa, Tom Ryan, Cameron Turley, and Elizabeth Meade—thanks for the laughs (and tears), the encouragement, and the necessary beers. To Brenda Prehal, my fellow expat and graduation buddy: we did it! A big high five to Sam Rose, my New York roommate, who helped me survive the first four years of grad school.

There are many people in Iceland who have contributed to my success, especially in the last three years. I have had the great pleasure of being hosted by Fornleifastofnun Íslands and must thank everyone there for letting me sort dirty bones in the basement in exchange for cakes and camaraderie. I am especially grateful to Lísabet, Guðrún, Lilja Pálsdóttir, Hólmfríður, Howell, Adolf, and Mjöll, for their patience with my poor Icelandic and their willingness to be distracted by a conversation. I would not have been able to complete my analysis without the help of Þorvaldur Björnsson at Náttúrufræðistofnun Íslands and Albína Hulda Pálsdóttir at Landbúnaðarháskóli Íslands, who granted me access to their comparative collections.

Big thanks to Valgerður and Grímur for their enthusiam for my unconventional hobbies, interesting conversations, unwavering support, and for always feeding me.

Takk Gunnar minn, for more than I can put into words. Thanks especially for making my maps, your infinite patience, bringing me dead birds and watching live birds with me, and your consistent cheerleading. You made it possible for me to push through to the very end.

Finally, my profound gratitude to my mom and granny, for accepting my physical and mental distance, infrequent phone calls, and even more infrequent visits. You've been my loudest supporters since day one.

Funding for fieldwork, analysis, and writing came from NSF (grant nos. DGE-1037525; PLR 1417772, 1523025), the Fulbright Foundation, The Graduate Center, the American Scandinavian Foundation, and the Leifur Eiríksson Foundation. Permits for survey and excavation were granted by Minjastofnun Íslands.

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Chapter 1. Introduction to the Dissertation

This dissertation focuses on the zooarchaeology of settlement during the Viking Age (ca. 870-1104 AD) on Hegranes, located in Skagafjörður, north Iceland. It will explore the use of animals at four early dwelling sites, with a specific emphasis on wild marine animals, in light of the process of settlement. This research provides evidence for a specialized dried fish economy and traces cultural continuity of seabird exploitation. It makes use of a multi-site regional approach in order to highlight local patterns. These local patterns are placed in context with current knowledge of the broader picture of settlement across the island by comparing the data with other contemporaneous zooarchaeological assemblages. Utilizing the historical ecology framework, which focuses on landscapes changing through time and the mutual and complex interactions of place, people, and environment (human ecodynamics) (Balée 2006; Crumley 1994, 2007), the patterns of animal use on Hegranes will add a piece to the puzzle of what we know about the range of economic strategies in use during the settlement period in Iceland.

Animals and their products—meat, milk, wool, transportation, companionship—are vital to the survival of many cultures (Table 1.1). They can make up a large portion of economic (trade, payment, status) and subsistence (primary food source) strategies and are especially important in areas where arable land for intensive farming is scarce. In the North Atlantic, both domesticates and wild animals play important roles in society. Animal husbandry has been a large part of farming in the North Atlantic since at least the early Iron Age (e.g., Øye 2009), and domesticates provide a major source of food, as well as secondary products. Likewise, fishing as a supplement to the diet has been important since at least the late Iron Age in Norway (e.g., Perdikaris 1998; Perdikaris and McGovern 2007). The preservation of fish through drying for a long-term stable food source and trade good has been common since the Viking Age in Norway, and perhaps even before (Perdikaris 1996). Sea mammals like seals and cetaceans were also available resources, and have been used for their meat, blubber, and oil, with seals being especially important in Norse Greenland (Perdikaris and McGovern 2008). Walruses were a source of prestigious ivory, and perhaps one of the reasons for the colonization of Iceland (Frei et al. 2015). Hunting of a variety of wild birds, as well as egg collection, has also been a staple of the North Atlantic subsistence strategy for millennia (Best and Mulville 2010, 2016; Fenton 1978; Hambrecht 2020; Keller 2010).

Table 1.1. Examples of types of animal products and their uses.

Use	Product
Food	Anything ingested for nutrition (meat, milk, fat, marrow, spices)
Medicine/Health	Anything ingested or applied for medicinal, cleanliness, health reasons (milk, ground horn, fish oil)
Structure	Items for constructing not-portable structures/features
Ornamental	Any taxa used for secular aesthetic reasons beyond personal adornment
Clothing	Includes personal adornment and decoration (skins, feathers, wool, hair, bone, horn)
Trade	Animals and animal tissues exchanged across territories
Commensal/Companions	Any domesticate that provides a companion relationship, such as dogs and cats
Artifact	Used to make any portable artifacts (e.g., tools, bowls, utensils)
Fuel	Anything used for heat, cooking, illumination (oil, fat, bone, dung)
Transportation	Anything used to move across land/seascape and construct technological items used in transportation (dogs, horses, bone, skin, sinew, guts)
Cosmology	Organisms that feature strongly in people's spiritual practice
Ritual	Includes tribute & religious use (e.g., monuments, art, visual communications)

The incorporation of a wide variety of animals into the economic strategy allows for more resilience in the face of external pressures, from climatic to environmental to demographic. Where domesticated animals are available, careful herd management allows for the extraction of multiple resources, such as milk and wool, from one herd. However, domesticates are at least partially reliant on humans for their survival and various factors can affect the ability of humans to meet the animals’ needs. Bad weather years or poor planning can limit the amount of fodder available to support animals over the winter, disease can spread, and other catastrophic events, such as volcanic eruptions in Iceland, can hinder survival. By including wild animal resources into a primarily domesticate-based economic strategy, people can mitigate the risks of focusing on a single resource type. Wild animal resources can act as a supplement or as a primary food source, and they may also be valued for their by-products, like feathers, skins, eggs, oil, ivory, sinew, and bones used for artisanal work or fuel (see for example Frei et al. 2015; Grömer et al. 2017; Lipe et al. 2020; MacGregor 2016; Robertson 2002).

Farming, a combination of animal husbandry and cereal agriculture, was believed to be the primary subsistence activity in the Norse North Atlantic. However, many years of zooarchaeological research in the North Atlantic and Iceland have shown that non-agricultural activities, like hunting and fishing, were also very important (e.g., Barrett et al. 2004; Brewington et al. 2015; Coleman 2019; Enghoff 2003; Hambrecht et al. 2019; McGovern 1980; Perdikaris and McGovern 2008). Especially in the first decades to centuries of settlement in Iceland, wild animals often contributed more to the diet and overall economic strategies than they did in the later centuries (Amorosi 1991; Edvardsson 2010; McGovern 2009; Perdikaris and McGovern 2008a).

Iceland

Iceland is one of the last places in the world to be inhabited by people. It was settled in the late 9th century (Schmid, Dugmore, et al. 2017), and the moment of human arrival is not only recent, but the changes to the landscape pre- and post-settlement have been documented in multiple records, such as pollen records and changes in sediment accumulation throughout the island (Arnalds et al. 2001; Edwards et al. 2011; Lawson et al. 2007; Streeter et al. 2015). Iceland is a relatively large island, at 103,000 km^2, though much of the land area is uninhabitable. About 10% of Iceland is covered by glaciers, and the interior of the island is a basically a highland desert, often with steep mountains and extensive lava fields. Due to this geology, most of the settlements do not extend much more than 50 kilometers inland (e.g., Vésteinsson et al. 2014) and perhaps only 50% of the land area is suitable for habitation.

Current archaeological research suggests that no people lived in Iceland before the Norse settlement, unlike its North Atlantic "neighbors" of Greenland, the outlying British Isles (the Northern and Western Isles), and possibly the Faroes (Figure 1.1). Archaeological evidence and tephrochronology have most recently placed the settlement of Iceland at AD 877 +/- 1 (Schmid, Dugmore, et al. 2017; Schmid, Zori, et al. 2017). Some historic accounts suggest that a small number of Irish Celtic monks lived in Iceland before the Norse colonization (Tierney 1967); however, there is no archaeological evidence to support this and, if there were Irish hermits, their presence must have been so limited as to leave no traces on the landscape (e.g., Buckland and Panagiotakopulu 2008; Dugmore et al. 2000; Vésteinsson 1998). Traces of human activities before the traditional settlement (under the *landnám* tephra layer) have been claimed for a couple of sites in south Iceland—namely multiple sites in Reykjavik (e.g., Nordahl 1988) and Herjólfsdalur in the Westman Islands (Hermanns-Auðardóttir 1989). However, these claims are not for Irish habitation, but for Norse settlements slightly earlier than previously believed.

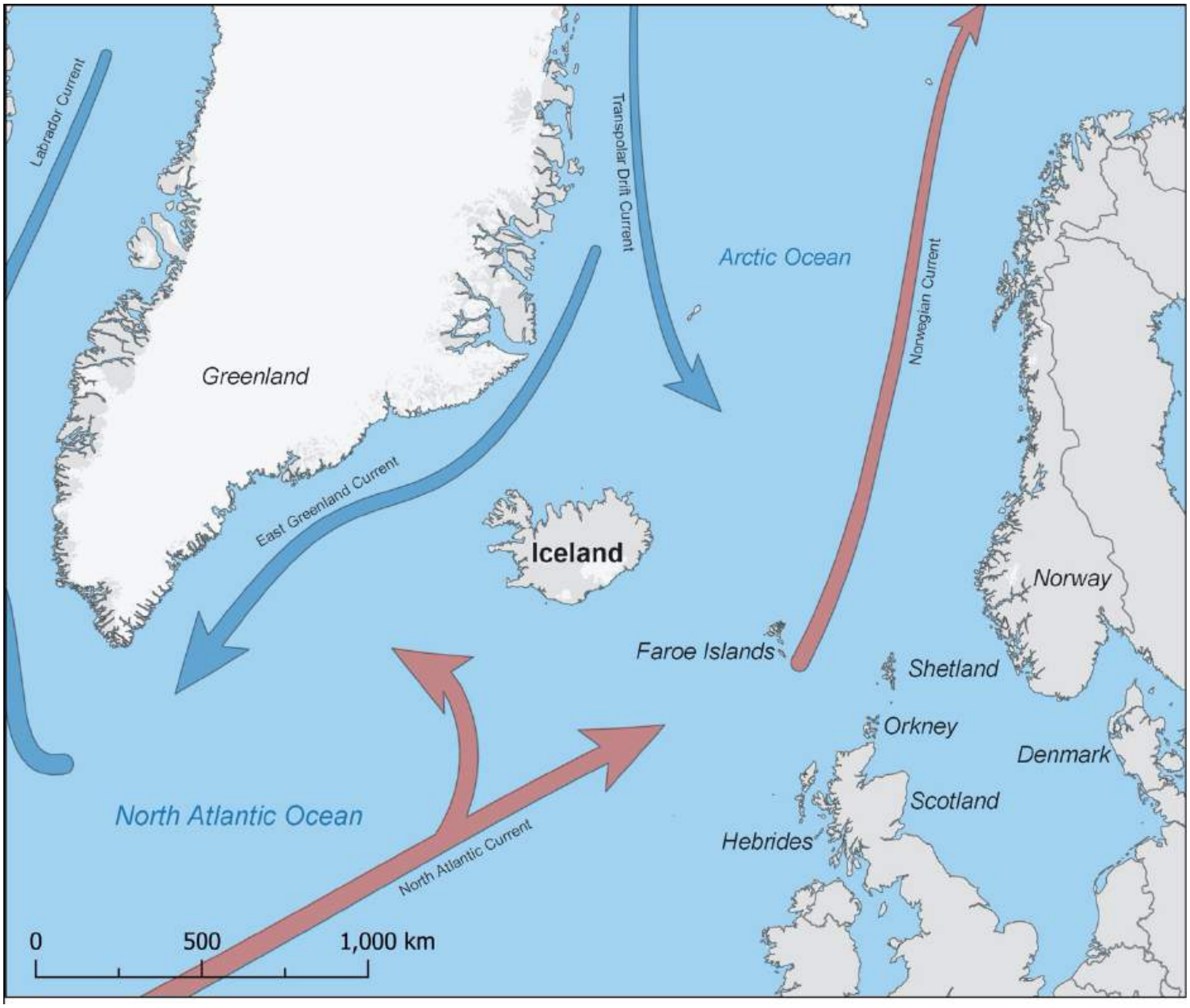

Figure 1.1. Iceland's location in the North Atlantic, along with other areas that have Norse settlements. Major ocean currents are shown; cold currents are blue and warm currents are red. Note that the Gulf Stream (not pictured) feeds into the North Atlantic current.

Environment

Iceland is a volcanic island located just below the Arctic Circle in the North Atlantic. It is warmed by the Gulf Stream, so the climate is relatively temperate, but it also lies close to the atmospheric and oceanic polar fronts, which puts the island at the northern climate limits for cereal cultivation and woodland growth (Øye 2005; Sveinbjarnardóttir et al. 2007). The interior highlands are mostly uninhabited, while the lower lying coastal regions are the more populated areas. Mean annual precipitation is usually between 600 mm and 1500 mm, but can vary depending on the region or year (Arnalds 2008, 2015; Ólafsson et al. 2007).

Many of the soils in Iceland are volcanic andosols which are prone to erosion by wind and water (Aradóttir and Arnalds 2001; Arnalds 1990, 2004; Óskarsson et al. 2004). These andosols are irregular in shape and do not stick together well which, in addition to making them vulnerable to erosion, makes them generally unsuitable for making pottery; all of the Viking Age and medieval ceramics that have been found in Iceland are imported, and ceramics were not locally produced until the 19th or 20th century (Mehler et al. 2018, 2020; Sveinbjarnardóttir 1996). Iceland's frequent freeze-thaw cycles cause cryoturbation that affects not only the land surface but the properties of the soil as well (Arnalds 2008).

During the time that Iceland was settled, the climate was relatively mild (Ogilvie 1984), but it was followed by at least two cold periods—one at the end of the settlement period in the 12th century and one at the end of the 13th century (Bergþórsson 1967; Hartman et al. 2017:127; Ogilvie 1991). There was also extensive birch woodland at the time of the colonization (Hallsdóttir 1995, 1996); estimated forest cover at settlement was about 27% of the total land area (Aradóttir and Arnalds 2001; Dugmore, Church, et al. 2007), but some estimates put it at over 30% (Aradóttir and Eysteinsson 2005). This is a stark contrast to the less than 1% of total land area today (Dugmore et al. 2005; Ólafsdóttir 2001).

Iceland Compared to other Norse North Atlantic Island Colonies

The differences between Iceland and the other islands of the Norse North Atlantic make the adaptations to the local environment unique. Clearly, none of the Norse colonies were isolated, and culture continuity can be traced, for example through shared material culture, animal exploitation and butchery strategies, and farming practices, across the North Atlantic as the Norse moved westward. Scandinavian maritime technology allowed long-distance ocean travel, and Greenland, the Faroes, the British Isles, and Norway were all within 1,000 km of Iceland by boat. This meant that the exchange of people, ideas, and materials continued after the settlement of Iceland in the late 9th century. Indeed, people kept immigrating to Iceland during the first century or so of the island's settlement (Price and Gestsdóttir 2014), and movement of people between Iceland and the British Isles, Norway, and beyond, seems to have persisted for even longer.

Climate and environmental changes would have had a great effect on the settlers. Historical studies on the 17th and 18th centuries in Iceland have shown that people were able to survive single cold years with little issue. Longer periods of cold, particularly during summers, lead to higher mortality rates, especially among the poor (Dugmore, Borthwick, et al. 2007; Vasey 2000). This may have been similar to how earlier populations in Iceland fared during extreme cold years. Long periods of cold, or repeated cold years "tended to deplete both stored food reserves and the accumulated social capital that could provide access to local, regional, and interregional buffering reserves" which would have severely affected the ability of farmers to bounce back after these stresses, especially mid-level farmers with ambitious stocking levels and/or mediocre grazing resources (Dugmore, Borthwick, et al. 2007:170). Adapting to and understanding their new climate would have been vital to survival; this includes attempting to prepare for bad years by producing surplus fodder for animals and remaining in good social standing with neighbors in order to preserve their social safety net.

One major difference between Iceland and the other Norse colonies is the presence of volcanoes and the effects of their episodic eruptions. Dugmore and Vésteinsson (2012:69) group the threats from volcanic eruptions into five categories: lava, flood, fallout, pollution, and climatic disturbance. Effects of these threats could have destroyed or buried farms, ruined field productivity, or killed or poisoned livestock and people. In some areas, entire settlements were abandoned, due in part to impacts of volcanic eruptions, especially the presence of tephra that both erodes quickly and covers vegetation (Dugmore, Church, et al. 2007; Dugmore et al. 2006). However, people would already have had to adapt to unfavorable weather, which was likely a greater threat than volcanic eruptions and happened more frequently (Dugmore and Vésteinsson 2012:76). Effective adaptations for extreme weather help to buffer communities from the impacts of livestock mortality and shortfalls in grazing and fodder production resulting from climate variations, and can also buffer communities from volcanic impacts. One of these adaptations is the diversification of the subsistence economy through inclusion of wild resources, reducing both culling and forage pressures on herds and thereby offering greater resilience to both herds and farming households.

The Settlement of Iceland

Debates over the timing of the settlement of Iceland have been ongoing since archaeological research began in earnest in the country (e.g., Bruun 1899; Jónsson and Bruun 1911). Early conversations on the settlement were primarily focused on the timing of settlement and relied very heavily on historical sources written centuries after the events occurred (Friðriksson and Vésteinsson 2003; Smith 1995). More recent work has emphasized colonization as a cultural and demographic process and explored the environmental impacts of settlement (Dugmore et al. 2005; Vésteinsson et al. 2002). Recent research has combined historical sources with archaeological evidence, including geochemical dating of tephra layers, to better understand not just the timing of the settlement, especially on a regional scale, but also the processes and their visibility in the archaeological record (Amorosi et al. 1997; Bolender et al. 2011; Catlin forthcoming; Dugmore et al. 2000, 2005, 2014; Frei et al. 2015; Friðriksson and Vésteinsson 2003; McGovern et al. 2006;

Schmid 2018; Schmid, Zori, et al. 2017; Smiarowski et al. 2017; Smith 1995; Steinberg, Bolender, et al. 2016; Vésteinsson 1998; Vésteinsson and McGovern 2012a). These research projects have shown that there is variability in the settlement strategy in different regions, including timing and method (see discussion below) and land and animal use. Local adaptations seem to drive these factors, and no singular model can be applied broadly across the island. In particular, this dissertation project addresses the local adaptations on Hegranes, especially to understand how wild animals contributed to the early economic strategy and range of activities that took place on the settlement landscape.

A Note on Historical Sources

Before discussing the models, it is important to present a caveat on the use of historical documentation on the settlement. While historical sources such as *Landnámabók* (The Book of Settlements), *Íslendingabók* (The Book of the Icelanders), and the sagas can be valuable sources of information, they must be taken in context. No historical documents are were written contemporaneously with the early settlement events; the earliest historical documents are from somewhere between the 12th-13th centuries (Friðriksson and Vésteinsson 2003; Smith 1995). Importantly though, archaeological evidence thus far does not disagree with the dating of the first settlement of Iceland. Questions about the veracity of these historical sources have often been the subject of scholarly debate in recent years. Friðriksson and Vésteinsson (2003) argue that the stories were more likely scholarly works, written down to suit social and cultural needs. Along the same vein, Smith (1995:320) suggests that some of the early sources like *Landnámabók* have been manipulated to legitimize the chiefly families of the 12th and 13th centuries. It may be the case that these sources actually tell us more about the time they were written down than the events they wrote about (Miller 1990:43–51).

Because it is unclear how accurate the sagas and other historical sources are, it is important not to take them at face-value. Archaeology need not be done only to prove or disprove the written sources (Friðriksson and Vésteinsson 2003:158), but to answer basic questions about the periods in Iceland that are essentially prehistoric. While the following discussion on settlement models does include some mention of saga evidence, it does so in light of archaeological evidence as well.

Models of Settlement

There are multiple models for the settlement of Iceland that have been proposed, based both on historical sources and archaeological evidence. They differ in speed, land claims and movement, resources desired and controlled, and population, among other things. The varied regional strategies for settlement show that there was not one specific process that everyone followed, despite their shared cultural heritage. That there are so many different processes for settling the land also lends credibility to the idea that there were different economic strategies that were part of the settlement process as well.

In the first settlement scenario, filling in the landscape is a slow process that takes a few generations, with elites claiming large tracts of land and distributing them over time to family and friends, crew and followers, or to other newly arrived elites in order to preserve and reinforce relationships (Smith 1995; Vésteinsson 1998; see also Scudder 2005:142-146 for the saga description). This settlement pattern is seen in Borgarfjörður, the setting of *Egil's Saga*, and also in Eyjafjörður, where *Landnámabók* (Book of Settlements) describes the land claims of Helgi the Lean who took the entire fjord for himself and later gave parcels of land to friends and family, resulting in 20-30 farms being established during the settlement period (Karlsson 2000:15; Vésteinsson 1998). In Borgarfjörður, both the *Landnámabók* and saga descriptions of Skallagrím's land claims match up; however, a later version of *Landnámabók* (*Melabók*) and a 13th century saga describe his land claims as much more limited (Smith 1995:321). When the later sources were written, chieftain Snorri Sturluson was attempting to claim full political control over the area that included Skallagrím's land claims (Smith 1995:321). The differences between the sources makes them seem unreliable as accurate depictions of historical processes, and rather focused on making political statements and legitimizing land claims, though there may be pieces of truth within them. Archaeological investigations of the area have found small, seemingly independent dwelling sites (Smith 1995), which do not contradict the historical accounts of site settlement, though it is impossible to say who exactly owned the land.

Another model describes a much more rapid settlement process in Iceland, with all available land settled by AD 930, and possibly even earlier. Vésteinsson and McGovern (2012a:208) argue that the early dates of sites in the deep interior valley of Mývatnssveit are evidence for a peopling process that "happened in a matter of decades" rather than taking multiple generations as the Skallagrím model describes, given that the initial settlement typically focused on coastal regions (Vésteinsson et al. 2002). They find early evidence of human occupation on marginal sites, those which would not be chosen if better places were available, and use this as a main point of evidence for a faster settlement. They propose that at least 24,000 people had to come to Iceland in less than 20 years in order to make sense of the early dates and density of sites in Mývatnssveit (Vésteinsson and McGovern 2012a). This number is based on the range of site types they recorded, the marginal location of some of the sites, and extrapolation of population size from early census records (Vésteinsson and McGovern 2012a:216). Of course, these sites are located only in one region of Iceland but, using the evidence currently available, it does seem to be a plausible explanation for the early and dense settlement of Mývatnssveit (Vésteinsson and McGovern 2012a, 2012b).

Recent chronological work, based on refining dates of tephra layers, also supports the rapid settlement of Mývatnssveit (Schmid et al. 2019, 2018; Schmid 2018; Schmid, Zori, et al. 2017).

A slightly more detailed model for settlement is that of the "probe-burst-trickle" scenario, as described by Madsen (2014:15) for the settlement of Greenland but which can be applied to Iceland as well. This model suggests that there was a small initial group of explorers who came in search of specific resources, and especially prestige resources, like walrus (Frei et al. 2015; Keller 2010). This first group is the "probe," those who seek out the good hunting grounds and perhaps begin to set up small, ephemeral camps and eventually, farms (e.g., Vésteinsson 1998:10; Vésteinsson et al. 2014:42). This "probe" group may have been similar to the groups that *Landnámabók* records as having accidentally found Iceland while sailing somewhere else, and told stories of the land to others (Pálsson and Edwards 1972:47–52). After this, a "burst" of new settlers come to set up farms and stake their own land claims, followed finally by the "trickle" of a few people who come in slowly over time and fill in the remaining gaps on the landscape. This model is also consistent with the dating evidence we have at present (Schmid 2018; Schmid, Dugmore, et al. 2017; Schmid, Zori, et al. 2017).

There are two Skagafjörður-specific settlement models that have been observed throughout the years of SASS/SCASS research. The Skagafjörður Archaeological Settlement Survey (SASS) was based in Langholt, a region located to the southwest of Hegranes, and examined the order of settlement and its effects on later success and the creation of a local hierarchy (Bolender 2006; Catlin 2011; Steinberg, Bolender, et al. 2016). As part of the SASS field method, farmstead establishment date and size in AD 1104 were assessed in order to understand the sequence of settlement. It was discovered that the farmsteads that were established earlier in the sequence were larger, likely wealthier, and that the benefits of being the first settlers were persistent through time (Steinberg, Bolender, et al. 2016:391).

Langholt was first settled with the establishment of two large farms in the late 9th century, one at either end of the district—Reynistaður in the north and Stóra-Seyla in the south. Both of these large farms later had churches. Then, after AD 930, three other large farms were established in the middle of the region (Glaumbær, Geldingaholt, Syðra-Skörðugil). Finally, the rest of the land was slowly divided and filled in by smaller farms (Bolender 2006; Bolender et al. 2008; Catlin 2011:24; Steinberg et al. 2008). Glaumbær and Geldingaholt also had churches and become parish seats, indicating that they were not low-status farmsteads (Bolender et al. 2008). The late 10th century farms were carved out of land owned by the two original farmsteads, but it is unclear if there was a familial relationship between the original landowners and the new owners. The smaller farms, established in the 11th century, represent another period of landscape reorganization and land division. The new farms were not independent, were smaller than the previously established farms, and are classified in medieval records as dependent or tenant farms, reliant on the larger landowners (Bolender et al. 2008:225). For example, Brautarholt and Holtskot were tenant farms of Seyla and Geldingaholt, respectively (e.g., Bolender et al. 2008:224).

Essentially, the settlement on Langholt begins with a few relatively equal large farms that represent early, independent farmsteads (Bolender et al. 2008:222). The 11th century property divisions result in dependent tenant farms, a new kind of farmstead and a lower class (Bolender et al. 2008:220; Steinberg and Bolender 2005). Thus, the Langholt model represents a multi-stage process of farmstead establishment where the final stage of land division leads to hierarchical inequalities that are perpetuated even after the end of the study period in AD 1104.

On Hegranes, the process of settlement differs from Langholt, its direct neighbor. Some of the earliest dwelling sites were established quickly after the fall of the *landnám* tephra, they were rather small, and the majority were completely abandoned after just a couple hundred years, noted by the lack of cultural material above the H1104 tephra (e.g., Catlin 2019; Catlin et al. 2017, 2018). However, there were also large wealthy farms established in the late 9th century, at the same time that the smaller, marginal dwellings were created. The creation of both large and small sites at the same time is rather unlike patterns seen elsewhere, though the settlement patterns in Mývatnssveit seem to be similar to Hegranes in this regard. Catlin (2019:244–247) suggests that the settlement pattern on Hegranes is a mixture of patterns seen elsewhere and follows a northeast to southwest division of the district, which seems to follow topographic differences in the landscape, with variable settlement patterns in the dry, rocky areas and in the flat, wet areas.

The presentation of these settlement models, and their variations, serves to show that there are many possibilities for establishing settlements within an area and there is not one single narrative that can be broadly applied across the entire island. It is clear that there is variation, both regional and sub-regional, and it follows that future trajectories will vary as well. Indeed, Langholt and Hegranes are perfect case studies to illustrate that, even within a region and among close neighbors, there is variation in the settlement sequence and the effects of the settlement on future social and political development. The settlement process can be taken as a proxy for understanding that other aspects of early life in Iceland also do not follow one specific narrative, and economic strategies, land use, and social organization, among other things, may all differ between regions and even between households within the same region.

Who Were the Settlers?

Various lines of evidence point to a Norwegian and British Isles origin for the (mostly) Norse colonizers. Studies of DNA (Ebenesersdóttir et al. 2018; Goodacre et al. 2005; Helgason et al. 2000, 2001) and isotopes (Price and Gestsdóttir 2014) tell us the geographic origins of the settlers. Mitochondrial DNA (mtDNA), which traces the matrilineal line, suggests a mix of British and Irish ancestry, with 62% of the genetic material coming from Scotland and Ireland (Ebenesersdóttir et al. 2018; Goodacre et al. 2005). Studies of the Y-chromosome, which traces the patrilineal line, found ~75-80% of the genetic material was Scandinavian (Ebenesersdóttir et al. 2018; Helgason et al. 2001:724, 733) and only 19.5-26.% could be attributed to Gaelic ancestry (Helgason et al. 2000). Strontium isotope analyses (Price and Gestsdóttir 2014) also found immigrants from both Scandinavia and the British Isles migrating to Iceland. These studies show that the genetic ancestry of the Norse who settled Iceland was a mix of Scandinavian and Gaelic, and that the men were primarily Scandinavian while the women were more likely to have Gaelic ancestry.

Cultural heritage and traditions, like weaving and spinning techniques that mix Norwegian and Celtic traditions (Hayeur Smith 2012a:28; Lee 2015:291–292), dried fish production that begins in Norway (Perdikaris and McGovern 2008a), and the concept of a farm (Øye 2005, 2013) also point to a hybrid culture. Outside of Norway, we also see extensive hunting of seabirds from their homes on cliffs, a practice that is more common in the Celtic Atlantic islands and that became part of the Norse subsistence package when they began to move into these areas and beyond (Best and Mulville 2010; Brewington 2015; Brewington et al. 2015; Guðmundsdóttir Beck 2013; Hambrecht 2020; Keller 2010; Petersen 2005).

The Norse settlers came from political systems where chieftainships were common and the basic economy was primarily based on agriculture and raising domesticates, with hunting and fishing as supplements (Amorosi et al. 1997; McGovern et al. 2007:29). Slaves may not have been uncommon, and they are mentioned in both law codes and the sagas. This political system and farming strategy were transported across the ocean in the minds of the settlers, and implemented in the new lands (e.g., Carter 2010:26).

Niche Construction, Landscape Domestication, and Environmental Memory

The process of building a society in a new land, where households and farms must be established in new environmental conditions, necessitates flexibility and a diverse economic strategy. Thus, the Norse colonization of the North Atlantic might be best viewed through the lenses of niche construction and landscape domestication. While there are broad environmental similarities between Norway and the Norse colonies, the "false analogies" of their similarity may have led to inappropriate initial settlement and land management choices (Dugmore et al. 2006). These initial decisions, such as establishing land claims and taking control of resource harvest areas, require people to carve out their own niche on the landscape.

Niche construction can be defined as the ways that organisms or actors, humans included, modify their environment to suit their needs (Jackson et al. 2018:666; Odling-Smee et al. 2013:5). These actions could also be considered landscape domestication, though the term domestication specifically indicates humans as the actors who modify the land to increase its use-value (Catlin 2019:50; Terrell et al. 2003), while niche construction can be undertaken by a variety of species. Niche construction theory looks at the "ecological and evolutionary ramifications" of the process of niche construction (Odling-Smee et al. 2013:5). Some of the ramifications of niche construction and landscape domestication include shifting biodiversity (increasing or decreasing), landscape degradation, and changing land productivity. Human effects on the landscape and on biodiversity have been a major focus of many historical ecology research regimes in the last decade (Armstrong et al. 2017; Kintigh et al. 2014).

Niche construction activities in the North Atlantic include the introduction of non-native plant and animal species, woodland clearance, fertilization of fields, diverting waterways, and building boundary walls or fences (Aldred 2008). All of these activities would have had effects on the landscape, which in some cases, like Iceland and possibly the Faroes, did not have any prior human intervention.

The Norse settlers drastically altered biodiversity on the islands they colonized by bringing in a suite of domesticated livestock animals and cereals. They also brought unintentional commensals, like mice, rats, and bugs (e.g., Buckland and Panagiotakopulu 2008; Mellows et al. 2012), and began to hunt animals that previously had few to no natural predators. The domesticates, in turn, had some long-lasting effects on the environment; sheep in particular contributed to what Buckland and Dugmore (1991) termed an "ovigenic landscape," or one that has been shaped by sheep activity. The grazing strategy of sheep contributes to soil erosion, and in Iceland this erosion had both positive and negative effects. On the positive side, erosion would have led to more available pastureland to graze animals, and the disturbed ground would also allow native species to spread to areas where they formerly could not grow (Buckland et al. 1991:252). Differential accumulation of eroded soils could increase land productivity in some areas, while decreasing it in others (e.g., Catlin and Bolender 2018; Dugmore et al. 2006).

Not all of the islands colonized by the Norse were forested. For example, the Faroes do not seem to have had much forest cover when they were settled, and still remain unforested today (Brewington 2015). In Iceland, the Norse settlers rapidly deforested the island in order to collect timber for house- and boat-building, as well as for fuel for fires and charcoal production, and to clear areas for hay fields to produce fodder for their livestock (Church et al. 2007; Hallsdóttir 1987, 1995; Mooney 2013:23). It was difficult for the Icelandic birch forests to regenerate due to grazing by sheep especially, but pigs and goats as well (Aradóttir and Arnalds 2001; Aradóttir and Eysteinsson 2005).

In addition to examples of overexploitation and loss of natural capital, the settlement of Iceland also provides examples of adaptive responses to their new environment. These adaptations represent "landscape learning" and changes to shared environmental memory (Jackson et al. 2018:672). Landscape learning is the process where information about the new landscape is incorporated into shared cultural memory. When the Norse left Norway and colonized other North Atlantic islands, they brought their memories of the environment and Norse "cultural niche" with them (Jackson et al. 2018:762). Since the environments of the North Atlantic islands during settlement were broadly similar to Norway, the settlers were able to utilize their memories of environmental adaptations and land use—how to farm, crop timing, calculating fodder needs, predicting weather patterns—and apply them to their new settlements. However, through landscape learning, environmental memory evolves, and the knowledge transmitted to the generations after settlement would have also included information on new local resources.

Examples of local adaptations in Iceland include preservation of natural capital. While the process of settlement often involved clearing woodland, there was also conservation of woodland resources over multi-century timescales (Church et al. 2007; Dugmore et al. 2007). Wetlands were also maintained to secure and even increase fodder productivity (Sigurðardóttir et al. 2018), and maintenance of biodiversity includes the long-term conservation of specific species, like management of ground nesting bird colonies (Brewington et al. 2015; Hicks et al. 2016).

Environmental memory does not always ensure successful adaptation. The original modifications made to a landscape may help on the short-term, such as during the first decades of settlement; however, on the long-term scale, climate changes and anthropogenic landscape degradation require updated adaptive strategies that rely on the transmission of new information (Jackson et al. 2018:666; Rowley-Conwy and Layton 2011). By studying how people constructed their niche, it is possible to also understand changes to environmental memory and perhaps the reasons for those changes.

Dissertation Layout

This dissertation uses zooarchaeology to argue that the range of economic strategies during the settlement period in Iceland is varied and that the current picture of early animal use is incomplete. Chapter 1 introduces some of the previously proposed models for settlement which are varied in their timing, number of settlers, and land claims made. The archaeological evidence for a wide range of settlement models supports the idea that there was also a varied economic strategy during this time. The concept of niche construction is also discussed, in order to set the stage for how people organized themselves on the landscape, and how they went about domesticating the landscape to suit their needs. Therefore, this project contributes to our understanding of early settlement strategies and shows that the range is broader than has been previously documented.

Chapter 2 summarizes the main theoretical background of historical ecology, which allows for a look at change in animal use over different time scales. The idea of marginal settlements, those that are socially and geographically marginal, is also explored in order to understand the status of the dwelling sites that make up the main focus of the dissertation. The concept of a farm, as brought to Iceland with the Norse settlers, is also explained. The production, consumption, and reproductive abilities of a household are explored, with specific examples from the Icelandic data as it relates to this dissertation.

The research context and case study sites are explained in Chapter 3. This dissertation project, called "Marine Animal Resource Specialization on Hegranes" (MARSH), is part of a larger research initiative aimed at recording the settlement history of Hegranes. As part of the larger Skagafjörður Church and Settlement Survey (SCASS) project, my work contributes to discussions of site activities and specialization, as well as bridging the gap between wealthier farms and abandoned dwellings. To place the Hegranes data in context with the broader Icelandic story and show that there are indeed many different early economic trajectories, three other regions of northern Iceland that will be used for comparisons are discussed.

In Chapter 4, the methods used in all aspects of the research are described. First, excavation methods, including survey strategy, are explained. Methods and standards for faunal identification, analysis, and curation are also discussed. Both the excavation and faunal analysis methods used for this project are also commonly used for other projects in Iceland and the North Atlantic, making the results presented in this dissertation comparable to many other research projects. The dating and phasing for this project are also explained.

The raw data is presented in Chapter 5. The data are presented from all of the sites on Hegranes and one in neighboring Langholt where archaeofaunal remains have been recovered, not just from the four sites that are the main focus of this dissertation. This chapter acts as another archive of the data for future researchers, as well as listing the less common taxa and information from sites with small sample sizes that will not be discussed in detail in the following chapters. There is also a discussion of prior zooarchaeological research in the region, which is generally lacking in major interpretation and comparison to other sites or regions.

Interpretation of the data on three major taxonomic groups is made in Chapters 6-8. The analyses discuss various aspects of the different major taxa, and what the patterns mean for human activity and economic strategies. Chapter 6 focuses on the domesticates. Particular attention is paid to how the MARSH data fits in with the other contemporaneous Icelandic sites. If the concept of a farm was brought over wholesale with the Norse, does that mean that all early sites have the same domesticate signature? When a site differs from the expected pattern (based on the Norse farm concept), what does that mean for their niche construction and adaptation activities? These ideas are discussed in relation to the overall Viking Age domesticate signature, as well as changes over time.

Chapter 7 discusses the fish assemblage from the MARSH sites in light of specialized butchery. The Norse have a rich history of marine fish exploitation, with similar butchery patterns seen from Norway to Iceland. These patterns indicate the creation of air-dried fish products which pre-date the standardization and commercialization of stockfish in the 13th century. In addition, the wealthy inland site of Stóra-Seyla is added to this discussion, as it allows for a discussion of the pre-commercial internal trade of dried fish products.

The final data chapter presents information about bird use. Cultural continuity of seabird use can be traced through their continued exploitation across the Norse settlements in the North Atlantic and through the similar butchery patterns that persist across time and space. Another Hegranes farm is brought to this discussion as well, in order to better understand early bird use and economic activities at sites of different statuses.

Finally, Chapter 9 brings together all of the interpretation from Chapters 6-8 and discusses how the patterns on Hegranes compare to other regions in Iceland. Special attention is paid to how Hegranes differs, and the importance of the patterns that can be seen in the region. By comparing

Hegranes with other early sites in Iceland, it becomes clear that early economic strategies of animal use are not the same across the island. The status of the Hegranes sites—as autonomous households or part of a larger system—is also explored in light of the information presented in this dissertation.

Chapter 2. Archaeology of Marginal Settlements

This dissertation focuses on early dwelling sites in northern Iceland and how they made a living. Four dwelling sites are discussed in detail, three of which were completely abandoned by the early 12th century and one which moved after AD 1300. All have similar zooarchaeological signatures, and by examining sites like this, we get information about those people and places on the margins that are often ignored in later documentary sources. Comparing the early dwelling sites on Hegranes with others across Iceland can give us insight into the varied political and social means of dealing with environmental change and creating a successful settlement landscape in different regions.

This chapter will discuss the theoretical orientation of the dissertation research, and how it applies to the archaeology of marginal settlements. It introduces the fundamental questions underlying the research, as well as a discussion of the concept of the farm. Then, there is a presentation of the story of North Atlantic subsistence economy as we currently know it, and the new evidence that this dissertation contributes. Finally, the household, the main unit of investigation, and how it is organized are considered in order to understand status.

This work fills a gap in our knowledge of the archaeological record in Iceland, while contributing to broadening cross-project collaboration across much of northern Iceland and providing a strong zooarchaeological component to ongoing research in an environmentally and historically critical area. It helps tease out some of the controversies over the earliest economic strategies in Iceland by adding zooarchaeological information to research on settlement patterns in Skagafjörður. Through its contribution to a regional case study, this dissertation makes diverse interregional comparisons possible and thus can help tease out spatial patterns and elaborate on the strategies that the earliest settlers employed in order to make a living in their new settlements.

Historical Ecology

Iceland has proven to be a productive area for research into island ecodynamics and historical ecology (Amorosi 1996; Feeley et al. 2010; Gísladóttir et al. 2013; Harrison 2013; Harrison and Maher 2014; Hicks et al. 2016; McGovern et al. 2007; Perdikaris and McGovern 2008a; Smiarowski et al. 2017; Woollett 2008). The historical ecology perspective (e.g., Crumley 1994) makes up the main theoretical framework of this dissertation, which will focus not only on the zooarchaeology of Hegranes, but which also builds upon prior environmental archaeological research in Iceland and the North Atlantic.

Historical ecology focuses on landscapes changing through time and the mutual and complex interactions of place, people, and environment (known as "human ecodynamics"), as well as the historical processes between climate, humans, landscapes, and animals (Balée 2006; Crumley 1994, 2007). It functions on three levels of time: the short-term (sub-seasonal to seasonal), the long-term (decadal), and the very long-term or the *longue durée* (centuries) (Balée 2006:78).

Historical ecology provides an exceptionally strong platform for landscape-scale research projects with an interest in human ecodynamics. This perspective allows for understanding of broader processes like sustainability, resilience, and vulnerability. As a theoretical framework, historical ecology incorporates a variety of evidence from different disciplines and ways of knowing (Local Traditional Knowledge or Traditional Ecological Knowledge especially) in order to take a holistic approach to research. It also allows us to see the long-term interaction of political economy, ideology, climate, and natural resources.

In this dissertation, the initial settlement of Hegranes is explored on different time scales, from the seasonal to the decadal to the *longue durée,* through the lens of historical ecology. The focus is on animal remains, and the economic activities represented by their patterns, and the change of animal use over the two centuries of the settlement period. Since the Norse are the first people to permanently settle in Iceland, they very quickly affect (and are affected by) their environment. Adaptation to a new landscape and the subsequent environmental changes both contribute to their decision-making in the first centuries of settlement.

The Fundamental Questions

This dissertation is based on zooarchaeological data, as zooarchaeology is uniquely positioned to answer questions about human-environment and human-human interactions. The use of animals acts as a proxy for how people not only sustained themselves, but also how they adapted (or not) to their physical environment as well as how they fit into their local social and political communities (e.g., Reitz and Wing 2008; see also Brewington 2015). By combining the historical ecology framework with archaeological data, we can understand how humans influenced their landscape, how they dealt with environmental and climate changes, and how organization on the landscape can be affected by social hierarchy and economic production.

The fundamental question, then, is what can zooarchaeology tell us about the animal resources that were essential to settlement of the North Atlantic islands? The current story of economic strategies in the North Atlantic, and in early Iceland in particular, is one of a terrestrial-focused farming society, where the term "farming" includes both agriculture and animal husbandry (e.g., Amorosi 1991; Brewington 2015; McGovern 2009). The farming strategy hearkens back to the Norwegian homeland (Øye 2005, 2009) and traveled across the North Atlantic with the Norse as they moved west (Keller 2009; McGovern et al. 2006). However, while the North Atlantic islands had broad environmental and climate similarities, there were important differences that dictated how the originally imported farming strategy changed over time. Upon the Norse arrival in the new settlements, the climate was likely to have been fairly mild (Ogilvie 1984) and the conditions for farming were quite good (Øye 2005:360), which allowed them to implement the Norwegian model with relative ease.

Orkney and Shetland had both already been farmed before Norse arrival, while Iceland and Greenland (and possibly the Faroes) had not been farmed, and Iceland had no prior long-term inhabitants (Øye 2005). Cereals could be grown in most areas, though in Greenland agriculture was rather unsuccessful except for a few small areas (Amorosi et al. 1997; Øye 2005:360). Despite the limited area suited for arable agriculture, woodlands and forests could be cleared to increase areas for pasture and grazing, and wild marine resources were abundant.

The Farm Concept

The ideal concept of the Norse farm—how it is structured, the kinds of animals to keep, the activities—comes from the Norwegian model (e.g., Øye 2005). Research has suggested that the entire farming structure moved west from Norway with the Norse settlers, rather than just elements of the system (Øye 2005). This is despite differing environmental and demographic conditions, which helped to shape the way the farming system changed in the new colonies. The farming system also includes social and political factors that come into play when people own and manage their own land (Øye 2005:360). Farming was supplemented with hunting for wild animal resources, especially birds and fish. The farm structure consisted of the main dwelling area and its buildings, infields and outfields, more distant grazing lands, and hunting/fishing areas (Øye 2003, 2005, 2013; Keller 2009; Figure 2.1 below). Terminology for parts of the farm, like *bœr* and *tún*, are used in the same way with the same meaning across the Norse settlements, which provides further evidence for the entire system being moved with the colonists (Øye 2005:361). That this same structure and terminology were implemented at farms of all sizes and statuses across the North Atlantic suggests a relatively strict adherence to traditional cultural practices, at least in the earliest phases of the Norse colonies. Keller (2009) asserts that the farm was the most important social, economic, ideological, and religious unit for the Norse, despite their reliance on wild animal resources.

Figure 2.1 shows a schematic of the zones that make up a farm property, according to models based on Medieval Norway (Øye 2013:304). Øye divides the property into four zones which each pertain to aspects of the farming strategy. The main nucleus of the farm is the habitation or dwelling unit, with the rest of the zones stretching out beyond. The first zone is the infield, which is closest to the central dwelling and includes areas for arable agriculture and wet meadows (Øye 2003:405). Zone two is the outfield which is comprised of dry meadows and pasturelands for grazing animals; this zone may also include woodland areas that are exploited for timber or further grazing (Øye 2003:405). There is a further discussion of infield and outfield systems below. The third zone is more distant from the farm, usually within 3-5 km in Iceland (Sveinbjarnardóttir 1991), and includes shielings and pastures, but does not include communal grazing land which is not part of the single-owned farm property (Øye 2003:405, 2005:364). The final zone is the most distant and can include hunting grounds for which ownership is legally dictated (Øye 2003:405; see also Dennis et al. 2000 for legal regulations).

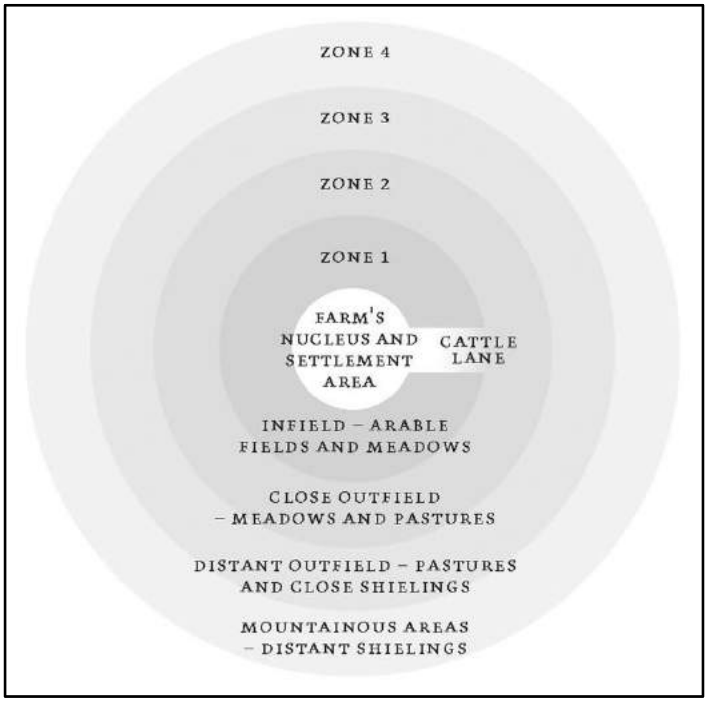

Figure 2.1. Farming zones based on the model of Medieval Norway (from Øye 2013:304, Figure 4).

The infield-outfield system was in use in Norway at least by the Iron Age and can be seen in the rest of the Norse colonies to some degree. While Greenland has limited traces of separate in- and out-fields, examples of this system are present in Shetland and Orkney, the Faroes, and Iceland (Øye 2005:362). In Iceland, turf walls dividing these two areas have been found that date to the first settlement (Aldred 2008:307; Sveinbjarnardóttir 1992), further suggesting that the field system was in use since first colonization. This system allowed for cereal growing on fertilized infields (also called homefield, or *tún*) (Adderley and Simpson 2005; Aldred 2008; Amorosi et al. 1998:46), and the productivity of the field was intrinsically linked to the size of the livestock herd—more animals produce more manure, more fertilization makes better fodder yields, and more fodder means that more animals can survive the winter and the cycle will continue (Keller 2009). Outfields provide areas for controlled grazing and more cultivation but also include structures for livestock management such as weaning pens, areas for shearing wool, and places to sort animals in the fall (Aldred 2008:309). Outfields may have also included other resources, such as woodlands and areas for cutting turf and peat (Aldred 2008:309). Infields were generally separated from the outfields with a fence or wall, which helped to prevent unintentional grazing and protect the arable fields and meadows, but both are necessary parts of the farming—agriculture and animal husbandry—strategy (Øye 2003) and their relationship was not fixed.

McGovern et al. (2001) suggest that the Iron Age chieftain's farm at Aaker in Norway (Perdikaris 1990), represented the "ideal farm" and that it would have been the model carried by the Norse as they colonized the North Atlantic islands. The zooarchaeological signature at Aaker shows that they utilized primarily domesticates, but also included fish and birds from the local area, and imported marine fish (Perdikaris 1990). The desire to implement this model may have driven the early uniform strategies—composition of herds, wild resources hunted, and organization of buildings and labor—that took place on farms across the North Atlantic during the time after their initial settlement.

The Story as We Know It

The archaeofauna from early phases of North Atlantic farms often show the introduction of a farming strategy focused on cattle and caprines (both sheep and goats), with a mix of pigs and horses (McGovern et al. 2001, 2006). Early North Atlantic sites, from the Faroes to Iceland and Greenland, also extensively utilized local wild fauna as a supplement to the limited number of domesticates they brought with them. For example, the archaeofauna from some of the earliest sites in the south of Iceland, like Tjarnargata 4 and Herjólfsdalur, are primarily composed of seabirds, including bones from the now-extinct great auk (*Pinguinus impennis*) (McGovern et al. 2001, 2006; Vésteinsson et al. 2002).

While the earliest settlement sites in Iceland utilized a wider variety of animal resources—both domesticate and wild—the later 11th-12th century assemblages show a shift to a domesticate-dominated economic strategy (McGovern et al. 2006:191). It has been proposed that the shift towards domesticates may indicate that the initially small herds had finally reached sufficient numbers to sustain individual farmsteads without the need to include as many wild resources (Edvardsson 2010; McGovern et al. 2001:8). Other possibilities leading to a more domesticate-heavy strategy during the 11th-12th centuries include deforestation that lead to the availability of more grazing and hay-growing areas (Church et al. 2007; Zutter 1997) and therefore the ability to keep more cattle and sheep, and human predation on wild species lowering their population numbers (McGovern et al. 2001). Not only do farms shift towards keeping more domesticates after the initial settlement, but they began to keep more caprines than cattle, though cattle were a priority in Norway and were markers of status (Amorosi 1991:281; McGovern 2009). However, the changes to sheep and cattle numbers cannot only be attributed to environmental conditions, but also to the broader changing socio-economic situation. In Iceland, the Faroes, Shetland, and possibly Orkney, sheep become much more important around AD 1200, when their products—butter, wool, *vaðmál*—are used as payment as well as goods for export (Hayeur Smith 2012a, 2012b; Øye 2005:365). These shifts from the Norwegian model evolved locally in response to local pressures, both social and environmental.

Beyond animal husbandry, early Norse settlements also grew cereals where the environment allowed. Greenland was generally unsuccessful in this regard, and over time cereal production became less common everywhere else, except for Norway (Øye 2005:363).

The New Evidence

The case study presented in this dissertation is a variation on this basic story of terrestrial farming. Most of the earliest sites in Iceland include wild resources in abundance (Amorosi 1996; Dupont-Hébert 2020; Harrison 2013; McGovern 2009); however, they rarely specialize on processing wild animals while also farming. Specialized animal processing sites, like fishing stations, seem to be uncommon during the settlement period in Iceland, though there is one known example of a Viking Age fishing station, Siglunes in Eyjafjörður (Harrison 2014).

The four dwelling sites that make up the focus of this dissertation present a typical domesticate signature indicative of the more standard Norwegian farming model—caprines and cattle make up the majority of the domesticates, with pigs and horses present in smaller quantities (see Chapter 6 for a more detailed explanation of the domesticates). However, the archaeofaunal assemblages are primarily (60-80%) wild animals, marine fish and seabirds especially. These two taxa show very specialized use patterns—the fish are being heavily worked into a dried product for local trade/exchange, and the seabirds are butchered in a specific way that disproportionately deposits wings into the middens. The chapters (Chapters 7 and 8 for fish and birds, respectively) on each taxon provide much more detailed information, but for now it suffices to say that the patterns are not seen anywhere else in Iceland where sites also participate in extensive animal husbandry.

Three of the dwelling sites are abandoned, which may also be part of the early settlement strategy. The sites may have been autonomous, but unable to sustain themselves any longer. It is also possible that they were part of a larger farm system, perhaps as outposts to secure a specific resource or simply activity areas outside of the main farmstead, that get absorbed into the larger farm property after the initial settlement activities. A look at the dwelling sites through the lens of household archaeology to further explore their status follows.

Household Archaeology of Marginal Dwelling Sites

To examine these sites in more detail, we can take a look at their organization on the household level. It is first important to define "household," and in this case there are three potentially overlapping concepts: the anthropological, the legal, and the archaeological. The anthropological definition of a household is the smallest unit "at which social groups articulate directly with economic and ecological processes" (Wilk and Rathje 1982:618). In Iceland, the legal definition comes from medieval law codes like *Grágás* which outline not only the necessary requirements to be considered a household, but also the rights and responsibilities associated with such legal status. Requirements included owning property, productive resources, and livestock, and householders were then given the right to representation at the assembly (*þing*) as well as responsibility for paying taxes. The medieval texts clearly determine the household as the main legal entity and legally, people had to belong to a household. Each household was associated with a farm property, and household members included the farmer, members of the farmer's family, and laborers (Karlsson 2000:109; Miller 1990). Farms, and by extension households, were supposed to be relatively self-sufficient (Miller 1990:78), and *Grágás* dictated this obligation in order to prevent people from becoming a drain on the social support system and to ensure sufficient labor for the farmers (Karlsson 2000:109).

It may be helpful to clarify here that *farm* refers to the wider economic and landscape unit that includes both nearby and distant resources and the activities that take place as part of that unit (see discussion of "The Farm Concept" above). Not only did the farming households rely on resources located directly on the main farm property, like their agricultural fields, but they also made use of resources outside of the main property, like distant communal grazing lands, driftwood beaches, fishing and hunting grounds, and boat landing/launching places. Thus, the farm is central to social life and especially to economic strategies. The *farmstead* is the central place on the farm property where people in the household live (in the farmhouse) and most of the other buildings are located.

In the archaeology, we cannot be sure if what we see in the Viking Age is a direct representation of the legal definition because the law codes were written after the sites under study were occupied. However, archaeology can examine full-time dwelling sites with evidence of domestic habitation as households. Archaeology investigates the physical infrastructure—the farmhouse, outbuildings, fields, and middens—to draw conclusions about social and economic relationships. The main activities of a household, as they are defined anthropologically, can also be explored through the archaeology. Zooarchaeology is particularly well-suited to an investigation of household activities, as will be explored in this dissertation. The main activities of the household fall under three categories: 1) production, 2) consumption, and 3) reproduction (e.g., Wilk and Rathje 1982:621). These three will be discussed in turn in order to better understand how the farming household functioned. It will also allow for a discussion of the status of the MARSH sites—are they autonomous households or are they part of a larger farm system?

Production

Production includes all of the human activities that collect resources, modify them, and increase their value and use potential. In Iceland, this includes livestock husbandry, fishing and birding, agriculture, food preservation and storage, and spinning and weaving, among other things. In order to be successful in such productive activities, efficient allocation of labor is essential (Wilk and Rathje 1982:622). In Iceland, the seasonal round requires differing levels of labor allocation based on activities and time of year. Summer was the most labor-intensive season (Jackson et al. 2018:667), as the productivity of the soil and the labor force dictated the ability of the farmstead to survive through the winter (Amorosi et al. 1998; Bolender 2006:58). Fodder needed to be grown, harvested, dried, and stored in order to support livestock over the winter (Adalsteinsson 1991); it was important to carefully calculate fodder needs to avoid shortfalls in late winter (Hartman et al.

2017; McGovern et al. 1988). Sheep and lambs were allowed out on summer pastures, and their wool was also collected in the summer, usually in June (Adalsteinsson 1991:289). Some milking ewes were brought to summer shielings, usually located a few kilometers from the main farm, and were generally cared for by women, who were in charge of milking, and young children, who acted as shepherds (Adalsteinsson 1991:289).

In addition to the on-farm task of haymaking, other animal resources, especially migratory seabirds, were only seasonally available in the summer. The collection of these seabirds would have diverted labor from fodder production to their procurement. The most important of the migratory seabirds was the puffin (*Fratercula arctica*), but other *alcids* (diving seabirds) that nest near puffins were also taken. To collect these birds from their nesting locations was a dangerous task, and not one that could be done by a single person. Indeed, often multiple farms needed to pool their labor to hunt these birds safely (Petersen 2005).

During the spring, animals were let out to graze on the newly sprouted grasses, though they still needed to be supplemented with stored fodder until the grass production ramped up in the summer. Some of the flock would also be moved to communal grazing pastures or to shielings for dairy production (Adalsteinsson 1991; Jackson et al. 2018:667). Homefields were tended during the spring as well, and fertilized with manure and household debris that had built up over the winter (Bolender 2006:57–58; Buckland et al. 1991; Øye 2005). During the late spring, in May, labor would also be diverted to the supervision of lambing and calving; historically, reproduction was carefully managed in order to ensure most births happened in the first week of May in order to take advantage of the new spring grass growth (McGovern 2009).

Winter was the time with the least need for intensive labor, and people could take on other productive activities. There was still a need for maintenance of the home; spinning and weaving;

and milking, feeding, and caring for the animals (Bolender 2006:57; Jackson et al. 2018). Winter was also a time where fishing could be undertaken much more intensely than during the other months, and it is the traditional time where people are sent away from the farms to distant fishing stations (Eggertsson 1996:4; Hartman et al. 2017:136; Karlsson 2000). Fish that were caught would have also needed processing, which requires differing amounts of labor based on the type of fish product being created. Perdikaris (1998:79) explains that, in Norway, the actual act of fishing was a job for men, but women would have aided in cleaning and preparing the fish for drying. In the case of flat-dried fish, the bodies would often be laid flat on beach cobbles or rocky areas and children could be given the task of scaring away birds and other scavengers and flipping the fish. These activities can include all genders and multiple age groups, especially children that may not be as helpful in other seasons.

In the fall, animals that were brought to distant communal grazing pastures in the late spring needed to be collected and returned to the farm. This round-up, and subsequent sorting of the animals, would have required communal cooperation and taken labor from multiple households. Slaughter also traditionally took place in the fall.

All of these labor needs would have necessarily included every possible household member that had the ability to work—only the elderly and the youngest children would have been excluded. Øye (2003:410) suggests that harvest, woodcutting, land clearing, herding, milking and dairy production all could have been the responsibility of low-status individuals of all genders; this included enslaved individuals that were part of the earliest settlement demographics.

Consumption

Many of the activities described in the previous section resulted in the production of products that were then consumed by the household. Wilk and Rathje (1982:624) call this *pooling,* where goods or products remain within one household and are consumed there. Pooling includes both dietary and non-dietary consumption. Examples of dietary consumption may be obvious—eating collected food resources for nutrition and energy. Non-dietary consumption includes anything non-nutritive that still consumes a resource, like weaving wool or plucking bird feathers for clothing.

Not all production and consumption took place on the household level and there is evidence that farming household also exchanged goods. *Exchange* (or trade) is the aspect of consumption that involves the movement of goods or products, including labor, to multiple households (Wilk and Rathje 1982:624). Exchange is especially relevant to the case study presented in this dissertation, as dried fish products from the more coastal MARSH sites are moved at least 20 km inland to at least one larger, wealthy farm (see Chapter 7 for discussion).

The participation in winter fishing may be an example of labor distribution. Winter farm tasks do not require as much of the labor force as the other seasons, so there was more "free" time. By sending people away to fish, whether for the entire season or for single days at a time, more resources can be procured. These fish could supplement the diet or be turned into another product. In the Norse North Atlantic, air-dried fish are a commodity that can provision the fishers and their households with food (pooling) or be exchanged with another household for other goods or payment of taxes and rents.

Reproduction

Reproduction includes both the social and biological. Biological reproduction is the act of having children; however, social reproduction includes much more—it relies on ensuring that culture and tradition continue. Activities include raising and clothing children, teaching them how to behave in social settings, and educating them in not only scholarly endeavors, but in how to manage the household and production-related tasks, and to ensure continuity (e.g., Wilk and Rathje

1982:630). Reproduction also focuses on survivorship and the support of those who cannot contribute as much to the labor force, namely very young children and the elderly.

These small sites do not appear to have been large enough to support continued biological reproduction, and Catlin and Bolender (forthcoming) discuss the sites' abandonment as a cessation in on-site social reproduction. While the people who lived at the MARSH sites likely contributed to broader social reproduction, their contribution was focused on reproducing other sites and not the ones where they lived and worked. After a few generations, their non-terrestrial focus may have no longer been useful or valued as part of the larger community.

Summary

The three functions of a household as explained above, with the labor allocations necessary for all of the activities that take place on site, indicate that the sites explored in this dissertation may not have been fully autonomous. They are too small to support the labor force that would have been necessary for all of the economic activities evident in the archaeofaunal assemblage. Hunting of seabirds is a dangerous activity that, in historic times at least, involves labor from multiple households. Fishing could theoretically be undertaken by a small number of men, but the production of dried fish requires labor beyond collecting the fish; people are needed to butcher the fish and monitor them during the drying process. The need for summer labor during the farming season is also potentially prohibitive of these sites being fully autonomous. It seems likely, then, that the small sites were related to larger farmsteads. Whether this was an early version of the tenant system or a satellite of the larger farm household is unclear.

Chapter Conclusion

The new archaeological evidence provided in this dissertation shows that the old story of settlement resource use that focuses on the farm as the main production unit, arable farming, and livestock management is an incomplete picture. There is actually a larger range of resources used and kinds of sites that are occupied than previously known.

The new evidence raises questions of the importance of hunting and foraging to the settlement economic strategy. Is foraging a supplement to terrestrial farming or a separate adaptive strategy because of different environments? What we can learn from the archaeological evidence is that the old story, a primarily domesticate-focused farming strategy, does not describe the true range of economic strategies that could have been implemented during the settlement period. This implies, much like the models discussed in Chapter 1, that the settlement does not have one distinctive signature, and that local adaptations are necessary for survival. By exploring the local, we can more fully appreciate the island-wide variations.

Chapter 3. Research Context and Case Study

This chapter presents information on the larger research project that this dissertation is a part of, as well as a parallel project that helped form the basis of this work. Next, the research area is described, including the local environment and topology. Definitions for major concepts that form the core of the interpretation follow. It also describes the main goals of this project, and the four case study sites. Finally, there is an overview of Icelandic zooarchaeology and the broader regional projects that will be comparisons for this work and help to place it in context with an island-wide picture of settlement zooarchaeology.

The Research and Field Project

This dissertation project is part of a much larger, multi-year, multidisciplinary project on Hegranes, located in Skagafjörður, north Iceland. The Skagafjörður Church and Settlement Survey (SCASS) is a collaborative project between the University of Massachusetts, Boston and Byggðasafn Skagfirðinga (the Skagafjörður Heritage Museum). Active fieldwork took place over four years, from 2015-2018. One of the main goals of the SCASS research project was to record the settlement process on Hegranes, including the date of site settlement and changes in site size over time (e.g., Bolender et al. 2016, 2017, 2018). There were 31 total sites that SCASS, and a partner project (FLASH, discussed below), were allowed access to for this research. Strategies for the fieldwork included systematic coring, non-invasive geophysics, and test excavations of at least 1x1 m at each explored site, targeted in the middens based on coring results. SCASS also recorded the presence of churches and Christian cemeteries on farm properties, and throughout the four years of the project excavated one entire early Christian household cemetery (Keflavík) and located another (Utanverðunes). The research centered on understanding the effects of early settlement patterns and later conversion to Christianity, beginning AD 1000, on the long-term processes of political and economic organization.

Another project that is aligned with SCASS and very closely connected to my dissertation project is the *Fornbýli* Landscape and Archaeological Survey on Hegranes (FLASH), Kathryn Catlin's dissertation project (Catlin 2019). FLASH explored the small, marginal dwelling sites, nearly all of which were abandoned by AD 1104, while SCASS focused primarily on the larger farm sites, most of which are still currently occupied (Catlin et al. 2017, 2018). Like SCASS, FLASH goals were to understand the settlement pattern, especially as it relates to the smaller habitation sites, and illuminate the social and ecological underpinnings of landscape organization on Hegranes.

By including data from both SCASS and FLASH, my dissertation project, called "Marine Animal Resource Specialization on Hegranes" (MARSH), brings together a spectrum of dwelling sites in order to understand the broader settlement economy of the region. Catlin (2019:83) calls the smaller sites that are the focus of FLASH "marginal sites," describes them as geographically and environmentally marginal, as well as socially marginal, and suggests that the inhabitants would have been lower status individuals. It follows, then, that the currently occupied farms that make up the SCASS research sites, would have been inhabited by higher status farming households in the past. MARSH includes three FLASH sites—Kotið, Næfurstaðir, and Grænagerði—and one SCASS site—Vatnskot (though the modern name is Svanavatn). These four sites together make up the "MARSH sites."

The MARSH sites were chosen not just because of their excellent bone preservation and dense concentrations of bone, but because they represent two different outcomes of the early settlement strategies. One site, Vatnskot, persisted to the present day and is still actively farmed.

The other three ceased to exist as habitation sites and were likely absorbed into larger farm properties. Thus, the MARSH sites allow for an exploration of multiple scales of status at the household level and can help distinguish regional patterns between high- and low-status dwelling sites in the Viking Age.

Since SCASS is the umbrella project for both FLASH and MARSH, when discussing aspects of the projects that apply to all three, just "SCASS" will be used. If there is a specific methodology or result that came from the actions of one of the projects, it will be specified.

Hegranes

Hegranes is a rocky peninsula located at the base of the fjord in Skagafjörður, north Iceland (Figure 3.1). Skagafjörður is neighbored to the east by Eyjafjörður and to the west by Húnafjörður. Hegranes is bordered on both sides by a river—the eastern and western portions of Héraðsvötn—and on the north by the sea. Much of the landscape is denuded due to soil erosion, though there are areas of deeper soils, and the interior of Hegranes is mostly exposed bedrock with very little soil.

Hegranes is an historically important place, as the location of Hegranesþing, one of the four local assembly sites for the Northern Quarter of Iceland and the site of the quarter assembly. Skagafjörður itself is also the home of the Ásbirningar, a powerful chieftain family who ruled over Skagafjörður during the 12th-13th centuries, and the site of many battles during the civil war in the 13th century (Karlsson 2000). The northern bishopric was also established at Hólar, in Skagafjörður, in AD 1106, making it a religious center (Karlsson 2000:38).

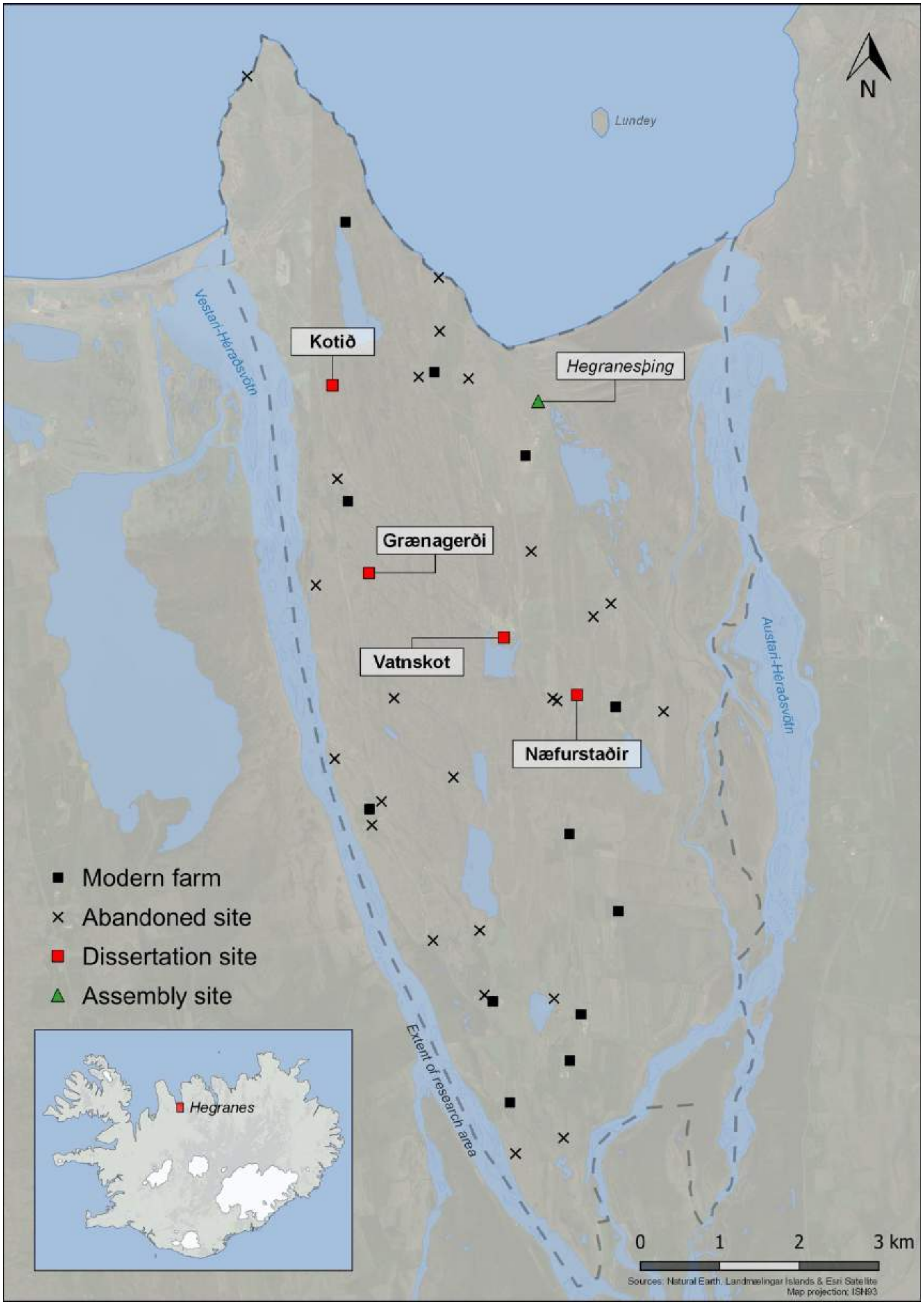

Figure 3.1. Map of Hegranes with site locations. The four dissertation sites are labeled, along with Hegranesþing, an historically important assembly site that is mentioned in the text above. Map by Gunnar Grímsson.

Dwelling Sites on Hegranes

Before introducing the archaeological sites that were explored on Hegranes, a brief discussion of terminology is warranted here. First, for "abandonment," I use the definition provided by Bolender et al. (2011:83): "a farm that no longer is the residence and primary production site of a household." Archaeologically, we can see signs of abandonment through evidence of domestic structures that have fallen into disrepair and no longer show signs of cultural activity (artifacts, bones, charcoal, etc.) and through middens that are no longer used after a period of time. Tephra layers aid in identifying the periods of use and disuse to more accurate phases. This definition of abandonment still allows for re-use of the surrounding land for grazing animals and perhaps for animal husbandry activities involving small buildings like shielings, but they are no longer domestic habitation sites (Catlin 2019:97).

One reason for abandonment may be lack of production from the land, because of erosion or declining yields as a result of intensive agricultural production with not enough fertilization. Other environmental issues may contribute to abandonment, including climatic changes that increase livestock mortality and reduce grazing, fodder production, and yields of meat and dairy products. However, sometimes areas are abandoned not because of environmental reasons, but due to the effects of famine or disease on a population (Bolender et al. 2011:84; see also Vasey 1991). I would add that social, political, and economic factors may also push people to abandon their farms and potentially even incorporate their household with another (Catlin forthcoming; Vésteinsson et al. 2014).

As part of SCASS, we use "farm" and "farmstead" to describe various aspects of sites. "Farm" contains the entire property owned by one person or family, while "farmstead" means the main building or longhouse and other outbuildings (for animals, etc.) that lie within the homefield boundary wall (Catlin 2019:263; Steinberg, Bolender, et al. 2016:391). However, this is the social and political definition of "farmstead." We also use the term in an archaeological sense to delineate the core area of the site by measuring the middens—which include layers of concentrated charcoal, turf, peat ash, and other domestic refuse such as animal bones and artifacts—and collapsed turf (Steinberg et al. 2016:391–392; see also Catlin 2019:115). Despite calling this measure "farmstead," it does not mean that the site qualified as a "farm" in the social and political sense. It is important to note these distinctions, especially between the social/political use of "farmstead" and the archaeological use. Here, only the archaeological definition of farmstead will be used.

Hegranes is home to 12 currently active farms. There are 19 abandoned farmstead ruins that were also examined as part of the FLASH research scheme (Catlin 2019; Catlin et al. 2017, 2018), bringing the total number of dwelling sites studied under the broader SCASS umbrella up to 31. The active farms are spread throughout the region in the areas with deeper soils. The abandoned dwelling sites dot the landscape between the modern farms and have been incorporated into modern farm properties. The abandoned sites tend to be smaller (Viking Age farmstead size ranges from 29-4,406 m^2, or 0.0029-0.4406 ha) than the active farms (from 1,139-15,265 m^2, or 0.1139-1.5265 ha) and are often located in marginal areas—whether environmental or social.

During the four years of the SCASS research project, nearly all known sites on Hegranes were surveyed, cored, and excavated. The results of the surveys, coring, and excavations can be found in various reports and theses (e.g., Bolender et al. 2016, 2017, 2018a; Catlin et al. 2017, 2018; Cesario 2018a, 2019a, 2019b; Cesario and Ritchey 2018; O'Connor 2019; Ritchey and Cesario 2018; Steinberg, Bolender, et al. 2016; Steinberg et al. 2018; Zeitlin 2020; see also Appendices A and B in this dissertation). During this time, the majority of the excavations consisted of 1x1 m test units in order to collect small samples (archaeofaunal, flotation, tephra), and find the earliest evidence of human occupation. The four sites that make up the basis of this dissertation will be discussed below.

The Dissertation Case Study

This dissertation focuses primarily on four sites, one currently active farm and three abandoned sites. These will be called the "MARSH sites" when referred to as a whole for the rest of the dissertation. The abandoned sites on Hegranes make up the majority of the excavated sites across the region, simply because there are more of them than there are occupied sites. They are the focus of FLASH and much more detailed information on each site, including results of coring, geophysics, and test excavations, can be found in Catlin's reports and dissertation (Catlin 2019; Catlin et al. 2017, 2018). The active farm—Vatnskot—was under the purview of SCASS, though I conducted both of the excavations (Bolender et al. 2018a; Cesario 2019a; Cesario and Ritchey 2018).

Kotið

Kotið is located north of Helluland and used to be part of their landholdings, though it is now owned by Helluland (Catlin et al. 2017:37; see Figure 3.1 and Figure 3.2 for site location and landscape). The archaeological farmstead itself is quite small, and with an estimated size of 0.0145-0.0158 ha (145-158 m^2) (Catlin 2019:111), it is the smallest of all four of the MARSH sites. It is also the earliest, with a calibrated radiocarbon date of AD 884 (1190 ± 15 BP, OxCal 4.3.2 AD 775-884 [95.4%]). The midden excavation took place over two summers and covered nearly the entire identified midden (Catlin et al. 2017, 2018). Based on tephrochronology, it spans the Viking Age (ca. AD 870-1104), though we believe it was abandoned before AD 1104, perhaps as early as AD 1000 (Catlin et al. 2017, 2018; Cesario 2018a), since all of the material comes from well below the H1104 tephra. The *landnám* tephra was clearly visible at the bottom of the excavation units, but no other tephra layers were reliably observed in the unit until the H1104 tephra that capped the cultural layers.

Figure 3.2. Kotið and the surrounding landscape, looking north. The midden excavation is located roughly within the red rectangle. Drone photo by John Schoenfelder for SCASS 2016, used with permission.

The only architectural ruins that have been recorded at Kotið are more recent and relate to animal husbandry rather than human occupation. A two-room structure roughly 14x5 m has been interpreted as a *stekkur*, or a weaning pen (Figure 3.3), and coring results of the structural turf contained the H1104 tephra, giving the structure a post-1104 date (Catlin et al. 2017:41, 2018). Hjalti Pálsson reported that other ruins may have been destroyed when the field was used for haymaking, but also suggested that Kotið was only ever a sheep house and never a human dwelling place (Pálsson 2010:169). However, the research undertaken by SCASS, FLASH (see especially

Catlin 2019), and MARSH has uncovered a domestic midden that confirms a pre-1104 human habitation.

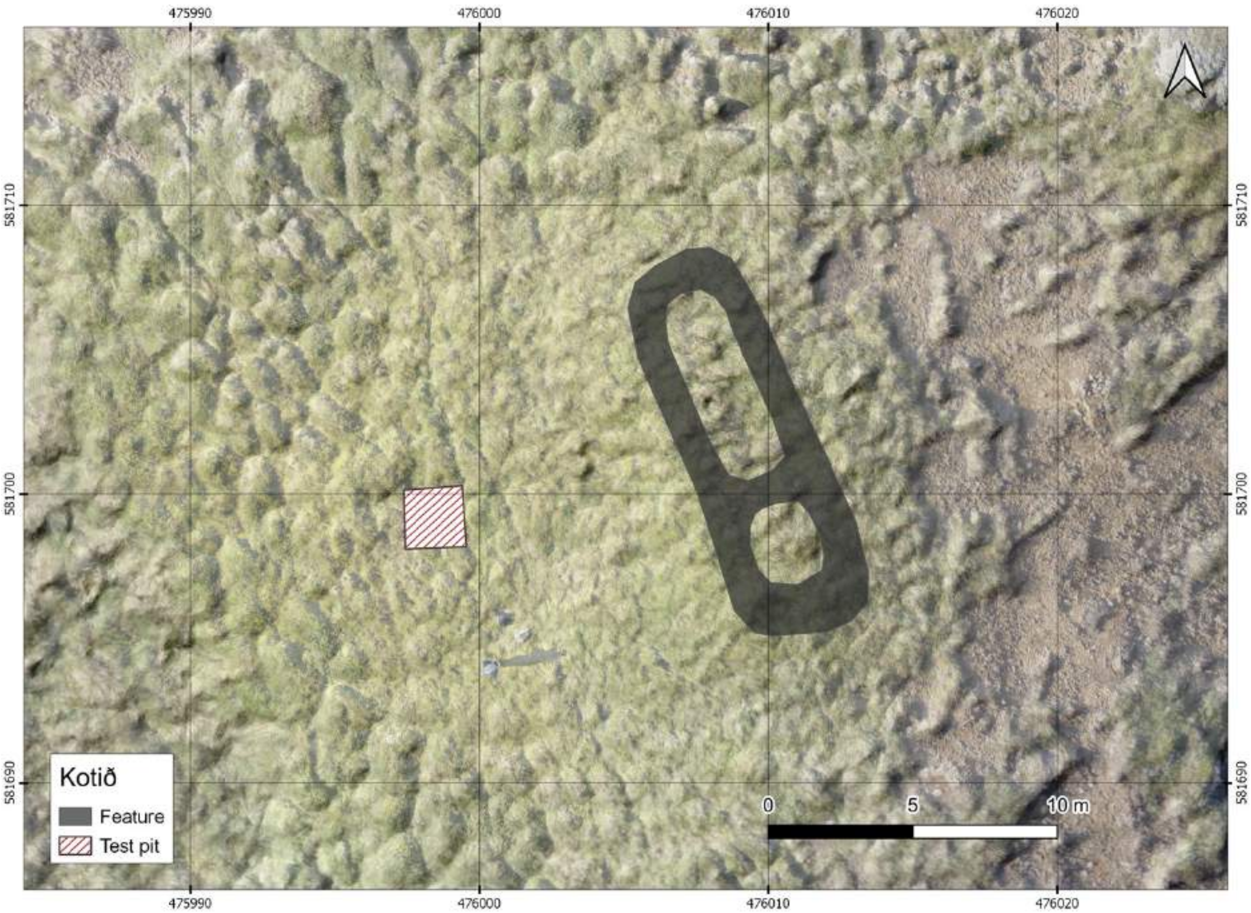

Figure 3.3. Overview of Kotið showing both the test pit and the outline of the *stekkur*. Survey data by Kathryn Catlin for SCASS and Bryndís Zoëga for Byggðasafn Skagfirðinga. Map by Gunnar Grímsson.

Grænagerði

Grænagerði is south of the modern farm of Helluland and also used to be part of their landholdings; however, now it is an independent property called Hulduland (Figure 3.1, Figure 3.4). It may be the same site that is called Lýsukot in historical sources (Pálsson 2010:168-169) and is the second smallest farmstead to be discussed here, with a size of 0.0465 ha (465 m^2) (Catlin 2019:111). There are architectural features that can be seen on the surface and which were cored to determine construction and use dates (Figure 3.5). Another two-roomed *stekkur*, larger than the one at Kotið at 23x5.5 m, is present at Grænagerði. Coring showed turf with the AD 1300 Hekla tephra in it, indicating that the structure was built and used after that date (Catlin et al. 2018:68). Catlin also notes a possible *skáli* (longhouse) and a ring-shaped structure on the hillside at Grænagerði (Catlin et al. 2018:68).

Figure 3.4. Landscape surrounding Grænagerði, facing roughly north. The excavation unit is in the red rectangle. Drone photo by John Schoenfelder for SCASS 2017, used with permission.

Similar to the other sites discussed here, Grænagerði was no longer occupied by people after AD 1104. The architectural remains, especially the *stekkur*, do suggest that people returned to the site for animal husbandry and related activities.

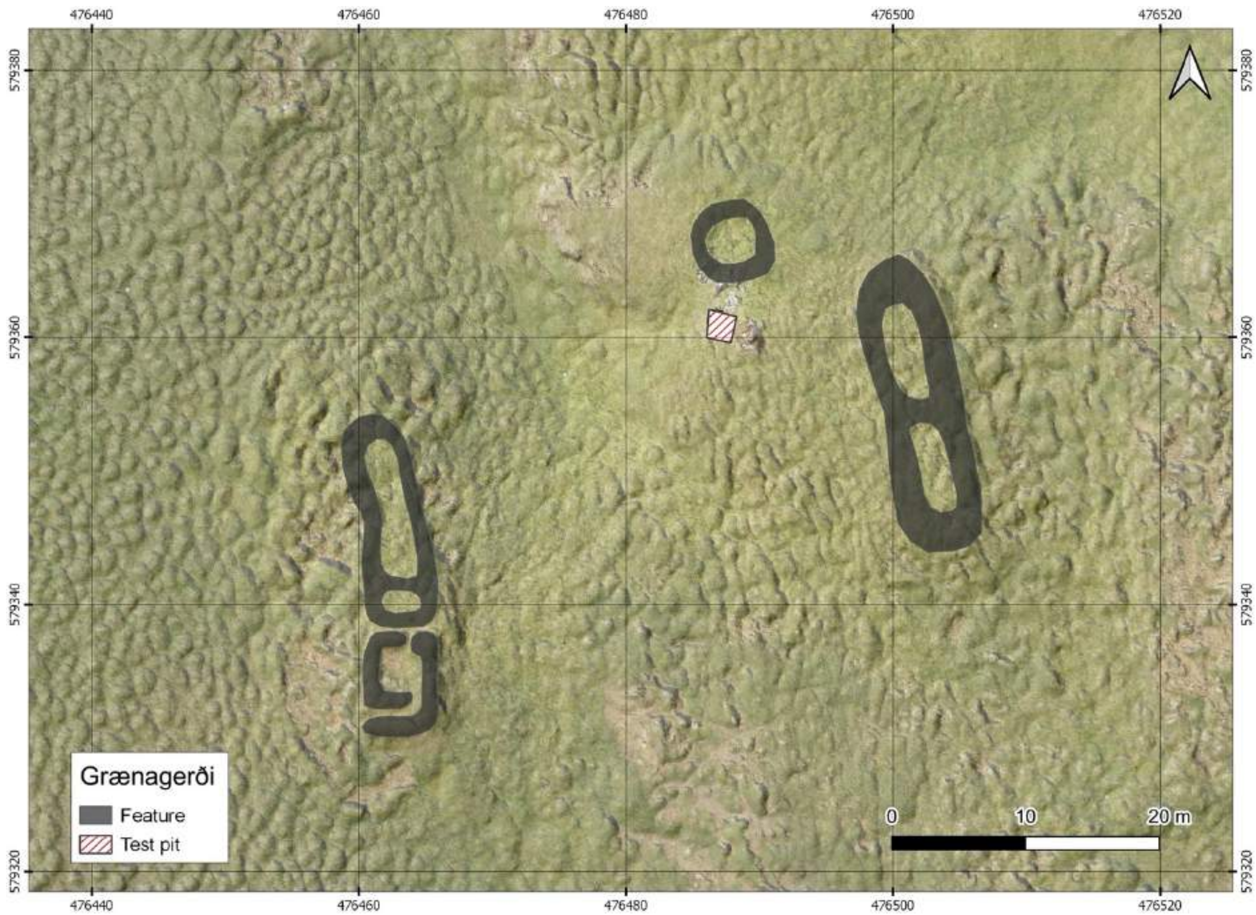

Figure 3.5. Overview of Grænagerði showing the test pit (TP2) and three architectural ruins. The two-roomed *stekkur* is to the left, and the possible *skáli* and ring-shaped structure are on the right, near the test pit. Survey data by Kathryn Catlin for SCASS and Bryndís Zoëga for Byggðasafn Skagfirðinga. Map by Gunnar Grímsson.

Næfurstaðir

Næfurstaðir is located on the property of the modern farm Ás (Figure 3.1, Figure 3.6). It is west of the medieval farm (Catlin et al. 2017:12) and has two visible architectural ruins (Figure 3.7). One is likely a *stekkur* (22x9 m) and the other is a one-roomed structure 8x7 m in size (Catlin et al. 2018:23). These appear to have been used post-1104 AD and in some cases even later—turf observed in the cores usually contained at least one later tephra layer. The Jarðabók 1713 tells us the old name of the site, Hafurstaðir (*hafur* meaning billy-goat), which suggests that the site may have had goats at some point (Catlin et al. 2017, 2018; Magnússon and Vídalín 1930; Pálsson 2010:58-59) though no goats were found in the analysis of the archaeofauna (Cesario 2019b). It is the largest of the abandoned sites, with a pre-AD 1104 farmstead size of 1967 m^2 (Catlin 2019:111).

Figure 3.6. View of Næfurstaðir during excavation in 2018, facing south. The drained fields of modern Ás are on the left side of the image, the excavation unit is in the red rectangle and measured 2x2 m at the time the photo was taken. The semi-circular feature highlighted by the yellow arrow is an enclosure wall, dated post-1104 based on the presence of H1104 tephra in the turf. Drone photo by SCASS 2018, used with permission.

The site was out of intensive use by AD 1104, though there is some evidence of cultural material accumulating after the deposition of H1104 (Catlin et al. 2017:17, 2018:27; Cesario 2019). We excavated at Næfurstaðir over two years, 2016 and 2018. The *landnám* tephra was clearly visible at the bottom of the excavation units, as were other tephra layers throughout the test pits (Catlin et al. 2017, 2018; Cesario 2018b). In some cases, animal bones were pressed directly into the *landnám* surface. The white H1104 tephra marked the time when the majority of the human occupation activity at the site ceased.

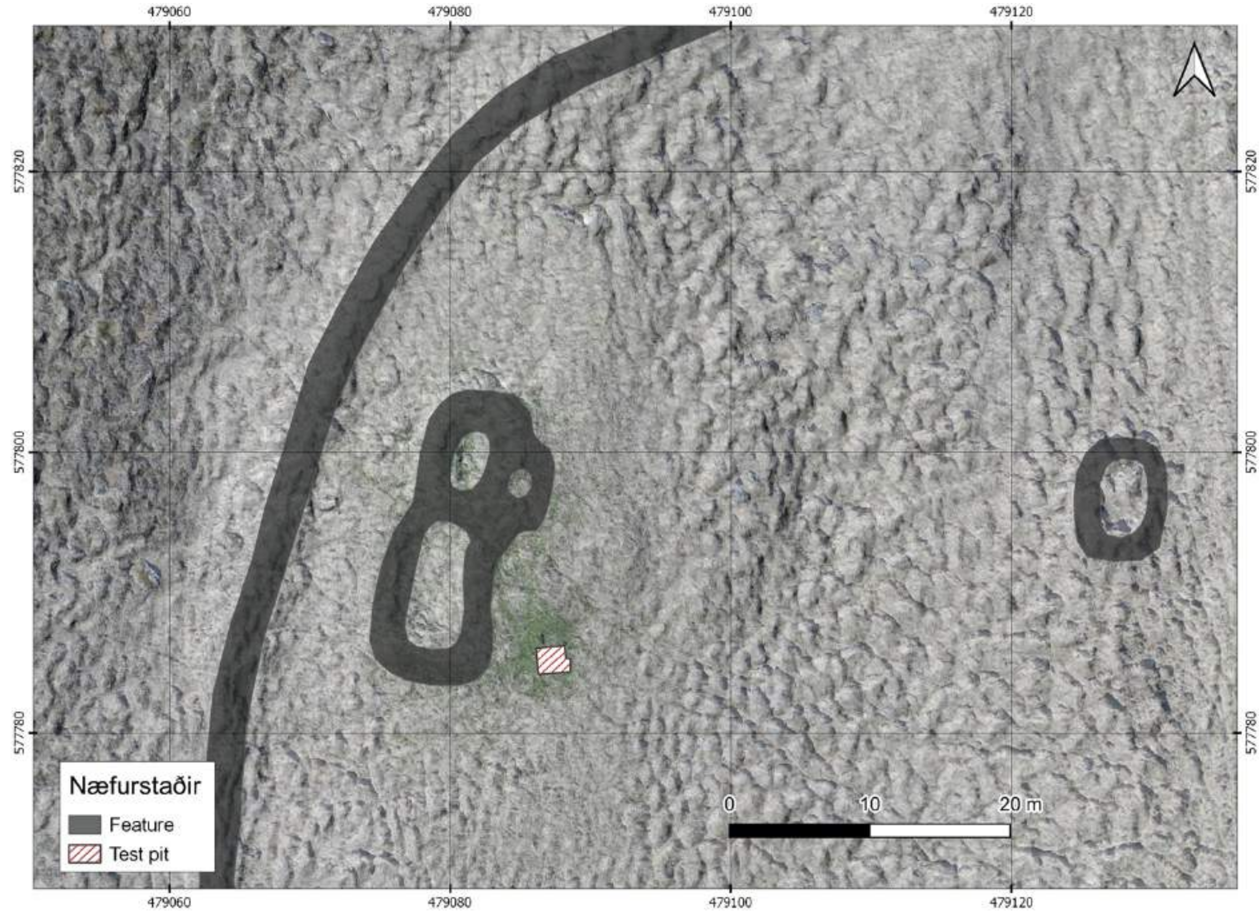

Figure 3.7. Overview of Næfurstaðir, showing both the test pit (TP2) and architectural ruins. All ruins are later than AD 1104 based on tephra from the cores. Survey data by Kathryn Catlin for SCASS and Bryndís Zoëga for Byggðasafn Skagfirðinga. Map by Gunnar Grímsson.

Vatnskot

Vatnskot is the only farmstead in this dissertation that is currently part of an occupied settlement (Figure 3.1, Figure 3.8). The historic farm was named Vatnskot in the 16th century, but it is likely the same as the earlier farm called Vatn (Bolender et al. 2018:20). It was separated into two farms—Svanavatn and Hegrabjarg—in AD 1937 (Bolender et al. 2018:20; Pálsson 2010:64). The actual site that was excavated as part of this dissertation research is located on modern-day Svanavatn. Documentary evidence suggests that historic Vatnskot was abandoned in the late 15th or early 16th centuries (Bolender et al. 2018:20).

Figure 3.8. Landscape surrounding Vatnskot. The excavation unit is inside the red rectangle. The lake can be seen at the top left of the image and the modern farmhouse is in the lower center. Drone photo by John Schoenfelder for SCASS 2016, used with permission.

There is a lake associated with Vatnskot, which is where the name comes from (*vatn* being Icelandic for water or lake). Sediment cores from the lake show that it has existed for at least 9000 years (Hallsdóttir 1996), and, at least in modern times, the lake supports two kinds of fish—Arctic char (*Salvelinus alpinus*, Icel. *bleikja*) and three-spined stickleback (*Gasterosteus aculeatus*, Icel. *hornsíli*) (LENDIS 2009). While the site of Vatnskot is located on the property of an active farm, the midden we excavated was no longer used after the deposition of the H1300 tephra. After this time, it seems that the farmstead was relocated north.

Table 3.1. The four dissertation sites and some of their attributes for comparison.

Site	Abandoned?	Pre-1104 Farmstead Size (m^2)	Excavated Area (m)	Viking Age Liters excavated
Kotið	Yes	158	4	1390
Grænagerði	Yes	465	4	1853
Næfurstaðir	Yes	1967	6	1323
Vatnskot	No	3539	4	2326

History of Zooarchaeology in Iceland

Zooarchaeological research in Iceland started in the late 19th century. Daniel Bruun, along with Finnur Jónsson in the early 20th century, often collected animal bones from their excavations in Iceland (Bruun 1899; Bruun and Jónsson 1909; Jónsson and Bruun 1911). The first zooarchaeological report on these bones comes from their work at Hofstaðir and is written by Herluf Winge from the University of Copenhagen Zoological Museum (Winge in Bruun and Jónsson 1909:291-292; see also McGovern et al. 2007:32; Smiarowski et al. 2017). This report is quite short and does not go into much detail. It mainly lists the species present and which bones were identified, with very little analysis or other comments, though he does mention that the cows (*Bos taurus*) are a small breed ("*Racen ret lille*;" in Bruun and Jónsson 1909:291) and that the condition of the bones is just like those from other settlements in the Middle Ages ("*Knoglernes Tilstand er ganske som i andre Boplads-Aflejringer fra Middelalderen*;" in Bruun and Jónsson 1909:292), though he does not specify what other settlements he means.

Later in the 20th century, Magnus Degerbøl, also of the University of Copenhagen Zoological Museum, continued to work on animal bone collections from Iceland (and Greenland). Again though, he did not do much interpretation and instead simply listed bones by species, as did many other zooarchaeologists of the time (McGovern et al. 2017:30). He also seems to have subjectively listed species abundances, saying only "'very common' or 'fairly rarely seen'" (McGovern et al. 2017:30). Of course, this information is better than nothing; however, as McGovern et al.

(2017:30) discuss, this kind of recording actually created more work for future researchers in order to make comparisons with other sites.

Since the 1970s, there has been a huge uptick in zooarchaeological research in Iceland, and in the North Atlantic as a whole. Much of this work can be attributed to the efforts of the North Atlantic Biocultural Organization (NABO). Not only did the work benefit from more standardized excavation and collection strategies (sieving, single-context excavation), but the introduction and spread of radiocarbon dating allowed better phasing and thus better understanding of the patterns shown in the archaeofauna over time (Smiarowski et al. 2017).

The work over the last three or so decades has studied a variety of sites, from small single-use sites to large feasting halls, and from one site in an area to multiple sites in a region. Landscape-scaled regional projects have become quite common in Iceland, and zooarchaeology often plays a large role in these types of studies (see for example Byock et al. 2005; Gísladóttir et al. 2013; Harrison 2010, 2013; Hicks 2014, 2019; McGovern et al. 2007; Woollett 2008). Indeed, animal remains are by far the most numerous finds at sites in Iceland, with material culture (iron items, glass beads, bone implements, etc.) often present, but in small numbers. Figure 3.9 shows the locations of many zooarchaeological collections in Iceland, but it not an exhaustive list, it is merely meant to illustrate the general distribution of zooarchaeological studies that have taken place in Iceland. Many of the zooarchaeological assemblages are from sites located in the northern part of the country, though this is likely due to fieldwork priorities rather than a lack of archaeofauna in the south. In addition, the map in Figure 3.9 makes it seem like there are many zooarchaeological projects in Skagafjörður; however, only three of those projects pre-date my analyses and the rest are from my research that has been added since 2015 (see Figure 5.1 in Chapter 5 for a closer view of Skagafjörður and distinction between sites).

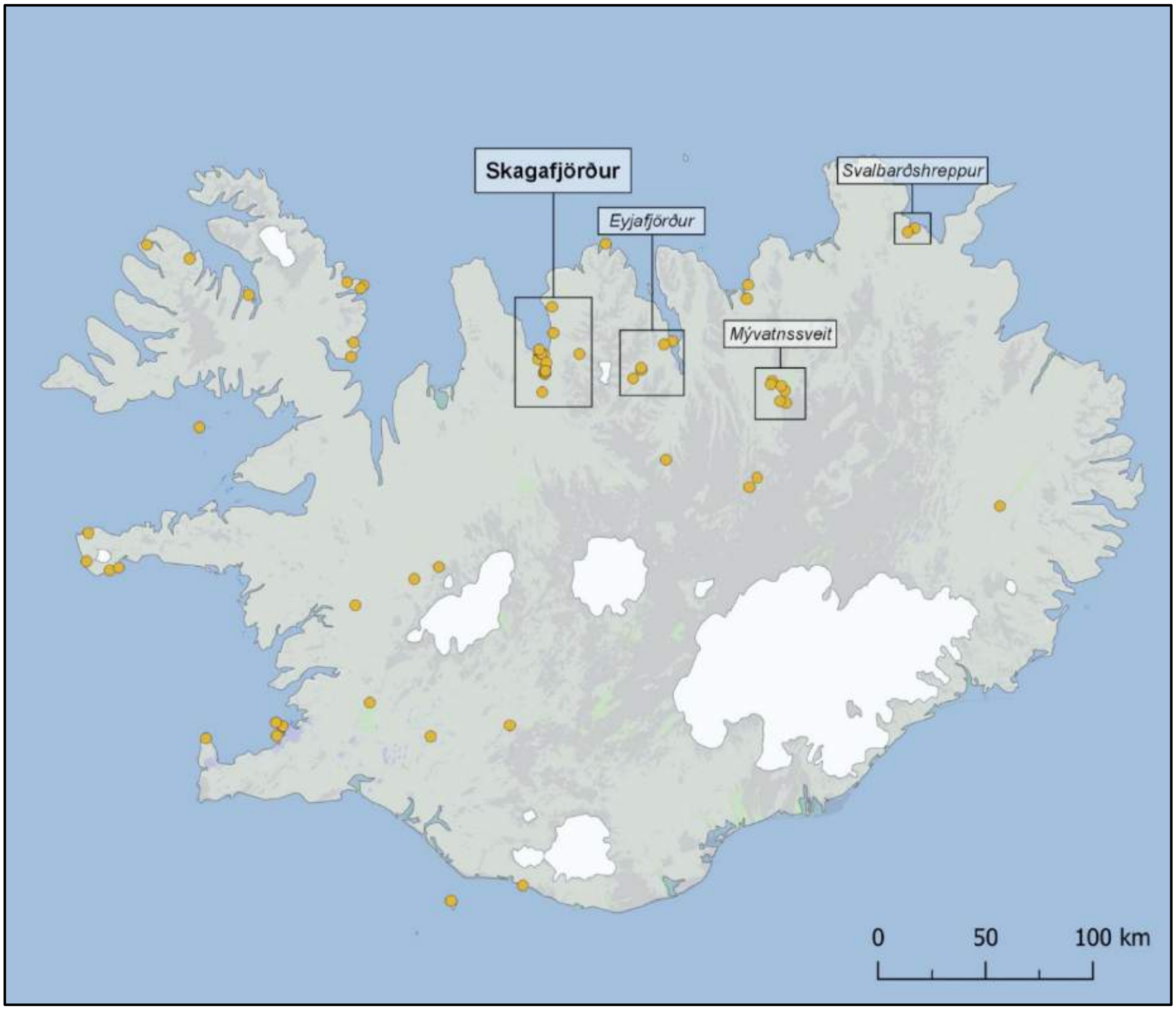

Figure 3.9. Locations of projects involving zooarchaeology. This is not an exhaustive list of all zooarchaeological collections in Iceland. The boxes represent regions where major landscape-scaled projects have taken place and areas which will be points of comparison in this dissertation. Map by Gunnar Grímsson.

Below, I will discuss a few regions where zooarchaeology has played a large role in landscape-scaled research projects over the last decades (those in the boxes in Figure 3.9). Landscape-scaled research projects provide a great deal of information and allow for a regional comparative approach that can help to understand broader patterns across Iceland. By placing the MARSH research in context with these other regional projects, I will show how this project not only fits into the established and still growing research trend of zooarchaeology in Iceland, but also adds new information on the range of settlement strategies and adaptations that have previously not been observed.

Regional Comparisons

One of the regions that has been extensively surveyed and excavated since 1992 is Mývatnssveit (e.g., Hicks et al. 2016; McGovern et al. 2007; Sayle et al. 2013). The projects undertaken in the region have led to detailed survey of the abandoned and occupied sites, and built up a robust data set on the long term regional settlement pattern (McGovern et al. 2007). Zooarchaeological research has been important in these investigations in order to understand paleoeconomy and change over time (Brewington et al. 2004; Hicks 2014, 2010; McGovern 2004, 2009; McGovern et al. 2016; McGovern and Perdikaris 2003). Settlement began in Mývatnssveit before AD 940, with some sites showing clear evidence of settlement very soon after the deposition of the *landnám* tephra layer. It has been argued that settlement in Mývatnssveit took place quickly, in about 20 years or less (Vésteinsson and McGovern 2012:215). There is a pattern of widespread abandonment of settlement sites before AD 940 and also in the 13th and early 14th centuries, perhaps due to changes in landscape management patterns or depopulation. This pattern of abandonment is similar to what we have recorded on Hegranes, as discussed above, raising the possibility that this change is driven by similar processes.

Another well-studied region is Svalbarðshreppur, in Þistilfjörður, northeast Iceland. Svalbarðshreppur offers a unique view into a location where farming is very sensitive to climatic influences because of the cool temperatures, short growing seasons and their impacts on grazing and fodder production. Farms in this area broadened their animal use to include many wild species, such as seals and cetaceans, that usually do not make up large portions of the Icelandic subsistence package (e.g., Dupont-Hébert 2013, 2017, 2020; Woollett 2008). Archaeological work in

Svalbarðshreppur began in 1986, when the major farm of Svalbarð, which acted as a central manager of the region, was revealed to have deeply stratified midden deposits easily accessible to archaeologists (Woollett 2008). Archaeological work has continued to the present day (Gísladóttir et al. 2013, 2014; Olafsson et al. 2013). Various economic strategies were practiced in Svalbarðshreppur, including traditional farming but also seal hunting, seabird use, and fishing (Woollett 2008), making a nice comparison with the wild resource use on Hegranes. Recent research at the Svalbarð farm proper has focused on its outlying sites, such as shielings and other specialized sites, in order to understand all of the activities that relate to resource use (Gísladóttir et al. 2014). This refocusing has allowed researchers to understand the social history of the farm and of the area as a whole, enabling an understanding of relationships between large farms and their smaller, often dependent, outposts. Furthermore, study of the smaller outlying sites, as also done by this dissertation, allows the examination of the development of more marginal economies, and in the case of Svalbarðshreppur, of the rural northeast coast of Iceland (e.g., Gísladóttir et al. 2014:7).

Eyjafjörður lies immediately to the east of Skagafjörður, and survey there has included coring and test pitting over the entire region, with larger excavations at various sites of different sizes and social standing. The farmland is relatively rich compared to Svalbarðshreppur and Mývatn, making the land more productive. This access to better land allowed the powerful chieftain families to thrive and is a major point of comparison with Skagafjörður as a region, where productive land and powerful families also played a major role in the creation of a cultural landscape. Eyjafjörður is home to the monastic center of Möðruvellir, which is still an active religious site today, with a local priest still holding mass and living on site; Skagafjörður is home to Hólar, the northern bishop’s See that still operates today. There are medieval trading sites in both regions—Gásir in Eyjafjörður and Kolkuós in Skagafjörður. The Gásir Hinterlands Project (GHP; Harrison 2013; Harrison et al. 2008) explored long-term human ecodynamics and historical ecology in Eyjafjörður beginning at settlement and going through to the present (Harrison 2008). The GHP also explored the settlement history and interactions between humans and their environment, juxtaposing low status and high status sites in different locations (Harrison 2010:7). This is similar to the work that has been done in Skagafjörður and makes for a useful point of comparison.

Chapter Summary

This chapter described the research and field projects that guided the creation of the dissertation project. By combining data from both SCASS, which focused on large wealthy farms, and FLASH, which studied abandoned marginal dwellings, MARSH is able to facilitate comparisons of economic strategies at sites of different status. The four MARSH sites represent a range of sizes and ultimate trajectories—Vatnskot persisted to the present and is a currently active farm, while the other three were abandoned by the end of the Viking Age.

A history of zooarchaeology in Iceland shows that it has been a research subject for over a century. Of course, methodological improvements have been made in the time since Daniel Bruun's early excavations, and the NABO cooperative has increased visibility and comparability of zooarchaeological data. A survey of three regions in northern Iceland that have contemporaneous archaeofauna demonstrate the variation in research questions, fieldwork priorities, landscape use, and economic strategies. Sites in these regions will act as broader comparatives throughout the rest of this dissertation in order to understand how the economic strategies at the MARSH sites fit into the overall picture of animal resource use in Iceland. This also brings Skagafjörður into the conversation of early settlement strategies informed by zooarchaeology.

Chapter 4. Methods

This chapter will describe the methods used in both excavation and analysis of the archaeofauna from the four sites. It will begin with a summary of the excavations carried out on Hegranes over the four years of the larger SCASS project, from 2015-2018. Then, I will discuss the post-excavation lab methods for faunal analysis.

Survey and Excavation Methods

SCASS utilized pedestrian survey, geophysical techniques, coring, and small, targeted excavations to gather data on all the sites in the region. We also made extensive use of previously published survey data about the location of farms, ruins, and old buildings (especially Pálsson 2010), which helped target our efforts in the field. The main data points collected were the establishment date of a dwelling site, the size and how it fluctuated over time, and the presence and date of other structures, including churchyards in some cases. Test excavations also collected macrobotanical samples, faunal remains, and finds.

Coring generally followed 10 m spacing in areas within the homefield wall (near the farm mound or other farm structures), and 50 m in the fields, unless cultural material was discovered. A JMC Backsaver core was used most frequently and can reach a depth of 120 cm, though many deposits were shallower than this. Other, larger cores were used in deep farm mounds where the JMC could not penetrate far enough to get a picture of the entire mound. The coring protocol has been refined over many years of research in Skagafjörður (Catlin 2011; Johnson 2015; Steinberg, Bolender, et al. 2016). Coring focused on recording evidence of cultural material—bones/shells, charcoal, peat/wood ash—and tephra layers in order to date the deposits. Geophysical techniques included GPR and remote sensing and was done primarily by Brian Damiata from UCLA.

Test pit excavations followed a single-context excavation strategy based on Lucas (2003), which is also widely used throughout archaeological excavations in Iceland. Coring helped narrow down the areas for these pits, targeting the deepest parts of the midden that also had the most tephra layers present. SCASS protocol dictates that all test pits be 1x1 m to begin with—just large enough to get a snapshot of the age of the farm and the activities taking place on it. However, the MARSH sites proved to have dense bone concentrations and good preservation, so their test pits were expanded further to increase the size of the archaeofauna for analysis.

For all test pits, all soil was sieved through 4 mm mesh, and where the soils were too wet or sticky to fully push through the sieve, anything left in the screen was collected and then wet screened (again through 4mm mesh) to ensure a non-biased sample. This methodology is quite standard for archaeological excavations in Iceland, so the data collected from the MARSH/SCASS excavations are comparable to other excavated sites. SCASS also collected soil samples from all contexts below the AD 1300 Hekla tephra layer for flotation. The goal of flotation was to find macrobotanical remains in order to help reconstruct the past landscape (Ritchey 2019), and SCASS has also found it more reliable to radiocarbon date carbonized seeds rather than animal bone. All heavy fraction has been screened for animal bones, so the archaeofauna have not been biased by this sampling strategy.

What follows is a short description of the excavations of the MARSH sites over three field seasons. For all excavations discussed below, profiles, thorough context discussions, photos, finds, and more can be found in the excavation reports (Catlin et al. 2017, 2018; Cesario 2018b; Cesario and Ritchey 2018; Ritchey and Cesario 2018; see also Appendix B).

