

# Across the fish event horizon: a comparative approach

Sophia Perdikaris, George Hambrecht, Seth Brewington, & Thomas McGovern

## Abstract

Collaborative zooarchaeological research in the N Atlantic area has recently produced major advances in understanding the origins of the commercial fisheries of the Middle Ages and Early Modern period. These large scale commercial fisheries became major economic engines for European expansion, and were based upon a standardized and commoditized product- dried Atlantic cod fish. Synthetic work by James Barrett's team has documented a marked "fish event horizon" (FEH) dated to AD 950-1050 in the zooarchaeological record of Britain. Prior to the FEH, marine fish bones of any kind are virtually absent in Britain, and the "fish middens" dominated by densely packed fish bones are rare in northern Scotland and the Northern and Western isles. Recent excavations in Iceland and the Faroe Islands indicate a Scandinavian origin for the FEH, and the development of a pre-commercial regional dried fish trade prior to AD 950. Zooarchaeological patterns now allow clear flagging of producer sites vs. consumer sites from element distribution and size reconstruction, and comparisons. This early dried fish trade produces zooarchaeological signatures unlike the post-FEH, with higher species diversity, less standardized fish cutting, and different patterns of element distribution between coastal producer and inland consumer sites. are drawn to later sites of known function.

**Keywords:** North Atlantic Fisheries, Zooarchaeology, Norse, Fish Event Horizon

## Introduction

Synthetic work over the past decade by James Barrett and his collaborators (1997, 2000, 2001, 2004, 2005, this volume) has made major contributions to our understanding of the origins and spread of commercial fishing in the British Isles and the larger N Atlantic region. Making use of all available datable British archaeofauna, Barrett's team have recently defined a surprising but convincing "fish event horizon" (FEH) of ca AD 950-1050 in Britain (Barrett, Locker & Callum 2004). Prior to this temporal and spatial horizon, marine fish bones are virtually absent on any inland site in Britain. The "fish middens" characterized by dense concentrations of fish bone documented by many workers in Northern Scotland and the Northern Isles also seem to post-date the horizon. While there is extensive evidence for pre-Norse Iron Age marine resource use in the Northern and Western Isles of Scotland, and it appears that there was a significant increase in deep water fishing with the arrival of the Norse ca AD 800, the major fish middens in the area dated thus far appear to belong to the post - FEH Late Norse/Medieval period. (Barrett et al. 1997, 2001, Cerron-Carrasco 1998, Nicholson 1998). It thus appears that the large scale production and exchange of dried fish in Europe (and eventually the New World) so well documented in later time periods by both zooarchaeology and written sources did not originate within the British Isles. The Scottish island evidence suggests a modest but potentially important expansion of off shore fishing occurred

in the nearly two hundred years between the arrival of Scandinavian raiders and colonists and the archaeologically visible fish middens plausibly linked to the FEH ca AD 1000.

These important findings raise two inter-related research questions:

- 1) If the origins of the FEH are not to be found in Iron Age Britain or in the initial early Viking Age (ca AD 800-1000) Scandinavian colonization of Scotland and England, where did the large scale dried fish production and distribution so visible after AD 1050-1100 come from, and when were these patterns first developed?
- 2) If there was a pre-commercial, pre-FEH pattern of production, distribution, and consumption of dried fish products before the late Viking age, what did it look like? What zooarchaeological patterns can be used to characterize this early pattern and provide points of comparison with the historical and zooarchaeological evidence for intensive post-FEH fishing in Scotland and the trans-Atlantic commercialized fisheries of the medieval and early modern periods?

This paper seeks to expand discussion of these points, making use of new zooarchaeological data from the Faroe Islands and Iceland, and suggesting some analytical approaches which may help in grappling with such complex social, economic, and zooarchaeological issues.

### North Norwegian origins of dried fish production?

Northern Norway has a long history of maritime adaptation, and has long been a center for commercial exploitation of large stocks of cod and related gadid fishes (Bertelsen 1991). Perdikaris has zooarchaeologically documented intensive deep water fishing combined with evidence for dried fish production extending back to the early Iron Age in the Vesterålen and Lofoten Islands (1996,1998,1999). Besides abundant cod, these arctic Norwegian islands provide ideal winter conditions for the production of air-dried cured fish (temperatures hovering around freezing for months at a time). This staple product could be stored for 5-7 years without salt or refrigeration, and provided a source of light, portable, and highly nutritious protein, which (after the FEH) was to provision millions of households throughout Europe and eventually underwrite European expansion into the New World. While a range of preservation methods were used, the two most common products were “stockfish” (air dried in the round, with most of the vertebral column left in the finished product) and “rotscher” (air dried as a flattened product, with the upper thoracic and precaudal vertebrae largely removed along with the head). While the use of later Norwegian or Hanseatic terms for specific dried fish products is tempting, it is probably better to use the more general terms “round dried” and “flat dried” in the prehistoric zooarchaeological context (Christian Keller pers com.). Round dried (“stockfish”) production is possible only where temperatures fluctuate around the freezing point for months at a time, and strong winds aid the freeze drying process. Flat dried fish (“rotscher/klipfisk”) can be produced under a wider range of temperatures, sometimes being dried simply by being spread over beach cobbles. Both products can be made from a range of white fleshed (non-oily) fish, but the cod family (gadid) fish have traditionally been the main species used. Round dried products are best made from individual fish between 60 and 110 cm in live length, while flat dried products are best made from fish around 40-70 cm in live length (Perdikaris 1999). In arctic Norway, there is evidence for both the large scale production of dried fish products prior to the Viking age, and for chiefly involvement in the redistribution of these products (Perdikaris 1999, Perdikaris & McGovern 2007). If we are to believe the much later written sources, several of the chiefly first colonizers of Iceland (especially the NW peninsula) were drawn from the powerful seagoing aristocracy of North Norway (Edvardsson 2005, Edvardsson & McGovern 2005). One source for early expertise in fishing and fish product production and distribution would thus seem to be Northern Norway, but what linkages can be established between these prehistoric patterns and the late Viking Age FEH?

### Approaches to pre-FEH fish production in the N-Atlantic: exploring zooarchaeological indicators.

This question requires some inter-regional comparison, and some attempt to refine our tools for understanding zooarchaeological evidence for fish processing and consumption. One initial point of comparison is simply the crude ratio of fish to mammal bones in regional archaeofauna. Figure 1 below presents a comparison of a range of comparably excavated sites generating large archaeofauna from across the region.

While there are certainly unresolved comparative problems and taphonomic noise in this sample, some patterns emerge even from this crude and incomplete summary of this simple relative abundance indicator. In the Iron Age, most N Norwegian sites (like Bleik and Toften) are dominated by fish bones, a pattern uncommon in the Northern and Western Isles of Scotland at the same time. In the Viking age (roughly AD 800-1050), there is a comparably wide range of relative abundance of fish, with the Faroese site of Junkarinsfløttur on Sandoy (Church et al 2005, Brewington in press) and the possibly specialized site of Smoo Cave in Caithness in Northern Scotland (Barrett 1996) showing the highest relative proportion of fish to domestic mammal bones. As noted by many workers, the Greenlandic Norse sites (W 51 and W 48 are both in the Western Settlement) show almost no marine fish bones at any period (McGovern 1985, Enghoff 2005, Perdikaris & McGovern 2001, 2007a). This pattern continues in the newly recovered 2005-06 archaeofauna from Brattahlíð North Farm in the Eastern Settlement (Edvardsson et al. in prep.). The Viking age Icelandic sites around Lake Mývatn are 50-60 km inland, but still show substantial amounts of marine fish bones (HST= Hofstaðir, SVK= Sveigakot, HRH= Hrísheimar, see Lucas 1998, Fridðriksson et al. 2004, Vésteinsson 2000, Vésteinsson et al 2002).

