A Fishing Farm in the West Fjords of Iceland: A Preliminary Report of the Archaeofauna from Gjögur

Yekaterina Krivogorskaya, Sophia Perdikaris, Thomas H. McGovern

CUNY Northern Science

and Education Center

NORSEC

CUNY Doctoral Program in Anthropology

Brooklyn College Zooarchaeology Laboratory

Hunter College Bioarchaeology Laboratory

NORSEC Laboratory Report No. 31

May 1 2005

Contact: nabo@voicenet.com

Published as : Yekaterina Krivogorskaya, Sophia Perdikaris, Thomas H. McGovern
Fish bones and Fishermen: the potential of Zooarchaeology in the Westfjords (2005) *Archaeologica Islandica* 4 : 31-51 Reykjavik

Abstract

The date for the onset of full scale commercial fisheries in Iceland remains somewhat controversial, but thus far the earliest radiocarbon dated seasonal fishing station (11th-13th century) is in NW Iceland's Strandasýsla County at Akurvík. This paper presents a preliminary report of the ongoing analysis of the large archaeofauna from the farm mound at Gjögur, 3 km from Akurvík, places the site of Gjögur in the wider context of the NW region of Iceland by comparing the site with the Akurvík archaeofauna, and outlines new methodologies of reconstructing live fish size and age based on recovered fish bones. Although the Akurvík site provides a first zooarchaeological look at a Medieval fishing station, it is the site of Gjögur that would have controlled and integrated Akurvík's catches into the larger regional arena of Northern Iceland, as well as using fishing to aid the economy of Gjögur itself.

KEYWORDS: North West Iceland, North Atlantic, Fishing Farm, Zooarchaeology

Introduction

This paper presents a brief overview of archaeological excavations in 1990 at the site of Gjögur, Strandasýsla, NW Iceland, and presents preliminary results of the animal bone collections from both the lower and the upper contexts from Gjögur as compared with results from excavation of nearby fishing booths at Ak et al. 2005 in press, Krivogorskaya et al. 2005 in press). The sites of Akurvík and Gjögur have radio-carbon dates spanning the 12th- 15th century A.D., and this paper compares early and later early medieval contexts of both sites. The Akurvík site archaeofauna (animal bone collection) came from two thick stratigraphically separate layers of fish bone associated with two small turf structures exposed along an 18 meter long erosion face. Stratigraphic evidence indicates multiple periods of abandonment and re-use of these lightly built structures, suggesting a seasonal rather than permanent occupation. The Akurvík ruins are best interpreted as one of a series of superimposed seasonal fishing "booths"- lightly built structures designed to temporarily hous s crew but not a farming household (Edvardsson *et al*., 2004, Edvardsson 1996, 2002, 2004a,b Edvardsson this volume). Gjögur is only 3 km from Akurvík, but was a permanent farm occupied from early settlement times down to the end of the 20th c, and its structures and midden form a “farm mound” nearly 3 meters deep (Perdikaris, 1998). These two roughly contemporary archaeofaunal of Akurvík and Gjögur thus come from two very different site types: a seasonal specialized fishing station and a large permanent farm.

The Site and Excavations 1990

In the summer 1990, an international interdisciplinary team directed by McGovern for CUNY and the *National Museum of Iceland* carried out survey, excavation, and paleoenvironmental research in Árneshreppur, Strandasýsla, North-West Iceland (fig. 1).

[Figure 1 here]

The investigations included two small-scale excavations, located at the end of the peninsula between Reykjarfjorður and Norðurfjorður, both of which produced substantial archaeofauna dominated by fish. One excavation sampled an eroding 18 meter long profile at the coastal site of Akurvík with small turf structures and dense concentrations of fish bones (Amundsen, *et al.,* 2005 *in press*). The other excavation centered on the deeply stratified midden associated with the farm mound at Gjögur 3 km South-West of Akurvík, which had been sampled by a first stage survey team in 1988. The objectives of the 1990 investigations were to clarify the nature and date of the deposits at Gjögur, draw profiles and recover useful collections of artifacts and animal bones. Despite a shortened season and some challenging weather, large bone collections and a small number of artifacts were recovered from both sites.
The Gjögur mound was disturbed by a *surhey* (silage) pit that was dug into it to produce

silage hay storage in the 1960's. The silage pit occupied the northeastern edge of the mound, mainly cutting through midden deposits, but the northwestern corner also disturbing a wall feature of one of the earlier building phases. Surface mapping suggested that the midden deposit sampled in 1990 may be only one of several deep cultural deposits on the site, which clearly retains c iderable untapped archaeological potential. The 1990 Gjögur excavation crew used a stratigraphic excavation strategy combined with 5 cm levels measured from ground surface in the upper 50-75 cm, excavating back from the profile exposed by the silage pit wherever possible. The profiles provided by the ca 4x5 m silage pit intrusion proved exceptionally useful, and investigations in 1990 concentrated on the eastern edg m the house ruins), combining a horizontal and vertical excavation strategy. Due to poor drainage, time constraints, and safety issues, the 4x2 meter 1990 excavation had to be stopped at the depth of 2.2 meters- well above the bottom of the cultural deposit. A core taken from the bottom of the unit indicated an additional 80 cm of cultural deposit coming down to a Holocene beach gravel natural substrate. Thus the current Gjögur sample does not extend to the base of the cultural deposit, and represents approximately the top two thirds of the midden. As at Akurvík, the excavated material was 100% sieved through a 4 mm mesh and a sample of approximately 5% was sieved through a 1 mm mesh as a control check.

Phasing of the Gjögur Midden

Even though structures on the farm mound at Gjögur itself were reportedly occupied down to 1860, the portion of the midden excavated in 1990 does not appear to extend into the early modern period. The absence of characteristic 17th-19th century Icelandic artifacts such as imported pottery, glass, and clay pipes, which were recovered in substantial numbers at a nearby farm excavation at Finnbogastaðir (Perdikaris, et al., 2003; Edvardsson et al., 2004) combined with the calibrated range of the upper AMS radiocarbon date suggest a late 15th or early 16th century terminus date for significant refuse deposition on this area of the site. A composite bone comb side-plate postdating ca. AD 1200 was encountered in a context (SU 43) approximately in the middle of the 1990 exposure. Near the bottom of the excavated profile (still ca 80 cm above the non-cultural surface) a base shard of a rounded steatite vessel was recovered from context SU 60. While steatite artifacts of this sort are usually associated with Viking Age occupations in Iceland, some later imports are kno d it is also quite possible that this battered fragment is residual evidence of earlier occupation of the site. Other artifacts recovered (worked whalebone, whetstones, iron nails) are not temporally diagnostic. The available radiocarbon dates and artifact assemblage thus suggest that the lower parts of the exposed midden deposit date to the 13th century and earlier, while the upper layers are mainly 14th and 15th century in date. For the purpose of this paper, the excavated stratigraphic units (layers) at Gjögur are broken down into 2 analytical units (AU, phases): upper and lower, with respective radiocarbon dates listed in Table 1 and graphed in Figure 2. As Figure 2 illustrates, the upper phases of both Gjögur and Akurvík are probably directly contemporary (despite some calibration plateau effects) and that the lower excavated phase (AU 2) at Gjögur is likewise approximately contemporary with the lower layers at Akurvík, although the basal layer at Akurvík (context 24) may possibly extend into the 11th century (plateau effects again limit precision).

[Figure 2 here]
[Table 1 here]

This preliminary paper reports samples taken from the lower (early medieval) and upper (late medieval) layers at Gjögur contemporary with the early medieval and late medieval deposits at the nearby fishing station of Akurvík. Analysis continues on the large Gjögur archaeofauna, and some conclusions may be later modified in the final report, but the sample reported here is substantial, w mber of Identified Specimens NISP (Grayson, 1984) currently numbering 19,933.

Methods

Analysis of the Gjögur collection was carried out at the Brooklyn College and Hunter College Zooarchaeology Laboratories and made use of extensive comparative skeletal collections at both laboratories and the holdings of the American Museum of Natural History. The contexts of the two sites used for the purposes of this paper represent directly comparable types of deposit (accretional midden rather than floor layers or short term specialized dump). All fragments were identified as far as taxonomically possible and selected element approach was not employed. The identifications of gadids follow the ICAZ Fish Remains Working Group recommendations (see Perdikaris *et al.* 2004; Cannon 1987; and Mujib 1967). Following the NABO Zooarchaeology Working Group recommendations and the established traditions of North Atlantic zooarchaeology we have made a simple identified fragment count (NISP) the basis for most quantitative presentation. Measurements (*Mitutoyo digimatic*, digital caliper) of fish bones follow Wheeler & Jones (1989). All of collected data was digitally recorded following the 8th edition NABONE recording package (Microsoft Access database supplemented with specialized Excel spreadsheets). All digital records, including archival element by element bone records, will be permanently curated at the *National Museum of Iceland*. CD Rom versions of all archived data are also available on request from nabo@voicenet.com. All archaeofauna used for comparisons in this paper were collected using closely comparable excavation strategy and analyzed using the same laboratory procedures and data management programs.

