CHAPTER 10

ZOOARCHAEOLOGY OF THE SCANDINAVIAN SETTLEMENTS IN ICELAND AND GREENLAND

diverging pathways

KONRAD SMIAROWSKI, RAMONA HARRISON, SETH BREWINGTON, MEGAN HICKS, FRANK J. FEELEY, CÉLINE DUPONT-HÉBERT, BRENDA PREHAL, GEORGE HAMBRECHT, JAMES WOOLLETT, AND THOMAS H. MCGOVERN

Common Origins, Different Ends

Both Iceland and Greenland were settled in the wave of sea-borne colonization that took European agricultural settlements to far offshore North Atlantic islands, reaching Iceland *c.* AD 875, Greenland *c.* AD 985, and briefly to Newfoundland by AD 1000 (Fig. 10.1). Both modern and ancient DNA analyses (Helgason et al., 2000a; 2000b; 2001) confirm the strong British Isles genetic component of Icelanders, and recent aDNA from Greenlandic cemeteries (Lynnerup and Nørby, 2004) provide confirmation of the traditional accounts of Greenlandic settlement from Iceland. The long-term fate of these communities presents a stark contrast: despite challenges of climate cooling, soil erosion, volcanic eruption, famine, smallpox, and plague, the Icelanders survived to become a fully developed twenty-first-century Scandinavian society. The Greenlanders were not as successful, and while the end of their community around AD 1450 has become a classic case of 'collapse' (Diamond, 2005), their dramatic fate remains an active subject for international, interdisciplinary research (Dugmore et al., 2012; 2013).

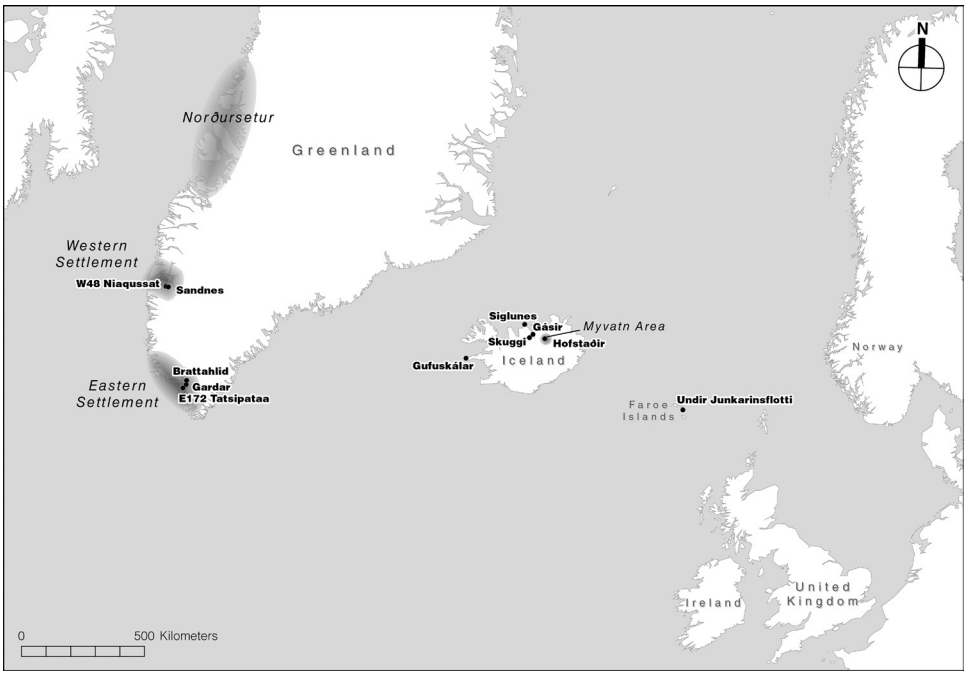

FIGURE 10.1 Map of the North Atlantic with regions and sites mentioned in the text. Authors' own image.