After the FEH (ca. 1050 onwards), sites dominated by fish bones become common, and true fish middens such as those at Storvågan in Lofoten, Helgoy in Vesterålen (Perdikaris 1999), Bornais in South Uist (Sharples 2005), Sandwick on Unst in Shetland (Bigelow 1984), Robert's Haven in Caithness (Barrett 1997), and at Gjögur and Akurvík in Northwest Iceland (Amundsen et al 2005, Krivogorskaya et al 2005) become common. While such broad inter-regional comparisons will always be somewhat problematic, this incomplete sampling of major site collections does serve to underline and perhaps expand upon a major point made by Barrett et al. (2004a, b). In the Faroes, Iceland, and N Norway as well as the British Isles (but not in Greenland) fish middens become widespread following the FEH. In Faroes and North Norway, such fish dominated collec-

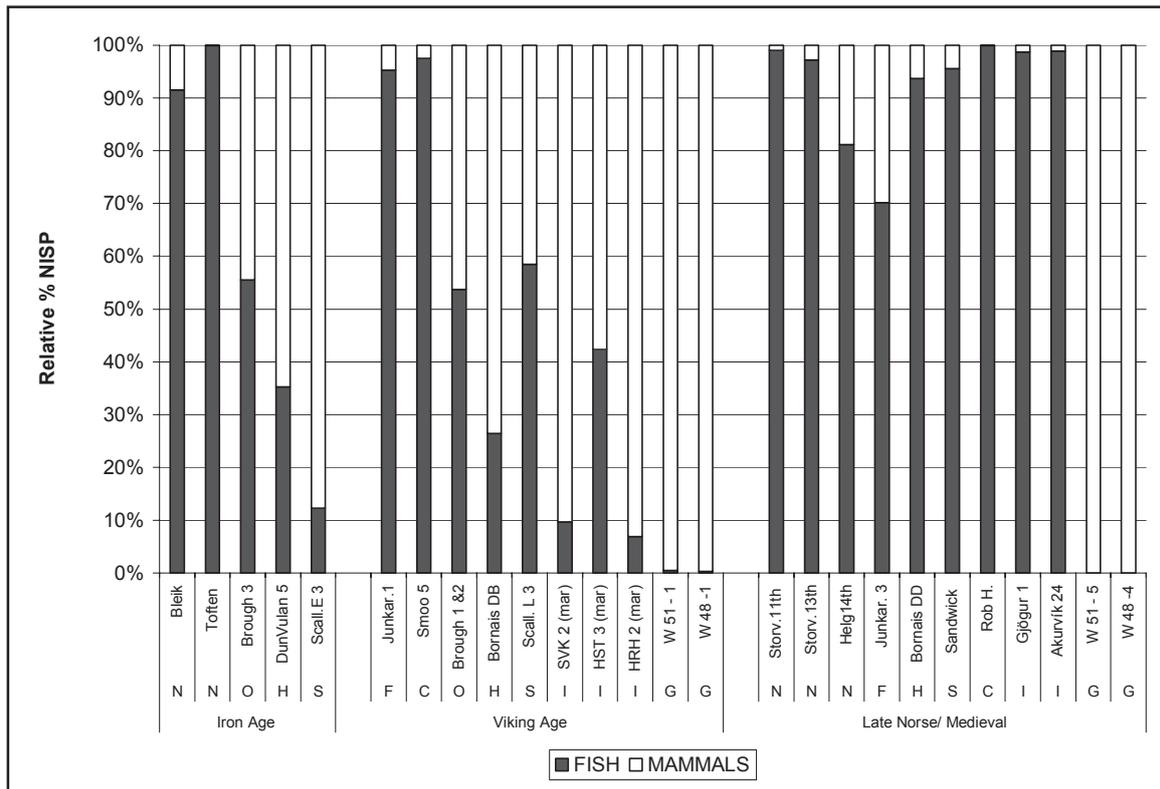


Fig. 1: A selection of comparably excavated (sieved) sites from Iron Age, Viking, and Late Norse/Medieval date from Norway (N), Orkney (O), Hebrides (H), Shetland (S), Faroes (F), Caithness (C), Iceland (I), and Greenland (G) that have produced large archaeofauna. For data references and site codes see Table 1.

tions are present *prior* to the event horizon further south.

Fish species proportions may be a more sensitive indicator than simple abundance of fish bones, and Figure 2 presents the distribution of identified cod-family (Gadidae) fish within some of the selected archaeofauna. The Nordic Iron Age collections from arctic Norway (Bleik and Toften) as well as the Pictish Iron Age collections from S Uist, Shetland, and Caithness show a fairly high diversity among the Gadidae, with substantial amounts of saithe (*Pollachius virens*), haddock (*Melanogrammus aeglefinus*), ling (*Molva molva.*) and hake (*Melanogrammus aeglefinus*Merluccius m.) as well as Atlantic cod (*Gadus morhua*).

The Viking Age archaeofauna continue to show high species diversity within the cod family, with haddock making up a large proportion of the fish imported to the inland Mývatn sites (Hofstaðir HST and Sveigakot SVK), with hake, ling, and saithe continuing to make up major portions of the Scottish sites' archaeofauna. The Faroese collection from Junkarinsfløttur (with 9<sup>th</sup> c basal radiocarbon dates, Church et al 2005) provides a contrast, with a strong, early focus upon cod. The later medieval (post-FEH, and at least partially commercialized production) shows a spreading single-species pattern centered on cod in North Norway (Storvågan, Helgoy),

Faroes, and the Icelandic sites of Akurvík and Gjögur. By contrast, Freswick links in Caithness and Bornais (phase DD) on South Uist continue patterns involving substantial deposit of ling, saithe and hake bone into the Late Norse/Medieval period.

We know from documentary sources (which become increasingly common after AD 1100 in the area) that cod was the primary (and often the only) species accepted for long distance trade as part of an increasingly regulated and commoditized transformation of a naturally variable product into an economic abstraction that could be traded on paper in comfortable offices far from windy beach landings. Thus this trend from multi-species representation to nearly mono-specific concentration upon cod would seem to carry a clear economic message of increased commercialization. However, in all times and places fisher folk feed themselves and their households with fish even if they are deeply involved in fully commoditized market production. They tend to eat the species less suitable for sale (wrong size, wrong species) and export the more marketable species. So while changing species diversity must be one indicator in an archaeofauna, it needs to be supplemented with other measures if we are to try to sort out subsistence fishing from export fishing (especially when both activities were carried out from the same landing point).