2016 Excavations

During the 2016 field season, as part of her dissertation research, Kathryn Catlin excavated test pits at two abandoned sites, Kotið and Næfurstaðir (Catlin et al. 2017). As her project was not focused on collecting large archaeofaunal samples, the test pits conformed to SCASS standards and were 1x1 m. All contexts were sieved and animal bones collected, along with finds, including a carved bone pin (Figure 4.1). Samples were taken for flotation, but bones were immediately picked out of the samples if they were visible, and the heavy fraction was examined for animal remains. Faunal remains were sent to Hunter College from these sites, as well as the others excavated during the same field season. Identification took place from the fall of 2016 through spring 2017. Reports on the faunal material from all sites are available on the NABO website and in Appendix A and the raw numbers are included in Chapter 5 of this dissertation (Cesario 2018c, 2018a, 2019b).

Figure 4.1. Bone pin from Kotið. Photo by conservator Josiah Wagener for SCASS, used with permission.

2017 Excavations

After analyzing the 2016 material and discovering its potential for a full research project, some of the excavations in 2017 were targeted specifically for MARSH. Kathryn Catlin and I went back to Kotið and continued the excavation there, using the old 1x1 m pit as the NE corner of the new 2x2 m excavation unit (Catlin et al. 2018). Since Kotið is such a small site, estimated at 145-158 m^2 (Catlin 2019:111), we believe that the final 2x2 m unit encompassed nearly the entire midden.

Two other test pits were opened in 2017 at new sites where we did not know the archaeofaunal potential. Catlin opened a 1x1 m unit at Grænagerði for her dissertation project (Catlin et al. 2018), and I was in charge of the excavation at Vatnskot, originally placed to determine the establishment date of the farm. This excavation began as a 1x1 m test pit; however, the bone preservation was very good and the midden was relatively dense, so I made the decision to expand the unit one meter to the south and create a 1x2 m trench (Bolender et al. 2018a:22). Including Vatnskot into the study was important, as it is a modern farm that was not abandoned like the other three sites. Thus, it would allow for a better understanding of the kinds of activities taking place at a broader range of site types and statuses. Another bone pin was found during the Vatnskot excavation (Figure 4.2).

Macrobotanical samples were taken from all test pits and finds were conserved in the field and sent to the National Museum of Iceland for final curation. Again, the faunal samples were sent to Hunter College where I completed the analysis in spring 2018.

Figure 4.2. Bone pin from Vatnskot. Photo by the author.

2018 Excavations

This was our last year of the project, and most of the work was “clean up” work where we filled in gaps in our coring survey and excavation and went back to sites where we needed better data. After completing analysis from all prior years, I wanted to return to three sites that had exceptional preservation, were noted to have dense middens during excavation, and, importantly, likely represented at least two different site types. These were Grænagerði, Vatnskot, and Næfurstaðir. Macrobotantical data from these sites were also used in a master’s project (Ritchey 2019), and more samples were needed to complete this work as well.

Grænagerði was first expanded to a 1x2 m unit for Ritchey’s project, placing a new 1x1 m directly south of the original test pit. However, when I saw the amount of bone coming out of the new test pit, I chose to excavate another two meters to the east, making the total excavation 2x2 m. After this, we returned to Vatnskot and placed a 1x2 m trench, running north-south, directly to the west of the previous year’s 1x2 m. Finally, we went to Næfurstaðir and, using the old 1x1 m pit as the SE corner of the new unit, expanded the excavation to a 2x2 m excavation. The midden was not quite as dense as I had hoped, so I expanded the excavation to add another 1x2 m to the west, making the total excavation area 3x2 m.

Dating and Phasing

Tephrochronology

Archaeological dating in most areas of Iceland is aided by tephrochronology. This dating method makes use of layers of volcanic ash, or tephra (Dugmore et al. 2009:3; Þórarinsson 1944:204). These layers are the products of explosive volcanic eruptions, and the tephra, primarily composed of shards of volcanic glass and small pieces of pumice, can be geochemically analyzed to identify the source volcano and eruption date. Correlation to the well-known volcanic history of Iceland allows dates to be applied that have been derived from written records, correlation to ice core records, or ages inferred from the interpolation of high resolution sediment accumulation rates or use of annually laminated sediments (Boygle 1999; Larsen 1984; Larsen et al. 1999; Þórarinsson 1967, 1958, 1981). Where these layers are present and well-documented, it can be easy to identify them in the field using the size and shape of the grains and the color and thickness of the layer (Boygle 1999:131). Thus, archaeologists can know where in time their sites fall while they are digging.

In Skagafjörður, there are five common identifiable historic tephra layers that help us date our sites. Many of these layers also coincide quite well with major historic events. These tephras are described in Table 4.1 below, along with their historic events. The dating and source for the tephra we called “1000” in the field have not yet been confirmed, but one potential candidate falls around AD 978/979. With the standard deviation, AD 1000 still falls within the possible time frame for this tephra layer, so the field designation is still used in this dissertation to split the two phases of the settlement period.

Table 4.1. Description of tephra layers found in Skagafjörður and the historic events that surround them.

Tephra	Description/Notes	Historic Event	References
Hekla 1766	Black and grainy tephra layer		Larsen et al. 1999; Þórarinsson 1967; Þórarinsson and Sigvaldason 1972
Hekla 1300	Blue-grey	-After Iceland is brought under Norwegian control (AD 1264) -During the Sturlung Age (civil war) -Beginning of the Little Ice Age	Larsen et al. 1999, 2002; Sveinbjarnardóttir 1992; Þórarinsson 1967
Hekla 1104	-White, yellowish white -Most ubiquitous tephra layer in Skagafjörður and very easily recognizable	Bracketed by the introduction of the tithe law in AD 1096 and the establishment of the bishopric at Hólar in AD 1106	Eiríksson et al. 2000; Larsen et al. 1999; Thompson et al. 1986; Þórarinsson 1967
~1000	-Blue-black to black -One potential date is AD 978/979, but is still uncertain so the field designation of 1000 will be used throughout this dissertation	Iceland converts to Christianity	Boygle 1999; Wastegård et al. 2003
Veiðivötn 877 +/- 1 "*Landnám* layer" or "*Landnám* sequence"	-Olive green -In the south, there is a lighter colored layer below the olive green (not visible in the north) -Sequence also often includes a thick, dark, organic layer underneath the tephra	Coincides with the earliest settlements on the island, hence its name which means land-taking	Boygle 1999; Schmid, Zori, et al. 2017; Schmid, Dugmore, et al. 2017; Wastegård et al. 2003

Radiocarbon Dating

In order to confirm the tephra dates and perhaps even get tighter phasing, we have sent carbonized seeds for radiocarbon dating by Brian Damiata at the Keck Laboratory at the University of California, Irvine. Where the seeds have not successfully produced dates, or where the dates are questionable (based on tephra, finds encountered during excavation, etc.), animal bone was tested.

We aimed to only date bones from cattle, as sheep have a wider diet and have been ethnographically recorded eating seaweed in parts of the North Atlantic (see for example Balasse et al. 2005). This would throw off the radiocarbon dates due to the marine reservoir effect (Ascough et al. 2006, 2007), and was avoided as often as possible.

Phases for the Purposes of this Dissertation

While historians have described various periods during Iceland's history based on local developments like political, social, and economic events, these are not always visible archaeologically (Edvardsson 2010:268). Traditionally, the period of settlement, called *Landnámsöld*, or simply *landnám* (land-taking), lasted from AD 870-930. By AD 930, historical sources say that most of the land had been claimed and settlement was complete; this is primarily based on the account of Ari Þorgilsson (Ari the Learned) in *Íslendingabók* (Book of the Icelanders) where he claims that "*Svá hafa ok spakir menn sagt, at á sex tigum vetra yrði Ísland albyggt, svá at eigi væri meir síðan*" (Jónsson 1953:5) ("Wise men have also said that Iceland was fully settled in sixty years, so that no further settlement was made after that" (Grønlie 2006:5)). The establishment of the national assembly (*Alþingi*) also took place in AD 930, bringing the country into the period known as the Commonwealth. Following this, Iceland fell under Norwegian rule in AD 1264. These first 400 or so years include other notable events, like the transition to Christianity in AD 1000, the introduction of the tithe law in AD 1096, the civil war during the *Sturlungaöld* (Sturlung Age) around AD 1180-1264 (Karlsson 2000:79–82), and the establishment of two episcopal Sees—Skálholt in AD 1056 and Hólar in AD 1106 (e.g., Karlsson 2000:38).

However, as Edvardsson (2010:268) notes, archaeologists have tried to use these historical periods in the explanations of their site's activities and changes over time, but these broader periods do not quite capture the changes seen in the archaeological record. Indeed, he mentions that "more and more archaeologists are becoming aware of the problem as they are identifying political, economic, etc. changes in the archaeological record that do not correspond with the historical sources" (e.g., Dugmore and Erskine 1994; Edvardsson 2010:268; Einarsson 1995; Vésteinsson 2002). For example, we now know that the AD 930 date for land claims and complete filling of the island was not actually the case. In fact, it seems that new people continued to move to Iceland at least until AD 1000 (Price and Gestsdóttir 2014), abandon and reuse areas, and create new farms (Bolender et al. 2011; Catlin 2019; Steinberg, Bolender, et al. 2016; Sveinbjarnardóttir 1992; Vésteinsson et al. 2014) much later than the traditional end of the "settlement" period in AD 930.

Therefore, the phasing in this dissertation is only loosely based on the historical periodization. It follows Edvardsson's (2010) argument that periods should be identified and divided based on the archaeology, rather than just historical documentation and historians' periodization. The two time periods that are the focus here are split based on tephra layers, as these still give constrained time periods, and there are differences that can be seen archaeologically to differentiate between phases. Broadly, the "Viking Age" encompasses the entire period from roughly AD 870 to 1104, based on the *landnám* tephra and the white silicic AD H1104 tephra. This is further broken down into "early Viking Age" and "late Viking Age," AD 870-1000, and AD 1000-1104, respectively, based on the AD 1000 tephra layer. Of the two tephra layers, the H1104 layer is the most common and is present at nearly every site excavated as part of SCASS.

On Hegranes, the whole of the Viking Age period (AD 870-1104) is characterized by settlement processes like the establishment of new occupational sites, abandonment of habitation sites, moving farm locations, and site size fluctuations over time. This is true also in neighboring Langholt (Steinberg, Bolender, et al. 2016), where establishment of new farms continues through the 10th century. Only after AD 1104 do things seem to stabilize in these two regions, marking the end of one period (*landnám*) and the beginning of the next (the Medieval Period). These divisions allow us to see what the earliest settlers did and how they may have had to modify their behaviors after the initial settlement.

Lab Methods and Identification

Analysis of the archaeofauna from Hegranes took place primarily in the Hunter College Zooarchaeology Laboratory and made use of the comparative collection there. The 2018 material was analyzed in Iceland at Fornleifastofnun Íslands (Archaeological Institute of Iceland) and Landbúnaðarháskóli Íslands (Agricultural University of Iceland), and also made use of the bird collection at Náttúrufræðistofnun Íslands (the Natural History Museum).

The approach to identification, analysis, and reporting is the standard NABONE methodology for all archaeofaunal collections (e.g., Brewington 2015; Brewington et al. 2004; Feeley et al. 2010; Harrison 2008; McGovern 2009). This standardized methodology allows for greater comparability between analysts and sites in Iceland and across the North Atlantic and will be explained further below. These protocols utilize the 9th edition of the NABONE recording package, a Microsoft Access database supplemented with specialized Microsoft Excel spreadsheets (available to download at www.nabohome.org). Digital records are all made using this package and will be preserved according to NSF policies on data curation and sharing. The animal bones excavated during this research will be permanently curated at the National Museum of Iceland, along with copies of all paper and digital records.

During analysis, all fragments were identified as far as taxonomically possible, and a selected element approach was not used. The only exception is that most mammal ribs, vertebrae, and long bone shaft fragments are assigned to size categories—large terrestrial mammal (cattle- or horse-sized), medium terrestrial mammal (sheep/goat-, pig-, or large dog-sized), or small terrestrial mammal (fox- or small dog-sized). Fish identification follows the most current ICAZ Fish Remains Working Group recommendations, and only positively identified fragments of fish bone are given species level identification. Those fragments that are unidentifiable to species were lumped into the family category where possible, often *gadid*, while others were identified simply as "fish."

Following widespread North Atlantic and NABONE tradition, bone fragment quantification makes use of the Number of Identified Specimens (NISP) method (Grayson 1984). Total Number of Fragments (TNF) is also recorded and includes both identified and unidentified bone fragments. Minimum Animal Units (MAU and %MAU) are used when it is necessary to correct for different frequencies of elements in a skeleton (Grayson 1984), most commonly used in this dissertation for fish, caprines, and cattle. NABO standards for sample size are at least 300 NISP for collections that are mostly made up of domesticates, and at least 1000 NISP for fish-rich collections. This allows for interpretations of patterns that more likely reflect actual use, rather than false patterns created by small sample sizes. The MARSH sites discussed here fall within these parameters.

Sheep (*Ovis aries*) and goat (*Capra hircus*) bones can be difficult to differentiate, so only those elements that could be positively identified to species are assigned to those categories. All other sheep/goat elements are assigned to a more general "caprine" category that might include both sheep and goats. Sheep/goat distinctions follow Boessneck (1969), Mainland and Halstead (2005), and Zeder and Lapham (2010).

All mammal measurements follow von den Driesch (1976) and fish measurements follow Wheeler and Jones (1976). Fish metrics, including actual measurements and live size reconstruction formulas, can be found in Appendix C. Tooth wear studies follow Grant (1982), Lemoine et al. (2014), and Legge (2013). Long bone fusion stages for caprines and cattle follow

Zeder (2006), while pig long bone fusion is based on Zeder et al. (2015). Presentation of age reconstruction is modeled after Enghoff (2003) and McGovern (2009).

Chapter 5. The Archaeofaunal Data

This chapter will first discuss the pre-existing zooarchaeological data from Skagafjörður, and what the data discussed in this dissertation will be contributing, including its strengths and weaknesses. Then, the raw data from all sites on Hegranes that produced archaeofaunal collections will be presented, along with one site in the neighboring region of Langholt. These data have previously been published in lab reports (see Appendix A) and discussed in various conference presentations (e.g., Cesario 2017, 2018d, 2018e, 2018f, 2019c).

Nature of the Pre-Existing Data

Pre-existing zooarchaeological data from Skagafjörður are few and far between. Despite many archaeological investigations, zooarchaeology has not been a major part of research efforts until now. However, there are some reports available and these will be discussed here. Figure 5.1 is a map locating each of the archaeofaunal collections in Skagafjörður, which also helps to show where research has been focused.

In 2002-2003, an archaeological project took place at Hólar (Traustadóttir et al. 2002, 2003); the project was later extended. Hólar was established in AD 1106 as the bishop's seat in the north. The church is still present and is the official church of Hólar's current bishop. The archaeological investigations at Hólar that are discussed here were directed by Ragnheiður Traustadóttir, and associated with Hólar College, the Skagafjörður Heritage Museum, and the National Museum of Iceland. Some of the goals were to find areas of human habitation and the farm mound. Prior to excavation, remote sensing and coring identified potential areas for futher investigation (Traustadóttir et al. 2002:5–6). The excavations produced archaeofaunal assemblages, which were analyzed by two different groups of researchers. The dates for the excavations at Hólar range from the 11th-12th century (Area E) to the 18th century (Area D) to the Middle Ages through 20th century (Area B) (Traustadóttir et al. 2002:9–14, 2003:7).

The first analysis was by Ylva Bäckström (Bäckström 2002, 2003) and included comparisons with the faunal assemblage from excavations at the nearby trading site of Kolkuós, which was active from about the 10th-16th centuries. Her reports include a list of species present as well as a small investigation into food use. The 2002 excavations covered various time periods (see above) and produced nearly 60 kg of bone that was included in the analysis. Most of these bones were unburned and come primarily from domesticates, especially sheep. The presence of biperforated or vertically split sheep metapodials is evidence for marrow extraction (Bäckström 2002:47). Bäckström also notes an overabundance of food waste, defined by the proportion of meat-rich bones being higher than 38.5% of the total NISP (Bäckström 2002:47). There is a small percentage of wild animals represented, including seals, whales, fish, and birds (Bäckström 2002:47). Bäckström suggests ways that the assemblage can be further analyzed, such as by comparing it with other farms in Iceland of both "normal" and "high" status, as well as other nearby sites like Kolkuós, in order to understand the differences in status (2002:45-46). However, the only comparisons Bäckström makes are with the medieval farmstead Herjólfsdalur, though its occupation is likely not contemporaneous with the Hólar assemblages, and Bessastaðir, which includes animal commodities and perhaps even shows evidence of long-distance trade (Bäckström 2002:47).

The 2003 excavations from Hólar, Area D, produced only 2 kg of bones, but still more than 80% came from domesticates (Bäckström 2003:37). Only 15% of the bones were burned, and just under 20% came from wild animals—fish and birds (Bäckström 2003:37). The same year, excavations also took place at Kolkuós. The archaeofauna from Kolkuós was also quite small, with just over 1 kg available for analysis. More of the bones are from fish and birds, and the ratio of wild to domestic is just about 50/50 (Bäckström 2003:38). More bones were burned at Kolkuós than at Hólar, with 36% showing evidence of burning. Craftworking using bones as a raw material can also be seen through marks on bone, primarily fragments of whale bone (Bäckström 2003:39). However, Kolkuós is a special use site—a trading port—and so it may not look similar to a proper farm or a marginal site, like the abandoned MARSH sites. Further research needs to be done to fully place all of these sites within their relative social, political, and economic contexts.

Another small analysis from Hólar was done in 2006 by Aaris-Sorensen, Møhl, and Rosenlund (Aaris-Sørensen et al. 2006) from the Natural History Museum of Denmark, in Copenhagen. So far, all that has been produced is a list of the species present in the sample. However, they state that their database also includes information on the side, age and sex, modifications (butchery, etc.), and measurements, where applicable (Aaris-Sørensen et al. 2006).

A standalone faunal report from the post-medieval (17th-19th century) excavations at the farm of Hornbrekka was the last available report from Skagafjörður before I began this dissertation research. The Hornbrekka excavation focused on the dwelling and midden and took place in 2009, and the archaeofaunal material was analyzed by Megan Hicks (Hicks 2016). This faunal report is the only one from Skagafjörður that interprets the animal bones in terms of human behavior. Hicks analyzes the midden remains from a single small household, a subdivision of the larger farm unit Brekka. Both the artifacts and the bones point to a broad use of animal resources that included domesticates as well as wild hunted animals like birds, fish, and sea mammals. Interestingly, significant numbers of the domestic mammal bones from Hornbrekka are burned, and Hicks suggests that this points to the residents using bone for a fuel resource (Hicks 2016:6). Since the farm is historic, analysis and interpretation benefit from contemporaneous documentation. Historic records on farm values say that Hornbrekka did not have abundant fuel resources and kept few domesticates that were likely used primarily for secondary products (Edwald 2009; Hicks 2016). Raising cattle for dairy seems to have been important to the inhabitants at Hornbrekka, and Hicks notes that a focus on dairying is a typical pattern at non-elite farms (Hicks 2016:9). The focus of Hornbrekka's residents on wild resources, including participation in commercial fishing, and their lack of productive land, are perhaps indicative of their lower status and the generally difficult social and environmental conditions during the Early Modern period in Iceland (Hicks 2016:22). This small, single household may have a similar function and social position as the MARSH sites, and Hornbrekka's reliance on wild resources is reflective of the patterns seen in the early Hegranes assemblages.

Finally, my first zooarchaeological report from Skagafjörður (Cesario 2016) details the animal bones from the site of Stóra-Seyla, also known as just Seyla. This site was excavated as part of the cemetery and settlement survey by the Skagafjörður Archaeological Settlement Survey (SASS) during their work on Langholt. The report not only outlines which species were present at Seyla and how that changed over time but uses the data to make interpretations of human activities at the site. While not part of the settlement survey discussed in depth in this dissertation, the work at Seyla is important to the overall picture of economic and social interactions in early Skagafjörður. The Seyla material will be briefly discussed in the next chapters to help interpret the Hegranes results in light of inter-regional patterns and status differences.

Also important to note is my first archaeofaunal report from Hegranes which covers archaeofauna recovered from the smaller excavations (Cesario 2018c). The four sites discussed in-depth in this dissertation are the only ones that produced large enough samples to do more than just list the species present. The 2018 report covers all ten of the 1x1 m test pits excavated during the 2016 field season, lists species present, and suggests patterns that could be explored if future excavations produced more bones. While these are small numbers, they can act as a sort of "baseline" for what faunal assemblages from Hegranes might look like and how the larger assemblages fit into the broader, regional pattern.

New Zooarchaeological Data

The data for this dissertation was collected using the same methods as many of the other zooarchaeological collections in Iceland (see Chapter 4 Methods for more information). Importantly, the modern excavation strategies we use recommend that all contexts are sieved to ensure the recovery of small animal remains and small finds that might be missed with only hand-collection. This method differs from the older strategies of people like Bruun (Bruun 1899; Jónsson and Bruun 1911), where hand collection was often the only way that bones were collected, biasing larger fragments or whole bones.

One weakness of the data that will be presented here is that they are relatively small collections compared to many other sites in Iceland. However, the assemblages from the four MARSH sites do meet the NABO Working Group recommendations for archaeofaunal analysis—at least 300 NISP for collections made up primarily of mammals, and at least 1,000 NISP for fish-rich collections (e.g., Amorosi et al. 1996; Hicks 2019:83).

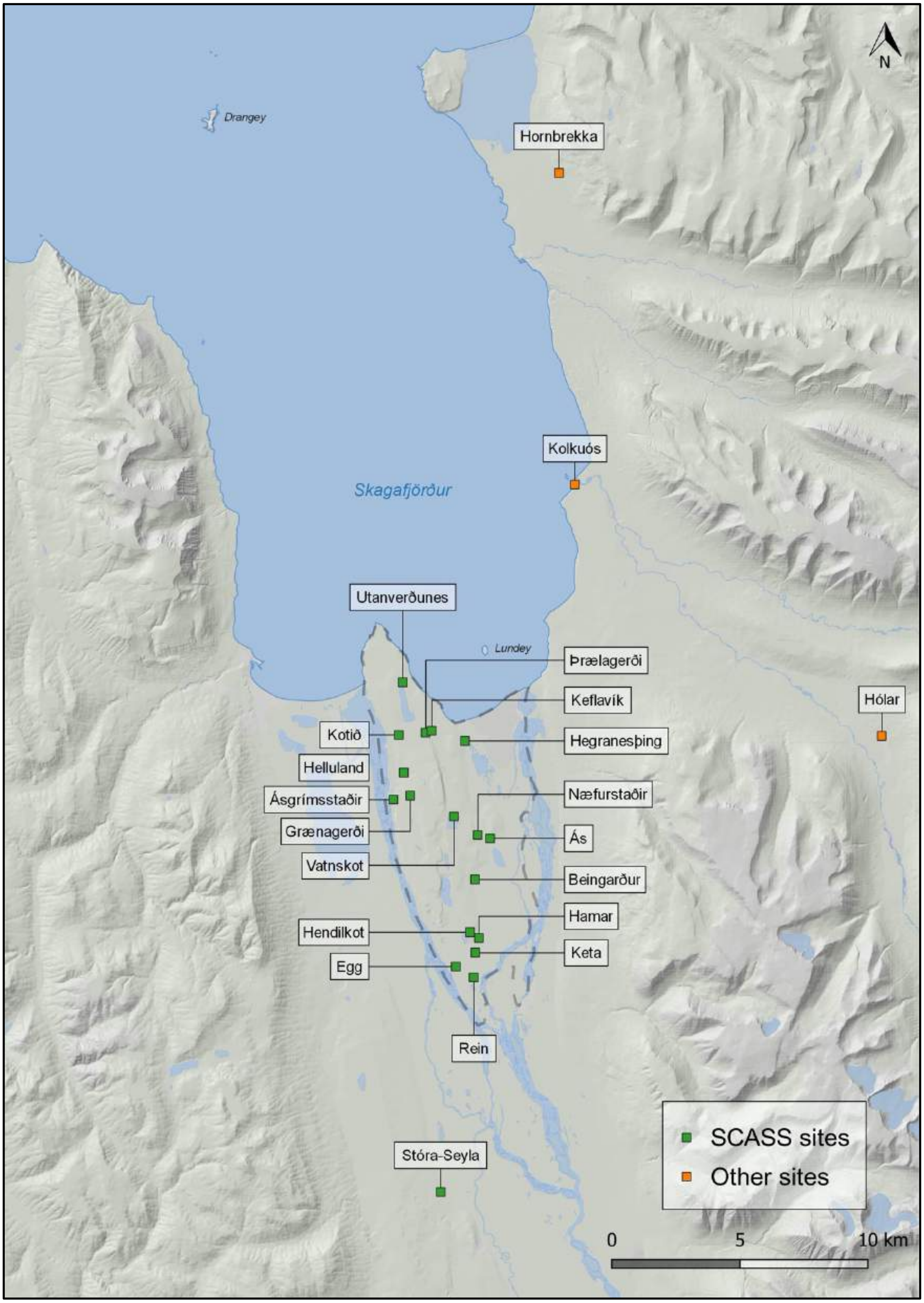

Figure 5.1. All of the analyzed archaeofauna in Skagafjörður discussed in the above text. Map by Gunnar Grímsson.

Basic Statistics on the Hegranes Data

While the four MARSH sites are the focus of this dissertation, many of the other sites on Hegranes did produce animal remains and, despite the small sample sizes, they can still be used in statistical analysis to understand how the MARSH sites compare. These basic statistics allow the use of "bad" data, or small sample sizes, to be aggregated and compared to larger datasets to determine broad trends. This can help determine if the MARSH sites are "typical" of Hegranes or if they are significantly different in some way.

From 2015-2018, the Skagafjörður Church and Settlement Survey (SCASS) investigated 31 habitation sites on Hegranes. SCASS excavated at least one 1x1 m test pit at each of the sites, and only 29 had pre-1104 cultural deposits. The average excavated volume of pre-1104 cultural material at those 29 sites was 535 liters (L). The average total volume was 639 L, indicating that about 84% of every pit excavated was composed of cultural material and the aeolian and turf deposits (non-cultural) were relatively small.

No bones were recovered from 41% (n=12) of the pre-1104 sites investigated (total n=29) during the project. From these 12 sites, a total of 4,241 L were excavated from pre-1104 cultural deposits. That is only about 20% of the total volume excavated from all cultural deposits where bones were recovered; however, it is still substantial and the fact that there were no bones recovered is intriguing. To explore this, we can look at the site with the lowest bone density, Ásgrímsstaðir, where only four bones were recovered from 256 L of pre-1104 cultural deposits. If that low density of bones (1.6 bones recovered from every 100 L of excavated soil) was present at the 12 sites where no bones were recovered, we would have recovered about 66 bones (or about five bones per site). Since this was not the case, the absence of bones at those 12 sites suggests a substantial and important difference between the excavated middens with bones and those without bones. This difference could be due to human behavior or taphonomy or, more likely, a combination of these factors. Many of the sites where bones were not recovered had peat-ash-based middens (Catlin 2019), and it has been observed that bone is often not preserved in peat ash middens, perhaps because of soil acidity. Measures of soil acidity have shown that the calcite in peat dissolves in acidic conditions (Karkanas and Goldberg 2018), and where calcite is observed, bone is also not present (Sawyer 2016:104).

From the 13 sites with bones that will not be discussed beyond the raw data presented here, fish bones made up, on average, 17% of the assemblages (Table 5.1, Figure 5.2). On the other hand, fish bones made up an average of 65% of the MARSH assemblages. Though Figure 5.2 shows averages between the two groups of sites, and the non-MARSH sites have small NISPs (<500), there is a clear difference in economic strategies between the two categories. What stands out the most is that there are many more fish in the MARSH assemblages than in the assemblages from non-MARSH sites.

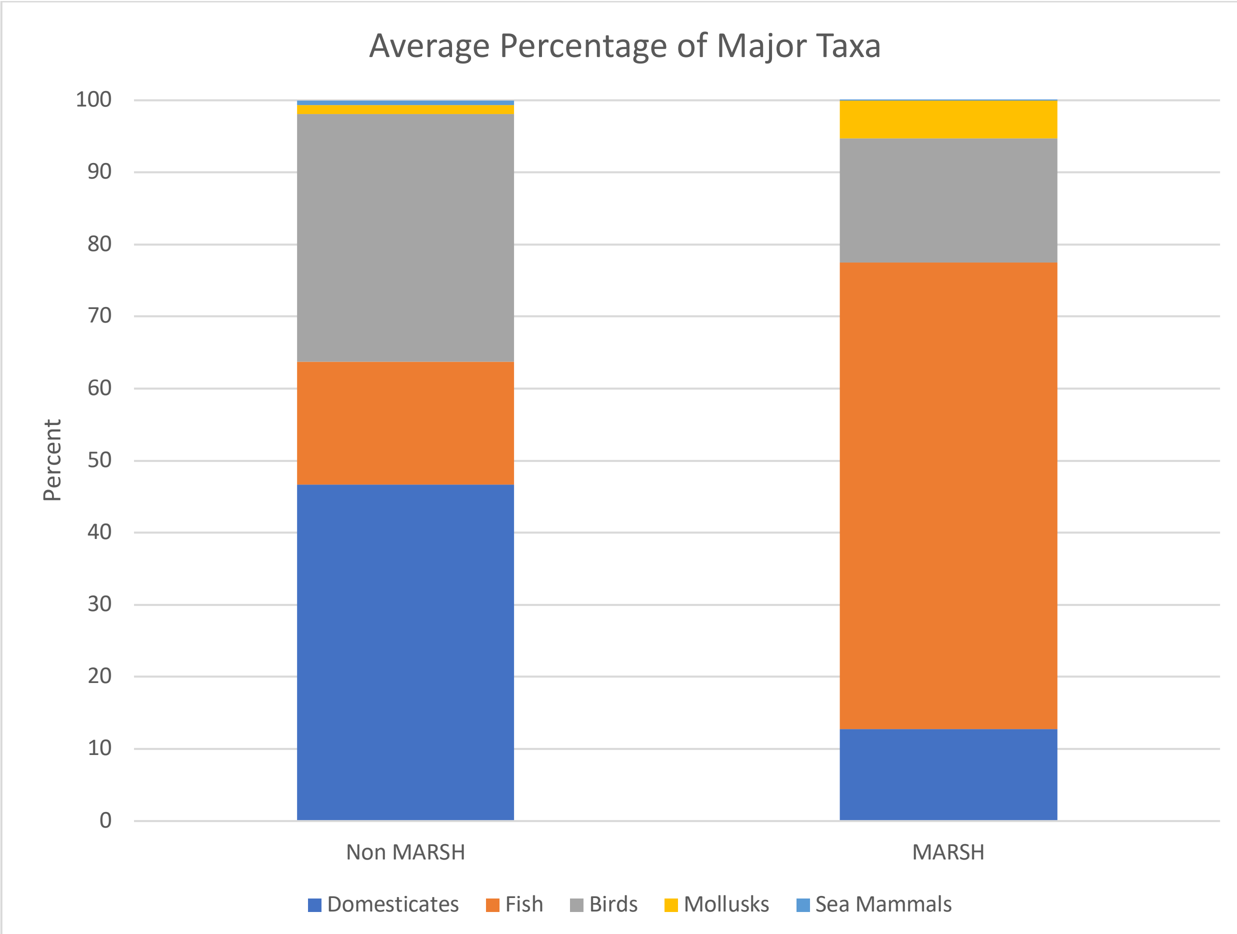

Figure 5.2. Average percentage of major taxa at non-MARSH sites (n=13) and MARSH sites (n=4).

Table 5.1. Data on all of the pre-1104 components of sites with bones recovered during excavation. Bones counts are provided by taxonomic groups, and show the raw count (#), the percent of the total assemblage (%), and the density per liter of cultural material excavated (D). The four sites that make up this dissertation are highlighted in the thick black box.

Site	Cultural deposit excavated (L)	Domesticates			Fish			Birds			Molluscs			Sea Mammals			Total NISP
		#	%	D	#	%	D	#	%	D	#	%	D	#	%	D	
Ásgrímsstaðir	256	2	50	0.008	0	0	0	2	50	0.008	0	0	0	0	0	0	4
Rein	254	2	9	0.008	12	55	0.047	5	23	0.019	2	9	0.008	1	5	0.004	22
Keta	341	17	74	0.05	2	9	0.006	4	17	0.012	0	0	0	0	0	0	23
Helluland	453	5	17	0.011	13	45	0.029	10	34	0.022	1	3	0.002	0	0	0	29
Lower Keflavík	227	33	92	0.145	2	6	0.008	0	0	0	0	0	0	1	3	0.004	36
Egg	747	32	65	0.043	0	0	0	17	35	0.022	0	0	0	0	0	0	49
Hamar	354	59	86	0.167	6	9	0.017	4	6	0.011	0	0	0	0	0	0	69
Beingarður	262	10	12	0.038	5	6	0.019	65	79	0.248	2	2	0.008	0	0	0	82
Ás	1183	58	67	0.049	5	6	0.004	23	27	0.019	0	0	0	0	0	0	86
Hendilkot	238	25	28	0.105	41	46	0.173	21	24	0.088	2	2	0.008	0	0	0	89
Þrælagerði	340	6	6	0.018	38	40	0.111	50	53	0.147	0	0	0	0	0	0	94
Hegranesþing	368	276	99	0.75	0	0	0	2	1	0.005	0	0	0	0	0	0	278
Utanverðunes	696	11	2	0.016	1	0	0.001	489	97	0.702	0	0	0	3	1	0.004	504
Kotið	1390	333	17	0.239	941	74	0.677	683	34	0.491	12	1	0.008	21	1	0.015	1990
Næfurstaðir	1323	175	8	0.132	1611	76	1.217	145	7	0.109	200	9	0.151	2	0	0.002	2133
Grænagerði	1815	594	18	0.327	1676	52	0.923	843	26	0.464	119	4	0.065	2	0	0.001	3234
Vatnskot	2226	452	8	0.203	4856	84	2.181	88	2	0.039	392	7	0.176	11	0	0.005	5799

The average density of fish bones at the MARSH sites was 1.3 fish bones per L (SD=0.659), while at the sites that were not selected for further analysis for this dissertation, the density was only 0.03 fish bones per L (SD=0.052) (Figure 5.3). Beyond fish, other major taxa are slightly over represented at the four MARSH sites, but not to the statistically significant extent (conditions; $t(3.012) = -3.7$, $p=.034$) seen in fish (Figure 5.4). Interestingly, three of the sites that had bones did not have any fish bones (Ásgrímsstaðir, Egg, and Hegranesþing). This makes fish the most unevenly distributed of the common major taxa. Domestic animal bones were only slightly denser (0.226 bones/L) at the four MARSH sites than at the 13 other sites (0.108 domestic animal bones/L), thus domesticates are the most evenly distributed of the common major taxa. Bird bones were recovered at the MARSH sites with a density of 0.28 bird bones/L while at the other sites with bones, the density was 0.10 bones/L. Only one site that had bones did not have any bird bones (Lower Keflavík).

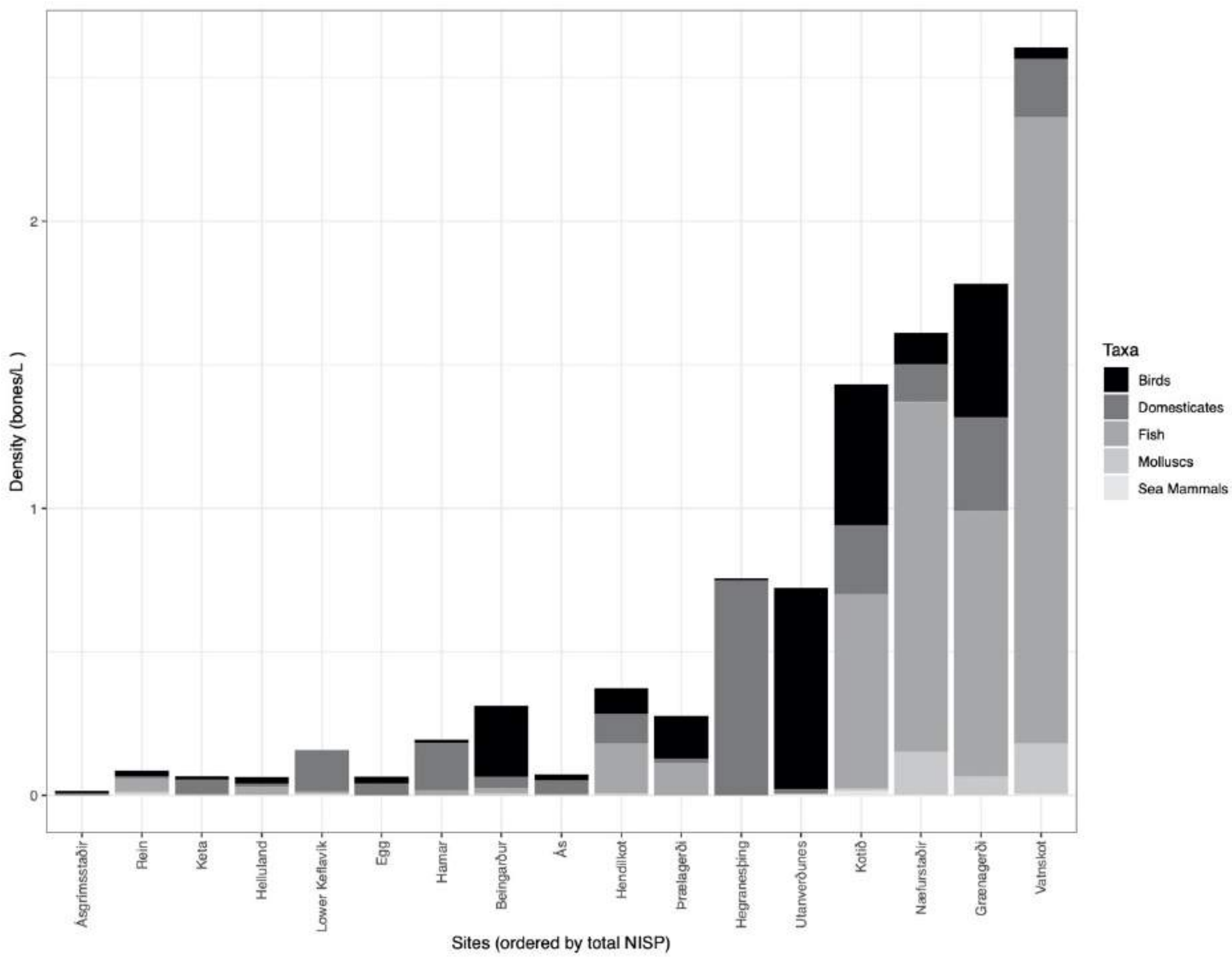

Figure 5.3. Density (bones per liter of cultural material) of the major taxa at all sites on Hegranes where bone was recovered during excavation. The sites are ordered by total NISP, from lowest on the left to highest on the right. The last four columns are the MARSH sites.

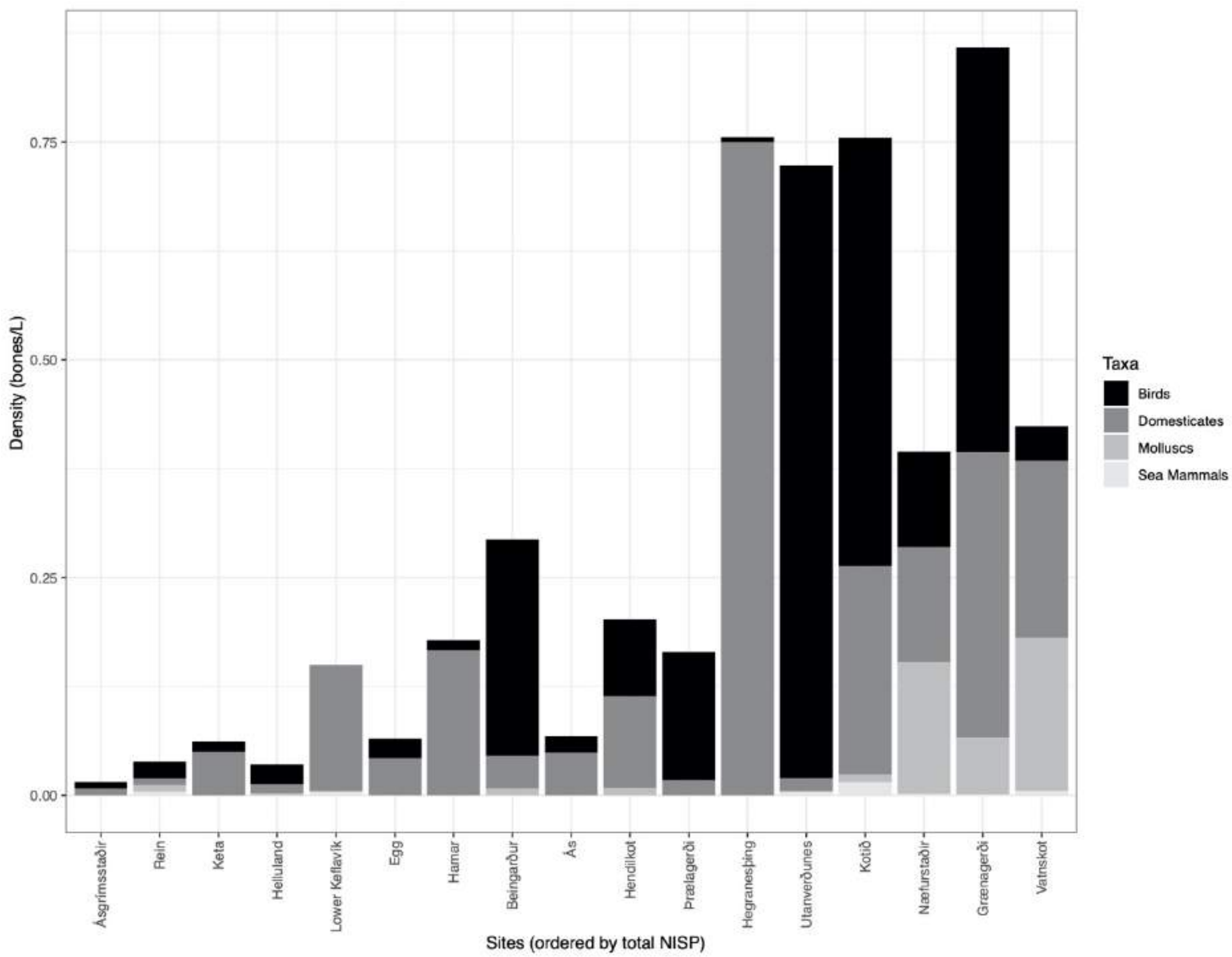

Figure 5.4. Density (bones per liter of cultural material) of the all major taxa except for fish. The sites are ordered by total NISP, from lowest on the left to highest on the right. The last four columns are the MARSH sites.

The Data

Below, I present all of the zooarchaeological data collected from Hegranes in 2015-2018, by site. Data from one site in the neighboring region of Langholt, Seyla, is also included here as it plays a large role in the interpretation of the MARSH sites that will be discussed in further detail in the next chapters. While the archaeofauna from 18 sites is included below, this dissertation focuses primarily on the four sites with the largest NISP—Kotið, Grænagerði, Næfurstaðir, and Vatnskot. After this chapter, they will be the primary focus in discussion, with other sites brought in when applicable.

This archaeofaunal data contributes to our growing body of zooarchaeological research in Iceland. It not only encompasses a regional study, but also includes an area of Iceland that has been well-covered with archaeological investigation, but which has so far been lacking in comparable zooarchaeology. In addition to this, the four MARSH sites, and indeed many more on Hegranes that fall outside of the scope of this dissertation (see Table 5.2 below and also Catlin 2019), are established and abandoned quite early and are thus prior to contemporary written records. The data from these sites are therefore valuable in understanding the different patterns of early adaptation and landscape formation that archaeologists have sought for decades.

Since the earliest periods of human habitation in Iceland are essentially prehistoric, and none of the written documents (sagas, law codes) are contemporaneous, archaeology is one of the best ways to understand how people lived. The role of animals in the economic strategy, the way people make a living, can help to understand early niche construction and adaptation. The next chapters (Chapters 6-8) will discuss these data in more detail and highlight the adaptation patterns and what they mean.

Phasing for each site is based on the well-known tephrochronology of the region and supported with radiocarbon dates (Catlin 2019; Catlin et al. 2017, 2018; Steinberg, Bolender, et al. 2016). The early phase lasts from settlement until AD 1000 and is marked by a grey-black tephra (see Table 4.1). The late phase follows, from AD 1000-1104, and is capped by the white AD 1104 Hekla tephra. Some sites persist beyond this date, but those phases are not discussed here. If bones were present beyond these phases, the data can be found in the main reports (see Appendix A).

Basic information on each of the 18 sites is listed in Table 5.2. This includes the region (Hegranes or Langholt), the sites' current status of abandoned or active, the size of the pre-1104 farmstead, and the area excavated.

Table 5.2. Basic information about each site that was excavated. *Liters excavated total measures everything that was excavated, including turf and aeolian deposits, while liters excavated cultural only includes layers categorized as midden, low-density cultural deposits, and floors. "Established After" and "Deserted Before" dates from Catlin (2019:91, Table 2.2).

Site	Abandoned?	Farmstead Size (m^2) pre-1104	Excavation Area (m^2)	Viking Age Liters excavated* cultural (total)	Established After	Deserted Before
Hegranes						
Kotið	Yes	158	4	1390 (1390)	871	1104
Grænagerði	Yes	465	4	1852 (1815)	871	1104
Næfurstaðir	Yes	1967	6	1323 (1323)	871	Post-1104
Vatnskot	No	3539	4	2326 (2226)	Pre-1000	Active
Helluland	No	12020	1	452 (452)	Pre-950	Active
Ásgrímsstaðir	Yes, historically	4406	1	484 (256)	Pre-950	Historic period
Egg	No	15265	1	898 (746)	Pre-950	Active
Rein	Yes	1067	1	354 (254)	Pre-1000	Historic period
Utanverðunes	No	4376	1	814 (695)	Pre-1000	Active
Keta	No	2306	1	341 (341)	Pre-1104	Active
Hendilkot	Yes	1305	1	285 (237)	989	Post-1104
Þrælagerði	Yes	535	1	340 (340)	871	Post-1000
Hegranesþing	Yes	4983	3	1381 (368)	Pre-950	1300?
Lower Keflavík	Yes, farm moved	4759	1	227 (227)	Pre-950	Moved after 1300?
Beingarður	No	1139	1	561 (261)	Pre-1104	Active
Ás TP5	No	12130	1	1590 (1182)	Pre-950	Active
Hamar	No	4362	1	424 (354)	1000	Active
Langholt						
Seyla	No	7179	~708		Pre-950	Active

Quantification

The most basic method of quantification is simply counting the number of bone fragments present in an assemblage. This does not focus solely on identifiable bones, but every piece of bone. This can give us an idea of the quality of preservation at a site and also allows for a calculation of the rate of identification at a particular site. In Table 5.3, the total number of fragments (TNF) is shown for each site by time period.

Table 5.3. Total Number of Fragments (identifiable and unidentifiable) counted at each site. Sites are listed by region and counts are presented by phase.

Site	Early (AD 870-1000)	Late (AD 1000-1104)	Unphased (AD 870-1104)	Total
Hegranes				
Kotið	N/A	N/A	4056	4056
Grænagerði	733	5567	2759	9063
Næfurstaðir	3851	305	N/A	4156
Vatnskot	5243	4570	N/A	9813
Helluland	8	92	N/A	100
Ásgrímsstaðir	1	3	N/A	4
Egg	83	N/A	N/A	83
Rein TP1	35	N/A	N/A	35
Rein TP2	N/A	27	N/A	27
Utanverðunes TP1	N/A	N/A	892	892
Utanverðunes TP2	16	N/A	N/A	16
Keta	N/A	N/A	87	87
Hendilkot	N/A	N/A	387	387
Þrælagerði	155	11	N/A	166
Hegranesþing TP1	585	9	N/A	594
Hegranesþing TP2	N/A	N/A	140	140
Lower Keflavík	210	N/A	N/A	210
Beingarður	N/A	57	N/A	57
Ás TP5	557	29	N/A	586
Hamar	N/A	N/A	208	208
Langholt				
Seyla	3948	4114	N/A	8062

Fragmentation and Modifications

Fragmentation and modifications are recorded based on the 9th edition of the NABONE manual (McGovern et al. 2010). In Table 5.4 below, the collections from each site are described based on four measures. The entire collection at each site is used in these calculations (TNF) rather than just the identified fragments (NISP) in order to understand the taphonomic processes that affected the whole archaeofauna. Each number is the percentage of the total collection that falls into each respective strategy (%TNF). Below, I briefly describe what each category measures and what the codes on the table mean (for more information, see the NABONE manual).

Fragmentation can tell us about taphonomy and post-depositional factors, as well as pre-deposition intensity of bone processing (McGovern 2009:201; Outram 2001, 2003). The

NABONE system categorizes bones in five size categories (Table 5.4), and this allows us to look at patterns of fragmentation across time and space for comparison within one site and across sites. Note that the bones at the four dissertation sites are primarily within the 1-2- and 2-5-cm categories. This does not necessarily reflect heavy processing, as the archaeofauna are primarily fish and their small vertebrae and skull fragments.

Burning is scored in four categories: white-grey ("W"), black ("B"), scorched ("S"), and unburned ("U"). Fully calcined bones in the "W" category represent high heat for long periods of time, perhaps from being burned in a hearth for fuel. Scorched bones are recognized by patches of black and dark brown on an otherwise unburned bone and are not representative of intensive processing but more likely roasting.

Gnawing includes all bones that have been gnawed by either rodents or carnivores, which are limited to dogs or foxes in Iceland. Finally, the butchery category includes all bones with any evidence of butchery. This includes chopping, knife scratches, impact fractures, and splitting. Both gnawing and butchery are only presented as the percentage of the collection that *does* show these indicators and does not include unmodified bones.

The rest of the data will be presented by NISP, or the number of identified fragments, which is the standard for NABO North Atlantic collections (see Chapter 4 Methods). First, a simple NISP count by phase for each site is shown in Table 5.5. Next, the breakdown of NISP by major taxa group for each site's total collection is shown in Table 5.6. This shows both raw counts, and the percent of the total NISP that each group contributes. The %NISP allows us to see a site's overall strategy and to compare sites with different sample sizes.

Table 5.4. Modifications based on %TNF for each site. The dissertation sites are within the thick border.

Site	**Fragmentation (cm)**					**Burning**				**Gnawing**	**Butchery**
	<1	**1-2**	**2-5**	**5-10**	**10+**	**W**	**B**	**S**	**U**	**% gnawed**	**% butchered**
Hegranes											
Kotið	3.35	42.48	35.18	16.81	2.17	16.27	3.43	0.71	79.59	0.05	0.74
Grænagerði	8.59	46.31	31.79	12.32	0.99	21.91	1.57	0.96	75.56	0.10	0.31
Næfurstaðir	2.43	44.03	42.25	10.72	0.58	10.82	0.70	0.10	88.39	0.02	0.34
Vatnskot	10.05	37.71	39.92	11.51	0.83	10.39	1.95	0.35	87.31	0.06	0.40
Helluland	14	25	47	13	1	1	2	0	97	0	1
Ásgrímsstaðir	0	25	75	0	0	0	0	0	100	0	0
Egg	4.81	34.94	36.14	21.69	2.4	6.02	0	0	93.98	1.2	0
Rein TP1	0	48.57	31.43	14.28	5.71	0	0	0	100	0	0
Rein TP2	22.22	29.63	29.63	18.52	0	14.81	0	0	85.19	0	0
Utanverðunes TP1	20.74	37.22	33.3	8.3	0.45	13.45	1.68	0.22	84.64	0	0.22
Utanverðunes TP2	31.25	25	31.25	12.5	0	0	0	0	0	0	6.25
Keta	0	18.39	50.57	28.74	2.29	3.45	6.89	1.15	86.52	0	0
Hendilkot	20.41	47.55	24.80	7.24	0	4.90	7.24	12.64	85.79	0	0.26
Þrælagerði	4.82	26.51	45.78	22.89	0	11.45	0.60	0	87.95	0	0
Hegranesþing TP1	0	40.40	27.27	25.42	6.90	18.52	9.26	0.51	71.72	0.17	1.52
Hegranesþing TP2	5.71	9.29	43.57	38.57	1.90	10	0	0	90	1.43	0.48
Lower Keflavík	2.86	40.48	47.62	8.57	0.47	24.29	20.47	0	55.24	0	1.43
Beingarður	1.75	47.37	50.88	0	0	5.26	28.07	7.02	59.65	0	0
Ás TP5	1.54	24.74	58.53	13.65	1.54	45.05	14.85	2.22	37.88	0	0.34
Hamar	0	25.48	53.85	15.87	4.81	14.76	1.90	0	82.38	0	0.48
Langholt											
Seyla	18.84	39.79	30.07	9.60	1.70	10.40	5.28	2.03	82.29	0.09	1.42

Table 5.5. NISP by phase for each site. Not all sites were able to be phased to the Early and Late Viking Age, and some do not have components in one or more phase. When sites do not have any contexts in a specific phase, that box is filled with a "-" to indicate no data.

NISP by Phase	Early 870-1000	Late 1000-1104	Unphased (Viking Age) 870-1104	Total
Hegranes				
Kotið	-	-	1990	1990
Grænagerði	351	1835	1056	3242
Næfurstaðir	1967	165	-	2132
Vatnskot	2833	2785	-	5618
Helluland	-	29	-	29
Ásgrímsstaðir	1	3	-	4
Egg	53	-	-	53
Rein TP1	7	-	-	7
Rein TP2	-	15	-	15
Utanverðunes TP1	-	-	504	504
Utanverðunes TP2	2	-	-	2
Keta	-	-	22	22
Hendilkot	-	-	89	89
Þrælagerði	91	4	-	95
Hegranesþing TP1	195	2	-	197
Hegranesþing TP2	-	-	36	36
Lower Keflavík	37	-	-	37
Beingarður	-	23	-	23
Ás TP5	101	-	-	101
Hamar	-	-	69	69
Langholt				
Seyla	522	746	-	1268

Table 5.6. Total NISP and %NISP (%) for major taxa at all sites on Hegranes and the one site on Langholt for which analysis has been completed. This shows the combined data from all pre-1104 (Viking Age) phases. *Other Mammals in this case refers only to the Arctic fox (*Alopex lagopus*).

All Phases	**Domesticates**		**Birds**		**Fish**		**Sea Mammals**		**Molluscs**		**Other Mammals***		**Gastropods**		**Total**
	NISP	**%**	**NISP**	**%**	**NISP**	**%**	**NISP**	**%**	**NISP**	**%**	**NISP**	**%**	**NISP**	**%**	**NISP**
Hegranes															
Kotið	333	16.73	683	34.32	941	47.29	21	1.06	12	0.60	0	0.00	0	0.00	1990
Grænagerði	593	18.29	843	26	1676	51.60	2	0.06	119	3.67	1	0.03	8	0.25	3242
Næfurstaðir	176	8.25	142	6.67	1611	75.56	2	0.09	199	9.33	0	0.00	2	0.09	2132
Vatnskot	452	8.04	86	1.53	4855	86.41	11	0.19	204	3.63	0	0.00	10	0.17	5618
Helluland	5	17.24	10	34.48	13	44.83	0	0.00	1	3.45	0	0.00	0	0.00	29
Ásgrímsstaðir	2	50.00	2	50.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	4
Egg	32	60.38	21	39.62	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	53
Rein TP1	0	0.00	4	57.14	0	0.00	1	14.29	2	28.57	0	0.00	0	0.00	7
Rein TP2	2	13.33	1	6.67	12	80.00	0	0.00	0	0.00	0	0.00	0	0.00	15
Utanverðunes TP1	11	2.18	489	97.02	1	0.20	3	0.60	0	0.00	0	0.00	0	0.00	504
Utanverðunes TP2	2	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	2
Keta	17	77.27	3	13.64	2	9.09	0	0.00	0	0.00	0	0.00	0	0.00	22
Hendilkot	25	28.09	21	23.60	41	46.07	0	0.00	2	2.25	0	0.00	0	0.00	89
Þrælagerði	6	6.32	50	52.63	38	40.00	0	0.00	0	0.00	1	1.05	0	0.00	95
Hegranesþing TP1	197	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	197
Hegranesþing TP2	36	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	36
Lower Keflavík	33	89.19	0	0.00	2	5.41	1	2.70	0	0.00	1	2.70	0	0.00	37
Beingarður	2	8.70	14	60.87	5	21.74	0	0.00	2	8.70	0	0.00	0	0.00	23
Ás TP5	67	66.34	28	27.72	6	5.94	0	0.00	0	0.00	0	0.00	0	0.00	101
Hamar	59	85.51	4	5.80	6	8.70	0	0.00	0	0.00	0	0.00	0	0.00	69
Langholt															
Seyla	754	59.46	26	2.05	452	35.65	2	0.16	8	0.63	0	0.00	0	0.00	1268

Phased Data

Now that the basic quantification data has been presented, what follows are multiple tables showing NISP at each site for taxonomic groups of species. Taxonomic presentation of the data shows the variety of animals that were used at the sites and provides a very quick look at representation of wild and domestic species. This data is presented by phase in order from early to late, followed by the unphased data. Where a site does not have contexts from a specific phase, it is left off of the tables. This means that each section and each table will not have all 18 sites listed. The first table in this section (Table 5.7) explains the codes for each species, giving the Latin name, English common name, and Icelandic name. These codes are used in the data presentation tables, and also in the raw Access databases where information about each bone is curated.

Early Phase (870-1000)

The early phase data is presented in a series of tables below (Table 5.8-Table 5.12). This phase characterizes the very beginning of the settlement in Skagafjörður and illustrates some of the earliest examples of how humans set up their lives and livelihoods in a previously uninhabited place. The early phase may represent an initial "gearing-up" of farm sites focusing on niche construction and breeding livestock, as well as incorporating wild resources into the economy to supplement the diet. Activities during the early phase include landscape clearance to create pastureland for grazing animals; this period may utilize pigs and goats more heavily than later periods, as they are quite effective for clearing land, but do not provide as many other useful secondary products as cattle and sheep. During this period, there may also be a heavier reliance on wild resources as they would have been a familiar resource to exploit while breeding the initially small numbers of livestock that were brought along during the voyage to Iceland. There are 11 sites on Hegranes that had early phase archaeofauna, in addition to Seyla.

Table 5.7. Chart of codes used in Tables 5.8-5.22.

Code	Latin Name	English Common Name	Icelandic Name
Domesticates			
BOS	*Bos taurus*	Cow	Nautgripur
EQU	*Equus caballus*	Horse	Hestur
CAN	*Canis familiaris*	Dog	Hundur
SUS	*Sus scrofa*	Pig	Svín
OVI	*Ovis aries*	Sheep	Kind
CRA	*Capra hircus*	Goat	Geit
OVCA		Caprine (sheep/goat)	
Other Mammals			
CESP	Cetacea sp.	Unidentified cetacean	Hvalur, höfrungur
SCET	Small cetacean	Small whale/dolphin	Hvalur, höfrungur
PSP	Phocid sp.	Seal species	Selur
PV	*Phoca vitulina*	Harbor/common seal	Landselur
AFX	*Alopex lagopus*	Arctic fox	Heimskautarefur
Fish			
COD	*Gadus morhua*	Atlantic cod	Þorskur
HAD	*Melanogrammus aeglefinus*	Haddock	Ýsa
LIN	*Molva molva*	Ling	Langa
POL	*Pollachius virens*	Pollock	Ufsi
BRO	*Brosme brosme*	Cusk/Tusk	Keila
GAD	Gadidae family	Cod family fish	
ANA	*Anarhichas lupus*	Atlantic wolffish	Steinbítur
TRT	*Salmo trutta*	Brown trout	Urriði
CHR	*Salvelinus alpinus*	Arctic char	Bleikja
FISH	Unidentified fish	Fish	Fiskur
Birds			
FRA	*Fratercula arctica*	Puffin	Lundi
URA	*Uria aalge*	Guillemot	Langvía
ALT	*Alca torda*	Razorbill	Álka
CEP	*Cepphus grylle*	Black guillemot	Teista
LAS	*Larus* sp.	Gull species	Máfur
STP	*Sterna paradisaea*	Arctic tern	Kría
GAV	*Gavia stellata*	Red-throated loon	Lómur
PHC	*Phalacrocorax carbo*	Great cormorant	Dílaskarfur
PLA	*Pluvialis apricaria*	European golden plover	Heiðlóa
MER	*Mergus serrator*	Red-breasted merganser	Toppönd
LAM	*Lagopus muta*	Ptarmigan	Rjúpa
AYT	*Aythya fuligula*	Tufted duck	Skúfönd
SOM	*Somateria mollissima*	Common eider	Æðarfugl
ANS	*Anser* sp.	Goose species	Gæs
DUCK	Anatidae?	Duck species	Önd
AVSP	Aves sp.	Unidentified bird species	Fugl
Molluscs			
CLM	*Mya* species	Clam species	Skelfiskur
MED	*Mytilus edulis*	Common/blue mussel	Bláskel
MOLSP	Indeterminate mollusc species	Mollusca	Lindýr
LSP	*Littorina* species	Periwinkle species	Fjörudoppa
PAT	*Patella vulgata*	Common limpet	Mararhetta
BUC	*Buccinum undatum*	Common/waved whelk	Beitukóngur
Gastropod			
SNAIL		Land snail	Snigill

Table 5.8. Domesticates from the early phase.

	BOS	EQU	CAN	SUS	OVI	CRA	OVCA
Hegranes							
Grænagerði	7	1	0	2	5	0	47
Næfurstaðir	43	0	0	2	6	0	96
Vatnskot	33	0	0	6	18	0	123
Ásgrímsstaðir	0	1	0	0	0	0	0
Egg	20	0	0	0	0	0	12
Rein TP1	0	0	0	0	0	0	0
Utanverðunes TP2	1	0	0	0	0	0	1
Þrælagerði	2	0	0	0	1	0	3
Hegranesþing TP1	12	0	0	4	55	0	124
Lower Keflavík	10	0	0	2	1	0	20
Ás TP5	16	1	0	2	4	0	44
Langholt							
Seyla	51	1	0	0	66	0	188

Table 5.9. Other mammals in the early phase. This includes both sea mammals and the arctic fox, the only wild land mammal in Iceland.

	Sea Mammals					Land Mammal
	CESP	SCET	PSP	PV		AFX
Hegranes						
Grænagerði	0	0	0	0		0
Næfurstaðir	1	0	1	0		0
Vatnskot	9	0	0	0		0
Ásgrímsstaðir	0	0	0	0		0
Egg	0	0	0	0		0
Rein TP1	0	0	1	0		0
Utanverðunes TP2	0	0	0	0		0
Þrælagerði	0	0	0	0		1
Hegranesþing TP1	0	0	0	0		0
Lower Keflavík	0	0	1	0		1
Ás TP5	0	0	0	0		0
Langholt						
Seyla	1	0	0	0		0

Table 5.10. Fish in the early phase.

	COD	HAD	LIN	POL	BRO	GAD	ANA	TRT	CHR	FISH
Hegranes										
Grænagerði	14	0	0	0	2	54	0	0	0	4
Næfurstaðir	216	7	12	2	0	807	0	0	0	534
Vatnskot	564	14	17	4	0	1665	3	0	0	268
Ásgrímsstaðir	0	0	0	0	0	0	0	0	0	0
Egg	0	0	0	0	0	0	0	0	0	0
Rein TP1	0	0	0	0	0	0	0	0	0	0
Utanverðunes TP2	0	0	0	0	0	0	0	0	0	0
Þrælagerði	6	0	0	3	0	0	0	0	0	29
Hegranesþing TP1	0	0	0	0	0	0	0	0	0	0
Lower Keflavík	0	0	0	0	0	2	0	0	0	0
Ás TP5	3	0	0	0	0	3	0	0	0	0
Langholt										
Seyla	7	0	0	0	0	9	0	0	0	156

Table 5.11. Early phase birds.

	FRA	URA	ALT	CEP	LAS	STP	GAV	PHC	PLA	MER	LAM	AYT	SOM	DUCK	ANS	AVSP
Hegranes																
Grænagerði	5	150	0	0	0	0	0	0	0	0	1	0	0	0	0	50
Næfurstaðir	30	8	1	0	2	0	0	0	0	0	1	0	0	1	0	88
Vatnskot	0	6	0	0	7	0	0	0	0	0	0	1	0	1	0	16
Ásgrímsstaðir	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Egg	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	20
Rein TP1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Utanverðunes TP2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Þrælagerði	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	24
Hegranesþing TP1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lower Keflavík	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ás TP5	0	0	0	0	0	0	0	0	0	0	0	0	4	4	0	20
Langholt																
Seyla	1	0	0	0	3	0	0	0	0	0	1	0	0	0	1	4

Table 5.12. Molluscs and land snails in the early phase.

	Molluscs							Land Snail
	CLM	MED	MOLSP	LSP	PAT	BUC		SNAIL
Hegranes								
Grænagerði	0	6	3	0	0	0		0
Næfurstaðir	41	0	66	1	1	0		0
Vatnskot	46	2	17	4	0	1		8
Ásgrímsstaðir	0	0	0	0	0	0		0
Egg	0	0	0	0	0	0		0
Rein TP1	0	0	2	0	0	0		0
Utanverðunes TP2	0	0	0	0	0	0		0
Þrælagerði	0	0	0	0	0	0		0
Hegranesþing TP1	0	0	0	0	0	0		0
Lower Keflavík	0	0	0	0	0	0		0
Ás TP5	0	0	0	0	0	0		0
Langholt								
Seyla	0	0	2	0	0	0		0

Late Phase (AD 1000-1104)

The data from the late phase (AD 1000-1104) are presented below (Tables 5.13-5.17). This phase represents the second half of the settlement, where people are still (re)organizing themselves on the landscape and also dealing with the environmental changes that have been at least partially brought about by human impacts on the landscape. During this period, there are likely still aspects of niche construction taking place, though they may be more focused on sustainable exploitation of resources rather than wholesale clearance of woodlands, for example. A decrease in goats and pigs might be expected since pastures and woodlands needed to be conserved (McGovern et al. 2007:45). The capacity to keep more livestock would have increased by this time, so there may be evidence of a broader mixed animal economy—dairy, meat, milk, and wool for household use. Wool had not yet become an export commodity, so the ratios of sheep to cattle are generally still quite low.

Table 5.13. Domesticates in the late phase.

	BOS	EQU	CAN	SUS	OVI	CRA	OVCA
Hegranes							
Grænagerði	64	0	2	38	49	0	235
Næfurstaðir	9	0	0	0	1	0	19
Vatnskot	56	4	0	10	17	2	183
Helluland	0	0	0	1	4	0	0
Ásgrímsstaðir	0	0	0	0	0	0	1
Rein TP2	0	0	0	0	2	0	0
Þrælagerði	0	0	0	0	0	0	0
Hegranesþing TP1	0	0	0	0	0	0	2
Beingarður	1	0	0	0	0	0	1
Langholt							
Seyla	67	1	0	0	104	0	271

Table 5.14. Wild sea and land mammals present in the late phase.

	Sea Mammals					Land Mammals
	CESP	SCET	PSP	PV		AFX
Hegranes						
Grænagerði	1	0	0	1		1
Næfurstaðir	0	0	0	0		0
Vatnskot	1	0	1	0		0
Helluland	0	0	0	0		0
Ásgrímsstaðir	0	0	0	0		0
Rein TP2	0	0	0	0		0
Þrælagerði	0	0	0	0		0
Hegranesþing TP1	0	0	0	0		0
Beingarður	0	0	0	0		0
Langholt						
Seyla	1	0	0	0		0

Table 5.15. Fish in the late phase.

	COD	HAD	LIN	POL	BRO	GAD	ANA	TRT	CHR	FISH
Hegranes										
Grænagerði	330	15	1	0	0	667	7	0	1	247
Næfurstaðir	10	1	0	0	0	20	0	0	0	2
Vatnskot	899	6	37	0	0	1172	0	0	1	205
Helluland	2	0	0	0	0	0	0	0	0	11
Ásgrímsstaðir	0	0	0	0	0	0	0	0	0	0
Rein TP2	0	0	0	0	0	3	0	0	0	9
Þrælagerði	0	0	0	0	0	0	0	0	0	0
Hegranesþing TP1	0	0	0	0	0	0	0	0	0	0
Beingarður	0	0	0	0	0	5	0	0	0	0
Langholt										
Seyla	31	1	0	0	0	52	0	0	0	196

Table 5.16. Late phase birds.

	FRA	URA	ALT	CEP	LAS	STP	GAV	PHC	PLA	MER	LAM	DUCK	ANS	AVSP
Hegranes														
Grænagerði	6	14	0	0	2	0	0	0	1	0	2	0	0	78
Næfurstaðir	5	0	0	0	0	0	0	0	0	0	0	0	0	6
Vatnskot	9	11	0	0	2	1	0	0	0	0	0	0	0	32
Helluland	2	3	0	0	0	0	0	0	0	0	0	0	0	5
Ásgrímsstaðir	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Rein TP2	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Þrælagerði	1	0	0	0	0	0	0	0	0	0	0	0	0	3
Hegranesþing TP1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Beingarður	0	0	0	0	0	0	0	0	0	0	0	0	0	14
Langholt														
Seyla	1	1	0	0	0	0	1	0	0	0	0	0	2	11

Table 5.17. Molluscs and land snails in the late phase.

	Molluscs							Land Snails
	CLM	MED	MOLSP	LSP	PAT	BUC		SNAIL
Hegranes								
Grænagerði	45	0	23	0	0	0		5
Næfurstaðir	75	0	15	0	0	0		2
Vatnskot	65	6	54	9	0	0		2
Helluland	0	0	1	0	0	0		1
Ásgrímsstaðir	0	0	0	0	0	0		0
Rein TP2	0	0	0	0	0	0		0
Þrælagerði	0	0	0	0	0	0		0
Hegranesþing TP1	0	0	0	0	0	0		0
Beingarður	0	0	2	0	0	0		0
Langholt								
Seyla	0	0	6	0	0	0		0

Viking Age (Unphased)

The data in the unphased category is broadly Viking Age (AD 870-1104). These sites did not have secure phasing and were often missing the AD 1000 tephra layer or only had it present across parts of the excavation units. These sites still fall within the larger settlement and (re)organization time period, and though we cannot see change over time, the patterns of animal use that we do see are still useful to understand the way people adapted to their new environment (Tables 5.18-5.22).

Table 5.18. Domesticates in the Viking Age.

	BOS	EQU	CAN	SUS	OVI	CRA	OVCA
Hegranes							
Kotið	57	13	0	3	45	0	215
Grænagerði	44	3	0	7	10	0	79
Utanverðunes TP1	6	0	1	0	0	0	4
Keta	2	0	0	0	2	0	13
Hendilkot	3	0	0	0	0	0	22
Hegranesþing TP2	0	0	0	0	3	0	33
Hamar	30	0	0	0	3	0	26

Table 5.19. Wild sea and land mammals in the Viking Age.

	Sea Mammals					Land Mammals
	CESP	SCET	PSP	PV		AFX
Hegranes						
Kotið	1	10	10	0		0
Grænagerði	0	0	0	0		0
Utanverðunes TP1	3	0	0	0		0
Keta	0	0	0	0		0
Hendilkot	0	0	0	0		0
Hegranesþing TP2	0	0	0	0		0
Hamar	0	0	0	0		0

Table 5.20. Viking Age fish.

	COD	HAD	LIN	POL	BRO	GAD	ANA	TRT	CHR	FISH
Hegranes										
Kotið	141	8	0	9	0	456	1	1	0	325
Grænagerði	104	3	2	0	0	197	0	0	0	28
Utanverðunes TP1	0	0	0	0	0	0	0	0	0	1
Keta	0	0	0	0	0	0	0	0	0	2
Hendilkot	9	0	0	0	0	3	0	0	0	29
Hegranesþing TP2	0	0	0	0	0	0	0	0	0	0
Hamar	0	0	0	0	0	6	0	0	0	0

Table 5.21. Viking Age birds.

	FRA	URA	ALT	CEP	LAS	STP	GAV	PHC	PLA	MER	LAM	DUCK	AVSP
Hegranes													
Kotið	166	125	0	4	4	0	15	5	2	4	0	7	351
Grænagerði	57	316	1	0	3	0	0	0	0	0	0	0	157
Utanverðunes TP1	155	43	0	0	0	0	0	0	0	0	0	0	291
Keta	3	0	0	0	0	0	0	0	0	0	0	0	0
Hendilkot	3	2	0	0	0	0	0	0	0	0	1	0	15
Hegranesþing TP2	0	0	0	0	0	0	0	0	0	0	0	0	0
Hamar	2	0	0	0	0	0	0	0	0	0	0	0	2

Table 5.22. Molluscs and land snails in the Viking Age.

	Molluscs							Land snails
	CLM	MED	MOLSP	LSP	PAT	BUC		SNAIL
Hegranes								
Kotið	2	7	3	0	0	0		0
Grænagerði	21	0	21	0	0	0		3
Utanverðunes TP1	0	0	0	0	0	0		0
Keta	0	0	0	0	0	0		0
Hendilkot	0	0	2	0	0	0		0
Hegranesþing TP2	0	0	0	0	0	0		0
Hamar	0	0	0	0	0	0		0

Chapter Summary

This chapter presented a brief history of the prior zooarchaeological research in Skagafjörður prior to the beginning of my research. Then, some basic statistics about the Hegranes sites were discussed, before moving on to the data itself. The data presented came from 18 total sites, 17 on Hegranes that were excavated from 2015-2018, and one from the neighboring region of Langholt. Basic information about each site, including the size of the farmstead, current status, and size of the excavation is displayed. In addition to the Total Number of Fragments (TNF), basic metrics on each assemblage's fragmentation, burning, and modifications are given as well. Finally, data from each of three time periods is presented by major taxonomic group. The purpose of this chapter was to compile the data from all excavated sites in one place, even though only four sites will be discussed in major detail going forward.

Chapter 6. The Domesticates

The Norse brought domesticated animals to Iceland with them when they settled the island. Prior to their arrival, the only land mammal native to Iceland was the arctic fox. The imported domesticate package included cattle, sheep, goats, pigs, horses, cats, and dogs. Also included were unintentional travelers like mice, rats, and various bugs like lice and sheep keds (Jones et al. 2012). Since *landnám*, much of the Icelandic economy has been focused on farming, which includes both agriculture and animal husbandry. This farming strategy comes straight from the Norwegian system, which was transferred wholesale with the settlers and made up the most important part of the Norse ideology (Keller 2009; Øye 2005). The earliest farms in Iceland seem to follow the same strategies of domesticate use, with a main focus on cattle and caprines (McGovern et al. 2001, 2006).

Agriculture that focused on cultivating fodder would have supported the Icelanders' farming lifestyle based on keeping cows and sheep (Amorosi et al. 1998; Fridriksson 1972; McGovern et al. 2007). Farms were partially valued based on how many cattle they could support, and much labor went into collecting fodder during the summer months—from both wetlands (early in the season) and dry meadows (later)—to support the herd over the winter (McGovern et al. 2007:29).

Despite the value of cattle, farms in Iceland tend to focus more on caprines, sheep in particular, for the wide range of products they provide—meat, milk, and wool. Cattle are also used for milk and meat, and calves culled for dairying purposes may have been used in vellum production, though this is more likely the case for the Medieval period and beyond (Keller 2009). Pigs were introduced with the first settlers, and they were an important part of the initial settlement and landscape domestication process. Pigs are a vital part of the niche construction toolkit since they are useful for clearing scrub and preventing the regeneration of forests, which helps to create pasture and grazing lands (Keller 2009; McGovern et al. 2007). Once the woodlands declined and landscape clearance was no longer needed, it would have been unsuccessful to keep pigs. The costs of keeping them—providing fodder, penning them, and policing the places they can graze—likely outweighed the benefits. Horses are used primarily for transportation but have become part of the diet in some cases, especially in pre-Christian times; horses are also found in early pagan burials (Smiarowski et al. 2017:150). Cats and dogs are also part of the farm, kept around for companionship, hunting and managing livestock (in the case of dogs), and perhaps even for their skin and fur in the case of cats (Prehal 2011).

The graph below shows the ratio of domesticates at all sites included in this dissertation (Figure 6.1). The range of domesticates present at these sites fits with what we know about their use. Caprines are the most common by far, with cattle following. Interestingly, all sites have some pigs present, and the number of pigs actually increases in the late phase at Grænagerði. This is in contrast to the general pattern where pigs become less common over time (see pig discussion below). There are very few horses or dogs represented in the assemblages, and no cats at all.

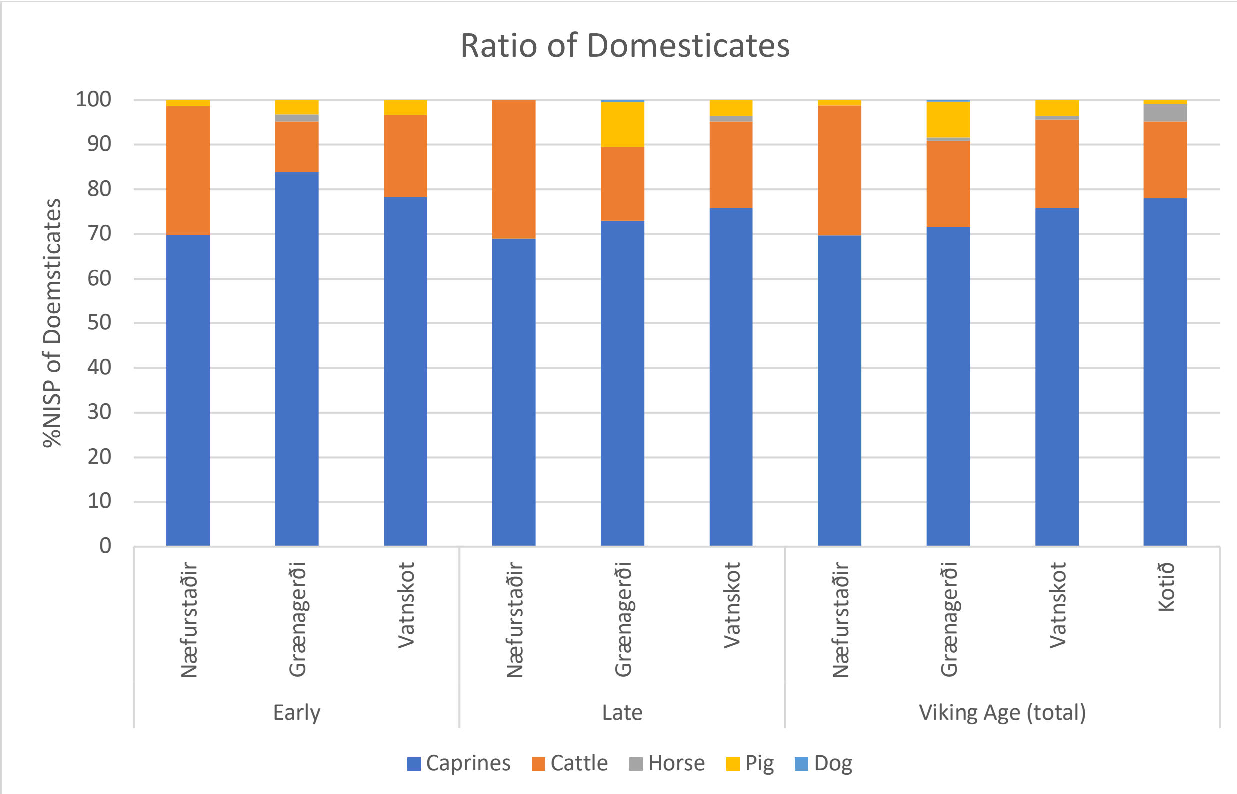

Figure 6.1. Range of domesticates at each site during the three time periods.

Caprines

The "caprines" category includes both sheep and goats. Their bones are often hard to differentiate, and fewer than 10 bones in the skeleton can be reliably used to distinguish the species (e.g., Boessneck 1969; Zeder and Lapham 2010). Goats were one of the animals brought to Iceland during the settlement process, but they become less common after the first couple of centuries. They are often found in archaeofauna from the earliest time periods at sites across Iceland, but there are very few goats found in Skagafjörður during any time period.

Goats can metabolize more marginal and brushy vegetation than sheep can, and they can utilize more marginal grazing areas that cannot support sheep (Redding 1981:45). Goats may be more environmentally friendly than sheep, since they tend to move between feeding areas more frequently, and are more adventurous eaters that will try a variety of foods rather than focusing on one particular plant species (Redding 1981:48–49; Zeder 2006). However, goats would have been useful for initial niche construction activities, since they are good at clearing woodlands and could be used to create and maintain grazing lands. Sheep tend to graze more, and often eat plants all the way down to the roots (Redding 1981) which can expose the underlying soil to erosion (Dugmore et al. 2009). Pastureland in Iceland has suffered from, among other things, "ovigenic" grazing, that is grazing attributed to sheep activity, which contributes to soil erosion (Amorosi et al. 1997:499; Buckland and Dugmore 1991). Thus, the choice to keep sheep rather than goats very likely contributed to environmental impacts.

The only goats present at the MARSH sites were found at Vatnskot. These are also the only goats to be recorded in Skagafjörður at all, which perhaps indicates that they were not brought to the region in large quantities for some reason. It could be that the environment was not conducive to raising goats or that farmers were able to keep more cows and had sufficient pasture for sheep, so they had no need for goats. It is also possible that goats were not seen to be as useful as sheep since they only offer two reasonable by-products—meat and milk—whereas sheep have the wool that is vital for people to survive the harsh Icelandic winters (and even the summers). Another possibility is that goats were present on these early farms, but only in very low numbers, making their identification in the archaeological record less likely.

Caprine Body Part Representation

Body parts that are represented in an archaeofauna can tell us about how the animals were used. If some parts are missing or overrepresented, it could indicate that specific pieces are being taken off-site for some reason (provisioning someone else, bringing food on a journey), or that the site is being provisioned by someone else and getting more of one particular part of the body. The figures below will look at caprine body parts at the four MARSH sites (Figures 6.2-6.4). One note for all sites and all time periods is that, due to NABONE protocol of identifying some elements only to animal size (small, medium, or large mammal, see Chapter 4 Methods for more), ribs and vertebrae are likely underrepresented rather than absent from the collections. In the cases where they are identified, it is most likely the axis or atlas vertebrae (easier to identify to species) or ribs that were found articulated with other identifiable elements. All data is also presented as %MAU in order to normalize for differing numbers of elements in each region of the body (see Chapter 4 Methods).

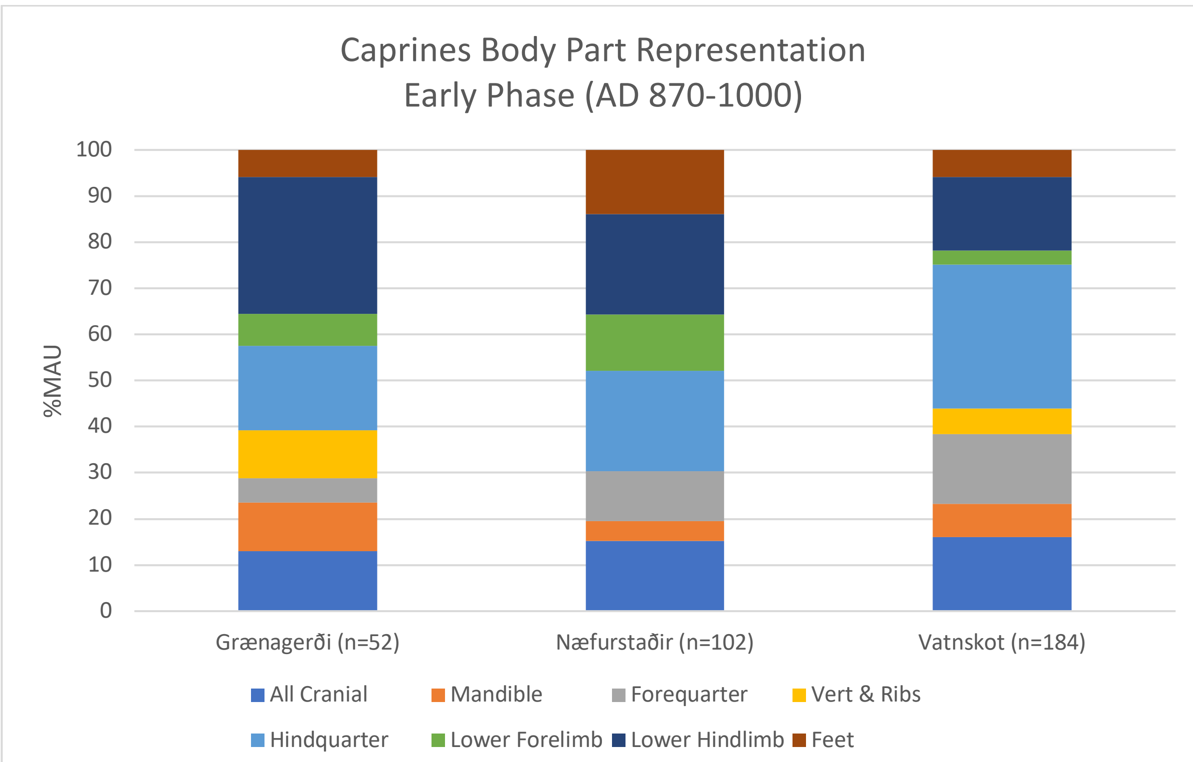

Figure 6.2. Caprine body elements in the early phase. Note that the values are presented in %MAU to normalize for differing numbers of each element in the skeleton (see Chapter 4 Methods for more information).

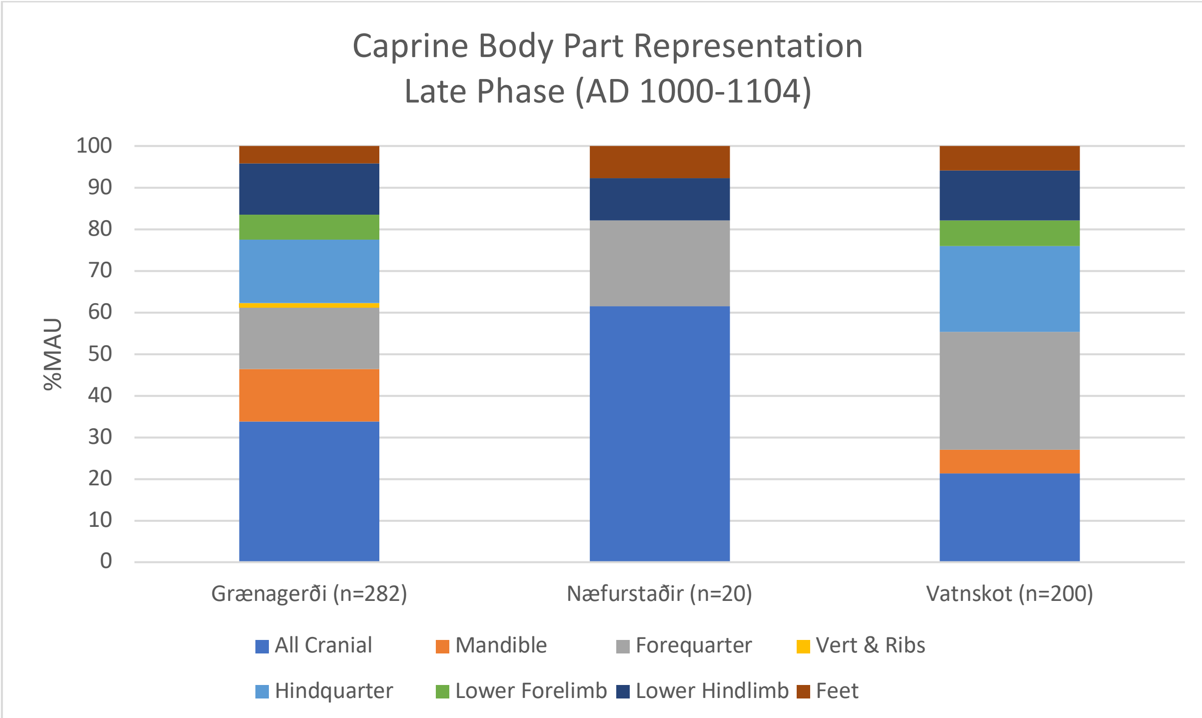

Figure 6.3. Caprine body elements in the late phase.

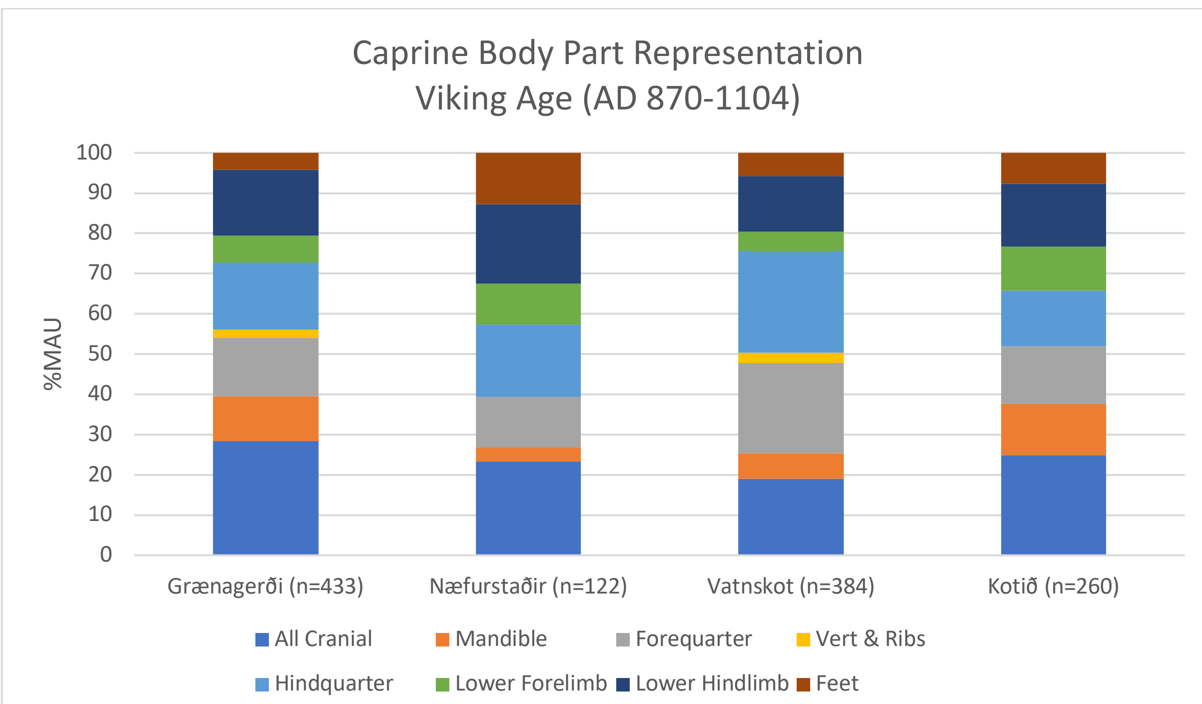

Figure 6.4. Caprine body elements in the Viking Age. This graph shows all caprine data from all periods at each site, including the unphased material from Grænagerði and all of the material from Kotið that have not been added to the prior two graphs.

All of the charts above (Figures 6.2-6.4) show caprine body part representation in each available phase. In general, all body parts are represented which shows that the caprines are being butchered and consumed on site, rather than being butchered elsewhere and pieces selectively brought back to site. Late phase Næfurstaðir has the smallest sample size, so it is not surprising that it looks like parts of the skeleton are missing. That the entire range of skeletal elements are present also makes clear that the MARSH sites are focusing on the most basic household subsistence strategy and that the people at these sites are not being provisioned with meat from somewhere else, like we see at sites like Gásir (Harrison 2013) and Gufuskálar (Feeley 2018). They also do not seem to be sending pieces of meat away, which could perhaps represent payment of taxes, rents, or integration into the domestic livestock production of a larger household unit.

Aging

Studying teeth can be a good way to tell the age of an animal. Both eruption and wear have merit in this methodology and should be used together (along with long bone fusion) for the best picture of herd composition. Tooth eruption is biological, though (mal)nutrition may also be a factor in the process of eruption (e.g., Zeder 2006). On the other hand, toothwear is heavily affected by diet and the type of plants consumed as well as grit that may be ingested during feeding (Moran and O'Connor 1994:270; Zeder 2006). Icelandic sheep tend to have heavier toothwear due to the high levels of grit in the diet. The volcanic andosols and tephra in Iceland wear down teeth faster than other soils might, and there is a tooth pathology seen in Icelandic sheep called "broken mouth" that can occur due to these conditions (McGovern 2009:229), though none of the MARSH sheep show this pathology. I have used tooth eruption (Figure 6.5), wear of the deciduous fourth premolar (dp4, a baby tooth, Figure 6.6), Mandibular Wear Score (MWS) according to Grant (1982) (Figure 6.8), and long bone fusion stages (Figure 6.9) in order to get a more thorough picture of the ages represented in these herds. In this section on aging using teeth, only those elements positively identified as sheep are included, and they are referred to as such. This is because there can be slight variation in toothwear between the caprines, since sheep and goats have different grazing preferences.

In addition to the tooth eruption and wear data from the MARSH sites, there has been an extensive study of sheep mandibles from Seyla. Since Seyla represents a large, early, wealthy farm in Skagafjörður, it makes an interesting comparison with the MARSH sites. Comparing all of these sites gives a better picture of the culling strategies, and will show if there are regional trends within Skagafjörður, or if there is clear differentiation between the regions.

Tooth Eruption

The number of MARSH mandibles that were available for aging using teeth was quite low, and Næfurstaðir did not have any mandibles at all. Seyla has more mandibles than any of the MARSH sites; however, the numbers are still rather small. The patterns that will be discussed below are, therefore, just glimpses of what might have been happening at the sites. For a proper analysis, the general recommendation is 25-30 mandibles per site, while each site in this study contains less than 30, and most have less than 15. More data would of course be better, but the combination of tooth eruption and wear along with the long bone fusion data gives a clearer picture of the animal husbandry strategies in place for sheep at these sites.

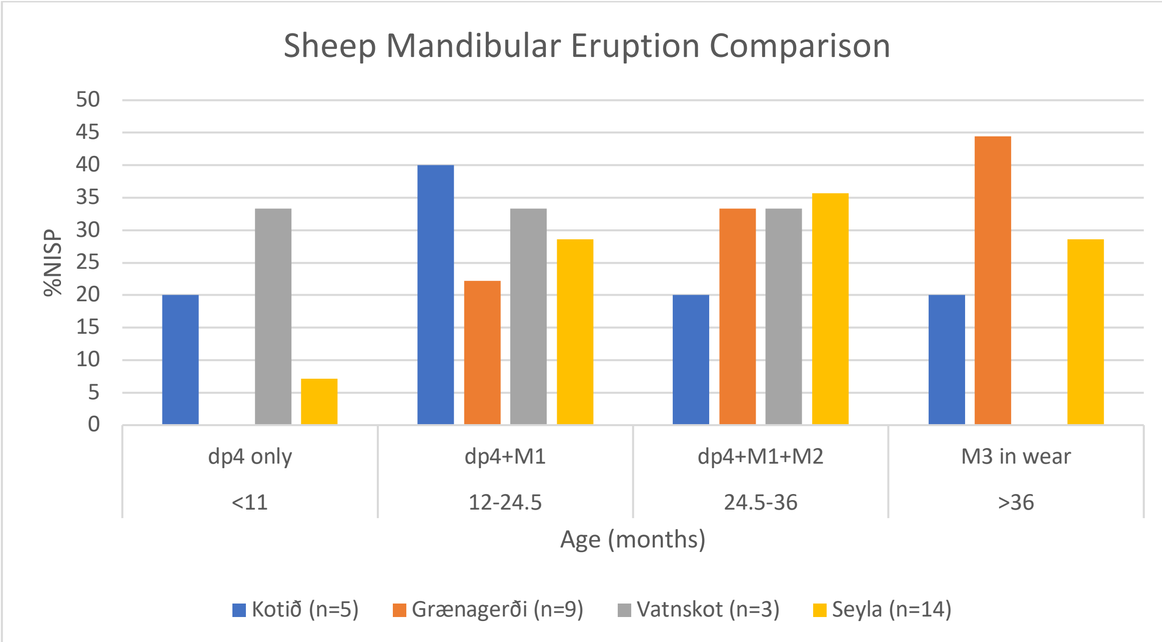

Figure 6.5. Sheep tooth eruption across the four sites in Skagafjörður. This method uses only mandibles positively identified to sheep and, to make the comparisons cleaner, aggregates all phases into the "Viking Age." Again, note that no mandibles were recovered from Næfurstaðir.

This first graph (Figure 6.5) shows only which teeth are present in the jaw. It includes only whole mandibles or mandibles for which the entire tooth row was present. The dp4 is the deciduous fourth premolar, a baby tooth that is lost by the time the M3, the third adult molar, comes into wear. It should also be mentioned that this graph only shows those mandibles that were positively identified as sheep.

From the graph, we can see that Grænagerði did not cull sheep in their first year of life, but Vatnskot, Kotið, and Seyla did. Most sheep at these sites seem to have been culled between one year and three years of age, which is nearing the prime age for meat-bearing, rather than for dairying or wool production. The final category, >36 months, does not give much more specific information for age, but that is remedied with the other methods that will be discussed below. For now, it is sufficient to see that the majority of Grænagerði sheep are culled in this "over 36 months" age, and all of the Vatnskot sheep are culled before this time. This points to a more robust meat profile rather than wool production, and the cull around 1-3 years indicates prime-age individuals with the best meat.

Tooth Wear

The wear of the dp4 is only relevant to juvenile animals. For those with a dp4 still present in the jaw, the wear stage can further differentiate age up to about two years, but the M3 erupts and starts to be in wear around the 18 month-2 year mark (e.g., Zeder 2006). The study of dp4 wear for the Skagafjörður sites (Figure 6.6) generally supports the eruption data discussed above (Figure 6.5) for the two earliest age groups. Grænagerði does not cull animals before at least four months of age according to the dp4 wear stages; however, eruption data indicates that no animals are culled before they reach their first year. This may be a factor of which mandibles were included in each methodology though, since the study of dp4 wear is not contingent on all teeth in a jaw being present. So, some of the specimens used in this methodology are not used in the eruption study above.

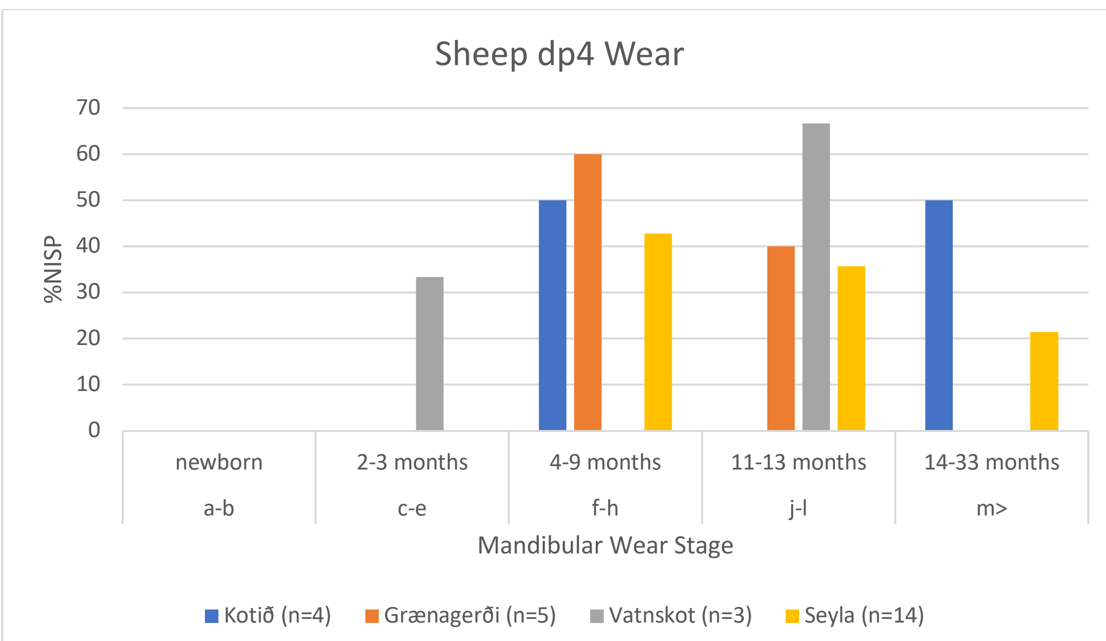

Figure 6.6. Wear of the fourth deciduous premolar (dp4) in sheep from the Skagafjörður sites. Again, the "Viking Age" numbers are used, and Næfurstaðir is excluded since no mandibles were recovered. The wear stage letters relate to the diagrams in Grant 1982.

At Seyla, eruption data indicates that most of the sheep are culled after reaching one year of age, but the dp4 wear shows that ~43% are culled in the 4-9 month range. Again, this is likely due to which mandibles are included in each study. Interestingly, only Vatnskot seems to cull animals in their first three months, and none in the 4-9 month group. This means that most of the sheep are kept through their first winter. Vatnskot and Grænagerði seem to cull most of their animals by the time they reach one year of age, while Kotið keeps about half to age two or three. Again this is in line with the eruption chart above (Figure 6.5), with the caveat that once the dp4 is lost, the M3 is in wear and the animal would not be included in this study of dp4 wear. At Vatnskot, a nearly complete skeleton of a fetal lamb was found during excavation (Figure 6.7), which may relate to their early culling strategy, or may represent a stillborn lamb.

Figure 6.7. A nearly complete fetal lamb skeleton found during excavation at Vatnskot.

Following Grant (1982), the studies of tooth eruption and wear shown in this analysis give each tooth a score which, when added together are called the Mandibular Wear Score or MWS.

Wear stages are each given a numeric score, and the stage of each tooth in a toothrow is added together to get the total MWS. These wear scores can help estimate age, and the inferred age estimates here come from Enghoff (2003:53) and McGovern (2009:225).

The estimated ages also support the other two aging-by-teeth methodologies presented in this section (Figure 6.8). A small proportion of the animals at Vatnskot and Grænagerði are culled early, around three months to one year. Vatnskot seems to cull all sheep by about their second year of life. Grænagerði has a much wider spread of ages, with some individuals making it beyond four years and even six years of life. Kotið does not start culling animals until they reach about one year of age, culls most by two years, but allows some to live to over six years. Seyla has the broadest range of culling ages, beginning around one year, but with some sheep reaching six years and beyond. There are no major peaks, though perhaps at the one-year and two-year mark there might be increased culling.

Both Vatnskot and Kotið have very small sample sizes, so their peaks are not necessarily representative of more individuals in a category. For example, each Vatnskot peak represents one individual, and 33% of the total NISP of mandibles. The culling patterns shown through these tooth eruption and wear studies will be discussed in more detail below, but each age group has a different use and these patterns can tell us a lot about the herd management strategy employed at each site.

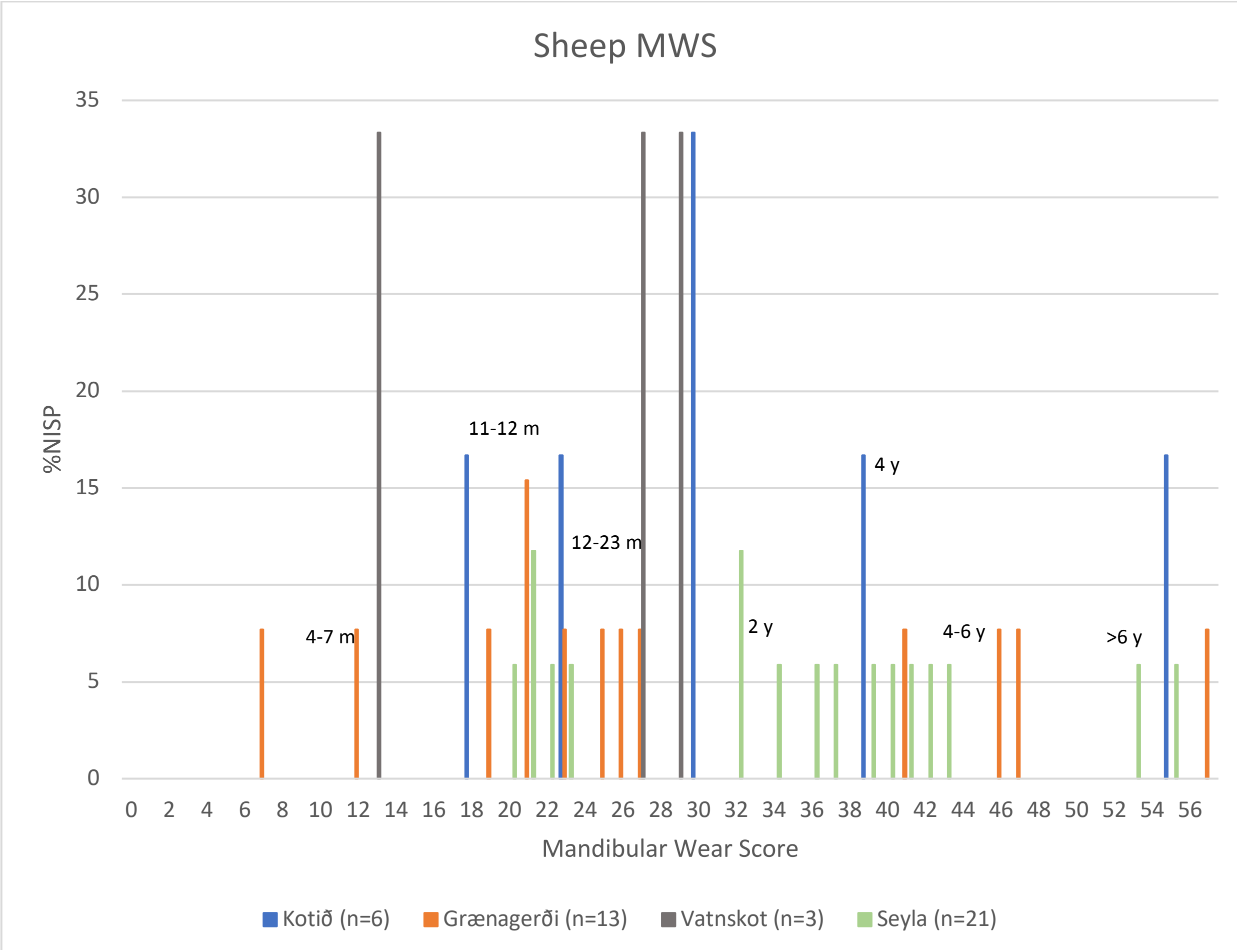

Figure 6.8. Mandibular wear score of sheep from the Skagafjörður sites. MWS is based on Grant (1982) and inferred age estimates come from McGovern (2009:225). Again, no mandibles were recovered from Næfurstaðir, so it is missing from this analysis.

Long Bone Fusion

Long bone fusion is the final aging methodology that will be discussed in this analysis. Four elements are used here, chosen since they represent a variety of age classes (Figure 6.9). The long bone fusion method includes all caprines, not just sheep, since one of the bones (the tibia) cannot always be reliably distinguished between sheep and goats (but see Zeder and Lapham 2010). Long bone fusion data from Seyla is also included in this discussion (Cesario 2016).

