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

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Figure 1: 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.

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 2018a). 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.

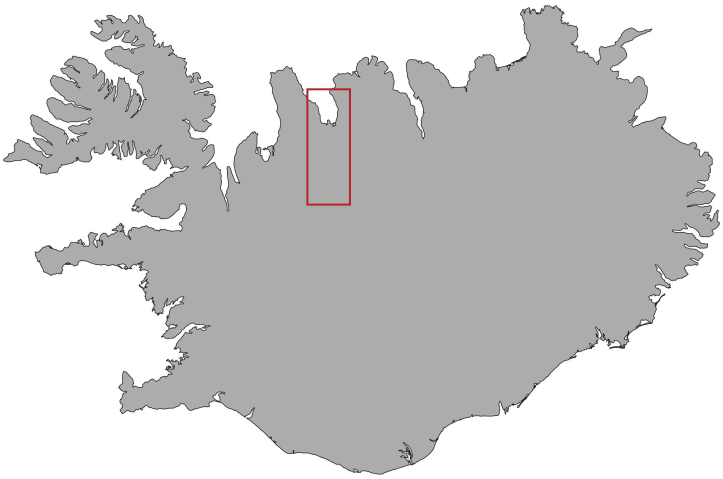

Figure 2: Map of Iceland. Skagafjörður is outlined by the red box.

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

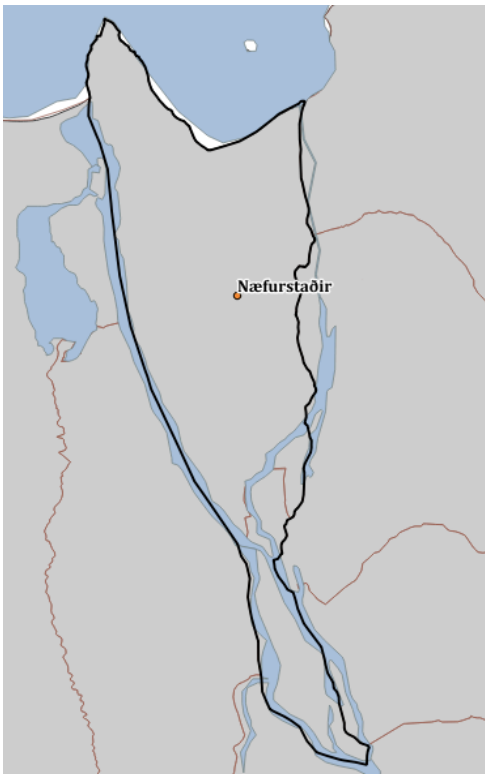

Figure 3: Location of Næfurstaðir on Hegranes.

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 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.

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**

Table 1: Table showing NISP and TNF for all phases at Næfurstaðir.

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.

Identification Rate

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%.

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.

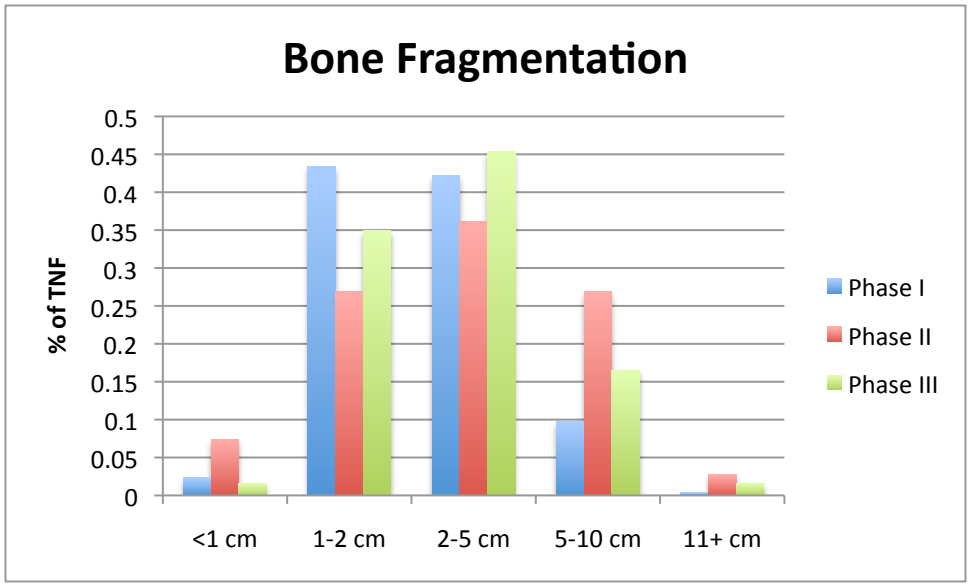

Figure 4: Bone fragmentation rates. Note that this graph shows TNF, not NISP, in order to characterize the entire assemblage.