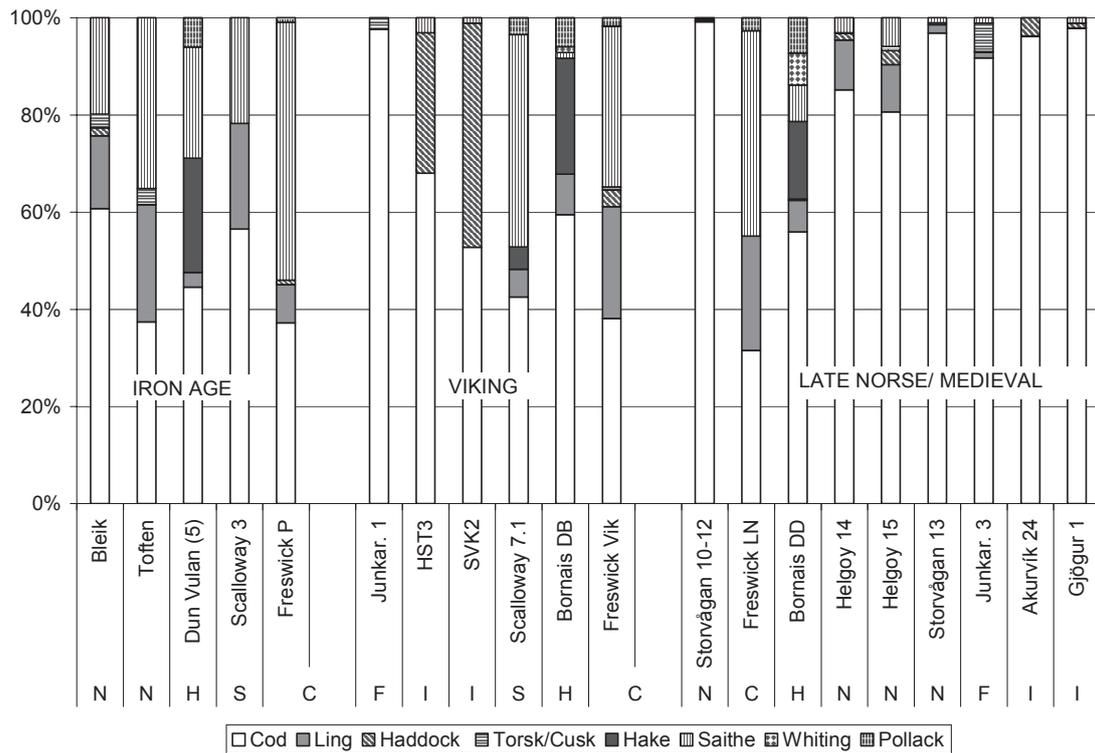


Fig. 2: Species Diversity within the Cod family: Iron Age and most Viking Age collections show considerable variability in species taken from within the cod (gadid) family. In the Late Norse/Medieval period there is often a shift towards collections dominated by Atlantic cod. The reduction in species diversity has been tied to growing standardization associated with commercial exploitation and cited as one evidence for the transformation of a naturally variable product of “first nature” into a socially constructed economic category “second nature” and then into an abstract, socially dis-embedded commodity which could be bought and sold far from fishing grounds or local fisher folk (Perdikaris 1999).

One consistent pattern in fish butchery is the separate deposit of elements regularly cut away and discarded at the primary processing point (near the landing) and elements normally included in the part of the fish prepared for export off site. For both round-dried and flat-dried preserved cod products, the mouth parts tend to be cut away with most of the head and left at the processing point, while the cleithrum and associated bones are usually left in the body. When spread, these curved bones tend to hold the body cavity open for better drying and help to keep the body from falling apart during curing and transport. Figure 3 compares the proportions of the premaxilla (mouth part) and cleithrum for a range of Iron Age, Viking Age, and Late Norse/Medieval archaeofauna (note: due to sample size all Gadidae were used together for the Icelandic sites of Hofstaðir, Sveigakot, Hrísheimar, and Granastaðir, all other sites use cod only). Cleithra and premaxillae are both robust bones of comparable size and identifiability, and are uniformly reported in the literature.

One clear pattern that emerges from this comparison of bone frequencies is a sharp differentiation of the Icelandic inland Viking age sites (Hofstaðir, Sveigakot, Hrísheimar, and Granastaðir) in all their phases from any of the coastal sites. Not a single premaxilla of any

gadid species seems to have reached these inland farms, which make useful models of clear “consumer” sites (see McGovern, Perdikaris et al. 2006 for detailed data presentation). By contrast, the large archaeofauna from the deeply stratified coastal midden deposit at Junkarinsfløttur on Sandoy in the Faroes has produced almost no cleithra and a great many premaxillae, suggesting extensive export (at least off site) of prepared headless cod dating back to first settlement (Brewington in press). Between these extremes are a series of patterns which suggest different patterns of cod deposition on the sites. The Iron Age sites of Tofthen in Norway and Dun Vulcan in the outer Hebrides show nearly natural proportions of cleithra and premaxillae, suggesting that most cod landed were probably consumed close by, or than any off-site transfers were of whole (fresh?) fish. In the post-FEH medieval period, tracking the cleithrum/premaxilla proportions serves to point up some qualifications to the expectations generated by the species diversity analysis of Figure 2. Note that while both medieval phases at Storvågan and Helgoy are dominated by cod, not all phases show the same patterning of disproportionately common premaxilla. The Late Norse/Medieval phases at Bornais in the Hebrides, Junarkinsfløttur in the Faroes, Freswick Links in Caithness, and all phases of the sites of Akurvík and Gjögur in Northwest Ice-

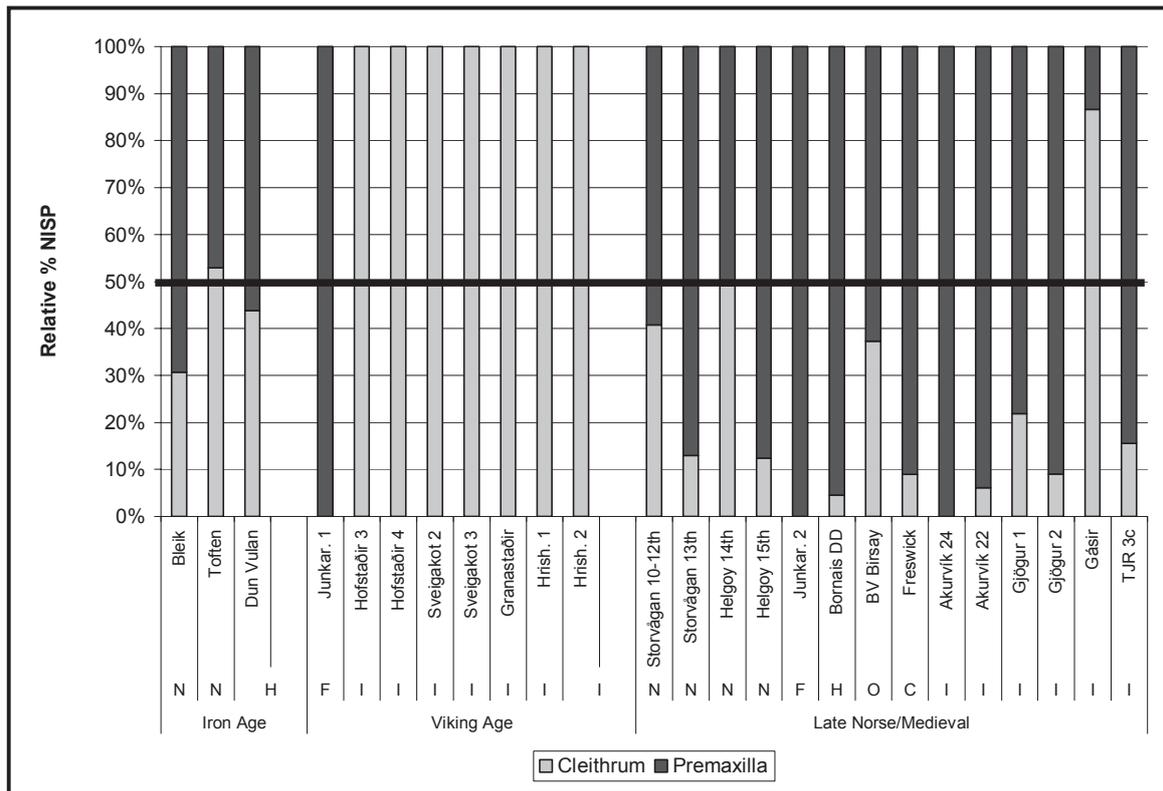


Fig. 3: Cleithrum and Premaxilla proportions. The relative proportion of the two elements in a whole fish is equal (heavy line), but where specialized production and consumption takes place the cleithra and premaxilla may become concentrated at different ends of the marketing system. Production sites will tend to generate surplus premaxillae, while consumption sites will accumulate cleithra.

land, and the late 18<sup>th</sup>-early 19<sup>th</sup> century site of Tjarnargata 3c (under modern Reykjavík) all show a clear “producer” signatures. The archaeofauna from Gásir in Eyjafjord in Northern Iceland is a specialized seasonal trading center rather than a farm or fishing station, and perhaps predictably shows a clear “consumer” signature of a surplus of cleithra (Harrison 2006).