[Table 2 here]

Presence and Abundance of Species

Even though domestic mammals, sea mammals, some birds, and mollusks are present, both sites contexts in all phases are dominated by fish. This paper will focus on the fish remains from the Gjögur farm mound and the Akurvík seasonal fishing station, making use of both long established and new approaches to reconstructing the nature of this early fishery. For discussion of the other taxa present in the Akurvík and Gjögur collections see Amundsen et al (2005 in press) and Krivogorskaya et al (2005 in press).

Quantity of fish bone

The quantity of fish bones recovered at Gjögur and Akurvík (over 80% of the archaeofauna in all phases of both sites) place both sites in the informal category of "fish middens" now known from many parts of the North Atlantic (Barrett, 2004; Bigelow, 1984). Such massive concentrations of fish bones in archaeological deposits are certainly one indicator of sustained fishing effort by ancient peoples and may be one indicator of production for export (Amorosi et al 1996), but some Mesolithic coastal sites are equally rich in fish bone, so sheer numbers of fish bone fragments in a deposit cannot demonstrate a commercial or commercializing fishery.
[Table 3 here]

Fish Species Diversity

Table 3 demonstrates the relative abundance of the identified fish taxa in Gjögur and Akurvík collections. A limited number of flatfish spe s, salmonids, skates and a Greenlandic shark (tooth) were identified in the recovered archaeofauna, but gadid (cod family) fish dominate the collection and definitely make up most of the fish bones not assignable securely to family. The majority of the gadid fish are Atlantic cod, distantly followed by haddock, saithe, torsk, and ling. While Gjögur and Akurvík are very different types of occupation, both show an overwhelming dominance of cod fish in both their early and later medieval archaeofauna. Such dominance le species has been used as an indicator of a commercialized or commercializing fishery concentrating on a single species that can be standardized and commoditized for export (see Perdikaris *et al.*, in press; Perdikaris, 1998 for discussion; Simpson *et al*., 2000). The narrow focus upon cod in these sites contrasts strongly with the mu igher species diversity evident in 9th-11th century bone collections from inland Mývatnssveit, which include substantial amounts of haddock and saithe as well as cod (McGovern, Perdikaris, Einarsson & Sidell in press 2005, McGovern, Perdikaris et al. 2001), or the high species diversity of Iron Age North Norwegian fish collections (Perdikaris 1998).

Fish Skeletal Element Distribution

Skeletal element distribution is often used as an aid in identifying specialized fish butchery and processing techniques that may disproportionately deposit cranial and some vertebral elements at landing/processing centers and concentrate other "meat bearing" body parts at consumption areas. Different fish processing techniques produce different patterns in the skeletal elements transported to consumers, but all tend to leave the bones of the pectoral girdle (around the gill slit) with the preserved product, as these bones (especially the large, curved cleithrum) help to keep the headless body together and when spread aid the drying of the body cavity. The relative amount of vertebrae that travel from coastal producer to distant consumer varies according to butchery strategy and the type of preserved fish product being produced on the coast. The staple of the later medieval and early modern dried fish trade was stockfish (*skreið*), a round-dried product that left almost all of the upper vertebrae (including thoracic and pre-caudal) in the exported fish. Other fish drying techniques produced a flattened product much like the modern Norwegian *'klipfisk'* which lacked upper vertebrae (missing thoracic and most pre-caudal) which would then tend to accumulate along with the head and jaw bones at the coastal processing center (see discussion in Perdikaris *et al.*, 2002, Amundsen *et al.,2005 in press*). The distribution of different parts of large gadids thus can provide tools for not ifying "consumer" sites receiving processed preserved fish from distant locations, but also for reconstructing the actual product being produced. Complicating such analyses is the universal habit of fisher-folk everywhere of provisioning themselves with part of their own catch, often eating species or size ranges not readily marketable and disposing of the domestic refuse along with bulk processing debris (Carrasco, 1998, Barrett, 1997, Bigelow, 1984). Large, comparably excavated samples analyzed using common zooarchaeological software are critical to attempts to separate out the patterns produced by on-site consumption, discard of spoiled or otherwise unmarketable whole individuals, and specialized processing for long distance trade in preserved fish, but no single approach is sufficient. Three different perspectives on fish body part representation may be useful: comparison of major skeletal element groups, relative proportions of the vertebral column present, and relative proportion of selected individual elements.

[Figure 3 here]

Figure 3 presents the proportions (MAU % adjusted for body part frequency in the live animal, Grayson 1984) of the major element groups (head and jaws, pectoral girdle, vertebrae) for four inland archaeofauna dating to the Viking Age (McGovern, Perdikaris et al 2005, 2001, Einarsson 1994), both early and late medieval phases at Akurvík and Gjögur, and the 18th c site of Finnbogastaðir (a farm combining a primary orientation towards subsistence fishing with some market productio 2004). As Figure 3 illustrates, cod bones from the upper head and jaws greatly outnumber axial (vertebral) elements at Gjögur, Akurvík and at Finnbogastadir. This “producer site” pattern strongly contrasts with the skeletal element distribution pattern seen on the inland Viking Age Mývatnssveit sites (Sveigakot, Hrísheimar) or at the contemporary site of Granastaðir in one of the highland valleys above Eyjafjord. These “consumer sites” with no direct access to salt water consistently produce gadid collections which have few or no jaw and skull bones and have a disproportionate concentration of pectoral girdle and vertebral bones. Early medieval Akurvik, however, demonstrates a pattern rather distinct from the later coastal sites in Strandasysla, with a higher proportion of all vertebrae being left on site along with a large number of head and jaw bones. It would appear that while the early medieval (11th-13th c) phase at Akurvík was engaged in a slightly different pattern of fish cuttin eposition than the later occupations in the same area.

[Figure 4 here]

Figure 4 presents a breakdown of the relative proportions of the vertebral series (thoracic and precaudal are from the upper body, caudal vertebrae are in the tail), again making use of the MAU% (a complete fish skeleton would have exactly equal proportions of all three vertebrae if quantified this way). In this analysis of relative proportions of the vertebrae, Finnbogastaðir provides the closest match to a complete fish where all three vertebrae are present in equal amounts (ca 30% each). The Akurvík and Gjögur patterns all suggest a more marked deficit of caudal vertebrae and surplus of thoracic and precaudal vertebrae, but the presence of all three vertebral types in these sites is an indication that at least so e whole fish (tails included) were also being deposited in all periods. The contrast with the inland consumer sites (Sveigakot, Granastaðir, Hrísheimar) is marked, as all of these sites show a clear surplus of caudal vertebrae and a shortage of thoracic and precaudal vertebrae. Since stockfish would include most of the thoracic and all of the precaudal vertebrae, while a flat dried *'klipfisk'* usually lacks most thoracic or precaudal vertebrae, it appears that the product most usually supplied to inland consumers in the 9th-11th centuries was not stockfish but something more similar to *'klipfisk'*. The pattern at Sveigakot in the 11th c indicates some upper body gadid vertebrae were coming inland, so it is not impossible that more than one product was being produced and cons med in the Viking age. As *'klipfisk'* is easier to produce in a wider range of drying locat d can generally be produced in warmer temperatures than stockfish, it is possible that a variety of factors (perhaps including seasonality and climate fluctuation) may have favored the production of *'klipfisk'*.

[Figure 5 here]

Figure 5 presents the relative proportions of two selected skeletal elements on the same set of site archaeofauna as compared in Fig 4 and 5. This comparison of selected elements inevitably reduces sample size, but it has the advantage of directly comparing two bones (cleithrum in the pectoral girdle and premaxilla in the jaw) which are comparable in size, density, are commonly recovered, and which are equally identifiable to species level. Cleithra should unambiguously stay with “meat” and premaxillae should equally regularly be deposited with heads, potentially providing a simple and robust indicator of differential deposition. As figure 5 demonstrates, this direct comparison of these two selected elements strongly emphasizes the contrast between all the inland consumer sites and the coastal   la collections (a complete gadid skeleton would have exactly equal representation of these bones and show a 50/50 split in this graph). Among the Strandasysla collections, the 18th century collection from Finnbogastaðir again most closely approaches the natural 50/50 balance, while the Akurvík collections show the most marked surplus of premaxillae over cleithra.