Zooarchaeology came early to Iceland and Greenland. The Danish Captain Daniel Bruun regularly collected unmodified animal bone remains from his very professionally conducted excavations in both islands just over a century ago (Bruun, 1895; 1896; 1899; 1903; 1917; Bruun and Jónsson, 1911), with pioneering zooarchaeological reports produced by Herluf Winge of the University of Copenhagen Zoological Museum (Winge in Bruun, 1895; 1917). Magnus Degerbøl and Ulrik Møhl continued the Zoological Museum tradition with a series of now-classic reports based on major Danish projects in Greenland and Iceland (Degerbøl, 1929; 1934; 1936; 1939). Post–World War II zooarchaeology in Greenland added radiocarbon-dated, stratified collections and sieved recovery (McGovern, 1985a; Buckland et al., 1996; McGovern et al., 1996; Enghoff, 2003). Since 1975 there has been an explosion of new zooarchaeological work in both Iceland and Greenland, as in the rest of the North Atlantic, much of which is now available through the North Atlantic Biocultural Organization (NABO) website (www.nabohome.org). During the 2007–11 International Polar Year and under the 2012–15 Comparative Island Ecodynamics Project, NABO research has focused on the diverging pathways and differing outcomes of 'long-term human ecodynamics' in Iceland and Greenland. This paper draws both upon this new work and upon a zooarchaeological research tradition extending over a century. The pace of research and large new archaeofauna still under analysis from both Iceland and Greenland will inevitably make this overview something of an interim report of work in progress, but the rich zooarchaeological record now in hand allows for some productive broad scale comparison.

Diverging Pathways at Landnám

The initial settlement (*Landnám*) of Iceland and Greenland was also a moment for initial branching of economic pathways. In Iceland, Norse settlement became widespread around the time of the volcanic ash fall datable to 871±2 AD with full-scale settlement spreading surprisingly rapidly to inland areas such as the well-studied Lake Mývatn basin up to 70 km from the coast (McGovern et al., 2007; Vésteinsson and McGovern, 2012). While the traditional written accounts (composed centuries after the event) emphasize chiefly land-taking in agricultural regions, there is both place name and zooarchaeological evidence for the major role of wild species in the Viking Age economy (McGovern et al., 2006; 2009). Since 1944, investigations in the Aðalstraeti area under modern downtown Reykjavik have produced walrus (*Odobenus rosmarus*) bone and substantial amounts of sea-bird including great auk (*Pinguinus impennis*) and marine fish bone datable to first settlement (summary in Harrison et al., in press). Walrus fragments include both tusks and post-cranial bone (some from very young individuals), suggesting nearby kill sites and local breeding populations. A segment of walrus vertebra and a scapula embedded in the exterior turf wall of the early long hall at Aðalstraeti, as apparent trophies, and walrus place names down the nearby Reykjanes peninsula suggest walrus hunting may have been an initial motive for the Icelandic *Landnám* (Pierce, 2009; McGovern, 2011). As in Faroese Viking Age archaeofauna (Brewington, 2006; 2010b; 2011; 2014; Brewington and McGovern, 2008; Church et al., 2005), sea-bird bones initially outnumber those of imported sheep (*Ovis aries*), goat (*Capra hircus*), pig (*Sus domesticus*), cattle (*Bos taurus*), and horse (*Equus caballus*) in the early southern Icelandic archaeofauna, indicating that both sea mammals and bird colonies provided a source of natural capital that was drawn down to support the early phases of colonization in southern Iceland.

In the north of Iceland multiple projects have demonstrated early use of marine fish and marine mammals, especially from the cod family (Gadidae) on both coastal and inland sites (McGovern et al., 2006; Gísladóttir et al., 2013). Volcanic tephra horizons have allowed secure dating of multiple contemporary sites in the inland Lake Mývatn basin prior to 940 AD that are rich in headless gadid fish, with post-cranial element distributions suggesting large scale consumption both as flat-dried and round-dried ('stockfish') products, along with smaller numbers of marine mammal, bird, and molluscan remains. These well-dated inland Mývatn archaeofauna provided critical evidence that the widespread 'Fish Event Horizon' observed in British and Continental archaeofauna (Barrett et al., 2004) has a Scandinavian origin, and may well represent one of the most lasting heritages of the Viking Age in Europe (Perdikaris and McGovern, 2008a; 2008b). Recent work at the eroding coastal site of Siglunes, an early chieftain's farm at the mouth of Siglufjord in northern Iceland, has provided radiocarbon and tephra dates extending well into the Viking Age. It has produced large, stratified archaeofauna dominated by cod-family fish and demonstrating the relative surplus of cranial *vs* post-cranial bones characterizing later 'producer sites' (Krivogorskaya et al., 2005).