Cleithrum/ Premaxilla proportions can also help track the changing use of different fish species for export or provisioning. The site of Akurvík in NW Iceland is a stratified sequence of seasonally occupied fishing booths and associated fish-rich middens and represents a classic production site in most aspects of its archaeology and archaeofauna (Amundsen et al 2005). Two major midden horizons generating NISP counts around 100,000 have been radiocarbon dated to the 11<sup>th</sup>-13<sup>th</sup> c (SU 24) and 15<sup>th</sup>-16<sup>th</sup> c (SU 22). Both phases are dominated by cod, and show a clear producer signature in cod cleithrum/premaxilla proportions, but as Figure 4 indicates, haddock show some contrasting patterns. In the earlier period, haddock seem to have been both exported from the site like the cod and also deposited as whole fish (probably being consumed fresh by the crews). In the late medieval period, the contrast between haddock and cod cleithrum/premaxilla ratios is stark: haddock seem to be only consumed fresh and were ap-

parently no longer being regularly prepared for export on site. Note that in the early Viking age inland sites in the Mývatn area (Hofstaðir and Sveigakot, Figure 2) these inland consumers were eating nearly as much haddock as cod, and haddock has been a favored species for home provisioning among Icelanders down to the present. Is the shift in haddock bone distribution at Akurvík an indication of a shift in orientation from home market to overseas export market by the later Middle Ages, with haddock then only being used to feed the crew?

The two major types of dried fish products (round dried and flat dried) both result in differential transport of the cleithra (and often some associated bones nearby) from producer to consumer sites, and both also result in the export of the caudal vertebrae (in the tail section of the fish) with the finished preserved product. However, the two preservation methods produce different signatures in the distribution of the pre-caudal and thoracic vertebrae in the mid-section of the fish body. Round dried stockfish-like products tend to retain most of these upper vertebrae in the finished product, while flat dried products usually have the thoracic and most of the pre-caudal vertebrae filleted away at the production site. Where sample size and uniformity of recovery and reporting allow, it is thus potentially possible to trace the type of product being produced and consumed at different sites

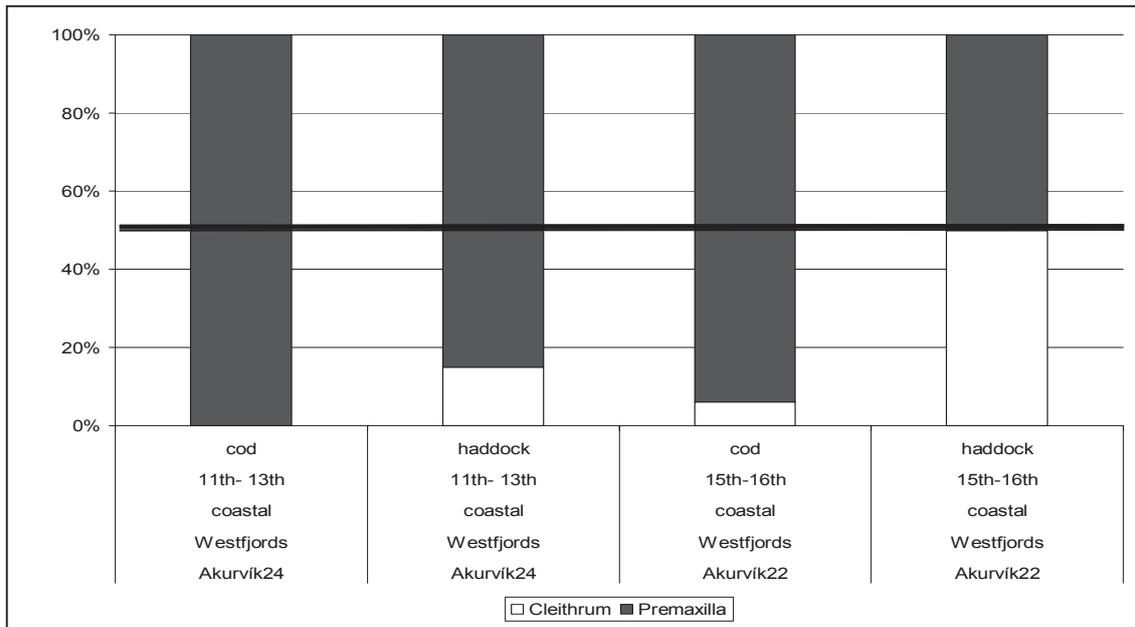


Fig. 4: Comparison of cod and haddock cleithrum/premaxilla proportions in two phases of deposition. In the earlier period there is an indication that some haddock were exported from this coastal fishing station (carrying with them the embedded cleithrum). In the late medieval phase there is no indication of differential deposit, and the haddock (unlike the cod) seem to have been consumed on site by the fisher-folk.

and at different periods by tracing the relative abundance of these three classes of vertebrae. Figure 5 compares relative abundance of thoracic, precaudal and caudal vertebrae for some directly comparable sites in Iceland and the Faroes. The three large stratified inland archaeofauna from the Mývatn area from Hofstaðir, Sveigakot, and Hrísheimar span the Viking age, with the earlier phases (HST3, SVK2, HRH1) before and the later phases (HST4, SVK3, HRH2) dating to just after the British FEH by both volcanic tephra and radiocarbon evidence (see McGovern et al 2007). The two phases at Junarkinsflöttur likewise span the FEH (Arge 2000, Church et al 2006, Brewington in press), while the two phases at the fishing station in NW Iceland at Akurvík date to 11<sup>th</sup>-13<sup>th</sup> centuries and 15<sup>th</sup>-16<sup>th</sup> centuries respectively (Amundsen et al 2005, Krivogorskaya et al 2005a).

The patterning at the three inland Icelandic consumer sites produces some intriguing variation. At Hofstaðir (a large, probably high status site with an ambitious chieftain) it seems that some sort of flat dried product was regularly being consumed, as caudal vertebrae (of both cod and haddock) dominate the collections from both phases, and pre-caudal and thoracic vertebrae are very rare. At Sveigakot approximately 12 km away, a different pattern emerges. While caudal vertebrae are still disproportionately common, there are also substantial amounts of thoracic and precaudal vertebrae present at this site, suggesting at least some round dried fish regularly reached the site. Sveigakot seems to have been a mid-lower ranking site, and probably declined in wealth and status during the period. It was almost cer-

tainly under the influence if not outright ownership of the nearby chieftain's farm at Grænavatn. The site of Hrísheimar is 8 km from Hofstaðir, and seems to have been a medium-high status farm heavily involved in iron production. Its large stratified archaeofauna (which is partitioned by tephra as well as radiocarbon, Ascough et al. 2006) is still under analysis, but there is a large preliminary sample available which at present suggests a shift in provisioning between lower layers (AD 871 – c950) and upper (c950-1050). The earlier phase vertebral patterns would suggest a mix of flat dried and round dried cod and haddock reached the site (as at Sveigakot), but the later phase pattern more closely resembles that of Hofstaðir, suggesting mainly flat dried product consumption. The Viking Age settlers of inland Iceland thus consumed a range of cod-family species, and provisioned themselves with a range of preserved gadid products. Are we seeing shifts in fish production patterns on the coast, or are we seeing shifts in chiefly provisioning arrangements linking coastal and inland sites? More work on these early patterns is ongoing, but it is clear that the commoditized uniformity of fish product production later promoted by the Hanseatic traders of the high Middle Ages was not to be found in the artisanal, chiefly, politicized world of fish production in the early Viking age in Iceland.