Size Reconstruction

Live length reconstructions for Atlantic cod have been widely carried out on selected bone elements, employing the widely used Wheeler & Jones (1989) regressions. Different sized fish are suitable for preparation as stockfish, *‘klipfisk’*, or for fresh consumption only. The ‘stockfish window’ is ca 60-110 cm live length. Fish smaller than this widow over dry, and fish much larger simply rot, for discussion, see Perdikaris (1998). However, smaller-sized fish in the ca 40-70 cm live length range can be ideal for preparing as *‘klipfisk’*.

Figure 6 presents the live length reconstruction for both phases at Gjögur and Akurvik based on atlas vertebrae (Enghoff, 1994).

[Figure 6 here]

The cod dentary and premaxilla are jaw parts that are robust and regularly recovered in excavation, and these elements have also been widely used for live length reconstruction (Wheeler and Jones, 1989). Both Gjögur and Akurvík have produced substantial numbers of both elements. The reconstructed size distributions show a similar pattern to the atlas reconstructions, but larger sample sizes provide more detail.

[Figure 7 here]

Figure 7 presents the reconstructed live length distribution for cod dentary and premaxilla from the roughly contemporary later medieval phases at Gjögur and Akurvík with the optimum size for stockfish (solid) and *'klipfisk'* (dotted) indicated as boxes. Note that the mutually consistent patterning of both premaxillae and dentaries on the two sites indicate two different patterns - a unimodal distribution centered around 60 cm reconstructed live length at Gjögur, and a bimodal distrib Akurvík with peaks at around 60 cm and around 80 cm.

[Figure 8 here]

Figure 8 presents the same live length reconstructions on premaxillae and dentaries for the earlier medieval contexts at Akurvík and Gjögur. In this case, the earlier Gjögur cod length reconstructions again indicate focus on the smaller individuals, while the Akurvík dentary and premaxillar reconstructions indicate a dua cus, but one more heavily weighted to the *'klipfisk'* It would appear that in both time periods, the fish m at Gjögur and the fishing booths at Akurvík were catching much the same species of fish, but that Akurvík regularly landed and prepared fish directly within the "stockfish window" (particularly in the late medieval period) and Gjögur did not. Both sites appear to have consistently landed and prepared cod in the middle of the smaller "*'klipfisk'* window". In neither case are these distributions result of a rando sample of the ancient local cod population, which would presumably have been dominated by much smaller fish as today, but reflect a selective combination of bait, de son, and fishing ground.

Cod Ageing Methods

While periodicity has been easy to record in other spe s such as salmon and in the otolith of mostly all species, archaeologically we rarely have the otolith and actually the bone structure of cod has been proven extremely difficult to read under thin sectioning due to the confused structure and opaqueness of the bone. After testing however, the

method that was simplest and easiest has given the most reliable results yet. The centrum of the vertebra, shows a regular periodic structure similar to what might be observed to the otolith. By using low level microscopy the growth rings can be counted and an approximate age estimated (pending on the ring clarity +/- a season).
While researchers (Van Neer 2003) has cautioned over the estimation of the season represented by growth rings on certain species, the overall age estimations in this paper are consistent and compare favorably to the growth rings present on codfish with known age and season of capture.
Atlas vertebrae, with dark and light rings, indicating winter and summer growths respectively, can be used to effectively reconstruct the age of the fish (based on experimental controls of cod of known age). The lighter, usually thicker rings are accumulated during spring and summer months when abundant food supplies produce more rapid growth. The darker and usually thinner rings are accumulated during winter and fall seasons when the food abundance is reduced. Thus a year is represented by a combination of a light and a dark band. Like analyses of mammalian tooth structure (Woollett, 2004) fish atlas ring counting can supply both the age and season of death of the individual. This development provides zooarchaeologists another tool for contributing to a better understanding of the long ter mics of cod stocks before the beginning of the modern fisheries record (around 1900).

Atlas vertebrae were selected based on their preservation and completeness. The vertebrae were then carefully brushed to remove dust and sand particles without damaging the bone. Atlas vertebrae were scanned using wlett Packard Scanjet ADF. As anterior and posterior sides of atlas have the same ring count (Storm, 2004), both sides were scanned so that a more accurate and consistent ring count could be obtained. After a preliminary scan was performed, vertebrae were then scanned to Adobe Photoshop 7.0 at a resolution of 600 dpi and saved as .jpeg files. Scans were then further analyzed for the ring clarity under magnification. Saved images were then exported into Powerpoint© and ring count performed using digital line and tick marks.

The annuli of the vertebrae were counted from the centrum to the edge of each specimen. A grouping of one dark band (winter band) and one light band (summer band) represented one year of the fish's life. Atlas vertebrae were also used to reconstruct the live size of fish (Enghoff, 1994).

The results for the Age reconstruction for Akurvík and Gjogur and presented in the figure 9. While this method is still somewhat experimental and is in need of further development, it would appear that fisheries zooarchaeologists will be able to provide age and season of death information even when the fragile otoliths usually employed by fisheries biologists have not survived in archaeological contexts.
[Figure 9 here]

Discussion: Fishing Farms and Fishing Stations

The Gjögur midden is the product of a wide range of activities carried out year round to provision a household as well as to generate potential surplus product, and the ephemeral Akurvík booths probably existed for a few weeks a year to shelter boats crews involved exclusively in fishing and marine hunting whose profits were consumed elsewhere. The archaeological records of the two settlements of Akurvik and Gjögur are very distinct, yet both produce archaeofauna dominated by cod fish. How different were the products of the specialized seasonal fishing site of Akurvik and the "fishing farm" at Gjögur? Was Gjögur involved in preparation of fish for export or exchange, or was its intense fishing effort entirely directed towards provisioning its own household? Based on the combination of size reconstruction and ele istribution, we can answer some of these questions with a fair degree of confidence. Akurvík seems to have always been strongly focused upon production for export, despite some on-site consumption of by-catch (note the cleithrum-premaxilla proportions and the disproportionate representation of head and jaws generally). Akurvík seems to have always produced both stockfish and '*klipfisk*' (or products very similar) but seems to have shifted emphasis from predominately *‘klipfisk*’ production in its early phases to a greater emphasis on stockfish production in the later medieval period (evident in changes in both element distribution and size profile). Gjögur also seems to have been consistently producing more fish than it was consuming, with a strong signal coming through its cod fish element distribution patterns. Ho s to have been focused upon *‘klipfisk’* production and would not have generated large amounts of stockfish in either period. If Gjögur and Akurvík can be seen as parts of an economic system (perhaps managed by the householders at Gjögur), then it seems that Gjögur’s stockfish production was carried out at the separate fishing station and not near home, perhaps supplying a different type of export product. In the Middle Ages, Gjögur was clearly not carrying on simply a subsistence fishery (as at 18^{th} c Finnbogastaðir) but was deeply involved in the production of preserved cod for export to local or distant markets, probably making use of a diversity of fishing and fish curing strategies.

There is a general pattern of increasing proportion sh bone relative to domestic mammal bone from early medieval to early modern times most Icelandic archaeofauna in all portions of the country, a pattern usually ascribed to increasing subsistence use of marine resources in response to cli e fluctuation, soil erosion, and changing social forces (Perdikaris *et al., in press*, Amorosi, *et al.,* 1996). Edvardsson (2000, 2004) has argued that NW Iceland played a critical role in fulfilling these growing Icelandic subsistence needs in the later Middle Ages, and has documented the role of powerful chieftains in managing the production and distribution of fish and other marine products from the NW into the rest of the country. Edvardsson has argued that the “ethnographic present” of the impoverished 18^{th}-19^{th} c subsistence fisher-farmers is a poor model for the greater wealth and economic complexity of high medieval Iceland. Were two fish distribution systems in operation at the same time in the 14^{th}-15^{th} centuries in Strandasýsla- one serving a long established (but evolving) Icelandic market and the other aimed at the growing internationa sh trade? Other dimensions of the interactions between fishing farms, fishing stations, and fish consumers in Iceland will surely emerge as fieldwork and analysis continue.