Burning

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).

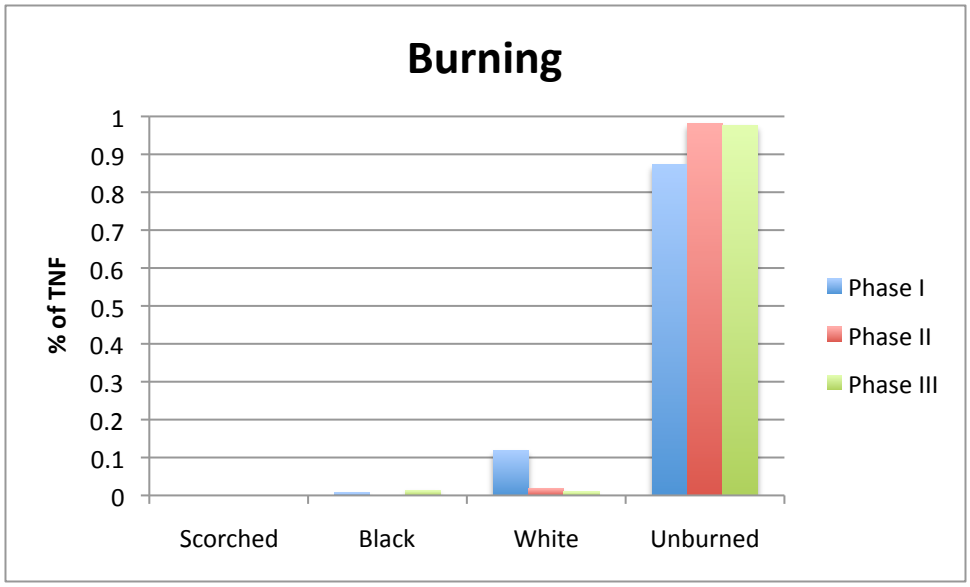

Figure 5: Burning, again presented as TNF

Gnawing

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.

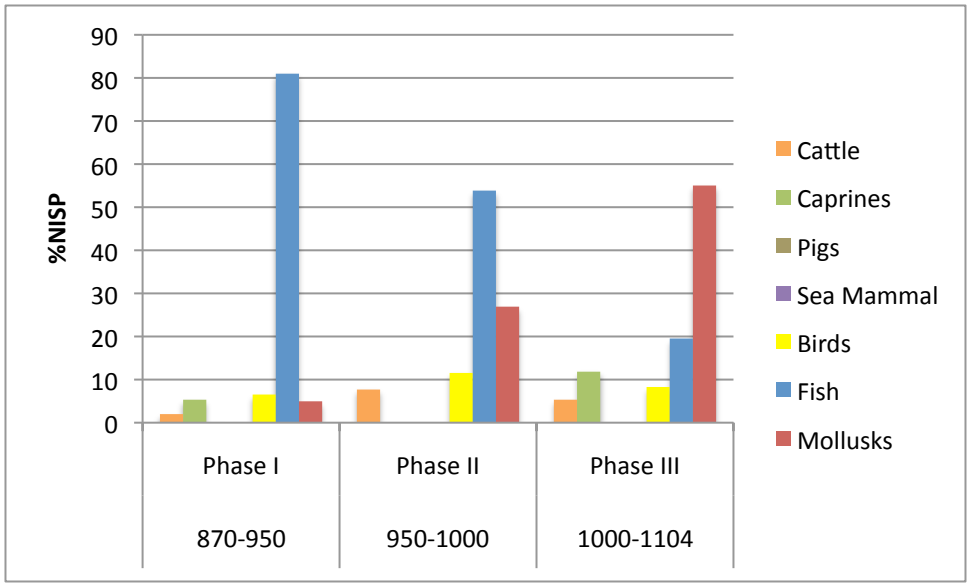

Figure 6: Relative percent of major taxa in all phases.

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 2019). 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.