Domestic mammals in the Icelandic Viking Age archaeofauna are dominated by cattle and caprines (in most cases mainly sheep but with a significant proportion of goats), with substantial numbers of pigs in some collections. Ancient DNA analysis of house mice (*Mus musculus*) accidentally imported to Iceland show connections to populations in both Continental Europe and Norse Greenland (Jones et al., 2012).

Horse bones are comparatively rare in all archaeofauna, but in pre-Christian contexts it is clear that they were occasionally butchered and consumed on most sites. Both horses and dogs were regularly included in pagan burials, and the horse bones (unaffected by partly marine or freshwater fish diet, Ascough et al., 2010) are now regularly used for radiocarbon dating of the rapidly growing corpus of pre-Christian Icelandic graves (Friðriksson, 2013). Stable nitrogen (N), carbon (C), and strontium (Sr) isotope analyses in the Mývatn area have all documented a significant freshwater reservoir effect (FRE) in local arctic char (*Salvelinus alpinus*) and trout (*Salmo trutta*), and allowed for the identification of a special freshwater-fish consumption signature in a few of the Viking Age pigs (Ascough et al., 2007; Sayle et al., 2013).

Recent work on pre-Christian cemetery complexes in northern Iceland (Roberts and Hreiðarsdóttir, 2012) and at the temple farm complex at Hofstaðir, near Mývatn (Lucas, 2009), suggests that cats (*Felis domesticus*) as well as dogs (*Canis familiaris*) and horses (*Equus caballus*) may have played a role in rituals (Maher, 2009; Prehal, 2011). Cats are found in rare and unusual circumstances, such as at the pre-Christian grave field at Ingiríðarstaðir, where one was found in a pit amongst human skull fragments (Brewington, 2010a). The modern large-scale excavations at Hofstaðir conducted by the Archaeological Institute of Iceland and NABO, followed the initial work by Daniel Bruun in 1908 (Bruun and Jónsson, 1911). The project produced both a substantial archaeofauna, dated *c.*940–1000 AD and evidence for skinning cats for fur as well as a recurring ritual beheading of bulls, with their skulls displayed along the exterior of the great hall (Lucas and McGovern, 2008; Lucas, 2009; McGovern et al., 2009).

The Mývatn archaeofauna also document a millennial-scale case of successful, community-level management of migratory waterfowl, beginning at Landnám and continuing down to the present (McGovern et al., 2006; Hicks et al., 2013; 2015). The Mývatn lake basin annually hosts up to 30,000 pairs of migratory waterfowl coming from both sides of the Atlantic, and modern lakeside farmers regularly collect 10,000 eggs annually without adversely impacting these species (Guðmundsson, 1979). Modern farmers carefully monitor nesting birds, take only a few eggs per nest, and only rarely consume the adults, while protecting the nesting grounds against predators (Beck-Guðmundsdóttir, 2013). This pattern can be documented back to the mid-nineteenth century AD, and current archaeological excavations around Mývatn have generated archaeofauna rich in eggshells but with only a small number of waterfowl bones (McGovern et al., 2006). Ongoing collaborative work making use of modern comparative specimens and SEM imagery is combining wildlife management, ethnography, and zooarchaeology to both document this case of long-term traditional ecological knowledge and apply lessons learned to future management for long-term sustainability (Hicks et al., 2015).

The zooarchaeology of Viking Age Iceland is thus producing an increasingly rich record of a North Atlantic community similar in many respects to contemporary communities in northwestern Europe. Wild species supplemented domestic stock (and initially widespread barley cultivation; Trigg et al., 2008), animals played varied roles in pre-Christian rituals, and cases of both rapid draw-down and long term sustainable management of animals as natural capital can be documented dating back to the first years of settlement. By the time Iceland was Christianized, in *c.*1000 AD, it had become a well-populated island community integrating farming with hunting and fishing, and producing modest surpluses of wool and dried fish mainly for internal exchange. By the end of the eleventh century AD, Iceland's population had probably neared its pre-modern maximum of 50,000–60,000 and supported two bishoprics and many large estates.