New Methods for Reconstructing Past Fishing Activity

Zooarchaeological analyses making use of a series of complementary approaches and drawing on comparisons to the wider Icelandic zooarchaeological record now indicate that :

- It is possible to clearly differentiate consumer from cer sites on fish skeletal element frequency measures. These techniques allow confirmation that the later medieval trading center at Gásir in Eyjafjord was being provisioned with prepared fish rather than acting as a major fishing center (Harrison et al. 2005 in press), and may help clarify role of other sites with direct access to the sea but which may or may not have produced their own fish.
- A substantial trade in preserved fish took place in Iceland as far back as the first settlement. The Mývatn and upper Eyjafjord archaeofauna are currently the best documented, but finds of marine fish cleithra and vertebrae have also been made in early medieval contexts in Hrafenkelsdalur in the east, and at Háls and Reykholt in the south west (Amundsen et al. 2005). The zooarchaeological record thus supports Edvardsson's hypothesis of substantial internal Viking Age fish trading within Iceland prior to the expansion of the international fish trade of the later Middle Ages.
- Different types of fish preparation and curing seem to have taken place at the same time in different sites. Stockfish production see to have increased in importance in the late medieval contexts at the Akurvík fishing station, but not at the nearby fishing farm of Gjögur. There seem to be differences between these patterns and those documented in early modern times, again underlining the danger of an uncritical use of the ethnographic record.
- There are indications of a still earlier fish processing pattern in the basal layers at Akurvík, one which may be complementary to the patterns seen on the Viking Age

consumer sites. More early (10th-11th c) fish producing sites may help resolve this issue.

Analysis of the Gjögur collection is ongoing, later work may change some conclusions presented here, and this paper should not be taken as sort of final statement. New research programs in the West Fjords and in other parts of the North Atlantic offer the prospects for still more effective interdisciplinary cooperation. It seems clear that the way forward in fisheries zooarchaeology in the West Fjords is through systematic comparisons of large archaeofauna, consistently recovered and analyzed to a comparable standard, and then combined with many other data sets to unravel the complex picture of pre-modern marine resource use in this region. By combinin zooarchaeological approaches (species diversity, element distribution, size and age reconstruction) with locational analysis, paleoclimate, modern fisheries science, historical documents, and archaeological excavation cooperative investigations in the near future can be expected to greatly improve our understanding of long-term dynamic interactions of environment, fish, and fishermen in NW Iceland.

Acknowledgements:

We would like to thank the people of the West Fjords for their generosity and kindness during the field seasons in 1987 and 1990, and especially recognize the invaluable assistance of Dr. Haukur Jóhannesson who first directed our attention to the erosion face at Akurvík and the mound at Gjögur . Thanks are also due to the hard working international field crew and the multidisciplinary team of collaborators who carried out the field work in the face of challenging weather. The National Museum of Iceland both sponsored the project and has expertly curated the finds. Generous support was provided by the Icelandic Science Council, US National Science Foundation, City University of New York, Sheffield and Aarhus Universities, and the US NSF Office of Polar Programs- Women in the North program- made the original fieldwork possible. The analysis is a product of the National Science Foundation Arctic Social Sciences *Research Experience for Undergraduates Program* and the North Atlantic Biocultural Organization (NABO) and the Leverhulme Trust Project *Landscapes Circum Landnám*. The NABO radiocarbon dating program has been generously supported by the PSC-CUNY awards program and the Leverhulme Trust Landscapes Circum Landnám Project and Dr Gordon Cook of SUERC Radiocarbon Dating Laboratory. We would like to thank Colin Amundsen, Matthew Brown, Alex Volkov, Malgorzata Frik, Monika Koczela, Konrad Smiarowski, Dmitri Chitov, Eduardo Martinez, Scott Roche, Courtney Scott and Jonathan Frankel for their support and aid with faunal identification.

References:

Amorosi T., Woollett J.W, Perdikaris S., & McGovern T.H. (1996) *Regional Zooarchaeology & Global Change Research: Problems and Potentials*, World Archaeology, 28(1):126-157.

Amundsen, Colin P. (2004) *Farming and Maritime resources at Miðbaer on Flatey in Breiðafjord, North-West Iceland*. In: R. A Housely & G Coles (eds) Atlantic Connections and Adaptations; economies, environments and subsistence in lands bordering the North Atlantic, AEA/NABO Environmental Archaeology Monographs 21, Oxbow Books. In press.

Amundsen, Colin P., Perdikaris, Sophia, McGovern, Thomas H., Krivogorskaya, Yekaterina, Brown, Matthew, Smiarowski, Konrad, Storm, Shaye, Modugno, Salena, Frik, Malgorzata, Koczela, Monika. (2005) *Fishing Booths and Fishing Strategies in Medieval Iceland: an Archaeofauna from the Akurvík, North-West Iceland.* Environmental Archaeology: in press.

Barrett, J. (1995). *"Few know Earl Fishing-clothes" Fish mddens and he Economy of the Viking Age and Late Norse Earldoms of Orkney and Caithness, Northern Scotland*". PhD thesis, University of Glasgow.

Barrett, J., Nicholson, R. and Cérron-Carrasco, R. (1997). "*Fish trade in Norse Orkney and Caithness: a Zooarchaeological Approach*". Antiquity 71,616-638.

Barrett, J. Nicholson R.A., and Cérron–Carrasco R. (1999), *Archaeoicthylogical evidence for long term socioeconomic trends in northern Scotland 3500 BC- AD 1500.* Journal of Archaeological Science 26,353-388.

Barrett, J., Beukens, R., Simpson, I.A., Ashmore, P., s, S. and Huntley, J. (2000). What was the Viking Age and when did it happen? A view from Orkney. *Norwegian Archaeological Review* 33, 1-39.

Barrett, J., Beukens, R. P., and Nicholson, R. A. (2001). Diet and ethnicity during the Viking colonization of Northern Scotland: evidence fro sh bones and stable carbon isotopes. *Antiquity* 75,145-154.

Barrett, J., Locker, A., Callum, R. (2004) *The Medieval Origins of Marine Intensive Fishing in Medieval Europe: the English Evidence.* Royal Society

Bigelow, G. F.(1984). *Subsistence in Late Norse Shetland: an investigation into a Northern Island Economy of the Middle Ages*. Unpublished PhD thesis, University of Cambridge.

Bigelow G. F. (1985). Sandwick Unst and the late Norse Shetlandic economy, pp. 95-127 in B. Smith (ed.), *Shetland Archaeology, New Work in the 197*0's. Lerwick: Shetland Times press.

Bronk Ramsey, C. (2003). *OxCal Version 3.9*. (http://www.units.ox.ac.uk/departments/rlaha/orau/06_in ml).

Cerón-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. *Environmental Archaeology* 3, 73-81.

Cannon, D. Y. 1987. *Marine fish osteology: a manual for archaeologists*. Department of Archaeology, Simon Fraser University, Publication No. **18**, 1-133.

Claassen, Cheryl (1998). *Shells*. Cambridge University Press. Cambridge

Edvardsson, R. (1996). *Fornleifaskráning í Bolungarvík, fyrsti hluti, Kaupstaðurinn og jarðirnar næstar honum.* Fornleifastofnun Íslands.

Edvardsson, Ragnar (2002). Statistical Analysis of the 1703-1712 Land Register: Four Districts in the Northwest of Iceland, in Garðar Guðmundsson (ed) *Current Issues in Nordic Archaeology, Proceedings of the 21st conference of Nordic Archaeologists*, pp 189-197 Society of Icelandic Archaeologists, Reykjavik

Edvardsson, Ragnar (2004a), *Fornleifarannsókn á verstöðvum í Kaldrananeshreppi*, Reykjavík. (Forthcoming)

Edvardsson, Ragnar (2004b). New Interdisciplinary Research in NW Iceland, Paper presentation at *Dynamics of Northern Societies a SILA and NABO conference*, May 2004 Copenhagen, Denmark

Edvardsson, Ragnar, Perdikaris, Sophia, McGovern, T.H., Zagor, N and M. Waxman. (2004). *Coping with hard times in North-West Iceland: Zooarchaeology, History, and Landscape Archaeology at Finnbogastaðir in the 18th century*, Archaeologica Islandica 3: 20-48.

Grayson, Donald 1984. *Quantitative Zooarchaeology*, Academic Press, NY.