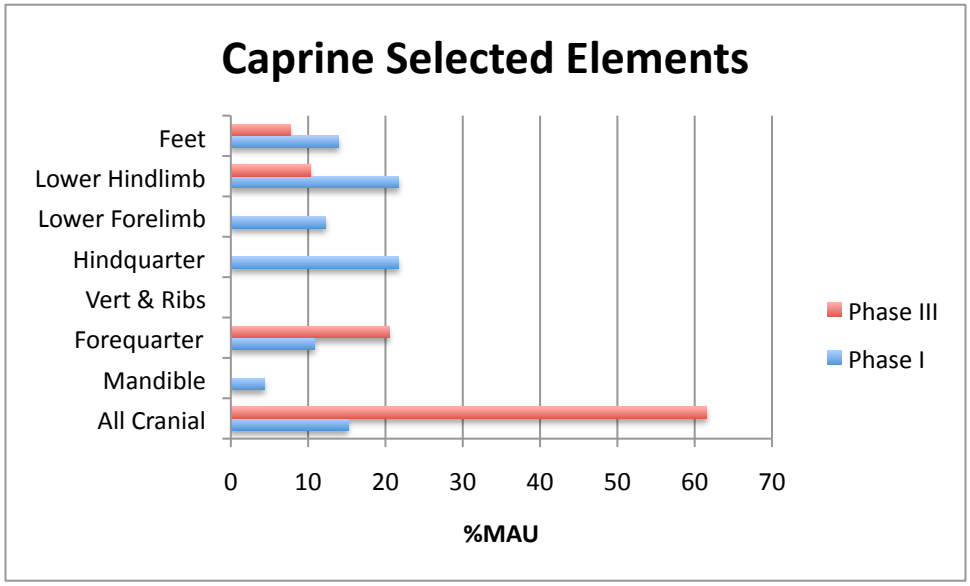

Figure 7: Caprine element distribution

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.

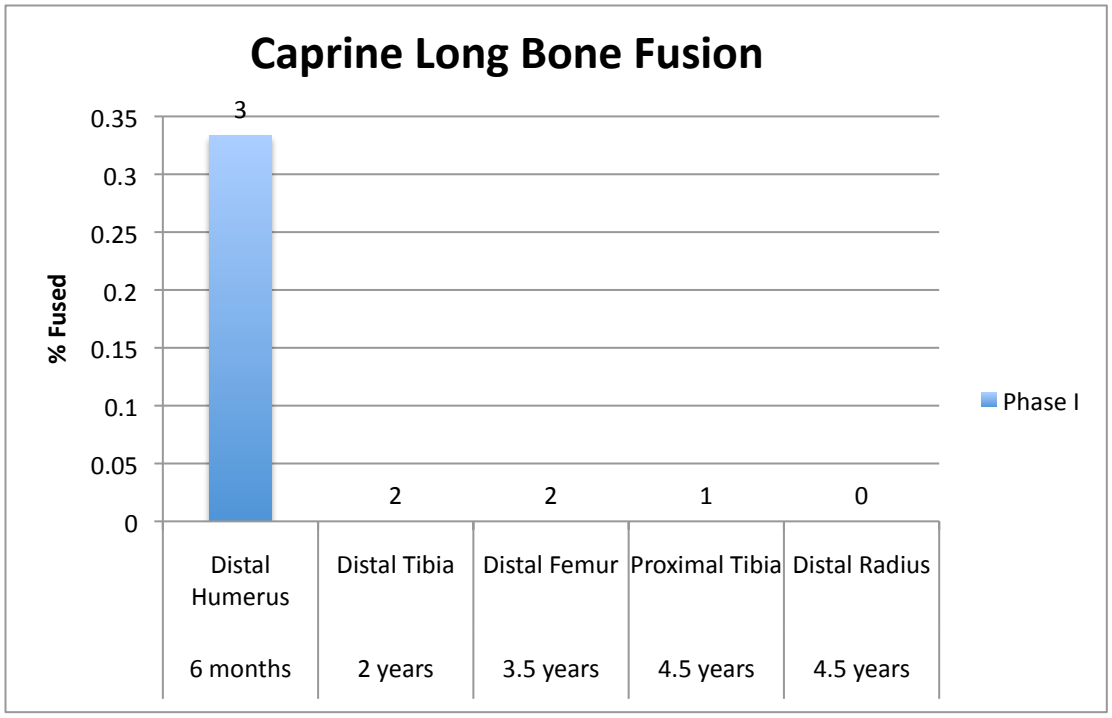

Figure 8: Long bone fusion stages for caprines. The number located above each element category represents the number of bones that were available for scoring; bar size indicates the percentage of these that were fused.

