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Fishing Booths and Fishing Strategies in Medieval Iceland: An Archaeofauna from the [Site] of Akurvík, North-West Iceland

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Abstract

Excavations in 1990 in North-West Iceland documented a stratified series of small turf structures and associated midden deposits at the eroding beach at Akurvík which date from the 11th–13th to the 15th–16th centuries AD. The site reflects a long series of small discontinuous occupations, probably associated with seasonal fishing. The shell sand matrix had allowed excellent organic preservation, and an archaeofauna of more than 100,000 identifiable fragments was recovered. The collections are dominated by fish, mainly Atlantic cod, but substantial amounts of whale bone suggest extensive exploitation of strandings or active whaling. This paper briefly summarizes the excavation results, presents a zooarchaeological analysis of the two largest radiocarbon dated contexts, and places the Akurvík collections in the wider context of intra-Icelandic and interregional trade in preserved fish.

Analysis of the Akurvík collection and comparison with other Icelandic collections from both inland and coastal sites dating from the 9th to 19th centuries AD both reinforces evidence for an early, pre-Hanseatic internal Icelandic fish trade and supports historical documentation of Icelandic participation in the growing international fish trade of the late Middle Ages.

Keywords: Iceland, North Atlantic, fisheries history, zooarchaeology

Introduction

This paper presents a brief overview of archaeological excavations at the site of Akurvík in North-West Iceland and a discussion of the animal bone collections from the two largest contexts from Akurvík dated by AMS radiocarbon assay to the 11th–13th centuries and 15th–16th centuries AD. This paper also seeks to place these collections in the wider context of Icelandic and North Atlantic fisheries zooarchaeology. North-West Iceland (also known as the West Fjords) is an agriculturally marginal region where sea mammal hunting, fowling, fishing, and the exploitation of strandage have traditionally played major roles in the local economy. The region is known from late medieval and early modern documentary sources to have been a center for commercial fishing aimed at overseas markets, and there are some documentary indications of an earlier fish trade aimed at supplying internal Icelandic markets (Edvardsson et al. 2004). While the fish trade of the later Middle Ages in Europe and the North Atlantic is well documented both by contemporary written sources and an increasing number of sophisticated zooarchaeological investigations, the earlier intra-Scandinavian fish trade is only hinted at by written sources which are often not contemporary with the events described. This paper seeks to initiate a wider investigation of the earlier fish exchange system whose roots may lie in later Iron Age Northern Norway (6th–9th centuries AD) and which spread to Iceland during the Viking expansion of the 9th–10th centuries AD. Since the excavation of the Akurvík collection in 1990, a number of other Icelandic archaeofauna have been excavated and analyzed using closely comparable methods from both inland and coastal sites which date from the Viking age settlement of the 9th–10th centuries AD down to the 19th century AD, and comparable data are also available from North Norwegian sites dating back to the first century AD. These sites allow a broader perspective on zooarchaeological "signatures" for large-scale commercial fish production and for the precommercial, intra-Scandinavian patterns of consumption in Iceland.

The Site and Excavation

In the summer of 1990, an international team under the direction of the National Museum of Iceland carried out survey, excavation, and paleoenvironmental research in Árneshreppur, Strandasýsla, North-West Iceland (Fig. 1). Two small-scale excavations were carried out on nearby sites located at the end of the peninsula between Reykjarfjorðr and Norðurfjorður, both producing substantial archaeofauna dominated by fish. One excavation centered on the deeply stratified midden associated with the farm mound at Gjögur, recovering what amounts to a large column sample (Amorosi 1996; T. McGovern et al. conference presentation NABO/SILA 2004). The other excavation sampled an eroding 18-meter-long profile at the coastal site of Akurvík 3 km to the North-East of Gjögur. The Akurvík site had been exposed and badly damaged by marine erosion, and a substantial portion of the site may have been affected by the post-medieval cultivation of potato fields on part of the small embayment. Small turf structures and dense concentrations of fish bones had been observed in 1987 near an active erosion face in the North-West corner of the small bay during a preliminary survey, and small collections of bones had been recovered from the erosion face.

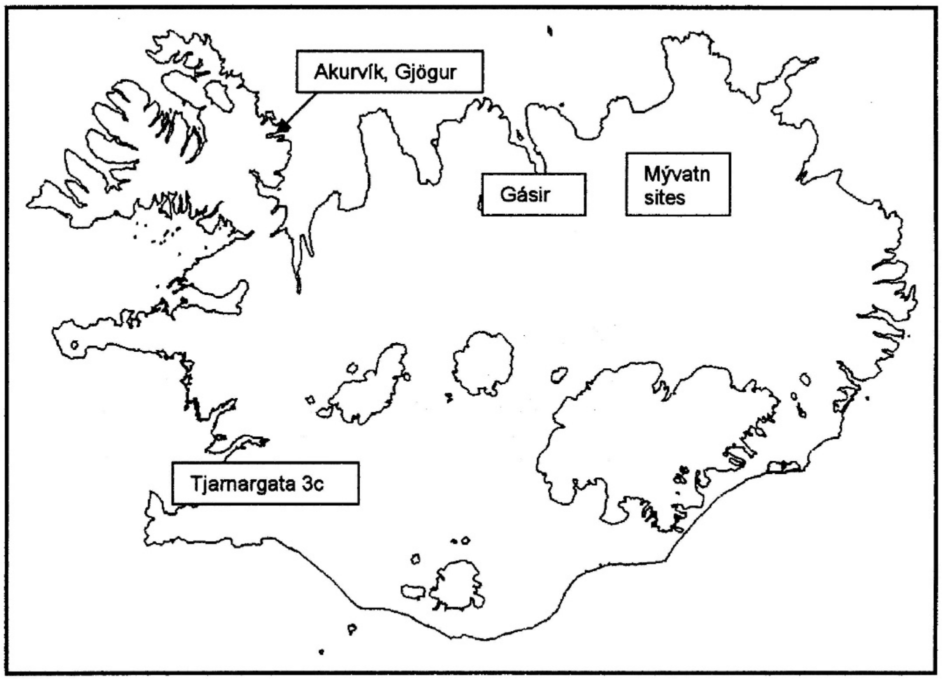

Figure 1. Outline map of Iceland with the coast and major glaciers indicated. The sites mentioned in the text are in the West Fjords (Akurvík and Gjögur), the Late Mývatn area (Hofstaðir, Sveigakot, Hrísheimar, Selhagi, Stein-bogi), Eyjafjord (Gásir), and under modern Reykjavik in the South-West (Tjarnargata 3c).