Harrison, Ramona, Brewington, Seth, Woollett, Jim, McGovern, T.H., Roberts, Howell, Perdikaris, Sophia, Krivogorskaya, Yekaterina. (2005). *Preliminary results from zooarchaeological analysis of the late medieval trading site of Gásir in Eyjafjörður, N Iceland*, in Gronnow and Arneborg (eds) *Dynamics of Northern Societies*, National Museum of Denmark, Copenhagen. In press.

Harrison, Ramona, Seth Brewington, Jim Woollett, T.H. McGovern, 2004. *Interim Report of Animal Bones from the 2003 Excavations at Gásir, Eyjafjörður, N Iceland.* NORSEC Laboratory Reports No. 16, CUNY.

Krivogorskaya Yekaterina , Sophia Perdikaris , Thomas H. McGovern (2005) Cleaning Up the Farm: A Later Medieval Archaeofauna from Gjögur, a Fishing Farm of NW Iceland, in Gronnow and Arneborg (eds) *Dynamics of Northern Societies*, National Museum of Denmark, Copenhagen. In press.

McGovern T.H., Sophia Perdikaris, Clayton Tinsley. (2001). Economy of Landnam: the Evidence of Zooarchaeology, in A. Wawn & Thorunn Sigurdardottir (eds) *Approaches to Vinland*, Sigurdur Nordal Inst. Studies 4 Reykjavik. 154-165.

McGovern Thomas H, Sophia Perdikaris, Colin P. Amundsen, Yekaterina Krivogorskaya, Shaye Storm, Malgorzata Frik, Salena Modugno, Monika Koczela, and Konrad Rydzewski-Smiarowski. (2004). The preliminary analysis of Icelandic fishing booths and a farm mound from the Late Medieval Period, Poster presentation at *Dynamics of Northern Societies a SILA and NABO conference*, May 2004 Copenhagen, Denmark,

Mujib, K. A. (1967). The cranial osteology of the gadidae. *Journal of the Fisheries Board of Canada* **24**, 1315-1375.

Perdikaris, S. (1996). Scaly Heads and Tales: Detecting Commercialization in Early Fisheries. Archaeofauna. Ichthyoarchaeology and the Archaeological record. Proceedings of the 8th meeting of the ICAZ Fish Remain Working Group, Madrid, Spain; A Morales (ed.). 5 (1996): 21-33.

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* no 25-26/1997:505-510.

Perdikaris, S. (1999). From chiefly provisioning to co   mercial fishery: Long term economic change in Arctic Norway. *World Archaeology* 30 (3):388-402

Perdikaris S, C.P. Amundsen & T.H. McGovern (2002) Report of Animal Bones from Tjarnargata 3C, Reykjavík, Iceland, NORSEC *Zooarchaeology Laboratory Reports, No1*

Perdikaris, S.; McGovern, T.; Krivogorskaya, Y., Waxman M. (2003) *Early Modern Fisher-Farmers at Finnbogastadir and Gjögur in Northwest Iceland.* Proceedings of the 12th meeting of the ICAZ Fish Remains Working Group, Guadalajara, Jalisco, Mexico; A.F.Guzman (ed): 139-144.

Perdikaris, S and T.H. McGovern. Walrus, cod fish and chieftains: patterns of intensification in the Western North Atlantic. In Tina Thurston (ed) *New Perspectives on Intensification*, Plenum Press. In Press

Perdikaris Sophia, McGovern, T.H, Árni Einarsson and Jane Sidell. Inland Sites and Coastal Connections - Patterns of Wild Animal Exploitation in Settlement Age Mývatn District, Northern Iceland, Paper presentation at *Dynamics of Northern Societies a SILA and NABO conference*, May 2004 Copenhagen, Denmark, *NORSEC Zooarchaeology Laboratory Reports No.4*

Simpson, I.A. Perdikaris, Cook, G., Campbell, J.L. and Teesdale, W.J. (2000). Cultural sediment analyses and transitions in early fishing activity at Langenesvaeret, Vesteralen, northern Norway. Geoarchaeology 15, 743-763.

Van Neer, Wim; Ervynck, Anton; Bolle, Loes J.; Rijnsdorp Adriaan D.; Milner, Richard S. (2003) *Seasonality only works in certain parts of the year. The reconstruction of fishing seasons through otolith analysis.* Presence of the archaeoichthyology in Mexico, Proceedings of the 12th meeting of the Fish Remains Working Group of the International Council for Archaeozoology. Ana Fabiola Guzman, Oscar J. Polaco and Felisa J. Aguilar (eds.) 167.

Wheeler, A. and A. Jones (1989) Fishes. Cambridge: Cambridge University Press.

Woollett, Jim. (2004a). Seals and Seasonality in NE Iceland during the Middle Ages and Early Modern Period, Paper presentation at Dynamics of Northern Societies a SILA and NABO conference, May 2004 Copenhagen, Denmark.

Woollett, Jim (2004b). Seal annuli and hunting reconstruction at Svalbarð, NE Iceland, Paper presentation at *NABO Fieldschool Seminar 2004*, August 2004, Husavik, N Iceland.

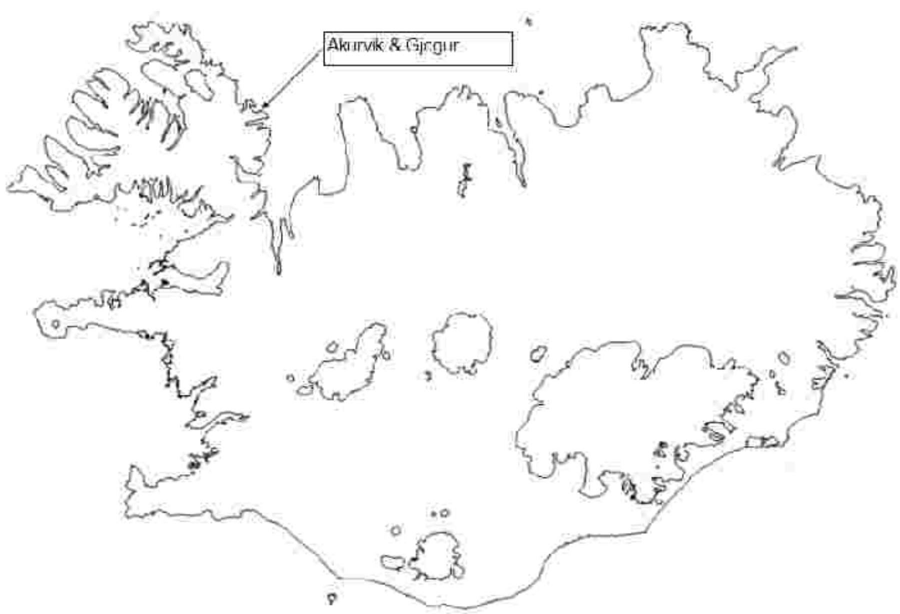

Figure 1 Location of Akurvík and Gjögur in Strandasysla, NW Iceland

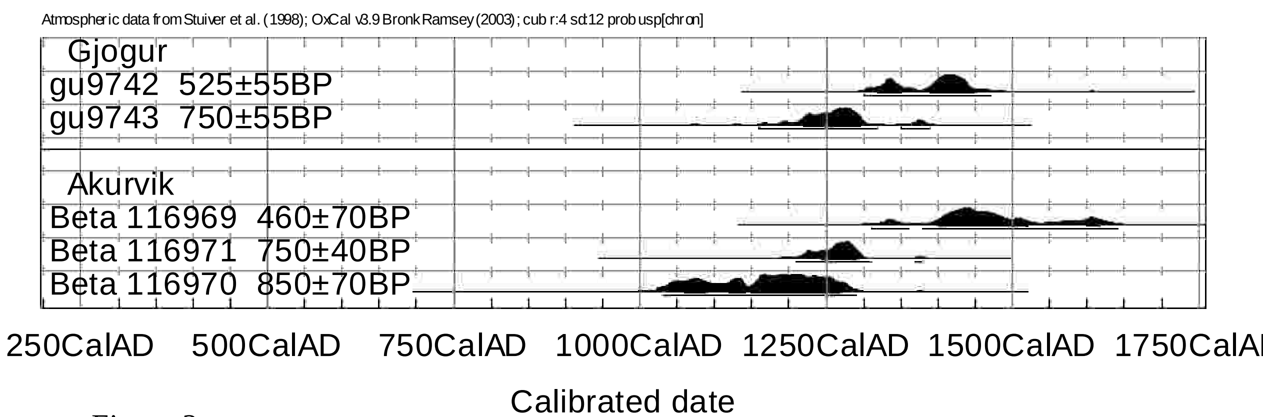

Figure 2.
Distribution graph of calibrated radiocarbon dates from Akurvík and Gjögur. Note that the basal date for SU 24 (Beta 116970) at Akurvik is potentially substantially older than the current basal date for Gjögur (GU 9743). Beta 11971 dates floor layers of a booth directly above the basal SU 24 midden.