Neonates

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.

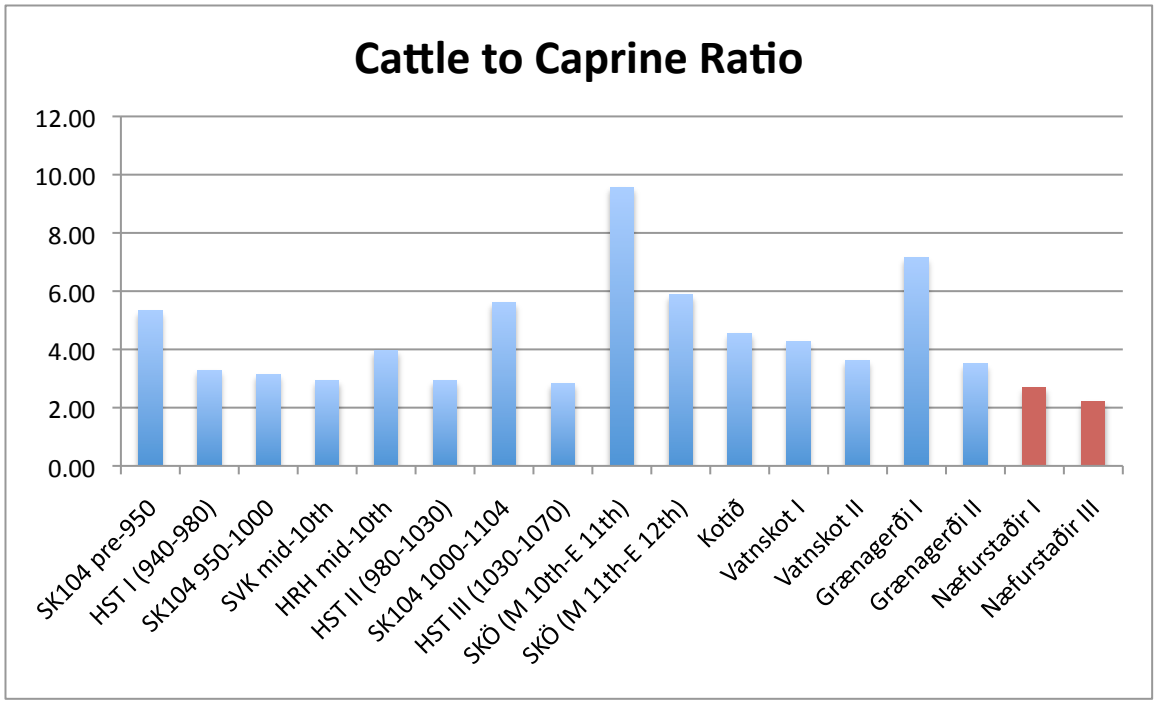

Figure 9: Cattle to caprine ratios throughout Iceland. Næfurstaðir is highlighted in red. Other sites in Skagafjörður include SK104 (Stóra-Seyla), Kotið, Vatnskot, and Grænagerði. As comparisons, we have Skuggi (SKÖ) in neighboring Eyjafjörður and in Mývatnssveit we have Hofstaðir (HST), Sveigakot (SVK),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