The objectives of the 1990 investigations were to clarify the nature and date of the deposits at Akurvík, drawing profiles and recovering useful collections of artifacts and animal bones. Despite a shortened season and some challenging weather, large bone collections and a small number of artifacts could be recovered, and a series of small turf structures visible in the eroding profile were documented. Several of these small structures measuring 2m wide × 3–5 m long were visible in a long exposure that had been created by storm wave erosion of the beach deposit, and additional subrectangular depressions probably representing additional structures of the same sort were visible in the undisturbed grassy meadow just to the South-West of the erosion face. The erosion face was also banded by successive layers of medium brown soil horizons separated by thick bands of grey-black shell sand, suggesting periods of natural sand accumulation and phases of temporarily stabilized turf cover. Among these largely noncultural deposits, several horizons of bone and other organic material appeared that were associated with the small structures visible in the profile, or with other structures not intersected by the erosion face. These layers of bone and organic material ranged from 3 to 40 cm in thickness and were full of fist-sized fire-cracked stones as well as substantial amounts of worked whalebone and a few iron objects, mainly boat nails.

When the erosion face was cleared and cut back 30–50 cm, a very large amount of animal bone was collected, especially from the two contexts reported here (stratigraphic units 22 and 24). The 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. The 18-m-long profile allowed excavators to differentiate midden spreads from different phases of occupation, and it was possible to stratigraphically connect contexts 22 and 24 with two structures (F and G) appearing in the profile.

The lower structure (F) was constructed directly upon a preexisting deposit of fish, bird, and mammal bone (context 24), which itself rested on natural preoccupational beach sands. The interior of structure F was filled with a hard-packed set of floor layers composed of fire-cracked stones trampled into a rough pavement mixed with substantial amounts of fish, bird, and mammal bone, turf ash, and small flecks of wood charcoal. These deposits formed a series of at least four successive floor layers (contexts 29–32), each separated by small layers of culturally sterile sand. These structures (F and G) were both small, lightly built, roughly rectangular constructions, made primarily of turf laid directly upon sand partially stabilized by earlier midden deposits. Both included several large fragments of whale bone buried at the base of the exposed corners. These may have provided footings for supports for a light roof, perhaps a tent. The foundations could not have supported a very heavy superstructure given the loose sandy matrix, and a removable roof covering would explain the layers of sterile beach sand separating successive thin floor layers. Following deliberate demolition and final abandonment, structure F was later capped by a thick layer of fish bones and other refuse (context 22) that was generated by the later structure (G) at a stratigraphically higher position (Amorosi and McGovern 1991).

This later structure G appeared to be of the same approximate size and construction as the earlier structure F and employed a complete right whale (*Eubalaena glacialis* L.) vertebra as a corner support. AMS radiocarbon dates on terrestrial mammal bone at one sigma indicate an occupation in the 12th–13th century for structure F (Table 1: context 30/31), an 11th–13th century deposition of midden context 24 (Table 1: context 24), and a 15th to early 16th century date for structure G and its associated midden context 22. In this paper we follow established tradition in Icelandic archaeology by using the one-sigma limits to the AMS radiocarbon assays as our primary guides for chronological reconstruction. For review and discussion of current issues in Icelandic radiocarbon dating see Sveinbjornsdóttir et al. (2004). Note that while context 24 is the stratigraphically lowest cultural layer in the area of the site investigated, this need not be the earliest occupation of the site as a whole, as earlier occupations may have been removed by marine erosion, or simply not have appeared in the erosion face profile investigated in 1990. In this paper, we compare the "early medieval" (11th–13th century AD) context 24 with the "late medieval" (15th–early 16th century AD) context 22.

Table 1. AMS radiocarbon assay results from Akurvík, based on terrestrial mammal bone (sheep or goat)

Context	22	30/31	24
Stratigraphic position	over structure G	floor of structure G	midden below structure G
Sample number	Beta 116969	Beta 116971	Beta 116970
Delta C13	–22.50%	–16.10%	–20.60%
C14 age	460 ± 70 BP	750 ± 40 BP	850 ± 70 BP
Calibrated Age Ranges: 68.2% probability	1400–1520 AD (63.4%) 1600–1620 AD (4.8%)	1244–1292 AD (68.2%)	1060–1090 AD (9.6%) 1120–1140 AD (6.2%) 1150–1270 AD (52.5%)
Calibrated Age Ranges: 95.4% probability	1310–1360 AD (5.7%) 1380–1640 (89.7%)	1210–1310 (93.9%) 1370–1380 AD (1.5%)	1030–1290 AD (95.4%)

The small turf structures are definitely not buildings indicative of a normal Icelandic farm, and most closely resemble in size and shape the many "fishing booths" still visible in localities around Iceland, though these were smaller and less solidly built than more recent structures (Edvardsson 1996; 2002; 2003). Most of these booth structures date to the 16th–19th centuries and are associated with the documented period of full-scale seasonal commercial fishing (R. Edvardsson conference presentation NABO/SILA 2004). Many fishing booth sites are on highly acidic volcanic sands that provide little organic preservation, but Akurvík is in a shell sand matrix with a neutral to slightly basic pH (6.9–7.5) allowing for excellent bone preservation.

Akurvík is in a fairly typical location for known fishing booths: at the tip of a long peninsula with limited pasturage around the site area but immediate access to deep-water fishing. The small buildings, constructed with light roofing and low turf walls (despite immediately available building stone on the nearby shingle beach) suggest a series of short-term, specialized, and probably seasonal occupations punctuated by periods of abandonment. No glass, ceramic, or kaolin tobacco pipe fragments were recovered. These are all common finds on sites dating after ca. AD 1650 in Iceland and were recovered in quantity from a disturbed 18th–early 20th century midden at the neighboring farm site of Reykjarnes 3.5 km to the North-West of Akurvík and the 18th century contexts at Finnbogastaðir farther to the north (Edvardsson et al. 2004). The entry to the small bay at Akurvík is now effectively closed by eustatic uplift, and even small inflatable craft do not normally land at the beach today. No mention is made of an active or recently abandoned site in the area in the comprehensive *Jarðabók* land survey of AD 1703–12, which usually included historical folk memory extending back into the mid 17th century (Vésteinsson and Simpson 2004).