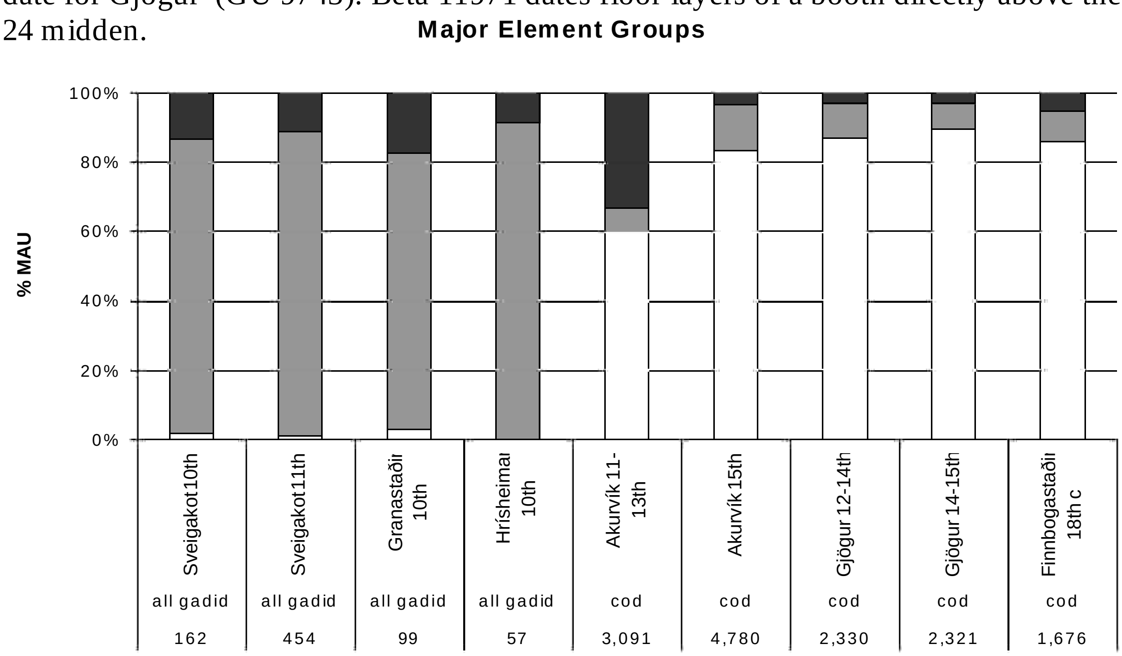

Figure 3. Major fish bone element groups, sample size indicated at bottom.

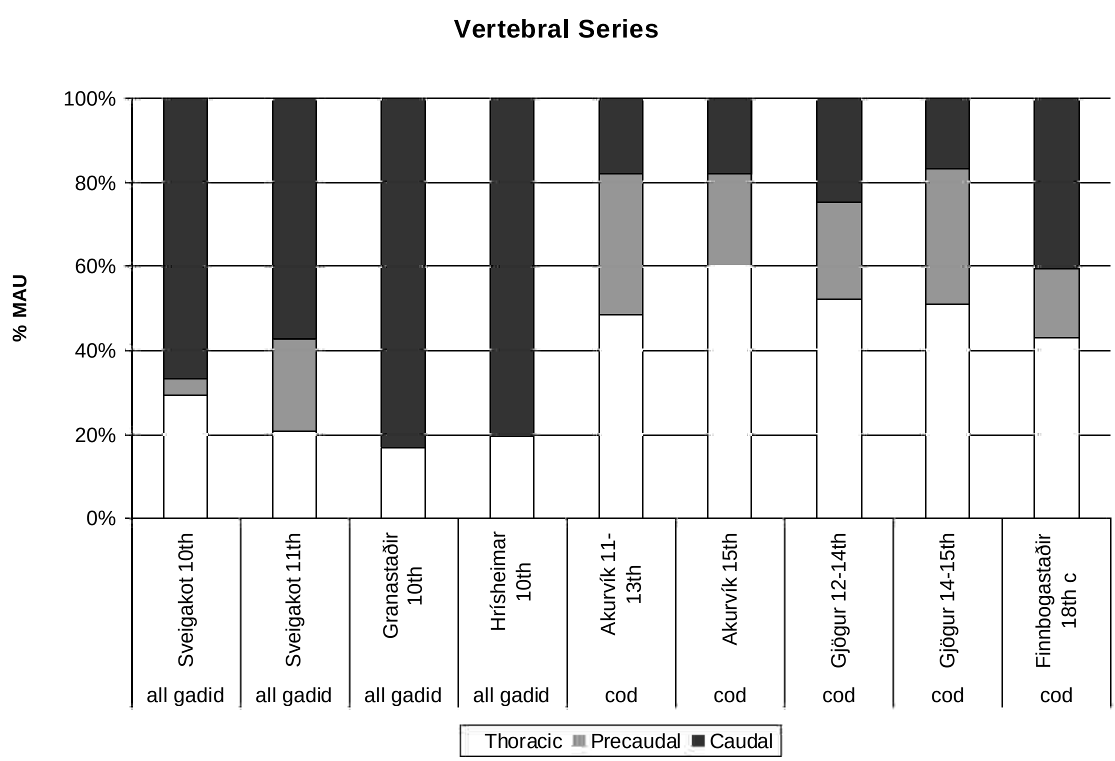

Figure 4 Body and tail vertebral series. Cervical (neck) vertebra normally travel with the skull parts in fish. A whole fish skeleton would produce a graph of exactly equal proportions for % MAU (33% each).

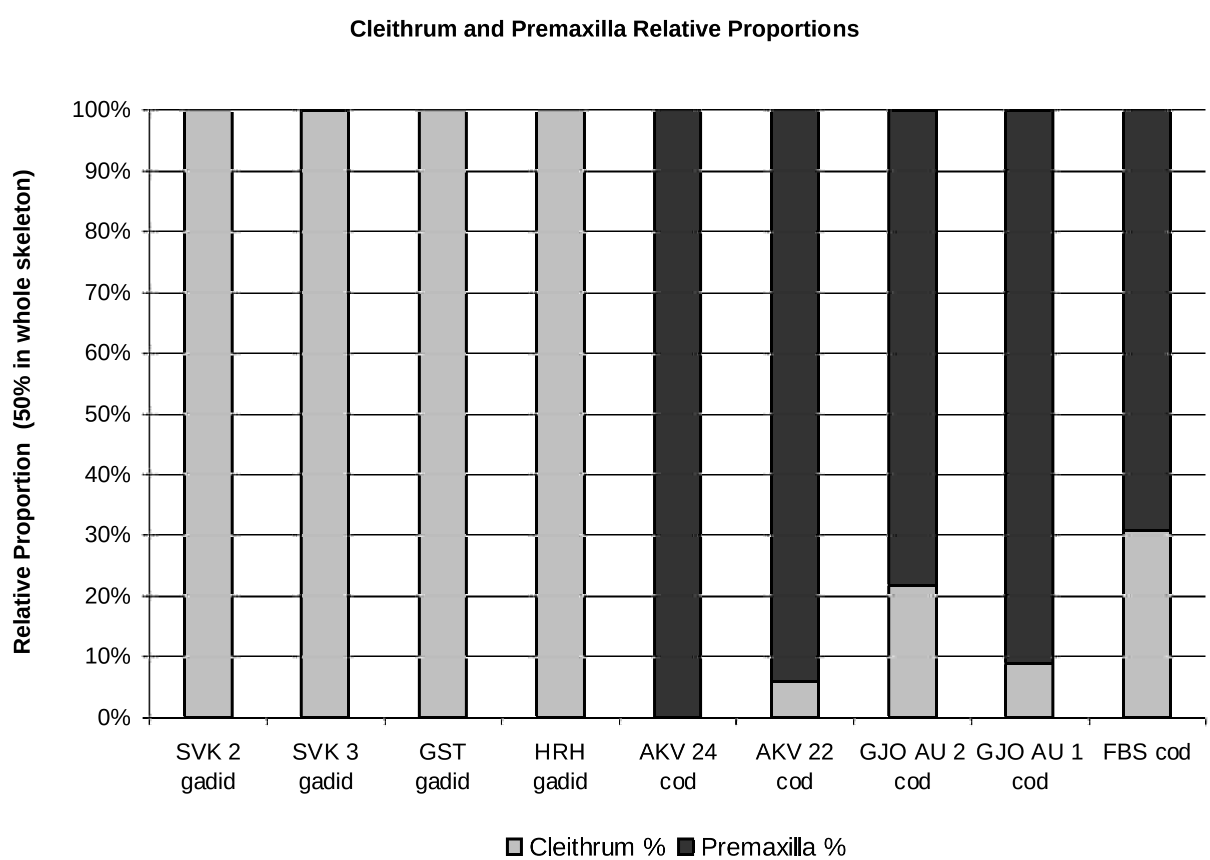
Cleithrum and Premaxilla Relative Proportions
Relative Proportion (50% in whole skeleton)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
SVK 2 gadid
SVK 3 gadid
GST gadid
HRH gadid
AKV 24 cod
AKV 22 cod
GJO AU 2 cod
GJO AU 1 cod
FBS cod
Cleithrum %
Premaxilla %