Greenland was always different. When Icelandic settlers crossed the Denmark Strait around AD 985–1000 to found two communities on the western coast (Eastern Settlement in modern Kujalleq district; Western Settlement further north in Sermersooq district, near Nuuk) they crossed significant climatic and biological frontiers, though these may not have all been immediately apparent (Dugmore et al., 2013). In Greenland they encountered caribou (*Rangifer tarandus*), polar bear (*Ursus maritimus*), and huge populations of walrus as well as both familiar North Atlantic and unfamiliar Arctic seals and whales. Greenland was probably always beyond the reach of cereal agriculture, and the two pockets of farmland in the inner fjords of the southwest were isolated by thousands of kilometres of barren coast and the interior ice sheet.

Strontium (Sr) isotope calibration samples unexpectedly identified two early cattle in Greenland who had been born in Iceland (Price, in press). Initially, the full Icelandic range of cattle, sheep, goats, dogs, horses, and pigs appear in early Greenlandic collections (Smiarowski, 2012; 2013; 2014).

Recent comparative research has increasingly underlined the character of the Greenlandic settlements as always something of a specialized arctic resource extraction community, with export-orientated hunting for ivory and furs being supported by subsistence hunting and farming, rather than a farming community supplementing agriculture with subsistence hunting and fishing as in Iceland (Dugmore et al., 2007b; Keller, 2010). The historic concentration of walrus and walrus hunting has centred on Disko Bay on the central western coast, in an area the Norse called the 'Norðursetur' or northern hunting grounds (Gad, 1970; McGovern, 1985b). Written sources indicate that annual hunting trips were launched from both settlement areas to the Norðursetur, up to 800 km one way from the farming districts. The zooarchaeological evidence for this remarkable long-range hunt has been found in virtually every archaeofauna from the home farms in the form of fragments of walrus maxilla from around the tusk root, left behind by careful extraction of the ivory from the maxilla. These walrus maxillary fragments are found on inland as well as coastal farms in both settlement areas and throughout the stratigraphic sequences, indicating the active participation of most of the community in the Norðursetur hunt and ivory preparation (McGovern et al., 1996). Tusk ivory or finished ivory pieces are rare on the home farms (though walrus

penis-bone trophies and post-canines used for craftwork are not unusual). There are no concentrations of walrus post-cranial elements as found in the Aðalstraeti deposits in Iceland, as the Greenlandic walrus kill sites were regularly hundreds of kilometres from the home farm processing area. This long-range Norðursetur walrus hunt thus seems to have been of a very different character and intensity from the sort of exploitation of nearby local walrus pods that we can now document from early Iceland. Processing of the furs and hides mentioned in written sources is harder to document through zooarchaeology, but new collections from the Greenlandic Bishop's manor at Gardar/Igaliku in the Eastern Settlement have produced multiple polar bear third phalanges with cut marks suggesting on-site final finishing of bear skins (Smiarowski, 2013).

On the Greenlandic home farms, shorter growing seasons and lower overall pasture productivity levels constrained stock production. Dairy cattle probably spent nearly nine months a year indoors being hand-fed fodder harvested in autumn (McGovern, 1992), and evidence of preserved dung concentrations suggests that at least some goats and sheep were also regularly stabled indoors in winter (Enghoff, 2003). The spectre of late winter shortfall in stored fodder and human provisions was a recurring threat to North Atlantic farmers (McGovern et al., 1988; Amorosi et al., 1998). Nevertheless, cattle were still maintained on all farms and there are no archaeofaunas indicating specialized caprine herding, even on the smallest farms with poor pastures. Among the caprines, goats were often more numerous than sheep in the Greenlandic archaeofauna from first settlement onwards (McGovern et al., 2014; Smiarowski, 2014).