As multiple horizons of apparently noncultural brown soil interband with the cultural deposits and layers of what appear to be stabilized grass surfaces in the long erosion face profile, it would appear that the beach area underwent multiple periods of sand drifting, human occupation, and turf formation; quite possibly at the same time in different parts of the small bay. It would thus appear that the booth structures at Akurvík were probably established by the 11th–13th centuries (and perhaps earlier) and saw regular but small-scale and probably seasonal occupation punctuated by periods of abandonment before becoming finally abandoned in the later Middle Ages, probably well before AD 1600. The Akurvík archaeofauna thus derives from what appears on archaeological criteria to be a specialized medieval seasonal fishing station sporadically in use from at least early medieval times down to the late Middle Ages and not a permanently occupied farm such as the site of Gjögur nearby.

Laboratory Methods

Analysis of the Akurvík 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 two layers, SU 22 and SU 24, used for the purposes of this paper, represent directly comparable types of deposit, true midden, not structural floors, or a mix of floor and midden deposit. These two contexts were fully analyzed and represent 90% of the total archaeofauna recovered from the site. All fragments were identified as far as taxonomically possible, and a selected element approach was not employed. The identifications of gadids follows the ICAZ Fish Remains Working Group recommendations (see Perdikaris et al. 2004a; Cannon 1987; 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 and Jones (1989). Digital records of all data collected were made 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.

Zooarchaeology: Presence and Abundance of Species

This report thus focuses upon the two major dated contexts at Akurvík and does not attempt to present the complete archaeofauna (which exceeds 150,000 NISP) in full detail. Table 2 presents an overview of the taxa identified and the NISP count for these two major contexts (11th–13th century context 24 and 15th–16th century late medieval context 22), which reflect early and late medieval patterns, respectively. While domestic mammals, sea mammals (especially whales), birds, and molluscs are present, both contexts are dominated by cod-family fish (gadids).

Table 2. Summary of bones from contexts 22 and 24 at Akurvík

	Context 24 NISP	Context 22 NISP	Context 24 %NISP	Context 22 %NISP
Domestic mammals	2	15	0.02	0.02
Seals	26	8	0.29	0.01
Whale	67	1,528	0.75	1.53
Birds	82	124	0.92	0.12
Fish	8,200	93,349	91.91	93.48
Shellfish	545	4,834	6.11	4.84
Total NISP	8,922	99,858		
Medium terrestrial mammal	4	23		
Small terrestrial mammal		4		
Unidentifiable mammal fragment	44	119		
Unidentifiable bone fragment	859	1,085		
Total number of fragments	9,829	101,089		

Notes: "Small terrestrial mammal" includes bones of small dog or small caprines. "Medium terrestrial mammal" includes bones of large dog, caprines, or pigs. NISP = fragments identifiable to a useful taxonomic level; TNF = all fragments.

Mammals

Table 3 presents the count of identified (NISP) mammal fragments, illustrating the very limited number and range of mammals present at Akurvík. Due to small sample size, it is unclear if the caprine bones represent entire animals brought to the site and slaughtered there or cuts of meat provided as fresh or preserved provisions. One caprine distal metatarsus came from a young neonatal lamb, suggesting either early spring occupation, since virtually all Icelandic lambs are born in early May, or equally likely preserved meat. Harbor (Common) seal (*Phoca vitulina* L.) colonies are present all along the coast, and both young and adults were regularly taken down to early modern times by clubbing and netting (Edvardsson et al. 2004; J. Woollett conference presentation NABO/SILA 2004). At farm sites such as Svalbarð in North-East Iceland, bones of harbor seal pups far out number adults, indicating a systematic predation upon pupping grounds in spring and an opportunistic encounter hunt of adults during other seasons (J. Woollett seminar presentation NABO 2004). Perhaps significantly, all the seal bones from Akurvík are from adults, suggesting netting or encounter hunting outside the spring pupping season. During initial site clearing, bones of the ice-riding harp seal (*Pagophilus groenlandicus* Erchleben) were found in the collapsed erosion face, but these cannot be tied to a stratigraphic context. Sealing does seem to have taken place from the site, but it appears to have been a minor activity compared to fishing.

Table 3. Mammal bones from contexts 22 and 24 at Akurvík

Scientific name	English common name	Context 24 NISP	Context 22 NISP
Ovis aries L.	Sheep	1	4
Capra hircus L. or *Ovis aries* L.	Sheep or goat (caprine)	1	11
Phoca vitulina L.	Harbor or common seal	0	4
Phocid sp.	Seal species indeterminate	26	4
Cetacea sp.	Whale species indeterminate	67	1,528

The large numbers of whale bone fragments recovered at Akurvík present a more difficult interpretive problem. It is possible to bring home tons of boneless whale meat, but alternatively it is possible to transport meatless whale bone for construction material or craft work from stranded carcasses (Enghoff 2003). The district is historically known for whale strandings, and these were probably more common before the impact of early modern whalers. It is also possible that active whaling was pursued from Akurvík at some point in the occupation, though this cannot be conclusively proved from current evidence. The large number of whale fragments recovered range in size from small chips produced by craft work to the complete great whale vertebra used as a corner support for structure F. Whalebone was extensively used in reinforcing the foundations of the small turf huts, and also seems to have been used as one element in the rough pavement of their floor layers. Craft debris and partially completed whalebone artifacts also make up a large proportion of the finds, including the remains of the production of a whalebone disk, perhaps destined to become a gaming piece, from context 31. It is unclear whether the occupants of the booths at Akurvík actively hunted great whales or not. They certainly made extensive use of their bones, possibly engaging in whalebone craft activities during periods of bad weather.

Birds

Table 4 presents the count of bird bones identified from Akurvík. Bird bones make up a small portion of the archaeofauna, and the species represented are all associated with local shoreline communities today, while the duck bone closely matches an eider in size and shape but is too damaged for secure identification. The substantial percentage of sea gulls (nearly 70%) is unusual on Icelandic sites, which tend to be dominated by the more palatable auks (puffins, guillemots, and razorbill). It is tempting to see the gulls as casualties of human defense of fish drying:racks since gulls are regularly entangled in the old nets used to protect modern fish racks, or as bycatch casualties, but they may also have been eaten. It is probable that gulls would congregate around medieval fish-processing stations, and some species may represent natural sea bird mortality and not the result of human hunting (Furness 2003; Garthe et al. 1996; Hudson and Furness 1989; Osterblom et al. 2002; Garthe and Scherp 2003; Tasker et al. 2000). Fowling clearly was not a major activity at Akurvík in any case.