Figure 5. Comparison of relative proportions of the cleithrum and premaxilla bones recovered. In a whole fish, the relative proportions would be equal (50% each).

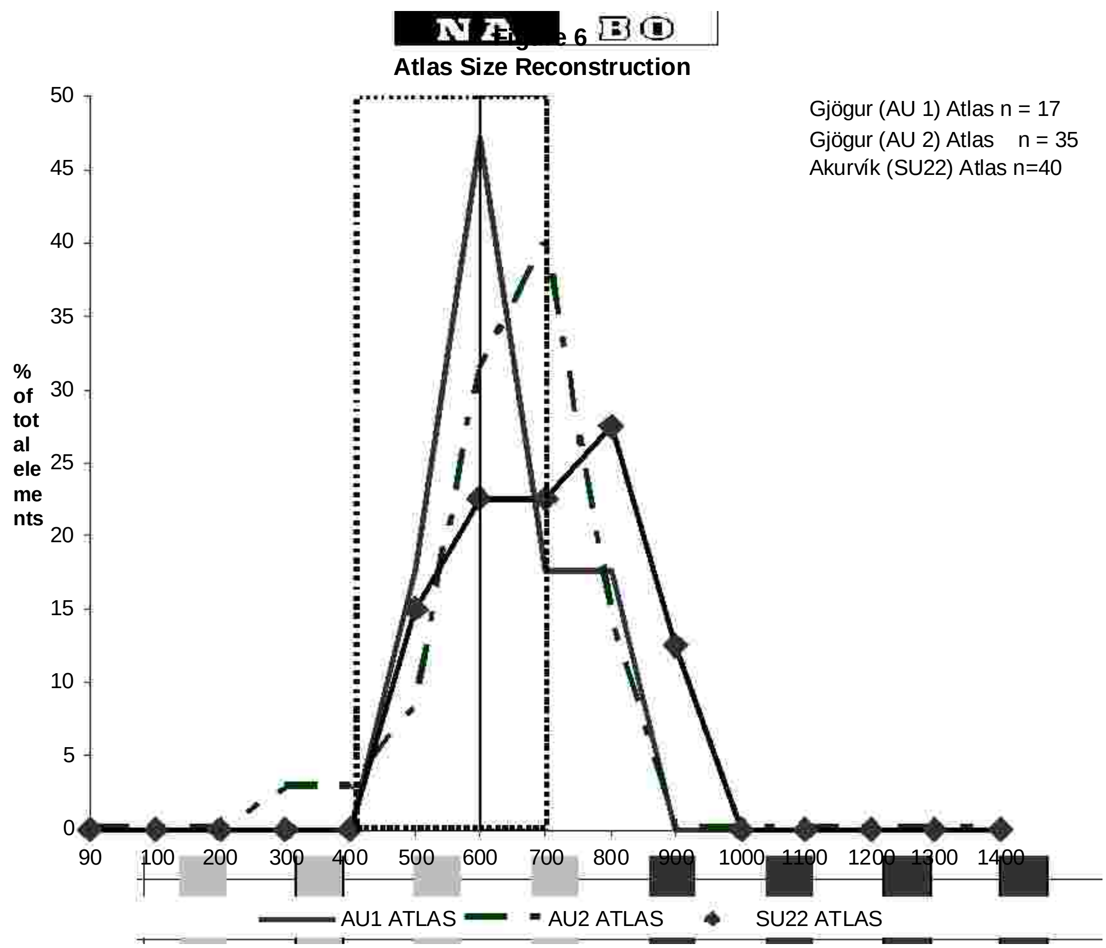

Figure 6 Reconstructed live length of cod fish based on measurement of the atlas vertebrae. The optimal size range for production of stockfish (solid line) and for *'klipfisk'* (dotted line) is indicated for reference.

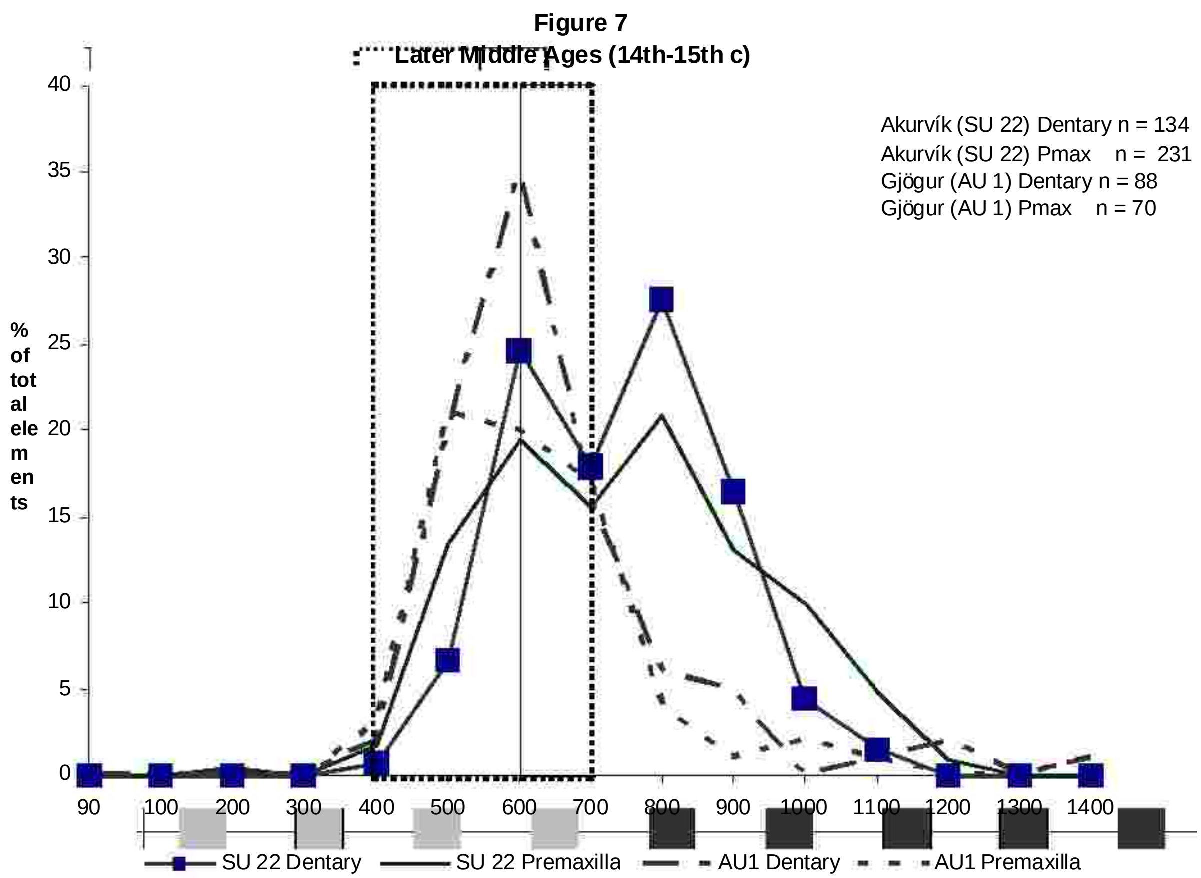

Figure 6, The distribution of cod fish reconstructed live length based on the dentary and premaxilla for both Akurvík and Gjögur late medieval contexts demonstrates clear bimodal distribution, at Akurvík with peaks in both stockfish and *'klipfisk'* "production windows". Note the close tracking of reconstructions based on both elements in both archaeofauna.