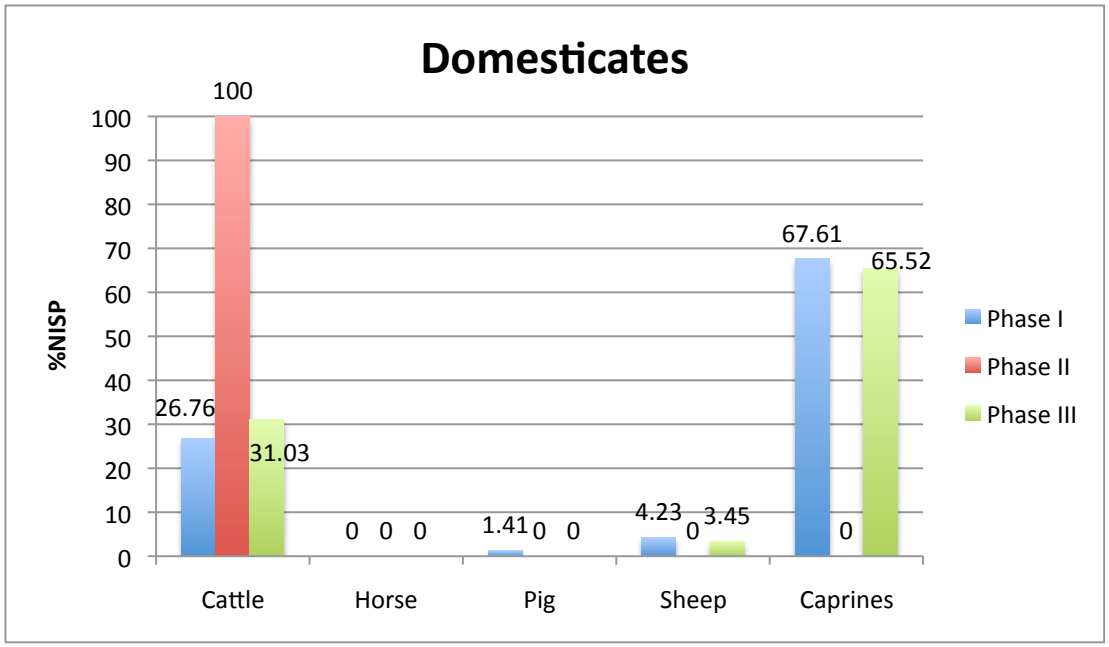

Figure 10: Relative percentage of domesticates in all phases.

Cattle Age Profile

Very few cattle bones were available for determining age, but those that were available are discussed below.

Tooth Eruption and Wear

While mandible fragments and loose teeth were recovered, no mandibles with teeth present in the jaw for aging were available for this collection.

Long Bone Fusion Stages

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.

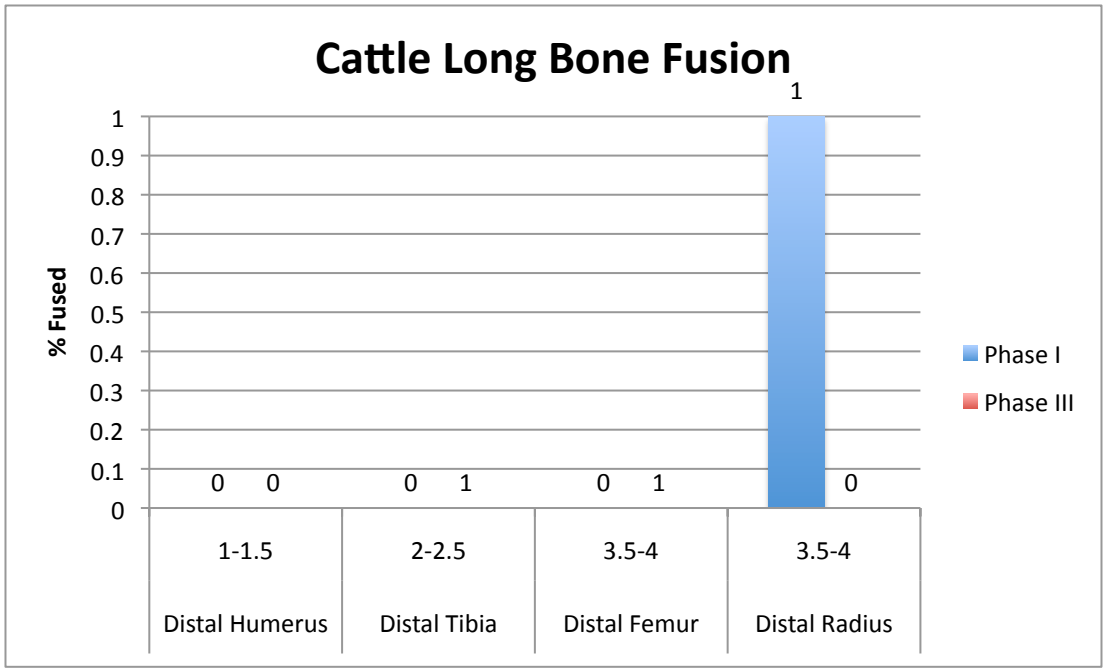

Figure 11: Cattle long bone fusion. Numbers above each bar represent the number of bones present in each category; size of bar indicates percentage of bones that were fused. Fusion data comes from McGovern (2009:221).