Table 4. Bird bones from contexts 22 and 24 at Akurvík

Scientific Name	English	Context 24 NISP	Context 22 NISP
Anatidae sp.	Duck species indeterminate		1
Charadrius hiaticula L.	Ringed plover	2	
Phalacrocorax carbo L.	Cormorant		1
Sula bassana L.	Gannet		1
Larus marinus L.	Greater black-backed gull	2	
Larus sp.	Gull species indeterminate	9	18
Alcidae sp.	Auk species indeterminate		1
Alca torda L.	Razorbill		1
Uria sp.	Murre or guillemot	6	4
Aves sp.	Bird species indeterminate	63	97
Total Aves		80	121

Molluscs

Table 5 presents the molluscan remains recovered from the two contexts. These were primarily fragmented clam and mussel shells, and the substantial numbers of small fragments not identified securely are in fact probably also mussel fragments. While it is never entirely safe to assume wholly human agency in the deposition of marine shellfish along an active beachfront, it seems likely that many of these invertebrates were collected purposively and used as food and bait (Claassen 1998).

Table 5. Shellfish remains from contexts 22 and 24 at Akurvík

Scientific Name	English	Context 24 NISP	Context 22 NISP
Mytilus edulis L.	Mussel	500	1,835
Mya sp.	Clam species indeterminate	5	504
Mollusca sp.	Shellfish species indeterminate	40	2,495
Total Mollusca		545	4,834

Fish

Fishing was certainly a major activity at Akurvík, and fish bones make up over 90% of the Akurvík archaeofauna in both early medieval and late medieval contexts. Table 6 presents the fish bone assemblage. A limited number of flatfish species, wolf fish, and a single salmonid bone are present 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 great majority of the gadid fish are Atlantic cod, with haddock a distant second.

Table 6. Fish bones from contexts 22 and 24 at Akurvík

Scientific Name	English	Context 24 NISP	Context 22 NISP
Gadus morhua L.	Atlantic cod	3,095	4,981
Pollachius virens L.	Saithe	0	92
Melanogramus aeglfinus L.	Haddock	119	528
Molva molva L.	Ling	5	81
Brosme brosme L.	Torsk	0	7
Gadidae, species indeterminate	Gadid family	2,030	6,356
Hippoglossus hippoglossus L.	Halibut	2	19
Scophthalmus rhombus L.	Brill	0	4
Pleuronectidae sp.	Skate sp.	4	4
Anarchichas lupus L.	Wolfish	45	78
Arajidae	Ray species indeterminate	0	5
Salmonidae	Salmonid family	0	1
Fish, species and family indeterminate	Fish species	2,900	81,193
Total fish		8,200	93,349

Akurvík and Fish Trading

There has been a long and productive international effort to identify early commercial fishing in the North Atlantic (Amundsen 2003; in press; Amundsen et al. 2003; Amorosi et al. 1996; Barrett 1995; Barrett et al. 1997; 1999; 2000; 2001; Bigelow 1984; 1985; Cérron-Carrasco 1994; Perdikaris and McGovern in press; Dockrill et al. 2001; Hendriksen et al. conference presentation NABO/SILA 2004; Jones 1991; Perdikaris 1996; 1998; 1999; Perdikaris et al. 2004b; J. Mulville conference presentation NABO/SILA 2004; Nicholson 1998; R. Nicholson conference presentation NABO/SILA 2004; Rackham et al. 1996; Simpson et al. 2000). A number of zooarchaeological indicators of potential involvement in local and regional fish trade have been proposed, including high fish NISP in collections, changing species diversity, body part representation, butchery strategy, and reconstructed live length. Since the Akurvík archaeofauna derives from two phases of occupation of what appears to be a specialized seasonal fishing camp, it maybe useful to make use of some of these proposed indicators and to place the Akurvík collection in a broader comparative context. Like many other North Atlantic "fish middens," the Akurvík collections are totally dominated by fish bones, without evidence for associated farming activity. However, the same could be said for other coastal sites of many periods back to the Mesolithic. Changes in species diversity may provide a more useful indicator, and Figure 2 compares fish species diversity at a series of sites of different periods in North Norway and Iceland.

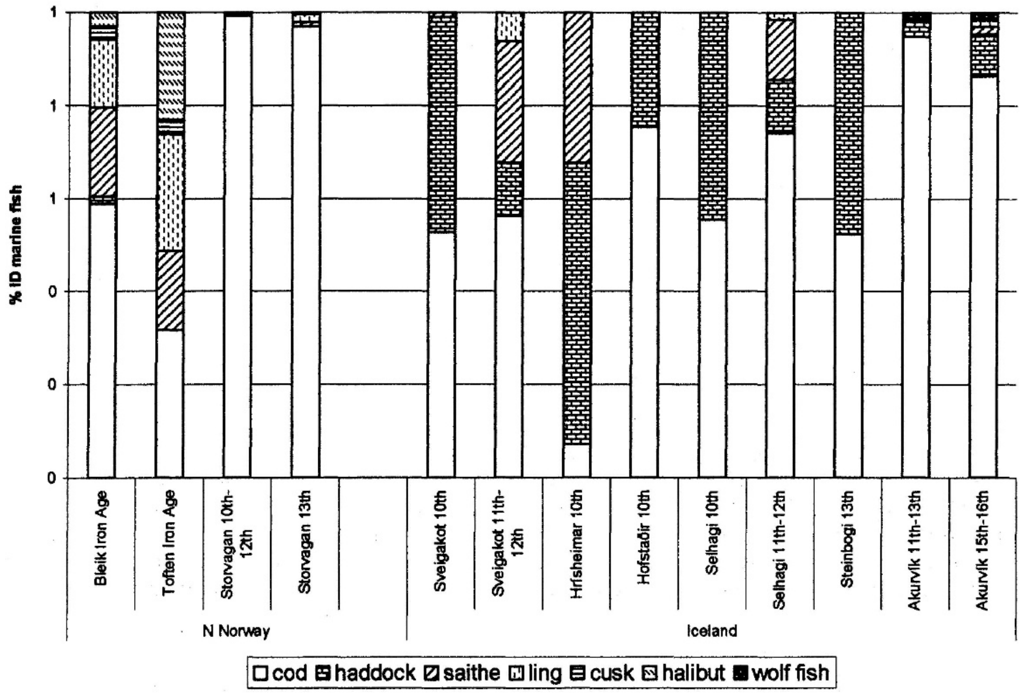

Figure 2. A comparison of fish species diversity between precommercial and potentially commercial periods in Northern Norway and Iceland.