Greenlandic settlers' encounter with the immense populations of migratory harp (*Pagophilus groenlandicus*) and hooded seals (*Cystophora cristata*) (rare or absent in Iceland and the eastern North Atlantic) had immediate and lasting impact on their subsistence economy. Current zooarchaeological evidence from both the Western Settlement (McGovern, 1985a) and the Eastern Settlement (Smiarowski et al., 2007; Smiarowski, 2012; 2013; 2014) dating to the early settlement period, indicates a rapid and radical shift in use of wild species by the original colonists. Marine fishing and dried fish production seems to have been immediately supplanted by large scale (probably communal) hunting of the newly encountered migratory seals, supplemented by sea-bird and caribou hunting. Seals were regularly taken throughout the North Atlantic from prehistoric times, but the harbour (*Phoca vitulina*) and grey seals (*Halichoerus grypus*) found in most of the eastern North Atlantic form comparatively small non-migratory pods and are very vulnerable to over-hunting. In Iceland, law codes regulated sealing beaches and harbour and grey seal populations seem to have generally been harvested sustainably at a fairly low level, with seal bones appearing as trace species in most archaeofauna in the Viking and early Middle Ages. In Greenland, harbour seal colonies were present, and the bones of this species appear regularly in Greenlandic archaeofauna (McGovern, 1985a; Ogilvie et al., 2009; Smiarowski, 2013), but they are greatly outnumbered by the bones of migratory harp seals (both settlements) and hooded seal (Eastern Settlement only). The bones of non-migratory arctic ringed (*Phoca hispida*) and bearded seals (*Erignathus barbatus*), which make breathing holes in winter ice but are not so readily taken with boat drives and other communal hunting strategies, are

rare in Norse collections from Greenland. The Norse Greenlanders apparently adapted communal seal hunting techniques to the newly encountered migratory species and did not make extensive use of the sea ice sealing practices of either the Dorset or Thule peoples or of the Nordic ringed-seal hunters of the contemporary northern Baltic (Storå and Lõugas, 2005).

Seal bones vary from about 25% of major identified taxa to nearly 80% on small farms with limited pasture, and are common on far inland Greenlandic farms. While a few marine and freshwater fish bones have now been identified in Greenlandic archaeofauna, they represent a trace element (less than 1%, Smiarowski, 2013; 2014), far less than the staple represented by marine fish (25 to over 80%) in Viking and Early Medieval Icelandic archaeofauna. Seals appear to have replaced marine fish almost entirely in the Greenlandic subsistence strategy, and this seems to have happened in the very first years of settlement. There has been extensive debate about the cause of this clear pattern, which seems strongly counter-intuitive given both the role of marine fisheries in modern Greenland and the now well-documented late ninth-century AD Icelandic fishing record. Scheduling issues, rather than ritual prohibitions (Diamond, 2005), are likely at the core of this unexpected divergence. In Iceland, marine fishing was regularly practised in winter, and the air drying of stockfish requires prolonged temperatures hovering around the freezing point for curing. Winter was also the agricultural slack season, and in later time periods Icelandic farm hands were regularly put to sea in winter as fishermen. In Greenland, winter sea conditions, even during a warmer climate, are far more affected by sea ice, and winter temperature ranges, for most of even the southwest, tend to be too cold for effective stockfish curing. Greenlandic seagoing boats and labour were needed for most of the summer for the weeks-long voyages to the Norðursetur and the walrus hunt, which thus would compete directly with a summer fishing effort.

The migratory seals would arrive in the outer fjords of the two Greenlandic settlements in late May and early June; before the probable start of the Norðursetur voyages and during the worst of any recurring late-winter household provisioning gap. Despite centuries of hunting, harp seals still number in the millions, and unlike the non-migratory harbour seals they could support a large-scale harvest sustainably. The Greenlandic choice of intensifying migratory seal hunting and de-emphasizing marine fishing thus appears rational, given the environmental conditions and the scheduling limitations imposed by the long-range Norðursetur hunt. As in more recent cases, the demands of production for export may have limited the options for viable local subsistence strategies.

The Gardar bishopric was established in AD 1126, and current evidence suggests that this became by far the largest manor and elite centre in Greenland, with cattle byres capable of housing nearly a hundred cattle (in contrast to the 3–5 stalls usually encountered on smaller farms). This site also contains the largest concentration of caribou bone in the Eastern Settlement (Smiarowski, 2013), adding to the pattern of elite caribou consumption suggested for the Western Settlement (McGovern et al., 1996).