The coastal producer sites (perhaps comfortingly) show complimentary distributions of the vertebral series; high in discarded thoracic and precaudal vertebrae and disproportionately low in the caudal vertebrae presumably exported along with the cleithra. Both phases at the

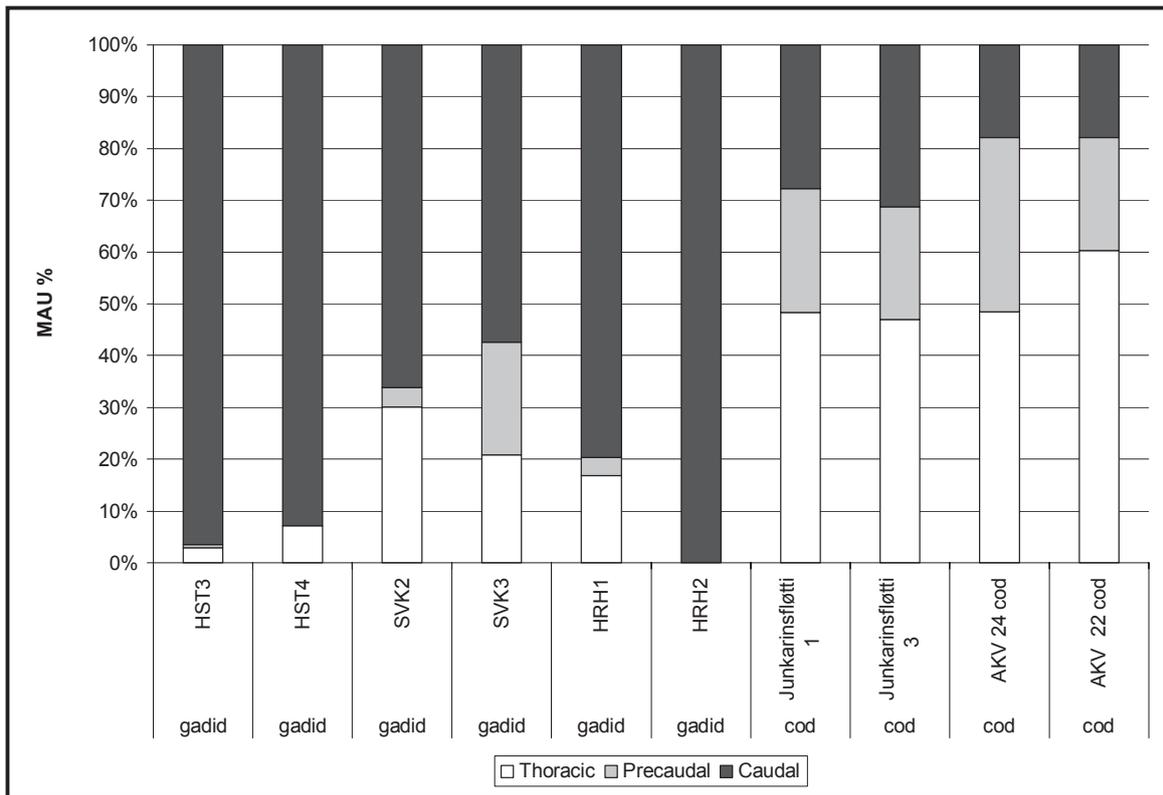


Fig. 5: Comparison of the relative abundance of thoracic, precaudal, and caudal vertebrae at selected Icelandic and Faroese sites. The NISP count per element has been transformed into MAU % to normalize for natural skeletal element frequency, so a whole fish in this graph would be represented by three equal columns (33% each).

Faroese site of Junarkinsflóttur produce similar discard patterns rich in thoracic and precaudal elements, suggesting that the product regularly being prepared and exported on site was almost certainly not round dried (“stockfish”) but a flat dried product with the upper vertebrae filleted out at the processing site. The two phases (early medieval and late medieval) at the seasonal fishing station at Akurvík are produce slightly different vertebral patterns, with the earlier phase more closely resembling the Faroese pattern. Analysis of the reconstructed cod live length in the two phases at Akurvík suggest that both large (“stockfish sized”) cod and smaller cod more suitable for flat drying were being landed and processed at the same station (Krivogorskaya et al, 2005, Amundson et al 2005), again illustrating the need for multiple analytic approaches in assessing the complex interplay of crew and household provisioning and the preparation of multiple potential export products on the same site area.

### Discussion

While a great deal more work needs to be done all across this highly productive research area, we can begin to address the two broad research questions posed at the beginning of this article.

- 1) The tradition of producing air dried cod family fish which underlies the FEH certainly originated in Scandinavia (probably in N Norway), and was connected to a well developed chiefly social network which transferred dried fish products from coastal production sites to inland consumers (in Iceland at least) by the late 9<sup>th</sup> c settlement, well before the FEH. Indications of intensive fishing and fish processing for export in the Faroes also pre-date the British FEH, generating classic fish middens in the early Viking age. It seems that the FEH and all that flowed from it was a major, previously undocumented product of the Viking Age expansion of Scandinavians from their homelands.
- 2) The pre-commercial, pre-FEH Scandinavian fish exchange system was different in character from the later post-FEH high medieval commercial fisheries in its acceptance of a wide range of species, higher variety in fish processing practice, and certainly in geographic scale. These differences certainly reflect a smaller and less formalized market probably run by chieftains and local magnates collecting from artisanal fishers through relationships still fully embedded in “non-economic” social issues of rank, reciprocity, and personal obligation. However, the Icelandic case demonstrates a pre-FEH network op-

erating on at least an inter-district level, and the internal market for fish appears to have been large enough to generate considerable wealth for chieftains in NW Iceland specializing in fish production and marketing. The variability in the type of preserved fish product consumed by nearby farms in Viking Age Mývatn (along with the presence of marine mammal bone, sea bird bone and egg, and indications of seaweed transport inland: see McGovern Perdikaris et al 2006) may suggest complex social webs probably mediated by different actors of different rank and social standing making use of parallel provisioning networks in ways totally divorced from the regularities of the commoditized post-FEH world. This pre-FEH internal Norse fish trade can be differentiated from later post-FEH high medieval patterns on multiple zooarchaeological indicators, but it remains a plausible precursor to the post-FEH patterns of large scale production and inland distribution. Nordic chieftains and (later) kings had already acquired a solid grounding in the political and economic uses of dried fish well before the British FEH, and it may not be an accident that the dates of the FEH coincide with the brief period of an Anglo-Scandinavian dynasty on the English throne (Perdikaris & McGovern 2007).

Many intriguing unresolved questions certainly remain for collective consideration, and for more collaborative investigation among North Atlantic scholars and research teams. If fishing and fish processing for regional-level distribution was a part of the pre-Viking heritage (at least in N Norway), why did the Norse Greenlanders not make more use of fish? The settlement of Greenland from Iceland took place ca 985; after nearly a hundred years of well established fishing and fish distribution in Mývatn. Why did the Greenlanders substitute seals for fish in their communal subsistence pattern? While we suspect that different seasonal round and labor scheduling issues may lie at the root of this divergence, the recent findings from Iceland serve if anything to deepen rather than clarify this longstanding mystery (Perdikaris & McGovern 2007a, b).

Equally interesting is the question of the apparent “fish midden gap” between the Icelandic and Faroese settlements and the initial Norse settlements in the Northern and Western Isles of Scotland. If Icelandic and Faroese Nordic settlers of the late 9<sup>th</sup>-early 10<sup>th</sup> centuries were busily setting up intensive fisheries to supply their local markets and generating the sorts of fish middens associated with such intensification from the earliest days of their respective island settlements, then why is there an apparent 200 year gap in such activities in Norse Shetland, Orkney, Caithness, and Hebrides? Is this gap only apparent and soon to be filled with earlier dated fish middens as fieldwork continues? Or (perhaps more

plausibly) is the archaeological record actually carrying a social as well as a zooarchaeological message? One major difference between Scotland and the more distant North Atlantic islands ca AD 800 is in the abundance of local residents already in place when the Norse arrived. While a few pre-Viking settlers (perhaps Celtic monastic) may have reached the Faroes and Iceland, the Norse settlers certainly did not inherit a comparably well developed cultural landscape with major pre-existing investments in arable agriculture or maritime economy. In Shetland, Orkney, Caithness, and the Hebrides the early Viking age must have seen extensive contact, conflict, and accommodation between populations and economies (Morris & Rackham 1992, Smith & Mulville 2002, Gammeltoft 2004). Icelandic and Faroese first settlers were probably largely left to work out their subsistence and exchange patterns alone, and these chieftains found themselves taking possession of landscapes without workers. By contrast, their relatives in Britain and Ireland were in the midst of culture contact and local Norse elites in the eastern North Atlantic could indulge in the sort of predatory wealth gathering that gives the Viking Age its popular image. Perhaps the potential of bulky, messy, un-heroic, fishy staple goods production was less immediately attractive to Nordic elites as a means of social and economic power in the “target rich” context of early Viking Britain and Ireland. Did the local absence of ready loot turn Faroese and Icelandic chieftains (some of whom are said to have come from Northern Norway) towards an early pattern of fishy staple goods management?