The two Iron Age North Norwegian sites of Bleik (1st–5th centuries AD) and Toften (5th–7th centuries AD) are dominated by fish bones but show a fairly high diversity in the gadids and flatfish landed. The 12th- and 13th-century contexts from the nearby Storvågan site, historically associated with early commercial fishery and royal control, reflect a dramatic reduction in species diversity, focusing nearly entirely upon cod even though fishing the same waters as the Iron Age population. (Perdikaris 1999; Amundsen 2003; Amundsen et al. 2003). In Iceland, a series of archaeofauna are available from inland sites in the Mývatn district (50–60 km from the coast) including 10th century collections from Sveigakot, Hrísheimar, Hofstaðir, and Selhagi and 11th–13th century collections from Sveigakot, Selhagi, and Steinbogi (Perdikaris et al. 2004b; Vesteinsson et al. 2002). These inland sites also contain small numbers of seal, porpoise, sea bird, and sea bird eggs, demonstrating a strong coastal connection dating to first settlement. These 9th–13th century inland "consumer sites" show a considerable variety of gadids (mainly cod, haddock, and saithe) and a few flatfish. By contrast, the 11th–16th century contexts at Akurvík demonstrate a strong concentration upon cod, similar to the pattern of the early commercial Storvågan collections. The scale of the economic concentration upon cod observed at Akurvík is characteristic of medieval commercial fisheries in Norway (Perdikaris 1999) and in commercial fisheries in early modern Iceland (Amundsen in press; Edvardsson et al. 2004; McGovern et al. 2001). This specialization and associated reduction in species diversity in the landed catch was part of the process of high medieval (12th–14th century) commoditization, which transformed the natural diversity of subsistence catch seen in Norwegian Iron Age and Viking Age Icelandic archaeofauna into a focused effort to land the species most salable on the international market. In the environmental historian William Cronon's terms, the transformation of a naturally variable animal in the sea into a regularized, graded, abstract token that could be exchanged, credited, and borrowed against in counting houses far distant from windswept beaches represents a transformation from first to second nature, a mobilization of "natural capital" for the many royal and ecclesiastical projects of the 12th–16th century (Cronon 1991). Bythe high Middle Ages, preserved, mainly air-dried, cod products had become fully standardized into multiple grades and price ranges and had become vital sources of protein for a wide range of Europeans as well as a vital source of credit and cash for northern monarchies and urban merchants (Gade 1951; Nielssen 1994; Nielssen and Christensen 1996). Was Akurvík part of this international network? Did it contribute to the older intra-Icelandic trade in fish documented by the Mývatn Viking Age collections?

Specialized fish butchery and the differential distribution of body parts provide zooarchaeological signatures that have proven useful as means to track commercial production. In most of the North Atlantic, large gadid heads consisting of mouth parts and crania tend to be cut off and left at coastal processing points. Depending on the preserving method (salting, flat drying, round air-dried "stockfish"), a variable amount of the vertebral column is commonly either left at the processing site (especially thoracic and precaudal vertebrae in flat-dried methods—for a diagram showing vertebral boundaries see Cannon 1987) or travels with the caudal vertebrae to the consumer. Virtually all gadid preparation methods tend to leave the large, crescent-shaped cleithrum (near the gill slits) in the finished product, as these elements keep the headless body from falling apart and when spread act to speed drying of the body cavity. Cleithra thus tend to travel with the finished product. The cleithrum is generally a robust element, readily recovered, and generally identifiable to species level, so their relative abundance in different contexts may help identify different production and consumption strategies. Table 7 presents the cleithrum % NISP for North Norwegian sites, including the Iron Age sites of Bleik and Toften, and 13th-century contexts from Storvågan as well as coastal Icelandic sites (Akurvík, Gjögur, Tjarnargata 3c) and the inland VikingAge Mývatn sites of Sveigakot, Hofstaðir, and Hrísheimar and the 14th-century trading site of Gásir on the shores of Eyjafjordur near modern Akureyri (Harrison et al. 2004; Vésteinsson et al. 2002; Perdikaris et al. 2004b; Perdikaris 1999, 1998). While the coastal sites show low NISP % of cod cleithra (zero to around four percent), the inland sites demonstrate concentrations of gadid cleithra (approximately ten to forty percent). The coastal trading site of Gásir thus far provides the largest relative percentage of cod cleithra, supporting other evidence for well-organized provisioning of this commercial site (Harrison et al. 2004). The relative abundance of cleithra thus seems to flag consumer sites of different periods in Iceland, both inland and coastal. While tracking the distribution of cleithra seems an informative strategy, there are clear dangers (taphonomy, recovery, and sampling problems) in focusing too closely upon the distribution of single elements.

Table 7. Comparison of the cleithrum % of NISP for selected sites from both coastal and inland locations in Northern Norway and Iceland

Site	Date	Location	Species	NISP for taxon	Cleithrum NISP	Cleithrum % NISP
Bleik	1st–5th C AD	coastal North Norway	cod	3,858	54	1.40
Toften	5th–7th C AD	coastal North Norway	cod	810	9	1.11
Storvågan	10th–11th C AD	coastal North Norway	cod	2,068	90	4.35
Storvågan	13th C AD	coastal North Norway	cod	331	1	0.69
Akurvík	11th–13th C AD	coastal North-West Iceland	cod	3,091	0	0.00
Akurvík	15th–16th C AD	coastal North-West Iceland	cod	4,780	16	0.33
Gjögur	15th C AD	coastal North-West Iceland	cod	1,007	6	0.60
Tjarnargata	c. 18th–19th C AD	coastal North-West Iceland	cod	18,742	152	0.81
Gásir	14th C AD	shore of Eyjafjord Iceland	cod	23	13	56.52
Hofstaðir	10th C AD	inland Iceland Mývatn	all gadid	407	65	15.97
Sveigakot	10th C AD	inland Iceland Mývatn	all gadid	162	18	11.11
Sveigakot	11th C AD	inland Iceland Mývatn	all gadid	454	114	25.11
Hrísheimar	10th C AD	inland Iceland Mývatn	all gadid	57	21	36.84
Selhagi	10th C AD	inland Iceland Mývatn	all gadid	15	5	33.33
Selhagi	11th–12th C AD	inland Iceland Mývatn	all gadid	137	65	47.45
Steinbogi	13th C AD	inland Iceland Mývatn	all gadid	24	15	62.50

Figure 3 makes use of the Icelandic archaeofauna to present a more generalized picture of gadid body part distribution, combining elements into "head and jaws" (cranium and mouth parts), "pectoral girdle" (cleithrum and bones nearby), and thoracic, precaudal, and caudal vertebrae presented as % MAU (to normalize for different natural skeletal frequency of elements, see Grayson 1984). This lumped element distribution chart is intended to broadly separate cranial elements normally discarded during primary processing from those that often travel with the axial skeleton. The inland sites (Viking age to high Medieval) show the high concentrations of pectoral girdle elements (including cleithra) suggested by Table 7. They lack the substantial numbers of thoracic and precaudal vertebrae which should be present on these consumer sites if the product they were receiving was stockfish/skreið (shipped with most of the axial skeleton inside). See Table 8 for the NISP data for these sites.