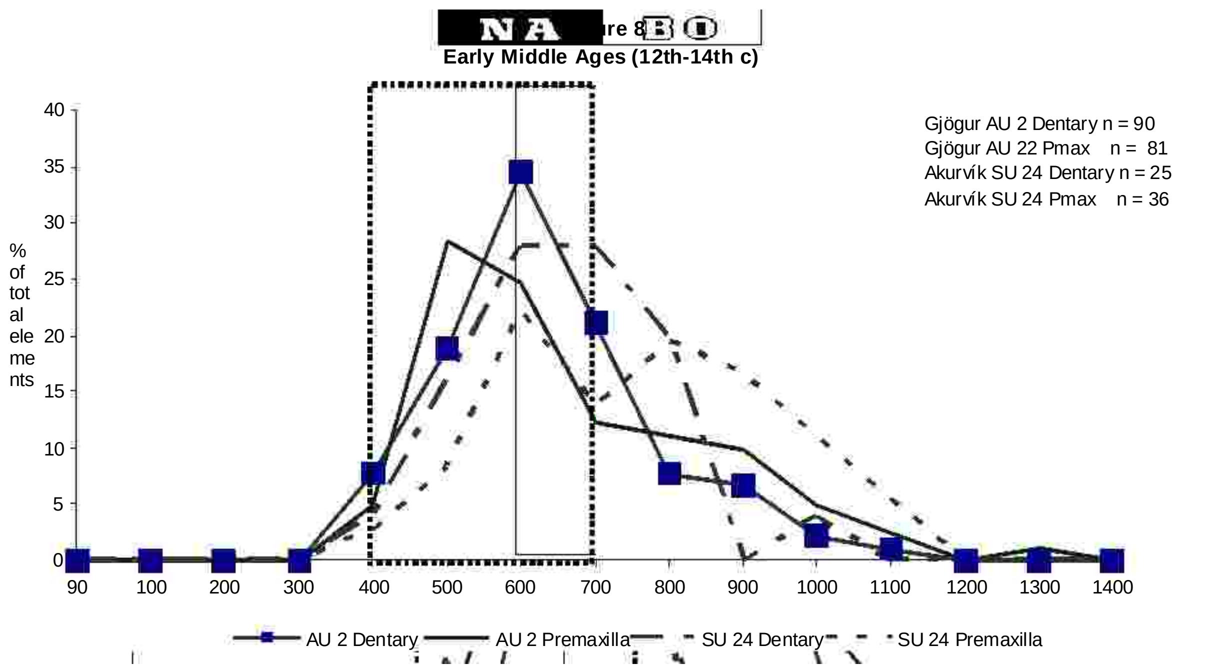

Figure 7, Distribution of reconstructed cod fish live length for the early medieval layers at Gjögur and Akurvík. The early Akurvík distribution is more heavily weighted towards optimal ‘*klipfisk*’ production, while Gjögur is consistently peaking in the ‘*klipfisk*’ window than in the later contexts at the same site.

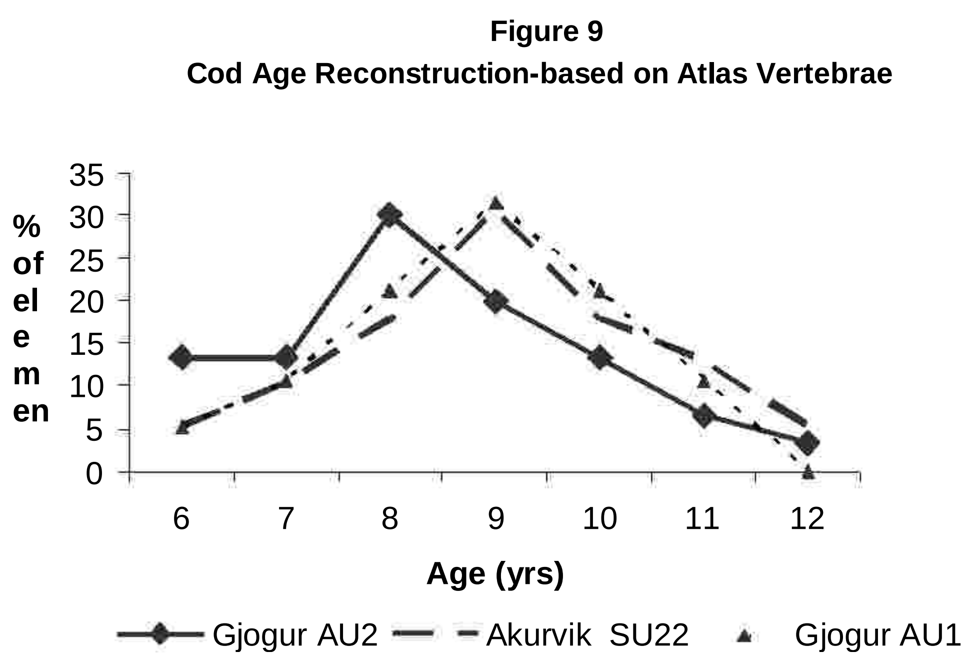

Figure 8, Reconstructed age distribution for landed cod based on atlas vertebrae ring counts.

Table 1
AMS Radiocarbon
Assay Results
Calibration OxCal 3.9 (Bronk-Ramsey 2003),
all samples caprine bone collagen

Context & Laboratory number		Radiocarbon age	delta C13	two sigma calibrated date range (AD)
Gjögur AU 1 Upper midden	GU 9742	525 +/- 55 BP	-21.40%	1300-1400
Gjögur AU 2 Lower midden	GU 9743	750 +/- 55 BP	-20.40%	1160-1390
Akurvík context 22 (upper) Midden	Beta 116969	460 +/- 70 BP	-22.50%	1310-1640
Akurvík context 30/31 (lower) hut floor	Beta 116971	750+/- 40 BP	-16.10%	1210-1380
Akurvík context 24 (lowest) midden	Beta 116970	850+/- 70 BP	-20.60%	1030-1290

Table 2

	Gjögur E. Medieval	***Akurvík E. Medieval***	***Gjögur L. Medieval***	***Akurvík L. Medieval***
	NISP	NISP	NISP	NISP
Domestic Mammals	77	2	96	15
Seals	21	26	51	8
Whale	18	67	30	1,528
Birds	7	82	24	124
Fish	8,611	8,200	7,685	93,349
Shellfish	889	545	1366	4,834
total NISP	9,623	8,922	9,252	99,858
Medium terrestrial mammal	207	4	142	23
Small terrestrial mammal	1		1	4
Large terrestrial mammal	16		17	
Unidentifiable mammal fragment	117	44	206	119
Unidentifiable bone fragment	308	859	43	1,085
Total TNF	10,272	9,829	9,661	101,089

Table 2. Summary of bones from upper and lower context

terrestrial mammal" includes bones of small dog or small caprines. "Medium Terrestrial mammal" includes bones of large dog, caprines, or pigs. Both categories at Akurvík are probably in fact sheep or goat. 'Large Terrestrial mammal' include bones of cow-horse-sized animals. NISP = fragments identifiable to a useful taxonomic le l, TNF= all fragments.

Table 3		***Gjögur E. Medieval***	***Akurvík E. Medieval***	***Gjögur L. Medieval***	***Akurvík L. Medieval***
Scientific Names	***English***	NISP	NISP	NISP	NISP
Gadus morhua L.	Atlantic cod	2320	3,095	2626	4,981
Pollachius virens L.	Saithe	26		38	92
Melanogramus aeglfinus L.	Haddock	23	119	69	528
Molva molva L.	Ling	2	5	10	81
Brosme brosme L.	Torsk			4	7
Gadidae, species indeterminate.	Gadid family	1623	2,030	1807	6,356
Hippoglossus hippoglossus L.	Halibut	11	2	31	19
Scophthalmus rhombus L.	Brill				4
Pleuronectidae sp.	Skate sp	7	4	1	4
Anarchichas lupus L.	Wolfish		45	1	78
Rajidae	Ray sp	7		6	5
Salmonidae	Salmonid family	1		8	1
Fish indeterminate	Fish species	4,592	2,900	4356	81,193
	total fish	8,612	93,349	8957	93,349

Table 3. Fish bones from upper and lower contexts Akurvík and Gjögur. The gadid family elements are all potentially from Atlantic cod.