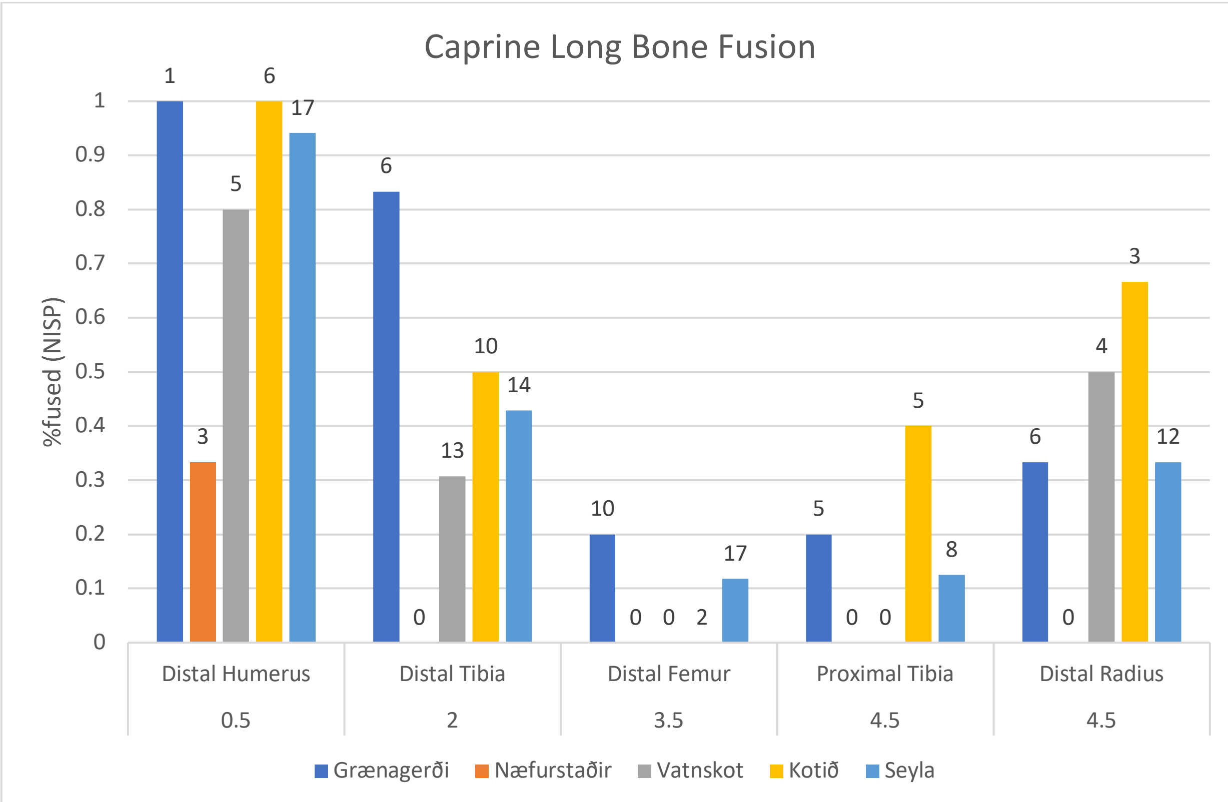

Figure 6.9. Comparison of caprine long bone fusion for all five Skagafjörður sites. Note that only the "Viking Age" numbers have been used to make the graph clearer. Labels above each column show the total NISP for each element, labels below each element represent age in years. Graph is based on McGovern (2009).

For Grænagerði and Kotið, all animals survive their first six months of life, while Næfurstaðir, Vatnskot, and Seyla either cull some individuals by this time, or they die due to natural causes like harsh weather conditions or lack of early fodder. The culling of these newborns or young animals can be an indicator of a dairy strategy, or an indicator that the farmer believed the ewe would not have been able to raise both of the lambs, as Icelandic sheep tend to give birth to twins (McGovern 2009:223). Unfortunately, Næfurstaðir only had humeri available for fusion data, so the age estimates by long bone fusion stages at Næfurstaðir is incomplete.

There is a noticeable lack of fused bones in the 2-4.5 year range. Vatnskot had no bones to age from the middle age range, 3.5 years, perhaps indicating that individuals were either culled before 3.5 years or that they were kept alive beyond that age. That many individuals survive beyond the first six months of live perhaps suggests less of a focus on milk. The culling strategies seem to point to a focus more on meat and wool.

Caprine Age Discussion

All of the methods to age the caprines that are discussed above show that a mixed herd management strategy was in place at all sites, with some variations. Many of the animals survived their first six months, though there is evidence to show that some were culled in their early months, indicating a dairy strategy. There are also older individuals that might have been kept for wool production—the best wool has been said to come from castrated male sheep (e.g., Ingimundarson 1995, 2010). However, at all sites there are few fused bones in the 3.5-4.5 year age range (see Figure 6.9), which looks like prime-age individuals being culled for their meat.

This mixed strategy is the most common one in Iceland, as it is difficult to manage a herd of sheep for just one product, but it is also "usually uneconomic to attempt to extract all possible products from the same sheep" (McGovern 2009:221; see also Ingimundarson 1995). Dairying requires the culling of very young animals, meaning fewer make it to the age where they can be useful in another way (more meat, better wool producers), while a focus on meat is very labor- and fodder-intensive, and raising animals for wool requires keeping them around for as long as possible. None of these strategies would be possible as a single focus, and mixing strategies is the most economically safe. Despite the small sample sizes from these sites, the patterns point to a mixed strategy with a tendency towards meat and away from wool production, but that still utilizes all age ranges in some proportion. It is interesting that both the MARSH sites and Seyla follow very similar culling strategies. This points to a shared economic strategy in the Viking Age that does not depend on site size or social status, but rather conforms to the Norse farming mindset.

There are also neonatal bones present in all of these assemblages, giving us more insight into the seasonality and occupation at the sites. Lambs are generally born in May to take advantage of the early parts of the growing season. The presence of animals from the entire lifespan indicates a year-round occupation, making seasonal habitation unlikely. It is an important point that the sites were occupied throughout the year, especially for the three abandoned MARSH sites, as it suggests that they began with the same economic trajectories despite social status, inferred based on site size, longevity, etc.

Cattle

Cattle were important economically for their milk and meat, but also socially and politically. Cows confer status, and in fact farms were at least partially valued based on how many cattle they could support, and much labor went into growing and collecting fodder during the summer months to support the herd over the winter (Adalsteinsson 1991:291; Amorosi et al. 1998; Fridriksson 1972; McGovern et al. 2007:29). The value of other animals used for standard payments was also measured against cows, as listed in the 12th and 13th century law codes, *Grágás* and *Jónsbók*. For example, *Grágás* defines a legal cow as being "three winters old or older, ten winters old or younger, capable of bearing calves, in milk, horned and free from defects, no worse than the average beast, fit enough to be driven from one district to another at the moving days and giving enough for a calf at milking" (Dennis et al. 2000:208).

Further, the laws then go on to describe how many cows of older age, lesser health, and/or infertile equal one "standard" cow (Dennis et al. 2000:208). Finally, the laws describe how many sheep, lambs, goats, horses, and pigs are equal to one standard cow. The numbers vary from one 4-10 year old male horse being equal to one cow, to one "sow of two winters or older with nine piglets," to "eight ewes completely barren, of three winters or older" (Dennis et al. 2000:208-209).

Jónsbók from AD 1281 instructs that pastureland needed for animals should be measured in cows as well:

> "A three winter ox shall be deemed the equivalent of a three winter cow, calves shall not be counted; a three winter horse or older the equivalent of two cows; a two winter horse or younger the equivalent of one cow, foals shall not be counted; five goats with one cow; ten old wethers with one cow; twenty lambs the equivalent of one cow. No quota of pigs shall be calculated for any land or pastureland" [Schulman 2010:161].

These few examples illustrate just how important cows were in terms of social and political norms, as well as in managing a farm.

Body Part Representation

Just like the caprines, body part representation of the cattle will tell us about the use of these animals at each site. Again, the lack of vertebrae and ribs is more likely to be due to the NABONE protocol of only identifying those elements to size-class rather than to species, unless they are found in close association (so as to be considered articulated) with other identifiable elements or if they are one of the first two vertebrae, the axis and atlas, which are much more easily identifiable to species. The results are presented here as %MAU to normalize for different numbers of bones in each skeletal category.

Early (AD 870-1000)

The data from the early phase can be seen in Figure 6.10 below. The sample size from Grænagerði is quite small (n=7), but interestingly, all elements are from the limbs—the hindquarter and feet. This could point to the site being provisioned with specific pieces of meat; however, the small sample size prohibits the idea of provisioning from being investigated further. Also, Vatnskot seems to be missing the lower forelimb (the carpals and metacarpals) and there are no mandibles represented. The parts at Næfurstaðir are relatively well-distributed throughout the body, indicating whole animals making it into the archaeological record.

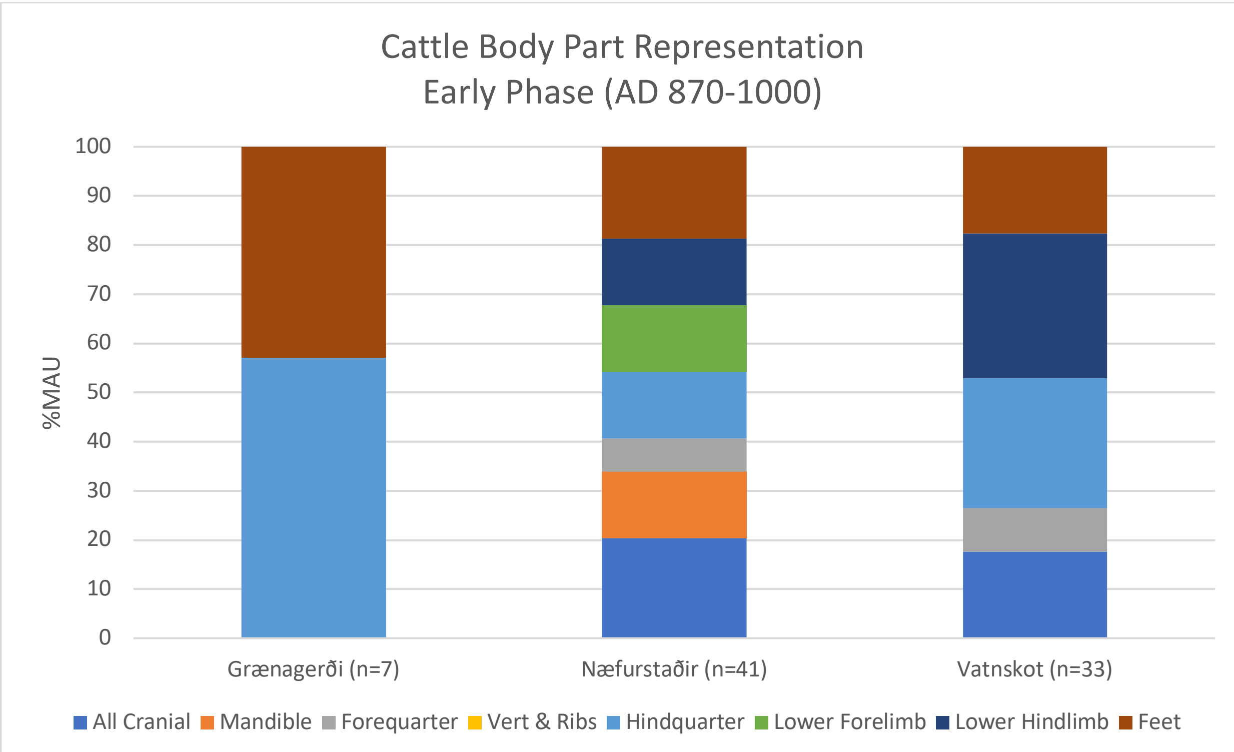

Figure 6.10. Cattle body part representation in the early phase.

Late (AD 1000-1104)

The total number of cattle bones in the late period is 128 (Figure 6.11). In this period, Næfurstaðir has a small sample size of only nine elements. These are concentrated on the limbs, and seemingly on the hind limbs, though the "feet" category could be from the front or back legs. Again, Vatnskot is missing the lower forelimb, but otherwise represents the entire skeleton. Grænagerði also has the entire skeleton represented in this phase, again pointing to whole animals being used on site.

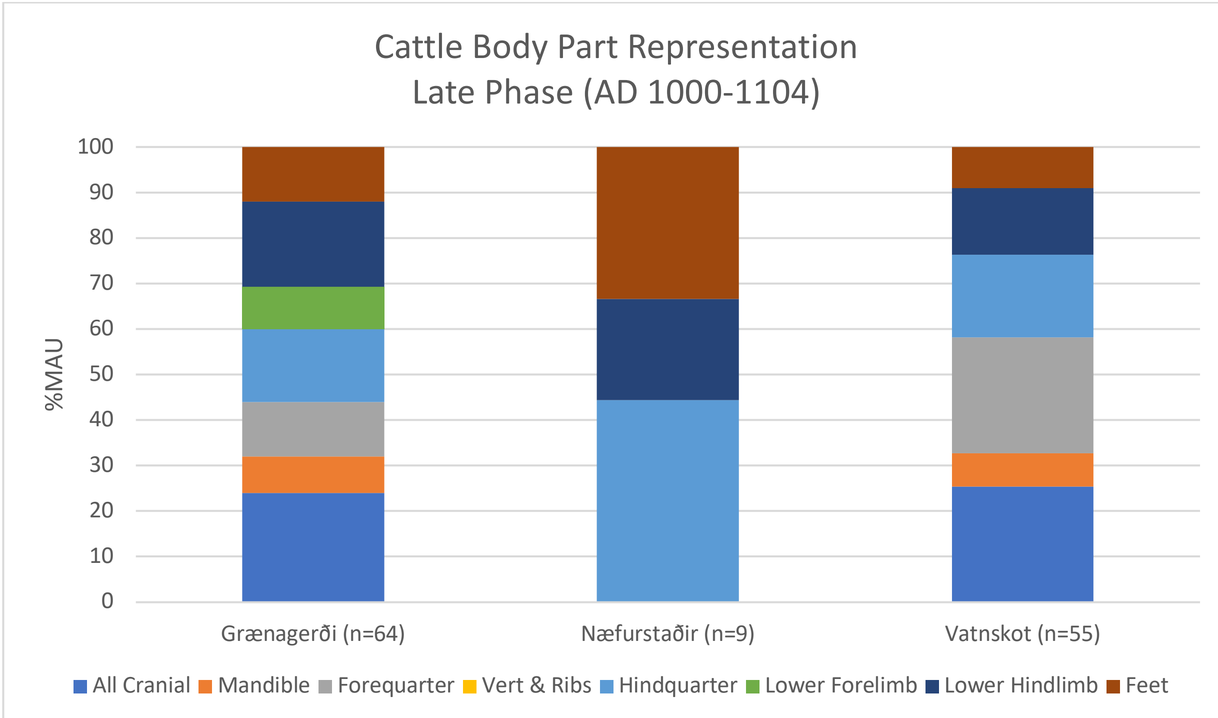

Figure 6.11. Cattle body part representation in the late phase.

Total Viking Age (AD 870-1104)

The total Viking Age assemblage includes Kotið and the unphased contexts from Grænagerði (Figure 6.12). The assemblage from Kotið represents the entire body, including an atlas vertebra that makes it the only site with information in the "vert & ribs" category. In fact, all sites, except for Vatnskot, have bones from the entire skeleton thus representing the entire body. Varying proportions are likely due to human behavior (disposal, burning, etc.) and taphonomy. Again, this makes it clear that Vatnskot is missing the lower forelimb, the carpals and metacarpals, and that there must be some behavioral reason for this. Carpals are relatively small and could be difficult to identify if they have been burned, broken, or digested by dogs; however, metacarpals are readily identifiable. It could be the case that both metacarpals and metatarsals were broken open for marrow and their identifiable ends are missing leaving only the shaft, which can at times be difficult to distinguish between fore- and hind-limb.

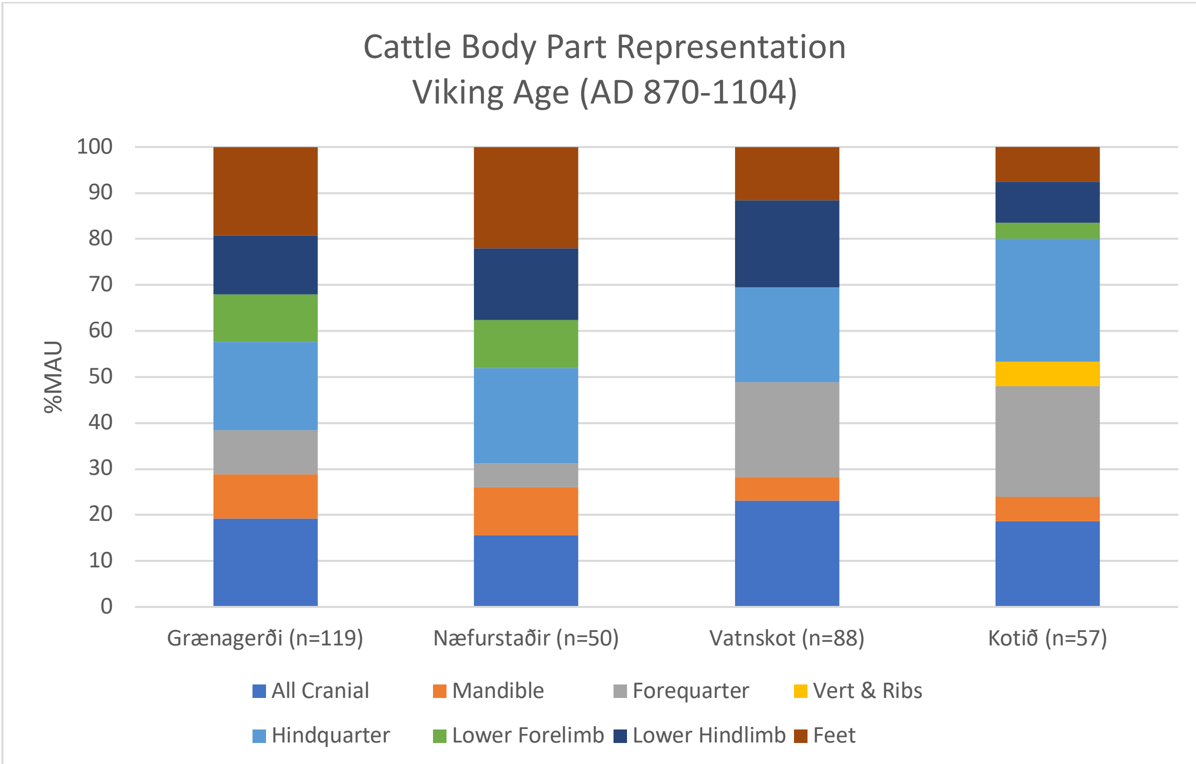

Figure 6.12. Cattle body part representation in the Viking Age. This shows the total from all phases for all sites.

For the most part, cattle are represented as whole animals at all four of the study sites. This indicates that they were provisioning themselves and represents a home butchery and consumption strategy. The missing lower forelimbs at Vatnskot are not likely to be representative of a provisioning situation where they are giving pieces of meat to someone else for some reason but are more likely to be due to taphonomy and disposal behaviors.

Aging

Normally, tooth eruption and wear are combined with long bone fusion in order to create an age profile. Unfortunately, there are no cattle mandibles present in the MARSH assemblages that can be used for aging. They were either too fragmented, had no teeth, or only had one tooth present and thus could not be used for aging. What follows is a discussion of the long bone fusion data and the number of neonatal elements present, in order to discuss the herd composition at these sites. Seyla is not included in this discussion because the number of cattle bones available (both mandibles and long bones) is too low for any real pattern to be determined.

Long Bone Fusion

The chart below (Figure 6.13) shows the cattle long bones for which fusion data were available. The numbers above the bars show the total NISP for each category, and the bars represent the percentage of those that were fused. If a bone is fused, it indicates that an animal reached that age category before it died; an unfused bone means the animal died before it reached that specific age range.

The long bone fusion data for cattle (Figure 6.13) show that different patterns of culling took place at the various farms. For example, at Grænagerði, half of the distal humeri and distal tibiae are fused, but no distal femora or radii. This means that no individuals reached 3.5-4 years of age, and some died before 2-2.5 years and even before 1-1.5 years. This preference for younger individuals could point to a dairying strategy, where newborn or very young calves are killed so that the milk can be collected for human use. Those animals that made it beyond 2-2.5 years but were culled before 3.5-4 years may have been killed for their meat, as this is a prime age for meat production (McGovern 2009:220). However, that is a very expensive strategy, as the time, labor, and fodder involved in getting an animal to the top of their growth curve is very high.

All individuals at Næfurstaðir seem to have made it past their first year of life. The data indicate that some were culled after 2-2.5 years (the two fused distal tibiae), but before 3.5-4 years, while others were culled around or after 3.5-4 years (the one fused distal radius). This points to a preference for older individuals, perhaps a more meat focused strategy rather than dairy.

At Vatnskot, again there are no individuals in the earliest age category, but the one unfused distal tibia indicates at least a few cattle were culled before they reached 2-2.5 years of age. There are also unfused femora and radii, indicating that no individuals reached 3.5-4 years. This seems to be a focus on the younger age range.

Finally, at Kotið, it seems that about half of the individuals reach 3.5-4 years (or beyond), while others are culled early (two that did not reach even 1-1.5 years). This looks like a classic milk and meat strategy, where calves are killed so humans can take the milk, but some are raised further so that they can become meat.

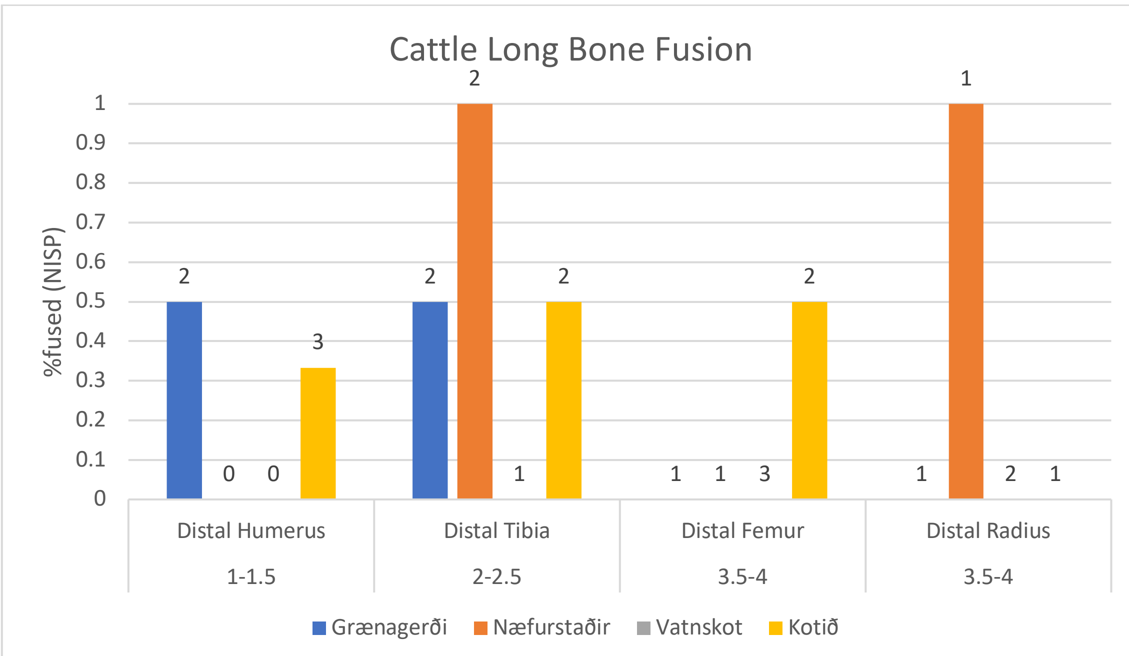

Figure 6.13. Comparison of cattle long bone fusion between all four Hegranes sites. Note that only the "Viking Age" numbers have been used to make the graph clearer. Labels above each column give the total NISP for each element, while bars show the percentage that were fused.

Neonates

Managing a herd of cattle for milk generally results in ca. 15-45% of an archaeological cattle collection being represented by neonates (Halstead 1998:13). In Iceland, the typical pattern is closer to 30-50% neonates (McGovern 2009:216). The benefit of using neonatal percentages as a point of comparison is that it utilizes the whole skeleton rather than specific elements or toothrows, unlike long bone fusion and toothwear/aging which focus on particular body parts. This makes it a robust measure, especially for smaller collections.

The presence of neonatal cattle bones in an archaeofaunal assemblage indicates an animal husbandry strategy that includes not only birthing but culling of newborn individuals in order to take the milk for human consumption. Some calves may also die in the process of being born, be stillborn, or die shortly after birth due to various complications, so the presence of neonatal bones does not *only* mean active culling. Just like the caprines, calves are generally born in May, so this pattern also tells us about the season of site occupation. While there is no evidence that the sites are only occupied seasonally, the presence of neonatal cattle (and caprines) confirms the presence of breeding stock, and humans to care for them, during the late spring.

Nearly all of the MARSH sites have at least 20% of the cattle assemblage made up of neonates, with only Vatnskot falling lower, at 18% (Figure 6.14). This in itself is a solid indicator of a dairying strategy, and places the sites within the expected range for dairy production (Halstead 1998).

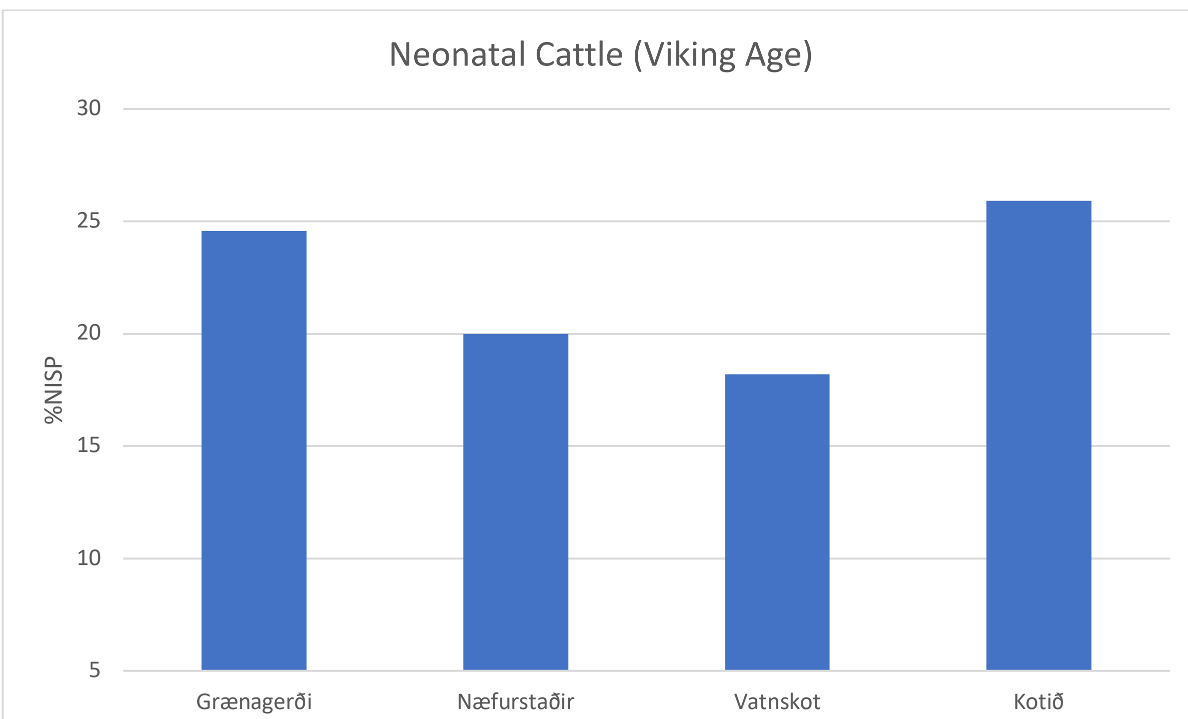

Figure 6.14. %NISP of neonatal cattle at all four sites on Hegranes. The Viking Age (composite) data is shown.

When comparing the percentages of neonatal cattle bones at the Hegranes sites with other sites across Iceland, they are generally a bit lower than the other sites, but still fall in line with the range of percentages typical of early Iceland (Figure 6.15). This means that the MARSH sites are managing their cattle herd in much the same way as other farms across Iceland. That sites of different functions, status, and location manage themselves in a similar way from the initial settlement points not only to their shared origins, but to their shared ideology of appropriate economic strategies.

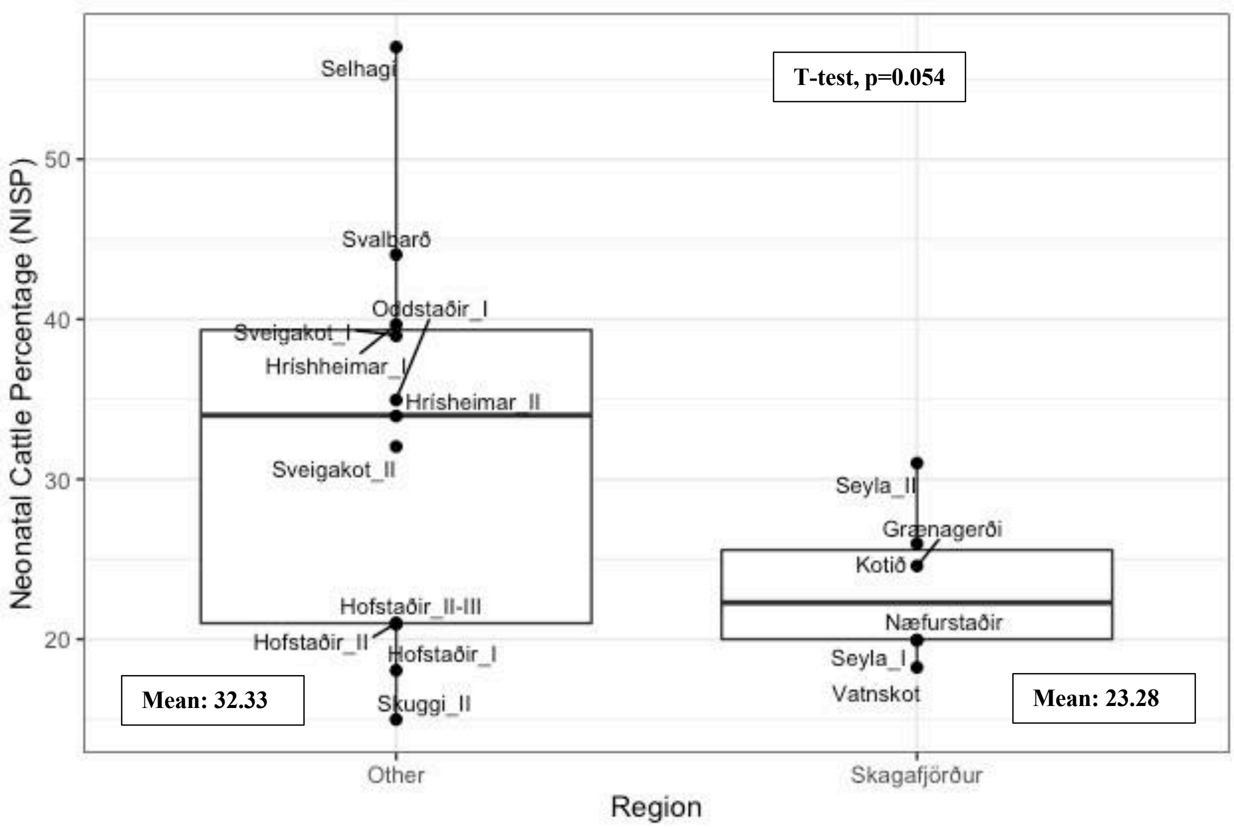

Figure 6.15. Boxplot showing the percentage of cattle that are neonates at various sites across north Iceland and Skagafjörður. The thick line in the middle of each box represents the median for each region. The sites in the "Other" category come from three regions across northern Iceland, and are the same comparative sites that have been used in other places in this dissertation.

Both the long bone fusion data and neonatal bone percentages above tell us about the composition of the cattle herds. At all sites, individuals of various ages are present, which provides evidence for a basic farming economy rather than one focused on a specific product. The presence of neonatal bones also gives us some information about the timing of site occupation, confirming on-site activity in the late spring. These lines of evidence suggest that the management of cattle at these sites is varied—they were bred for both meat and milk, and people likely made use of cattle by-products like horn and bone for craftworking.

Cattle and Caprines

In Iceland, there is a general increase in caprine use over time, especially as sheep gain importance for export of the standardized woolen cloth *vaðmál* as well as remaining a vital part of Icelandic household economy. The tradeoff seems to be that fewer cattle are kept in favor of increasing the number of sheep that can be raised. The caprine to cattle ratio is a quick measure to see how many caprines are kept per head of cattle. The figures below first examine the ratios at the Hegranes sites and then put them in context with other sites in Iceland.

The boxplot (Figure 6.16) shows the caprine to cattle ratios for the three sites where early and late phases could be separated—Næfurstaðir, Grænagerði, and Vatnskot. The caprine to cattle ratios go down over time, though the change is not statistically significant ($p=0.49$). However, the changing ratio is still interesting, and there are multiple potential causes. One possibility for a lower caprine to cattle ratio is that fewer caprines are being kept over time. This is not the pattern we would expect to see in Iceland, where sheep usually become more important over time. This could represent a decrease in goats, though only Vatnskot had positively identifiable goats. Another option is to keep more cattle while keeping the number of caprines relatively stable. It is also possible that they began to keep more cattle, perhaps in an effort to establish a proper farm that relied less on wild resources.

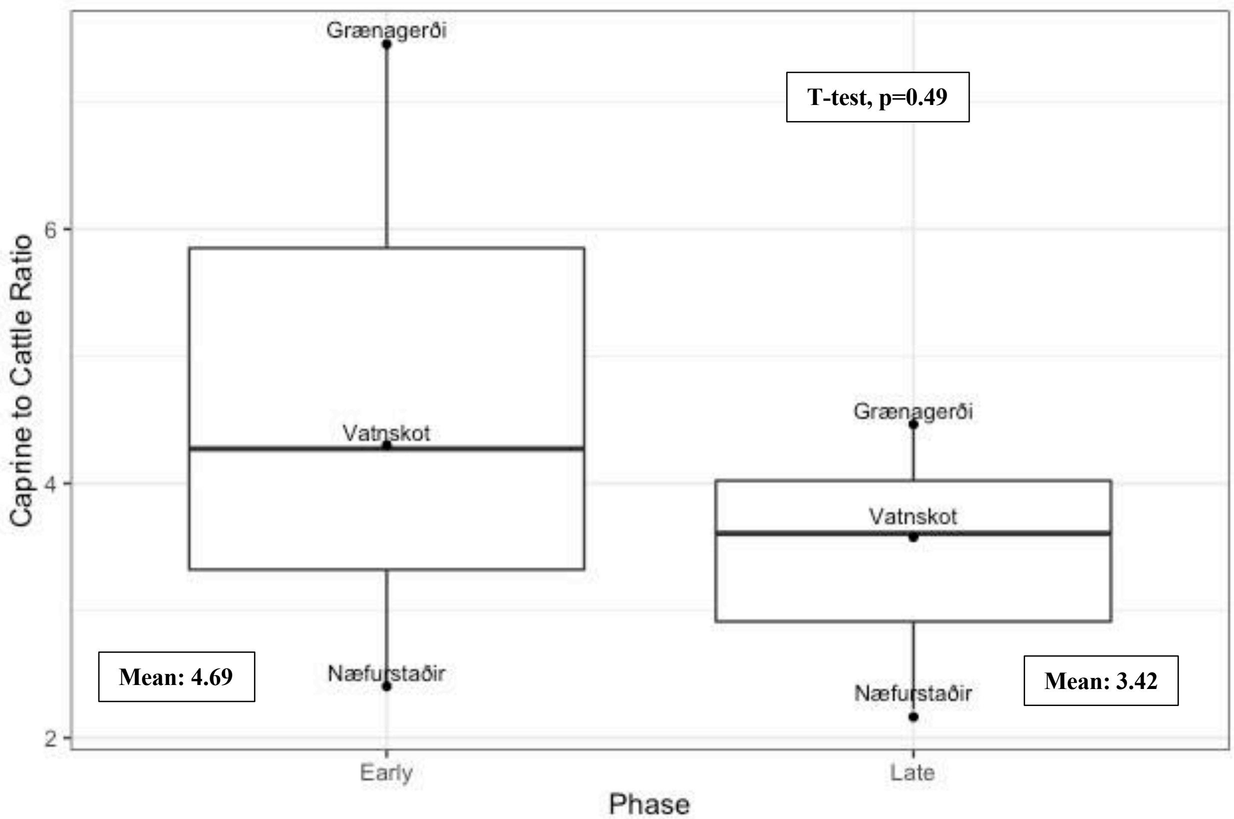

Figure 6.16. Boxplot showing the caprine to cattle ratios for the early and late phases on Hegranes. The thick line in the middle of the box shows the median for each time period. The late phase has a lower mean and median and the sites have lower ratios overall.

By looking at the raw numbers of each species in the two phases, the cause of the shift in herd management strategies over time can be understood (Figure 6.17). The raw counts of caprine and cattle bones at both Grænagerði and Vatnskot increase in the late phase, while the raw counts at Næfurstaðir actually decrease. What is interesting is that the numbers are correlated—as the number of caprine bones increases or decreases, so do the number of cattle bones. This means that the strategies themselves are not changing all that much, but that the actual herd size is what changes. Again, the change in ratios is not statistically significant, and likely does not reflect actual changes in herding dynamics.

One aspect of caprine-keeping that can be understood through the caprine to cattle ratio is the potential for wool production. For household use, McGovern et al. (2014) suggest that small farms with a low ratio (1:2-1:6) will only just be able to produce enough wool for the household. A ratio above 1:15 is quite likely to be involved in surplus wool production (McGovern et al. 2014). It is clear that none of the MARSH sites were producing surplus wool; even the broader Viking Age comparisons (Figure 6.20) show that very few farms would have been involved in surplus wool production during the Viking Age (McGovern et al. 2014).

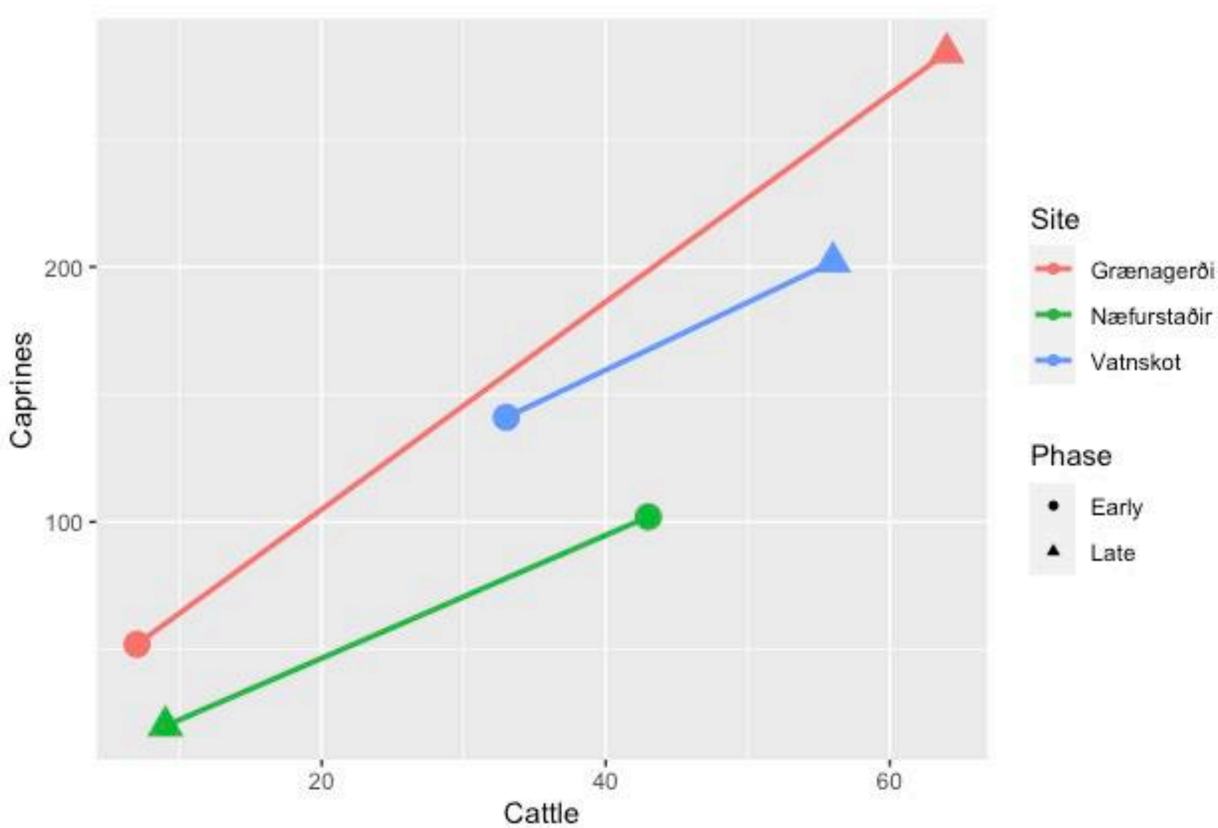

Figure 6.17. Raw counts of cattle and caprines at three Hegranes sites. This shows change over time, from the early phase to the late phase, of cattle and caprines.

To put the Hegranes caprine to cattle ratios in context with other contemporaneous sites in Iceland, the Viking Age (total) ratios will be used. When we compare the total caprine to cattle ratios from the Hegranes sites to other sites in Iceland, it becomes clear that they are well within the same range (Figure 6.18-Figure 6.20). The sites shown in Figure 6.18-Figure 6.20 are all in northern Iceland, though they range in size, status, and date. Figure 6.18 shows the raw counts of cattle and caprine bones and includes sites with very large NISPs (Hjálmarvík and Hofstaðir phase II) which obscure the sites with smaller sample sizes. Figure 6.19 zooms in on the lower end of the graph, cutting out the outliers in order to show the majority of the sites better. In Figure 6.19, it becomes clear that the Skagafjörður sites cluster in the same area as the sites from other regions and therefore do not appear to be outliers in any way.

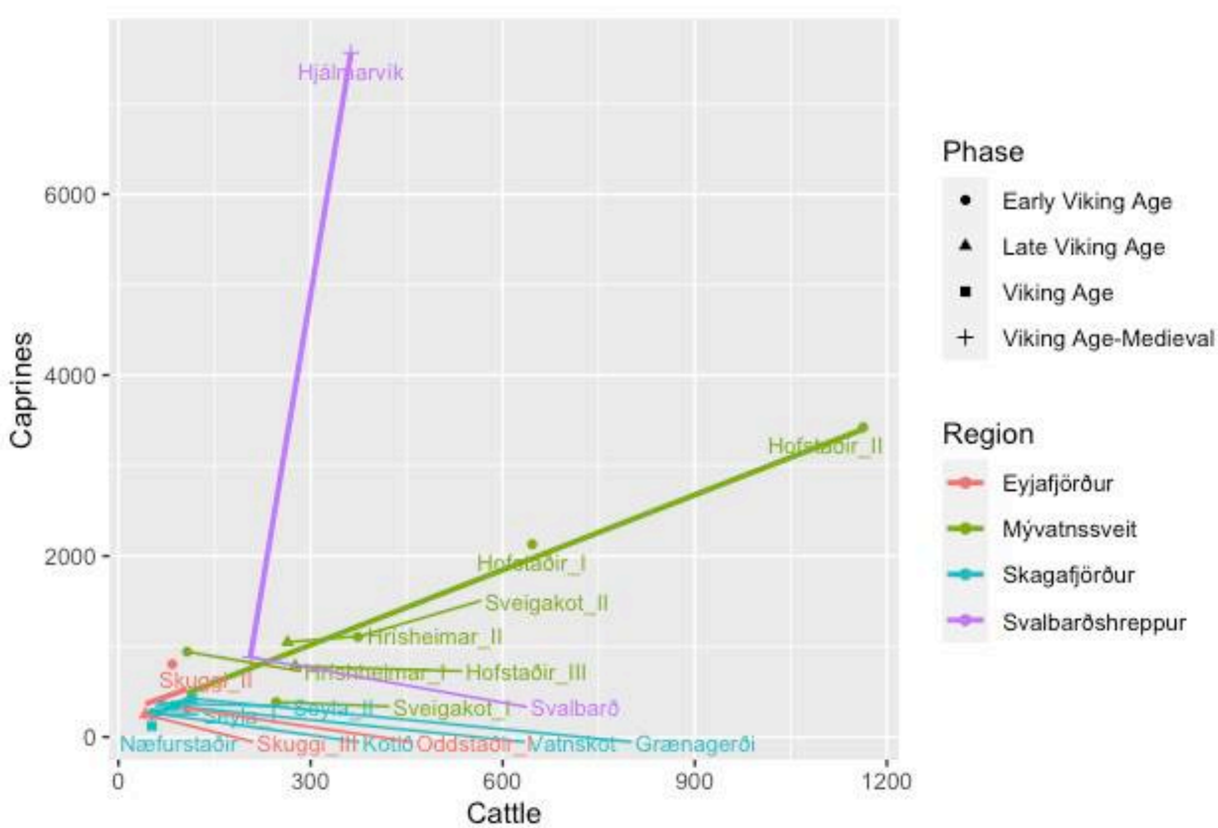

Figure 6.18. Raw counts (NISP) of cattle and caprines at a variety of sites across northern Iceland. The thick colored lines represent the average for each region. Both Hjálmarvík and Hofstaðir phase II have large NISP counts, so they obscure the lower end of the graph.

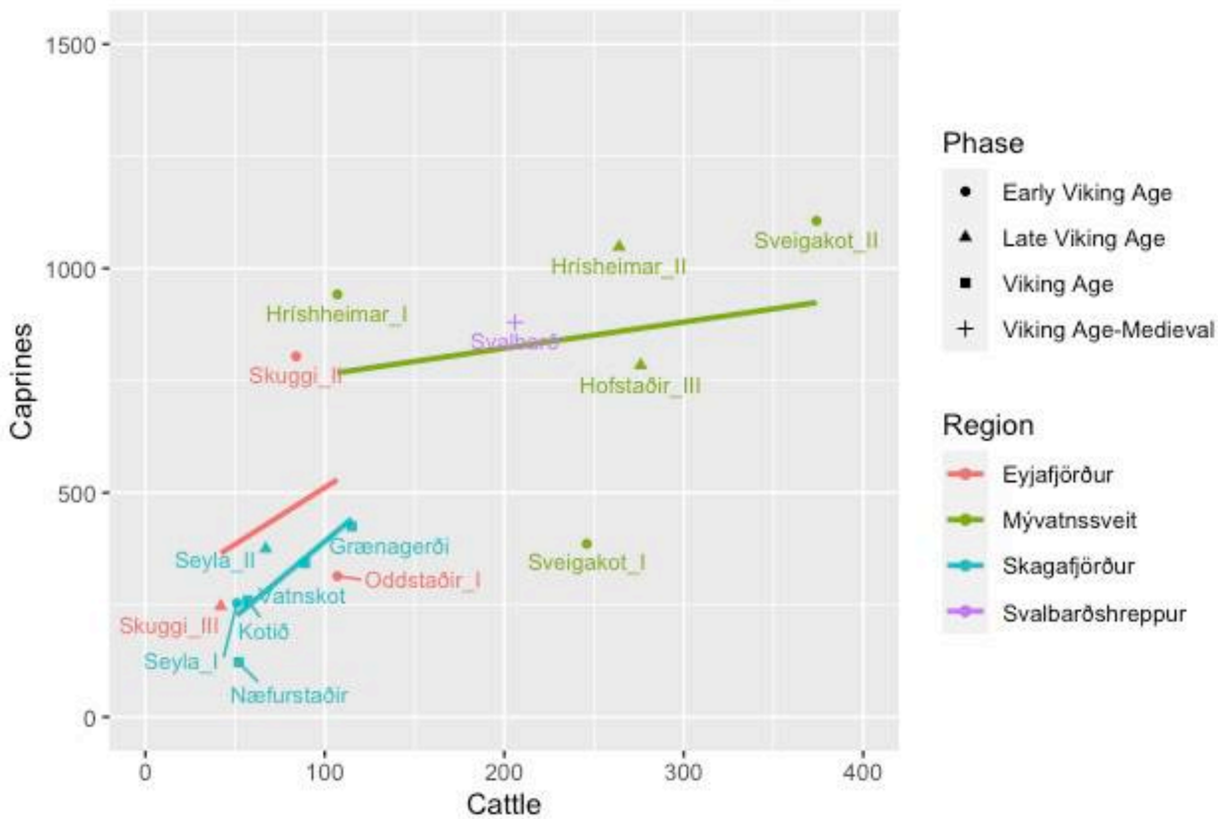

Figure 6.19. Close up of the lower end of Figure 6.18. This cuts off the outliers, but does not make any transformation of the data. Again, this graph shows the raw counts (NISP) of cattle and caprines and the thick colored lines represent the average for each region, where it can be calculated.

Finally, Figure 6.20 presents a boxplot that shows how the caprine to cattle ratios in Skagafjörður compare to the other three regions. The Skagafjörður sites cluster much more tightly than the others, perhaps because of the smaller number of sites, or perhaps because of a regional trend. Ignoring Hjálmarvík, an obvious outlier, the two categories are quite similar, and the differences between them are not statistically significant (p=0.32). That these small, abandoned sites are employing the same general animal husbandry strategies as sites elsewhere also points to their use, at least in the early period, being similar to farms in the rest of Iceland. In addition, that the caprine to cattle ratios at wealthy farms and at small, abandoned sites are similar may suggest that the inhabitants at the early abandoned sites were not necessarily of lower status or socially marginal. In the Skagafjörður category, the large wealthy farm Seyla, located in neighboring

Langholt, is included, and has very similar ratios to the Hegranes sites. This indicates that there may be intra-regional similarities in the way that livestock herds are managed—Hegranes does not seem to be all that different from its nearby neighbors, despite differences in site size and potentially in social status.

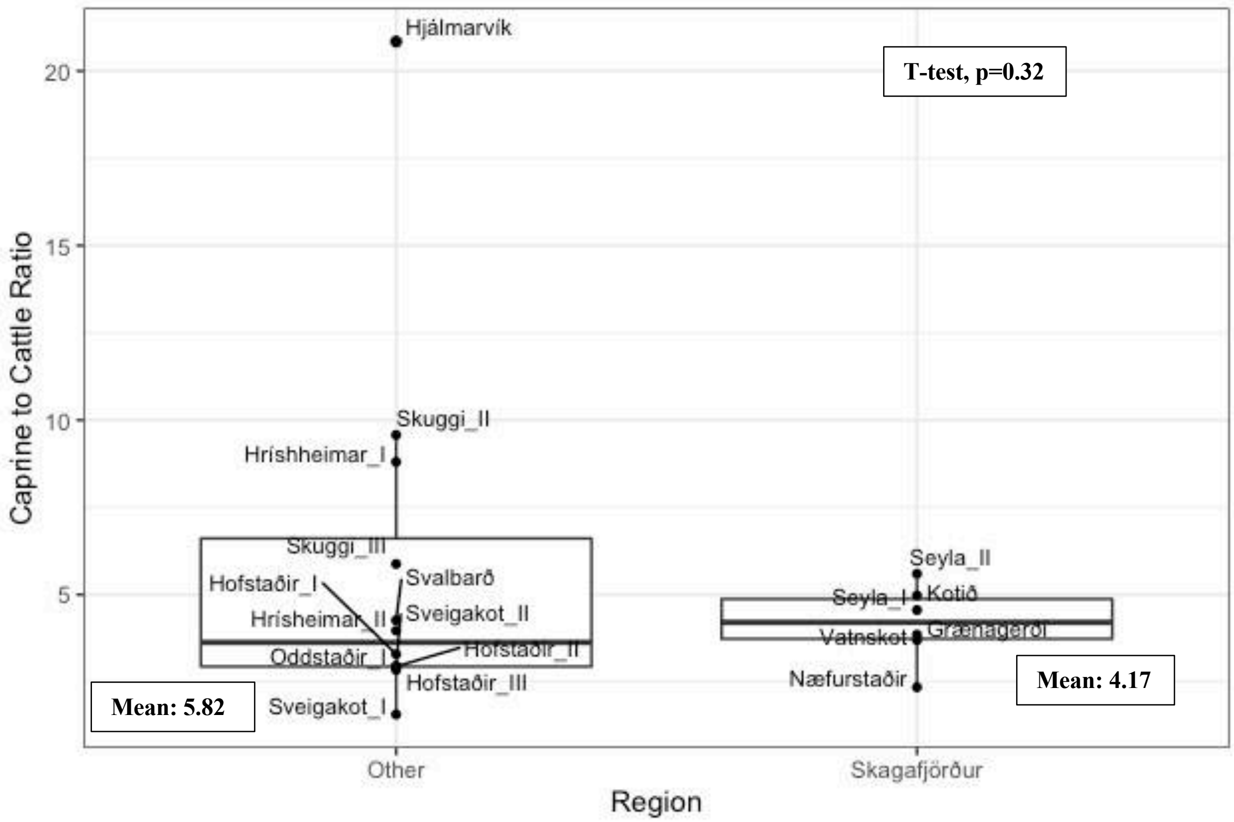

Figure 6.20. Boxplot showing how the caprine to cattle ratios from sites in Skagafjörður compare to sites in other regions of northern Iceland. The "other" sites are the same as those shown in Figure 6.18 and Figure 6.19. The thick line in the middle of each box represents the median for each group.

Pigs

Pigs (*Sus scrofa*) were part of the initial settlement package, but they never became a common livestock animal in Iceland. They could have played a key role in the initial challenge of clearing woodland for home fields. Beginning around AD 1200, we start to see very few pigs in Icelandic archaeofauna, and their presence remains low thereafter (Brewington et al. 2015; McGovern et al. 2014). Pigs can either be free-range or kept penned, and the keeping of pigs may have been a signature of high status chieftains and an ideal for others to work towards (Perdikaris 1990). Pigs in the Faroes were carefully managed to protect barley fields and puffin nesting habitats (Brewington 2015), and seem to have also been penned in early Iceland, at least in Mývatnssveit, to manage woodlands and defend duck colonies (Brewington et al. 2015).

The percentage of pigs kept in relation to other domesticates at various sites across northern Iceland, including Skagafjörður, is shown in the boxplot below in order to see how Skagafjörður compares with other regions (Figure 6.21). As is the case for cattle and caprines, Hjálmarvík is an outlier, probably due to its looser phasing and very large NISP. The boxplot shows that Skagafjörður pig-keeping is not very different from other regions and any differences are not statistically significant (p=0.37).

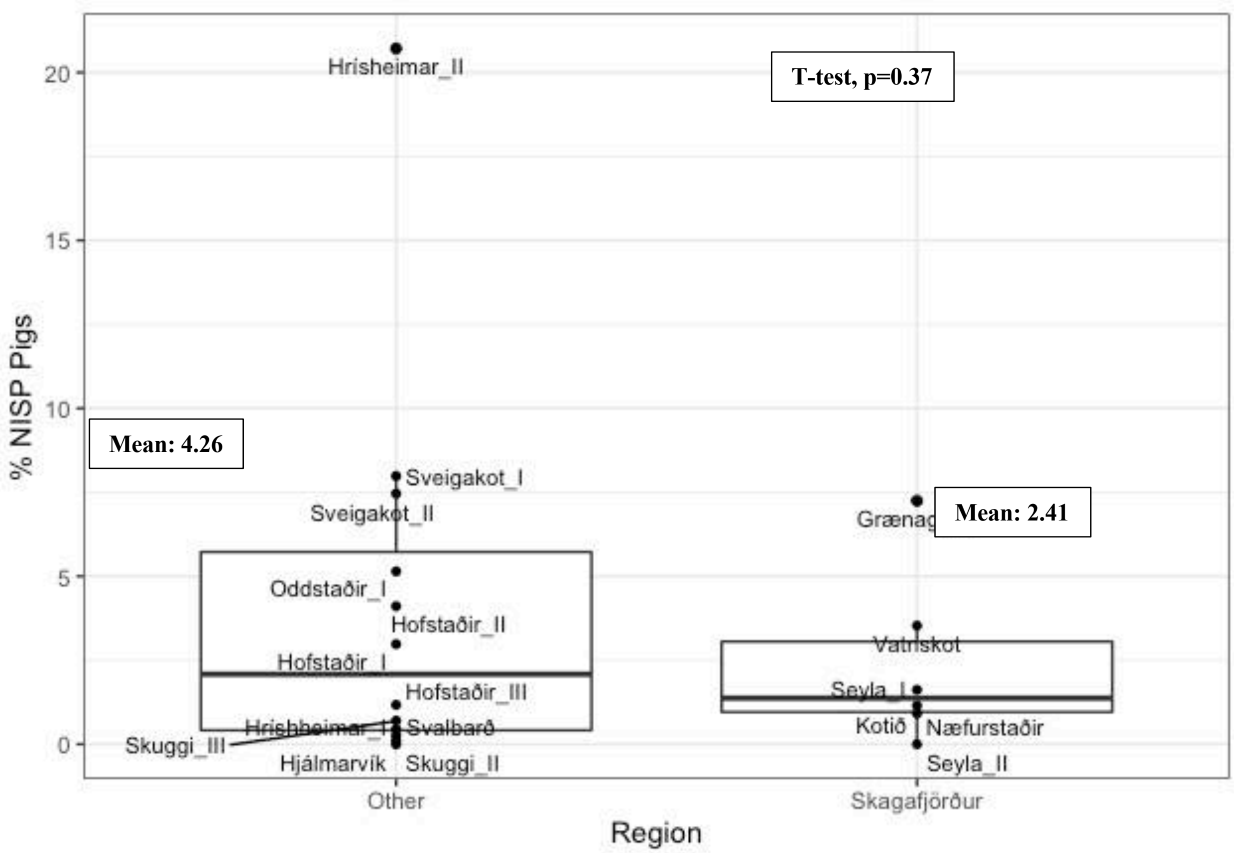

Figure 6.21. Boxplot showing the percentage of domesticates made up by pigs at various contemporaneous sites across northern Iceland. The thick black line in each box represents the median for each group.

Aging

Most of the pig remains from these four sites are teeth or tooth fragments, but some long bones are present. Both of these categories are used for aging and discussed below, beginning with a discussion of the pig mandibles with teeth present and followed by long bone fusion.

Teeth

The aging of pig teeth based on eruption is fraught with inconsistent information from various researchers over time. Legge (2013) compiles the most commonly cited studies on pig tooth eruption, and looks at four kinds of pigs—domestic, feral, captive wild, and free wild. The data presented below will use Legge's average ages of tooth eruption based on all the studies he combined, and the age estimates will follow Lemoine et al. (2014). Tooth wear was recorded according to Grant (1982).

Two pig mandibles were present that could be assessed for age estimates, both from the late phase (AD 1000-1104). The first mandible is from Vatnskot. According to tooth eruption, this individual was between about six and 11 months of age—the first adult molar is present and in wear (erupts ~5-6 months, Legge 2013), but the second molar is only visible by a perforation in the bone. Tooth wear scoring on this mandible puts the individual into Lemoine et al.'s (2014) age class 3, refining the age closer to 6-8 months.

The mandible from Grænagerði has all adult teeth present and in wear. The final adult tooth, the third molar, can erupt anywhere between 21-24 months (Legge 2013). This puts the individual over 24 months of age, as the tooth is fully erupted and in wear, scored at wear stage "d" according to Grant (1982). This falls into Lemoine et al.'s (2014) age class 8, making this individual somewhere between 52-72 months old.

Long Bone Fusion

Long bone fusion ages presented below (Figure 6.22) are based on Zeder et al. (2015). Only one bone was categorized as "fusing" according to the NABONE system, but was counted as fused here, since the line of fusion was barely visible. No attempt was made to eliminate the possibility of double counting an individual. It is possible that, for example, the five metapodials from Vatnskot are from the same animal. Indeed, this does appear to be the case, since all of the metapodials were at the same stage of fusion. However, the numbers of pig bones are quite low, and one site—Næfurstaðir—had no bones that could be used in this aging study.

The long bone fusion data indicate that most individuals did not live beyond about 36-48 months of age. At least one individual died before reaching 6-7 months, as shown by the unfused axis vertebra at Kotið.

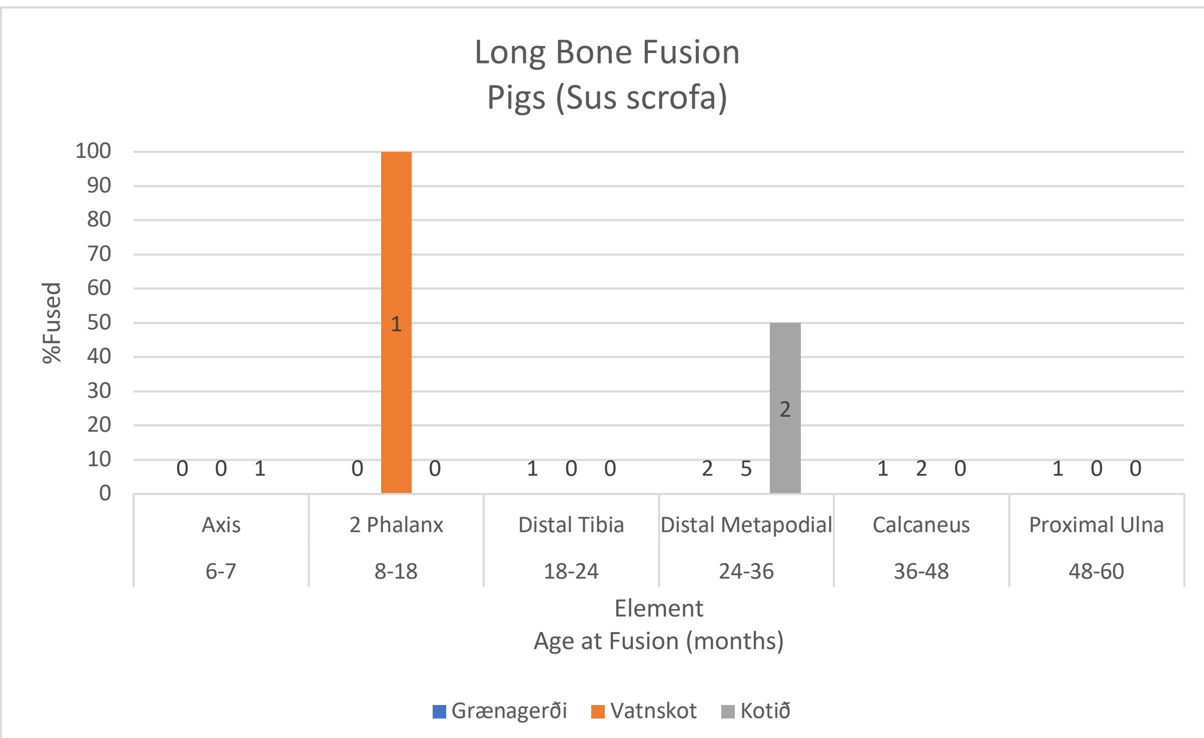

Figure 6.22. Long bone fusion stages in pigs over the entire Viking Age period. The numbers above each bar indicate the total NISP, while the bar itself represents the percentage of each category that was actually fused.

Pig Aging Conclusions

The long bone fusion and tooth wear and eruption profiles for the pigs consist of very small sample sizes. Despite this, there is general agreement between the two. The Grænagerði mandible falls far outside the age estimates given by the long bone fusion for any of the sites. No individuals live beyond 24-36 months according to the fusion data, but the Grænagerði mandible represents an individual between 52-72 months. The Vatnskot mandible does not have a correlate in the long bone fusion, but it is closer to the pattern we see where younger animals are more commonly present. While these data do not match up perfectly, they point to a general strategy where younger animals are culled and most are not surviving beyond three years of age. It is possible that the animals are being killed at/near the top of their growth curve to maximize meat offtake; however, pigs are rather expensive to take care of, and can also be a nuisance as they will eat anything they can find. Another possibility is that pigs were culled after people completed their landscape clearance and early niche construction activities and pigs were no longer useful.

Domesticates Discussion

The caprines, cattle, and pigs presented above make up the majority of the domesticates present in the archaeofauna at these sites. In general, most farms in Iceland are primarily comprised of caprines and then cattle, in terms of numbers, and the MARSH sites follow this pattern. The age ranges of both caprines and cattle indicate mixed economies of meat/milk/wool and meat/milk for each taxon, respectively. This is to be expected, as mixed economies make the best use of a herd while mitigating the risks of focusing on a single strategy.

Interestingly, the relationship of the numbers of caprines to cattle is correlated—when one species goes up, the other goes up as well, and the same is true for when numbers of these animals decrease (Figure 6.17). This pattern supports the Viking Age use of caprines, which were mostly sheep, for household production activities rather than surplus production, which does not become common until *vaðmál* becomes a standardized form of legal currency around the 12th century (Hayeur Smith 2012a).

Since there are very few goats, it is not possible to say anything about their early use. However, the presence of pigs, and the increase in pig use during the later period at Grænagerði, may indicate landscape domestication activities that revolve around clearing woodlands. Goats could have been used for this niche construction as well, but perhaps there were enough pigs to not need goats. Pigs reproduce rather quickly, so they may have been preferred for landscape clearance over goats. Once the landscape was sufficiently modified and people were ready to maintain the land rather than clear it, the pigs would have become much less useful, and their fodder needs too expensive to justify keeping them.

Overall, the domesticate patterns at the four MARSH sites look like farms we see elsewhere in Iceland with small variations. The body parts represented, age ranges, and proportions of animals kept all fall in line with other typical farms. A comparison between the MARSH sites and Seyla also shows shared economic patterns within Skagafjörður and supports the idea that Viking Age domesticate strategies are fairly similar despite site size or status. This evidence all supports the idea that the inhabitants on Hegranes were participating in normal farming activities, as prescribed by Norse social memory, though they also undertook specialized labor related to procuring and processing wild animal resources, as will be discussed in the next two chapters.

Chapter 7. The Fish

Norse exploitation of marine fish has its origins in Iron Age Norway with air-dried fish (Perdikaris 1998; Perdikaris and McGovern 2008b). Some of the written sources indicate that the chieftains who first settled Iceland were from the "seagoing aristocracy of North Norway" (Perdikaris et al. 2007:52). Thus, just as the domesticate-focused farming system is transferred across the North Atlantic islands with the first Norse settlers, so too is marine fishing and fish drying (Perdikaris et al. 2007; Perdikaris and McGovern 2008b). Edvardsson (2010:270) notes that the early fishing system in Iceland mixed basic subsistence use with local trade and exchange, before ramping up to the global commercialization and export of dried fish that came in the 13th century (Edvardsson 2010; Keller 2010; Vésteinsson 2016).

Barrett et al. (2004) describe a Fish Event Horizon (FEH) around AD 950-1050 in Britain. This is when major increases of marine fish, especially of the cod family, at inland sites (further than 10 km from the coast) can be seen in the archaeological record, and they note that it represents the beginning of intensive marine resource exploitation (Barrett et al. 2004:2420). Outside of Britain, fish middens become more common after AD 1050 as well (see sites referenced in Perdikaris et al. 2007:52), though Norway, the Faroes, and Iceland also have significant numbers of fish prior to the FEH. Icelandic zooarchaeological data have shown that marine fish have been intensely exploited since the settlement. Early sites in Mývatnssveit, located 60 km inland, have marine fish bone signatures that show internal trade of dried stockfish much before the FEH (McGovern 2009; McGovern et al. 2006; McGovern and Perdikaris 2003; Vésteinsson et al. 2002).

The early production of dried fish in Iceland started a local trade and exchange network that moved marine fish to inland sites as a dried product (McGovern et al. 2006). Compared to the heavily standardized stockfish industry that began later and focused on cod in specific size windows, the early dried fish producers utilized more species, a wider variety of fish sizes, and created two main products—flat-dried and round-dried, the latter of which is also known as stockfish or *skreið*.

Fish in Iceland

To highlight fish production and/or consumption, Perdikaris et al. (2007:52) suggest first using the most basic ratio of fish to mammal bones in an archaeofauna. The graph below (Figure 7.1) shows this ratio for the MARSH sites, as well as for sites across the North Atlantic that were comparably excavated and are in similar time periods. Sites from Iron Age Norway are included to show the patterns in the place where they are thought to originate.

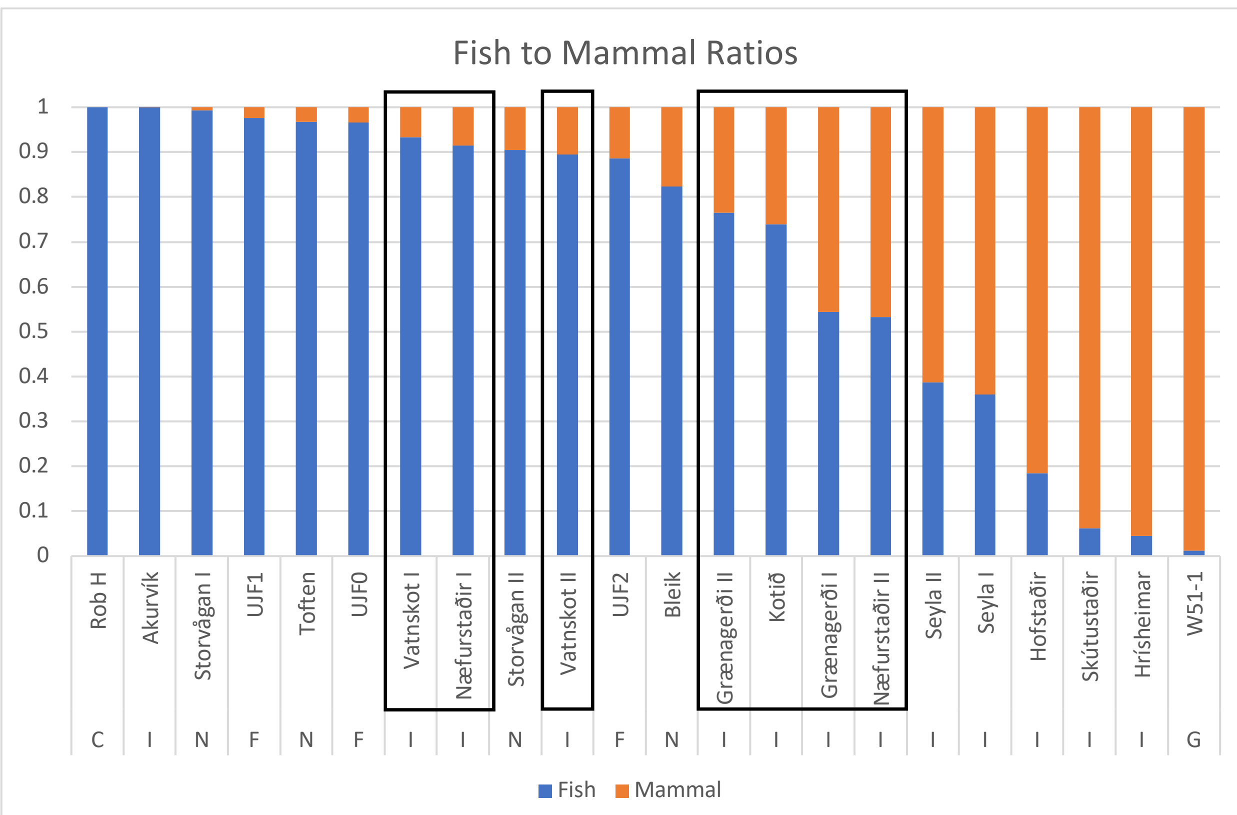

Figure 7.1. Sites from the Iron Age, early Viking Age, and late Viking Age. Locations range from Norway (N), Iceland (I), the Faroe Islands (F), Greenland (G), and Caithness (C). This graph is modeled after Perdikaris et al. (2007:53, Figure 1) and some of the data sources therein. For descriptive statistics see Table 7.1, for site codes and references, see Table 7.2.

The graph above shows that the Hegranes sites (highlighted with black rectangles) look most similar to Iron Age Norway and the Faroes. Most of the other early Icelandic sites are located in Mývatnssveit, about 60 km inland. In the late Viking Age/Medieval period, the Icelandic site of Akurvík (AKV) is included to show what a specialized fishing site looks like. The single Greenlandic site is also interesting as it shows a very small percentage of fish being used. Instead of marine fish, the Norse in Greenland heavily exploited seals; explanations for this include labor shortage and religious restrictions (McGovern 1980; Perdikaris and McGovern 2008a), though (Smiarowski et al. 2017:153) suggest that labor scheduling is the more likely explanation. With marine fishing, and especially the drying of these fish during the winter, being such a big part of the Norse economic strategy from Norway to Iceland, it seems odd that Norse Greenlanders would not take advantage of this resource. The climate in Greenland may also be responsible for this—it likely would have been too cold to successfully dry fish in the winter (Smiarowski et al. 2017:153).

Table 7.1. Descriptive statistics by time period for the sites presented in Figure 7.1.

	Iron Age		**Early Viking Age**		**Late Viking Age/Medieval**	
	Mammals	**Fish**	**Mammals**	**Fish**	**Mammals**	**Fish**
Mean	10.499	89.50	47.85	52.15	18.19	81.81
Median	10.499	89.50	45.59	54.41	10.49	89.51
Standard Deviation	10.20		40.20		21.93	
Interquartile Range	7.22		80.15		22.74	

There is one more Icelandic site that is included in Figure 7.1 that will be an integral part to this fish discussion. The site of Seyla is located in Langholt, Skagafjörður, directly southwest of Hegranes. This site shows more mammals than fish but does not look quite like the inland sites in Mývatn because Seyla utilized more fish (over 30%) while the Mývatn sites had less than 20% fish in their assemblages. There seems to be a connection between the Hegranes sites and Langholt which will be discussed further below.

Table 7.2. Site codes and references for data sources presented in Figure 7.1.

Site Code	Site Name (Region)	Time Period	Reference
--	Bleik	Iron Age (~AD 50)	Perdikaris 1998
--	Toften	Iron Age (AD 400-600)	Perdikaris 1998
--	Hrísheimar (Mývatn)	9^{th}-10^{th} c (Early Viking Age)	McGovern et al. 2006
--	Skútustaðir (Mývatn)	9^{th}-10^{th} c (Early Viking Age)	Hicks n.d.
--	Hofstaðir (Mývatn)	10^{th}-11^{th} (Early Viking Age)	McGovern 2009
--	Kotið (Skagafjörður)	9^{th}-12^{th} c (Early Viking Age)	Cesario 2018b
Grænagerði I	Grænagerði (Skagafjörður)	9^{th}-11^{th} c (Early Viking Age)	Cesario 2018a
Næfurstaðir I	Næfurstaðir (Skagafjörður)	9^{th}-11^{th} c (Early Viking Age)	Cesario 2019b
Vatnskot I	Vatnskot (Skagafjörður)	9^{th}-11^{th} c (Early Viking Age)	Cesario 2019a
Seyla I	Stóra-Seyla (Skagafjörður)	9^{th}-10^{th} c (Early Viking Age)	Cesario 2016
UJF0	Undir Junkarinsfløtti	8^{th}-10^{th} c (Early Viking Age)	Brewington 2015
UJF1	Undir Junkarinsfløtti	9^{th}-12^{th} c (Early Viking Age)	Brewington 2015
W51-1	Sandnes	AD 1025-1150 (Early Viking Age)	McGovern et al. 1996
Storvågan I	Storvågan	10^{th}-12^{th} c (Late Viking Age/Medieval)	Perdikaris 1998
Storvågan II	Storvågan	13^{th} c (Late Viking Age/Medieval)	Perdikaris 1998
--	Akurvík (Westfjords)	15^{th} c (Late Viking Age/Medieval)	Amundsen et al. 2004
Grænagerði II	Grænagerði (Skagafjörður)	11^{th}-12^{th} c (Late Viking Age/Medieval)	Cesario 2018a
Næfurstaðir II	Næfurstaðir (Skagafjörður)	11^{th}-12^{th} c (Late Viking Age/Medieval)	Cesario 2019b
Vatnskot II	Vatnskot (Skagafjörður)	11^{th}-12^{th} c (Late Viking Age/Medieval)	Cesario 2019a
Seyla II	Stóra-Seyla (Skagafjörður)	10^{th}-12^{th} c (Late Viking Age/Medieval)	Cesario 2016
UJF2	Undir Junkarinsfløtti	11^{th}-12^{th} c (Late Viking Age/Medieval)	Brewington 2015
Rob H	Robert's Haven	13^{th}-14^{th} c (Late Viking Age/Medieval)	Barrett 1997

Very few freshwater fish were found in the MARSH archaeofauna. This seems a bit strange, since Vatnskot is located directly next to a freshwater lake that, at least currently, supports fish, both Arctic char and three-spined stickleback (LENDIS 2009). The Héraðsvötn rivers on either side of Hegranes also have brown trout (*Salmo trutta*, Icel. *urriði*), which are often caught with nets, and Arctic char that live at sea but spawn in freshwater (sea char, Icel. *sjóbleikja*) (LENDIS 2009). These waters would have been easier to access as they do not require a boat to fish from and they are within a much closer distance to the sites. Despite the proximity to freshwater fish habitats, *gadids*, or cod family fish, are the primary identifiable fish found in the collections from both the MARSH and Seyla assemblages. While there could be a preservation bias towards *gadids*, which are generally larger and with more robust bones (McGovern 2009:255), the sheer quantity of fish bones recovered, even smaller bones, makes it highly unlikely that freshwater fish are underrepresented compared to their actual use.

The *gadids* are represented in the Skagafjörður archaeofaunal assemblages by five species (Figure 7.2). Atlantic cod (*Gadus morhua*) are the most numerous by far, pointing to a specialization on cod with other *gadids* incorporated in varying amounts. This pre-commercial specialization pattern will be explored in more detail below.

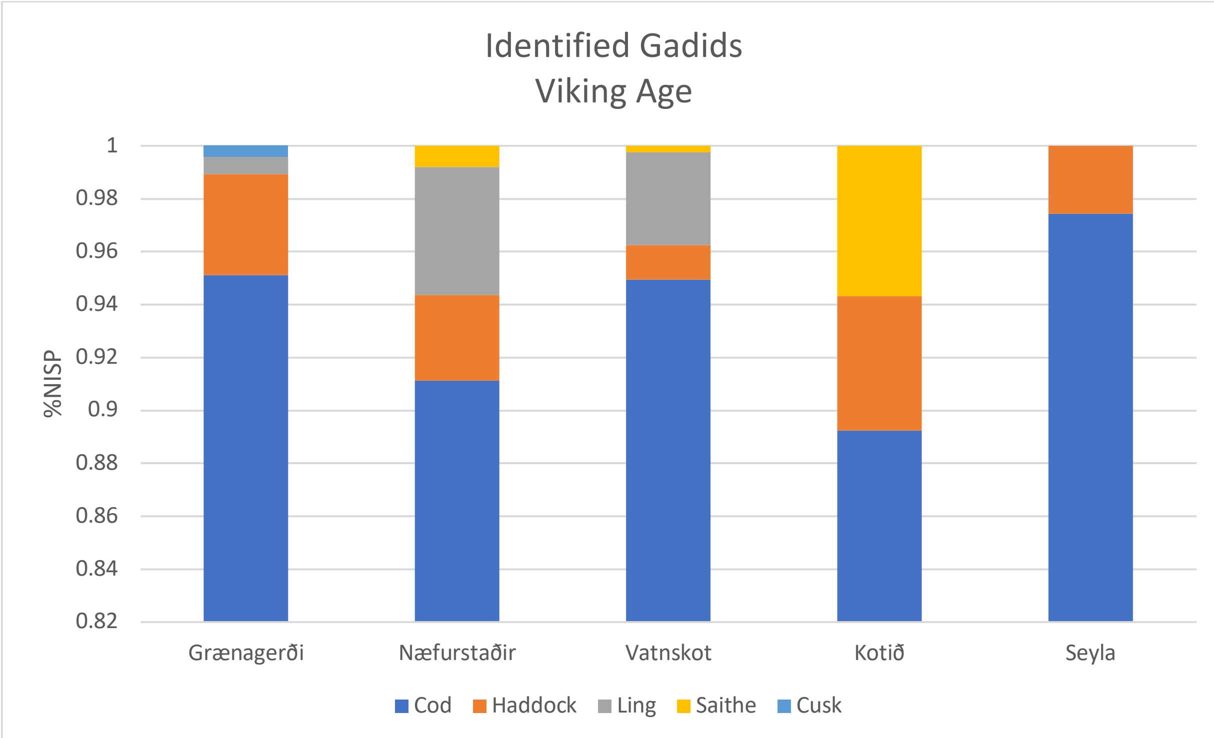

Figure 7.2. This chart shows the percent NISP of the identifiable *gadids* from the four sites on Hegranes and the site in Langholt. It uses the total numbers of fish from each site, which combines all time periods.

Zooarchaeological Indicators of Specialization

The issue of commercialization versus subsistence has been frequently discussed for marine fish on North Atlantic sites. Commercialization, that is the production of surplus fish products (Perdikaris 1996:22), cannot be determined with one single measure. A combination of factors—percentage of the collection made up by fish, species selection, element representation, and size reconstruction—need to be taken together to provide evidence for non-subsistence use of *gadids*. It has already been established above that the MARSH assemblages contain more than 50% fish (Figure 7.1) and that over 80% of the fish are cod (Figure 7.2). These two pieces of evidence begin to point to a specialized use of *gadid* fish, especially since subsistence use would not target a specific species. While there is not a particular percentage of fish that would indicate commercialization or specialization (Perdikaris 1996:22), especially since the initial settlement strategies in Iceland utilized a lot of wild resources, such a high percentage of one particular taxon is still interesting.

Numbers of fish compared to other taxa in an assemblage are a good starting point to explore fish use, but analysis of the actual bones is perhaps more important. In particular, body part representation can give much more specific information on *how* the fish were used. There are four main measures that zooarchaeologists use to determine patterns of fish use—a simple ratio of cranial versus axial elements; the ratio of two specific bones, one from the skull and one from the body; the range of vertebrae present in an assemblage; and live size reconstructions (e.g., Barrett 1997:622; Harrison 2014; Perdikaris 1998). These will each be discussed in detail in the following sections. Since cod were the most commonly identified fish, each section will display one graph of all *gadids* (including cod) and one graph with just cod. This is to see if cod were treated any differently than *gadids* as a whole.

Since the interpretation of specialization relies heavily on body part representation, an image of a fish with the body parts to be discussed in the following analysis is shown below (Figure 7.3). The most general comparison is between the cranial and axial parts of the body; these are sectioned off in boxes on the image. The individual elements are colored in. An example of the kinds of *gadid* bone assemblages that were common at the MARSH sites is shown in Figure 7.4.

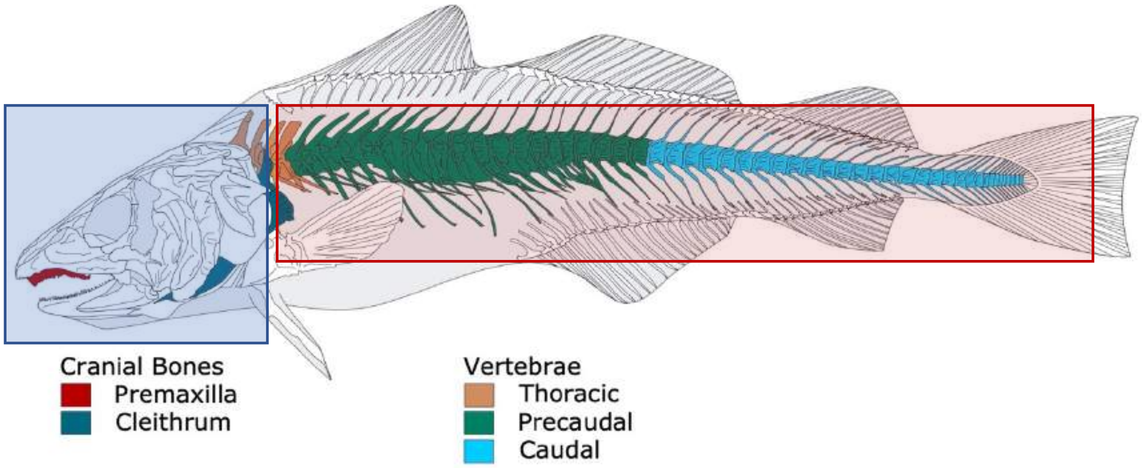

Figure 7.3. Fish skeleton showing the body parts that are included in the subsequent analyses. Each element that is mentioned is colored according to the legend; the general "head" or cranial region is within the transparent blue box, while the "tail" or axial skeleton is in the transparent red box. Base image ©ArcheoZoo 2004, but edited by the author.

Figure 7.4. Photo of *gadid* bones from Vatnskot TP2, context [124].

Heads Vs. Tails

The main thing to look at to understand how fish are used at a site is the presence of elements from the head versus elements from the pectoral girdle and the rest of the body, or the "tail" (see Figure 7.3 for an illustration of these two regions of the body). If we see relatively equal proportions of heads to tails, it would indicate that the fish were consumed whole on site, and likely fresh. Other ratios, more heads than tails or vice-versa, point to a different use of fish (Barrett 1997; Barrett et al. 1999; Perdikaris 1996).

When body parts are not equally represented, it is evidence for dried fish products. More heads indicate the preparation of dried fish, since the head is removed before drying and left at the processing site. More tails point to consumption; since the heads are left at the processing site, only vertebrae remain in the finished product. At the four Hegranes sites, we see primarily heads at all sites and in all phases for both the general "*gadid*" category and only cod (see Figure 7.5-Figure 7.8 below). Even though Seyla has clear early and late Viking Age phasing, the sample size of *gadids* and cod is so low that only the combined total Viking Age counts are presented (Figure 7.6 and Figure 7.8).

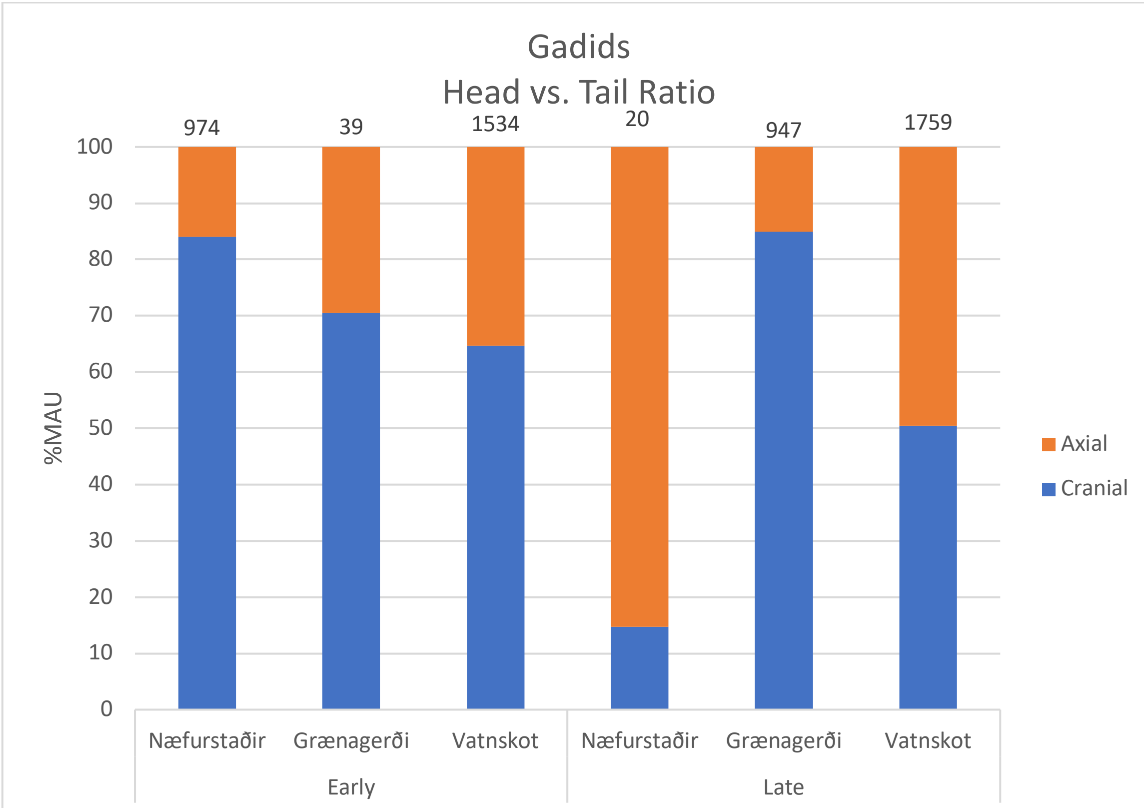

Figure 7.5. This chart shows the ratios of heads to tails for *gadids*. The "early" category is from AD 870-1000, and "late" is from AD 1000-1104. The numbers above each column are total NISP.

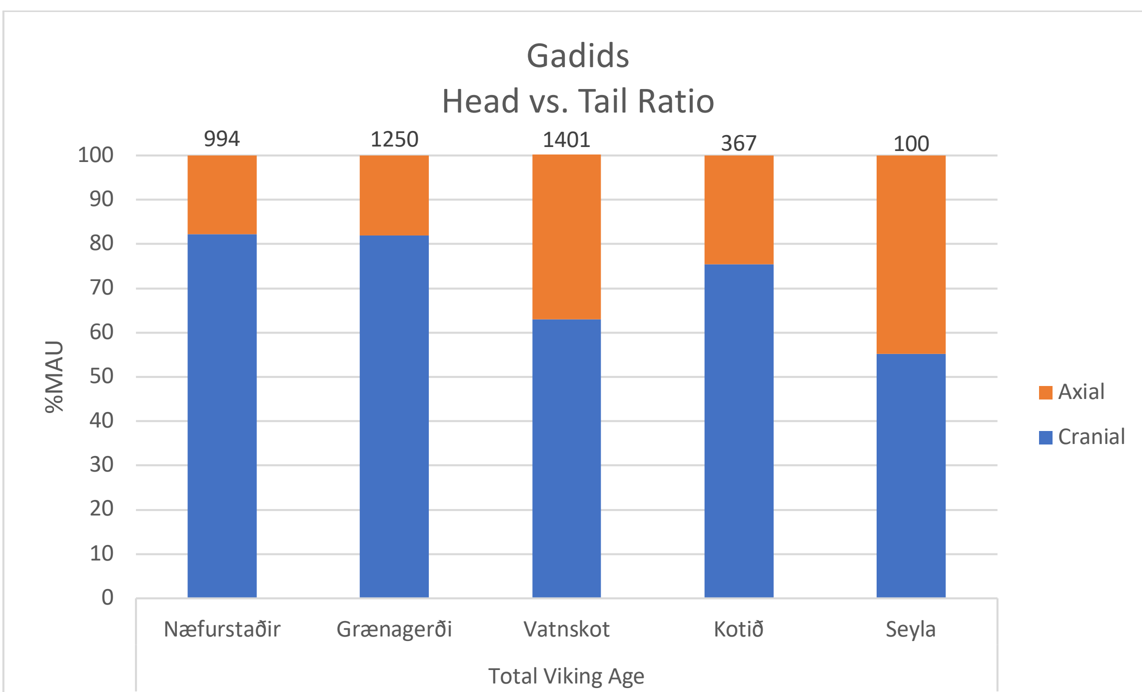

Figure 7.6. This shows the total Viking Age head vs. tail ratios for *gadids*. The numbers at the end of each bar indicate the total NISP used in each calculation of %MAU.

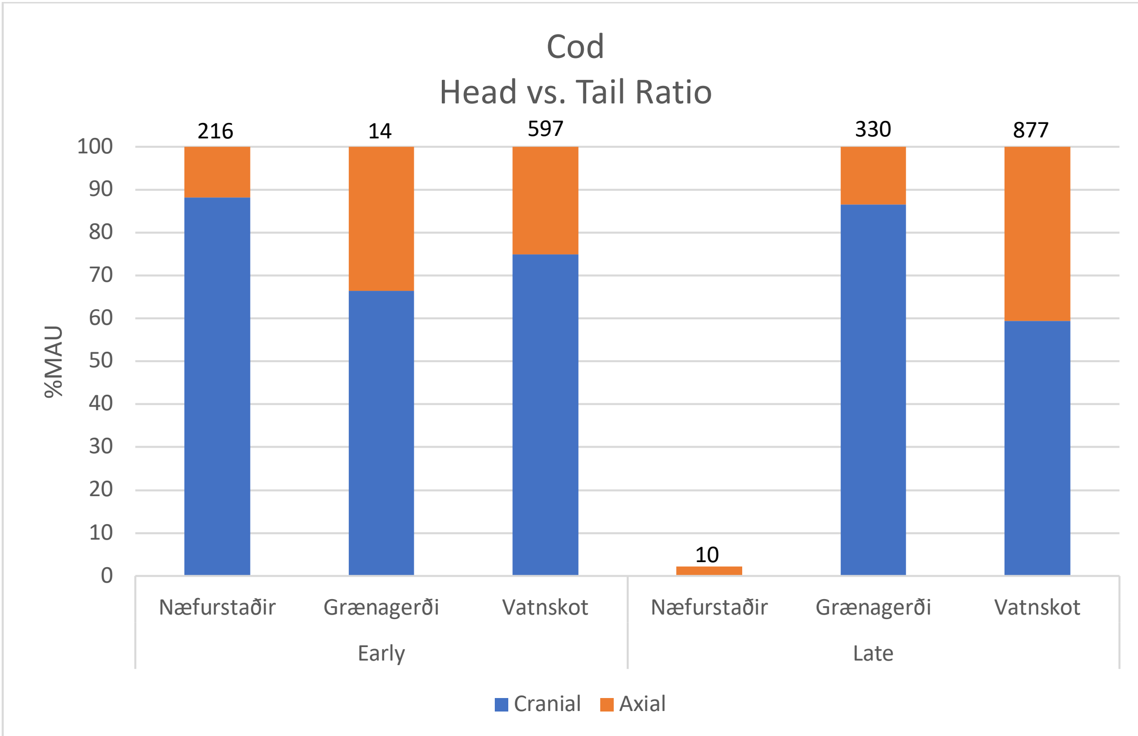

Figure 7.7. This chart shows the ratios of heads to tails for just the cod bones. The numbers at the end of each column show the total NISP. Note that late Næfurstaðir had no cranial elements present, so only axial elements are represented on the graph.

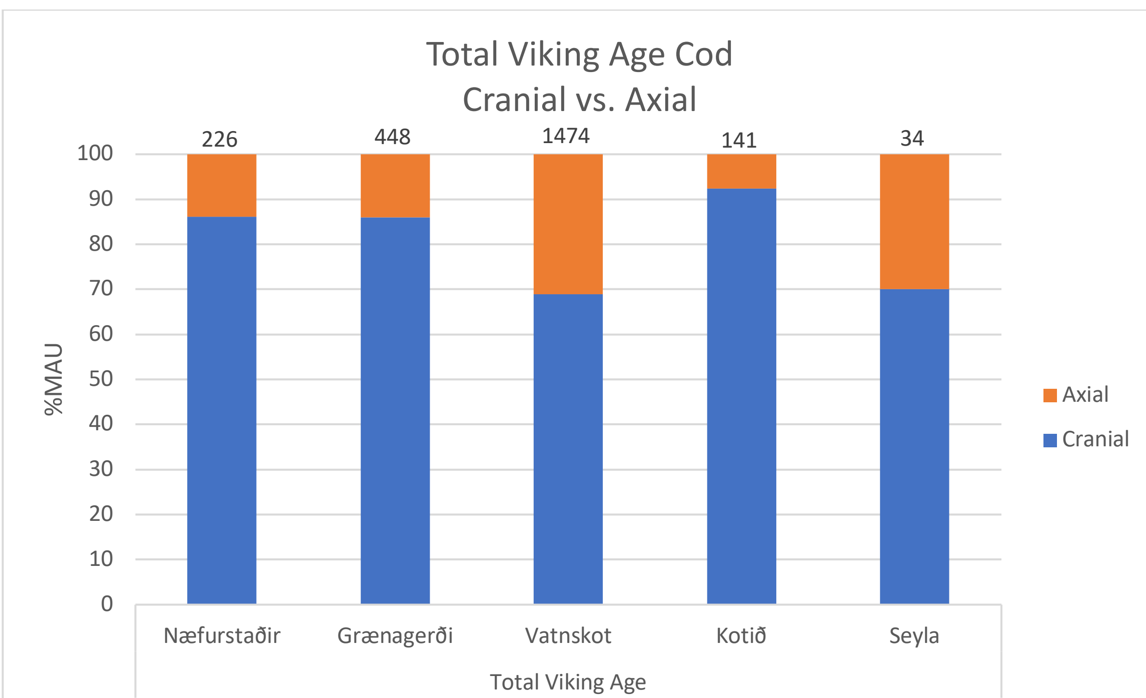

Figure 7.8. This graph shows the total cod head vs. tail ratios from all sites. The numbers at the end of each column show total NISP.

When using the heads versus tails metric, it is important to highlight that the comparison does not happen with raw counts. Fish skulls are quite complex and contain many paired bones as well as single bones. There are more bones in a fish skull than in the rest of the body, so raw numbers are likely to over represent the skull elements. Instead of raw counts, the data are presented as %MAU. This measure normalizes for the number of times an element appears in the skeleton, and thus makes comparisons possible between areas of the body that have more or less bones without over- or under-representing them—%MAU ensures that these differences are accounted for (see Chapter 4 Methods). Note that all the graphs above are presenting %MAU.

At all of the MARSH sites, cranial elements are more common than axial. This points to the sites acting as processing locations for dried fish. The removed heads are disposed of at the point of processing, while the finished product goes elsewhere. Interestingly, the Seyla total *gadids* are nearly 50/50 cranial to axial, but when looking at just cod, the ratio goes up to 70/30 cranial to axial. This might point to some whole fish being consumed on site, with cod preferred; however, the other analyses below challenge this as a primary consumption pattern.

Premaxilla vs. Cleithrum

Another indicator of a fish processing site is the differential presence of two specific bones—the premaxilla and the cleithrum. The premaxilla is a bone from the mouth that would be removed with the head and left at a production site. The cleithrum is located in the pectoral girdle and is often left in a fish while drying in order to keep the body intact throughout the drying and transportation process (Perdikaris et al. 2007:54). These bones are chosen for this analysis because of their location in the body, the fact that both are paired bones (there are two of each in a live fish) of similar size that are easily identifiable, and they are similar densities and therefore would not be biased by taphonomic factors (Perdikaris et al. 2007:54).

In a site where mostly whole fish were being consumed, these two bones would be found in relatively equal proportions. At a site where dried fish were consumed, we would expect to find more cleithra than premaxillae. Where dried fish were produced, we would see more premaxillae than cleithra (Cesario 2018a, 2019a, 2019b, 2020; Edvardsson 2010; Hambrecht et al. 2019; McGovern 2009). This goes along with the more general heads versus tails analysis.

At the four MARSH sites, there are more premaxillae than cleithra in all periods with substantial NISP, but see Figure 7.9 and Figure 7.11 (and their captions) below for explanation of the one phase where this is not the case. The presence of some cleithra suggests that some whole fish were consumed on these sites. There were also a few haddock (*Melanogrammus aeglefinus*) cleithra that may point to craft production. The cleithrum of this species has a very robust ventral process that can be carved and made into many things, like gaming pieces, etc. This would have been very small-scale craft working, with goods likely made just for household use.

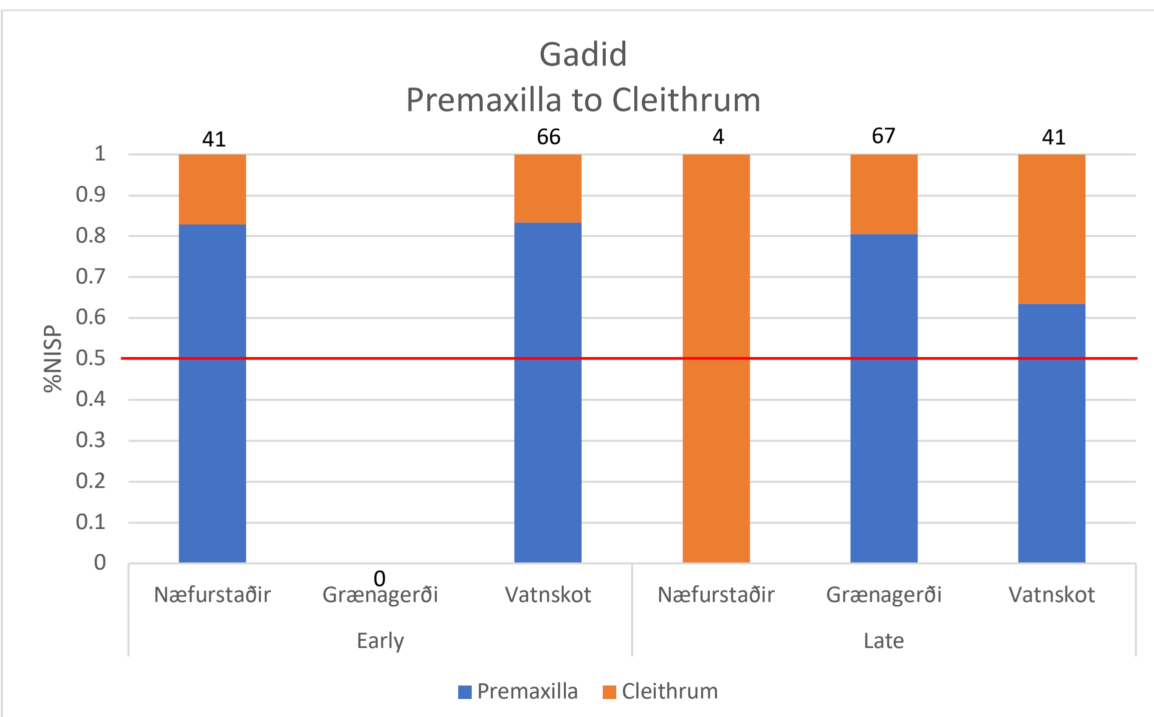

Figure 7.9. Premaxilla to cleithrum ratios in *gadids* for phased time periods. The red line shows what the ratio is in a whole fish, 0.5. The numbers above each column indicate the total NISP of premaxillae and cleithra at each site.

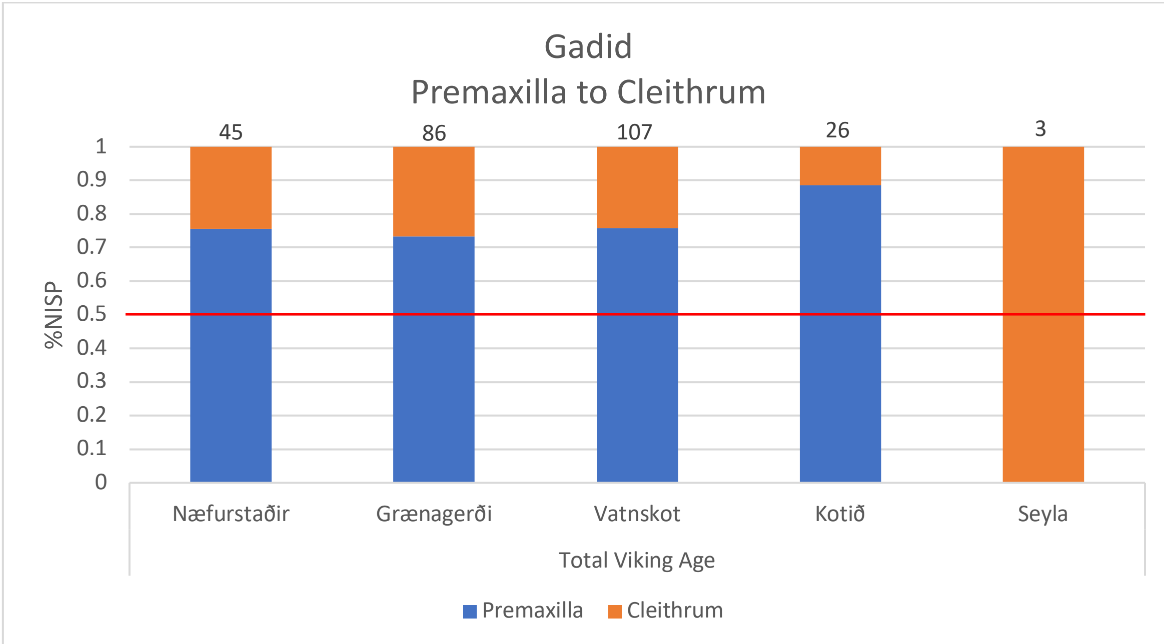

Figure 7.10. *Gadid* premaxilla to cleithrum ratios for the total sample at each site. Again, note that the red line shows what the ratio should be for a whole fish. The numbers above each column indicate the NISP of premaxillae and cleithra.

Using the total Viking Age data as the average for each site (Figure 7.10), it is clear that there is a difference between the Hegranes sites and Seyla. On Hegranes, all of the sites have more premaxillae than expected in a whole fish. This indicates that there are more heads than bodies being eaten/discarded than one would expect if whole fresh fish were the main focus. On the other hand, the pattern at Seyla shows only cleithra. This is a distinct signature for the consumption of dried fish, though the small sample size at Seyla is not a great indicator on its own. However, all of the lines of evidence taken together show a clear picture of consumption of flat-dried fish at Seyla.

For the sites with better phasing (Figure 7.9), there is really only one site with enough data to look at changing practices over time. At Vatnskot, the number of premaxillae goes down in the late phase, pointing to the possibility of more fresh fish being consumed on site.

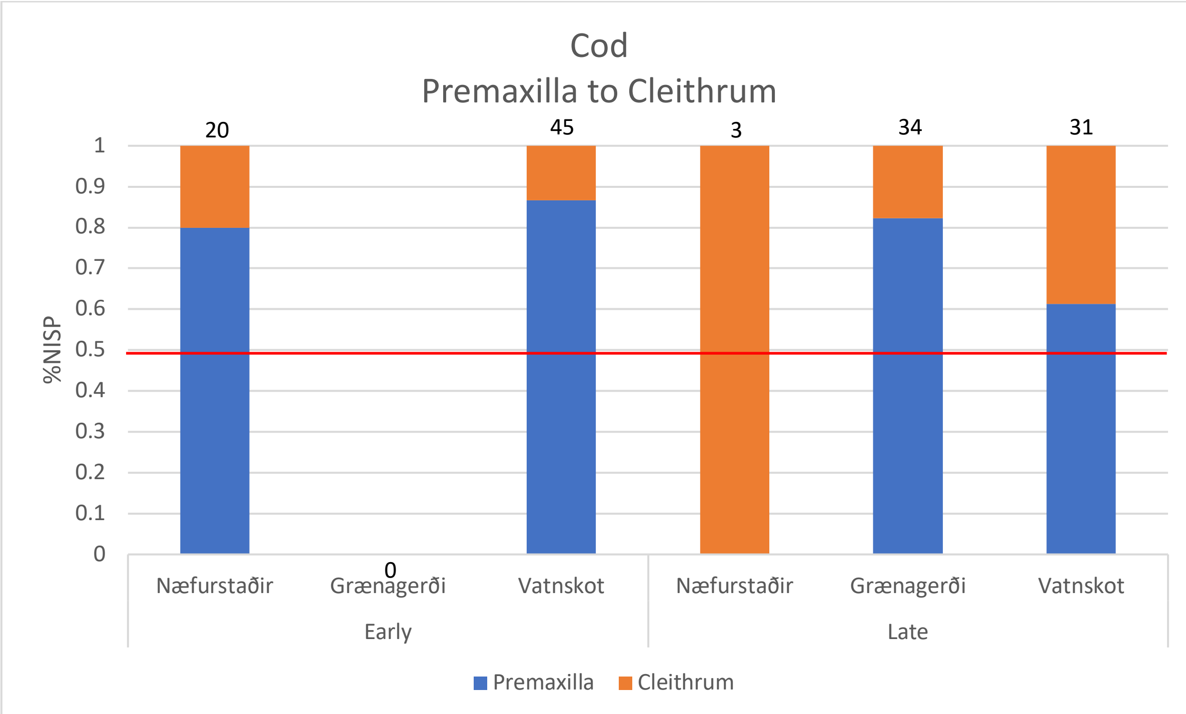

Figure 7.11. Premaxilla to cleithrum ratios for just cod. Note that the red line represents the ratios in a whole fish and the numbers above each column show the total NISP of premaxillae and cleithra.

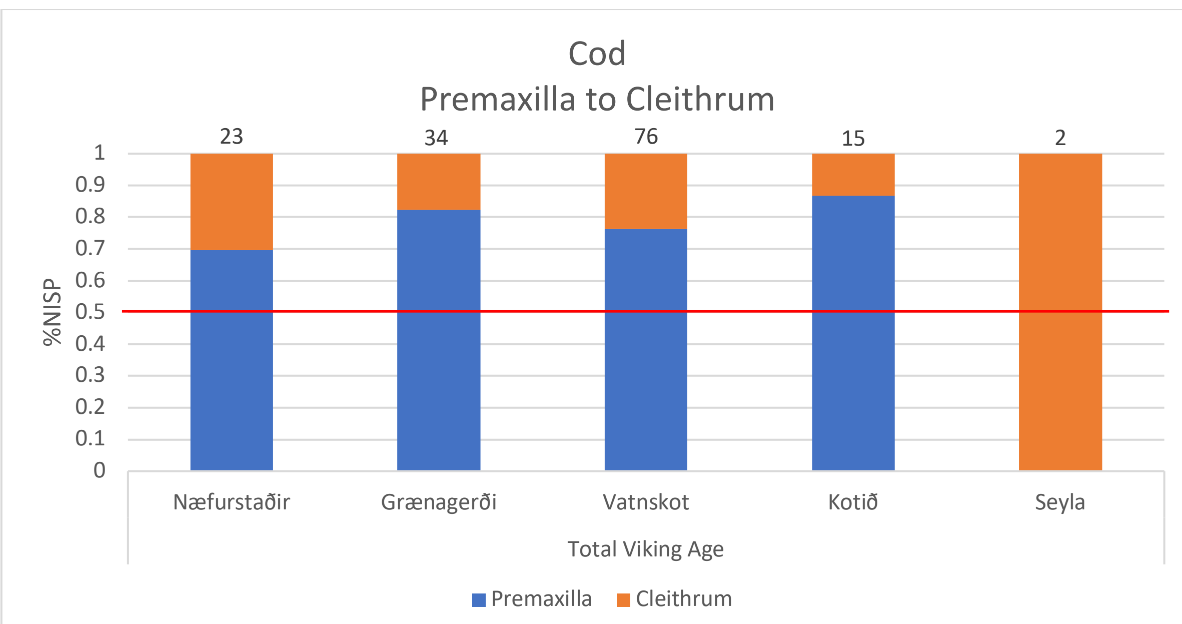

Figure 7.12. Premaxilla to cleithrum ratios for cod at all sites. This represents the total sample from all time periods, including those that could not be phased into early or late periods. The numbers above each column show the total NISP of premaxillae and cleithra.