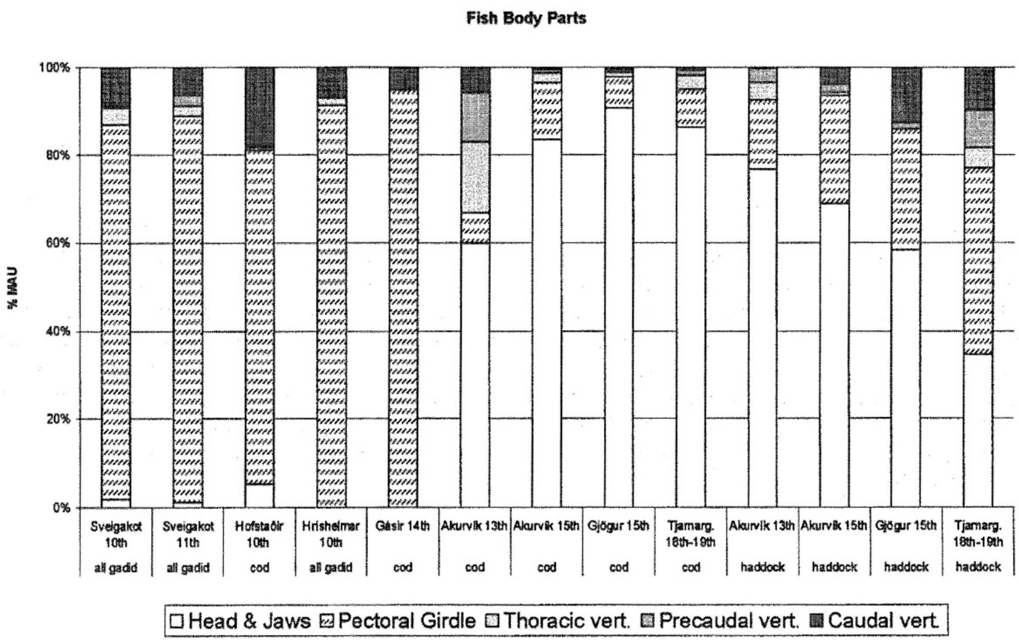

Figure 3. A comparison of the distribution of grouped fish skeletal elements for the larger 9th–11th century inland Mývatn area archaeofauna (Sveigakot, Hofstaðir, Hrísheimar), a 13th century Mývatn area archaeofauna from Steinbogi, the 14th century trading site of Gásir, the 18th–19th century deposits at Tjarnargata 3c under modern Reykjavik, and the two sites of Akurvík and Gjögur in the West Fjords using % MAU (NISP/natural element frequency in the skeleton). NISP is provided in Table 8.

Since caudal vertebrae are smaller and inherently harder to recover than the larger thoracic and precaudal vertebrae, this pattern is probably not an artifact of recovery bias (all sites used for comparative purposes have been sieved to the same standard). The later medieval and early modern (15th–19th century) possible fish producer sites create a very different cod element distribution pattern from the inland consumer sites, with a predominance of head and mouth parts, relatively few pelvic girdle elements, and few vertebrae. The few cod elements that are in fact from the pelvic girdle or the vertebral column area appear to come from smaller cod. This pattern is consistent with the production of stockfish or a similar round-dried product containing most of the pectoral girdle and the vertebral column, and the local consumption of smaller unsaleable fish as a fresh product.

A clear exception to the pattern formed by the 15th–19th century collections is the distribution of cod elements in the early medieval 11th–13th century contexts of Akurvík. In this case there are many thoracic and precaudal vertebrae (most of larger cod) present in the collection along with the head and jaws (Table 8). This suggests a different strategy for fish butchery and preservation, and indicates that at least some of the cod were probably being flat dried, with the upper portion of the vertebral series being cut away and discarded at the production site. The early medieval pattern of cod butchery at Akurvík is

Table 8. Presentation of the major fish NISP data by taxon and element for the unpublished Icelandic sites mentioned in the text. For Finnbogastaoir see Edvardsson et al. (2004), for Miobaer see Amundsen (2004), for all North Norwegian sites see Perdikaris (1989).

Site	Akurvík	Akurvík	Akurvík	Akurvík	Gjögur	Gjögur	Gásir	Tjarnargata 3c	Tjarnargata 3c	Hofstaðir	Hofstaðir	Sveigakot	Sveigakot	Hrísheimar	Steinbogi	Selhagi	Selhagi
Location	Westfjords	Westfjords	Westfjords	Westfjords	Westfjords	Westfjords	Eyjafjord	Reykjavík	Reykjavík	Mývatn	Mývatn	Mývatn	Mývatn	Mývatn	Mývatn	Mývatn	Mývatn
Coastal or inland	coastal	coastal	coastal	coastal	coastal	coastal	coastal	coastal	coastal	inland	inland	inland	inland	inland	inland	inland	inland
Date (cent. AD)	11th-13th	11th-13th	15th-16th	15th-16th	14th-15th	14th-15th	14th c	18th-19th	18th-19th	10th c	10th c	10th	10th	10th	13th	10th	10th
Species	cod	haddock	cod	haddock	cod	haddock	cod	cod	haddock	cod	haddock	all gadid	all gadid	all gadid	all gadid	all gadid	all gadid
Element																	
Ethmoid																	
Prefrontal	5		1	1	36			637	9								
Vomer	46	1	15	6	58			394	7								
Mesethmoid	13	2	87	4	12			65	5	1							
Alisphenoid					1												
Parasphenoid	2		101		33			715	26	1							
Orbitosphenoid																	
Supraoccipital	1		3					10			2						
Exoccipital	1		7					145	3								
Basioccipital	9		67	1	24			291	1								
Sphenotic			86	2	25			250	10								
Pterotic	13	14	111	36	17	2		410	31		4						
Epiotic			9	1				48									
Opisthotic	1		10					117	2								
Prootic	1		1		3			109	1		1						
Otolith	24		81	4				1									
Nasal			27					71									
Frontal			11		10			198	1								
Parietal																	
Supratemporal																	
Premaxilla	77	17	248	22	77			829	5								
Maxilla	13	2	171	6	40			709	27								
Supraorbital																	
Lachrymal		1	44	10	3			178	10								
Suborbital				2				24									
Dentary	87	3	221	7	78	1		972	33								
Angular	17	1	162	4	47			1043	44				1				
Retroarticular	66		116		8												
Suprapreopercle																	
Preopercle	11		75	5	9			109	1								
Supramaxilla																	
Opercle	18	2	141	13	31			897	44								
Subopercle	12	1	42		12			433	20								
Interopercle	2	3	64	6	15			377	15								
Branchiostegal Ray			100	12	11	1		304	50	3	2	1	3				
Palatine	12		122	2	33			303	10								
Ectopterygoid			58		11			309	1								
Quadrate	31	6	178		41			570	1				1				
Mesopterygoid			6		1			65	5								
Metapterygoid			25		4			5									