Neonates

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.

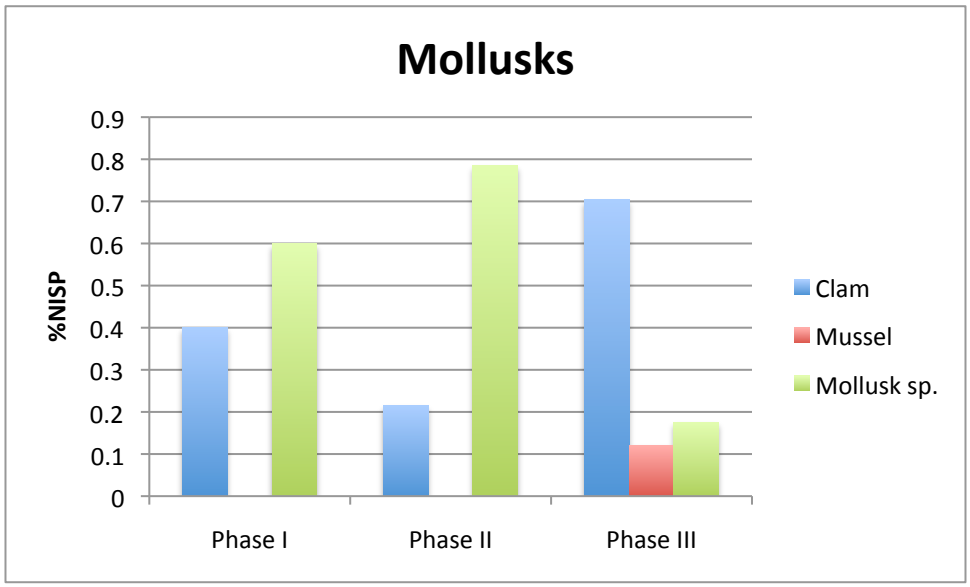

Figure 12: %NISP of mollusks

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."

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

Table 2: Birds in all phases

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.

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

Table 3: Fish NISP by phase

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.