Comparative investigations of church and settlement patterns between Iceland and Greenland during the period *c.* AD 1000–1200 suggest a pattern of consolidation

by higher-ranking elites who in both communities seem to have gathered power at the expense of middle-ranking chieftains and farmers (Arneborg et al., 2008). The Greenlandic settlements remained much smaller than the Icelandic, with maximum population probably well under 4,000 at peak.

By the thirteenth century AD both Greenland and Iceland were well-established Medieval communities, with ecclesiastical and secular hierarchies in place. Though by AD 1264 both were part of a trans-Atlantic Norwegian realm, they had become very different places, with a similar mix of imported northwestern European domestic livestock masking major contrasts in the use of wild species and the role of surplus extraction. While Icelandic fisheries and marine-mammal hunting seem to have been initially focused on supplying local subsistence demand and could be readily integrated into an annual agricultural cycle, the Greenlandic Norðursetur hunt generated inedible trans-Atlantic trade goods while creating significant conflict with the subsistence round (McGovern, 1985b).

High Medieval Course Changes

In the mid-thirteenth to early fourteenth century AD a conjuncture of local, regional, and extra-regional social, economic, and environmental changes placed both stresses and opportunities before these two westernmost Scandinavian communities. Growing links between East Asia, the Mediterranean, and northern Europe during the *Pax Mongolica* of the mid-thirteenth to the mid-fourteenth century AD developed into a Medieval proto-world-system, with distant echoes in the Scandinavian North Atlantic (Abu-Lughod, 1981). In Iceland, this period saw the establishment of a number of seasonal trading centres distributed around the coastal fjords, with Gásir in Eyjafjord currently the best archaeologically documented (Hermannsdóttir, 1987; Roberts, 2002; Roberts et al., 2009; 2010; Harrison et al., 2004; 2008; Harrison, 2005; 2006; 2009; Pálsdóttir and Roberts, 2006; 2007; Vésteinsson et al., 2008; 2011 Vésteinsson, 2009; 2011). The investigations at Gásir have developed into a multi-site investigation of the impact of this seasonal trading centre on a broader hinterland (Harrison, 2009; 2010a; 2010b; 2010c; 2011a; 2011b; 2011c; 2013; 2014). Among the findings of this ongoing research is that farms in this hinterland altered the traditional dairying economy in order to provision Gásir with prime-beef aged cattle. In return, some of these farms were consuming imported barley, and even had access to fashionable continental lap dogs; this area of rural Iceland was clearly connected to the larger world on multiple levels. While the Gásir excavations have confirmed documentary references to Medieval trade in Icelandic falcons and sulfur, the major exports seem to have been woolen cloth and dried fish (Harrison et al., 2008).

Coastal fishing sites increase in numbers and distribution in northern Iceland and the West Fjords after *c.* AD 1250, with the small seasonal site of Akurvík producing two large, fish-dominated archaeofauna, the first datable to the thirteenth century AD and

the second to the fifteenth (Amundsen et al., 2005). These both show a clear 'producer signature' of surplus fish heads, as well as indications of the production of both flat-dried and round-dried cod and haddock in the thirteenth century AD, switching in the fifteenth century AD to a concentration on round-dried 'stockfish' cod. The nearby farm at Gjögur shows a dramatic increase in fish bone after *c.* AD 1250 and in later times was known as a major fishing farm (Krivogorskaya et al., 2005). By the late thirteenth century AD Icelandic magnate families were switching their core holdings from the main agricultural areas to the prime fishing regions, and it seems clear that the local-level artisanal subsistence fisheries of Viking Age Iceland were undergoing intensification for wider export (Vésteinsson in press).

In the thirteenth century AD some Icelandic archaeofaunas show a dramatic change in cattle to caprine bone ratios, shifting from the 1: 3 to 1: 5 ratios common in the Viking Age and Early Medieval periods to the 1: 20 ratios characteristic of eighteenth-century AD stock records. Goats become very rare, and the zooarchaeological data suggest higher proportions of older (and larger) sheep likely representing wethers or older ewes maintained for wool production (McGovern et al., 2007; Harrison, 2013). In Eyjafjord, the Gásir hinterlands were spatially re-organized, with small subsistence farms like Skuggi replaced by specialized sheep-herding structures on valley floors (Harrison, 2010a; 2013). Woolen cloth fragments show standardization into the legally defined *vaðmal*, suitable for exchange and valuation as a commodity (Hayeur-Smith, 2011). In Iceland by the mid-thirteenth century AD it appears that wool production and marine fishing were both being intensified, and that both woolen goods and dried-fish products were undergoing standardization and commoditization for a new export market as well as domestic consumption.