Continued next page

Table 8 continued

Site	Akurvík	Akurvík	Akurvík	Akurvík	Gjögur	Gjögur	Gásir	Tjarnargata 3c	Tjarnargata 3c	Hofstaðir	Hofstaðir	Sveigakot	Sveigakot	Hrisheimar	Steinbogi	Selhagi	Selhagi
Location	Westfjords	Westfjords	Westfjords	Westfjords	Westfjords	Westfjords	Eyjafjord	Reykjavik	Reykjavik	Mývatn	Mývatn	Mývatn	Mývatn	Mývatn	Mývatn	Mývatn	Mývatn
Coastal or inland	coastal	coastal	coastal	coastal	coastal	coastal	coastal	coastal	coastal	inland	inland	inland	inland	inland	inland	inland	inland
Date (cent. AD)	11th-13th	11th-13th	15th-16th	15th-16th	14th-15th	14th-15th	14th c	18th-19th	18th-19th	10th c	10th c	10th	10th	10th	13th	10th	10th
Species	cod	haddock	cod	haddock	cod	haddock	cod	cod	haddock	cod	haddock	all gadid	all gadid	all gadid	all gadid	all gadid	all gadid
Element																	
Hyomandibular	28	1	85	19	22			490	18								
Symplectic	4		92	1	11	1		297									
Interhyal			90	7	3			66	2								
Epihyal	30	2	109	10	27			276	21								
Ceratohyal				7	35			586	43			1					
Hypohyal	38		77		9			7									
Basihyal																	
Pharyngeal Plate	6	5	181	10	9			17									
Epibranchial																	
Ceratobranchial			77														
Hyporanchial			24														
Basibranchial	1		21														
Basibranchial Plate																	
Urohyal	2	1	65	4	4				3								
Pharyngobranchial	14		98	8													
Posttemporal	30	7	275	28	34			645	49	1							
Supracleithrum	42	4	237	18	29	1		459	21			1				2	1
Scapula	1		12	1				1		41	1	20	44	4	1	1	7
Cleithrum		3	16	22	6	1	13	152	480	21	44	18	114	21	15	5	65
Postcleithrum	1		8	10	1			145	16	1	18	16	30	2			4
Coracoid										3							
Mesocoracoid																	
Radials																	
Basipterygium			12							2	1	2	1				
Interrhaemal Spine																	12
Vertebral Frags			15	2				85	7	4		17	7		1	2	2
Atlas	28		60	3	23			354	22			1					
Thoracic	350	7	174	4	22			1024	128	1		5	10	1			
Precaudal	1152	25	299	55	56	1		1615	1074	2		3	50				
Caudal	902	5	363	175	76	13	10	1926	1849	224	29	77	193	29	7	5	46
Penultimate		6															
Ultimate								9									
Hypural																	
Uroneural																	
Epural																	
Caudal Bony Plate																	
Expanded Neural Spine																	
Expanded Haemal Spine																	

precisely complimentary to the pattern of element distribution found on the Icelandic Viking Age and early medieval archaeofauna (which lack the concentrations of thoracic and precaudal vertebrae to be expected if they were exclusively consuming round-dried stockfish or a similar product).

While the 15th–19th century cod element distributions suggest production of a standardized "Hanseatic" stockfish, the 11th–13th century Akurvík cod element distribution suggests a very different finished product was being created from the cod landed. The haddock element distributions from the same set of putative producer sites also suggest either a radically different preserved fish product was being produced from this species, or that whole haddock were being consumed on site (or both). In the 19th–20th century haddock and small cod were the normal food of Icelandic fish consumers, with larger cod being reserved for export (Icelandic consumers still tend to prefer haddock to cod today). Table 8 presents all the identified elements from cod and haddock for the unpublished sites used here. For comparable data on North Norwegian sites see Perdikaris (1999) and for Akurvík see Amundsen (2004).

Thanks to the work of Wheeler and Jones (1989) live size reconstruction based on multiple bone elements is now commonplace in fisheries zooarchaeology. Figure 4 applies Wheeler and Jones (1989) cod live length reconstruction formulae to dentary and premaxillary bones from the 11th–13th (SU 24) and 15th–16th century (SU 22), producing very similar reconstructed size distributions. The rectangle encloses the "stockfish window" (ca. 600–1,100 mm) of gadid size optimal for stockfish and air-dried fish production generally. Individuals much smaller than 60 cm tend to dry too hard to be edible, and cod much over a meter ten to rot rather than dry (Perdikaris 1999). The Akurvík cod from both early and later medieval deposits fall mainly within this window but with an interesting peak at the lower margin and a "tail" of cod probably too small to effectively dry. Crews based at Akurvík in both time periods probably ate the smaller cod and haddock landed (as well as the few flatfish and other nongadids), but the cod element distribution pattern indicates that most code landed were in the optimal drying range and were prepared on site for export for consumption elsewhere.