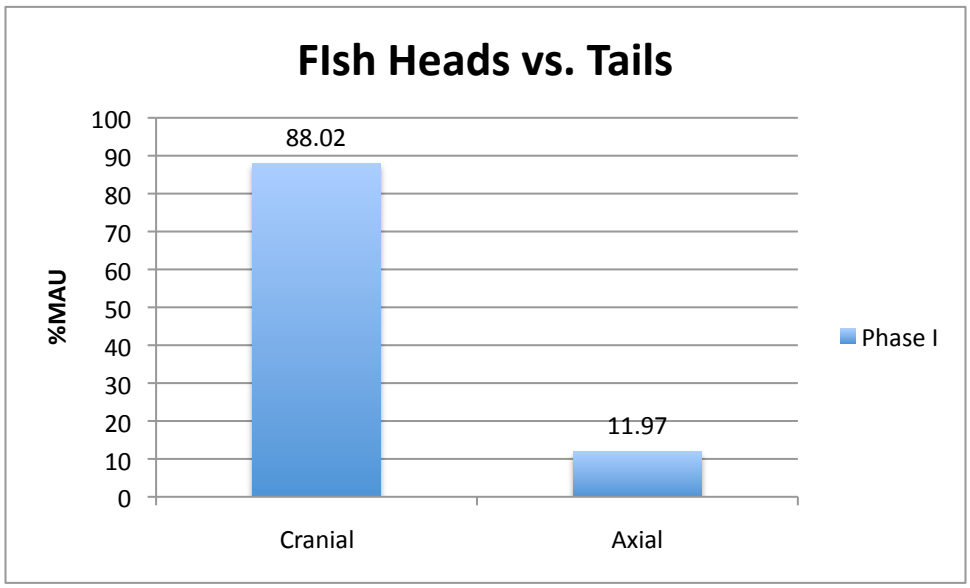

Figure 13: Fish cranial and axial elements

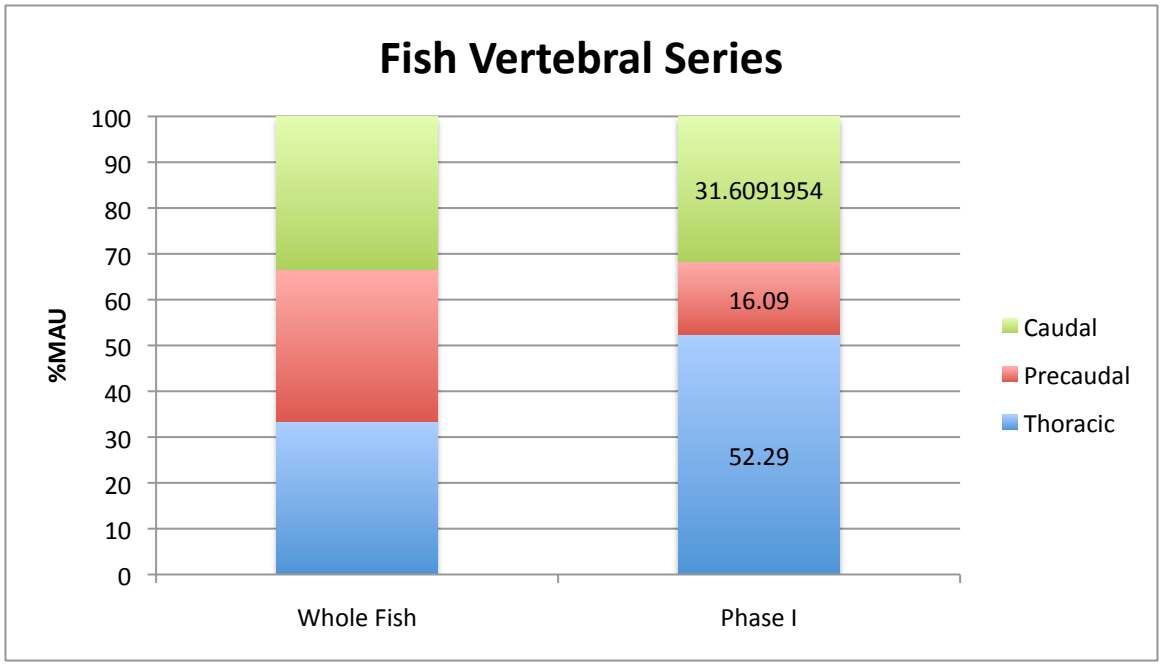

Figure 14: %MAU of different vertebrae from all gadids. Note that the leftmost column shows the ratios in a whole fish.

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 2018c, 2018d, 2019). 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.

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References

Amundsen, Colin, Sophia Perdikaris, Matthew Brown, Yekaterina Krivogorskaya, Salena Modugno, Konrad Smiarowski, Shaye Storm, Malgorzata Frik, Monica Koczela, and Thomas H. McGovern

2004 *A 15th c Archaeofauna from Akurvík, an early Fishing Station on NW Iceland*. CUNY NORSEC Laboratory Reports No 15.

Amundsen, Colin, Sophia Perdikaris, Thomas H. McGovern, Yekaterina Krivogorskaya, Matthew Brown, Konrad Smiarowski, Shaye Storm, Salena Modugno, and Monica Koczela

2005 Fishing Booths and Fishing Strategies in Medieval Iceland: An Archaeofauna from the site of Akurvík, North-West Iceland. *Environmental Archaeology* 10(2):127–142.

Boessneck, J.

1969 Osteological differences between sheep (Ovis aries Linné) and goats (Capra hircus Linné). In *Science in Archaeology*, edited by D. Brothwell and E. Higgs, pp. 331–358. Thames and Hudson, London, UK.

Bolender, Douglas J., John M. Steinberg, Brian N. Damiata, and Guðný Zoëga

2016 *Hegranes Settlement Survey: Interim Report 2015*. Fiske Center for Archaeological Research, Boston.

2017 *Hegranes Settlement Survey: Rein, Keta, Hamar, Utanverðunes, Ásgrímsstaðir. Interim Report 2016*. University of Massachusetts, Boston, Fiske Center.

Catlin, Kathryn A., John Steinberg, and Douglas Bolender
2017 *Fornbýli Landscape and Archaeological Survey on Hegranes (FLASH): Interim Report 2016*. Byggðasafn Skagfirðinga, Sauðárkrókur.