There is not much difference between the way all *gadids* (including cod, Figure 7.9 and Figure 7.10) and just cod (Figure 7.11 and Figure 7.12) are treated. The graphs above show that there are always more premaxillae than cleithra at the Hegranes sites, with the exception of Næfurstaðir, which has a very small NISP and is likely an outlier in this case. At Seyla, there are no premaxillae at all.

Vertebral Series

Where a pattern of more heads than tails and more premaxillae than cleithra is established, we can conclude that fish processing took place on site. In order to understand what kind of dried fish product was being produced, we can look to the presence of various types of vertebrae. There are three vertebral categories in a fish—thoracic, precaudal, and caudal (Figure 7.3). Thoracic vertebrae make up the "neck" of the fish and include the first vertebra, the atlas. The precaudal vertebrae are in the middle of the body, and the caudal vertebrae make up the end closest to the tail.

When the head is removed for drying, often the first few thoracic vertebrae, including the atlas, will be removed as well. This means that the atlas will be very uncommon at sites where primarily dried fish were consumed. After removing the head, there are two options for drying a fish. The fish can be dried in the round, similar to the historically known "*stockfish*" that later become a major commodity and get exported from Iceland in the late Medieval and Early Modern periods. The other option is to dry the fish flat, in a way that resembles "*klipfisk*." Both of these methods leave distinct archaeofaunal signatures (Amundsen et al. 2004, 2005; Perdikaris and McGovern 2008b).

Fish dried in the round will essentially be a tube, holding in most of the vertebrae during the drying and transportation process (Perdikaris et al. 2007:55). This means that a site where round-dried fish are produced will have very few vertebrae at all, perhaps only atlases and the first few thoracic vertebrae. A consumption site where round-dried fish are eaten would have nearly a full sequence of vertebrae. However, when fish are dried flat, they are more heavily processed. After the head is removed, the fish is split down the belly almost all the way to the tail and laid open to dry. This allows more vertebrae to fall out, especially those closer to the front end of the fish, the thoracic and precaudal vertebrae. These would be more common at production sites (Perdikaris et al. 2007:55), while a consumption site is more likely to have just caudal vertebrae, with very few other types represented.

Looking at the *gadid* vertebral series for both phased (Figure 7.13) and total Viking Age material (Figure 7.14) shows a distinct difference between the four MARSH sites and Seyla. For the MARSH *gadids* (Figure 7.13), thoracic vertebrae makeup nearly 50% or more of the vertebrae in the assemblages, excluding late Næfurstaðir which has a very low total *gadid* NISP (n=20). However, at Seyla, the only identifiable vertebrae present in the entire collection are caudal vertebrae (n=36) (Figure 7.14).

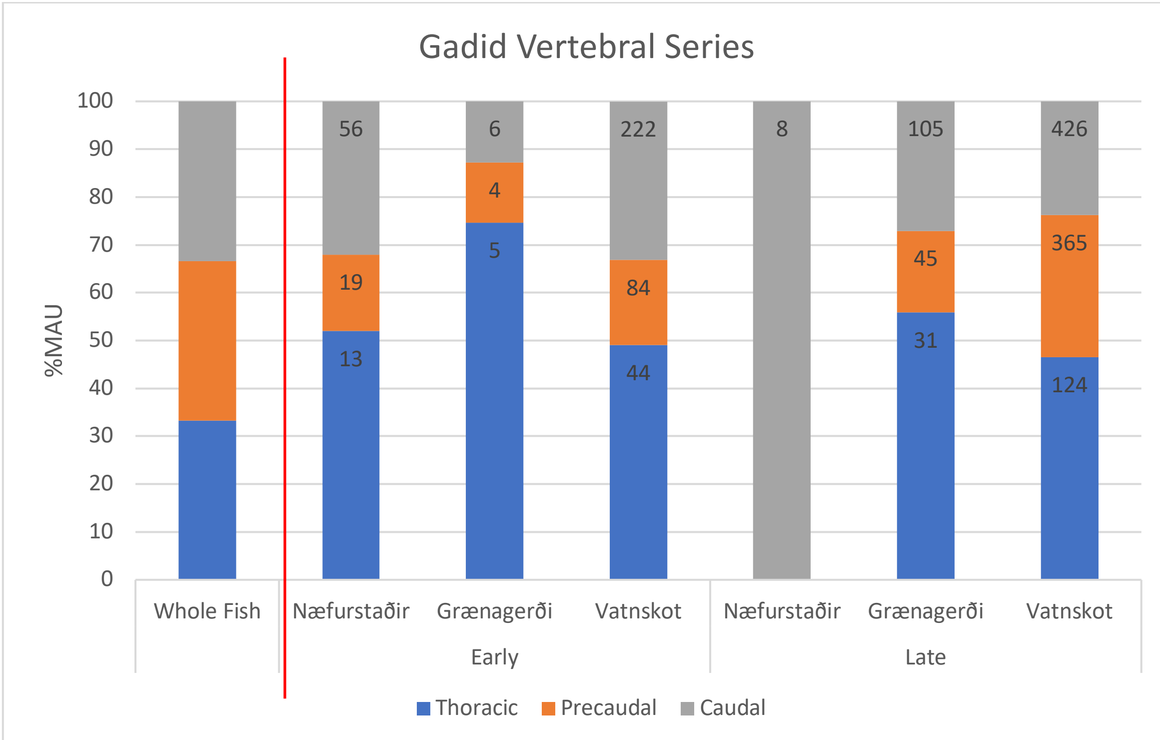

Figure 7.13. This chart shows the ratios of each type of vertebra present in the assemblages. The first column represents the ratios in a whole fish (note that %MAU is being used to normalize for the different numbers of each type of vertebra). Late Næfurstaðir has a NISP of 20 and early Grænagerði has only 39 NISP. The numbers on each column represent the raw count of each vertebral group.

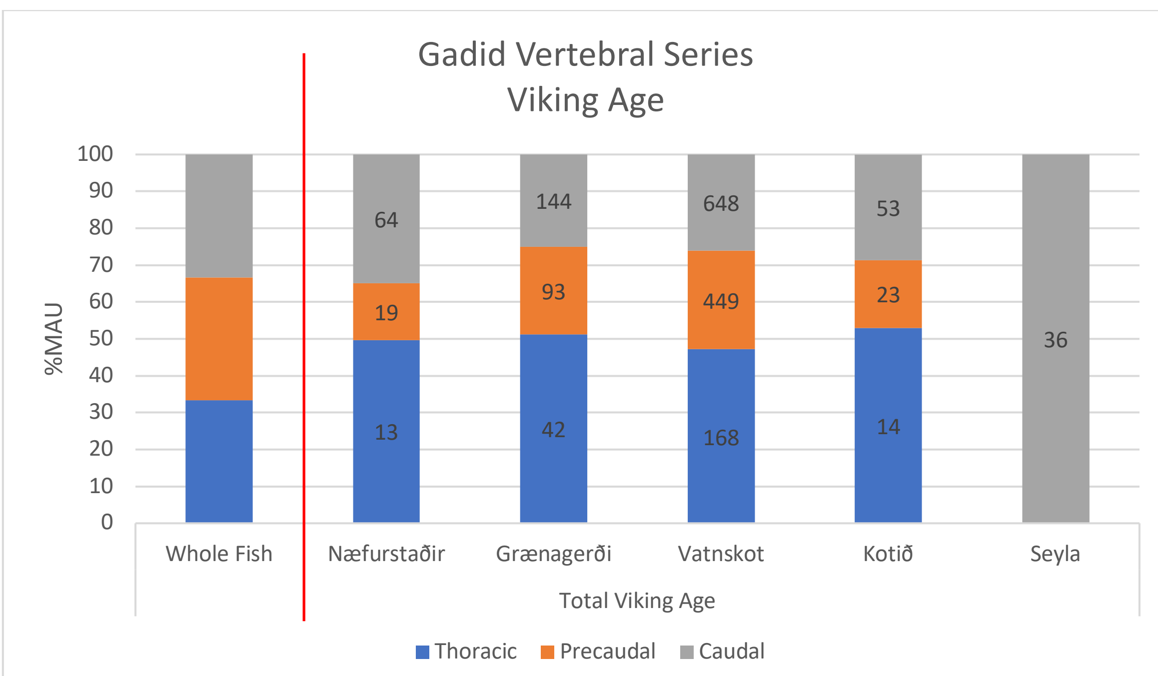

Figure 7.14. Vertebral series for all five sites in the Viking Age. The first column represents the ratios in a whole fish (using %MAU). The numbers on each column represent the raw count of each vertebral group.

The vertebrae present are slightly more variable for cod, where a few sites may indicate more whole cod being consumed (see late Vatnskot in Figure 7.15). However, the MARSH sites still have thoracic vertebrae as the most common (Figure 7.15). Showing the opposite pattern, Seyla again only has caudal vertebrae (Figure 7.16).

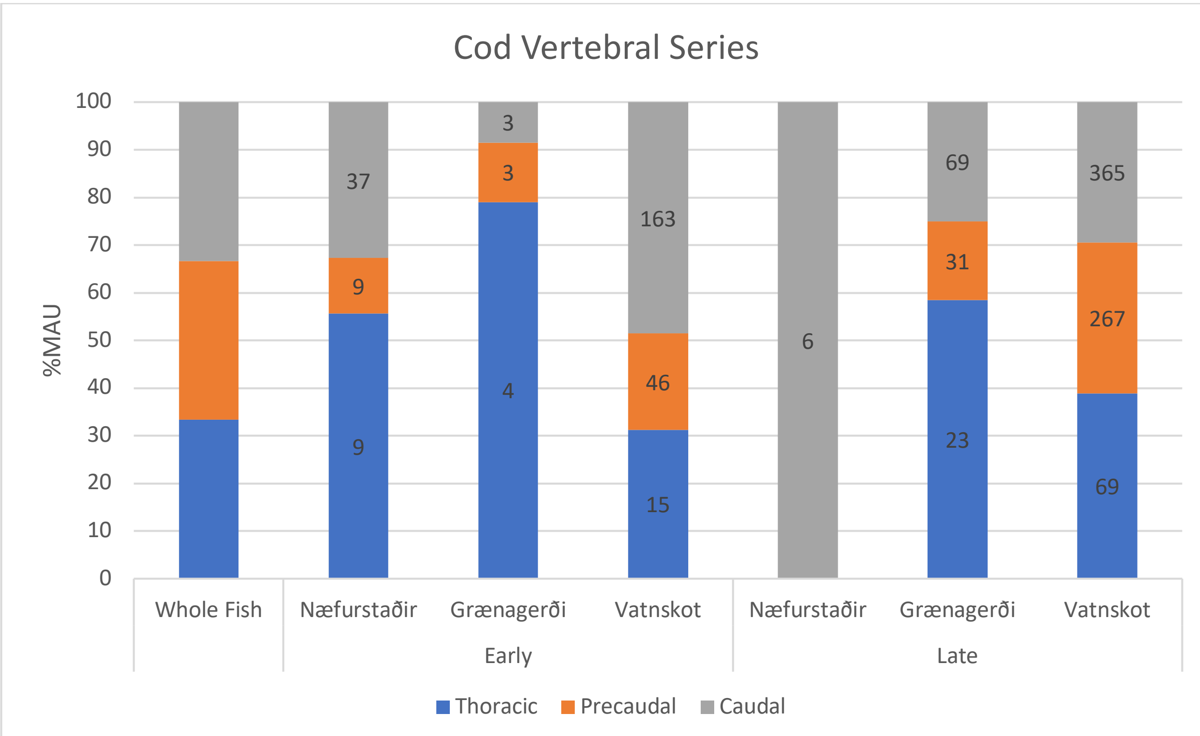

Figure 7.15. Cod vertebral series. Again, the first column represents the ratios in a whole fish. The late Næfurstaðir cod NISP is 10 and early Grænagerði is 14. The numbers on each column represent the raw count of each vertebral group.

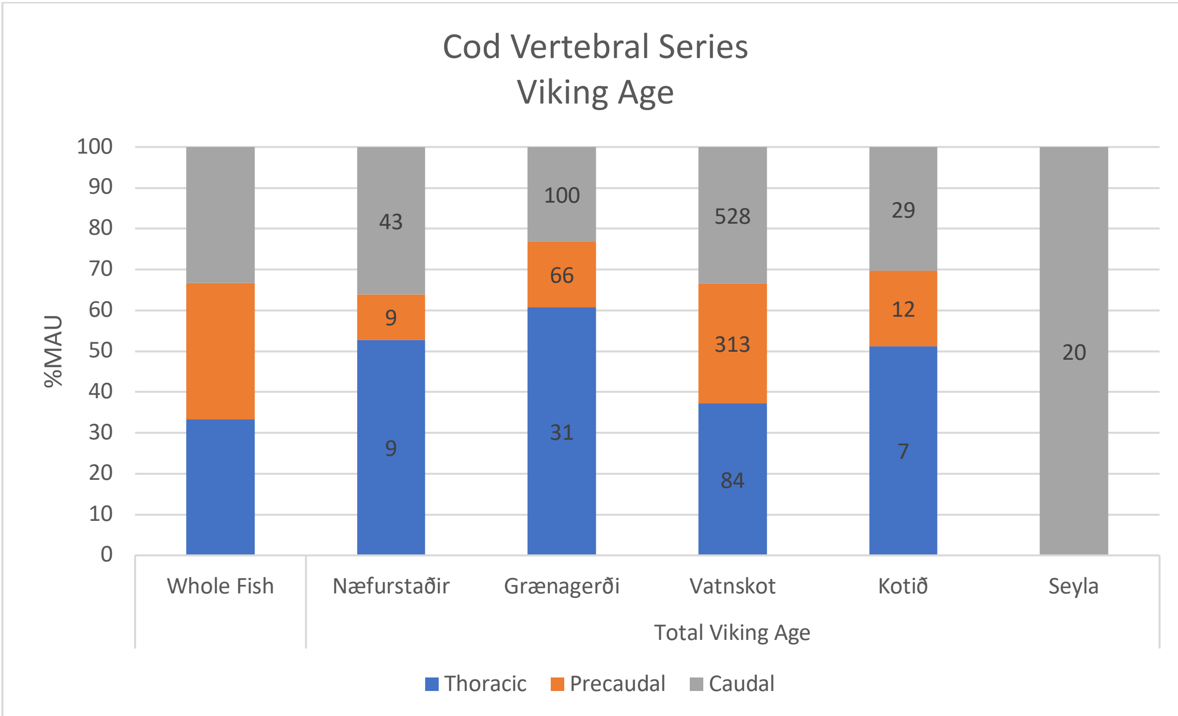

Figure 7.16. Viking Age cod vertebral series. The numbers on each column represent the raw count of each vertebral group.

To put this in context with other sites in Iceland, the broad "Viking Age" numbers for the five sites discussed here are compared to a selection of other sites across the country (Figure 7.17, Table 7.3). Most of the sites on the graph below are contemporaneous with the Skagafjörður sites (the Viking Age sites on the left side of the graph). The contemporaneous sites are mostly located inland, and they all show a consumer signature, with caudal vertebrae making up the vast majority of the cod elements. This is consistent with the consumer signature seen at Seyla, and exactly the opposite of the signatures of the MARSH sites.

The other sites ("Medieval," on the right-hand side of the graph) are not contemporaneous; however, they represent specialized sites and can draw unique parallels with the Skagafjörður sites. With the exception of Gásir, the other three sites in the Medieval category are fishing stations or fishing farms where fish were being processed specifically for export or trade (Amundsen et al. 2005; Feeley et al. 2010; Krivogorskaya et al. 2005; Pálsdóttir and Feeley 2017). The fact that the

MARSH sites show striking similarities to these other sites of known function perhaps indicates something of their use as well. While the MARSH sites were abandoned prior to the commercialization of cod for export, they seem to have played at least one role as producers of dried fish products, likely supplying inland farms like Seyla (Cesario 2016). The MARSH dwelling sites therefore represent areas of early specialization activity.

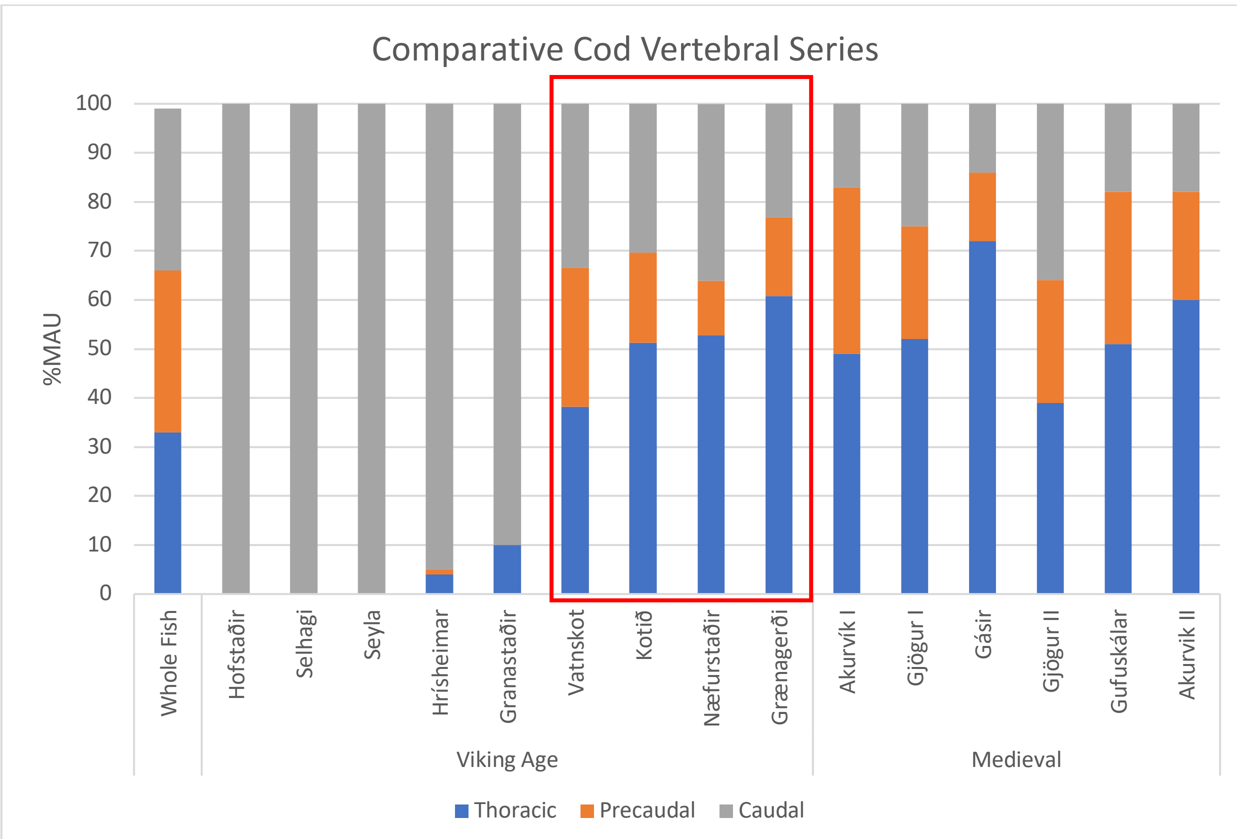

Figure 7.17. Comparative cod vertebral series for various sites in Iceland. The data for the MARSH sites comes from the entire collection (the broadest “Viking Age” category). The first column represents the ratios in a whole fish. The sites on the right side of the graph are later in time than the MARSH sites, but they are a good comparison for what sites begin to look like when fish become a commodity. This graph is based on Hambrecht et al. (2019) and updated with the Skagafjörður sites.

Table 7.3. Site name, region, and date for each site used in comparative cod vertebral series in Figure 7.17.

Site	Region	Date
Hofstaðir	Mývatnssveit	10^{th}-11^{th} century
Selhagi	Mývatnssveit	10^{th}-12^{th} century
Seyla	Skagafjörður	9^{th}-12^{th} century
Hrísheimar	Mývatnssveit	10^{th}-11^{th} century
Granastaðir	Eyjafjörður	10^{th}-11^{th} century
Vatnskot	Skagafjörður	9^{th}-12^{th} century
Kotið	Skagafjörður	9^{th}-12^{th} century
Næfurstaðir	Skagafjörður	9^{th}-12^{th} century
Grænagerði	Skagafjörður	9^{th}-12^{th} century
Akurvík I	Vestfirðir	13^{th} century
Gjögur I	Vestfirðir	13^{th} century
Gásir	Eyjafjörður	13^{th}-14^{th} century
Gjögur II	Vestfirðir	14^{th}-15^{th} century
Gufuskálar	Snæfellsnes	15^{th}-16^{th} century
Akurvík II	Vestfirðir	15^{th} century

Size Reconstruction

The final method for determining fish usage that I will discuss here is live-size reconstruction. Using formulas from Wheeler and Jones (1976) and Enghoff (1994), measurements taken from various fish bones can be used to estimate the size of the fish while it was alive (see Appendix C). The three bones used in this analysis are the dentary, premaxilla, and atlas. Since the formulas are specific to species, the only species presented here is cod. There were no bones from Seyla that could be measured, so it is not included in this part of the discussion.

Historically, round-dried and flat-dried fish have specific "size windows" that will make the best product. Fish that are too small tend to dry too quickly if done in the round, while larger fish done flat do not dry as well. The size range for flat-dried fish is about 400-700 mm, while the round-dried window is between 600-1100 mm (Perdikaris and McGovern 2008b). The creation of a dried fish product also requires very specific environmental conditions. Dried fish can only reliably be produced during the winter, when the conditions are such that the processed fish freeze overnight, thaw slowly during the day, and dry slowly enough that the fish does not rot (Perdikaris 1998:73).

In the early period, there are two size peaks (Figure 7.18). The number of measurable bones was greatest at Vatnskot in this period, and most of the bones fall into the smaller size category, from 350-650 mm. The other peak is in the 800-900 mm size category; however, the small sample size from Grænagerði (n=2) likely inflates this. Without including Grænagerði, most of the fish from the early period fall into the flat-dried size window, with just a few (n=7 from all sites) in the larger size range. This points to the majority of the fish being made into a flat-dried product. If this were representative of a solely subsistence-based fishing practice, there would not be any size selection, and the spread of reconstructed fish lengths would not show such defined peaks as seen in here.

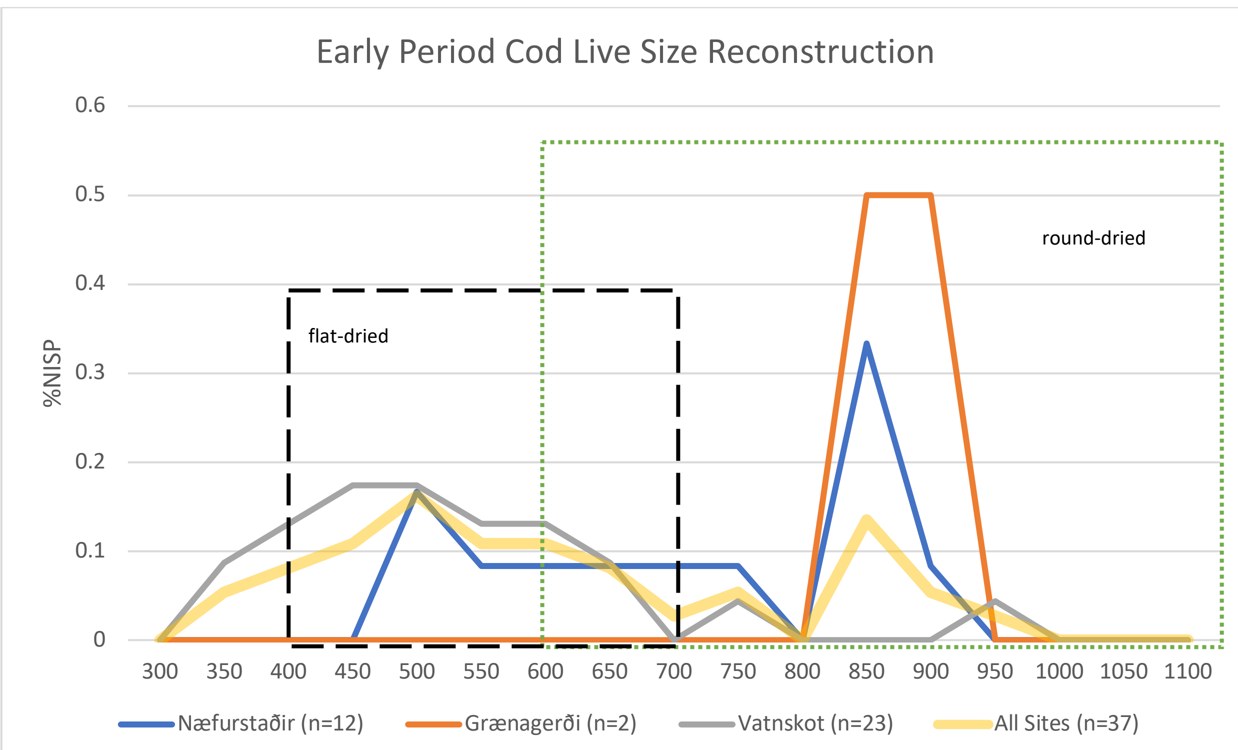

Figure 7.18. Live size reconstruction of cod from the early (AD 870-1000) period based on three elements—the premaxilla, dentary, and atlas. The transparent yellow line represents an aggregate of all sites to show the overall pattern. See Appendix C for measurements and reconstruction formulas.

The late period cod almost entirely fall within the flat-dried size window (Figure 7.19). There is just one element, from Vatnskot, that falls outside of this window. Again, this indicates that most of the fish were made into a flat-dried product.

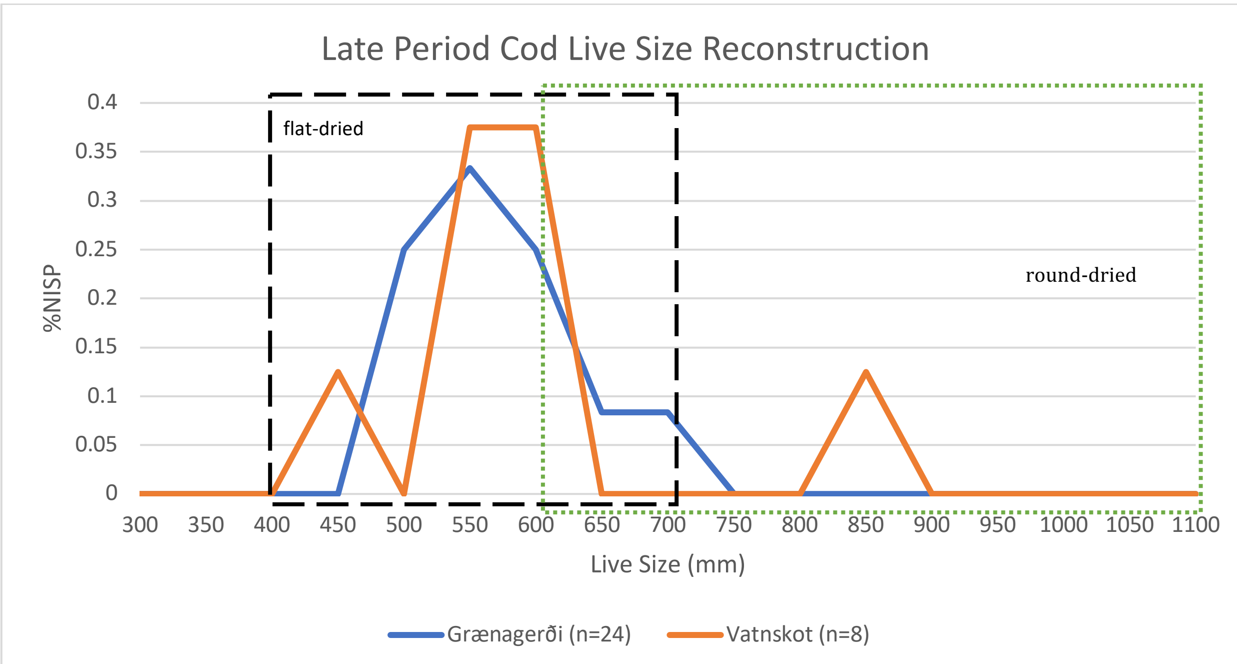

Figure 7.19. Late period (AD 1000-1104) cod live size reconstruction based on three elements—the premaxilla, dentary, and atlas.

Finally, looking at the broader Viking Age pattern, all four sites can be examined. Again, the vast majority of the fish fall into the flat-dried window, though there is a small peak of larger fish (Figure 7.20). This could be indicative of fish that were not the right size for drying and were instead consumed whole on site (Perdikaris et al. 2007:53). It is also possible that they were dried, perhaps flat (unsuccessfully) or in the round.

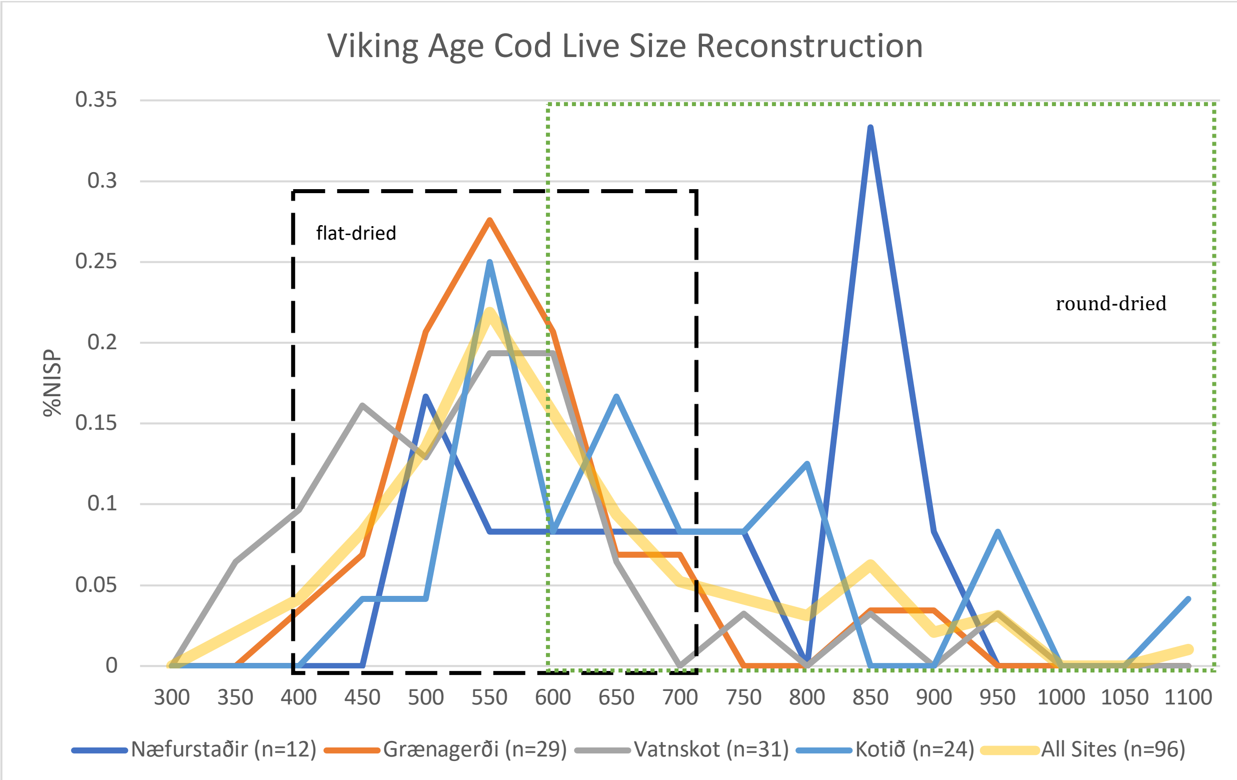

Figure 7.20. Cod live size reconstruction from the Viking Age (AD 870-1104) based on measures of the premaxilla, dentary, and atlas. The transparent yellow line represents an aggregate of all sites to show the overall pattern.

Conclusions

The four sites on Hegranes—Næfurstaðir, Grænagerði, Vatnskot, and Kotið—seem to have played a role as producers of dried fish products. In neighboring Langholt, Seyla looks like a consumer of dried fish. The data point to flat-dried fish as the main product, though it also looks like those inhabiting the MARSH sites also consumed whole fish from time to time (see Table 7.4 for a summary of the signatures). These fish may have been unsuitable for drying (wrong size, wrong species) or simply taken because of need. Early farms would have needed to supplement their diet with wild food resources while they raised their initially small stocks of domesticates, and fish would have been a familiar food to procure, process, eat, and trade (Edvardsson 2010:271). Therefore, it is possible that the MARSH dwelling sites were actually tied into the early production strategy of larger, terrestrial-focused farms, acting not as autonomous farms but as specialized resource processing areas. The fish dried on Hegranes are the most likely candidates for the fish that were consumed at Seyla. This could also point to a local trade/exchange network of these pre-commercial, artisanal products.

Table 7.4. Table showing archaeological signatures of producers and consumers of each dried fish product.

	Producers		**Consumers**	
Product	*Round dried*	*Flat dried*	*Round dried*	*Flat dried*
Heads or tails?	More heads than tails		More tails than heads	
Cleithrum or premaxilla?	Little to no cleithra		Little to no premaxillae	
Vertebrae present	Mostly thoracic vertebrae	Thoracic and precaudal vertebrae most common	Full vertebral sequence, though fewer thoracic/no atlases	Mostly caudal vertebrae and some precaudal, few thoracic
Size?	600-1100 mm	400-700 mm	600-1100 mm	400-700 mm

The fish body part patterns explored here are not representative of basic subsistence fishing. An abundance of one species in a specific size window, as well as the representation of some body parts over others indicates that there was a need for specific characteristics of fish. Subsistence fishing would have taken any species, of any size, and the whole body would be represented in middens. Preference for one species over another is possible, though body size and skeletal element representation would still not follow the pre-commercial patterns seen at the Skagafjörður sites.

Chapter 8. The Birds

Bird species in Iceland are abundant and varied. Many of the same species and families are also present across the North Atlantic, so birds made up an abundant resource that the first settlers would have already been familiar with when they set up their new colonies. It has been suggested that exploitation of seabird cliffs is a Celtic island adaptation, and intensified use of seabirds likely began there rather than Norway (Brewington 2015; Guðmundsdóttir Beck 2013; Hambrecht 2020; Keller 2010; Petersen 2005).

In Iceland, ducks, shorebirds, and seabirds are quite common, and there are both resident and migratory birds of these groups that spend time on the island. The birds were likely unwary of humans when they first colonized Iceland, making them easy targets to include in their subsistence strategy (Vésteinsson et al. 2002). Seabirds especially would have been a familiar resource as the settlers crossed the North Atlantic, but ptarmigan (*Lagopus muta*) also contributed to the diet in large numbers in some areas of the country, especially at inland sites.

Archaeological Evidence of Bird Use in Iceland

Prior research in Iceland and the North Atlantic has suggested that birds were not major parts of the archaeofauna at most sites, and provided “a supplement rather than a staple resource” (Perdikaris and McGovern 2008a:195). However, more recent research has been illustrating that, at some sites, birds may have been relied on much more heavily than previously seen (see for example Brewington 2015; Cesario 2018a, 2018b, 2019b, 2019a; Hicks et al. 2016). Figure 8.1 shows the percent of each archaeofauna that is made up of birds for a selection of sites in Iceland and across the North Atlantic, including the MARSH sites.

Though birds are present at all the sites shown in Figure 8.1, they do not seem to make up a significant portion of the assemblages from Norway, Mývatnssveit, or Svalbarðshreppur. However, the assemblages from Undir Junkarinsfløtti in the Faroes have quite large bird components in most phases. The numbers of birds at Kotið and Grænagerði both come close to the Faroes, where puffins make up a large portion of the diet. Also, in the mid-11th to early 12th century phase at Skuggi, located in Hörgárdalur, Eyjafjörður, birds contributed nearly 40% to the archaeofauna.

In Iceland some birds, ducks especially, are managed for their eggs rather than taking adult individuals for meat (e.g., Brewington et al. 2015; Hicks et al. 2016). This management strategy includes the active suppression of other predators (keeping fewer or no pigs, killing foxes, controlling dogs) and only taking specific numbers of eggs so that the adults do not abandon their nests. Seabird eggs are also taken, though they tend to produce fewer eggs than ducks, but adult individuals are taken more frequently than adult ducks, for example.

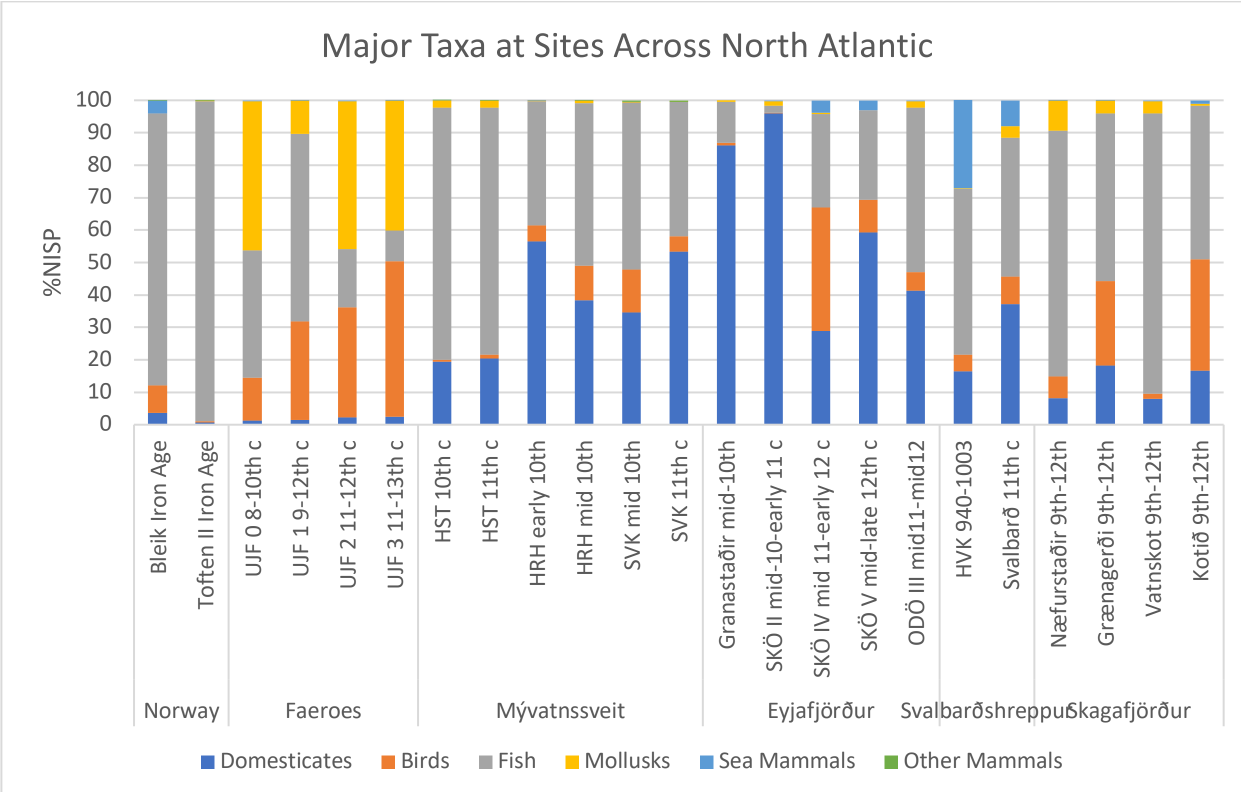

Figure 8.1. Major taxa at various sites across the North Atlantic. Time periods range from the Iron Age through the 12th century, though most are contemporary with the Skagafjörður sites. UJF=Undir Junkarinsfløtti, HST=Hofstaðir, HRH=Hrísheimar, SVK=Sveigakot, SKÖ=Skuggi, ODÖ=Oddstaðir, HVK=Hjálmarvík

Hegranes Birds

In addition to the four MARSH sites, there is one more farm on Hegranes that had a sufficient sample size (NISP >500) to be able to add it to the discussion about patterns of bird use in this section. Utanverðunes, which seems to have been established in the mid-10th century, is the northernmost farm on Hegranes (Figure 5.1), and is located near the mouth of the fjord and the now-abandoned boat landing Naustavík. The bird bones from Utanverðunes made up 97% of the entire assemblage (Table 5.6) and were concentrated at the bottom of the Viking Age midden sequence, below several floor deposits and burning events.

The birds from the Hegranes sites are primarily seabirds from the *alcid* family (Figure 8.2). *Alcidae* are diving seabirds, including puffin, guillemot, razorbill, and auks. These seabirds represent nearly year-round availability, though puffins are seasonal and migrate to Iceland in the late spring to breed. The *alcids* in the Hegranes assemblages are dominated by guillemot (*Uria aalge*) and puffin (*Fratercula arctica*), but there are also a few razorbills (*Alca torda*) present.

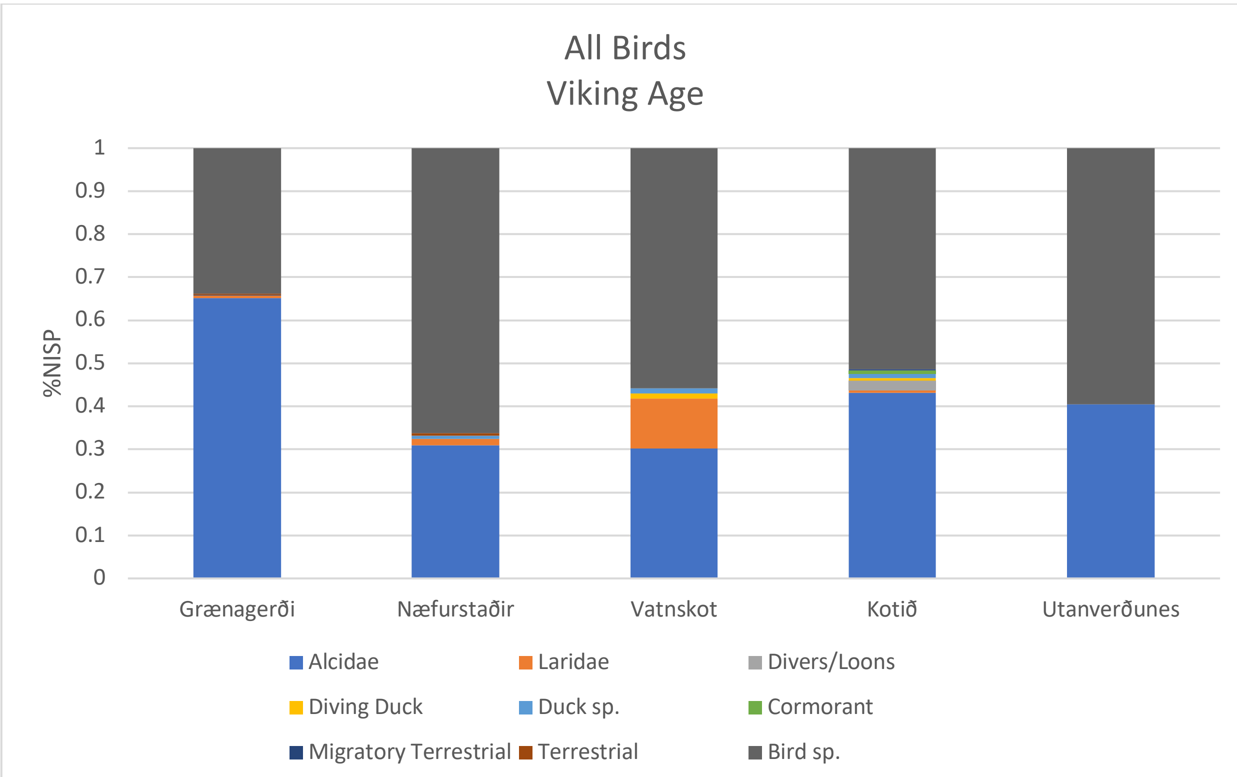

Figure 8.2. This chart shows the total of all birds, both identified and unidentified, at each site during the Viking Age. Birds are grouped by family, and the numbers of each particular species can be found in the tables in Chapter 5.

These *alcids* were most likely hunted during the summer breeding season, since they migrate to Iceland specifically for breeding (puffins) or live out on the sea during the rest of the year (guillemot and other auks) (Lack 1934; Serjeantson 1998:24). Each of the three bird species tends to lay a single egg, but they vary in their preferred egg-laying habitat—puffins dig burrows, guillemot lay their eggs on bare spots, and razorbills prefer more sheltered crevices for their eggs. Because of this spatial variation, these three birds can cohabitate relatively easily on sea cliffs. For example, in Skagafjörður, the islands Drangey and Lundey are home to many birds during the summer breeding season, these three species included, among others (Figure 8.3). The cliffs at the northern end of Hegranes may also have been a summer nesting area, though the bird colonies could not reach the same densities there as they could on the islands.

Figure 8.3. View from Drangey, facing roughly south. The white spots on the cliffs are places where birds congregate. Photo by Kathryn Catlin 2016, used with permission.

Shore and terrestrial birds were, and still are, present on Hegranes and available to include in the local subsistence strategies (e.g., Pálsson 2010); however, these birds do not appear to have made a major contribution to the economic strategy on Hegranes during the Viking Age. The rest of the birds in the five assemblages are made up of various duck species, birds in the gull (*Laridae*) family, or terrestrial birds, both resident and migratory (Figure 8.2).

Kotið has the most varied number of bird species present, despite *alcids* making up the majority of the identified species (Figure 8.2). Duck species were only found at two sites, and, overall, gulls make up the second most common bird family group. Since *Alcidae* are by far the most common of the identified bird species at the Hegranes sites, they will be the focus of the rest of this chapter, as they show an interesting pattern of use that gives more insight into the early marine strategy on Hegranes.

Identified vs. Unidentified

Table 8.1 provides information on the number of bones that were identified to the species (or family) level and those that were not identified beyond "bird." Table 8.1 shows the results of a chi-square analysis of the actual count ("Count") of bones present in the assemblage and the expected ("Expected") number based on the archaeological data.

At Grænagerði, more birds were identified than expected, while at the other four sites, there were fewer birds identified than expected, though the sample sizes of birds at both Næfurstaðir and Vatnskot are quite low in general. This data says something about taphonomy at each of the sites, and also likely speaks to sample size. Grænagerði has the largest sample of birds, and many of the bones were complete, thus making identification of more bones possible. Kotið also had good preservation, but the density of bones per liter of cultural material excavated was lower than at Grænagerði (e.g., Figure 5.3), so perhaps with more excavation the numbers of identified birds would have been more similar. Utanverðunes also had much lower density of bones per liter than the other four sites, and the bones were more often broken or eroded and unable to be identified to species. The last two sites, Næfurstaðir and Vatnskot, had small numbers of bird bones overall though the preservation was quite good. These results are statistically significant at $p < .05$.

Table 8.1. Results of chi-square test on identified vs. unidentified bird bones. The actual count from the archaeofauna ("Count") and the expected count based on the archaeofauna ("Expected", the expected counts if there were no relationship) are shown. The chi-square tests how likely it is that the observed ("Count") is due to chance.

		Site					**Total**
		Grænagerði	**Kotið**	**Næfurstaðir**	**Vatnskot**	**Utanverðunes**	
Identified	**Count**	558	332	49	39	198	1176
	Expected	469	379.9	80.7	48.4	255.9	1176
Unidentified	**Count**	285	351	96	48	291	1071
	Expected	374.03	303.04	64.33	38.6	233	1071
Total		843	683	145	87	489	2247

Bird Species Representation

Since guillemot and puffin were the most common species at all five sites in terms of raw numbers, it was important to measure if their abundance was statistically significant or not. Thus, the analysis below focuses on just the guillemot and puffin numbers from each of the five Hegranes sites. It presents the numbers of bones identified to each species ("Count") and the number expected ("Expected") based on a chi-square analysis of all five assemblages (Table 8.2).

At Grænagerði, guillemot are vastly overrepresented, with over 100 more than expected (Table 8.2). On the other hand, puffins are underrepresented, with the actual count at about one-third of the expected value. That guillemot are overrepresented suggests their importance for some reason (easier to hunt, preferred for food and/or feathers, more meat, etc.). At both Kotið and Utanverðunes, the opposite pattern is seen. In these cases, guillemot are underrepresented and there are more than the expected number of puffins. Again, this shows that puffins were used more often than they should have been based on the chi-square analysis. These results are statistically significant, and point to site-specific bird use. The numbers of these species at Næfurstaðir and Vatnskot are quite low, and so it is difficult to say much about their representation and use.

Table 8.2. Chi-square analysis of guillemot and puffin representation at each of the five study sites.

		Site					Total
Species		**Grænagerði**	**Kotið**	**Næfurstaðir**	**Vatnskot**	**Utanverðunes**	
Guillemot	**Count**	482	125	10	17	43	677
	Expected	335	177	27	16	121	677
Puffin	**Count**	68	166	35	9	155	433
	Expected	215	114	18	10	77	433
Total	**Count**	550	291	45	26	198	1110

The representation of guillemot and puffin at Grænagerði, Kotið, and Utanverðunes may tell us something about the communal hunting strategy that would have been employed to catch these seabirds. The birds lay their eggs in burrows near the sea (puffins) and on cliff edges (guillemot). Both species are quite populous on the nearby islands, Drangey and Lundey, where they are still hunted to this day. It is a dangerous activity and required community cooperation "which in manpower normally extended outside the realms of one farm" (Petersen 2005:205). This may indicate that the people from these three sites hunted the birds together, and each took the majority of the species they preferred. This is purely speculation, as we do not have any written evidence from this time period and the sites are out of use by the time written documentation becomes more common, but these sites are not far away from each other, and likely interacted in some way. The location of Utanverðunes near the boat landing is particularly interesting, as they may have had legal access to it and therefore been allowed to launch boats from there.

Wing-to-Leg Ratio

One of the measures used to understand bird use at various archaeological sites across the world is the wing-to-leg ratio, based on work done by Bovy (2002, 2012). A modified version of this calculation will be used here to understand the patterns of bird body part representation at the Hegranes sites. In this method, the total wing elements are compared to the total leg elements (see caption for Table 8.3 below for which bones are included in each body part and Figure 8.4 for an illustration of a whole bird). Note that most phalanges are not included in either category, as they are notoriously difficult to identify to species and also are more likely to be lost or destroyed because of their size. The expected ratio for a whole bird is 1.66, due to the number of bones included in each body part (10 for wings and 6 for legs). Ratios above 1.66 indicate that there are more wings than there should be if whole birds were being deposited into the midden. The following tables show the wing-to-leg ratios for the puffins (Table 8.3) and guillemot (Table 8.4) from each site. Figure 8.4 shows a bird skeleton with the bones of the wing and leg that are included in this calculation highlighted to make clear where in the body they come from.

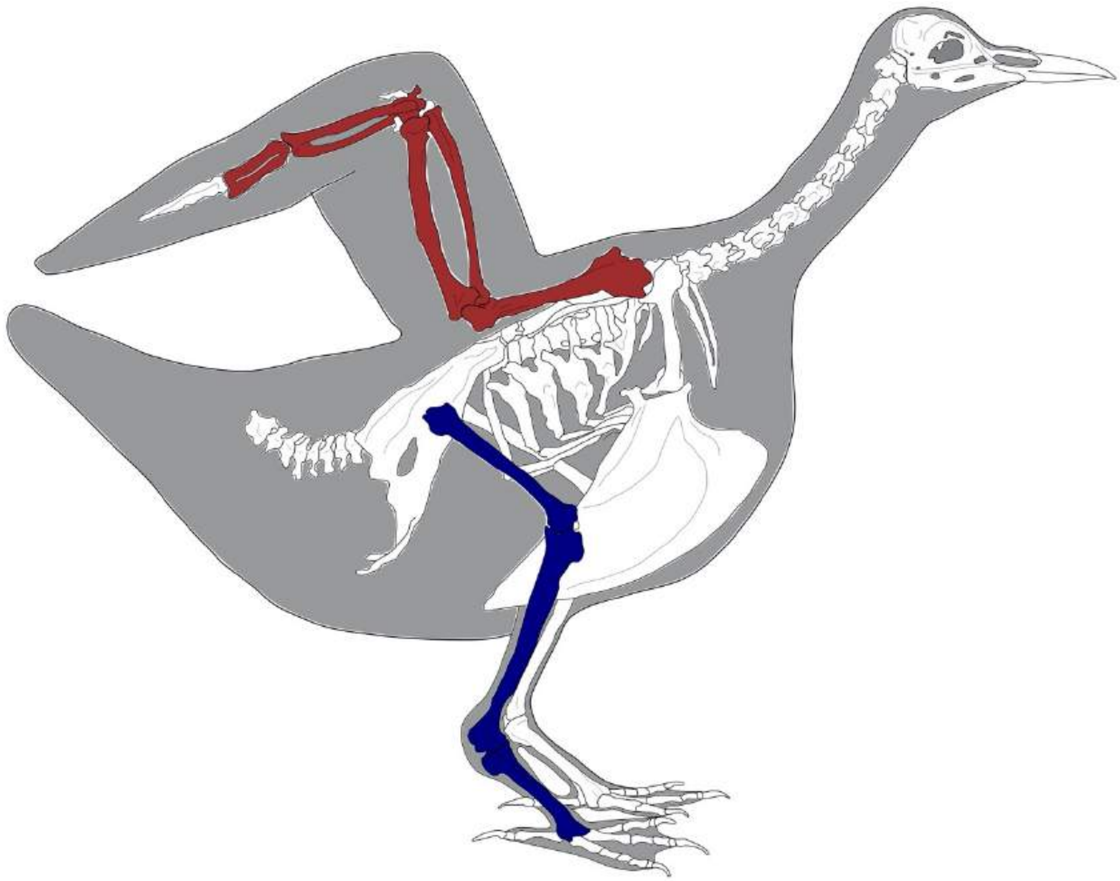

Figure 8.4. Bird skeleton with elements included in the wing-to-leg ratio highlighted. Wing elements are shown in red and leg elements in blue. Base image from ©Archeozoo but heavily modified by the author.

For the early period, puffin use can only be examined at two sites, as there are no puffin bones from that phase at Vatnskot, and neither Kotið nor Utanverðunes can be split into phases (Table 8.3). Grænagerði seems to use mostly whole birds in the early period, with a ratio only slightly below the expected number for a whole bird, 1.50 versus 1.66. Næfurstaðir deposits slightly more wings than would be expected if they were using whole birds, with a ratio of 2.60. All of the late period contexts have very small NISPs and no leg bones at all were identified in the Næfurstaðir assemblage. At Grænagerði, the ratio is lower than the expected, while at Vatnskot it is double the expected. With a larger sample size, this would indicate that Vatnskot is disproportionately disposing of wings; however, the total NISP is far too low to actually say anything about bird use during this period.

Finally, in the Viking Age, we can see the broad trend throughout all of a site's occupation. This gives us the best picture of bird use over time. All five sites have average ratios above the expected 1.66, but sample sizes vary. At both Utanverðunes and Kotið, the sites with the largest sample sizes, it is clear that bird wings vastly outnumber other body parts. Grænagerði also has a high ratio of wings to legs, which again points to selective use and deposition of wings. Næfurstaðir and Vatnskot have the lowest NISPs, but still their ratios are above the expected.

For guillemot, Grænagerði has the highest NISP of all the sites by far (Table 8.4). Both the early and total Viking Age periods have the highest ratios, 28.40 and 13.31 respectively. The ratio for the late period cannot be calculated because there are no leg bones at all, but only six wing bones. It is clear that guillemot are the preferred bird species at Grænagerði (Table 8.2), and that wings are disproportionately deposited into the middens over other body parts.

By contrast, ratios at Næfurstaðir cannot be calculated for any period because there are no leg bones of guillemot present at all. The early period has three wing bones present, and the late period has no wing or leg bones. Guillemot make up only about 22% of the bird assemblage at Næfurstaðir, so it is not surprising that they are not well-represented in this wing-to-leg ratio analysis.

Vatnskot ratios range from 3.00 in the early period to 1.67 in the late and 2.00 as the average for the entire Viking Age. Again, the NISP here is rather small. However, this could point to guillemot being most often used whole. Utanverðunes has a small guillemot sample, but a high proportion of wings and a wing-to-leg ratio far above the expected. Finally, the wing-to-leg ratio at Kotið is also above the expected, at 2.87. This indicates selectively chosen wings, but not to a high degree like we can see at Grænagerði.

Table 8.3. Wing-to-leg ratios for puffins (*Fratercula arctica*) from all four Hegranes sites during all time periods. Table based on Bovy (2002:974, Table 3). HUM=humerus, RAD=radius, ULN=ulna, CMT=carpometacarpus, DIG=proximal phalanx of the second wing digit, FEM=femur, TBT=tibiotarsus, TMT=tarsometatarsus. These codes are used in the rest of the tables below.

Time Period	Site	HUM	RAD	ULN	CMT	DIG	Wings (total)	FEM	TBT	TMT	Legs (total)	Total NISP	Wing-to-Leg Ratio
Expected Whole Bird		2	2	2	2	2	10	2	2	2	6	14	1.66
Early	**Grænagerði**	1	1	1	0	0	3	1	1	0	2	5	1.50
	Næfurstaðir	8	2	2	1	0	13	3	2	0	5	18	2.60
	Vatnskot	0	0	0	0	0	0	0	0	0	0	0	--
Late	**Grænagerði**	2	0	0	0	0	2	1	0	1	2	4	1.00
	Næfurstaðir	1	0	1	1	0	3	0	0	0	0	3	--
	Vatnskot	1	2	0	0	0	3	0	1	0	1	4	3.00
Viking Age (Unphased)	**Grænagerði**	10	8	14	14	0	46	1	1	0	2	48	23
	Næfurstaðir	0	0	0	0	0	0	0	0	0	0	0	0
	Vatnskot	0	0	0	0	0	0	0	0	0	0	0	0
	Kotið	30	19	46	19	7	121	9	10	4	23	144	5.26
	Utanverðunes	22	40	37	35	0	134	0	6	5	11	145	12.18
TOTAL (All Viking Age)	**Grænagerði**	13	9	15	14	0	51	3	2	1	6	57	8.50
	Næfurstaðir	9	2	3	2	0	16	3	2	0	5	21	3.20
	Vatnskot	1	2	2	2	0	7	0	1	0	1	8	7.00
	Kotið	30	19	46	19	7	121	9	10	4	23	144	5.26
	Utanverðunes	22	40	37	35	0	134	0	6	5	11	145	12.18

Table 8.4. Wing-to-leg ratios for guillemot (*Uria aalge*) from all four Hegranes sites during all time periods.

Time Period	Site	HUM	RAD	ULN	CMT	DIG	Wings (total)	FEM	TBT	TMT	Legs (total)	Total NISP	Wing-to-Leg Ratio
Expected Whole Bird		2	2	2	2	2	10	2	2	2	6	14	1.66
Early	**Grænagerði**	23	32	41	30	16	142	1	3	1	5	147	28.40
	Næfurstaðir	2	0	1	0	0	3	0	0	0	0	3	--
	Vatnskot	0	1	0	2	0	3	0	0	1	1	4	3.00
Late	**Grænagerði**	1	0	2	3	1	7	0	0	0	0	7	--
	Næfurstaðir	0	0	0	0	0	0	0	0	0	0	0	--
	Vatnskot	4	1	0	0	0	5	2	0	1	3	8	1.67
Viking Age (Unphased)	**Grænagerði**	63	57	72	55	30	277	7	11	9	27	304	10.26
	Næfurstaðir	0	0	0	0	0	0	0	0	0	0	0	--
	Vatnskot	0	0	0	0	0	0	0	0	0	0	0	--
	Kotið	23	13	21	9	2	68	6	17	0	23	91	2.96
	Utanverðunes	7	9	5	10	0	31	0	3	1	4	35	7.75
TOTAL (All Viking Age)	**Grænagerði**	87	89	115	88	47	426	8	14	10	32	458	13.31
	Næfurstaðir	2	0	1	0	0	3	0	0	0	0	3	--
	Vatnskot	4	2	0	2	0	8	2	0	2	4	12	2.00
	Kotið	23	13	21	9	2	68	6	17	0	23	91	2.96
	Utanverðunes	7	9	5	10	0	31	0	3	1	4	35	7.75

What the tables above show is that wings are overrepresented compared to other body parts in nearly all cases. This indicates that there is something going on to privilege the deposition of bird wings over legs or other parts of the body. Though there may be site-specific species choice (see Table 8.2), it seems that the same basic depositional processes are taking place at the Hegranes sites without regard to species. This indicates that all *alcids* are treated in the same way. Looking at the ratios for different time periods also makes it clear that bird use does not change much, if at all, over the Viking Age. This makes it possible to use the total (All Viking Age) ratios to make statistical comparisons. Plotting the total number of wings against the total number of legs (Figure 8.5) makes it even more clear that there are more wings than expected in every case.

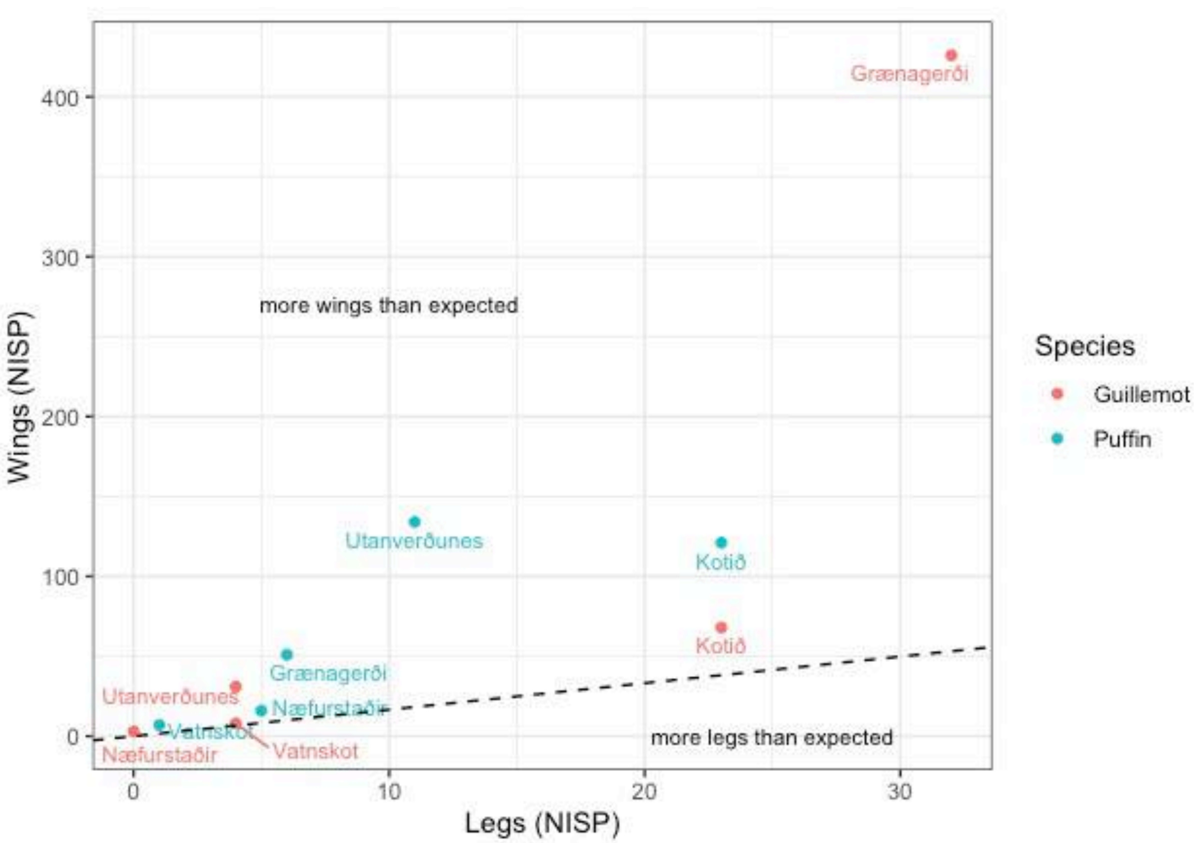

Figure 8.5. Scatter plot of the Viking Age total wing and leg elements included in the tables above. The dashed line shows where the points should fall if the birds were being deposited whole into the middens.

To test the significance of wing representation, I deviate from Bovy and use a one sample t-test instead of a goodness-of-fit test. This is because some of the sites (especially Grænagerði) have much larger sample sizes than the others, which would swamp out the other sites if using a goodness-of-fit test, which privileges each bone. Instead, the one sample t-test weights each site equally.

For both species, the average combined wing-to-leg ratio in the Viking Age (M=6.01, SD = 4.2) is significantly higher than the expected ratio of 1.66 (conditions t(8)=3.073, p=0.015). When taking puffin and guillemot individually, their means are much higher than the expected—the puffin mean ratio is 5.9 with SD = 4.5, and the guillemot mean ratio is 6.1 with SD = 4.6. However, the results are not significant because of the small sample size (puffin t(4) = 2.117, p=0.102; guillemot t(3)= 1.945, p = 0.147). Thus, while the ratios for individual species and sites are not significantly higher than the expected, the broad trend of *alcid* use is significantly higher than expected.

Distal Wing Index

The Distal Wing Index (Bovy 2012) compares the ratio of proximal to distal wing elements. There are six paired bones in the proximal wing measure—two each of humerus, radius, and ulna—and four in the distal wing—two each of carpometacarpus and the proximal phalanx of the second wing digit (Figure 8.6). The index is calculated by dividing the total distal wing elements identified by the sum of both the distal and proximal wings, and so the expected value of the distal wing index in a whole bird is 0.40 (Bovy 2012:2056). If a number is higher than this ratio, then there are more distal wings represented; numbers below 0.40 mean that proximal wings are more common. During some time periods, sites might have no elements present at all (early Vatnskot puffins for example), but it is more common for sites to have no distal wing elements present. This already tells us that distal wings may be underrepresented in some cases.

This is likely due in part to taphonomic factors, as one of the distal wing elements, the proximal phalanx of the second wing digit, is smaller than the others and could be destroyed more easily. It is also more difficult to identify to species, especially if it is broken or eroded.

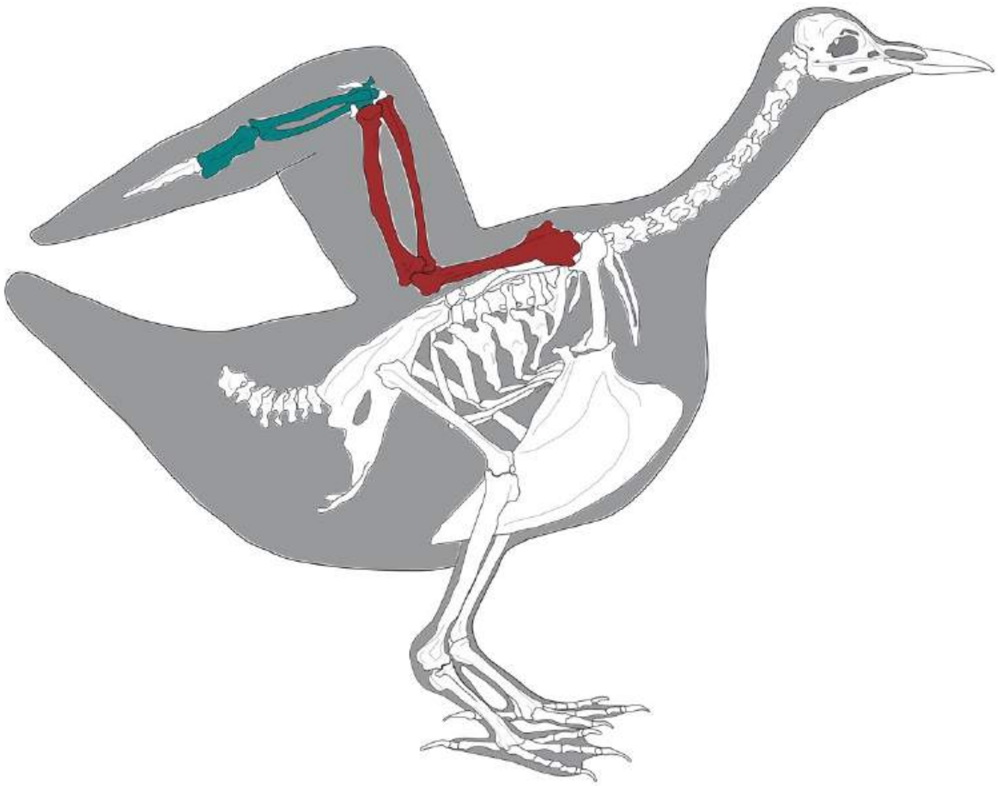

Figure 8.6. Bird skeleton showing which bones are included in the calculation of the distal wing index. Proximal wing elements (humerus, radius, ulna) are colored red and distal wing elements (carpometacarpus and the proximal phalanx of the second wing digit) are colored green.

The puffin data show that distal wings are less common at all sites—none of the calculated indices are above the 0.40 expected in a whole bird (Table 8.5). Utanverðunes has the highest number of total wing elements of all the sites, and the distal wing index is 0.261, indicating that there are more proximal wings in the middens than would be expected if birds were being deposited whole. Kotið shows the same pattern as Utanverðunes and has the second highest number of wing elements of all five sites. The lack of distal wing elements at some sites means that an index cannot even be calculated, but many of those sites also have small numbers of proximal wing elements (see early Grænagerði, late Grænagerði and Vatnskot).

Table 8.5. Distal wing index for puffins at all four sites. HUM=humerus, RAD=radius, ULN=ulna, CMT=carpometacarpus, DIG=proximal phalanx of the second wing digit.

Time Period	Site	HUM	RAD	ULN	Proximal Wing (total)	CMT	DIG	Distal Wing (total)	Total NISP	Distal Wing Index
Expected Whole Bird		2	2	2	6	2	2	4	10	0.40
Early	**Grænagerði**	1	1	1	3	0	0	0	3	--
	Næfurstaðir	8	2	2	12	1	0	1	13	0.08
	Vatnskot	0	0	0	0	0	0	0	0	--
Late	**Grænagerði**	2	0	0	2	0	0	0	2	----
	Næfurstaðir	1	0	1	2	1	0	1	3	0.33
	Vatnskot	1	2	0	3	0	0	0	3	--
Viking Age (Unphased)	**Grænagerði**	10	8	14	32	14	0	14	46	0.30
	Næfurstaðir	0	0	0	0	0	0	0	0	0
	Vatnskot	0	0	0	0	0	0	0	0	--
	Kotið	30	19	46	95	19	7	26	121	0.21
	Utanverðunes	22	40	37	99	35	0	35	134	0.261
TOTAL (all Viking Age)	**Grænagerði**	13	9	15	37	14	0	14	51	0.275
	Næfurstaðir	9	2	3	14	2	0	2	16	0.125
	Vatnskot	1	2	2	5	2	0	2	7	0.286
	Kotið	30	19	46	95	19	7	26	121	0.215
	Utanverðunes	22	40	37	99	35	0	35	134	0.261

Table 8.6. Guillemot distal wing indices.

Time Period	Site	HUM	RAD	ULN	Proximal Wing (total)	CMT	DIG	Distal Wing (total)	Total NISP	Distal Wing Index
Expected Whole Bird		2	2	2	6	2	2	4	10	0.40
Early	**Grænagerði**	23	32	41	96	30	16	46	142	0.32
	Næfurstaðir	2	0	1	3	0	0	0	3	--
	Vatnskot	0	1	0	1	2	0	2	3	0.67
Late	**Grænagerði**	1	0	2	3	3	1	4	7	0.57
	Næfurstaðir	0	0	0	0	0	0	0	0	--
	Vatnskot	4	1	0	5	0	0	0	5	--
Viking Age (unphased)	**Grænagerði**	63	57	72	192	55	30	85	277	0.30
	Næfurstaðir	0	0	0	0	0	0	0	0	--
	Vatnskot	0	0	0	0	0	0	0	0	0
	Kotið	23	13	21	57	9	2	11	68	0.162
	Utanverðunes	7	9	5	21	10	0	10	31	0.323
TOTAL (All Viking Age)	**Grænagerði**	87	89	115	291	88	47	135	426	0.316
	Næfurstaðir	2	0	1	3	0	0	0	3	--
	Vatnskot	4	2	1	7	3	0	3	10	0.300
	Kotið	23	13	21	57	9	2	11	68	0.162
	Utanverðunes	7	9	5	21	10	0	10	31	0.323

The guillemot data are more variable than the data for puffins; however, again many of the sample sizes are quite small (Table 8.6). For those sites with decent sample sizes (early and Viking Age Grænagerði, Kotið), all of the distal wing index values are below 0.40. Again, this means that there are more proximal wings in the archaeofaunal assemblages than there should be if the bird wings were deposited whole. While taphonomy may play a role in this, it is likely not the only factor causing an overrepresentation of proximal wing elements, and a human behavioral explanation must be explored. This seems to be selective use of bird wings in general, and proximal guillemot wings specifically.

The tables above (Table 8.5 and Table 8.6) clearly indicate that, for both species, there are more proximal wing elements present than distal wings in nearly all cases. While there are two times when the distal wing index rises above the expected index of 0.40, the sample sizes for those instances are quite small and, when the total Viking Age index is taken into account, none of the sites have more distal wings (Table 8.6). What we also see in the above tables is very little change over time in the use of wings; this is what allows for the use of the total (Viking Age) numbers as a representation of the entire site.

A scatterplot of the total (Viking Age) numbers of distal and proximal wing elements for each species (Figure 8.7) helps to further illustrate that there are more proximal wings than should be expected if whole wings were deposited into the middens. It also shows just how many more guillemot bones were found at Grænagerði compared to the other three sites.

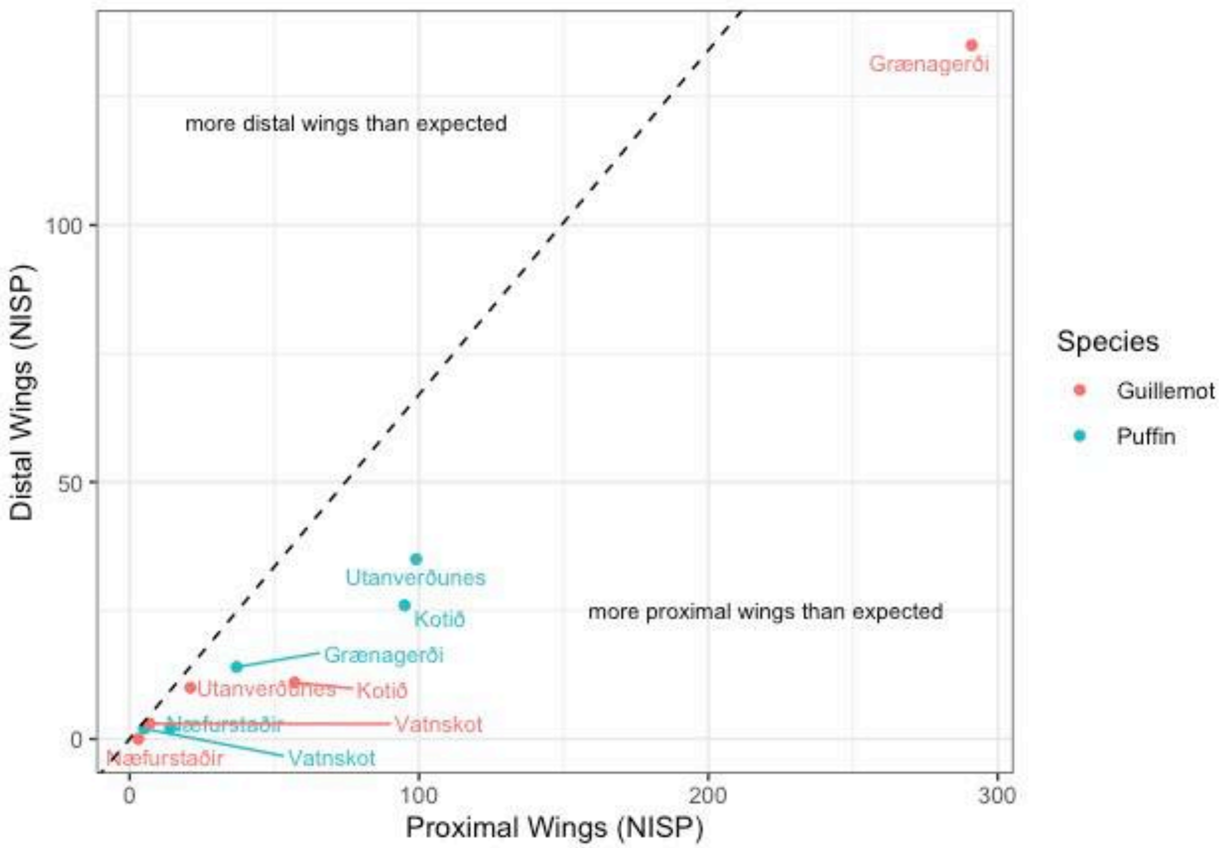

Figure 8.7. Scatter plot of the Viking Age proximal and distal wing elements included in the tables above. The dashed line shows where the points should fall if the wings were being deposited whole into the middens.

Again, using a one sample t-test on the Viking Age total, the distal wing indices presented above are tested for statistical significance. The average combined distal wing index for both species at all sites in the Viking Age ($M=0.238$, $SD = 0.0677$) is significantly lower than the expected index of 0.40 (conditions $t(3)= -6.736$, $p=0.000$). When taking puffin and guillemot individually, their means (puffin mean ratio = 0.2175, SD = 0.063; guillemot mean ratio = 0.260, SD = 0.037) are also significantly lower than the expected (puffin $t(3)$ -5.706, $p=0.011$; guillemot $t(3)= -3.810$, $p = 0.032$). Again, when the ratio falls below the expected, it means that more proximal wings are present. Just like the wing-to-leg ratio, the distal wing index shows that the same depositional processes take place at all sites without regard to species; all *alcids* seem to be used in the same way which disproportionately deposits proximal wings into the middens.

Explaining All the Wings

This case study has shown that the patterns of seabird butchery on early Hegranes differentially deposit proximal wing elements into the middens. Below, I discuss a few possible hypotheses for the abundance of wing elements and elaborate on the validity of each hypothesis. The hypotheses can be broken down into two main categories—preservation- and taphonomy-based and human behavior.

Preservation and Taphonomy

Bone Density

One hypothesis for the prevalence of wings is differential preservation due to bone density. Bovy (2002:969) discusses bone density, and one of the main conclusions is that there just is not enough work that has been done to measure the density of bird bones to prove or disprove this hypothesis. However, Bovy (2002:970) does suggest that *alcids* should have denser wings since they swim underwater; however, that is a behaviorally based hypothesis, and there has not been a study on the actual density of *alcid* bones, so this hypothesis needs more testing to determine its validity.

Recovery and Preservation

Recovery strategies and preservation could also play a role in certain bones being missing from the collection. However, all five sites were excavated using the same methods and by the same team of researchers (the author was present for the majority of all excavations). Since recovery strategies do not differ between sites, and even the smallest vertebrae of birds and fish are present in the assemblages, we can conclude that recovery strategies did not bias the collections towards wing elements.

Preservation was similarly good at all sites, and they all had primarily charcoal-based middens (Catlin 2019) which preserve bone better than the peat ash middens we found at other sites in the region. Therefore, taphonomy does not seem to be a major contributor to this patterning either. However, degradation pre-disposal may influence which bones end up in the midden. Best and Mulville (2010:90) point out that bones are more likely to be weakened by cooking, destroyed during consumption, or broken enough during cooking/consumption activities that they become unidentifiable. This only applies to bones that are cooked and/or consumed, and other hypotheses point to wings being discarded without cooking. This may partially explain why bones from the wing are more common in the middens excavated for this dissertation.

Identification Bias

Identification bias could also be a factor in the overabundance of wings. For example, smaller bones tend to be more difficult to identify to species. However, the bones used in the analyses presented here are generally easy to identify to species, so this is unlikely to be a factor *in this case*. Also, all analysis was carried out by the author, and so inter-analyst bias in identification is also not a concern.

Drift Carcass Hypothesis

There is a hypothesis that humans scavenged parts of birds that drifted onto the beach (Schalk 1993 in Bovy 2002). While these bird parts would not have been suitable for food, the bones could have been used for craftworking and the feathers collected for clothing or bedding. There are no artifacts made of bird bones at these sites, and feathers have not been preserved in our excavations. Bovy (2002:968) suggests that if the drift carcass hypothesis is true, aquatic birds should be overrepresented. It is true that there are primarily seabirds in these assemblages. Anecdotally, I have often seen wings and the attached sternum while walking on beaches in Iceland.

Human Behavior

Ease of Hunting

It is possible that the focus on seabirds is because of their abundance in the summer. They nest in large colonies and, while dangerous to hunt, it is not difficult to take many birds at one time. They were also a familiar resource from the British Isles and Faroes (Best and Mulville 2010; Brewington 2015; Keller 2010:20), and were probably unwary of the first humans to arrive in Iceland (e.g., Frei et al. 2015; Vésteinsson et al. 2002), as the birds have very few natural predators on the cliffs where they nest. However, the other birds that are present on the landscape (ducks, ptarmigan) would also have been unwary of humans and easier to access.

Labor demand is highest in the summer months, when most of the energy goes into growing, harvesting, drying, and storing fodder for the winter months. Sending men off to hunt birds would have taken away labor from the main farm activities, and so it may be assumed that these seabirds were an important part of the economic strategy that justified diverting farm labor.

Primary Carcass Processing

Ease of hunting may explain the numbers of birds in the assemblages, but it does not fully explain the overrepresentation of wings. Primary carcass processing of these seabirds may explain the abundance of wings observed in these collections (see Figure 8.8 for an example of wing bones that were typical of the MARSH assemblages). The pattern of abundant seabird wings, and especially those from puffin and guillemot, has been observed and discussed at other sites in the North Atlantic (Best and Mulville 2010; Brewington 2015). Both studies suggest pre-consumption processing as the main reason for more wings to end up in the midden.

Ethnographically in the North Atlantic, primary processing of seabirds includes wing removal and discard, as bird wings are less rich in meat than other parts of the body (e.g., Best and Mulville 2010:90; Gotfredsen 1997:280). Best and Mulville (2010:94) also suggest that removing the wings "may also make the bird easier to fit in a cooking pot or to preserve," while still keeping the most meat-rich portions.

Historically, seabirds in Shetland were salted and smoked to be eaten in the winter months, with fresh birds being eaten in the summer (Fenton 1978:512). In Iceland too, birds were thought to be "smoked, wind dried, or stored in whey" if they were not immediately eaten fresh, and after the 18th century when salt became more common, the birds would be salted whole, or the wings, heads, and feet removed before salting (Guðmundsdóttir Beck 2013:36).

Figure 8.8. Guillemot wing bones from Grænagerði TP2, context [108].

Feather Collection

It has been hypothesized that *alcids* are harvested not only for meat, but for feather collection as well. Best and Mulville (2010:94) propose that the puffin wings from the Shiant Isles were specifically curated for feather collection and they have observed butchery marks on the ends of the long bones that suggest feather removal. Bird feathers have historically been used in bedding and have been exported or traded from North Atlantic islands at least from the 17th century and into the recent past (e.g., Best and Mulville 2010:94; Petersen 2005:203). While it is always a bit questionable to impose the ethnographic present onto the past, we have culture continuity from settlement to the present, and the continuity of seabird use in Iceland lends itself well to using ethnographic analogies as possible explanations for past patterns.

Human and Scavenger Modifications

Both human modification and scavenger intervention are contributors to biased archaeofaunal collections. When humans process animals for food, butchery marks and burning may affect the bones. In the case of the Hegranes birds, there are no butchery marks on the bones at all, and the percentage of each collection that is burnt is always below 6%, except at Kotið where 13.5% of the bird bones show evidence of some degree of burning. In addition to this, there is very little evidence of scavengers at the sites. None of the bird bones show evidence of gnawing by either rodents or carnivores (dogs and foxes in Iceland), and the rest of the assemblages also show very low incidences of scavenging by animals. Therefore, scavengers and most human modifications do not appear to be major contributors to the abundance of bird wings.

Wings as Fuel

Ethnographically in Iceland, puffin wings have been used as fuel along with other leftover body parts. The breast was the only part of the puffin that was used as food, while everything else (including wings, back, and head) could be tied into a bundle, hung, and dried to be used as fuel (Kristjánsson 1987:209). This dried bundle is called *spílur* or *lundaspílur,* sometimes spelled *spýlur.* Hicks notes a pattern of burned *alcid* wings in the Hornbrekka assemblage and attributes it to the use of dried wings as fuel (Hicks 2016:19–20). The use of dried wings as fuel is unlikely to be the case at the Hegranes sites—as mentioned above, very few of the bird bones are burned at all.

Results

All of the preservation and taphonomy hypotheses were able to be refuted, leaving human behavioral activities as the drivers for wing abundance. I have proposed five potential reasons for the pattern of wing bones in the assemblages, and all of them likely contribute in some way. First, these sites are dated to the Viking Age, when people first came to Iceland and encountered wild animals that were unwary of humans as predators. This, along with the huge numbers of birds in the summer breeding season, likely made it easy to hunt the birds and collect many at one time in one season. In addition, the familiarity of seabirds as a resource and their initial abundance probably made them an obvious target for early exploitation. Seasonal summer labor would need to be diverted for bird hunting, and since they are hunted during the busiest season, this diversion of labor shows the importance of birds to the economic strategy during the settlement period.

Once harvested, the birds would have been brought home whole for processing; this needed to happen quickly, before the meat could spoil. Historically, primary carcass processing of seabirds begins with plucking the entire bird, and this was usually a job for women (Kristjánsson 1987:356). Then, men remove and discard the wings and feet in favor of keeping the meatier parts of the bird. In the summer, the birds were eaten fresh, and preserved in a number of ways for consumption during the rest of the year. In Iceland, birds were salted whole after the 19th century, with their wings, heads, and feet removed first and discarded (Guðmundsdóttir Beck 2013:36). These historically known patterns of butchery inform our interpretation of the past. What seems to be common in these historical butchery patterns is that wings are removed and discarded since they have very little utility. It is unclear, based on the archaeological assemblages, where the rest of the bird bodies are consumed. If wings were discarded and then the rest of the bird consumed, one might expect to see evidence of whole birds in the middens. Since this is not the case at the Hegranes sites, and the bodies are missing, it is possible that the rest of the birds were consumed off-site, processed to the point that the bones become unrecognizable, or preserved in a way which might cause bones to become weakened.

It has also been suggested that bird wings are overrepresented in archaeological collection because of feather collection. In Iceland specifically, once removed from the rest of the body, auk wings would be dried and then the feathers collected to make bedding, while the bones were discarded (Guðmundsdóttir Beck 2013:37). Auks are in the same family as puffin and guillemot, and it is quite possible that they were also used in this way in the Viking Age. Best and Mulville (2010) argue for feather collection from in the Shiant Isles (Outer Hebrides) due to butchery marks on the ends of long bones. There are no butchery marks on any of the wing bones in the Hegranes assemblages. However, feathers could have been simply plucked from the bird, which would not leave marks on the bones, so wing curation for feather collection as an explanation for the number of wing bones from the Hegranes sites cannot be proven or discounted.

One possibility that is not discussed in the other North Atlantic studies of bird body part representation is the use of bird wings as brooms. Historically in Iceland, bird wings are used to "sweep floors and for dusting" (Guðmundsdóttir Beck 2013:37), though the wings used were generally from larger birds like swans (Milek 2006:72). However, if the seabirds were already being collected for consumption and wings were removed as part of the primary processing strategy, the wings would have been a relatively abundant resource and it is not unlikely that they could be used in some way, like for sweeping.

I have given a few potential explanations for the overabundance of wings, and while some seem more likely than others, none can be completely discounted. What is clear is that the explanation for these patterns must be cultural. The pattern of overabundant seabird wings in Iceland is not limited to Hegranes, Skagafjörður, or even to coastal areas. There is growing evidence that this same butchery strategy is also used at inland sites. *Alcid* wings are abundant at a site in south Iceland that is nearly 40 km inland (Cesario 2021). Future work will explore bird use at this and other sites in Iceland, including information on both seabirds and other birds, in order to understand if there are specialized strategies for different classes of birds or if there are regional differences in butchery strategies.

Bird Conclusions

One of the most important conclusions from this analysis is to refute the idea that birds were a supplement rather than a primary staple in the diet of the early settlers. Of course, it has been over a decade since Perdikaris and McGovern (2008) described these patterns, and as research continues we learn more and modify our prior views. The bird use described here shows that birds, and especially seabirds, were an important resource to the early settlers on Hegranes. Seabirds would have been familiar, as they are present across the North Atlantic, and often in large numbers during their nesting season.

The overrepresentation of bird wings shows a behavioral preference for these body parts, and the continuation of this pattern from the British Isles, the Faroes, and into Iceland may indicate some cultural continuity. This pattern also mirrors historic and modern butchery strategies, another point for cultural continuity and the ability to use ethnographic resources to describe bird use in the past. The butchery pattern represented in the seabird collections from the Hegranes sites is further evidence towards a specialized marine resource focus and early artisanal processing strategies, though the exact reason for the abundance of wings is still being studied.

Chapter 9. Major Findings

The previous three chapters discussed the major taxonomic groups in the MARSH archaeofaunal assemblages. This chapter aims to bring together the results of those analyses and tie them into the broader picture of early Icelandic animal use. The fundamental question for this dissertation was: what are the range of economic strategies employed by the Norse settlers in Iceland, and how do the MARSH sites fit into, or alter, the current story of economic adaptation?

The Norse concept of the farm was imported in the mind of the settlers and implemented in much the same way in the earliest periods of all of the Norse colonies. However, each island represented unique environmental challenges, and niche construction activities shaped the trajectories and landscapes of the settlements.

Norse Animal Husbandry

The animal husbandry aspect of Norse farming focuses primarily on raising cattle and caprines, with pigs, goats, and horses kept in varying quantities. While exact numbers of each animal are not rigidly defined, this general pattern seems to be followed across the North Atlantic. In Iceland, cattle and caprines are the two main livestock species that persist through time, while pigs and goats become relatively uncommon after the initial settlement.

The mix of domesticates at the MARSH sites fall well in line with other early Icelandic farms across the country (Figure 9.1). Caprines make up the majority of the domesticates, and they are managed for a general meat/milk/wool strategy rather than specialized for one specific product, which would be economically disadvantageous (see Chapter 6). Cattle make up the next highest proportion of the domesticates, and they are kept for both meat and dairy. In this sense, the four

MARSH sites, both the abandoned sites and the active farm, were continuing the Norse farming tradition from the beginning of the settlement.

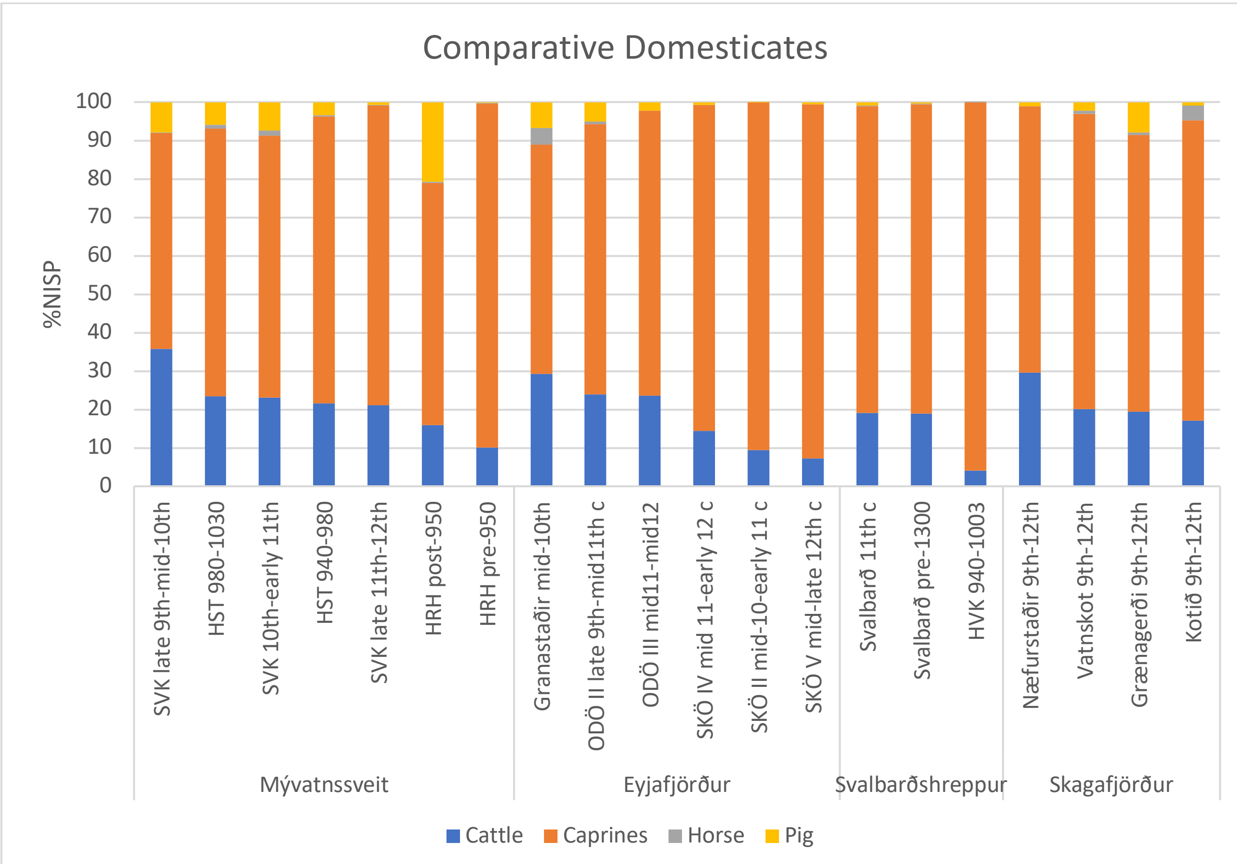

Figure 9.1. Comparative percentages of major domesticate groups at sites across Iceland. HST=Hofstaðir, HRH=Hrísheimar, SVK=Sveigakot, SKÖ=Skuggi, ODÖ=Oddstaðir, HVK=Hjálmarvík.

The other measures used to look at comparative animal husbandry in Chapter 6 included neonatal cattle percentages and caprine to cattle ratios. Both of these studies place the MARSH sites within the range of other contemporaneous Icelandic farm sites. Taking all three together again supports the idea that those on Hegranes are managing their animals, and specifically caprines and cattle, in similar ways as other early farmers.

Pigs are also kept in numbers that correlate well with the numbers of pigs at other early settlement dwellings in Iceland. While pigs become less common after AD 1200, they were an important part of the initial settlement and niche construction package. Pigs were useful for clearing grasslands, and perhaps as an early source of food since they reproduce quickly compared to some of the other domesticates. Once the landscape had been sufficiently domesticated, pigs would have become more expensive to feed and the decrease in pigs is likely correlated with a shift to conservation of woodlands and grazing areas rather than the land-clearing that was initially necessary to impose the Norse farm concept upon the Icelandic landscape.

The domesticates at the MARSH sites show a "farm" signature that matches the range seen across contemporaneous Icelandic sites. However, when the entire archaeofaunal assemblage is taken as a whole, a very different story emerges. The Norse farm always included a variety of the available wild animal resources (Øye 2005), but these were generally meant to supplement a terrestrial-focused livestock strategy.

The majority of contemporaneous settlement period farms in Iceland utilize more domesticates than the MARSH sites. The ratio of wild animals to domesticates shows just how much each contributes to the economic strategy; a higher ratio means more wild animals. Comparing the MARSH sites to other contemporaneous farms in northern Iceland will show if the mix of animals utilized on Hegranes is the same, and therefore that the early economic strategies do not differ much between regions (Figure 9.2). The boxplot below (Figure 9.2) shows that there are significantly ($p=0.11$) more wild animals in the MARSH assemblages than there are at the majority of the other early settlement farms in Iceland. That the difference in wild to domesticate ratio is so statistically significant supports the idea that the MARSH sites, while participating in "farm-like" activities, rely much more on wild resources.

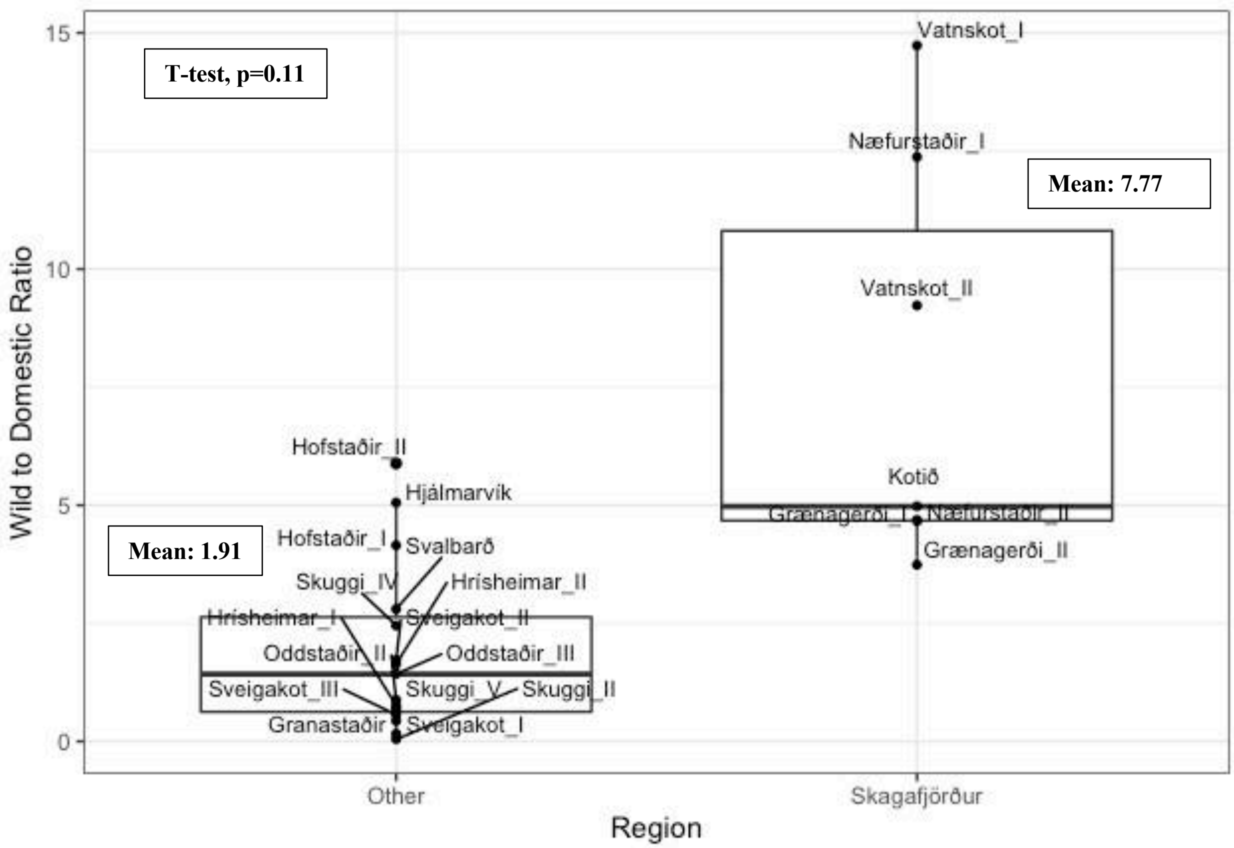

Figure 9.2. Boxplot showing the ratio of wild animals to domesticates at the MARSH sites and various sites across Northern Iceland for comparison. The thick black line in the middle of each box represents the median.

Wild Animal Resources

While the MARSH sites utilize significantly more wild resources than most other contemporaneous sites in Iceland, the mix of wild animals is comparable (Figure 9.3). The sites in Svabarðshreppur tend to use many more sea mammals than most other sites, and an early phase at Skuggi has the largest percentage of mollusks out of all the sites. Otherwise, fish tend to be the most common wild resource at all sites, making up at least 40% of the wild animal category in all cases. The wild animal mix during the earliest phases at Hofstaðir is almost entirely comprised of fish. The graph does not distinguish between freshwater and marine fish; however, the fish at Hofstaðir are primarily freshwater fish, which are abundant in Mývatn (McGovern 2009).

The mix of wild resources that are incorporated into the economic strategy at these early sites is relatively similar across regions. This may indicate opportunistic use of locally available resources and the integration of learned Local Traditional Knowledge (LTK). All sites incorporate wild resources, whether they are large and high status, like Hofstaðir, or small and low status, like the MARSH sites. The difference appears to be in the relative percentage of wild to domestic resources that are utilized.

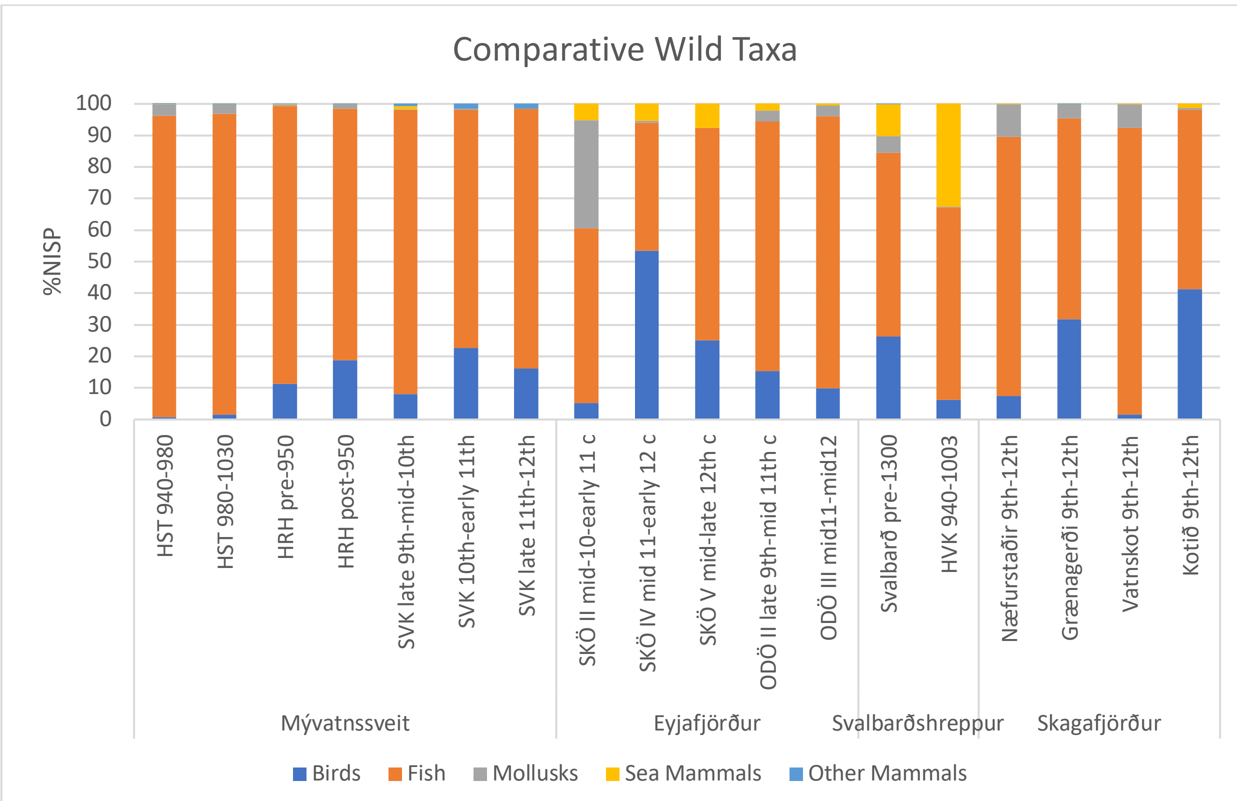

Figure 9.3. Mix of wild taxa at contemporaneous sites in northern Iceland. HST=Hofstaðir, HRH=Hrísheimar, SVK=Sveigakot, SKÖ=Skuggi, ODÖ=Oddstaðir, HVK=Hjálmarvík.

As Figure 9.3 shows, there is a strong focus on fish and birds at the MARSH sites. Both the fish and birds are primarily marine; the birds are seabirds in the *alcid* family, and the fish are in the *gadid*, or cod, family. This points to a highly specialized marine resource exploitation strategy and the sites' use as areas primarily for specialized resource acquisition and processing.

Fish

The highest percentage of all taxa at the four MARSH sites is fish. These are marine fish that are represented primarily by skull elements. This patterning points to specialized use of the site as a place to process *gadid* fish in order to create a particular dried-fish product. As discussed in the fish chapter (Chapter 7), there is also evidence for nearby inland sites consuming dried-fish products, most likely produced at sites in Skagafjörður like those identified on Hegranes, and perhaps even from the MARSH sites. This has important implications for the early use of fish in Iceland.

In light of the Fish Event Horizon (e.g., Barrett et al. 2004), the sites on Hegranes (and other sites in Iceland) become significant in the story of fish specialization. Prior to the AD 950-1050 dates when marine fish at inland sites increase in Britain, we see significant exploitation of marine fish in Norway, the Faroes, and Iceland. The fish patterns observed in the MARSH assemblages point to the creation of an early artisanal fish product that circulated within Iceland (Cesario 2016, 2018, 2019a, 2019b). This specialization and local exchange network begin right at the settlement of Iceland, well before the FEH in Britain. This pushes the origins of fish specialization much earlier, perhaps to Iron Age Norway, rather than later in Britain (McGovern 2009:277). This is not new information, as prior research in Mývatnssveit (at sites like Hofstaðir, Sveigakot, Hrísheimar, and Skútustaðir) has shown early consumption of dried marine fish products through their presence inland (McGovern 2009:254–261); however, this is some of the earliest evidence for the production of dried fish products in Iceland.

The only other site where we see this kind of early intensification and evidence for production of dried fish is in the mounds associated with the fishing station at Siglunes, located in the far north of Eyjafjörður's western coast (Harrison 2014). The contemporary contexts (10th-12th

century) have a low NISP of 247 (Harrison 2014:6) due to sampling strategy, but the fish signatures are very similar to the MARSH sites. For example, cleithra are underrepresented and there are more premaxillae, which "clearly support[s] that Siglunes was indeed a fishing site and the remains from Mound E and B display on-site fish cleaning and processing" (Harrison 2014:17). The size reconstructions also point to a pre-commercial preparation of dried fish, with an even split of flat- and round-dried fish sizes (Harrison 2014).

The presence of fish skull elements in the middens at the MARSH sites does not mean that they were simply thrown away, unused. It is of course possible that they were consumed by those who inhabited the sites, and indeed some of the skull bones show evidence of cut marks, though the number of elements with butchery marks is quite low. There is also some ethnographic evidence that fish heads were used as payment for fishermen (e.g., Hicks 2019:129–130), but this is from the Early Modern period, and cannot be reliably argued to be the case in the Viking Age when the economic and labor systems were not prioritizing global trade and exchange, but were instead focused on niche construction and local trade and exchange. It cannot be ignored, however, that the overwhelming majority of the fish bone evidence from the MARSH sites points to at least one of the functions of the sites being places where fish were processed into a flat-dried product. Patterns of fish processing and consumption in the North Atlantic have been studied for decades at this point (Barrett 1997; Barrett et al. 2004; Perdikaris 1998; Perdikaris et al. 2007), and these signatures are well-documented.