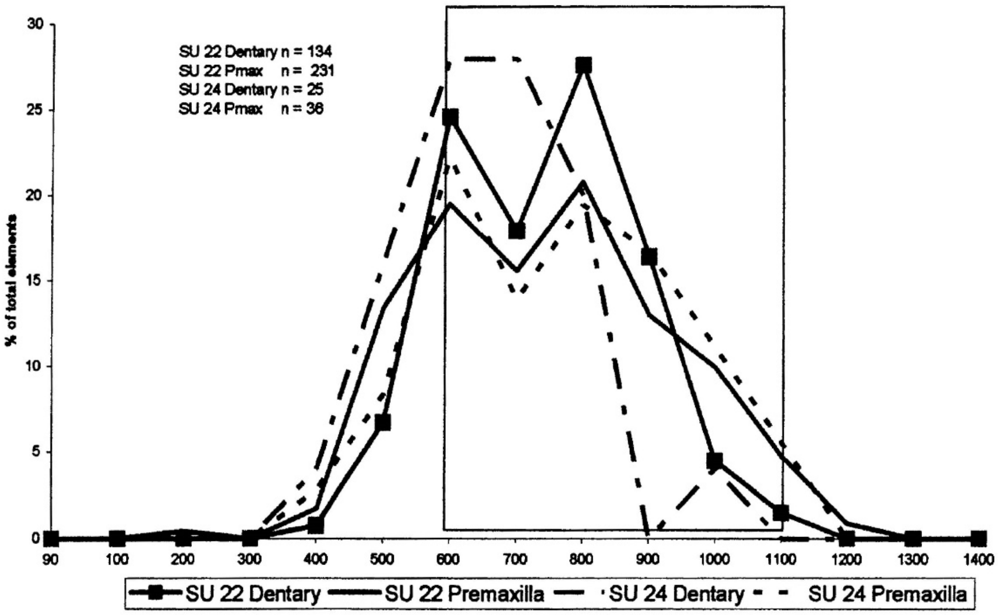

Figure 4. A comparison of reconstructed live length (in cm) for cod from Akurvík based on measurements of premaxilla (Pmax) and dentary, following methods of Wheeler & Jones (1989). The open box encloses the "stockfish window," the size range most suitable for the production of stockfish and other air-dried preserved fish products.

Figure 5 compares the distribution of reconstructed cod length based on the dentary for the two phases at Akurvík and 18th–19th century Tjarnargata 3c (probable producer sites) and contrasting site types with a stronger subsistence fishing component. The collection of Miðbaer comes from late medieval layers of a farm on the island of Flatey in Breiðafjord (Amundsen in press). The Miðbaer reconstructed cod length appears to reflect a subsistence fishery aimed at smaller cod, possibly taken close to the island, with negligible component of larger cod suitable for drying. Element distribution of cod from Miðbaer also suggests on-site consumption of whole cod. The site of Finnbogastaðir is a farm 15 km to the North-East of Akurvík, and the 18th century levels sampled in 1990 produced a substantial archeofauna from a period comparatively rich in supporting documentary evidence (Edvardsson et al. 2004). This collection reflects what is known to have been both limited production of stockfish for purchase of imported goods and rent payment and subsistence fishing for cod and haddock. The substantial "tail" of smaller cod in the Finnbogastaðir distribution again probably reflects the strong subsistence component of this collection. The Gjögur farm mound's 15th century layers likewise seem to reflect a mix of strategies, despite the strong "producer" signal provided by its cod element distribution patterns. The interplay of the demands of household provisioning, fishing crew provisioning, and specialist production (potentially aimed at multiple markets) clearly produce a series of overlapping zooarchaeological patterns at such sites, which make the interpretation of archaeofauna from such multifunctional sites challenging.

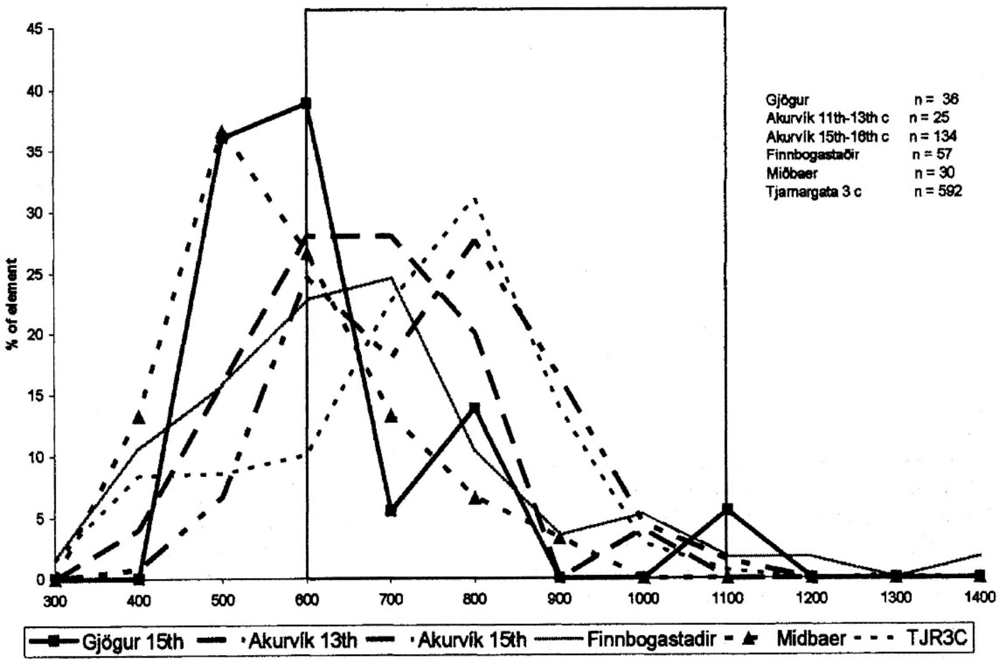

Figure 5. A comparison of reconstructed live length (in cm) for cod from Akurvík, Gjögur, Finnbogastaoir, Miobaer, and Tjarnargata 3c based on dentary measurements following Wheeler & Jones (1989).

Discussion

The site of Akurvík appears to represent a fairly common site-type along the coast of Iceland: a concentration of specialized fishing booths clustered at the end of a peninsula offering ready access to deep sea fishing. The site's excellent bone preserva tion and suite of AMS radiocarbon dates provide a presently unique opportunity to exploit zooarchaeological evidence for medieval fisheries in North-West Iceland. The far inland "consumer sites" dating from first settlement (9th century) of Iceland down through the high Middle Ages (14th century) emphasize the important role preserved fish played in the economy and society of Scandinavia from Iron Age times (ca. 100 BC) onward.

Long prior to the penetration of the international fish trade in the 14th century, chiefly economics in Iceland certainly involved control and manipulation of the major staple represented by dried fish. While additional work on more sites is required, present evidence from Akurvík suggests that the early phases of fish processing at the site were probably aimed at supplying a domestic Icelandic market rather than producing a standardized international product. A major international research program directed by Ragnar Edvardsson is now underway in North-West Iceland, with bone-bearing deposits under excavation covering the Viking Age to the early modern period. It is hoped that this new program of research in the West Fjords will add further evidence of the long-term interactions of codfish, climate, and human economy in this region.

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