In Greenland, there is no indication of similar alterations in the relation of subsistence and surplus production for trade. The amount of walrus maxillary bone tusk-extraction debris remains constant or increases in the stratified Western and Eastern Settlement archaeofauna (McGovern et al., 1996; Smiarowski, 2013; 2014). Documentary records indicate that while hundreds of kilos of Greenlandic walrus ivory were still being collected by church factors in the mid-fourteenth century AD, this product was increasingly difficult to market profitably (Keller, 2010). Cattle-to-caprine ratios remain fairly stable on larger manor farms, and where caprine bones increase on smaller farms many of these are goats rather than sheep (Smiarowski 2014; McGovern et al., 2014). No evidence for standardization of woolen cloth production has yet been identified in the Greenlandic collections (Hayeur-Smith, 2014). While initially probably far more engaged in cash hunting for low-bulk, high-value exchange products in the Viking Age, the Greenlandic community proved less able than the Icelanders to shift to high-bulk, low-value commoditized trade in the thirteenth century AD.

Climate change as well as early globalization impacted both Medieval Iceland and Greenland. In AD 1257–1258 a massive volcanic eruption on Lombok (Indonesia) triggered an immediate cooling across the North Atlantic, and between 1275–1300 AD a threshold-crossing increase in summer sea ice impacted both northern Iceland and southwest Greenland (Miller et al., 2012). Pasture productivity in both communities

was adversely affected, and the summer drift ice impacted trans-Atlantic voyages to Greenland, local travel, and the viability of harbour seal colonies in the Eastern Settlement area (Ogilvie et al., 2009). In Iceland, a *c.* AD 1300 archaeofauna from Hofstaðir exhibits both intensive bone processing for collagen extraction and the sudden appearance of substantial numbers of harp seal bones on this inland farm; both patterns indicating not only 'hard times' but also the resilient use of a newly available wild resource (McGovern et al., 2014). In Greenland, later archaeofauna show a marked intensification of the existing harp seal hunt, a pattern mirrored by the human stable isotope data that indicate Norse Greenlanders moving decisively into the marine food web after *c.* AD 1250 (Arneborg et al., 2012). The combined zooarchaeological and bioarchaeological record indicates that the Norse Greenlanders successfully survived the climate shocks of AD 1275–1300 by intensifying their existing communal seal hunting strategies to compensate for stress on the farming economy. Around AD 1425, a second climate shock impacted the whole region, with a dramatic increase in storminess (Dugmore et al., 2007a). The successful Greenlandic response to the initial climate impact may have rendered this small community tragically vulnerable to loss of life at sea in a radically stormier North Atlantic, and by around AD 1450 Norse Greenland was extinct.

While the Icelanders were impacted by both increased storminess and the appearance of the Black Death in AD 1402, their larger population and more effective combination of subsistence and exchange economies may have provided critical buffering (Streeter et al., 2012). European demand for stockfish continued to expand. Recent work on the Snæfellsnes peninsula has revealed nearly a kilometre of exposed dense fishbone midden 50–75 cm thick with radiocarbon dates indicating an accumulation within a few decades in the mid- to late fifteenth century AD (Pálsdóttir, 2011; 2013). While field and laboratory work at Gufuskálar continues, mammal bones suggest a pattern of provisioning with cuts of high quality lamb and beef more similar to the consumption patterns at the earlier Gásir trading site than the contemporary but much smaller Akurvík fishing station (Feeley, 2012; 2013). Finds of amber and pewter rosary beads, a bronze finger ring, fragments of chain mail armour, and a concentration of imported glazed red wares within a substantial stone structure suggests that this 'near industrial scale' fishing station may have been occupied and run by English or other Europeans as well as Icelanders. While Norse Greenland was slipping into final obscurity by the mid-fifteenth century AD, Iceland remained vital, with an economy that now appears more complex and diverse than previously thought (Boulhosa, 2010).

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