These are all clearly questions for future research, and it is abundantly clear that while we have collectively made great progress in the understanding of one of the major economic turning points in world history (for the FEH is nothing less), there is a huge amount of work to be done by North Atlantic zooarchaeology and great opportunity for expanding our growing kit of zooarchaeological pattern recognition tools. The fish middens have only begun to speak.

## Acknowledgements

The research summarized in this paper is the product of a great many collaborating scholars and institutions in the NABO cooperative, all of whom have our warmest thanks for over a decade of cooperative effort. Special thanks are due to Steve Dockrill, Julie Bond, Mike Church, Arni Einarsson, Orri Vésteinsson, Adolf Friðriksson, Simun Arge, Ian Simpson, Ian Lawson, Christian Keller and Andy Dugmore for stimulating ideas, to the Archaeological Institute Iceland and the Faroese National Museum for excellent and ongoing cooperation in the field, and to Colin Amundsen, Ramona Harrison, Yekaterina Krivogorskaya, Konrad Smiarowski

## Data Sources

Period	Region	Site & Phase	Reference	
Iron Age	N Norway	Bleik	Perdikaris 1998	
	N Norway	Toften	Perdikaris 1998	
	Orkney	Brough Rd. 3	Colley 1989 Rackham 1989	
	Orkney	Saevar Howe 1	Colley 1983; Rowley-Conwy 1983	
	S. Uist	DunVulan 5	(Pearson and Sharples, 1999)	
	Shetland	Scalloway E 3		
Viking Age	Faroes	Junkarinsfløtti 1	Church et al. 2005	
	Caithness	Smoo 5	Barrett in Pollard 2005	
	Orkney	Brough Rd. 1 &2	Colley 1989, Rackham 1989	
	Orkney	Birsay Beachview	1997	
	S. Uist	Bornais DB	Sharples 2005	
	Shetland	Scalloway L 3		
	N Iceland	Sveigakot 1-3	McGovern et al 2007	
	N Iceland	Hofstaðir 1-3	McGovern et al 2007	
	N Iceland	Hrísheimar 2	McGovern et al 2007	
	N Iceland	Granastaðir	Einarsson 1994	
	S Iceland	Tjarnargata 4	Amorosi 1997	
	Greenland	W 51 - 1 Sandnes	McGovern et al 1996	
	Greenland	W 48 -1	McGovern et al 1981	
	Late Norse/Medieval	N Norway	Storvågan 11th	Perdikaris 1998
		N Norway	Storvågan 13th	Perdikaris 1998
		N Norway	Helgoy 14th	Perdikaris 1998
Faroes		Junkarinsfløtti 3	Church et al. 2005	
S. Uist		Bornais DD	Sharples 2005	
Shetland		Sandwick North 3-4	Bigelow 1984	
Caithness		Roberts Haven	Barrett 1997	
Caithness		Freswick	Morris, Batey, & Rackham 1995	
NW Icel.		Gjögur 1-2		
NW Icel.		Akurvík 22, 24		
NW Icel.		Finnbogastaðir	Edvardsson et al. 2004	

Table 1

and Jim Woollett for their dedicated work on some of the large archaeofauna reported here. Support for this research was generously provided by the US National Science Foundation (both archaeology and arctic social

sciences programs), the National Geographic Society Committee for Research and Exploration, the Icelandic Science Council, CUNY Northern Science & Education Center, and the Leverhulme Trust.

## References

- Amorosi, Thomas; Buckland, Paul C.; Dugmore, Andrew J.; Ingi-mundarson, Jón Haukur; McGovern, Thomas H. 1997:  
*Raiding the landscape: human impact in the North Atlantic*. In: *Human Ecology* 25:491-518.
- Amundsen, Colin; Perdikaris, Sophia; McGovern, Thomas H.; Krivogorskaya, Yekaterina; Brown, Matthew; Smiarowski, Konrad; Storm, Shaye; Modugno, Salena; Frik, Malgorzata; Koczela, Monica. 2005:  
*Fishing Booths and Fishing Strategies in Medieval Iceland : an Archaeofauna from the of Akurvík, North-West Iceland*, In: *Environmental Archaeology* 10,2: 141-198.
- Arge, Simun V. 2005:  
*Cultural Landscapes and Cultural Environmental issues in the Faroes*. In: Mortensen, Andras; Arge, Simun V. (eds.) *Viking and Norse in the North Atlantic: Select Papers from the Proceedings of the 14<sup>th</sup> Viking Congress, Tórshavn 2001*. Annales Societatis Scientiarum Faeroensis XLIV. Tóshavn Faroe Islands: 22-39.
- Ascough, P.L.; Cook, G.T.; Church, M.J.; Dugmore, A.J.; Arge, S.V.; McGovern, T.H. 2006:  
*Variability in North Atlantic marine radiocarbon reservoir effects at c. AD 1000*. In: *The Holocene*, Jan2006, (16) 1:131-136.
- Barrett, J. 1995:  
*Few know Earl Fishing-clothes. Fish middens and the Economy of the Viking Age and Late Norse Earldoms of Orkney and Caithness, Northern Scotland*, PhD thesis University of Glasgow.
- Barrett, J. 2002:  
*Quoygrew-Nether Trenabie*. In: *Discovery & Excavation in Scotland* 2:73.
- Barrett, J. 2003:  
*Culture Contact in Viking Age Scotland*, In: James Barrett (ed.) *Contact, Continuity, and Collapse: the Norse Colonization of the North Atlantic*, Brepols, Turnhout, Belgium: 73-113.
- Barrett, James H. 2005:  
*Economic Intensification in Viking and Medieval Orkney, Scotland: Excavations at Quoygrew*. In: Mortensen, Andras; Arge, Simun (eds.) *Viking and Norse in the North Atlantic: Select Papers from the Proceedings of the 14<sup>th</sup> Viking Congress, Tórshavn 2001*. Annales Societatis Scientiarum Faeroensis XLIV, Tóshavn Faroe Islands: 264-284.
- Barrett, James H. 2005:  
*Animal Bones from Smoo Cave*. In: Pollard, Tony *The Excavation of Four Caves in the Geodha Smoo near Durness, Sutherland*, Scottish Archaeological Internet Report 18: 23-26.
- Barrett, J.; Nicholson, R.; Cérron-Carrasco, R. 1997:  
*Fish trade in Norse Orkney and Caithness: a Zooarchaeological Approach*. In: *Antiquity* 71: 616-638.
- Barrett, J.; Nicholson R.A.; Cérron-Carrasco R. 1999:  
*Archaeoithyological evidence for long term socioeconomic trends in northern Scotland 3500 BC- AD 1500*. In: *Journal of Archaeological Science* 26: 353-388.
- Barrett, J.; Beukens, R.; Simpson, I.A.; Ashmore, P.; Poaps, S.; Huntley, J. 2000:  
*What was the Viking Age and when did it happen? A view from Orkney*. In: *Norwegian Archaeological Review* 33: 1-39.
- Barrett, J.; Beukens, R. P.; Nicholson, R. A. 2001:  
*Diet and ethnicity during the Viking colonization of Northern Scotland: evidence from fish bones and stable carbon isotopes*. In: *Antiquity* 75: 145-154.
- Barrett, J. H.; Locker, A. M.; Roberts, C. M. 2004:  
*The origin of intensive marine fishing in medieval Europe: The English evidence*. In: *Proceedings of the Royal Society B* 271: 2417-2421.
- Barrett, J. H.; Locker, A. M.; Roberts, C. M. 2004:  
*'Dark Age Economics' revisited: The English fish bone evidence AD 600-1600*. In: *Antiquity* 78 (301): 618-636.
- Bertelsen, Reidar. 1991:  
*A North-East Atlantic Perspective*. In Bigelow (ed): *The Norse of the North Atlantic*. In: *Acta Archaeologica* Vol. 61-1990: 22-28. Copenhagen.
- Bigelow, G. 1984:  
*Subsistence in Late Norse Shetland: an investigation into a Northern Island Economy of the Middle Ages*, PhD University of Cambridge.
- Bigelow, Gerald F. (ed). 1991:  
*The Norse of the North Atlantic*. In: *Acta Archaeologica* 61: Special Volume.
- Bond, J.M.; Guttman, Erika; Simpson, Ian A. 2004:  
*Bringing in the Sheaves: farming intensification in the Post-Bronch Iron Age*. In: R.A. Houseley and G. Coles, *Atlantic Connections and Adaptations; Economies, environments and subsistence in lands bordering the North Atlantic*, AEA/NABO 21: 138-146. Oxbow Books, Oxford.
- Bond, J.M.; Nicholson, R.A.; Simpson; Ian A. 2005:  
*Living Off the Land: Farming and Fishing at Old Scatness*. In: Turner, Val; Nicholson, R.A.; Dockrill, S.J.; Bond, J.M. (eds.). *Tall Stories? Two Millennia of Brochs*, Shetland Amenity Trust: 211-221. Lerwick.
- Brewington, Seth D. (in press). 2006:  
*Viking-Age to Late-Norse Archaeofauna from Undir Junkarinsflótti, Faroe Islands: A Preliminary Report*. In: Wickler, Stephen; Amundsen, Colin P. (eds.). *Life on the Edge: Maritime Archaeology from the North Atlantic Rim of Europe*, British Archaeological Reports, Oxford.
- Cérron-Carrasco, R. 1998:  
*Fishing: evidence for seasonality and processing of fish for preservation in the Northern Island of Scotland during the Iron Age and Norse times*. In: *Environmental Archaeology* 3: 73-81.
- Cérron-Carrasco, R.; Church, Mike; Thoms, Jennifer. 2005:  
*Towards an Economic Landscape of the Bhaltois Peninsula, Lewis, During the Mid to Late Iron Age*. In: Turner, Val; Nicholson, R.A.; Dockrill, S.J.; Bond, J.M (eds.). *Tall Stories? Two Millennia of Brochs*, Shetland Amenity Trust: 221-235. Lerwick.
- Church, Mike; Arge, Simun; Brewington, S.; McGovern, T.H.; Woollett, J.; Perdikaris, Sophia; Lawson, Ian T.; Cook, Gordon C.; Amundsen, Colin; Harrison, Ramona; Krivogorskaya Yekaterina. 2005:  
*Puffins, pigs, cod and barley: paleoeconomy at Undir Junkarinsflótti, Sandoy, Faroe Islands*, In: *Environmental Archaeology* 10, 2: 198-221.
- Colley, S.M. 1983:  
*The role of fish bone studies in economic archaeology: With spe-*