Trade

While the early production of a dried fish product on Hegranes is interesting in and of itself, what happens to the product may be even more important in understanding social and economic dynamics of early Icelandic society. Seyla, located ~20 kilometers inland in the neighboring Langholt area, has evidence for the consumption of dried fish, specifically flat-dried fish (Cesario

2016). Due to their geographically close relationship, it is quite possible that the fish consumed at Seyla came from the MARSH sites. This is the earliest evidence we have for a whole producer-consumer trade network of dried fish in Iceland. Of course, the consumption patterns in Mývatnssveit indicate a supplier from somewhere nearer to the coast; however, we do not yet have data from the potential producer sites there. Once dried fish become more of a commodity in the 12th century, we begin to see larger scale fish processing at specialized sites (Akurvík, Gjögur, Gufuskálar) for commercial export. The earlier local artisanal trade is less well-understood, and this dissertation research speaks to both ends of that network.

Birds

The next highest percentage of the major taxa at Grænagerði and Kotið is birds. Næfurstaðir and Vatnskot both have fewer birds than domesticates; however, the element representation pattern of birds as explored in Chapter 8 is comparable to the other two sites. Nearly all of the birds at all four sites are *alcids*, with very few ducks or terrestrial birds represented (see Chapter 5 for non-*alcid* species representation). Again, this focused use of marine resources points to specialized strategies at the four MARSH sites.

First, the large numbers of seabirds at Grænagerði and Kotið provide evidence that birds could actually make up a large proportion of the animal economy during settlement, contrary to prior belief (Perdikaris and McGovern 2008a). There is further evidence for major bird exploitation during the earliest phase from at least one other Hegranes site—Utanverðunes—where the assemblage is 97% bird bones (Cesario 2018c). The bird bones at Utanverðunes are nearly all concentrated in the lowest contexts, below several floor deposits, and may represent specialized pre-farm activities, similar to what has been observed at the MARSH sites. Later phases at

Utanverðunes, beyond AD 1104, do not have many bones, and so it is unclear if they switch from a hunting-focused strategy to an animal husbandry- and farming-focused economy.

The exploration of bird body part representation in Chapter 8 points to highly specialized butchery of seabirds. That proximal wings are overrepresented compared to other parts of the body indicates some kind of cultural carcass processing strategy for these particular kinds of birds. The same strategy was employed historically and is still in use today where the wings are removed from the body before cooking. This pattern has also been observed in the Faroes (Brewington 2015) and the Shiant Isles (Best and Mulville 2010), and more recently at a site in southern Iceland that is nearly 40 kilometers inland (Cesario 2021). Future research on bird use in Iceland will expand upon the data presented in this dissertation and include all birds of all species across Iceland in order to understand if and how different classes of birds were utilized and if there is continuity or change over time and/or space.

Autonomous Households or Part of a Larger System?

A major question that can begin to be answered by this research is on the status of the marginal dwelling sites on Hegranes. Were these sites autonomous households, able to support their own production, distribution, and reproduction? Or were they part of a larger farm system, providing labor and goods, but unable to fully sustain themselves? While the answer is still not certain, the data presented within this dissertation can provide some answers.

First, the possible household size at the MARSH sites needs to be established. Of course, it is quite difficult to establish the population size at these very early sites; however, some reasonable assumptions can be made based on the data we do have. Catlin (2019:119–124) has a much more detailed discussion on the calculation of population size based on farmstead area, historical records, and other direct archaeological evidence than will be presented here. Here, I will briefly discuss two medieval cemetery population on Hegranes and how they can provide a baseline for population size based on farmstead (accumulated midden) size. Zoëga (2015:5–6) suggests that the Keldudalur household averaged 10 individuals at any one time, including adults and children. Keldudalur, which is located at the southern end of Hegranes, had a pre-1104 farmstead size of 13,041 m^2 which is over three times the size of the largest of the MARSH sites (Vatnskot, 3,539 m^2) during the same time period. Similarly, the cemetery population at Keflavík suggests an average of 7-9 individuals (Zoëga, personal communication), though the pre-1104 farmstead size there was 8,618 m^2, only about 2.5 times larger than Vatnskot. Using this logic, Catlin (2019:123) suggests that the marginal FLASH sites, which includes most of the MARSH sites, could only support at most six individuals but are more likely to have housed 1-3 people at a time.

In light of these population estimates, the two non-terrestrially focused activities—fishing and birding—are quite informative about the status of the sites as autonomous households or part of a larger system. The fishing pattern at the MARSH sites is above and beyond that which is needed on the household level. In addition, the manpower needed to procure fish for trade and exchange often outnumbered the available labor from a single household. In the Early Modern period, and likely before, laborers were sent to coastal fishing stations during the winter, which is the least labor-intensive season at the farm. If the MARSH sites only housed 1-3 people, as Catlin (2019) suggests, they could not have been fishing autonomously but would have needed to aggregate labor at a supra-household scale instead. Even after the fish were brought back to the farm, labor was needed to butcher and dry them. However, this could include the women and children who would traditionally not partake in the actual fishing (e.g., Perdikaris 1998).

Bird hunting is even more illustrative of how the households at the MARSH sites could not sustain autonomous production. The vast majority of the birds at all four sites are only seasonally available in the summer, which is the most labor-intensive season on the farm. The collection of seabirds from the cliffs where they make their homes, much like fishing, includes manpower from multiple households (Petersen 2005). It was simply not possible to send just one or two men on their own due to the dangerous conditions. In addition, people were still needed to work on haying and caring for animals at the farm, though some of these activities could have fallen to women and children.

From a production and consumption standpoint, it is clear that the MARSH sites were not independent and needed to collaborate with others to mount the labor force necessary for the activities they undertook. Since the fish were not consumed on site, this also points to the sites supporting production and consumption for some unit other than themselves. Labor from multiple households came together to produce goods that were then exchanged with other households.

The three abandoned MARSH sites also do not seem to have been capable of sufficient reproduction. Given the current dating, we know that at least some of the MARSH sites are in use long enough that there would have had to be new generations to continue the household activities. However, it is not clear if the reproduction was happening on site with the people who lived there, or if laborers were being sent from a larger household. The MARSH sites are all occupied year-round and seem to be long-term productive units, but were they able to support a full household of adults, children, and the elderly? Or would they have been dependent on a larger household to supply labor? The answers to these questions are not completely clear from the archaeology, but the current data suggest that they were dependent on other households at least for labor, and likely for reproduction as well.

Finally, the abandonment of three of the MARSH sites also speaks to their inability to reproduce successfully. There are at least two potential reasons for the cessation in use of the

MARSH sites as dwellings. First, it is possible that the sites were no longer viable, due to environmental change or a shift in what kinds of production activities are valued after the initial settlement in the Viking Age. After the initial settlement, it may have been socially or politically more acceptable to focus on household-level terrestrial farming rather than fishing or bird hunting for exchange. Another possibility is that the MARSH sites were no longer useful to the larger economic unit that they once contributed to. It may have no longer been a benefit to others, especially high-status farmers, to allow the MARSH sites to exist on the landscape, but rather to incorporate the labor back into the larger household unit. Perhaps the landscape was becoming too crowded with the increased population, or the land was needed for communal grazing or other livestock activities.

All of this data suggests that the MARSH sites, at least the three abandoned sites, were not autonomous households capable of sustaining themselves fully. They were related in some way to the production, distribution, and reproduction of a larger farming household or economic unit. These sites may have been an early form of a tenant farm or acted as specialized processing stations for the needs of a larger farm.

Final Conclusions

Our knowledge is constantly growing and leading to changes in previously held beliefs, consistently showing that there is not one blueprint for how to set up a farm and thrive in early Iceland. As we continue excavation and research, it has become clear that different regions, and even different sites within a region, had their own processes of niche construction, landscape domestication, and adaptation suited to their needs, whether environmental, social, or political.

While domesticates are present at the MARSH sites in ratios that look like other contemporaneous farms, the quantities of marine fish and seabirds indicate that animal husbandry was not the primary economic strategy for these sites. The MARSH sites instead represent an early, pre-commercial specialization on marine resources. The archaeofauna point to an adaptive strategy that heavily relied on wild resources for major economic contributions. The marine fish are flat-dried and consumed off-site, and the presence of the final product at an inland farm, Seyla in the neighboring region of Langholt (Cesario 2016), reveals for the first time both the production and consumption ends of a pre-commercial artisanal trade network within one region. Seabirds are the most common birds, and especially *alcids* which seem to be the preferred bird family. Wings of guillemot and puffin are found in the middens at higher rates than would be expected if whole birds are being consumed and demonstrates a cultural explanation for this pattern.

Edvardsson (2010:271) and others have proposed that early sites in Iceland would have had to use more wild resources while they worked at niche construction and domesticating the landscape to suit their needs. There was limited space on their boats to bring supplies, including their livestock, and they would have had to breed the animals first to increase their numbers before culling any. During this time, the abundant wild resources, especially fish and birds, would have been vital for sustenance. However, this does not seem to have been the case everywhere. As this dissertation shows, there is no singular model of early economic strategies or niche construction activities that can be applied broadly across the island. Instead, it shows both a degree of cultural conformity but also strategies of adaptation that are highly tuned to the local environment. For example, more wild resources than domesticates are used on early Hegranes and in the Westfjords (Edvardsson 2010). But in Mývatnssveit, where fishing and fowling are possible on the productive lake, there is little evidence of a specialized focus on wild resources. Instead, even the sites located in the best spots for hunting still stick to the livestock-based economic strategy characteristic of a farm, rather than incorporating wild resources to a larger degree (Vésteinsson and McGovern

2012a:209). However, wild resources may act as an insurance policy when there are hard years or extenuating circumstances; Hofstaðir in Mývatnssveit includes many freshwater fish during the earliest period of landscape domestication.

The MARSH sites seem to represent a special type of site that was part of the initial settlement package, but which was no longer useful or necessary after the first couple of centuries. Whether they could no longer support themselves after a few generations or were prevented from persisting on the landscape by a larger entity is unclear. However, what is clear is that this kind of small, non-autonomous site was not uncommon on the settlement landscape of Hegranes (see Catlin 2019), and the evidence from the MARSH sites points to them being a necessary part of the initial niche construction and landscape domestication strategy.

I believe that future research should focus more on finding and studying sites like these, especially in other regions across Iceland, to update the story of settlement processes and bring the non-autonomous, marginal households into the discussion. This dissertation provides evidence for modes of production and exchange that are not organized exclusively on the household level, and also shows that not all sites were self-sufficient farms. It is the contribution of these non-autonomous marginal households that allowed larger, autonomous households to persist.

Appendix A: Bone Reports

This appendix contains the bone reports from Langholt and Hegranes that have been completed to date and are referenced within the body of the dissertation. The reports have been appended exactly as they appear in publication, with the exception of a font change to suit the requirements for the submission of the dissertation. Bibliographies for each individual report have also been removed since they can be found in the final bibliography for the dissertation. The original reports can be found on the NABO website at https://www.nabohome.org/cgi-bin/explore.pl?seq=230.

The reports are presented in the following order:

1. Cesario 2016: Skagafjörður Archaeological Settlement Survey, 2008 Excavations: The Archaeofauna of Stóra-Seyla Area C and Area D
2. Cesario 2018a: Skagafjörður Church and Settlement Survey: Archaeofauna from Kotið, 2016 and 2017
3. Cesario 2018c: Skagafjörður Church and Settlement Survey: Archaeofauna from the 2016 Field Season
4. Cesario 2018d: Skagafjörður Church and Settlement Survey: Final Report on the Archaeofauna from Grænagerði, Hegranes, Skagafjörður
5. Cesario 2019a: Skagafjörður Church and Settlement Survey: Final Report on the Archaeofauna from Vatnskot on Hegranes, Skagafjörður
6. Cesario 2019b: Skagafjörður Church and Settlement Survey: Final Report on the Archaeofauna from Næfurstaðir on Hegranes, Skagafjörður
7. Cesario 2020: Skagafjörður Church and Settlement Survey: Archaeofauna from the 2017 Field Season on Hegranes, Skagafjörður

NABO

Skagafjörður Archaeological Settlement Survey, 2008 Excavations
The Archaeofauna of Stóra-Seyla Area C and Area D

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CUNY NORSEC Laboratory Report No. 63

Introduction and Excavations

The Skagafjörður Archaeological Settlement Survey (SASS) project surveyed the Langholt region, in Skagafjörður, northern Iceland between 2001 and 2014 (Figure 1, Figure 2). Major excavations of Stóra-Seyla took place in 2008 and 2009 (Bolender 2008; Bolender et al. 2009). Stóra-Seyla is one of two settlement period farms located in the Langholt region of Skagafjörður (Bolender 2008:4), and may have been occupied since first settlement in 871 AD (Bolender et al. 2011:86). This farm was one of the wealthiest in the region, and there was a church constructed there by the 13th century which was maintained until the 18th century (Bolender 2008:4). Stóra-Seyla is also one of two farms in Langholt to be relocated, moving from a lower elevation area to a higher one after in the 11th century.

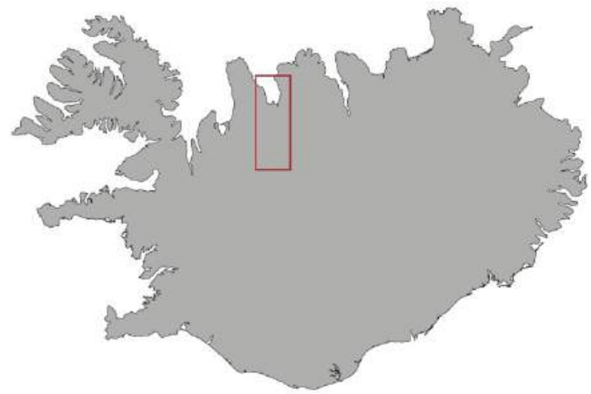

Figure 1: Map of Iceland. Skagafjörður is highlighted in the red box.

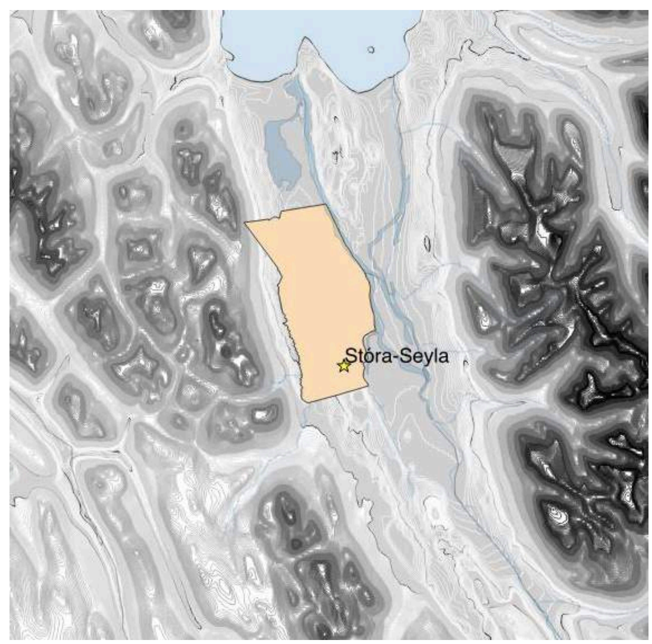

Figure 2: Location of Stóra-Seyla on Langholt, Skagafjörður.

Excavations at Stóra-Seyla consist of multiple distinct areas; the two focused on for this analysis are Area C and Area D. Area C is made up of a few different structures, the majority of which were no longer used after the relocation of the farmstead. Structure 1, a medieval barn, was built post-1104 and after the farmstead relocated; however, it shows that the site was used continuously, despite moving the main farm (e.g., Bolender 2008:9; Bolender et al. 2009:4–5). There was midden material that came from Structure 1. Structure 2 is a large rectilinear building that looks similar to a Viking Age hall (Bolender et al. 2009:20). It was built before 1104 AD, and possibly before 1000 AD, and has a domestic floor (Bolender 2008:9; Bolender et al. 2009:14). Only 21 fragments of bone came from this structure. The third structure is a small *skáli* that also dates to the Viking Age (Bolender 2008:9; Bolender et al. 2009:14). The majority of the archaeofauna from Area C comes from this structure.

Area D is a midden located northeast of Area C and near a stream (Steinberg et al. 2008:2). This stream caused issues during excavation, as the team was able to see that it had undercut portions of the midden. This excavation consisted of a 2x3m pit that met up with Area C when excavations of the structures expanded in 2009 (Bolender et al. 2009:13). None of the material from Area D was deposited after 1104 A.D.

Though these two areas were excavated separately and treated as distinct groups, their deposition and dates indicate that, for the most part, they are part of the same depositional events. The exception to this is the material deposited post-1104 in Structure 1 of Area C. The farmstead had relocated at this point and while the structure was likely used as a small animal barn, the deposition of material inside of it would not have been contemporary with the use of the midden in Area D. For this analysis, Area C and Area D will be treated as one archaeofauna and analyzed as such, with the post-1104 material from Area C being analyzed separately.

Methods

The faunal materials were analyzed at the Hunter College Zooarchaeology Laboratory, and made use of the comparative collection there. Recording and data curation follow NABONE protocols, utilizing the 9th edition of this recording package (a Microsoft Access database supplemented with specialized Microsoft Excel spreadsheets, available to download at www.nabohome.org). Digital records were all made using this package. The animal bones excavated will be permanently curated at the National Museum of Iceland along with all digital records. Digital records will also be preserved in the NABO collection on The Digital Archaeological Record (tDAR). An electronic copy of this report is available at www.nabohome.org and at the UMB SCASS website/Fiske Center site.

All fragments were identified as far as taxonomically possible, and a selected element approach was not used. Most mammal ribs, vertebrae, and long bone shaft fragments were assigned to "Large Terrestrial Mammal" (cattle or horse sized), "Medium Terrestrial Mammal" (sheep, goat, pig, or large dog sized), and "Small Terrestrial Mammal" (fox or small dog sized). Only those elements which can be positively identified as sheep, *Ovis aries*, were assigned to this category while all other sheep/goat elements were assigned to a more general "caprine" category.

Following widespread North Atlantic tradition, bone fragment quantification makes use of the Number of Identified Specimens (NISP) method (Grayson 1984). All mammal measurements follow von den Driesch (1976). Sheep/goat distinctions follow Boessneck (1969) and Mainland and Halstead (2005). Only positively identified fragments of fish bone were given species level identification, with those unidentifiable to species placed in the family category where possible, often *gadid*, while others were identified simply as fish. No fish bones from this collection required measurement.

Tooth wear studies were completed by Dr. David Landon at The University of Massachusetts, Boston and follow Grant (1982). Long bone fusion stage calibrations follow Zeder (2006) and presentation of age reconstruction makes use of Enghoff (2003) and McGovern (2009).

The Archaeofauna

This report provides analysis of the faunal collections excavated from Stóra-Seyla Area C and Area D in 2008 and 2009. All of the fauna recovered during excavation of the site have been analyzed in their entirety. Using tephrochronology, radiocarbon dates, and the stratigraphic Harris matrix, the site has been separated into three chronological phases: settlement (870 A.D.) to 1000 A.D., 1000-1104 A.D., and post-1104 A.D. In the case of Area D, there is another tephra present that dates to ~950 A.D., which allows us to break the first phase in half (870-950, 950-1000). This provides insight into the two halves of the settlement period. As noted above, the two areas will be treated as one for the purpose of this analysis, with the material dating post-

1104 A.D. examined separately. Some of the material did not come from secure contexts, so it will be included in the NISP count but not in the actual analysis.

Pre-1104 Archaeofauna

The Total Number of Fragments (TNF) for all phases, including the unstratified material, is 10,601 (see Table 1). Removing the contexts that were not secure (due to erosion, river action, slumping, etc.) brings the TNF to 8,062 and the total NISP to 1,268 (Table 2).

Table 1: Table showing Total Number of Fragments (TNF) for all Stóra-Seyla material.

Species	**Pre-950**	**950-1000**	**Pre-1000**	**1000-1104**	**Post-1104**	**Unstrat**	**Total**
Domestic Mammals							
Cattle (*Bos Taurus*)	9	26	16	67	9	24	151
Horse (*Equus caballus*)	1	0	0	1	4	0	6
Pig (*Sus scrofa*)	1	4	0	0	4	3	12
Sheep (*Ovis aries*)	9	16	41	104	46	19	235
Caprine	39	66	83	271	47	94	600
Wild Mammals							
Arctic Fox (*Alopex lagopus*)	0	0	0	0	3	0	3
Unidentified whale (*Cetacea* sp.)	1	0	0	1	0	0	2
Birds							
Puffin (*Fratercula arctica*)	0	1	0	1	0	0	2
Guillemot (*Uria aalge*)	0	0	0	1	0	0	1
Indeterminate Gull species (*Larus* sp.)	0	3	0	0	0	0	3
Goose (*Anser* sp.)	0	1	0	2	2	1	6
Ptarmigan (*Lagopus mutus*)	0	1	0	0	0	0	1
Red-Throated Diver (*Gavia Stellata*)	0	0	0	1	0	0	1
Unidentified bird (*Aves* sp.)	2	2	0	11	5	2	22
Fish							
Haddock (*Melanogrammus aeglefinus*)	0	0	0	1	0	2	3
Cod (*Gadus morhua*)	6	1	0	31	0	8	46
Gadid sp.	9	0	0	52	0	12	73
Unidentified fish	133	23	0	196	1	60	413
Molluscs							
Indeterminate Mollusc species (*Mollusca sp.*)	2	0	0	6	0	3	11
Other Mammals							
Small terrestrial mammal	0	2	0	13	3	2	20
Medium terrestrial mammal	64	108	69	499	158	200	1098
Large terrestrial mammal	27	60	37	116	45	55	340
Indeterminate mammal	627	2228	204	2393	439	1245	7136
Indeterminate	0	0	0	347	43	0	390
Total	955	2543	450	4114	809	1730	10575

Table 2: NISP for material included in this analysis. TNF for these secure contexts is 8,036.

Species	**Pre-950**	**950-1000**	**Pre-1000**	**1000-1104**	**Total**
Domestic Mammals					
Cattle (*Bos Taurus*)	9	26	16	67	118
Horse (*Equus caballus*)	1	0	0	1	2

Pig (*Sus scrofa*)	1	4	0	0	5
Sheep (*Ovis aries*)	9	16	41	104	170
Caprine	39	66	83	271	459
Wild Mammals					
Unidentified whale species (*Cetacea sp.*)	1	0	0	1	2
Birds					
Puffin (*Fratercula arctica*)	0	1	0	1	2
Guillemot (*Uria aalge*)	0	0	0	1	1
Indeterminate Gull Species (*Larus sp.*)	0	3	0	0	3
Goose (*Anser sp.*)	0	1	0	2	3
Ptarmigan (*Lagopus muta*)	0	1	0	0	1
Red-Throated Diver (*Gavia stellata*)	0	0	0	1	1
Indeterminate Bird Species (*Aves sp.*)	2	2	0	11	15
Fish					
Gadid sp.	15	1	0	84	100
Unidentified Fish	133	23	0	196	352
Molluscs					
Indeterminate Mollusc species (*Mollusca sp.*)	2	0	0	6	8
Total	237	145	140	746	1242

Taphonomy

Burning affected 1,423 of the TNF (Figure 3). Most of the burnt bones were from unidentified mammals, and were often highly fragmented. The majority of the burnt bones were burned white (836 or 11%), indicating that they were heated for a long time in a very hot fire. Of these white-burned bones, 821 were from unidentifiable mammals. Similarly, of the black-burned bones, 414 were from the unidentifiable mammal category.

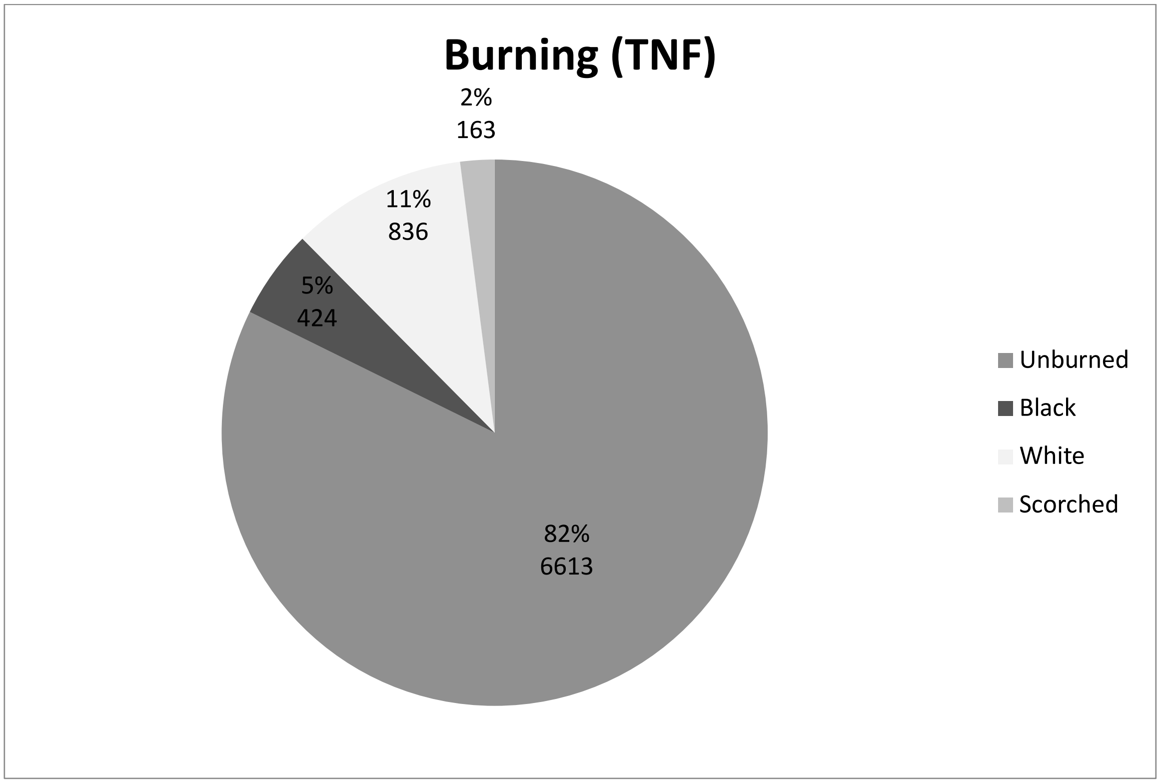

Figure 3: Burning. Total Number of Fragments (TNF) of 8,036. Total affected by burning is 1,423

The majority of bones (~70%) from the Stóra-Seyla material were of fragment sizes between 2-5 cm (39.92%) and 5-10 cm (30.16%) (Figure 4). The bones in the fragment category "1" are mostly scraps of bone—small, broken bits that cannot be identified beyond the mammal category, and sometimes cannot even be securely called mammal. Often, this includes "bone skins" or bits of cortical bone that have sloughed off due to various taphonomic factors. Wherever possible, if the bone skins can be matched to another bone, they are not counted so that the same bone is not included twice in the analysis. Some of the bones in this size category are smaller identifiable bones, like carpals and tarsals or phalanges of neonatal animals. The bones in the larger size categories are often whole bones or those of larger mammals, like cattle or horse.

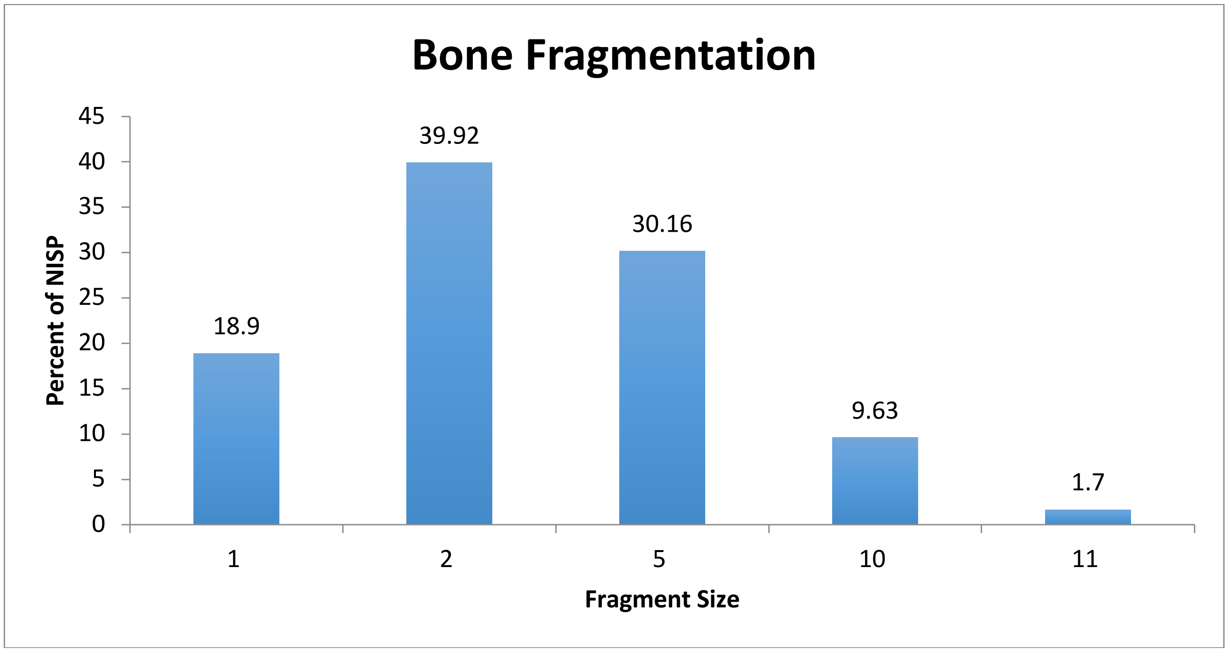

Figure 4: Bone fragmentation size classes by percent of NISP.

Gnawing

Seven total elements showed evidence of gnawing, one by a rodent and the other six by a dog. Though there were no dog bones present in the archaeofauna, the gnawed bones are proxy indicators of their presence at the site.

Butchery

Most of the bones in this archaeofauna were unmodified by butchery. Only 115 elements (~1.4%) were noted to have been butchered (Figure 5). Of those that were butchered, 74 (64%) showed knife marks. Many of these were cut marks on the bone and did not fully cut through the bone. Chopping makes up the second highest proportion of the butchered bones (27 bones or 24% of the butchered elements). The chopped bones could be either chopped all the way through, or present as marks on the bone that did not sever it. One of the chopped bones is a haddock cleithrum. These bones are favored for carving; however, here, there does not seem to be a focus on this type of specialization. One worked haddock cleithrum was recovered, though it seems to have been discarded before being made into anything identifiable.

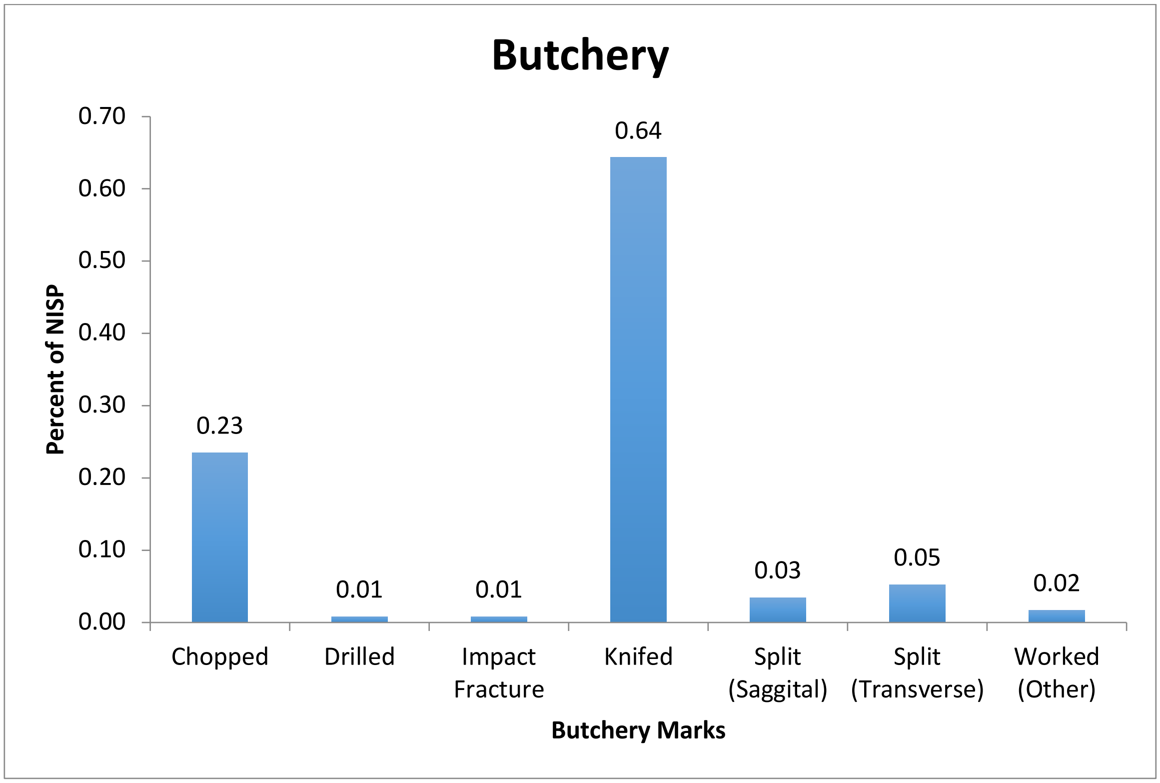

Figure 5: Butchery marks present on bones from the Stóra-Seyla archaeofauna. NISP for bones bearing butchery marks is 115.

The rest of the butchery marks are present in very low numbers. However, the butchery pattern seen here looks like a typical midden—including foods for consumption and craftworking discard. The chop marks are likely from the initial dismemberment of the animal. Knife marks point to at-table consumption, while impact fractures generally indicate marrow extraction. The split bones could have been butchered for marrow or for craftwork. The drilled and worked categories indicate bone-working for craft purposes was taking place at Stóra-Seyla. Of course, the sample size here is small and with a larger sample size, a pattern may emerge.

Analysis

This analysis includes only those contexts that were securely dated using tephrachronology, radiocarbon dating, and stratigraphic relationship at the time of excavation. The latest date for these contexts is 1104 A.D., defined by the Hekla 1104 white tephra. The earliest date is before 950 A.D. and likely right around the beginning of the settlement period. The NISP for these contexts is 1,242.

Major Taxa

The majority of the archaeofauna from Stóra-Seyla (Figure 6, Figure 7, Table 3) were domesticates (60.71%). Fish make up the second highest proportion of the collection, at 36.39%. In the category of domesticates, caprines (sheep and goats) make up the vast majority, at 83.42% of the group, or 655 fragments. Cattle are present in smaller quantities, with 118 fragments, or 15.65% of the group. Other domesticates are present in very small quantities—2 horses and 5 pigs.

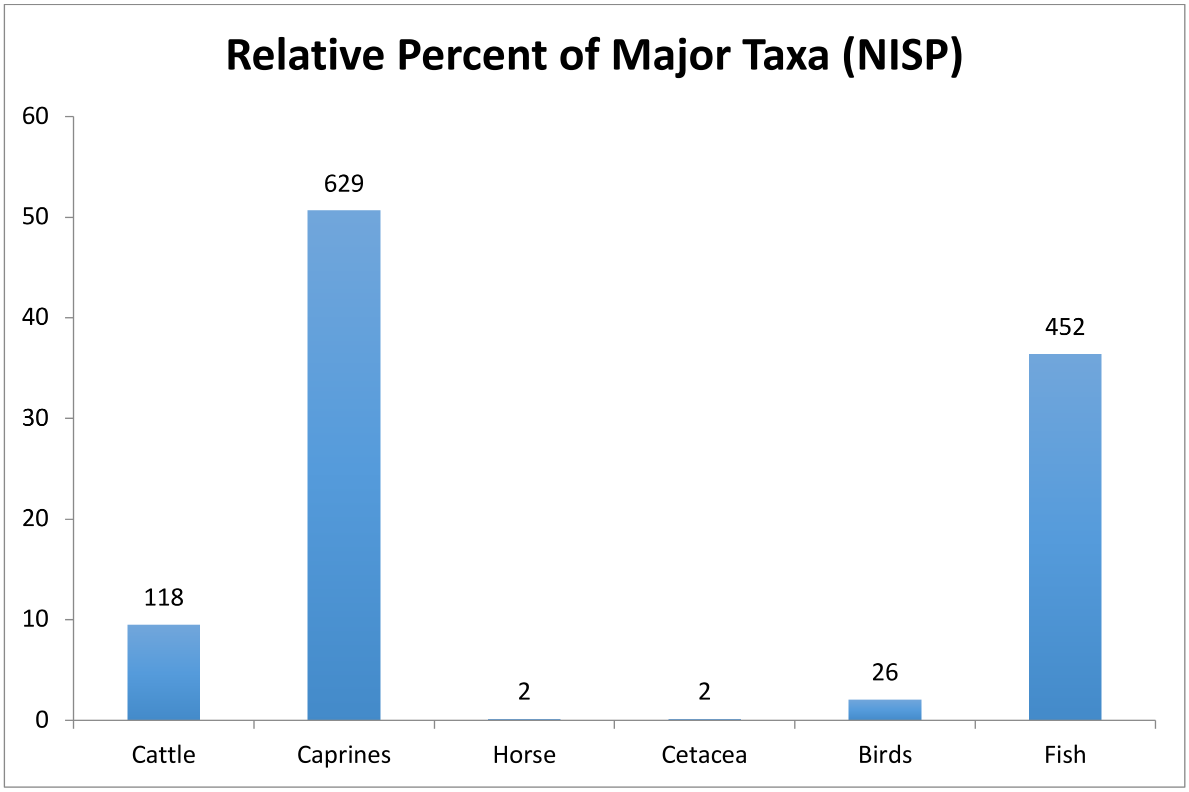

Figure 6: Relative percent of major taxa for NISP of 1,242.

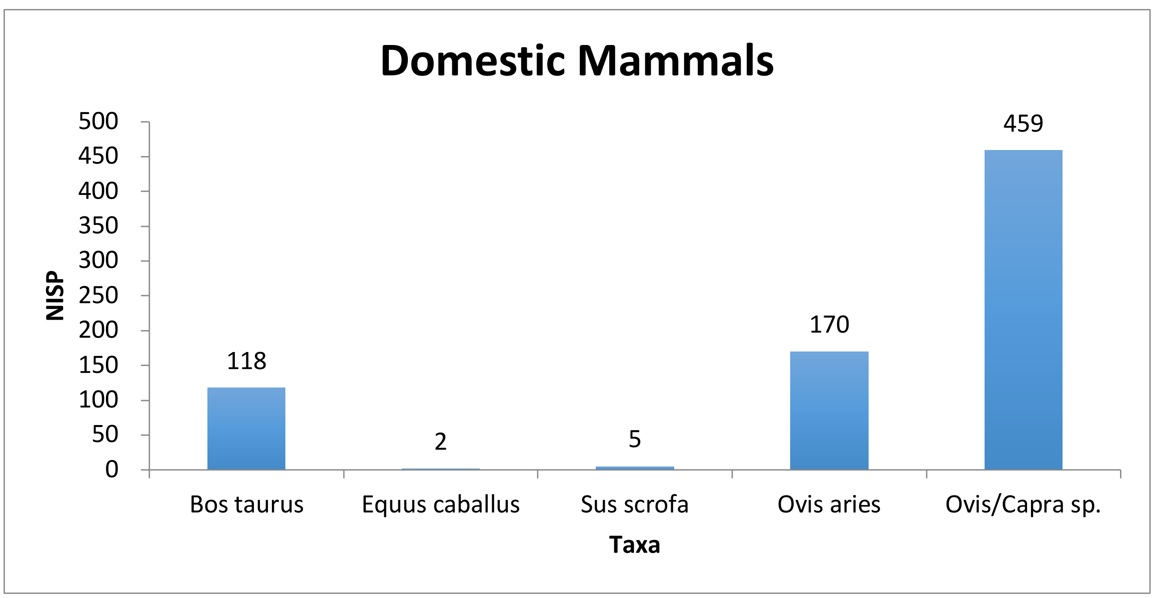

Figure 7: Domestic mammals present in the Stóra-Seyla archaeofauna. Note that the caprine category includes all elements that could not be positively identified as sheep or goat.

Table 3: Number of domesticates and their relative percent of all domestic mammals.

Domesticates	NISP	% of domesticates
Bos taurus	118	15.65
Equus caballus	2	0.27
Sus scrofa	5	0.66
Ovis aries	170	22.55
Ovis/Capra sp	459	60.88
Total Caprine	629	83.42
Total Domesticates	754	100

Caprines

The caprine category includes both sheep and goats. In the Stóra-Seyla archaeofauna, none of the bones that can be distinguished between sheep and goats (see Boessneck 1969 and Mainland and Halstead 2005 for a list of elements and their distinguishing features) were positively identified as goat. It is possible that the indistinguishable elements could be from goats; however, many of the bones used to determine sheep vs. goat are quite dense and preserve well in the archaeological record, so the lack of goats is likely not an issue of preservation and most probably an accurate representation of the number and types of animals kept.

In Iceland in general, keeping of goats declines over time and goats begin to make up a much lower proportion of the caprines during later periods. Goats are relatively cheap to keep, and they can eat and metabolize more marginal, brushy vegetation better than sheep can. Their grazing strategy is also different—they tend to move more quickly between patches of vegetation and do not generally take the plants all the way down to the soil (see for example Zeder 2006:98 and references therein). Goats are not particularly high-status animals, and their only by-product, other than meat, is milk. It is possible that goats just would not have been an efficient use of resources in the settlement environment of Skagafjörður, and so were never introduced or were only present in very low numbers.

Interestingly, the 17th-19th century low-status farm at Hornbrekka, also in Skagafjörður, did not have any evidence of goats either (Hicks 2016). While this farm is dated later than the deposit at Stóra-Seyla, and we know that historically there are fewer goats as time goes on, it is potentially significant to note that no goats are present in the archaeofauna from non-church farms in Skagafjörður. In addition to this, even the archaeofauna from the Episcopal residence at Hólar did not produce any goat remains (e.g., Aaris-Sørensen et al. 2006; Bäckström 2002). These other examples of farms without goats from different time periods might point to a political or social reason for their absence in Skagafjörður, though the study of more archaeofauna over a wider time period will be most helpful in exploring the role, or lack thereof, of goats in Skagafjörður. In addition to a larger archaeofauna, pollen analyses to examine forestry practices and the type of vegetation in Skagafjörður may help to determine if the environmental conditions were favorable for goats.

Caprine Age Profile

The age profile for caprines at Stóra-Seyla before 1104 A.D. is constructed based on tooth eruption patterns, tooth wear stages, and long bone fusion data. Utilizing these three methods gives a clearer pattern of time of death for these animals. In this analysis, both those elements positively identified as sheep and the ones in the general caprine category are grouped together to present the age data.

Tooth Eruption

Tooth eruption is fairly predictable, since it is based on biology and not as much on diet or environmental factors, though nutrition will play a small role. For this reason, tooth eruption classes are a preferred method by zooarchaeologists for aging animals. Using tooth eruption data, we can assess mortality patterns (Figure 8). In the Stóra-Seyla material, less than half (35%) of the mandibles for which tooth eruption information could be gathered were from animals greater than 36 months of age. The younger animals, especially those below one year of age, could have been killed to save milk for human consumption. Another possibility is that a ewe had twins, which is not uncommon in Iceland, and one of the lambs was killed to ensure the health and survival of the mother and the surviving lamb. Other young individuals (12-24.5 months old) were likely killed for their meat.

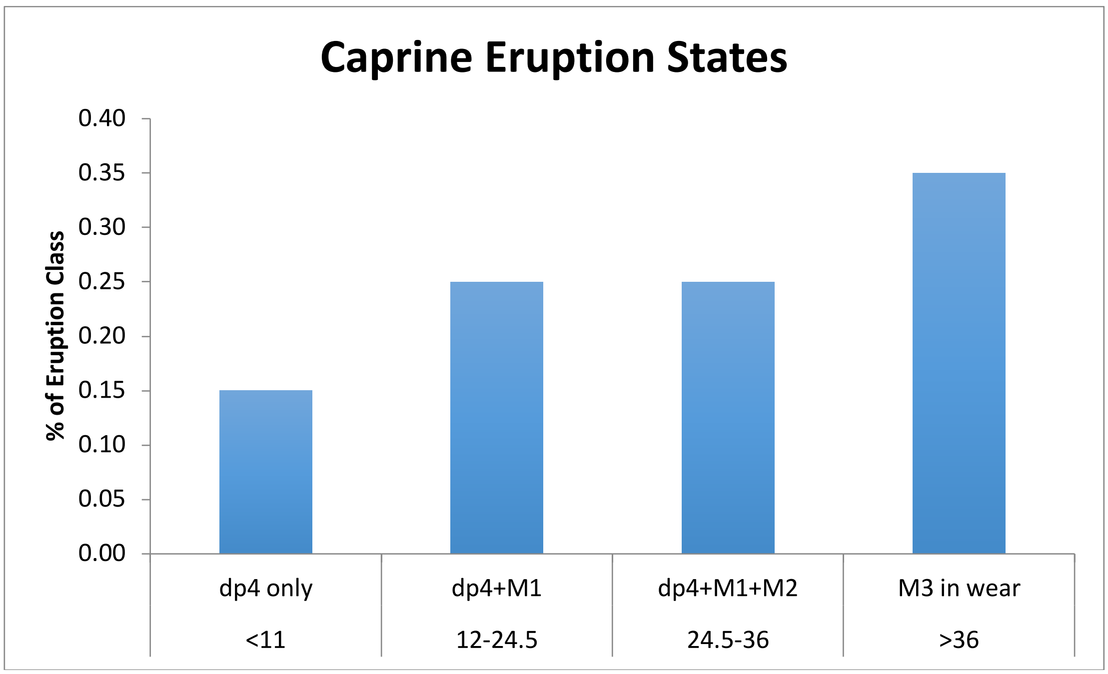

Figure 8: Caprine tooth eruption age categories. Age is presented in months. Number of mandibles included in this study is n=20. Tooth wear and eruption were recorded by Dr. David Landon at the University of Massachusetts, Boston. Age class was interpreted by the author and follows McGovern (2009) and Enghoff (2003).

Tooth Wear Analysis

With tooth wear studies, it is important to add the caveat that wear patterns are not solely dependent on age, but also on type of food eaten (e.g., Reitz and Wing 2008:174). If there is a lot of grit in the plant material that the animals eat, it will wear away tooth enamel much faster than a grit-free diet would (Mainland 2000; McGovern 2009:192; Zeder 2006:98), potentially making the animals appear older than their actual age. Indeed, especially with the different foraging strategies of sheep and goats, differential tooth wear will be more dependent on diet than on age. However, using tooth eruption and wear data along with long bone fusion data, as will be done here, can help to reconcile the two, potentially very different, age profiles (see Zeder 2006:97–98).

There were 20 mandibles included in the analysis of tooth wear (Figure 9, Table 4). The data indicate that a little more than a quarter (n=6) of the caprines were killed before or by the time they reached one year of age. The killing of the youngest sheep is likely for dairying (or to kill one lamb out of a set of twins, see above), while the older lambs were probably killed for their meat. Regular culls happen in the fall (September-November), and lambs are generally born in May, so lambs culled in their first year of life would be around 5-6 months old. This regular culling schedule could account for the three lambs less than 6 months old in the tooth wear analysis.

Though some animals did not make it past their first year, the majority survived. These older caprines are kept for a variety of reasons. Assuming they were sheep, this could be indicative of a focus on wool production (see section below for discussion of wool production and surplus). Wethers (castrated male sheep) are the best wool-producers, and would be vital to producing fleeces for the household. Other older caprines may be kept because they are continuing to produce good milk.

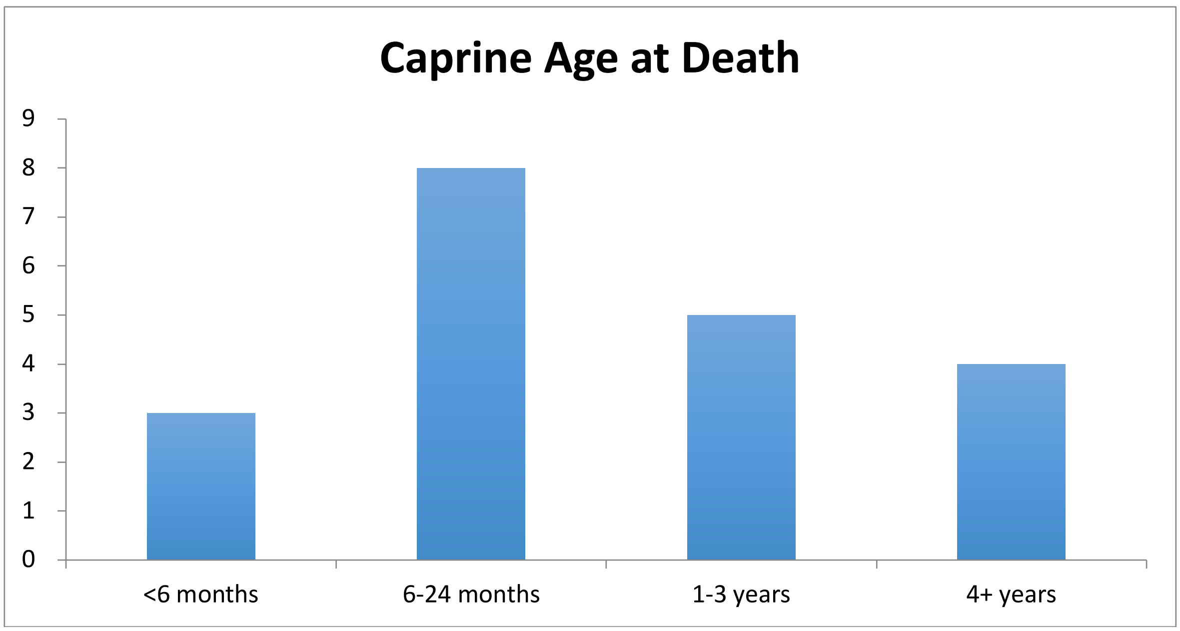

Figure 9: Caprine age at death profile based on tooth wear (Grant 1982) of 20 caprine mandibles. This tooth wear analysis and age calculation was conducted by Dr. David Landon at the University of Massachusetts, Boston; graph produced by the author. For information on seasonality of death, see Wagner (2016).

Table 4: Caprine age reconstruction by Dr. David Landon, with age classes broken down further than the above graph (Figure 9

Age Group	Number of Individuals
2-5 months	2
5-6 months	1
6-12 months	3
16-22 months	5
1-2 years	3
2-3 years	1
3-4 years	1
4-6 years	3
6-8 years	1

Long Bone Fusion Stages

Using fusion data compiled by Zeder (2006:107; chart reproduced below in Table 5), long bone fusion stages for the caprines are explored here. The data from Zeder indicate that sheep and goats have very similar ages of fusion for most long bones, and the differences between the two species seem to lie in the order of fusion while ages at time of fusion remain the same. Since the fusion schedule is essentially the same between the two species, this analysis uses both the bones confidently identified as sheep and those in the general caprine category (which could include goats).

Table 5: Age (in months) of fusion of various long bones for caprines. Data compiled by Zeder (2006).

Bone	Age of Fusion (in months)
Proximal Radius	0-6
Distal Humerus	6-12
Pelvis	6-12
Scapula	6-12
2nd Phalanx	12-18
1st Phalanx	12-18
Distal Tibia	18-30
Distal Metacarpal	18-30
Distal Metatarsal	18-30
Calcaneus	30-48
Proximal Femur	30-48
Distal Femur	30-48
Proximal Ulna	30-48
Distal Radius	30-48
Proximal Tibia	30-48
Proximal Humerus	48+

The long bone fusion data (Figure 10, Table 6) seems to parallel the tooth eruption and wear data above, with a few deviations. Both methods have a peak of subadult (before ~18-24 months old) animals killed for meat and milk. The long bone fusion data differs from the tooth data when it comes to older animals—long bone fusion shows very few older individuals. This can be explained by taphonomy. Mandibles and teeth are some of the densest elements in the body and tend to preserve very well in the archaeological record. Long bones, on the other hand, have more varied densities and their preservation is much more sensitive to taphonomic effects. This is one of the reasons that using a combination of methods for aging is preferred.

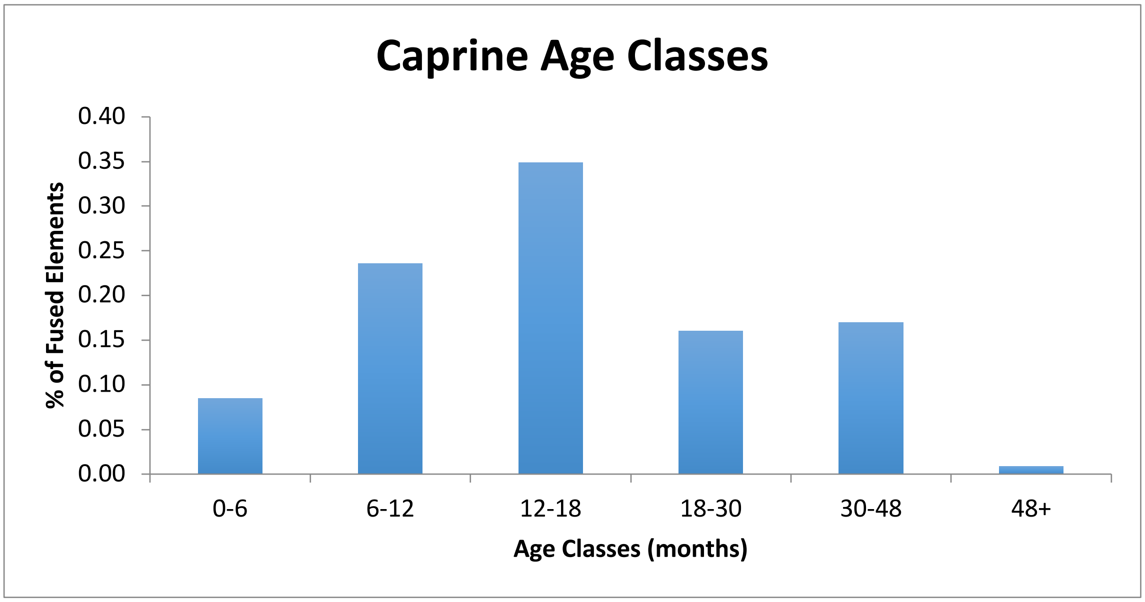

Figure 10: Age classes based on caprine long bone fusion. Age of fusion is based on Zeder (2006). Total number of caprine elements with fusion data recorded is 106.

Table 6: Number of animals at Stóra-Seyla in each age class based on long bone fusion data. Fusion is broken down by element in this table, compared to the combined classes in Figure 10 above.

Bone	**Age of Fusion (months)**	**Number of Individuals**
Proximal Radius	0-6	9
Distal Humerus	6-12	16
Pelvis	6-12	3
Scapula	6-12	6
2nd Phalanx	12-18	12
1st Phalanx	12-18	25
Distal Tibia	18-30	6
Distal Metapodial	18-30	11
Calcaneus	30-48	7
Proximal Femur	30-48	4
Distal Femur	30-48	2
Proximal Ulna	30-48	0
Distal Radius	30-48	4
Proximal Tibia	30-48	1
Proximal Humerus	48+	1

All of these age reconstruction methods seem to point to a mixed economy of milk, meat, and wool. The youngest animals are indicators for milk production, the young (6-18 months) of meat provision, and the older animals for wool. There are no huge peaks in any age class that would indicate specialization of any particular activity at Stóra-Seyla.

Cattle to Caprine Ratios

Overall, the cattle-to-caprine ratio for all phases is 1 to 5.33. Over time, this fluctuates from a low of 3.15 sheep per every head of cattle and a high of 5.6 in the Late Viking/Early Medieval period (Table 7, Figure 11).

Table 7: NISP of cattle (BOS) and caprines (OVCA) for each identified phase and the cattle to caprine ratio associated with each phase.

	Pre-950	**950-1000**	**1000-1104**
BOS	9	26	67
OVCA	48	82	375
Ratio	**5.33**	**3.15**	**5.60**

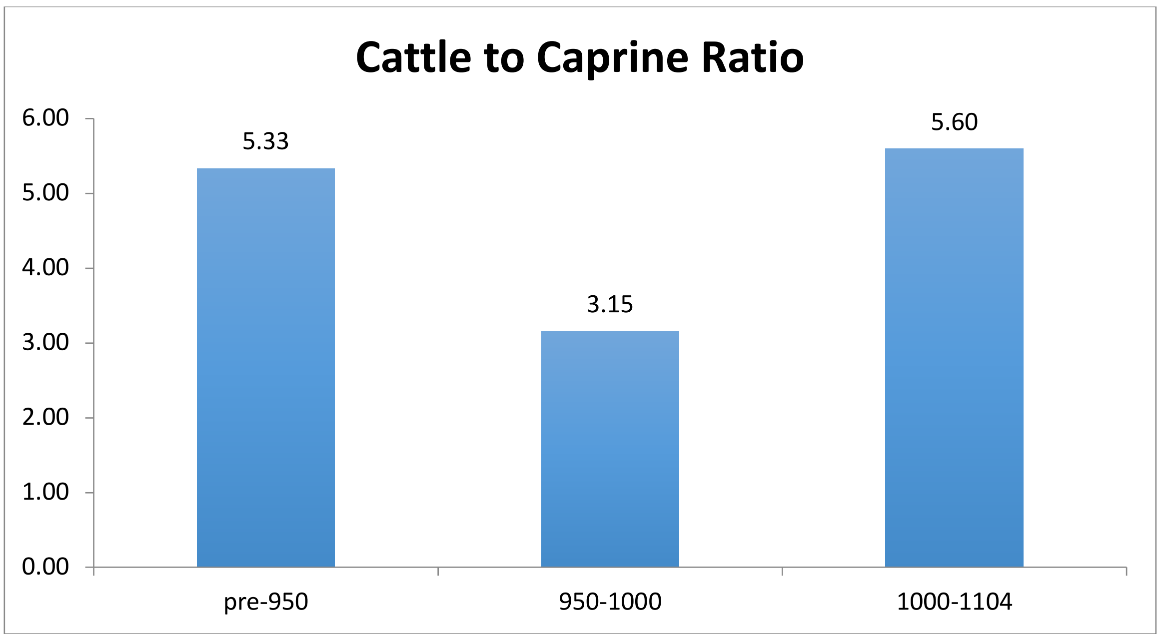

Figure 11: Chart showing the cattle to caprine ratios at Stóra-Seyla and their changes over time.

These ratios can be compared to the cattle-caprine ratios we see in other areas of northern Iceland (Figure 12). Here, the ratios at Stóra-Seyla are compared to sites of similar time periods in Mývatn and in Eyjafjörður. At Hofstaðir in Mývatn, the ratio stays relatively stable over time—it starts out a bit higher (1 cattle per every 3.3 sheep) and drops only slightly in later periods. At Skuggi, in neighboring Eyjafjörður, the mid-10th-early 11th century deposits have the highest cattle-caprine ratio of the sites compared here, with 9.57 caprines per every head of cattle. In a comparable phase at Stóra-Seyla, the ratio is much lower, around 3.15. This indicates different herd management strategies and perhaps a wool specialization at Skuggi.

At Stóra-Seyla, the ratios move around quite a bit. At settlement, the farmers at Stóra-Seyla had 5.33 sheep (and perhaps goats, though there is currently no evidence for goats) for every head of cattle. Towards the end of the settlement period, 950-1000, the ratio drops significantly, and gets closer to the numbers we see at Hofstaðir and Sveigakot in comparable time periods. In the last period of this continuous occupation at Stóra-Seyla, the ratio has risen again to its highest, though at 5.6 it is not much higher than the 5.33 at settlement. This final ratio is most similar to the mid-11th-early 12th century phase at Skuggi.

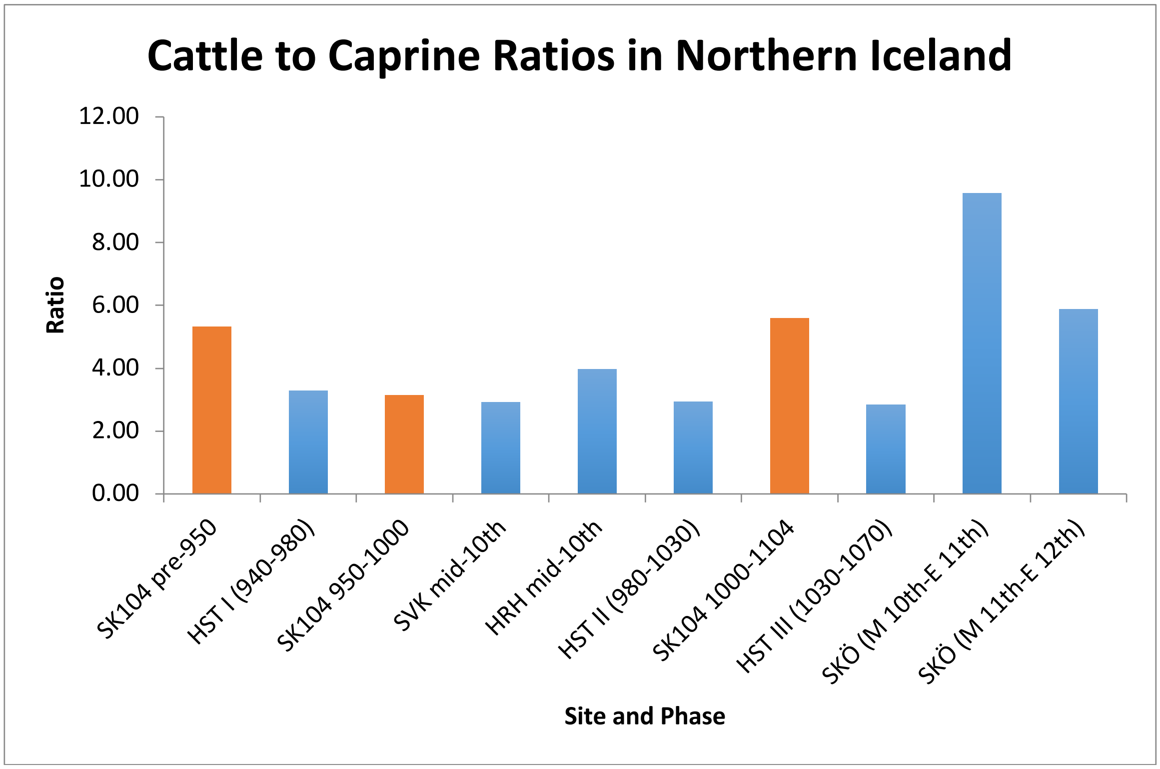

Figure 12: Cattle to caprine ratio at different sites in Northern Iceland with similar phasing. The only site in Skagafjörður is SK104=Stóra-Seyla, highlighted here in orange. In Mývatn are SVK=Sveigakot, HRH=Hrísheimar, and HST=Hofstaðir. Skuggi (SKÖ) is in Eyjafjörður.

Wool Production and Surplus

With such low numbers of caprines to cattle, it would seem that the farmers at Stóra-Seyla are not focusing on intensified surplus wool production. In fact, depending on the size of the household, they may be struggling to produce enough wool to clothe everyone. According to McGovern et al. (2014), a small farm will be able to produce enough fleeces for their household with a cattle to caprine ratio of between 1:2 and 1:6, but will not be producing surplus wool (and this assumes that all of the caprines are sheep and that they are all shorn every year). On the other end of the spectrum, a large farm will be able to produce just enough fleeces for the household at a ratio of 1:6, but anything lower would require procurement of fleeces from elsewhere (McGovern et al. 2014).

As the aging data discussed above suggest, older caprines were definitely present on the farm, and they were potentially wool-producing wethers. This age data, plus the ratios at Stóra-Seyla that fall within the range defined by McGovern et al. (2014), seem to point to the farm being able to support its household with fleeces. Of course, the sample size here is still quite low compared to other collections and more material would aid in exploring the wool story at Stóra-Seyla.

Neonates

There were 41 total neonatal and fetal caprine elements in the Stóra-Seyla material. At this age, it is very difficult to distinguish between sheep and goats, even on the elements that are normally used for this determination when the animals are of older age. Two of the identified elements were fragments of the frontal bone of the skull, and these were likely from a fetal caprine. The majority of the rest of the bones are long bones from a fetal animal (see Figure 13 for an example of these bones).

The fetal elements could conceivably come from one animal, and they are all (except for one scapula fragment) from two pre-950 contexts that are stratigraphically positioned one on top of the other (contexts [200] and [201]). None of the elements overlap nor are they present in larger quantities than they would exist in the skeleton, further giving evidence to the bones being from one animal. As noted above, this lamb could have been killed to provide a greater chance for its twin to survive; it is also possible that it was stillborn. It is important to mention that these fetal elements do not display any evidence of butchery or marrow extraction, which would suggest that the lamb was not eaten and was just discarded.

Figure 13: Example of some of the fetal caprine elements from the midden in Area D, context [201].

Caprines as a Food Source

The graph below (Figure 14) shows the distribution of caprine elements at Stóra-Seyla. Looking at element distribution can indicate if animals were butchered on site or if the farm was provisioned by meat cuts from other farms. Since all parts of the body are represented in this archaeofauna, it would seem that many of the animals were butchered on site at Stóra-Seyla.

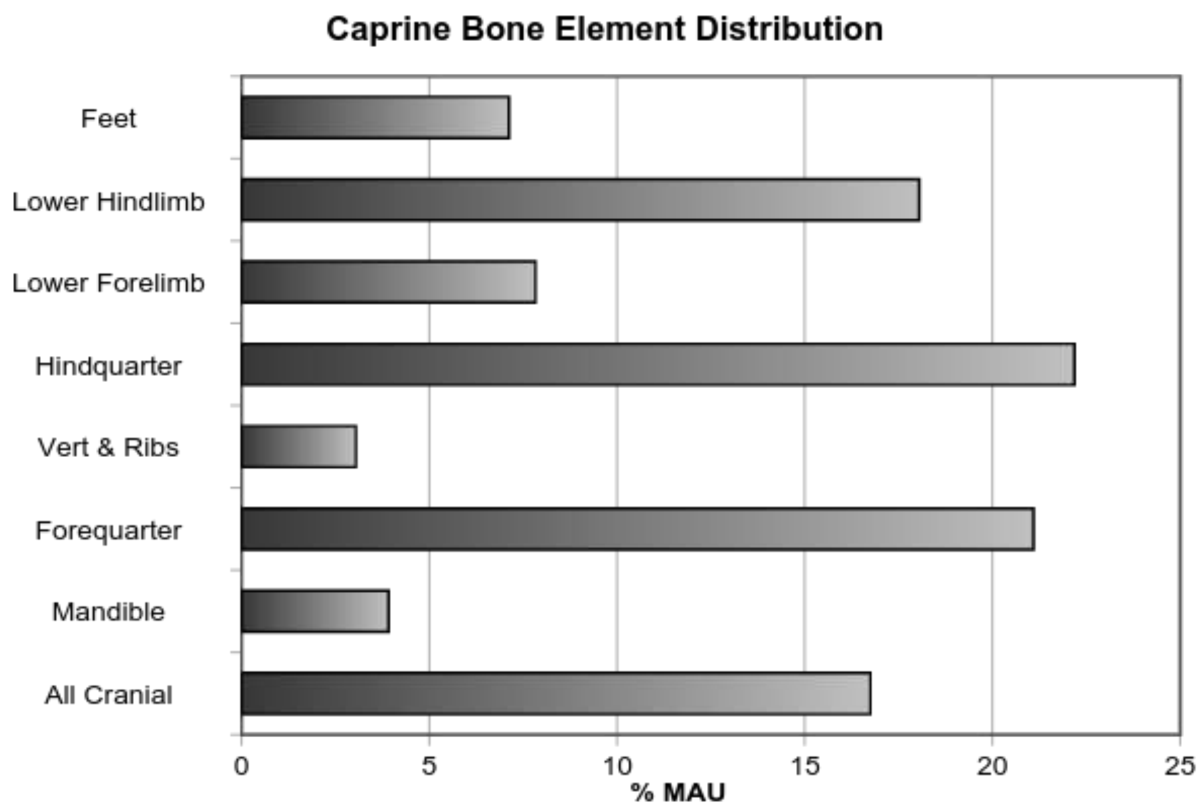

Figure 14: Chart of caprine bone element distribution, indicating parts of the body that the bones come from.

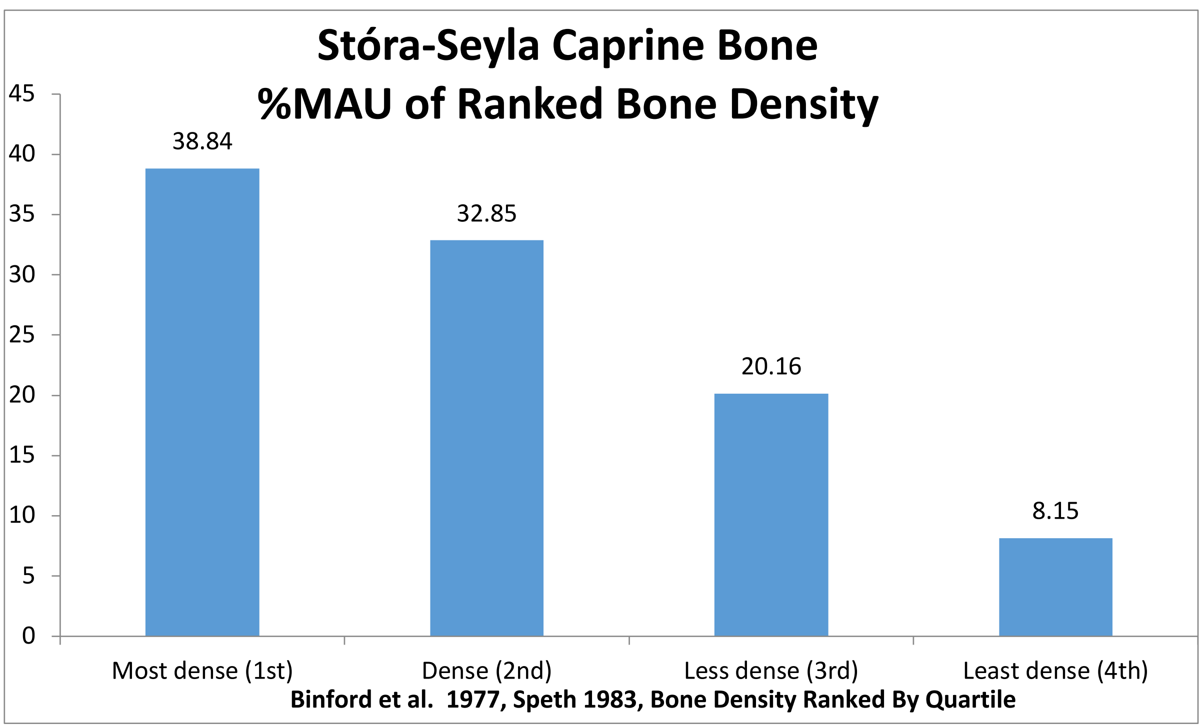

Figure 15: Bone density distribution of preserved caprine bones.

Bone density can clue us in to taphonomic processes. In this case, bones from all density classes are present in varying quantities (Figure 15). This indicates favorable conditions for preservation and provides support for the conclusions drawn from this archaeofauna, since taphonomic effects do not seem to have biased preservation to any great degree. Less favorable conditions might produce bone density distributions that look "heavily ravaged" and where the only preserved elements are those in the 1st (most dense) category, and for which conclusions would not accurately reflect the actual living population at the site.

Size Reconstruction

Reconstructing the body size of animals in an archaeological population can give another view into the types of culling strategies taking place at a site. The reconstruction here will use Teichert (1975) for stature estimates and O'Connor (1989) for live body weight estimates.

Withers height estimates for the Stóra-Seyla caprines range from 59-70 cm tall (Table 8) and body weight calculations range from 31-40 kg (Table 9). These sheep would be considered small by modern standards (see McGovern 2009:227 for withers height and weight estimates of modern North Atlantic sheep populations), however, they do fall within the range of reconstructed withers height presented in Enghoff's (2003:59) overview of North Atlantic sheep collections. In 1913, weight data was collected in southern Iceland from a flock of 60 ewes. This data "produced a mean live weight of 31.5 kg (minimum 27.5 kg)" (McGovern 2009:228, and references therein). The sheep from Stóra-Seyla fit fairly well within this range. The flock from 1913 is likely more similar to these archaeological sheep, in that neither have benefitted from more modern management and feeding.

Of course, the sample size for this analysis is quite low (n=5 for withers height, n=2 for live body weight), so these observations are only preliminary. There appears to be a mixed economy, or "dual flock" herding strategy at Stóra-Seyla (McGovern 2009:228). Some of the sheep (2, or 40%) overlap with the size ranges for modern Greenlandic and Faroese males (65-75cm) and are very likely rams or wethers (McGovern 2009:228). Wethers are castrated males that produce arguably the best wool, so it can be inferred that wool production was important at the farm (see above discussion on wool production and surplus). The other animals are more in the height range of modern North Atlantic ewes and are likely being managed for milk.

Table 8: Sheep withers height reconstruction. Measurements follow (von den Driesch 1976), reconstructed stature follows (Teichert 1975). Formula for metatarsals is GL x 4.54. Formula for metacarpals is GL x 4.89.

Bone	**GL (Greatest Length)**	**Height at Withers (cm)**
Metatarsal	131.62	60
Metatarsal	129.68	59
Metatarsal	154.13	70
Metacarpal	136.28	66
Metacarpal	120.73	59

Table 9: Sheep live body weight reconstruction using distal radius. Measurements follow von den Driesch (1976), reconstructed body weight follows O'Connor (1989). Formula is (1.79 x Bd) – 13.3.

Bone	**Bd (Breadth of Distal End)**	**Body Weight (kg)**
Radius	24.83	31
Radius	29.69	40

Cattle

Cattle make up the second largest proportion of the domestic mammals (15.65% or 118 fragments). The distribution of cattle elements, like the caprine elements, shows a pattern of local butchery. In the chart below (Figure 16), there are no vertebrae or ribs listed; however, this is likely an artifact of the NABONE protocol of putting most ribs and vertebrae into size categories rather than identifying them to species and not due to lack of presence of these bones at the site.

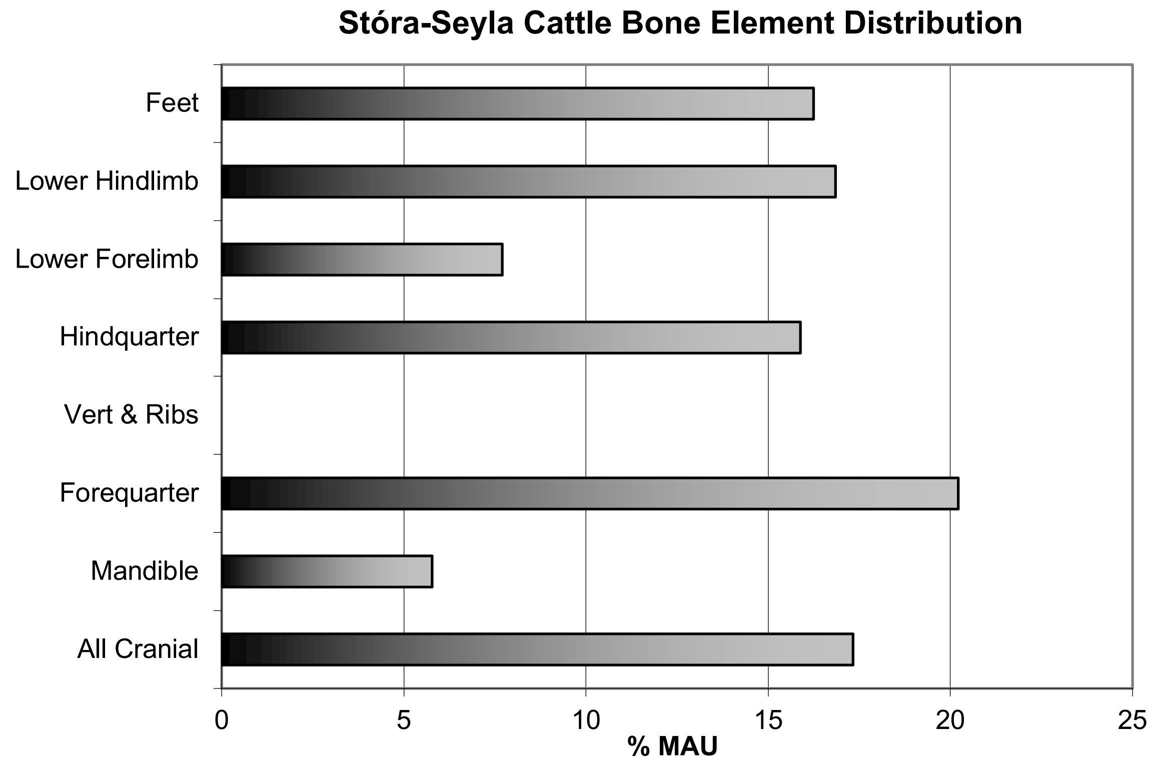

Figure 16: Distribution of cattle elements by %MAU.

There are not enough long bones or mandibles to accurately say anything about the age of the cattle at Stóra-Seyla and a larger sample size is necessary to draw any firm conclusions. Preliminary results of long bone fusion states (presented in Table 10 below), indicate that at least some of the cattle were younger than 1-1.5 years. Peak meat production age is roughly 2.5-3 years (McGovern 2009:220). While the current data does not seem to show that cattle were killed during this peak age range, more data could change the picture significantly. Two individuals younger than 1-1.5 years of age could indicate killing of surplus young cattle that cannot be supported by the farm, but it is more likely that they are part of a dairying strategy.

The number of neonatal cattle (see next section) hints at a dairy profile at Stóra-Seyla. Unlike the caprine strategy of managing for multiple products (milk, meat, and wool), cattle cannot usually be successfully managed for meat and milk in this way. Cattle have more specialized grazing needs, and raising a calf takes a lot of milk. If the milk is needed for human consumption, the calf must be killed. A high percentage of neonatal animals to adult animals is indicative of this management model.

Table 10: Cattle long bone fusion at Stóra-Seyla.

Bone	Age at Fusion	Number Fused	Number Unfused
Distal Humerus	1-1.5 years	1	2
Distal Tibia	2-2.5 years	0	1
Distal Femur	3.5-4 years	1	1

Neonates

Of the 118 cattle bones, 23 (19.5%) are from neonatal cattle (Figure 17). According to (McGovern 2009:216), a typical Icelandic dairy economy would create an archaeofauna where 30-50% of the cattle bones are from neonates. This is not the case at Stóra-Seyla, but the percentages are not far off, suggesting the kind of dairy-based herding strategy discussed above.

Figure 17: Neonatal cattle elements from the midden at Area D, context [169].

Comparing the cattle neonatal percentages at Stóra-Seyla to other Icelandic sites shows that the pattern for a dairy economy is quite widespread. The majority of the sites in Figure 18 have cattle neonatal percentages in the range given by McGovern (2009) for a dairy economy. The chart also shows that Stóra-Seyla is most similar to the Viking Age phases at Hofstaðir in terms of its neonatal percentages. The outlier here is the medieval trading site at Gásir. We now know that Gásir was being provisioned by farms in its hinterlands, and thus were actually consuming prime-age beef that was brought in rather than managing their own cattle (e.g., Harrison 2013).

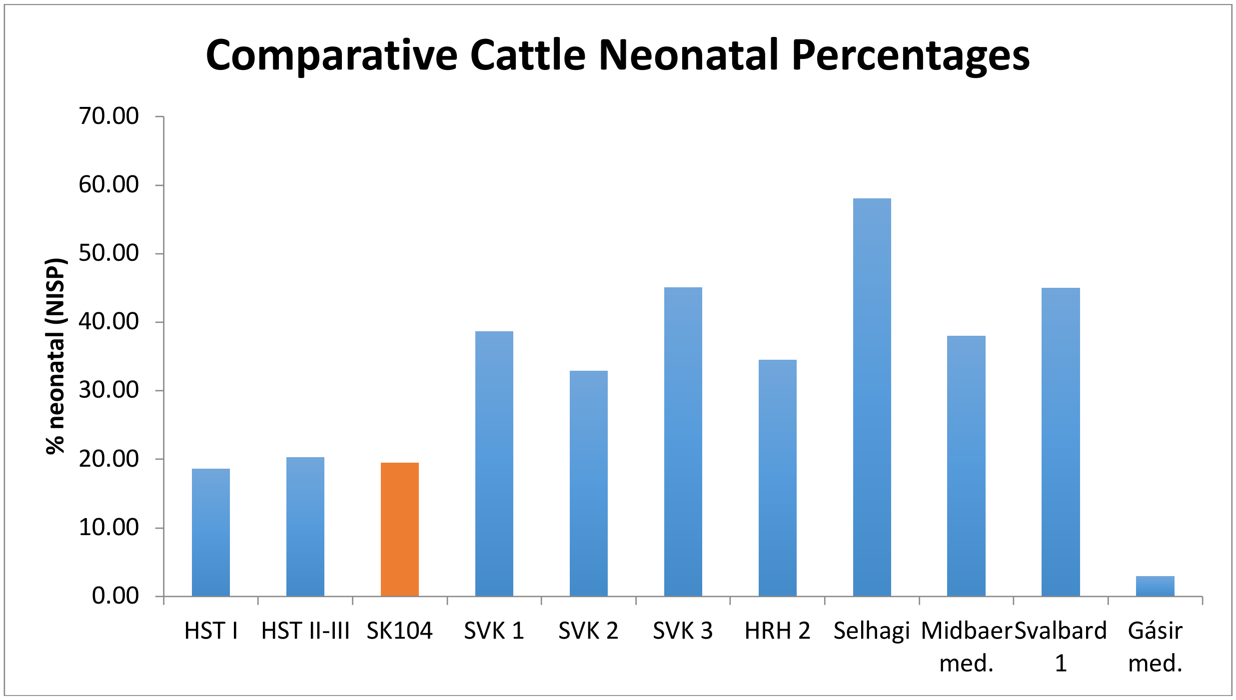

Figure 18: Comparison of cattle neonatal percentages from Stóra-Seyla (SK104, highlighted in orange) and other Icelandic sites. HST=Hofstaðir (Late Viking Age, ca. 940-1000 A.D.), SVK=Sveigakot (Viking Age, 871-1000 A.D.), HRH=Hrísheimur (Viking Age, ca. 871-1050). Selhagi dates to the Early Medieval period (prior to 1300 A.D.), Miðbær (on Flatey) is post-1200 A.D. Svalbarð 1 dates to the Late Viking Age/Early Medieval. The Medieval period at Gásir is ca. 1250-1400 A.D.

Birds

The pre-1104 archaeofauna from Stóra-Seyla contains 26 bird bones. These bones come from a variety of birds with different habitats, showing the variability of wild resource use by the inhabitants at Stóra-Seyla.

There were six bones from sea birds in this archaeofauna, indicating a maritime connection. Stóra-Seyla is in the southern portion of Langholt, further away from the sea, meaning that the birds are less likely to have made their way to the farm on their own. They could have been hunted by the inhabitants at Stóra-Seyla or brought in through a trade network. The gulls may have flown further from the sea and their scavenging behaviors could have led them to Stóra-Seyla on their own.

However, there were two puffin (*Fratercula arctica*) bones and one from a Guillemot (*Uria aalge*). These birds nest on cliffs and sea stacks, with puffins building burrows and guillemot laying their eggs on bare ground. In modern times, both species are present in great quantities on Drangey. They are also migratory, and lay their eggs in the summer time, giving us a picture of seasonality at Stóra-Seyla. Interestingly, neither of these species were exploited during the first half of the settlement period. Only after 950 A.D. did these birds show up in the archaeofauna from Stóra-Seyla. In fact, the majority of the seabirds, including the gulls, were not present in the midden until after 950 A.D. Perhaps the settlers did not know where the seabird colonies were at the time of initial settlement, especially since they settled inland. Over time, it is likely that a distribution network for marine birds was established.

Other birds include a Red-Throated Diver (or Red-Throated Loon, *Gavia stellata*). This bird is a freshwater migratory species, and is present in Iceland year-round, with summertime breeding activity happening all over the island. There was also one bone from a non-migratory ptarmigan (*Lagopus muta*) that could have been hunted at any time during the year.

There are three goose remains (*Anser* sp.) from Stóra-Seyla; however, distinguishing between domestic species and wild species is difficult. The distinction has not been made here, but future use of the comparative collections at the American Museum of Natural History will help determine if these remains are from wild or domestic geese.

Finally, there were 15 bird bones for which species could not be determined. The above data, however, do indicate that the people who lived at Stóra-Seyla exploited a variety of wild bird resources from different habitats and for which procurement strategies were likely very different. Despite the presence of bird bones, including those birds that would have been nesting at the time, there is currently no evidence of eggshells at Stóra-Seyla. Either eggshell did not preserve or people were not exploiting bird eggs as a resource, perhaps indicating some sustainable harvesting of wild resources.

Fish

Fish make up nearly 36% of the archaeofauna from Stóra-Seyla. The majority of these fragments (352 out of 452) were unidentifiable except as fish bone. All of the 100 identifiable fish fragments are from the gadid family, with 38 positively identified as cod (*Gadus morhua*, see Figure 19 for a cod skeleton) and one as haddock (*Melanogrammus aeglefinus*).

Of the 100 gadid fragments, 75% are vertebrae. All of the identifiable vertebrae are caudal (n=30) and the ultimate caudal vertebra (n=1) (Figure 20). The other 44 are fragments that cannot be identified to location along the spine. It is clear that both cranial elements and axial elements (vertebrae included) make it to the site (Figure 21). Though more fish bones are needed to gain a clearer picture of consumption at the site, current data allows us to draw a few conclusions.

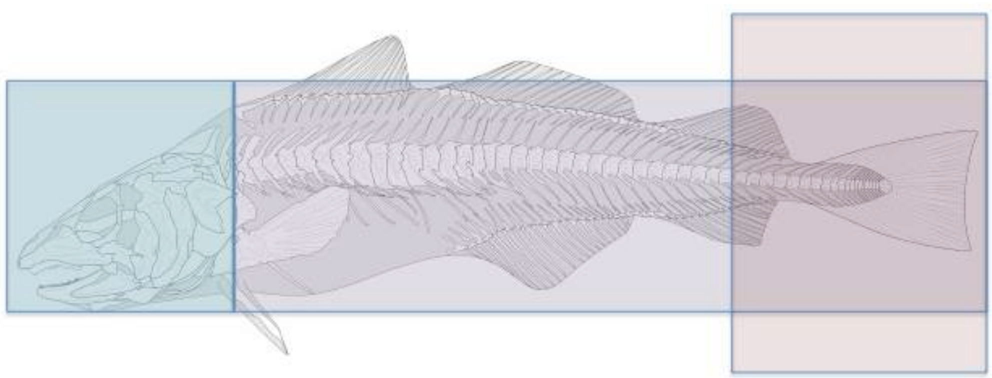

Figure 19: Cod (*Gadus morhua*) skeleton with key areas highlighted. Blue is cranial elements, purple is axial. The red box shows the caudal vertebrae, the most common of the identified vertebrae in the Stóra-Seyla archaeofauna.

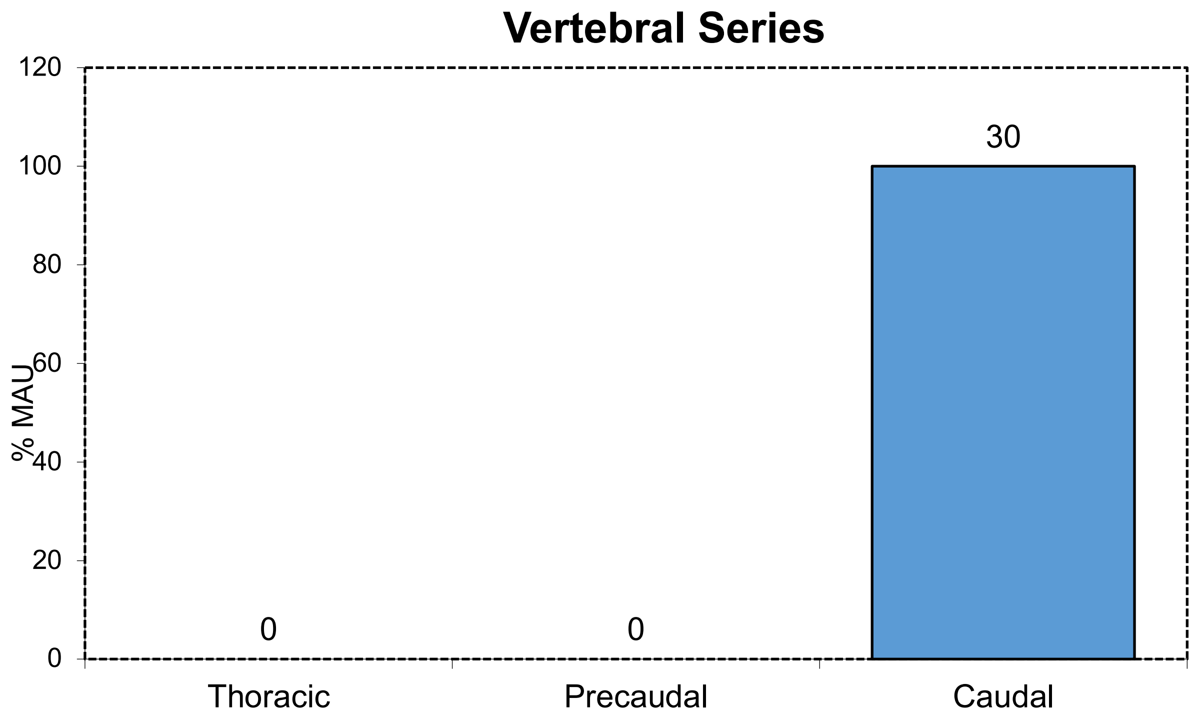

Figure 20: % MAU of all identifiable gadid vertebrae along the spine. Note that all vertebrae that could be identified are caudal.

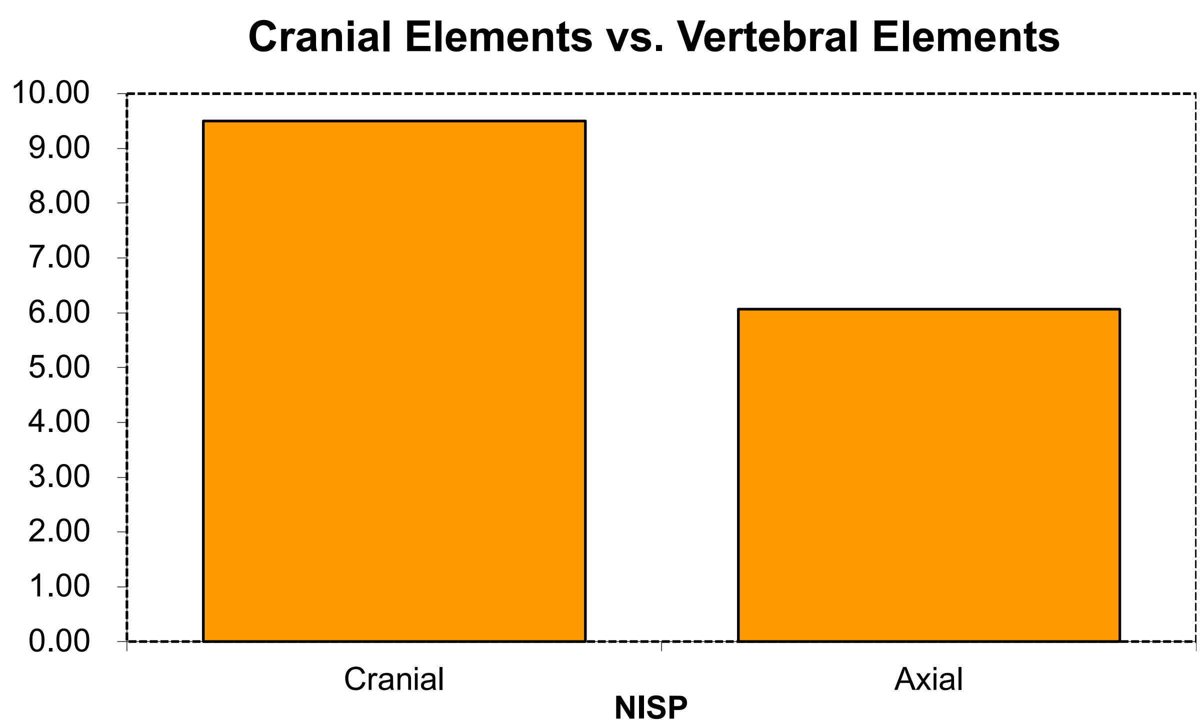

Figure 21: MAU of cranial elements (including atlas vertebra) vs. axial elements (includes vertebrae and cleithrum) in all gadids, NISP=100.

Fish Interpretation

Our model for early Icelandic dried marine fish production indicates that at least two distinct types of fish products were being produced in Viking Age Iceland (Amundsen et al. 2004, 2005; Perdikaris and McGovern 2008a). One product was dried in the round, probably closely resembling the historically known "stockfish" later exported in large quantities from late medieval and early modern Iceland. The other product was more heavily filleted and spread open to produce a flat dried product that may have circulated more intensively within Iceland.

There are archaeological signatures for each of these types of fish product. With round-dried fish ("stockfish"), one would expect to find vertebrae from the entire length of the fish (thoracic, precaudal, and caudal) along with cleithra. With flat-dried fish, the fish is split down the middle almost all of the way to the tail. Because of this filleting, during the drying process, the flat-dried fish loses many of the vertebrae that are closer to the head and caudal vertebrae are often the only ones left. The cleithra are normally left in the filleted product as they help to spread open the body cavity and to hold the body together during drying. It seems that at Stóra-Seyla in the Viking-early medieval period, the dried marine fish are being consumed as a flat-dried product, with some fresh fish also reaching the farm.

With fish bones, there is always the possibility that taphonomy has destroyed many of the bones or that the collection strategy will not favor smaller bones and the archaeofauna will be biased. A biased collection strategy is not the case at Stóra-Seyla, since the caudal vertebrae are the smallest of all the vertebrae and many were collected. Since these smaller bones were preserved, it can be assumed that the soil conditions were favorable, and so taphonomy does not play a role in the high number of caudal vertebrae recovered. Patterns of marine fish product consumption on inland sites have considerable potential to shed light on still poorly-understood patterns of pre-commercial, artisanal production and distribution of these characteristic Nordic dried fish products (Perdikaris and McGovern 2008a, 2008b).

Other Mammals

There were two whale bones in this archaeofauna. One was clearly an artifact (Figure 22); the other piece is a fragment of spongy bone, likely broken off of a large piece used as a tool. These bones do not show any indication of butchery, so we cannot know if they were eating whale. However, it is clear that they had access to whale bones right at settlement, as the unworked piece is from a pre-950 A.D. context. These bones could have been scavenged from the beach for use as tools or in craftworking. It is also possible that the bones are from a beached whale or one that was purposely hunted and killed for its meat.


Figure 22: Whale bone artifact (perhaps part of a clamp or vice) from Area D (midden) context [171].

Concluding Remarks

Though the NISP of 1,242 is not large by North Atlantic standards, the data collected from this archaeofauna gives a decent picture of what kinds of activities were taking place at Stóra-Seyla between settlement and 1104 A.D.

The domestic mammal pattern is quite similar to the patterns seen at the Viking Age hall at Hofstaðir. Both sites exhibit similar herd management strategies, with caprines being managed for a mixed economy of meat, milk, and wool. Structure 2 at Stóra-Seyla resembled a Viking Age hall and was built before 1104 A.D. and potentially before 1000 A.D. Though there were few bone fragments recovered from the structure itself, it is contemporaneous with use of the midden. One major difference between these two sites (halls?) is that there are no identifiable goats at Stóra-Seyla. In fact, there are no goats in any of the other (limited) archaeofauna from Skagafjörður. Could this be due to the small sample size? Or perhaps there are social or political reasons for the lack of goats? Was the environment unfavorable towards goat husbandry? More excavation and an increased sample size will help investigate these questions.

The cattle to caprine ratios and the percentage of neonatal cattle at Stóra-Seyla are closer to Hofstaðir values than they are to most of the other farms used in comparison. These ratios may also indicate changing fortunes at the farm—there are more cattle in the 950-1000 time period, which could mean the farm was of a higher status during that time. Again, there is the caveat that the sample size makes this simply speculation, and a larger archaeofauna would be useful in exploring this further. In addition to the zooarchaeological data, coupling the animal data with the farm mound volume and areal extent data from SCASS will provide another line of evidence about the farm status and changing fortunes.

At Stóra-Seyla, cattle seem to have been managed for dairy, with the high relative percentage of neonatal elements to adult elements fitting in nicely with the Viking Age phases at Hofstaðir. Butchery of cattle also happened on site, as elements from all parts of the body are represented in the archaeofauna.

The presence of seabirds at Stóra-Seyla is significant, as it likely indicates a distribution network from the coast to the inland sites that was put in place at least by 950 A.D. No eggshells were recovered, potentially due to taphonomic factors. Another possible interpretation of the lack of eggshells is that there may have been some sustainability practices like we see at Skútustaðir in Mývatn happening at Stóra-Seyla, but maybe in Langholt as a region as well (see for example Brewington et al. 2015; Hicks 2010). More excavation is needed if this is to be explored.

There were no freshwater fish in the archaeofauna from Stóra-Seyla. This is interesting because there is a river that runs right next to the site (which caused some issues during the excavation and interpretation of Area D) and would have been easy to access. The presence of marine fish shows provisioning from the sea, most likely through trade networks. The archaeofauna points to fish being consumed as a flat-dried product, as opposed to round-dried "stockfish," due to the lack of thoracic and precaudal vertebrae. Some whole fish did make it inland to the site, based on the cranial elements recovered.

Acknowledgements

This analysis was supported by the National Science Foundation Graduate Research Fellowship Program grant no. DGE-1037525. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author and do not necessarily reflect the views of the National Science Foundation.

Excavations were funded by the National Science Foundation (BCS 0731371), with the institutional assistance of Hólaskóli, Byggðasafn Skagfirðinga Glaumbæ, and Árskóli Sauðárkróki.

Special thanks to Doug Bolender and John Steinberg for allowing me to work on this material and to them and Guðný Zoëga for taking me to the field in 2015 and inviting me back again. Thanks also to Dr. David Landon for the tooth data.

Many thanks to Tom McGovern for productive and informative conversations, helpful comments, and always being available. To all of my Hunter lab friends for their assistance and advice, especially Ramona who helped me sort through many boxes at the beginning of this project, Konrad for helping me solve mysteries, Frank for all of his fish knowledge, and to Megan for help with everything and for our many necessary tea and snack breaks.

NABO

Skagafjörður Church and Settlement Survey: Archaeofauna from Kotið, 2016 and 2017

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CUNY NORSEC Laboratory Report No. 69
BSK-2018-201 / SCASS-17

Introduction and Excavations

For the past three years, the Skagafjörður Church and Settlement Survey (SCASS) has been exploring the settlement pattern on Hegranes, in Skagafjörður (Figure 1) (e.g., Bolender et al. 2016, 2017; Steinberg et al. 2016). This report focuses on test pits excavated at the site of Kotið in 2016 and 2017. Located on the land of the main farm of Helluland, but over a kilometer north of the modern farmhouse, Kotið is in between an eroded outcrop and a bog (Figure 2). Since the property of Helluland was subdivided, Helluland no longer owns Kotið (Catlin et al. 2017:36). Coring revealed that the soils around Kotið, in general, are not very deep, though some areas have significant soil deposition. Loss on ignition studies have shown that the area was more marshy in the past, and would have looked quite different than it does today.

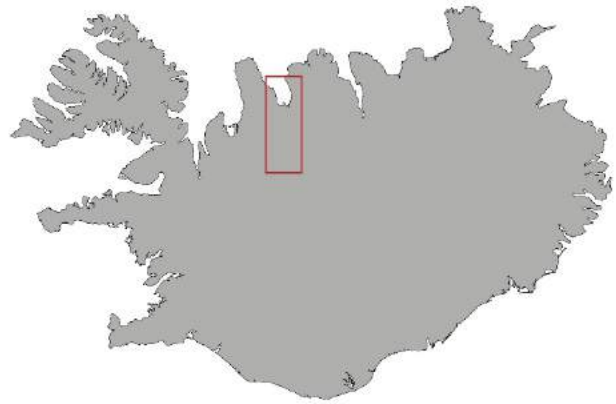

Figure 1: Location of Skagafjörður in Iceland

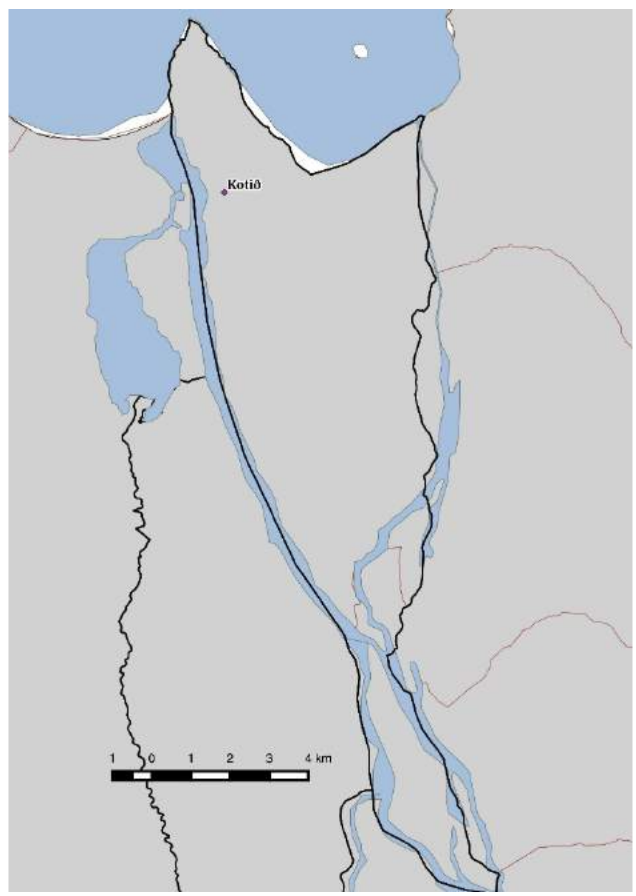

Figure 2: Location of Kotið on Hegranes

The 2016 test pit was a 1x1 meter unit (Catlin et al. 2017), and in 2017 that unit was expanded to a 2x2 (Catlin et al. 2018), using the previous test pit as the northeast corner. Results are presented here as a combination of the two units, since they are connected and the stratigraphy could be correlated. Catlin et al. (2017:46) identified four potential phases of occupation at this site, but the tephra sequence became more unclear during 2017 excavations, and the results are reported here as one phase, from settlement (ca. 871) to AD 1104. Figure 3 shows Kotið during excavation in 2017.

These test pits were originally targeted to collect data for Kathryn Catlin's dissertation research on the *fornbýli*, or ruins, on Hegranes (Catlin et al. 2017, 2018), and the archaeofauna recovered are now forming the basis of my dissertation project. Both projects are informed by the Skagafjörður Church and Settlement Survey (SCASS) research on settlement patterns on Hegranes, and are also contributing data to the settlement story.

Figure 3: Kotið during excavation.

Methods

The faunal materials were analyzed at the Hunter College Zooarchaeology Laboratory, and made use of the comparative collection there. Recording and data curation follow NABONE protocols, utilizing the 9th edition of this recording package (a Microsoft Access database supplemented with specialized Microsoft Excel spreadsheets, available to download at www.nabohome.org). Digital records were all made using this package. The animal bones excavated will be permanently curated at the National Museum of Iceland along with all digital records. Digital records will also be preserved in the NABO collection on The Digital Archaeological Record (tDAR). An electronic copy of this report is available at www.nabohome.org and at the UMB SCASS website/Fiske Center site.

All fragments were identified as far as taxonomically possible, and a selected element approach was not used. Most mammal ribs, vertebrae, and long bone shaft fragments were assigned to "Large Terrestrial Mammal" (cattle or horse sized), "Medium Terrestrial Mammal" (sheep, goat, pig, or large dog sized), and "Small Terrestrial Mammal" (fox or small dog sized). Only those elements that could be positively identified as sheep, *Ovis aries*, or goat, *Capra hircus*, were assigned to these categories while all other sheep/goat elements were assigned to a more general "caprine" category.

Following widespread North Atlantic tradition, bone fragment quantification makes use of the Number of Identified Specimens (NISP) method (Grayson 1984). All mammal measurements follow von den Driesch (1976). Sheep/goat distinctions follow Boessneck (1969) and Mainland and Halstead (2005). Only positively identified fragments of fish bone were given species level identification, with those unidentifiable to species placed in the family category where possible, often *gadid*, while others were identified simply as fish.

Tooth wear studies follow Grant (1982). Long bone fusion stage calibrations follow Zeder (2006) and presentation of age reconstruction makes use of Enghoff (2003) and McGovern (2009).

The Archaeofauna

The table below (Table 1) shows the entire archaeofaunal assemblage from Kotið. The first section of the table shows all elements that were identified to species (for domesticates) or family (for fish, birds, and mollusks). These make up the Number of Identified Specimens (NISP) and are the elements that are included in the majority of the analysis. The bottom portion of the table includes those fragments that could not be identified beyond the broad size categories explained above. These unidentifiable pieces plus the NISP make up the Total Number of Fragments (TNF) for the assemblage. The TNF is only discussed in the taphonomy section, as taphonomic factors affected the entire archaeofauna. Otherwise, all discussion focuses on those elements included in the NISP.

Taphonomy

Various taphonomic factors can affect bones. Here, four measures of taphonomic effects will be explored to help characterize the entire archaeofaunal assemblage. The taphonomy is discussed in terms of the assemblage as a whole, using the Total Number of Fragments (TNF).

Fragment Size

Size of a bone can affect its identification rate. Larger bone fragments are often much easier to identify than smaller, more broken pieces. Some animals, however, have smaller bones that can be recovered whole and identified at a higher rate than broken fragments of a large mammal bone. In Figure 4 below, the categories with the most fragments are the 1-2 cm and 2-5 cm categories. Since over half of the assemblage is made up of birds and fish, this is not surprising. Very few of their bones fit into the larger size categories, which are mostly comprised of large terrestrial domesticates. In addition, the majority of the pieces under 1 cm are unidentifiable.

Table 1: All bones from Kotið, including NISP and TNF.

	TOTAL NISP
Domesticates	
Bos taurus	57
Equus caballus	13
Sus scrofa	3
Ovis aries	45
Ovis/Capra sp.	215
SEALS	
Phocid sp.	10
CETACEA	
Small whale/porpoise	10
Cetacea sp.	1
BIRDS	
Wildfowl - sea birds	304
Wildfowl - land birds	28
Bird sp.	351
FISH	
Gadid sp.	614
Salmonid sp.	1
Other Fish	1
Fish sp.indet.	325
MOLLUSCA	
Mollusca sp.	12
TOTAL NISP (Identified fragments) =	**1,990**
Small Terrestrial Mammal	15
Medium Terrestrial Mammal	286
Large Terrestrial Mammal	100
Unidentifiable Fragments	1,661
TOTAL TNF (all fragments)	**4,052**

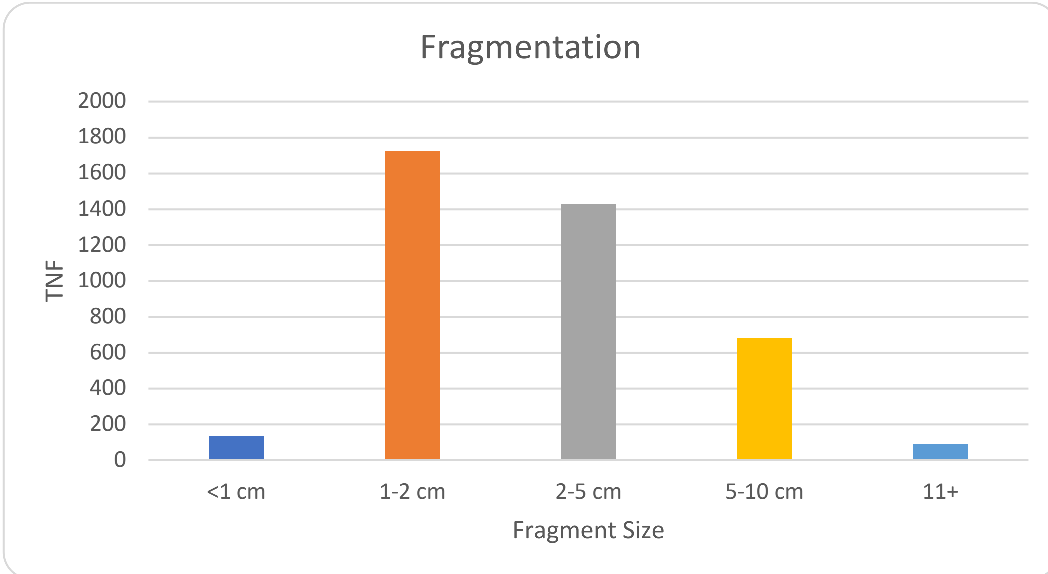

Figure 4: Fragment size based on entire assemblage (TNF).