Cesario, Grace M.
2016 *Skagafjörður Archaeological Settlement Survey: The Archaeofauna from Stóra-Seyla Area C and Area D*. CUNY NORSEC Laboratory Reports No 63.

2018a *Skagafjörður Church and Settlement Survey: Archaeofauna from the 2016 Field Season.* CUNY NORSEC Laboratory Reports No. 66. New York, NY.

2018b *Hegranes Settlement Survey: Næfurstaðir Excavation Report 2018*. Byggðasafn Skagfirðinga.

2018c *Skagafjörður Church and Settlement Survey: Archaeofauna from Kotið, 2016 and 2017.* CUNY NORSEC Laboratory Reports No. 69. New York, NY.

2018d *Skagafjörður Church and Settlement Survey: Archaeofauna from Grænagerði.* CUNY NORSEC Laboratory Reports No. 70. New York, NY.

2019 *Skagafjörður Church and Settlement Survey: Final Report on the Archaeofauna from Vatnskot on Hegranes, Skagafjörður.* CUNY NORSEC Laboratory Reports No. 68. New York, NY.

von den Driesch, Angela
1976 *A Guide to the Measurement of Animal Bones from Archaeological Sites*. Peabody Museum Bulletin 1. Peabody Museum of Archaeology and Ethnology, Harvard University, Cambridge, Massachusetts.

Enghoff, Inge Bødker
2003 *Hunting, Fishing and Animal Husbandry at the Farm Beneath the Sand, Western Greenland: An Archaeozoological Analysis of a Norse Farm in the Western Settlement*. Danish Polar Center, Copenhagen.

Grant, A
1982 The Use of Tooth Wear as a Guide to the Age of Domestic Ungulates. In *Ageing and Sexing Animal Bones from Archaeological Sites*, edited by R Wilson, C Grigson, and S Payne, pp. 91–108. BAR British Series 109. Oxford, UK.

Grayson, Donald K.
1984 *Quantitative Zooarchaeology*. Academic Press, Orlando, FL.

Lemoine, Ximena, Melinda A. Zeder, Katelyn J. Bishop, and Scott J. Rufolo
2014 A new system for computing dentition-based age profiles in Sus scrofa. *Journal of Archaeological Science* 47:179–193.

Mainland, Ingrid, and Paul Halstead
2005 The Economics of Sheep and Goat Husbandry in Norse Greenland. *Arctic Anthropology* 42(1):103–120.

McGovern, Thomas
2009 The Archaeofauna. In *Hofstaðir: Excavations of a Viking Age Feasting Hall in North-Eastern Iceland*, edited by Gavin Lucas. Institute of Archaeology Monograph Series 1. Fornleifastofnun Íslands, Reykjavik.

Perdikaris, Sophia, and Thomas H. McGovern
2008a Codfish and Kings, Seals and Subsistence: Norse Marine Resource Use in the North Atlantic. In *Human Impacts on Marine Environments*, edited by Torben Rick and Jon Erlandson, pp. 157–190. UCLA Press Historical Ecology Series.

2008b Viking Age Economics and the Origins of Commercial Cod Fisheries in the North Atlantic. In *The North Atlantic Fisheries in the Middle Ages and Early Modern Period: Interdisciplinary Approaches in History, Archaeology, and Biology*, edited by Louis Sickling and Darlene Abreu-Ferreira, pp. 61–90. Brill Publisher, Netherlands.

Steinberg, John M., Brian N. Damiata, Rita S. Shepard, Kathryn A. Catlin, and John W. Schoenfelder
2016 *Egg on Hegranes: Geophysical Prospection, Coring, and Test Excavations*. Fiske Center for Archaeological Research, Boston.

Zeder, Melinda A.
2006 Reconciling rates of long-bone fusion and tooth eruption and wear in sheep (Ovis) and goat (Capra). In *Recent Advances in Ageing and Sexing Animal Bones*, edited by Deborah Ruscillo, pp. 87–118. Proceedings of the 9th Conference of the International Council of Archaeozoology, Durham, August 2002. Oxbow Press, Oxford, UK.

Zeder, Melinda A., and Heather A. Lapham
2010 Assessing the reliability of criteria used to identify postcranial bones in sheep, Ovis, and goats, Capra. *Journal of Archaeological Science* 37(11):2887–2905. DOI:10.1016/j.jas.2010.06.032.