- cial reference to the Orkney Isles*. Unpublished doctoral dissertation, University of Southampton, Southampton, U.K.
- Dockrill, S.; Batt, C.M. 2004:  
*Power over Time; an overview of the Old Scatness Broch excavations*. In: Houseley, R.A.; Coles, G. *Atlantic Connections and Adaptations; Economies, environments and subsistence in lands bordering the North Atlantic*, AEA/NABO 21: 128-138. Oxbow Books, Oxford.
- Dockrill S.J.; Bond, J.M.; Batt, C.M. 2005:  
*Old Scatness: the First Millenium AD*. In: Turner, Val; Nicholson, R.A.; Dockrill, S.J.; Bond, J.M. (eds.). *Tall Stories? Two Millennia of Brochs*: 52-66. Shetland Amenity Trust, Lerwick.
- Dugmore, Andrew J.; Church, Mike J.; Buckland, Paul C.; Edwards, Kevin J.; Lawson, Ian T.; McGovern, Thomas H.; Panagiotakopulu, Eva; Simpson, Ian A.; Skidmore, Peter; and Guðrún Sveinbjarnardóttir. 2005:  
*The Norse landnám on the North Atlantic islands: an environmental impact assessment*. In: *Polar Record* 41: 21-37.
- Edvardsson, Ragnar; Sophia Perdikaris; T.H.McGovern; Zagor, N.; Waxman, M. 2004:  
*Coping with hard times in North-West Iceland: Zooarchaeology, History, and Landscape Archaeology at Finnbogastaðir in the 18<sup>th</sup> century*. In: *Archaeologica Islandica* 3: 20-48.
- Edvardsson Ragnar; McGovern, Thomas H. 2005:  
*Archaeological excavations at Vatnsfjordur 2003-04*. In: *Archaeologica Islandica* 4: 16-31.
- Einarsson, Bjarni F. 1994:  
*The Settlement of Iceland: A Critical Approach: Granastadir and the Ecological Heritage*. In: *Series B Gothenburg Archaeological Theses* No 4 Gothenberg, Sweden.
- Enghoff, I. B. 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*. In: *Meddelelser om Grønland Man & Society* 28. Copenhagen.
- Fitzhugh, William W.; Ward, Elisabeth I. (eds). 2000:  
*The demise of Norse Greenland*. In: *Vikings: The North Atlantic Saga*. 327-39. Smithsonian Institution Press. Washington.
- Friðriksson Adolf; Vésteinsson, Orri; McGovern, T.H. 2004:  
*Recent investigations at Hofstaðir, northern Iceland*. In: Houseley, R.A.; Coles, G. (eds). *Atlantic Connections and Adaptations; economies, environments and subsistence in lands bordering the North Atlantic*, AEA/NABO Environmental Archaeology Monographs 21: 191-202. Oxbow Books.
- Gammeltoft, Peder. 2004:  
*Contact or Conflict? What can we learn from the Island-Names of the Northern Isles?* In: Adams, J.; Holman, K. (eds). *Scandinavia and Europe 800-1350 Contact, Conflict, and Coexistence*: 87-97. Brepols Turnhout Belgium.
- Grahame-Campbell J.; Batey, Colleen. 1998:  
*Vikings in Scotland*, Edinburgh U Press.
- Harrison Ramona. 2005:  
*Preliminary results from zooarchaeological analysis of the late medieval trading site of Gásir in Eyjafjörður, N Iceland*, paper presented at the 2005 Icelandic Archaeological Association meetings, Holar Iceland Aug 10-12<sup>th</sup> 2005.
- Hedeager, Lotte. 2000:  
*From Warrior to Trade Economy*. In: Fitzhugh W.W. & E. Ward (eds). *Vikings, the North Atlantic Saga*: 84-86. Smithsonian Inst. Press.
- Krivogorskaya, Yekaterina; Perdikaris, Sophia; McGovern, T.H. 2005:  
*Fish bones and Fishermen: the potential of Zooarchaeology in the Westfjords*. In: *Archaeologica islandica* 4: 31-51.
- Krivogorskaya, Yekaterina; Perdikaris, Sophia; McGovern, T.H. 2005:  
*Cleaning Up the Farm: A Later Medieval Archaeofauna from Gjögur, a Fishing Farm of NW Iceland*. In: Arneborg, Jette & Grønnow, B (eds). *Dynamics of Northern Societies*, Proceedings of the SILA/NABO conference on Arctic & North Atlantic Archaeology 2004: 383-395. National Museum of Denmark. Copenhagen.
- Lucas, Gavin. 1998:  
*Prehistory at Hofstaðir: An Introduction to the 1996-97 Excavations*. In: *Archaeologica Islandica* 1.
- McGovern, T. H. 1994:  
*Management for extinction in Norse Greenland*. In: Crumley, Carole (ed). *Historical ecology: cultural knowledge and changing landscapes*: 127-154. School of American Research. Santa Fe.
- McGovern T.H.; Amorosi T.; Perdikaris S.; Woollett J.W.; 1996:  
*Zooarchaeology of Sandnes V51: Economic Change at a Chieftain's Farm in West Greenland*. In: *Arctic Anthropology* 33(2): 94-122.
- McGovern T.H.; Perdikaris, Sophia; Tinsley, Clayton. 2001:  
*Economy of Landnám: the Evidence of Zooarchaeology*. In Wawn A.; Sigurdardottir, Thorunn (eds). *Approaches to Vinland*, Sigurdur Nordal Inst. Studies 4: 154-165. Reykjavik.
- McGovern T.H.; Vésteinsson, Orri; Friðriksson, Adolf; Church, Mike; Lawson, Ian; Simpson, Ian A.; Einarsson, Arni; Dugmore, Andy; Cook, Gordon; Perdikaris, Sophia; Edwards, Kevin; Thomson, Amanda M.; Adderley, W. Paul; Newton, Anthony; Lucas, Gavin; Aldred, Oscar (in press). 2007:  
*Landscapes of Settlement in Northern Iceland: Historical Ecology of Human Impact & Climate Fluctuation on the Millennial Scale*. In: *American Anthropologist*. March 2007.
- Morris, Christopher D.; Rackham, D. James. 1994:  
*Norse and later settlement and subsistence in the North Atlantic*. Archetype Publications. Glasgow.
- Morris C. D. (ed). 1996:  
*The Birsay Bay Project, Volume 2 Sites in Birsay Village and on the Brough of Birsay*, Orkney University of Durham, Dept of Archaeology Monograph 2, Alden Press Oxford.
- Morris, C.D.; Batey, Colleen; Rackham, James. 1995:  
*Freswick Links Caithness; Excavation and Survey of a Norse Settlement*. University of Glasgow and NABO.
- 1989:  
*Birsay Bay, Orkney: Human Exploitation of Natural and Agricultural Resources*. In: *Hikuin* 15: 207-222.
- Mulville, Jacqui ;Thoms, J. 2005:  
*Animals and Ambiguity in the Iron Age of the Western Isles*. In: Turner, Val; Nicholson, R.A.; Dockrill, S.J.; Bond, J.M. (eds.). *Tall Stories? Two Millennia of Brochs*, Shetland Amenity Trust: 235-246. Lerwick.