<u>Burning</u>

As the chart below (Figure 5) shows, most of the bones from Kotið were unburned. The majority of those that were burned are completely calcined, the "white" category. This indicates a very hot fire. The midden at Kotið is primarily dark and made of charcoal (Catlin et al. 2018:65), so they were burning more wood than peat on site. These bones could have been burned as fuel and then eventually deposited into the midden during a cleaning event.

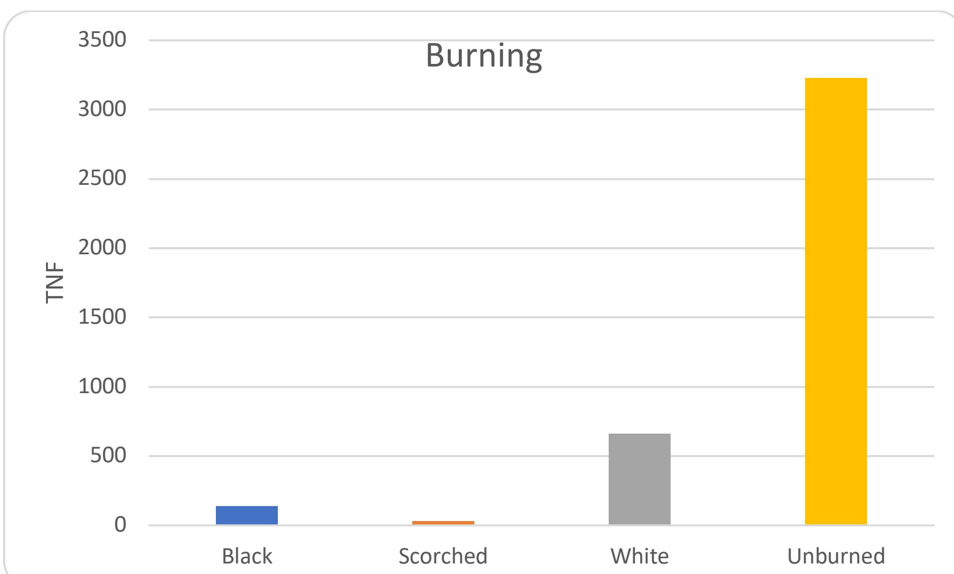

Figure 5: Total number of burned fragments in the Kotið assemblage

Gnawing

Only two bones showed evidence of gnawing by a dog. Though no dog bones were recovered from the site, the presence of gnawed bones indicates their presence. No rodent chew marks or rodent bones were found in the assemblage.

Butchery

Since most of the bones recovered from Kotið were birds and fish, it's not surprising that there is very little butchery present in the assemblage. Neither birds nor fish require great amounts of processing that would leave traces on the bones in most cases, though it is not impossible. One of the chopped bones is a haddock cleithrum, a bone often used in craftworking to create items such as gaming pieces. There are also two whale bones that have been worked (1) and chopped (1). Whalebone is also used in craftworking, though more as a platform or table for working on other materials. However, the rest of the bones from Kotið that show evidence of butchery are domesticated mammals. Only 12 domesticate bones were chopped—6 cattle, 3 caprines, 2 horse, and 1 pig (Figure 6). One sheep frontal bone was split, a signature of the svið preparation where the skull is split in half along the sagittal plane. The rest of the domesticated mammal bones were unmodified.

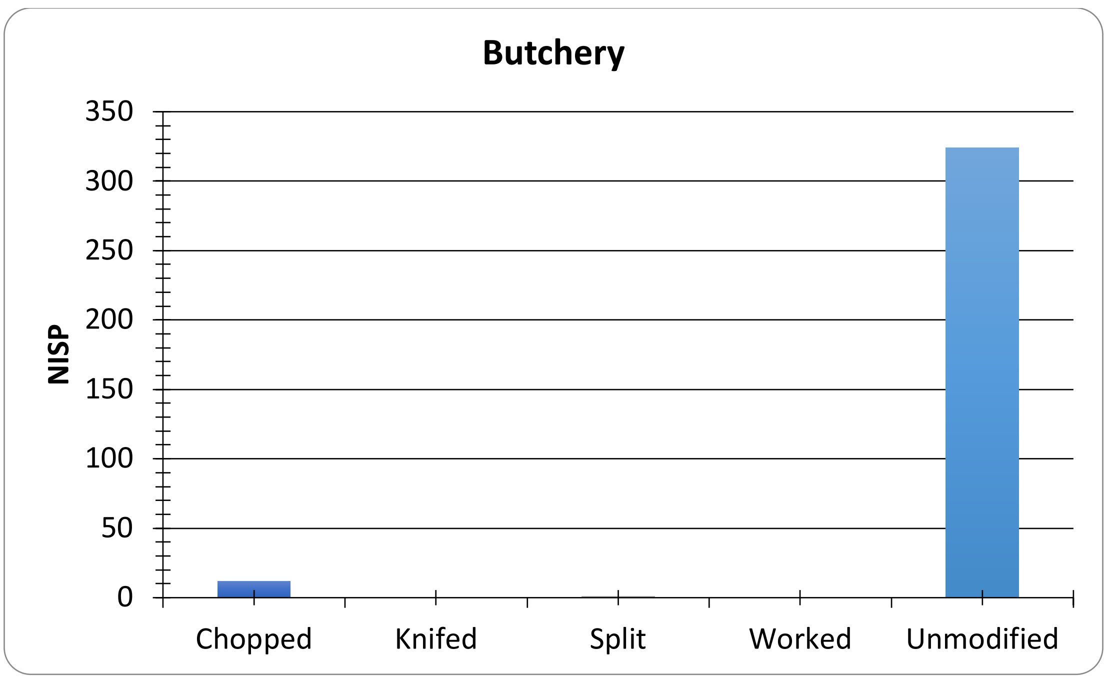

Figure 6: Butchery marks on domesticated mammal bone fragments from Kotið

Major Taxa

Figure 7 below shows the major taxa present in the Kotið assemblage based on NISP. Most of the assemblage is comprised of fish (47%) and birds (34%). Domesticates make up less than 17% of the assemblage. The next sections will discuss these major taxa in more depth in order to understand the activities taking place at Kotið.

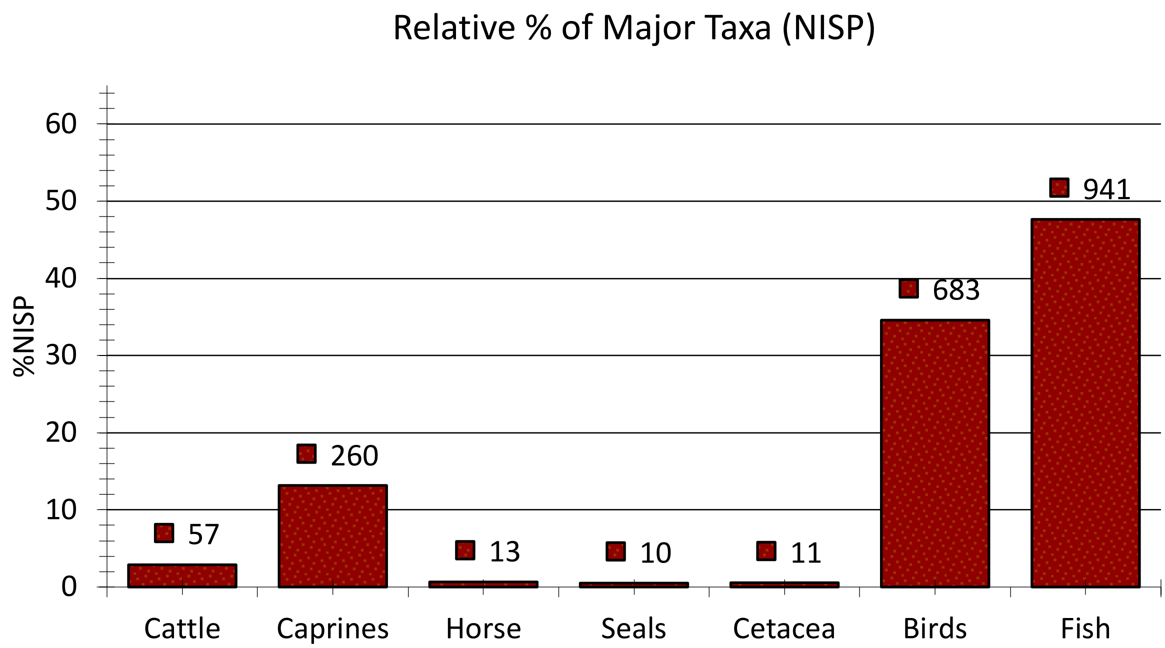

Figure 7: Major taxa present. Bars represent %NISP and the numbers above each bar are the NISP counts for each group.

At Kotið, the assemblage is made up of nearly 85% wild resources. When comparing this pattern to other contemporaneous farm sites, Kotið seems atypical. Looking at Figure 8 below, it is immediately obvious that Kotið has the highest percentage of wild resources than any of the other contemporary sites anywhere else in Iceland. However, the percentage of wild resources is similar to Hofstaðir in Mývatnssveit, though Hofstaðir does not get started until after AD 940, so it is not quite contemporary (McGovern 2009). Also, most of the wild species at Hofstaðir are freshwater fish, due to its inland location, while Kotið has a more marine focus.

Other sites with over 50% wild resources include Tjarnargata in Reykjavik and Herjolfsdalur on the Westman Islands. These are both early sites that focus on birds. The Kotið assemblage also contained large numbers of birds (~34%), indicating a marine resource exploitation strategy. Hoever, Kotið is unique in that they split their marine resource use into fish (~47%) and birds, with domesticates making up a small percentage of their economic strategy. No other site seems to have split their focus on marine fish and birds in quite the same way, though the later period at Skuggi (mid-11th to early 12th century) is close (Harrison 2013). This period is right before Skuggi was closed down, and at Kotið, we see a similar resource use pattern followed by abandonment.

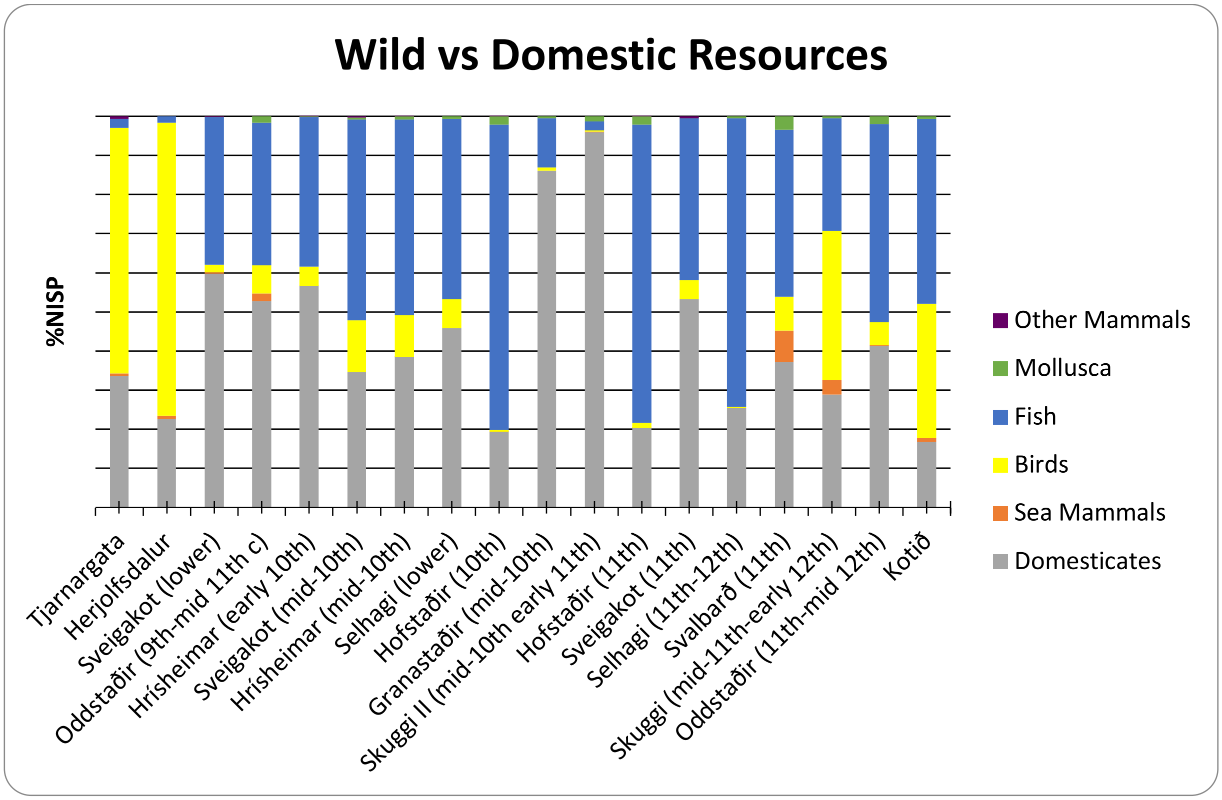

Figure 8: Wild versus domesticate bones present at sites all over Iceland. Tjarnargata is in Reykjavik and dates to the 10th century. Herjolfsdalur is on the Westman Islands and is an early period site. Sveigakot, Hrísheimar, Hofstaðir, and Selhagi are all located in Mývatnssveit. Granastaðir, Oddstaðir and Skuggi are in Eyjafjörður.

Caprines

There are 260 caprine bones in the Kotið assemblage, making up 13% of the NISP. None could be positively identified as goat (*Capra hircus*), but 45 were identified as sheep (*Ovis aries*). Bones from the entire body were recovered, though in Figure 9, it looks like there are no ribs or vertebrae. This is due to the NABONE protocol of not identifying ribs or vertebrae beyond size class, in this case "Medium Terrestrial Mammal" and not because they are not present in the archaeofauna. The presence of elements from the entire body indicates that specific cuts of meat were not being sent in to provision those who lived at Kotið, nor were they sending away portions of their slaughtered herd to provision others.

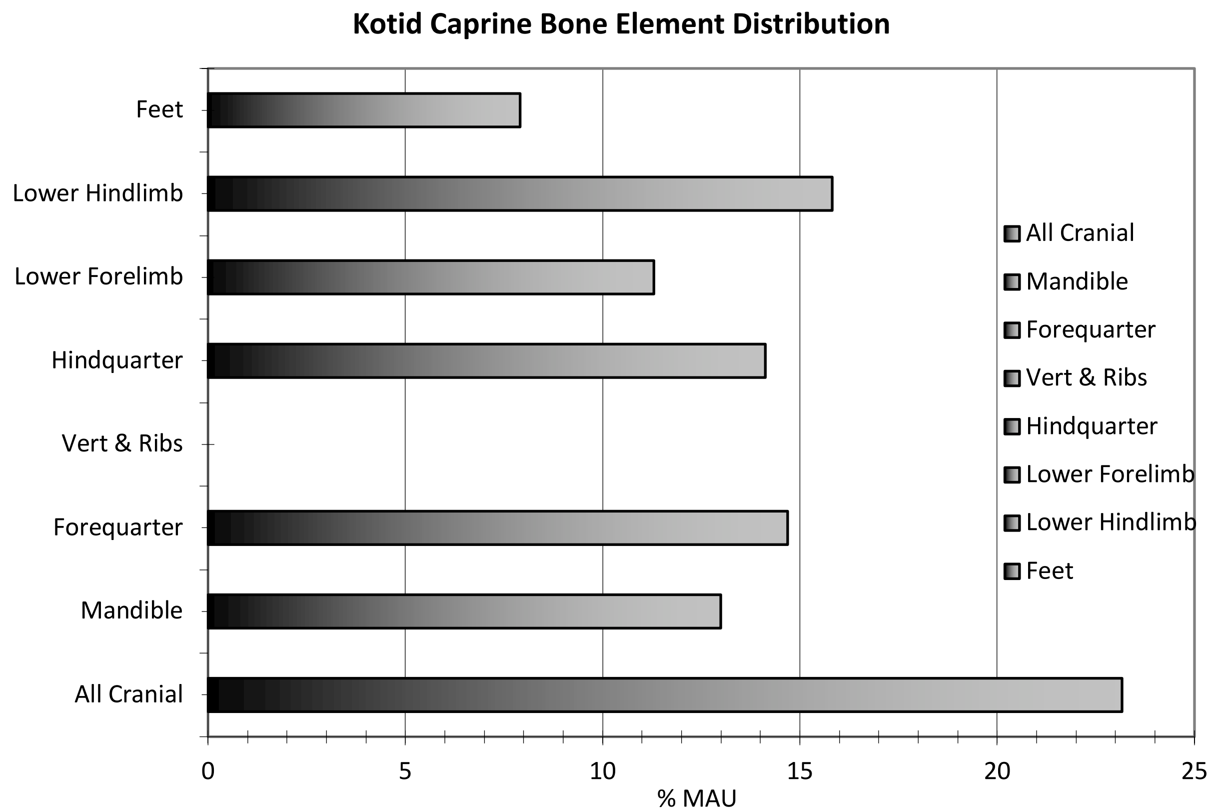

Figure 9: Caprine bones recovered and identified

Caprine Age Profile

The age profile for caprines at Kotið is constructed based on tooth eruption patterns, tooth wear stages, and long bone fusion data. Utilizing these three methods gives a clearer pattern of time of death for these animals. In this analysis, both those elements positively identified as sheep and the ones in the general caprine category are grouped together to present the age data. It is important to note that only five mandibles were available for tooth wear and eruption analysis.

<u>Tooth Eruption</u>

Tooth eruption is fairly predictable, since it is based on biology and not as much on diet or environmental factors, though nutrition will play a small role. For this reason, tooth eruption classes are a preferred method by zooarchaeologists for aging animals. Using tooth eruption data, we can assess mortality patterns. The eruption states for the five mandibles from Kotið are shown below in Figure 10.

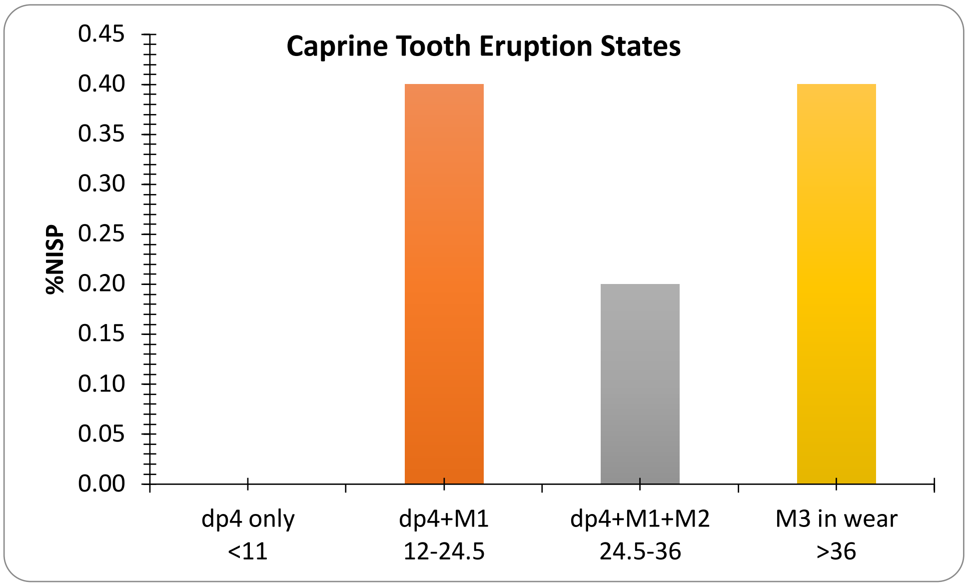

Figure 4: Tooth eruption for caprine mandibles, n=5

This analysis shows that there were no individuals less than one year of age at the time of their death.

<u>Tooth Wear Analysis</u>

With tooth wear studies, it is important to add the caveat that wear patterns are not solely dependent on age, but also on type of food eaten (e.g., Reitz and Wing 2008:174). If there is a lot of grit in the plant material that the animals eat, it will wear away tooth enamel much faster than a grit-free diet would (Mainland 2000; McGovern 2009:192; Zeder 2006:98), potentially making the animals appear older than their actual age. Indeed, especially with the different foraging strategies of sheep and goats, differential tooth wear will be more dependent on diet than on age. However, using tooth eruption and wear data along with long bone fusion data, as will be done here, can help to reconcile the two, potentially very different, age profiles (see Zeder 2006:97–98).

Again, there are only 5 mandibles included in the analysis of tooth wear. The wear stages for each tooth and total mandibular wear scores (MWS) are shown below in Table 2.

Table 2: Mandibular Wear Scores (MWS) according to Grant (1982).

Toothwear Reference Number	dp4	P4	M1	M2	M3	MWS
165		j	l	h	g	55
167	g		f			23
169		j	g	h		39
170	m		h			30
173	h		g	U		30

Long Bone Fusion Stages

Using fusion data compiled by Zeder (2006:107; chart reproduced below in Table 3), long bone fusion stages for the caprines are explored here. The data from Zeder indicate that sheep and goats have very similar ages of fusion for most long bones, and the differences between the two species seem to lie in the order of fusion while ages at time of fusion remain the same. Since the fusion schedule is essentially the same between the two species, this analysis uses both the bones confidently identified as sheep and those in the general caprine category (which could include goats).

Table 3: Long bone fusion stages in caprines. Fusion data from Zeder (2006:107), number of elements in each fusion stage (fused, intermediate, and unfused) are listed for the Kotið assemblage.

Bone	Age of Fusion (in months)	Fused	Intermediate	Unfused
Proximal Radius	0-6	3	0	0
Distal Humerus	6-12	6	0	0
Pelvis	6-12	0	0	1
Scapula	6-12	1	0	0
2nd Phalanx	12-18	12	4	2
1st Phalanx	12-18	18	0	4
Distal Tibia	18-30	3	2	5
Distal Metapodial	18-30	14	0	16
Calcaneus	30-48	2	0	4
Proximal Femur	30-48	0	0	1
Distal Femur	30-48	0	0	2
Proximal Ulna	30-48	0	0	2
Distal Radius	30-48	1	0	0
Proximal Tibia	30-48	2	0	3
Proximal Humerus	48+	0	0	5

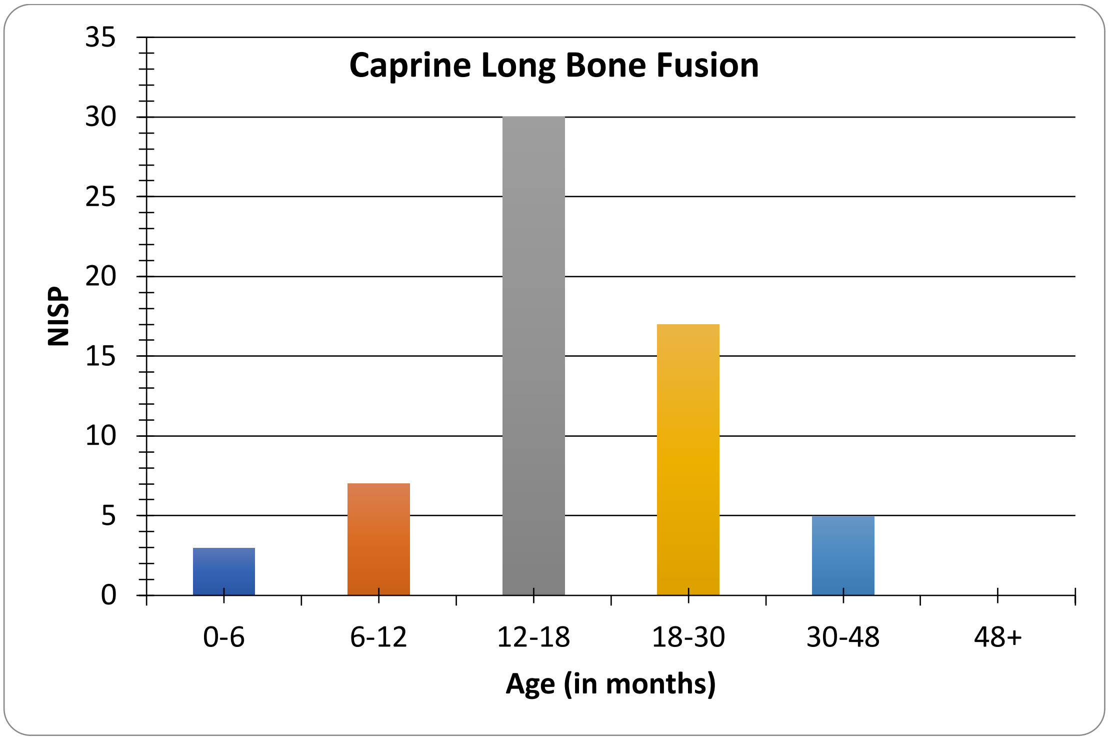

Figure 11: Caprine age classes based on long bone fusion

The long bone fusion data shown in Figure 11 above indicates that many individuals had reached their first year and were then killed. The few younger individuals may indicate a dairy strategy, with young lambs killed shortly after birth in order to collect the milk for human consumption. There were neonatal caprine elements present in the assemblage (n=7, or 2.69% of the total NISP), adding additional evidence to show that some young caprines were killed or died very early in their lives. The older individuals seem to point to a meat-focused economy. Prime meat age for sheep is around 1-2 years, and we see 47 bones from caprines in this age range. This is an expensive strategy, both in labor and in supplies, since the animals need to be raised to the peak of their growth curve. If they were not killed at this age, they would still take up resources and labor, but would give wool and milk (if female) in return. The lack of many old sheep suggests that wool production was not a focus at Kotið, and that mixed meat and milk production was the main focus. This is a common Viking Age strategy, as wool was mostly produced for the household during this time. Later, these profiles shift as wool became more important for export.

Cattle to Caprine Ratios

Ratios of cattle to caprines are used in Iceland to understand shifting importance in resource use over time. While cattle impart status, sheep provide the wool that is vital to surviving the Icelandic winter. Wool also becomes valuable as a trade good and a standardized form of measurement and currency, called *vaðmál*. Over time, the numbers of sheep kept increases, and numbers of cows decrease.

The ratio of cattle to caprines at Kotið is 4.56. This means there are about 4.5 caprines per every head of cattle. We can compare these ratios to those we see in other areas of northern Iceland (Figure 12). Here, the ratios at Kotið are compared to sites of similar time periods in a neighboring region of Skagafjörður, in Mývatn, and in Eyjafjörður. At Hofstaðir in Mývatn, the ratio stays relatively stable over time—it starts out a bit higher (1 cattle per every 3.3 sheep) and drops only slightly in later periods. At Skuggi, in neighboring Eyjafjörður, the mid-10th-early 11th century deposits have the highest cattle-caprine ratio of the sites compared here, with 9.57 caprines per every head of cattle. In the Kotið archaeofauna, the ratio falls around the middle of the sites presented. It is quite similar to the ratio at Hrísheimar in Mývatnssveit and to the earliest period at Stóra-Seyla in nearby Langholt.

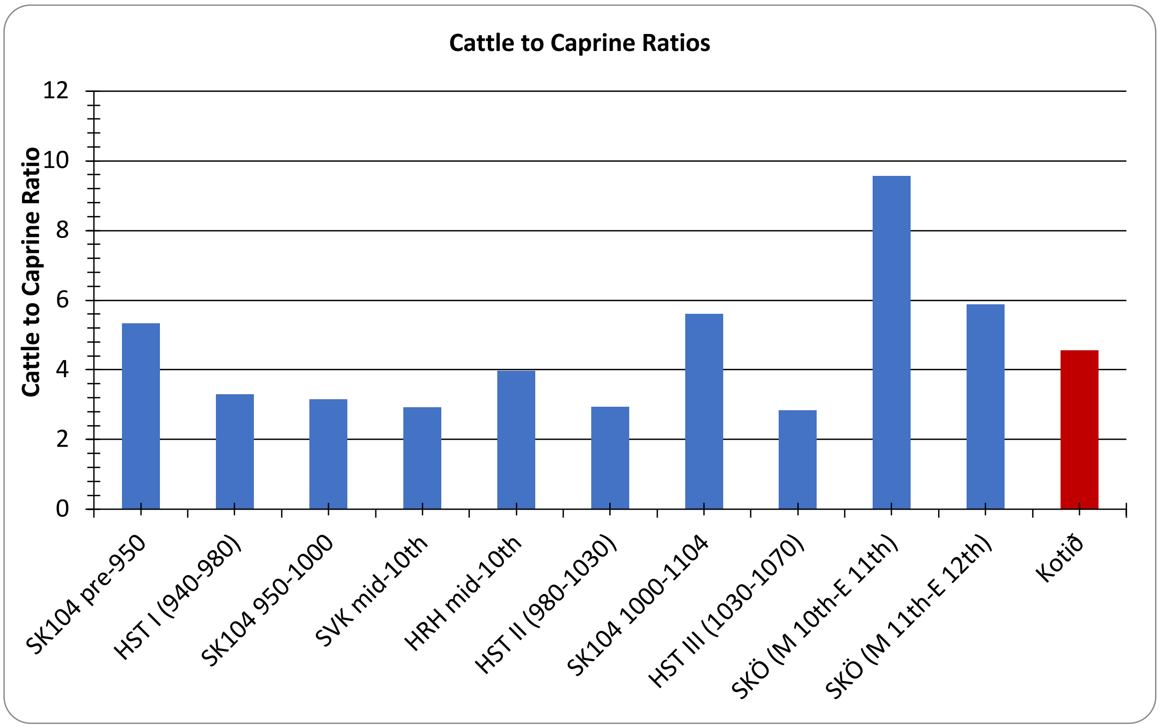

Figure 12: Cattle to caprine ratio at different sites in Northern Iceland around the same time period. Kotið is highlighted here in red. The only other site in Skagafjörður is SK104=Stóra-Seyla. In Mývatn are SVK=Sveigakot, HRH=Hrísheimar, and HST=Hofstaðir. Skuggi (SKÖ) is in Eyjafjörður. A taller bar indicates more caprines.

Cattle

Cattle make up less than 3% of the total archaeofauna. Bones from the entire skeleton are present (Figure 13), with limb bones being represented at a higher quantity than other bones. Similar to the caprine element distribution, this again represents a home butchery strategy.

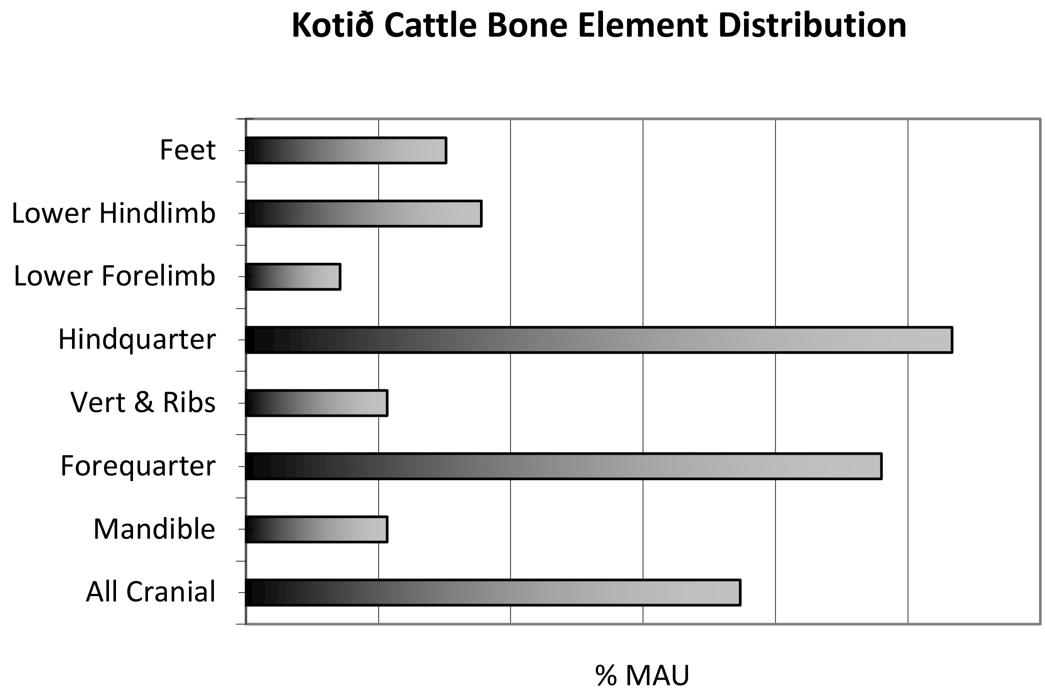

Figure 13: Cattle bone elements present at Kotið. The entire skeleton is represented.

Neonates

Of the 57 total cattle bones, 14 (24.5%) are from neonatal cattle (Figure 14). Unlike the caprine strategy of mixed management for multiple products (milk, meat, and wool), cattle cannot usually be successfully managed for both meat and milk in this way. Cattle have more specialized grazing needs, and raising a calf takes a lot of milk. If the milk is needed for human consumption, the calf must be killed. A high percentage of neonatal animals to adult animals is indicative of a focus on dairy for humans.

According to McGovern (2009:216), a typical Icelandic dairy economy would create an archaeofauna where 30-50% of the cattle bones are from neonates. This is not the case at Kotið, but the percentages are not far off, suggesting an attempt at the kind of dairy-based herding strategy discussed above.

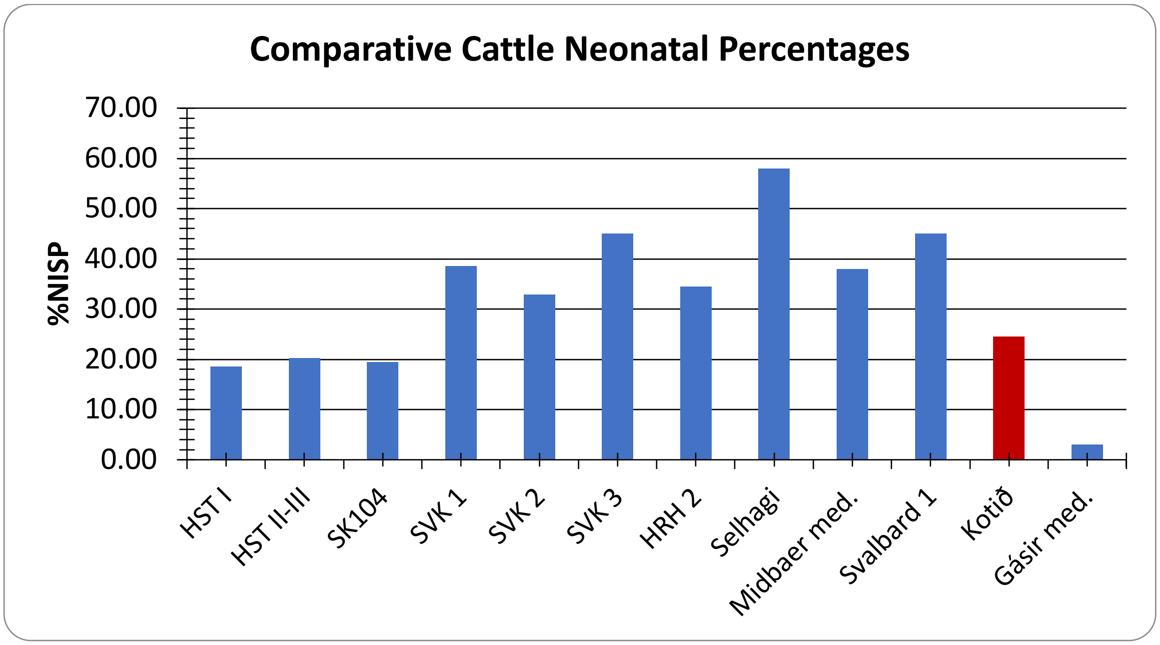

Figure 14: Comparison of cattle neonatal percentages from Kotið (highlighted in red) and other contemporaneous Icelandic sites. Stóra-Seyla (SK104) is located in Skagafjörður. HST=Hofstaðir (Late Viking Age, ca. 940-1000 A.D.), SVK=Sveigakot (Viking Age, 871-1000 A.D.), HRH=Hrísheimar (Viking Age, ca. 871-1050). Selhagi dates to the Early Medieval period (prior to 1300 A.D.), Miðbær (on Flatey) is post-1200 A.D. Svalbarð 1 dates to the Late Viking Age/Early Medieval. The Medieval period at Gásir is ca. 1250-1400 A.D.

Comparing the cattle neonatal percentages at Kotið to other Icelandic sites shows that the pattern for a dairy economy is quite widespread. The majority of the sites in Figure 14 have cattle neonatal percentages in the range given by McGovern (2009) for a dairy economy. The chart also shows that Kotið, while having a slightly higher percentage of neonatal bones, is close to the Viking Age phases at Hofstaðir and to Stóra-Seyla. This sample size at Kotið is smaller than the other two sites, but the site itself is also smaller, so this should be a reasonable approximation of actual activities on site. The outlier shown on the graph is the medieval trading site at Gásir. We now know that Gásir was being provisioned by farms in its hinterlands, and thus were actually consuming prime-age beef that was brought in rather than managing their own cattle (e.g., Harrison 2013).

Cattle Age Profile

There are not enough long bones or mandibles to accurately say anything about the age of the cattle at Kotið and a larger sample size is necessary to draw any firm conclusions. Preliminary results of long bone fusion states (presented in Table 4 below) include 5 bones. They indicate that at least some of the cattle were younger than 1-1.5 years. Peak meat production age is roughly 2.5-3 years (McGovern 2009:220). The current data shows that at least one animal was killed or died during this peak age range (2-2.5 years), but more data could change the picture significantly.

Table 4: Cattle long bone fusion, based on McGovern (2009).

Bone	Age at Fusion	Number Fused	Number Unfused
Distal Humerus	1-1.5 years	1	1
Distal Tibia	2-2.5 years	1	0
Distal Femur	3.5-4 years	1	1

Other Mammals

There were also marine mammals found in this archaeofauna. These include both cetacea and seals. Eleven cetacean bones were identified in total. Nine of these are vertebrae from a small cetacean (Figure 15) and they seem to belong to the same individual based on where they were found and their size. The single piece from a larger cetacean is a fragment that is unidentifiable without aDNA analysis. The final piece is a mandible found in 2016. Ancient DNA (aDNA) analysis on this mandible fragment came back as belonging to the dolphin family (Delphinidae) (Szabo, personal communication).

Figure 15: Vertebrae from a small cetacean

The seal bones (n=10) were not diagnostic to species, but they may also be sent for aDNA analysis. Seal remains include teeth, a rib, and a femur.

Birds

Birds make up 34% of the archaeofauna at Kotið. They include seabirds, land birds, and freshwater birds Figure 16. The seabirds present are mostly alcids—puffin and guillemot. These migratory birds come to Iceland in the summer months to nest. They prefer cliffs, though puffins dig burrows to lay their eggs in. In Skagafjörður, there are huge populations on Drangey, a steep-sided island in the fjord. To collect these birds would require teamwork, since the island is far away and difficult to climb, even with the modern ropes and ladders. Also present were a few gulls and some cormorant (*Phalacrocorax carbo*) bones. These could easily have been collected while hunting puffin and guillemot, or even from the shore. Gulls may have even flown over the site.

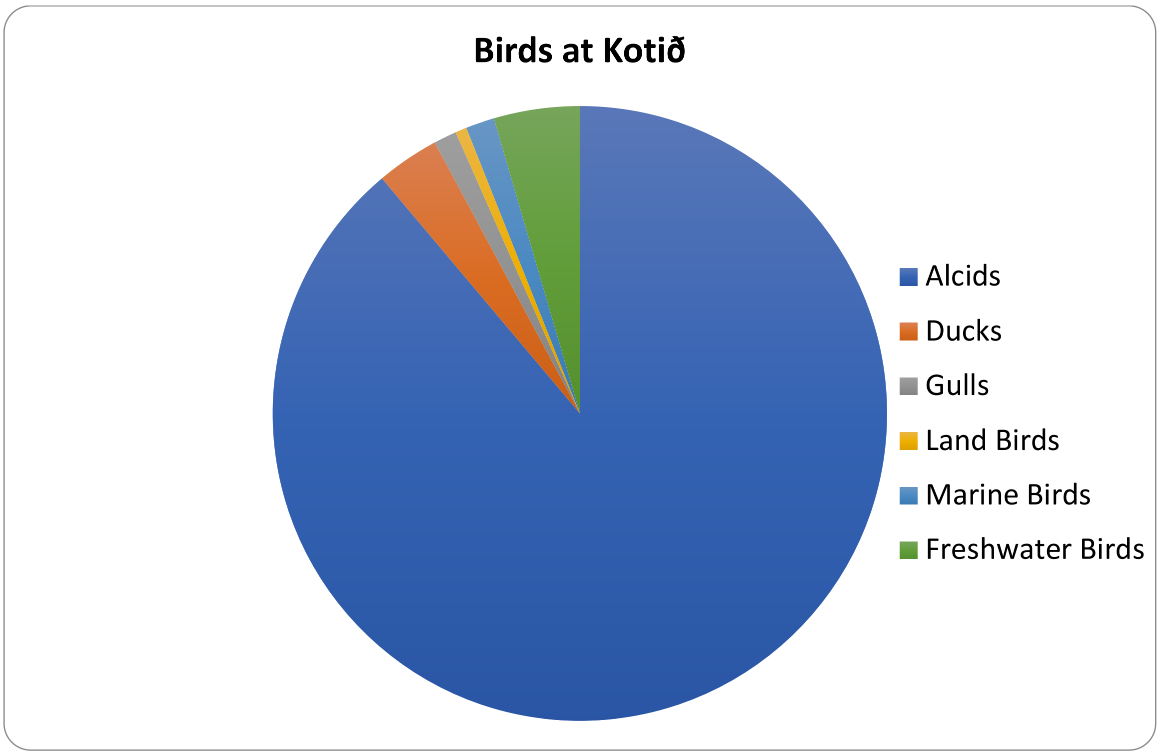

Figure 16: Identified birds at Kotið.

There are 11 ducks in the assemblage. Most of the ducks were not identifiable beyond the family level, but there are 4 red-breasted merganser (*Mergus serrator*) bones in the assemblage. These birds are migratory diving ducks, and they breed around freshwater. Ducks like a more marshy environment and are generally found near water. Today, Kotið does not fit the bill for the ideal duck habitat and there are no colonies nearby. However, Catlin et al.'s (2018:64) loss-on-ignition study shows that the area around Kotið had more organic material in the past, indicating a wetter environment.

The gulls include a black-headed gull (*Larus ridibundus*) and other unidentifiable gull species. The land birds are limited to two plover (*Pluvialis apricaria*) bones. These birds also show up in the summer time, and we have seen them on site today. The marine birds category contains only cormorant (*Phalacrocorax carbo*). The only freshwater bird was the red-throated look (*Gavia stellata*).

Many of the birds in the archaeofauna at Kotið are summer birds. They also represent a necessity for communal cooperation. Their presence indicates a summer occupation at Kotið, but does not mean that people did not occupy the site year-round.

Fish

The fish at Kotið represent an interesting case of resource specialization. Only two of the identifiable fish remains were not from gadids, and these were one trout (*Salmo trutta*) vertebra and a single wolfish (*Anarhichas lupus*) tooth. The focus on gadids, and mostly cod, is interesting in and of itself, because the site does not currently contain any coastline within its borders or the borders of the larger farm, Helluland, to which it belongs. However, it is the specialized fish production signature that is the most intriguing.

Our model for early Icelandic dried marine fish production indicates that at least two distinct types of fish products were being produced in Viking Age Iceland (Amundsen et al. 2004, 2005; Perdikaris and McGovern 2008a). One product was dried in the round, probably closely resembling the historically known "stockfish" later exported in large quantities from late medieval and early modern Iceland. The other product was more heavily filleted and spread open to produce a flat dried product that may have circulated more intensively within Iceland.

The production of these kinds of products leaves distinct archaeological signatures, as does the consumption. With a round dried product, production takes just the skull and the entire fish is dried. Vertebrae from the entire length of the fish (thoracic, precaudal, and caudal) stay with the fish, along with the cleithra, and these bones should all be found at the consumption site. So at a consumer sites, the graphs below (Figure 17 and Figure 18) would show equal bars for all vertebrae, as it presents %MAU and thus controls for quantities of each vertebra in the body.

For a flat-dried product, production cuts off the head and splits the fish down the middle almost all of the way to the tail, again leaving the cleithra to aid in keeping the body together. During the drying process, this filleting allows vertebrae to fall out. Therefore, at site where production of the flat-dried product is the focus, skull fragments and thoracic vertebrae are expected. At a site consuming flat-dried fish, more precaudal and caudal vertebrae will be found.

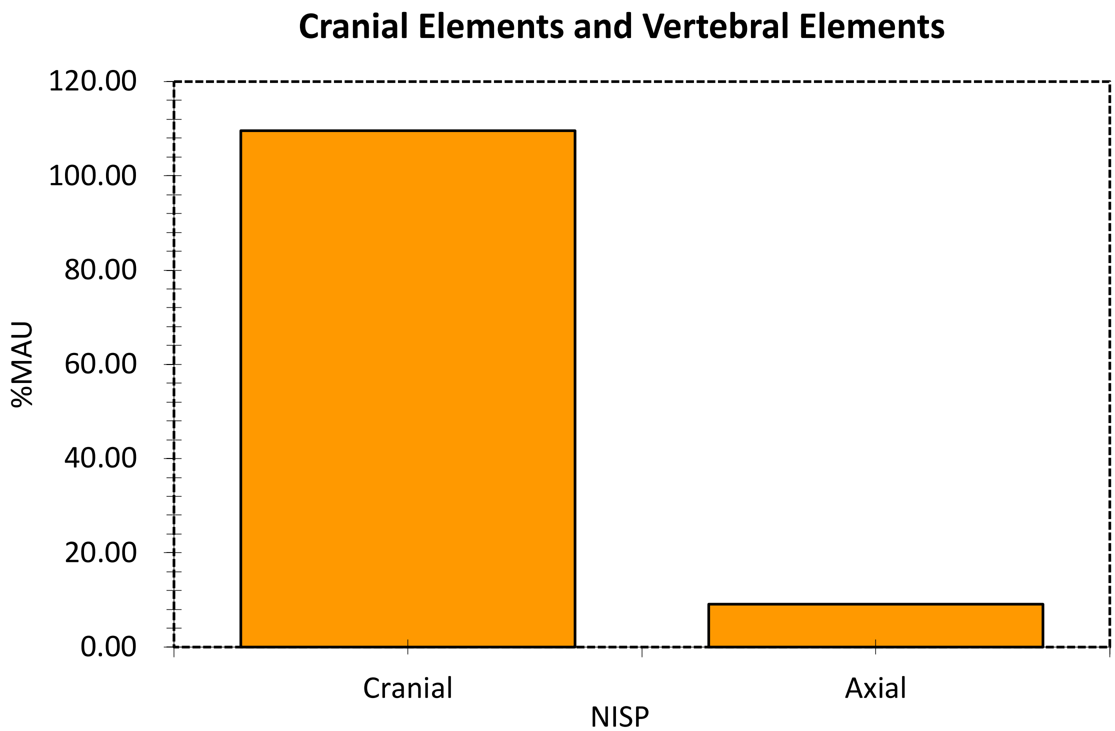

Figure 17: %MAU of cranial elements and axial elements for all gadids.

As can be seen in Figure 17 above, cranial elements are much more common than axial elements. In addition to this, the vertebral analysis Figure 18 shows that mostly thoracic vertebrae are found, in relation to how many are present in the body. This is strong evidence for the production of a flat-dried product at Kotið. The presence of small quantities of the other vertebrae also indicates that fresh fish were consumed whole on site on occasion. This pattern points to a Viking Age artisanal fishing strategy that began at the settlement of the region. Archaeological investigations at sites further inland in Skagafjörður also suggest a local trade network of this dried fish product. At the site of Stóra-Seyla in Langholt, zooarchaeological analyses point to the consumption of a flat-dried fish product (Cesario 2016). Patterns of marine fish product production and consumption have considerable potential to shed light on still poorly-understood patterns of pre-commercial, artisanal production and distribution of these characteristic Nordic dried fish products (Perdikaris and McGovern 2008a, 2008b).

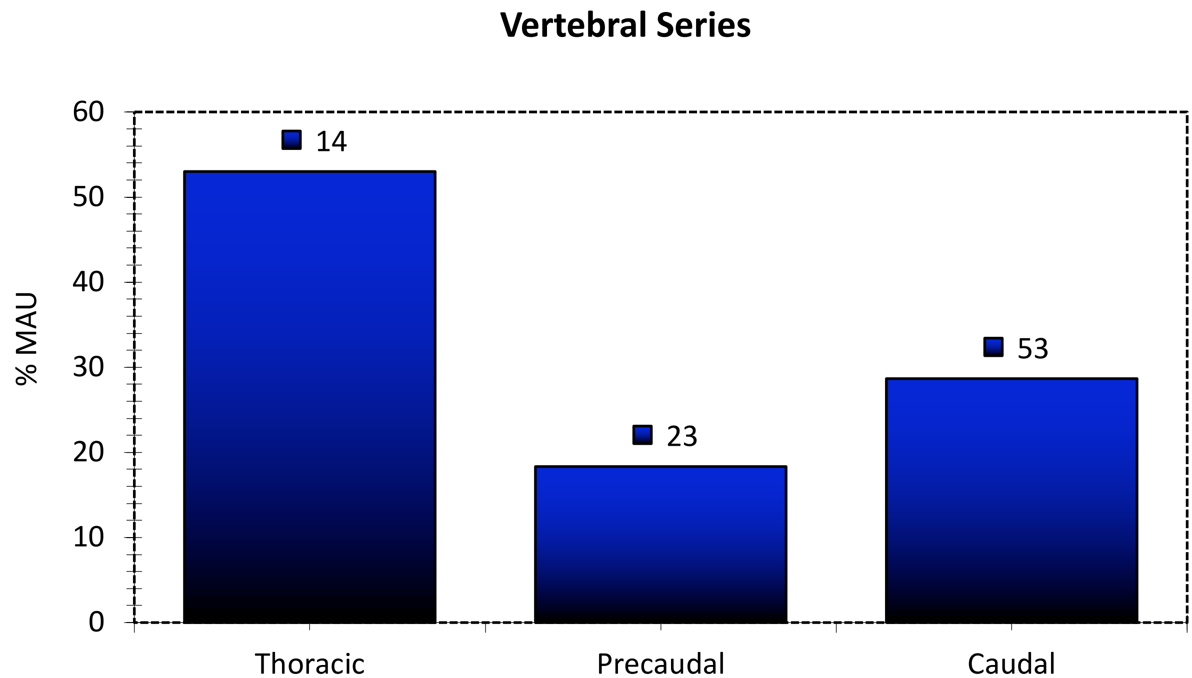

Figure 18: %MAU of vertebrae recovered from Kotið.

With fish bones, there is always the possibility that taphonomy has destroyed many of the bones or that the collection strategy will not favor smaller bones and the archaeofauna will be biased. A biased collection strategy was not the case at Kotið, since the caudal vertebrae are the smallest of all the vertebrae and many were collected. Since these smaller bones were preserved, it can be assumed that the soil conditions were favorable, and so taphonomy does not play a dominant role in the number of fish bones recovered.

Figure 19: View of Kotið. Note how little green there is; the land here is quite eroded and soils are not very deep in most places

Concluding Remarks

For a small site occupied for a relatively short time period, the NISP of 1,990 provides a sound base for quantification. Thus, this analysis can tell us a little bit about the economic activities that took place at Kotið and might be able to bring to light reasons for the site's abandonment before AD 1104. There are very few domesticates present in the assemblage, indicating that animal husbandry was not the only focus of the site. The presence of neonatal caprines and cattle points to occupation during the lambing and calving season, which today takes place in May.

The presence of alcids and plover also indicate a summer occupation. The harvesting of puffin and guillemot would have been a communal strategy, and may hint that the people inhabiting Kotið were an integral part of the community. This does not mean that they were elites, but that their labor or expertise were needed for this communal activity.

The fish signature marks Kotið as a producer site within a local artisanal fish strategy and trade network. Fishing usually takes place in the winter, when farm activities have slowed. However, Kotið does not seem to have been as heavily into farming (animal husbandry and fodder production) as one might expect (refer to Figure 8, the graph comparing wild versus domestic resources at a variety of sites throughout Iceland).

Kotið ceases to be occupied by humans by AD 1104, and possibly earlier. After this, it is reused for livestock grazing and animal structures are also built post-abandonment. The abandonment happens after Icelanders convert to Christianity (AD 1000), after the imposition of the tithe tax law (AD 1096), and right before Hólar comes into power as the bishopric in Skagafjörður (AD 1106). This was a time of social and political change in Iceland, coupled with the effects of environmental changes that began with human occupation of this previously uninhabited island.

Acknowledgements

This fieldwork was supported by the US National Science Foundation (PLR # 1523025, 1242829, 1345066, & 1417772) in a joint project of the Skagafjörður Heritage Museum (Byggðasafn Skagfirðinga), the University of Massachusetts Boston, and Northwestern University. Analysis was supported by the National Science Foundation Graduate Research Fellowship Program grant no. DGE-1037525. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author and do not necessarily reflect the views of the National Science Foundation.

Thanks to Kat, for our adventure into expanding Kotið to a 2x2. To John Steinberg and Doug Bolender for all of their support over the years and for bringing me onto this project in the first place. To the Skagafjörður Heritage Museum and especially Guðný, Sirrí, and Bryndís.

As always, Thomas McGovern gets my thanks for productive conversations about interpreting the data and enthusiastic support.

NABO

Skagafjörður Church and Settlement Survey: Archaeofauna from the 2016 Field Season

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CUNY NORSEC Laboratory Report No. 66
BSK-2018-202 / SCASS-18

Introduction and Excavations

In 2016, as part of the Skagafjörður Church and Settlement Survey (NSF PLR # 1242829, 1345066, 1417772 & 1523025), nine farms on Hegranes (Figure 1) were intensively surveyed, cored, and test pitted. In addition, the Fornbýli Landscape and Archaeological Survey on Hegranes (FLASH) surveyed, cored, and test pitted seven small sites, four of which are included in this research. This report on the archaeofauna from these test pit excavations supplements Bolender et al. (2017) and Catlin et al. (2017) by providing economic context to their survey and excavation results. The only farm excavated in 2016 that will not be reported here is Kotið, because we expanded that excavation unit in 2017 and it will be reported on its own.

The sites explored in Hegranes fall into two major categories—abandoned sites, or *fornbýli*, and those that are currently occupied and farmed. The abandoned sites are small and located physically on the margins of the large farms. These sites are also environmentally marginal, as they tend to be located in eroded areas. SCASS research focuses on the large farms, while FLASH studies the abandoned sites. The vast majority of the *fornbýli* are abandoned by AD 1104.

Test pits were 1x1 meter units, placed in areas of the farm mound with the best tephra preservation and evidence of human activities. The archaeofaunal samples collected from these excavations are too small to present more than a species list, though a few observations based on broader patterns will be discussed once all the data has been presented.

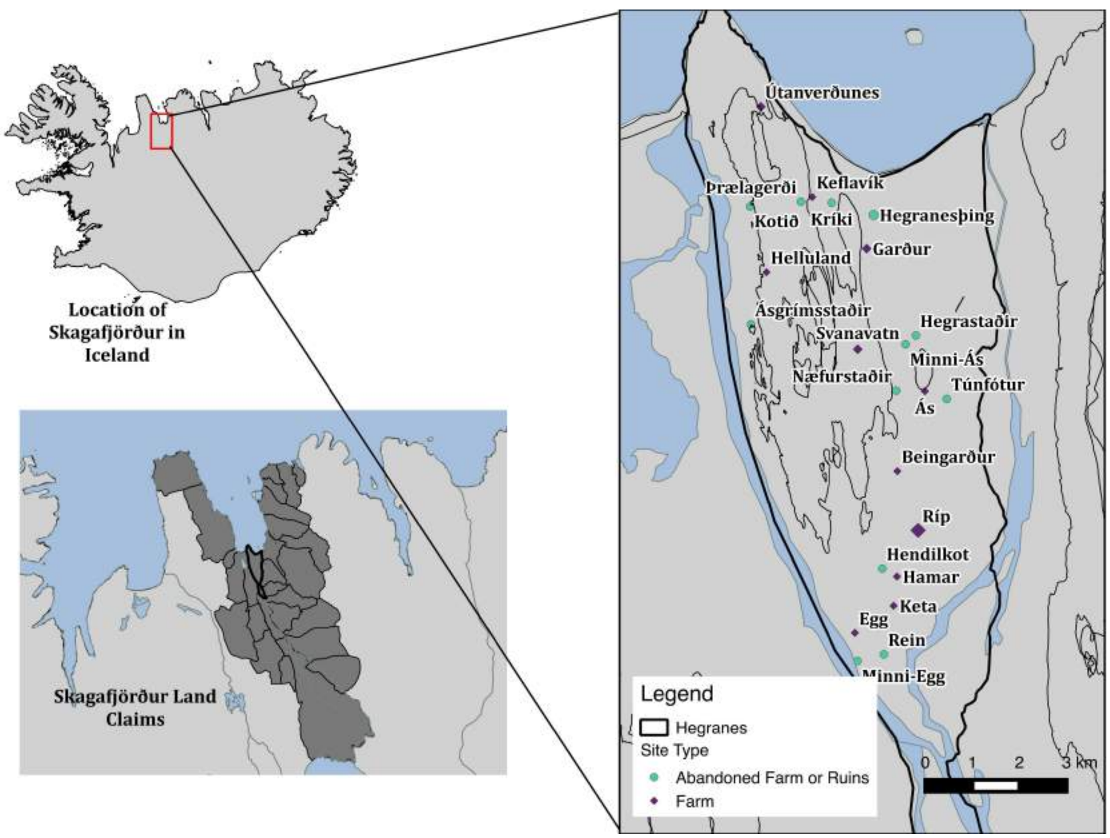

Figure 1: Location of Skagafjörður in Iceland. Lower left shows land claims, with Hegranes outlined in bold. Right shows site locations. Currently active farms are labeled with purple diamonds and abandoned sites are green circles. Symbol size indicates farm mound area in AD 1104.

Methods

The faunal materials were analyzed at the Hunter College Zooarchaeology Laboratory, and made use of the comparative collection there. Recording and data curation follow NABONE protocols, utilizing the 9th edition of this recording package (a Microsoft Access database supplemented with specialized Microsoft Excel spreadsheets, available to download at www.nabohome.org). Digital records were all made using this package. The animal bones excavated will be permanently curated at the National Museum of Iceland along with all digital records. Digital records will also be preserved in the NABO collection on The Digital Archaeological Record (tDAR). An electronic copy of this report is available at www.nabohome.org and at the UMB SCASS website/Fiske Center site.

All fragments were identified as far as taxonomically possible, and a selected element approach was not used. Most mammal ribs, vertebrae, and long bone shaft fragments were assigned to "Large Terrestrial Mammal" (cattle or horse sized), "Medium Terrestrial Mammal" (sheep, goat, pig, or large dog sized), and "Small Terrestrial Mammal" (fox or small dog sized). Only those elements which can be positively identified as sheep, *Ovis aries*, were assigned to this category while all other sheep/goat elements were assigned to a more general "caprine" category.

Following widespread North Atlantic tradition, bone fragment quantification makes use of the Number of Identified Specimens (NISP) method (Grayson 1984). All mammal measurements follow von den Driesch (1976). Sheep/goat distinctions follow Boessneck (1969) and Mainland and Halstead (2005). Only positively identified fragments of fish bone were given species level identification, with those unidentifiable to species placed in the family category where possible, often *gadid*, while others were identified simply as fish. No fish bones from this collection required measurement.

Results

For ease of comparison, the results are presented here in one large table containing most of the sites excavated in 2016. Two sites are not included on the tables because their dating does not fall into the phasing categories of the other farms. These are Ríp and Þrælagerði. They are still reported here separately with their own dating scheme.

Each assemblage has been analyzed by time period based on volcanic tephra present during excavation and subsequent radiocarbon dating on carbonized seeds. What follows is a bit of background information on each site, and then tables presenting NISP and TNF (Total Number of Fragments) for all sites during comparable phases. I have broken the sites into two phases—pre-1104 (Table 1) and post-1104 (Table 2). I made this choice because phasing has not been completed for all sites, and we are waiting for results of radiocarbon dating to help clear up stratigraphy where tephra is unclear or not present. However, one tephra layer that is quite obvious is the white AD 1104 tephra and it tends to be present in most of our excavations, making it a perfect place to separate the phases.

Helluland

Helluland is located on the west side of Hegranes (see Figure 1). Much of the land owned by Helluland is quite rocky and eroded, though the area of farming activity still has deeper soils. This test pit was placed near the modern pig barn, in the old farm mound. Only two time periods of activity have been identified so far: 934-1000 A.D. and 1000-1104 A.D. For the purpose of this analysis, these two phases have been lumped together, though most of the material (92 of

100 TNF, and the entire 29 NISP) comes from the later phase, 1000-1104. It is possible that the main farm moved after 1104, and that is the reason that no material was found after the 1104 tephra.

Identifiable marine animals found at Helluland include cod (n=2), puffin (n=2), and guillemot (n=3). The single pig bone, a mandible fragment, comes from the 1000-1104 phase. Pigs are common in the Viking Age, but become rare in archaeofauna after about AD 1100. However, this pig is not totally unexpected during this time period. The majority of the bones recovered from this test pit were unburned.

Ásgrímsstaðir

Ásgrímsstaðir is located across the modern road from the farm of Helluland and is part of its current landholdings. It is currently unfarmed and was abandoned in early modern times, by 1579 A.D. (Bolender et al. 2017:36). While it is currently abandoned, it is included as part of SCASS research, rather than FLASH, since it is considered a major farm and not a ruin (Catlin et al. 2017:36). Two 1x1 test pits were dug at Ásgrímsstaðir, but only TP1 yielded any faunal remains. The test pit was placed in the west side of the farm mound, where an early tephra sequence was visible (Bolender et al. 2017:39).

One dog tooth was present at Ásgrímsstaðir, indicating presence of at least one dog on site, though no bones showed evidence of gnawing. The majority of the wild resources discovered at Ásgrímsstaðir are fish, with nine cod elements identified and six from the gadid family. The birds are marine—five guillemot and three puffins. These birds indicate summer acquisition, likely from Drangey, where the birds nest over the summer months. Only one neonatal cattle bone was recorded and the majority of the material recovered was unburnt.

Egg

Egg is located near the southern tip of Hegranes. In AD 1388, it was listed as belonging to the bishopric of Hólar (Steinberg, Damiata, et al. 2016:8). Three test pits were excavated at Egg, but only TP1 contained animal remains. The majority of cultural material was found below the 1104 tephra and the patchy 1000 tephra (Steinberg, Damiata, et al. 2016:37). It appears that this area of the site was not in continual use, and perhaps that it was used early and then abandoned (Steinberg, Damiata, et al. 2016:37).

Few of the bones at Egg were identifiable. Of the 21 total bird bones, just one—a guillemot humerus—was identifiable to species. No bones from neonatal animals were present and one bone showed evidence of rodent gnawing. None of the caprine bones were identifiable as sheep or goat. The bones that were burnt (n=5) were white and completely calcined.

Rein

Rein is an abandoned farm that is currently the property of the modern farm Egg. Historically, the farm belonged to the bishopric of Hólar, and based on documentary records, was first abandoned by AD 1449. It went through several periods of reoccupation and abandonment, before being permanently unoccupied in 1931 (see Bolender et al. 2017:16-23 for a more thorough overview of the site's history and survey results).

Two test pits were excavated at Rein, both focused on areas with evidence of human activity before the AD 1104 tephra (Bolender et al. 2017:21). The first pit, TP1, was shallower and contained fewer faunal remains than TP2. Faunal remains from TP1 only came from one time period, pre-1104. In TP2, there are four distinct periods based on the tephra present. TP2 has material after the AD 1766 tephra, though there was not much from this period. For the purpose of comparison, the four periods have been combined into two—pre and post-1104. In TP2, there are actually three phases after 1104, though they all had low NISP numbers—1104-1300 (NISP 36), 1300-1766 (NISP 48), and post-1766 (NISP 11).

One seal bone was recovered from TP1. None of the birds recovered were identifiable to species. Four gadid family fish elements were identified, with the rest of the fish being unidentifiable beyond "fish." There are neonatal vertebral fragments, likely belonging to a caprine. Most elements are unburnt, but those that are run the spectrum from lightly scorched to completely calcined.

Utanverðunes

Utanverðunes is the most northern farm of Hegranes, extending all the way up to the main road. Its lands include a lake, Nesvatn, and to the east and south of the modern house are boggy areas (Bolender et al. 2017:30). Two test pits were excavated at Utanverðunes, but only TP1 contained faunal remains. This test pit was placed on the northwest of the farm mound, and the upper layers were mixed with gravel and modern refuse from various construction projects (Bolender et al. 2017:32).

This test pit had a distinct burned layer, underneath which the majority of the archaeofauna were retrieved. Most of the bones come from one context, [116], which was collected nearly in its entirety and then wet screened to retrieve all of the small bones. This context was full of mostly bird remains, though some domesticated mammals were also identified. The identifiable bird remains are from seabirds, exclusively puffin (*Fratercula arctica*, n=155) and guillemot (*Uria aalge*, n=43). There are floor layers above this context, as well as the 1104 tephra. Radiocarbon dating from context [109] returned a very early date (Steinberg, personal communication), indicating that all contexts beneath this, including the bird-rich layer, are even earlier, perhaps right at settlement.

Two samples of whale bone were sent for aDNA analysis and a species-level identification was made. One was a humpback whale and the other was sperm whale (Szabo, personal communication). The presence of whale bone fragments does not necessarily mean that people were hunting whales specifically, but often represent scavenged beach finds. Whale bones are large and often used as surfaces, like chopping blocks, or raw material for craft projects. Whales also get stranded and washed ashore, and whoever has legal rights to the whale stranding spot can take its meat.

The presence of such a large quantity of bird bones very close to settlement may indicate exploitation of an abundant wild resource. Frei et al. (2015) suggest that wild resources, mostly walrus, were a driving factor in the colonization of Iceland. In Skagafjörður, there is a small steep-sided island, Drangey, that hosts hundreds of thousands of nesting seabirds every year. It has been called the "food pantry of Skagafjörður" and people have been collecting eggs and birds there for all of recorded history, and likely before that as well. It is possible that the abundance of bird bones we see in this early context at Útanverðunes represent a specialized activity, happening one time, rather than a habitual subsistence practice. This would also indicate a communal hunting endeavor. Further excavation is needed to understand this outlier and is planned for the summer of 2018.

Keta

Keta is located just north of Egg on a dry ridge between two bogs (Bolender et al. 2017:23). The farm mound is located near the modern road, and seems to have been truncated during construction. The test pit here was placed west of the road, where coring indicated that deep soils and pre-1104 midden were preserved intact (Bolender et al. 2017:26). The uppermost layers were disturbed by bulldozing, likely during construction, and only two time periods produced any archaeofauna.

One neonatal caprine and one cattle bone were present. Sheep are born in May, so the presence of this bone, while not positively identified as a sheep, points to human activity at the site in the summer. Most of the bones were unburnt, and none showed evidence of butchery or gnawing by animals. Only three bird bones were identifiable, and all were puffin. Two bones were positively identified as adult sheep.

Hendilkot

Hendilkot is located northwest of the modern farm of Hamar and across the road, and is now part of their landholdings (Figure 2). The site is near a lake, Hendilkotsvatn, and plowing has truncated many of the deposits. Coring and the 1x1 meter test excavation found that most deposits above 1300 AD were affected by plowing. Few tephra were found during excavation, and the phasing is still being sorted out.

The identifiable fish at Hendilkot were cod (n=9) and most of the identifiable birds were puffin (n=3) and guillemot (n=3), indicating use of marine resources. The seabirds are also migratory, present in Iceland only during the summer months. There was one ptarmigan bone, and these birds are present in Iceland year-round. One seal bone was recovered.

There are neonatal cattle elements (n=3) as well as medium terrestrial mammal vertebrae (n=2) that are likely from neonatal caprines. Cattle are born in the spring, so the presence of these neonates indicates springtime activity, while neonatal caprines indicate a summer occupation.

Figure 2: View of the lush green areas of Hendilkot. This land is now owned by the farm of Hamar, and they still grow hay here in the summer.

Næfurstaðir

Næfurstaðir is located on the modern day landholdings of Ás, west of the medieval farm (Catlin et al. 2017:12). The site itself is currently abandoned, and was likely out of use by AD 1104. Investigations here are part of Catlin's focused work on marginal sites, or *fornbýli*. The test pit excavation at Næfurstaðir was a 1x1 meter pit with evidence of human occupation very shortly after settlement. While the name may suggest that goats were kept on the site at some point during its use (Catlin et al. 2017), no goats were present in the archaeofauna.

Catlin (2017:21) identifies three main periods of occupation at Næfurstaðir. There is some evidence of site use after AD 1104, but it is not intensely occupied and was likely just used for animal barns (Figure 3).

The archaeofauna are a mix of wild and domestic mammals, as well as wild birds, fish, and mollusks. Upon settlement of the site and during its first occupational period, the majority of the assemblage is made up of wild resources, especially fish. All identifiable fish were gadids, likely cod or haddock though some saithe were present as well. During its final major occupational phase, a pattern of fewer fish and more mollusks can be seen. There are not many domestic mammals used in any of the occupational phases, though the ones that can be identified are cattle and caprines, and therefore not unexpected. However, a typical farm would be expected to have many more domesticated animals than wild, at least after an initial settlement phase. Since this is not the case at Næfurstaðir, it would seem that the site did not function as a proper farm, but perhaps an outpost or specialized activity area of the main farm of Ás. Summer fieldwork in 2018 will expand this test pit in order to understand its use and relation to the main farm at Ás.

Figure 3: Næfurstaðir during excavation. The white line near the middle of the unit is the AD 1104 tephra. The 1000 tephra is present as a grey-ish line below the 1104, and the ca. 950 tephra is present in the unit, but not visible in this photo. The blue arrow is pointing to the 1000 tephra.

Table 1. Pre-1104 data from all farms except Ríp and Þrælagerði. NISP (Number of Identified Specimens) and TNF (Total Number of Fragments) are both reported.

Pre-1104	Helluland	Ásgrímsstaðir	Egg	Rein		Utanverðunes	Keta	Hendilkot	Næfurstaðir
DOMESTICATES				TP1	TP2				
Bos taurus	0	0	20	0	0	6	2	3	15
Equus caballus	0	1	0	0	0	0	0	0	0
Canis familiaris	0	0	0	0	0	1	0	0	0
Sus scrofa	1	0	0	0	0	0	0	0	0
Ovis aries	4	0	0	0	2	0	2	0	1
Capra hircus	0	0	0	0	0	0	0	0	0
Ovis/Capra sp.	0	1	12	0	0	4	13	22	9
SEALS									
Phocid sp.	0	0	0	1	0	0	0	0	1
CETACEA									
Cetacea sp.	0	0	0	0	0	3	0	0	0
BIRDS									
Wildfowl - sea birds	5	0	1	1	0	198	3	5	5
Wildfowl - land birds	0	0	0	0	0	0	0	1	0
Bird sp.	5	2	16	3	1	291	1	15	9
FISH									
Gadid sp.	2	0	0	0	3	0	0	12	32
Fish sp.indet.	11	0	0	0	9	1	2	29	141
MOLLUSCA									
Mollusca sp.	1	0	0	2	0	0	0	2	45
TOTAL NISP=	**29**	**4**	**49**	**7**	**15**	**504**	**22**	**89**	**259**
Medium Terrestrial Mammal	20	0	5	15	3	27	24	33	54
Large Terrestrial Mammal	4	0	3	3	0	19	9	0	12
Unidentified Frags	47	0	22	10	9	333	32	265	113
TOTAL TNF=	100	4	79	**35**	**27**	**883**	**87**	**387**	**496**

Table 2: Post-1104 data from all farms with a post-1104 component. Fornbýli are mostly abandoned by this time, and only TP2 at Rein contained material post-dating 1104.

Post-1104	**Ásgrímsstaðir**	**Rein TP2**	**Utanverðunes**	**Keta**	**Hendilkot**	**Næfurstaðir**
DOMESTICATES						
Bos taurus	5	1	1	0	2	0
Equus caballus	0	1	0	0	0	0
Canis familiaris	1	0	0	0	0	0
Ovis aries	3	1	0	0	0	0
Capra hircus	0	0	0	0	0	0
Ovis/Capra sp.	19	8	1	1	1	4
SEALS						
Phocid sp.	0	0	0	0	1	0
BIRDS						
Sea birds	8	1	0	0	1	1
Bird sp.	5	8	0	3	3	4
FISH						
Gadid sp.	15	1	0	0	0	0
Fish sp.indet.	22	65	0	0	11	0
MOLLUSCA						
Mollusca sp.	0	9	0	0	0	8
TOTAL NISP=	**78**	**95**	**2**	**4**	**19**	**17**
Small Terrestrial Mammal	1	0	0	0	0	0
Medium Terrestrial Mammal	52	29	1	10	38	16
Large Terrestrial Mammal	14	0	3	0	8	1
Unidentified	66	195	19	15	144	24
TOTAL TNF=	211	319	25	**29**	**209**	**58**

Ríp

Ríp is one of the largest farms on Hegranes. Multiple test pits were excavated, but only one yielded faunal material that is included in this analysis. Unfortunately, the tephra sequence in TP1 was not very clear, and the only time periods that can be separated are pre- or post-AD 1766.

Table 3: TNF and NISP for TP1 from Ríp.

	Post 1766	Pre 1766	Total
DOMESTICATES			
Bos taurus	0	20	20
Equus caballus	0	1	1
Ovis aries	0	3	3
Capra hircus	0	0	0
Ovis/Capra sp.	7	38	45
BIRDS			
Wildfowl - sea birds	0	4	4
Bird sp.	0	2	2
FISH			
Gadid sp.	0	1	1
Fish sp.indet.	2	3	5
TOTAL NISP=	**9**	**72**	**81**
Small Terrestrial Mammal	0	4	4
Medium Terrestrial Mammal	6	76	82
Large Terrestrial Mammal	1	15	16
Unidentified	2	55	57
TOTAL TNF=	**18**	**222**	**240**

The birds identified at Ríp were all puffin (*Fratercula arctica*). Some of the cattle elements (n=7) were from neonates, indicating a spring occupation and possibly a cattle management strategy aimed at dairy production.

Þrælagerði

Þrælagerði is located on land currently owned by Keflavík, but it is also quite close to Útanverðunes. Historical documents say that the site has never been occupied (Catlin et al. 2017:61), though its name may suggest an area where thralls lived or worked. The nearby bog seems to have been cut for peat at some point in the past.

The test pit here was placed based on a core that showed a dark, charcoal-rich midden layer. There was a large rock in the unit that took up most of one corner, but it was placed on top of the midden deposit. Unfortunately, due to its size, the rock was not removed during excavation and the material underneath it was not recovered. The tephra layers were unclear, but I have used Catlin et al.'s (2017:66) estimation for the three analytical phases here.

Table 4: TNF and NISP for Þrælagerði.

	Post 1000	**~1000**	**Pre ~950**	**Total**
DOMESTICATES				
Bos taurus	0	0	2	2
Ovis aries	0	1	0	1
Capra hircus	0	0	0	0
Ovis/Capra sp.	0	3	0	3
WILD MAMMALS				
Alopex lagopus	0	0	1	1
BIRDS				
Wildfowl - sea birds	1	5	17	23
Bird sp.	3	9	15	27
FISH				
Gadid sp.	0	0	9	9
Fish sp.indet.	0	0	29	29
TOTAL NISP=	**4**	**18**	**73**	**95**
Small Terrestrial Mammal	0	0	0	0
Medium Terrestrial Mammal	2	1	18	21
Large Terrestrial Mammal		1	3	4
Unidentified	5	11	30	46
TOTAL TNF=	**11**	**31**	**124**	**166**

The fox bone is from a neonate. This could indicate preventative hunting of kits before they leave the dens in order to protect some other wild resource. In Mývatn, this is a common practice to protect the local nesting duck colonies (McGovern, personal communication). It is unclear if ducks or other ground nesting birds were present in the vicinity of this site in the past, though in the present there are not large nesting grounds nearby. No land birds were present in the assemblage and no eggshell was found in this small excavation, so more research is needed to understand if this was a strategy for the sustainability of another wild resource.

The identifiable birds were all puffin (n=23), indicating summer harvesting from their nesting cliffs. The majority of the bones are unburned; however, of the burned bones, most are completely calcined. This is evidence of being in a very hot fire for a long period of time, perhaps as a processing strategy for bone grease.

Figure 4: CMD work in a potential structure at Þrælagerði in 2017. In the background, you can see an eroded outcrop of bedrock.

General Patterns/Observations

While the sample sizes from these test pits are too small for any major conclusions to be drawn, some patterns have emerged that warrant further discussion and future excavation. The first and most obvious pattern from the archaeofauna is the difference in wild versus domestic resources used at a site. Small, abandoned sites seem to use more wild resources, while large farms use more domesticates. Figure 5 below shows which percentage of the assemblage is wild and which is domestic based on NISP.

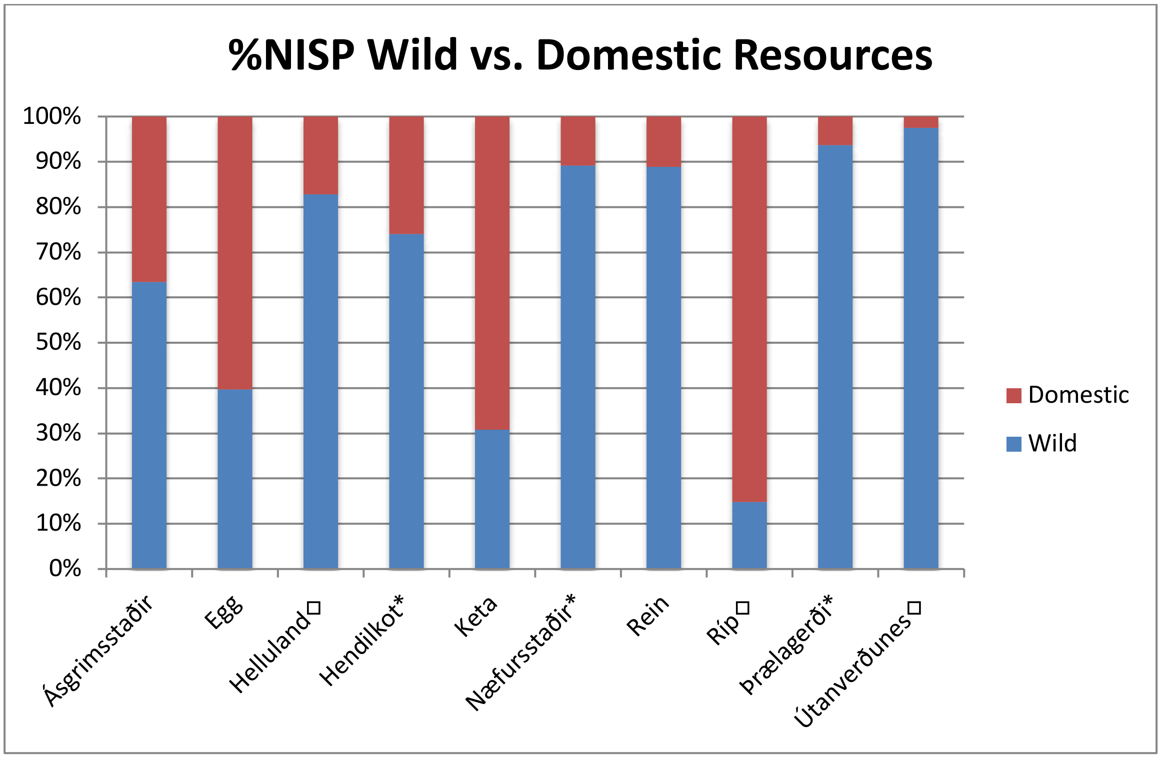

Figure 5: Graph showing percent of wild versus domestic resources present at each site. Sites with a diamond (◇) after their name are historically known to have had churches. Sites with an asterisk (*) are *fornbýli*.

The major outlier is Útanverðunes, a large farm that is currently occupied, and that has over 97% of its NISP from wild resources. The most likely explanation for this is that TP1 was placed in a specialized activity area for bird processing, rather than in the proper farm midden. Further excavations are planned in the summer of 2018 in order to understand animal resource use and human activities at this site.

Further, looking at just the wild resources (Figure 6) shows another difference between sites. Again excluding Útanverðunes as an outlier, we can see that some sites focus on fish, like Næfurstaðir, Ásgrímsstaðir, and Rein, while others have a more even mix of fish and birds. Very few sites used sea mammals, and mollusks do not make up a large proportion of any assemblage either, though they are present in the highest quantities at Næfurstaðir.

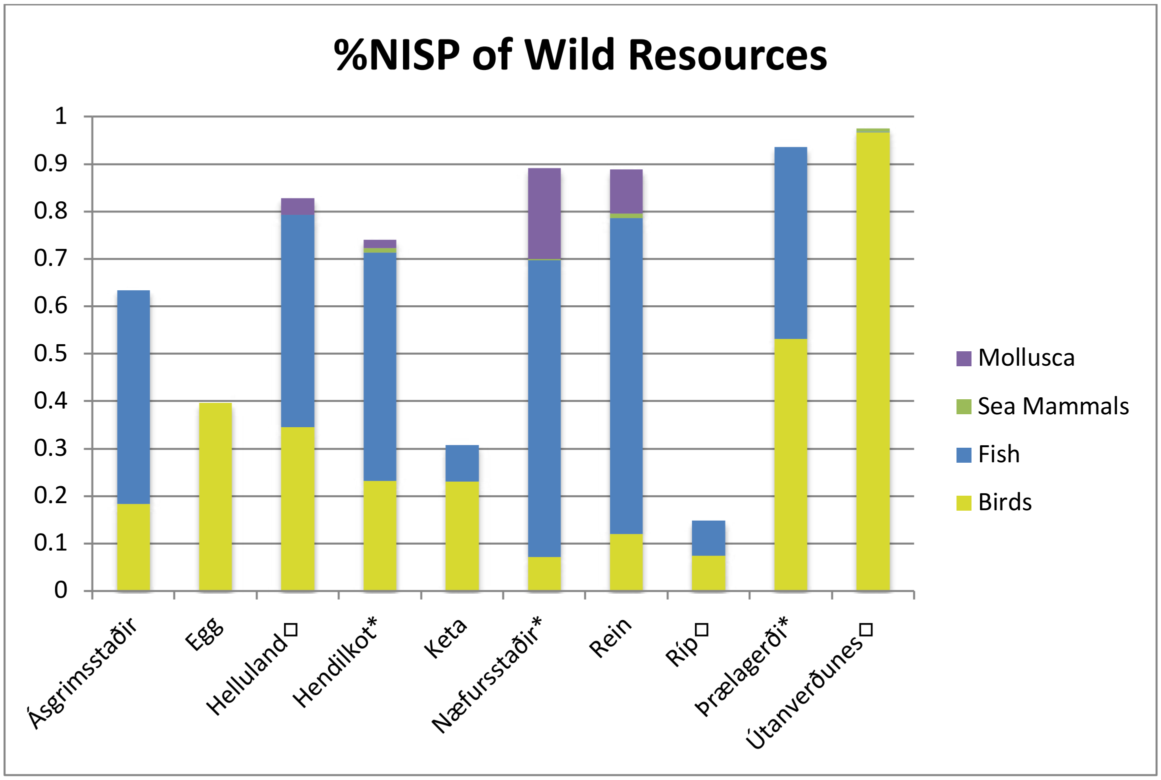

Figure 6: Graph showing the breakdown of types of wild resources by site. Sites with a diamond (◇) after their name are historically known to have had churches. Sites with an asterisk (*) are *fornbýli*.

Conclusions

Again, it is important to remember that samples sizes here are small. None of the observations discussed above can be proven with the data at hand. However, the patterns seen here do warrant further investigation. One of the major questions we have is why the small sites fall out of use all at once, around AD 1104. What were the social, environmental, and/or political factors at play during this time that might have affected the longevity of sites? The relationships of the small sites to the larger farms is unclear, and continued research, including zooarchaeological analyses, will help to understand the complex interactions at play on the landscape.

Acknowledgements

Thanks go out to all of the farmers on Hegranes for granting us permission to work on their land. Thanks also to Guðný, Sirrí, and Bryndís from the Skagafjörður Heritage Museum for their help, support, and friendship. To Doug Bolender and John Steinberg for continuing to trust me with fieldwork and archaeofauna. The 2016 field crew was amazing and their efforts are much appreciated.

This fieldwork was supported by the US National Science Foundation (PLR # 1523025, 1242829, 1345066, & 1417772) in a joint project of the Skagafjörður Heritage Museum (Byggðasafn Skagfirðinga), the University of Massachusetts Boston, and Northwestern University. Analysis was supported by the National Science Foundation Graduate Research Fellowship Program grant no. DGE-1037525. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author and do not necessarily reflect the views of the National Science Foundation.

As always, Thomas McGovern gets my thanks for productive conversations about interpreting the data and enthusiastic support during the whole process.

NABO

Skagafjörður Church and Settlement Survey: Final Report on the Archaeofauna from Grænagerði, Hegranes, Skagafjörður

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CUNY NORSEC Laboratory Report No. 70
BSK 2018- / SCASS-2019-26

Introduction and Excavations

For the past four years, the Skagafjörður Church and Settlement Survey (SCASS) has been exploring the settlement pattern on Hegranes, in Skagafjörður (Figure 1) (e.g., Bolender et al. 2016, 2017; Steinberg et al. 2016). In tandem with SCASS, the Fornbýli Landscape and Archaeological Survey on Hegranes (FLASH) has focused on the small marginal sites on Hegranes (Catlin et al. 2017, 2018). Grænagerði (Figure 2) is one of these marginal sites, formerly part of the land claims of Helluland, but now on a separate piece of property called Hulduland (Catlin et al. 2018:60).

The first coring at Grænagerði took place in 2015 and found a charcoal-rich midden. In 2017, more coring was done to secure a location for the 1x1 meter test pit. This test pit contained midden material (bones, finds, charcoal) underneath the AD 1104 tephra and no cultural material above the tephra layer. This indicates that the site was no longer used for extensive human occupation after AD 1104, similar to the nearby *fornbýli* site of Kotið (Catlin et al. 2017, 2018; Cesario 2018a). In 2018, the original test pit was used as the northwest corner of a new excavation, which covered 2x2 meters (Ritchey and Cesario 2018). The archaeofauna from both test pits is reported on here.

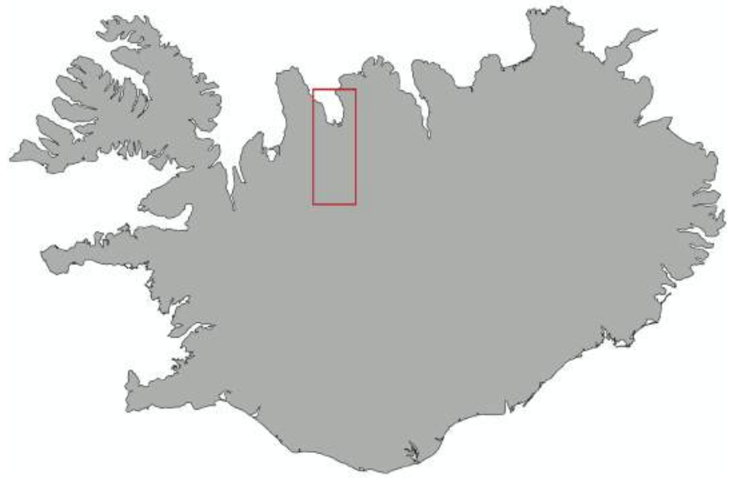

Figure 1: Map of Iceland. Skagafjörður is outlined in the red box.

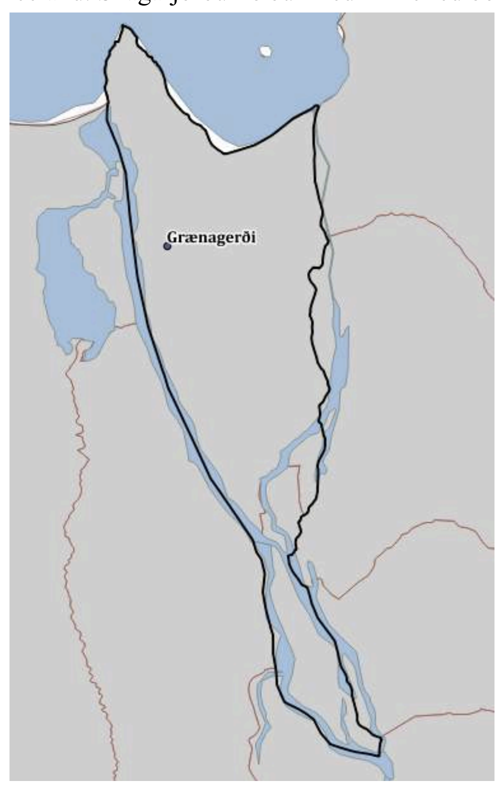

Figure 72: Location of Grænagerði on Hegranes.

Methods

The faunal materials were analyzed at the Hunter College Zooarchaeology Laboratory, and made use of the comparative collection there. The 2018 material was analyzed in Iceland, at Fornleifastofnun Íslands (FSÍ) and using the comparative collection housed at the Agricultural College in Keldnaholt as well as the Natural History Museum in Garðabær. Recording and data curation follow NABONE protocols, utilizing the 9th edition of this recording package (a Microsoft Access database supplemented with specialized Microsoft Excel spreadsheets, available to download at www.nabohome.org). Digital records were all made using this package. The animal bones excavated will be permanently curated at the National Museum of Iceland along with all digital records. Digital records will also be preserved in the NABO collection on The Digital Archaeological Record (tDAR).

An electronic copy of this report is available at www.nabohome.org and at the UMB SCASS website/Fiske Center site.

All fragments were identified as far as taxonomically possible, and a selected element approach was not used. Most mammal ribs, vertebrae, and long bone shaft fragments were assigned to "Large Terrestrial Mammal" (cattle or horse sized), "Medium Terrestrial Mammal" (sheep, goat, pig, or large dog sized), and "Small Terrestrial Mammal" (fox or small dog sized). Only those elements that could be positively identified as sheep, *Ovis aries*, or goat, *Capra hircus*, were assigned to these categories while all other sheep/goat elements were assigned to a more general "caprine" category.

Following widespread North Atlantic tradition, bone fragment quantification makes use of the Number of Identified Specimens (NISP) method (Grayson 1984). All mammal measurements follow von den Driesch (1976). Sheep/goat distinctions follow Boessneck (1969), Mainland and Halstead (2005), and (Zeder and Lapham (2010). Only positively identified fragments of fish bone were given species level identification, with those unidentifiable to species placed in the family category where possible, often *gadid*, while others were identified simply as fish. No fish bones from this collection required measurement. Long bone fusion stage calibrations follow Zeder (2006) and presentation of age reconstruction makes use of Enghoff (2003) and McGovern (2009).

The Archaeofauna

The analytical units for this excavation have been separated by time period. Volcanic tephra observed during excavation was used to date the deposits, and carbonized seeds recovered through flotation have been sent for radiocarbon dating in order to get more precise dates. Table 1 below presents the NISP and TNF for all phases at Grænagerði. Phase I is AD 871-1000 and is capped by the dark grey 1000 tephra. Phase II is the period AD 1000-1104 and ends at the white AD 1104 tephra. The 1000 tephra was not continuous across the entire excavation, and therefore the "unphased" column includes fauna from the contexts that cannot be phased (though radiocarbon dates are forthcoming), though it is all pre-1104. The site was mostly abandoned for human activities by AD 1104 and there was only one context above the 1104 tephra. The post-1104 material has a very small NISP and will not be discussed in detail here.

Taphonomy

Various taphonomic factors can affect bones. Here, four measures of taphonomic effects will be explored to help characterize the entire archaeofaunal assemblage. The taphonomy is discussed in terms of the assemblage as a whole, using the Total Number of Fragments (TNF). Using the whole assemblage for taphonomic analysis, rather than just the identified bones (NISP), gives us a better picture of what happened to the entire assemblage.

Table 1: NISP and TNF for Grænagerði archaeofauna. Total NISP for all phases is 3,273. Note that the Post-1104 material will not be discussed in this report so the NISP for analysis is 3,243.

Phase	**I**	**II**	**Unphased**	**Post-1104**	**Total**
Domesticates					
Bos taurus	7	64	44	4	119
Equus caballus	1	0	3	0	4
Canis familiaris	0	2	0	0	2
Sus scrofa	2	39	7	3	51
Ovis aries	5	49	10	3	67
Capra hircus	0	0	0	0	0
Ovis/Capra sp.	47	235	79	10	371
SEA MAMMALS					
Phoca vitulina	0	1	0	0	1
Cetacea sp.	0	1	0	0	1
OTHER MAMMALS					
Alopex lagopus	0	1	0	0	1
BIRDS					
Wildfowl - sea birds	155	22	377	1	555
Wildfowl - land birds	1	3	0	0	4
Bird sp.	50	78	157	0	285
FISH					
Gadid sp.	70	1,013	306	9	1,398
Salmonid sp.	0	1	0	0	1
Other Fish	0	7	0	0	7
Fish sp.indet.	4	247	28	0	279
MOLLUSCA					
Mollusca sp.	9	68	42	0	119
GASTROPODS					
Snail sp.	0	5	3	0	8
TOTAL NISP (Identified fragments) =	**351**	**1,836**	**1,056**	**30**	**3,273**
Small Terrestrial Mammal	0	6	3	0	9
Medium Terrestrial Mammal	76	442	165	35	718
Large Terrestrial Mammal	16	116	52	11	195
Unident. Mammal Frags	290	3,171	1,483	43	4,987
TOTAL TNF (all fragments)	**733**	**5,571**	**2,759**	**119**	**9,182**

Fragment Size

Size of a bone can affect its identification rate. Larger bone fragments are often much easier to identify than smaller, more broken pieces. Some animals, however, have smaller bones that can be recovered whole and identified at a higher rate than broken fragments of a large mammal bone. At Grænagerði, the majority of the bones are in the 1-2 cm and 2-5 cm categories in both phases (Figure 3). Most of the pieces under 1 cm are unidentifiable.

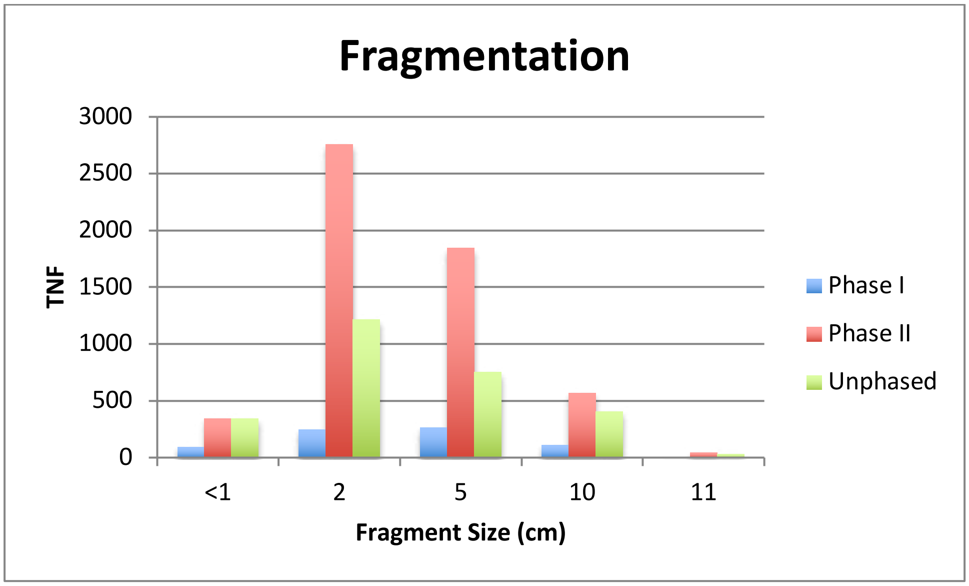

Figure 3: Fragmentation

Burning

As Figure 4 below shows, most of the bones from Grænagerði were unburned. The majority of those that were burned are completely calcined, the "white" category. This indicates a very hot fire. The midden layers at Grænagerði were dark and mostly charcoal-based with little to no peat (Catlin et al. 2018). This darker charcoal midden may indicate that more wood was being burned at the site rather than peat. The white burned bones could have been included in this and burned as fuel, then eventually deposited into the midden during a cleaning event. Another interpretation for white-burned bone in the Viking Age is that people would have disposed of their food waste in the long fire in the middle of the house, then during cleaning of the fire pit, calcined bone fragments mixed with wood charcoal and fire cracked rocks are disposed of in the midden (Thomas McGovern, personal communication).

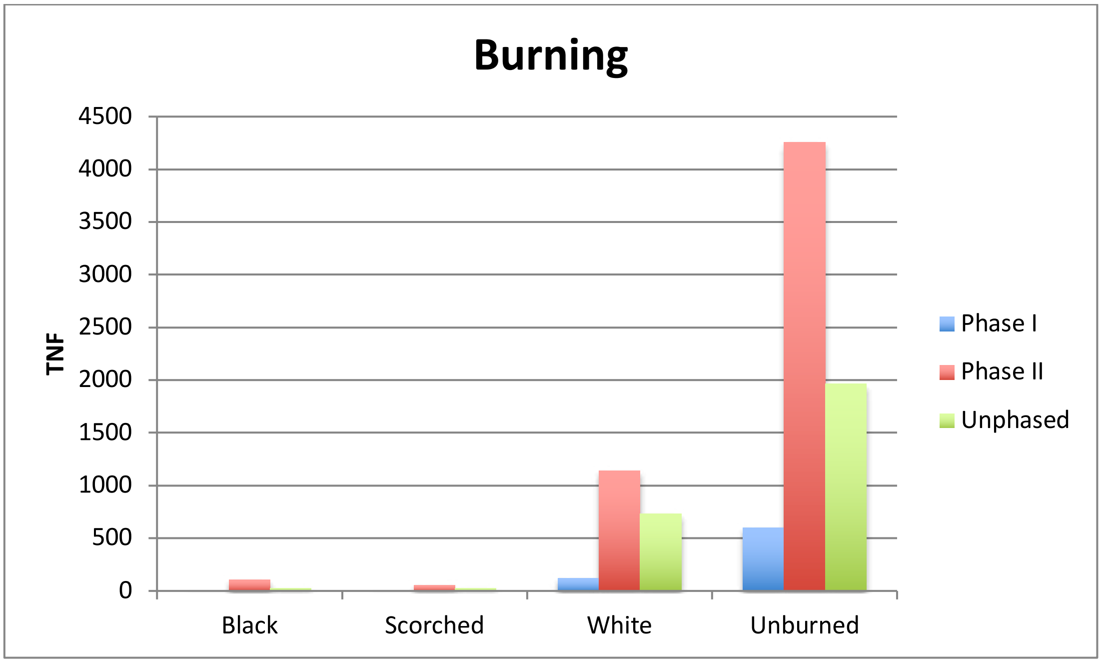

Figure 4: Burned bones at Grænagerði

<u>Gnawing</u>

Dogs gnawed nine total bones in the Grænagerði archaeofauna. Two bones in Phase I and seven in Phase II showed evidence of gnawing. All of the gnawed bones were either caprine or small-medium terrestrial mammal, which are also likely to be caprine based on size. These gnawed bones indicate the presence of dogs on site, even though no dog remains were recovered.

<u>Butchery</u>

Most bones did not show evidence of butchery (Figure 5). More bones in Phase II had knife cutmarks, and more bones in Phase I showed evidence of being chopped.

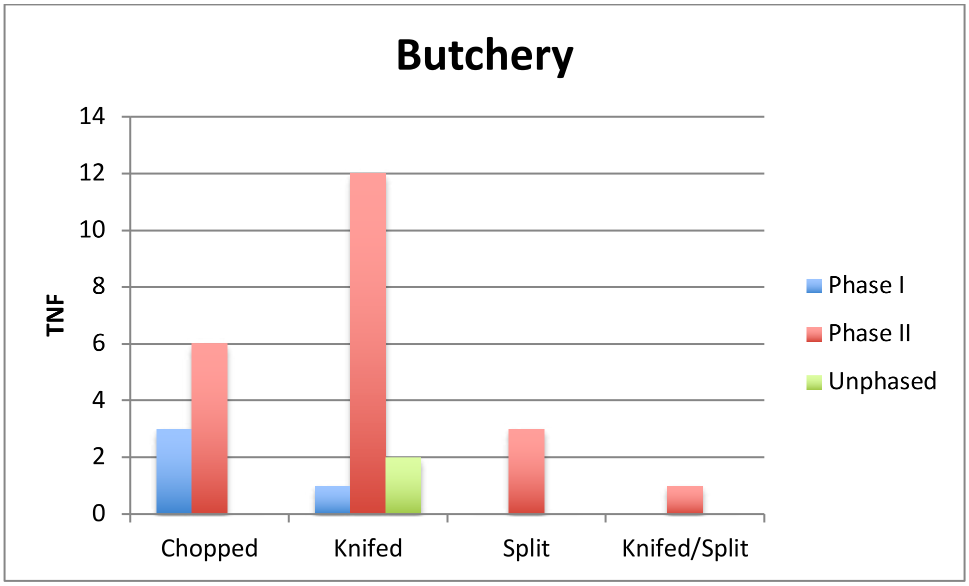

Figure 5: Butchery patterns at Grænagerði

Major Taxa

Figure 6 below shows the major taxa present in the Grænagerði assemblage based on NISP. In Phase I and the unphased material, birds dominate the assemblage at nearly 60% and 50% of the total NISP, respectively. Most of these birds were waterfowl, but see "Bird" section below for more discussion. Domesticates make up less than 50% of the assemblage in all phases, but the number kept in Phase II has more than doubled from Phase I. In addition to an increased domesticate focus, Phase II also sees a heavier reliance on fish, which more than double in Phase II while bird exploitation decreases dramatically. The rest of the assemblage contains small amounts of mollusks and sea mammals. The next sections will discuss these major taxa in more depth in order to understand the activities taking place at Grænagerði.

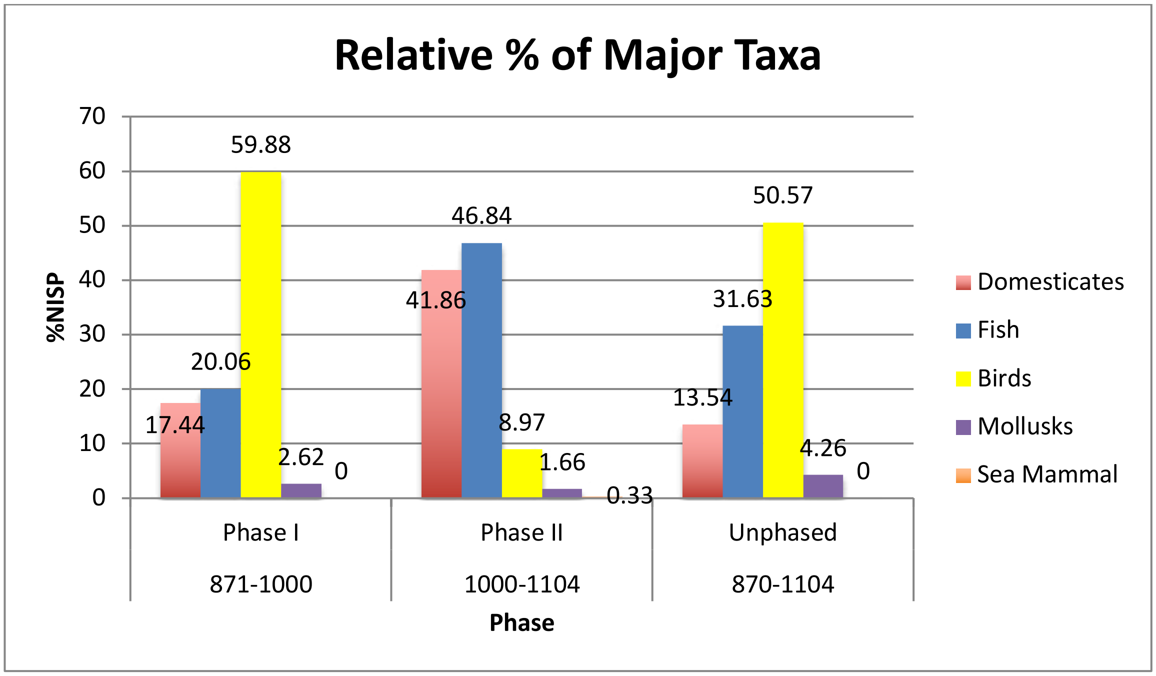

Figure 6: Relative percent of major taxa in all phases at Grænagerði

Caprines

The caprine category includes both sheep and goats. It can be quite difficult to distinguish between the two, especially on phalanges and long bone shafts. However, the ends of many long bones have diagnostic features allowing the identification of sheep or goat (see Boessneck [1969], Mainland and Halstead [2005], and Zeder and Lapham [2010] for a list of elements and their distinguishing features). These distinguishing bones are generally quite dense and preserve well in the archaeological record.

In the Grænagerði archaeofauna, no bones were positively identified as goat. Previous zooarchaeological analyses have shown that goats are uncommon in Skagafjörður (Aaris-Sørensen et al. 2006; Cesario 2016, 2018a, 2018c; Hicks 2016); however, they are not altogether absent from the region (Cesario 2019a).

Element Distribution

The caprine elements present in the Grænagerði archaeofauna are from the entire skeleton (Figure 7). The lack of vertebrae and ribs for the unphased material in Figure 7 is likely due to the NABONE protocol of identifying these elements to size categories (see Methods section above) rather than the bones actually being missing from the archaeofauna.

The presence of elements from the entire skeleton indicates a home butchery strategy, where the inhabitants at Grænagerði were sustaining themselves. There is no evidence for extra body parts coming into the site, which would suggest that they were being provisioned from elsewhere, nor is there evidence of specific body parts leaving the site, which would indicate that they were provisioning others.

In Phase I, there is a much higher percentage of lower hindlimb and hindquarter elements than any other elements in the same phase. More cranial elements are present in Phase II than we see in Phase I, and there are more cranial elements than any other element in Phase II.

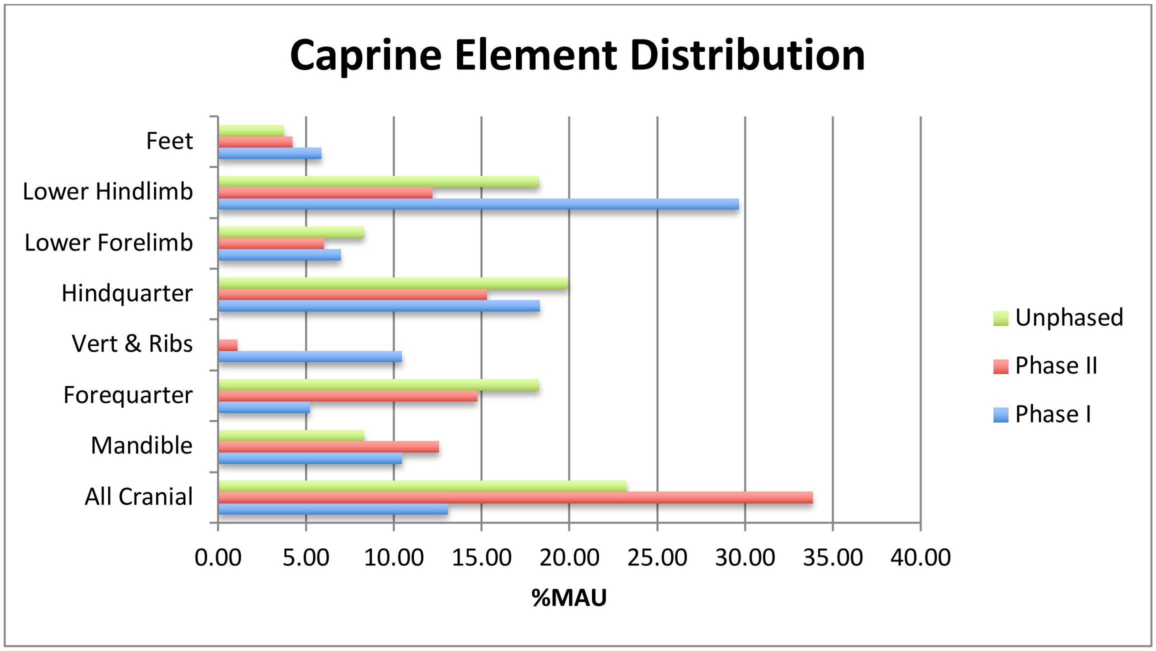

Figure 7: Caprine element distribution for both phases at Grænagerði

Caprine Age Profile

Tooth Eruption and Wear

Mandible fragments and loose teeth were recovered, and 13 mandibles with teeth present in the jaw for aging were available for this collection.

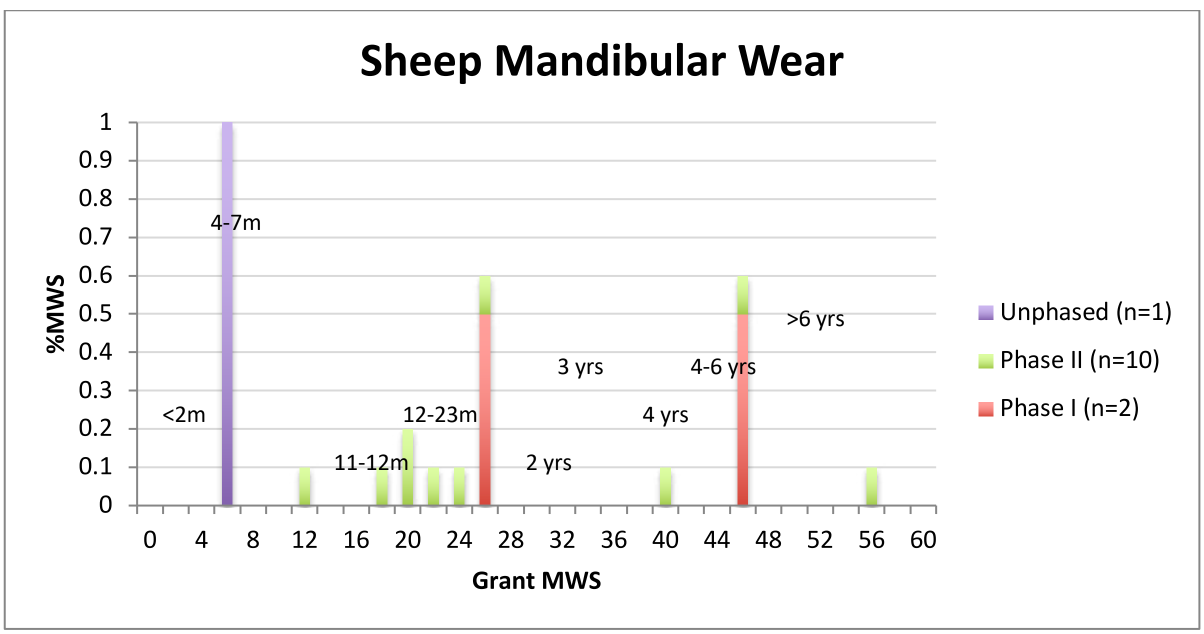

Figure 8: Sheep mandibular wear states. Graph based on McGovern 2009:225 (Figure 4.23) and mandibular wear stage calculations follow Grant 1982.

Figure 8 above shows that this assemblage has both younger and older individuals. However, the small sample size (n=13) is not enough to fully understand the herding strategy at Grænagerði. However; there is a springtime signature, with individuals being culled around one year of age. This pattern also looks like a relatively normal multi-use Viking Age caprine strategy where the herd is being used for multiple products—milk, meat, and wool. The older individuals especially point to use as wool-producers. Along with the cattle to caprine ratios (see Figure 9), this points to non-surplus wool production, likely only for household use.

Long Bone Fusion Stages

Most long bones could not be scored for fusion. In Phase I, one unfused distal tibia indicates an individual less than two years of age, while two fused distal tibiae come from animals over two years old. A fused distal femur comes from an animal over about 3.5 years old (McGovern 2009:226). In Phase II, an unfused distal humerus comes from a neonate, less than 6 months of age. An unfused distal femur indicates an animal under 3.5 years of age while two fused distal tibiae represent animals over two years old (McGovern 2009:226).

Neonates

Neonatal caprines were present in all phases. Phase I had 12 elements identified, while Phase II had five neonates and one fetal element present. The unphased material only included one neonatal bone. The presence of these neonates indicates a dairying strategy, as babies need to be culled to collect milk for human consumption. It also indicates site occupation during the late spring/early summer, since lambs are generally born in May.

The long bone fusion data presented above suggests that the age profile remains relatively stable through the phases, so the herding strategy likely remains the same or similar, with a mixed meat/milk/wool strategy, perhaps leaning more heavily on one than the others over time but not to such a degree that it is visible in the archaeological record.

Cattle to Caprine Ratios

In Iceland, there is a general increase in caprine use over time, especially as sheep gain importance for export of the standardized woolen cloth *vaðmál* as well as remaining a vital part of Icelandic household economy. The tradeoff seems to be that fewer cattle are kept in favor of increasing the number of sheep that can be raised.

At Grænagerði, this is not the case. While there are increased numbers of caprines, the majority of which are likely sheep, in Phase II, the ratio does not change in favor of more caprines. In Phase I, the cattle to caprine ratio is 7.43, so for every head of cattle there are 7.43 caprines (Figure 9). In Phase II, this ratio drops to 4.44. With the increased importance of caprines over time, we might expect that the ratio would increase, as we see with later phases at other sites like Vatnskot. However, we see something similar happen at Stóra-Seyla, located inland in Skagafjörður, where caprine use decreases after the initial phase, in this case between 950-1000, and then increases again in later phases.

Phase I at Grænagerði is most similar to Stóra-Seyla (SK104) in 1000-1104. They seem to be keeping more caprines relative to cattle than anyone else on Hegranes during the same time period. The Phase II decrease looks more similar to Phase I at Vatnskot or the 950-1000 time period at Stóra-Seyla. Both ratios at Grænagerði seem to be well within the range seen in Viking

Age Iceland, though the decreased ratio in Phase II does not follow the general pattern of increased caprine use over time. Phase I is on the higher end of this range, with only mid-10th-early 11th century Skuggi (SKÖ, Figure 9) having a higher ratio.

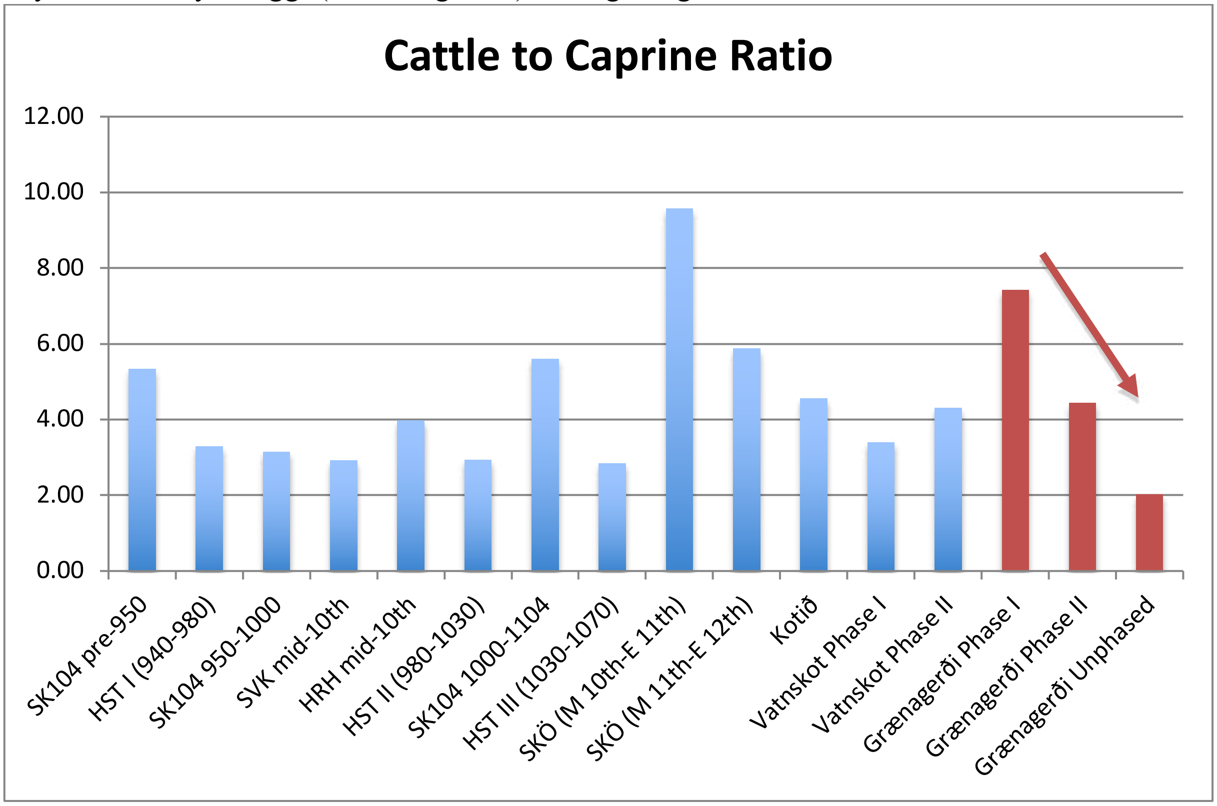

Figure 9: Cattle to caprine ratios throughout Iceland. Grænagerði is highlighted in red. Other sites in Skagafjörður include SK104 (Stóra-Seyla), Kotið, and Vatnskot. As comparisons, we have Skuggi (SKÖ) in neighboring Eyjafjörður and in Mývatnssveit we have Hofstaðir (HST), Sveigakot (SVK), and Hrísheimar (HRH).

Cattle

The number of cattle at Grænagerði increases in Phase II along with the increased use of domesticates overall (Figure 10).

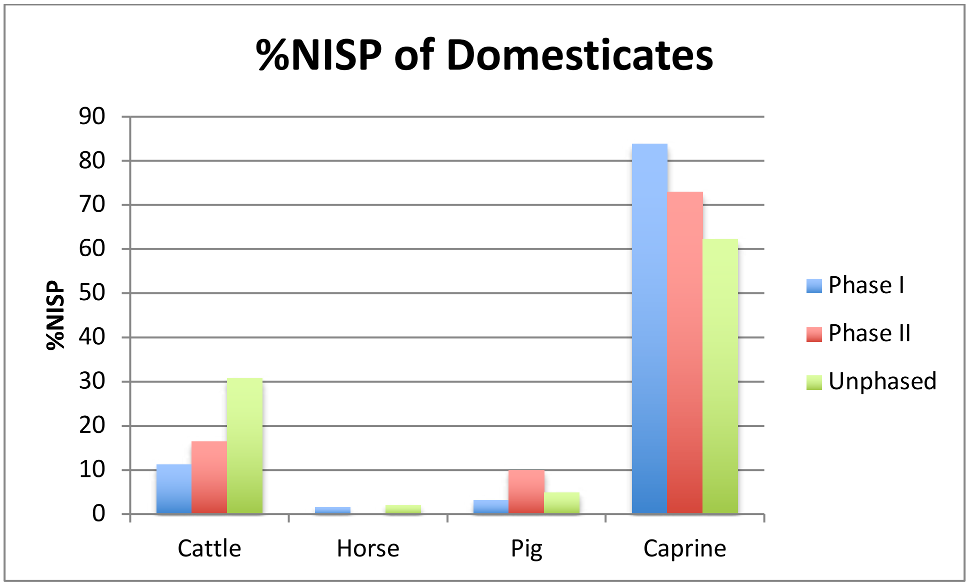

Figure 10: Relative %NISP of domesticates.

Cattle Age Profile

No mandibles with teeth present were recovered and so an age profile based on tooth eruption and wear is not possible. In addition, most long bones could not be scored for fusion, with the exception of one distal femur from Phase II that was unfused. This points to an animal under 3.5-4 years of age at death (McGovern 2009:221).

<u>Neonates</u>

Neonatal cattle were uncommon in both phases. In Phase I, a single third phalanx from a neonate was present. In Phase II, there were six neonatal elements. The unphased material contains two neonatal phalanges. The presence of these young individuals on site points to a springtime occupation, as that is when cattle are traditionally born. It also is a signature of dairy production, as babies would need to be culled in order to collect milk for human use and consumption.

Other Mammals

Other mammals present on the site are a mix of domesticates and wild animals. Pigs are present in both phases, with two in Phase I and 39 in Phase II. Pigs are not common in the archaeological record after about 1100, and it is interesting that the number increases in Phase II. Most of the elements from Phase II are teeth and fragments of mandibles and maxillae, though there are axial elements present as well. Other domesticate bones include a horse molar in Phase I and two dog mandible fragments.

Wild animals were only represented in Phase II. One arctic fox (*Alopex lagopus*) bone was identified, while the others were sea mammals. One unidentifiable whale bone was found as well as one harbor seal (*Phoca vitulina*) tooth.

Mollusks and Gastropods

The mollusks from Grænagerði are shown in Figure 11 below. Phase I has the fewest mollusks, at nine total. This was also the only phase where mussels were identified. Phase II has the highest number of mollusks, and those that were identifiable were clams. These shellfish only make up between 2.62 and 4.26 percent of the archaeofauna from any phase, and therefore did not contribute heavily to the economic strategy at Grænagerði. It is possible that they were collected for food or perhaps for bait, though no tool marks were present on the shells. Shellfish are generally quite easy to collect, and nearly anyone can do it, so they may represent a part-time activity on the shore while fishing or other ventures are also taking place. However, if the clams are *Arctica islandica*, they may be coming from deep water and are more likely to be collected from the beach without meat inside, and therefore not used as bait. These shells are used ethnographically as spoons or scoops, and so this could be another explanation for their presence in the assemblage.

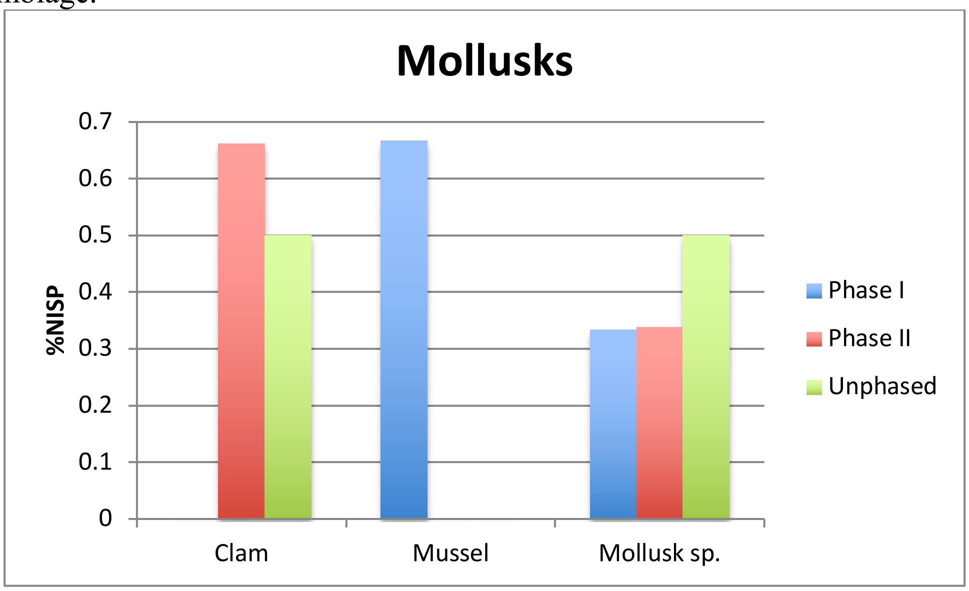

Figure 11: %NISP of mollusks

Gastropods were also found at Grænagerði. These are likely land snails, but a species-level identification has not been made. There were five in Phase II and three in the unphased material.

Birds

Birds are the most common taxa from Grænagerði in Phase I, making up nearly 60% of the assemblage (Figure 6). They drop off to just 9% of the archaeofauna in Phase II. They represent just over 50% of the archaeofauna from the unphased material.

Table 2 below shows all of the birds from Grænagerði. Phase I birds are mostly seabirds—150 guillemot (*Uria aalge*) and 5 puffins (*Fratercula arctica*). There was also 1 ptarmigan (*Lagopus muta*), and 50 unidentifiable birds. Seabirds represent a rich resource in Skagafjörður, as there are good nesting areas in the fjord for them. Seabirds like puffins and guillemot nest on cliffs, and Drangey, a steep-sided island in the fjord, hosts tens of thousands of mating pairs of these birds and others every year. They also represent a communal harvesting strategy, as their collection is dangerous and requires teamwork.

Phase II birds include guillemot and puffin as well as European Golden Plover and ptarmigan. However, the majority are unidentifiable birds. The unphased material is made up of mostly seabirds, and again guillemot make up the highest percentage of these. No identifiable land birds were present in the unphased material.

Table 2: Birds in all phases at Grænagerði.

		I	II	Unphased	Total
Seabirds					
Uria aalge	Guillemot	150	14	316	481
Fratercula arctica	Puffin	5	6	57	68
Alca torda	Razorbill	0	0	1	
Gull sp.	Unidentified gull species	0	2	3	5
Land Birds					
Lagopus muta	Ptarmigan	1	2	0	3
Pluvialis apricaria	European Golden Plover	0	1	0	1
Unidentifiable birds		50	78	157	285
Total		206	103	534	843

Fish

While most of the fish in the Grænagerði archaeofauna are marine, one char (*Salvelinus alpinus*) vertebra was identified (Table 3). Most marine fish were from the gadidae family, with a few Atlantic wolffish (*Anarhichas lupus*) in Phase II.

Phase I Fish

The total NISP for Phase I fish is 74 (Table 3). All of the identifiable fish were gadids, mostly cod. However, two torsk (*Brosme brosme*) elements were identified. Element distributions (Figure 12) indicate that the head parts are more common than those from the rest of the body, and analysis of the vertebrae (Figure 13) has shown that thoracic vertebrae are more common than either precaudal or caudal. This pattern is typical of the production of a flat-dried fish product, as will be discussed further below. There is still evidence of whole fish being consumed, as can be seen through the presence of some precaudal and caudal vertebrae that remained on site.

Table 3: Fish NISP by phase at Grænagerði.

Phase		I	II	Unphased	Total
Marine					
Gadus morhua	Atlantic cod	14	330	104	448
Brosme brosme	Torsk	2	0	0	2
Melanogrammus aeglefinus	Haddock	0	15	3	18
Molva molva	Ling	0	1	2	3
Gadidae	Gadid family	54	667	197	918
Anarhichas lupus	Atlantic wolffish	0	7	0	7
Freshwater					
Salvelinus alpinus	Arctic char	0	1	0	1
Unidentified fish		4	247	28	279
Total		74	1,268	334	1,676

Phase II Fish

The total NISP for Phase II fish is much higher than that of Phase I at 1,268 (Table 3). A pattern of mostly cod is present in this phase as well, though other gadids include haddock and ling. There were also seven elements of Atlantic wolf fish, which is likely a bycatch from the cod fishing process. This is the only phase that had a freshwater fish, with one char vertebra identified. Element distributions (Figure 12) and vertebral series (Figure 13) indicate the same pattern of the production of a flat-dried fish product and some whole fish consumption as in Phase I.

Unphased Fish

The unphased fish follow the overall species diversity and element patterning that we see in Phase I and II. The NISP of 334 is higher than that in Phase I (Table 3). There is a preponderance of heads in relation to elements from the rest of the body (Figure 12), just like the other two phases. There is a slightly more even distribution of vertebrae (Figure 13), which could point to some fresh fish being eaten on site.

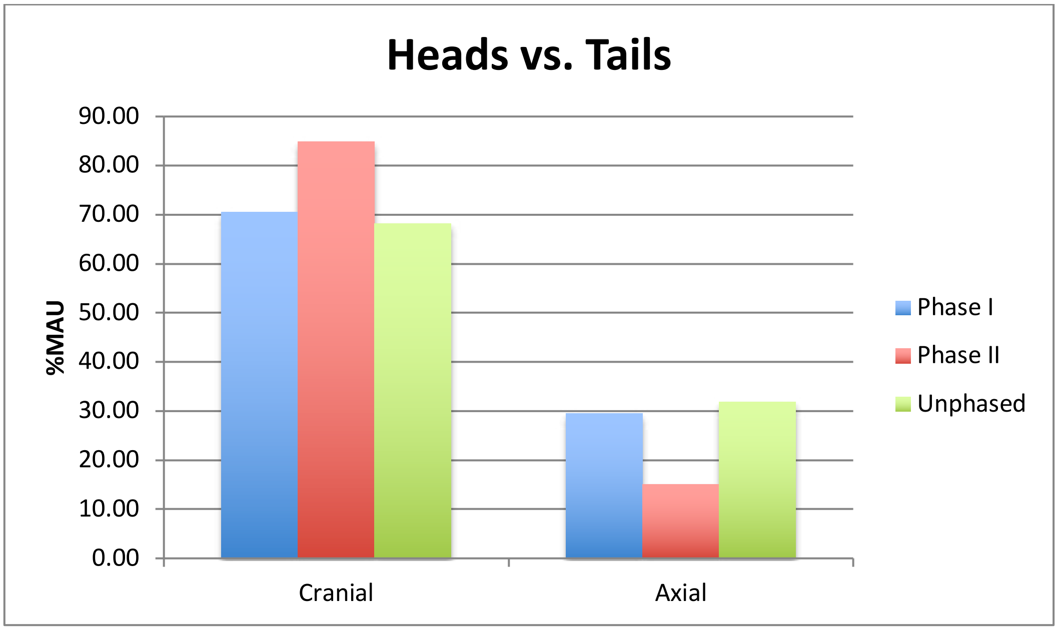

Figure 12: %MAU of cranial elements vs axial in all gadids for all phases

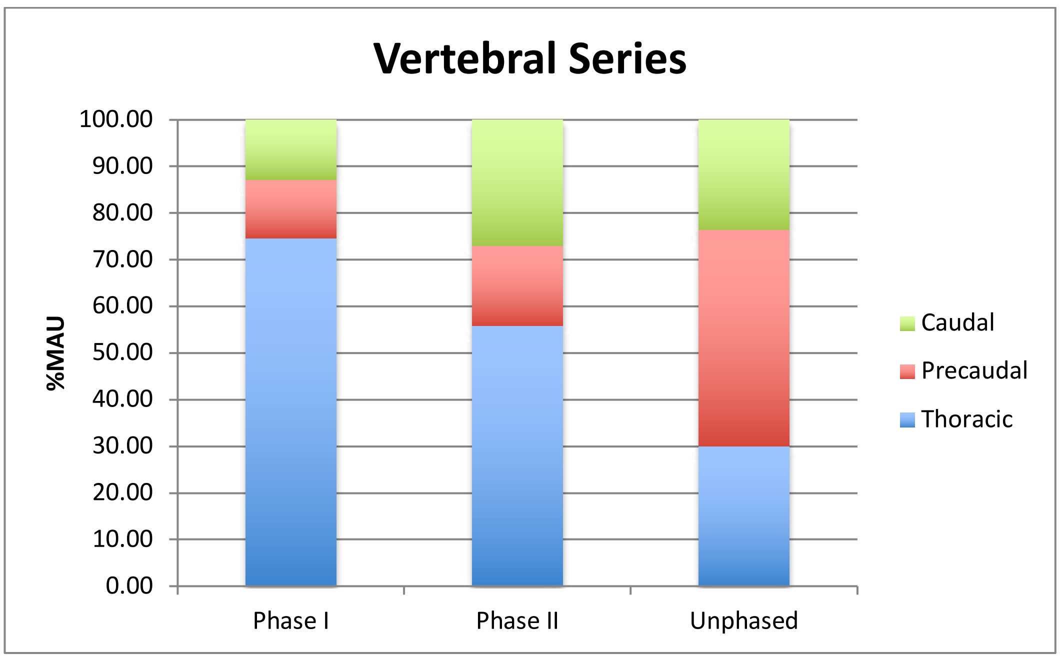

Figure 13: %MAU of different vertebrae from all gadids for all phases

Fish Interpretation

For both Figure 12 and Figure 13, the analysis makes use of %MAU. This normalizes for the number of times an element appears in the skeleton, and makes comparisons possible between areas of the body that have more or less bones without over- or under-representing them. For example, fish skulls are quite complex and include many more bones than the rest of the skeleton. However, to understand butchery patterns and production/consumption, %MAU ensures that these differences are accounted for.

The fish at Grænagerði show a distinct signature of more head elements than those from the tail. There are also more thoracic vertebrae represented than any other type of vertebra in Phases I and II. This signature tells us not only that Grænagerði was a fish-processing site, but that they were producing a flat-dried fish product rather than one dried in the round (e.g., Amundsen et al. 2004, 2005; Perdikaris and McGovern 2008a).

Sites where fish are being processed and dried will contain disproportionately more elements from the head of the fish, since the head is not left with the finished product. Sites where dried fish are consumed will contain more elements from the body of the fish, mostly vertebrae. The kinds of vertebrae present can tell us if the product was dried in the round or dried flat.

Round dried fish closely resemble the historically known "stockfish" later exported in large quantities from late medieval and early modern Iceland. The head is cut off, leaving the cleithrum and most of the vertebrae, though the first few thoracic vertebrae may be cut away with the head, leaving few atlas vertebrae in the finished product. Thus, a site where production of round dried fish is the focus will have mostly head bits and very few vertebrae of any kind. Consumption of round dried fish shows more vertebrae than other elements.

On the other hand, flat-dried fish were more heavily filleted and may have circulated more intensively within Iceland. For a flat-dried product, the head is cut off, and the fish is split down the middle almost all of the way to the tail, leaving the cleithrum to aid in keeping the body together. During the drying process, this filleting allows some vertebrae to fall out. Therefore, at site where production of the flat-dried product is the focus, skull fragments and thoracic vertebrae are expected, as well as some precaudal vertebrae. At a site consuming flat-dried fish, more precaudal and caudal vertebrae will be found. If these fish were instead consumed whole, the graphs above would show equal bars for all vertebrae, as it presents %MAU and thus controls for carrying quantities of each vertebra in the body. There is some evidence for whole fish being consumed on site here; however, the pattern for dried fish production is quite clear.

As can be seen in Figure 12 and Figure 13 above, cranial elements are much more common than axial in both phases. In addition to this, the vertebral analysis shows that mostly thoracic vertebrae are found. This is strong evidence for the production of a flat-dried product at Grænagerði. The presence of other vertebrae and axial elements also indicates that fresh fish were sometimes consumed whole on site. This pattern points to a Viking Age artisanal fishing strategy that began at the settlement of the region. Archaeological investigations at sites further inland in Skagafjörður also confirm a local trade network of this dried fish product. At the site of Stóra-Seyla in Langholt, zooarchaeological analyses point to the consumption of a flat-dried fish product (Cesario 2016). Other nearby sites on Hegranes (Kotið, Vatnskot) also seem to have produced flat-dried fish, illuminating the possibility of an even larger network of producers and consumers (Cesario 2018a, 2019a). Patterns of marine fish product production and consumption have considerable potential to shed light on still poorly-understood patterns of pre-commercial, artisanal production and distribution of these characteristic Nordic dried fish products (Perdikaris and McGovern 2008a, 2008b).

With fish bones, there is always the possibility that taphonomy has destroyed many of the bones or that the collection strategy will not favor smaller bones and the archaeofauna will be biased. A biased collection strategy was not the case at Grænagerði, since the caudal vertebrae are the smallest of all the vertebrae and many were collected. The bones from Grænagerði were also wet-screened. The soil was too moist to go through the screen, so the excavators made the decision to screen as much as possible and then collect everything left in the screen for wet screening. Since the smaller bones were preserved, it can be assumed that the soil conditions were favorable, and so taphonomy does not seem to have played a dominant role in the number of fish bones recovered.

Concluding Remarks

The fish remains at Grænagerði along with the heavy reliance on seabirds at settlement tell an interesting story of Viking Age marine adaptations. The fish represent an artisanal fishing enterprise participating in a local trade network. It also looks like fish production increased in Phase II along with the inclusion of more domesticates on site and less of a focus on birds. The heavy reliance on seabirds right at settlement points to their importance as a subsistence resource before farms can be properly established and productive.

Acknowledgements

Many thanks to María Eymundsdóttir and Pálmi Jónsson at Hulduland (Grænagerði) for allowing us permission to excavate on their land.

Thanks also to the field crew—Sarah Breiter, Lauren Welch-O’Connor, Sean Deryck, and especially Kathryn Catlin, Melissa Ritchey, and Grace Bello. To John Steinberg and Doug Bolender for all of their support over the years and for bringing me onto this project in the first place. I am forever grateful to Sirrí and Guðný and Byggðasafn Skagfirðinga for their support.

Fieldwork was supported by the US National Science Foundation (PLR # 1523025, 1242829, 1345066, & 1417772) in a joint project of the Skagafjörður Heritage Museum (Byggðasafn Skagfirðinga), the University of Massachusetts Boston, and Northwestern University. Analysis was also supported by the National Science Foundation Graduate Research Fellowship Program grant no. DGE-1037525. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author and do not necessarily reflect the views of the National Science Foundation.

As always, Thomas McGovern gets my thanks for productive conversations about interpreting the data and enthusiastic support.

NABO

Skagafjörður Church and Settlement Survey: Final Report on the Archaeofauna from Vatnskot on Hegranes, Skagafjörður

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CUNY NORSEC Laboratory Report No. 68
BSK 2019-219 / SCASS-2019-24

Introduction and Excavations

From 2015-2018, the Skagafjörður Church and Settlement Survey (SCASS) explored the settlement pattern on Hegranes, in Skagafjörður (Figure 1) (e.g., Bolender et al. 2016, 2017; Steinberg et al. 2016). Vatnskot is located in central Hegranes, about 4 km inland (Figure 2). The modern day farms on this site are called Svanavatn and Hegrabjarg, both of which were created by dividing Vatnskot in the early 20th century (Pálsson 2010). Documentary records suggest that Vatnskot may have been abandoned in the late 15th or early 16th centuries, but we do not yet have archaeological confirmation of this. It seems that the farmstead relocated north after about AD 1300, which may be related to the potential abandonment (Bolender, personal communication). There is a lake associated with this farm, which is perhaps where the name *Vatn* comes from, and it has been present on the landscape since before human occupation of the island (Hallsdóttir 1996).

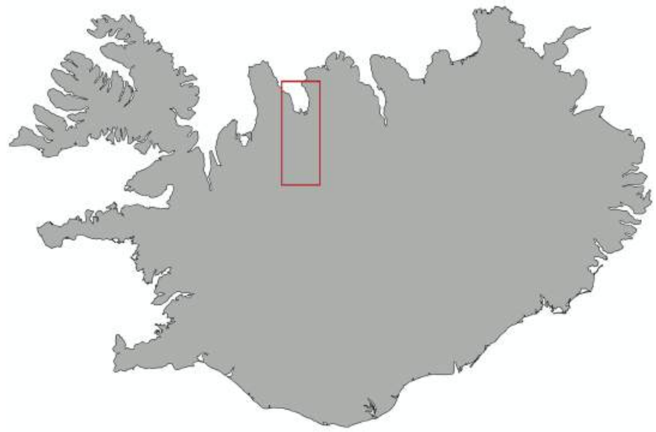

Figure 1: Map of Iceland. Skagafjörður is outlined by the red box.

In 2017, excavations began with a 1x1 meter test pit that was then expanded another meter south because the deposit was quite dense and it allowed us to collect a larger sample of archaeofauna and other samples (macrobotanical, tephra). In 2018, we reopened the original test pit and expanded it to the west by adding another 1x2 running north-south (Cesario and Ritchey 2018). The archaeofauna collected from these excavations are the focus of analysis here.

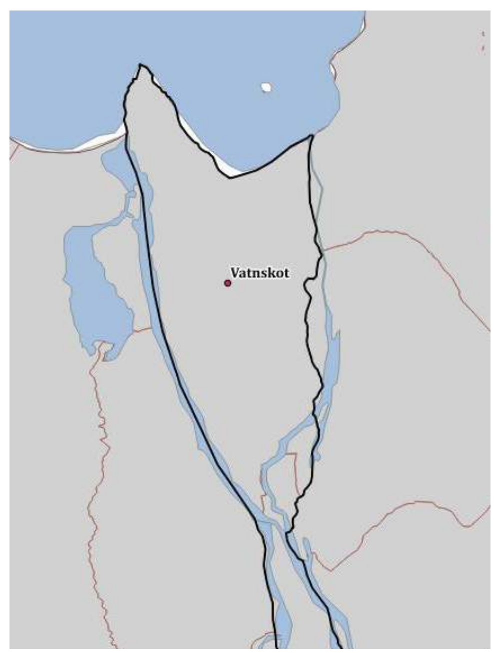

Figure 2: Location of Vatnskot on Hegranes

Methods

The faunal materials were partially analyzed at the Hunter College Zooarchaeology Laboratory, and made use of the comparative collection there. The 2018 material was analyzed in Iceland, at Fornleifastofnun Íslands (FSÍ) and using the comparative collection housed at the Agricultural College in Keldnaholt as well as the Natural History Museum in Garðabær. Recording and data curation follow NABONE protocols, utilizing the 9th edition of this recording package (a Microsoft Access database supplemented with specialized Microsoft Excel spreadsheets, available to download at www.nabohome.org). Digital records were all made using this package. The animal bones excavated will be permanently curated at the National Museum of Iceland along with all digital records. Digital records will also be preserved in the

NABO collection on The Digital Archaeological Record (tDAR). An electronic copy of this report is available at www.nabohome.org and at the UMB SCASS website/Fiske Center site.

All fragments were identified as far as taxonomically possible, and a selected element approach was not used. Most mammal ribs, vertebrae, and long bone shaft fragments were assigned to "Large Terrestrial Mammal" (cattle or horse sized), "Medium Terrestrial Mammal" (sheep, goat, pig, or large dog sized), and "Small Terrestrial Mammal" (fox or small dog sized). Only those elements that could be positively identified as sheep, *Ovis aries*, or goat, *Capra hircus*, were assigned to these categories while all other sheep/goat elements were assigned to a more general "caprine" category.

Following widespread North Atlantic tradition, bone fragment quantification makes use of the Number of Identified Specimens (NISP) method (Grayson 1984). All mammal measurements follow (von den Driesch 1976). Sheep/goat distinctions follow (Boessneck 1969), (Mainland and Halstead 2005), and (Zeder and Lapham (2010). Only positively identified fragments of fish bone were given species level identification, with those unidentifiable to species placed in the family category where possible, often *gadid*, while others were identified simply as fish. No fish bones from this collection required measurement.

Tooth wear studies follow Grant (1982) and Lemoine et al. (2014). Long bone fusion stage calibrations follow Zeder (2006) and presentation of age reconstruction makes use of Enghoff (2003) and McGovern (2009).

The Archaeofauna

The analytical units for this excavation have been separated by time period (Table 1). Volcanic tephra observed during excavation was used to date the deposits, and carbonized seeds recovered through flotation have been sent for radiocarbon dating in order to get more precise dates. For this site, Phase I is AD 871-1000 and is capped by the dark grey 1000 tephra. Phase II is AD 1000-1104 and ends at the white AD 1104 tephra. Phase III is capped by the AD 1300 tephra and Phase IV is material from post-1766 (this comes from a modern cut, see excavation report for more details). For the purposes of this report, Phases III and IV will not be included in analysis, since the sample sizes are so small.

Taphonomy

Various taphonomic factors can affect bones. Here, four measures of taphonomic effects will be explored to help characterize the entire archaeofaunal assemblage. The taphonomy is discussed in terms of the assemblage as a whole, using the Total Number of Fragments (TNF). Using the whole assemblage for taphonomic analysis, rather than just the identified bones (NISP), gives us a better picture of what happened to the entire assemblage from its deposition until excavation.

Table 1: NISP and TNF for Vatnskot archaeofauna. Total NISP for all phases is 5,878. Note that Phase III and IV will not be discussed in this report, and the NISP for Phases I and II is 5,818.

Phase	**I**	**II**	**III**	**IV**	**Total**
Domesticates					
Bos taurus	33	56	1	1	91
Equus caballus	0	4	0	0	4
Sus scrofa	6	10	0	0	16
Ovis aries	18	17	0	0	35
Capra hircus	0	2	0	0	2
Ovis/Capra sp.	123	183	5	2	313
SEALS					
Phocid sp.	0	1	0	0	1
CETACEA					
Cetacea sp.	9	1	0	0	10
BIRDS					
Wildfowl - sea birds	14	23	0	0	37
Wildfowl - land birds	2	0	0	0	3
Bird sp.	15	32	0	1	49
FISH					
Gadid sp.	2,265	2,114	9	33	4,421
Salmonid sp.	0	1	0	0	1
Other fish	3	0	0	0	3
Fish sp.indet.	268	205	0	0	473
MOLLUSCA					
Mollusca sp.	258	134	2	5	399
GASTROPOD					
Snail sp.	19	2	0	0	21
TOTAL NISP (Identified fragments) =	**3,033**	**2,785**	**17**	**42**	**5,877**
Small Terrestrial Mammal	4	10	0	0	14
Medium Terrestrial Mammal	272	325	4	10	611
Large Terrestrial Mammal	92	81	1	1	175
Unident. Mammal Frags	1,923	1,372	28	32	3,355
TOTAL TNF (all fragments)	5,324	4,573	50	85	**10,032**

Identification Rate

The identification rate is calculated simply by looking at the NISP versus TNF. In both phases, over half of the assemblage could be identified. This high rate of identification indicates good preservation and not much post-butchery processing. However, the vast majority of the archaeofauna is made up of fish bones. Fish bones do not have marrow so they do not get further processed for marrow extraction. They are also, in general, not used for craftworking or household tools, though some fish bones, like the haddock cleithrum, are great for carving.

Fragment Size

Size of a bone can affect its identification rate. Larger bone fragments are often much easier to identify than smaller, more broken pieces. Some animals, however, have smaller bones that can be recovered whole and identified at a higher rate than broken fragments of a large mammal bone. At Vatnskot, the majority of the bones from both phases are in the 1-2 cm and 2-5 cm categories (Figure 3). This makes sense, as over 75% of the assemblage is made up of fish bones, which tend to fall within this range. Most of the pieces under 1 cm are unidentifiable or fish vertebrae with no spines.

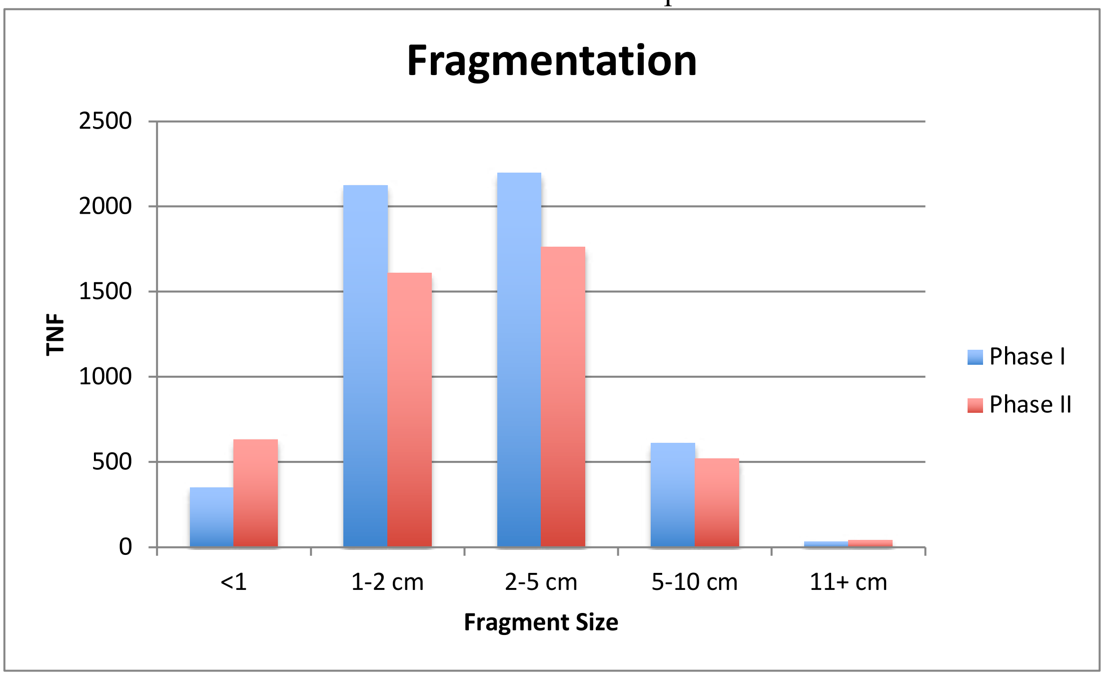

Figure 3: Fragmentation

Burning

As Figure 4 below shows, most of the bones from Vatnskot were unburned. The majority of those that were burned are completely calcined, the "white" category. This indicates a very hot fire. The midden layers at Vatnskot varied between peat ash midden and a darker, charcoal-based deposit. The darker charcoal midden may indicate periods of time when more wood was being burned rather than peat. The white burned bones could have been included in this and burned as fuel, then eventually deposited into the midden during a cleaning event. Another interpretation for white-burned bone in the Viking Age is that people would have disposed of their food waste in the long fire in the middle of the house, then during cleaning of the fire pit, calcined bone fragments mixed with wood charcoal and fire cracked rocks are disposed of in the midden (Thomas McGovern, personal communication).

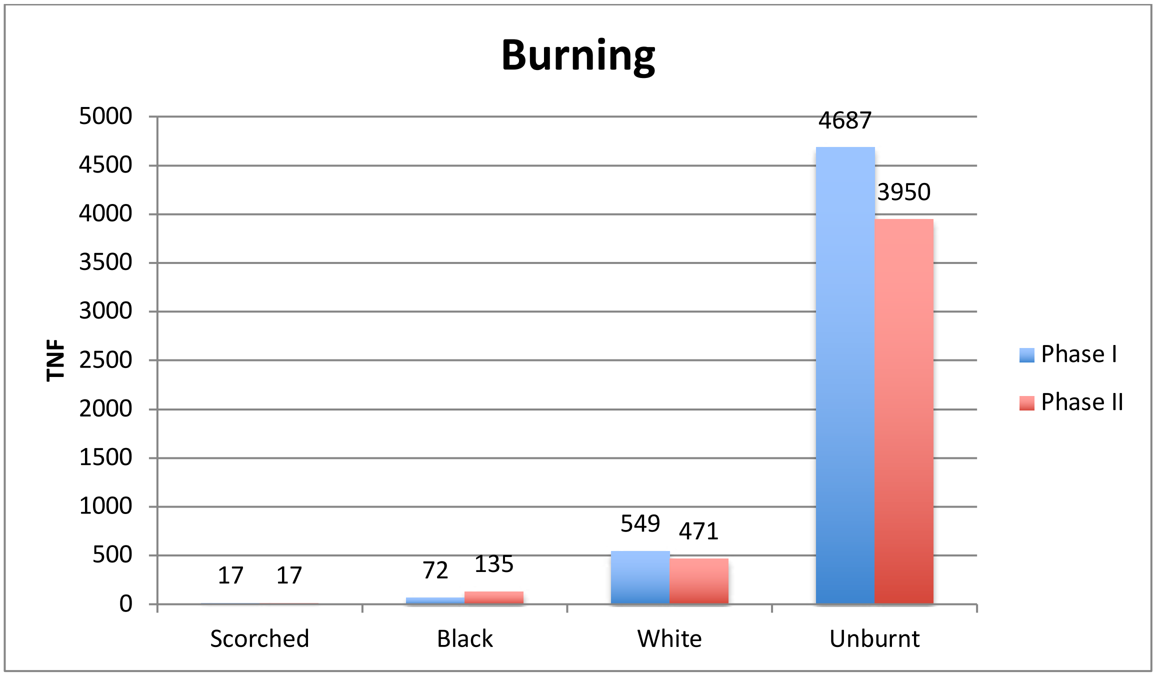

Figure 4: Burned bones at Vatnskot

<u>Gnawing</u>

Only six elements showed gnawing from a dog—two from Phase I and four from Phase II. This indicates the presence of dogs on site even though no dog remains were found. All of the bones with evidence of gnawing were from domesticates.

Major Taxa

Figure 5 below shows the major taxa present in the Vatnskot assemblages based on NISP. In both phases, fish make up the majority of the assemblage, between 84% and 83% in Phase I and Phase II, respectively. In both phases, domesticates make up 10% or less of the assemblage. The rest of the assemblage is made up of an assortment of birds, sea mammals, and mollusks in varying amounts. The next sections will discuss these major taxa in more depth in order to understand the activities taking place at Vatnskot.

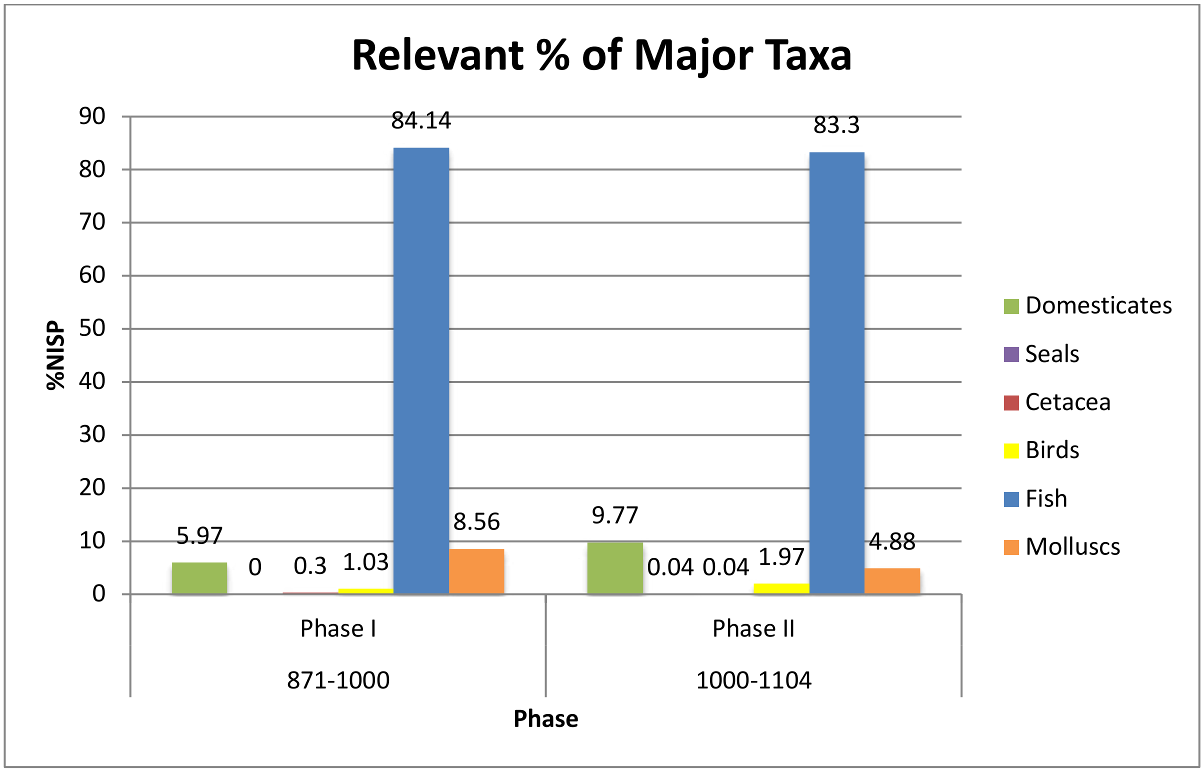

Figure 5: Relative percent of major taxa in both major phases at Vatnskot

Caprines

The caprine category includes both sheep and goats. It can be quite difficult to distinguish between the two, especially on phalanges and long bone shafts. However, the ends of many long bones have diagnostic features allowing the identification of sheep or goat (see Boessneck 1969, Mainland and Halstead 2005, and Zeder and Lapham (2010) for a list of elements and their distinguishing features). These distinguishing bones are generally quite dense and preserve well in the archaeological record.

In the Vatnskot archaeofauna, two bones were positively identified as goat, a distal humerus and a calcaneus, both from Phase II. These are the first goat remains to be identified in Skagafjörður. This could be due to many reasons, one of which is that there have been very few zooarchaeological analyses on Skagafjörður archaeofauna and sample sizes are smaller than other comparable studies in Iceland. Another potential reason for the lack of goats is that they simply were not present in large quantities in Skagafjörður for social, political, and/or environmental reasons.

Element Distribution

The caprine elements present in the Vatnskot archaeofauna are from the entire skeleton. The lack of vertebrae and ribs in Figure 6 is due to the NABONE protocol of identifying these elements only to size categories (see Methods section above) rather than the bones actually being missing from the archaeofauna.

The presence of elements from the entire skeleton indicates a home butchery strategy, where the inhabitants at Vatnskot were sustaining themselves. There is no evidence for extra body parts coming into the site, which would suggest that they were being provisioned from elsewhere, nor is there evidence of specific body parts leaving the site, which would indicate that they were provisioning others. In Phase II, there is a much higher percentage of forequarter elements than any other elements during the same phase. It is also important to note that a nearly complete lamb skeleton was found in Phase I, which will be discussed further in the "neonates" section below.

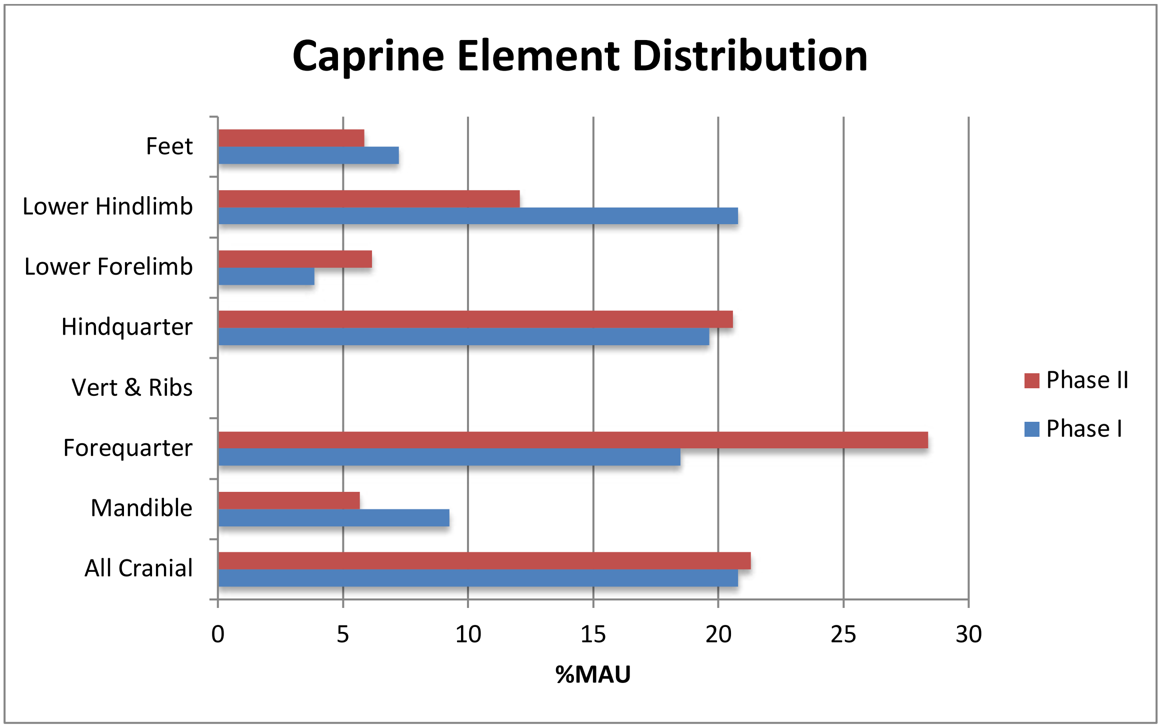

Figure 6: Caprine element distribution for both phases at Vatnskot

Caprine Age Profile

Tooth Eruption and Wear

Only six mandibles were available with teeth present. Eruption and wear were scored based on Grant (1982) and age ranges based on McGovern (2009) and Enghoff (2003). One mandible had a deciduous fourth premolar (dp4) with the first adult molar (M1) in the process of erupting. This indicates an individual around 11 months of age, since the M1 is fully present around 1 year. Three mandibles had both the dp4 and M1 present and in wear, indicating an age range between 12-24.5 months. The last two had a dp4 and M1 present with the M2 visible in the crypt but not fully erupted. These individuals were likely towards the tail end of the 12-24.5 months age category.

Long Bone Fusion Stages

There were 37 long bones present for which fusion data can be scored. Figure 7 below shows the percentage of fused bones in various age categories. In Phase I, all of the bones indicate that caprines survived their first 6 months of life, but only 50% survived beyond two years. There were no fused elements present beyond the two year age, perhaps indicating a focus on meat rather than wool or milk. The caprines in Phase II show a more mixed economy, with

2/3 of caprines surviving their first six months of life, 1/5 living to two years of age, and then there are none present from in the 3.5 year old category. These missing caprines are of prime meat bearing age, and point towards a meat economy.

Combining this set of long bone fusion data with the tooth eruption and wear supports the idea that most animals made it past their first 6 months of age and then were culled at some point after that time but before reaching 4.5 years. These all point to animals that were being killed in their prime meat-bearing years rather than being kept for milk or wool specifically. However, at least one caprine survived to 4.5 years of age, which could indicate a shift to wool-focused animal husbandry. Sheep herding nearly always mixes strategies for milk, meat, and wool, so this mixture of all herding strategies is not uncommon.

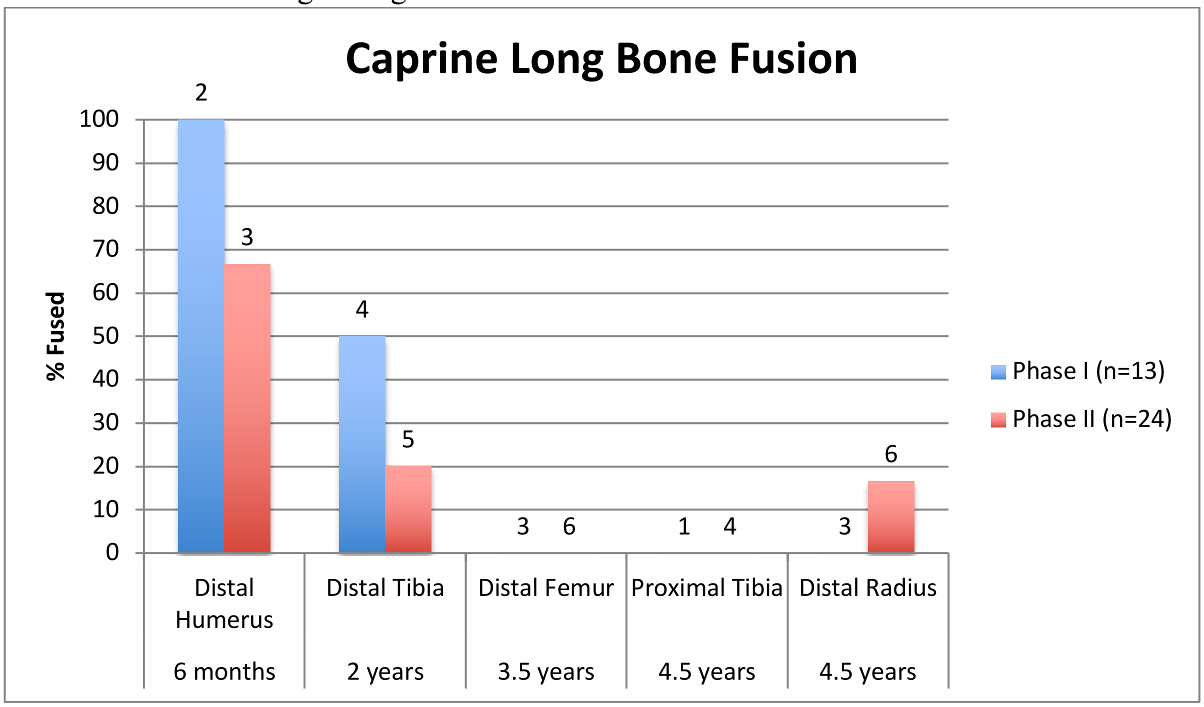

Figure 7: Long bone fusion stages for all caprine elements. Numbers shown above each bar represent how many of each element was available for scoring fusion.

<u>Neonates</u>

Neonates were not common at Vatnskot in either phase. In Phase I, however, a nearly complete neonatal caprine was found articulated in context [108]. Its forelimbs were missing, along with the skull, but it is likely that these were just not preserved. The NISP was adjusted to reflect this articulated skeleton, ensuring that the same animal was not counted multiple times. Other than the nearly complete individual, there were small numbers of isolated neonatal elements in both phases. The presence of neonates indicates an early summer occupation, since lambing season begins in May.

Cattle to Caprine Ratios

In Iceland, there is a general increase in caprine use over time, especially as sheep gain importance for the creation of the standardized woolen cloth *vaðmál* as well as remaining a vital part of Icelandic household economy. The tradeoff seems to be that fewer cattle are kept in favor of increasing the number of sheep that can be raised.

At Vatnskot, the cattle to caprine ratios are in the low end, and quite typical of the Viking Age patterns as we currently know them (Figure 8). In Phase I, the cattle to caprine ratio is 4.27, so for every head of cattle there are 4.27 caprines. In Phase II, this ratio drops to 3.61. These ratios are not all that different and essentially round to four caprines per head of cattle. The slight change may signify the growing importance of sheep; however, they would have been first and foremost vital for making household goods and clothing before surplus can be produced. Vaðmál also becomes a standardized product and legal currency by about the 11th century, towards the end of the occupation phases covered here, and is regulated until the 17th century (Hayeur Smith 2011:2).

Phase I at Vatnskot is very similar to nearby Kotið (Figure 8), which spans the time period from AD 871-1104, but seems to be sparsely used beyond AD 1000 (Catlin et al. 2017; Cesario 2018a). It also looks like the mid-10th century deposit at Hrísheimar in Mývatnssveit. Vatnskot Phase II is most similar to Phase II at Grænagerði in Skagafjörður, which dates to the same time period and is located relatively nearby (Catlin et al. 2018; Cesario 2020; Ritchey and Cesario 2018). Thus, these cattle to caprine ratios at Vatnskot are well within the Viking Age range that we see in other contemporaneous sites both within the same region and in other areas of Iceland.

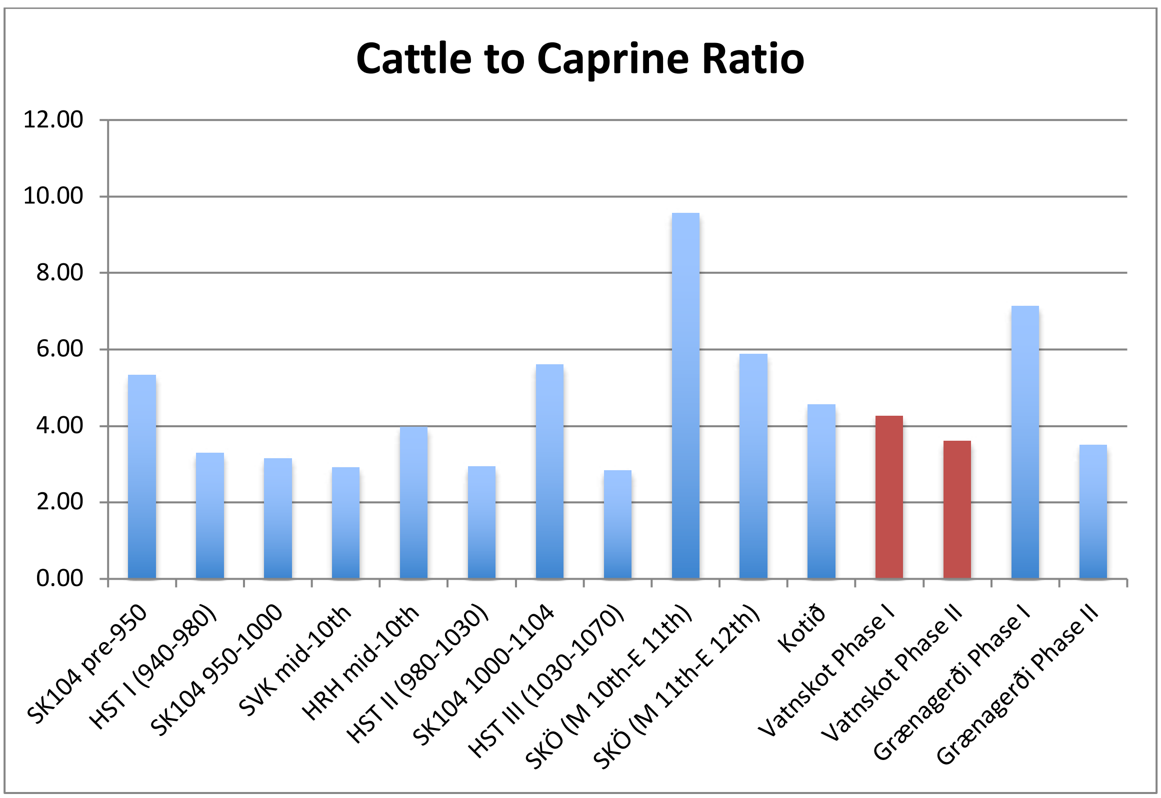

Figure 8: Cattle to caprine ratios throughout Iceland. Vatnskot is highlighted in red. Other sites in Skagafjörður include SK104 (Stóra-Seyla), Kotið, and Grænagerði. As comparisons, we have Skuggi (SKÖ) in neighboring Eyjafjörður and in Mývatnssveit we have Hofstaðir (HST), Sveigakot (SVK), and Hrísheimar (HRH).

Cattle

The use of cattle at Vatnskot increases from Phase I to Phase II. In Phase I, they made up 18% of the NISP of domesticates, in Phase II they are 21%. (see graph of domesticates, Figure 9). This slight increase in cattle percentage is followed also by a decrease in caprine numbers. These changes are not drastic, and likely would not have changed herding strategies in any notable way.

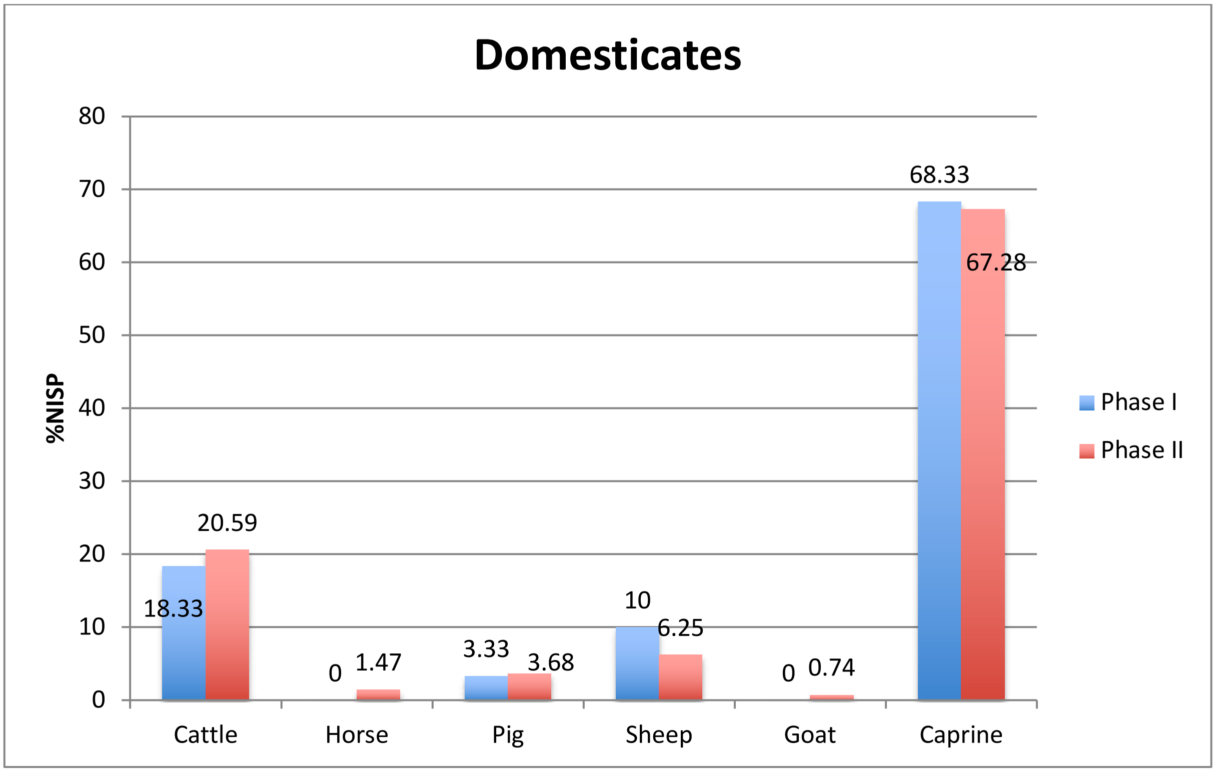

Figure 9: Relative percentage of domesticates in both phases.

Cattle Age Profile

Very few cattle bones were available for determining age. Only one fragmented mandible was present, and there was no wear on the teeth that were present. This indicates a young individual. There were five long bones that could be scored for fusion, all from Phase II. One unfused distal tibia indicates and individual below 2-2.5 years of age. Three unfused distal femora and one unfused distal radius suggest animals younger than 3.5-4 years of age (e.g., McGovern 2009:221).

<u>Neonates</u>

There were 16 neonatal cattle elements at Vatnskot, making up about 18% of the assemblage. The presence of neonates indicates a spring occupation, as that is when the cattle are born. They also represent a dairying signature, where the young are culled in order to collect milk for human consumption.

Other Mammals

While the majority of domestic mammals at Vatnskot were cattle and caprines, a few other species were also present (see Figure 9 above). Pigs and horses were found in the assemblage, but no dogs or cats. There were no wild land mammals.

The pigs represent mostly adult individuals where the elements are all fused. In Phase II, one unfused calcaneus suggests an individual under 36-48 months of age and an unfused ulna represents an individual under 48-60 months (Zeder et al. 2015). One pig mandible was also present from Phase II, with three teeth available for scoring. The not-quite-erupted 2nd molar indicates an age below 12 months and perhaps below 8 months (Grant 1982; Lemoine et al. 2014). Pigs were brought to Iceland as part of the settlement package, but their use fades out relatively quickly and we do not see many in the archaeological record anywhere in Iceland after about AD 1100.

Sea mammals were present in very small quantities, with ten cetacean bones total—nine in Phase I and one in Phase II. There was also one seal bone in Phase II. None of these can be identified to species through morphology alone, but they may be sent for aDNA extraction in order to identify species.

Mollusks and Gastropods

The mollusks from Vatnskot are shown in Figure 10 below. Most of the identifiable mollusks present in Phase I are clams. In Phase II, clams and unidentifiable mollusks make up nearly the same percentage of the assemblage. There are also mussels and periwinkle present in both phases, with one whelk in phase I. These shellfish only make up between 2 and 5 percent of the archaeofauna from each phase, respectively, and therefore did not contribute heavily to the economic strategy at Vatnskot. It is possible that they were collected for food or perhaps for bait, though no tool marks were present on the shells. Shellfish are generally quite easy to collect, and nearly anyone can do it, so they may represent a part-time activity on the shore while fishing or other ventures are also taking place. However, if the clams are *Arctica islandica*, they may be coming from deep water and are more likely to be collected from the beach without meat inside, and therefore not used as bait. These shells are used ethnographically as spoons or scoops, and so this could be another explanation for their presence in the assemblage.

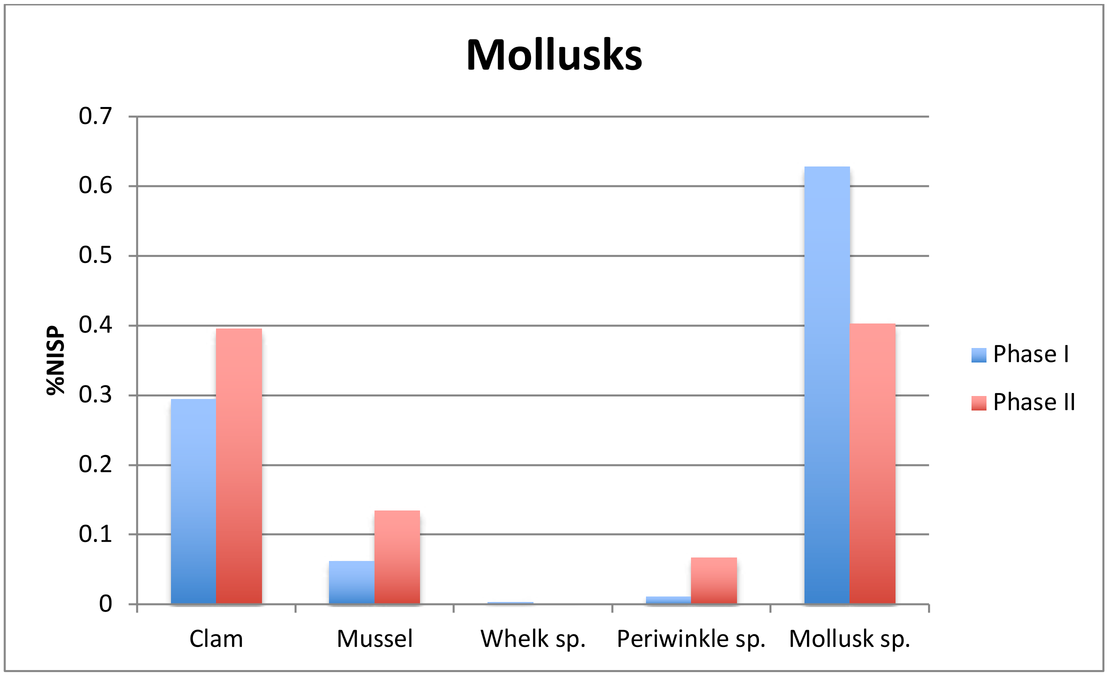

Figure 10: %NISP of mollusks at Vatnskot.

Gastropods were also found at Vatnskot. These are likely land snails, but a species-level identification has not been made. There were 19 in Phase I and only 2 in Phase II.

Birds

Birds were not common at Vatnskot, making up only 1.03% of the Phase I NISP and 1.97 of Phase II (Table 2). Of the identifiable birds in Phase I, the majority were seabirds—gulls and guillemot. In Phase II, the identifiable birds were all seabirds—gulls, puffins, and guillemot. The only bird in the "other" category is an Arctic tern (*Sterna paradisaea*).

Gulls can easily make their way inland, and may also represent birds that got tangled up in lines during fishing. Puffin and guillemot are cliff-nesting birds that would have been purposely collected, as they generally do not come further inland on their own. These two are interesting because they are only found in the summer during their breeding season. The collection of these seabirds is also dangerous and would have been a communal activity.

Table 2: Birds present in both phases at Vatnskot.

	Phase I	**Phase II**	**Total**
Seabirds			
Puffin (*Fratercula arctica*)	2	11	13
Guillemot (*Uria aalge*)	3	8	11
Razorbill (*Alca torda*)	1	0	1
Gull sp.	8	2	10
Other	0	1	1
Land birds			

Duck sp.	2	0	2
Unidentifiable birds	15	32	47
Total	**31**	**54**	**85**

Fish

Even though Vatnskot is located next to a lake, all but one of the identifiable fish bones were from marine fish (Table 3). Many of the marine fish were from the gadidae family; however, there were a couple elements from the Atlantic wolffish (*Anarhichas lupus*) in Phase I. This likely represents by-catch from fishing for gadids. Most of the identifiable bones were Atlantic cod (*Gadus morhua*).

Table 3: Fish NISP by phase at Vatnskot.

Phase		**I**	**II**	**Total**
Marine				
Gadus morhua	Atlantic cod	565	899	1,464
Pollachius virens	Saithe	4	0	4
Melanogramus aegilfinus	Haddock	14	6	20
Molva molva	Ling	17	37	54
Gadidae	Gadid family	1,665	1,172	2,837
Freshwater				
Salvelinus alpinus	Arctic char	0	1	1
Other Fish				
Anarhichas lupus	Wolffish	3	0	3
Unidentified fish		268	205	473
Total		2,536	2,320	4,856

Looking at only the fish that could be identified to species (Figure 11), it is again clear that cod are the most common. However, the next most common fish is ling (*Molva molva*), with haddock (*Melanogramus aegilfinus*) close behind in Phase I, but falling nearly out of use in Phase II. This is slightly different from other Viking Age distributions, where haddock usually make up the next highest percentage of fish after cod.

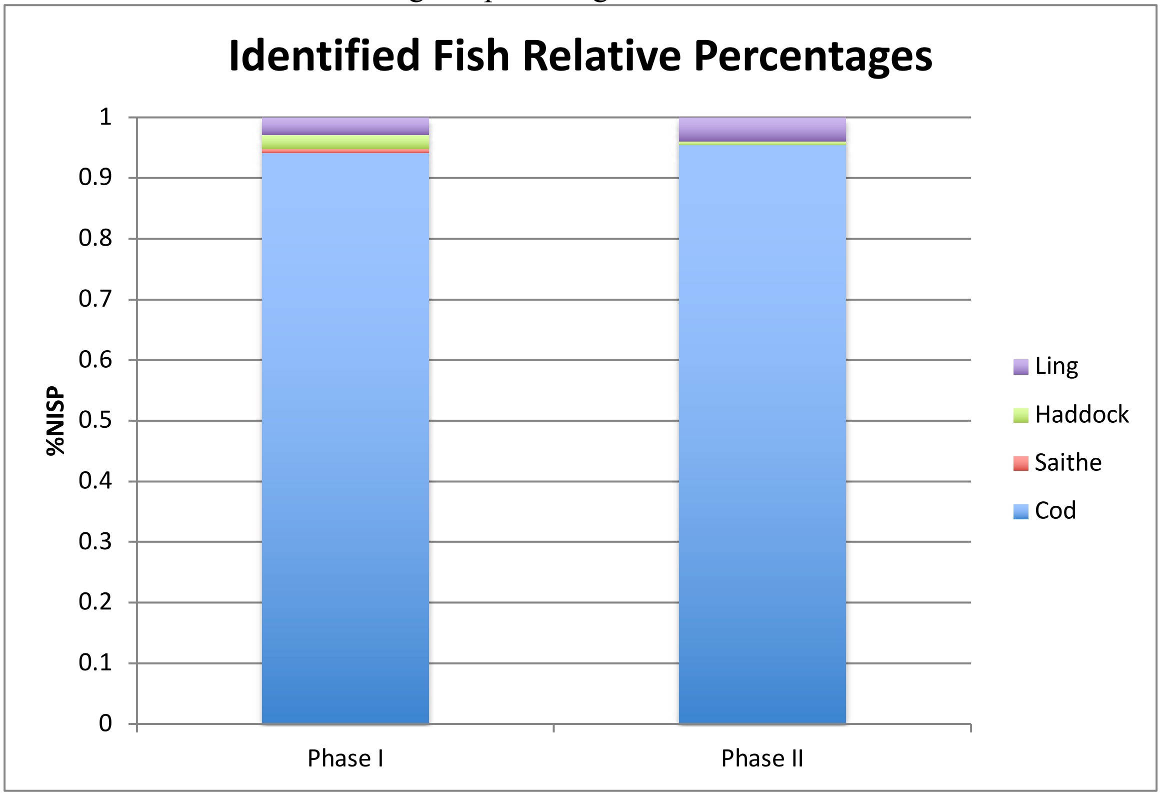

Figure 11: Fish that could be identified to species.

Phase I Fish

The total NISP for Phase I fish is 2,536 (Table 3). Most of these fish were gadids, and the majority of the identifiable ones were cod (*Gadus morhua*). Element distributions (Figure 12) indicate that head parts are more common than those from the rest of the body, and analysis of the vertebrae (Figure 13) has shown that thoracic vertebrae are more common than precaudal or caudal. This pattern is typical of the production of a flat-dried fish product, as will be discussed further below. There is still evidence of whole fish being consumed on the site, as can be seen through the presence of some precaudal and caudal vertebrae on the site.

Phase II Fish

The total NISP for Phase II fish is similar to Phase I, at 2,320 (Table 3). A pattern of mostly cod is present in this phase as well, and element distributions (Figure 12) and vertebral series (Figure 13) indicate the same production of a flat-dried fish product as well as the occasional whole fish consumed on site that we see in Phase I. The presence of the single char vertebra is interesting, as the site is located directly next to a freshwater lake, but they do not seem to have exploited freshwater fish in any noticeable quantity.

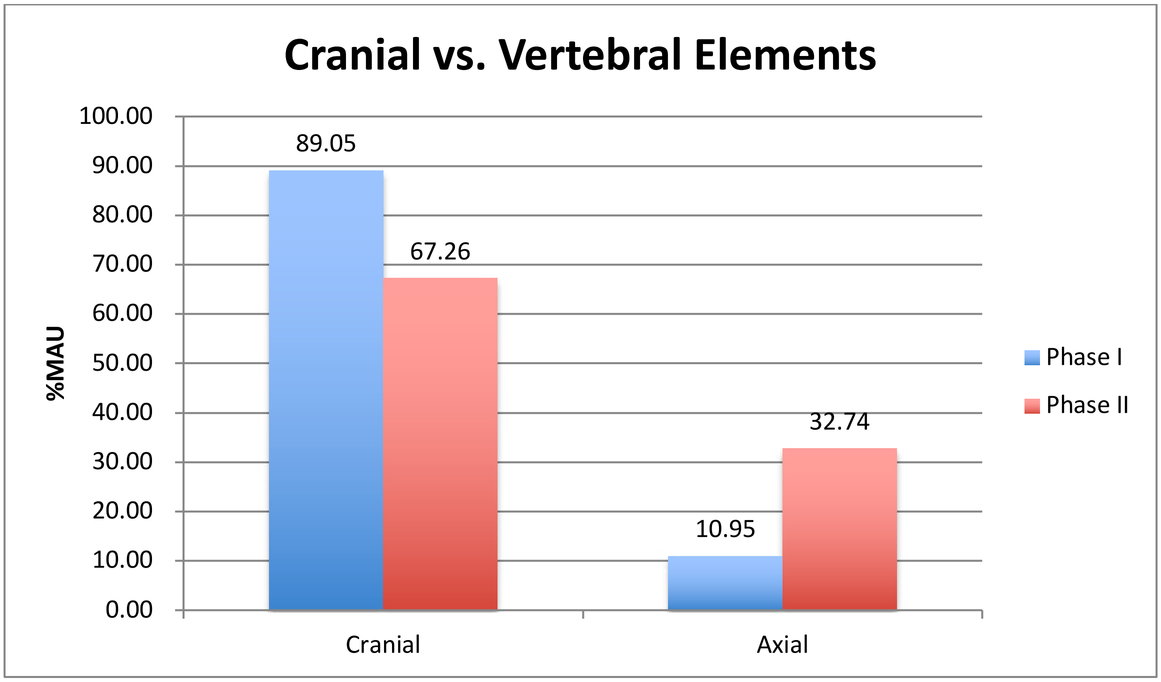

Figure 12: %MAU of cranial elements vs. axial in all gadids

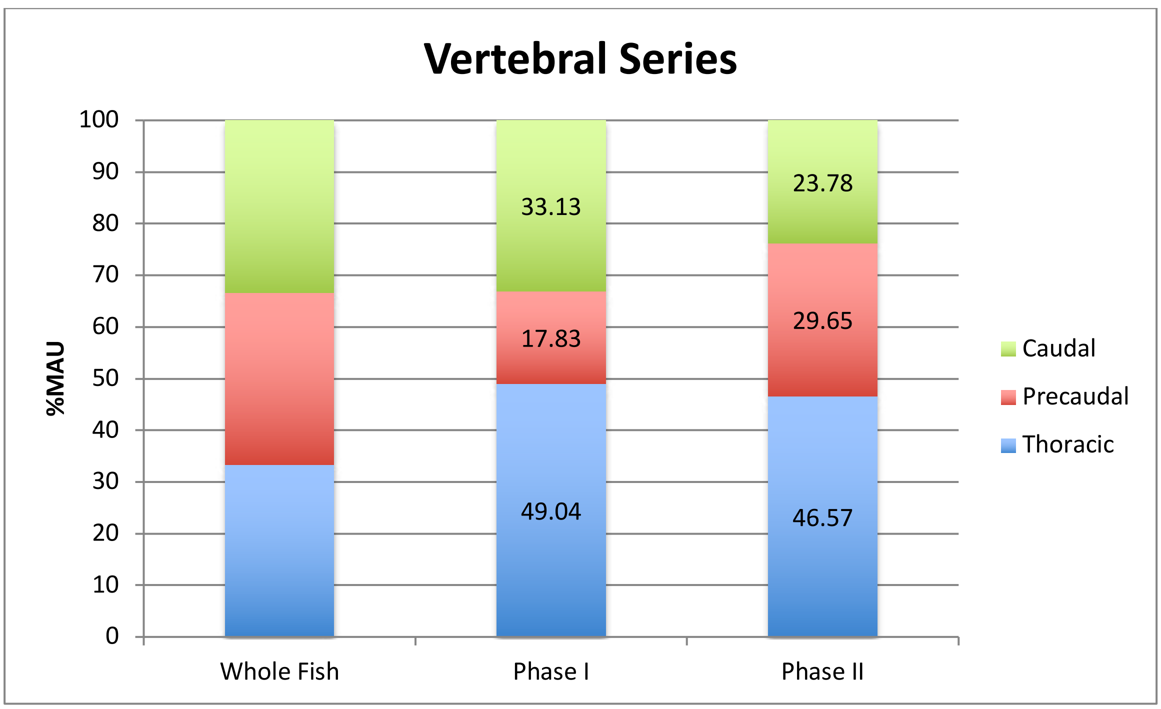

Figure 13: %MAU of different vertebrae from all gadids. Note that the leftmost column shows the ratios in a whole fish.

Fish Interpretation

The fish at Vatnskot show a distinct signature of more head elements than those from the tail. There are also more thoracic vertebrae than any other type of vertebra. This signature tells us not only that Vatnskot was a fish-processing site during both phases analyzed here, but that they were producing a flat-dried fish product rather than one dried in the round (e.g., Amundsen et al. 2004, 2005; Perdikaris and McGovern 2008a).

Sites where fish are being processed and dried will contain disproportionately more elements from the head of the fish, since the head is not left with the finished product. Sites where dried fish are consumed will contain more elements from the body of the fish, mostly vertebrae. The kinds of vertebrae present can tell us if the product was dried in the round or dried flat.

Round dried fish closely resemble the historically known "stockfish" later exported in large quantities from late medieval and early modern Iceland. The head is cut off, leaving the cleithrum and all vertebrae. Thus, a site where production of round dried fish is the focus will have mostly head bits and very few vertebrae. Consumption of round dried fish shows more vertebrae than other elements.

On the other hand, flat-dried fish were more heavily filleted and may have circulated more intensively within Iceland. For a flat-dried product, the head is cut off, and the fish is split down the middle almost all of the way to the tail, leaving the cleithrum to aid in keeping the body together. During the drying process, this filleting allows some vertebrae to fall out. Therefore, at site where production of the flat-dried product is the focus, skull fragments and thoracic vertebrae are expected, with some precaudal and caudal as well. At a site consuming flat-dried fish, mostly caudal vertebrae will be found, along with small numbers of precaudal and perhaps thoracic vertebrae. If these fish were instead consumed whole, the graphs above would show equal bars for all vertebrae, as it presents %MAU and thus controls for carrying quantities of each vertebra in the body.

As can be seen in Figure 12 and Figure 13 above, cranial elements are much more common than axial in both phases. In addition to this, the vertebral analysis shows that mostly thoracic vertebrae are found. This is strong evidence for the production of a flat-dried product at Vatnskot. The presence of other vertebrae and axial elements also indicates that whole fresh fish were sometimes consumed on site. This pattern points to a Viking Age artisanal fishing strategy that began at the settlement of the region. Archaeological investigations at sites further inland in Skagafjörður also confirm a local trade network of this dried fish product. At the site of Stóra-Seyla in Langholt, zooarchaeological analyses point to the consumption of a flat-dried fish product (Cesario 2016). Other sites on Hegranes (Kotið, Grænagerði, and Næfurstaðir) also seem to have produced flat-dried fish, illuminating the possibility of an even larger network of producers and consumers (Cesario 2018a, 2019b, 2020). Patterns of marine fish product production and consumption have considerable potential to shed light on still poorly-understood patterns of pre-commercial, artisanal production and distribution of these characteristic Nordic dried fish products (Perdikaris and McGovern 2008a, 2008b).

With fish bones, there is always the possibility that taphonomy has destroyed many of the bones or that the collection strategy will not favor smaller bones and the archaeofauna will be biased. A biased collection strategy was not the case at Vatnskot, since the caudal vertebrae are the smallest of all the vertebrae and many were collected. Since these smaller bones were preserved, it can be assumed that the soil conditions were favorable, and so taphonomy does not seem to have played a dominant role in the number of fish bones recovered.

Concluding Remarks

The fish remains at Vatnskot tell an interesting story of a Viking Age artisanal fishing enterprise and open up avenues for research of interregional (i.e., coastal and inland) exchange. It is important to remember that these would have been pre-commercial fishing ventures, and standardization of size or product made would not have been as highly regulated as it became later in time.

Sites like Vatnskot, Kotið, Næfurstaðir, and Grænagerði participated in the production of a specialized product while also maintaining small farms for their own use. They likely played pivotal roles in the local economy, and understanding these kinds of sites within the larger social system is important for making sense of the changes in landscape organization over time.

Acknowledgements

Many thanks to Margrét Ólafsdóttir, Sigrún Ólafsdóttir, and Sæunn Jónsdóttir at Svanavatn (Vatnskot) for allowing us to excavate in their front yard and for taking an enthusiastic interest in the archaeology.

Thanks also to the field crew—Alicia Sawyer, Rita Shepherd, Tyler Perkins. To John Steinberg and Doug Bolender for all of their support over the years and for bringing me onto this project in the first place. I am forever grateful to Sirrí and Guðný and Byggðasafn Skagfirðinga for their support and wisdom.

Fieldwork was supported by the US National Science Foundation (PLR # 1523025, 1242829, 1345066, & 1417772) in a joint project of the Skagafjörður Heritage Museum (Byggðasafn Skagfirðinga), the University of Massachusetts Boston, and Northwestern University. Analysis was also supported by the National Science Foundation Graduate Research Fellowship Program grant no. DGE-1037525. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author and do not necessarily reflect the views of the National Science Foundation.

As always, Thomas McGovern gets my thanks for productive conversations about interpreting the data and enthusiastic support.

NABO

Skagafjörður Church and Settlement Survey: Final Report on the Archaeofauna from Næfurstaðir on Hegranes, Skagafjörður

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CUNY NORSEC Laboratory Report No. 71
BSK 2019-220 / SCASS-2019-25

Figure 1: Næfurstaðir during excavation. The white line near the middle of the unit is the AD 1104 tephra. The blue arrow is pointing at the 978/9 AD tephra.

Introduction and Excavations

From 2015-2018, the Skagafjörður Church and Settlement Survey (SCASS) explored the settlement pattern on Hegranes, in Skagafjörður (Figure 2) (e.g., Bolender et al. 2016, 2017; Steinberg et al. 2016). Næfurstaðir (Figure 3) is located on the modern day landholdings of Ás, west of the medieval farm (Catlin et al. 2017:12). The site itself is currently abandoned, and was likely out of use by AD 1104. While the name may suggest that goats were kept on the site at some point during its use (Catlin et al. 2017), no goats were present in the archaeofauna.

In 2016, a 1x1 meter test pit was opened at Næfurstaðir for Catlin's dissertation research. The archaeofauna was small and preliminary results are reported elsewhere (Cesario 2018c). In 2018, in order to collect more faunal remains for my dissertation, we reopened the original test pit, using it as the southeast corner of a 3x2 meter excavation (Cesario 2018b). The archaeofauna collected from both of these excavations will be the focus of analysis here.

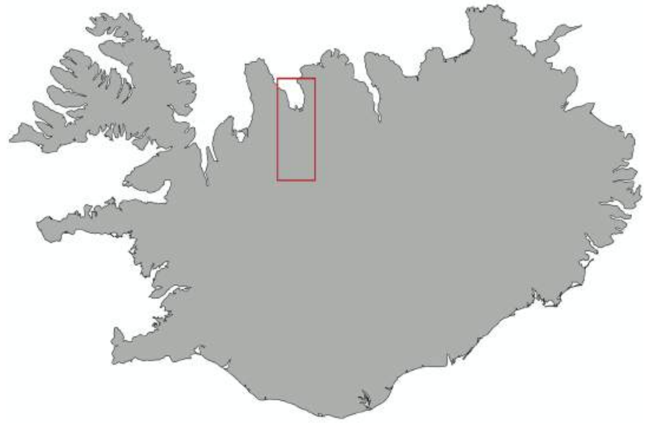

Figure 2: Map of Iceland. Skagafjörður is outlined by the red box.

Methods

The faunal materials were partially analyzed at the Hunter College Zooarchaeology Laboratory, and made use of the comparative collection there. The 2018 material was analyzed in Iceland, at Fornleifastofnun Íslands (FSÍ) and using the comparative collection housed at the Agricultural College in Keldnaholt as well as the Natural History Museum in Garðabær. Recording and data curation follow NABONE protocols, utilizing the 9th edition of this recording package (a Microsoft Access database supplemented with specialized Microsoft Excel spreadsheets, available to download at www.nabohome.org). Digital records were all made using this package. The animal bones excavated will be permanently curated at the National Museum of Iceland along with all digital records. Digital records will also be preserved in the NABO collection on The Digital Archaeological Record (tDAR). An electronic copy of this report is available at www.nabohome.org and at the UMB SCASS website/Fiske Center site.

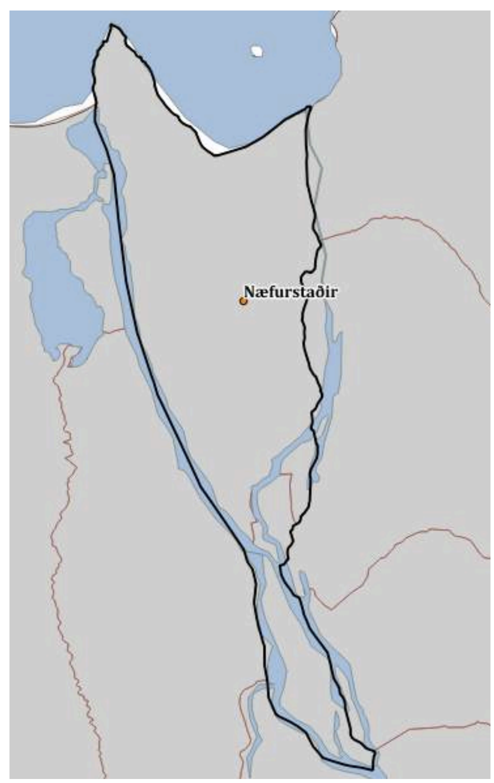

Figure 3: Location of Næfurstaðir on Hegranes.

All fragments were identified as far as taxonomically possible, and a selected element approach was not used. Most mammal ribs, vertebrae, and long bone shaft fragments were assigned to "Large Terrestrial Mammal" (cattle or horse sized), "Medium Terrestrial Mammal" (sheep, goat, pig, or large dog sized), and "Small Terrestrial Mammal" (fox or small dog sized). Only those elements that could be positively identified as sheep, *Ovis aries*, or goat, *Capra hircus*, were assigned to these categories while all other sheep/goat elements were assigned to a more general "caprine" category.

Following widespread North Atlantic tradition, bone fragment quantification makes use of the Number of Identified Specimens (NISP) method (Grayson 1984). All mammal measurements follow (von den Driesch 1976). Sheep/goat distinctions follow Boessneck (1969), Mainland and Halstead (2005), and Zeder and Lapham (2010). Only positively identified fragments of fish bone were given species level identification, with those unidentifiable to species placed in the family category where possible, often *gadid*, while others were identified simply as fish. No fish bones from this collection required measurement.

Tooth wear studies follow Grant (1982) and Lemoine et al. (2014). Long bone fusion stage calibrations follow Zeder (2006) and presentation of age reconstruction makes use of Enghoff (2003) and McGovern (2009).

The Archaeofauna

The archaeofauna at Næfurstaðir have been separated into three analytical units based on tephra layers observed during excavation (see Table 1 below). Carbonized seeds recovered through flotation have been sent for radiocarbon dating in order to get more precise dates. Phase I is from ca 870-950, Phase II from ca 950-1000, and Phase III from ca 1000-1104.

Taphonomy

Various taphonomic factors can affect bones. Here, four measures of taphonomic effects will be explored to help characterize the entire archaeofaunal assemblage. The taphonomy is discussed in terms of the assemblage as a whole, using the Total Number of Fragments (TNF). Using the whole assemblage for taphonomic analysis, rather than just the identified bones (NISP), gives us a better picture of what happened to the entire assemblage from its deposition until excavation.

<u>Identification Rate</u>

The identification rate is calculated simply by looking at the NISP versus TNF. In Phase I and Phase III, the identification rate is between 50-55%, while in Phase II it is about 48%.

Table 1: Table showing NISP and TNF for all phases at Næfurstaðir.

Phase	I	II	III	Total
Domesticates				
Bos taurus	38	4	9	51
Equus caballus	0	0	0	0
Sus scrofa	2	0	0	2
Ovis aries	6	0	1	7
Capra hircus	0	0	0	0
Ovis/Capra sp.	96	0	19	115
SEALS				
Phocid sp.	1	0	0	1
CETACEA				
Cetacea sp.	1	0	0	1
BIRDS				
Wildfowl - sea birds	40	2	5	47
Wildfowl - land birds	2	0	0	2
Bird sp.	83	4	9	96
FISH				
Gadid sp.	1,019	25	31	1,075
Salmonid sp.	0	0	0	0
Other fish	0	0	0	0
Fish sp.indet.	531	3	2	536
MOLLUSCA				
Mollusca sp.	95	14	91	200
GASTROPOD				
Snail sp.	0	0	2	2
TOTAL NISP (Identified fragments) =	1,914	52	169	**2,135**
Small Terrestrial Mammal	7	0	0	7
Medium Terrestrial Mammal	183	23	48	254
Large Terrestrial Mammal	80	3	8	91
Unident. Mammal Frags	1,558	30	84	1,702
TOTAL TNF (all fragments)	3,742	108	309	**4,159**

Fragment Size

Size of a bone can affect its identification rate. Larger bone fragments are often much easier to identify than smaller, more broken pieces. Some animals, however, have smaller bones that can be recovered whole and identified at a higher rate than broken fragments of a large mammal bone. At Næfurstaðir, the majority of the bones from all phases are in the 1-2 cm and 2-5 cm categories (see Figure 4). This makes sense, as most of the assemblage is made up of fish bones, which tend to fall within this range. The exception to this is Phase III, which is 55% mollusks. Pieces under 1 cm tend to be unidentifiable, but those that were identified are usually fish vertebrae with no spines or mollusk shell fragments.

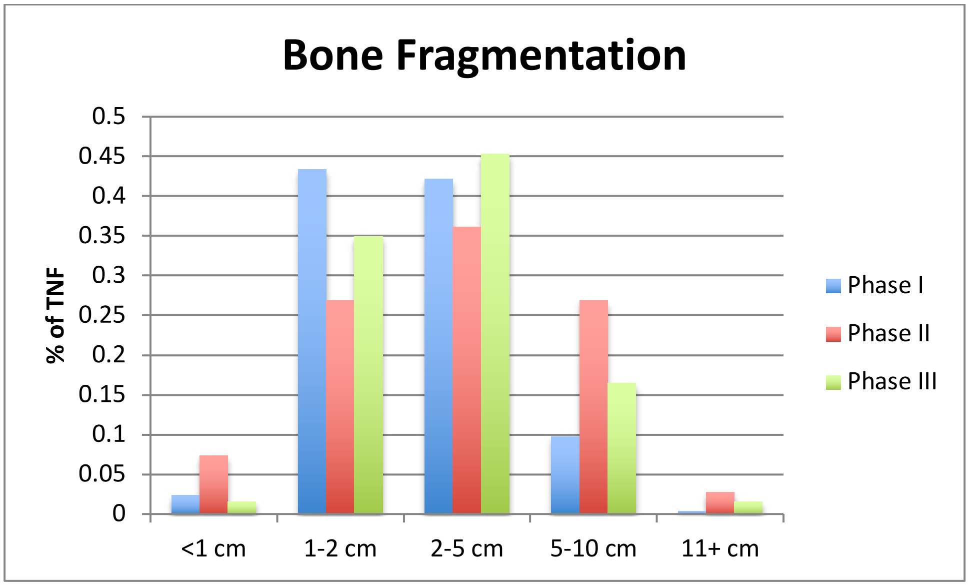

Figure 4: Bone fragmentation rates. Note that this graph shows TNF, not NISP, in order to characterize the entire assemblage.

<u>Burning</u>

As Figure 5 below shows, most of the bones from Næfurstaðir were unburned. The majority of those that were burned are completely calcined, the "white" category. This indicates a very hot fire. The midden layers varied between peat ash midden and a darker, charcoal-based deposit. The darker charcoal midden indicates periods of time when more wood was being burned rather than peat. The white burned bones could have been included in this and burned as fuel, then eventually deposited into the midden during a cleaning event. Another interpretation for white-burned bone in the Viking Age is that people would have disposed of their food waste in the long fire in the middle of the house, then during cleaning of the fire pit, calcined bone fragments mixed with wood charcoal and fire cracked rocks are disposed of in the midden (Thomas McGovern, personal communication).

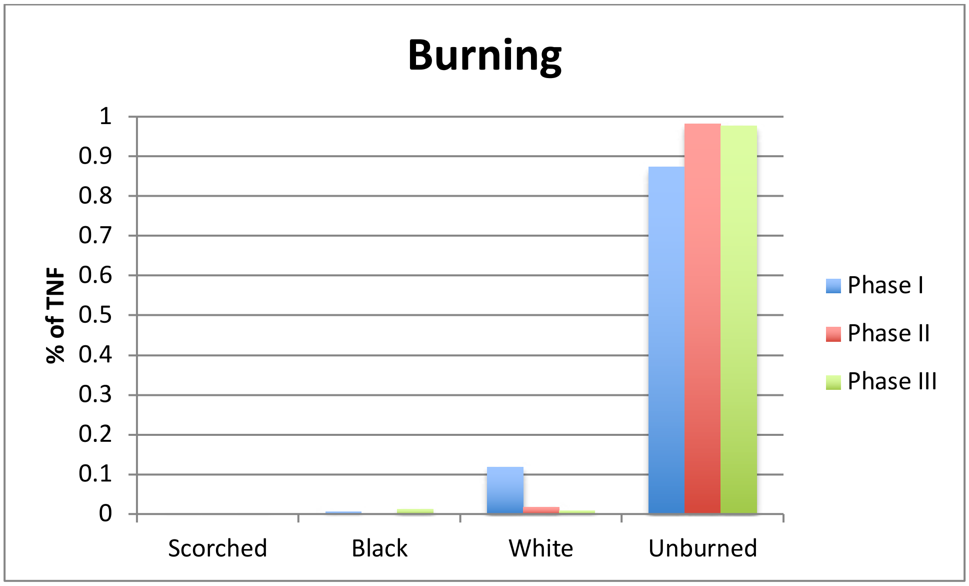

Figure 5: Burning, again presented as TNF

<u>Gnawing</u>

Only one bone showed evidence that appeared to be gnawing from a dog—a gull femur from Phase II. This indicates the presence of dogs on site, though no dog bones were identified.

Major Taxa

Figure 6 below shows the major taxa present in the Næfurstaðir assemblage based on NISP. In Phases I and II, fish make up the majority of the assemblage, while in Phase III, mollusks make up over half of the archaeofauna. In all phases, domesticates make up less than 20% of the assemblage. Birds and sea mammals are present in varying amounts. It is important to note, however, that only Phase I has a substantial enough NISP to discuss patterns (NISP=1,914), while the other two phases have very low NISPs (52 in Phase II and 169 in Phase III). The next sections will discuss these major taxa in more depth in order to understand the activities taking place at Næfurstaðir.

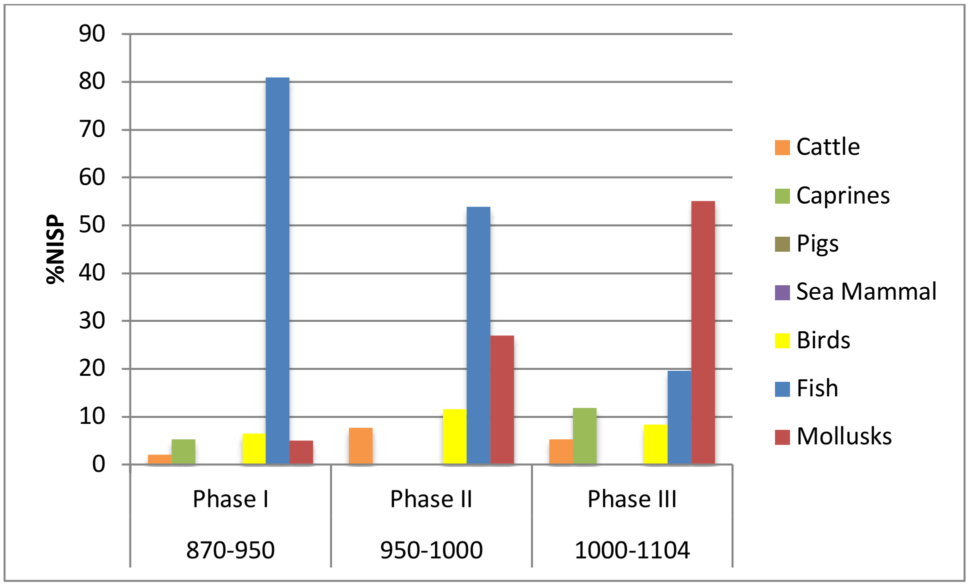

Figure 6: Relative percent of major taxa in all phases.

Caprines

The caprine category includes both sheep and goats. It can be quite difficult to distinguish between the two, especially on phalanges and long bone shafts. However, the ends of many long bones have diagnostic features allowing the identification of sheep or goat (see Boessneck 1969, Mainland and Halstead 2005, and Zeder and Lapham 2010) for a list of elements and their distinguishing features). These distinguishing bones are generally quite dense and preserve well in the archaeological record.

None of the distinguishable bones at Næfurstaðir could be assigned to goats. In fact, there have only been two goat bones identified in Skagafjörður (Cesario 2019a). Goats were part of the original settlement package and have been identified archaeologically alongside sheep at many farms. They fall out of favor in later times as sheep wool becomes more and more important not only for the household but for export as well. The lack of goats in Skagafjörður could have many reasons, one of which is simply that there have been relatively few zooarchaeological projects in Skagafjörður and those that have been conducted have sample sizes that are quite a bit smaller than other comparable studies in Iceland. Another potential reason for the lack of goats is that they simply were not present in large quantities in Skagafjörður for social, political, and/or environmental reasons.

Element Distribution

Only Phases I and III had any identifiable caprine bones. The caprine elements present in the Næfurstaðir archaeofauna are from the entire skeleton. The lack of vertebrae and ribs in Figure 7 is due to the NABONE protocol of identifying these elements only to size categories (see Methods section above) rather than the bones actually being missing from the archaeofauna.

The presence of elements from the entire skeleton indicates a home butchery strategy, where the inhabitants at Næfurstaðir were sustaining themselves. There is no evidence for extra body parts coming into the site, which would suggest that they were being provisioned from elsewhere, nor is there evidence of specific body parts leaving the site, which would indicate that they were provisioning others. In Phase III, there is a much higher percentage of cranial elements than any other elements during the same phase; however, the NISP of caprines in this phase is only 20, and so these patterns must not be taken as a truly representative sample.

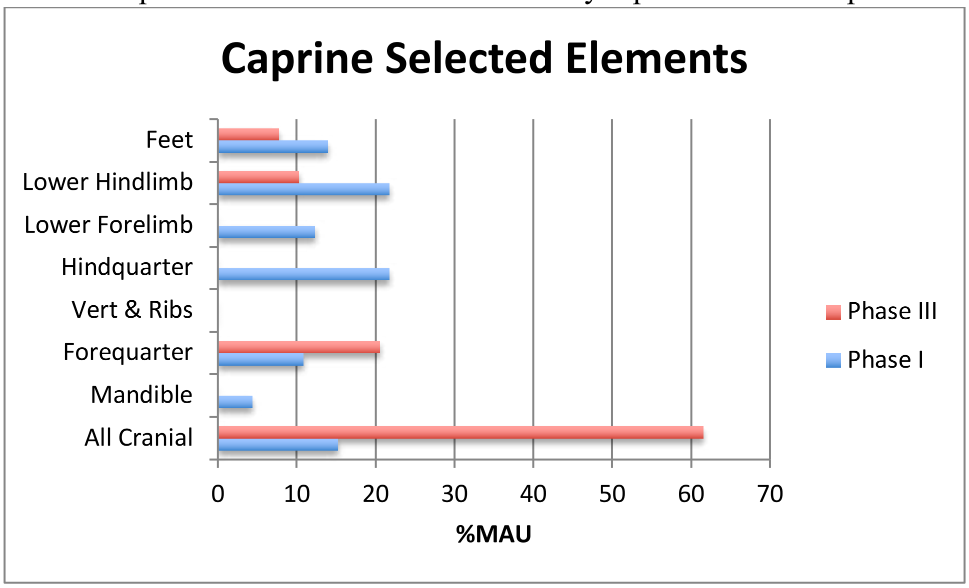

Figure 7: Caprine element distribution

Caprine Age Profile

Tooth Eruption and Wear

The assemblage did not include any mandibles with teeth, and so eruption and wear patterns could not be recorded.

Long Bone Fusion Stages

Only Phase I had long bone elements that could be scored for their fusion states (Figure 8). There were only 8 (out of 102) caprine bones for which fusion states could be recorded. Only 1/3 of the distal humerus were fused, meaning 1/3 caprines made it beyond their first 6 months of age. None of the other long bones were fused. This indicates a strategy in which most individuals are culled before they reach 6 months of age, and very few make it beyond 2 years. However, some animals would have to be raised to the two year mark and beyond in order to reproduce, so our small sample size is likely not wholly representative of the living population.

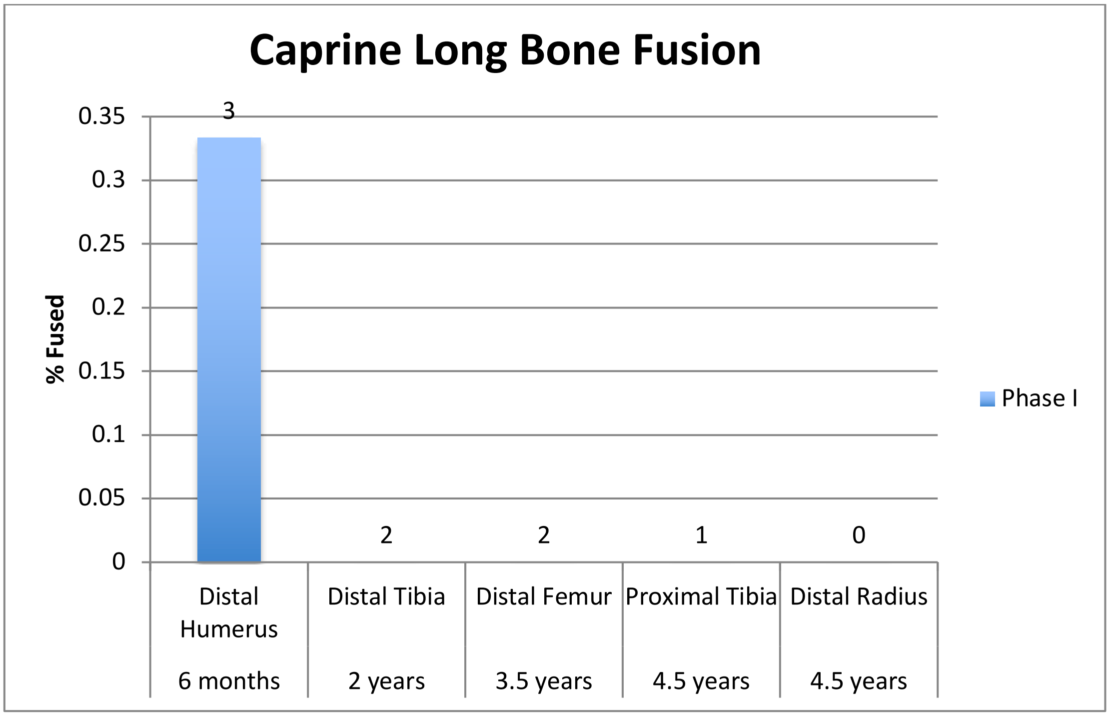

Figure 8: Long bone fusion stages for caprines. The number located above each element category represents the number of bones that were available for scoring; bar size indicates the percentage of these that were fused.