- Nicholson, R.A. 2004:  
*Iron Age Fishing in the Northern Isles: the Evolution of a Stored Product?* In: Housely, R.A.; Coles, G. *Atlantic Connections and Adaptations; Economies, environments and subsistence in lands bordering the North Atlantic*, AEA/NABO 21: 155-163. Oxbow Books, Oxford.
- Nicholson, R. 1998:  
*Fishing in the Northern Isles, a case study based on fish bone assemblages from two multi-period sites on Sanday, Orkney*. In: *Environmental Archaeology* 2: 15-29.
- Ogilvie, A. E. J. 1997:  
*Fisheries, climate and sea ice in Iceland: an historical perspective*. In: Vickers, D. (ed). *Marine Resources and Human Societies in the North Atlantic Since 1500*: 69-87. Institute of Social and Economic Research, Memorial University of Newfoundland. St. Johns, Canada.
- Ogilvie, Astrid E.J.; McGovern, T.H. 2000:  
*Sagas and science: climate and human impacts in the North Atlantic*. In: *Vikings: The North Atlantic Saga*. Fitzhugh, William W.; Ward, Elisabeth I. (eds.): 385-393. Smithsonian Institution Press. Washington.
- Parker-Pearson, M.; Sharples, N. (eds.). 1999:  
*Between Land and Sea: Excavations at Dun Vulan, South Uist*, Sheffield Academic Press, Sheffield.
- Perdikaris, S. 1996:  
*Scaly Heads and Tales: Detecting Commercialization*. In: A. Morales (ed.). *Early Fisheries, Archaeofauna, Ichthyoarchaeology and the Archaeological record*. Proceedings of the 8th meeting of the ICAZ Fish Remains Working Group: 5 (1996): 21-33. Madrid, Spain.
- Perdikaris, S. 1998:  
*The Transition to a Commercial Economy: Lofoten Fishing in the Middle Ages, A Preliminary Report*. 7th ICAZ Conference Proceedings, September 1994, Konstanz, Germany. *Anthropozoologica* 25-26/1997: 505-510.
- Perdikaris, S. 1999:  
*From chiefly provisioning to commercial fishery: Long term economic change in Arctic Norway*. In: Peter Rowley Conwy (ed). *World Archaeology* 30 (3): 388-402.
- Perdikaris, Sophia; McGovern T.H. 2005:  
*King Alfred, King Knut, and the Codfish: new evidence for the beginning of North Atlantic commercial fisheries*. Paper presented at the 2005 Society for American Archaeology meetings, Salt Lake City Utah.
- Perdikaris, S.; McGovern T.H. 2007a:  
*Walrus, Cod Fish, and Chieftains : Intensification in the Norse North Atlantic*. In: Thurston, T. L. and Fisher, C.T. (eds.). *Seeking A Richer Harvest: The Archaeology of Subsistence Intensification, Innovation, and Change*: 193-216. Springer Science+Business Media, New York.
- Perdikaris S.; McGovern T.H. (in press). 2007b:  
*Codfish and Kings, Seals and Subsistence: Norse Marine Resource Use in the North Atlantic*. In: Rick, Torben; Erlandson, Jon (eds). *Human Impacts on Marine Environments*, UCLA Press Historical Ecology Series.
- Rowley-Conwy. 1983:  
*Sedentary hunters: the Ertebølle example*. In: Bailey, G.N. (ed.), *Hunter-gatherer economy in prehistory: a European perspective*: 111-126. Cambridge University Press, Cambridge.
- Sharples, N.; Parker-Pearson, Mike; Symonds, J. 2004:  
*The Archaeological Landscape of South Uist*. In: Housely, R.A.; Coles, G. *Atlantic Connections and Adaptations; Economies, environments and subsistence in lands bordering the North Atlantic*, AEA/NABO 21: 28-48. Oxbow Books.
- Sharples, Niall (ed.) 2005:  
*A Norse Farmstead in the Outer Hebrides, Excavations at Mound 3, Bornais, South Uist*, Oxbow Books, Oxford.
- Sharples, Niall (ed.) 1998:  
*Scalloway: A Broch, Late Iron Age Settlement, and Medieval Cemetery in Shetland*. *Oxbow Monograph* 82, Oxbow Books, Oxford.
- Smith Helen; Mulville, Jaqui. 2002:  
*Resource Management in the Outer Hebrides*. In: Housely, R.A.; Coles, G. *Atlantic Connections and Adaptations; Economies, environments and subsistence in lands bordering the North Atlantic*, AEA/NABO 21: 48-65. Oxbow Books, Oxford.
- Vésteinsson, Orri. 2000:  
*The Archaeology of Landnam, Early Settlement in Iceland*. In: Fitzhugh, W.W.; Ward, E. (eds). *Vikings The North Atlantic Saga*: 164-174. Smithsonian Inst. Press.
- Vésteinsson, Orri; McGovern, T.H.; Keller, Christian. 2002:  
*Enduring Impacts: social and environmental aspects of Viking Age Settlement in Iceland and Greenland*. In: *Archaeologica islandica* 2: 98-136.