<u>Neonates</u>

There were neonatal caprines present in both Phase I (n=2) and Phase III (n=1). These, along with the long bone fusion data above, indicate a strategy geared towards dairy production. The young are culled and the mother's milk is collected for human consumption, either directly, or through the creation of other products (skyr, whey for preserving, cheese, etc.). This also indicates seasonality, as the lambing season is traditionally in May.

Cattle to Caprine Ratios

In Iceland, there is a general increase in caprine use over time, especially as sheep gain importance for export of the standardized woolen cloth *vaðmál* as well as remaining a vital part of Icelandic household economy. The tradeoff seems to be that fewer cattle are kept in favor of increasing the number of sheep that can be raised.

At Næfurstaðir, this pattern is not clear (Figure 9). In Phase I, the ratio of cattle to caprines is 2.68, so for every head of cattle there are 2.68 caprines. This changes slightly in Phase III, where the ratio is 2.22. There are no caprines in Phase II, and the NISP is very small, so change during that period is not recorded. These ratios are quite low, and not very similar to other sites in Skagafjörður. The ratios are actually closest to two sites in Mývatnssveit—the mid-10th century phase at Sveigakot and Hofstaðir Phase III, which dates to 1030-1070 AD. These are sites are roughly contemporary with Næfurstaðir, though Hofstaðir was settled later than Næfurstaðir.

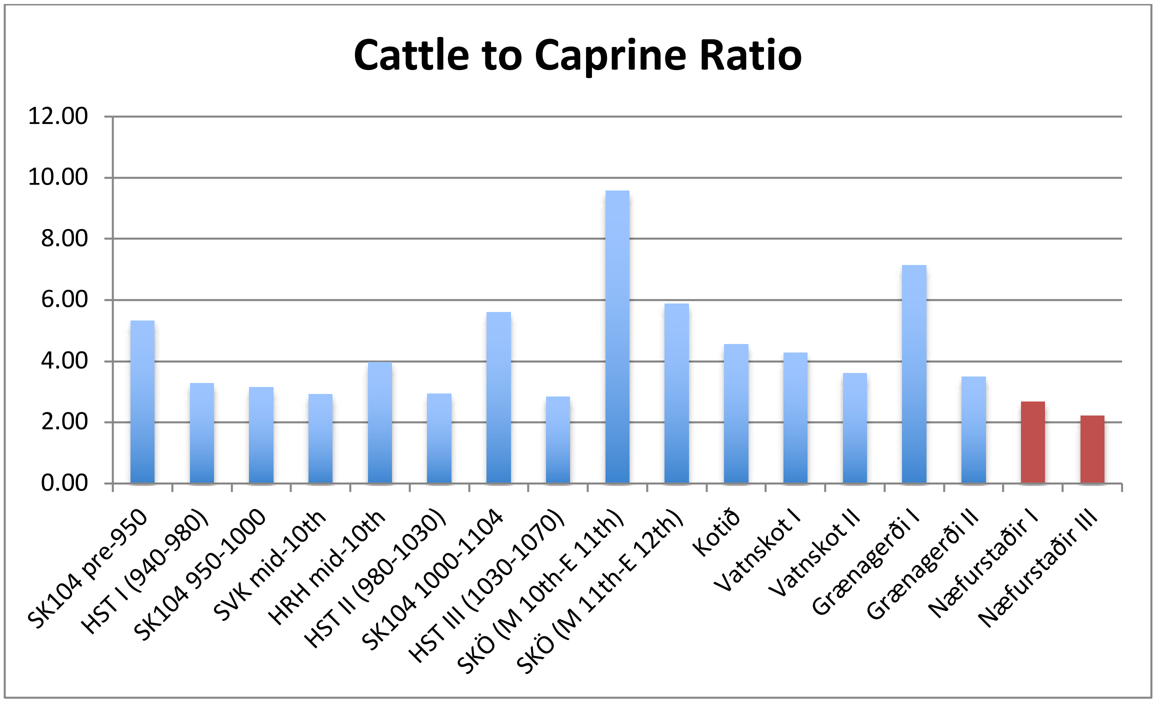

Figure 9: Cattle to caprine ratios throughout Iceland. Næfurstaðir is highlighted in red. Other sites in Skagafjörður include SK104 (Stóra-Seyla), Kotið, Vatnskot, and Grænagerði. As comparisons, we have Skuggi (SKÖ) in neighboring Eyjafjörður and in Mývatnssveit we have Hofstaðir (HST), Sveigakot (SVK), and Hrísheimar (HRH).

Cattle

The use of cattle at Næfurstaðir stays relatively stable over time, considering the use of other domesticates as well. In Phase I, cattle make up ~27% of domesticates (Figure 10). Phase III cattle make up 31% of the domesticates, while in Phase II, they are the only domesticates that could be identified. Phase II is anomalous because of the low total NISP.

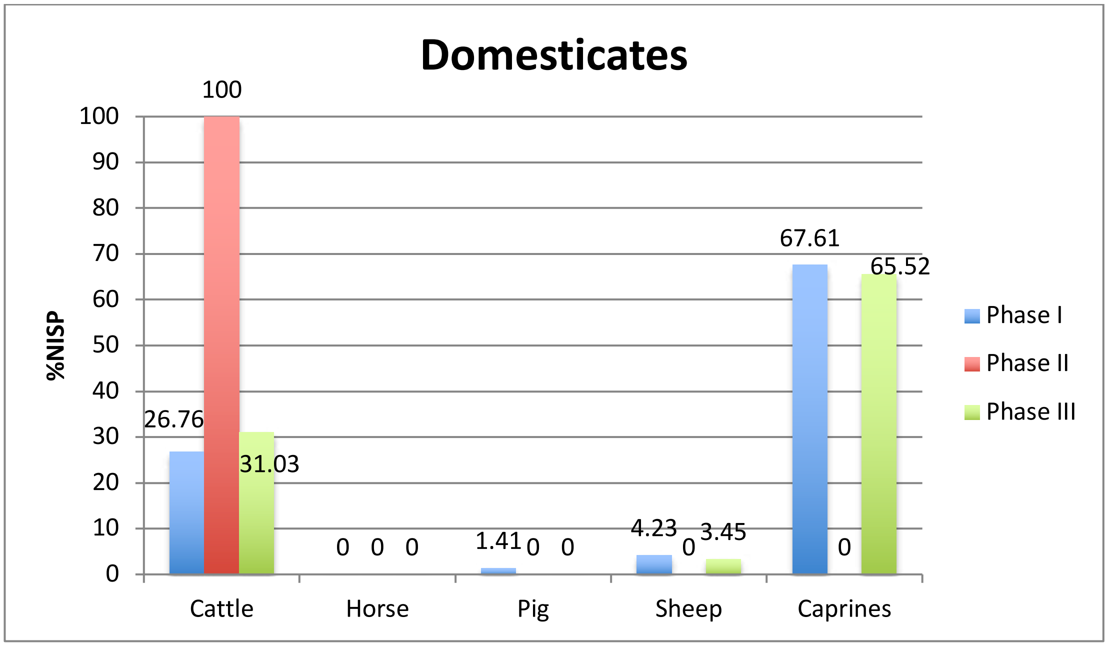

Figure 10: Relative percentage of domesticates in all phases.

Cattle Age Profile

Very few cattle bones were available for determining age, but those that were available are discussed below.

<u>Tooth Eruption and Wear</u>

While mandible fragments and loose teeth were recovered, no mandibles with teeth present in the jaw for aging were available for this collection.

<u>Long Bone Fusion Stages</u>

Only three long bones could be scored for fusion. In Phase I, one distal radius was fused, indicating an individual over 3.5-4 years of age (see figure 11). In Phase II, two bones were unfused, a distal tibia and a distal femur. These represent animals under 2-2.5 and 3.5-4 years of age, respectively.

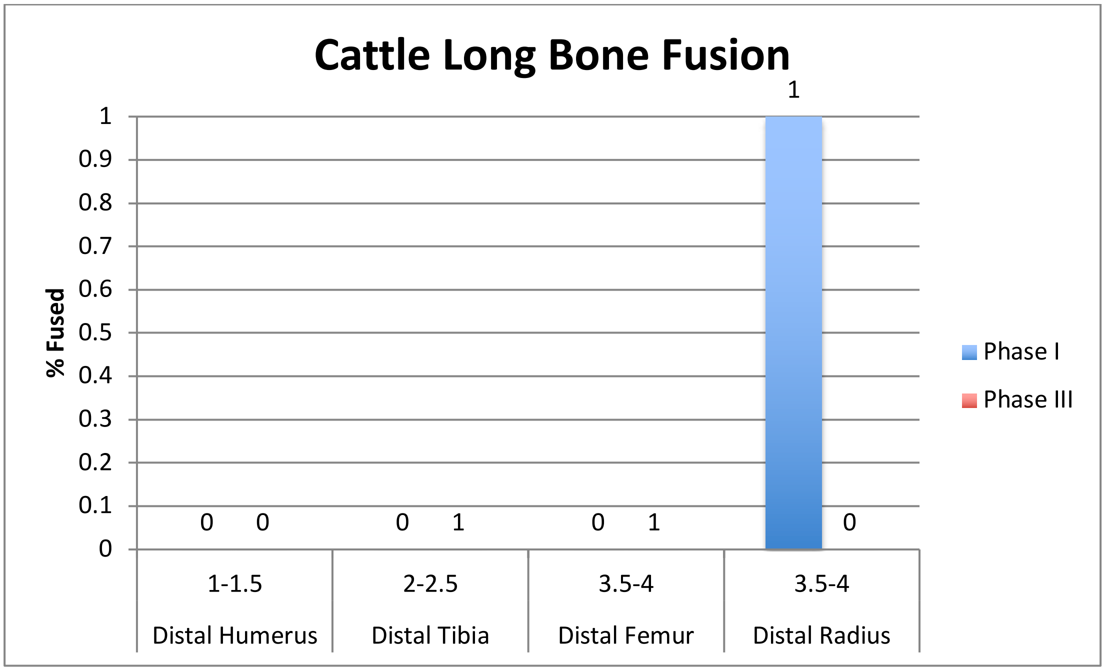

Figure 11: Cattle long bone fusion. Numbers above each bar represent the number of bones present in each category; size of bar indicates percentage of bones that were fused. Fusion data comes from McGovern (2009:221).

<u>Neonates</u>

There are neonatal cattle present in all three phases at Næfurstaðir. Like the caprines, this indicates a dairying strategy where the babies are culled in order to collect the milk for human consumption. Again, this also points to a late spring/early summer occupation, as calves are often born around this time.

Other Mammals

Most of the mammals found in all phases were domesticates. In Phase I, other than the cattle and caprines discussed above, there were two pig bones. Pigs were also part of the domesticate package brought over at settlement, but they quickly fall out of use and almost no pigs are seen in the archaeological record after 1104 AD.

Sea mammals were also present in small quantities at Næfurstaðir in Phase I. One seal bone and one cetacean fragment were recovered. Neither have been identified to species, because it is quite difficult to identify cetacean fragments to element, let alone to species. The seal bone was a distal phalanx, which are not readily identifiable to species. However, their presence is interesting when thinking about intensive use of marine resources, as we see with the fish, sea birds, and mollusks.

Mollusks and Gastropods

The identifiable mollusks at Næfurstaðir are either clams or mussels (Figure 12), though mussels are only present in Phase III. Of the identifiable mollusks, clams dominate. These shells may represent shellfish that were collected while other activities were taking place on the shore, or in the case of Phases II and III, they may have made up a significant portion of the diet. Both of these phases have relatively low NISPs though (52 in Phase II, 169 in Phase III), so this could be a case of overrepresentation based on fragmentation, among other factors. None of the shells showed tool marks, though they could have also been collected to use the meat as bait for fishing. However, if the clams are *Arctica islandica*, they may be coming from deep water and are more likely to be collected from the beach without meat inside, and therefore not used as bait. These shells are used ethnographically as spoons or scoops, and so this could be another explanation for their presence in the assemblage.

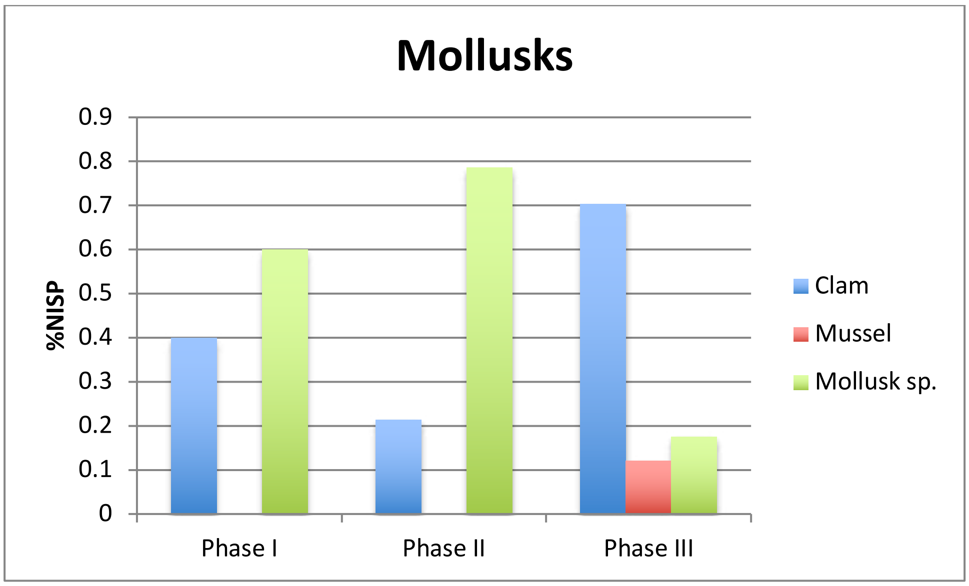

Figure 12: %NISP of mollusks

Gastropods were also found at Næfurstaðir. These are likely land snails, but a species-level identification has not been made. There were only 2 found, both in Phase III.

Birds

Of the identifiable birds, most are seabirds (Table 2). The puffin and guillemot are migratory species that breed in Iceland in the summer months. They nest on cliffs and harvesting both adult birds and their eggs is a dangerous activity that would not have been undertaken alone. They represent a communal harvesting strategy that would have taken people away from summer farming activities. There are not many of these birds, and so they may represent ones that were collected during a fishing trip or some other activity, rather than a specifically targeted species.

The unidentifiable bird remains are mostly skull fragments that are difficult to identify to species or other bones that are too fragmented to identify beyond "bird."

Table 2: Birds in all phases.

Species	Common Name	Phase I	Phase II	Phase III	Total
Seabirds					
Fratercula arctica	Puffin	29	1	5	35
Uria aalge	Guillemot	10	0	0	10
Gull sp.	Unidentified gull	1	1	0	2
Land birds					
Duck sp.	Unidentified duck	1	0	0	1
Lagopus muta	Ptarmigan	1	0	0	1
Unidentified birds					
Bird sp.	Unidentified bird	83	4	9	96

Fish

All of the identifiable fish at Næfurstaðir are from marine fish of the cod family, or gadids (Table 3). No freshwater fish were found in the archaeofauna.

Table 3: Fish NISP by phase

Phase		**I**	**II**	**III**	**Total**
Marine					
Gadus morhua	Atlantic cod	215	1	10	226
Pollachius virens	Saithe	2	0	0	2
Melanogramus aegilfinus	Haddock	7	0	1	8
Molva molva	Ling	12	0	0	12
Gadidae	Gadid family	783	24	20	827
Unidentified fish		531	3	2	536
Total		1,550	28	33	1,641

Phase I Fish

Phase I had the most substantial numbers of fish (Table 3) and the highest total NISP (1,914) of all three phases. In Phase I, nearly 2/3 of the fish were identifiable as gadid fish (1,019), most of which were cod, while only 531 were simply identified as fish. Element distributions (Figure 13) indicate that the majority of the gadid remains were from the skull rather than the body of the fish. Analysis of the vertebrae (Figure 14) has shown that thoracic vertebrae are more common than precaudal or caudal. This pattern is typical of the production of a flat-dried fish product, as will be discussed further below. There is however still evidence of whole fish being consumed on the site, as can be seen through the presence of some precaudal and caudal vertebrae on the site.

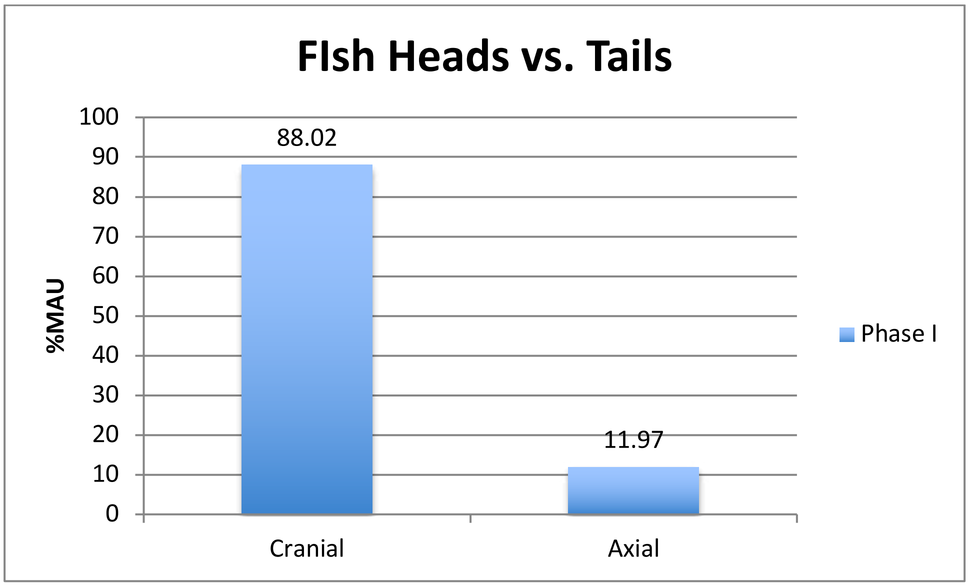

Figure 13: Fish cranial and axial elements

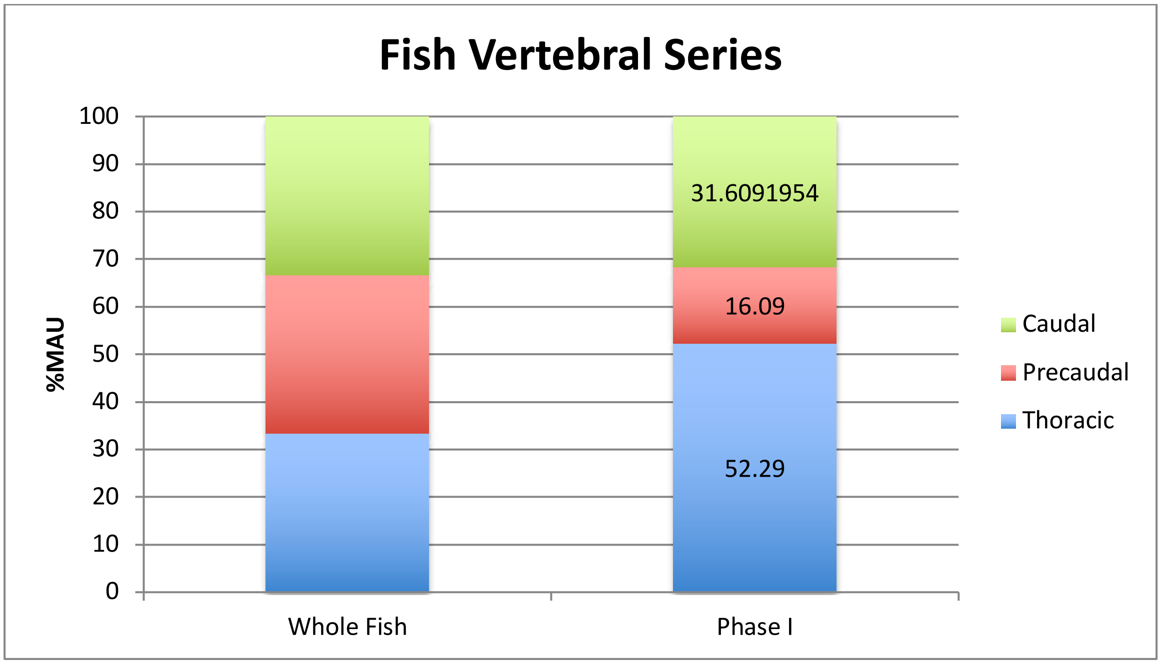

Figure 14: %MAU of different vertebrae from all gadids. Note that the leftmost column shows the ratios in a whole fish.

Phase II & III Fish

The numbers of fish in the Phase II and Phase III samples are quite small, and so their patterns are not shown in the figures above. In Phase II, the number of elements that could be used for establishing these patterns was only 6, while there were 21 in Phase III.

Fish Interpretation

Since Phase II and Phase III had really low numbers of fish, only Phase I will be discussed here. These fish show a distinct signature of more head elements than tail elements. There are also more thoracic vertebrae than any other type of vertebra. These signatures tells us not only that Næfurstaðir participated in fish-processing, but that they were producing a flat-dried fish product rather than one dried in the round (e.g., Amundsen et al. 2004, 2005; Perdikaris and McGovern 2008a).

Sites where fish are being processed and dried will contain disproportionately more elements from the head of the fish, since the head is not left with the finished product. Sites where dried fish are consumed will contain more elements from the body of the fish, mostly vertebrae. The kinds of vertebrae present tell us if the product was dried in the round or dried flat.

Round dried fish closely resemble the historically known “stockfish” later exported in large quantities from late medieval and early modern Iceland. The head is cut off, leaving the cleithrum and all vertebrae. Thus, a site where production of round dried fish is the focus will have mostly head bits and very few vertebrae. Consumption of round dried fish shows more vertebrae than other elements, and these are more evenly distributed through the three different kinds of vertebrae.

On the other hand, flat-dried fish were more heavily filleted and may have circulated more intensively within Iceland. To make a flat-dried product, the head is cut off, and the fish is split down the middle almost all of the way to the tail, leaving the cleithrum to aid in keeping the body together. During the drying process, this filleting allows some vertebrae to fall out. Therefore, at site where production of the flat-dried product is the focus, skull fragments and thoracic vertebrae are expected, with a few precaudal and caudal as well. At a site consuming flat-dried fish, mostly caudal vertebrae will be found, along with small numbers of precaudal and perhaps a couple of thoracic vertebrae. If these fish were instead consumed whole, the graphs above would show equal bars for all vertebrae, as it presents %MAU and thus controls for carrying quantities of each vertebra in the body.

As can be seen in Figure 13 and Figure 14 above, cranial elements are much more common than axial in both phases. In addition to this, the vertebral analysis shows that mostly thoracic vertebrae are found. This is strong evidence for the production of a flat-dried product at Næfurstaðir. The presence of other vertebrae and axial elements also indicates that whole fresh fish were sometimes consumed on site. This pattern points to a Viking Age artisanal fishing strategy that began at the settlement of the region. Archaeological investigations at sites further inland in Skagafjörður also confirm a local trade network of this dried fish product. At the site of Stóra-Seyla in Langholt, zooarchaeological analyses point to the consumption of a flat-dried fish product (Cesario 2016). Other sites on Hegranes (Kotið, Grænagerði, and Vatnskot) also seem to have produced flat-dried fish, illuminating the possibility of an even larger network of producers and consumers (Cesario 2018a, 2019a, 2020). Patterns of marine fish product production and consumption have considerable potential to shed light on still poorly-understood patterns of pre-commercial, artisanal production and distribution of these characteristic Nordic dried fish products (Perdikaris and McGovern 2008a, 2008b).

With fish bones, there is always the possibility that taphonomy has destroyed many of the bones or that the collection strategy will not favor smaller bones and the archaeofauna will be biased. A biased collection strategy was not the case at Næfurstaðir, since the caudal vertebrae are the smallest of all the vertebrae and many were collected. Since these smaller bones were preserved, it can also be assumed that the soil conditions were favorable, and so taphonomy does not seem to have played a dominant role in the number of fish bones recovered.

Concluding Remarks

The fish remains at Næfurstaðir tell an interesting story of a Viking Age artisanal fishing enterprise and open up avenues for research of interregional (i.e., coastal and inland) exchange. It is important to remember that these would have been pre-commercial fishing ventures, and standardization of size or product made would not have been as highly regulated as it became later in time.

Sites like Vatnskot, Kotið, Næfurstaðir, and Grænagerði participated in the production of a specialized product while also maintaining small farms for their own use. They likely played pivotal roles in the local economy, and understanding these kinds of sites within the larger social system is important for making sense of the changes in landscape organization over time.

Acknowledgements

Thanks also to the field crew—Kathryn Catlin, Grace Bello, Melissa Ritchey, Tyler Perkins, and Nicholas Zeitlin. To John Steinberg and Doug Bolender for all of their support over the years and for bringing me onto this project in the first place. I am forever grateful to Sirrí and Guðný and Byggðasafn Skagfirðinga for their support.

Fieldwork was supported by the US National Science Foundation (PLR # 1523025, 1242829, 1345066, & 1417772) in a joint project of the Skagafjörður Heritage Museum (Byggðasafn Skagfirðinga), the University of Massachusetts Boston, and Northwestern University. Analysis was also supported by the National Science Foundation Graduate Research Fellowship Program grant no. DGE-1037525. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author and do not necessarily reflect the views of the National Science Foundation.

As always, Thomas McGovern gets my thanks for productive conversations about interpreting the data and enthusiastic support.

NABO

Skagafjörður Church and Settlement Survey: Archaeofauna from the 2017 Field Season on Hegranes, Skagafjörður

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CUNY NORSEC Laboratory Report No. 75

Introduction and Excavations

In 2017, as part of the Skagafjörður Church and Settlement Survey (NSF PLR # 1242829, 1345066, 1417772 & 1523025) and Fornbýli Landscape and Archaeological Survey on Hegranes (FLASH), five sites on Hegranes (Figure 1) were intensively surveyed, cored, and test pitted. These ranged from large, active farms to small, abandoned sites. This report on the archaeofauna from these test pit excavations supplements Bolender et al (2018) and Catlin et al (2018) by providing economic context to their survey and excavation results. Two farms excavated in 2017 will not be reported here—Vatnskot and Grænagerði—because they produced much larger archaeofauna with distinct signatures that required separate reporting (Cesario 2019a, 2020).

The sites explored in Hegranes fall into two major categories—abandoned sites, or *fornbýli*, and those that are currently occupied and farmed. The abandoned sites are small and located physically on the margins of the large farms. These sites are also environmentally marginal, as they tend to be located in eroded areas. SCASS research focuses on the large farms, while FLASH studies the abandoned sites. The vast majority of the *fornbýli* are abandoned by AD 1104.

Test pits were 1x1 meter units, placed in areas of the farm mound with the best tephra preservation and evidence of human activities. The archaeofaunal samples collected from these excavations are too small to present more than a species list, though a few observations based on broader patterns will be discussed once all the data has been presented.

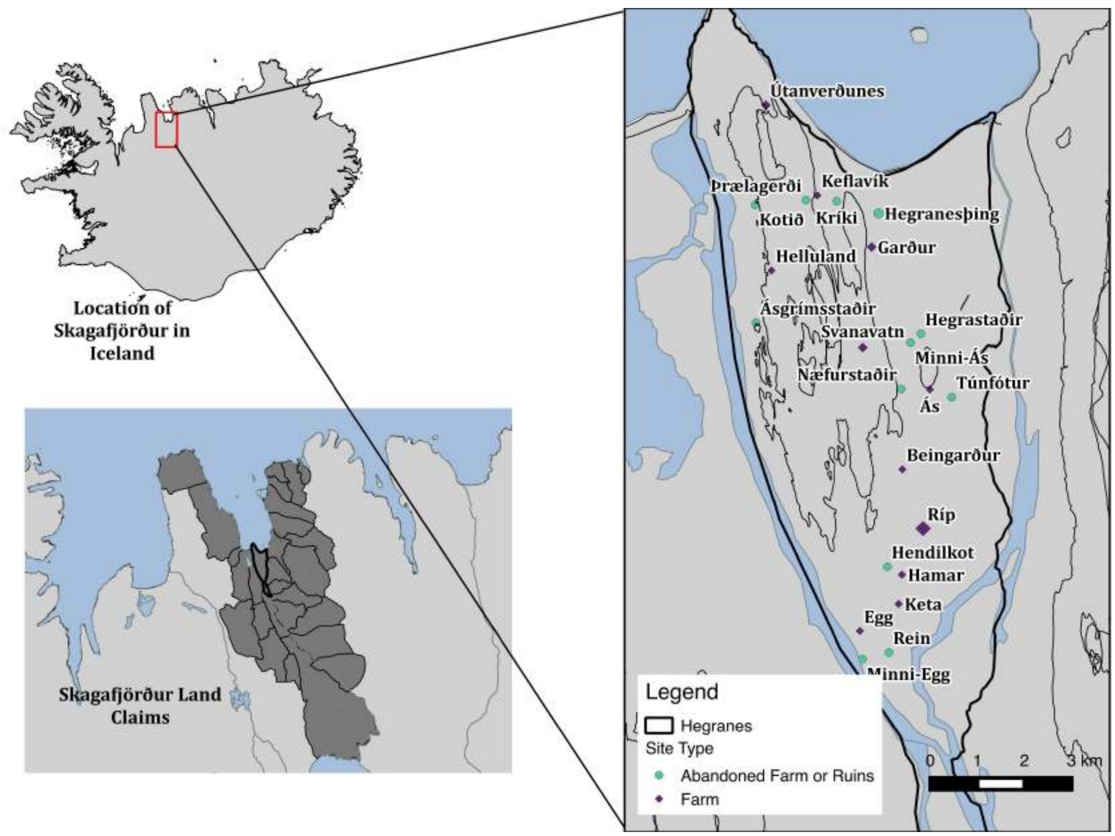

Figure 73: Map showing the location of Skagafjordur in Iceland (upper left), the land claims in Skagafjordur with Hegranes outlined with a bold black line (bottom left), and the locations of the sites on Hegranes (right).

Methods

The faunal materials were analyzed at the Hunter College Zooarchaeology Laboratory, and made use of the comparative collection there. Recording and data curation follow NABONE protocols, utilizing the 9th edition of this recording package (a Microsoft Access database supplemented with specialized Microsoft Excel spreadsheets, available to download at www.nabohome.org). Digital records were all made using this package. The animal bones excavated will be permanently curated at the National Museum of Iceland along with all digital records. Digital records will also be preserved in the NABO collection on The Digital Archaeological Record (tDAR). An electronic copy of this report is available at www.nabohome.org and at the UMB SCASS website/Fiske Center site.

All fragments were identified as far as taxonomically possible, and a selected element approach was not used. Most mammal ribs, vertebrae, and long bone shaft fragments were assigned to "Large Terrestrial Mammal" (cattle or horse sized), "Medium Terrestrial Mammal" (sheep, goat, pig, or large dog sized), and "Small Terrestrial Mammal" (fox or small dog sized). Only those elements which can be positively identified as sheep, *Ovis aries*, were assigned to this category while all other sheep/goat elements were assigned to a more general "caprine" category.

Following widespread North Atlantic tradition, bone fragment quantification makes use of the Number of Identified Specimens (NISP) method (Grayson 1984). All mammal measurements follow von den Driesch (1976). Sheep/goat distinctions follow Boessneck (1969) and Mainland and Halstead (2005). Only positively identified fragments of fish bone were given species level identification, with those unidentifiable to species placed in the family category where possible, often *gadid*, while others were identified simply as fish. No fish bones from this collection required measurement.

Results

For most of these sites, the archaeofauna were too small to draw any conclusions. They are not generally presented in tables, because there are so few bones. The two sites with slightly more substantial collections—Beingarður and Keflavík—do have tables which present NISP and TNF (Total Number of Fragments).

Unfortunately, the two sites did not have the same phasing as not all tephra was present during excavation and so they cannot be directly compared. However, each of these assemblages has been analyzed by time period based on the volcanic tephra present during excavation. Beingarður was separated into pre- and post-1104 because the white AD 1104 tephra was present during excavation (Bolender et al. 2018a). The two time periods at Keflavík are pre- and post-950 based on Steinberg et al (2018:28). Subsequent radiocarbon dating on carbonized seeds will help to further refine these dating sequences and may allow us to directly compare assemblages if contemporaneity is found.

What follows is a bit of background information on each site, and then the archaeofaunal data, whether in table form or prose. Finally, a few general observations and conclusions about the assemblages.

Beingarður

Beingarður is one of two active farms that will be reported on here. It has gone through periods of abandonment in the past, and was abandoned for the majority of the 18th century (Bolender et al. 2018a:33). Compared to other farmsteads on Hegranes, Beingarður was small, and coring revealed that most of the activity took place near the modern farmstead (Bolender et al. 2018a:33–34).

Excavation focused on an area near the house where the midden was the deepest, where tephra was present in cores, and where bones were visible on the surface. The 1x1 meter test pit yielded a total of 195 bone fragments (Table 1), 82 of which were identifiable.

Table 1: TNF and NISP for both phases at Beingarður.

	Pre-1104	Post-1104	Total
DOMESTICATES			
Bos taurus	1	2	3
Equus caballus	0	0	0
Ovis aries	0	0	0
Capra hircus	0	0	0
Ovis/Capra sp.	1	6	7
BIRDS			
Wildfowl - sea birds	0	13	13
Bird sp.	14	38	52
FISH			
Gadid sp.	5	0	5
Fish sp.indet.	0	0	0
MOLLUSCA			
Mollusca sp.	2	0	2
TOTAL NISP=	**23**	**59**	**82**
Small Terrestrial Mammal	0	0	0
Medium Terrestrial Mammal	2	14	16
Large Terrestrial Mammal	1	4	5
Unidentified	31	61	92
TOTAL TNF=	**57**	**138**	**195**

This small sample size does not reveal much about the economic activities taking place at the farm, and many of the post-1104 bones (n=36) come from the intrusive pit [103] that cuts through the other contexts. More birds are present later in the sequence (post-1104), many of which were burned and come from pit [103].

Lower Keflavík

Lower Keflavík is part of the current Keflavík property, located downhill and east of the cemetery, in between the farm mound and the modern farm buildings. There is a long tún wall that helps to define Lower Keflavík (Steinberg et al. 2018:8). The 1x1 meter excavation unit here (TP6) was placed based on cores that indicated good midden preservation as well as the presence of multiple tephra layers (Steinberg et al. 2018:27).

TP6 confirmed that there was a Viking Age longhouse separate from the main farm mound that was established early, perhaps right at settlement. It seems to have been occupied for a short time and was out of intensive use by the end of the 10th century. Following Steinberg et al. (2018), two time periods have been used as the analytical units here—pre- and post-950. In the pre-950 period are contexts [128] and [129] and in the post-950 period are contexts [126] and [127].

Table 2: TNF and NISP for Lower Keflavík TP6.

	Pre-950	Post-950	Total
DOMESTICATES			
Bos taurus	0	10	10
Sus scrofa	0	2	2
Ovis aries	1	0	1
Ovis/Capra sp.	5	15	20
OTHER MAMMALS			
Phocid sp.	0	1	1
Alopex lagopus	0	1	1
FISH			
Gadid sp.	0	2	2
TOTAL NISP=	**6**	**31**	**82**
Medium Terrestrial Mammal	3	3	6
Large Terrestrial Mammal	4	8	12
Unidentified	60	95	155
TOTAL TNF=	**73**	**137**	**210**

Again, there is a sample size issue here and not many conclusions can be drawn (Table 2). However, both phases are primarily comprised of domesticates, with very few wild species. Perhaps the higher NISP in the post-950 phase is indicative of increased farming activities and success post-settlement.

Gerði

Gerði is located on the property of Keldudalur, in one of their hay fields (Catlin et al. 2018:76). The site is mentioned in some historic documents, but rarely in detail though one source describes a part of the field with a sheep shed on it that was called Gerði (Catlin et al. 2018:76). Since the site is in a currently cultivated field, it has been subject to plowing and bulldozing.

The excavation unit was placed based on the presence of the AD 1104 tephra in order to find the earliest evidence of occupation at the site (Catlin et al. 2018:78). The excavations recovered only nine bones from three contexts, three of which were identifiable. The identifiable bones come from two contexts likely dated to post-1000 (Catlin et al. 2018:79), and consist of one cattle and two caprine bones. Three unidentifiable bones also come from these contexts, and two unidentifiable fragments come from a pre-1000 context.

There are too few bones to draw any conclusions about the site, and Catlin (2018:81) believes that the midden was quite small, perhaps just one square meter, meaning most of it was fully excavated in 2017.

Grænakot

Grænakot is located on land owned by Keflavík. Historical records also indicate a site called Vík on Keflavík, but it is unclear if Vík and Grænakot are the same or two different sites (Catlin et al. 2018:48). After coring, a 1x1 meter test pit was excavated. Catlin (2018:54-55) has concluded that the excavation was placed into a pit that had been dug for trash disposal, with later buildings being placed on top and going through cycles of demolition, filling, and/or rebuilding.

Very few bones were recovered from Grænakot/Vík. Only 16 total fragments were found, and they come from two different contexts—seven bones from [103] and nine from [106]. None of the bones were identifiable.

Minni-Egg

Minni-Egg is located on the property of Egg, about 650 meters south of the modern farm (Catlin et al. 2018:82). Its use is unclear, and it has been described as an abandoned cottage or an ancient farm, as well as likely being used for livestock management (Catlin et al. 2018:82 and references therein). The entire site has been highly affected by freeze/thaw cycles and is surrounded by rocky areas. Coring efforts in 2015-2017 finally identified a very small midden deposit, and in 2017 a 1x1 test pit was placed to target that area.

Very few bones were recovered during excavation, but preservation was decent. Only eight total bone fragments were found, all from context [104] (Catlin et al. 2018). Of those eight bones, only six could be identified and these include one horse, two caprines, and 3 gadids.

This sample size is far too small to say anything about the site, and the midden too ephemeral to justify going back for further excavation. It seems that the human occupation at Minni-Egg was short, though livestock management continued later in time.

General Patterns

One of the most striking patterns is that even though excavations aimed for the areas that would have the most midden material, hardly any bones were present in the small sites. However, this is not always the case at these small sites, or *fornbýli* (see Cesario 2018a, 2018b, 2018c). In this case, it may be that the population size was smaller at these sites, and indeed the sites discussed here have less area than some of the other *fornbýli.* Smaller site size may also point to less refuse being generated, and therefore less being thrown into the midden. Sample sizes from the two large sites are greater than those from the *fornbýli*, but they still do not make it possible to draw conclusions about site use patterns.

Acknowledgements

Thanks go out to all of the farmers on Hegranes for granting us permission to work on their land. Thanks also to Guðný, Sirrí, and Bryndís from the Skagafjörður Heritage Museum for their help, support, and friendship. To Doug Bolender and John Steinberg for continuing to trust me with fieldwork and archaeofauna. The 2017 field crew was great and their efforts are much appreciated.

This fieldwork was supported by the US National Science Foundation (PLR # 1523025, 1242829, 1345066, & 1417772) in a joint project of the Skagafjörður Heritage Museum

(Byggðasafn Skagfirðinga), the University of Massachusetts Boston, and Northwestern University. Analysis was supported by the National Science Foundation Graduate Research Fellowship Program grant no. DGE-1037525. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author and do not necessarily reflect the views of the National Science Foundation.

As always, Thomas McGovern gets my thanks for productive conversations about interpreting the data and enthusiastic support during the whole process.

Appendix B: Excavation Reports

This appendix contains the excavation reports from the 2018 excavations on Hegranes. The excavations that year were targeted specifically to collect more data for this dissertation and for a master's thesis (Ritchey 2019). The reports have been appended exactly as they appear in publication, with the exception of a font change to suit the requirements for the submission of the dissertation and some minor formatting.

The reports are presented in the following order, with their in-text citations listed first and the titles after:

1. Cesario 2018b: Næfurstadir on Hegranes: TP2 Excavation
2. Cesario and Ritchey 2018: Vatnskot on Hegranes: TP2 Excavation
3. Ritchey and Cesario 2018: Grænagerði on Hegranes: TP2 Excavation Report 2018

Skagafjörður Church and Settlement Survey

Næfurstaðir on Hegranes: TP2 Excavation

Grace Cesario

27 July 2020

Picture on front page – Grace Bello and Grace Cesario excavate the extended portion of TP2 on 18 July 2018

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Byggðasafn Skagfirðinga/Fiske Center for Archaeological Research, UMass Boston
BSK-2020-238
2020

Acknowledgements

We are greatly indebted to the farmers at Ás 2, Einar Valur Valgarðsson, Elísa Björk Einarsdóttir, and Bjarney Anna Björnsdóttir, who allowed us to excavate on their land over two field seasons, and who have been incredibly kind and helpful throughout.

We are also grateful to the field crew who participated in both years of excavation. In the summer of 2016, Kathryn Catlin directed a team including Lauren Welch O´Connor and Nicholas Zeitlin in the excavation of the original 1x1. The 2018 crew, directed by Grace Cesario, included Grace Bello, Melissa Ritchey, Tyler Perkins, and Nicholas Zeitlin.

The project was dependent on a number of permissions.

- Minjastofnun Íslands (The Cultural Heritage Agency of Iceland) granted permission for the excavation. Project number: ***201606-0051***
- And Þjóðminjasafn Íslands (The National Museum of Iceland) granted the site number used for finds: ***Þjms-2018-49***

We also want to thank the funding bodies that made the excavation possible. The excavation was made possible by a grant from the Icelandic Archaeology fund with additional support from the National Science Foundation Grant nos. PLR-1417772, 1523025.

Introduction

A 1x1 test pit at Næfurstaðir (site 442-4), TP1, was excavated in 2016 by Kathryn Catlin, Lauren O'Connor, and Nicholas Zeitlin (Catlin et al. 2017). This excavation was placed near a visible ruined structure and coring showed that there were at least two tephra layers present—the white AD 1104 and the grey-ish AD ~950 (see Catlin et al. 2017:17 for more information and site background).

In 2018, another test pit was opened at Næfurstaðir in order to collect more archaeofaunal and macrobotanical samples (Cesario 2018c). Kathryn Catlin and Grace Cesario cored around all sides of TP1 in order to determine which direction the new pit should be placed. Based on the presence of thick midden layers and tephra, the 2018 excavation was placed north and west of TP1, making the original 1x1 the southeast unit of the new pit. Originally, TP2 was opened as a 2x2 excavation, however, after reaching the sterile subsoil, Cesario decided to expand an extra 1x2 to the west in order to ensure a large faunal sample for her dissertation. The total size of the 2018 excavation, including TP1, was 3x2m.

Sampling Strategy

Floats

All float samples came from the NE unit in order to remain consistent with the sampling strategy of the larger project. The SCASS protocol usually only calls for excavation of a 1x1 unit in order to answer questions about settlement date, so samples for flotation come from a 1x1. Where possible, we took two seven-liter bags for flotation. We did not take any macrobotanical samples from the 1x2m extension in 2018.

Bones

Contexts were sieved through 4mm mesh and bones collected from the screen. In cases where the soil was too sticky or the day too wet to identify bone from rock and other debris in the field, as much soil as possible was sieved off and the rest poured into a bag to be wet screened later. Wet screening used the same 4mm mesh screen in order to keep sampling consistent.

Bones from the extension were given different sample numbers, though the contexts matched up with the rest of TP2.

Excavation

TP2 was measured, placed, and opened by Melissa Ritchey, Grace Bello, Grace Cesario, and Kathryn Catlin on 12 July 2018. Further excavation crew included Nicholas Zeitlin and Tyler Perkins. The 1x2m extension was opened 17 July and the entire excavation closed on 18 July 2018.

Contexts from the 2018 excavation were numbered sequentially, following the last number from TP1 in 2016. Most contexts from the original TP2 2x2m matched in the extension 1x2m, so no new contexts were made. Contexts from TP1 in 2016 loosely correspond to TP2, though we split more contexts in 2018 than were split in 2016 (see Table 1 below for context correlations).

Table 1: Context correspondence between TP1 and TP2, including context numbers and short descriptions.

TP1	Description	TP2	Description
101	Bioturbated root mat	**101**	Bioturbated root mat
102	Turfy and bioturbated, includes 1300	**109**	Bioturbated aeolian to 1300
		1300	Blue-ish tephra
		110	Bioturbated aeolian after 1300
		111	Bioturbated and turfy
1104	White tephra	**1104**	White tephra
103	Midden, peat ash	**112**	Dark yellow grey midden
		113	Peat ash midden
		114	Grey midden
1000?		---------	-----------
104	LDC midden, mid-orange brown	**115**	Yellow brown LDC
934	Blue-grey tephra	**934**	Blue-grey tephra
105	LDC midden, mid-yellow brown, more compact	**116**	LDC
106	Greasy layer	**117**	Greasy
107	Midden/LDC mid-red brown	**118**	Dark orange brown LDC
108	Dark midden plus LNS to subsoil	**119**	Dark midden
		871	LNS

The first context to be removed was the root mat [101] which matches the root mat from TP1 and is the only context that was given the same number as its TP1 counterpart. This context was entirely shoveled and was quite bioturbated, making the boundary between the root mat and the next context [109] unclear. Context [109] was a bioturbated aeolian deposit that had less roots than the root mat. This context continued until the 1300 tephra and we were able to shovel off the majority of [109] until we got to the interface, where we switched to trowels to clear off the tephra layer. The bioturbation made the tephra patchy, but it was present across the entire unit, though it went deeper in the extension. There is no evidence of human occupation above the 1300 tephra layer at Næfurstaðir, so these contexts were not screened.

The next layer was more bioturbated aeolian [110], followed by a bioturbated turfy layer [111]. The turfy layer was most noticeable in the north and very thin across the rest of the unit. These two contexts were also deeper in the extension. No flotation samples were taken from [110] because of the extensive bioturbation and also because the context quickly gave way to [111] and was not thick enough to sample. The turf bits in [111] had lenses of the AD 1104 tephra, as well as iron staining and small pieces of charcoal. Contexts [109], [110], and [111] were all included in context [102] in TP1, but the presence of the 1300 tephra layer between [109] and [110] and the more turfy character of [111] made us split them into separate contexts for TP2.

Underneath these layers was the white AD 1104 tephra. It was present across almost the entire unit but was truncated in the north unit by turf (Figure 1). It is not clear if this turf represented an *in situ* wall or collapse from one of the nearby structures.

Figure 1: Photo showing the truncation of the 1104 tephra. Note the distinct line in the northern half of the unit where the tephra is not present.

The next three contexts were all midden layers that were designated [103] in TP1. However, during excavation of TP2, we split them due to different colors and inclusions. Context [112] was dark yellow grey with wood ash, bone, shell, charcoal, and fire-cracked rocks. This layer thins out in the southwest of the original 2x2m unit and is nearly non-existent in the 1x2m extension. Context [113] was also a midden but was primarily pink peat ash rather than darker wood ash. This context contained small bits of charcoal as well as bone and gravel inclusions. It was thicker in the northeastern part of the unit and also thinned to almost nothing in the southwest and the extension. Underneath this was another charcoal-based midden [114] that had wood ash, charcoal pieces, bones, and bits of turf. This context follows the above two in that it peters out in the southwest and the extension. These contexts all seem to be part of a relatively short deposition sequence, given their thickness and the difficulty in telling them apart. The presence of ash and both burnt and unburnt bone as well as some fire-cracked rock suggests that these represent deposition from domestic cooking activities.

Below [114] was a layer that was called the 1000 tephra in the 2016 excavation. Samples were taken from TP1 and subsequently analyzed, and it turned out to not be tephra at all. We still saw this layer in TP2, though it was quite thin and not present across the entire unit. It was not recorded as a separate context and was included with context [115] for sieving and sampling. Context [115] was a yellow brown low-density cultural layer with small amounts of bone, shell, and charcoal as well as flecks of peat ash. Directly underneath [115] was the 934/950 tephra layer. It was continuous across the entire original unit and the extension, though it was patchy in some places.

Below the 934/950 tephra layer was another low-density cultural layer [116]. This context was a yellowish brown and corresponds nicely with [105] from TP1. This layer had some fire-cracked rocks as well as small numbers of bones and charcoal flecks. The layer was mottled with tephra inclusions likely brought down through bioturbation.

The next context [117] was a grayish brown greasy midden layer that matches [106] in TP1. This layer has been interpreted as a hay or dung midden or an animal floor. There were turfy bits and pieces of charcoal mixed in this layer, as well as small amounts of animal bone. Underneath this was a dark orange brown low-density cultural layer [118] that matches [107] from TP1. Small pieces of charcoal were present in the layer, and the boundary between [118] and the layer below was mottled and unclear.

These low-density layers were followed by a dark brownish black midden [119] that was filled with bones. There was a small lens of wood ash in the northwest wall that did not extend very far into the excavation unit itself. This context contained fire-cracked rock as well as charcoal and ash which, together with all the bone, suggests a domestic cooking deposit. Directly below [119] was the *landnám* sequence, LNS, though the actual AD 871 tephra layer was not continually present. This layer was quite thick in some places but was not a clear layer across the entire excavation unit. In TP1, the corresponding context to [119] is [108] and it includes both the dark midden and the LNS down to the sterile subsoil. We split these in order to separately sample the LNS for flotation.

Overall, TP2 corresponds quite nicely with TP1. We split more of the contexts in order to gain better stratigraphic, and therefore chronological, control. Human occupation seems to have ceased at Næfurstaðir by AD 1104, though after this the site may have been used for livestock activities. Before 1104, there were periods of greater deposition (the midden contexts, [112], [113], [114], [119]) interspersed with periods where deposition was less frequent or perhaps less dense (low-density cultural deposits [115], [116], [118]). Occupation at this site seems to have begun very soon after the LNS tephra fell in 877 +/- 1, as some bone and charcoal were pressed directly into the surface of the tephra layer. Despite the dense deposition of bones, there were very few finds at Næfurstaðir and the majority were pieces of iron too corroded to identify. There were a few lithic flakes found, including some obsidian (find #2) from context [111] and some flakes from a white stone, perhaps quartz, from [112] (find #5, Figure 2).

Figure 2: White stone flakes from context [112]. Photo by Josiah Wagener.

Profiles

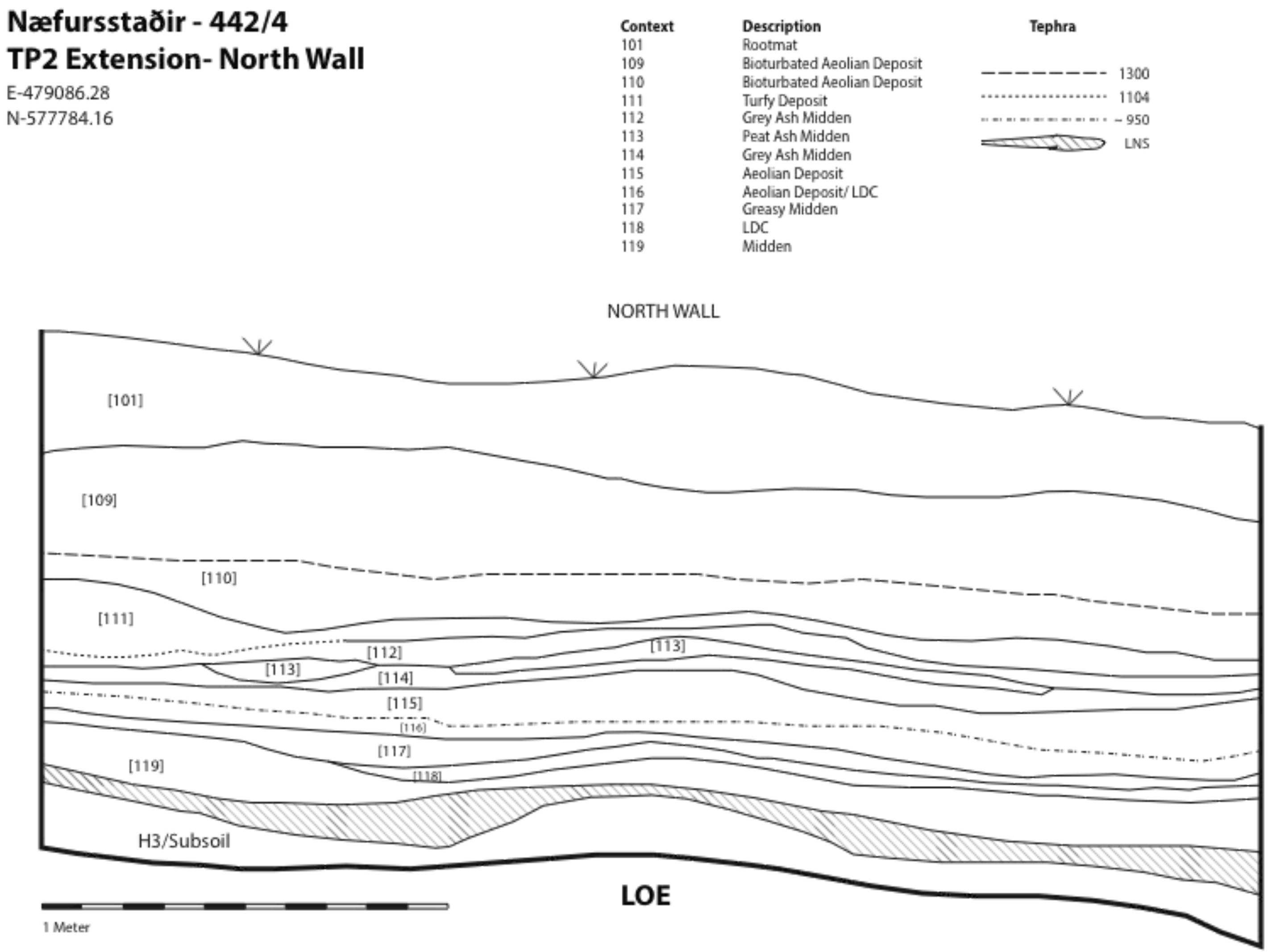

Figure 3: Profile of the entire north wall of the final 3x2m TP2 excavation.

Næfursstaðir 442/4
TP2 Extension- West Wall

E-479086.28
N-577784.16

Context	Description
101	Rootmat
109	Bioturbated Aeolian Deposit
110	Bioturbated Aeolian Deposit
111	Turfy Deposit
112/114	Grey Ash Midden
115	Aeolian Deposit
116	Aeolian Deposit/ LDC
117	Greasy Midden
118	LDC
119	Midden

Tephra and Inclusions

1300
1104
~ 950
LNS
Ash

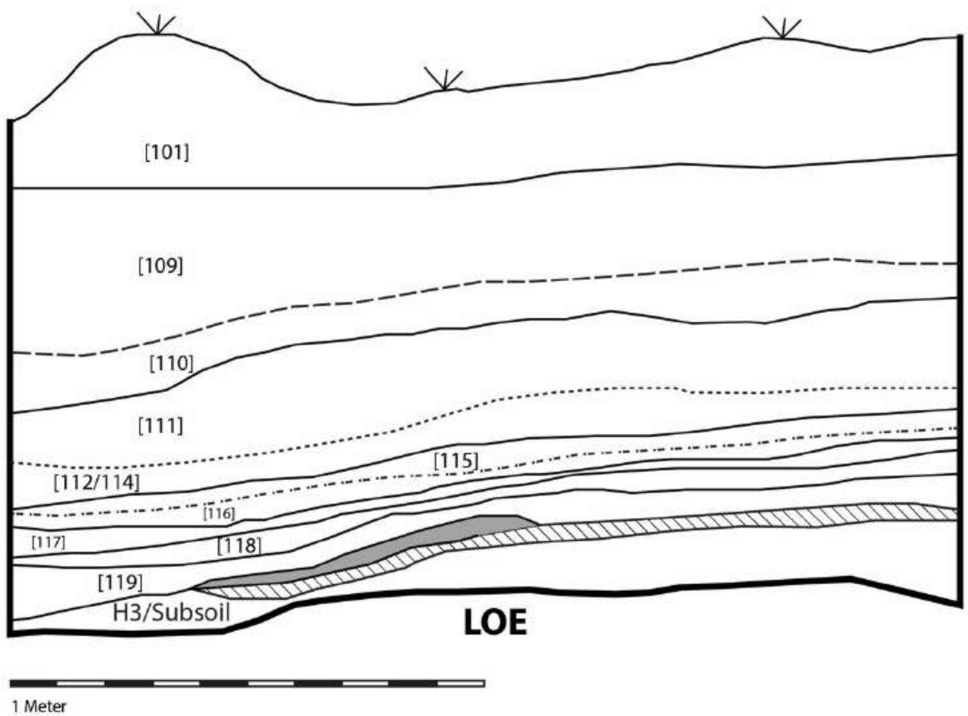

Figure 4: West wall of the final 3x2 excavation unit.

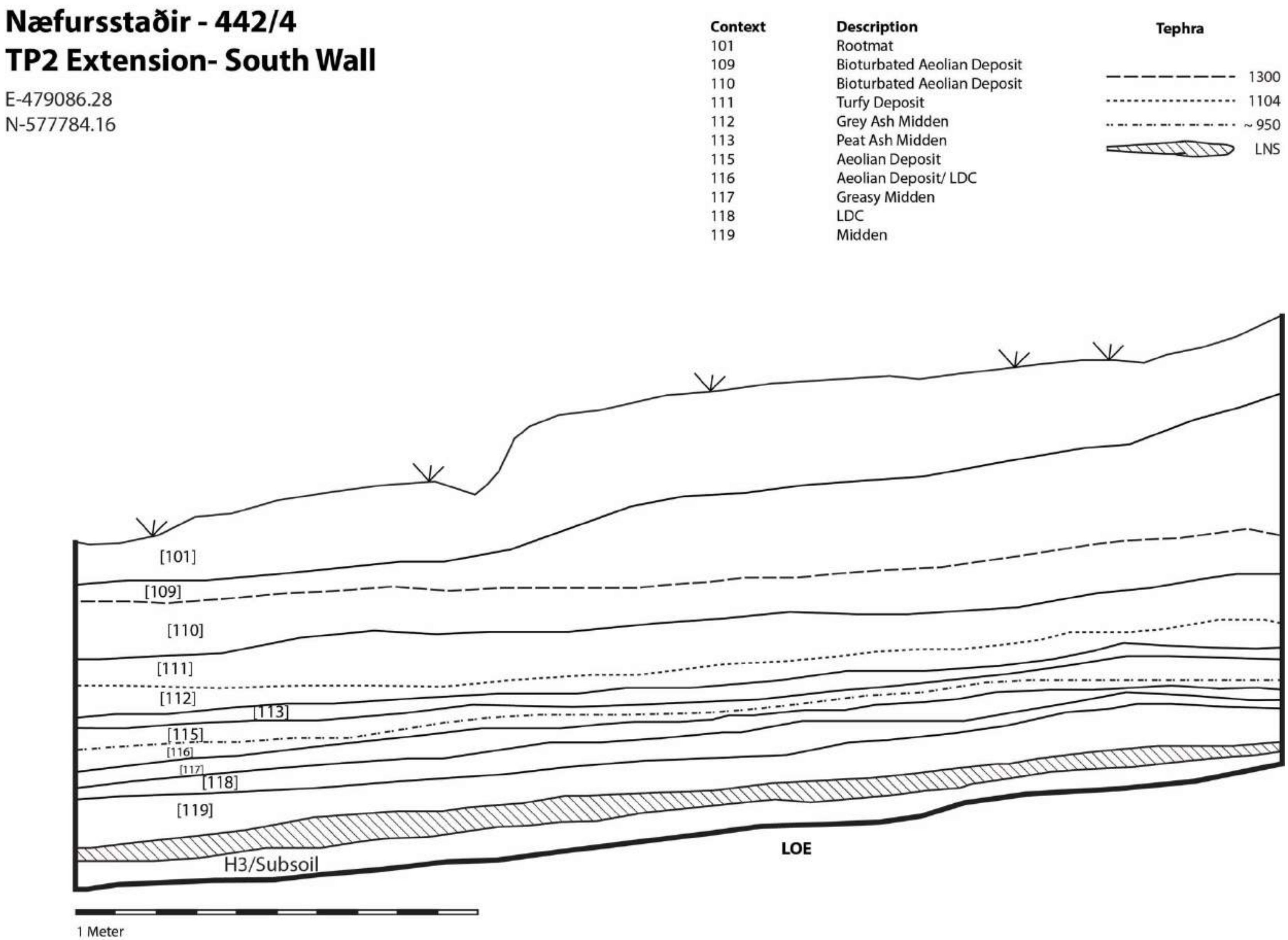

Figure 5: South wall profile. This shows the entire 3 meters of the final excavation unit, including part of TP1.

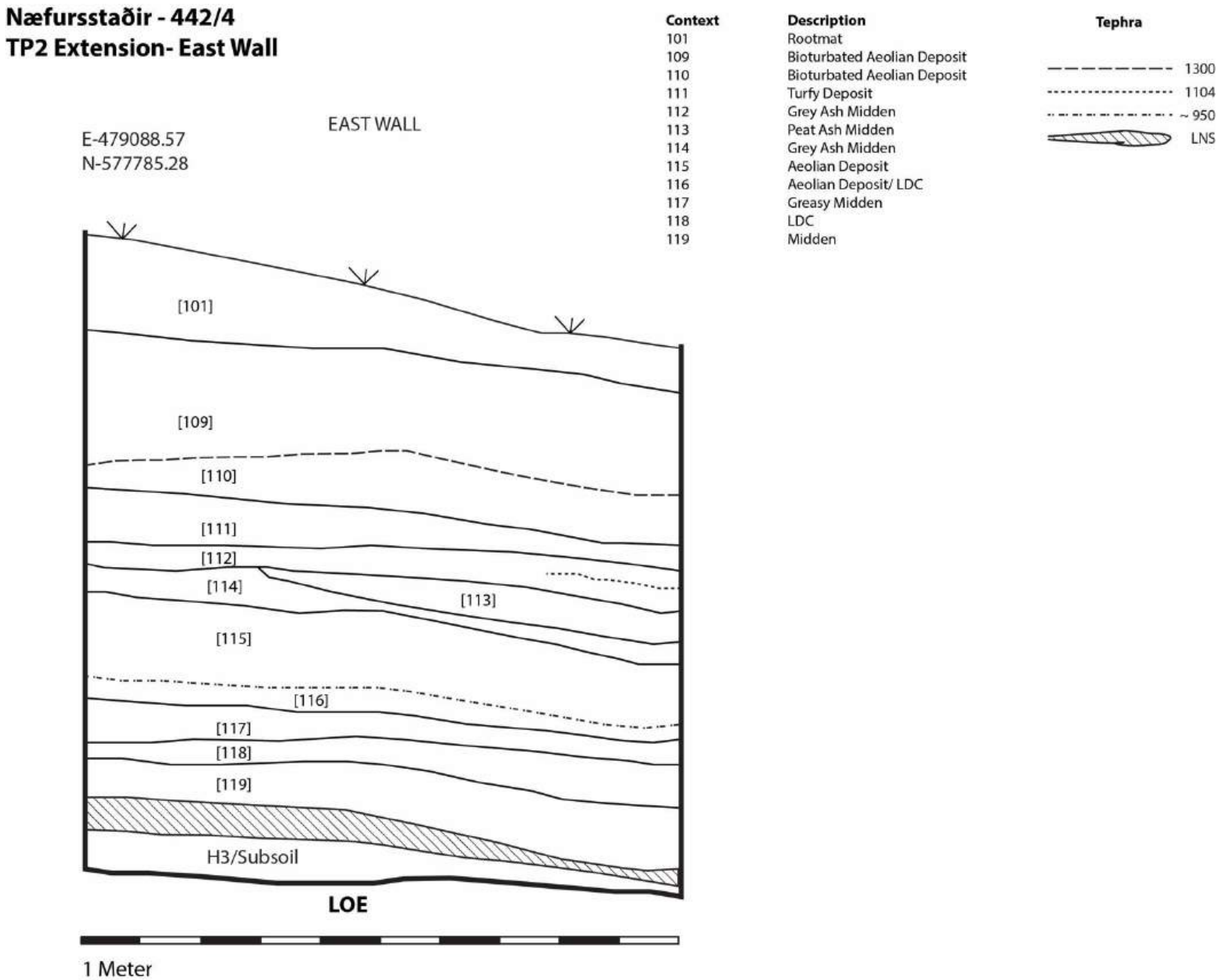

Figure 6: Profile drawing of the east wall. We only drew the northernmost 1 meter of the east wall since the southern half was drawn in 2016 when TP1 was excavated and the profile was damaged by our coring in 2018.

Skagafjörður Church and Settlement Survey

Vatnskot on Hegranes: TP2 Excavation

Grace Cesario and Melissa Ritchey

2020

Picture on front page – Melissa Ritchey and Grace Bello remove the root mat from Vatnskot TP2

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Byggðasafn Skagfirðinga/Fiske Center for Archaeological Research, UMass Boston
BSK-2020-239
2020

Acknowledgements

We are greatly indebted to the farmers at Vatnskot, Margrét Ólafsdóttir, Sigrún Ólafsdóttir, and Sæunn Jónsdóttir, who allowed us to excavate on their land over two field seasons, and who have been incredibly kind and helpful throughout.

We are also grateful to the field crew who participated in both years of excavation. In the summer of 2017, a team of four—Alicia Sawyer, Rita Shepherd, Tyler Perkins, and Grace Cesario—excavated the original 1x2 m test pit. In the summer of 2018, Melissa Ritchey, Grace Bello, Grace Cesario, Kathryn Catlin, Nicholas Zeitlin, and Douglas Bolender all contributed to excavation, sieving, profile drawing, and backfilling.

The project was dependent on a number of permissions.

- Minjastofnun Íslands (The Cultural Heritage Agency of Iceland) granted permission for the excavation. Project number: ***201606-0051***
- And Þjóðminjasafn Íslands (The National Museum of Iceland) granted the site number used for finds: ***Þjms-2018-49***

We also want to thank the funding bodies that made the excavation possible. The excavation was made possible by a grant from the Icelandic Archaeology fund with additional support from the National Science Foundation Grant nos. PLR-1417772, 1523025.

Introduction

In 2017, a 1x1 was opened at Vatnskot (site 443-0), based on coring results (Bolender et al. 2018a) that revealed midden material and tephra layers. This was originally opened as a 1x1 m unit, according to SCASS protocol, but was expanded to a 1x2 m unit, running north-south, after the initial 1x1 produced a large, well-preserved archaeofauna.

In 2018, we returned to Vatnskot to collect more animal bones and flotation samples, based on results of the archaeofaunal analysis (Cesario 2019a) and findings of potential oats as well as barley in the macrobotanical samples (Ritchey, personal communication). After coring to confirm the presence of tephra and midden deposits, we opened another 1x2 m unit. This unit runs north-south and is located directly to the west of the 2017 excavation.

Sampling Strategy

Seeds

Archaeobotanical analysis of the 2017 excavation at Vatnskot (443-0, TP1) found two oat and nineteen barley grains (see Bolender et al. (2018b) for descriptions of the 2017 excavations). The large number of barley seeds in addition to the two oats was surprising and differed from the sample removed from Grænagerði (447-1, TP 2), where two barley and twenty-two oats were recovered. The new samples from 2018 will be used as a comparison to the samples at Grænagerði and the other sites in our study area.

The initial plan was to follow the same sampling strategy as TP1, but to also target cereal-rich layers to the increase the possibility of recovering macrobotanical remains. We recovered charred cereal grains from TP1 contexts [104]/[112] and [113] in 2017, and thus their matching contexts were targeted by this year's sampling. Context [114] was also added to this targeted sampling because, although no cereal grains were recovered from it, the nature of the dark, laminated charcoal midden had the possibility of including higher numbers of charred seed remains that could possibly include cereals. The 1x2 meter excavation unit was divided into two 1x1 meter halves for sampling–designated "NW" and "SW." This preliminary plan thus comprised of non-targeted contexts sampled with a single seven-liter bag from each half, targeted contexts sampled with two seven-liter bags from each half, and context [112] sampled from the top and bottom of the context to follow the previous year's sampling strategy.

As excavations were underway, changes in the nature of the deposits and inconsistencies between what was seen versus recorded from the previous excavations caused some adjustments in the sampling strategy and context divisions. The first changes from the previous excavation were seen when coming down upon [118], [119] and [120]. In the southwest corner of the unit, an intrusive pit feature began [118] with bone and gravel inclusions within a mottled soil matrix of subsoil, H3 tephra, and midden. It was decided that this was a later, post-1104 historic feature, and was only screened for faunal remains, with no flotation samples taken.

The 2017 excavations describe context [112] as an orange-brown ash layer with charcoal inclusions, and this context roughly corresponds with [119] and [120] in TP2. The difference, however, is that there was a tephra deposit expanding across [119] on top of a midden. The tephra was bluish-gray and wispy, but it spread across most of both halves of TP2. In the field, it was tentatively designated as the ~934 but it has not yet been chemically identified. It is possible that this tephra layer was present in the 2017 excavations but was difficult to see and thus excavated without being noted. No flotation samples were taken from [119]. Two flotation samples each were taken from the NW and SW halves of [120] from the full depth of the layer. This differed from the initial sampling strategy, where top and bottom were planned to be sampled, but during excavations the boundaries were unclear and taking samples from the full depth of the layer ensured that the samples were large enough.

The following context, [121], was sampled with two seven-liter bags taken from the top and bottom of the context in both the NW and SW halves. During excavation, it was thought that we had reached the bottom of the context, and therefore sampled as such. However, as we continued excavating, we found the context continued farther, and thus we sampled once more, collecting two seven-liter bags from the SW half for an actual bottom sample (in the NW half, the actual bottom had been excavated through before realizing it and thus could not be sampled). Contexts [122] and [123], which coincide with the 2017 [113], each received targeted samples of two bags per half. [124] and [125] both received basic sampling of a single bag taken from each half.

Bones

All contexts were sieved through 4 mm mesh and bones collected from the screen. Some contexts were very moist and sticky, so to save time in the field, as much of the loose dirt as possible was sieved away, and the rest collected in a large sample bag to be wet screened later, again through 4 mm mesh to keep the sampling strategy the same. A report on the bones can be found in Cesario (2019).

Table 1: Macrobotanical samples taken for flotation from Vatnskot (443-0, TP2). Samples are grouped by context and location within the excavation unit where the sample was taken. Each sample bag is seven liters.

Context and Description	NW	SW
116 **Bioturbated Aeolian**	*Sample 1*: 1 bag – middle of context	*Sample 2*: 1 bag – middle of context
117 **Orangish-brown low density cultural**	*Sample 4*: 2 bags – top of context	*Sample 5*: 2 bags – top of context
120 **Orangish-brown midden with peat ash lens**	Sample 9: 2 bags – full vertical of context	*Sample 10*: 2 bags – full vertical of context
121 **Dark, mottled midden**	*Sample 12*: 2 bags – top of context *Sample 15*: 2 bags – bottom of context	*Sample 13*: 2 bags – top of context *Sample 16*: 2 bags – bottom of context *Sample 18*: 2 bags - actual bottom
122 **Peat ash midden**	*Sample 19*: 2 bags – full vertical of context	*Sample 20*: 2 bags – full vertical of context
123 **Mottled midden with ash, charcoal, peat ash and H3**	*Sample 22*: 2 bags – full vertical of context	*Sample 23*: 2 bags – full vertical of context
124 **Dark, laminated charcoal floor**	*Sample 26*: 1 bag – full vertical of context	*Sample 27*: 1 bag – full vertical of context
125 **Greasy midden**	*Sample 29*: 1 bag – full vertical of context	*Sample 30*: 1 bag – full vertical of context

Excavation

Vatnskot TP2 was excavated by Melissa Ritchey and Grace Cesario, with help from Grace Bello, Kathryn Catlin, Nicholas Zeitlin, and Douglas Bolender. Excavation took place from 19-22 July 2018. In order to match contexts from the 2017 excavation and make digging easier, we first reopened the western 50 centimeters of TP1.

Contexts from the 2018 excavation were numbered sequentially, following the last number from TP1 in 2017. Most of the contexts in TP2 correlate to contexts from TP1 but see Table 2 for differences.

The first context, [101], is the root mat and disturbed aeolian deposit underlying it, which directly matches [101] in TP1, and is the only context that is given the same number as its corresponding TP1 context. The aeolian was disturbed by worms and possible field flattening. There was also a recent, intrusive pit [118] in the southwest corner that was not immediately obvious when [101] was removed but in profile the cut is clear (Figure 1). This pit is post-1104, since there were patches of 1104 within the fill, and it seems to be quite modern since the root mat lies almost directly on top of the fill. The pit also contained smashed turf pieces, which confused us during excavation until the shape of the pit became clearer. Small numbers of animal bones and a single white rock (find #4) came from this pit.

Table 2. Context correlation table for TP1 and TP2 at Vatnskot.

<table>
<tr><th colspan="2">TP1</th><th colspan="2">TP1 southern extension</th><th colspan="2">TP2</th></tr>
<tr><th>Context</th><th>Description</th><th>Context</th><th>Description</th><th>Context</th><th>Description</th></tr>
<tr><td>101</td><td>Disturbed</td><td>101</td><td>Disturbed</td><td>101</td><td>Disturbed</td></tr>
<tr><td>--</td><td>--</td><td>--</td><td>--</td><td>118</td><td>Post-1104 cut (SW only)</td></tr>
<tr><td rowspan="2">102</td><td rowspan="2">Cut/fill in [101]</td><td>1300</td><td>Blue-grey tephra</td><td>1300</td><td>Blue-grey tephra</td></tr>
<tr><td>110</td><td>Disturbed brown black with bone</td><td>116</td><td>Disturbed yellow brown AD</td></tr>
<tr><td>1104</td><td>White tephra</td><td>1104</td><td>White tephra</td><td>1104</td><td>White tephra</td></tr>
<tr><td>103</td><td>Orange-brown low density cultural (LDC)</td><td>111</td><td>Orange brown LDC</td><td>117</td><td>Orange brown LDC w/ wood ash and FCR</td></tr>
<tr><td>104</td><td>Orange-brown ash with charcoal, bone</td><td>112</td><td>Reddish- brown ash w/ charcoal bone turf</td><td>119/120</td><td>Orange brown midden with bone, peat ash</td></tr>
<tr><td>-</td><td></td><td>-</td><td></td><td>121/122</td><td>Dark mottled midden w/ peat ash</td></tr>
<tr><td>1000</td><td>Black tephra</td><td>1000</td><td>Black tephra</td><td>1000</td><td>Black tephra</td></tr>
<tr><td>105</td><td>Brown-black charcoal layer</td><td rowspan="2">113</td><td rowspan="2">Pinkish brown ash/charcoal with bone, turf</td><td>123</td><td>Yellow brown midden w/ bone and shell, peat ash and turf</td></tr>
<tr><td>106</td><td>Orange brown charcoal/ash w/ bone, turf</td><td>--</td><td>--</td></tr>
<tr><td>107</td><td>Dark black, laminated with charcoal</td><td>114</td><td>Compact brown black floor w/ ash, charcoal bone turf</td><td>124</td><td>Dark thick charcoal floor with peat ash, burnt turf</td></tr>
</table>

108	Greasy brown-black with charcoal, bone, FCR	115	Grayish brown LDC w/ charcoal bone, FCR	125	Mid-grey black, greasy with mixed H3
109	Mixed H3 w/ charcoal	--	--	--	--

Figure 1: West wall profile. Intrusive pit [118] is on the left of the photo. The white line about 1/3 of the way down is the AD 1104 tephra.

Underneath [101] was the 1300 tephra layer. This layer was patchy and bioturbated and did not cover the whole unit evenly. Context [116], a mid-yellowish brown deposit, was below the 1300 tephra; however the boundary was unclear because this layer was also heavily bioturbated. A spindle whorl came from this layer (find #1) along with an iron object (find #3).

Context [116] was followed by the white 1104 tephra layer. This tephra layer was also patchy but more obvious than the blue-grey 1300 layer. It also covered most of the unit, though there were some spots in the northwest that were very thin and which we troweled through while trying to trace out the layer. There appeared to be turf in the southwest corner of the unit that we thought might have been part of a structural collapse, but we realized later that it was from the intrusive pit [118].

Below the 1104 tephra was a mid-orange brown context with a low density of cultural material [117]. There was wood ash and fire-cracked rock present in the context, and a small amount of animal bone was also recovered. This layer also contained a green glass bead, recovered in the screen (Figure 2). The presence of fire-cracked rock as well as animal bone indicates that this is was a fairly typical deposition of household debris.

Figure 2: Green bead (find #5) from context [117]. Photo by Josiah Wagener.

Context [119] was a thin orangey midden with patches of blue-grey tephra and wood ash. While excavating, this tephra looked a lot like the 934/950 tephra, but being so close to the 1104 tephra layer this did not make sense. The tephra was mostly present on the eastern half of the unit but was not present in any of the side walls. It was quite patchy and might have been in small bits of turf. Ultimately, we decided that it was not *in situ*. This context was also bioturbated and the boundary between [119] and the context below, [120], was unclear. Context [120] was similar in color to [119], a mottled mid orange-brown, but it was more compact and had peat ash lenses as well as charcoal flecks. In the southwest corner near the pit [118] was a more distinct peat ash lens. The two contexts [119] and [120] seemed to have different characters while excavating but were difficult to tell apart while drawing the profile, so they were ultimately lumped together, as can be seen in Table 2 above. It must be noted that the profile was drawn on a cloudy day in the rain, and a clearer day may have made the difference between contexts more noticeable.

The next context, [121], was a darker orange-brown mottled midden, though the boundary between [120] and [121] was unclear due to bioturbation. This was a more high-density midden with a lot of peat ash and charcoal, as well as some H3 tephra mixed in. Both burned and unburned bones indicate household cooking refuse. A small charcoal lens was noted in the northwest corner, and a lump of turfy material in the northeast had some tephra in it that appeared to be the 1000 or possibly 934/950 tephra. The entire midden was very mixed up with peat ash lensing and an unclear boundary with both the above and below contexts. Underneath [121] was context [122], a mid-pinkish brown midden layer with more peat ash than the previous context. This midden was more compact and homogenous than the very mottled layer above, though lenses of H3 tephra were also present. Similar to the above contexts, [121] and [122] looked different while excavating but during profile drawing, it was difficult to distinguish between the two and so they were also combined as one larger layer.

The boundary between [122] and [123] was gradual, but [123] was a mid-yellowish brown with less peat ash and more easily distinguished in profile. In addition, a very patchy and discontinuous 1000 tephra layer separated the two contexts. This tephra layer was not present across the entire unit and did not show up in the profiles. Context [123] had lensing of the H3 tephra as well as peat ash and turf pieces throughout the context. Bone and shell were also present, indicating domestic activities.

Below [123] was a very firm context [124]. We interpreted this as a floor (matching with [107] and [114] from TP1). It was a very dark grey brown with lenses of peat ash and burned turf. One bag of bone was recovered from this layer. In the northwest of the unit the floor was truncated and consisted only of ashy patches, which lines up with TP1 where the floor [107] was thinner and less obvious in the north/northwest.

Context [125] is a mid-greyish black greasy layer that was directly below the floor layer. This context contained charcoal and bone inclusions, as well as large amounts of fire-cracked rock. There was also H3 tephra mixed throughout the context, which was on top of the sterile subsoil. No landnám tephra was present between the last cultural deposit and the subsoil. As noted by Bolender et al. (2018), the presence of a compacted floor layer directly on top of a domestic midden raises questions about the interpretation of the “floor” and it being part of a structure or simply a very trampled midden deposit.

Profile

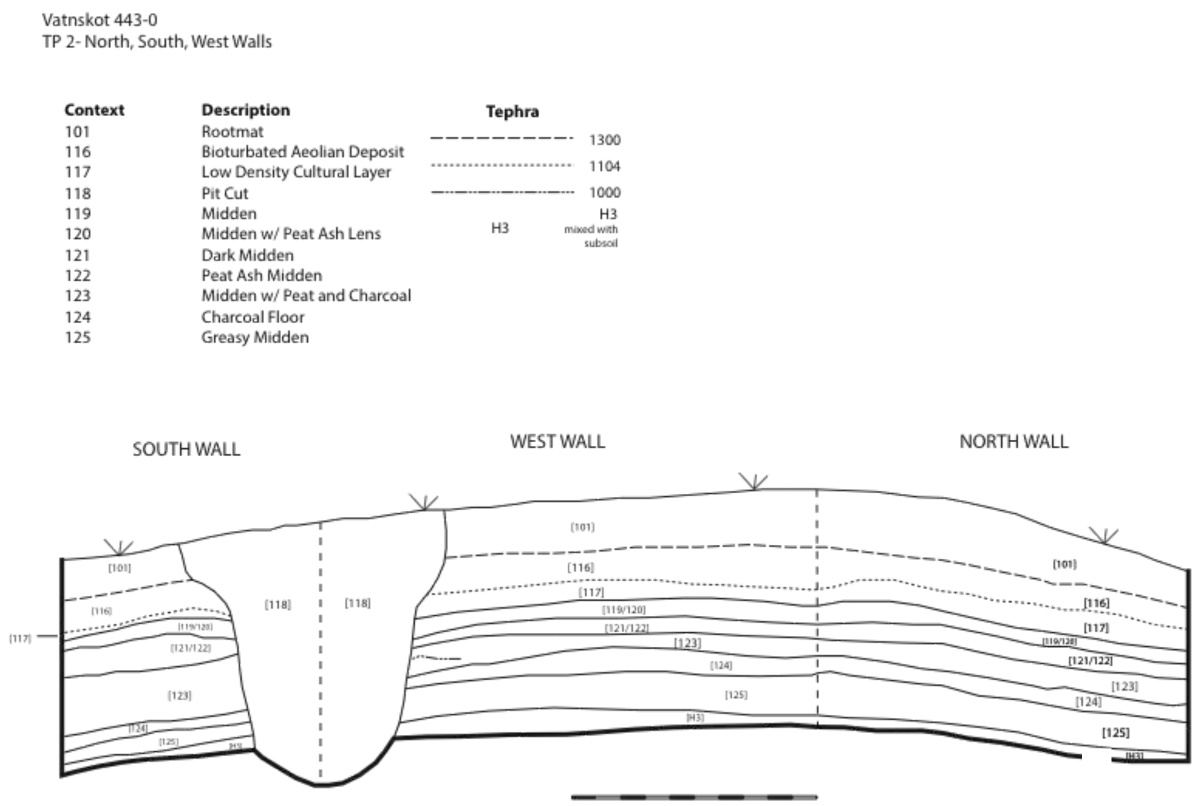


Figure 3: Profile drawing showing the entire exposed profile of TP2.

Skagafjörður Church and Settlement Survey

Grænagerði on Hegranes: TP2 Excavation Report 2018

Melissa Ritchey and Grace Cesario
2020

Picture on front page – Grace Bello and Kathryn Catlin excavate the eastern expansion of TP2 while John Steinberg observes

© Grace Cesario, Melissa Ritchey
Byggðasafn Skagfirðinga/Fiske Center for Archaeological Research, UMass Boston
BSK-201x-xxx / SCASS-201x-xxx

2018

Acknowledgements

We are greatly indebted to the farmers at Grænagerði (Hulduland), María Eymundsdóttir and Pálmi Jónsson, who allowed us to excavate on their land over two field seasons, and who have been incredibly kind and helpful throughout.

In the summer of 2016, a team of 4 students, led by Kathryn Catlin cored the entire farm, and in the summer of 2017 Kathryn and 3 more students opened up a 1x1 meter test excavation. The summer of 2018 brought 4 more students to expand the previous test pit to a total of 2x2 meters. **The student specialists were** Kathryn Catlin (present all three years and directing for two), Grace Cesario (present for coring in 2016 and supervision in 2018), Shala Carter and Allison Carlton for coring; Sarah Breiter, Sean Deryck, and Lauren Welch O'Connor for TP1 excavation; Melissa Ritchey and Grace Bello for TP2 excavation.

The project was dependent on a number of permissions.

- Minjastofnun Íslands (The Cultural Heritage Agency of Iceland) granted permission for the excavation. Project number: ***201506-0056***
- And Þjóðminjasafn Íslands (The National Museum of Iceland) granted the site number used for finds: ***Þjms-2016-40***

We also want to thank the funding bodies that made the excavation possible. The excavation was made possible by a grant from the Icelandic Archaeology fund with additional support from the National Science Foundation Grant #1417772.

Introduction

A test pit at Grænagerði (site 447-1, TP1) was excavated in 2017 by Kathryn Catlin, Lauren O'Connor, Sarah Breiter, and Sean Deryck (Catlin et al. 2018). This excavation was placed based on the presence of midden below the AD 1104 tephra (see Catlin et al. 2018 for more information and site background).

Macrobotanical and archaeofaunal remains from TP1 were analyzed over the winter and spring and the results (Cesario 2020) drove us to return to Grænagerði for another excavation to increase sample sizes. The 2018 excavation, called TP2, was placed using TP1 as a guide. The first expansion was focused on collecting archaeobotanical samples—a 1x1 meter test pit directly south of TP1. After this first 1x1 was complete, it was clear that the faunal sample would not be large enough for Cesario's dissertation and the unit was expanded east. This final expansion made the entire excavation area 2x2 meters, with TP1 as the northwestern unit.

Sampling Strategy

Seeds

Archaeobotanical analysis of the 2017 excavation at Grænagerði found twenty-three oat (*cf. Avena)* caryopses and two barley (*Horduem)* caryopses. The large number of oat seeds was surprising and has challenged our understanding of cereal production in Iceland, which drove us to return to Grænagerði to recover a more robust sample.

The first 1x1 meter unit (TP2 SW) that extended to the south of the 2017 unit (TP1) followed the same sampling strategy as the previous excavation. No sample was taken from context [101], which encompasses the root mat. All lower contexts were sampled until sterile H3 tephra or subsoil was reached. The top and bottom of contexts were taken as separate flotation samples, each filling an approximately seven-liter plastic bag. Two of these bags were filled per sample for the top and bottom of each context. For thinner contexts, two flotation sample bags were taken that covered the full vertical extent of the context.

Most of the contexts from TP2 matched up to those from TP1. Those that did not were the remobilized H3 tephra layer [107], H3 capping the charcoal pit [109], and the charcoal pit feature [110]. The previous year's excavation came down upon the remobilized H3 layer, which was believed to be the extent of the cultural layers. However, after digging through it, more cultural contexts were found and it is now understood that this is actually a layer of remobilized H3 tephra. For this year's extension units, the remobilized H3 was sampled and excavated as a separate context because it is now known to represent a separate depositional process. Additionally, a wood ash lens within context [108] was sampled separately.

This same sampling strategy was followed in the further extension east (1x2). The two 1x1 meter blocks within this new unit were labeled TP2 NE and TP2 SE and were sampled separately. This was done to keep a consistent volume of soil sampled from the same size unit. Therefore, two approximately seven-liter bag flotation samples were taken from each context in both the NE and SE sides of the 1x2 meter unit. A single bag sample was taken from a charcoal pit feature [110] located below context [108] in the NE unit. This pit was only present in the NE unit. Additionally, a two-bag sample was taken for the NE and SE units for context [107], the remobilized H3 layer, because it was a thicker deposit in these units and allowed for a larger sample. In the NE unit of the extension, samples were taken from what was perceived as the bottom of the context. When we came down further, we found the Landnám layer, and sampled this in the NE unit. The table below (Table 1) shows the samples taken from contexts in the NE, SE and SW units.

Table 1: Samples taken from TP2 in each unit of the expanded test pit.

Contexts	SW	NE	SE
[105] **Aeolian deposit with wisps of H1**	Sample 1: 2 bags – full vertical of context	Sample 16: 2 bags – full vertical of context	Sample 17: 2 bags – full vertical of context
[106] **Midden**	Sample 3: 2 bags – Top of context (including turf lens) Sample 7: 2 bags – bottom of context	Sample 19: 2 bags – Top of context Sample 24: 2 bags – Bottom of context	Sample 20: bags – Top of context Sample 25: 2 bags – Bottom of context
[107] **Remobilized H3**	Sample 8: 1 bag – full vertical of context	Sample 26: 2 bags – full vertical of context	Sample 27: 2 bags – full vertical of context
[108] **Midden**	Sample 11: 2 bags – Top of context Sample 14: 2 bags – Ash lens Sample 15: 2 bags – Bottom of context	Sample 30: 2 bags – Top of context Sample 33: 2 bags – Bottom of context Sample 35: 1 bag – Landnam; actual bottom	Sample 31: 2 bags – Top of context Sample 34: 2 bags – Bottom of context
[110] **Charcoal pit**		Sample 36: 1 bag – Charcoal pit feature	

Excavation

TP2 was excavated by Melissa Ritchey, Grace Cesario, Grace Bello, and Kathryn Catlin between July 8-10, 2018. The first task was to dig out TP1 in order to follow the stratigraphy from the old unit and match contexts in TP2 (Table 2).

The root mat was designated context [101] and matched with [101] in TP1. It was mostly removed with shovels. This layer was bioturbated and had AD 1104 tephra present at the bottom of the context, but it was not a clear layer. The tephra was mostly visible in the NE unit.

Context [105] is same as [102] in TP1—cryoturbated aeolian, mid orangish-brown in color, with very few inclusions. Some charcoal bits and a few small pieces of bone were present near the bottom of the context, and it is likely that these were coming up from the midden below because of the cryoturbation.

Context [106] was a dark brownish-black midden with wood ash, charcoal, fire-crack rocked, and bits of turf mixed in as well as bone throughout. There was possible burnt turf in SW unit. The midden began as a mottled layer with ashy lenses and became more homogenous as we got closer to the bottom. Some lenses of remobilized H3 tephra were present in this context, likely upcast from the layer below. Finds from this context include white stones and a bone pin (Figure 1) found near the top of the context in the NE unit. The presence of ash and bone suggests that this deposit represents household cooking debris.

Context [107] is the remobilized H3 layer that was not given a separate context designation in the 2017 excavation. It is equal to [103] from TP1 (along with [106], see Table 2 below for context correlations). It was a light brownish-yellow, with tephra mixed in with the aeolian. Some lensing may have been the 1000 tephra (Catlin et al. 2018).

Context [108] is a midden context that is equal to [104] in TP1. This layer was filled with bone, charcoal, and wood ash and was less mottled and lighter in color than the previous midden [106]. There was an ashy lens in the SW unit that did not extend far into the other units, but that can be seen in the profile on the southwestern end. This lens was sampled separately for flotation, but was not given its own context number. There was a smaller (1x10 cm, ~1 cm thick) ashy lens in the northwest but it did not show up in the profile. In the eastern wall of the unit, on the northern end, we uncovered a large burnt log. Pieces were collected for charcoal identification. In addition to the burnt log, charcoal pieces had spread throughout the unit in context [108]. There were rocks near this log and they seem to be part of a pit feature. It is not clear how or if the log is associated with the pit feature.

Contexts [109] and [110] are parts of a charcoal pit feature present in the northeast corner of the excavation, underneath the burnt log in [108] (Figure 2). This feature is present in the profile. At the end of [108], we thought we were coming down onto the subsoil at reaching the end of the excavation; however, charcoal started popping up within a semi-circle of rocks that we could see in the midden. The rocks made the shape of a pit more obvious, and so we continued to excavate that area. We came down on a layer of H3 with small charcoal pieces [109], underneath of which was a charcoal-filled layer [110]. This context [110] was a pit-shape (deeper in the middle and more shallow on the sides) that filled in the area between the rocks on the walls of the unit. The pit was dug directly into sterile subsoil. Charcoal of various sizes filled the pit and some pieces were relatively large (~3-5 cm).

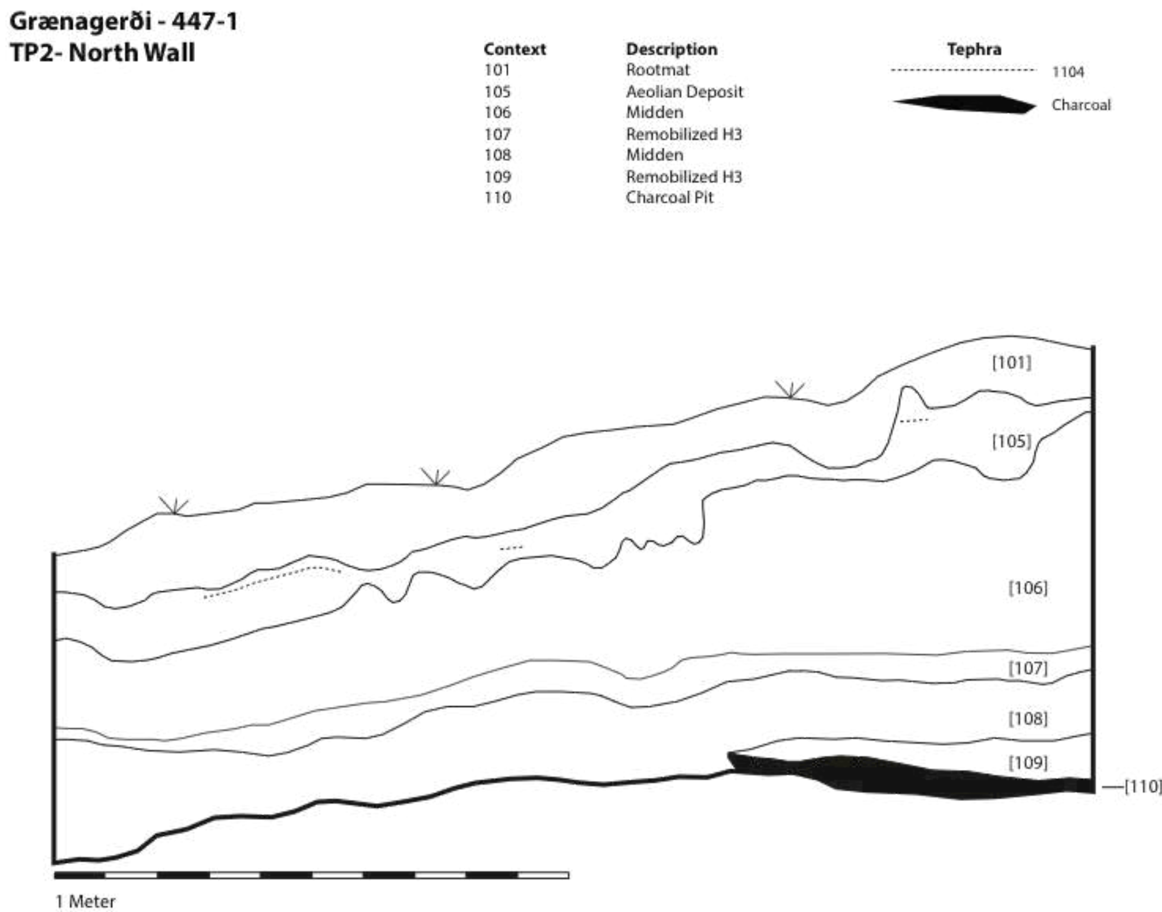
Table 2: Context correlation table

<table>
<tr><th>TP1</th><th>TP2</th></tr>
<tr><td>101</td><td>101</td></tr>
<tr><td>102</td><td>105</td></tr>
<tr><td rowspan="2">103</td><td>106</td></tr>
<tr><td>107</td></tr>
<tr><td>104</td><td>108</td></tr>
<tr><td>-</td><td>109</td></tr>
<tr><td>-</td><td>110</td></tr>
</table>

Figure 1: Bone pin from context [106]. Find #9.

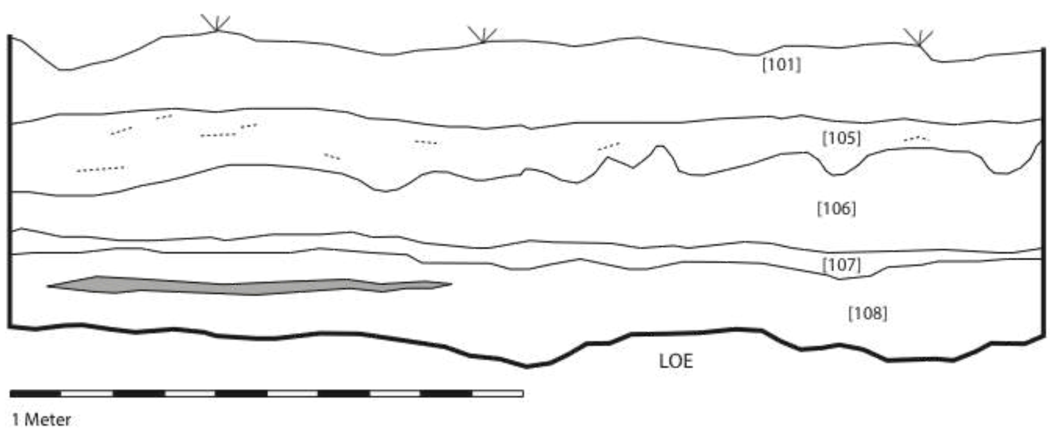
Figure 2: Charcoal pit feature (NE unit, above north arrow) in Grænagerði TP2 extension.

Profiles


Grænagerði - 447-1
TP2- North Wall
Context
Description
101 Rootmat
105 Aeolian Deposit
106 Midden
107 Remobilized H3
108 Midden
109 Remobilized H3
110 Charcoal Pit
Tephra
1104
Charcoal
[101]
[105]
[106]
[107]
[108]
[109]
[110]
1 Meter

Grænagerði - 447-1
TP2- West Wall

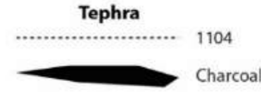
Context	Description
101	Rootmat
105	Aeolian Deposit
106	Midden
107	Remobilized H3
108	Midden

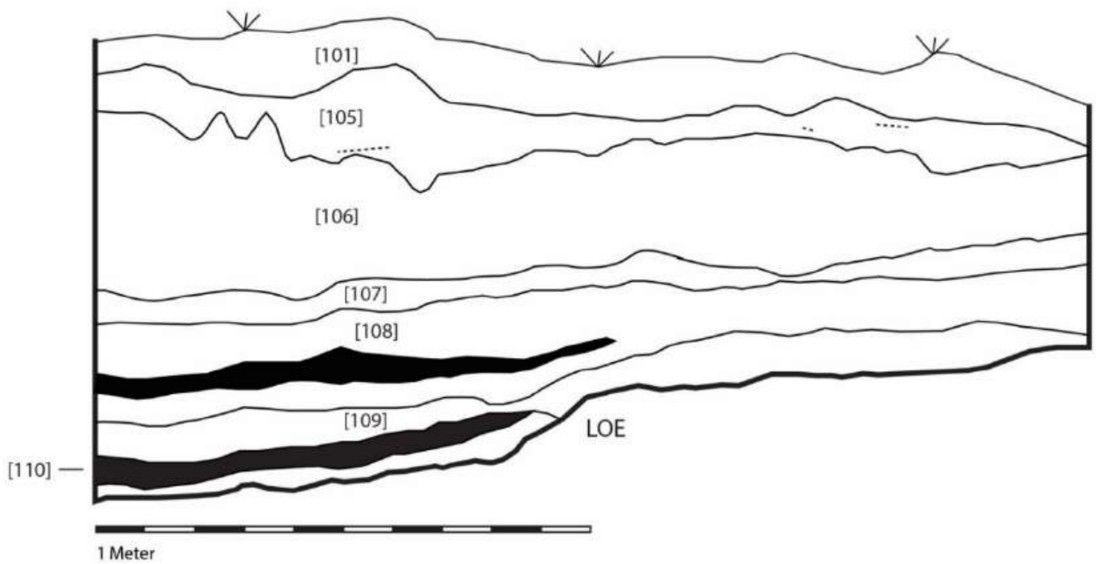


Grænagerði - 447-1
TP2- East Wall

Context	Description
101	Rootmat
105	Aeolian Deposit
106	Midden
107	Remobilized H3
108	Midden
109	Remobilized H3
110	Charcoal Pit

Tephra





Appendix C: Fish Metrics

- Measurements were taken in mm using a Mitutoyo caliper
- Formulas for live size reconstruction are as follows, where “x” is the value for the measurement being taken:

Atlas (Enghoff 1994)

- Total Length=8.73172***x**$^{0.8260}$

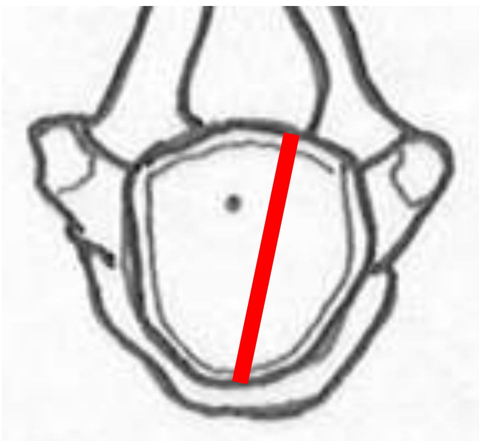


Figure 1. Drawing of cod atlas vertebra showing measurement location (red line). Measurements are taken on the posterior side, across the widest part.

Premaxilla (Wheeler and Jones 1976)

- Total Length=(60.83***x**)+10.35

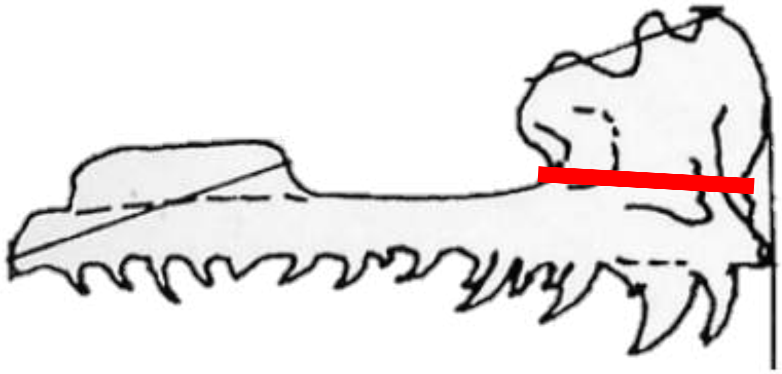


Figure 2. Drawing of cod premaxilla with red line to show where the measurement is taken.

Dentary (Wheeler and Jones 1976)

- Total Length=(80.14***x**)+102.3

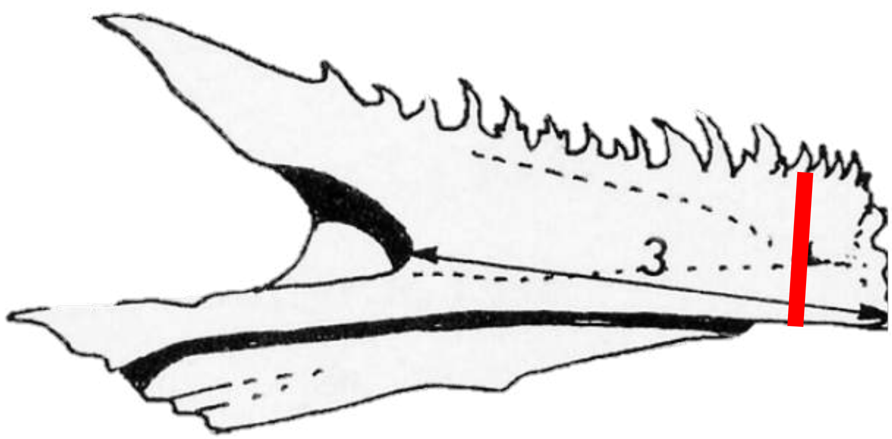


Figure 3. Drawing of cod dentary with red line showing where the measurement is taken. Line is covering up the mental foramen, and calipers should rest between any teeth that might be in the way (teeth are not to be included in the measurement).

The tables that follow present the reconstructed length of MARSH cod specimens, presented by element. The data from these tables are the source for the live size reconstruction figures in Chapter 7.

Table 1. Atlas measurements

Site	Phase	Metrics Reference Number	Measurement (x)	Reconstructed Length (mm)
Næfurstaðir	Early	215	8.31	501.98
Næfurstaðir	Early	524	16.08	865.95
Grænagerði	Late	232	11.41	652.26
Grænagerði	Late	233	8.82	527.30
Grænagerði	Late	234	12.59	707.49
Grænagerði	Late	235	10.73	619.98
Grænagerði	Late	222	10.23	596.01
Grænagerði	Viking Age	245	7.37	454.60
Grænagerði	Viking Age	243	6.66	418.11
Vatnskot	Early	256	9.95	582.51
Vatnskot	Early	257	6.72	421.22
Vatnskot	Late	248	7.82	477.41
Kotið	Viking Age	512	18.26	961.83
Kotið	Viking Age	513	11.32	648.0
Kotið	Viking Age	514	9.86	578.15
Kotið	Viking Age	515	7.82	477.41
Kotið	Viking Age	516	15.42	836.48

Table 2. Dentary measurements.

Site	Phase	Metrics Reference Number	Measurement (x)	Reconstructed Length (mm)
Næfurstaðir	Early	209	6.12	592.76
Næfurstaðir	Early	214	10.13	914.12
Næfurstaðir	Early	527	6.96	660.88
Grænagerði	Late	223	6.55	627.22
Grænagerði	Late	228	5.89	574.32
Grænagerði	Late	229	6.37	612.79
Grænagerði	Late	230	5.42	536.66
Grænagerði	Late	231	5.59	550.28
Grænagerði	Late	238	6.12	592.76
Vatnskot	Early	259	6.28	605.58
Vatnskot	Early	258	4.05	426.87
Vatnskot	Early	275	8.43	777.88
Vatnskot	Early	276	4.37	452.51
Vatnskot	Early	277	4.35	450.91
Vatnskot	Early	260	6.12	592.76
Vatnskot	Early	261	6.69	638.44
Vatnskot	Early	278	5.51	543.87
Kotið	Viking Age	500	7.59	710.56
Kotið	Viking Age	501	8.27	765.06
Kotið	Viking Age	502	5.57	548.68
Kotið	Viking Age	503	5.96	579.93
Kotið	Viking Age	518	5.84	570.32
Kotið	Viking Age	520	6.75	643.25
Kotið	Viking Age	517	8.25	763.46
Kotið	Viking Age	519	6.17	596.76

Table 3. Premaxilla measurements.

Site	Phase	Metrics Reference Number	Measurement (x)	Reconstructed Length (mm)
Næfurstaðir	Early	210	14.22	875.35
Næfurstaðir	Early	211	12.89	794.45
Næfurstaðir	Early	212	14.38	885.09
Næfurstaðir	Early	213	11.80	728.14
Næfurstaðir	Early	525	14.11	868.66
Næfurstaðir	Early	216	8.46	524.97
Næfurstaðir	Early	526	10.39	642.37
Grænagerði	Late	217	8.26	512.81
Grænagerði	Late	218	10.14	627.17
Grænagerði	Late	219	9.52	589.45
Grænagerði	Late	220	8.38	520.11
Grænagerði	Late	221	9.68	599.18
Grænagerði	Late	224	8.31	515.85
Grænagerði	Late	225	9.25	573.03
Grænagerði	Late	226	10.24	633.25
Grænagerði	Late	227	10.58	653.93
Grænagerði	Early	236	14.62	899.68
Grænagerði	Early	237	14.74	906.98
Grænagerði	Late	239	10.03	620.47
Grænagerði	Late	240	9.66	597.97
Grænagerði	Late	241	11.77	726.32
Grænagerði	Late	242	8.61	534.10
Grænagerði	Viking Age	244	7.97	495.17
Vatnskot	Late	249	10.06	622.30
Vatnskot	Late	250	9.43	583.98
Vatnskot	Late	251	9.05	560.86
Vatnskot	Late	252	14.51	892.99
Vatnskot	Late	253	8.98	556.60
Vatnskot	Late	254	9.80	606.48
Vatnskot	Late	255	10.16	628.38
Vatnskot	Early	268	16.21	996.40
Vatnskot	Early	262	10.03	620.48
Vatnskot	Early	269	11.23	693.47
Vatnskot	Early	267	7.62	473.87
Vatnskot	Early	273	6.75	420.95
Vatnskot	Early	274	11.30	697.73
Vatnskot	Early	263	6.09	380.80
Vatnskot	Early	264	7.88	489.69
Vatnskot	Early	265	9.15	566.94
Vatnskot	Early	266	8.45	524.36
Vatnskot	Early	270	8.24	511.59
Vatnskot	Early	271	6.03	377.15
Vatnskot	Early	272	8.56	531.05
Kotið	Viking Age	506	10.89	672.79
Kotið	Viking Age	507	11.21	692.35
Kotið	Viking Age	508	11.61	716.59

Kotið	Viking Age	509	9.43	583.98
Kotið	Viking Age	510	13.02	802.36
Kotið	Viking Age	511	10.84	669.75
Kotið	Viking Age	522	15.51	953.82
Kotið	Viking Age	523	10.56	652.71
Kotið	Viking Age	505	9.65	597.36
Kotið	Viking Age	504	18.42	1130.84
Kotið	Viking Age	521	13.61	838.25

Thanks to Frank Feeley for compiling the size reconstruction formulas and measurement diagrams.

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